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The Impact of Climate Variability on Water Resource Management in Skardu

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ABSTRACT

Climate variability is posing a great threat to the world particularly in water-scarce regions in every aspect. It is characterized by fluctuating temperatures, shifting precipitation patterns, and extreme weather events.District Skardu, being located in the Karakoram Mountain Range, depends heavily on glacial melt water to meet its water demands in every sector. However, the increasing temperature, rising glacial retreat, unpredictable snowfall, and water shortages in the dry seasons have become great challenges to cope with to the water resource management in region. The current study aims at exploring the impact of climate variability on the water resource management in Skardu, a region heavily reliant on glacial melt water. The study employs a qualitative research approach using secondary data sources. Findings of the study indicate that glacial melting, on one hand, increases water availability temporarily, but on the other hand, poses a great threat by putting long-term sustainability of water at risk. To overcome this challenge, the study suggests some key interventions including,to promote efficient irrigation techniques, to expand water storage infrastructure, and to implement Integrated Water Resource Management, and strengthening climate adaptation policies. Moreover, active community engagement through different seminars, creating awareness among the public regarding efficient use of water, institutional reforms, and scientific monitoring are some other essential measures to take in order to mitigate the risks regarding water shortage and to ensure long-term water security for the region, Skardu and its reliance on downstream regions.

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1. Introduction

Climate impact has emerged as one of the most pressing environmental concerns of the 21st century, profoundly influencing hydrological cycles and water resource systems worldwide. For human survival, economic activities, and ecological balance, water is the most fundamental resource that plays a crucial role in sustaining agriculture, generating hydropower, supporting biodiversity, and ensuring the well-being of communities around the world ("Potentially Dangerous Glacial Lakes and Geo-Hazard Assessment in Upper Indus Basin," 2024). However, the availability, distribution, and quality of this resource mainly depend on the climate change, known as climate variability. It is a phenomenon characterized by shifts in temperature, precipitation patterns, and the frequency of extreme weather events. The factor of climate variability has profound implications for hydrological systems particularly in mountainous areas that rely on glacial melt-water and seasonal precipitation, as even minor change in temperature and rainfall can disrupt hydrological cycles. Mountainous regions such as Karakorum Range in the Northern Pakistan are among the most vulnerable to these changes. The dependence of local communities on natural water resources including glaciers, rivers, and

underground reservoirs, makes them highly susceptible to fluctuations in water supply. Changes in climatic pattern not only affect water availability but also impacts agriculture, energy production, and overall livelihood sustainability (Kongnso & Dongfack, 2024). With increasing global temperatures, there is a growing concern that the accelerating retreat of glaciers, irregular precipitation, and altered river flow patterns may lead to severe water shortages, heightened competition for resources, and long-term socio-economic challenges. These factors highlight the urgent need to assess the impact of climate variability on water resource management, particularly in fragile ecological zones such as Skardu.

Over the last two decades, Skardu has experienced noticeable transformations in its climate and hydrological regime. Local observations, corroborated with satellites and meteorological data, shows increasing temperature, reducing rate of snowfall, high glacier melting, and seasonal shifts in streamflow. These changes are deteriorating the traditional techniques of irrigation, emphasizing water-sharing arrangements like Waternbandi (a rotational water distribution practice), and posing a great risk to both food and water security. These climate induced water stress brutally impacts agriculture system which is considered the backbone of the region's economy. Consequently, this impact directly influences livelihoods, give rise to rural poverty, and rises the region's vulnerability to socio-economic instability. Despite of a large number of previous studies on the impact of climate change on the glacial systems in Gilgit Baltistan, most existing researches have focused on physical or technical aspects like the river discharge modeling, glacial dynamics, or infrastructural damage from glacial lake outburst floods. However, limited studies have focused on how local water resource management systems are adapting to these current climatic patterns at the community level. This highlights a significant research gap in understanding the interplay between climatic variability and local governance, traditional practices and institutional responses in water management. The current study aims to closer this gap by exploring how climatic variability effects water resource management in Skardu, using a qualitative approach grounded in secondary data and literature synthesis. In addition, the study discusses the socio-political and infrastructural constraints that worsen the impact of climate change in the region. Furthermore, by bringing the environmental and governance dimension in one discussion, the research focuses to provide a clearer holistic understanding of the water crisis, offering recommendations that are both context-specific and actionable.

1.1. Statement of the Problem

A major part of Pakistan depends on mountain water resources for its domestic purposes, agriculture, energy and mechanical uses so an effective water resource management is very important in order to maintain a balance and stability in these sectors. However, the climatic change impacts the hydrological power effecting the water resource management negatively.Such climatic changes affect farming system the most, which is considered the base of economy for agricultural countries like Pakistan (Adnan et al., 2024). The effect of change in climate is so fatal that even the giant glacial and ice stores cannot protect themselves in this consequence which leads to mismanagement of water resource. In the continuity, Skardu, like many other regions, faces extreme shortage of water because its sole source of water is the only dam i.e Sadpara Dam. Therefore it has become a dire need of the time to consider other strategies for the sustainability of water instead of relying on a single Dam. Measures must also be taken to cope with emergency situation like natural disasters and the study recommends strategies for it as well.

1.2. Objectives of the Study

- To explore the impact of climate variability on the water shortage in Skardu
- To explore the impact of climate variability on water resource management in Skardu

1.3. Research Questions

- How does climate variability impact water resource management?
- What is the impact of climate variability on water availability?

1.4. Significance of the Study

Water resource management is among the primary challenges that Pakistan is facing since its independence in 1947. Studies have been conducted on the importance of glacial melt water and hydropower however there are limited studies on the challenge of climatic change especially in regions like Skardu that mainly depends on glacial fed water. The current study

primarily aims to explore this aspect by investigating the impact of climatic variability on the water resource management in Skardu. Skardu being a mountainous region heavily relies on the snowfall, rainwater and glacial runoff water to meet its demands in agriculture, industrial, and domestic purposes. Therefore an effective water resource management system is compulsory to utilize the available water strategically. In summer season, glaciers melt at a fast pace producing excessive water. Due to lack of proper water storage system a large amount of this water gets wasted creating water scarcity in the dry season when there is zero glacial-melt water. The significance of the study also lies in its localized focus and interdisciplinary perspectives. Water resource management of Skardu due to its traditional techniques and limited technological interventions is under research. Keeping in view this condition, the study significantly highlights the issues that the local communities in Skardu are facing. In addition, the study holds significance for policy makers, environmental planners, and non-governmental actors seeking to improve water governance in similar ecology sensitive and climate vulnerable regions. By searching out the specific areas of weakness like infrastructure deficits, institutional fragmentation, and the eradication of traditional techniques, the study focuses to highlight required interventions that enhance resilience and sustainability.

2. Literature Review

The impact of climate variability on water resources has emerged as a central concern in environmental and resource management discourse globally (Gupta et al., 2024). With the changing climate patterns, mountainous regions like Skardu that are heavily reliable on glacial-melt water are facing severe challenges in sustaining water availability for agriculture, domestic utilization, and ecosystem sustainability. Many of the previous studies have investigated the inter-impacts of rising temperatures, changing precipitation trends, and their effects on hydrological systems. Researchers have highlighted that the decline in glaciers, changing time pattern of snowmelt, and the frequent occurrence of extreme weather events have significant implications for water governance particularly in mountainous and arid regions. The literature of current study is also an attempt of the continuity in finding out the impact of climate variability on the water resource management with a particular focus on region Skardu.

2.1. Glacial Retreat and Its Impact on Water Management

The factor of climate change is acting as a driving force in the hydrological changes that globally impacts the equal distribution and availability of fresh water resources(Nguyet, 2025). Scientific studies have extensively documented that glaciers in the Karakorum region especially in Biafo, Baltoro and Siachan Glaciers are retreating rapidly(Giilany, 2014). Although the glaciers in the Karakorum Range are reported stable glaciers compared to those of Himalayas but recent research shows that many smaller glaciers in Karakorum Range feeding Skardu's river system are receding. The melting of these glaciers causes changing pattern in the water flow. This retreat changes the seasonal water supply, shifting peak flow from summer months to spring. It misaligns with the traditional agricultural calendar creating periods of both surplus and scarcity. According to the Intergovernmental Panel on Climate Change(IPCC, 2021), the main cause the altered precipitation patterns, and today's more frequently occurring extreme weather events like floods and droughts is the rising global temperature. These changes are causing great threat to the water resource management globally, particularly in regions that are dependent on water running from glaciers and seasonal rainfall. Researches further indicate that the increase in temperature and erratic precipitation patterns are disturbing the volume and time of water flow. This factor is consequently leading towards heavy flooding and severe water scarcity(IPCC, 2021). (Muhammad et al., 2024), discusses that water storage infrastructure in northern Pakistan is not strong enough to cope with severe climate variability which every year leads to water shortage in the dry season. Furthermore, the traditional irrigation techniques like Kuhl and Gul, though historically excellent techniques are no more effective in the current time with modern climate stress (Ali, Ali, & Hashim, 2024). The existing studies further emphasize the need for a functional climate-resilient water governance including Integrated Water Resource Management so that sustainability of water could be ensured ("Surface water quality assessment of Skardu springs using Water Quality Index," 2021a).

2.2. Infrastructure Gaps in Water Management

Being an agricultural country, water resources function as backbone of the economy of the country. But the inadequate infrastructure, lacking proper system for water storage, leads towards water crisis. The currently employed traditional strategies for irrigation, although

effective in the past, are no longer adequate to handle the increased variability. Among the water resources, ground water is the main source that fulfills the 60% of irrigation water needs of the country. Moreover, ground water meets 100% industrial needs and around 90% of drinking water. This source of water played a vital role in growing generally harvesting strength in Pakistan from approximately 63% in 1947 to 120% in 2000(*Refinement of Skimming Well Design and Operational Strategies for Sustainable Groundwater Management*, 2007).Despite of this availability of ground water, the water resource management system fails to ensure the equal distribution of water. According to the (Zulfiqar et al., 2019), the modern engineering solutions such as lined canals, small reservoirs, and efficient distribution networks are either missing or severely under developed. Because of this inadequate system, the seepage rates in previously designed canals cause approximately 30-40% of water losses before it reaches the agricultural field. Furthermore, the unnecessary utilization and wastage of water in some sectors makes other sectors deprived of meeting the basic necessity. As a result of this inequality country faces economic loss in many sectors as well (Ragmoun, 2023, 2024).

2.3. Policy Challenges and Institutional Fragmentation

Despite the numerous development programs in Gilgit Baltistan, water governance remains fragmented between multiple bodies, including the Public Works Department (PWD), local municipal councils, and ad-hoc NGOs and community based groups. These bodies have overlapping but poorly coordinated mandates related to water management. This fragmentation gives rise to duplication of efforts with no solid outcome, wastage of resources, and lack of coordination and long term strategies to address the water related issues. Because of these overlapping efforts of different bodies, the policies regarding water conservation, climate adaptation, and infrastructure development often seems to be reactive instead of being proactive. In addition, most of the currently employed frameworks focus merely on the physical infrastructure development because of which the socio-institutional aspects of sustainable water governance get neglected. It includes the lack of community engagement, no effort for capacity building, and lack of integrated watershed management. Thus in Skardu, all these fragmented institutions and their policies clashes, lack of inter-sectoral integration, and absence of community engagement contribute significantly to the ongoing water crisis in the region(Ahmed, Azhar, & Mohammad, 2024).

2.4. Causes of Water Crisis in Skardu

Today Skardu is facing a threatening water crisis especially in the dry seasons which is getting worse with the passage of time. The factors behind this critical situation can be observed as a complex interplay of environmental, infrastructural, and socio-political factors, with climate variability functioning as a primary driving force (Ali et al., 2024). The region enjoys adequate water availability in the summer season as the glaciers are melting at a fast pace due to increasing temperature but the counter effect can be seen in the form of declining glaciers. It poses a great threat for the future water sustainability. This factor has led to an altered pattern of glacial melt and disrupted seasonal water availability. Moreover, erratic and reduced precipitation, especially in the form of snowfall, has led to insufficient natural replenishment of glacial and groundwater reserves.

Compounding the environmental challenges is the lack of adequate water storage infrastructure (Ali, Ali, & Hashim, 2024). For the access of water, the habitants of Skardu primarily rely on the traditional water channels and open-flow systems. These techniques are absolutely inefficient and cause water loss through seepage and evaporation. Presence of small dams and reservoirs could have prevented the water from loss but poor infrastructure of water management system and the absence of such resources cause failure in the prevention and collection of excess water during periods of surplus. The inefficient irrigation methods contribute further in the overuse and wastage of water especially in agriculture sector which is the primary livelihood in the region.

Moreover, the unregulated urban expansion and the increased tourism contribute further in the crisis and puts additional pressure on the existing limited water resources("Surface water quality assessment of Skardu springs using Water Quality Index," 2021b). The crisis is worsened by poor waste management and pollution of natural water bodies often from untreated sewage and plastic waste. In the continuity, some institutional weaknesses add more in degrading the water quality. It may include lack of integrated water policies, insufficient investment in water infrastructure, and limited public awareness. Besides the environmental and infrastructural

causes, socio-economic and governance related factors play a significant role in water crisis in Skardu. The region lacks a proper and formal framework for coordinated water resource management which makes it much difficult to implement the modern water conservation practices. Due to lack of an integrated system, the government institutions often play their role in silos which results in multiple and individualized policies and poor implementation of existing policies and regulations related to water use, pollution control, and infrastructure development. In addition, the unawareness of local community about the modern water sustainability techniques and storage systems makes them rely more on traditional techniques wasting a large amount of water in the surplus periods (Butt et al., 2024). The reliance of local communities on traditional knowledge systems, although valuable, is no longer efficient enough to cope with the scale and intensity of water challenges posed by climate variability. This factor of ignorance among the local communities along with lack of public awareness campaigns and technical trainings further exacerbates the challenge and limits the capacity of habitants to adapt water efficient practices. As far as the policy making is concerned, the lack of reliable data on water and scientific monitoring systems cause a great barrier for the policy makers to assess vulnerabilities accurately and design appropriate measures. Thus it can be concluded that the crisis of water in Skardu is caused not only by the natural processes but there is a list of systematic institutional and social failures that need urgent response by the relevant responsible departments through integrated, participatory, and evidence-based policy responses. All these factors collectively have developed a critical water scenario in Skardu, demanding urgent, multidimensional responses to avert a deepening crisis.

2.5. Water Resource Management Approach

2.5.1. Traditional vs. Modern Water Management Practices

In the old times, the communities, especially farmers of Skardu have relied on traditional irrigation system to meet water demands. Small irrigation channels, known as "Kuhls" were designed where needed and other natural storage methods were being used for the efficient utilization of water resources. A study conducted by (Hill, 2017), highlights that these in built and local techniques have sustained agricultural activities for centuries which facilitated farmers to cultivate crops despite the challenging arid condition of the region. However with the changing time and climate, these old techniques are becoming ineffective in ensuring water security. Today, many modern water management approaches have been explored as potential solutions against the traditional ineffective techniques. These include building small dams, improved irrigation technologies, and community-based water governance. Lack of these factors has led to severe shortcoming in utilizing the available water effectively. Currently, there is only one functional dam in whole Baltistan division i.e. the Sadpara Dam which is functional since last few years and is working as a main water storage source in the region. Before that it was a small lake functioning as a water reservoir for a limited population in Skardu. The construction of the dam has improved the water storage to some extent. But many areas still rely on the traditional techniques for getting irrigation water. A study conducted by (Hill, 2014), discusses the importance of integrating both the traditional and modern techniques to enhance water management in mountainous regions. The current study also explores the need for improved water storage infrastructure, policy reforms, and better forecasting mechanisms to mitigate the adverse effects of changing climate on the availability of water.

2.6. Protection and Conservation of Water Resources

In regions, like Skardu that are vulnerable to climate variability, it is much critical to protect and conserve water resources for ensuring long-term sustainability (Khan et al., 2024). Effective strategies need to be designed and implemented to cope with this challenge. The strategies may include policy intervention, technological advancements, community participation, and ecosystem-based approaches. The implementation of these strategies may safeguard freshwater sources to a large extent for a longer period of time. Constructing small dams and reservoirs is one the most effective strategies for the sustainability and conservation of water (Sauveur & Amolo, 2025). During the time of glacial melt and high water flow, these dams and reservoirs help in storing the excess water preventing it from getting waste. The strategy can prevent the local communities from the problem of water shortcomings in the dry season which they often face. In particular with mountainous regions like Skardu, constructing such dams and reservoirs at a high altitude has significant importance as it helps in a steady flow of water regulating it and minimizing the risk of both seasonal shortage and flooding.

Furthermore, the modern irrigation techniques like drip irrigation and sprinkler system also proves beneficial in preventing water wastage in agriculture sector.

In addition, the community led water management initiatives are also a great measure towards the conservation of water. It is a proven fact that giving authority to the local community regarding water governance issues has mitigated problems to a large extent. Likewise, applying the policy in Skardu can overcome the water crisis making equitable water distribution by locals according to their own needs and promoting water sharing agreements. Moreover, arranging awareness sessions for the locals regarding the conservation methods of water and its importance and urgency, helps in preventing excessive use of water. Some important measure that can be highlighted in such sessions may include rainfall harvesting, wastewater recycling, and efficient household water use. In conclusion, Skardu can develop sustainable water conservation strategies to ensure long-term water security in the face of increasing climate variability by integrating scientific research, local knowledge, technological innovations, and policy support. Protecting and conserving water resources is not only an environmental need but also an economic and social necessity for the well-being of current and up-coming generations.

3. Methodology

The study employs a qualitative, exploratory research design that aims at exploring the impact of climate variability on water resource management in Skardu. The study primarily relied on the systematic review and secondary data sources as there were limited availability of consistent primary data in the remote area.

3.1. Data Collection

Secondary data were gathered from reliable sources including government reports, non-governmental organizations publications, peer-reviewed journal articles, environmental assessments, and academic books. Following criteria were emphasized for selection of secondary data:

- Relevance to the themes of climate change, glacial melt, water resources and management, and water management related policy frameworks in GilgitBaltitan especially Skardu.
- Prioritizing works from indexed journals, reputable publishers, and official reports.
- Focusing sources from the past 15 to 20 years to ensure recent reflection of climatic variability and governance responses.

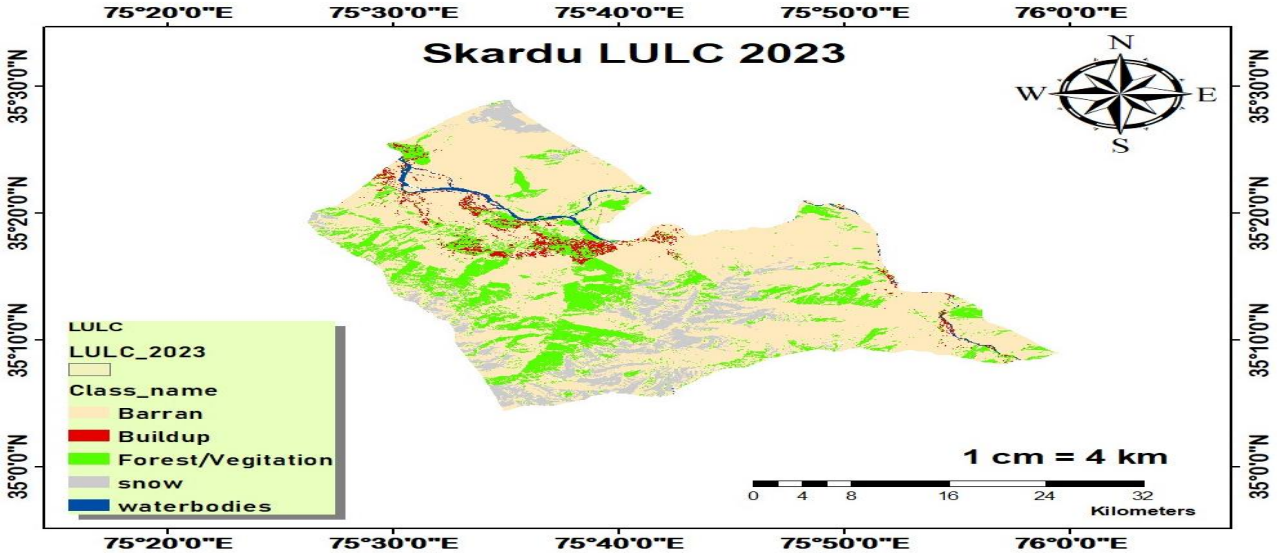
In addition, local communities and online platforms were consulted selectively to explore the indigenous practices like Kuhls and Waterbandi systems. To ensure methodological transparency and credibility, diverse types of sources were triangulated such as empirical studies, policy documents, technical reports etc. analytical objectivity was maintained by cross-verifying claims against multiple references. Moreover, limitations associate with secondary data reliance were acknowledged and mitigated by critically evaluating each source's validity and context. For analysis of the collected literature, the researcher employed a thematic synthesis approach. Based on recurring challenges and concepts, key themes were identified. The literature was categorized into thematic clusters including glacial retreat and climate variability, infrastructure gaps and water losses, traditional water management systems, and policy challenges and institutional fragmentations. Within each themes, data was taken from multiple sources. The studied findings were compared, contrasted and synthesized to draw broader insights into the evolving dynamics of water resource management in Skardu.

3.2. Study Area

For the current study, the researcher has focused on a mountainous region, Skardu, a district of Gilgit-Baltistan located in the Northern Pakistan. It lies in the Karakorum Mountain Range. Skarud is well known for its giant glaciers, rivers, and high-altitude Lakes. Having these giant mountains and glaciers Skardu serves as a critical source of water for the Indus River. It is primarily fed by the famous Siachan glacier, Baltoro glacier and Biafo glacier. The habitants of Skardu mainly depend on glacial-melt water to meets the demands of agriculture, drinking water and hydropower. This factor makes the region extremely vulnerable to climate induced water shortages, glacial lake outburst floods, and changing hydrological patterns. In water

resource management the strategic importance of the area underscores the urgency of sustainable policies to cope with climate risks and ensure long-term water security.

Figure 1: Skardu LULC 2023



4. Results and Discussion

The results and discussions highlighted here are drawn from secondary data sources exploring the impact of climate variability on water resource management in Skardu. It further discusses the implications of these findings. The discussion section elaborates these key findings providing a deep understanding of the current challenges, adaptation strategies, and policy recommendations for sustainable water management in the region.

4.1. Climate Variability and its Impacts on Water Resources

Gilgit Baltistan is facing a rapid glacial melt due to increasing global and regional temperatures. Indus River is a primary source of water which relies heavily on the glaciers in the mountain ranges of Karakoram, Hindukush, and Himalayan. The changing pattern of climate since last few decades is disturbing the pace of glacial melting which is creating an alarming situation for the water availability in the future. Although this phenomenon increases water availability for a short-term but also poses a great threat of water scarcity in the long-term as glaciers continue to shrink. In the line, another key finding is the erratic precipitation patterns and changing hydrology that have caused declined in the rate of snowfall and regular rainfall in the Skardu region. Reports highlight that because of less snow accumulation in the mountains, winter snowfall has decreased. This factor directly affects water availability in the summer when the snow melts and replenishes rivers and streams.

4.2. Water Management Challenges in Skardu

Another key finding of the study highlights the inefficiency and ineffectiveness of management regarding the storage of water in Skardu. In the summer the flow of water increases as glaciers melt rapidly but the excess water is lost downstream because of lack of storage infrastructure and water storage. There is no proper water conservation system, large reservoirs, or effective water distribution network that could prevent seasonal water scarcity during the dry months. Furthermore, the inefficient and traditional techniques of irrigation contribute to significant water wastage in the agricultural sector. Studies highlight that the more than 50% of water loss is caused by the traditional irrigation methods that leads to water shortage in the dry season.

4.3. Adaptation Strategies for Sustainable Water Management

Historically, communities in Skardu have developed and agreed on traditional water management systems that have played a vital role in sustaining agriculture and domestic water utilization. Some of these traditional strategies include;Kuhls (irrigation channels) i.e. small scale water channels managed by local community that distributes water efficiently. Second strategy was the waterbandi system which is a water sharing system on a specific time rotation

ensuring fair water distribution among the farmers. Third, rainwater harvesting was also a strategy for sustaining water. It involves collecting and storing rainwater for later use. In today's time, these traditional techniques have lost their effectiveness and efficiency therefore, to address water management challenges researchers suggest implementing modern water conservation techniques. The modern techniques include; drip irrigation and efficient water distribution networks, construction of small dams and storage reservoirs, and groundwater recharge projects.

4.4. Future Directions and Recommendations

Keeping in view the increasing impact of climate variability, future water management in Skardu must focus on climate-resilient strategies. These may include; Glacial Lake Monitoring System, Sustainable Urban Water Planning, Expansion of Alternative Water Sources. A major gap identified during the study is the lack of continuous monitoring and data collection on Skardu's water resource. The establishment of hydrological monitoring stations to track glacial changes, river flow rates and groundwater levels would provide critical data for future water management planning. Moreover, the engagement of community and arranging awareness programs by ensuring public awareness and local participation in water conservation is necessary. The awareness programs may include educational campaigns, training programs, and incentives for sustainable wateruse. These steps can empower local communities to take active role in managing water resources effectively. In addition, upgrading infrastructure is needed on urgent basis. The traditional Kuhls can be revamped using low-cost, climate-resilient technologies reducing seepage and evaporation loses. Institutional coordination is another major step that needs to be considered on priority basis. This coordination can be practiced by establishing a centralized water resource management authority for GilgitBaltistan that empowers the coordination across local counsils, NGOs, and national agencies. Moreover, community led-governance like revitalizing Waterbandi through formal recognition, capacity building programs, and participatory water budgeting models also proves good initiatives in addressing the issue. Specific agencies like the GilgitBaltistan Environmental Protection Agency, the Department of Water and Power (PWD), and community based organizations should be tasked with leading and coordinating these efforts, with technical and financial support from federal and international development partners.

5. Conclusion

In the current study, the researcher has highlighted the critical impact of climate variability on water resource management in Skardu, a region that primarily depends on glacial-melt water from the Karakoram Range to meet its water demand. The findings of the study revealed the alarming situation of glacier melting at a fast pace due to globally increasing temperature along with some local causes. The rapid melting of glaciers occur in peak summer season which results in flow of excessive water from the mountains. It is the reason that people get maximum access to water in the summer season. But this availability of water is for a shorter period of time as there is no proper storage system in the region. It causes extreme drought in the dry season. In addition, the hydrological stability of the region has been disturbed by many other factors as well including severe weather events, reduced snowfall, and erratic precipitation patterns. The factors collectively have made water management extremely challenging. Despite of having abundant natural water resources, Skardu faces extreme drought in the dry season and the future of water sustainability in the region is also at a great risk. The root cause of this situation can be found in the poor water management system and lack of proper infrastructure for storing water in the surplus period.

The present traditional strategies and techniques of water management systems are no longer effective and efficient to overcome the increasing demands of current time. Dependence on glacial-melt water with no alternative water sources raises the region's vulnerability to climate-induced water crisis. Furthermore, there is also a high risk to public health and agriculture because of degraded water quality which is caused by water pollution from unregulated tourism, agricultural run-off, and poor waste management. To address these challenges, it has become crucial to integrate traditional water management practices with modern conservation techniques. The currently facing water storage and conservation challenges can be overcome by strategies like improving storage infrastructure, adopting efficient irrigation methods, and strengthening policy frameworks. Moreover, scientific monitoring, climate-resilient planning, and active community engagement are essential steps to take for sustainable resource management. Ensuring Skardu's long-term water sustainability

needs immediate policy action, technological investment, and collective governmental and local efforts. By adopting integrated water management strategies, the region can mitigate climate risks and secure a stable water future for both the local population and downstream users.

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