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Melting Glaciers and the Indus Water Treaty: A Looming Crisis

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Abstract: *The Indus Waters Treaty was created in 1960 to allocate water between India and Pakistan. Climate change was not considered then, but hydrology and conflict resolution have progressed. Climate change has altered water availability, including volume, timing, frequency, and quality. Population growth, urbanization, and climatic events have impacted Pakistan's water supply. This tension could escalate into conflict without addressing the treaty's knowledge and practice gaps. Advancements in transboundary watercourse management, environmental monitoring, and data acquisition are necessary. Water remains a source of tension, and prompt action is needed to ensure sustainable water resource management. One possible solution to this issue is to integrate modern knowledge on climate change into the IWT and harmonize it with the current set of international water laws and regulations. Hence, it is imperative to formulate a framework enabling both countries to reach a consensus and introduce climate change-related clauses and provisions into the IWT.*

Key Words: Climate Change; IWT; Indus Basin; India; Pakistan

Introduction

Mankind is the main environmental force changing Earth's geology. Climate change, a human-caused phenomenon, is now a global reality. Its main evidence is global warming and glacier melting. According to the IPCC special report, human activity in the 20th century caused a global surface temperature increase of 0.670C, disrupting weather systems and making snow and rainfall unpredictable (Santer, et., al 2006). In river basins with transboundary jurisdictions, this has disrupted the water balance. In snow-dominated basins such as the Indus River Basin, climate change has impacted the timing, intensity, magnitude, and duration of water flow, resulting in declining and uncertain water availability amidst rising water demand due to population growth, urbanization, and industrialization (Wijngaard, 2018). Such water distribution uncertainty can lead to food insecurity, with freshwater sources being vulnerable to the effects of climate change, ultimately harming Earth's primary water sources.

The British colonial powers established Pakistan and India on August 14 and 15, 1947, before decolonization. However, the geographical division between these newly formed states did not consider the hydrological realities of available water resources. In response to this challenge, on September 19, 1960, both nations signed the Indus Water Treaty (IWT) to share the waters of the Indus River Basin. (Ali, & Khuhro,2021).

The Indus Waters Treaty (IWT) outlines the responsibilities and entitlements of India and Pakistan regarding distinct groups of rivers located in the western and eastern regions. The treaty comprises provisions for information, data, and implementation. Despite enduring over six decades of tense times, the treaty's functional efficacy now appears questionable due to its inherent limitations and concerns. Notably, the treaty did not consider the implications of climate change during its conception, a reality now severely impacting the Indus River Basin (IRB) (Mondal, Wang, & Jiang, 2021). Over the past fifty years, water quantity, volume, timing, duration, and intensity have undergone significant transformations, with water quality suffering due to fluctuations in water quantity.

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This research has identified gaps that require addressing, particularly regarding climate change. To maintain Treaty stability in the face of water variability, it is necessary to incorporate mechanisms for flexibility and introduce climate change-related clauses and provisions that address water quantity and quality issues. Climate proofing, incorporating climate change clauses and provisions, will guarantee the IWT's sustainability. Incorporating climate change-related clauses and provisions in a transboundary water agreement is crucial for sustainable water regulation, considering how climate change affects water resources. Climate-proofing enables agreements to be flexible and adaptable to changing climate conditions. Inclusively, treaties must address equitable and sustainable water use while preventing harm to other riparian states. Proper integration of climate change factors such as managing extreme events, maintaining the ecological balance, and monitoring aquifer and groundwater in the Indus Waters Treaty (IWT) (Zawahri, & Michel, 2018), will encourage cooperation and yield socio-economic, environmental, and political benefits, aiding in drought and flood management. The agreement may also contain shared data and information, joint institutions for managing watersheds, amendment and review procedures, and dispute resolution and conflict management to establish a conducive environment for cooperation and peaceful and stable relations between Pakistan and India.

Human activity, particularly in the 20th century, has become the primary driver of environmental changes on Earth, including climate change. The evidence of this change is apparent in global warming and the melting of glaciers, which has disrupted weather patterns and made precipitation patterns unpredictable. In river basins that span multiple jurisdictions, such changes have disrupted the water balance and altered the timing, intensity, and frequency of water flow, particularly in snow-dominated basins such as the Indus River Basin. This has resulted in decreased water availability and increased demand due to population growth, urbanization, and industrialization, potentially leading to food insecurity. Climate change has also made freshwater sources more vulnerable, and all major water sources on Earth have been impacted.

The British established Pakistan and India as separate states in 1947, but the division did not consider the hydrological demands of available water resources (Wolf, & Hamner, 2000). In 1960, the IWT was signed by both countries to address the distribution Indus waters (IWT, 1960). The Indus Waters Treaty (IWT) was established to delineate the entitlements and responsibilities of India and Pakistan regarding the utilization of rivers within their respective territories. Pursuant to this agreement, three western rivers were allocated to Pakistan and three eastern rivers to India, with India being granted authorization to utilize certain water from the western rivers. India was permitted to use some water from the western rivers. Unfortunately, the treaty was drafted without due consideration of the impact of climate change on water resources, resulting in a range of predicaments concerning water quantity, quality, and timing. The effects have been more pronounced in Pakistan, which has access to only one river basin to satisfy its water demands, compared to India, which has access to over a dozen.

In order to address the difficulties associated with water resources in the Indus River Basin, the Indus Waters Treaty (IWT) needs to be "climate-proofed" through the incorporation of provisions that consider climate change-related factors such as sustainable and equitable water use, management of extreme events such as droughts and floods, and data sharing and monitoring. By integrating these provisions into the treaty, it can adapt to changing climatic conditions and ensure sustainable water regulation. Additionally, implementing joint institutions for watershed administration, modification and evaluation procedures, and dispute-resolution mechanisms can encourage collaboration and peace between India and Pakistan. Ultimately, such measures can bring socio-economic, environmental, and political advantages to the region.

Research Questions(s)

This study claims the following research questions.

1) What are the potential impacts of climate change on the Indus Waters Treaty and the region's water resources?
2) Given the impending challenges posed by climate change, how can the Indus Waters Treaty be modified to ensure the sustainable management of water resources in the region?

Aim(s) and Objective(s)

This study endeavours to undertake a comprehensive assessment of the ramifications of climate change on the Indus Waters Treaty and the water resources of the Indus River Basin. The study's primary objective is to evaluate the efficacy of the treaty in managing water allocation between India and Pakistan and highlight the imminent threats and challenges climate change poses

to sustainable water resource management in the region. Moreover, the study aims to underscore the pivotal role of climate change mitigation measures in the Indus Waters Treaty and provide recommendations for necessary amendments to guarantee the sustainable management of water resources in the face of emerging climate change challenges.

Indus River Basin

The Indus River Basin, which India and Pakistan share, comprises six rivers: "the Indus, Jhelum, Chenab, Ravi, Beas, and Sutlej." The Indus River is the longest among its tributaries and passes through the Hindukash-Karakorum-Himalayan (HKH) Ranges, with most of its path in Pakistan (Shah, 2021). The basin covers an area of around 1.12 square kilometres, and its distribution among the four major countries is as follows: Pakistan has 47%, India has 39%, China has 8%, and Afghanistan has 6%. The total water flow in the basin is 171 Million Acre Feet (MAF), with 20% (34 MAF) in the eastern rivers and 80% (138 MAF) in the western rivers (Rossi, 2020). Due to various factors such as geography, politics, society, and economics, India and Pakistan are major stakeholders in the Indus River Basin (Karki, Shrestha, & Winiger, 2011).

IWT as Successful Treaty

The IWT stands as a noteworthy accomplishment in the realm of mediation, as it managed to bring together two historically hostile nations to reach a mutual resolution. Without this treaty, the likelihood of India and Pakistan experiencing heightened conflict over the last 60 years would have been significantly greater. Indeed, factors such as poverty, rampant diseases, environmental degradation, and social and political unrest have often served as catalysts for warfare. The fact that the treaty could manifest under such daunting circumstances is a triumph in its own right. The treaty has been the primary governing framework for the past six decades, even amidst numerous disputes and two full-scale wars between India and Pakistan (Michael, 2018). The treaty has efficaciously averted any potential outbreak of belligerence stemming from water-related issues. It has afforded ample openings for growth, irrigation, and economic expansion, which would have been considerably more arduous to realize without the treaty. Beyond the economic merits, the treaty has also forestalled any confrontations pertaining to water entitlements for over six decades. It is unequivocally evident that the Indus Waters Treaty has facilitated the progression of these countries and stands as a resounding triumph in the domain of water management (Qamar, Azmat, & Claps, 2019).

The treaty was formalized through the signature of "India's Prime Minister, Jawaharlal Nehru, and Pakistan's President, Muhammad Ayub Khan, with W.A.B. Iliff as the World Bank's representative" (Bhat). Upon approval in 1961, the treaty embracing of three parts, "the Preamble, 12 Articles and Annexes A to H (Thatte, 2008), entered into force retrospectively from April 1 1960." The Preamble of the Treaty establishes its fundamental objective as the requirement to "settle and define, in a spirit of amicability and harmony, the respective rights and obligations of each party with the use of these waters". In addition to other subjects, Annexes A through H encapsulate the following areas: Pakistan's agricultural utilization of specific tributaries of Ravi, India's agricultural utilization of the upper portions of the western rivers, a mechanism for resolving disputes, and India's capacity for generating hydropower and storing water.

Assessing the Effects of Climate Change on the IWT

The occurrence of climate change has had a widespread impact on various facets of human existence, particularly concerning the management of water resources. Within the context of the Indus Waters Treaty, which governs the allocation of water resources between India and Pakistan, the consequences of climate change have emerged as a significant area of apprehension. The Indus Basin depend heavily on glacier melt in the Western Himalayas (Archer, 2003). The mountain act as water reservoirs holding the water and releasing it over time. The precarious future of water supplies in the Indus Basin is attributed to the impacts of climate change. Projections derived from climate models reveal a bleak outlook in the short term, as water flows are expected to dwindle by the close of the current century. This is mainly attributed to the melting of the Himalayan glaciers, which is in line with the observed rise in temperatures and aligns with the anticipated effects of global climate change.

According to this study, the Indus Waters Treaty (IWT) is antiquated and does not adequately factor in the ramifications of climate change on the ecosystem. Even though climate change was not a primary consideration during the creation of the IWT, the evolving state of the rivers necessitates a reassessment of the treaty's provisions. While the ongoing Kashmir dispute may be a primary concern in India-Pakistan relations, the unique nature of the water conflict,

influenced by both environmental and anthropogenic factors, cannot be ignored.

Given the size of India and Pakistan, both countries consume a significant amount of water that cannot be easily replenished without sufficient precipitation and a proper hydrological cycle. However, with climate change, this cycle is being significantly altered, making the issue of water scarcity even more pressing (Wolf, 2007). While an outright war between countries over water resources is unlikely, disputes over transboundary resources often lack cooperationand can be a source of tension.

India and Pakistan face extreme water scarcity, which is expected to worsen (Mahato, Upadhyay,& Sharma, 2022). Hence, it is in the best interest of both nations to acknowledge their potential for collaboration and collaborate in making decisions that are advantageous to both parties. This is of exceptional significance given that the Indus Basin, "spanning a vast expanse of 1.12 million square kilometres and inhabited by 300 million people spanning Afghanistan, India, Pakistan, and China, heavily relies on glaciers in the western Himalayas" (Bhat, 2020). The glaciers serve as a natural storage system, gradually releasing water over an extended period. Moreover, melting these glaciers in the Western Himalayas contributes more than 40% of the basin's yearly water flow (Pritchard, 2019). Unfortunately, forecasts predict that the number of glaciers will decrease in the next 50 years, leading to an increase in river flow. This highlights the pressing need for India and Pakistan to address their water concerns cooperatively, particularly given the significant impact of climate change on the environment.

The lessening of glacial assets in the Indus Basin is predicted to cause a significant deterioration in water flow in the Indus River, the region's primary waterway (Rameez, 2019). Climate change is projected to substantially impact rainfall patterns, potentially resulting in more severe droughts or floods. Pakistan, in particular, is expected to experience a decrease in rainy days but an increase in intense precipitation events.

Access to freshwater is critical, and the antagonistic effects of climate change can reduce it, leading to conflicts. Therefore, it is essential to revise the Indus Water treaty to accommodate climate change, which has become an irreversible problem, and even if we tackle other factors, climate change will persist as a burden on society. Failure to adapt to changing conditions may render the treaty ineffective in fulfilling its water treaty vows.

Furthermore, climate change could negatively affect food security, people's lives, environmental safety and the economy. Although the IWT has been an effective negotiation tool, (Qamar, 2019), it has not stood without its ambiguities. The unforeseen threat of climate change puts the credibility of the IWT at risk (Nax, 2016). Therefore, it is crucial to update the treaty to address the evolving environmental conditions of waterways.

Why Should India and Pakistan be Concerned about Climate Change?

Climate change is a universal concern that affects all nations, including India and Pakistan, causing extreme weather patterns, rising sea levels, and frequent natural disasters. The impact is particularly significant in developing nations with large populations dependent on agriculture and natural resources for livelihoods. Thus, India and Pakistan must act to mitigate the effects of climate change. The adverse effects of climate change on their economies, societies, and environment make them highly vulnerable. Both nations should prioritize climate change mitigation measures to safeguard their well-being.

One of the most significant impacts of climate change on India and Pakistan is the increase in extreme weather conditions. This has led to more frequent and severe droughts, floods, and heat waves. These events have had a devastating effect on agriculture, significantly contributing to both countries' economies. Climate change is causing a decline in crop yields, which affects the food security of the people living in these regions. In addition, natural disasters like floods and cyclones have the potential to cause significant damage to infrastructure, housing, and businesses.

As per the "Intergovernmental Panel on Climate Change (IPCC) findings, freshwater systems are highly vulnerable to the impacts of climate change" (McCarthy, et al., 2001). This vulnerability stems from the projected increase in precipitation and variability, which is anticipated to heighten the risk of floods and droughts. These consequences, in turn, have the potential to undermine food security and disrupt water infrastructure, posing a severe threat to the region. The frequency and intensity of extreme weather events and cyclones are on the rise due to climate change. These events can cause significant damage to infrastructure, crops, and property, leading to economic losses.

The Himalayan mountains' topography and elevated altitudes have made it difficult to accurately assess the rate of glacial melting that sustains the Indus

River Basin. Nevertheless, the employment of hydrological modelling, in conjunction with glacier mass-balance computations, has predicted a decrease in the average water supply originating from the upper Indus, suggesting a troubling outlook regarding the glaciers (Immerzeel, et.al 2010). A significant portion of the glacial melt into the Indus Rivers tributaries occurs in the ablation zone, constituting 18% of the total flow (Winston, et al., 2013). The remaining 82% is assumed to originate from the melt of the winter snowpack (Winston et al., 2013). The shrinking glaciers are predicted to reduce the Indus River's flow by 8% by 2050, exacerbating the harmful effects of water scarcity (Nie, et al., 2021). The downstream area of the Indus Basin, with a population exceeding 300 million individuals whose livelihoods depend heavily on agriculture, relies heavily on the water flow of the Indus River as its primary water source. Besides, roughly one-third of the basin's replenishable water supply is derived from groundwater, with an expected average potential of 287 km3, equivalent to approximately 1,329 m3 per person.

Nonetheless, the advent of climate change is expected to decrease the availability of renewable water, with estimates projecting it to fall below 750 m3 per capita by 2050 (Nax, 2016). India and Pakistan depend heavily on agriculture, which requires significant water. Climate change is triggering variations in rainfall patterns, melting of glaciers, and erratic weather, leading to water scarcity in many parts of both countries.

Climate change is causing increased air pollution, which can lead to respiratory and cardiovascular diseases. Heatwaves and droughts can cause dehydration, heat stroke, and other health issues. India and Pakistan are home to a rich biodiversity of plants and animals. Climate change is causing habitat loss, which can lead to the extinction of many species. This loss of biodiversity can have significant ecological and economic consequences. India and Pakistan should be concerned about climate change due to its adverse impacts on water, agriculture, health, and biodiversity.

Emphasizing Climate Change Mitigation in the Indus Waters Treaty

The management of water in the Indus Basin by India and Pakistan is governed by the Indus Waters Treaty (IWT), which was negotiated in the 1950s and formally ratified on September 19, 1960 (Kakakhel, 2014). At the time, this treaty was considered one of the most effective means of resolving a longstanding water dispute that arose after the partition of the newly formed states of Pakistan and India. Looking back, it can be surmised that the most up-to-date knowledge of that era was employed in formulating the Indus Waters Treaty (IWT).

Nevertheless, within the last fifty years, "significant developments have materialized in hydrology, water resource management, transboundary watercourse management, conflict resolution, environmental monitoring methodologies, and data acquisition, storage, and sharing mechanisms as a result of technological and educational advancements." Furthermore, a new climate change model has developed, which was unknown at the time of the treaty's negotiation. Moreover, the water demand has risen due to population growth, enhanced living standards, and economic development (Vorosmarty, & Lammers, 2000). Conversely, climate change has engendered an environment of unpredictable and fluctuating freshwater availability, rendering freshwater a finite resource that has become a source of strife and discord among nations that share a mutual transboundary watercourse (De Chazournes, et.,al 2013). Severe meteorological incidents have introduced an additional layer of complexity to the problem, underscoring deficiencies in water resource management more emphatically than ever before. While other solutions may enhance water resource management, the primary solution entails reevaluating the Indus Waters Treaty (IWT) to integrate current knowledge, particularly in climate change, which is currently absent from the treaty. Failure to promptly address the gaps in the IWT could lead to tension and conflict between India and Pakistan, which may have significant consequences.

When the IWT was established in the 1950s, the focus was exclusively on the quantitative aspect of shared water, without accounting for the ramifications of climate change. Moreover, the critical role of groundwater and aquifers, instrumental in water utilization within the basin, was disregarded. The treaty's absence of provisions regarding environmental challenges. Given the comprehensive effects of climate change on all facets of human existence, accurately and promptly measuring its effects is imperative for an effective response. Integrating water mapping, data acquisition, and monitoring via GIS and Remote Sensing in the IWT will foster precise water analysis and response, thereby contributing to efficient management by riparian nations.

In managing complex transboundary water resources with insufficient bilateral monitoring and implementation mechanisms, establishing an external body agreed upon by all stakeholders is vital. This

approach will enhance transparency and responsiveness, leading to more efficient response strategies, especially during extreme floods. Incorporating current climate change knowledge into the Indus Waters Treaty is essential for ensuring climate resilience and sustainable management of water resources. This would serve as a valuable reference point for addressing future transboundary water disputes between India and Pakistan. Prioritizing sustainable management of the Indus River basin through treaty amendments is crucial for the benefit of all stakeholders involved.

Conclusion

The Indus Water Treaty has been commendable for resolving water disputes between Indus riparians. However, the evolving circumstances are expected to pose challenges to its future effectiveness. Despite the strained relationship between the two nations, the treaty has endured. Nevertheless, it fails to account for the predicaments associated with pollution upstream and downstream, as well as the far-reaching consequences of climate change. The adverse effects of climate change are indisputable, with a significant reduction in water levels being a primary repercussion. This will result in diminished water availability for agricultural and livestock purposes, impaired water quality, and alterations in typical weather patterns. In nations like India and Pakistan, where water serves as the lifeblood of the populace, climate change and the heavy dependence on water resources will have substantial implications for ecological, social, and economic systems. These effects can be particularly pronounced in countries with a history of political and social conflicts. Therefore, this study presents various recommendations for enhancing the Indus Waters Treaty, focusing on collaboration, communication, and education. The most effective approach to realizing these goals is to restructure the responsibilities of the Indus Commission and reevaluate the extent of current agreements.

The issue of climate change and its predicted consequences drive the need for a thorough revision of the current structure of the Indus Waters Treaty (IWT). It is no longer sufficient to rely solely on technical and technological solutions developed by engineers and government officials. Instead, a new river management agreement must consider different social groups' diverse experiences and perspectives regarding the Indus waters. Effective management of transboundary water resources necessitates cooperation between nations in the basin, as this involves building trust and engaging in constructive interactions. While UN declarations on water management are welcome, it is crucial to take concrete and effective steps towards fair and sustainable water cooperation that involves the participation of local communities at all levels. With increasing water demand due to populace growth, urbanization, industrialization, higher per capita consumption, and greater losses associated with climate change, it is clear that the changing conditions, especially those related to climatic pressures, are likely to pose significant challenges to the IWT shortly. Therefore, renegotiating the IWT to adapt to these changing circumstances and to establish a more integrated system would benefit all parties involved and is imperative.

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