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The Effect of Water Shortage on the Livelihood of Local Communities in District Karak

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Abstract

Water scarcity is one of the acute issues currently affecting the entire globe; it has been the core issue in most of the developing countries, where Pakistan is no exception. It creates severe barriers before farmers for the cultivation of crops and vegetables and stops the sustainable generation of income from this area. It is a general study focusing on the exploration and assessment of the impact of water scarcity on most aspects of livelihoods by the locals in Karak. In the result, it reflects that scarcity adversely affects the livelihoods 81.8% of which were perceived to have an impact. Furthermore, rainfall is one of the critical factors considered to be fundamental for crop productivity because the crop yields have been proved to enhance during the periods of rainfall, and this has increased by 78%. Animal husbandry also is observed to be boosted by wetlands, and this was found to be statistically positively correlated since Pearson's R = 0.107, and $p < 0.05$. There is little evidence provided about any relationship between water shortage and an income-generating source which is sustainable enough, leaving one to imagine that, in the major part, socio-economic parameters may drive these

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interrelating characteristics. A set of undertakings from the plan is expected to reduce this water shortage's impact like the construction of a water canal, upgrading irrigations' systems, as well as community-managed water supply projects. It places an emphasis on the interaction between natural resource management and the socio-economic policy in boosting the resilience in vulnerable groups. Long-term strategies about sustainable water usage and how livelihoods will be made secure can then be done as future research.

Keywords: Water scarcity; Livelihood; Sustainable Incomes; Rainfall.

Introduction

Water is essential to all, playing a vital role in the life of humans, agricultural productivity, and ecological balance (Mishra et al., 2021; Young et al., 2021; Wang, 2022). Water scarcity is one of the biggest pressing issues facing humanity today, closely followed by agricultural output, the livelihood of people, and sustainable development. It is a fundamental resource necessary for survival, economic growth, and human health (Mishra, 2023; Lin, Yang, & Xu, 2022). Population growth and urban expansion, industrial development as well as climate change contribute to the augmentation of demands for water (Islam, & Karim, 2019). It leaves the communities around the globe in a struggle to make this resource accessible (Enqvist, & Ziervogel, 2019). This study examines the effects of water shortage on the livelihoods of people in Karak District, which is coping with a number of water-related problems, including food security, agriculture, and economic stability.

Over half of the world's population faces acute water shortages at some time throughout the year, and there are over 2.3 billion people without access to safe drinking water worldwide (SDGs, 2022; IPCC, 2022). Besides that, freshwater demand is going to be surpassed by supply by 40% by 2030 according to the World Economic Forum (2023), based on the growth of the population, urbanization, and

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climate change. Pakistan is among the top ten countries most vulnerable to climate change and is highly challenged in terms of water (PIDE, 2022).

The district of Karak exemplifies the challenges faced by arid and semi-arid regions globally. This reduces crop yields and the chances of livelihoods among the agricultural population in the region due to the persistent lack of water (Ahmad, Yaseen, & Saqib, 2022; Week, & Wizor, 2020). It is further worsened by the presence of brackish groundwater, minimal infrastructure on water management, and lack of attention from the provincial authority (Pointet, 2022; Morote, Olcina, & Hernández, 2019). The case is also more of a national generalization as Pakistan had already crossed the 1,000 cubic meters per capita by 2005 and was going to further decline to 500 cubic meters per capita by 2025 (Rasool et al., 2023). In District Karak, the average annual rainfall is less than 300 millimeters, which is insufficient to replenish groundwater reserves and sustain agriculture and livestock farming (Lytton et al., 2021;).

Climate change is further exacerbating water deficits in Africa as it changes the rainfall pattern and increases the evapotranspiration rates (Haile et al., 2020; Kew et al., 2019; Leal Filho et al., 2022). In a similar vein, in Pakistan, the mainly agrarian economy contributes 20 percent of the national GDP and gives employment to nearly 60 percent of the population and, thus, is extremely sensitive to consistent and adequate availability of water (Munir et al., 2021). The imbalances in water availability and seasonal imbalances further strain the agricultural sector, thus undermining food security and rural livelihoods (Suleymanov, 2024; Wang, 2022; Bukhari, Khan, & Noreen, 2024).

In Karak, the lack of water is critical to human health and the environment. The land was salty, and it was not suitable for agriculture, hence salty and non-utilizable for drinking purposes either in irrigation (Van Opstal et al., 2021). This has significantly lead to out-migration through family out-migration to pursue better living elsewhere without their children left behind facing incapable

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livelihoods in support. The problems in Karak are the same problems that other regions experience as water-scarce areas, where the interaction of climate change, poor governance, and socioeconomic inequalities enhances the problem.

Given that these factors are interconnected, this dimension should, therefore, be regulated with integrated water resources and sustainable approaches. Policy makers will have to spend in terms of infrastructure improvements in the water, have agriculture more resilient to the impacts of climate change and ensure equitable availability of this life resource as well. This report focuses on perceptions of local communities toward Karak in relation to water scarcity and its impacts on agriculture and related issues concerning their livelihood. This study attempts to understand the local context to provide actionable insights to mitigate the adverse effects of water scarcity in Karak and similar regions.

Materials and Methods

This was a quantitative study, gathering field data in the form of questionnaires to produce statistical inferences and analyzing findings. Population under research is the district Karak, consisting of Tehsil Banda Daud Shah, Tehsil Tahte Nasrati, and Tehsil Karak with special reference to Tehsil Karak's population 155,642. Using simple random sampling, 390 respondents were selected based on Taro Yamane's formula. Key concepts such as water scarcity, livelihood strategies, and local community dynamics were operationally defined. Data was gathered using a structured questionnaire containing demographic, multiple-choice, and open-ended questions, enabling participants to respond at their convenience. However, the alpha value of Cronbach (0.71) confirms the reliability of the tool. Data was analyzed by using SPSS software and applied both descriptive and inferential statistics. Ethical considerations were kept intact, and participants were ascertained to seek permission before data collection, their confidentiality and anonymity maintained in the study.

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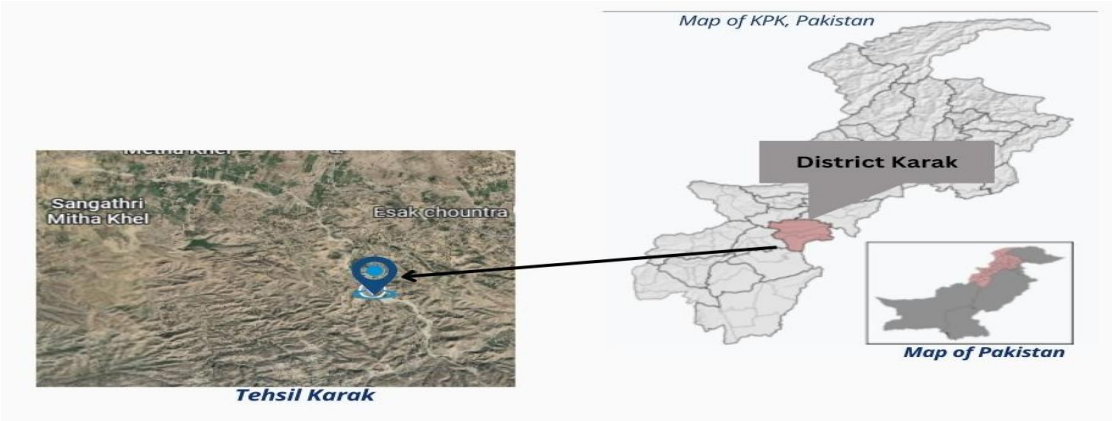

Figure 1: Map of the Study Area

Results

The demographic characteristics of the respondents show a diverse age distribution, educational background, marital status, and income sources. Demographic data represents in detail characteristic features of categories of respondents. The age distribution according to which 37% of the respondents fall in the 26-35 years category. Then follows the category with 29% of people in the age group of 36-45 years, followed by those of 25 years and younger at 22%. Other smaller groups include people in the age category of 46-55 years at 9%, and 3% belong to the category older than 56 years. A majority, 37%, have primary to middle school level education. 27% have high school to intermediate levels. 21% are illiterate, and 15% have graduate or professional qualification.

Among the marital status, 40% are married, 21% are separated, and 17% are divorced. 11% are widowers and 12% are single. The main sources of income indicate that agriculture has a huge dominance, accounting for the highest share at 33%. Government jobs seem to rank as the second common source of income, amounting to 26%. Private jobs rank third, with 21%. A much smaller proportion of income sources is accounted for by business activities at 7%, skilled labor at 8%, self-employment at 3%, and unskilled labor at 2%. In this respect, the data in question reflects different sociocultural backgrounds as well as other livelihood strategies of respondents surveyed.

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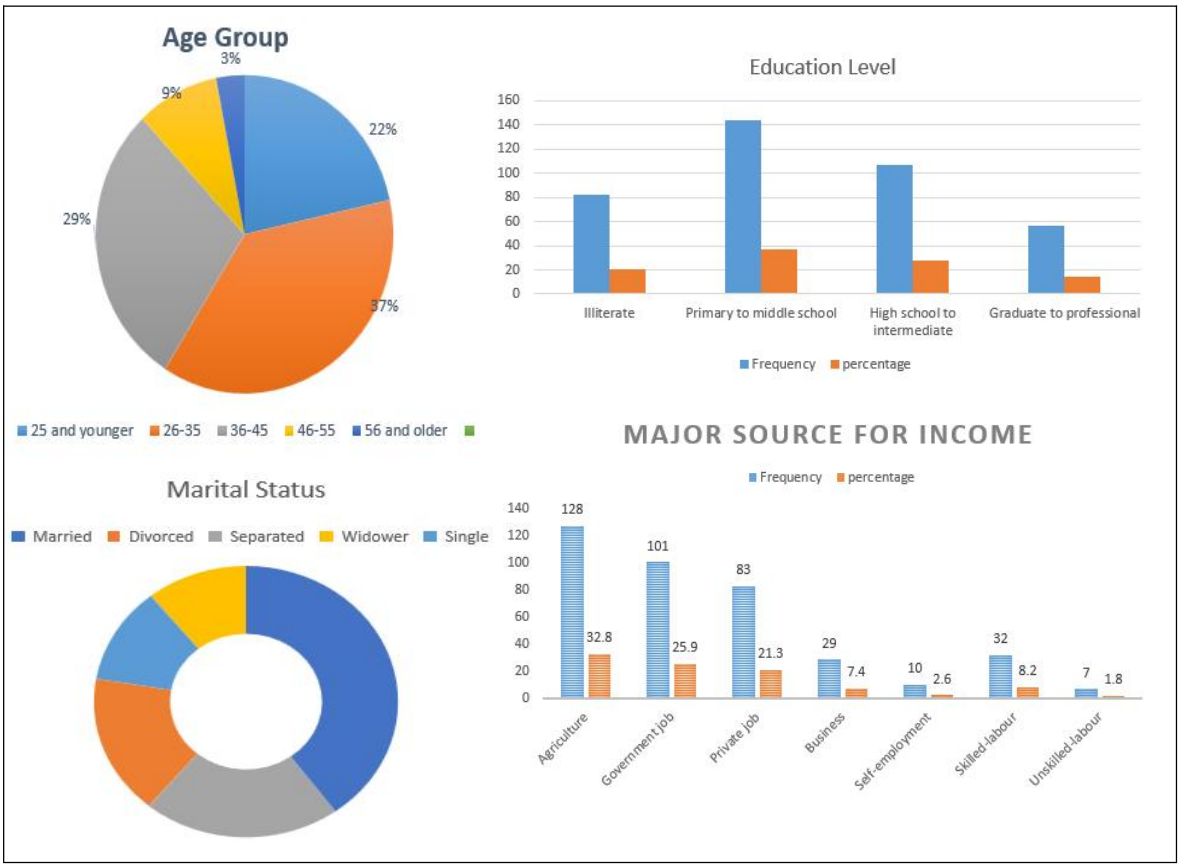

Figure 2: Socio-Economic Characteristics of the Respondents

The findings of this study reveal that water shortage had an impact on their livelihood (81.8%). According to the survey, 68.7% of respondents cultivate crops in their fields, while 69.0% cultivate vegetables. The study also found that 63.8% of respondents have livestock sheds, and 64.4% raise poultry. Similarly, 64.4% of respondents have livestock sheds. The results of this study also suggest that majority of respondents (71.8%) believe that wetlands help farmers produce more crops, while 28.2% do not hold this belief. In addition, 69.7% of respondents reported that their income increases through cultivating crops, and 30.3% reported that their income does not increase through cultivating crops.

Water scarcity creates more economic crises for farmers' families to spend their lives normally (77.7%), however hard to cultivate forage for livestock due to a lack of easy access to water (68.2%). The findings also indicate that 71.5% of respondents believe that the construction of dams would make it easier for farmers

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to supply water to their gardens or plants. A significant majority of respondents believe that herding animals without enough water resources would be challenging (76.2%), and that the government should make water canals throughout the district of Karak to reduce water shortage in the area (84.6%).

Additionally, the main sources of water for respondents were bore wells/hand pumps (47.4%), public taps (26.9%), and community wells (18.7%), and the main available resources of water for local farmers were tube wells (42.8%), canals (27.2%), and rainwater (30%). The scarcity of water poses a crucial challenge in the district of Karak, especially for individuals who rely on the agricultural sector as their means of sustenance. The main objective of this research is to study the impact of water scarcity on the local community's livelihood, and to assess the effects of water shortage on livestock farming and crops. Table 1 below indicates the cross-tabulation of rainfall and crop production shows a clear relationship. Of the 390 respondents, 284 experienced rainfalls while 106 did not. Among those who experienced rainfall, 221 (78%) had crop production, while 63 (22%) had no crops. In contrast, of the respondents who indicated no rainfall, only 62 (58%) reported crop production, while 44 (42%) reported no production at all. This data shows rainfall playing a very critical role in crop production due to the high yields produced where rainfall occurs.

Table 1: Cross Tabulation between Rainfall and Production of Crops

		Production of Crops		
Rainfall		Yes	No	Total
	Yes	221	63	284
	No	62	44	106
	Total	283	107	390
Symmetric Measures				
	Value	Asymptotic Standard	Approximate T[b]	Approximate Significance

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		Error[a]		
Pearson's R	0.193	0.053	3.868	0.000[c]
Spearman Correlation	0.193	0.053	3.868	0.000[c]

The symmetric measures also verify the correlation. Both Pearson's R and Spearman Correlation values are at 0.193, indicating a positive but weak association between rainfall and crop production. The p-value for the two tests is about 0.000, which is below the standard threshold of 0.05, thus verifying that the statistical significance of the correlation has been established. The Asymptotic Standard Error of 0.053 and the T-value of 3.868 also support these findings. Summarily, the conclusion indicates that rainfall is a relevant factor in crop production while enough water resources should always be available to sustain the productivity of agriculture. As a result, the statistically meaningful relationship points out that this environmental factor is critical when it comes to determining results in agriculture.

Table 2: Cross Tabulation between Wetlands and Livestock Rearing

		Livestock Rearing		
Wetlands		Yes	No	Total
	Yes	206	74	280
	No	69	41	110
	Total	275	115	390

Symmetric Measures

	Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Pearson's R	0.107	0.052	2.120	0.035[c]
Spearman Correlation	0.107	0.052	2.120	0.035[c]

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Table 2 indicates the cross-tabulation of wetlands and livestock rearing showed that the existence of wetlands is correlated with the rearing of livestock. Of the 390 respondents, 280 indicated that there were wetlands, while 110 reported that there were no wetlands. Of the 280 respondents who reported the existence of wetlands, 206 (74%) reported rearing livestock. Those who did not rear livestock accounted for 74 (26%). On the other hand, while 69 (63%) of those who said there were no wetlands engage in livestock rearing, 41 (37%) do not. This gives an indication that the existence of wetlands positively contributes to livestock rearing because areas with wetlands tend to have more involvement in this activity. The symmetric measures also confirm the observation. Pearson's R and Spearman Correlation values are identical at 0.107, and this reflects a weak positive correlation between wetlands and livestock rearing. The approximate significance for both tests is at 0.035, which is lower than the threshold of 0.05. The correlation is thus statistically significant, although weak. Asymptotic Standard Error is 0.052, and the T-value is 2.120, all confirming the correctness of the result. Overall, the analysis indicates that wetlands are associated with the livestock rearing practices but this is at a modest association degree. The statistical significance of the findings gives further ecological importance to wetlands as they support livestock-based livelihoods.

Table 3: Cross Tabulation between Water Scarcity and Income Opportunities

		Income opportunities		
Water		Yes	No	Total
Scarcity	Yes	251	68	319
	No	52	19	71
	Total	303	87	390
Symmetric Measures				
	Value	Asymptotic Standard	Approximate T[b]	Approximate Significance

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		Error[a]		
Pearson's R	0.050	0.053	0.995	0.320[c]
Spearman Correlation	0.050	0.053	0.995	0.320[c]

Table 3 indicates the relationship between water scarcity and sustainable income opportunities for local communities. The findings reveal that 251 farmers answered "Yes" to the question of whether water scarcity creates more economic crisis for farmers' families to spend their lives normally, while 68 answered "No". In response to the question of whether water shortage has an impact on their livelihood, 303 farmers answered "Yes", while only 87 answered "No". The correlation coefficient value (0.050) and asymptotic standard error (0.053) confirming the results that show a weak positive relationship between water scarcity and income. The approximate significance is 0.320, indicating that the relationship is not statistically significant at the 0.05 level. In summary, table 3 suggests that water scarcity has a negative impact on the livelihood of local communities, as evidenced by the higher number of farmers who answered "yes" to the question. However, the weak correlation between water scarcity and sustainable income opportunities suggests that other factors may also influence economic well-being.

Discussion

This research provides an in-depth assessment of how water scarcity affects the livelihoods of communities in District Karak, particularly regarding agricultural productivity, livestock rearing, and economic opportunities. Based on the analytical framework of the Livelihood Approach Theory (Chambers & Conway, 1992), the findings are situated within the greater understanding of the multidimensional nature of livelihoods. It finds that water scarcity turns to an essential livestock unsustainable constraint, with the adverse effects reported to be of a worrying degree of 81.8 percent. As anticipated, the findings are found

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congruent with the theory underlining the Livelihood Approach that natural physical assets, financial, human assets, and social resources play very significant roles in rural livelihoods.

Results from this analysis show that 68.7% of those answering this question cultivate crops, though still, 69% grow vegetables. However, water scarcity undermines irrigation practices, leading to low crop yields and, therefore, low incomes (Bjornlund et al., 2020). Whereas Verma & Gupta (2020) further postulate that water scarcity has led to increased food insecurity and economic vulnerability. Further, 63.8% of the respondents own livestock sheds, and 64.4% keep poultry, which also gives an insight into their dependency on the water resources. The absence of water impacts forage farming at 68.2%, and hence, livestock health and productivity keep going down, a scenario that is supported by FAO (2017).

The inadequate physical water resources-bore wells, hand pumps (47.4%), public taps (26.9%), and community wells (18.7%) hinder communities from responding to water shortage. The dependence on outdated infrastructure only increases the problems and gives a hint of resource distribution and infrastructure development deficits (Kim, 2023; Lawrence et al., 2024). Although 69.7% of respondents report an increase in income through crop cultivation, water scarcity leads to economic crises for 77.7% of the households. The lack of finances hampers investments in water-efficient technologies, thus perpetuating the cycle of vulnerability. As noted by Ahmed (2023) and other scholars, water scarcity disproportionately affects low-income households, thus reducing resilience to environmental stressors (Balasubramanya, & Stifel, 2020; Mukherjee, & Fransen, 2024).

Water scarcity limits human resources in terms of clean water, health risks, and productivity (Tzanakakis et al., 2020). The study results indicate that 71.5% of the participants support the construction of dams as a means of expanding access to water. This is according to the theory of the Livelihood Approach, which states

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that collective action may be facilitated due to social cohesion in meeting the challenges of water scarcity (Chambers & Conway, 1992). The research indicates that wetlands are a vital support to the livestock operations, as 74% reported to have reared stock in areas close to where they live. Wetlands are significant for retaining water and forage functions. According to the Ramsar Convention (2018), wetlands are of paramount importance in fighting water scarcity issues and supporting livelihoods of people in rural areas. Although the relationship of wetlands with livestock activities is relatively weak (Pearson's R = 0.107, p = 0.035), their contribution to resilience in arid regions is still significant.

Rainfall is considered the most important factor that determines crop success, as 78 percent of the respondents have assured positive crop harvesting after ample rainfall. Its strong connection with crop development (Pearson's R = 0.193, p = 0.000) further indicates that agriculture based on rain is mostly dependent on natural rainfall. The Livelihood Approach Theory emphasizes adaptive strategies for coping with resource scarcity. Communities of District Karak have a host of coping mechanisms, for example, diversification of sources of income and demanding better infrastructure. However, systemic factors, such as policy lack and market imperfections, limit the efficiency of such strategies.

The findings are a reflection of the need for government intervention, especially since 84.6% of the respondents support water canal construction in the district. Some of the effective policy interventions include; investment in water infrastructure, adoption of water-saving technologies, management strength in community-based structures, capacity building programs and institutional support (Dangui, & Jia, 2022; Zhang et al., 2019; Tai et al., 2024; Kaarthikeyan, & Suresh, 2019; Hamilton et al., 2022; Nandineni, & Dash, 2022; Tantoh et al., 2021; Reid, 2016; Le, & Lei, 2019). From these results, the water scarcity impacts the rural economies of District Karak in a complex manner and combining these with Livelihood Approach Theory reveal that natural, physical, financial, human, and

social assets are intertwined and interdependent in forming their resilience to resource scarcity. Combating scarcity of water requires - infrastructural development; policy change at a level; community strengthening. These shall enable adaptive capacities to foster sustainability of livelihoods.

Conclusion

This study highlights the significant impact of water scarcity on the livelihoods of local communities in District Karak. The study reflects that scarcity adversely affects the livelihoods 81.8% of which were perceived to have an impact. Furthermore, rainfall is one of the critical factors considered to be fundamental for crop productivity because the crop yields have been proved to enhance during the periods of rainfall, and this has increased by 78%. Animal husbandry also is observed to be boosted by wetlands, and this was found to be statistically positively correlated since Pearson's $R = 0.107$, and $p < 0.05$. However, there was weak and statistically insignificant evidence on the relationship between scarcity of water and sustainable incomes opportunities; therefore, socio-economic factors might be operating to affect these relationships. Such research includes interventions such as the building of water canals, better irrigation systems, and community-based water management programs to reduce the impacts of water scarcity brought to the fore by this study. Such studies show that a combination between natural resource management and socio-economic policies must be in place so they can work together and improve resilience towards the vulnerable groups more effectively. Such future research includes an analysis of long-term sustainable water use and livelihood security strategies in such contexts.

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