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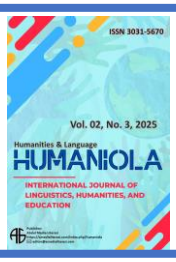

Socioeconomic and Cultural Impacts of Water Scarcity on Rural Communities in Pakistan's Pothwar Plateau

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ABSTRACT

The Pothwar Plateau in Pakistan, encompassing the districts of Chakwal, Attock, and Jhelum, is experiencing severe water scarcity, which has a significant socioeconomic impact on the nearby rural population that primarily depends on rain-fed agriculture. Through semi-structured interviews, focus groups, and field observations, this study employed a qualitative research methodology to investigate the impact of water shortages on household income, agricultural production, migratory trends, health, education, and social stability. According to the findings, crop yields have decreased significantly due to unpredictable rainfall and groundwater depletion, prompting many farmers to abandon farming altogether or switch to low-value crops. Rural-urban migration has been exacerbated by the decline in agricultural revenue, particularly the loss of young male labour, which has intensified the economic and social constraints on families left behind, especially women. Competition for water supplies has also led to disputes within communities and the eventual breakdown of traditional water-sharing systems. The poverty cycle has been made worse by declining health and education investment as a result of family financial hardships. Although local communities have attempted to address water shortages through conventional means, their efforts have been constrained by a lack of infrastructure investment and regulatory support. To increase water use efficiency and social resilience, the Pothwar region urgently needs an integrated water resources management (IWRM) strategy that combines contemporary water-saving technologies (like drip irrigation and rainwater harvesting) with community participatory governance, according to the study. The study's findings provide valuable insights for policymakers in Pakistan and other regions affected by drought, supporting the pursuit of sustainable development and equitable water distribution.

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1. Introduction

In Pakistan, particularly in the semi-arid Pothwar plateau, which encompasses the districts of Chakwal, Attock, and Jhelum, water scarcity has become a significant environmental and developmental concern. With its rolling hills, thin soils, and reliance on unpredictable monsoon rainfall, the area's farming-based economy is highly vulnerable to climate change (Durrani, 2020; Panhwar et al., 2021). Long-term dry

periods, dwindling groundwater supplies, and increasingly erratic rainfall patterns have increased the hazards to rural livelihoods and agricultural sustainability (Memon, 2002; Ahmad, 2011). Communities are exposed to food insecurity, lower incomes, and increased socioeconomic vulnerability due to inadequate irrigation infrastructure (Jamil, 2019).

Farmers in Pothwar rely on groundwater drawn from tube wells, small dams, and natural ponds, as they lack extensive canal irrigation infrastructure. However, agriculture is becoming increasingly unsustainable due to high extraction costs, rapid groundwater depletion, and a lack of investment in modern water-saving technologies (Saeed et al. 2023). In addition to lowering crop yields over the last 20 years, water scarcity has led to significant socioeconomic changes, including rural-to-urban migration, an increase in poverty, and a decline in community resilience. The area has gotten little consideration in national water policy and development planning, despite these mounting difficulties (Anwar et al. 2016).

The need to comprehend how Pothwar's social and economic landscape is changing due to water constraint is the driving force behind this study. To shed further light on the intricate connection between environmental stress and rural livelihoods, the research will focus on the lived experiences of rural populations in Chakwal, Attock, and Jhelum. Additionally, it aims to draw attention to the pressing need for community-based adaptation plans and coordinated water resource management to ensure sustainable development in this economically significant and ecologically sensitive area.

Because Pothwar's agriculture is mostly rain-fed, variations in precipitation have a direct impact on crop production, livestock health, and household income (Anwar et al. 2016). Research has demonstrated similarities to the Pishin Lora Basin in Balochistan, where water scarcity has led to decreased yields, monetary losses, and emigration (Shah et al. 2023). The situation is exacerbated by an excessive reliance on tube wells, ineffective use of conventional farming techniques, and limited access to modern irrigation technologies (Yousuf & Barrech, 2022). To ensure livelihoods and regional development, addressing water shortages in this delicate ecosystem requires increased resilience techniques, the deployment of water-efficient technology, and sustainable management practices.

In the Pothwar region, water scarcity also has significant societal repercussions. Similar to patterns observed in water-stressed locations worldwide, the depletion of water supplies has led to an increase in out-migration from rural to urban areas (Hussain et al. 2022). In addition to upsetting family dynamics, this movement strains metropolitan resources and exacerbates socioeconomic disparities. Furthermore, because households prioritise short-term survival needs above long-term investments in human capital, water scarcity lowers spending on health and education (Ahmed, 2019). Poor sanitation and inadequate access to safe drinking water exacerbate health issues, and educational achievement declines, especially for children from marginalised agricultural families.

Furthermore, the effects of Pothwar's water shortage go beyond social welfare and agriculture to the larger economic structure. The rural economy is weakened by declining productivity and decreased agricultural income, which exacerbates inequality and poverty. Farmers are fighting for scarce resources during the busiest planting seasons, leading to an increase in disputes over water distribution and use (Shaheen et al. 2011). These conflicts are exacerbated by the lack of community-based water governance and integrated water resource management regulations (Panhwar et al., 2021). When water scarcity is ignored, it exacerbates socioeconomic and environmental

issues, endangering long-term sustainability, as is the case in places like Jordan and Balochistan.

The development of adaptive techniques to manage water scarcity is crucial, given the socio-economic importance of agriculture in the Pothwar region. These include community-led water management projects, effective irrigation methods, rainwater collection, and the advancement of climate-smart agriculture (DAS & BHUTTA, 2025). Water scarcity in Chakwal, Attock, and Jhelum could seriously jeopardise food security, rural livelihoods, and socioeconomic development in this historically significant yet environmentally vulnerable region if prompt and thorough solutions are not implemented (Alvi et al., 2025).

Despite being renowned for its varied terrain and historical significance, the Pothwar plateau is currently facing an increasing amount of ecological stress due to growing water scarcity. Due to the region's reliance on rain-fed (barani) agriculture, crop planning, sowing patterns, and final yields are all significantly impacted by even little changes in seasonal rainfall (Taj et al. 2007). Traditionally reliant on wheat, barley, and pulses, farmers in regions such as Chakwal and Jhelum are now forced to either abandon farming altogether or switch to low-value but less water-intensive crops. This change reduces the nutritional intake of rural families, having a direct impact on household food security. Due to the lack of dependable water sources during crucial development seasons, orchard-based agriculture, a defining feature of the area's economic identity, has significantly declined in several villages (Afzal, 2021).

Agrarian stress brought on by water scarcity is also manifesting in sociodemographic shifts. Migration trends are increasing as more young men from rural households move to cities like Rawalpindi and Islamabad in search of other sources of income (Ahmed et al. 2020). In addition to reducing the number of workers in rural areas, this movement imposes more social obligations on women, who often run farms without male assistance. Although it can be empowering at times, the feminisation of agriculture is occurring without the accompanying access to extension services, water, or land rights (Ali, 1993). Furthermore, the financial losses resulting from poor crops, livestock deaths, and decreased farm productivity cannot be fully compensated by the remittances that migrating members send home. Water scarcity is causing the Pothwar region's traditional water governance institutions to deteriorate in addition to disrupting livelihoods (Zahra et al. 2014). Pothwar inhabitants have traditionally met their residential and agricultural needs by using ponds, small-scale rainwater collection systems, and natural streams (nullahs). However, the sustainability of groundwater has become a significant concern due to the degradation of these indigenous systems and the excessive reliance on mechanised groundwater extraction, particularly through tube wells. For example, many wells in Chakwal are already non-operational due to falling water tables, and in some areas of Attock, small farmers cannot afford groundwater due to the high cost of diesel and power needed for pumping (*Shah*). As a result, disparities in access to water have emerged, with poorer individuals lagging further behind and wealthy landowners having better access (Naheed Zahra et al. 2014).

Furthermore, the issue is made worse by a lack of institutional support and infrastructure. Ineffective responses to the crisis have been caused by a lack of funding for water conservation programs, inadequate training for farmers on water-efficient techniques, and a lack of cooperation among local water management agencies. Climate change has exacerbated the problem by causing longer dry spells and more unpredictable monsoon patterns, making it harder to plan and schedule agricultural operations (Zahra et al. 2017). When water shortages persist without a comprehensive

response, as observed in other case studies such as Jordan and Balochistan, their effects ripple across all sectors, impacting public health services, labour markets, food costs, and educational attainment.

As a result, professionals and local stakeholders are increasingly in agreement that Pothwar urgently needs an integrated water resource management (IWRM) strategy. To optimise water use efficiency, such a strategy would integrate traditional knowledge with contemporary technologies, including drip irrigation, solar-powered pumps, and small check dams. Long-term sustainability and equitable water distribution can also be ensured through participatory governance that involves women, young people, and local farmers (Basharat, 2015). Water scarcity will continue to endanger not only the agricultural foundation of Chakwal, Attock, and Jhelum, but also the social cohesion and economic prospects of the Pothwar plateau in the absence of such concerted effort.

1.2. Summary of Previous Studies on Water Scarcity in Pakistan

Table 1. Previous Studies on Water Scarcity in Pakistan

Author(s)	Year	Study Focus	Key Findings/ Conclusions	Contribution	Methodological Approaches
Ullah	2016	Hydrology and retreat of glaciers in northern Pakistan	Increased glacier melt affects long-term water storage and seasonal flows	Linked national water security to glacier health and emphasised hydrological modelling	Hydrological modelling, glacier monitoring
Amin et al.	2018	Punjab's groundwater depletion	Water table decline due to over-extraction	Urgent need for groundwater recharge and regulation	Groundwater data analysis, field surveys
Ullah	2019	Baluchistan farmers' response to water scarcity	Farmers use water-saving methods and traditional knowledge	Highlighted importance of local expertise and indigenous solutions	Qualitative interviews, participatory rural appraisal
Janjua et al.	2021	Water governance and policy frameworks	Institutional gaps, policy weaknesses, poor enforcement worsen scarcity	Called for integrated governance and stakeholder participation	Policy review, institutional analysis
Panhwar et al.	2021	Climate variability in Pothwar	Rain-fed farming highly vulnerable to	Emphasised resilience building in	Climate trend analysis, GIS and rainfall data

			erratic rainfall and droughts	rain-fed agriculture	
Yousuf & Barrech	2022	Groundwater stress and irrigation in Baluchistan	Tube-well dependence worsens depletion; lack of modern irrigation	Urged adoption of high-efficiency irrigation systems	Case studies, water balance assessment
Shah et al.	2023	Impacts of water scarcity in Pishin Lora Basin	Agricultural yield loss, migration, and income decline due to scarcity	Drew parallels between water scarcity, livelihood risks, and migration	Household surveys, livelihood vulnerability analysis
Mirza et al.	2023	Food-Energy-Water (FEW) nexus under scarcity	Agriculture and energy sectors are highly impacted; need integrated solutions	Promoted nexus-based integrated water resource management	Nexus framework analysis, systems modelling
Nadeem	2024	Climate change and future water demand in Pakistan	Increasing demand projected to exceed supply under current practices	Advocated national-level adaptation and demand management	Simulation modelling, climate projections

1.3. Significance of the Study

This study is important because it aims to clarify the significant issue of water scarcity and its extensive socioeconomic impacts in Pakistan's Pothwar region, specifically in the districts of Chakwal, Attock, and Jhelum. Due to their heavy reliance on rain-fed agriculture, these regions are especially susceptible to inadequate water management techniques, groundwater depletion, and climate variability. The study advances our understanding of how water scarcity affects food security, income levels, migratory patterns, agricultural productivity, and rural livelihoods—all of which are crucial to Pakistan's sustainable development—by focusing on this semi-arid region.

The research's importance also stems from its capacity to influence national and local policy decisions. With per capita water availability below the water scarcity threshold, Pakistan is experiencing an increasingly severe water crisis. However, a significant portion of the policy discussion still focuses on the Indus Basin and massive irrigation schemes, neglecting smaller, underserved areas, such as Pothwar. Localised data and analysis from this study can inform focused initiatives, including promoting climate-resilient crops, small-scale water harvesting, and equitable access to water technology. In keeping with Pakistan's commitments to the Sustainable Development

Goals (SDGs), particularly SDG 2 (Zero Hunger) and SDG 6 (Clean Water and Sanitation), it also emphasises the necessity of integrated and community-led water management techniques.

The study is noteworthy for its contribution to elevating the perspectives and experiences of rural agricultural communities, which are frequently overlooked in planning and research processes. The study extends beyond technical evaluations to provide a more comprehensive understanding of the human cost of environmental degradation by examining the socioeconomic aspects of water scarcity, including migration, education, health, and social cohesion. Ultimately, the results can be utilised to develop more sustainable, equitable, and inclusive water policies for Pothwar, as well as other areas of Pakistan that are similarly affected.

1.4. Rationality of the Study

The growing worry over water scarcity in Pakistan's semi-arid regions—particularly the Pothwar plateau, which includes Chakwal, Attock, and Jhelum—is the driving force behind this study. Due to their heavy reliance on rain-fed agriculture, these regions are particularly vulnerable to prolonged dry periods, climate variability, and inefficient water use. This area has gotten little attention in national water and agricultural strategies, despite its vital role in food production and rural life. The lack of contemporary irrigation infrastructure, rising drought frequency, and declining groundwater levels have all had a significant impact on crop production, farmer incomes, and socioeconomic stability. Therefore, to close this important knowledge gap, this study aims to comprehend and document the socioeconomic effects of water scarcity in the Pothwar region.

Furthermore, water shortages in this setting are a multifaceted development issue, rather than merely an environmental or agricultural one. In addition to food security, it also impacts health, education, migratory trends, and rural poverty. The study offers evidence-based insights that can assist local government, guide integrated water resource management plans, and support more equitable and sustainable development planning by examining these interconnected aspects. Designing context-specific treatments that increase the resilience of impacted populations requires an understanding of how Pothwar's rural life is disrupted by water scarcity. Therefore, the justification is both intellectual and practical: to support scholarship, practice, and policy that addresses one of Pakistan's most urgent environmental and socioeconomic issues.

1.5. Objective of the Study

With an emphasis on how decreasing water availability impacts agricultural productivity, household income, migration trends, and overall livelihood sustainability, the main goal of this study is to investigate the socioeconomic effects of water scarcity on local communities in the Pothwar region of Pakistan, specifically in the districts of Chakwal, Attock, and Jhelum.

2. Method

With a focus on the Pakistani districts of Chakwal, Attock, and Jhelum, this study employs a qualitative research methodology to examine the socioeconomic impacts of water scarcity in the Pothwar region. To gain a deeper understanding of the lived experiences, perspectives, and coping mechanisms of rural populations affected by declining water supplies, a qualitative approach was employed. This method enables a comprehensive understanding of how water scarcity impacts not only farming methods

but also broader aspects of rural life, including migration, revenue generation, health, and education.

The study notes that to increase methodological rigour, three focus groups with a varied participant pool and thirty semi-structured interviews with various stakeholders—including ten women, five community leaders, and fifteen smallholder farmers—were conducted. Since women and small-scale farmers are the populations most directly affected by water scarcity in rural Pothwar, a purposive sample approach was adopted to ensure that their opinions were heard. The majority of the interviews were conducted in Punjabi and Urdu, and translations were used to ensure interpretation accuracy during the transcription and analysis stages.

Semi-structured interviews, focus groups, and field observations were used to gather data. Participants were selected using a purposive sampling technique, ensuring representation from women, senior community members, smallholder farmers, and local development professionals. Because the interviews were done in the local tongues, participants were able to share their worries and personal stories. Focus group discussions helped identify common patterns of response to water scarcity and provided a forum for community viewpoints. The qualitative data were analysed using thematic analysis, which enabled the identification of important themes and recurring problems related to socioeconomic vulnerability, resilience, and regional water management techniques. This methodological framework provides a comprehensive and contextualised understanding of water scarcity and its ripple effects on rural lives in the Pothwar region.

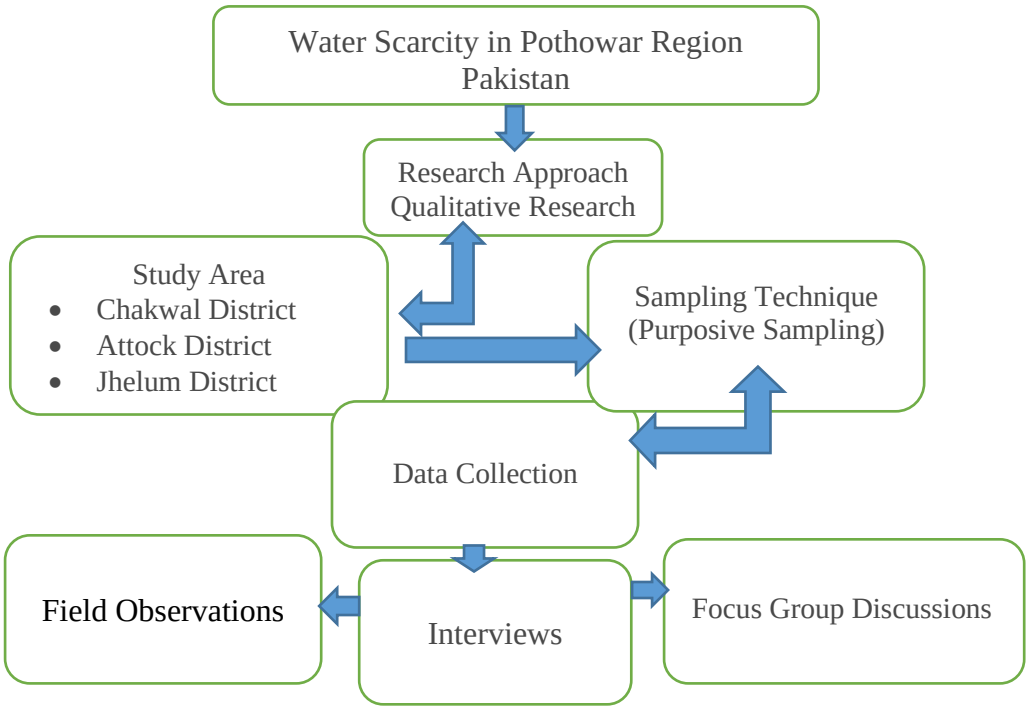

Figure 1. Methodological framework

3. Result and discussion

The findings of this qualitative study are based on field observations, focus groups, and in-depth interviews conducted in various rural communities across the Pothwar region's Chakwal, Attock, and Jhelum districts. To identify key trends, issues, and

experiences shared by locals—especially women, smallholder farmers, and community leaders—a thematic analysis was employed. Five major topic areas are used to describe the findings, which illustrate the complex effects of water scarcity on rural socioeconomic life.

3.1. Decline in Agricultural Productivity

The dramatic drop in agricultural output brought on by erratic rainfall and depleted groundwater was one of the main themes that surfaced (Nadeem et al. 2010). For wheat, pulses and oilseeds in particular, the majority of respondents reported late seeding or field abandonment. Owners of orchards reported that fruit plants, including citrus and olives, either dried up entirely or experienced stunted development (Anjum et al. 2010). Due to erratic weather patterns, farmers have reported that once-fertile terrain has become arid over the last five to ten years, and even rainwater collection has lost its effectiveness (Khalid Bashir & Mehmood, 2010).

According to field interviews, recurrent water shortages have led smallholder farmers in Chakwal and Attock to reduce their planted area by half over the last ten years. Several respondents clarified that they are compelled to abandon some areas of their land that are uncultivated due to the unaffordable cost of maintaining tube wells and buying diesel for water pumping. Women participants also emphasised that household kitchen gardens, which were once a stable source of vegetables, have largely disappeared, leading to increased dependence on local markets and higher household food prices. In addition, focus group discussions revealed that many families have switched from crops that require a lot of water to ones that can withstand drought, albeit with limited success in regaining their prior income levels.

Pothwar's main source of income is rain-fed agriculture, although crop yields have decreased due to insufficient and delayed rainfall. Aquifer levels have fallen below economically feasible pumping depths due to overuse of tube wells and overexploitation of groundwater resources (Afzal, 2021). Farmers consequently face high input costs and water constraints, which reduce their profitability and increase the likelihood of food poverty (Qasim, 2012).

3.2. Livelihood Disruption and Increased Migration

The disruption of traditional livelihoods and the rise in rural-to-urban migration were two additional noteworthy findings. Many households said that agriculture no longer offered a steady source of income, particularly those with modest landholdings (Zakir-Hassan et al. 2023). Younger male members have therefore moved to places like Islamabad and Rawalpindi to work as drivers, labourers, or in small enterprises. Remittances are the only source of income for some families.

Migration is often viewed as a survival tactic rather than a deliberate decision, according to interviews with farming households. Respondents in Jhelum noted that following recurrent crop failures, many young men migrated to surrounding urban centres, with some even seeking employment in the Middle East. Focus group participants highlighted the additional strain of running farms and houses without male family members, and older participants discussed how acreage that has been abandoned is slowly becoming unusable. Remittances, while useful for everyday expenses, are insufficient to support long-term needs such as healthcare, education, or agricultural reinvestment, according to several families, which leads to a cycle of insecurity and dependency.

Gendered implications of migration and water scarcity were particularly visible in the research area. Women reported shouldering additional obligations in both household and agricultural tasks once male household members left for the cities. Many said they had trouble getting water for their homes because they had to walk farther to collect it, which exacerbated their physical and mental burdens. Participants also emphasised how women's restricted decision-making authority over land use, crop selection, and remittance use perpetuates gender inequality. Notwithstanding these obstacles, several women reported that they are increasingly becoming more involved in community discourse and unofficial job markets, indicating a gradual shift in conventional gender norms.

This change reflects a collapse in the rural economy, where migration is frequently permanent rather than seasonal. Women and older household members who are left behind to manage farms and household duties with fewer financial resources and less physical support are also under pressure as a result of outmigration (Salik, 2023). Additionally, the loss of labour lowers community resilience and agricultural output (Azhar, 2008).

3.3. Water Conflicts and Social Tensions

The findings show that, particularly during the planting and harvesting seasons, competition and conflict over water have escalated due to water constraint. Farmers' disagreements over common irrigation sources, illicit water channel tapping, and declining cooperation in water-sharing agreements were all frequently mentioned (Afzal, 2021).

The breakdown of traditional water-sharing systems in Pothwar was supported by specific cases of water-related disputes found in primary data. In Chakwal, farmers described conflicts resulting from neighbours diverting small rainwater channels without permission. In Attock, disputes arose over unequal access to community tube wells, which favoured wealthier landowners. These practices have undermined long-standing cooperative norms that once governed water distribution. Comparisons with other regions, such as Balochistan, reveal similar patterns, where declining groundwater has fueled tensions between smallholders and large landowners. In Jordan, studies show that limited water resources have strained rural livelihoods and stoked tribal conflicts. These analogies illustrate that water shortages not only impact agricultural sustainability but also pose broader societal challenges, linking Pothwar’s experience to global discussions on resource competitiveness and community resilience.

Rural communities' relationships have changed from cooperative to competitive due to water constraint. Neighbour trust is declining, and traditional water-sharing practices are disintegrating. Local officials have occasionally had to step in and mediate conflicts. Social cohesiveness and community solidarity are weakened as a result of these conflicts (Abbasi et al. 2014).

3.4. Educational Challenges and Household Sacrifices

The diminished capacity of households to make educational investments due to economic losses associated with water was a recurring subject (Taj et al. 2007). Parents reported taking their kids out of school, especially their daughters, to help around the house or care for the animals while the adults were at work. Some families also mentioned that they couldn't afford uniforms, books, or transportation (Mohyuddin & Khan, 2015).

When families struggle to meet their basic needs, education becomes less important (Qasim, 2012). Water shortages lower agricultural income and force households to make tough decisions, frequently forgoing the long-term benefits of education in favour of short-term survival. This restricts rural youth's prospects for social mobility and feeds the poverty cycle (Ahmad, 2013).

3.5. Impacts on Health and Sanitation

According to respondents, there has been a discernible increase in health issues associated with low-quality water and its restricted availability for cooking, drinking, and sanitation. Commonly mentioned were waterborne illnesses, such as typhoid, skin infections, and diarrhoea. Families were often compelled to obtain water from distant and occasionally hazardous sources (Hussain et al. 2025).

There are direct health effects of the clean water scarcity, particularly for young people and the elderly. Rural households are more susceptible to illness outbreaks because of the impact that limited water supply has on hygiene habits (Majeed & Munir, 2020). Consequently, poor health reduces productivity and places additional financial strain on families already struggling (Panhwar et al., 2021).

3.6. Sociocultural Dimensions of Water Scarcity in Rural Communities

Water scarcity has a profound impact on the sociocultural fabric of rural communities, in addition to being an environmental and resource allocation issue. Farmers' agricultural practices, lifestyles, and power dynamics within communities will all shift in response to water constraints. Reduced revenues and a threat to food security can result from farmers being forced to change cropping patterns or reduce farmed areas due to a lack of agricultural water (Pelser, 2001). Additionally, the unequal allocation of water resources can widen the wealth divide by placing poorer households at a greater risk when they rely on public water supplies. In contrast, wealthier households depend on private wells or water purchases to sustain their production (Emile et al. 2022). Additionally, as water supplies dwindle, customs, festivals, and cultural memories associated with water may fade, eroding the cohesiveness and cultural identity of the community.

Gender role changes are more noticeable in areas with water shortages. When it comes to home water management, women are frequently primarily responsible for gathering, storing, and securing water for daily consumption. In addition to adding to their time and physical workload, this also reduces their access to economic and educational opportunities (Wutich et al. 2022). Girls who work long hours collecting water may have to leave school, which may lower their future social and economic standing. But in certain situations, water shortage can also strengthen women's influence in local affairs, especially when it comes to small-scale water delivery initiatives and grassroots water resource management (Hohenthal & Minoia, 2017). All things considered, women are both direct victims of water scarcity and potential change agents; their involvement is essential to achieving sustainable management of water resources.

3.7. Gendered Impacts and Women's Roles in Water-Scarce Environments

Gender disparities in the effects and coping mechanisms are especially noticeable in water-scarce regions. At the household level, women typically handle the majority of work related to gathering, storing, purifying, and distributing water. In addition to requiring a significant amount of time and physical exertion, this work may pose health

concerns, including infections caused by consuming contaminated water sources and accidents resulting from prolonged lifting of heavy objects. Women frequently have to travel farther to fetch water during times of water scarcity, which drastically reduces their free time and negatively affects their ability to participate in communal affairs, education, and earning a living (Mpatlise, 2024). Additionally, women are under increased strain in their families and society as a whole due to water shortage since they must not only manage the day-to-day operations of their households but also make tough decisions about resource distribution (Sigenu, 2006).

However, when it comes to dealing with water constraints, women have also shown a great deal of flexibility and leadership. Women's involvement in rainwater gathering initiatives, community water supply management, and water conservation initiatives has improved family water access and encouraged more sustainable and equitable water management models in many rural regions (Bandyopadhyay & Saha, 2020). Experience in certain areas has demonstrated that water allocation and infrastructure maintenance rates are generally more inclusive when women are included in decision-making processes. To mitigate the social impacts of water scarcity and promote community resilience, women must be recognised as active participants in water management, rather than merely as victims (Kortam, 2024).

4. Conclusion

The results of this qualitative study indicate that water scarcity and socioeconomic development in Pakistan's Pothwar region—specifically in the districts of Chakwal, Attock, and Jhelum—are intricately linked. The study, which draws from field observations, focus groups, and in-depth interviews, emphasises how water scarcity impacts many facets of rural life, including livelihoods, education, migration, social stability, and agriculture. The evidence suggests that water shortage is a serious development issue that jeopardises the sustainability of rural populations in this semi-arid area, rather than just an environmental problem.

In conclusion, water shortage changes the responsibilities that women play in their homes and communities in addition to making gender inequity worse. Even though they have to deal with more work and health issues while dealing with water stress, they also show outstanding organisational and adaptive skills. In addition to improving water fairness and efficiency, empowering women and boosting their involvement in water resource management can also strengthen communities' general resilience and promote sustainable development. To guarantee that women's perspectives and power are fully represented in the solutions, a gender perspective should be a fundamental component of any policies and initiatives addressing water scarcity.

The direct relationship between water scarcity and agricultural productivity is one of the most important themes that emerged. Rain-fed agriculture is the mainstay of the Pothwar region, and crop cycles have been seriously disturbed by the unpredictable rainfall in recent years. Due to the unpredictable nature of water availability, farmers reported lower yields of staple crops, including wheat, maise, and pulses, and some even stopped cultivating altogether. This is comparable to the situation in Balochistan's Pishin Lora Basin, where a lack of water caused a sharp decline in arable land and a fall in farmers' earnings. Irrigation has become an expensive and unsustainable choice for smallholder farmers due to the depletion of conventional water sources, including ponds, springs, and shallow wells, as well as the high cost of deep tube well operations.

Another serious consequence of the protracted water crisis is the interruption of livelihoods. Families are compelled to seek alternative forms of income as agriculture

becomes less profitable. This has resulted in increased labour mobility, especially among young males who relocate to cities in search of employment. Remittances do offer some respite, but they often fall short of compensating for the overall decline in household income and food production. Without sufficient assistance or resources, women are often left to handle home duties, childcare, and even small-scale land management when there are no male family members available. The gendered effects of water shortage and the necessity of inclusive, gender-sensitive policies are further highlighted by the feminisation of agriculture under such stressful circumstances.

Water scarcity has equally grave societal repercussions. Several participants expressed concerns about growing hostilities and tensions over scarce water supplies. Theft from irrigation ditches, disputes between nearby farms over water access, and disruptions in customary water-sharing agreements have all increased in frequency. These disputes undermine the communal relationships and social cohesiveness that have traditionally helped rural communities manage their common resources. Similar patterns have been observed in other water-scarce regions, such as Jordan, where social unrest and inequality have emerged due to competition for limited water supplies.

Health and education are also impacted by water scarcity. Many households rely on contaminated sources of water due to limited access to clean drinking water, which increases the risk of waterborne illnesses such as typhoid, skin infections, and diarrhoea. The healthcare systems in these rural areas often lack the necessary resources to treat illnesses associated with water effectively. Families that lose money due to water-related issues often have to withdraw their children from school, especially girls, to assist with agricultural or household duties. When income is limited, the costs of books, uniforms, transportation, and the absence of local schools become unaffordable (Batterman et al., 2009). This perpetuates cycles of poverty and underdevelopment, jeopardising the younger generation's capacity for long-term development.

The inability of infrastructure and policy to meet the region's unique water management requirements was a significant topic of discussion. Farmers complained about the lack of government assistance, the absence of programs to collect rainwater, and the difficulty in obtaining extension services that may help them use water more effectively. Due to neglect and modernisation, traditional water management techniques, including check dams, terracing, and communal storage tanks, have become less common. However, these inexpensive, neighbourhood-based methods have the potential to increase water retention and lessen reliance on erratic rainfall significantly.

The conversation also emphasises how urgently the Pothwar region needs coordinated and context-specific water management plans. The socioeconomic realities of the community must be addressed in addition to engineering projects. A water shortage can be considerably lessened by climate-smart agriculture, water conservation awareness programs, and the adoption of effective irrigation techniques, such as sprinkler or drip systems. A crucial element in fostering resilience is community involvement in water governance, which guarantees that farmers, women, and local leaders actively participate in planning and decision-making.

The study's conclusion emphasises that the Pothwar region's water shortage is a complex situation with significant socioeconomic ramifications rather than a singular environmental problem. The difficulties encountered in qualitative research are indicative of broader structural weaknesses and governance shortcomings. A comprehensive strategy that incorporates traditional knowledge, contemporary methods, community involvement, and policy reform is needed to address the water shortage in Chakwal, Attock, and Jhelum. The sustainability of rural life in this historically

significant yet ecologically vulnerable area remains in danger in the absence of such initiatives.

5. Recommendations

To proceed from diagnosis to action, the study underscores the urgent need for targeted measures that address both immediate water shortages and long-term resilience in the Pothwar region. The promotion of high-efficiency irrigation systems, such as drip and sprinkler systems, community-led rainwater collection projects, and groundwater extraction regulation to stop further depletion, are all examples of integrated water resources management (IWRM) measures that should be given top priority. To minimise conflicts and ensure fair access, community-based water management committees can help revive and formalise customary sharing agreements. To protect livelihoods and reduce vulnerability in semi-arid environments, policymakers must invest in small-scale water storage infrastructure, train farmers in climate-resilient agriculture, and incorporate women into water governance structures.

Beyond its useful suggestions, this study adds to the body of knowledge on water scarcity and rural development by offering a grounded, qualitative perspective from Pakistan's semi-arid rain-fed regions. This area is frequently ignored in international water debates. By connecting the lived experiences of farming households to broader processes of migration, gender inequality, and social conflict, the findings deepen our understanding of how water scarcity alters not only agricultural productivity but also the socioeconomic fabric of rural communities, by providing examples from places like Jordan and Balochistan, the study positions Pothwar as a crucial case study that emphasises the urgent need for community-centred, adaptive, and globally relevant strategies in managing water scarcity.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper. Authors also disclose that there is no funding involved in this research paper.

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