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Public Perceptions on the Nexus of Climate Extremes, Drinking Water Quality, and Community Health in Khyber Pakhtunkhwa, Pakistan

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Abstract

Climate change has intensified the frequency and severity of extreme weather events in Pakistan, especially in flood-prone areas, such as Charsadda and Nowshera in Khyber Pakhtunkhwa. This study examines local perceptions of the impacts of floods and droughts on drinking water quality and public health. A structured questionnaire was administered to 800 respondents (400 per district), and the data were analyzed using descriptive statistics. The results indicate that 66.3% of respondents in Charsadda and 70.8% in Nowshera were aware of climate change, though only 70% (Charsadda) and 65.5% (Nowshera) attributed it to human activities. Floods were perceived as the primary cause of water quality deterioration (44.5% in Charsadda and 47.8% in Nowshera), followed by droughts. Microbial contamination, unpleasant odor, and unusual taste were commonly reported, aligning with the WHO (2017) safety thresholds. Health effects were notable: 32.3% of respondents in Charsadda and 35.8% in Nowshera reported diarrhea during drought periods. Coping strategies varied: 42.3% in Charsadda and 47.8% in Nowshera used purification methods, although chlorine tablet utilization remained limited. These results highlight the urgent need for integrated water safety planning, strengthened public health preparedness, and climate-resilient infrastructure to mitigate localized vulnerabilities in flood-prone regions.

Keywords: *Climate Change, Kabul River, WHO, Floods, Pakistan*

1. Introduction

The impacts of climate change on water resources and public health are increasingly evident across Pakistan, particularly in flood-prone and ecologically sensitive regions. In recent years, extreme weather events such as floods, droughts, and prolonged heatwaves have disrupted drinking water systems, reduced water quality, and increased the risk of disease outbreaks in vulnerable communities (Noureen et al., 2022). According to the Climate Risk Index (2021) and Ullah et al. (2025), Pakistan ranks among the most climate-affected countries globally, with Khyber Pakhtunkhwa facing repeated flood disasters, especially in riverine districts such as Charsadda and Nowshera.

In these districts, a significant portion of the population relies on shallow groundwater sources, including hand pumps, dug wells, and boreholes, many of which are less than 40 feet deep and lack adequate protection against contamination. Research conducted by WHO (2017) and the Pakistan Council of Research in Water Resources (PCRWR, 2019) has shown that such sources are highly vulnerable to microbial pollution during and after floods. This risk is further exacerbated by limited awareness of water safety practices and insufficient institutional mechanisms to ensure access to clean water during emergencies (Ahmad et al., 2022). Although several national and international organizations, including UNDP, WaterAid, and WWF-Pakistan, have initiated programs focusing on water quality, climate resilience, and community-based management, many local communities still lack a clear understanding of the link between climate extremes and waterborne diseases. For instance, a WWF-Pakistan (2022) survey highlighted that only 61% of respondents in Khyber Pakhtunkhwa could accurately define climate change, and misconceptions attributing climatic events to supernatural causes remain widespread.

This study aims to assess how local communities in Charsadda and Nowshera perceive the impacts of climate extremes, specifically floods and droughts, on drinking water quality and public health. By analyzing survey data from 800 respondents, this research explores seasonal water shortages, common purification methods, institutional responses, and health challenges associated with unsafe water. These findings are intended to inform policymakers, NGOs, and disaster management authorities about local risk perceptions, coping behaviors, and the need for climate-adaptive water management in Khyber Pakhtunkhwa flood-prone regions.

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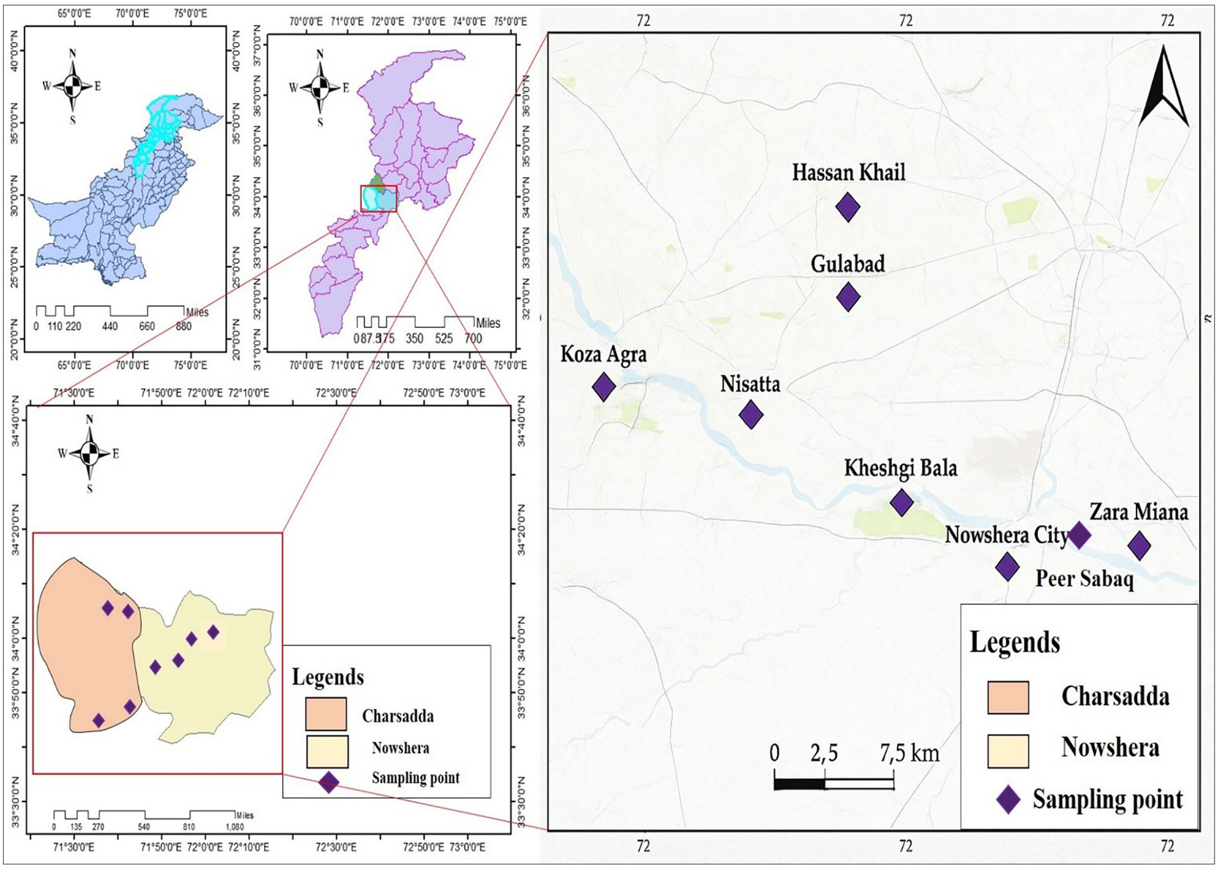

Figure 1. The map showing the sampling collection points from flood-prone districts of Khyber Pakhtunkhwa, Pakistan.

2. Methodology

This study was conducted in two flood-prone districts Charsadda and Nowshera, Khyber Pakhtunkhwa Pakistan as shown in figure 1. A total of 800 respondents were surveyed, with an equal number of samples from each district (400 respondents were from District Charsadda and 400 from Nowshera).

2.1. Sampling and Data Collection

Participants were selected using a random sampling technique to ensure a representative demographic spread. After gaining their assent, interviews were conducted with both male and female respondents using a structured questionnaire. The questionnaire was designed to capture perceptions related to the climate extremes, drinking water quality and public health.

2.2. Demographic Profile

Following participant consent, key demographic information including age, gender, and education level were recorded. In District Charsadda, the majority of the respondents were male 88.8%, while females accounted for only 11.3% of the sample. A comparable trend was observed in District Nowshera, where males comprised 92.3% of the participants, and females constituted merely 7.8%. The respondents from both districts also demonstrated diverse educational backgrounds. In Charsadda, 5% of the participants were illiterate, 8.5% had attained education up to the middle level, and 12% up to the intermediate level. Additionally, 62.5% held undergraduate degrees, 9% had completed a Master of Philosophy (M.Phil.), and 3% possessed a Doctor of Philosophy (Ph.D.) qualification. Conversely, in Nowshera, a higher proportion of respondents lacked formal education 9% or had education up to the middle level 18.5%. Moreover, 8.3% had completed intermediate education, 49.8% held bachelor's degrees, 10.3% had master's degrees, and 4.3% had earned Ph.D. qualifications, as depicted in Figures 2 and 3.

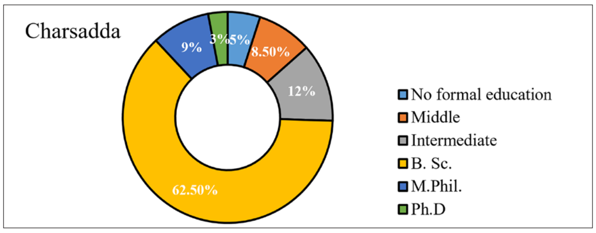

Figure 2. Educational background of the respondents from Charsadda District

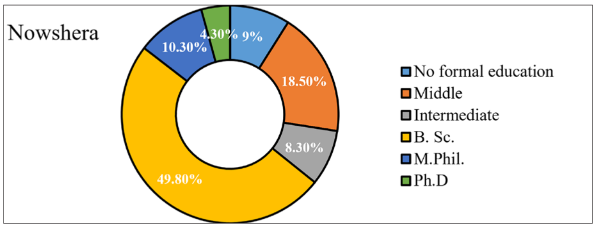

Figure 3. Educational background of the respondents from Nowshera District

2.3. Data Analysis

The data collected from the surveys were coded and analyzed using descriptive statistical methods. Frequencies and percentages were used to summarize and compare responses across the two districts. Charts and figures were developed to visualize the findings using SPSS software.

3. Results and Discussions

3.1. Public Awareness and Perceptions Towards Climate Change

The academic survey is a preliminary attempt to understand how residents in the study area perceive and understand climate change. In Charsadda, 66.3% of the population considered themselves aware of climate change, while 33.8% stated they were not aware of it at all. On the contrary, in Nowshera, 70.8% of respondents reported awareness of climate change, while 29.3% were unaware of it. Regarding the local level effects of climate change, 68.5% of respondents from Charsadda stated that they were aware of environmental changes in their setting, while 31.5% did not witness any local impacts. A greater percentage of Nowshera respondents confirmed the local impact of climate change on their environment (74.3%); the remaining 25.8% did not report any apparent effects. Regarding human activities, 70% of respondents from Charsadda believed that climate change is due to human activities; 30% did not share this belief. Among the Nowshera respondents, 65.5% agreed with the view of human-induced climate change, while 34.5% did not agree. Furthermore, the results show that in Charsadda, 73.3% felt that, in some way or another, climate change is related to water pollution, while 26.8% felt otherwise. In Nowshera, 66.8 % were found to be aware of this relationship, whereas the remaining 33.3 % were not aware of any connectivity with climate change. Overall, the findings reveal that respondents from Nowshera were less aware than those from other districts regarding local climate impacts, although they attributed fewer of those changes to human activity.

The above-mentioned data show that 66.3% of Charsadda and 70.8% of Nowshera respondents were aware of climate change, but fewer recognized its local impacts or human causes. These statistics show that communities in flood-prone areas have living experiences of climate variability, but their understanding of anthropogenic causes is limited (Gul et al., 2024; Iqbal and Nazir., 2023; United Nations Development Program, 2021; Water Aid Pakistan, 2022) Similarly, a World Wide Fund for Nature (WWF-2022) survey found that only 61% of respondents in Khyber Pakhtunkhwa could correctly define climate change. In both districts in this study, about one-third of people attributed climate change to divine or natural causes, thereby limiting the opportunities for grassroots-level action.

These results emphasize the need for targeted climate education using culturally appropriate language and platforms, such as schools, mosques, and radio (Sabra and Al-Moaz, 2022). Empowering people with climate knowledge is foundational to adaptive water behavior and resilience planning (Yadav, 2025).

3.2. Extreme Weather and Drinking Water Sources

The studies revealed notable variations in community perceptions between residents of Charsadda and Nowshera regarding the impacts of extreme weather events on drinking water quality. In Charsadda, floods were identified as the primary factor affecting water quality by 44.5% of respondents, followed by heatwaves (21.3%), droughts (19%), and storms (15.3%). In contrast, participants from Nowshera attributed poor water quality to floods (47.8%), droughts (20.3%), heatwaves (16.5%), and storms (15.5%) (Figure 4).

The depth of these water sources also varied between the two districts. In Charsadda, 13.8% of water obtained from depths of 10–20 feet, 20.3% from 20–30 feet, 28.3% from 30–40 feet, 12.8% from 40–50 feet, 16.8% from 50–80 feet, and 8.3% from depths exceeding 80 feet. Conversely, in Nowshera, 11.8% of respondents accessed water from 10–20 feet, 14.8% from 20–30 feet, 17% from 30–40 feet, 21% from 40–50 feet, 21.5% from 50–80 feet, and 14% from beyond 80 feet (Figure 6).

Survey participants also reported specific water quality issues experienced during or after flooding events. In Charsadda, the most frequently cited problems included unusual taste (34.5%), foul odor (28.8%), increased turbidity (19%), and bacterial contamination (17.8%). Similar concerns were raised in Nowshera, where 41.5% noted an unusual taste, 25.5% reported odor, 16% observed turbidity, and 17% reported bacterial contamination (Figure 7).

These findings indicate that flooding was perceived as the principal cause of deteriorating water quality in both districts, by 44.5% of respondents in Charsadda and 47.8% in Nowshera. The dominant water sources hand pumps, dug wells, and shallow boreholes were mostly situated at depths less than 40 feet, making them highly susceptible to contamination. This observation aligns with the World Health Organization (2017), which classifies wells less than 50 feet deep and lacking protective sealing as unsafe in flood-prone regions (Musche et al., 2018). Similarly, a field survey by the Pakistan Council of Research in Water Resources (PCRWR, 2019) in southern Khyber Pakhtunkhwa reported increased E. coli counts and turbidity levels in post-flood hand pump samples, particularly in areas without elevated platforms.

Overall, the results highlight the structural vulnerability of rural water infrastructure to extreme weather events. It is therefore essential for local governments and non-governmental organizations to prioritize interventions such as well deepening, installation of protective coverings, and community-level chlorination training to ensure the safety and sustainability of drinking water sources (Rasool et al., 2024).

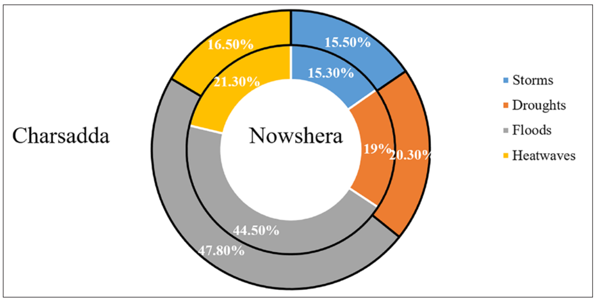

Figure 4. Perceived impact of Extreme weather on Drinking Water Quality

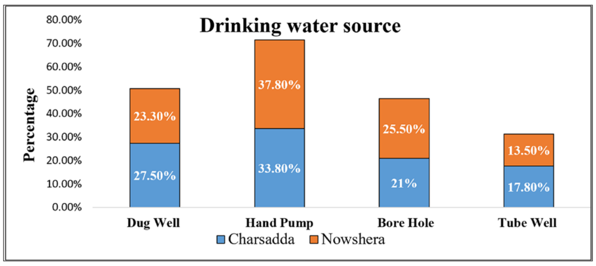

Figure 5. Primary Drinking Water Source of Charsadda and Nowshera Districts Quality

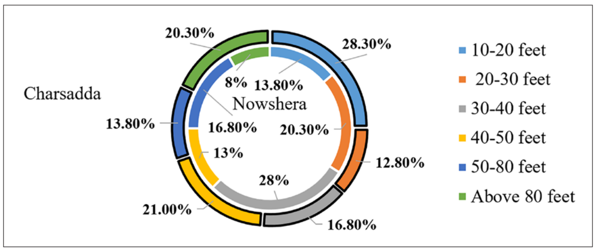

Figure 6. Depth Distribution of Water Source in the Kabul River Flood Plains.

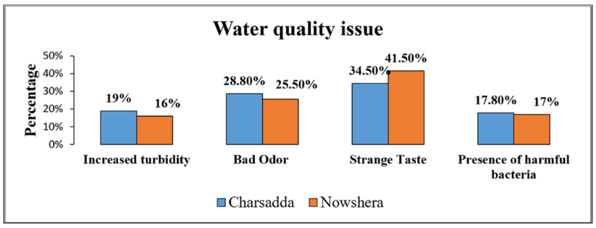

Figure 7. Water Quality Issues reported during or after floods Flood Plains.

3.3. Seasonal and Long-Term Changes in Water Quality

The survey results reveal the effects of extreme weather events on the long-term variation in drinking water quality. A higher proportion of respondents in Charsadda (73.5%) reported observing long-term changes in water quality, while 59% in Nowshera shared the same opinion. In Charsadda, 31% of respondents said that water quality was bad during floods, 21.5% during droughts, and 24.8% after heavy rainfall. However, 22.8% reported no major changes in water quality throughout the year. In Nowshera, by contrast, 35.3% reported that flooding affected water quality, while droughts were recalled by 26.5%, and heavy rains by 21.8%. Only 16.5% reported no significant changes in water quality throughout the year (Figure 8). These results align with the Food and Agriculture Organization of the United Nations (FAO, 2021) groundwater vulnerability maps, which identify Khyber Pakhtunkhwa's alluvial aquifers as prone to both contamination and seasonal drawdown. In similar studies in India's Bihar and Assam floodplains, post-monsoon water quality deterioration included increased turbidity, nitrate leaching, and pathogen load (Shamim and Chakraborty, 2025). To mitigate these trends, integrated watershed recharge zones, elevated storage tanks, and low-cost rainwater harvesting models used by UNICEF Bangladesh could be piloted in Pakistan's floodplain communities (Akbar et al., 2024; Nawaz et al., 2024).

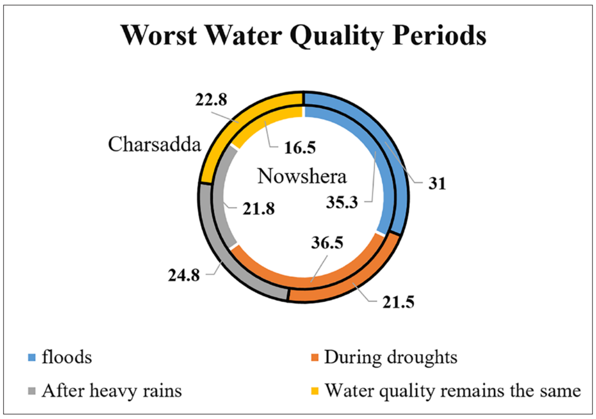

Figure 8. Perceptions of respondents on the worst period of water quality

3.4. Flood Impacts on Access to Safe Water

Flooding appeared to exert a considerable influence on drinking-water quality in both districts. In Charsadda, 65.8% reported that flooding indeed worsened water quality, while 34.3% observed no such adverse influence. In Nowshera, a similar trend was observed: 58.3% of respondents reported a flooding impact on water quality, while 41.8% said there was no such impact. The availability of clean water during flood events also differed. In Charsadda, 60.5% said flood-affected drinking water was unavailable, while 39.3% said it was available. The situation was much worse in Nowshera, where 73.3% reported no clean water during floods, while only 26.8% reported drinking water was available after floods.

Regarding pollution, 70.3% of respondents in Charsadda said their water sources were contaminated by flooding, while 29.8% reported no effect on their water. In Nowshera, 62.8% reported contamination of drinking water due to flooding; however, 37.3% reported no contamination. These outcomes are consistent with WaterAid (2019) flood response reports in Khyber Pakhtunkhwa and Punjab, where over 65% of shallow hand pumps failed to meet WHO microbial safety standards. Furthermore, MSF's (2010, 2011, 2022) post-flood health data from KP highlighted increased cases of diarrheal and skin diseases within 7–14 days of flood exposure, exacerbated by unsafe water use. The scale of disruption calls for decentralized water storage, chlorine tablet distribution, and emergency WASH mobile units as proposed in the NDMA Flood Response Framework (2023).

3.5. Government Response, Flood Control, and Community Awareness

In terms of government assistance, flood management initiatives, and community awareness during flood incidents, significant variations were noted between Nowshera and Charsadda. In Charsadda, slightly more than half of the participants (52%) reported receiving some government support to obtain clean drinking water following flooding, whereas 45% indicated they had not received any government support. In Nowshera, support seemed more prevalent, as 60.3% of participants reported receiving government support during the flood for clean drinking water, while 39.8% indicated they did not receive any support. In addition, when surveyed in Charsadda about flood management systems, 45% of residents reported that certain flood control measures were available, while 64% believed these initiatives were either insufficient or ineffective. Conversely, 64% of participants in Nowshera acknowledged the existence of flood mitigation measures, while 36% reported that no such plans were available in their locality regarding public awareness and preparedness during floods, 63% of individuals in Charsadda reported being informed about flood-related information, whereas 37% acknowledged they were not. Awareness levels were relatively higher in Nowshera, where 75.3% of residents reported being well-informed during floods, while 24.8% reported lacking that information.

Government assistance for clean water was acknowledged by 52% of respondents in Charsadda and 60.3% in Nowshera. However, satisfaction with flood control infrastructure was mixed, and awareness of protective measures varied across districts. This reflects broader findings by the International Rescue Committee (2022), which noted significant delays in WASH service coordination during KP floods due to fragmented local responsibilities. International best practices, such as the WASH Cluster model used by UN OCHA in Mozambique and Pakistan (2022), emphasize pre-disaster coordination, clear role assignments, and resource mapping among stakeholders. Adoption of a similar approach at the district level in Khyber Pakhtunkhwa could vastly improve WASH service reliability.

3.6. Flood Frequency and Most Affected Areas

In Charsadda, 34% of respondents reported experiencing floods annually, 32% reported flooding every 2–4 years, 15.3% reported flooding every 5–10 years, and 18.8% reported flooding only rarely. Similarly, in District Nowshera, 37.3% of respondents experienced floods annually, 28.3% every two to four years, 19.8% every five to ten years, and 14.8% rarely experienced floods (Figure 9). Furthermore, in Charsadda, the most impacted regions were agricultural land (15.5%), residential areas (25.8%), water sources (31.8%), and roads and infrastructure (27%). In Nowshera, the impact on agricultural land was indicated by (21.5%) of the population, residential areas 29.5%, water sources by 35.3%, and roads and infrastructure by 13.8%, and these results showed that floods are a major and common occurrence in both districts, mostly affecting residential areas and water sources, as shown in figures 10 and 11. Annual flooding was reported by 34% of respondents in Charsadda and 37.3% of respondents in Nowshera. Most affected areas included water sources, homes, and roads. These findings are supported by NDMA's GIS-based Flood Hazard Maps, which confirm that settlements near the Kabul River in both districts fall within the high-risk red zone (Bibi et al., 2018). A comparative study of the Indus and Brahmaputra basins found that proximity of water sources to flood channels was the strongest predictor of post-flood waterborne disease outbreaks (Kumar et al., 2022; Atif et al., 2021).

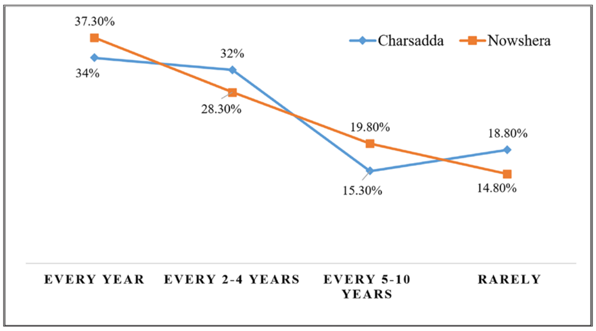

Figure 9. Frequency of flood occurrence in the flood prone districts

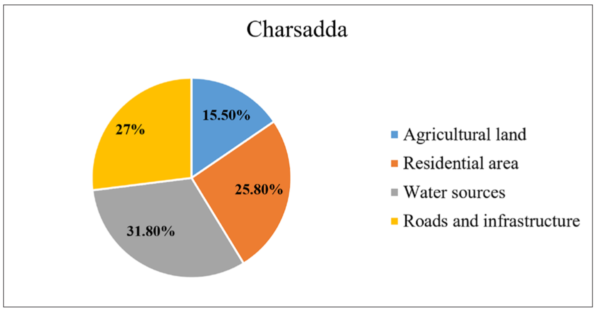

Figure 10. Most flood-affected areas in Charsadda

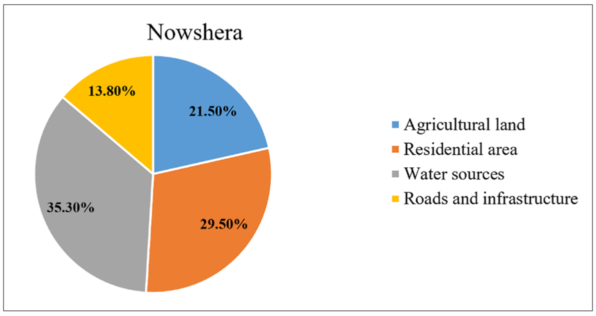

Figure 11. Most flood-affected areas in Nowshera

3.7. Water Management Practices During Floods

The survey identified significant issues concerning water management in Charsadda and Nowshera during flood occurrences. In Charsadda, 16.3% of participants reported disruptions to their water supply, whereas 34.8% reported pollution of water sources. 27% of participants reported overflowing drainage systems, while 22% indicated a lack of access to clean drinking water during flooding. In Nowshera, 20.3% of participants experienced interruptions in water supply, 29.3% managed polluted sources, 37.8% indicated drainage system spills, and 12.8% had no access to clean water (Figure 12). In both areas, residents employed various strategies to secure safe drinking water after flood incidents. In Charsadda, 21.8% of people boiled their water, 14% chlorine tablets or similar disinfection methods, 30% chose to purchase bottled water, and 34.3% depended on household filtration systems. In contrast, 28.3% of Nowshera inhabitants boiled their water, 12.4% utilized chlorine or similar methods, 20.8% bought bottled water, and 38.8% relied on filtration systems (Figure 13). Participants also recognized various organizations that oversee water quality during floods. In Charsadda, 16% of respondents attributed their support to local government bodies, 26.3% cited national agencies, 30.8% recognized non-governmental organizations (NGOs), and 27% cited engagement with local community organizations. In Nowshera, 20.5% identified the local government's contribution, 28% mentioned national entities, 34.3% recognized NGOs, and 17.3% highlighted community initiatives (Figure 14). These results highlight the complex challenges communities face during flooding and underscore the adaptive methods and support systems essential to preserving water quality and access in both areas. During floods, 34.8% of respondents in Charsadda and 29.3% in Nowshera reported contamination of their drinking water sources. Filtration (34–38%), boiling (21–28%), and bottled water were used as coping strategies, though chlorine tablets remained underutilized. Similar behavior patterns were observed in the UNICEF 2022 KP WASH Assessment, which cited cost, supply chain gaps, and a lack of user confidence as major reasons for low disinfection rates.

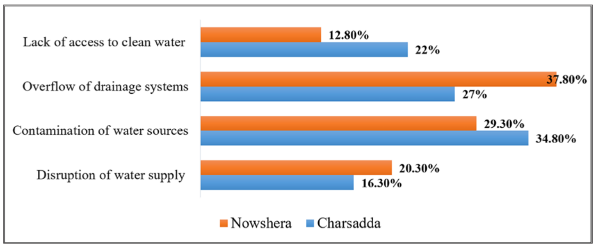

Figure 12. Major water management challenges during floods

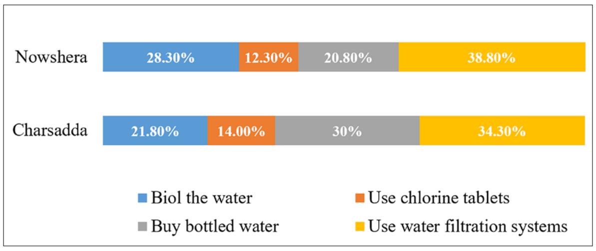

Figure 13. Household drinking water management after floods

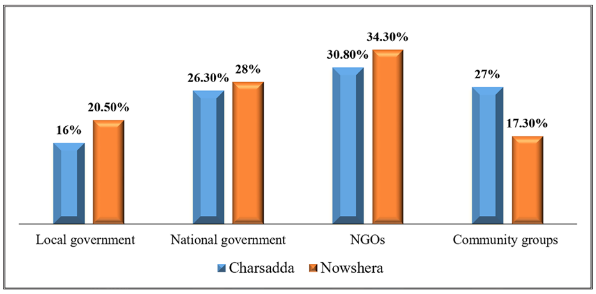

Figure 14. Effective organizations in water quality management

3.8. Public Preparation and Barriers to Water Quality Development

The survey revealed various obstacles and community responses linked to water quality control and readiness in areas vulnerable to flooding. In Charsadda, 13% of participants reported storing drinking water for potential floods, 31% implemented measures to clean and maintain their water sources, 32% built temporary barriers for protection, and 24% did not adopt any particular precautionary actions. In Nowshera, a somewhat larger percentage (18.3%) continued to use drinking water, 34.5% focused on conserving water sources, 19.5% constructed temporary flood barriers, and 27.8% took no precautions (Figure 15). Respondents from both areas identified multiple significant obstacles that impede initiatives to enhance water quality. Seventeen per cent of respondents in Charsadda and 22.5% in Nowshera expressed concerns about inadequate funding. A notable percentage also cited the lack of political commitment, with 30.5% in Charsadda and 32.8% in Nowshera. Public unawareness was reported by 29.3% of residents in Charsadda and 31.5% in Nowshera, whereas inadequate infrastructure was cited by 23.3% in Charsadda and 13.3% in Nowshera as a constraint (Figure 16). Various strategies were reported to address health risks health risks and avert waterborne diseases. In Charsadda, 26.8% of participants reported vaccination initiatives, 23.5% mentioned using mass media for awareness, 27.8% indicated emergency sanitation and water quality inspections, and 22% highlighted air quality assessments. In Nowshera, 30.3% of participants recognized vaccination programs, 28% acknowledged media campaigns, 31% noted emergency water and sanitation monitoring, and 10.8% mentioned air quality assessments (Figure 17). The main barriers identified were a lack of political will (30.5%), funding constraints (22.5%), low public awareness (31.5%), and weak infrastructure (13–23%). These constraints are nearly identical to those documented in the ADB 2022 Pakistan WASH Diagnostic Report, which emphasized how fragmented governance and underfunded Tehsil offices lead to structural failures. Globally, the International Water Association (IWA, 2022) suggests that local water utilities must be empowered with technical budgets, GIS-based monitoring, and disaster financing tools. Similar district-level reforms should be considered by KP's PHED and PDMA to address recurring infrastructure vulnerabilities.

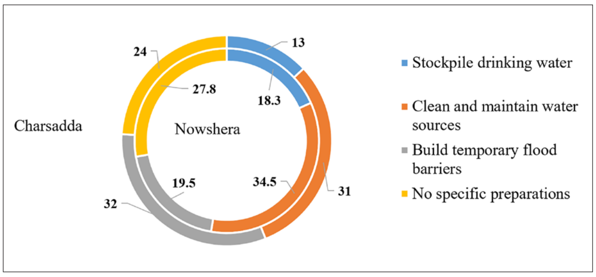

Figure 15. Community level preparation for water safety

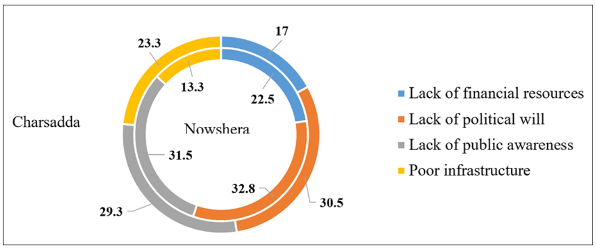

Figure 16. Key barriers to improving water quality in floodplains districts

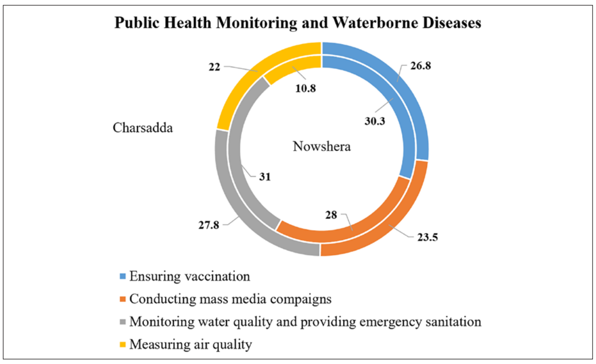

Figure 17. Public health monitoring and waterborne diseases prevention initiatives.

3.9. Seasonal Drinking Water Quality Challenges and Household Purification Methods

The survey examined seasonal water challenges, purification techniques, and their perceived efficacy in Charsadda and Nowshera. In Charsadda, 42.3% of families indicated they used water purification methods like boiling or filtration, whereas 57.8% did not practice any water treatment. Likewise, in Nowshera, 47.8% of participants reported that they treated their drinking water, while 52.3% did not report any treatment. When questioned regarding the success of these purification initiatives, 39.3% of residents in Charsadda and 46.5% of individuals in Nowshera believed that these actions improved water quality. Nonetheless, a greater percentage, 60.8% in Charsadda and 53.5% in Nowshera, indicated no significant enhancement due to purification techniques. The problem of seasonal water scarcity was also emphasized in both districts. In Charsadda, 40.5% of respondents faced water shortages at specific times each year, whereas 59.5% did not. In Nowshera, 45.8% indicated experiencing shortages, while 54.3% reported no such problems. Seasonal trends indicated that water shortages were considerably more frequent during the winter months. In Charsadda, 74.3% of participants indicated experiencing shortages in winter, while 25.8% reported the same in summer. In Nowshera, 61.3% faced shortages in winter, while 38.8% did so in summer.

3.10. Water Sources During Droughts and Associated Health Risks

During droughts, households in Charsadda and Nowshera implemented various strategies to obtain water for everyday needs. In Charsadda, 35% of households relied on groundwater sources, 25.3% utilized previously stored water, 14.8% bought water from local vendors, and 25% obtained water from a government supply. In Nowshera, 26.8% depended on groundwater, 30.3% utilized stored water, 13% acquired water from vendors, and 30% accessed water supplied by government agencies (Figure 18).

Health problems associated with drought-related water concerns were also apparent in both districts. In Charsadda, 32.3% of participants indicated diarrhea, 29.5% experienced cholera, and 18.3% faced skin infections. At the same time, 20% reported experiencing no major health issues during droughts. In Nowshera, health problems displayed a comparable pattern: 35.8% of participants had diarrhea, 32.3% acquired cholera, and 16.3% dealt with skin issues. A smaller group, 15.8%, reported no significant health issues during these dry spells. In addressing seasonal water shortages and associated health risks in drought-prone regions like Nowshera and Charsadda, replicating successful intervention models is critical (Figure 19). A notable example is the UNDP (2021) Community-Based Water Management Program in Tharparkar, Sindh, where solar-powered reverse osmosis plants and rainwater harvesting systems were introduced to ensure a sustainable water supply during droughts. Similarly, WWF-Pakistan's Water Stewardship Initiative in Punjab involved local communities in monitoring water quality, conserving groundwater, and adopting household-level filtration techniques, which significantly reduced the incidence of waterborne diseases (Khalid et al., 2024). These models highlight the effectiveness of decentralized water governance, public health integration, and community ownership. Applying such frameworks in KP, particularly with locally adapted solar desalination units, trained water committees, and mobile WASH clinics, could reduce health vulnerabilities, such as the high prevalence of diarrhea (35.8%) and cholera (32.3%), reported during droughts. Leveraging partnerships with NGOs, enhancing local infrastructure, and embedding these proven models into district-level policy can offer practical solutions tailored to regional needs.

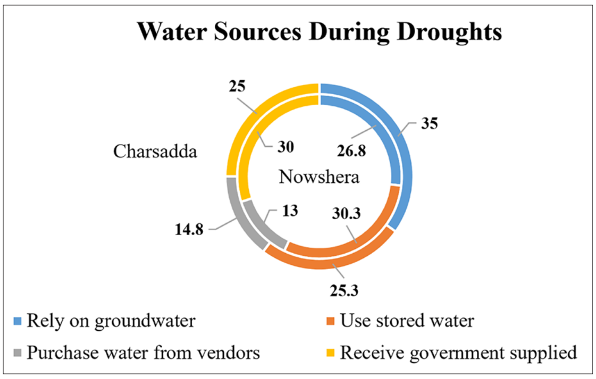

Figure 18. Water sources during droughts in the flood plains districts.

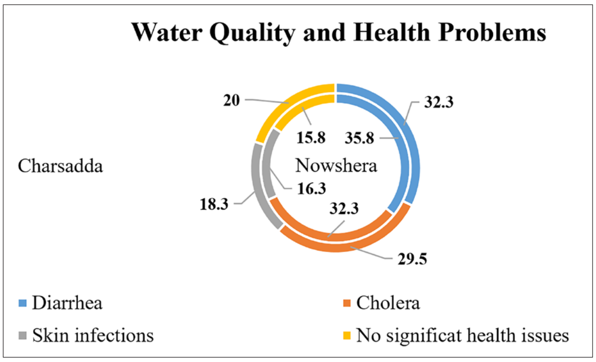

Figure 19. Water quality and health problems in the District Charsadda and Nowshera

4. Conclusion

In conclusion, the study highlights the significant challenges faced by communities in Charsadda and Nowshera regarding drinking water quality and public health during climate induced extreme weather events. Many families depend on shallow water sources, such as hand pumps and dug wells, which are easily polluted during floods. About 70% of people in Charsadda and 63% in Nowshera reported that drinking water became contaminated after floods. Common complaints included bad taste, foul smell, and dirty water. These unsafe conditions led to increased health issues such as diarrhea, cholera, and skin infections, which were reported by over 30% of people in both districts during droughts. Even though nearly half of the households used boiling or filtering methods, very few used chlorine tablets, which are known to be effective. Government and NGO support helped to some extent, but many people still lack clean water during emergencies. Overall, there is a clear need for safer water infrastructure, stronger public awareness, and better coordination among local agencies to protect public health during extreme weather conditions.

5. Recommendations

Based on the findings of this study, the following recommendations are proposed to improve drinking water safety and public health resilience in the context of climate extremes in flood-prone areas. First, water sources should be improved by digging deeper wells, properly sealing hand pumps, and building raised platforms to prevent floodwater from entering drinking water systems. At the household level, people should be encouraged and trained to use safe, simple water treatment methods such as chlorine tablets, boiling, and filtration. Awareness campaigns should be carried out in schools, mosques, and through local media to help people understand how climate change affects their health and water supplies. The government and NGOs should work together closely to provide clean water during emergencies and support long-term solutions. Local authorities should set up better planning and early-warning systems so that communities are better prepared. Finally, findings from this and similar studies should inform district and provincial governments in making water and health systems more resilient to climate change.

References

Ahmad, S., Zahra, J., Ali, M., Ali, S., Iqbal, S., Kamal, S., Aborode, A. T. (2022). Impact of water insecurity amidst endemic and pandemic in Pakistan: Two tales unsolved. Annals of Medicine and Surgery, 81.

Akbar, G., Ashraf, A., Hameed, S. (2024). Design and Evaluation of a Low-Cost Artificial Groundwater Recharge System Using Rainwater Harvested from Rooftop: A Case Study in Islamabad, Pakistan. Sustainability and Climate Change 17(4): 298-307.

Asian Development Bank (ADB). (2022). Pakistan: Water, sanitation, and hygiene sector assessment, strategy, and roadmap. Manila: ADB.

Atif, S., Umar, M., Ullah, F. (2021). Investigating the flood damages in Lower Indus Basin since 2000: Spatiotemporal analyses of the major flood events. Natural Hazards 108(2): 2357-2383.

Bibi, T., Nawaz, F., Abdul Rahman, A., Azahari Razak, K., Latif, A. (2018). Flood risk assessment of river Kabul and Swat catchment area: district Charsadda, Pakistan. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences 42: 105-113.

Eckstein, D., Künzel, V., Schäfer, L. (2021). The global climate risk index 2021. Bonn Germanwatch.

FAO. (2021). Groundwater management in South Asia: Challenges and strategies. Rome: Food and Agriculture Organization of the United Nations.

Gul, S., Khan, N., Nisar, S., Ali, Z., Ullah, U. (2024). Impact of Climate Change-Induced Flood on Women's Life: A Case Study of 2022 Flood in District Nowshera, Khyber Pakhtunkhwa, Pakistan. Journal of Asian Development Studies 13(2): 1468-1482.

International Rescue Committee (IRC). (2022). WASH response report in KP flood-affected regions.

International Water Association (IWA). (2021). Resilient water and sanitation systems: Guidelines for decentralized management. London: IWA Publishing.

Iqbal, A., Nazir, H. (2023). Community perceptions of flood risks and their attributes: a case study of rural communities of Khipro, district Sanghar, Pakistan. Urban Climate 52: 101715.

Khalid, S., Hafeez, M., Aqib, S. (2024). Who is more water insecure? Gendered evidence from urban Pakistan. Frontiers in Water 6: 1423237.

Kumar, A., Mondal, S., Lal, P. (2022). Analysing frequent extreme flood incidences in Brahmaputra basin, South Asia. Plos one17(8): e0273384.

Médecins Sans Frontières (MSF). (2010Pakistan: Summary of MSF's flood response (July–October 2010). MSF UK/USA.

Médecins Sans Frontières (MSF). (2011). Pakistan: Six months after the floods — Special report. MSF Field Epidemiology Unit.

Médecins Sans Frontières (MSF). (2022). Pakistan Flood Update: Health response & water provision in floodaffected zones. (Sindh, Balochistan, Khyber Pakhtunkhwa) MSF South Asia.

Musche, F., Sandhu, C., Grischek, T., Patwal, P. S., Kimothi, P. C., Heisler, A. (2018). A field study on the construction of a flood-proof riverbank filtration well in India–Challenges and opportunities. International journal of disaster risk reduction 31: 489-497.

National Disaster Management Authority (NDMA). (2023). Monsoon contingency and flood response plan. Islamabad: NDMA Pakistan.

Nawaz Khan, M., Mukhtar, A. (2024). Water Management in Pakistan: Challenges and Way Forward. In The Water, Climate, and Food Nexus: Linkages, Challenges and Emerging Solutions (pp. 435-456). Cham: Springer International Publishing.

Noureen, A., Aziz, R., Ismail, A., Trzcinski, A. P. (2022). The impact of climate change on waterborne diseases in Pakistan. Sustainability and Climate Change 15(2): 138-152.

Pakistan Council of Research in Water Resources (PCRWR). (2019). Water quality status in Pakistan 2017–2019. Islamabad: Ministry of Science and Technology.

Rasool, A., Saeed, S., Ahmad, S., Iqbal, A., Ali, A. (2024). Empowering community participation for sustainable rural water supply: Navigating water scarcity in Karak district Pakistan. Groundwater for Sustainable Development 26: 101269.

Sabra, P., & Al-Moaz, M. A. (2022). Awareness of Climate Change-The role of art, education and culture in raising awareness of climate change. International journal of education and learning research, 5(1), 48-70.

Shamim, F., & Chakraborty, B. (2025). Temporal analysis of the Hooghly River's water quality: investigating pre-and post-monsoon scenarios in West Bengal, India. Water Science & Technology, 91(3), 266-279.

Ullah, W., Dong, H., Shah, A. A., Xu, C., Alotaibi, B. A. (2025). Unveiling the Multi-Dimensional Vulnerabilities of Flood-Affected Communities in Khyber Pakhtunkhwa, Pakistan. Water 17(2): 198.

UN OCHA. (2022). Pakistan floods: Humanitarian response plan and WASH cluster performance. New York: United Nations Office for the Coordination of Humanitarian Affairs.

UNDP Pakistan. (2021). Climate awareness and behavior change among rural households. Islamabad: United Nations Development Programme.

UNICEF Pakistan. (2022). Post-flood WASH assessment: Khyber Pakhtunkhwa province. Islamabad: UNICEF.

WaterAid Pakistan. (2022). Building resilience in flood-prone areas: A WASH perspective from northern Pakistan. Islamabad: WaterAid.

WaterAid. (2019). WASH in emergencies: Pakistan flood case study. London: WaterAid Global.

WHO. (2017). Guidelines for drinking-water quality: 4th edition incorporating 1st addendum. Geneva: World Health Organization.

WWF-Pakistan. (2022). Community perception of climate change in Khyber Pakhtunkhwa. World Wide Fund for Nature – Pakistan.

Yadav, S. (2025). Empowering Communities for Climate Resilience: Bridging Knowledge and Action to Combat Climate Change. In Community Climate Justice and Sustainable Development (pp. 83-104). IGI Global Scientific Publishing.