EVALUATION OF BALOCHISTAN'S KACHHI CANAL PROJECT

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(CGP # 06-136)

5TH RASTA CONFERENCE
Wednesday, January 26 & Thursday, January 27, 2025
Roomy Signature Hotel, Islamabad

This document is unedited author's version submitted to RASTA.

RESEARCH FOR SOCIAL TRANSFORMATION & ADVANCEMENT

Competitive Grants Programme for Policy-oriented Research

Pakistan Institute of Development Economics

ABSTRACT

Kachhi Canal Project (KCP) is a PSDP project, conceived in 2002, to boost agriculture and enhance the socio-economic profile of the area for the underprivileged population of Balochistan. Owing to a multitude of issues of incompetence, poor planning, and change in project goals, Phase I of the project was completed in 2018 with an expected irrigation area of 72,000 acres of land and an economic benefit of Rs 3 billion annually. This study assesses the performance of Phase I of the project and its contributions to bringing socio-economic betterment to the populace living in the area in the past 5 years using mixed-method approaches. The study also conducted a cost-benefit analysis of the project and its long-term feasibility using economic & financial internal rates of return. The focus group discussion has been conducted with the farmers and landowners who have access to and benefit from the irrigation of water in the Kachhi Canal Phase I (Part A). For quantitative analysis, data has been obtained from the agriculture extension department of Balochistan. The results indicate that initially, KCP had a substantial positive impact on indicators of socio-economic conditions after its operationality. However, massive flooding in the area in 2022 has rendered the canal non-operational, requiring substantial effort for its restoration. Due to its non-operationality, the socio-economic indicators have regressed to pre-KCP levels, casting serious doubts about its long-term viability. The findings of economic and financial analysis indicate that the canal is economically and financially viable only if the reconstruction starts in 2024-25. This study concludes that any delay in restoration work or in the case of any massive flooding would make this project financially unviable. This study also offers policy recommendations for the sustainable development of the region, improvement of socio-economic conditions, and reconstruction of the canal.

Keywords: KCP, PSDP, Socio-economic Impacts, Impact Evaluation, Balochistan, Agriculture, Culturable Command Area.

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KCP	Kachhi Canal Project
CCA	Culturable Command Area
WAPDA	Water and Power Development Authority
AGP	Auditor General of Pakistan
FDG	Focus Group Discussion
PSDP	Public Sector Development Program

INTRODUCTION

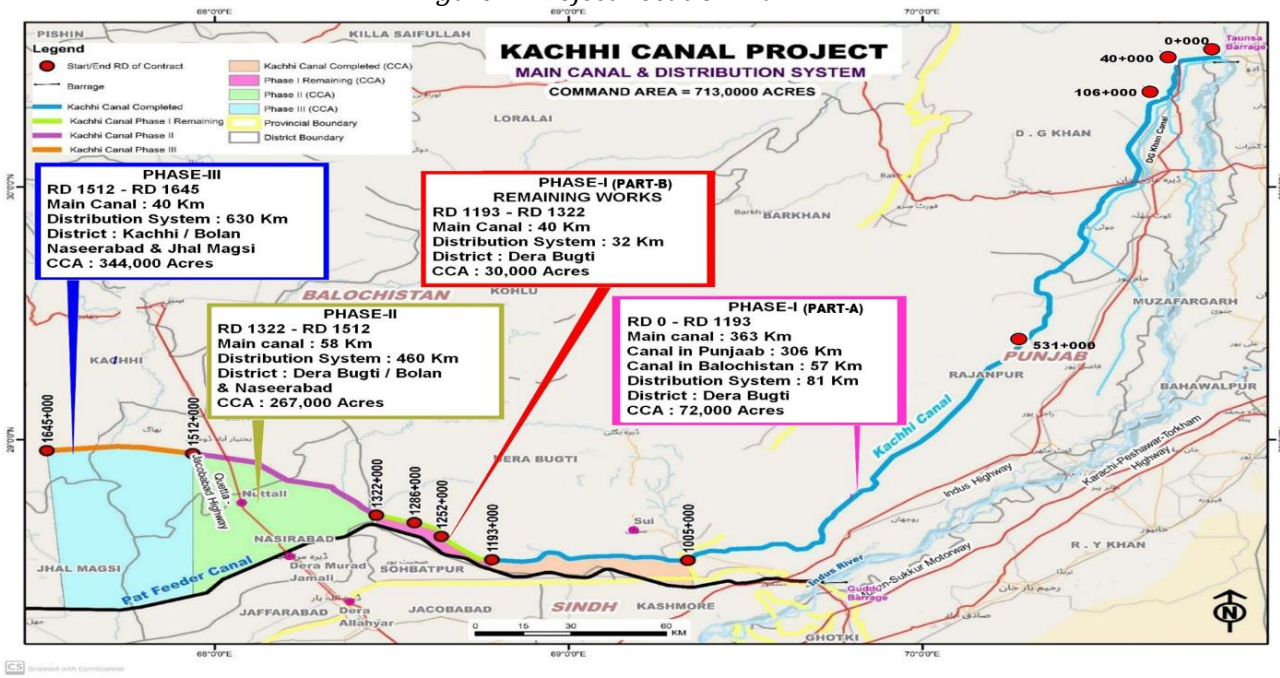
Balochistan is the most underdeveloped province of Pakistan, facing abject poverty, acute food shortages, and malnutrition. According to the United Nations Children's Fund (UNICEF), 16 percent of the children in Balochistan are malnourished, 52 percent are stunted, and 39.6 percent are underweight (UNPO, 2017). In order to offset these disadvantages, the Kachhi Canal Project (KCP) was conceived to develop water and land resources in the Kachhi Plains of Balochistan. The aim of the project was to "enhance agricultural production, resulting in a boost to the economy, improvements in the physical environment, including the atmosphere, climate, land, and water, and an improvement in the quality of life due to improvements in socio-cultural and socio-economic conditions" (WAPDA, 2023).

KCP originates from Taunsa Barrage, Punjab, and passes through the districts of Muzaffargarh, Rajanpur, and DG Khan in Punjab, and Dera Bugti, Naseerabad, and Bolan in Balochistan, irrigating 713,000 acres of Culturable Command Area (CCA) in the Kachhi Plain of Balochistan (AGP, 2019). The main canal has a total length of 500 kilometres, with 306 kilometres located in the Punjab province and the remaining 194 kilometres extending into Balochistan (WAPDA, 2023). The project's command area encompasses the districts of Dera Bugti, Naseerabad, Kachhi (Bolan), and Jhal Magsi, located in the Kachhi Plains of Pakistan.

KCP is envisioned as a lifeline for Balochistan's agriculture, unlocking a new era of socio-economic development in the region and transforming the lives of millions of local populations in the districts of Punjab and Balochistan. It aims to significantly raise the current annual cropping intensity from 4.68% to about 88.50% in the project region, resulting in an annual benefit of Rs. 19.66 billion (with Rs. 3.82 billion for phase I) to the national economy (AGP, 2019). The primary crops cultivated on the plain are wheat, pulses, oilseeds, and sorghum. The projected agricultural benefit from the project amounts to Rs. 6 billion annually. The project has been funded by the Government of Pakistan (GoP) via the Public Sector Development Program (PSDP), without any assistance from international sources, and is being executed by the Water and Power Development Authority (WAPDA).

Since its inception in 2002, the project has faced multiple snags and is not yet fully operational. It was initiated as part of the ten-year Perspective Development Plan 2001–2011, and its execution began on October 4, 2002**. Figure 1** shows the project's location plan. According to the initial PC-1, the project was allocated a budget of Rs. 31,204 million and was expected to be completed by 2007 (AGP, 2019). The project encountered many obstacles, and its completion estimates and timeframes had to be updated twice in 2013 and 2017. Following the second revision, the project was split into three distinct stages: Phase I, II, and III. The approved cost for the project increased from Rs. 31,204 million to Rs. 80,352 million, with a revised deadline of December 2018—a 10-year delay for Phase I only.

Figure 1: Project Location Plan



Source: WAPDA (2023).

In 2017, owing to its weak performance, the Auditor General of Pakistan was tasked with conducting a comprehensive audit of the project. The AGP report identified poor contract administration, numerous design modifications, and insufficient internal controls as the primary factors contributing to the project's dismal performance (AGP, 2019).

In 2018, Phase I (Part A) of the project was finally inaugurated by the former Prime Minister of Pakistan, Shahid Khaqan Abbasi, to irrigate an area of 72,000 acres in Sui Tehsil of Dera Bugti. Work on Phase I (Part B) is in progress to irrigate an additional 29,000 acres of land, with an expected completion timeline of December 2023.

Despite its challenges and setbacks, Phase I (Part A) of the project has been successfully completed and operational since 2018. This phase of the project has been operationalized for the past five years and was expected to irrigate 72,000 acres of land with annual benefits of Rs. 3 billion to enhance the overall socio-economic profile of the area (AGP, 2019). The work on the remaining phases of the project (Phases II and III) has not started and would entail substantial economic costs. Before the commencement of work on the remaining phases, it is imperative to assess the performance of Phase I of the project and its contributions to bringing socio-cultural and socio-economic betterment to the populace living in the area.

This study aims to assess the socio-economic effects of KCP on the local population, including improvements in their quality of life. The study also conducts an economic and financial viability analysis of the project under alternative simulated scenarios.

LITERATURE REVIEW

Pakistan's public sector development projects (PSDP) contain numerous megaprojects, referred to as the "privileged particles of the development process," through which the government determines its development objectives via a set of socio-economic goals (Hirschman, 2014). These megaprojects are primarily different breeds of projects with respect to lead time, stakeholder involvement, level of aspiration, complexity, and impact (Flyvbjerg, 2017). Some examples of such large-scale development projects include motorways, seaports, airports, canal irrigation projects, oil extraction projects, and dams – all of which normally cost billions of rupees, considering their scale of operation (Hirschman, 2014).

Despite the opportunities megaprojects present for the development of a country, Flyvbjerg (2017) identified some recurring issues with them, regardless of the sector a project falls under. These "iron laws of megaprojects," as referred to by the author, include overrunning timelines, exceeding allotted budgets, overselling benefits, and underestimating costs (Flyvbjerg, 2017).

One such megaproject comprises the development and expansion of irrigation infrastructure, which has consistently been presented in existing literature as a solution to intensify agricultural production, enhance resilience to climate change and variability, and support rural economic development in the face of water scarcity (Aw & Diemer, 2005; Bertoncin et al., 2019). Such initiatives significantly affect crop-yield gaps in smallholder farming systems across Asia and Africa outside of the tropics (Hanjra et al., 2009; Higginbottom et al., 2021; Moris, 1990).

The aforesaid notion has also been supported by The Green Revolution of the 1950s as one way of achieving global food security (Shah et al., 2002). Under this revolution, the construction of water channels was one of the most popular methods implemented in South Asia and Africa throughout the 1960s and 1970s. In the 1980s, however, the utility of water canals in improving socio-economic conditions was scrutinised, as various examples of their failure to uplift local communities came to light (Cleaver, 1972).

One such example arose in Malawi, where the Likangala and Domasi irrigation schemes worsened the socio-economic status of the country's rural communities by disrupting local communities, exposing farmers to water-related diseases, and relocating families away from their ancestral land without proper compensation (Gwiyani-Nkhoma, 2011). This occurred because the production of rice, the expansion of rural communities' sources of income, and the growth of towns associated with irrigation schemes were limited in quality and quantity and benefited only a few privileged farmers. To improve the implementation of such schemes, the study strongly recommended the recognition of local structures and systems and minimal dependency on donor support (Gwiyani-Nkhoma, 2011).

On the other hand, the socio-economic conditions of the local population improved after the construction of the Teesta-Jhaldhaka and Karotwa-Kalama Canals in the Jalpaiguri districts of India. By tracing temporal changes in the development of canal irrigation, identifying the existing socio-economic status of farmers in the district, and measuring the impact of canal irrigation on the farmers' socio-economic status, it was concluded that canal irrigation had a significant and positive relationship with the socio-economic standards of local communities (Mandal et al., 2020).

The nexus between such megaprojects and socio-economic development is further explained by Rukuni et al. (2006), who suggest that the development of irrigation systems is an essential connection between water and land resources. Higher irrigation development leads to improved

quality and quantity of raw materials and food production, which subsequently fosters rural development and ensures food security (Barau et al., 1999; Branca & Natali, 2020). Irrigation is thus of paramount importance in agrarian economies, as it significantly contributes to poverty reduction and rural development by increasing agricultural output (Nathan & Sinha, 2013). The benefits of an improved irrigation system for rural development, however, may also manifest through effects on other economic variables, including the demographic distribution patterns of rural settlements and the advancement of public services (Ali & Ali, 2023).

Improvements in the socio-economic status of local communities are not, however, solely a function of megaprojects. One study evaluating the socio-economic effectiveness of two community-based small-scale irrigation schemes in Adami Tullu Jido Kombolcha Woreda (ATJK) assessed different socio-economic characteristics of households before and after the implementation of irrigation schemes. It concluded that small-scale irrigation schemes have potentially low environmental impacts and no significant soil erosion. Poor coordination and a lack of transparency in financial affairs, however, resulted in lower economic performance (Assefa et al., 2008).

Apart from direct benefits such as increasing the income of agricultural communities and reducing poverty, the development of irrigation schemes also provides spillover advantages for surrounding communities, including job creation, higher income, food diversification, and sharecropping (Masela et al., 2018). Socio-economic factors, however, determine the extent of benefits received by families. These factors include proximity to the project, primary income source, gender of the head of the household, employment, marital status, and agricultural land availability.

It is further noteworthy that water has been used for agriculture since ancient times, while canals have served as a major and significant channel of inter-regional trade that augments commerce and transportation, which further reiterates the importance of the development of irrigation schemes (Pietz & Zeisler-Vralsted, 2021). Given its importance, the enhancement in the well-being of rural settlements requires programs that aim to improve infrastructure such as irrigation systems (Manggat et al., 2018).

The establishment of irrigation or canal systems has a positive and significant effect on family income, particularly when employing the tillage methods (Turdalieva & Abdiyeva, 2002). Lined canal projects further enhance the overall welfare and contentment of farmers (Nadeem et al., 2021). Additionally, irrigation is vital for the sustained survival of populations living in dry areas because it enables them to engage in trade (Pietz & Zeisler-Vralsted, 2021). In arid regions, irrigation is further essential for the effective control of over-agriculture production, landscape preservation, weed growth suppression, and soil fertility restoration (Muthuminal & Priya, 2023). The acknowledgement of the existence of local structures and institutions, nevertheless, is essential to ensure that irrigated farming improves the well-being of the rural populace (Gwiyani-Nkhoma, 2011).

Further evaluating the impact of irrigation schemes in arid regions, Ashraf et al. (2016) carried out the impact evaluation of the karez irrigation scheme of Dilsora on the socio-economic conditions of the local population in Baluchistan, Pakistan. The study collected data from farmers through a questionnaire survey to assess the impact of the scheme, as well as the restraints on farmers. The results suggested that, along with positively affecting the socio-economic conditions of the farmers and local populace by increasing farmers' income, crop yields, area under

irrigation, and volume of water, the development of an irrigation network further reduced the drudgery on women, disputes over water, and maintenance costs in terms of financial and physical liabilities. The primary concerns and constraints reported by farmers, however, comprised deferred necessary overhaul and repairs of irrigation systems, a decline in water quality at conveyance, and, inter alia, the absence of watershed management initiatives.

Further adding to the literature, Razzaq et al. (2018) analysed the impact evaluation of high-efficiency irrigation systems (HEIs), i.e., sprinkler and drip irrigation, in Khushab, Bhalwal, Sargodha, and district Lodharan, in Punjab, Pakistan, while also comparing and measuring the water productivity from conventional and modern irrigated farms and estimating the net present worth and cost-benefit ratio. Their results not only suggested significant benefits for farmers that use HEIs in terms of higher gross margins but also indicated that the development and implementation of such systems is an economical option.

In close relevance to the aforementioned, Shah (2018) suggests that the pace at which the execution of public sector development projects (PSDP) takes place in Pakistan is highly inefficient in terms of cost and time. According to the PSDP 2018-19 time overrun study, it was determined that 399 projects have been delayed for over 10 years, 98 projects have been delayed for 5 to 10 years, 44 projects have been delayed for 3 to 5 years, and 218 projects have been delayed for one to three years. Furthermore, cost overrun analysis indicates that a total of 94 projects surpassed their cost as compared to the estimated cost in PC-1. Out of 94 projects, nine projects have experienced an increase of less than 30% in total cost, 13 projects have experienced an increase of 31 to 60 percent in total cost, 17 projects have experienced an increase of 61 to 100 percent in total cost, and 55 projects have experienced an increase of more than 100 percent in total cost. The study additionally identified several bottlenecks in the implementation of PSDP projects; the most problematic one of those is perhaps the delay in the release of funds that has slowed the progress of 450 projects. Other factors include unfamiliarity with PPRA procedures and rules, lack of coordination, delays in staff recruitments, land acquisition, and, inter alia, adverse law & order situations.

Outdated irrigation infrastructure in developing countries, such as Pakistan, also poses a significant risk to livelihoods and food security, as this results in substantial water losses. However, higher investment in order to increase efficiency can assist countries to manage water scarcity and enhance the well-being of farmers (Nadeem et al., 2021). Moreover, in a developing country like Pakistan, PSDP funds need to be utilized on projects of immense potential and utility. KCP is a significant irrigation project under PSDP designed to irrigate 713,000 acres of the CCA in the Kachhi Plain in Balochistan and improve agricultural output and productivity. This initiative is widely regarded as a possible driver for socio-economic change in the province of Balochistan and will improve food security and provide significant job opportunities. In addition to providing water for agricultural and arid areas, it will also help alleviate the water scarcity issue for around two million people who lack access to safe drinking water.

Balochistan is getting only 3.5% of its allocated share of 12% of water resources of Pakistan with existing irrigation canals in the province consisting of Patfeeder, Kirther, Uch, Faizabad, and Mauthi canals (Khan & Malik, 2023). The extension of the Patfeeder Canal and construction of the Kachhi Canal will enable the province to obtain a total of 805.5 million m^3 (0.653 MAF) of the remaining allotted water effectively (Ramzan, 2013). KCP's progress, however, has been hindered by insufficient funds and internal disputes among its divisions (Ramzan, 2013).

Despite the potential benefits of KCP, there are also potential challenges, such as apprehensions over the social and cultural impact on local people in terms of land use and acquisition. There has been no research study that has examined the socio-economic impacts of KCP on the local population. In the existing academic debates about the utility of irrigation canals in improving the socio-economic conditions of the local population, KCP provides an interesting case study, and our research would further enrich the debate. Furthermore, it would facilitate better utilization of PSDP funds before the commencement of the next phases of the project.

RESEARCH METHODOLOGY

3.1. Methodology

The primary objective of this study is to examine the socio-economic impacts of KCP Phase-1 on the livelihood of the local population and carry out an economic and financial viability analysis of KCP Phase-1 (Part A). The stakeholders include landowners and farmers who accessed and benefitted from canal irrigation water. This objective is achieved by ascertaining the improvements in groundwater, land use and cropping intensities, crop yield, farmer's income, livestock development, and education level of people in the study area.

The perspectives of the WAPDA representatives and the agriculture department of Balochistan have been incorporated through the lens of their experiences with the management and operationalization of KCP. The landowners' and farmers' perspectives have been included through the lens of their experiences with the benefits obtained from KCP irrigation water and problems faced while the Kachhi canal was damaged after the hill torrent in August 2022.

The economic and economic and financial viability analysis of the project has been carried out using benefit-cost ratios, net present value and internal rate of return. The data has been obtained from the agriculture extension department of Balochistan. The analysis is based on wholesale prices while retail prices have been used to conduct the financial analysis, The details discussion on methodology adapted to achieve objective 2 is presented in section 4.8.3.

The motivation to use the mixed methods, i.e., both qualitative and quantitative approaches, is that the study is set under the research philosophy of "Social Constructivism (SC)" in the case of qualitative analysis. SC takes the stance that there is no fixed or single truth; rather, there are multiple versions of truth, and that reality is socially defined; therefore, there are no set hypotheses in this philosophy (unlike positivism).

3.2. Research Philosophy

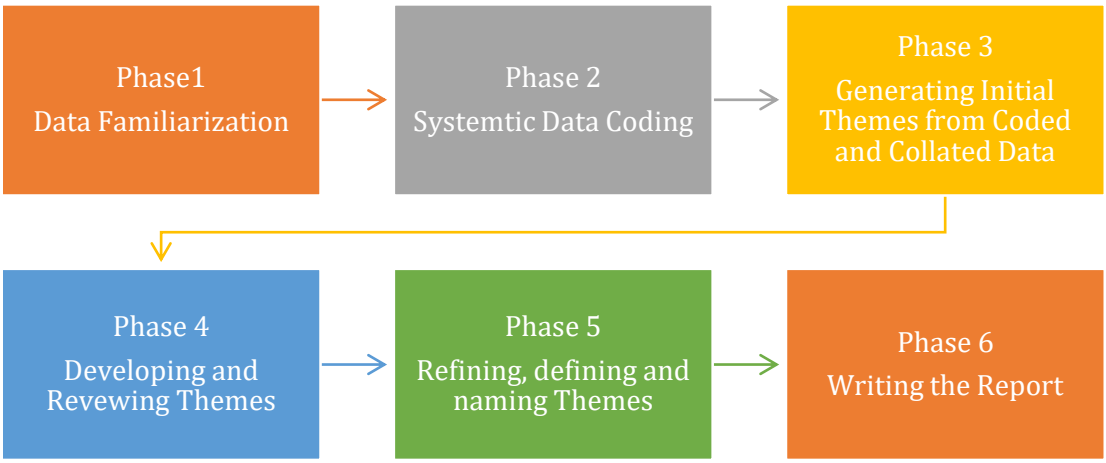
The purpose of scientific research is to elaborate a phenomenon in a way that is consistent with current scientific understanding.

The objective of a standard scientific inquiry is to enlighten a phenomenon in accordance with contemporary scientific understanding. Since this is where the power of inquiry is concentrated as most of the efforts are concentrated. Research philosophy is the application of simplifying assumptions to explain complex social and natural phenomena by combining scientific intelligence with a human philosophical outlook (Creswell, 2013).

For the objective stated previously, we have conducted Focus Group Discussions (FGDs) of the relevant landowners and farmers to examine the stakeholders' perceptions about the socio-economic impacts of the completed phase, we have conducted FGDs of purposively selected landowners and farmers who benefit from the project directly and indirectly, to understand the socio-economic effects. The FGDs included those farm owners/farmers that have access to and benefited from irrigated water from KCP in the Sui region of Dera Bugti, Balochistan.

To ensure trustworthiness and rigour, the research has been guided by the Lincoln & Guba (1985) model. All ethical guidelines have been followed, and ethical certificate have been obtained from the university's ethical committee before conducting FGDs. Data is being analysed using reflexive thematic analysis based on Braun and Clarke (2021).

Figure 2: Phases of Reflexive Thematic Analysis



Source: Braun & Clarke (2021).

This research enabled us to evaluate improvement in socio-economic conditions including quality of life as KCP phase-I has been completed and operationalized for the last 5 years approximately. This also enabled us to measure the benefits of projects as stated originally.

3.3. Sampling Methodology

Choosing to appropriate sampling methodology is necessary to determine reliable generalization from the investigation. This section provides a detailed description of the sampling methods that were followed.

1. Ethical approval to conduct the focus group discussions was obtained from the ethics committee of the School of Social Sciences and Humanities (S3H), NUST, Islamabad vide letter number 0839/Ethics/07/S3H/38/ECO. The committee waived the need to obtain separate informed consent.
2. Informed consents prior to the focus group discussion were obtained from each participant.
3. The focus group participants were informed that their data will remain confidential and will be used for research purposes only as none of the participants' microlevel details will be shared unless data has been anonymized.

To meet the research objective, purposive sampling has been done. We planned to conduct 6 to 8 FGDs, (according to saturation; In FGDs, when the researcher begins to hear the same comments again and again, data saturation is being reached), so far, 6 FGDs have been conducted.

For the selection of landlords/farmers, a purposive sampling methodology has been adopted. Initially, 7 Mouzas have been selected from Mauzas who have access to the KCP irrigation system. The Mauzas from where KCP passes through in the Sui region of Dera Bugti, Balochistan includes Lanju, Saghari, Go, Landow, Shazain, Kattan, Mozoi, Ladkha Mari, Toba Sandrani, Punhan, Gizi Junwi, Nadranja, and Uch. We have selected Saghari, Go, Landow, Shazain, Khattan, Mozoi, and Nadranja. Then, landowners/farmers have been selected from Mouzas/villages selected previously. So far, 6 FGDs have been conducted with landowners/farmers living nearby KCP to access the benefits coming out of the project.

The participants of FGDs are individuals above 25 years and head of household that have access to and benefited from irrigated water from KCP in the Sui region of Dera Bugti, Balochistan. They demonstrated willing to participate, are landowners/farmers and are residents of the study area.

3.4. Research Instruments

The current study employs landowners and farmers who have access to and benefit from canal irrigation water of KCP Phase-I part A that has been inaugurated in 2017. Field notes were maintained during the FGDs which were carried out over a period of two moths that is from June 2024 to July 2024. The FGDs with landowners and farmers lasted for 30 to 50 minutes. The average duration of a FGD was 41 minutes.

3.5. Transcription of Interviews

Participants of FGDs were allowed to express their views either in Urdu or Balochi. Due to the remoteness of the area most of the participants predominantly opted for their Balochi as it was hard for them to communicate in Urdu and express their opinions at length in a language other than Balochi which is their mother tongue. Hence, vernacular Balochi was used by the majority of participants. The FGDs were transcribed by the professionals to avoid subjectivity. Additionally, all the transcribed FGDs were validated by the principal investigator of the current study as Balochi is his mother tongue as well.

3.6. Data Analysis

The authors collaboratively processed the focus group discussions' transcripts from a series of collective meetings. The validation and accuracy of every transcript were ensured prior to the beginning of the coding procedure. Initially, codes were assigned to various statements ensuring their accuracy with the objectives of the study. At this stage, colour-coding patterns were adapted to align similar statements with their respective codes. As coding is an iterative process, authors frequently combined analogous codes and altered existing codes as patterns appeared. This process led to a refined and standardized coding framework that the team mutually endorsed.

Throughout this process, different coding methods, perspectives and/or interpretations were openly discussed to reduce the complexity of the coding process and consensually resolved. One methodology of coding was the use of Microsoft Excel and its built-in features and/or formulas which was adapted throughout the coding process and previous coding was modified. This fostered a cohesive approach towards data analysis. The authors mutually decided how and when to incorporate new themes in the transcripts based on an evolving understanding of the data. The team also maintained the thematic memoranda and field notes to describe, summarize key insights, and analyse the content of each theme.

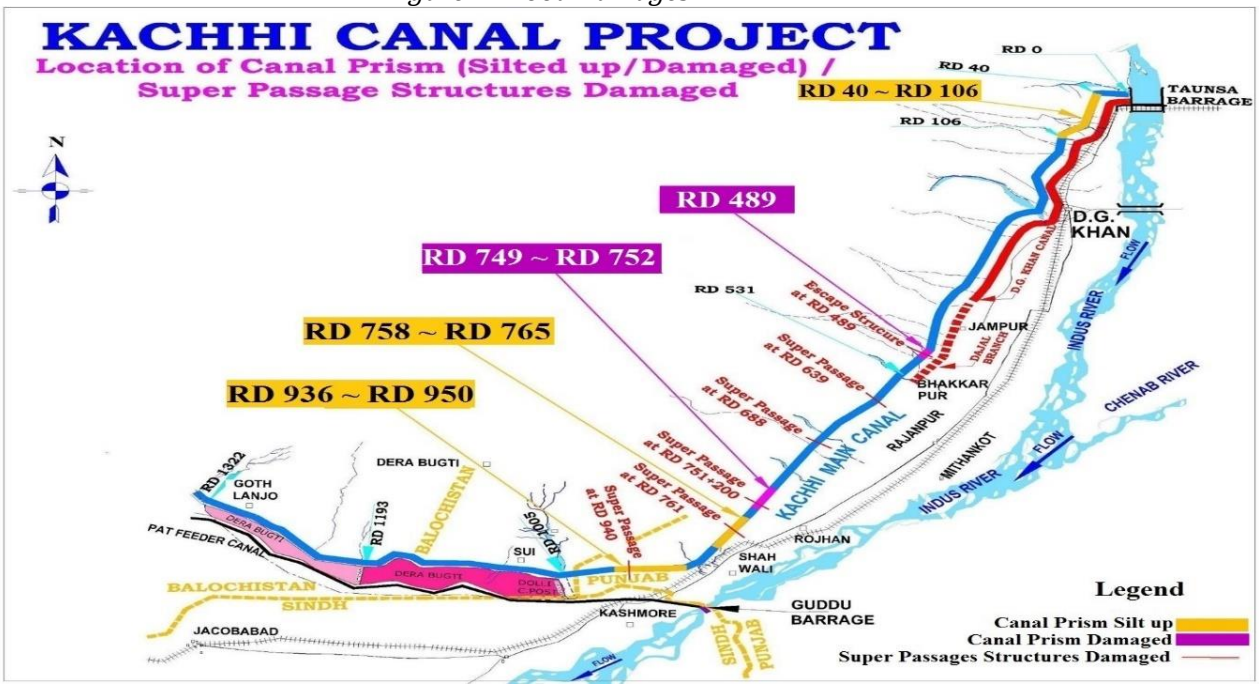
FINDINGS AND DISCUSSION

4.1. Situation Analysis-Flood Damages

In August 2022, a flash flood from the Koh-e-Suleman hill torrents severely damaged the Kachhi Canal in the Punjab portion, rendering the canal nonoperational. The canal suffered 129 major cuts/breaches, and six structures were partially or completely damaged; the canal bed was eroded at two (2) locations, and heavy silt was deposited at three (3) locations (See Figure 3). Owing to substantial damages, massive restoration work would be required to make the canal operational. In November 2023, a PC-I amounting to Rs. 10.572 billion was submitted to the MoWR suggesting thirty-six months would be required for the restoration effort.

The restoration PC-1 has been under a lot of debate, and no authority is willing to take ownership of the project. The Project Steering Committee has advised direct contracting, and WAPDA's request for the construction of Cuneate to the MoWR on an urgent basis before Kharif 2023 (May 2023) didn't reap any results. The MoWR funds from the GoB, which has so far shown an inability to undertake the project and has requested the federal government to bear the restoration cost. The urgent restoration work for the restoration of 400 to 500 cusecs of the water supply has a financial implication of Rs. 1500.00 million, requiring 3 to 4 months for completion.

Figure 3: Flood Damages – 2022



Source: WAPDA (2023).

4.2. Initial Field Visits

Initial field surveys were conducted to ascertain the situation in the vicinity of the Kacchi Canal, identify the socio-economic status of the area, and assess the benefits that have been incurred due to the operationalization of the canal.

During the initial field visits, we focused on determining which areas to visit and understanding the situation of the Kachhi Canal in the area. We discovered that the area is completely barren, with only a few lands being cultivated using tube wells. Such cultivated lands are rare to find, and most agricultural lands were found to be barren. It was observed that the watercourses have been damaged, and most of them are filled with sand, i.e., they have silted up. The lands were covered

with various types of wild plants. However, we found traces suggesting that, years ago, the land was levelled for agricultural purposes and fields were plowed.

Currently, we hardly see any fields being cultivated, except for those using tube wells. The water in the area is saline due to underground gas pockets. However, landlords repeatedly emphasized that the investment in tube wells would not last long, as the water continues to become increasingly saline as it is extracted from deeper levels and will no longer remain suitable for cultivation.

Water is not available in the area for several miles and people do not have enough water to drink or use for other purposes. We spotted an individual in the vicinity of Gate 9 (RD 1109+081), who was transporting water from an area called "Jani Berri near Patfeeder," which was approximately 14 to 15 kilometres away from our current location. In the vicinity of Mouza Shazain, we discovered a pond where both animals and humans were drinking water together. This place is called ASRELI (see Figure 4). Additionally, people were migrating from different areas of the Kacchi Canal to other parts of the district. The landowners and farmers are migrating to Sindh, Punjab, and other parts of the District Dera Bugti. Initially, farmers mostly came from Sindh, Dera Bugti and other areas of District Dera Bugti, especially from the areas adjacent to the Sui to cultivate lands.

Figure 4: Mouza Shazain

Source: Authors' photography.

The mosques in the area were found to be deserted. We also visited some mosques, some of which were under construction. During visits to the fully constructed mosques, we noticed the presence of birds inside, likely due to the closure of the mosques for an extended period, with no one present to offer prayers or maintain cleanliness. Moreover, houses had been abandoned as farmers had vacated them since the Kachhi Canal had not been operational in 2022. School buildings were left incomplete, as their construction was halted when the KCP became non-operational.

4.3. Respondent Profile

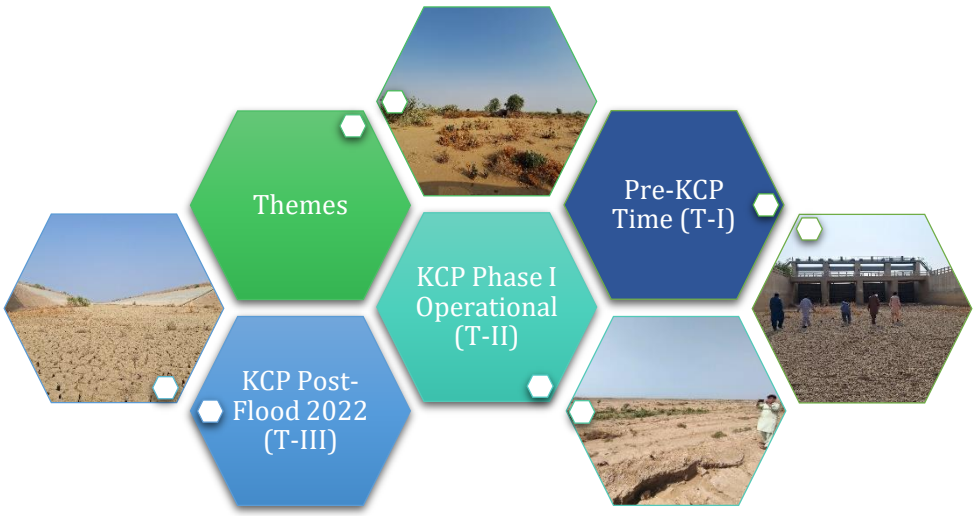
In order to ensure the sample representativeness, a wide range of participants in FGDs were sampled. Multiplicity in terms of Mouzas, their age, agricultural experience, landholdings, and family income sources other than agriculture were ensured. The participant's age, education, and

farming experience ranged from 25 to 70 years, 0 to 16 years, and 0 to 61 years, respectively, while landholdings ranged from 12 to 500 acres of land. Family sources of income other than agriculture include business, semi, and government jobs. The family size of respondents ranges from 3 to 108 members. All of the respondents were male, while the majority of them were landowners, except one who is currently working as a tenant of another landlord due to the unavailability of water in his own lands in the Kachhi canal. Details of the participants are provided in Table 1.

The main Bugti tribe having land ownership adjacent to Kachhi Canal belongs to Rahijo which is the main tribe of Bugti. The main tribe is further subdivided into four subtribes whicha are Khalpher, Perozani, Masori, Shambani. Within Bugti tribe, the Khalper, Perozani and Rahijo (Nawab family) tribes hold a majority of the land adjacent to Kachhi canal phase-1 (part A).

In this research, we inquired of participants of FGDs about the socio-economic impacts of KCP in changing the livelihood of the local populace. The transcription of FDGs indicates that the socio-economic impacts of KCP phase I (part A) fall into three main themes: pre-KCP time (T-I), KCP phase I operational (T-II), and KCP post-flood 2022 (T-III), as indicated in Figure 5. Separate discussions on each of the aforementioned themes have been provided in subsequent sections in detail (See Appendix A: thematic map for each Sub-Theme).

Figure 5: Main Themes



Source: Authors' computations.

Table 1: FGD Participants Profile

FGD No.	Mouza/ Village	Respondent No.	Age	Edu	Landholdings (Acres)	Family Size	Farming Experience (Years)	Family Income Sources other than Agri
01	Saghari	01	46+	10	350	26	7	Business
		02	25-30	16	70	40	5	Govt Servant
		03	25-30	16	15	14	0	Semi Govt
		04	25-30	16	45	39	5	None
		05	25-30	16	12	18	10	None
02	Go	01	57	16	30	9	50	Govt Servant
		02	37	16	10	12	5	Teaching
		03	40-45	0	40	12	23	None
		04	40-45	0	125	8	32	None
		05	31	10	140	7	20	None
		06	70	0	100	27	61	Education
03	Landow	01	46+	16	150	9	20	Teacher
		02	46+	0	300+	19	55	None
		03	46+	0	20-25	15+	50+	Line worker
		04	46+	0	200+	14+	30+	None
		05	46+	0	280+	20+	55+	None
04	Shazain	01	46+	5	250	28	40	Livestock
		02	46+	0	50	25	30+	Tractor Driver
		03*	40-45	0	30	30	12	Farming
		04	46+	10	150	25	20	None
		05	35-39	0	100	35	26	None
		06	46+	0	50	35	30	None
		07	40-45	0	60	27	30	Govt Servant (Air force)
05	Mozoi	01	31-34	10	10	9	20	None
		02	35-39	8	50	30	25	None
		03	40-45	0	50	7	32	None
		04	31-34	12	80	10	26	PPL
		05	25-30	10	500	3	20	None
06	Kattan	01	35-39	14	40	108	20	Govt Servant
		02	56	14	25	25	44	Govt Servant
		03	40-45	5	20	25	20	Semi Govt (PPL)
		04	55	0	50	35	28	Semi Govt
		05	70	0	60	45	50	Semi Govt
		06	35-39	16	150	20	10	Govt Servant

*Note: * indicate that participant is "Landowner and Farmer".*

4.4. Pre-KCP Time (T-I)

The socio-economic development and problems faced by the local populace before the operationalization of KCP in the Sui region of the Dera Bugti district of Balochistan were brought together in this theme. The major problems faced by the community were grouped into those related to agriculture, water management, socio-economic conditions, and land record management.

4.4.1. Agriculture

Prior to the Kachhi Canal project, the Sui region of district Dera Bugti, Balochistan, relied predominantly on the Khushkaba system, which is rainfed agriculture. Rainfed agriculture is a

practice intrinsically associated with seasonal rainfall that governs agricultural output and stability that not only characterizes crop selection but also governs the socio-economic landscape of the area, signifying the era of limited productivity, growth, and agricultural output. The uncertainty in rainfall and rudimentary farming techniques left the local population vulnerable to climatic conditions. In the pre-KCP time, the lack of alternative crops and limited water availability were the chief barriers to sustainable economic growth and development in the area.

Prior to the Kachhi Canal construction, the agricultural landscape of the region was characterized by limited crop output, intensity, variety, and productivity. In particular, there exist rain-fed agriculture systems in the region, with limited agricultural output and variety. PGD participants indicated that most of the farmers relied on only a few traditional crops, such as pearl millet (bajra), wheat, mustard (sarso), and occasionally sorghum (jawar), which were grown in the area employing rainwater. The cropping intensity was very low in the area. The limited water availability and arid climate conditions in the region hampered crop diversity and productivity, influencing both the resilience of the local populace and their socio-economic conditions in the area.

During the research, it was informed by the focus group discussion's participants that wheat was the staple crop grown in the area before the Kachhi canal. *"Prior to Kachhi Canal, we used to cultivate onion and wheat"* (FGD 01, Respondent 01). The crops that require water intensively were not grown in the area due to water scarcity. *"As far as crops are concerned, wheat was cultivated here as the crops like rice require more water"* (FGD 01, Respondent 02). This constraint had a significant impact on the local economy since it limited the crops that could be cultivated. Consequently, it affected the standard of living and socio-economic conditions of those dependent on agriculture in the area.

Before the operationalization of the KCP phase-I (part A), mustard and millet used to be important crops as well, but their yield heavily depended on the seasonal rainfall that was often inadequate and unpredictable. As one participant responded that *"prior to Kachhi canal, mustard was cultivated using rainwater"* (FGD 01, Respondent 05). Another FGD participant seconded the dependency on the rain-fed irrigation system, stating that *"earlier, sorghum and millet were grown by our forefathers"* (FGD 03, Respondent 04). The traditional farming system with minimal diversification in crop variety was adapted due to harsh weather conditions, as suggested by these responses. The heavy reliance on rain-fed agriculture with a limited crop variety reflects the vulnerability of the local populace to climatic conditions. Additionally, it highlights the significance of the availability of water for the expansion of agricultural practices.

The absence of efficient irrigation infrastructure also hindered agricultural productivity. As suggested by the respondents of FGD 04, *"Prior to the Kachhi canal, we could only cultivate a few crops such as millet and a limited number of vegetables. If it rained, these crops would grow; otherwise, nothing"*. Such dependence on unpredictable rainfall has led to problems in attaining stable, reliable, and predictable agricultural output.

The agricultural methods, before the Kachhi Canal project, were simple, orthodox, and predominantly dependent on rainfall, which limited the type of crops that used to be cultivated in the area, resulting in low-value grains that did not offer significant economic benefits. Moreover, extensive agricultural practices were rare, as mentioned by respondent 05 of the FGD 05, that *"only 4 to 5 acres of land used to be cultivated from occasional rains."* Such restrictions on

the cultivable area severely restricted the agricultural output and productivity, as the rainfed system was not suitable for extensive farming.

Beyond such restrictions, the system of seasonal rainfall made agricultural productivity highly unstable. This has a direct impact on the socio-economic conditions and prosperity of the area. *"Previously there were intermittent periods of cultivation; there was no prosperity"* (FGD 04, Respondent 02). This uncertainty created a situation where the prosperity of the community was heavily reliant on unpredictable rainfall, resulting in a fragile agricultural base and food insecurity in the area.

Additionally, the landscape of the area was totally barren and deserted prior to KCP, as iterated by many respondents. "Before the canal, the area was like a desert without any vegetation" (FGD 03, Respondent 04). Earlier the area looked like a desert, and the villages did not have any canal system with a limited population. This underlines that the region was totally inhospitable, further compounded by the desert-like harsh conditions, which led to complications in attaining sustainable agricultural output, productivity, growth, and food security.

The economic system in the area was simple with scarce infrastructure and development. Businesses were rare, and the economy was mainly dependent on agriculture with limited income. "Earlier people did not have their own businesses" (FGD 01, respondent 05). The commercial opportunities were highly scarce in the area, along with the limited exposure of the local population to alternative income generation sources. Furthermore, the pre-KCP era was marked by the presence of absentee landlordism, where many landlords did not actively participate in agricultural activities directly or indirectly and lived in major cities of the Balochistan, Sindh, and Punjab provinces. This indicates that a significant portion of land is either underutilized or left in the hands of either farmers or tenants who do not possess the resources to improve it.

The sparse population density was another prominent feature in the area. "Before KCP, the population density was quite low" (FGD 01, Respondent 02). As the water was highly scarce in the area, population density remained sparse. This contributed to a low level of social ties.

As a whole, the area prior to KCP was dependent heavily on the rainfed agricultural system with a harsh landscape, limited economic opportunity, lack of prosperity, low population density, and minimal infrastructure.

4.4.2. Water Management

Before the establishment of the Kachhi Canal, there had been two sources of water available to the local community: the rainfed system and tubewells. The region faced substantial challenges due to scarce water resources, which led to precarious socio-economic conditions. Agriculture is mainly dependent on water which was scarce in the area and sustained through the use of rainwater and tubewells, which often comes with great financial risk. Many landlords and farmers of the area invested in the tubewells without knowing that the water would be fresh or brackish. "If the water turns out to be fresh, the settlement will thrive, but if it is saline, all the investment will go to waste" (FGD 01, Respondent 01). The underground water is predominantly brackish due to the existence of gas pockets. This unpredictability in the access to the water constructed a delicate foundation for the development of agriculture in the region.

The potable water scarcity was another serious problem in pre-KCP times that affected daily life. Local populations often travelled miles to obtain drinkable water which underscored the extreme

hardship before KCP. “People used to travel to Sui, which is 30 to 40 kilometres away, only to obtain drinking water” (FGD 01, Respondent 03). The lack of consistent water resources raised immense inconvenience and halted the economic growth of the Sui region. A few wealthy landlords who could afford tubewells had some relief, which was not a viable solution for the majority of the local populace. Subsequently, social disparities were worsened due to access to groundwater while the poor endured extensive hardships in the region.

Another prominent issue that landlords and farmers faced in the region was the depth of underground water. Before KCP, the underground water level was around 190 to 200 feet. While areas near the Patfeeder canal had shallower water tables, making the water slightly more accessible and tubewells less costly. “Prior to the canal, the underground water table was 200 feet” (FGD 01, Respondent 04).

In sum, before the Kachhi canal’s construction, the local population contended with unreliable irrigation, acute scarcity of water, and deeply buried groundwater. These obstacles impeded not only agricultural output, productivity, and daily life of the local population, resulting in far-reaching impacts on socio-economic conditions.

4.4.3. Socio-economic Conditions

The area of Sui in the Dera Bugti exhibited significant disparities in several key socio-economic aspects, characterized by a sparse population, heavy dependence on traditional means of livelihood, and limited employment opportunities. The social and economic structure of the region was closely associated with the accessibility of natural resources and subsistence methods.

Population density was astonishingly low prior to the KCP. “There wasn’t a large population here before the Kachhi canal” (FGD 01, Respondent 02). Correspondingly, others seconded the opinion that “there was indeed population, but it was not as dense” (FGD 03, Respondent 05). These responses indicate that population density was extremely low in the area that underwent significant transformation after the construction of the Kachhi Canal. Additionally, the employment opportunities were predominantly reliant on Pakistan Petroleum Limited (PPL), characterizing the narrow scope of economic opportunities available in the area. “Initially, the sole source of employment was dependent on the Pakistan Petroleum Limited in the District Dera Bugti” (FGD 01, Respondent 03). This apparent lack of economic opportunities, on gas fields operated by the PPL, signified the deficiency of diversity in job variety, made the local economy vulnerable, and had low socio-economic indicators.

The primary means of livelihood also depended heavily on the livestock in most of the areas of the Dera Bugti. “Our livelihood is mainly tied with the livestock” (FGD 02, Respondent 02). This reliance on livestock and conventional means not only shaped the economic landscape of the area but also restricted access to economic prospects, leaving the local economy primitive. “Earlier people did not have shops or other small businesses” (FGD 01, Respondent 05). This underscores the deficiency of infrastructure and economic opportunities available to the local population.

The pre-KCP time showcased the challenges encountered by the population, ranging from low employment opportunities and reliance on livestock and traditional methods of farming to restricted access to business opportunities.

4.4.4. Land Record Management

The land was largely unproductive, barren, sandy, and deserted in the region. The land record and ownership were tied to ancestral rights and traditional tribal practices based on the verbal

agreements rather than the formal documentation. "*People used to reply on verbal transactions and receive payment based on that"* (FGD 01, Respondent 03). Land ownership was a fluid concept in the area governed by the tribal norms that define land rights. Moreover, the formal documentations were rare. *"Initially, the land records were written on cloths, and those who had such records could claim the land"* (FGD 01, Respondent 05). Furthermore, land was traditionally distributed and managed among tribes and then among the individuals within the tribe. These customary practices possessed challenges with the arrival of KCP, as access to resources often necessitated a more organized structure.

The absence of formal land records was a recurring problem. *"Historically, there was no formal land records management system; it was just understood that certain lands belonged to certain tribes"* (FGD 01, Respondent 03). Such a system often led to social and armed conflicts where a formal land record system became increasingly essential to maintain law and order situations along with securing water rights and agricultural productivity once the canal arrived. Earlier land records inscribed on cloths became increasingly insufficient to prove the owner's rights and secure legal recognition.

Land in the area was divided into a tribal system, in which it was distributed among various families and communities that illustrate a communal land use system. Land allocation was carried out by the tribes themselves. *"Our lands were divided by the owners themselves inherently"* (FGD 02, Respondent 04). This method of land allocation, along with no formal land record management system, resulted in confusion and disagreements. Such a system also posed challenges in formalizing land use, land records systems, and property rights.

Most of the land is owned by the various Bugti tribes: *"Khalper tribe and other Bugti tribes are landowners"* (FGD 06, Respondent 01). Nevertheless, due to the lack of formal land records, many of the tribes remained unaware of the particulars and precise boundaries. Moreover, the cost of accessing formal land records was prohibitive*. "The records were stored in the DC office of Dera Bugti, and a significant amount was required to access them"* (FGD 01, Respondent 01). This lack of accessibility to formal land records hindered locals from formalizing ownership, hence further complicated the land management system before the operationalizing of the Kachhi canal.

4.5. KCP Phase I Operational (T-II)

The operationalization of the Kachhi Canal signified an era of agricultural development in the region, profoundly affecting socio-economic conditions. With the water availability from the canal, previously barren and sandy land was cultivated, fostering crop variety, agricultural output, productivity, and yield. The sustained availability of water from the canal irrigation system enabled farmers to diversify the crop varieties, resulting in a significant increase in the cultivation of wheat, cotton, and mustard, along with vegetables. This shift fostered economic stability and improved food security. The Kachhi canal evolved as an influential project rejuvenating the local economy and supplying critical resources for sustained agricultural growth.

4.5.1. Agriculture

The implementation of the Kachhi Canal significantly transformed the area's agriculture and socio-economic conditions. A dependable water supply has been ensured due to the canal that allowed landowners and farmers to diversify the crops and enhance agricultural output that was once dependent upon rainfall water, including crops that were non-viable previously. *"From 2021 to 2022, almost 72,000 acres of land came under cultivation in Sui Dera Bugti"* (FGD 05, Respondent

01). The newfound agricultural potential was a catalyst for prosperity, as emphasized by the multitude of respondents. *"Once Kachhi canal started, we experienced tremendous prosperity; the previously barren lands became fertile and productive"* (FGD 05, Respondent 04). Kachhi Canal introduced an unprecedented level of productivity; the previously barren and sandy lands were thriving with crops. Such views were consistently echoed, highlighting that access to water not only boosted cultivation but also revitalized the barren and sandy lands.

The operationalization of the Kachhi canal facilitated a significant increase in crop variety. The introduction of water to dry and desolate lands fostered the crop variety and volume of output that was once unattainable*. "Upon the activation of the Kachhi canal, yield remarkably improved; now one acre of land can yield up to 45 maunds of wheat"* (FGD 03, Respondent 02). This increase in yield significantly benefited staple crops such as wheat and mustard, which not only satisfied regional demands but also aided in economic stability and widespread prosperity of the region.

Beyond crop yield, the introduction of water to arid and desolate lands altered land use and labor dynamics. The area that was once uncultivable and uninhabited due to water scarcity is now experiencing extensive cultivation. *"Fields in which we could not envision installing a tubewell are now producing crops. Those areas were filled with sand like a desert, and because of the Kachhi Canal, agriculture became possible in such areas"* (FGD 01, Respondent 03). This revolution affected the socio-economic landscape of the local populace as they migrated to new cultivable lands for farming, which enhanced population density within the region and fostered the growth of domestic markets.

The Kachhi canal significantly affected the agricultural intensity, with a multitude of farmers enhancing the frequency of cropping cycles. The reliable water source from the canal enabled the landowners and farmers to experiment with various cropping patterns, allowing crop diversity and increasing agricultural intensity. The canal's impacted the introduction of new crops as well. Farmers started to cultivate high-value crops such as cotton. This shift to new crops had significantly enhanced their income levels. "Once the canal started, we cultivated diverse crops from wheat and cotton to mustard and pulses" (FGD 06, Respondent 01). This transformation significantly stabilized the local economy and protected the farmers and landowners from risks coupled with monoculture farming.

In addition to benefits incurred to individual landowners and farmers, the Kachhi Canal also provided community-wide benefits in boosting the socio-economic landscape. Elevated income from agriculture substantially increased the quality of life of the local population. The agricultural income facilitated investment in education, mosques (also serving as educational institutes in rural areas), and housing. Moreover, the Kachhi canal also facilitated technological advancement and modernization in agricultural practices that enabled the farmers to adopt modern machinery, fertilizers, and farming techniques that were previously unfeasible. The integration of technology in farming practices facilitated per-acre productivity. "It is not feasible to till the land with the use of cows to cultivate cotton and onions" (FGD 03, Respondent 01). This transition not only enhanced agricultural output but also established a sustainable farming ecosystem with minimal resources.

As a whole, the introduction of the Kachhi Canal marked a profound transformation in the agricultural landscape of the region. It resulted in substantial gains in crop diversity, productivity, yield, and output, along with enhanced agricultural intensity, area under cultivation, and adaptation of modern machinery and know-how. The ripple effects of this transition transcended

agriculture, elevated quality of life, and enhanced economic stability. The canal did not merely bring water; it revitalized the lands and hope in the local population.

4.5.2. Water Management

The focus group discussion participants express their opinion about irrigation systems, groundwater, and water management. The operationalization of the canal brought a transformative shift to the area's water management, tackling the long-standing issue faced by the local population.

In water management, we asked the FGD participants about water management when the Kachhi Canal was operational. One of the prominent benefits reported by FGD participants was concerned with the enhanced water availability for irrigation. Prior to KCP, local communities faced severe water scarcity. *"The first thing is that initially, the irrigation water was extracted straight from its source with an engine and brought to fields."* (FGD 04, Respondent 01). This indicates the chaotic nature of the rainfed irrigation system prior to the operationalization of KCP, where the reliance was on less efficient methods. Conversely, the canal offered a more reliable and sustained supply of water, guaranteeing that agricultural fields were regularly irrigated, especially amid fluctuating seasonal weather conditions.

The canal also led to improvements in groundwater levels in various areas, especially adjacent to the Kachhi canal. Before the canal, many areas faced critically low levels of groundwater table. *"Before the groundwater level was as deep as 600 feet. With the arrival of the Kachhi Canal, it has come up significantly at about 180 to 200 feet"* (FGD 04, Respondent 01). This demonstrates that the canal directly replenished the region's groundwater table by regulating the flow of water to natural aquifers. However, as noted by other respondents, *"The arrival of the Kachhi canal did not exert any noticeable impact on groundwater level"* (FGD 03, Respondent 04). This indicates that the benefits from the Kachhi Canal in terms of replenishment of groundwater levels were not uniformly experienced across the region. Additionally, "*brackish water converted to fresh water*" (FGD 04, Respondent 02), suggests the critical shift in the region's groundwater resources, which could be used for irrigation purposes to some extent once unviable.

The improvement in access to water directly aided a shift to modern irrigation techniques from conventional methods such as animal-drawn plows to mechanized irrigation methods employing tractors. "With the advent of KCP, awareness among the enhanced, and they started employing tractors, which replaced the conventional bullock carts for plowing" (FGD 04, Respondent 03). Moreover, other respondents reiterated that "The tractor-based system is now in place; the old days of utilizing oxen plows have been over. With the influx of the Kachhi canal, everyone became happy, gave up the oxen, and started employing tractors; the livelihood of everyone has improved" (FGD 04, Respondent 04). The adoption of modern technology enhanced water efficiency, markedly augmented productivity, minimized labor-intensive techniques and spawned new economic prospects, including the generation of employment opportunities, particularly in the study area.

The social welfare of the local population was also affected by the advent of the canal. The FGD participants generally highlighted that they were very pleased with the arrival of irrigated water in the Kachhi canal. Their thirst was quenched along with the livestock and other animals, as before KCP, water was unavailable for animals.

Nonetheless, the operational time of KCP also encountered challenges. Insufficient canal branches and poor maintenance had been identified as some of the deficiencies. It was identified by the

respondents that "WAPDA constructed only main branches, did not build smaller branches" (FGD 05, Respondent 01). Moreover, water was available, but there were some minor issues with the distribution of branches. Additionally, disputes also arose on water utilization due to a lack of a conflict resolution process. "There were conflicts on distributaries because of lack of checks and balances" (FGD 02, Respondent 02). "Neither was there any tribal force to prevent conflicts or resolve issues" (FGD 02, Respondent 02). This emphasized the deficiency of effective dispute-resolution mechanisms.

Notwithstanding these deficiencies, the overall impact of the canal on water management and the livelihood of the local population was profound. It enhanced access to water for agricultural purposes. "As soon as the Kachhi canal was initiated, the government made the water available; we were very pleased" (FGD 02, Respondent 04). Thus, reliable water availability increased prosperity and improved living conditions in the region.

4.5.3. Socio-economic Conditions

Substantial changes were observed during the operational phase of the Kachhi Canal. The socio-economic condition was changed profoundly. The significant positive impacts were noted across various dimensions. The most evident benefit was the growth of commercial activities, enhancing wealth, and alleviating poverty in the region. The canal's other positive impacts include increased agricultural output, water resource availability, and enhanced livelihood prospects for the local populace.

The canal instilled the hope of employment opportunities and prosperity in the region. *"The Kachhi canal's arrival undoubtedly provided benefits as it instilled hope for employment"* (FGD 02, Respondent 02). People believed that with the operationalization of the irrigation system, work opportunities and prosperity in the area would come. This indicates that the canal has the potential to transform people's lives. Additionally, people were optimistic about the transformation in their lives.

FGD respondents highlighted that economic development was experienced in the region because of the availability of water. New businesses and shops opened up in the region. *"After the agriculture started, people started shops"* (FGD 01, Respondent 05). After the surge in economic activity, the business community took benefits as well. "Obviously several businessmen also benefitted" (FGD 03, Respondent 01).

The canal also facilitated the generation of employment in the region by offering job opportunities for previously unemployed people. "*Those who were unemployed found sources of income because of the Kachhi Canal"* (FGD 01, Respondent 03). People find employment in various ways; some of them become tractor drivers, some start transportation of wheat and other crops via *rickshaws*, and others start farming.

Agricultural productivity was also enhanced because of improvements in the canal irrigation system, resulting in enhanced farmers' income. The barren and sandy lands transformed into fertile lands, allowing farmers to grow all types of crops and generate income. *"When water comes, the lands become fertile, which enables agriculture and obviously raises income."* (FGD 01, Respondent 02). These improvements significantly increased the living standards of people and individuals dependent upon agriculture. *"We earned PKR. 800,000 from an acre when the canal was operational"* (FGD 06, Respondent 01). Thus, significant benefits were reaped from the Kachhi Canal in the form of income generation.

Beyond revenue generation, the regions experienced improvements in the form of infrastructure development, including better electricity supply and roads. *"With the enhanced electricity supplies and construction of roads, such benefits were observed."* (FGD 01, Respondent 04). Additionally, canals brought an influx of skilled workers and farmers from varied places, including adjacent areas as well as from other provinces. This influx of skilled workers and farmers imparted agricultural skills and knowledge to locals, causing knowledge diffusion and spillover effects. *"Most of the farmers belong to Sui; many came from Sindh who had knowledge of cultivating other crops such as melon"* (FGD 02, Respondent 05). This migration of farmers and skilled labor, along with knowledge sharing, promoted agricultural productivity, yield, and output with the use of modern techniques.

The benefits of the canal transcended beyond individual welfare to subnational and national levels. As highlighted by the FGD respondent that *"If this issue is considered, the benefits of the Kachhi Canal extend not only to Balochistan but to all of Pakistan"* (FGD 03, Respondent 01). This statement demonstrates the broader economic and development impacts anticipated from the operationalization of the canal.

Moreover, participants consistently mentioned that the canal had brought widespread prosperity to their lives and villages by significantly enhancing their standards of living. *"The individuals nearby us were also happy"* (FGD 03, Respondent 05). *"The impoverished benefited greatly"* (FGD 05, Respondent 02). This indicates that the Kachhi canal significantly contributed to fostering social advancement and economic relief for society, particularly for the marginalized segment of society at large.

Besides economic advantage, the canal also facilitated return migration. The individuals who vacated their hometowns in search of economic opportunities returned back to their homes and started cultivating their lands. *"Those who left their homeland in search of employment also returned because of the Kachhi Canal; this was an additional advantage"* (FGD 01, Respondent 04). This return migration to rural areas from cities underscores the significance of canals in revitalizing lands abandoned before.

Despite the substantial positive impacts of the canal, issues related to corruption on various grounds and unequal resource distribution had been experienced by the local population. Instances of fraudulent land transactions in terms of land ownership transfers and corruption in land leveling compromised the realization of the full potential of the Kachhi Canal. The respondent expressed their dissatisfaction over such matters. "Settlement officials accepted bribes from powerful individuals and altered the land records" (FGD 03, Respondent 02). "The big landlord got some benefits from the government" (FGD 05, Respondent 02). This indicates inequitable benefits accrued to farmers and small and large landlords in the region.

The operation of the Kachhi Canal has undeniably brought transformative changes to the region, which significantly reduced poverty, created employment opportunities, and enhanced the socio-economic conditions and livelihood conditions, especially in the Sui area of Dera Bugti. As a whole, it had significantly enhanced the overall well-being of the local populace. Nonetheless, proper addressing of corruption in various aspects, resolving social conflicts that arise due to land conflicts, and enhancing infrastructure are key factors in realizing maximum benefits from the canal.

4.5.4. Land Record Management

Land record management plays a significant role in mitigating conflicts by mitigating equitable land distribution. The functioning of the Kachhi Canal resulted in significant changes in terms of land management, highlighting prospects and challenges inherent to such transactions. The respondents identified enhanced awareness about the land records following the operationalization of the Kachhi Canal, as many locals, for the first time, became aware of formal land records. Despite these positive impacts, problems such as incorrect land registration and disputes over land ownership due to improper land records persisted.

A significant positive effect experienced by the local population during the operational time of the Kachhi Canal was the resolution of land disputes mediated by the security forces and local tribal leaders. As the respondent mentioned that "*this is why the Frontier Corps (security forces) and others intervene to resolve the issues, and thereafter the situation had been normalized"* (FGD 01, Respondent 01). The tribal leaders also played their role in the dispute resolution process. This effective dispute-resolution process brought stability to the region and enabled the local population to focus on agricultural production without fear of conflict. Moreover, the land allocation and formalization of land records mitigated conflicts and significantly enhanced agricultural productivity. *"Land was being distributed through tribes, with the availability of water in the Kachhi canal"* (FGD 01, Respondent 05). This system was perceived as fair in many instances, as another respondent added that *"in our area, no instances of transferring land to others than the original owner had occurred"* (FGD 03, Respondent 02). However, respondents also indicated their regret over the performance of the settlement department of Balochistan. *"Settlement department did not play any role in the area"* (FGD 03, Respondent 03). This support from law-and-order enforcement authorizes tribal leaders to play a significant role in equitable land distribution, demonstrating lasting effects on the land distribution system.

The local population became aware of formal land documentation in the operational phase of the Kachhi Canal. Numerous individuals became cognizant of land entitlements during this phase. *"Most of the people population living nearby became aware of the system of formal land document (Khatta) after the operationalization of Kachhi canal"* (FGD 01, Respondent 04). This awareness reduced ambiguities about land ownership; however, the problem of inaccurate land registrations and social and armed conflicts over land ownership persisted.

The operationalization of the canal brought widespread prosperity to the region. The availability of water increased agricultural productivity; a greater area came under cultivation, and arable land generated greater returns to landowners and farmers. The land that was leveled naturally benefited more as compared to other lands. *"Conversely, there are areas where land was leveled and more fertile, obtaining greater benefits"* (FGD 02, Respondent 05). This economic uplift of landowners and farmers encouraged further investment in land leveling and development. *"With the operation of the Kachhi canal, everyone developed their lands"* (FGD 02, Respondent 05).

Notwithstanding these factors, the operationalization phase was marked with a multitude of challenges, such as flaws in the land registration system. *"Land possession was handed over to others instead of the original owner"* (FGD 02, Respondent 02). People managed the land ownership in such a way that led to ambiguity in ownership; such disparities resulted in grievances and occasional conflicts.

The period when the Kachhi Canal was operational appears to be a significant phase for regional progress and development. It boasted an agricultural economy, improved awareness regarding

the land registry system, and brought significant areas under cultivation along with improvement in governance mechanisms. The distribution of lands was ensured with the help of law enforcement authorities and tribal leaders. This blend of modern techniques and traditional practices resulted in significant impacts.

4.6. KCP Post-Flood 2022 (T-III)

The post-flood phase of KCP is characterized by significant socio-economic and environmental challenges. One of the most critical issues faced by the local population is acute water scarcity, rendering the communities fighting for survival. Participants in FGDs unanimously highlighted the problem of dire water scarcity. "We are longing even for a glass of water" (FGD 03, Respondent 03). The acute water scarcity not only disrupts daily life but also damages the backbone of the region, which is agriculture output, yield, and productivity.

The severe flooding has damaged the Kachhi Canal, which has significantly affected the socio-economic dynamics. Respondents expressed their sorrow about the operation of the canal, stating that the canal was merely functional for two years. The canal dysfunctionality halted water supplies, making the land infertile, and forced the local population to migrate.

4.6.1. Agriculture

Agricultural activities, previously revitalized by the functioning of the Kachhi Canal, have returned to barren and unproductive conditions, even critical to rainfed time, because of the inoperability of the canal. A multitude of respondents emphasized the catastrophic impact of canal cessation on production and livestock. *"Now it has become non-operational; the land has become barren"* (FGD 02, Respondent 05). Landowners and farmers forsook their properties and vacated the area due to a severe water crisis. *"People have migrated from where they once lived because of water scarcity"* (FGD 02, Respondent 01). The loss of the primary source of income resulted in outmigration, which has destroyed community cohesion and exacerbated economic challenges.

The economic repercussions exerted by the canal closure are profound. The inadequate water supplies necessary for sustainable agriculture and livestock production have been stressed by several respondents. *"The agricultural production flourished due to water; now there is no water, and available water is saline"* (FGD 04, Respondent 05). The paradigm shift from canal-driven irrigation to a drought-affected region has led to all-embracing poverty, compelling local residents to liquidate their personal assets and livestock barely to satisfy their day-to-day needs. *"Individuals are selling three to four goats to buy flour and resolve their problems"* (FGD 03, Respondent 02).

Landowners experimented with the installation of tubewells in the region. The overwhelming occurrence of saline water from tubewells rendered it unsuitable for human as well as livestock utilization. *"Tubewells are being installed; however, water is saline"* (FGD 02, Respondent 04). This water salinity restrained not only drinking water availability but also constrained agricultural recovery, compounding the difficulties of the region.

Notwithstanding these grim circumstances, the respondents persistently called for government action to restore the canal on an emergent basis. "Complete this work for us, for God's sake" (FGD 06, Respondent 02). The potential benefits of the Kachhi Canal have been highlighted in the case of operationalization of the canal. "If it had remained operational for 5 to 6 years, there would have been significant benefits" (FGD 02, Respondent 05). These perspectives emphasized the

dependence of the community on external assistance, which in turn reversed their plight and rebuilt the sole source of their livelihood.

As a whole, the post-flood scenario portrays a picture of acute water scarcity resulting in extensive loss of agricultural output and compelled migration. The community collectively emphasized the urgent need to restore the canal, underscoring the crucial role of large-scale irrigation projects in sustainable socio-economic development and stability.

4.6.2. Water Management

The aftermath of the Kachhi Canal represents a critical moment in various aspects, such as changes in socio-economic conditions, environmental impacts, water scarcity, etc. The operational phase of the canal transformed the region by enhancing water availability, agricultural output, and income levels. Nonetheless, its inoperability and damage resulting from extensive hill torrents, which caused a massive flood, have reversed the pace of advancement, leading to stark issues faced by the local populace.

The restoration of the canal brings prosperity to the local economy as it is essential for the regional recovery. *"The entire system would be restored once water flows into the canal"* (FGD 03, Respondent 03). This implies that a canal is of utmost necessity for local economic revival. *"Once the canal has been restored, all the problems will be resolved"* (FGD 03, Respondent 03). The issue of water scarcity is resolved once the water flow has been established, which is crucial for mitigating the scarcity of water and rejuvenating agricultural techniques.

The frustration among the local populace has been exacerbated by the lack of restoration work and government intervention. *"The Kachhi canal water should be restored promptly, and water be available in the rabbi season so that our village thrives again"* (FGD 06, Respondent 01). Notwithstanding the logistics and technological solutions, including prompt repair, FGD respondents highlighted the lethargy of authorities. *"The repair work can be finished within a month if the federal government assumes responsibility"* (FGD 06, Respondent 03). This necessitates the authorities to take immediate action to address the administrative and technical hurdles, among others, to initiate restoration work.

The availability of inadequate alternatives, such as tubewells, resulting in saline groundwater, has further intensified the problem. "There is no water nowadays; if there is, it is saline" (FGD 04, Respondent 02). The problem requires having an alternative source of sustainable water management infrastructure to overcome the misery faced by local residents. Additionally, the absence of supplementary infrastructure such as dams has rendered the local population vulnerable to water shortages. "The rainwater could have been stored, and water could be used if there existed dams" (FGD 01, Respondent 04).

In sum, the post-flood situation requires immediate rehabilitation work to be initiated on an urgent basis. The responses not only narrate the canal's centrality to the livelihood but also highlight the frustration of the local population with the failure to restore the canal. This demands attention to restoring sustainable water supplies to revive socio-economic stability in the region.

4.6.3. Socio-economic Conditions

The socio-economic impacts of the post-flood situation are profound. The closure of the water canal resulted in water constraints. It starkly contrasts with the previously generated wealth due to the operations of the canal. The community is facing considerable difficulties encompassing economic hardship, social turmoil, and demographic decline. The canal inoperability and damage

resulted in extensive social, economic, and agricultural repercussions that have critically impacted the standard of living and stability of the study area.

The economic hardship is most prominent in the region. The population, previously dependent on a canal irrigation system, now faces extreme water shortages, which resulted in employing expensive alternatives such as tubewells. However, the risk is highly attached to the tubewell as underground water is mostly saline*. "Due to the closure of the canal, nowadays there is uncertainty attached to the successful installation of the borehole, whether the water would be drinkable or saline"* (FGD 01, Respondent 03). The financial strain resulting from unsuccessful attempts at tubewells has already worsened the situation. *"We obtain loans on interest and borrow money from others"* (FGD 06, Respondent 01). *"This led to greater losses to the poor"* (FGD 06, Respondent 04). The economic repercussions not only affected agriculturists but also extended to the broader community, leading to difficulties in securing basic amenities, as one of the respondents stated *that "the population residing in villages and adjacent areas is very distressed"* (FGD 06, Respondent 01).

The infrastructure gap played a massive role in compounding the challenges faced by the local population. The unavailability of adequate dams has been emphasized by the FGD respondent, who stated that such infrastructure could have significantly mitigated the damages from massive hill torrents. *"Because there exist no dams or comparable system, if there had been dams, water could have been stored and utilized, but no such system exists"* (FGD 01, Respondent 04). The recurring hill torrent water from Koh-e-Suleman has been highlighted to be the main cause of canal damage. The construction of dams to store water coming from Koh-e-Suleman has been proposed as the solution. *"The solution involves the construction of dams to manage the water of Koh-e-Suleman in order to prevent the canal from damage"* (FGD 03, Respondent 01). The economic hardship has been further intensified due to a lack of basic facilities such as schools, hospitals, and electricity. *"You cannot find schools, clinics, or electricity; the whole budget is being utilized in the cities"* (FGD 06, Respondent 03). These responses imply the urgent need for basic infrastructure facilities to ensure long-term sustainability, development, and resilience.

The canal damage triggered massive depopulation in the region. The migration started due to water scarcity, which undermined community cohesion and highlighted the extensive displacement. This situation left the community to depend solely on cattle farming. The formerly prosperous region has become desert and barren. "Everyone departed from the region as it has been wrecked" (FGD 03, Respondent 05). The abandonment is also evident in places of worship that also serve as educational institutes in the region. "Even now mosques have become deserted as there are no worshippers; everyone has fled" (FGD 05, Respondent 02). This massive depopulation resulted in lawlessness. "Consequently, it's a jungle out there; everyone acts as per their own desires where might is right" (FGD 02, Respondent 02).

Considerable social and psychological anguish has been caused by canal inoperability. The once-deemed blessings now turn into misery. "Every landowner was grieved when the Kachhi Canal became inoperable. It brings intense pain when Allah provides a blessing, and it is taken away." (FGD 04, Respondent 03). This loss has affected society at large by diminishing its social cohesion, with many grappling with the harsh realities of life.

4.6.4. Land Record Management

The damage and inoperability of the Kachhi Canal brought issues to land record management. The post-flood situation highlighted a surge of social conflicts over land. A multitude of

respondents highlighted the existence of inaccuracies in land registry and issues relevant to land appropriation. “Those who do not have land illegally occupied it” (FGD 01, Respondent 05). There has been a systematic issue as well. The land records are being altered by registering lands in someone else’s name, which gives rise to social conflicts. These conflicts necessitate that a strong and transparent framework should be adopted to reestablish order and justice to uphold the land record management system.

Despite such challenges, conventional tribal methods provided a glimmer of hope to local residents to resolve land issues. The role of the jirga system and tribal system has been highlighted by respondents in mediating conflicts and resolving land-related issues. “The jirga system is held to find resolution of land disputes, and solutions are generally found as they know which land belongs to whom” (FGD 02, Respondent 02).

4.6.5. Future Course of Action

The post-flood situation has been marked by widespread problems such as agricultural deterioration, economic stagnation, and social adversity. The urgent rehabilitation of the canal has been consistently reiterated by the respondents as the destruction of the canal plunged the local population into despair because of heavy reliance on agriculture.

The key issue identified by the respondents was the failure of planning and policy that intensified the precarious situation. The lack of comprehensive feasibility studies and improper assessment of environmental factors has been highlighted as a prime factor leading to the currently prevailing fragile situation. “The feasibility plan was totally flawed” (FGD 03, Respondent 01). Moreover, “the super passages were not properly identified” (FGD 03, Respondent 01). Such observation raised critical questions about the sustainability of the project, its future planning, and resource allocation, rendering restoration more complicated.

The restoration request is solely a call for canal repair, but it is a desperate plea for the survival of a community heavily dependent upon agriculture. “We appeal to the president and prime minister of Pakistan to restore the canal on an urgent basis” (FGD 05, Respondent 04). Moreover, the socio-economic effects of the canal’s inoperability are devastating. “There will be nothing left for us if this resource is eliminated” (FGD 06, Respondent 01). Hence this collective desperation underlines the heavy reliance of the local population on the Kachhi Canal for survival. The way forward requires a comprehensive strategy, a proper feasibility strategy to devise super passages that can handle massive water coming from the mountains of Koh-e-Suleman and other areas, long-term maintenance, and inclusive planning. Repair of the canal not only brings prosperity to the region but also revives the agricultural economy, promotes sustainable economic development, and addresses the issues of marginalized populations.

4.7. Discussion of Results

4.7.1. Impact Timeline with Annotations

Key events and their effects across different phases of the Kachhi Canal project have been illustrated in Table 2. In the pre-KCP time (T-I) reliance on rain-fed agriculture led to limited economic growth and low crop yields with recurrent conflicts due to scarcity of water and limited opportunities available to the local population. During the KCP Phase I Operational (T-II), the local population experienced a boost in agricultural productivity and economic growth with the formalization of the land record system and technology adaptation because of the operationalization of the Kachhi canal. While in the KCP Post-Flood 2022 (T-III) severe hill

torrents damaged the canal causing the local population to return to scarcity of water and an economic downturn.

Table 2: Impact Timeline with Annotations

Phase/Time Period	Key Events	Impacts/Changes	Annotations/Insights
Pre-KCP Time (T-I)	Dependence on rain-fed agriculture	Low crop yields, limited economic growth	Water scarcity led to frequent conflicts; and reliance on traditional methods.
KCP Phase I Operational (T-II)	Canal construction and full operation	Increase in agricultural productivity, economic growth	Community collaboration improved; technology adoption; formal land records introduced.
KCP Post-Flood 2022 (T-III)	Severe flood damages canal	Return to water scarcity, economic downturn	Lack of maintenance was blamed; conflicts resurfaced; and reliance on tubewells through the solar system.

Source: Authors' compilations.

4.7.2. Layered Impact

The layered impact analysis has been presented in Table 3. The layered impact analysis refers to a multistage complex impact that unfolds over time as a result of a specific project that is the construction and operationalization of the Kachhi Canal in this case. Such analysis reflects negative and positive changes across various phases.

Table 3 indicates the evolving consequences of the Kachhi Canal project on four main thematic areas: agriculture, water management, socio-economic conditions, and land record management. These thematic areas have been unfolded in three distinct stages over time, reflecting positive and negative impacts over time.

Table 3: Layered Impact

Thematic Area	Pre-KCP Time (T-I)	KCP Phase I Operational (T-II)	KCP Post-Flood 2022 (T-III)	Annotations
Agriculture	Rain-fed agriculture, Limited crop variety, Drought-resistant crops	Increased productivity, Change in crop patterns, livestock	Productivity decline, Reversion to drought-resistant varieties but to a lesser extent	Shifts in agricultural practices due to water availability and subsequent scarcity
Water Management	Tubewells, Limited water for livestock, lower water table	Groundwater replenishment, Effective irrigation	Water Scarcity, Return to rain-fed agriculture, tubewells with solar systems	Impact of irrigation on crop choices and socio-economic activities
Socio-Economic Conditions	Migration with livestock, Economic disparately Lessor economic opportunities	Economic development, Decline in migration (Return migrations), Improved income sources,	Migration resumed, Economic stress and downturn	How water availability influences socio-economic dynamics

		Lower food inflation		
Land Record Management	Informal/Verbal land dealings, Lack of formal documentation	Formalized land records, Dispute resolution mechanisms introduced	Increase in land disputes, Erosion of formal land record management (land record confusion)	The role of irrigation in formalizing or complicating land ownership and management

Source: Authors' compilations.

4.8. Economic and Financial Analysis

This section provides a detailed discussion of cropping intensity, land utilization, crop production expenses, gross production values, and economic and financial analysis.

4.8.1. Cropping Intensity

The cropping intensity has increased in the sui region of Dera Bugti when the canal becomes operational. During the rainfed era, the cropping intensity was substantially low with a total of 1948 acres of land were being cultivated while after the water availability from the canal system, the cropping intensity significantly increased as evident from Figures 6 and 7. According to the Agriculture Extension Department of Balochistan, the total area under cultivation increased from 1948 to 55,200 acres from 2016 to 2021. The increase in area under cultivation is also evident from Figures 6 and 7 indicating the project's capability to supply water to the command area highlighting the project's success in enhancing water accessibility and showcasing its wider benefits in terms of agriculture output, employment and other benefits.

Figure 6: Satellite image of KCP Part 1 (Phase-A) for the Year 2015

Source: Agriculture Extension Department of Balochistan.

Figure 7: Satellite image of KCP Part 1 (Phase-A) for the Year 2020

Source: Google Earth.

Figure 8: Satellite image of KCP Part 1 (Phase-A) for the Year 2023

Source: Google Earth.

However, these benefits did not last long enough, as severe hill torrents damaged the Kachhi Canal in 2022, and these benefits were no more available to the local populace. **Figure 8** indicates the command area is no greener, as the cultivation of crops vanished with the damage to the Kachhi canal, which resulted in severe water scarcity. Moreover, as evident from **Figure 8**, some parts of the land are green; this is because of Calotropis gigantea (a wild plant) covering the land as shown in **Figures 9** and **10**. Thus, the destruction of the Kachhi canal has resulted in the loss of all the benefits once realized.

Figure 9: Massive Presence of Calotropis gigantea (a wild plant)

Source: Author's photograph.

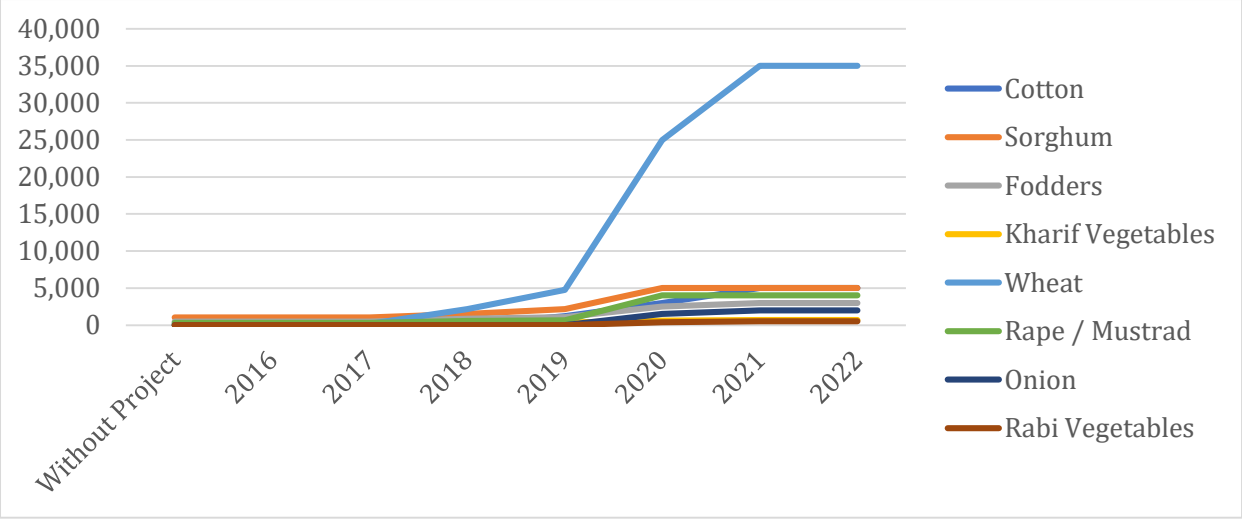
Figure 10: Massive Presence of Calotropis gigantea (a wild plant)

Source: Author's photograph.

4.8.2. Land Utilization, Crop Production Expenses and Value

The trends in land utilization for growing different crops during the rainfed time and subsequent years when the Kachhi Canal became operational are indicated in **Figure 11**. Initially, all crops grown in the region had limited land utilization; however, after 2018, there has been a sharp increase in land utilization, especially for wheat. By 2020, wheat utilizes the maximum cultivable command area of the Kachi Canal, reaching approximately 35,000 acres of land during 2021 and 2022. This phenomenal growth features large-scale wheat cultivation enabled by the project. Other crops, including cotton, onion, mustard, rabi, and kharif vegetables, also portray a gradual and consistent rise in land utilization. However, their growth remained comparatively low compared to wheat.

Figure 11: Land Utilization (Rabi & Kharif) (Values in Acres)



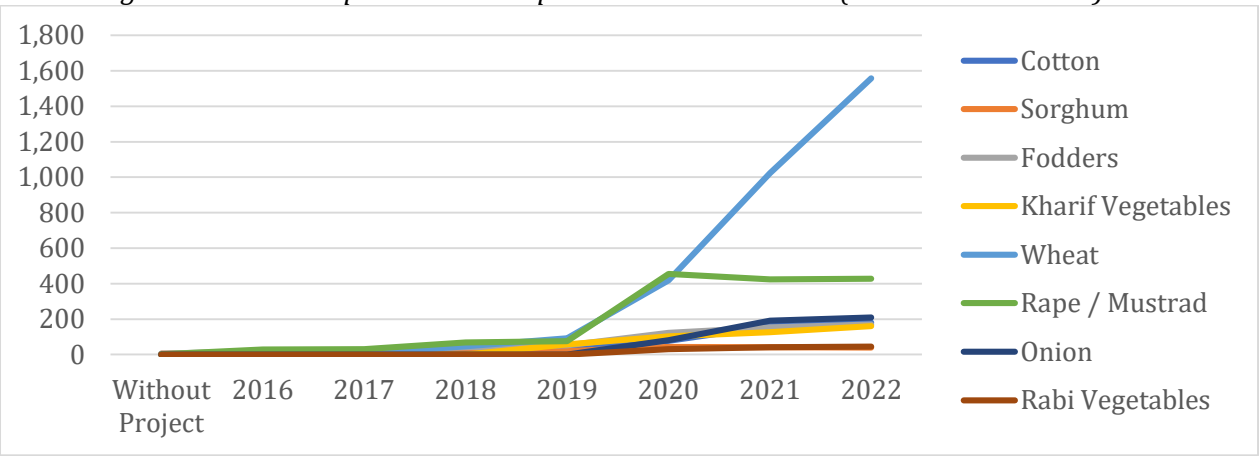
Source: Agriculture Extension Department of Balochistan.

Figure 12 presents total crop production expenses at wholesale prices over time. Prior to the Kachhi canal in the rainfed irrigation system expenses were minimal. With the initiation of the project, expenses began to rise with a substantial spike started in 2019 as more areas came under cultivation as evident in Figure 11. The total wheat expenses reached PKR. 1,600 million in 2022 reflecting large-scale wheat cultivation. Notably other crops showed minimal expenses due to limited land utilization and crop production.

Gross production value indicates the total value of production in a given year. It has been estimated by multiplying the economic price with the total crop production in per-acre terms. Figure 13 illustrates the progression in the total value of production per acre for various crops from the rainfed irrigation system to the operationalization of the Kachhi canal from 2015 to 2022. The trend indicates that with the enhanced availability of water through the implementation of the project productivity increased across all crops. The significant rise in gross production values, especially in cotton, mustard, rabi and kharif vegetables underscores the benefits of the project along with its role in transforming the agricultural output in the area.

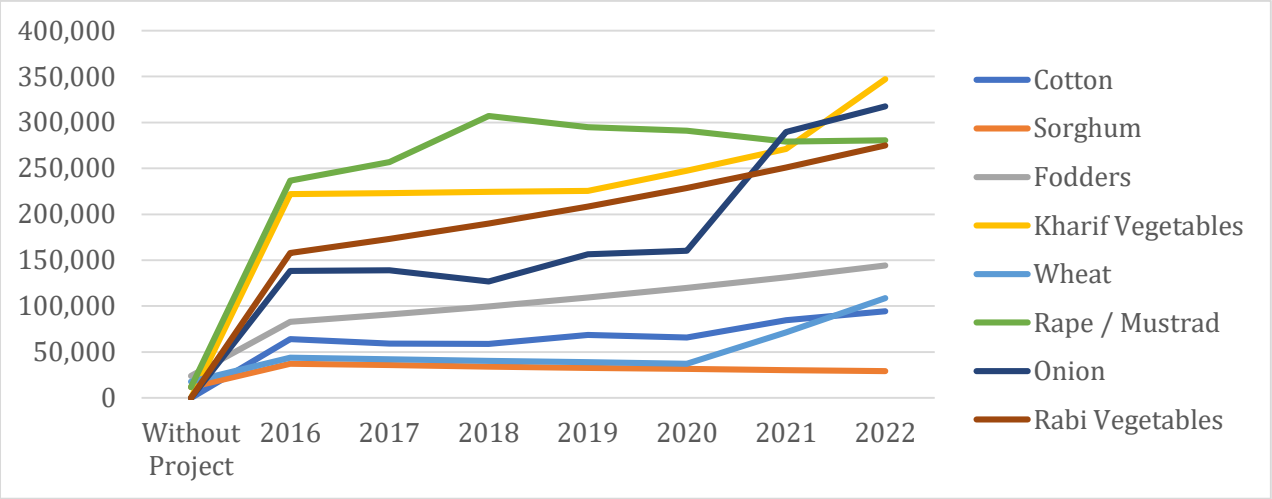
Together trend analysis emphasises the significant effect of the Kachhi Canal project on land utilization, production expenses, and gross value production with wheat being the most dominant crop in terms of land utilization and financial expenses.

Figure 12: Total Crop Production Expenses- Economic Prices (Values in Rs. Million)



Source: Agriculture Extension Department of Balochistan.

Figure 13: Gross Production Values (GPV) Per Acre - Economic Prices



Source: Agriculture Extension Department of Balochistan.

4.8.3. Economic Analysis

The objective of economic analysis is to assess the economic viability of the project. The results have been compared with the economic analysis conducted by the agricultural extension department of Balochistan. This enabled us to re-examine the potential risks involved in the long-term sustainability of the project.

The standard economic analysis approach has been employed to compute the present worth of benefits and costs using different numbers of time horizons compared against a threshold period of twenty years discounted at the opportunity cost of capital. A conservative approach has been adopted in order to compare the performance of the project with the estimate available previously. Evidently, the project's total life cycle is much more than twenty years as the threshold; however, a conservative has been adopted. Nonetheless, this period has also been increased to thirty years in order to account for project performance at a larger scale.

The data for benefit and cost realized from projects come from the agriculture extension department of Balochistan which is based on quantifiable physical inputs and outputs. The benefits have been estimated based on changes that have been incurred and other conditions expected to occur in the region. While wholesale prices have been used in the study. Costs consist of actual costs incurred for the development of cultivable command areas which include civil works, management of the project, and technical assistance. The financial cost includes PKR. 1779.051 million for the development of cultivable command area and PKR. 4570.88 for the construction of Kachhi canal phase-1 (Part A). These estimates have been converted to economic costs by applying the conversion of 0.914 providing PKR. 1517.848 million and PKR. 4178.271 million for the development of CCA and construction costs.

The economic analysis involves the determination of cost and benefits in terms of economic prices, computation of benefit-cost ratios, net present worth, economic internal rate of return and finally carrying out sensitivity analysis.

Table 4 demonstrates the estimates of economic analysis which include economic internal rate of return, benefit-cost ratio and net present value (NPV). Appendix B provides details on the computation of these estimates. The estimates of the agriculture extension department carried out economic analysis which indicates the EIRR was 33.65% against the cropping area of 46,500

acres for the Rabi season and 8,700 acres for the Kharif season. The economic estimates at the project appraisal indicate an EIRR of 16.04%, assuming an increase of 24,031 and 19,129 acres in CCA of phase 1 (Part A). The current study has repeated the analysis based on land utilization and CCA being only 25% of rainfed times, a very optimistic estimate, postulates that EIRR is 18.18% provided the construction of the Kachhi canal started as planned once damaged in the financial year 2022. Unfortunately, the construction has not started as planned thus we assumed another scenario that "If repair work starts in 2024-25" and pre-flood agricultural production levels are reached immediately after the restoration of the canal. Based on this scenario the EIRR turns out to be 16.59%, which is still higher than the estimates at the project appraisal. The benefit-cost ratio indicates that the project is beneficial if the restoration work of the project starts immediately i.e., in 2024-25. The project, however, does not remain economically viable if there is a gradual increase in agricultural production after the restoration of the canal.

Table 4: Economic Analysis (Economic Prices)

Scenario	NPV (Million PKR)				Benefit Cost Ratio				EIRR (%) After Completion
	Interest Rate				Interest Rate				
	10%	12%	15%	18%	10%	12%	15%	18%	
Agri. Extension Dept. Estimates	25,466	19,513.16	13,103.92	-	2.01	1.94	1.81	-	33.65
Scenario A: 25% of Rainfed	5,393.28	3,403.28	1,364.32	60.91	1.29	1.22	1.11	1.01	18.18
Scenario B: If repair starts in 2024-25	3,580.29	2,087.34	566.88	-403.72	1.23	1.15	1.05	0.96	16.59
Scenario C: Gradual prod increase	-1,378.77	-1,623.04	-1,861.58	-2,013.63	0.89	0.86	0.80	0.75	0.17
Scenario C1: Gradual prod increase extended till 2039-40	773.46	-221.18	1,113.29	-1,607.15	1.05	0.98	0.89	0.81	11.48
Scenario C2: Gradual prod increase extended till 2044-45	2109.83	574.27	741.25	-1,429.48	1.14	1.05	0.93	0.83	13.07

Source: Authors computations.

4.8.4. Financial Analysis

The estimates for financial analysis have been reported in Table 5. Financial estimates are based on the financial internal rate of return (FIRR), benefit-cost ratio, and NPV. The results indicate that FIRR significantly reduced from 35.46% i.e., agriculture extension department estimates to 21.25% in case reconstruction of the canal starts in 2024-25 and is complete within the postulated timeframe which is 3 years. Benefit-cost estimates also indicate that the project is still financially viable if the restoration of the Kachhi Canal complete in 2027-28 and production approaches peak immediately.

Table 5: Financial Analysis (Financial Prices)

Scenario	NPV (Million PKR)				Benefit Cost Ratio				FIRR (%) at completion
	Interest Rate				Interest Rate				
	10%	12%	15%	18%	10%	12%	15%	18%	

Agri. Extension Dept. Estimates	29,833.70	23,055.85	15,719.85	-	2.03	1.96	1.84	-	35.46
Scenario A: 25% of Rainfed	20,706.61	15,028.54	9,161.60	5,369.38	1.93	1.80	1.61	1.43	27.24
Scenario B: If repair starts in 2024-25	11,584.20	7,742.42	3,921.23	1,567.61	1.51	1.41	1.26	1.13	21.25
Scenario C: Gradual prod increase	-3,390.98	-3,363.82	-3,260.52	-3,141.97	0.81	0.79	0.75	0.72	0.17
Scenario C1: Gradual prod increase extended till 2039-40	-626.64	-1,563.27	-2,299.40	-2,619.89	0.97	0.91	0.83	0.77	9.08
Scenario C2: Gradual prod increase extended till 2044-45	1,089.79	-541.58	-1,821.56	-2,391.68	1.05	0.97	0.87	0.80	11.21

Source: Authors computations.

4.9. Sensitivity Analysis

Sensitivity analysis is a crucial step to determine how sources of uncertainty impact the project. The sensitivity analysis has been conducted by assuming the changes in the project's costs and benefits. Specifically, analysis has been undertaken by increasing the project cost by 10%, reducing the benefits by 10% and a simultaneous increase & decrease in project costs & benefits by 10% respectively.

Error! Reference source not found.6 shows the results of sensitivity analysis based on economic prices. The details estimates of sensitivity analysis for both economic and financial approximations have been provided in **Error! Reference source not found.**7 and **Error! Reference source not found.**8 respectively. EIRR estimates indicate that the project rate of return reduces as the conditions become adverse. However, no substantial impact is visible in terms of EIRR. Thus, the results indicate that if the restoration of the canal completes in 2027-28 project remains economically feasible.

Table 6: Sensitivity Analysis

Scenario	EIRR (%) (At Appraisal)	EIRR (%) After completion (Agri. Extension Dept. Estimates)	EIRR (%) After Completion (Current Study Estimates)
Base Case	16.04	33.65	18.18
Sensitivity Analysis			
10 percent increase in Project costs	15.11	32.14	17.04
10 percent decrease in Project benefits	15.02	30.77	18.14
Benefits reduction & cost overrun by 10 percent both occurring simultaneously	14.13	29.34	13.89

Source: Authors computations.

Table 7: Sensitivity Analysis (Calculation Based on Economic Prices)

Scenario	NPV (Million PKR)				Benefit Cost Ratio				EIRR (%)
	Interest Rate				Interest Rate				
	10%	12%	15%	18%	10%	12%	15%	18%	
Agri. Extension Dept. Estimates	25,466	19,513.16	13,103.92	-	2.01	1.94	1.81	-	33.65
Scenario A: 25% of Rainfed	5,393.28	3,403.28	1,364.32	60.91	1.29	1.22	1.11	1.01	18.18
Scenario B: If repair starts in 2024-25	3580.29	2087.34	566.88	-403.72	1.23	1.15	1.05	0.96	16.59
10 percent increase in Project costs									
Scenario A: 25% of Rainfed	4,933.54	2,957.01	936.46	-350.38	1.26	1.18	1.07	0.97	17.04
Scenario B: If repair starts in 2024-25	3,111.56	1,633.50	133.14	-819.60	1.19	1.12	1.01	0.92	15.35
Scenario C: Gradual prod increase	-1,847.50	-2,076.88	-2,295.32	-2,429.51	0.86	0.82	0.77	0.72	3.70
Scenario C1: Gradual prod increase extended till 2039-40	304.73	-675.02	-1,547.02	-2,023.03	1.02	0.95	0.85	0.77	10.53
Scenario C2: Gradual prod increase extended till 2044-45	1,641.09	120.44	-1,174.98	-1,845.36	1.10	1.01	0.89	0.79	12.21
10 percent decrease in Project benefits									
Scenario A: 25% of Rainfed	5,390.61	3,400.65	1,361.77	58.42	1.16	1.09	1.00	0.91	18.17
Scenario B: If repair starts in 2024-25	1,609.64	503.98	-601.37	-1,288.90	1.10	1.04	0.95	0.86	13.19
Scenario C: Gradual prod increase	-2,526.94	-2,590.98	-2,626.99	-2,631.73	0.80	0.77	0.72	0.68	0.42
Scenario C1: Gradual prod increase extended till 2039-40	-732.73	-1,422.32	-2,003.17	-2,292.87	0.95	0.89	0.80	0.73	8.58
Scenario C2: Gradual prod increase extended till 2044-45	2,109.83	574.27	-741.25	-1,429.48	1.03	0.94	0.83	0.75	13.07
Benefit reduction and cost overrun (each by 10 percent) occurring simultaneously									
Scenario A: 25% of Rainfed	2,538.20	1,034.45	-475.75	-1412.56	1.13	1.06	0.96	0.87	13.89
Scenario B: If repair starts in 2024-25	1,140.91	50.15	-1,035.10	-1,704.79	1.07	1.00	0.91	0.84	12.11
Scenario C: Gradual prod increase	-2,995.67	-3,044.81	-3,060.72	-3,047.61	0.78	0.74	0.69	0.65	-0.27
Scenario C1: Gradual prod increase extended till 2039-40	-1,201.46	-1,876.15	-2,436.91	-2,708.76	0.92	0.85	0.77	0.69	7.85
Scenario C2: Gradual prod increase extended till 2044-45	-87.40	-1,213.02	-2,126.76	-2,560.64	0.99	0.91	0.80	0.72	9.88

Source: Authors computations.

Table 8: Sensitivity Analysis (Calculation Based on Financial Prices)

Scenario	NPV (Million PKR)				Benefit Cost Ratio				FIRR (%)
	Interest Rate				Interest Rate				
	10%	12%	15%		10%	12%	15%	18%	
Agri. Extension Dept. Estimates	29,833.70	23,055.85	15,719.85	-	2.03	1.96	1.84	-	35.46
Scenario A: 25% of Rainfed	20,706.61	15,028.54	9,161.60	5,369.38	1.93	1.80	1.61	1.43	27.24
Scenario B: If repair starts in 2024-25	11,584.20	7,742.42	3,921.23	1,567.61	1.51	1.41	1.26	1.13	21.25
10 percent increase in Project costs									
Scenario A: 25% of Rainfed	20,203.66	14,540.33	8,693.52	4,919.43	1.89	1.75	1.56	1.56	25.98
Scenario B: If repair starts in 2024-25	10,745.61	6,971.26	3,232.88	945.04	1.46	1.35	1.20	1.07	19.83
Scenario C: Gradual prod increase	-4,229.56	-4,134.99	-3,948.87	-3,764.55	0.78	0.75	0.72	0.68	-0.94
Scenario C1: Gradual prod increase extended till 2039-40	-1,465.23	-2,334.43	-2,987.75	-3,242.47	0.93	0.87	0.79	0.73	8.03
Scenario C2: Gradual prod increase extended till 2044-45	251.20	-1,312.74	-2,509.91	-3,014.26	1.01	0.93	0.83	0.75	10.26
10 percent decrease in Project benefits									
Scenario A: 25% of Rainfed	20,706.61	15,028.54	9,161.60	5,369.38	1.74	1.62	1.45	1.29	27.24
Scenario B: If repair starts in 2024-25	8,174.75	5,059.73	2,002.76	157.21	1.36	1.27	1.13	1.01	18.34
Scenario C: Gradual prod increase	-5,976.96	-5,370.90	-4,685.10	-4,195.33	0.67	0.66	0.65	0.62	*
Scenario C1: Gradual prod increase extended till 2039-40	-626.64	-1,563.27	-2,299.40	-2,619.89	0.87	0.82	0.75	0.70	9.08
Scenario C2: Gradual prod increase extended till 2044-45	1,089.79	-541.58	-1,821.56	-2,391.68	0.95	0.87	0.78	0.72	11.21
Benefit reduction and cost overrun (each by 10 percent) occurring simultaneously									
Scenario A: 25% of Rainfed	15,908.15	11,149.94	6,266.05	3,139.76	1.70	1.58	0.40	1.40	23.38
Scenario B: If repair starts in 2024-25	7,336.17	4,288.57	1,314.41	-465.36	1.31	1.22	1.08	0.96	1706
Scenario C: Gradual prod increase	-5,721.75	-5,392.85	-4,943.39	-4,567.49	0.70	0.68	0.64	0.47	-4.26

Scenario C1: Gradual prod increase extended till 2039-40	-3,418.12	-3,892.38	-4,142.46	-4,132.42	0.84	0.78	0.71	0.66	5.39
Scenario C2: Gradual prod increase extended till 2044-45	-1,987.75	-3,040.97	-3,744.25	-3,942.25	0.91	0.84	0.75	0.68	7.96

Source: Authors computations.

4.10. Financial Viability

The financial viability of the project is based on certain financial indicators. These indicators include NPV, benefit-cost ratio, and financial internal rate of return. Furthermore, estimates of the current study have been compared with the estimate at the appraisal of the project and estimates of the agriculture extension department of Balochistan. The results indicate that the project is financially viable in all scenarios, including scenarios A & B of the current study, as shown in Table 9.

Table 9: Financial Viability

Financial Indicators	Estimates at the time of Appraisal at 12% Interest Rate	Agri. Extension Dept. Estimates at 12% Interest Rate (after completion)	Current Study Estimates at 12% Interest Rate (after completion) Scenario A	Current Study Estimates at 12% Interest Rate (after completion) Scenario B
Net Present Value (Rs. Million)	3174.41	23,055.85	15,028.54	2,087.34
B/ C Ratio	1.52:1	1.96	1.80	1.15
FIRR (Percent)	15.75	35.46	27.24	16.59

Source: Authors computations.

CONCLUSION

Kachhi Canal is in the most underdeveloped province of Pakistan. It originates from the Taunsa Barrage of Punjab province, enters in Dera Bugti district of Balochistan province and stretches to Jhal Magsi District. This project irrigates 713,000 acres of CAA in the Kachhi plain of Balochistan with a total length of 194 kilometres in the province. It has been envisioned as a lifeline for Balochistan agriculture.

The project has faced multiple challenges in terms of cost and time overruns since its inception in 2002. KCP has been revised twice, following the second revision, the project was split into three distinct phases. The approved cost of the project increased from PKR. 31.204 billion to PKR. 80.352 billion and a delay of at least 10 years for phase-1 only. However, in 2018 phase-1 (Part A) has been inaugurated which irrigates 72,000 acres of CAA.

This study examines the socio-economic impacts of the Kachhi Canal and carries out the economic and financial viability analysis of phase-1 (Part A). Mix methods, both qualitative and quantitative approaches, have been utilized in the study. For qualitative analysis, group discussions have been conducted with the stakeholders, which include landowners and farmers which access to and benefited from canal irrigation water. While quantitative data has been obtained from the agriculture extension department of Balochistan which has been used to calculate net present value, benefit-cost ratio, sensitivity analysis and internal rate of return.

In the initial field survey, it was found that the land is completely barren, with some lands being cultivated using tubewells. This is because the Kachhi Canal has become nonfunctional as a result of severe hill torrents that occurred in the DG Khan & Rajanpur areas. The severe floodwater of the Koh-e-Suleman badly damaged the canal, and it has become inoperable. An annual benefit of Rs. 3.82 billion was expected from Phase I, and Rs. 19.66 billion was expected from the whole KCP to the national economy against the total cost of Rs. 80.352 billion (Rs. 77.246 billion expenditures made already). The amount required for emergent restoration work amounts to Rs. 1500 million (1.5 billion) to reap the annual benefits, and for restoration, Rs. 10.572 billion are required. Despite the investment, total benefits have been realized only for 2 to 3 years, and a massive amount is required to make the canal operational. This raises questions about the adequacy of initial project planning, super passages, and climate considerations. The impact of rainfall and natural hazards was either underestimated or not accounted for. As a result, more expenditure is being required to restore KCP. Given the nature of flash floods and rainfall above the historic averages in the area, not only restoration but also replanning/restructuring of the project is necessary in order to cater to the megafloods in the future. During restoration, it is essential that super passages should be constructed in such a way that they can handle massive amounts of water flow, ensuring the canal remains operational.

Additionally, the quantity of tubewells was very limited due to saline underground water. Houses were abandoned by the farmers because of severe water scarcity. The socio-economic impacts of KCP ascertained through focus group discussion fall into three main themes, which are Pre-KCP Time (T-I), KCP Phase I Operational (T-II), and KCP Post-Flood 2022 (T-III). These themes are further divided into agriculture, water management, socio-economic conditions, and land record management.

The result indicates that prior to KCP rain-fed agriculture was practiced in the area which has low output, yield and agricultural productivity. Traditional farming methods were practiced in the region which cropping intensity and land utilization were very low along with the existence of

water scarcity. While the socio-economic conditions were characterized by a sparse population, limited employment and economic opportunities. The operational phase of KCP has been depicted by the cultivation of sandy and barren lands, higher crop variety, enhanced agriculture output, productivity and yield. The sustained water availability enabled the farmers to focus on crop diversity, fostering economic stability, improved food security and sustained agricultural growth. The operationalization of KCP has profoundly improved the socio-economic conditions. The social and armed conflict has significantly reduced. This period brought widespread prosperity to the region. In contrast to the operational phase of KCP, the post-flood phase of KCP is distinguished by significant socio-economic challenges, severe water scarcity, migration of farmers to other provinces, damage to agricultural output, productivity, yield, and making land infertile as land levelling has damaged the rain-fed system. The socio-economic conditions deteriorated significantly. The social and armed conflict resurged in the region.

The economic and financial analysis has been carried out using net present value, benefit-cost ratio, and internal rate of return. The sensitivity analysis has also been carried out. The findings of economic and financial analysis indicate that the canal is economically and financially viable only if the reconstruction starts in 2024-25. This study concludes that any delay in restoration work or in the case of any massive flooding would make this project financially unviable.

RECOMMENDATIONS

Canals have historically been a substantial contributor to improving socio-economic indicators. The KCP project was conceived with the right intent to transform the socio-economic landscape of the population of Balochistan. However, cost overruns and project delays have substantially enhanced the cost effect and delayed the promised returns. Even after its completion, the project has suffered a major setback due to flash flooding, making the project non-operational. Being an agriculture-based economy, Pakistan is likely to undertake numerous such initiatives in the future as well. Cholistan Canal is also in the offing as part of the Green Pakistan Initiative. Therefore, it is imperative to take the right policy decisions in the future before the commencement of such major undertakings. The gist of a few policy implications from our study is as follows:

1. In order to keep KCP financially feasible, the restoration work needs to be completed on a priority basis. There should be special emphasis to make it climate resilient to subsequent flash flooding by devising flood control and resilience strategies, for instance, the construction of protective structures, embankments, and floodwater diversion systems.
2. Before initiating any future project, expected impact of climate change should be studied in detail and sufficient safeguards should be taken to make them climate resilient.
3. KCP is a classic case of project mismanagement, as the project costs were increased considerably and timelines for completion have been delayed by almost two decades. Although the reasons for these delays were not deliberated as they were out of scope of study objectives, there is a need to identify the root cause of these delays for future reference.
4. The raison d'etre for KCP was to reduce the backwardness of the area by improving upon socio-economic indicators, which is yet to be materialized. GoB should undertake socio-economic support programs in the region, for example, financial aid, subsidized inputs, and interest-free loans to encourage farmers and landowners to invest in tubewells and rehabilitate their lands.
5. Offer skill development programs, training, and alternative livelihoods options to attract farmers and reduce the outflow of farmers and mitigate economic distress.
6. Upon completion of the project, land disputes between tribes are likely to emerge as a major challenge in the future, which may result in a conflict situation. Therefore, there is a need to address the issue of social and armed conflicts by promoting dialogue among stakeholders and involving law enforcement agencies and tribal leaders.

BIBLIOGRAPHY

AGP (Auditor General of Pakistan). (2019). *Performance audit report on Kachhi Canal Project WAPDA Dera Ghazi Khan audit year 2017-18.* AGP, Islamabad. https://na.gov.pk/uploads/documents/1596523284_848.pdf

Ali, F. H., & Ali, A. H. S. (2023). The role of irrigation projects in the development of rural settlements conceptual framework and experiences. *IOP Conference Series: Earth and Environmental Science, 1129*(1), 012021). IOP Publishing.

Ashraf, M., Majeed, A., & Saeed, M. (2016). Impact evaluation of a Karez irrigation scheme in Balochistan-Pakistan: Issues and options. *Pakistan Journal of Agricultural Sciences*, *53*(3), 661–671.

Assefa, M., Wesseler, J. H. H., & Hengsdijk, H. (2008). *Socio-economic assessment of two small-scale irrigation schemes in Adami Tullu Jido Kombolcha Woreda, Central Rift Valley of Ethiopia*. Environmental Economics and Natural Resources Group.

Aw, D., & Diemer, G. (2005). *Making a large irrigation scheme work: A case study from Mali*. World Bank Publications.

Barau, A. D., Atala, T. K., & Agbo, C. I. (1999). Factors affecting efficiency of resource use under large scale farming: A case study of dadin kowa irrigation project, Bauchi State. *Nig. J. Rur. Econ. Soc*, *1*, 1-6.

Bertoncin, M., Pase, A., Quatrida, D., & Turrini, S. (2019). At the junction between state, nature and capital: Irrigation mega-projects in Sudan. *Geoforum*, *106*, 24-37.

Branca, G., & Natali, F. (2020). On positive externalities from irrigated agriculture and their policy implications: An overview. *Economia Agro-Alimentare, FrancoAngeli Editore*, *22*(2), 1–25.

Braun, V., & Clarke, V. (2021). One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qualitative Research in Psychology*, *18*(3), 328–352.

Cleaver, H. (1972). Cleaver, H. 1972. The contradictions of the green revolution. *American Economic Review*, *62*(2), 177–186.

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five approaches.* Sage publications.

Flyvbjerg, B. (Ed.). (2017). *The Oxford handbook of megaproject management*. Oxford University Press.

Gwiyani-Nkhoma, B. (2011). Irrigation development and its socioeconomic impact on rural communities in Malawi. *Development Southern Africa*, *28*(2), 209-223.

Hanjra, M. A., Ferede, T., & Gutta, D. G. (2009). Reducing poverty in sub-Saharan Africa through investments in water and other priorities. *Agricultural Water Management*, *96*(7), 1062–1070.

Higginbottom, T. P., Adhikari, R., Dimova, R., Redicker, S., & Foster, T. (2021). Performance of large-scale irrigation projects in sub-Saharan Africa. *Nature Sustainability*, *4*(6), 501–508.

Hirschman, A. O. (2014). *Development projects observed*. Brookings Institution Press.

Khan, R., & Malik, M. (2023). Scarcity of water in Quetta–a way forward. *Journal of Positive School*

Psychology, 1–10.

Lincoln, Y. S. (1985). *Naturalistic inquiry* (Vol. 75). Sage.

Mandal, M., Mandal, G., & Bose, A. (2020). *Development of Canal Irrigation and Socio-Economic Status of Farmers in Jalpaiguri District*. In R. S. P. Das (Ed.) *Socio-economic development and environmental sustainability: The Indian perspective* (pp. 268-282). Namya Press.

Manggat, I., Zain, R., & Jamaluddin, Z. (2018). The impact of infrastructure development on rural communities: A literature review. *International Journal of Academic Research in Business and Social Sciences*, *8*(1), 637–648.

Masela, Z., Mushunje, A., Ngarava, S., Taruvinga, A., & Tatsvarei, S. (2018). Benefits of an irrigation scheme and its determinants to surrounding peripheral rural communities. *Journal of Economics and Behavioral Studies*, *10*(6(J)), 79-90.

Moris, J. R. (1990). *Irrigation development in Africa: Lessons of Experience*. Routledge.

Muthuminal, R., & Priya, R. M. (2023). An outlook over smart irrigation system for sustainable rural development. In M. A. Khan, B. Gupta, A. R. Verma, P. Praveen, and C. J. Peoples (Eds.) *Smart village infrastructure and sustainable rural communities* (pp. 134-160). IGI Global.

Nadeem, A. M., Ali, T., Wei, W., Cui, Q., & Huang, S. (2021). can irrigation conditions improve farmers' subjective well-being? An investigation in rural Pakistan. *Water*, *13*(4), 505.

Nathan, L. A. V., & Sinha, S. K. (2013). Irrigation development profile under accelerated irrigation benefits programme. *NDCWWC Journal (A Half Yearly Journal of New Delhi Centre of WWC)*, *2*(1), 15–29.

Pietz, D. A., & Zeisler-Vralsted, D. (2021). Water and production. *Water and Human Societies: Historical and Contemporary Perspectives*, 55–79.

Ramzan, S. (2013). Ownership and management of natural resources in federal systems: cChallenges, prospects and a way forward for Balochistan. *Public Policy and Administration Research*, *3*(1), 42.

Razzaq, A., Rehman, A., Qureshi, A. H., Javed, I., Saqib, R., & Iqbal, M. N. (2018). An economic analysis of high efficiency irrigation systems in Punjab, Pakistan. *Sarhad Journal of Agriculture*, *34*(4), 818–826.

Rukuni, M., Tawonezvi, P., Eicher, C. K., Munyuki-Hungwe, M., & Matondi, P. B. (Eds.). (2006). *Zimbabwe's agricultural revolution revisited* (pp. 119-140). Harare: University of Zimbabwe publications.

Shah, S. A. H. (2018). *Appraisal of PSDP projects' implementation*. Ministry of Planning, Development & Special Initiatives, Islamaabd.

Shah, T., Van Koppen, B., de Lange, D. M. M., & Samad, M. (2002). *Institutional alternatives in African smallholder irrigation: Lessons from international experience with irrigation management transfer.* International Water Management Institute, Colombo.

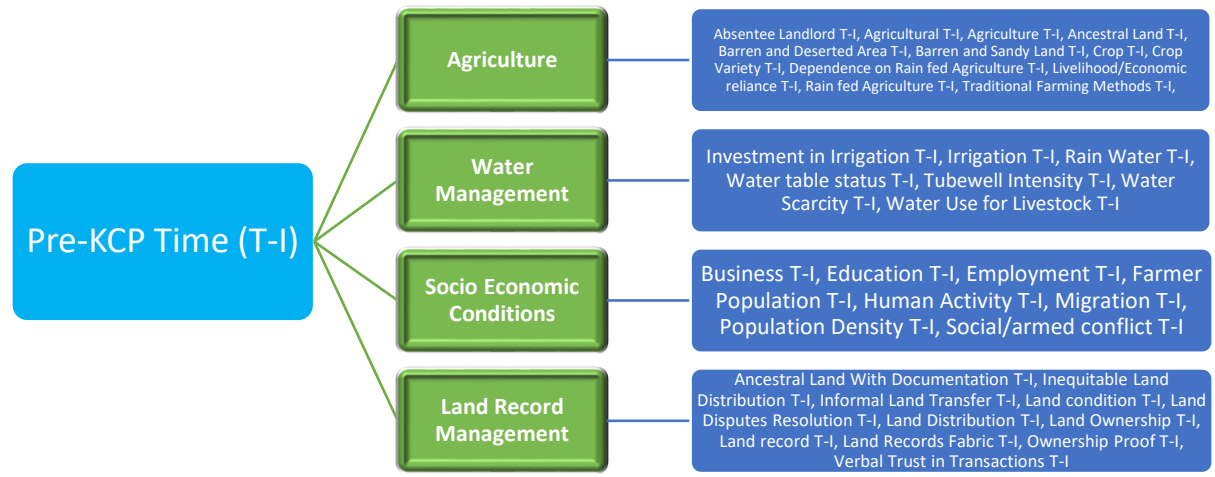
Turdalieva, A., & Abdiyeva, R. (2002). The impact of access to irrigation on rural household income in Kyrgyzstan [Conference paper]. International Conference on Eurasian Economies, 20-22 September 2022, Baku, Azerbaijan.

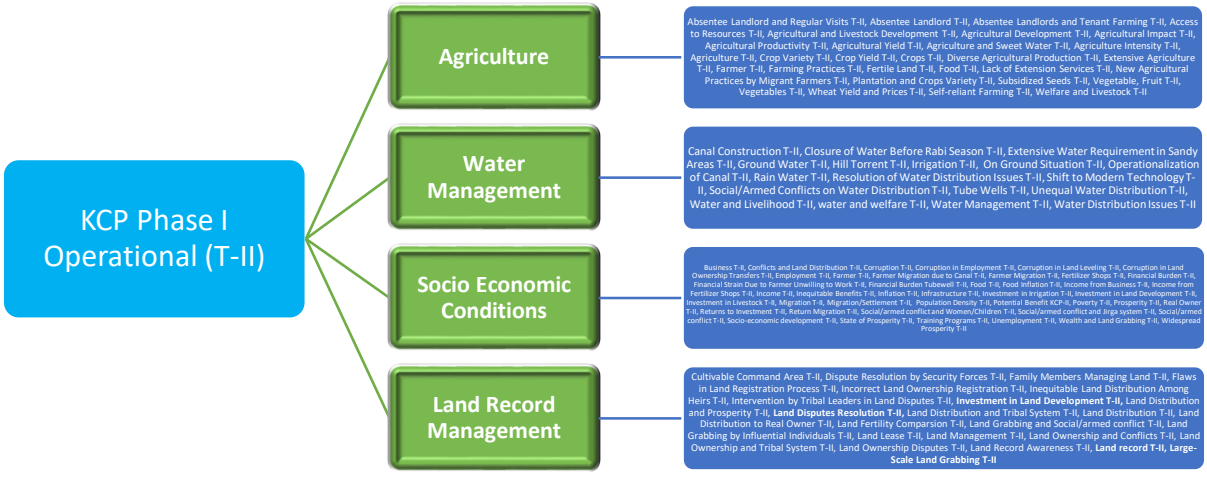
UNPO. (2017). *Balochistan: Malnutrition and child mortality still rampant. UNICEF* https://unpo.org/article/19756.

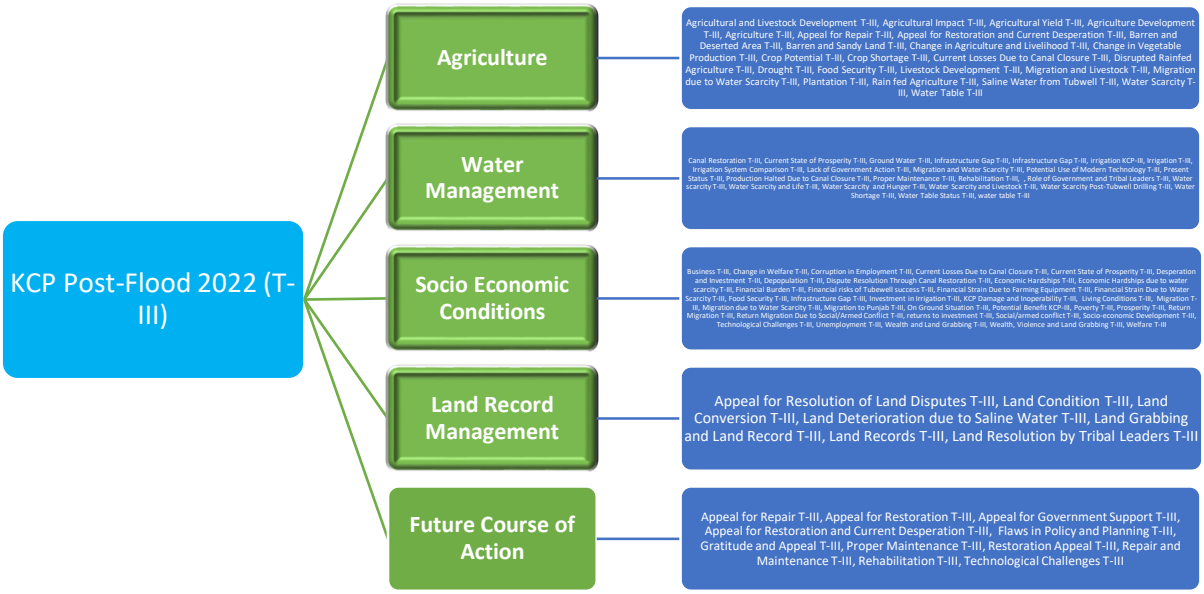
WAPDA (Water and Power Development Authority). (2023). Kachhi Canal Project. http://archive.wapda.gov.pk/index.php/projects/water-sector/o-m/kachhi-canal-project

APPENDICES

Appendix A: Thematic Map for Each Sub-Theme






KCP Post-Flood 2022 (T-III)
Agriculture
Agricultural and Livestock Development T-III, Agricultural Impact T-III, Agricultural Yield T-III, Agriculture Development T-III, Agriculture T-III, Appeal for Repair T-III, Appeal for Restoration and Current Desperation T-III, Barren and Deserted Area T-III, Barren and Sandy Land T-III, Change in Agriculture and Livelihood T-III, Change in Vegetable Production T-III, Crop Potential T-III, Crop Shortage T-III, Current Losses Due to Canal Closure T-III, Disrupted Rainfed Agriculture T-III, Drought T-III, Food Security T-III, Livestock Development T-III, Migration and Livestock T-III, Migration due to Water Scarcity T-III, Plantation T-III, Rain fed Agriculture T-III, Saline Water from Tubwell T-III, Water Scarcity T-III, Water Table T-III
Water Management
Canal Restoration T-III, Current State of Prosperity T-III, Ground Water T-III, Infrastructure Gap T-III, Infrastructure Gap T-III, irrigation KCP-III, Irrigation T-III, Irrigation System Comparison T-III, Lack of Government Action T-III, Migration and Water Scarcity T-III, Potential Use of Modern Technology T-II, Present Status T-III, Production Halted Due to Canal Closure T-III, Proper Maintenance T-III, Rehabilitation T-III, , Role of Government and Tribal Leaders T-III, Water scarcity T-III, Water Scarcity and Life T-III, Water Scarcity and Hunger T-III, Water Scarcity and Livestock T-III, Water Scarcity Post-Tubwell Drilling T-III, Water Shortage T-III, Water Table Status T-III, water table T-III
Socio Economic Conditions
Business T-III, Change in Welfare T-III, Corruption in Employment T-III, Current Losses Due to Canal Closure T-III, Current State of Prosperity T-III, Desperation and Investment T-III, Depopulation T-III, Dispute Resolution Through Canal Restoration T-III, Economic Hardships T-III, Economic Hardships due to water scarcity T-III, Financial Burden T-III, Financial risks of Tubewell success T-III, Financial Strain Due to Farming Equipment T-III, Financial Strain Due to Water Scarcity T-III, Food Security T-III, Infrastructure Gap T-III, Investment in Irrigation T-III, KCP Damage and Inoperability T-III, Living Conditions T-III, Migration T-III, Migration due to Water Scarcity T-III, Migration to Punjab T-III, On Ground Situation T-III, Potential Benefit KCP-III, Poverty T-III, Prosperity T-III, Return Migration T-III, Return Migration Due to Social/Armed Conflict T-III, returns to investment T-III, Social/armed conflict T-III, Socio-economic Development T-III, Technological Challenges T-III, Unemployment T-III, Wealth and Land Grabbing T-III, Wealth, Violence and Land Grabbing T-III, Welfare T-III
Land Record Management
Appeal for Resolution of Land Disputes T-III, Land Condition T-III, Land Conversion T-III, Land Deterioration due to Saline Water T-III, Land Grabbing and Land Record T-III, Land Records T-III, Land Resolution by Tribal Leaders T-III
Future Course of Action
Appeal for Repair T-III, Appeal for Restoration T-III, Appeal for Government Support T-III, Appeal for Restoration and Current Desperation T-III, Flaws in Policy and Planning T-III, Gratitude and Appeal T-III, Proper Maintenance T-III, Restoration Appeal T-III, Repair and Maintenance T-III, Rehabilitation T-III, Technological Challenges T-III

Appendix B: Benefit Cost Ratio, IRR and NPV Analysis

Agriculture Extension Department of Balochistan Estimates

Calculation of Economic Internal Rate of Return (Values in Rs. Million)

Years	Costs		Total Cost	Benefits	Net Benefits
	Production	**Investment**	**Total Cost**	**Benefits**	
0	14.755	4,178.27	4,193.03	29.418	-4,163.61
1	63.578	91.4	154.98	151.263	-3.72
2	65.343	252.835	318.18	158.806	-159.37
3	171.547	109.68	281.23	400.553	119.33
4	331.401	265.06	596.46	733.39	136.93
5	1,330.15	137.1	1,467.25	3,228.95	1,761.70
6	2,160.67	274.2	2,434.87	5,475.12	3,040.26
7	2,787.68	162.61	2,950.29	6,989.18	4,038.90
8	3,582.02	83.293	3,665.31	8,909.86	5,244.55
9	4,719.31	141.67	4,860.98	11,798.19	6,937.21
10	5,385.47	-	5,385.47	13,320.30	7,934.84
11	5,385.47	-	5,385.47	13,320.30	7,934.84
12	5,385.47	-	5,385.47	13,320.30	7,934.84
13	5,385.47	-	5,385.47	13,320.30	7,934.84
14	5,385.47	-	5,385.47	13,320.30	7,934.84
15	5,385.47	-	5,385.47	13,320.30	7,934.84
16	5,385.47	-	5,385.47	13,320.30	7,934.84
17	5,385.47	-	5,385.47	13,320.30	7,934.84
18	5,385.47	-	5,385.47	13,320.30	7,934.84
19	5,385.47	-	5,385.47	13,320.30	7,934.84
20	5,385.47	-	5,385.47	13,320.30	7,934.84
Benefit Cost Ratio					
	10%		2.01		
	12%		1.94		
	15%		1.81		
Net Present Value					
	10%		25,466.00	(Million Rs.)	
	12%		19,513.16	(Million Rs.)	
	15%		13,103.92	(Million Rs.)	
<u>Economic Internal Rate of Return</u>					
	EIRR		33.65%		

Calculation of Financial Internal Rate of Return (in Rs. Million)

Years	Costs		Total Cost	Benefits	Net Benefits
	Production	**Investment**			
0	14.755	4,570.88	4,585.64	29.418	-4,556.22
1	69.56	100	169.56	165.496	-4.064
2	75.128	276.625	351.753	182.562	-169.192
3	209.84	120	329.84	487.518	157.677
4	445.728	290	735.728	976.168	240.44
5	1,900.93	150	2,050.93	4,574.76	2,523.83
6	2,732.18	300	3,032.18	6,903.32	3,871.15
7	3,597.30	177.91	3,775.21	8,993.73	5,218.53
8	4,818.15	91.13	4,909.28	11,928.58	7,019.30
9	5,892.15	155	6,047.15	14,573.50	8,526.35

10	5,892.20	-	5,892.20	14,573.64	8,681.44
11	5,892.20	-	5,892.20	14,573.64	8,681.44
12	5,892.20	-	5,892.20	14,573.64	8,681.44
13	5,892.20	-	5,892.20	14,573.64	8,681.44
14	5,892.20	-	5,892.20	14,573.64	8,681.44
15	5,892.20	-	5,892.20	14,573.64	8,681.44
16	5,892.20	-	5,892.20	14,573.64	8,681.44
17	5,892.20	-	5,892.20	14,573.64	8,681.44
18	5,892.20	-	5,892.20	14,573.64	8,681.44
19	5,892.20	-	5,892.20	14,573.64	8,681.44
20	5,892.20	-	5,892.20	14,573.64	8,681.44
Benefit Cost Ratio					
	at 10%		2.03		
	at 12%		1.96		
	at 15%		1.84		
Net Present Value					
	at 10%		29,833.70	(Million Rs.)	
	at 12%		23,055.85	(Million Rs.)	
	at 15%		15,719.85	(Million Rs.)	
Financial Internal Rate of Return					
	IRR		35.46%		

Scenario A: 25% of Rainfed

Calculation of Economic Internal Rate of Return (Values in Rs. Million)

Years	Costs		Total Cost	Benefits	Net Benefits
	Production 25% of rainfed	Investment			
Without Project_ Rainfed Agri Sys	14.755	4,178.27	4,193.03	29.418	-4,163.61
2015-16	63.578	91.4	154.98	151.263	-3.72
2016-17	65.343	252.835	318.18	158.806	-159.37
2017-18	171.547	109.68	281.23	400.553	119.33
2018-19	331.401	265.06	596.46	733.39	136.93
2019-20	1,330.15	137.1	1,467.25	3,228.95	1,761.70
2020-21	2,160.67	274.2	2,434.87	5,475.12	3,040.26
2021-22	2,787.68	162.61	2,950.29	6,989.18	4,038.90
2022-23	3.69	3,761.22	3,764.91	7.35	-3,757.56
2023-24	3.69	3,819.6	3,823.29	7.35	-3,815.93
2024-25	3.69	3,677.93	3,681.62	7.35	-3,674.26
2025-26	2,787.68		2,787.68	6,989.18	4,201.51
2026-27	2,787.68		2,787.68	6,989.18	4,201.51
2027-28	2,787.68		2,787.68	6,989.18	4,201.51
2028-29	2,787.68		2,787.68	6,989.18	4,201.51
2029-30	2,787.68		2,787.68	6,989.18	4,201.51
2030-31	2,787.68		2,787.68	6,989.18	4,201.51
2031-32	2,787.68		2,787.68	6,989.18	4,201.51
2032-33	2,787.68		2,787.68	6,989.18	4,201.51
2033-34	2,787.68		2,787.68	6,989.18	4,201.51

2034-35	2,787.68		2,787.68	6,989.18	4,201.51
Benefit Cost Ratio					
	10%		1.29		
	12%		1.22		
	15%		1.11		
Net Present Value					
	10%		5,393.28	(Million Rs.)	
	12%		3,403.28	(Million Rs.)	
	15%		1,364.32	(Million Rs.)	
Economic Internal Rate of Return					
	EIRR		18.18%		

Calculation of Financial Internal Rate of Return (in Rs. Million)

Years	Costs		Total Cost	Benefits	Net Benefits
	Production 25% of rainfed	Investment			
Without Project_ Rainfed Agri Sys	14.755	4,570.88	4,585.64	29.418	-4,556.22
2015-16	69.56	100	169.56	165.496	-4.06
2016-17	75.128	276.625	351.75	182.562	-169.19
2017-18	209.84	120	329.84	487.518	157.68
2018-19	445.728	290	735.73	976.168	240.44
2019-20	1,900.93	150	2,050.93	4,574.76	2,523.83
2020-21	2,732.18	300	3,032.18	6,903.32	3,871.15
2021-22	3,597.30	177.91	3,775.21	8,993.73	5,218.53
2022-23	3.69	4115.13	4,118.82	7.35	-4,111.46
2023-24	3.69	4179	4,182.69	7.35	-4,175.33
2024-25	3.69	4024	4,027.69	7.35	-4,020.33
2025-26	3,597.30		3,597.30	14,573.64	10,976.34
2026-27	3,597.30		3,597.30	14,573.64	10,976.34
2027-28	3,597.30		3,597.30	14,573.64	10,976.34
2028-29	3,597.30		3,597.30	14,573.64	10,976.34
2029-30	3,597.30		3,597.30	14,573.64	10,976.34
2030-31	3,597.30		3,597.30	14,573.64	10,976.34
2031-32	3,597.30		3,597.30	14,573.64	10,976.34
2032-33	3,597.30		3,597.30	14,573.64	10,976.34
2033-34	3,597.30		3,597.30	14,573.64	10,976.34
2034-35	3,597.30		3,597.30	14,573.64	10,976.34
	Benefit Cost Ratio				
	at 10%		1.93		
	at 12%		1.80		
	at 15%		1.61		
	Net Present Value				
	at 10%		20,706.61	(Million Rs.)	
	at 12%		15,028.54	(Million Rs.)	
	at 15%		9,161.60	(Million Rs.)	
	Financial Internal Rate of Return				
	IRR		27.24%		

Scenario B: If repair starts in 2024-25

Calculation of Economic Internal Rate of Return (Values in Rs. Million)

Years	Costs		Total Cost	Benefits	Net Benefits
	Production 25% of rainfed	**Investment**			
Without Project_ Rainfed Agri Sys	14.755	4,178.27	4,193.03	29.418	-4,163.61
2015-16	63.578	91.4	154.98	151.263	-3.72
2016-17	65.343	252.835	318.18	158.806	-159.37
2017-18	171.547	109.68	281.23	400.553	119.33
2018-19	331.401	265.06	596.46	733.39	136.93
2019-20	1,330.15	137.1	1,467.25	3,228.95	1,761.70
2020-21	2,160.67	274.2	2,434.87	5,475.12	3,040.26
2021-22	2,787.68	162.61	2,950.29	6,989.18	4,038.90
2022-23	3.69	83.293	86.98	7.35	-79.63
2023-24	3.69	141.67	145.36	7.35	-138.00
2024-25	3.69	3677.93	3,681.62	7.35	-3,674.26
2025-26	3.69	3677.93	3,681.62	7.35	-3,674.26
2026-27	3.69	3677.93	3,681.62	7.35	-3,674.26
2027-28	2,787.68		2,787.68	6,989.18	4,201.51
2028-29	2,787.68		2,787.68	6,989.18	4,201.51
2029-30	2,787.68		2,787.68	6,989.18	4,201.51
2030-31	2,787.68		2,787.68	6,989.18	4,201.51
2031-32	2,787.68		2,787.68	6,989.18	4,201.51
2032-33	2,787.68		2,787.68	6,989.18	4,201.51
2033-34	2,787.68		2,787.68	6,989.18	4,201.51
2034-35	2,787.68		2,787.68	6,989.18	4,201.51
Benefit Cost Ratio					
	10%		1.22		
	12%		1.15		
	15%		1.05		
Net Present Value					
	10%		3,580.29	(Million Rs.)	
	12%		2,087.34	(Million Rs.)	
	15%		566.88	(Million Rs.)	
Economic Internal Rate of Return					
	EIRR		16.59%		

Calculation of Financial Internal Rate of Return (in Rs. Million)

Years	Costs		Total Cost	Benefits	Net Benefits
	Production 25% of rainfed	**Investment**			
Without Project_ Rainfed Agri Sys	14.755	4,570.88	4,585.64	29.418	-4,556.22
2015-16	69.56	100	169.56	165.496	-4.06
2016-17	75.128	276.625	351.75	182.562	-169.19
2017-18	209.84	120	329.84	487.518	157.68
2018-19	445.728	290	735.73	976.168	240.44
2019-20	1,900.93	150	2,050.93	4,574.76	2,523.83

2020-21	2,732.18	300	3,032.18	6,903.32	3,871.15
2021-22	3,597.30	177.91	3,775.21	8,993.73	5,218.53
2022-23	3.69	4115.13	4,118.82	7.35	-4,111.46
2023-24	3.69	4179	4,182.69	7.35	-4,175.33
2024-25	3.69	4024	4,027.69	7.35	-4,020.33
2025-26	3.69	4024	4,027.69	7.35	-4,020.33
2026-27	3.69	4024	4,027.69	7.35	-4,020.33
2027-28	3,597.30		3,597.30	14,573.64	10,976.34
2028-29	3,597.30		3,597.30	14,573.64	10,976.34
2029-30	3,597.30		3,597.30	14,573.64	10,976.34
2030-31	3,597.30		3,597.30	14,573.64	10,976.34
2031-32	3,597.30		3,597.30	14,573.64	10,976.34
2032-33	3,597.30		3,597.30	14,573.64	10,976.34
2033-34	3,597.30		3,597.30	14,573.64	10,976.34
2034-35	3,597.30		3,597.30	14,573.64	10,976.34
	Benefit Cost Ratio				
	at 10%		1.51		
	at 12%		1.41		
	at 15%		1.26		
	Net Present Value				
	at 10%		11,584.20	(Million Rs.)	
	at 12%		7,742.42	(Million Rs.)	
	at 15%		3,921.23	(Million Rs.)	
	Financial Internal Rate of Return				
	FIRR		21.25%		