Digital ecosystems and migration responses to climate extremes: Case study from Rahim Yar Khan District, Punjab in Pakistan

Kanwal Waqar, Mohsin Hafeez, Maryam Rehman, and Hafsa Aeman

December 2024

Contents

Author Affiliation

Kanwal Waqar, Regional Researcher–Gender and Social Inclusion Specialist, IWMI Pakistan

Mohsin Hafeez, Director–Water, Food and Ecosystems; Country Representative, IWMI Pakistan

Maryam Rehman, Consultant–Gender and Social Inclusion, IWMI Pakistan

Hafsa Aeman, National Researcher–Geoinformatics, IWMI Pakistan

Acknowledgments

The International Water Management Institute (IWMI), Pakistan, prepared this report, financially supported by the CGIAR Initiative on Fragility, Conflict, and Migration (FCM). Acknowledging FCM team in Pakistan: Zeshan Ali, Sidra Khalid, and Novaira Junaid for their technical discussion and support. CGIAR is a global research partnership for a food-secure future dedicated to transforming food, land, and water systems in a climate crisis. We would like to thank all funders who supported this research through their contributions to the CGIAR Trust Fund: https://www.cgiar.org/funders/.

The team thanks all those who contributed to this study, especially the climate migrant communities for sharing their stories and experiences and all key informants for their time and insights. We also appreciate the REEDS team in Rahim Yar Khan for their support in identifying and engaging with these communities. This study was complemented by ongoing research conducted under the CGIAR Initiative on NEXUS Gains, which aims to improve integrated management across the water, energy, food and environment (WEFE) nexus for sustainable development. We are grateful to the NEXUS Gains Pakistan team for providing biophysical data and groundwater quality maps of Rahim Yar Khan district, which allowed for a deeper analysis of water and climate issues across the district.

Project

WP3 of the FCM initiative aimed to identify and evaluate scalable interventions to stabilize community and individual livelihoods in FCASs, promoting food security, gender equity, resilience, poverty reduction, social cohesion, trust, government accountability, and inclusive benefits from food, land and water systems (FLWS).

It aimed at analyzing migration's role in livelihoods and income generation and study policies supporting migrants and host communities. In fragile settings, including migrant communities, this will include rigorous evaluations (e.g., randomized controlled trials) of innovative social protection, food system development, and climate adaptation programs.

Citation

Waqar, K.; Hafeez, M.; Rehman, M.; Aeman, H. 2024. *Digital ecosystems and migration responses to climate extremes: case study from Rahim Yar Khan District, Punjab in Pakistan.* Research report. Colombo, Sri Lanka: International Water Management Institute (IWMI). CGIAR Initiative on Fragility, Conflict, and Migration. 62p.

/keywords/

Pakistan / Punjab /Rahim Yar Khan / digital ecosystem / early warnings / disaster management / community resilience / policy implications

Collaborators

International Water Management Institute (IWMI)

Rural Education & Economic Development Society (REEDS)

CGIAR Initiative on NEXUS Gains

Khwaja Fareed University of Engineering & Information Technology

Donor

This study was carried out under the CGIAR Initiative on Fragility, Conflict, and Migration, which is grateful for the support of CGIAR Trust Fund contributors (https://www.cgiar.org/funders).

Disclaimer

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS AND ACRONYMS

AI	Artificial Intelligence
DDMA	District Disaster Management Authority
DRR	Disaster Risk Reduction
EWS	Early Warning System
FCM	Fragility, Conflict, and Migration
FGDs	Focus Group Discussions
FLWS	Food, Land, and Water Systems
GIS	Geographic Information Systems
GLOF	Glacial Lake Outburst Floods
IDPs	Internally Displaced Persons
IoT	Internet of Things
KIIs	Key Informant Interviews
IWMI	International Water Management Institute
MHEWS	Multi-Hazard Early Warning System
ML	Machine Learning
NDMA	National Disaster Management Authority
NDMP	National Disaster Management Plan
NGOs	Non-Governmental Organizations
PDMA	Provincial Disaster Management Authority
PMD	Pakistan Meteorological Department

SUMMARY

The report titled "Digital Ecosystems and Migration Responses to Climate Extremes in Pakistan" focuses on the impacts of climate change, particularly in Rahim Yar Khan district, Punjab. A digital ecosystem is a network of digital technologies, individuals, and organizations working together to achieve developmental goals like poverty reduction, economic growth, and improved healthcare and disaster management. The study highlights how climate-induced events like floods and droughts have driven migration, affecting vulnerable communities, especially women. As indicated in recent study, approximately 2 million people in Pakistan are expected to become climate migrants by 2050 due to climate disasters. The report emphasizes the need for better disaster preparedness and response mechanisms, including the role of digital ecosystems, social media, and early warning systems in building community resilience. However, there are challenges, such as limited access to technology, the Gender Digital Divide, and inadequate government support for displaced populations.

The study also emphasizes the importance of strengthening institutional capacities at both local and provincial levels to effectively manage climate-induced migrations. By improving disaster response mechanisms and integrating digital technology into these processes, officials can better address the needs of affected communities. The report advocates for the development of internal migration policies that can safeguard migrants' rights and provide essential services, including health, education, and shelter, to displaced populations. Furthermore, it underscores the need for global and regional collaboration to better understand climate change impacts and to devise collective solutions that can mitigate the risks of forced migration.

The research methodology employed in this report is robust, involving household surveys, focus group discussions (FGDs), and key informant interviews (KIIs) with diverse stakeholders. This comprehensive approach provides a rich dataset that captures the lived experiences of those affected by migration and climate change, as well as the potential role that digital tools could play in enhancing their resilience.

Under the CGIAR Initiative on Fragility, Conflict and Migration, the International Water Management Institute (IWMI) in Pakistan conducted a comprehensive research case study in Rahim Yar Khan, a disaster-prone district in Punjab Province of Pakistan. One of the key components of FCM's initiative is Work Package (WP)-3, which focuses on the role of the digital ecosystem in building community resilience during climate-induced migration. The case study in Rahim Yar Khan—southern part of Punjab, a high-risk area for drought and floods, provides insights into climate vulnerabilities. As a host community for climate migrants facing multiple natural hazards, Rahim Yar Khan illustrates the complex effects of climate change on economic, social, and environmental dynamics.

Key Findings

A total of 826 climate-induced migrants were surveyed between December 2023 and January 2024 in Rahim Yar Khan, comprising 322 women and 504 men. The average household size is 7.44 family members, including an average of five children. The surveyed households are predominantly male headed, with only 24% reporting joint household heads. The primary driver of migration or displacement in Rahim Yar Khan District is overwhelmingly attributed to floods (98%), with a minority citing drought or economic factors. Majority families migrated from other districts in Punjab province, within another town or city in Rahim Yar Khan, and from neighboring Sindh province, with a very small minority having migrated from Khyber Pakhtunkhwa or Baluchistan provinces.

- Limited access to early warning systems: Less than half of the respondents reported receiving any form of early warning of extreme weather events within Rahim Yar Khan (116 respondents), and Khanpur (80 respondents) showing slightly higher rates of receiving warnings.
- Gender disparities in early warning reception: Among the respondents, 186 (58%) women and 296 (59%) men indicated they had not received any early warnings regarding changes in temperature or extreme weather events.
- Primary sources of warnings: Most early warnings were conveyed through informal channels, such as family members, neighbors, and community centers. In contrast, formal sources like television, phone calls, and radio were significantly less utilized, with only 5% of women receiving warnings via TV, compared to 8% of men.

- Mobile phone ownership: The analysis revealed a notable gender gap in mobile phone ownership, with 75% of women lacking personal mobile phones, compared to 50% of men. In contrast, 46% of men owned their own phones, while only 22% of women had access to shared devices.
- Reluctance to use social media during the 2022 floods: A significant majority of individuals across different regions refrained from using social media to share stories and warnings during the 2022 floods, with reluctance rates ranging from 61% to 87%, resulting in an overall abstention rate of 70%.
- Low engagement in social media for information sharing: During the floods, 40% of women and a substantial 77% of men, totaling 70% overall, did not utilize social media to share information or warnings. Conversely, 12% of respondents were unsure about their usage, while only 18% confirmed using social media for these purposes.

These insights highlight critical gaps in access to early warning systems, gender disparities in technology ownership, and the need for improved communication strategies in disaster preparedness and response.

Key recommendations from the study include the development of gender-sensitive digital and disaster response policies that address the specific challenges faced by women in accessing information and resources during disasters. It also calls for the capacity building of local institutions to ensure that they are equipped to respond to future climate events effectively. Additionally, the report highlights the need for the expansion and improvement of early warning systems, ensuring they are accessible to all, particularly marginalized groups. Finally, it stresses the integration of digital tools into disaster response strategies to improve coordination, information flow, and resource allocation in times of crisis, ultimately helping to reduce the vulnerability of affected populations.

This research report is one of several outputs contributing to the FCM Initiative in Pakistan. A technical report of Pakistan's early warning systems (EWS) and digital ecosystems provides a deeper analysis of respondents' access to EWS and use of technology during disasters, including a gender analysis of access to information and technology after the 2022 floods. A second companion report provides a retrospective analysis of Pakistan's 2022 flood response and more details on Pakistan's disaster management policy landscape, gaps in disaster management through a closer analysis of the 2022 flood response and areas for improving anticipatory action (WP1.6). A third report outlines the development of a Climate Vulnerability Index (CVI) for District Rahim Yar Khan (WP1.5).

CHAPTER 1 BACKGROUND AND INTRODUCTION

1.1 Introduction

According to the Global Climate Risk Index, between 1999 and 2018, Pakistan witnessed 152 extreme weather events with the loss of 9,989 lives (Nisar 2022). Blistering heat waves, torrential rains, lingering dry spells, and water shortages have further exacerbated the governance challenges in Pakistan. However, climate-induced migration is another significant climate impact that has been overlooked and understudied, especially in Pakistan. The last decade has seen a growth in climate migrants moving towards urban cities due to weather calamities. Approximately 2 million people in Pakistan are expected to become climate migrants by 2050 due to climate disasters (Chandrashekhar 2023). Another report by Action Aid suggests that even with emission reduction, 600,000 people will get displaced due to climate events by 2030 (Prescia 2021).

Climate change is altering migration patterns throughout the Global South, but the poorest and most vulnerable people are the most impacted. Pakistan's economy is agrarian, and three in every four people living in poverty depend on agriculture and natural resources for survival. The increased competition over scarce water resources and food, exacerbated by climate change, is a matter of life and death for poor communities (UN 2021).

In Pakistan, the changing climatic events such as floods, extreme rainfall, and heat waves are causing sudden loss of livelihood sources, crop failure, and damage to life and property. As a result, human and ecosystem vulnerability to climate change has become manifold, leading to increased migration flows and displacement in all ecological zones of Pakistan. In the past, for instance, people of the northern mountains used to migrate to the areas close to their trade routes. However, their migration pattern has changed due to extreme climatic conditions. Now, they willingly or forcibly migrate to urban areas such as Karachi, Lahore, and Islamabad in search of their livelihood. The plains of Pakistan show similar trends of migration flows, where most of the national population resides (Salik et al. 2020).

However, the impacts of climate change do not affect everyone equally. Women disproportionately bear the burden of the effects of climate change, which are often aggravated in times of conflict and political instability (Husaini and Davies 2022). Women bear the more significant burden of climate change impacts because of their traditional roles as caretakers and providers of food, water, and family welfare within the households, as well as work responsibilities that are mostly confined to agricultural labor. When crops are damaged because of climate change, women have limited opportunities to make a living. Addressing negative gender norms at every level of planning and programming, whether livelihoods, nutrition, water management, or any other area, is critical to avoid conflicts. If women do not have agency, control, or decision-making power over their resources, it can't be utilized efficiently, and the benefits of the resources can't be shared to generate sustainable livelihoods, guarantee peace, or achieve sustainable human development (Action Aid 2020).

1.2 Vulnerabilities

Disasters, from hurricanes to floods, can have devastating and long-term impacts on communities (Waseem and Rana 2023). In the Global Climate Risk Index (2021), Pakistan is ranked as the world's eighth most vulnerable country to long-term climate risk during the last 10 years. It faces high exposure to various forms of flooding and has some vulnerability to tropical cyclones—jointly ranked 40th, and drought—jointly ranked 43rd. Despite its considerable distance from the Arctic region, Pakistan's environmental landscape has been significantly impacted by Arctic warming. Pakistan has over 7,200 glaciers rapidly melting due to higher temperatures, adding more water to overflowing rivers and lakes. Glacial lakes rapidly expand, and the ice barriers in mountainous regions form "glacial lake outbursts," making Pakistan more vulnerable to floods (Chandrashekhar 2023).

In the past 17 years, Pakistan has faced three significant crises affecting nearly 28 million residents. These include the 2005 earthquake impacting 3.5 million people, the 2010 floods affecting over 20 million people, and the 2008-2010 Internally Displaced Persons (IDP) crisis displacing 4.2 million people (Raza 2022). The most common natural

hazards that did not escalate into disasters include the 2010 and the 2022 super floods. Significant climatic events in Pakistan's history include persistent drought that prevailed in the southern part of the country during 1998-2002 and again in 2014 and 2015; an extreme heat wave in 2015, where over 65,000 people were hospitalized with heat stroke; and the 2010 catastrophic flood which affected one-fifth of the country—20 million people and claimed over 2,000 lives (FAO 2022).

1.3 Floods

The flooding events have severely impacted the impoverished communities in the affected regions in Pakistan, with its repercussions significantly affecting women who were already facing difficult circumstances (UNFPA 2023). As per the United Nations Development Programme (UNDP), women and children face a significantly higher risk of fatalities during natural disasters, being 14 times more vulnerable than men (UNDP 2022).

The 2010 flooding event led to a staggering economic loss of US$ 9.7 billion. The event alone resulted in a cumulative financial loss of US$ 10 billion as well as the deaths of 1,985 people. It affected approximately 20 million people nationwide who lost their homes and livelihoods (World Bank 2022). Fifty percent of the population affected were women (IDMC 2022a). The floods resulted in leaving more than 7 million people homeless and destroying at least 1.8 million homes. This flooding caused damage across 46 of the country's 135 districts (Yaseen et al. 2023). The rural economy suffered greatly, affecting sectors such as agriculture, fertilizers, agricultural machinery, livestock, animal shelters, personal seed stocks, fisheries, and forestry, and caused damage to 80% of the national food reserve (Schiffling et al. 2020).

In 2022, around 15 million people were again directly exposed to or near flood areas. The 2022 flooding was caused by the intense monsoon rains during the summer season, further intensified by extremely heavy rainfall, especially in August 2022, majorly affecting the provinces of Sindh and Baluchistan. During this period, Pakistan saw a remarkable 243% increase in rainfall compared to the average, with 192.7mm recorded against the normal 56.2mm. This made it the wettest August on record since 1961 (PMD 2022). The flooding impacted more than 33 million individuals, destroying 1.7 million homes and resulting in nearly 1500 casualties (Gul 2022). According to the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA), infrastructure damage included 6,700 kilometers of roads, 269 bridges, and 1,460 healthcare facilities destroyed (OCHA 2022a), along with 18,590 schools damaged (Save the Children 2022). Approximately 750,000 livestock perished, and around 18,000 square kilometers of cropland, including 45% of the cotton crop (a key export) were ruined (Mangi 2022). The loss of food crops amounted to approximately US$2.3 billion (Mangi 2022).

1.3.1 Drought

Droughts pose significant threats, particularly in the arid regions of Pakistan. Southern Pakistan is highly vulnerable to the impacts of climate change (Naz et al. 2020), with a substantial portion of the region experiencing severe drought conditions and reduced precipitation. According to the Pakistan Meteorological Department (PMD), severe to extreme drought conditions are prevalent across much of Southern Pakistan, with eight districts in Sindh experiencing moderate to severe drought in 2022. Although light to moderate rainfall was recorded across Pakistan in February 2022, overall precipitation from January to April was below normal. April 2022 was found to be a largely deficient-rain month with only 5.9mm (area-weighted) rain against its normal of 22.5mm (PMD 2022). January's rainfall mitigated the earlier drought conditions, but a subsequent rise in daily maximum temperatures led to a heatwave, particularly affecting regions with low rainfall, such as Sindh, Baluchistan, Southern Khyber Pakhtunkhwa, and Southern Punjab.

The heatwave exacerbated drought conditions in these high-temperature areas, impacting agriculture, water resources, and livestock, with adverse effects expected until mid-June 2022 as per the seasonal forecast from the PMD (PMD 2022). Parts of south-west Baluchistan, southern Khyber Pakhtunkhwa, south-east Sindh, and Southern Punjab have experienced persistent moderate to severe drought conditions for at least the past six years (Prescia 2021). The Cholistan region in Punjab also experienced a severe heatwave in March-April 2022, affecting water sources, vegetation, and livestock. This prolonged heatwave raised concerns about potential drought due to water depletion and reduced soil moisture (PMD 2022). Furthermore, five significant desert locust outbreaks occurred in South Asia, impacting crop yields and causing losses estimated at around US$3 billion in Pakistan (FAO 2022).

As climate extremes become more frequent, the vulnerability of women and girls also escalates due to their restricted access to resources, exclusion from decision-making processes, lack of land ownership, and exposure to

systemic violence (McCarthy 2020). During droughts, women engaged in agricultural activities for income travel long distances, leading to heightened risks of injuries and incidents of sexual violence (Abbasi et al. 2021).

1.3.2 Health challenges

Immediate health risks following floods include drowning, injuries, burns, hypothermia, electrocution, and carbon monoxide poisoning (Alied et al. 2024). There's also a potential risk of snake bites, as observed during the floods in 2022 in Pakistan (Daily Times 2022). Malnutrition is another primary concern during floods, with over 3 million children at heightened risk in Pakistan alone (UNICEF 2022). Additionally, ensuring the well-being of pregnant women, safe deliveries, and access to quality reproductive health services pose significant challenges for healthcare workers during such crises (UNFPA 2022). Reports indicate that 45 districts across Baluchistan, Sindh, Punjab, Khyber Pakhtunkhwa, and Islamabad have seen outbreaks of acute watery diarrhea. Among displaced individuals living in unhygienic conditions for extended periods, common illnesses include acute diarrhea, typhoid fever, and skin diseases, in addition to malaria (OCHA 2022b). Before the floods, Pakistan witnessed an increase in cholera cases, notably in regions like Khyber Pakhtunkhwa, Sindh, Punjab, and Baluchistan. Efforts to establish oral cholera vaccine distribution and surveillance programs were underway, but the onset of floods likely delayed or disrupted many of these initiatives (Minicucci 2022).

Pakistan has one of the highest maternal mortality rates (MMR) in South Asia with 186 deaths per 100,000 live births in 2019, a 32% increase from 2017 (140/100,000 livebirths) (Shaeen et al. 2022). Most affected were specifically the rural areas, with an MMR of 199 per 100,000 live births, as compared to the urban areas with an MMR of 158 per 100,000 live births. In the flood-affected regions, the maternal mortality rate surged to 381 per 100,000 live births, underscoring the heightened risks faced by pregnant women during such disasters (Puskur and Mishra 2022). Water and vector-borne diseases and respiratory illnesses remain major health concerns in flood-affected areas of Sindh and Baluchistan (OCHA 2022c). In Sindh, officials reported over 137,000 cases of diarrhea, 10,000 cases of dysentery, and 4,000 malaria cases in September 2022, prompting the setup of 450 medical camps. In August 2022, UNFPA Pakistan estimated that over 650,000 pregnant women in flood-hit regions urgently needed maternal health services, with 73,000 expected to deliver in September (UNFPA 2022). Numerous instances have been reported where pregnant women have delivered their babies in hazardous locations due to the collapse of their homes and nearby hospitals during the floods (Wallen and Yusufzai 2022).

1.4 Climate-induced displacement and migration

In 2021, South Asia experienced significant internal displacements due to disasters, affecting 5.3 million people, with Pakistan recording 70,000 internal displacements (IDMC 2022b). Climate models predict that Pakistan could see up to 2 million climate migrants within its borders by 2050. While there's evidence of climate change contributing to migration, more research is needed to understand its full impact and vulnerabilities faced by migrant and host communities. Displacement trends in Pakistan show temporary shifts due to disasters, but slow-onset climate-driven migration may be more permanent and extensive (Khalid et al. 2024). Current data lacks insights into how climate change interacts with social, political, economic, and demographic factors (UNDP 2022).

Patterns of climate-induced displacement and migration are evident across all provinces of Pakistan, stemming from diverse causes. In Khyber Pakhtunkhwa and Gilgit-Baltistan, seasonal or permanent migration occurs due to Glacial Lake Outburst Floods (GLOF), flash floods, and riverine flooding. In Sindh's coastal areas, sea intrusion due to deforestation is eroding arable land, prompting local communities to migrate (Nisar 2022). Islamic Relief (2021) report suggests that Thatta and Badin in Sindh may be submerged by 2050, leading to significant internal displacement. Drought and water scarcity also drive climate-induced migration, particularly in Baluchistan and Sindh (Islamic Relief 2021). Since 2000, droughts and dry spells have disrupted livelihoods, causing food insecurity, famine, and livestock losses. Water scarcity has forced locals to migrate seasonally, with two observed patterns: families moving to areas with better resources and economic opportunities and men migrating for job prospects to support their families (Nisar 2022). For instance, in 2018, severe drought and water shortages compelled 33,000 residents of Noshki village in Baluchistan to migrate (The News International 2022).

Moreover, extreme climatic events, including flash floods and extreme wind in the summer every year, have forced the nomadic and impoverished communities residing along riverbanks in Southern Khyber Pakhtunkhwa to relocate to other regions (Islamic Relief 2021). Flash floods have washed away homes along the riverbanks, while raising underground water levels, leading to waterlogging. Since these communities heavily rely on agriculture for

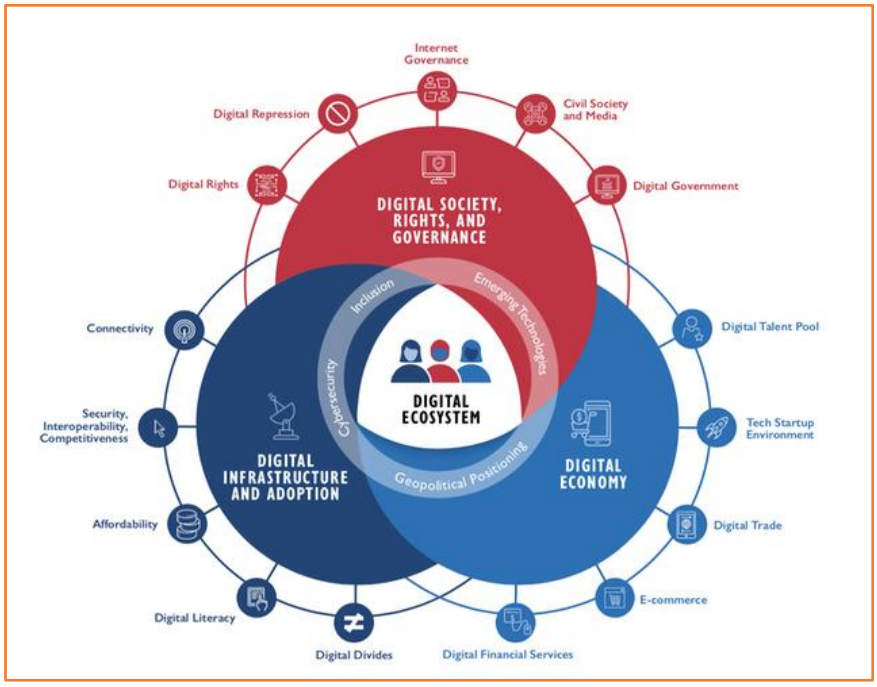
their livelihoods and waterlogged areas are unsuitable for farming, they have been forced to migrate to other areas within Khyber Pakhtunkhwa and Punjab (Islamic Relief 2021). Persistent and recurrent droughts in Baluchistan have led to a rise in seasonal and permanent migration among its people. Following traditional patterns, Khuzdar communities relocate to Sindh, while those from Barkhan and nearby areas move towards Punjab (Prescia 2021).

The floods of 2010 highlighted the stark inequality present in society. During this period, nearly half of the 1.5 million internally displaced individuals in Sindh province were women. In certain affected villages, men chose not to evacuate to relief camps due to the belief that taking women out of their villages would compromise their honor. Despite facing disease, food shortages, and livelihood problems, families remain hesitant to jeopardize their women's honor (Maheen and Hoban 2017).

1.5 Digital ecosystems

A digital ecosystem is a network of digital technologies, individuals, and organizations working together to achieve developmental goals like poverty reduction, economic growth, and improved healthcare and disaster management. In humanitarian aid, this ecosystem includes software, hardware, data, networks, and devices managed by national and local stakeholders (Figure 1) (Vota 2022).

Figure 1. Digital ecosystems



Source: Vota, 2022

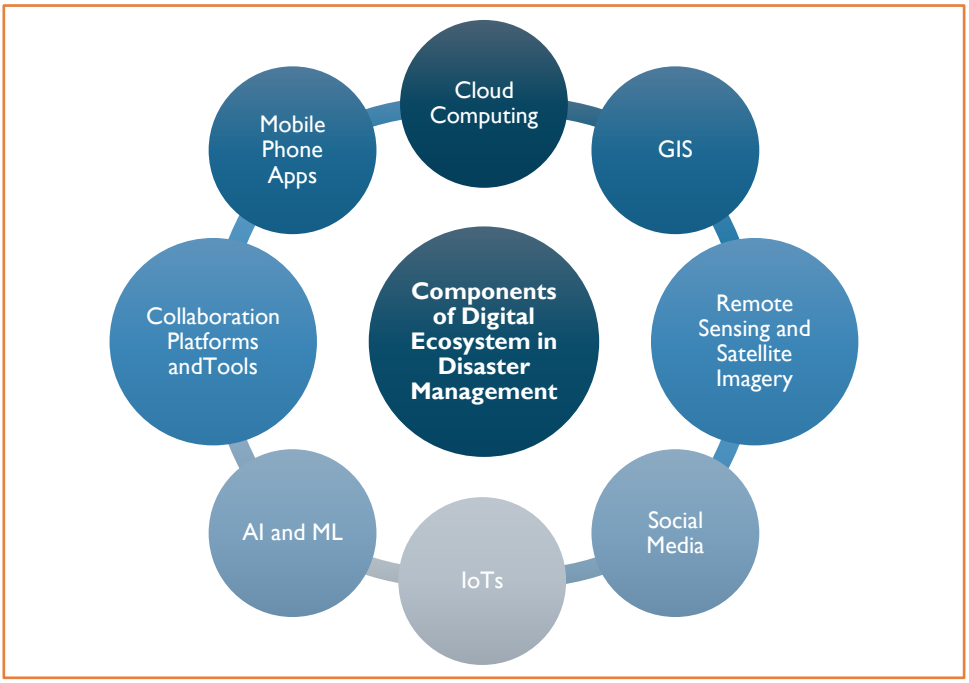
1.5.1 Components of digital ecosystem

Digital ecosystems for disaster risk reduction encompass a network of technologies, organizations, and individuals dedicated to managing and reducing disaster risks. This includes early warning systems, disaster response technologies, data management, and communication tools (Srinivas 2023). According to United Nations Office for disaster risk reduction (UNDRR) 2022, major components of the digital ecosystem in disaster management include (Figure 2):

- Cloud Computing allows storing, processing, and analyzing large amounts of data without relying solely on local infrastructure. It enables organizations to access resources on-demand, scale operations as needed and collaborate in real-time during disaster events.
- Geographic Information Systems (GIS) technologies are essential for mapping and spatial analysis in disaster risk reduction. They help visualize hazards, vulnerabilities, and assets, allowing for informed decision-making and resource allocation.

- Remote Sensing and Satellite Imagery including aerial surveys provide valuable data for assessing damage, monitoring environmental changes, and supporting recovery efforts in disaster-affected regions.
- Social media platforms play a crucial role in disseminating real-time information, gathering situational updates from affected communities (crowdsourcing), and facilitating communication among responders and affected individuals.
- Internet of Things (IoT) devices such as sensors, drones, and wearables provide real-time data on environmental conditions, infrastructure integrity, and health status, enhancing situational awareness and early warning capabilities.
- Artificial Intelligence (AI) and Machine Learning (ML) algorithms can automate data analysis, identify patterns, optimize resource allocation, and enhance decision-making processes in disaster management operations.
- Mobile Phone Applications facilitate communication, data collection, reporting, and coordination among responders, volunteers, and affected populations.
- Collaboration Platforms and communication tools enable stakeholders from different organizations, sectors, and geographical locations to collaborate, share information, and coordinate activities seamlessly during disaster response and recovery phases.

Figure 2. Components of digital ecosystem



Source: UNDRR, 2022

1.5.2 Government of Pakistan initiatives towards digital ecosystem

The Government of Pakistan has taken various measures to foster and drive digital transformation. Initiatives such as Pakistan Vision 2025 and the Digital Policy of Pakistan 2018 have played a pivotal role in reshaping the digital environment to support institutions and people to combat the impacts of climate change and how people and institutions interact within it. Nevertheless, Pakistan faces several socio-economic obstacles that impede the attainment of universal digital access. These challenges are exacerbated by socio-economic factors that make families less inclined to invest in digital devices for women and grant them the same level of digital privacy as their male counterparts.

However, it is worth noting that the National Digital Policy 2018 strongly emphasizes the empowering of girls in the realm of Information and Communication Technology (ICT). The Punjab Digital Policy 2021-2025 underlines the smartification of cities in Punjab, which will deal with smart energy, smart water, smart waste management, and disaster and risk management through IoTs, AI, and machine learning. For this purpose, the government shall endeavor to:

1. Encourage innovative solutions for urban issues.
2. Set up at least five smart cities in the province.

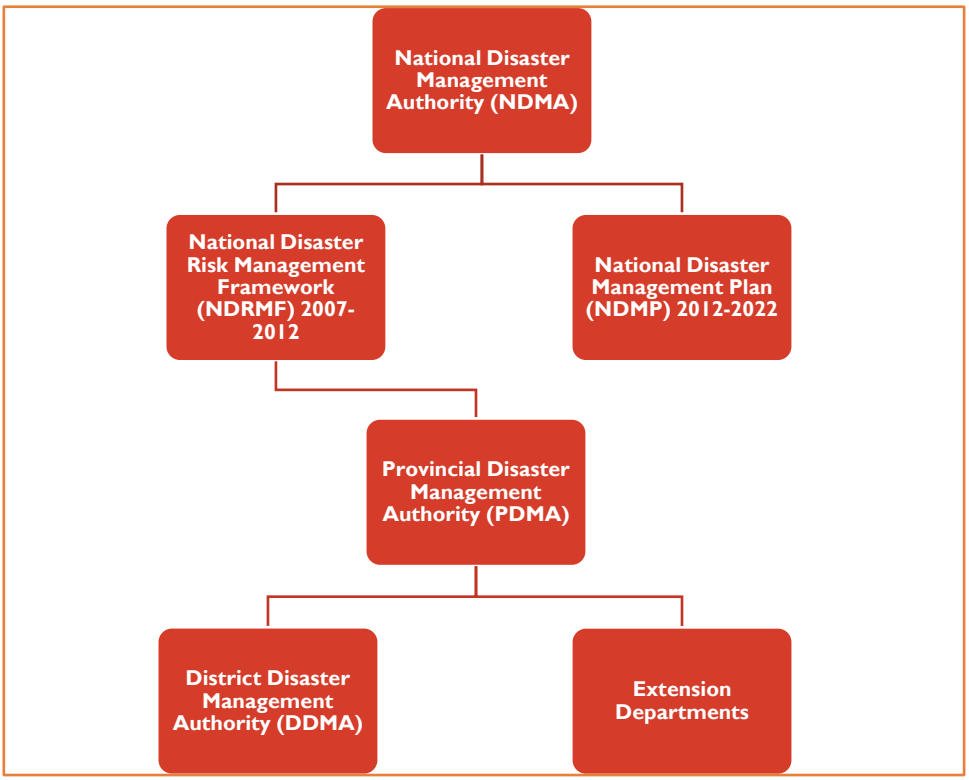
These policies strongly focus on digitizing the cities and empowering youth, but the need for rural transformation—in an inclusive way, is totally missing in building the resilience of communities during extreme events.

1.5.3 The role of digital ecosystems in disaster response and management

Digital transformation within disaster risk reduction and management (DRRM) signifies the shift towards utilizing digital technologies to develop innovative operational procedures or adapting existing ones, alongside fostering an organizational culture. This transformation addresses the complexities and interconnected aspects that contribute to disaster risks (UNDP 2022). The evolution of digital technologies encompasses high-resolution satellite imaging, cloud computing, ML, and artificial intelligence, offering substantial support for DRR and recovery efforts. Additionally, the extensive adoption of mobile phones and improved internet accessibility allows disadvantaged communities to innovate solutions and enhance their resilience.

In Pakistan, disaster management is facilitated by the National Disaster Management Authority (NDMA) through the National Disaster Risk Management Framework (NDRMF) 2007-2012 and the National Disaster Management Plan (NDMP) 2012-2022, operating within the digital ecosystem. At the provincial and district levels, the Provincial Disaster Management Authority (PDMA) and District Disaster Management Authority (DDMA) utilize digital tools and strategies to coordinate disaster response efforts in collaboration with various stakeholders (Figure 3) (PDMA 2023).

Figure 3. Disaster management system in Pakistan



The NDMA, in collaboration with the Pakistan Telecommunication Authority (PTA) and the telecommunications industry, has developed an effective early warning system for local communities at federal and provincial levels. This system is part of the NDMP's efforts to ensure timely and cost-effective dissemination of early warning messages through a comprehensive Multi-Hazard Early Warning System (MHEWS) Plan. The MHEWS Plan, with a budget of around US$188 million, includes upgrading radar stations, establishing connections between national and regional disaster management authorities, and implementing other measures to enhance early warning systems (NDMA 2023).

In partnership with the UNDP, the Ministry of Climate Change and Environmental Coordination (MoCC & EC) has launched the GLOF-I project in northern Pakistan to bolster community resilience against GLOFs. This initiative includes installing early warning and radar systems in over 200 valleys across Gilgit-Baltistan, enhancing critical infrastructure, and promoting community-based disaster risk management. The project aims to equip vulnerable communities with tools to prepare for and mitigate GLOF risks (UNDP 2023).

Natural disasters damage essential healthcare facilities, educational institutions, and land-based communication systems. To address these challenges, the Space and Upper Atmosphere Research Commission (SUPARCO) Pakistan, with its expertise in satellite communications, initiated a pilot project for Satellite Communication-based Telemedicine. This project established connectivity between two sites via PAKSAT, a communication satellite, to assess the technology's advantages for social and healthcare sectors during emergencies (ADB 2021).

The 2022 flood crisis has underscored the importance of delivering humanitarian aid efficiently and transparently, leveraging technology as a facilitator for implementation, distribution, and utilization (Sehgal 2022). With existing resources, infrastructure, and technology, initiatives such as the World Bank's "financial inclusion" scheme and Pakistan's "Asaan Mobile Account" (AMA) Scheme play pivotal roles. These initiatives have enabled millions of Pakistanis to access bank accounts, facilitating receiving emergency funds during the flooding crisis (Sehgal 2022). As per Vota 2022, humanitarian aid organizations can also channel digital ecosystems in various ways to assist people following natural disasters. Here are four examples:

- Digital technologies enable aid organizations, government bodies, and stakeholders to communicate and coordinate effectively post-disaster. Mobile apps and online platforms facilitate information sharing, logistics coordination, and aid progress tracking.
- Digital tools aid in collecting and analyzing data regarding the needs and challenges of disaster-affected communities. This data helps organizations target resources efficiently and evaluate program effectiveness.
- Digital platforms facilitate delivering crucial services like healthcare and financial assistance to affected communities. For instance, mobile apps and online platforms disseminate healthcare information and distribute financial aid immediately.
- Digital technologies play a vital role in disaster response and recovery by providing real-time data on community needs and enabling immediate distribution of aid and resources.

1.5.4 Role of social media in building community resilience

In the vast landscape of the digital ecosystem, social media has emerged as a dominant force. Platforms like Facebook, Twitter, Instagram, and LinkedIn have connected billions worldwide and revolutionized how information spreads and communities form (Ong and Toh 2023). The increasing integration of social media, communications, and internet connectivity in daily life facilitates information exchange, social connections, and financial transactions. According to statistics published by Kemp (2023) in the Data Reports, Pakistan has 46 million social media users on platforms including Facebook, YouTube, Snapchat, Instagram, LinkedIn, and Twitter. Pakistan has witnessed more frequent and severe floods between 2010 and 2023, often prompting communities along riverbanks in Punjab and Sindh to seek safety in higher areas or government-designated safe zones. During rapid flood evacuations, households usually leave belongings behind, but mobile phones remain essential tools. They provide access to vital information through SMS messaging or internet access on smartphones, sustaining livelihood security and connecting dispersed community members (Perera 2023).

There have been numerous cases where a tweet from a member of an affected community made headlines on television news, or an incident reported initially on social media platforms got picked up on the news and generated a response from the authorities to address the gap or problem (Ishtiaq 2022). Following the 2022 floods, the Government of Pakistan utilized social media to support the entire disaster management cycle, including rehabilitation, risk reduction, mitigation, and relief efforts. Local authorities, government agencies, and NGOs utilized these platforms to disseminate evacuation orders, flood warnings, and relief information. While SMS and social media are used for immediate public emergency warnings, a significant gap exists in gendered access to information, making half of the affected population more vulnerable.

The most severe impacts of floods occur in remote areas where poverty, illiteracy, and limited access to digital tools create barriers to seeking assistance, especially for women and older people. Many in these regions cannot use mobile phones or recognize numbers. This digital divide presents two critical challenges: if left unaddressed, it could become a normalized part of insecurity in climate-vulnerable areas. Second, effective disaster management requires equal access to the digital ecosystem. Addressing these issues is crucial to responding to the climate crisis and addressing gender inequalities. The widespread use of social media in Pakistan contrasts with limited access in individual households, which could impact future disaster response and risk reduction efforts.

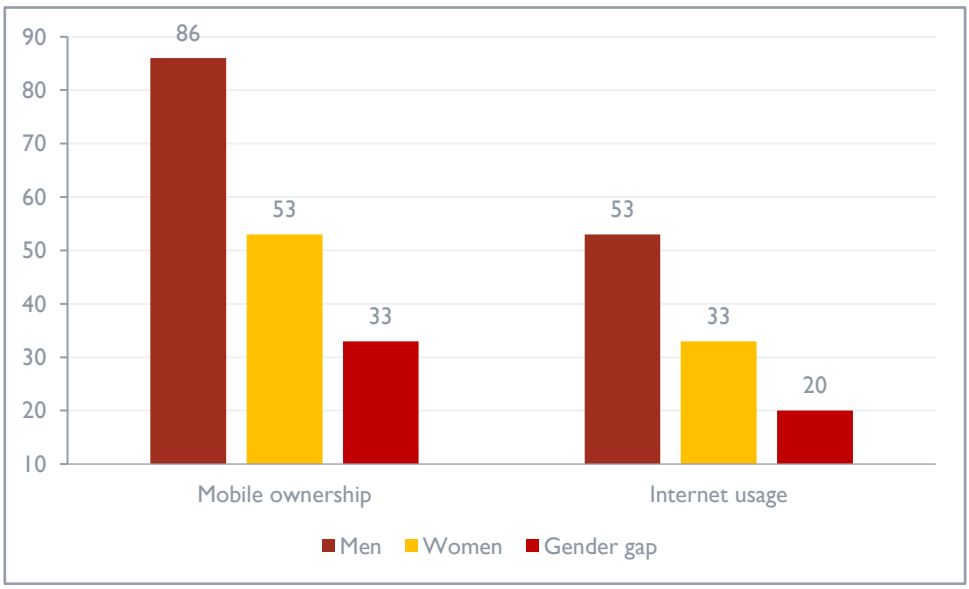
1.5.5 Gender Digital Divide

The Gender Digital Divide (GDD) highlights the disparities in digital connectivity caused by gender differences. According to the latest 2024 GSMA survey, women in South Asian countries are still less likely than men to own a mobile phone. Women are also less likely to use mobile internet, with the gender gap in mobile internet adoption being even more pronounced than those in mobile phone ownership.

The women who do not own mobile phones are particularly challenging to reach, and typically, the most underserved including those who have low literacy levels, those who are older than 55, unemployed, have low incomes, live in rural areas, or have a disability. The research has shown that the top barriers to mobile ownership for women (and men) who still do not own a phone are affordability (primarily of handsets), literacy, and digital skills (GSMA 2024).

Gender disparities are evident in Pakistan's digital landscape, with mobile ownership at 86% for men and 53% for women, resulting in a 38% gender gap. Additionally, internet usage shows a significant 38% gap between men (53%) and women (33%) (Figure 4).

Figure 4. Gender gap in Pakistan's digital landscape



Source: GSMA, 2024

In Pakistan, at least 23% of female mobile internet users—compared to 5% of male mobile internet users, use someone else's mobile phone to go online. 35% of female mobile internet users in Pakistan report they cannot use it anymore because the phone they use to access the internet with is shared (compared to only 14% of male users). These disparities highlight women's lower likelihood of owning a mobile phone or using mobile internet than men (GSMA 2024). Overall, 61% of adult Pakistanis own a mobile phone, varying across demographics such as age, location, education, employment status, and income level. Financially independent individuals and those with higher education levels have higher mobile ownership rates. Lack of income can hinder women from accessing mobile phones, emphasizing the link between financial independence and technological access (GSMA 2021).

In the 2024 survey conducted by GSMA, respondents from 11 of the 12 surveyed countries (men and women) did not believe that mobile internet was equally crucial for men and women. Instead, they were more likely to report that mobile internet was more important for men. This belief was most pronounced in Pakistan, where 42% of men and 28% of women who are aware of mobile internet, considered it more important for men. Conversely, only 1% of male and 4% of female respondents felt it was more important for women. These findings were consistent across both urban and rural areas, as well as across different age groups.

According to the 2023 Karandaaz Financial Inclusion Survey, individuals with no formal education have a low ownership rate of 30%, as do those who are financially excluded, at 47%. Notably, 13% of Pakistanis borrow mobile phones for use. Regarding gender differences, only 5% of men borrow phones, while 23% of women do, highlighting significant demand. Among these women, 68% rely on their spouses for borrowed phones. In contrast, men primarily borrow phones from their children (40.4%) and parents (34%) (Karandaaz 2023).

1.6 Rationale of study

The CGIAR Research Initiative on Fragility, Conflict, and Migration (FCM) is an important initiative to address the challenges posed by climate change, gender vulnerabilities, and conflicts. It recognizes that these challenges are interconnected and require integrated solutions encompassing climate resilience, gender equity, and social inclusion. FCM's work focuses on enhancing the resilience of FLWS within fragile and conflict-affected settings. Its holistic approach aims to achieve sustainable development through a gender-sensitive and socially inclusive lens.

One of the key components of FCM's initiative is Work Package (WP) 3, which focuses on the role of the digital ecosystem in building community resilience during climate-induced migration. It examines policies supporting migrants and host communities, aiming to stabilize individual and community livelihoods under the STABILIZE banner. In fragile settings, including migrant communities, this component highlights the importance of digital technologies, social media, early warnings, and government-implemented climate adaptation programs to build resilience. Women's empowerment is central, seen as an end goal and a means to achieve desired outcomes.

The research explores the impact of sudden, climate-related migration on host community resources, including FLWS, and addresses economic, social, and environmental challenges. It also highlights digital inequality in disaster response, noting a gender gap in mobile phone usage and internet access. The case study in Rahim Yar Khan southern part of Punjab, a high-risk area for drought and floods, provides insights into climate vulnerabilities. As a host community for climate migrants facing multiple natural hazards, Rahim Yar Khan illustrates the complex effects of climate change on economic, social, and environmental dynamics.

This study aims to develop a comprehensive case study to enhance disaster response mechanisms, focusing on anticipatory action. The research involves engaging with government authorities and local partners and conducting interviews and surveys with climate-induced migrant communities.

1.7 Research questions

The following research questions have been examined under WP 3 in this study.

- How are disasters, such as floods, droughts, locust attacks, and health crises, linked to mobility? How have mobility trends been further affected by disasters in the past five years (2018-2023)?
- What role has social media played in the decisions and responses of households during disasters (including floods, droughts, locust attacks, and health)? How far have these changes been gendered?

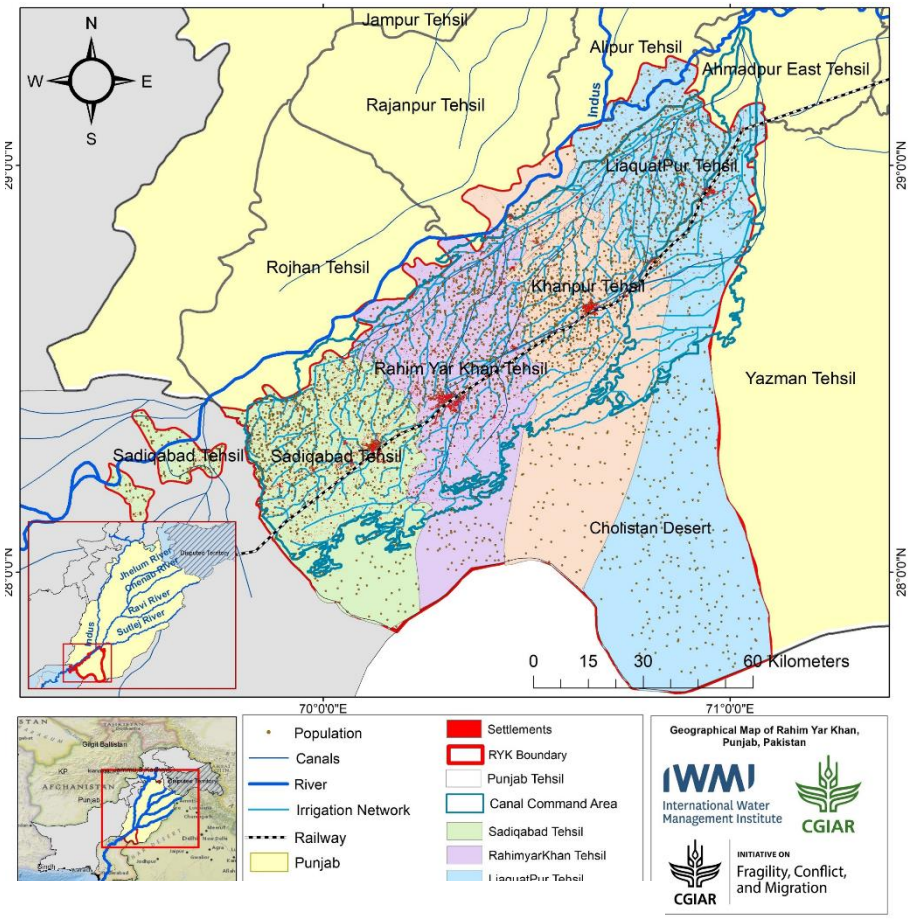
- What are the specific challenges in relation to gender, social media, and mobility in the context of major disaster-related impacts (including floods, droughts, locust attacks, and health) on the most vulnerable communities?
- How can the government more effectively support disaster responses for women through social media—especially for marginalized communities?
- What are the identified recommendations for building resilience; creating more inclusive social media platforms for migrants; and designing tools and features that prioritize their safety, information needs, and unique challenges?

CHAPTER 2 METHODOLOGY

2.1 Study area

The study encompasses a diverse and strategically significant area within the Rahim Yar Khan District, in south Punjab, within the broader province of Punjab, Pakistan. This district, with its extensive area of 11,880 square kilometers, is home to approximately 4.8 million people, resulting in a population density of 405 individuals per square kilometer. Despite its vast geographical spread, the urban population accounts for 21.4% of the total, highlighting a predominantly rural demographic. The average household size in the district is notably large, at 6.8 members (Khalid et al. 2024). The administrative map of Rahim Yar Khan District (Figure 5).

Figure 5. Administrative map of Rahim Yar Khan district



The selected study locations within the Rahim Yar Khan District include the Cholistan Desert and four tehsils[1]— Liaquatpur, Khanpur, Rahim Yar Khan, Sadiq Abad offering a rich tapestry of Punjab's cultural and ecological diversity. These areas are integral to understanding the region's myriad challenges and opportunities, particularly concerning water and food security in the context of climate change and migration.

In Rahim Yar Khan, most of the population (96.5%) are natives of the district, with a smaller portion (3.5%) migrating from other areas. Within the district, there is also intra-migration (1.9%), where individuals move within Rahim Yar Khan and inter-migration (1.6%), where people move either to another district in Punjab or a different province in Pakistan (Government of Pakistan 2023). The primary hazard Rahim Yar Khan faces is flooding,

[1] Tehsils: Tehsils are sub-district administrative units similar to counties. They usually include towns and surrounding villages.

primarily due to the Indus River's high-water levels along the district's 120-kilometer western border. Past flood events in 2010, 2013, 2014, 2015, 2017, 2020, and 2022 have significantly impacted millions of individuals, resulting in tragic losses (OCHA 2022d).

2.2 Sampling

The primary analysis considers the practices, perception of, and planning for climate-induced migration in Rahim Yar Khan as derived from a range of stakeholders, including relevant government departments, non-governmental organizations (NGOs), and academics. The data is collected in the following steps.

- Household Survey
- Focus Group Discussions (FGDs)
- Key Informant Interviews (KIIs)

2.2.1 Household survey

A structured 200-question Household Survey was conducted among 826 households (334 women and 492 men). The survey targeted climate-induced migrant communities in all four tehsils and the Cholistan Desert to ensure robust statistical representation. The household questionnaire was divided into the following themes (Table 1):

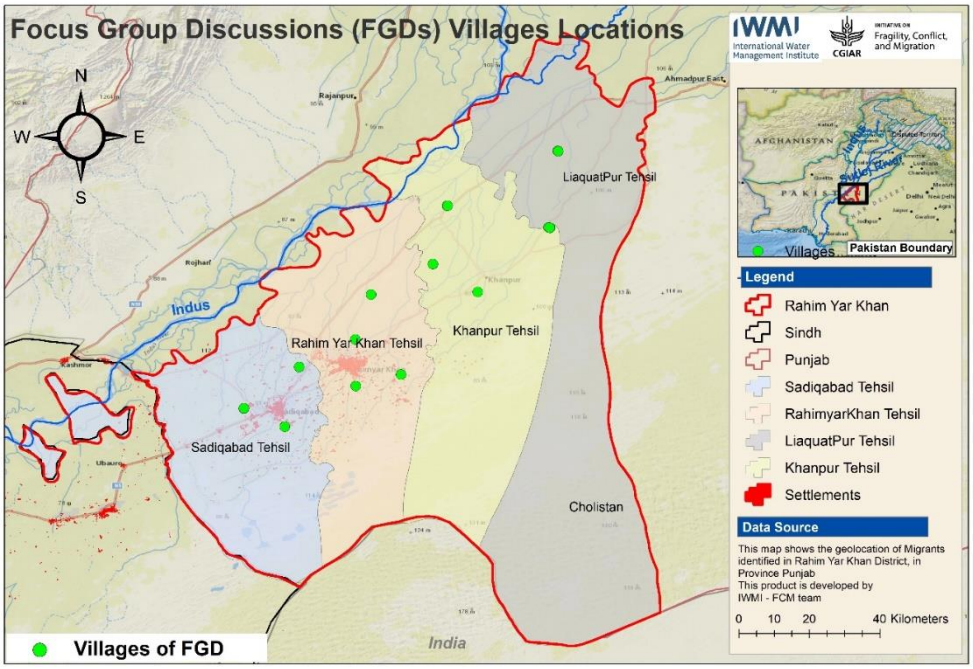
Table 1. Table of themes for the household questionnaire.

S. No.	Themes
1.	Socio-demographic characteristics
2.	Source of water and level of satisfaction
3.	Sanitation
4.	Wealth index or equity
5.	Food insecurity scale
6.	Menstrual hygiene management (MHM)
7.	Household water insecurity scale
8.	Health waterborne disease
9.	Early warning awareness and digital ecosystem

2.2.2 FGDs

Focus group discussions were conducted to explore cause-and-effect relationships, policy interventions, and mobility of people, acquiring details about family, migration causes, preferred locations, duration, facilities, livelihood sources, and hardships. There were 12 focus group sessions—seven with female participants and five with male participants, involving 45 men and 89 women. These discussions took place in specific villages, including Barohi Baloch, Tiba Ghareeb Shah, Shair Muhammad, Basti Langi War, Hareer, Jan Muhammad, Model village Lal Shah, 179/7R, 181/7R, 52/P, and 45/P in the target area (Figure 6).

Figure 6. Village locations within Rahim Yar Khan for FGDs



The FGDs explored the following aspects during the discussions (Table 2):

Table 2. Table of themes for focus group discussions.

S. No.	Themes
1.	Impact of disasters
2.	Gendered and age-related differences
3.	Conflict dynamics during or before the drought
4.	Migration dynamics
Early Warning/Early Action	
5.	Perception of early warning
6.	Communicating early warning information
7.	Digital ecosystem
8.	Usefulness of warnings

2.2.3 KIIs

Several informal discussions, such as KIIs, were conducted with qualified individuals working with the community on climate change at the federal, provincial, and district levels (Table 3). The stakeholders were from relevant Government Organizations and NGOs. These stakeholders included representatives from the Disaster Management Authority, the Agriculture Extension Department, the Federal Flood Commission, On-Farm Water Management, the Environment Protection Authority, the Livestock Department, Semi-Government and NGOs (Table 3).

Table 3. Table of themes for key informant interviews.

S. No.	Themes
1.	Understanding the event and risk drivers
2.	Understanding Early Warning Early Action (EWEA) potential at the time
3.	Forecast and monitoring
4.	Monitoring vulnerabilities from disasters
5.	Early action
6.	Financing and recommendations

2.3 Data collection

The data collection strategy for the Household Survey involved conducting rigorous surveys using Kobo Collect, an app based on the open-source ODK Collect app.

i. Kobo Toolbox was chosen for its advanced features supporting efficient data capture, submission, and real-time monitoring. Enumerators with GPS-enabled devices were strategically deployed across the designated study areas. GPS coordinates facilitated the verification of data collection locations, enhancing the geographical validity of the gathered data. The survey aimed to thoroughly explore the impact of climate change, early warnings, and the role of social media in identifying future directions for resilient practices among migrant communities. Four teams, each with one female and one male enumerator, conducted the surveys over 20 days.

   Before fieldwork, enumerators received thorough training on the survey instrument and used Kobo Collect to ensure consistency and reliability in data collection. The questionnaire was designed to delve deeply into various aspects of the respondents' experiences and perceptions of climate change, including its effects on their livelihoods, migration patterns, and community resilience.

   Interviews: data from the KIIs were collected through in-depth interviews to gather in-depth insights from knowledgeable individuals. First, key informants were identified based on their expertise and involvement in areas relevant to community and climate change, including representatives from government departments, semi-government organizations, and NGOs. An interview guide with open-ended questions was developed to ensure comprehensive coverage of themes such as policy interventions, migration dynamics, and livelihood challenges. In-depth interviews were scheduled at convenient times and locations for the informants to facilitate a comfortable and private setting, encouraging candid discussions. With the consent of the informants, interviews were audio-recorded to ensure accuracy while detailed notes were also taken. The recordings were transcribed, and the data were organized and categorized by themes for systematic analysis.

ii. FGD: Each FGD session for data collection was facilitated by trained moderators who guided the discussions using a semi-structured guide to ensure consistency while allowing open-ended responses. Respondents were selected based on their experiences and relevance to the areas under study, ensuring that the discussions captured a wide range of views and experiences. Detailed notes and audio recordings (with participant consent) were made during each session to ensure accurate data collection. These recordings were then transcribed and analyzed thematically to identify critical patterns and insights. This methodological approach enabled the collection of rich, qualitative data that complemented the quantitative findings from household surveys, offering a comprehensive understanding of the community dynamics and challenges faced by migrant populations.

2.4 Data analysis

In the data analysis phase, the collected data from Household Surveys, KIIs, and FGDs were systematically processed and interpreted. For the household surveys, data collected with the Kobo Collect app were synchronized to a central database, cleaned to remove inconsistencies, and prepared for analysis. Descriptive

statistics were generated to summarize demographic characteristics and key variables, while inferential statistics were employed to explore relationships between variables and assess significant predictors of migration behavior. For the KIIs, audio recordings were transcribed verbatim and coded using qualitative data analysis. Thematic analysis was conducted to identify significant themes and patterns, providing insights into policy interventions, migration dynamics, and community resilience.

Similarly, FGD recordings were transcribed and coded, using thematic content analysis to categorize data into meaningful themes related to migration causes, livelihood sources, and hardships. Comparative analysis across different groups and locations highlighted commonalities and differences in experiences. The qualitative findings from FGDs were integrated with the quantitative survey data, offering a holistic view of the impact of climate change on migrant communities and guiding future directions for resilient practices.

2.5 Research ethics

Ethical considerations were paramount, with protocols established to safeguard the dignity and privacy of participants. This included obtaining informed consent from all respondents and ensuring the confidentiality of the data collected. Interviews were conducted by enumerators of the same gender as the respondents, aligning with the cultural sensitivities of the study's context.

2.6 Limitations

The study delves into the experiences of communities, families, and individuals affected by climate-related migration and the roles of institutions involved. It also examines the responsibilities of countries regarding such migration and identifies areas for improvement in existing regulations. However, the study acknowledges its limitations, recognizing that findings may not universally apply to all locations and that data accuracy can vary. It considers various factors influencing migration decisions and emphasizes the importance of ethical research practices in this context. Additionally, the study recognizes the dynamic nature of climate change and its impacts, focusing on a specific aspect while acknowledging potential shifts in the future. Collaborative efforts among experts from diverse fields are crucial for comprehensively understanding these complex issues.

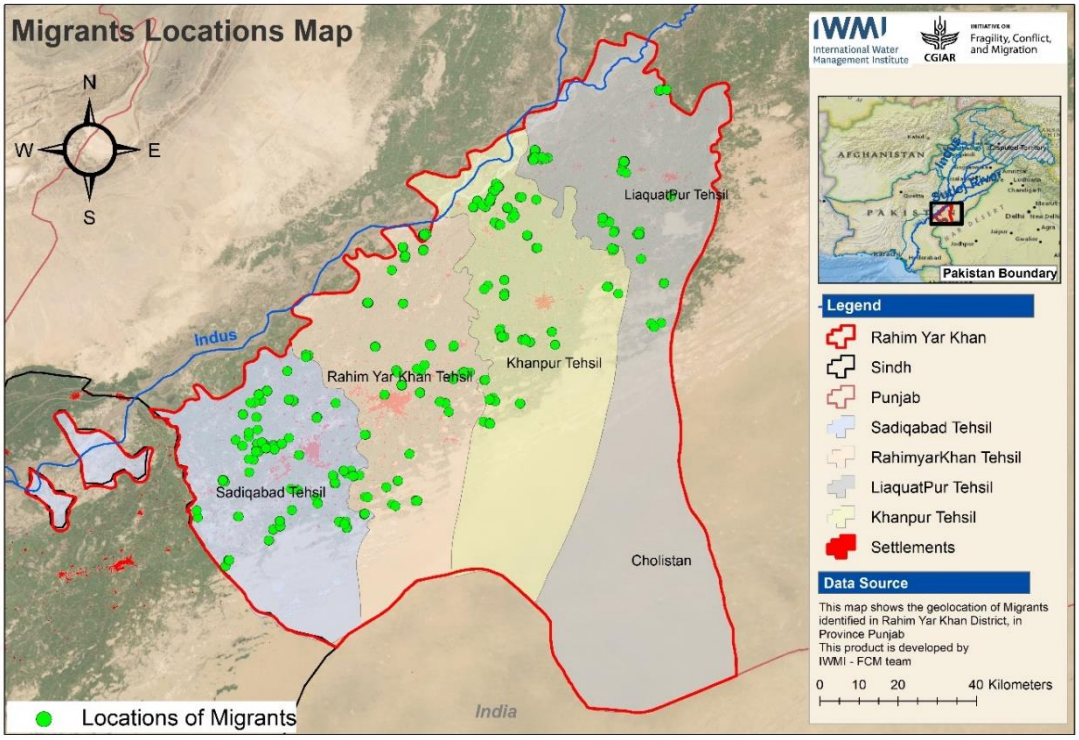
CHAPTER 3 RESULTS

3.1 Survey results

3.1.1 Socio-demographic and migration details

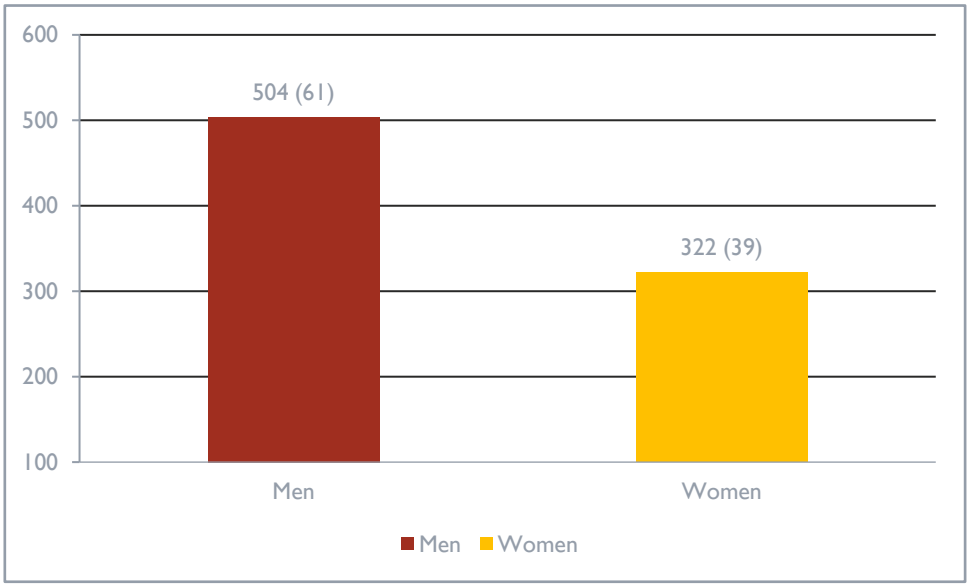
The study surveyed 826 participants including Cholistan followed by Liaquatpur, Khanpur, Rahim Yar Khan and Sadiq Abad tehsil (Figure 7).

Figure 7. Dot map for migrant locations



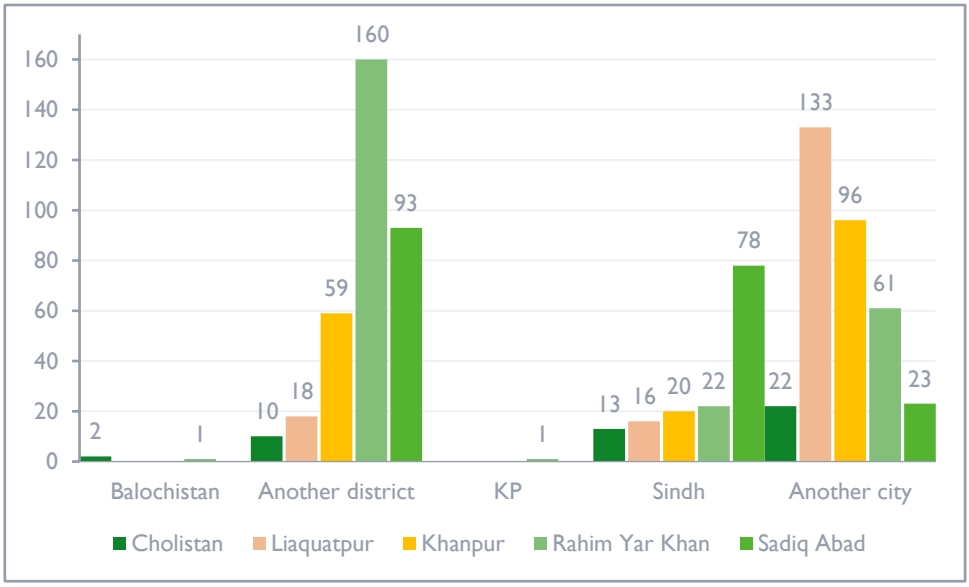
The respondents included 322 women (39%) and 504 men (61%) (Figure 8).

Figure 8. Number of respondents disaggregated by sex



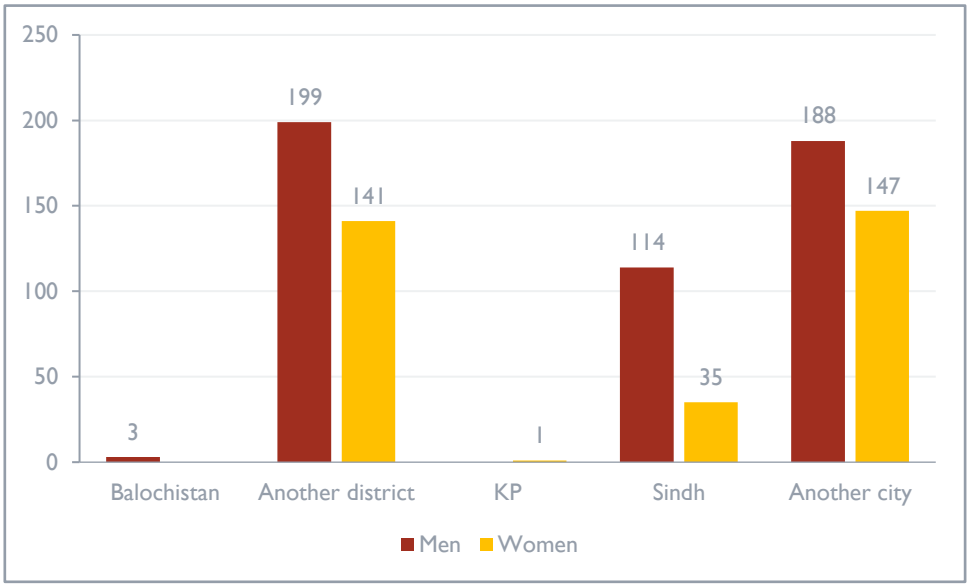
Migration patterns in Rahim Yar Khan District, analyzed by tehsil and gender, reveal diverse origins of migrant populations. Many migrants come from within the district, where 133 (80%) migrants in Liaquatpur are local, indicating high internal migration. Additionally, 160 (65%) of migrants to Rahim Yar Khan come from other districts in Punjab, showing significant inter-district mobility. In Sadiq Abad, a notable portion of the 78 people (40%) migrated from Sindh province highlighting significant cross-provincial movement influenced by economic or environmental factors (Figure 9).

Figure 9. Migration pattern segregated by tehsil



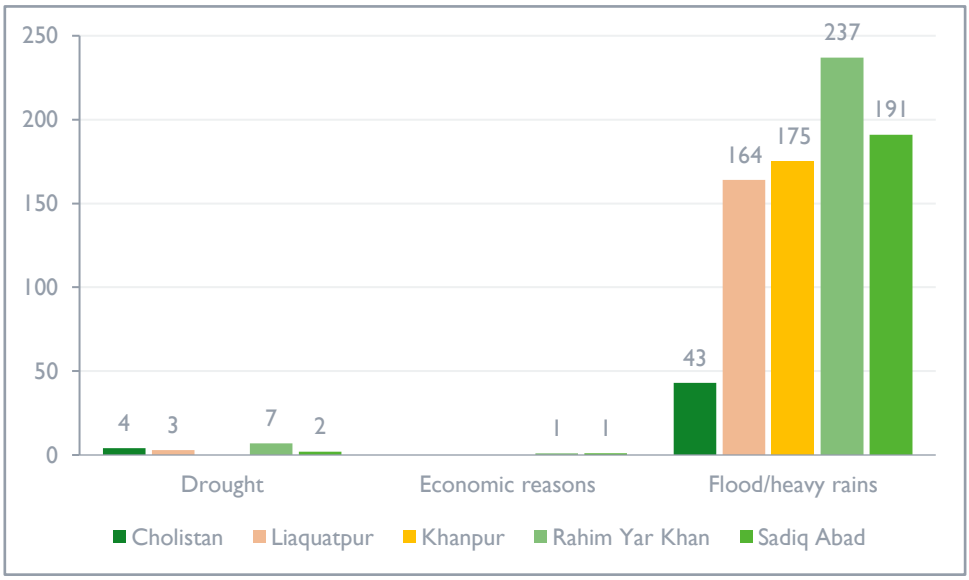
Gender-disaggregated data shows that both men and women migrants largely come from within Punjab and the local district. However, a slightly higher proportion of women migrate from other districts in Punjab, suggesting gender-specific motivations or circumstances. Notably, all migrants from Baluchistan and the sole migrant from KP province are men, possibly reflecting specific occupational or social networks (Figure 10).

Figure 10. Migration pattern segregated by gender



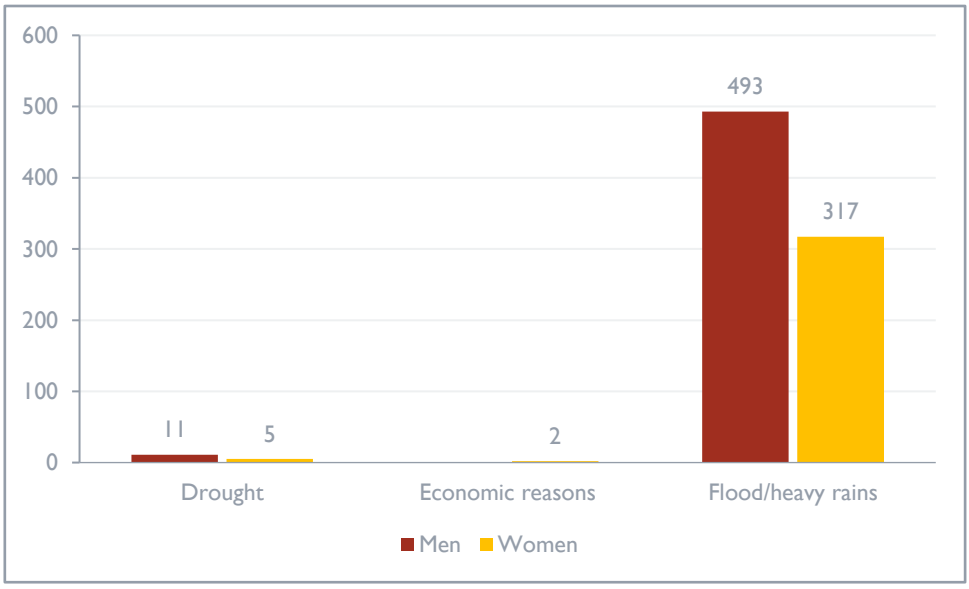
Floods, monsoons, and heavy rains are the primary reasons for migration, affecting 810 (98%) respondents from the 826 samples. This highlights a significant vulnerability to climate-related events across the district, particularly in Liaquatpur, Khanpur, Rahim Yar Khan, and Sadiq Abad. In the Cholistan Desert, 43 respondents i.e., 91% of migrations, are due to floods and monsoons, while 4 migrations (9%), are attributed to drought (Figure 11).

Figure 11. Reasons for migration segregated by tehsil



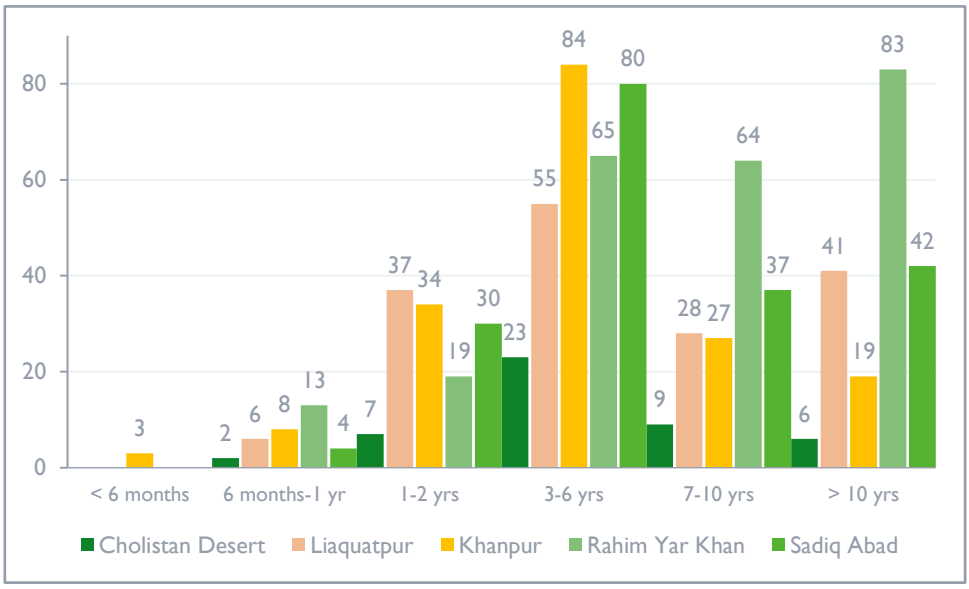
Gender-disaggregated data shows that both women and men are equally affected by flood and monsoon displacements, each citing these as their primary reason for migration. However, a slight difference is noted in reasons such as drought and economic opportunities, with 5 (2%) of women citing drought and 2 (1%) citing economic reasons, slightly more than men (Figure 12).

Figure 12. Reasons for migration segregated by gender



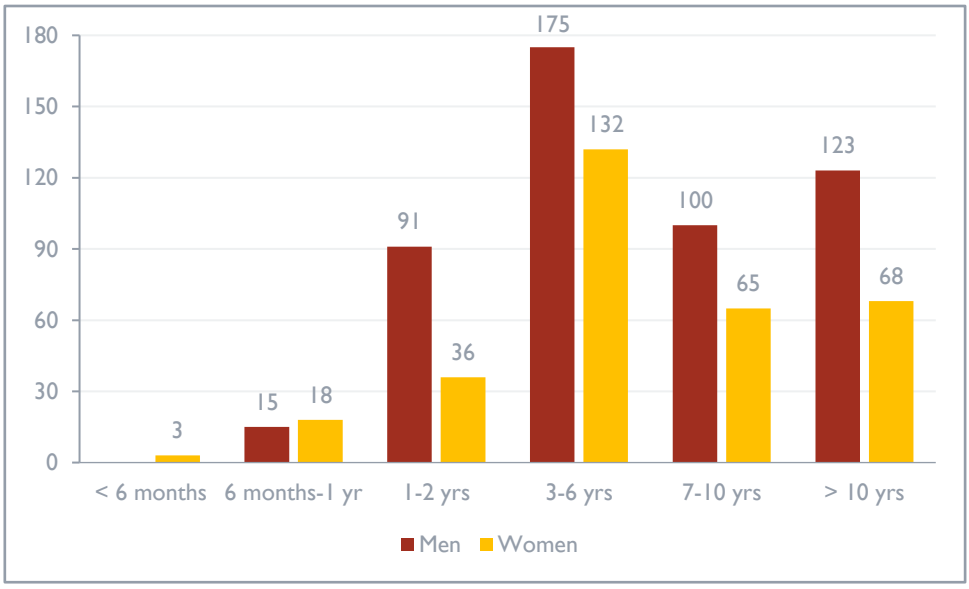
Across the tehsils, 307 respondents (37%) have lived in their current location for 3-6 years, with the Cholistan Desert showing the highest number of respondents at 23 (49%). In contrast, Rahim Yar Khan has the highest percentage of long-term residents, with 83 (34%) living in their current location for over 10 years, indicating a stronger tendency for long-term residency (Figure 13).

Figure 13. Duration of stay segregated by tehsil



Gender-segregated data reveals that 175 (35%) men have lived in their current location for 3-6 years, compared to 132 (41%) women. This suggests that women tend to stay in one place longer than men. A slightly higher number of men at 123 (24%) compared to 68 (21%) women, have resided in their current location for over 10 years (Figure 14).

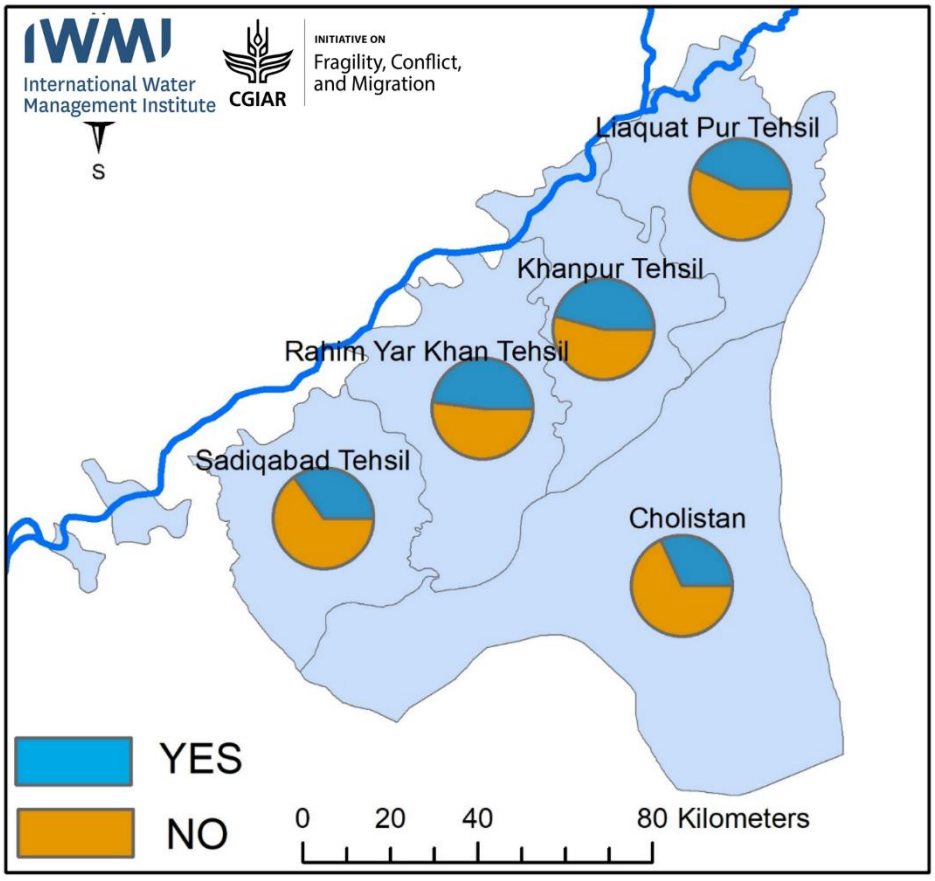
Figure 14. Duration of stay segregated by gender



3.1.2 Early warning awareness and digital ecosystem

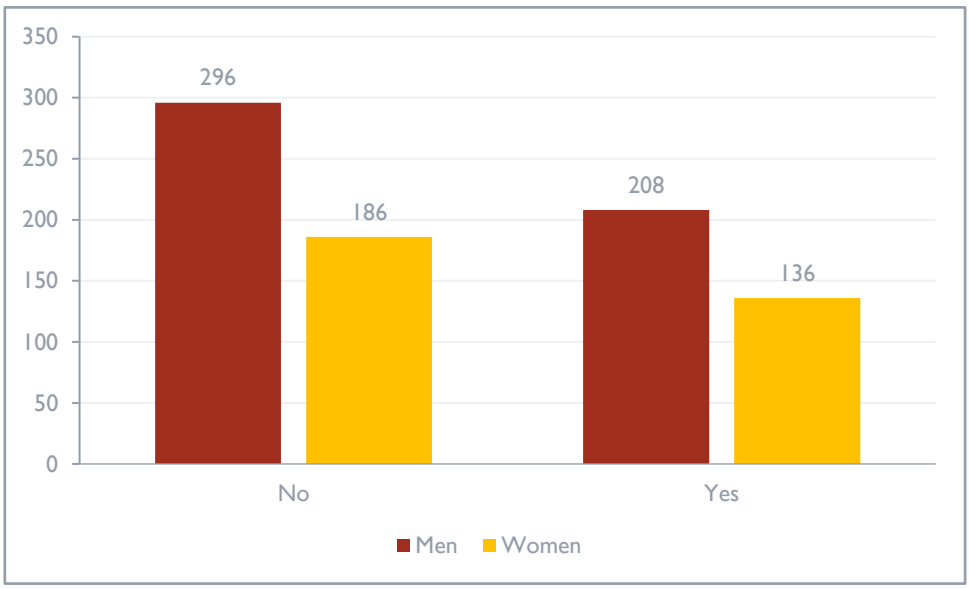
Regarding early warning systems for extreme weather events, less than half of the respondents received any form of early warning, with Rahim Yar Khan (116) and Khanpur (80) having slightly higher rates of receiving warnings (Figure 15).

Figure 15. Early warnings segregated by tehsil: "Have you ever received any early warning notice about weather events?"



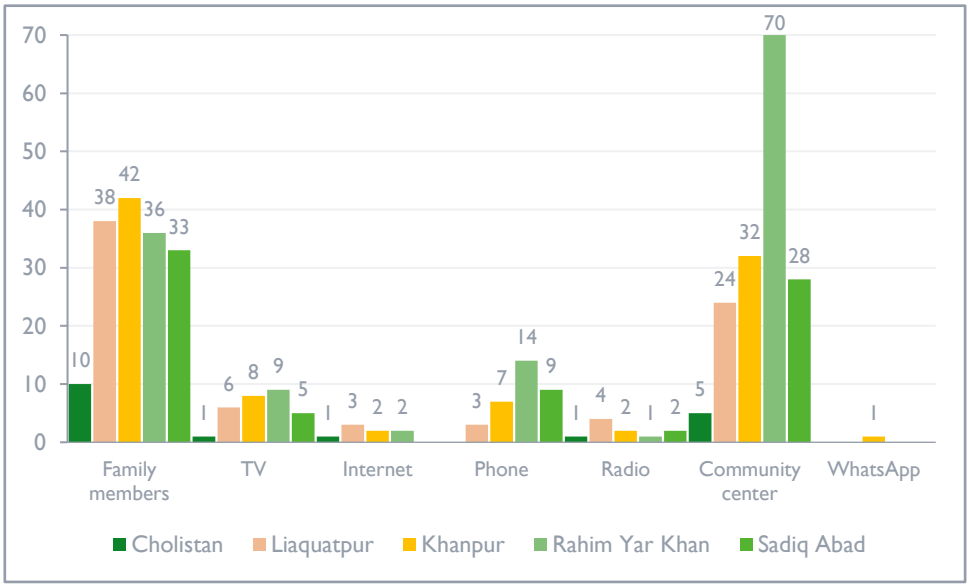
Regarding the early warnings about extreme weather events, 186 (58%) women and 296 (59%) men reported that they had not received any early warnings about changes in temperature or extreme weather events. However, 136 (42%) women and 208 (41%) men confirmed receiving such warnings (Figure 16).

Figure 16. Early warnings segregated by gender



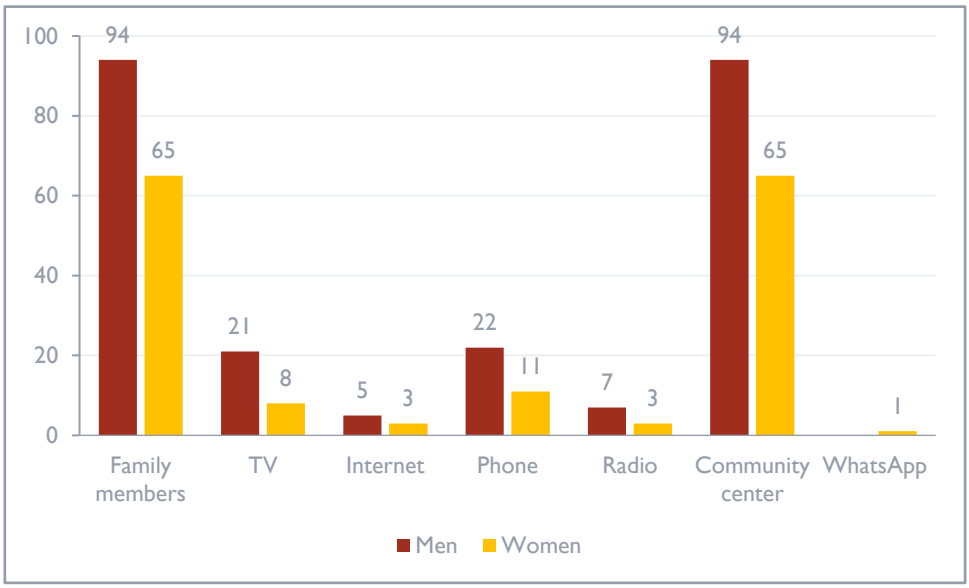
Source of EWs: The primary sources of these warnings were family, neighbors, and community centers, indicating a dependence on informal networks and local institutions for crucial information (Figure 17).

Figure 17. Sources of early warnings segregated by tehsil



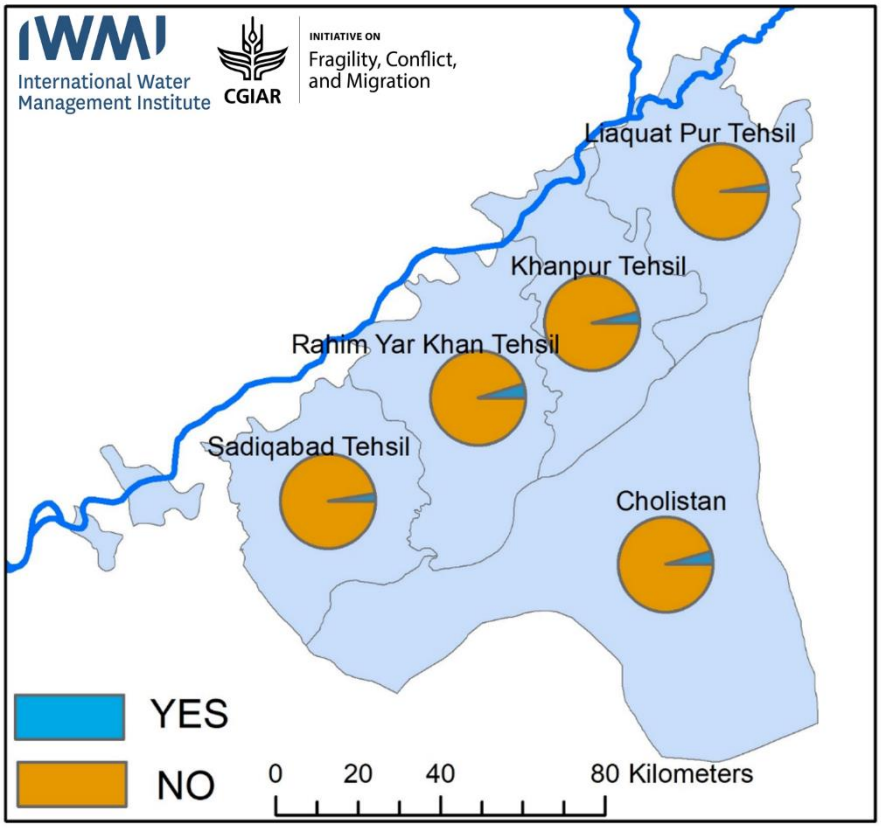
Most early warnings for extreme weather events were received from family members, neighbors, and community centers. Other sources like television, phone calls or texts, and radio were significantly less common, with only 5% of women receiving warnings through TV. In comparison, 8% and 9% of men have received warnings via TV and phone, respectively (Figure 18).

Figure 18. Sources of warning segregated by gender



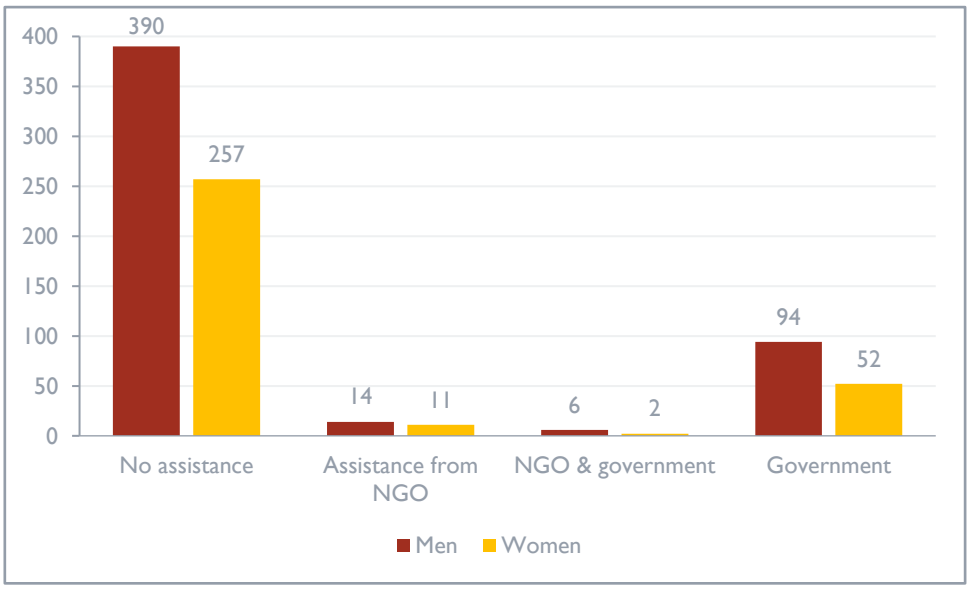
Government Assistance: Most displaced individuals did not receive government assistance, revealing a substantial gap in support mechanisms for displaced populations across all tehsils (Figure 19).

Figure 19. Government assistance after migration: "Did you ever receive any government assistance after migrating or displacement?"



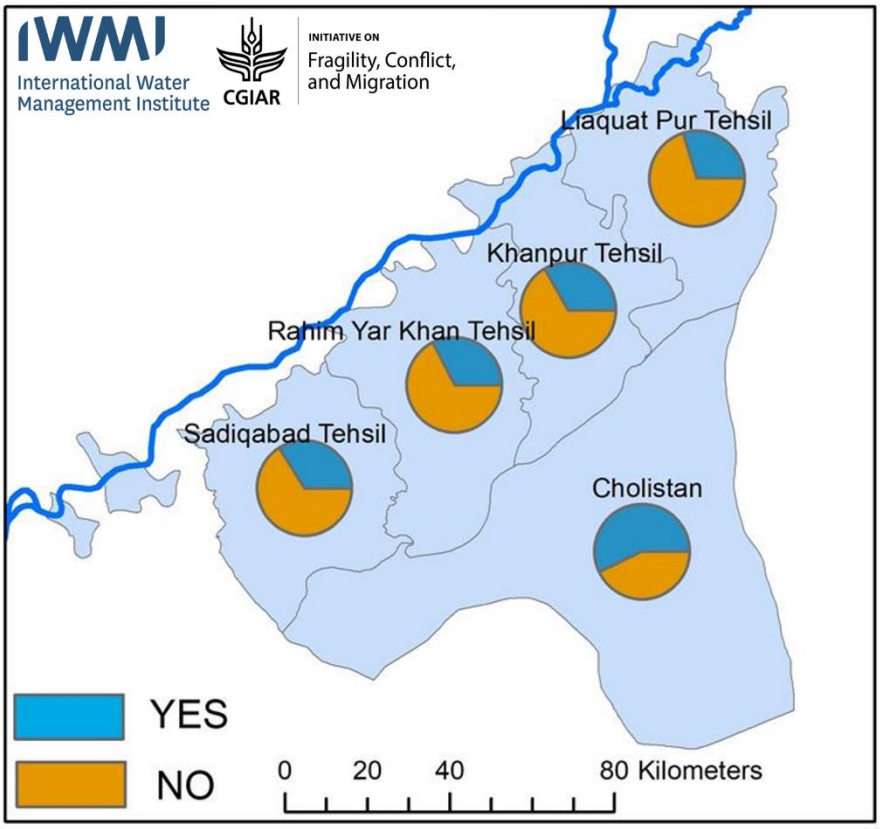
Most respondents, almost 257 women (80%) and 390 men (77%) did not receive government assistance after migrating or being displaced. However, a small percentage of six men (3%) and two women (1%) received support from NGOs/civil society (Figure 20).

Figure 20. Government assistance after migration segregated by gender



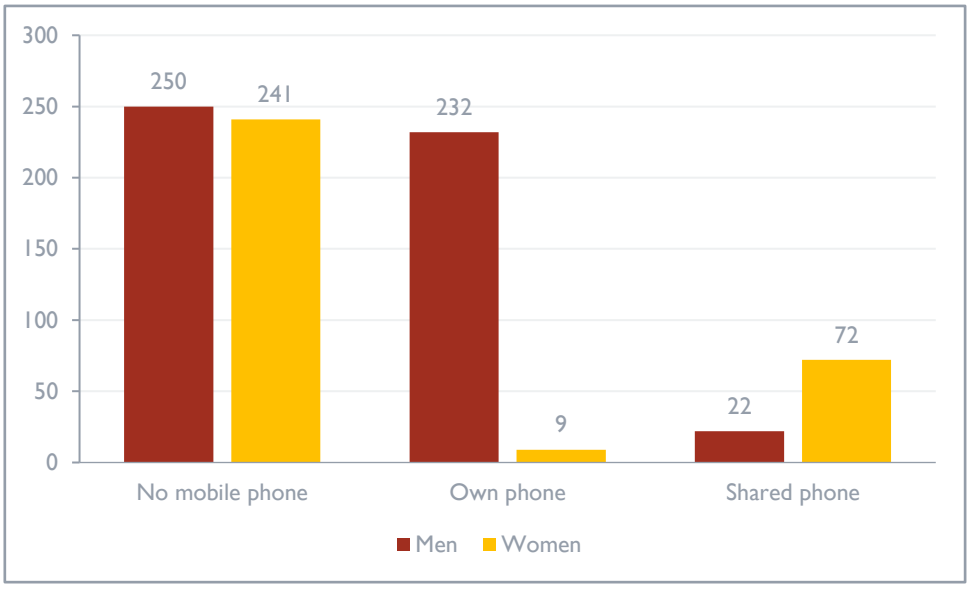
Mobile phone ownership: A significant portion of the population lacks ownership and access to mobile phones, with the majority not having one. Among those who do, basic phones are more common than smartphones, highlighting barriers to technological access (Figure 21).

Figure 21. Mobile phone ownership: "Do you own or have access to a mobile phone?"



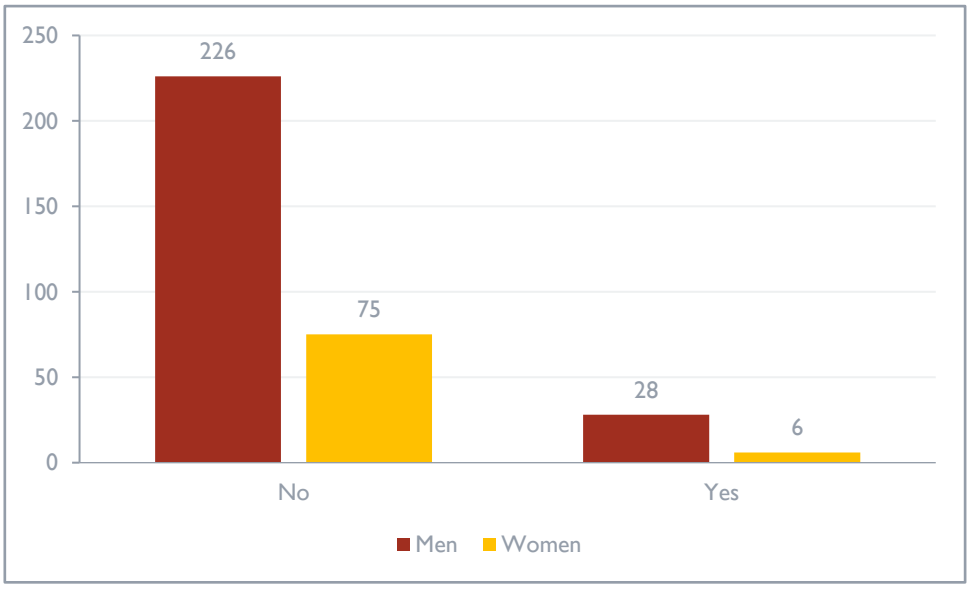
The analysis illustrates that a higher percentage of women (75%) than men (50%) do not own mobile phones. On the other hand, a significant proportion of men (46%) have their phones, while for women, a larger share (22%) has access to shared phones (Figure 22).

Figure 22. Access to mobile phone segregated by gender



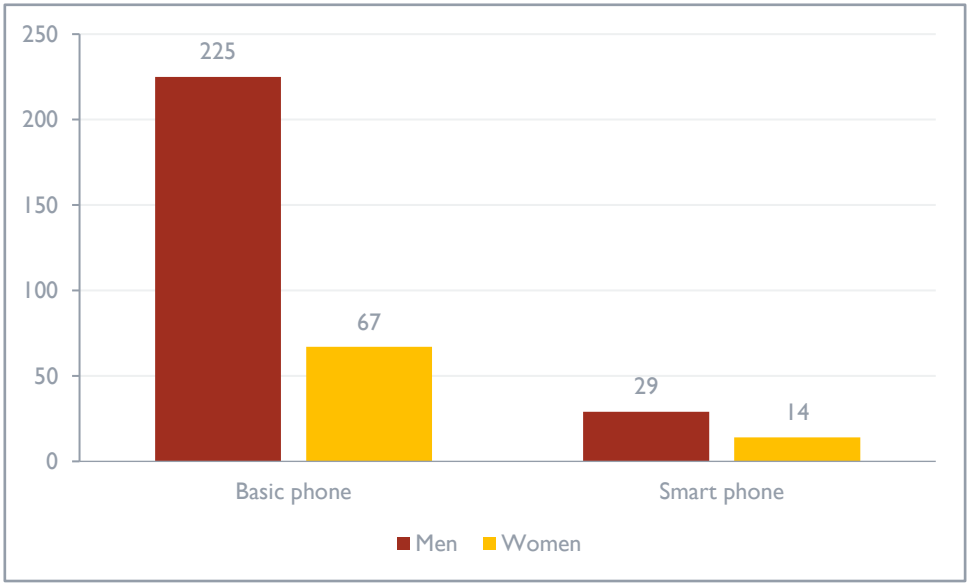
After migrating, most women (93%) and men (89%) did not have access to a mobile phone. However, a small percentage of women (7%) and men (11%)—overall 10%, still had access to a mobile phone after migration (Figure 23).

Figure 23. Access to mobile phone after migration segregated by gender



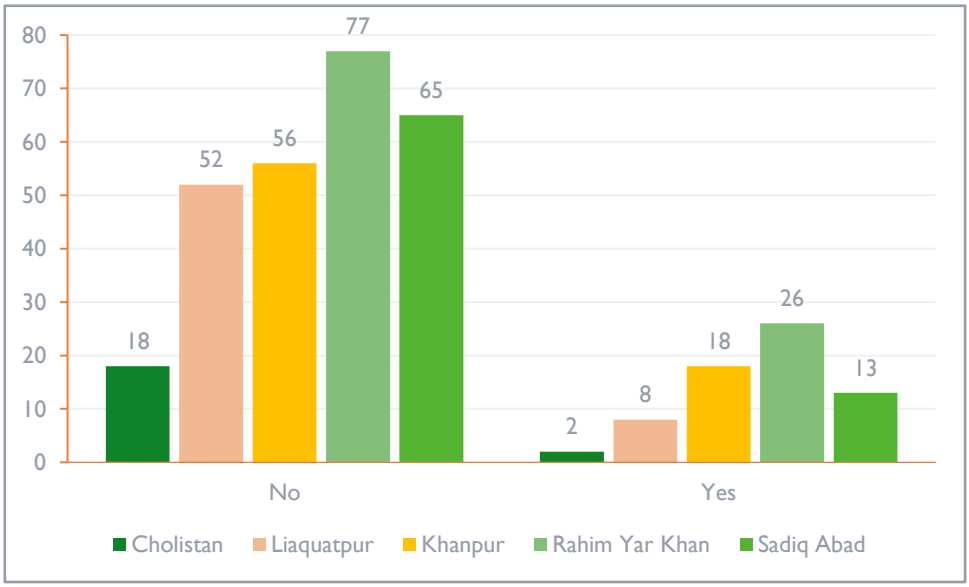
Types of mobile phones: Among those who had access to a phone post-migration, almost 87% of men owned basic phones, while only 3% of women owned basic mobile phones after migration. Smartphone ownership is minimal, with only 13% owning smartphones (Figure 24).

Figure 24. Access to basic phone and smartphone segregated by gender



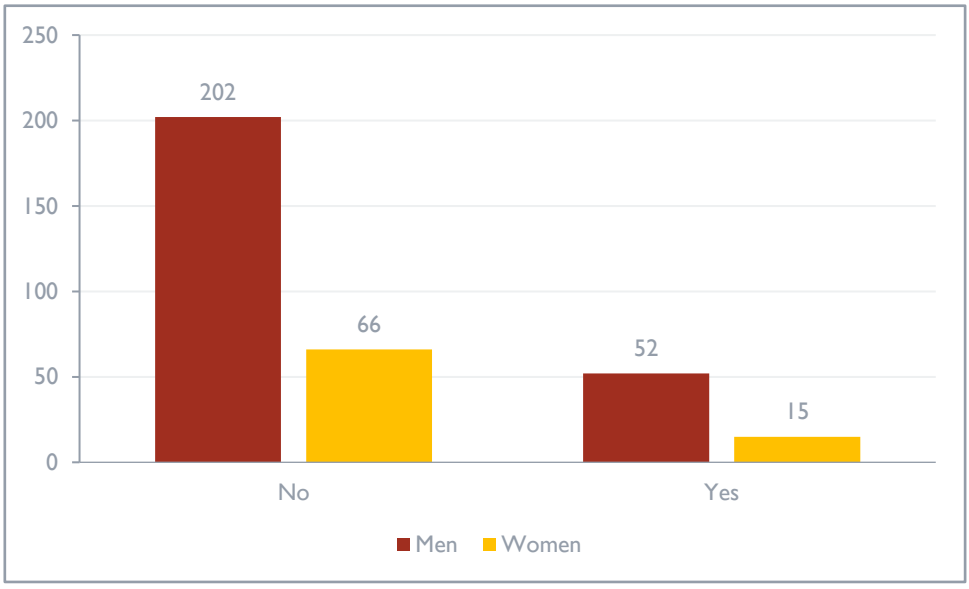
Warnings through SMS: Across different areas, most respondents did not receive any SMS warnings on their phones regarding weather events, with percentages ranging from 75% to 90% across different tehsils and averaging 80% overall. However, a notably small number of respondents did receive such SMS warnings, with percentages ranging from 10% to 25% across areas and totaling 20% overall (Figure 25).

Figure 25. SMS warnings on phone segregated by tehsils



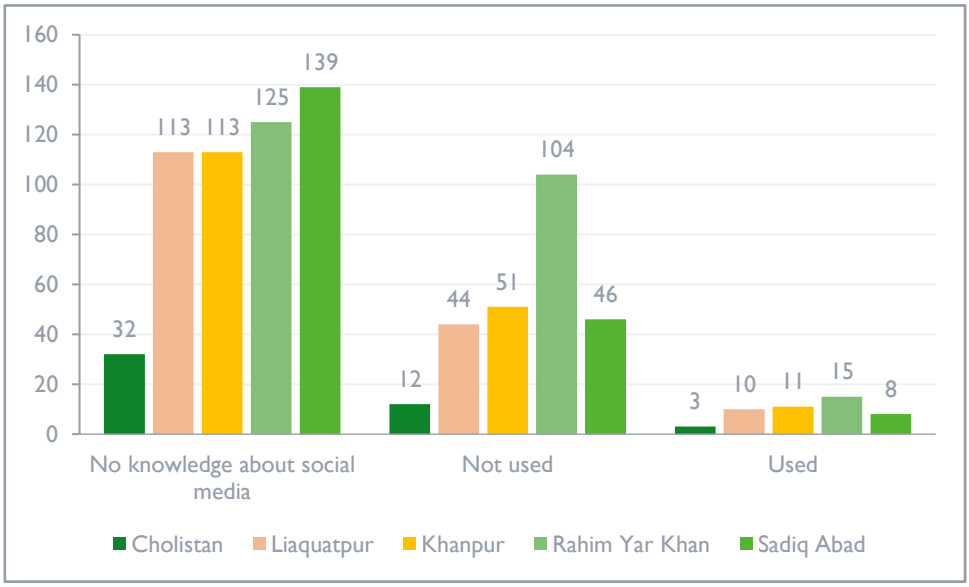
The data shows that 80% of women and 80% of men, making up 80% overall, did not receive SMS weather warnings on their phones. Meanwhile, 19% of women and 20% of men, totaling 20% overall, did receive these warnings (Figure 26).

Figure 26. SMS alerts on mobile phone segregated by gender



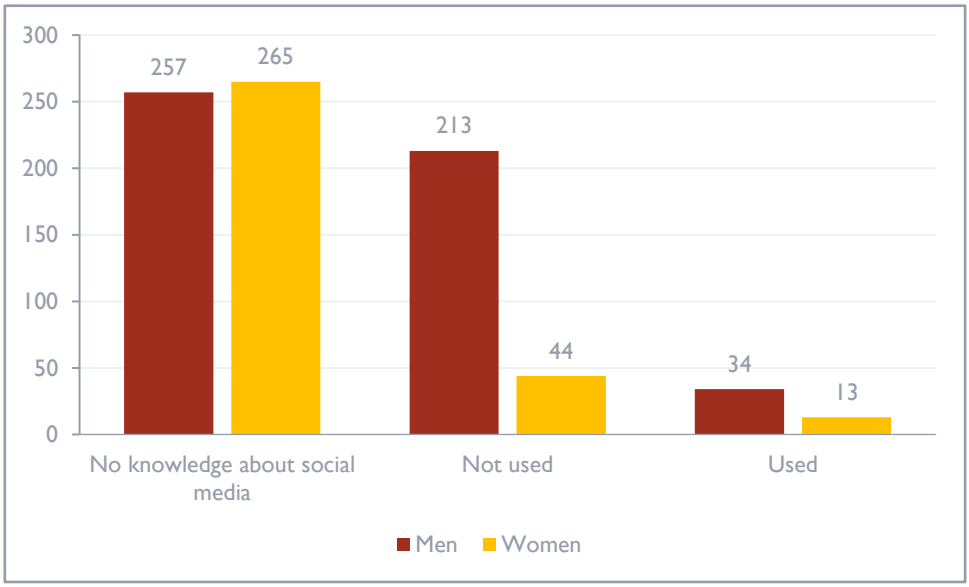
Social media platforms: The surveyed population shows minimal usage of social media, with most individuals—almost 80% being unaware of social media platforms. This low engagement with digital platforms aligns with the general trend of limited technology access and literacy (Figure 27).

Figure 27. Use of social media platforms segregated by tehsils



The data indicates that 82% of women and 51% of men, making up 63%, are unfamiliar with social media platforms. Additionally, 31% of all respondents reported not using social media, while 6% mentioned using such platforms (Figure 28).

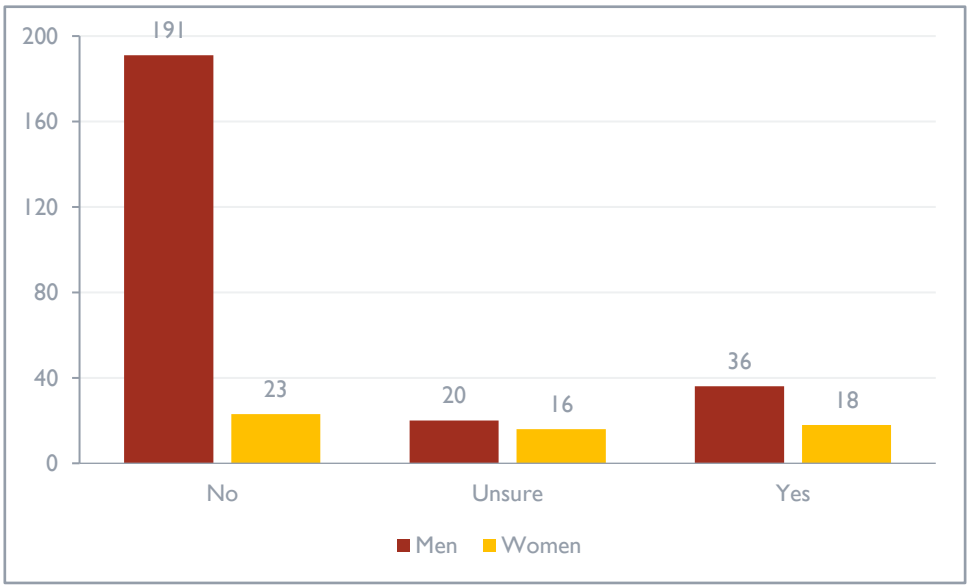
Figure 28. Use of social media platforms segregated by gender



In the context of the 2022 floods, a notable majority of individuals across varying regions abstained from utilizing social media for sharing stories and warnings. This reluctance ranged from 61% to 87% per area, up to 70% overall.

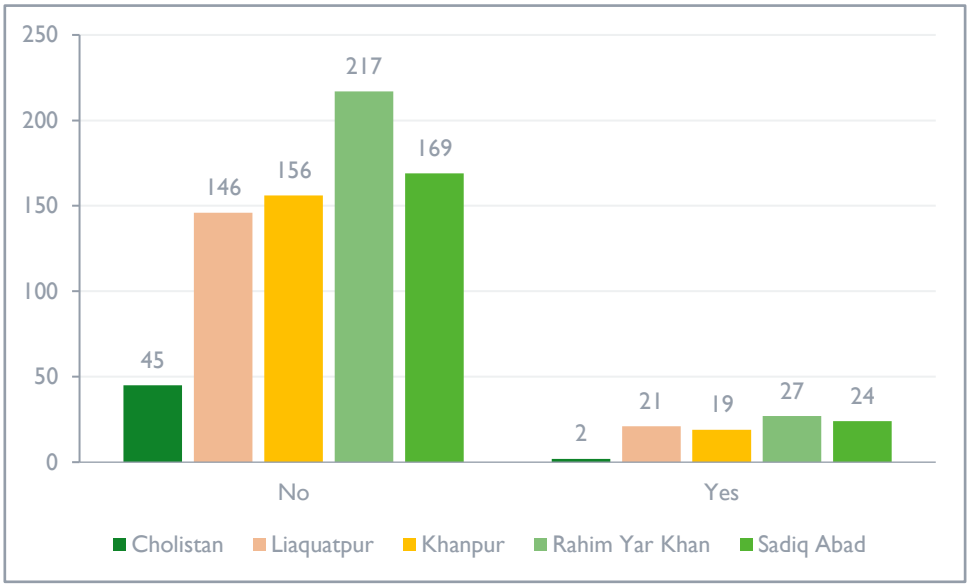
During the 2022 floods, a majority of women (40%) and a significant majority of men (77%), making 70% overall, did not use social media to share stories and warnings. Conversely, 12% were unsure, and 18% confirmed that they were using social media for such purposes (Figure 29).

Figure 29. Use of social media during the 2022 floods segregated by gender



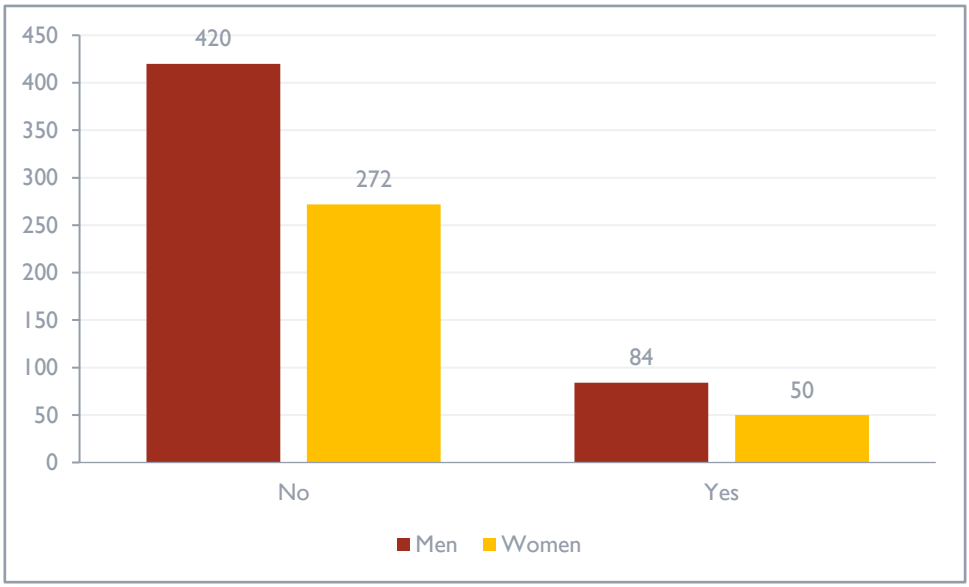
The utilization of television for news among respondents is surprisingly low, with most choosing not to engage with it. This was especially apparent during the 2022 floods, where a significant majority did not have exposure to any news coverage before relocating, indicating a significant shortfall in access to information (Figure 30).

Figure 30. Preference using TV as a source of information



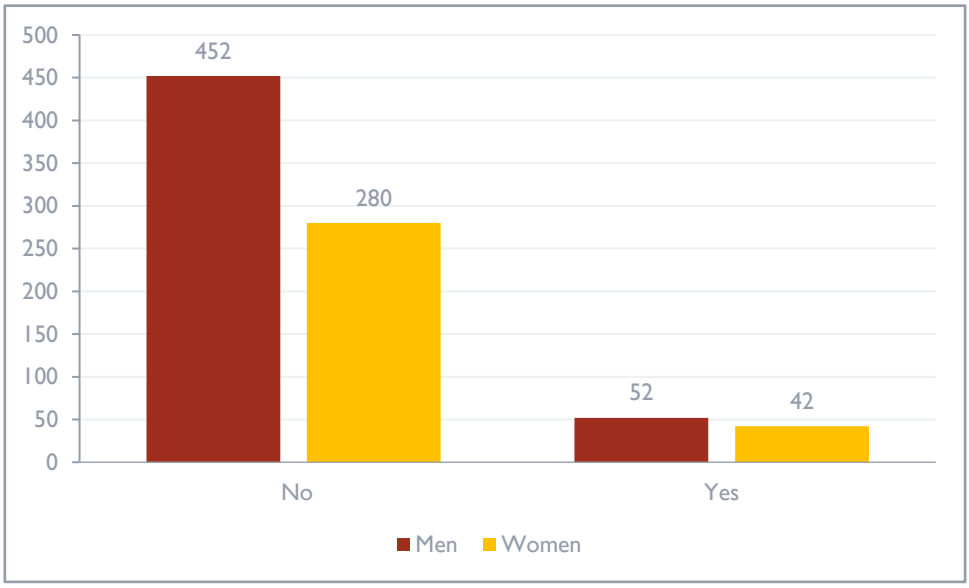
In the preceding migration, 84% of women and 83% of men, making up 84% overall, did not possess a TV in their residences, whereas 16% of women and 17% of men, totaling 16% overall, did have one (Figure 31).

Figure 31. Access to TV segregated by gender



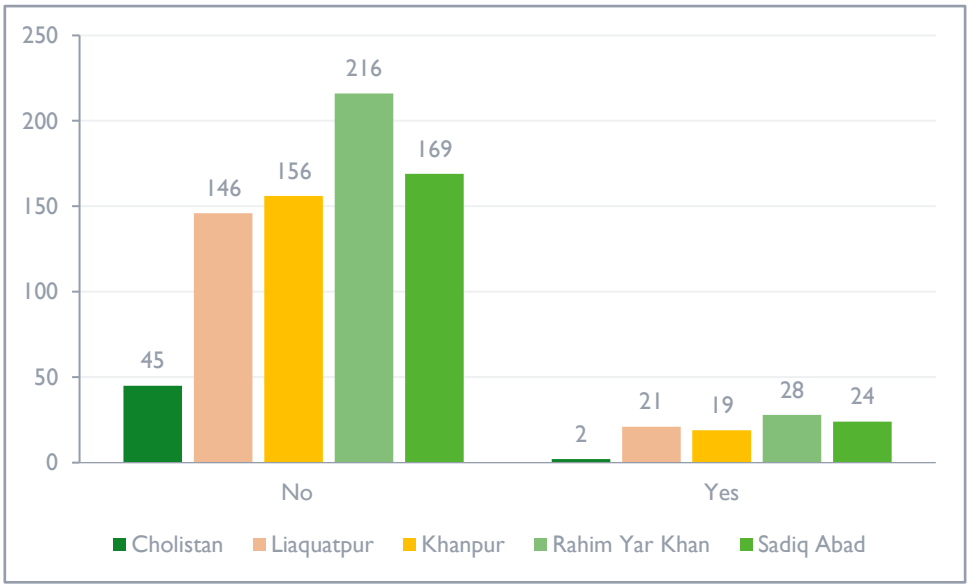
After migration, data shows that most women (87%) and men (90%), totaling 89% overall, no longer had access to a TV. However, 11% of respondents continued to have access to a TV overall (Figure 32).

Figure 32. Access to TV after migration segregated by gender



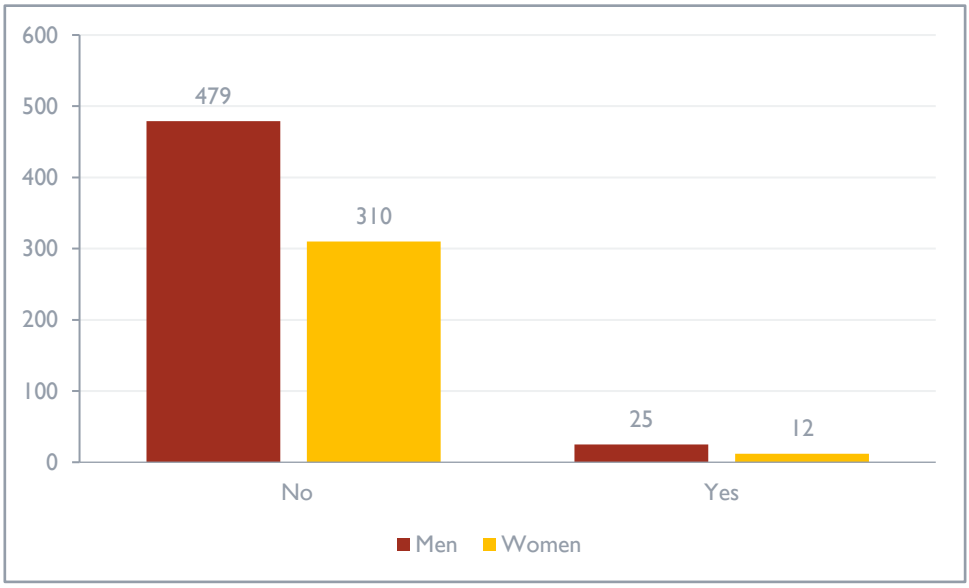
The data shows that a vast majority, around 89%, of respondents across different areas did not see news coverage of the 2022 floods before they had to move, indicating limited prior awareness among the affected population (Figure 33).

Figure 33. Assistance from news coverage of 2022 floods before migration



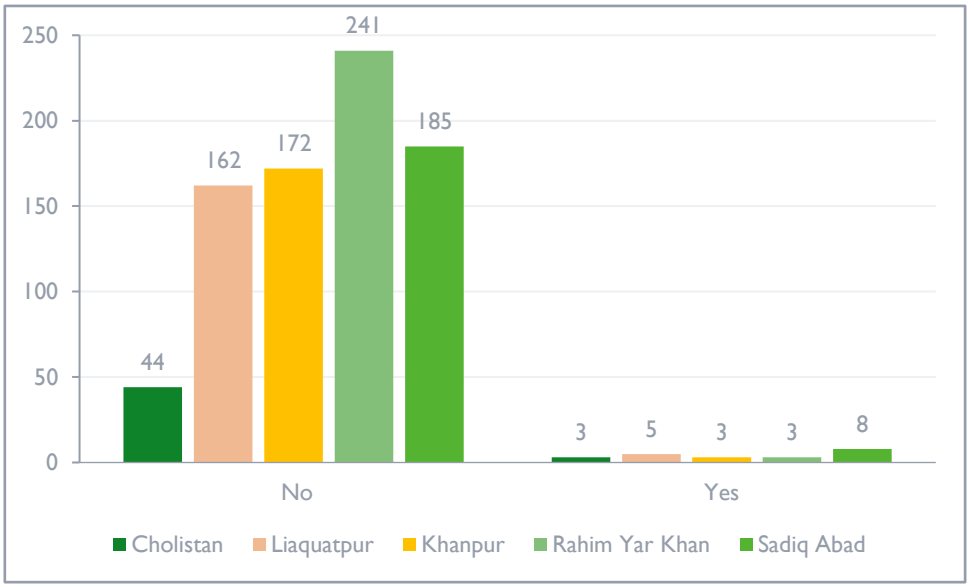
The majority, around 96%, of both women and men did not see news coverage of the climate event before they had to move, suggesting limited pre-existing awareness among the surveyed population. Only a small percentage—4%, had seen news coverage before their relocation (Figure 34).

Figure 34. Assistance from news coverage of 2022 floods segregated by gender



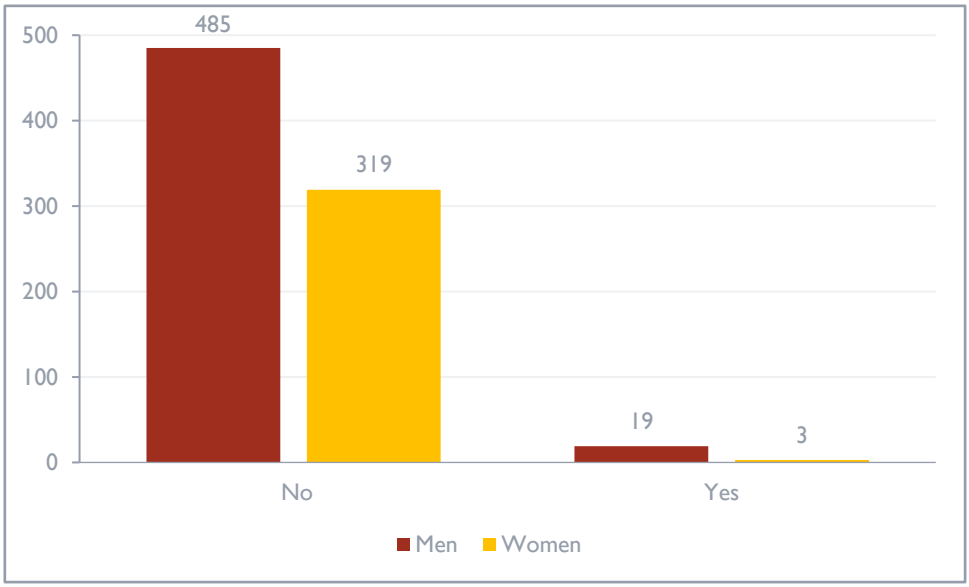
After migration, the data reveals that the vast majority of respondents, approximately 97%, no longer have radio access across different areas. A small minority, around 3%, still retain radio access post-migration (Figure 35).

Figure 35. Access to radio channels after migration



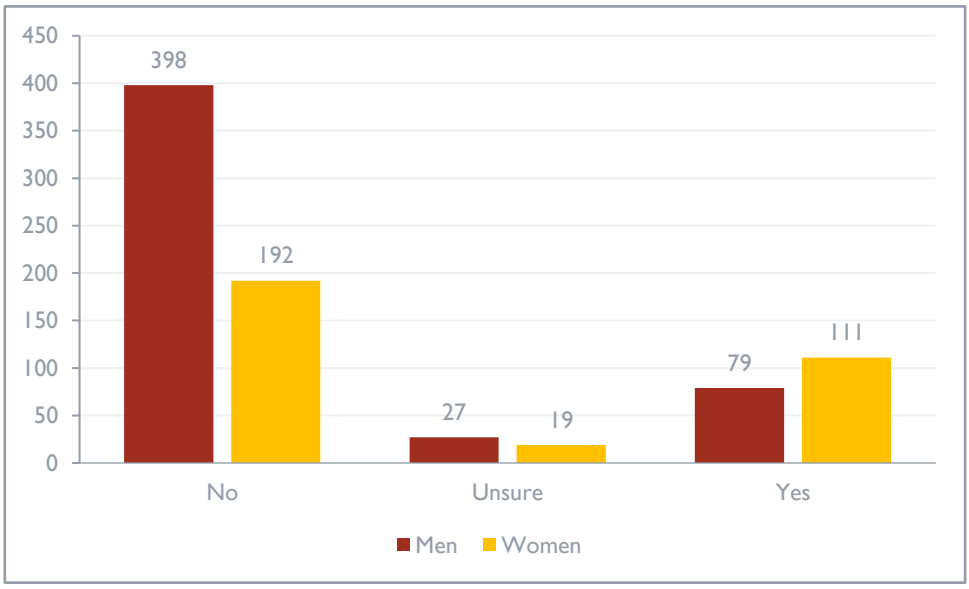
After migration, nearly all women (99%) and a significant majority of men (96%) reported losing radio access, resulting in an overall 97% decline in access to radio among the surveyed population post-migration. Only a tiny fraction, around 3%, retained access to radio after migrating (Figure 36).

Figure 36. Access to radio channels after migration segregated by gender



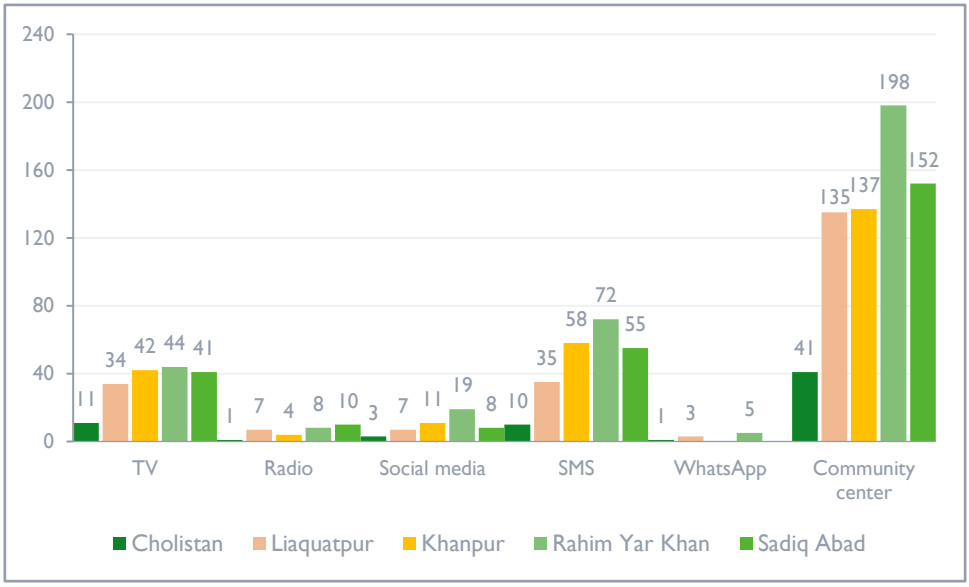
About 71% of respondents, with a higher percentage among men (79%), reported that radio channels did not provide any coverage or warning during extreme climate events. However, around 23% of respondents, with a more significant proportion among women (34%), indicated that radio channels did provide coverage or warning during such events (Figure 37).

Figure 37. Radio channels coverage or warning during extreme climate events segregated by gender



Trusted Source of Information: Community centers like mosques are the most trusted medium for early warnings—preferred by 80% of respondents, followed by SMS alerts at 28%. Television and social media are less favored, at 21% and 6%, respectively (Figure 38).

Figure 38. Preferred medium to share early warnings about extreme events



3.2 Qualitative results

FGDs

Insights gathered through the focus group discussions shed light on the critical role of early warnings in mitigating the impact of natural disasters such as floods. Despite the challenges in disseminating information, particularly among low-income rural households with limited access to technology, the early warning system emerged as a vital tool in prompting communities to take necessary precautions and relocate to safer areas. Participants shared accounts of receiving early warnings through various channels, including public announcements in villages, mosque loudspeakers, and mobile phone messages. For those fortunate enough to receive these warnings, it provided crucial time to gather belongings, including livestock, and move to higher ground or safer locations. However, some mentioned not having access to such information due to limited resources or cultural norms restricting women's mobile phone use. Recommendations were made to enhance early warning systems, such as broadcasting messages through mobile phones or mosque loudspeakers. Nevertheless, the effectiveness of early warning dissemination depended on factors like access to technology, literacy levels, and community awareness (Figure 39).

Figure 39. Focus group discussion with women

Photo Credit: IWMI Pakistan

Based on the community insight during FGDs, it becomes evident that limited awareness of government schemes or flood relief programs exists among the affected communities. The discussions predominantly revolve around the immediate impact of the flood, the challenges encountered during and after the disaster, and the pressing need for assistance in rebuilding lives and livelihoods. Participants express deep concerns about the absence of government support concerning early warnings, evacuation assistance, provision of shelter, education for children, healthcare facilities, and economic opportunities. They distinctly depict the devastating effects of the flood on their homes, livelihoods, and overall well-being, underscoring the urgent requirement for governmental intervention to address these pressing issues.

While some participants mentioned receiving early warnings from the government, there was no mention of specific flood relief programs or assistance provided by governmental or NGOs. The participants emphasize the critical importance of timely and accurate information and tangible support in the form of shelter, food, healthcare, and livelihood opportunities. After the discussion with affected communities, it is evident that a gap exists between the needs of the affected communities and the assistance provided by government agencies or relief organizations. The participants express feelings of vulnerability and dependency on external support, thereby highlighting the necessity for comprehensive and coordinated efforts to address the flood's long-term impact and to support the recovery and resilience of the affected communities.

During the discussion, illiteracy emerged as another challenging factor among these communities. Most participants cannot read or write messages in Urdu or English. This limitation hampers their ability to independently access information, mainly through written communication channels such as text messages. While very few respondents, primarily men, reported using social media platforms like WhatsApp, TikTok, Facebook, and YouTube, the overall usage remains low.

> "There was no time for prior information. Before we could think about it, the floodwater had entered our homes. We barely managed to save ourselves and came out of our homes. Later, we retrieved the remaining belongings from our homes using boats.

Flood-affected migrant women—Liaquatpur tehsil

i. Gender disparities in access to technology

The focus group discussions revealed varied responses about receiving early warnings for changes in temperature or extreme weather events. Some participants received warnings through mobile phones, mosque announcements, and radio broadcasts, while others lacked access due to limited resources or cultural norms. Gender disparities in access to technology and information within the community were evident from the discussions. It was observed that mobile phone ownership is predominantly a tradition among men, with women lacking personal mobiles.

Financial constraints were mentioned as a significant barrier, making acquiring and maintaining a mobile phone challenging due to limited resources. Consequently, women often rely on men for information dissemination, as there is less access to television in the area. Instead, men serve as the primary information channels, relaying updates upon returning from outside.

Additionally, traditional norms play a role in restricting women's access to mobile phones, with some households not permitting women to own them. However, educated and assertive women desire mobile phone access, recognizing its importance for communication and information sharing.

> Women here don't have mobile phones; it's a tradition for men to have them. If the resources were better, they would surely keep a mobile.

Flood-affected migrant women—Rahim Yar Khan tehsil

Despite the challenges, there was unanimous agreement among women regarding the necessity of basic community structures such as schools, hospitals, and electricity for TVs in the community. Furthermore, while some women demonstrated literacy in reading Urdu messages, most relied on literate men to compose and send messages when necessary.

The women affected by the flood shared valuable insights and suggestions for improving the early warning system. They emphasized the critical need for timely and comprehensive information about impending disasters, suggesting that announcements should be made in advance, preferably 12 hours to a day before the event. Recognizing the prevalence of mobile phones in their communities, they recommended utilizing this technology for alerts, advocating for voice recording calls to be sent to mobile phones with specific instructions on where to seek refuge during emergencies. Additionally, the women stressed the importance of community collaboration and effective communication networks, often relying on word of mouth to share news. They called for establishing accessible relief centers in safe locations, providing essential supplies and services during disasters. Some women expressed a desire for education and awareness programs to learn how to use mobile phones and access information online, recognizing the empowering potential of knowledge in emergencies. Furthermore, they highlighted the necessity of infrastructure improvements, such as stronger riverbanks and drainage systems, to mitigate the impact of floods.

> Eight women mentioned that some people received weather updates on their mobile keypads before the flood, but not everyone. Women shared those, men who received updates informed others in their homes. They don't know how to use smartphones, download apps, or understand QR codes or hotspots. They are not familiar with social media and don't use it.

Flood-affected migrant women—Liaquatpur tehsil

Ultimately, the women underscored the importance of government assistance and support in rebuilding homes, providing livelihood opportunities, and addressing socio-economic challenges exacerbated by disasters. Their suggestions reflect a holistic approach to disaster management, encompassing communication, community engagement, education, infrastructure development, and government intervention.

> The government provided early warnings, but we were unprepared. We need assistance to relocate safely, especially for our children. The flood caught us off guard, and we lost everything. Without resources or livestock, we fear we won't withstand another disaster. We're in dire need of food and medical assistance, as we lack the means to cope with these challenges.

Flood-affected migrant women—Rahim Yar Khan

ii. Effectiveness of early warnings

During the FGDs, some participants acknowledged the benefits of early warnings in prompt evacuation and asset protection, while others faced challenges in preparation and coping due to poverty, resource scarcity, and distrust of warnings. The distrust surrounding the early warnings appears to arise from multiple factors. Firstly, concerns were raised about the timeliness and adequacy of the warnings, with some received shortly before the disaster, leaving little time for preparation. This led to doubts about their effectiveness and whether they were sufficient for taking necessary precautions. Additionally, past experiences where warnings were either inaccurate or insufficient may have contributed to a lack of trust in the warnings' credibility, influencing the perception that they were not to be taken seriously.

Moreover, issues related to accessibility and communication channels were highlighted, with some individuals not being at home or lacking access to mobile phones to receive warnings, further exacerbating feelings of unpreparedness and skepticism. Furthermore, doubts regarding the credibility of the sources providing the warnings, whether the government, NGOs, or other organizations, may have also played a role in shaping perceptions of their reliability (Figure 40).

Figure 40. Focus group discussion with migrant community

Photo Credit: IWMI Pakistan

Findings from KIIs

The Key Informants Interviews were conducted with almost 40 relevant departments at the federal, Provincial, and district levels i.e., Agriculture, Water, Disaster Management, and NGOs. They highlighted the gendered impacts of floods and stressed the importance of reaching women, children and other vulnerable groups during disasters. During the discussion, they highlighted how disasters disproportionately affect women and children due to their roles and responsibilities within households and communities. For example, women often shoulder the bulk of caregiving responsibilities, including caring for children, the elderly, and the sick, during and after disasters. Additionally, they may face increased risks of gender-based violence and exploitation in displacement settings. The KII and their responses were divided according to the themes below.

i. Understanding the event and risk drivers

The responses from the interviewees showed notable consideration of the flooding events, as highlighted below.

- According to the Irrigation Department, Lahore Punjab, the period from 2018 to 2020 focused on significant events like floods, droughts, heat waves, and locust attacks. The timeline was also considered suitable for the study due to the numerous climatic events that occurred. Since the devastating 2010 flood, the department has improved significantly in flood preparedness and response, with an annual evaluation process that starts on July 15 to assess readiness for potential floods.
- From 2018 to 2020, the irrigation department's prime focus was on maintaining canals, barrages, and flood management structures.
- Established in 2004 for health emergency responses, the 1122 Emergency Services Department shifted focus to comprehensive disaster coverage, including urban flooding after the 2010 floods. Between 2018 and 2020, various regions faced floods or droughts, showcasing disaster management challenges. With 1122 offices across Punjab, the department implemented evacuation plans, flood responses, and volunteer training equipped with evacuation boats for efficient operations.
- According to an interviewee from the Pest Management Department, Agriculture Department, Government of Punjab, the country faced major challenges, including a significant locust attack in Rahim Yar Khan and Rajan Pur, causing extensive crop damage between 2018 and 2019. In 2021, despite high cotton production expectations, locusts caused substantial losses. The department adopted an Integrated Pest Management (IPM) approach to combat pest outbreaks. Coordinated efforts, including helicopter spraying with the agriculture department, were initiated to control the locust disaster. While the locust issue did not cause migration, other factors like education and poverty did.

ii. Major impacts from the flood or droughts experienced in 2019-2023

Regarding the major impacts of extreme weather events, key informants from relevant departments shared valuable insights below.

- Insights from the Irrigation Department representative showcased that from 2018 to 2022, DG Khan faced floods while Sindh experienced drought, impacting water resources, food security, and ecosystems. The government provided food, shelter, and health facilities, but people preferred temporary migration to relatives over permanent relocation. Floods also led to health issues like dengue and malaria, prompting the setup of medical camps. People in flood-prone areas relied on personal experience for evacuation, often sending families to relatives or camps while men stayed behind.
- Insights from the Local Government and Community Development Unit emphasized the significant impacts of floods as injuries, livelihood disruption, waterborne diseases, and displacement. Droughts increased food insecurity and water shortages, leading to short-term migration from Cholistan.
- As discussed by 1122 Emergency Services Department, major impacts included that evacuation plans were hindered by people's reluctance to leave their animals. Since then, progress has been made, including evacuating animals and enforcing evacuation through Act 44A. Floods and droughts damaged homes, livelihoods, and agricultural lands. Access to clean water was also considered a major challenge and it was addressed by NGOs and local departments that provide water and food to displaced people.

- Insights from the representative of the Pest Management Department, Agriculture Department, and Government of Punjab highlighted extreme events like floods, droughts, and locust attacks as well as reduced agricultural productivity, causing farmers to lease their land and migrate to cities. These events also decreased purchasing power, leading to economic hardships and food insecurity, which impacted women's reproductive health.

iii. Drivers of these impacts

KIIs also delved deeper into the impact drivers of floods or droughts from 2019-2023.

- According to the response from the Irrigation Department, Lahore, Punjab, disaster preparedness awareness was increased with a focus on evacuation plans post-2010. However, a reactive approach persisted due to provincial disputes hindering proactive measures.
- Another representative from the Irrigation Department mentioned the government's lack of climate change awareness and its reactive approach to increasing vulnerabilities among poor people.
- The Local Government and Community Development Unit also emphasized budget constraints, local administration's limited interest in disaster preparedness, reliance on post-flood camps, and NGO support for women's sanitation issues.
- The findings from the representative of the 1122 Emergency Services Department showcased the ignorance, departmental capacity, and lack of awareness that caused significant damage in the 2010 flood. The lack of improved flood monitoring and awareness systems, and a lack of legislation that prevents people from living in flood-prone areas also stood out. Alternative compensation methods should be considered to discourage people from residing in these areas.

iv. Preparedness and government priority

The insights gained from key informant interviews regarding disaster preparedness and governmental priorities have proven valuable as follows.

- The response from the Irrigation Department extended preparedness for risk situations post-2010 floods, with PDMA and local administration sharing timely information. Flood-induced migration was short-term, and there is a lack of sex-disaggregated data on flood impacts. Typically, women and children are sent to camps until the flood subsides.
- The Irrigation Department also highlighted the budget constraints in handling situations, with PDMA assisting and having limited resources. Improved infrastructure by the irrigation department has not fully resolved inter-departmental disconnects, impacting disaster response.
- The local government departments struggle financially, affecting infrastructure maintenance and staff salaries. Pre-flood assessments hamper the disaster preparedness implementation. Climate-resistant vulnerability assessments and Nature Based Solutions are part of interventions, but implementation lags.
- According to the 1122 Emergency Services Department, the government actively addressed climate change impacts, with the department taking a proactive approach through training, gender-inclusive efforts, and community safety plans since 2006. The department conducts pre-flood meetings, evacuation drills, and public awareness campaigns using WhatsApp and mosque contacts.
- Regarding disaster preparedness and government priorities, the interviewee from Pest Management Department, Agriculture Department, and Government of Punjab emphasized the lack of practical steps, especially in addressing displacement and migration issues. The government's reactive approach was evident in the lack of timely information and preparedness for the 2022 hill torrents, leading to significant damage.

v. Understanding EWEA potential at the time

Substantial responses regarding early warning plans and action were gained from interviewees during KIIs.

- As for the key informant interview, post-2010 floods, preparedness response from the Irrigation Department improved notably in subsequent floods in 2014 and 2022. PMD shares early warnings with the PDMA, disseminating the information to local departments, as shown below.

> At the time of the 2010 floods, departments were not well prepared, and the government never took flood as a serious issue.

Flood-affected migrant women—model village Lal Shah

Photo Credit: IWMI Pakistan

PMD-PDMA-Local Departments-Communities

- Another finding from the Irrigation Department is that the PMD provided early warnings to local administration through messages, TV news, mosques, and Rescue 1122 volunteers. Information was widely accessible, with mobile phones primarily used by male household members for communication.
- Findings from the Local Government and Community Development Unit regarding early warnings revealed that despite improved early warnings, significant gaps remained, failing to reach many vulnerable groups due to language barriers, literacy, and trust issues. Moreover, some community members still view the warnings as false alarms.
- The 1122 Emergency Services Department revealed a well-connected early warning system where PMD provides information to PDMA, which informs local departments. Centers in all Punjab tehsils and WhatsApp groups facilitate efficient, ongoing communication.
- Findings from the KIIs among the Pest Management Department and Agriculture Department revealed that in Punjab, locust activity is monitored regularly and receives early information and substantial government support to prepare and stop invasions at the Sindh and Baluchistan borders. With ample human resources, the extension department and the media liaison department effectively communicate with local communities and farmers through various media channels.

vi. Forecast and monitoring

- The findings from the interview with the Irrigation Department revealed that for the 2022 floods, timely information from departments improved preparedness and flood management plans. Local departments disseminated this information in local languages through WhatsApp, Rescue 1122, mosques, and mobile vans, ensuring community-wide awareness despite challenges in timely dissemination and inter-departmental coordination.

> Our cultural values highlight respect for women, particularly during disasters such as floods and droughts. In such situations, it is common for the male head of the household to prioritize the safety of women and children, sending them to a safe place.

XEN, Irrigation Department, Lahore Punjab

- Another finding from the same department showcases that since the 2010 floods, the forecast and monitoring system has significantly improved. The flood preparedness strategy initiates preparations as early as June or July each year.
- The interview discovered that the Local Government and Community Development Unit's capacity is insufficient for monitoring the vulnerabilities or impacts on the communities.
- The forecasting system of the 1122 Emergency Services Department has dramatically improved, with volunteers in vulnerable areas monitoring and reporting flood severity and necessary actions. This firsthand communication enhances the preparedness and response efforts.
- The volunteer support system has been extended across Punjab, and capacity-building training programs for the youth have been executed nationwide—including initiatives like girls' scouts.
- Findings reveal that coordination has weakened in the Pest Management Department since the 18th Amendment decentralized power to the provinces, leading to ineffective information sharing and collaboration on common issues.

vii. Monitoring vulnerabilities from disasters

- The Irrigation Department reveals that it is not collecting such data, but local departments and district administration of every province must have the relevant data.
- The Irrigation Department also reveals that it does not collect economic loss or sex-disaggregated data after floods, as the local administration handles this. NGOs, CBOs, and other departments only provide humanitarian assistance after disasters.
- The local government departments have limited funds and awareness, which leads to a lack of socio-economic data and vulnerability assessments for minorities and vulnerable groups in society.
- The 1122 Emergency Services Department revealed an online data portal that collects daily road accident data but has not yet gathered information on economic or human losses from floods.
- The Pest Management Department collects data on pest attacks and hotspots but lacks systematic data collection on other disasters. Shattered data across departments is a barrier; consolidating information under one department would streamline data management.

> Women are often employed as laborers in agriculture, but the decision-making authority typically rests with male farmers. That's why our WhatsApp groups primarily consist of male farmers who are responsible for decision-making. I have not seen any female farmers actively engaged in farming or managing agricultural land in this area.

Director General, PEST Management Department, Agriculture Department, Government of Punjab

Photo Credit: IWMI Pakistan

viii. Financing

- Findings from the Irrigation Department reveal that federal departments provide financial support to provincial departments during disasters, but no specific budget is allocated on climate services.
- Local Government and Community Development Unit highlights the importance of funds, but they never reach the communities.
- The 1122 department reveals that support from the Government of Punjab is received during disasters and the department has established its resources.
- The Pest Management Department showcased the provision of funding and technical support from the federal and provincial departments during the locust attack.

Photo Credit: IWMI Pakistan

> We have a significant amount of money allocated for various projects, but unfortunately, none of them seem to directly benefit the people.

Addition, Local Government and Community Development Unit

CHAPTER 4 DISCUSSION

This study conducted in the Rahim Yar Khan district of South Punjab provides a detailed exploration of the challenges experienced by communities at the intersection of socio-demographic factors and digital connectivity in the context of climate-induced migration. The analysis uncovers a societal structure strongly influenced by traditional norms, evident in high marriage rates and self-leadership within households. Within this framework, significant gender gaps in accessing technology emerge as a critical issue exacerbating susceptibility to environmental shocks. This socio-economic fragility and environmental risks drive migration patterns primarily triggered by natural disasters like floods and monsoons. The study also emphasizes the role of digital technology in disaster response, pointing out significant inequalities in access and usage. It highlights a notable gender gap in mobile phone usage and internet access, impeding effective communication and coordination during crises. This digital divide has left women and other marginalized groups more vulnerable during emergencies, as they do not receive timely information or do not have the means to access critical services. Addressing this digital inequality is essential for ensuring inclusive and effective disaster response strategies.

However, the study also highlights the varying effectiveness and reach of governmental assistance post-migration, indicating disparities in access to information and resources. In summary, addressing climate resilience challenges necessitates a comprehensive approach integrating climate adaptation with strategies for socio-economic empowerment, infrastructure development, and digital inclusivity. Prioritizing gender-sensitive interventions in water security, improving sanitation and menstrual hygiene access, and leveraging digital technologies for EWS are crucial steps toward building community resilience. Collaborative, multi-stakeholder strategies are essential, focusing on active community engagement, empowering women in critical roles, and advocating for policies bridging emergency and development contexts. The insights from Rahim Yar Khan district offer valuable lessons informing broader efforts to mitigate climate vulnerability and enhance community well-being in similar settings.

Disaster preparedness from 2010 to 2022 floods

The 2010 floods, termed a 'super flood' by the Punjab government, were unprecedented in the history of the Indus River system, resulting from the annual monsoon season (Haq and Zaidi 2011). The scale of the disaster overwhelmed local political structures, which were unprepared and undergoing a transitional phase at the time (Deen 2015). Concurrently, there were developments in disaster risk management, particularly within the NDMA, which had recently replaced provincial relief officers with the PDMAs and DDMAs (NDMA 2024). Despite these structural changes, the NDMA's sub-national authorities lacked on-ground capabilities, mirroring the inconsistency in political governance structures across provinces. The Punjab's PDMA, however, did create a detailed website documenting flood relief and reconstruction efforts, which is effective to date (PDMA 2024).

Moreover, in 2010, pre-disaster alerts were inadequate in convincing residents to evacuate flood-affected areas, resulting in significant losses of lives and property. Many residents chose to stay home due to skepticism about the flood warnings (Shah et al. 2022). During the 2010 floods in Pakistan, social media played a crucial role by consistently sharing updates and vital information about the rapidly evolving situation in various provinces. This included details about the health status of over 1,700 individuals and the extent of flooding, which affected more than 20% of the impacted regions (Ishtiaq 2022).

Overall, the 2010 floods highlighted significant policy and implementation gaps in disaster management, exposing the disconnect between local, provincial, and federal governments. Research indicates that despite establishing disaster agencies, substantial gaps remain in their response capabilities for sudden, powerful floods, strong earthquakes, and severe droughts. Key lessons from the 2010 floods have yet to be effectively translated into robust disaster response and rehabilitation policies.

During the 2022 floods in Pakistan, the NDMA utilized social media platforms to manage the disaster cycle, including rehabilitation, risk reduction, mitigation, and relief efforts. Government agencies, NGOs, and local authorities leveraged these platforms to share crucial information such as flood warnings, evacuation guidelines, and relief programs.

Findings from the interviews with relevant departments also pointed to a stark difference between the 2022 flooding and the 2010 floods, highlighting that the recent floods have inundated four times more land. Moreover, the number of affected people doubled, and the economic damage to crops and livestock was four times greater than after the 2010 floods. Despite the PMD issuing warnings for above-average rainfall, it remains uncertain to what extent these warnings were factored in for the monsoon planning by the NDMA and its provincial counterparts (Siddiqui 2022).

Compared to the 2010 floods, the government made significant improvements in disaster preparedness, highlighted by several key initiatives in the 2022 flooding event. Establishing the National Disaster Risk Management Fund (NDMRF) provided essential funding for government and non-government disaster risk reduction projects nationwide. The NDMA and PDMA set up strategic warehouses stocked with essential non-food items for use during emergencies. Additionally, contingency planning was conducted at the PDMA level, although follow-up responses remain inadequate. Provincial emergency operation centers have also been established to enhance coordination during disasters. From 2016 to 2021, NDMA trained 3,556 officials in various critical areas, including Multisector Initial Rapid Assessment, Early Recovery Needs Assessment, and disaster risk reduction. These initiatives collectively represent significant advancements in the government's disaster preparedness efforts.

In 2010, the Watan card empowered people by giving them the autonomy to make purchasing decisions, stimulating the local economy. Building on this approach, the government made rapid cash disbursements in 2022, which similarly aims to support local procurement at the individual level. Emergency services effectively utilized social media and SMS to swiftly communicate emergency alerts to the public. Although some areas received localized, real-time emergency alerts via SMS and social networks, as well as through traditional channels like radio, TV, and online platforms, the effectiveness of these messages was limited. Despite efforts to tailor messages culturally and linguistically to the Rahim Yar Khan community, many residents did not receive or respond to these communications. Consequently, the expected impact of SMS alerts fell short of expectations.

RECOMMENDATIONS

Based on the vulnerabilities identified through the survey and interviews, the following recommendations are proposed to tackle the disparities in digital ecosystem related challenges in disaster response to enhance climate resilience in Pakistan.

1. Short-term recommendations

Establishment of a disaster management coordination platform: Strengthening linkages with national and provincial institutions is essential for enhancing disaster management capacity at the district level. The Disaster management platform should include representatives from key institutions such as the PMD, PDMAs, District Disaster Management Authorities (DDMAs), and other relevant stakeholders. The platform would serve as a central hub for sharing meteorological data, early warning systems, disaster response protocols, and updates on evolving disaster scenarios.

Sex-disaggregated data: The lack of sex-disaggregated data for migrant communities is a significant gap in understanding the gender-specific challenges faced by men and women during migration, particularly in the context of disasters and climate change. Collecting sex-disaggregated data is a critical step in understanding the differing impacts of disasters on men and women, especially regarding their access to and use of digital technologies. This type of data helps identify gender-specific barriers, such as unequal access to smartphones, internet connectivity, and digital literacy, which may hinder women and other marginalized groups from effectively utilizing digital tools during disaster preparedness, response, and recovery efforts. With a clear understanding of the digital divide, authorities can design and implement policies and programs that ensure equitable access to technology, improving disaster resilience for all segments of the population.

Capacity building of department: Building the capacity of national, provincial, and district-level disaster management authorities (NDMA, PDMAs, and DDMAs) is essential for enhancing disaster response capabilities and fostering climate resilience. In response to increasingly complex disasters driven by climate change, these institutions require modern, data-driven, and gender-responsive approaches. The disaster management authorities should be equipped with the necessary tools for real-time data analysis, remote sensing, and the integration of GIS to improve decision-making during emergencies. Additionally, communication protocols should be strengthened for seamless coordination between national, provincial, and local bodies to ensure an effective and timely disaster response. Capacity-building efforts should emphasize gender and social inclusion frameworks, enabling local institutions to design disaster strategies that address the unique needs of women, children, and marginalized groups.

Telecommunication linkages: Local departments should collaborate with telecommunication authorities to establish critical communication channels, especially during disaster situations. These connections can facilitate the delivery of early warning messages in local languages, ensuring that communities are well-informed and prepared. Additionally, telecommunication authorities can explore providing special internet packages and ensuring network availability during disasters to support both emergency response teams and affected communities. This enhanced communication infrastructure will be instrumental in improving the effectiveness of disaster preparedness, response, and recovery efforts.

2. Medium-term recommendations

Gender-inclusive guidelines: Develop gender-inclusive guidelines for the implementation of the Pakistan Digital Policy 2018. The policy implementation plan should incorporate the vulnerabilities of migrants and IDPs in accessing digital technologies. A comprehensive roadmap should be developed by PMD, NDMA, and PDMAs to ensure these groups can benefit from digital tools, fostering resilience and providing them with critical access to information, services, and opportunities. By addressing the unique challenges faced by migrants and IDPs, the guidelines will promote inclusivity and help bridge the digital divide, enhancing their ability to adapt and thrive in a digital world.

Inclusive post-disaster recovery plan: The NDMA should develop an inclusive post-disaster recovery plan that focuses on empowering women and children in post-disaster camps by providing them with essential digital skills. By equipping them with skills in areas such as digital literacy, online communication, and data management, they will be better prepared to navigate the challenges of displacement and access critical services. Additionally, the recovery plan should prioritize the creation of safe and supportive environments in post-disaster camps, where women and children feel secure in engaging with digital technologies. Training sessions can be conducted in collaboration with local NGOs and community organizations, ensuring that the content is culturally relevant and accessible.

3. Long-term recommendations

Climate migrant support system: Implementing climate migrant support systems through social media platforms is a vital strategy to provide timely and relevant migration-related information to communities affected by climate change. As climate-induced displacement becomes increasingly common, social media can serve as an effective tool for reaching vulnerable populations who may lack access to traditional forms of communication. These systems can utilize platforms such as Facebook, Twitter, WhatsApp, and Instagram to disseminate critical information regarding safe migration routes, available resources, legal assistance, health services, and emergency support. By sharing real-time updates and alerts, these platforms can help migrants make informed decisions and reduce their vulnerability during crises.

Gender transformative trainings for communities: The Local Government and Community Development Unit (LGCD) should design a comprehensive curriculum that not only addresses the cultural norms restricting women's access to information during disasters but also promotes gender inclusivity in disaster preparedness and response strategies. These cultural barriers often prevent women from receiving critical information on time, making them more vulnerable to the impacts of disasters, such as displacement, loss of livelihoods, and health risks.

CONCLUSION

Climate change and its effects, particularly climate-induced migration, pose a multifaceted challenge to human safety in Pakistan. Rising temperatures, frequent extreme weather events, and dwindling water resources push vulnerable communities to their limits. These environmental strains exacerbate existing social, economic, and political issues, leading to conflicts, displacement, and a decline in overall well-being. This study delves into the wide-ranging impacts of climate change on rural and urban livelihoods.

Frequent floods and droughts disrupt agricultural productivity and profitability, affecting farm employment and incomes, especially for landless agrarian laborers and sharecroppers in rural areas. The resulting income loss, depletion of assets such as livestock, and mounting debts contribute to food insecurity and malnutrition, which, in turn, drive migration due to limited access to welfare programs and public services. Furthermore, the study reveals a limited capacity to adapt and respond to climate challenges, exacerbated by the lack of effective EWS and infrastructure to handle extreme weather events, resulting in heightened vulnerabilities affecting livelihoods and coping mechanisms.

The findings from the FCM Work Package 3 shed light on critical disconnects among departments regarding EWS, revealing systemic weaknesses in disaster preparedness and response mechanisms. Despite the widespread use of social media platforms, their role in enhancing community resilience during or after floods remains limited. While social media can potentially serve as a valuable tool for disseminating timely information and mobilizing resources, its effectiveness is undermined by various factors, including the digital divide, literacy barriers, and cultural constraints.

One significant gap highlighted in the findings is the lack of gender inclusivity in disaster plans and recovery strategies. Women, who often bear the brunt of disasters due to their socio-economic roles and responsibilities, are disproportionately affected by the failure to address their specific needs and vulnerabilities. Cultural norms and societal expectations further constrain women's access to information and support, particularly through social media. These constraints not only limit women's ability to seek assistance but also perpetuate their marginalization in decision-making processes related to disaster management.

Illiteracy and poverty compound the challenges communities face, exacerbating their vulnerability to disasters. Limited access to education and resources inhibits the ability of individuals to effectively understand and respond to early warnings. Moreover, poverty restricts access to essential services and infrastructure, leaving marginalized communities particularly susceptible to the adverse impacts of floods and other natural hazards.

In conclusion, this report has explored the complex interactions between digital ecosystems and migration responses to climate extremes in Pakistan, specifically focusing on the Rahim Yar Khan District in Punjab. The findings reveal that while digital technologies offer significant potential for enhancing disaster preparedness and response, there are critical gaps in accessibility and utilization, particularly among vulnerable populations such as women and marginalized communities. Thus, the study highlights the necessity of integrating climate adaptation strategies with socio-economic empowerment, infrastructure development, and digital inclusivity. Key areas for improvement include expanding weather monitoring networks, enhancing data collection to understand community vulnerabilities better, and developing comprehensive, gender-sensitive policies. Religious leaders can also play a role in awareness campaigns and financial assistance for disaster preparedness. Strengthening early warning systems and ensuring effective coordination and communication through social media and other digital platforms are essential to building community resilience.

The government's efforts, such as the rapid cash disbursements and establishment of the NDMRF, demonstrate a commitment to improving disaster response. However, more proactive and holistic approaches are needed, including strict enforcement of construction policies in flood-prone areas and better integration of disaster risk reduction into planning and budgeting processes. Collaboration between government entities, the humanitarian community, and local stakeholders is crucial to achieve these goals. Implementing evidence-based solutions, fostering community engagement, and prioritizing the needs of the most vulnerable will enhance the effectiveness of disaster management strategies. By leveraging the lessons learned from the Rahim Yar Khan District, Pakistan

can move towards a more resilient and inclusive future and be better equipped to handle the challenges posed by climate extremes.

REFERENCES

Abbasi, M. S.; Naeem, K.; Ansari, D. H. 2021. Climate Induced Migration Among Women: Stories from Muzaffargarh and Tharparkar districts Pakistan. Sustainable Development Policy Institute (SDPI). Available at https://www.budapestprocess.org/wp-content/uploads/2021/09/Climate-induced-migration-among-women-Pakistan-compressed.pdf Accessed on May 27, 2024

Action Aid. 2020. Climate migration in South Asia set to treble by 2050 due to political inaction on global warming. *ActionAid International*. https://actionaid.org/news/2020/climate-migration-south-asia-set-treble-2050-due-political-inaction-global-warming Accessed on October 8, 2024

ADB (Asian Development Bank). 2021. *Digital Health Implementation Guide for The Pacific*. Asian Development Bank (ADB). Available at https://adb.org/sites/default/files/publication/677181/digital-health-implementation-guide.pdf Accessed on May 28, 2024

Alied, M.; Salam, A.; Sediqi, S. M.; Kwaah, P. A.; Tran, L.; Huy, N. T. 2024. Disaster after disaster: The outbreak of infectious diseases in Pakistan in the wake of 2022 floods. *Annals of Medicine and Surgery* 86(2): 891-898. https://doi.org/10.1097/MS9.0000000000001597

Chandrashekhar, V. 2023. Melting at the world's "third pole" endangers South Asia. *Welthungerhilfe*. Available at https://www.welthungerhilfe.org/global-food-journal/rubrics/climate-resources/glacier-melt-in-the-himalayas-endangers-south-asia Accessed on December 18, 2024

Daily Times. August 2022. Woman dies as 134 bitten by venomous snakes in Nowshera. *Daily Times*. August 31, 2022. Available at https://dailytimes.com.pk/989955/woman-dies-as-134-bitten-by-venomous-snakes-in-nowshera/ Accessed on September 18, 2023

Deen, S. 2015. Pakistan 2010 floods. Policy gaps in disaster preparedness and response. *International Journal of Disaster Risk Reduction* 12: 341–349. https://doi.org/10.1016/j.ijdrr.2015.03.007

FAO (Food and Agriculture Organization of the United Nations). 2022. *Crop Prospects and Food Situation. Quarterly Global Report No. 4.* Rome, Italy: Food and Agriculture Organization of the United Nations (FAO). 46p. https://doi.org/10.4060/cc3233en

Government of Pakistan. 2023. Pakistan Economic Survey 2022-23 | Ministry of Finance. Government of Pakistan. Available at https://www.finance.gov.pk/survey_2023.html Accessed on September 18, 2023

GSMA (Global System for Mobile Communications Association). 2024. *The Mobile Gender Gap Report 2024*. Global System for Mobile Communications Association (GSMA). Available at https://www.gsma.com/r/wp-content/uploads/2024/05/The-Mobile-Gender-Gap-Report-2024.pdf?utm_source=website&utm_medium=button&utm_campaign=gender-gap-2024 Accessed on May 29, 2024

GSMA. 2021. *The Mobile Gender Gap Report 2021.* Global System for Mobile Communications Association (GSMA). Available at https://www.gsma.com/r/wp-content/uploads/2021/07/The-Mobile-Gender-Gap-Report-2021.pdf Accessed on May 29, 2024

Gul, A. 2022. Study: Pakistan flood damages, economic losses exceed $30 billion. *VOA News*, October 28, 2022 https://www.voanews.com/a/study-pakistan-flood-damages-economic-losses-exceed-30-billion-/6810207.html Accessed on April 26, 2024

Haq, A. U.; Zaidi, S. M. A. 2011. Flood 2010: The event, issues and way forward. International Workshop on Floods in Pakistan-2010: Paper No. 272. Pakistan Engineering Congress. https://pecongress.org.pk/images/upload/books/3-Flood%202010%20(Asrar%20ul%20Haq)-11pt.pdf Accessed on October 8, 2024

Ishtiaq, N. 2022. The Use of Social Media During the 2022 Flooding in Pakistan: A Study of the National Disaster Management Authority Crisis Communication. JONKOPING UNIVERSITY - School of Education and Communication. Available at https://hj.diva-portal.org/smash/get/diva2:1791078/FULLTEXT01.pdf Accessed on May 29, 2024

Husaini, S.; Davies, S. E. 2022. Case Report: Another Burden to Bear: The Impacts of Climate Change on Access to Sexual and Reproductive Health Rights and Services in Bangladesh. *Frontiers in Climate* 4:875515. https://doi.org/10.3389/fclim.2022.875515

IDMC (Internal Displacement Monitoring Centre). 2022a. *Record-breaking rainfall triggers displacement of half a million people, threatens food security in Pakistan*. Internal Displacement Monitoring Centre (IDMC). https://www.internal-displacement.org/news/record-breaking-rainfall-triggers-displacement-of-half-a-million-people-threatens-food/ Accessed on May 28, 2024

IDMC. 2022b. *Children and youth in internal displacement*. Global Report on Internal Displacement 2022. Internal Displacement Monitoring Centre (IDMC). Available at https://api.internal-displacement.org/sites/default/files/publications/documents/IDMC_GRID_2022_LR.pdf#page=37 Accessed on May 28, 2024

Islamic Relief. 2021. *Climate Induced Migration in Pakistan: Global discourse, local realities and governance 2021*. Research report on Climate Induced Migration: Global discourse, local realities and governance. Islamic Relief. Available at https://islamic-relief.org/wp-content/uploads/2021/11/IRWClimateInducedMigration_Digital-V2.pdf Accessed on May 28, 2024

Karandaaz Pakistan. 2023. Karandaaz Financial Inclusion Survey (K-Fis): Narrative Report. Available at https://smefinanceforum.org/sites/default/files/Karandaaz-Financial-Inclusion-Survey-2.pdf Accessed on September 18, 2023

Kemp, S. 2023. Digital 2023: Pakistan — Global Digital Insights. *DataReportal.* February 23, 2023. https://datareportal.com/reports/digital-2023-pakistan Accessed on September 18, 2023

Khalid, S.; Aeman, H.; Waqar, K.; Hafeez, M. 2024. *The hidden crisis of disaster displacement and host community struggles in rural areas of Pakistan*. CGIAR Initiative on Fragility, Conflict, and Migration. Available at https://www.cgiar.org/news-events/news/the-hidden-crisis-of-disaster-displacement-and-host-community-struggles-in-rural-areas-of-pakistan/ Accessed on October 8, 2024

Maheen, H.; Hoban, E. 2017. Rural Women's Experience of Living and Giving Birth in Relief Camps in Pakistan. *PLOS Currents 9*. August 18, 2018. https://doi.org/10.1371/currents.dis.7285361a16eefbeddacc8599f326a1dd

Mangi, F. 2022. Damage from Pakistan floods is 'far greater' than $10 billion. *Bloomberg*. September 6, 2022. Available at https://www.bloomberg.com/news/articles/2022-09-06/damage-from-pakistan-floods-is-far-greater-than-10-billion?leadSource=uverify%20wall April 15, 2024

McCarthy, J. 2020. Understanding Why Climate Change Impacts Women More Than Men. *Global Citizen*. March 5, 2020. Available at https://www.globalcitizen.org/en/content/how-climate-change-affects-women/ Accessed on May 28, 2024

Minicucci, C.; Rest, E.; Zhang, E. 2022. Flood Recovery and Resilience in Pakistan. Yale School of Medicine. Available at https://medicine.yale.edu/yigh/students/case-competition/2023/yigh%202023%20ghcc_case_470151_58250_v1.pdf Accessed on May 28, 2024

Naz, R.; Shah, M.; Ullah, A.; Alam, I.; Khan, Y. 2020. An Assessment of Effects of Climate Change on Human Lives in Context of Local Response to Agricultural Production in District Buner. *Sarhad Journal of Agriculture* 36:1. https://doi.org/10.17582/journal.sja/2020/36.1.110.119

NDMA (National Disaster Management Plan). 2024. NDMA's National Disaster Management Plan - III. Available at https://www.ndma.gov.pk/storage/plans/July2024/vWxklzviXxzbgPGHuitB.pdf Accessed on May 29, 2024

NDMA Pakistan (National Disaster Management Plan). 2023. *Midterm Review of the Implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030*. Pakistan National Voluntary Report. National Disaster Management Authority, Government of Pakistan, Islamabad, Pakistan. Available at https://sendaiframework-mtr.undrr.org/media/88072/download?startDownload=20241218 Accessed on May 29, 2024

Nisar, N. 2022. Climate-Induced Migration in Pakistan. *Centre for Strategic and Contemporary Research (CSCR)*, June 10, 2022. https://cscr.pk/explore/themes/energy-environment/climate-induced-migration-in-pakistan/ Accessed on September 18, 2023

UN OCHA (United Nations Office for the Coordination of Humanitarian Affairs). 2022a. Pakistan: Floods - July 2022. *ReliefWeb*. https://reliefweb.int/disaster/fl-2022-000254-pak Accessed on May 29, 2024

UN OCHA. 2022b. Pakistan: 2022 Monsoon Floods - Situation Report No. 5 (As of 9 September 2022). *Situation Report. ReliefWeb*, September 9, 2022. https://reliefweb.int/report/pakistan/pakistan-2022-monsoon-floods-situation-report-no-5-9-september-2022 Accessed on May 29, 2024

UN OCHA. 2022c. Pakistan: 2022 Monsoon Floods - Situation Report No. 11 (As of 11 November 2022). *Situation Report. ReliefWeb*, November 13, 2022. https://reliefweb.int/report/pakistan/pakistan-2022-monsoon-floods-situation-report-no-11-11-november-2022 Accessed on May 29, 2024

UN OCHA. 2022d. Pakistan: 2022 FLOODS RESPONSE PLAN. OCHA-Asia and the Pacific Pakistan. United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA). Available at https://www.unocha.org/publications/report/pakistan/revised-pakistan-2022-floods-response-plan-01-sep-2022-31-may-2023-04-oct-2022 Accessed on May 29, 2024

Ong, B.; Toh, D. J. 2023. Digital Dominance and Social Media Platforms: Are Competition Authorities Up to the Task? *Springer Nature Link* 54:527–572. https://doi.org/10.1007/s40319-023-01302-1

PDMA (Provincial Disaster Management Authority). 2024. *Punjab Disaster Response Plan-2024*. Available at https://pdma.punjab.gov.pk/system/files/2.pdf Accessed on May 29, 2024

Perera, T. 2024. *Digital inequality – A challenge to climate risk responses in Pakistan?* Colombo, Sri Lanka: International Water Management Institute (IWMI). Available at https://www.iwmi.cgiar.org/blogs/digital-inequality-a-challenge-to-climate-risk-responses-in-pakistan/ Accessed on September 18, 2023

PMD (Pakistan Meteorological Department). 2022. Pakistan's Monthly Climate Summary, August 2022. Pakistan meteorological department. Available athttps://cdpc.pmd.gov.pk/Pakistan_Monthly_Climate_Summary_August_2022.pdf Accessed on May 29, 2024

Prescia, M. 2021. The Immediate Threat of Climate Change in Pakistan. *Climate Refugees* July 30, 2021. https://www.climate-refugees.org/spotlight/2021/7/30/pakistan Accessed on September 24, 2023

Puskur, R.; Mishra, A. 2022. *Rural women in Pakistan are the most affected by 'apocalyptic' floods. CGIAR Gender Impact Platform* October 4, 2022. Available at https://gender.cgiar.org/news/rural-women-pakistan-are-most-affected-apocalyptic-floods Accessed on September 24, 2023

Raza, M. 2022. Pakistan's history of disasters and the lessons we fail to learn. *DAWN.COM*. August 31, 2022. Available at https://www.dawn.com/news/1707390 Accessed on April 18, 2024

Salik, K. M.; Shabbir, M.; Naeem, K. 2020. CLIMATE-INDUCED DISPLACEMENT AND MIGRATION IN PAKISTAN: Insights from Muzaffargarh and Tharparkar districts. CANSA. Available at https://cansouthasia.net/wp-content/uploads/2021/02/Migration_Pakistan_17_12_2020.pdf Accessed on May 27, 2024

Save the Children. 2022. No Back-to-school For Thousands of Children as Nearly 19,000 Schools Damaged, Destroyed by Floods in Pakistan. *Scoop News* Sept 2, 2022. Available at https://www.scoop.co.nz/stories/WO2209/S00013/no-back-to-school-for-thousands-of-children-as-nearly-19000-schools-damaged-destroyed-by-floods-in-pakistan.htm Accessed on April 25, 2024

Schiffling, S.; Hannibal, C.; Tickle, M.; Fan, Y. 2020. The implications of complexity for humanitarian logistics: a complex adaptive systems perspective. *Annals of Operation Research* 319:1379–1410. https://doi.org/10.1007/s10479-020-03658-w

Sehgal, Z. 2022. How digitalization kept aid coming to flood-hit Pakistanis. *Climate Action. World Economic Forum*, Sep 26, 2022. Available at https://www.weforum.org/agenda/2022/09/how-digitalization-kept-aid-coming-to-flood-hit-pakistanis/ Accessed on May 2, 2024

Shaeen, S. K.; Tharwani, Z. H.; Bilal, W.; Islam, Z.; Essar, M. Y. 2022. Maternal mortality in Pakistan: Challenges, efforts, and recommendations. Annals of Medicine and Surgery, 81, 104380. https://doi.org/10.1016/j.amsu.2022.104380

Shah, A. A.; Ullah, A.; Khan, N. A.; Pal, I.; Alotaibi, B. A.; Traore, A. 2022. Gender Perspective of Flood Early Warning Systems: People-Centered Approach. *Water (Switzerland)* 14:14. https://doi.org/10.3390/w14142261

Siddiqui, Z. 2022. Pakistan floods pose urgent questions over preparedness and climate reparations. *The New Humanitarian*. Available at https://www.thenewhumanitarian.org/news-feature/2022/09/05/Pakistan-floods-urgent-questions-climate-crisis Accessed on May 29, 2024

Srinivas, H. 2023 *A Disaster Technology Continuum: Technology Ecosystems for Disaster Risk Reduction*. GDRC Research Output. Policy Analysis Series E-197. Kobe, Japan: Global Development Research Center. Available at https://www.gdrc.org/techtran/tech-conti/index.html Accessed on September 24, 2023

The News International. 2022. UN lists Pakistan among drought-hit countries. *News Report. The News International*. Available at https://www.thenews.com.pk/print/958172-un-lists-pakistan-among-drought-hit-countries Accessed on September 18, 2023

UN (United Nations). 2021. *Climate Change 'Biggest Threat Modern Humans Have Ever Faced', World-Renowned Naturalist Tells Security Council, Calls for Greater Global Cooperation*. Meetings Coverage and Press Releases. United Nations (UN). https://press.un.org/en/2021/sc14445.doc.htm Accessed on October 8, 2024

UNDP (United Nations Development Program). 2022. *Women are hit hardest in disasters, so why are responses too often gender-blind?* United Nations Development Program (UNDP). https://www.undp.org/blog/women-are-hit-hardest-disasters-so-why-are-responses-too-often-gender-blind Accessed on May 29, 2024

UNDP. 2023. *Scaling-up of Glacial Lake Outburst Flood (GLOF) risk reduction in Northern Pakistan.* United Nations Development Program Pakistan (UNDP). https://www.undp.org/pakistan/projects/scaling-glacial-lake-outburst-flood-glof-risk-reduction-northern-pakistan Accessed on May 29, 2024

UNDRR (United Nations Office for Disaster Risk Reduction). 2022. *Data and Digital Maturity for Disaster Risk Reduction Informing the Next Generation of Disaster Loss and Damage Databases*. United Nations Office for Disaster Risk Reduction (UNDRR). Available at https://www.undrr.org/media/84892/download?startDownload=20240528 Accessed on May 28, 2024

UNFPA (United Nations Population Fund). 2022. *Women and girls bearing the brunt of the Pakistan Monsoon floods.* United Nations Population Fund Pakistan (UNFPA). https://pakistan.unfpa.org/en/news/women-and-girls-bearing-brunt-pakistan-monsoon-floods Accessed on September 21, 2023

UNFPA. 2023. *Addressing Persistent Challenges Faced by Flood-Affected Women and Girls in Pakistan – one year on*. United Nations Population Fund Pakistan (UNFPA). https://pakistan.unfpa.org/en/news/addressing-persistent-challenges-faced-flood-affected-women-and-girls-pakistan-%E2%80%93-one-year Accessed on September 21, 2023

UNICEF (United Nations Children's Fund). 2022. *More than three million children at risk as devastating floods hit Pakistan.* United Nations Children's Fund (UNICEF). Available at https://www.unicef.org/pakistan/press-releases/more-three-million-children-risk-devastating-floods-hit-pakistan Accessed on May 27, 2024

Vota, W. 2022. *What is Digital Ecosystem in International Development Programs?* ICT works. Available at https://www.ictworks.org/digital-ecosystem-international-development/ Accessed on May 28, 2024

Wallen, J.; Yusufzai, A. 2022. Women forced to 'give birth by the side of the road' after floods devastate Pakistan. *The Telegraph*, September 3, 2020. Available at https://www.telegraph.co.uk/global-health/climate-and-people/women-forced-give-birth-side-road-floods-devastate-pakistan/ Accessed on January 25, 2024

Waseem, H. B.; Rana, I. A. 2023. Floods in Pakistan: A state-of-the-art review. *Natural Hazards Research* 3*: 359-373* https://doi.org/10.1016/j.nhres.2023.06.005

World Bank. 2022. Pakistan: Flood Damages and Economic Losses Over USD 30 billion and Reconstruction Needs Over USD 16 billion - New Assessment. World Bank. https://www.worldbank.org/en/news/press-release/2022/10/28/pakistan-flood-damages-and-economic-losses-over-usd-30-billion-and-reconstruction-needs-over-usd-16-billion-new-assessme Accessed on May 2, 2024

Yaseen, M.; Saqib, S. E.; Visetnoi, S.; McCauley, J. F.; Iqbal, J. 2023. Flood risk and household losses: Empirical findings from a rural community in Khyber Pakhtunkhwa, Pakistan. *International Journal of Disaster Risk Reduction* 96:103930. https://doi.org/10.1016/j.ijdrr.2023.103930

Kanwal Waqar, Regional Researcher, Gender and Social Inclusion, k.waqar@cgiar.org

Dr Mohsin Hafeez, Director, Water Food Ecosystems, m.hafeez@cgiar.org

CGIAR is a global research partnership for a food-secure future. CGIAR science is dedicated to transforming food, land, and water systems in a climate crisis. Its research is carried out by 13 CGIAR Centers/Alliances in close collaboration with hundreds of partners, including national and regional research institutes, civil society organizations, academia, development organizations and the private sector. www.cgiar.org

We would like to thank all funders who support this research through their contributions to the CGIAR Trust Fund: www.cgiar.org/funders.

To learn more about this Initiative, please visit this webpage.

To learn more about this and other Initiatives in the CGIAR Research Portfolio, please visit www.cgiar.org/cgiar-portfolio

INITIATIVE ON
Fragility, Conflict, and Migration