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Hydro-Politics under Stress: A Quantitative Investigation of Water Scarcity and India–Pakistan Tensions (2015–2021)

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Abstract
Keeping in view the intensifying geopolitical tensions and the water shortage in South Asia, this research highlights the relationship between the hydro-political conflict and water availability among India and Pakistan (2015-2021). Although there are various theories in the existing literature on environmental conflict but only a few studies have examined the phenomena quantitatively. This study does not find a significant correlation between water scarcity and conflict intensity, but a strong positive correlation between disagreement frequency and conflict severity ($r = 0.935$, $p < 0.01$) through time series data and Pearson Correlation test. This result suggests that the environmental degradation is not the only driving factor of the conflict but the strategic mistrust and the framing of the issue play a significant role. Rooted in realism and securitization theory, the study tells how nationalist narratives, such as the ones after Pulwama incident, shapes conflicts. By challenging environmental determinism, the research proposes a dual-theory framework and emphasizes the role of perception, diplomacy, and institutional trust in conflict prevention.

Keywords: *Water scarcity, hydro-political tensions, Indus Waters Treaty, conflict intensity, securitization theory, classical realism, transboundary water governance, strategic mistrust, climate-induced stress, environmental diplomacy*

Introduction

The history between India and Pakistan goes way back, and it has taken many turns since both countries gained independence. The birthday rivals have been engaged in various wars like the 1965 war and the Kargil conflict solely over the matter of Kashmir. But in the recent past, the world has witnessed that there is a change in the

reason why these wars occur because water is now one of the primary reasons for the escalations between India and Pakistan (Ahmed & Baloch, 2024). The origins of water tensions date back all the way to the post-Partition times itself, when India had temporarily cut off the supply of water to Pakistan from the Upper Bari Doab Canal in April 1948—a first instance that water had been employed as a geopolitical tool (Sattar & Bhargav, 2019). Reading through the history of the two countries there are glimmers of hope for the diplomatic initiatives taken by both the countries, of which Indus Water Treaty is one of the strongest. While it has been stabilizing force for years now but in the recent past, especially since 2015, the two countries have been indulging in escalations that are very powerful compared to their past.

The principal cause of this change is the climatic change-induced increase in water scarcity that has led to erratic weather patterns resulting in fluctuation in quantity of rainfall every year and glacial melting. Population growth in South Asia has also led to an increase in the demand for natural resources, and primarily water for agricultural purposes. These major drivers in turn affect the availability of water and contributes primarily to augmented water scarcity (Suhail, 2023). Pakistan, as of 2021, dipped below the absolute water scarcity of 500 m^3 per capita, a red line for an agriculture economy. India is similarly reaching stress levels in some river basins, like the Ganges and Yamuna, even though its national average is bigger (Ali, 2023). Coupled with all these is the existence of strategic distrust among Pakistan and India, with each of the nation's dreading their adversary's step resulting in a gigantic obstacle in cooperation and negotiation capable of neutralizing the effect of mounting water shortage. This mutual harmony between water shortage, climatic stress and strategic distrust defines India-Pakistan relations post-2015 and its very presence threatens to ignite perilous degrees of hydro-political tensions between the two countries. Therefore, it is clear now that water is no longer an everyday resource but a subject of controversy and competition and a focal point in realizing the South Asian dynamics (Mahmood, 2025).

This transformation of water from being an environmental and technological problem to one of national security does not confine itself to South Asia alone. Transboundary river basins across the world, like the Nile (Egypt–Ethiopia), Tigris–Euphrates (Turkey–Iraq–Syria), and Jordan River (Israel–Jordan–Palestine), have seen a heightened politicization of water. Academics and global institutions now see water diplomacy as a critical pillar of regional peace and conflict avoidance (Stimson Center, 2021; Eco Peace Middle East, n.d.; Madani et al., 2021). The region of South Asia is still among the most vulnerable because it has weak institutions, unsettled bilateral tensions, and climate vulnerability.

Much of the available literature on India-Pakistan has extensively examined the historical nature of India-Pakistan water conflict but none of the studies are based on empirical data and have evaluated the interaction between different magnitudes of water flow and magnitude of such tensions between both nations. Furthermore, the majority of studies are based on legal-institutional approach or narrative history only, but not on the rigorous statistical analysis that is used to test empirically the central hypothesis: does water scarcity actually cause conflict? therefore, this article is going to examine the linkages between water shortage and India-Pakistan hydro-political tensions in 2015-2021 using a quantitative research design, drawing on secondary data. By performing a Pearson correlation test of time-series data of water availability and frequency of conflict,

this paper makes an evidence-based verdict regarding a common assumption: that reductions in water availability have direct causal effects on rising geopolitical tension. Addressing this assumption is significant in policy, theory, and regional peace.

Literature Review

Water governance has a crucial function in comprehending the character of international world or predicting any future water-related conflicts. Prior to 2015 researchers in previous literature started acknowledging that nowadays water is not just an issue of environment but it is becoming like such a commodity whose degeneration or improvement can either end up potentially challenging escalation and de-escalation of conflict among riparian nations, becoming a major subject of foreign policy of states. This repositioning of water as a matter of national security is more put in context among the greater theoretical discussions of international relations, such as realism and securitization theory, which conceptualize states as rational actors defending their strategic interests. With the military clash between Pakistan and India and the tribal conflicts in East Africa, it can be seen that water scarcity is playing a pivotal role in shaping the global dynamics. Such instances, giving meaning to self-serving state action give us an arena in which we can test concept of realism and securitization. (Wolf, 2007)

Kreamer (2012) in his article introduces water as a security risk and at the same time an aspect of a State's foreign policy especially where he traces areas sharing water bodies. In support of his claim, he goes back to World War II, when the British Royal Airforce employed water in trying to defeat the Germans by bombing dams and ultimately leading to loss of infrastructure and water scarcity. In such a circumstance, he brings into prominence the relations of water between India and Pakistan in South Asia particularly along the Indus. Kreamer is in consonance with the realistic school of thought that the absence of cooperation and trust between states sustains conflict by playing with meager resources as an instrument for promoting a conflict and exercising political supremacy.

As stated earlier, water is not just a source of increasing tensions but also employed by states in maintaining peace and stability. A prime example is the Indus Water treaty being one of the most significant and long-standing bilateral treaties when it comes to water diplomacy. It has been credited with its resilience and resistance during times of escalation between India and Pakistan and the scholars have valued its role towards the stability of the region. In summary, it has delivered, structured mechanisms to water allocation and opened doors towards communication between the two nations along with the roles towards agricultural and economic stability in the long run (Sahni, 2006).

Despite its success, the treaty is encountered with several challenges that researchers are now focusing on. The most significant of them is the strategic distrust, and bellicosity of the present Indian government. Though new issues like climate change, use of groundwater, and degrading water quality and that the treaty could not place emphasis on food security and sustainability are beyond its original agenda which is a serious flaw in its architecture. Moreover, unilateral developments in water infrastructure raise further security issues that ultimately result in military tensions. According to Ali and Khuhro, (2021) that the complicated and difficult character of transboundary water management cannot be managed by the existing institutional framework

based predominantly on bilateral thinking. The mentioned issues highlight the necessity to reassess the validity and effectiveness of the treaty in meeting looming water issues (Ali & Khuhro, 2021).

They are compounded by the increased political assertiveness of India and the bilateral nature of the treaty, which tends to provide Pakistan with few diplomatic and legal options.The IWT, despite its strength, is thought by scholars to be afflicted with structural asymmetries. The higher riparian power, India, has more strategic room and infrastructural capability, while Pakistan still depends on the western rivers. This discrepancy, combined with climatic change and hydrological volatility, raises the risks to Pakistan.

There is more perception regarding how tensions between Pakistan and India regarding the water have been rising after 2015 particularly over Indian hydropower projects that is perceived by Pakistan as India attempting to breach the Indus water treaty by constructing water infrastructure. India has insisted that the deal be canceled, and Pakistan introduced it as an issue of "water jihad." Political nationalism has raised things further. All this combined with the effects of climate change and military actions like the Uri and Pulwama attacks made water a strategic and symbolic weapon in their wider geopolitics of conflict (Ranjan, 2015). This overlap of national concerns with nationalist and military interests has added more securitization to the narrative of South Asian transboundary water management.

Additionally, international examples demonstrate that South Asia is not the only region affected by these concerns. Egypt-Ethiopia Nile Basin, Tigris-Euphrates (Turkey-Iraq-Syria), and Jordan River (Israel-Palestine-Jordan) transboundary water conflicts have also become intensely politicized, part of an emerging global pattern in which shared water resources are becoming geopolitical flashpoints (Zeitoun & Mirumachi, 2008). South Asia's vulnerability, unlike in these cases, is being aggravated by weak institutions, unresolved territorial claims, and the accelerating impacts of climate change.

While it is simple to find plenty of literature arguing political implications of water conflicts and the Indus Water Treaty, few research works comprise a comprehensive quantitative assessment of the effect of water scarcity on hydro-political tensions between India and Pakistan, particularly in the recent post-2015 period of rising nationalism and climatic change. That is specifically a concern because hydrological, climatic, and conflict datasets are more readily available. There is a crying need to know how diminishing per capita water resources—most notably in Pakistan, which has breached the absolute threshold of 500 m^3—will have a direct bearing on conflict intensity or frequency of diplomatic augmentation. Additionally, current literature does not strive to reconcile how new drivers like lawfare, hybrid warfare, and digital securitization are recalibrating conventional water conflict dynamics. Thus, the current research contributes to the growing body of work by outlining a quantitative examination of Indo-Pak hydro-political tensions during 2015-2021. It tries to empirically evaluate the correlation between water scarcity and political conflict based on measurable factors.

Theoretical Framework

This research applies the lens of two theoretical schools that encompass securitization theory and traditional realism. Both theories fully explain how the connection between water scarcity and hydro-political tensions exists. Securitization theory responds to the question of how the riparian States convert water scarcity into an issue of nature to one of national security? State behavior in the international anarchy order is explained

through realism. Korab-Karpowicz (2010) illustrates Morgenthau's realism theory as a conflict for power and a race for achieving national interests. He is of the view that because of the presence of anarchy in the international community, the states have to prioritize security instead of seeking cooperation for the survival of the state. It can be seen under Indo-Pak competition that both the riparian states are seldom found cooperating on the Indus and rather compete with one another over the shared water making the water a source of dispute. India's construction of water infrastructure such as the Kishanganga and Pakal Dul dam projects is read by Pakistan not as development initiatives, but as strategic steps that have the potential to manipulate water flows, subjecting Pakistan to hydrological vulnerability. This encapsulates the realist argument that international institutions and agreements, including the Indus Waters Treaty (IWT), tend to be undermined by power politics whenever state interests intervene. The writer also emphasizes the realist concept of "Pragmatism" as opposed to "Political moralism". This idea points towards the truth that being an upper riparian country, India exercises political dominance over Pakistan's water and uses it in the most effective manner. While Pakistan's excessive dependency on legal system under Indus water treaty has not been that productive. This is what sets up the reason why states have to do what is required in their self-interest instead of doing what is morally right. While the realist idea rationalizes the Indo-Pak competition as a power struggle but realist-materialism analysis overlooks the process of change of such issues as water scarcity in a security issue through public opinion and debate. To fill in this gap of the realism concept, this study uses the securitization approach to explain how security matters are socially constructed by the states.

Securitization theory argues that an issue becomes a security concern not inherently, but when it is presented as such by influential actors and accepted by a relevant audience. Under the securitization lens, it is evident that Pakistan is framing water scarcity as a threat to survival and national security. For example, in 2018 Prime Minister Imran Khan, during his second national television address, asserted that "Our debt today stands at Rs30,000 billion but the biggest problem we currently face is the water crisis". This speech act was a securitizing act since it escalated water scarcity to a prime threat to national security from a developmental issue. In prioritizing water even over fear in the hierarchy of national security, Khan's statement was the perfect illustration of how threat construction is made possible by political discourse. Furthermore, state-led campaign for the building of the Diamer-Bhasha Dam is the classic definition of securitization. Through this campaign, the state was the referent object—what needed to be secured—and the public was the audience whose active approval was being solicited. Major public actors, such as military leaders, judges, and celebrities, ran speeches, fundraising, and media events, all of which contributed to the securitized construct that water scarcity faces Pakistan's future. In Miller's (2015) view, these campaigns are the best illustrations of how security threats tend to be constructed by consensus and symbolic action rather than objective conditions themselves.

Together, securitization theory and realism provide a fuller description of Indo-Pak water tensions. Realism describes material competition for strategic resources and state action zero-sum rationality in an anarchic world. Securitization theory, on the other hand, describes discursively and socially constructed nature of threat construction, and how scarcity of water gets dramatized in national discourse to authorize extraordinary measures.

Collectively, these theories account for both the actions and words of the two states. Realism accounts for India's aggressiveness, Pakistan's defensiveness—both maximizing national interest—and securitization theory accounts for how these actions are legitimized in the local and global spaces. This two-theory prism eliminates hydro-political tensions reductionism: they aren't necessarily cubic meters of water disputes but inscribed with concerns of identity, sovereignty, power, and survival.

Methodology

The research employs a quantitative, longitudinal, and correlational study design to investigate the statistical correlation of water scarcity and Indo-Pak hydro-political tensions between 2015 and 2021. The research design is correlational, not causal, in which the research does not intend to establish that water scarcity leads to conflict per se but instead aims to determine whether there is a statistically significant correlation between the two events. This is specifically in conflict-environment analysis where numerous intervening variables may complicate causality. The research analyzes whether or not a connection exists between per capita water availability decline and the intensity and frequency of water conflict between the two riparian nations based on time-series data. Secondary sources from which information for use in the research was retrieved were available for free. Annual renewable freshwater resources per capita for India and Pakistan (cubic meters per capita) were collected from World Bank database of World Development Indicators. Hydro-political conflict data were collected from a variety of sources of credibility, including news reports from newspapers, government reports, and foreign policy think tanks like foreign Crisis Group and Observer Research Foundation. Given the intensity of conflict, diplomatic consequences, and frequency of conflict, the data set was coded to produce a rating of conflict intensity between 1 (low tension) and 5 (high tension), as well as the quantity of water-related conflict incidents reported each year.

Upon collection, data was tested using Pearson's Correlation test to determine the linear correlation between the independent (water availability) and dependent variables (conflict intensity score and water dispute incidents). The test of choice for parametric testing is that the involved variables are continuous and presumed to be normally distributed, as required by the Pearson's test assumptions. Apart from that, descriptive statistics were used to compute the mean, minimum, maximum and standard deviation of data that had been gathered. SPSS (Statistical Package for the Social Sciences) Version 25.0 was used in analysis owing to its capability in handling small sets of data and appropriateness for simple inferential statistics

There are some methodological constraints that need to be mentioned. First, the sample is quite small, consisting of only seven years' worth of data (2015–2021), which may restrict statistical power and generalizability of results. Second, the inherently subjective process of conflict intensity scoring—albeit with efforts to achieve inter-coder reliability—cannot be wholly excluded. Third, the use of secondary data, in this instance media reports, also poses the risk of reporting bias and uneven event coverage between years or regions.

In addition, the analysis does not control for other possible confounding factors like monsoon variability, construction schedules at dams, or politics in home nations that individually can affect either water availability

or diplomatic tensions independently. Future analysis has the potential to utilize multivariate regression or time-series analysis with finer-grained datasets.

However, while the study has these constraints, it does present a promising first approximation of quantifying the relationship between hydro-political tensions and water scarcity in perhaps the world's most unstable transboundary river basin.

Key Findings

The descriptive statistics of 2015-2021 data also yield interesting information on the evolution of water scarcity and hydro-political tensions between Pakistan and India. A critical analysis of the descriptive statistics informs that there is a steep declining trend in the per capita availability of water for both nations each year, but it is more critical in the case of Pakistan relative to India. Pakistan's per capita average water availability was 241.95 m^3, which improved from an all-time high of 253.12 m^3 in 2015 to the all-time low of 229.67 m^3 in 2021. It is below the absolute water scarcity line of 500 m^3, which signals the scale of its water crisis. At the same time, India had a consistently higher average of 1053.51 m^3 per capita, ranging between 1022.48 m^3 and 1088.83 m^3 during the study. Although India still stays above the threshold of scarcity, the consistent decrease in the amount of available water indicates increased pressure on current water resources in both nations, especially with increasing populations and climatic uncertainty.

At the same time, the mean conflict intensity measure was 4.00 and had a standard deviation of 1.00, reflecting largely intense and consistent tensions across the seven years. Water dispute events occurred between 0 and 3 times a year, averaged 1.86, and had a standard deviation of 1.07, so while conflict events were not incessant, they were a common and prominent feature of bilateral relations. These facts collectively are in favor of the hypothesis that geopolitical tensions have been increasing with decreasing water availability and provide the basis for a statistical test of the relationship between the two variables.

Table 1: Descriptive statistics

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Pakistan_Water_m3_per_capita	7	229.6663815	253.1169244	241.952550471	8.4965004762
India_Water_m3_per_capita	7	1022.483394	1088.835336	1053.51429957	24.090153806
Water_Dispute_Events	7	0	3	1.86	1.069
Conflict_Intensity_Score	7	2	5	4.00	1.000
Valid N (listwise)	7				

Pearson’s correlation analysis, however, showed no statistically significant association between the degree of conflict or dispute occurrences and water availability (for either country). Water availability in Pakistan and conflict severity were correlated with r = -0.355 (p = 0.435) and r = -0.420 (p = 0.348) for India, respectively. Both

are negative, weak, and not statistically significant. The number of water-related disagreement events and conflict intensity scores were shown to be strongly positively correlated ($r = 0.935$, $p < 0.01$), which is interesting since it suggests that perceived tension levels are significantly shaped by the frequency of conflicts. In short, the results present:

1. A very strong positive correlation between Water_Dispute_Events and Conflict_Intensity_Score ($r = 0.935$, $p = 0.002$), which is statistically significant at the 0.01 level.
2. A moderate negative correlation between Pakistan_Water_m3_per_capita and Conflict_Intensity_Score ($r = -0.355$, $p = 0.435$), which is not statistically significant.
3. A similar moderate negative, non-significant correlation between India_Water_m3_per_capita and Conflict_Intensity_Score ($r = -0.420$, $p = 0.348$).

Table 2: Pearson's correlation test

Correlations

		Pakistan_Water_m3_per_capita	India_Water_m3_per_capita	Water_Dispute_Events	Conflict_Intensity_Score
Pakistan_Water_m3_per_capita	Pearson Correlation	1	.993**	-.187	-.355
	Sig. (2-tailed)		.000	.688	.435
	N	7	7	7	7
India_Water_m3_per_capita	Pearson Correlation	.993**	1	-.247	-.420
	Sig. (2-tailed)	.000		.594	.348
	N	7	7	7	7
Water_Dispute_Events	Pearson Correlation	-.187	-.247	1	.935**
	Sig. (2-tailed)	.688	.594		.002
	N	7	7	7	7
Conflict_Intensity_Score	Pearson Correlation	-.355	-.420	.935**	1
	Sig. (2-tailed)	.435	.348	.002	
	N	7	7	7	7

. Correlation is significant at the 0.01 level (2-tailed).

It is evident from the results that there is a significant and strong positive correlation among the Water_Dispute_Events and Conflict_Intensity_Score, emphasizing that the more accurate indicator of hydro-

political stress is event frequency rather than absolute scarcity. This highlights that increased conflict severity is caused by the political management and frequency of conflicts, even when decreasing water availability creates a backdrop for tension. With its emphasis on the importance of speech, perception, and diplomacy above unprocessed environmental data, this understanding is particularly helpful for policy formulation and theoretical conceptualization.

From a theoretical perspective these findings suggest the existence of resource cooperation, which is undermined by geopolitical competition and strategic mistrust when the issue is considered through the realist lens. Although there are sluggish changes in availability, quite often disputes indicate a tendency towards zero-sum positing. The presentation of water as a national security issue within the securitization paradigm may be seen in crises like the Pulwama-Balakot crisis in 2019 and the Uri crisis in 2016. The claim that the diminishing resources are an existential threat by Pakistan supports this argument. The intensity of the conflict was highest not in the years of worst scarcity but in the years when there were major events in the world. This highlights that although water scarcity provides a background setting, bigger security problems act as triggers. Their role in magnifying perceptions is also justified by the fact that the number of dispute events is strongly related to conflict scores.

There are a few reasons why no strong correlation between water scarcity and hydro-political conflict would be found here. To begin with, the brief sample period of only seven years (2015–2021) necessarily limits the statistical strength of the results. If the horizon were longer, the longer-term trends could be more easily identified, and more powerful statistical tests could be used to search for them. Second, the analysis depends on yearly-level aggregation of data, which can dampen peak short-run peaks or passing spikes in both water availability and the intensity of conflict. Therefore, a serious water shortage for several key months may be tension-generating, but this can be cancelled out in year statistics and, thus, underestimates its real potential effect. Third, scarcity and conflict causality are seldom linear and unqualified. South Asian hydro-political tensions are influenced by a combination of factors such as unresolved border disputes, political discourse based on nationalism, militarization, and changes in regional alignments. Such diplomacy-and security-oriented factors instinctively take precedence over the environmental issues so that it becomes impossible to determine the role the availability of water plays. Finally, even the methodology used can be limited, most significantly in being forced to subjectively code conflict intensity. Even after attempts at standardizing scores, interpretation of political statements' and media portrayals' meaning may be tainted with researcher bias, compromising data consistency.

Conclusion

This study was conducted to empirically find out whether water scarcity plays any significant purpose in hydro-political tensions between India and Pakistan between 2015 and 2021. A quantitative approach and the correlation test (Pearson) showed that there is no statistically significant relationship between the severity of the conflict and the per capita water availability in a year. The occurrence rate of water-conflict incidences and the severity, however, were observed to be very highly and statistically significantly correlated. This suggests that, whereas water scarcity creates a structural background of stress, the development of conflict is

determined by the manner in which water problems are managed and politically framed instead of the scarcity per se.

Importantly, the research contributes to the literature because it stresses the fact that hydro-political stress is more directly linked to perception, diplomacy, and the frequency of the occurrence of events, rather than to water scarcity as an independent variable. This study criticizes the deterministic assumptions of the traditional theories of environmental conflict and argues a complicated understanding of the conflict dynamics.

Moreover, the findings highlight the urgent need for depoliticized water governance frameworks that prioritize long-term basin-wide cooperation over short-term strategic posturing. Future study should use finer-grained temporal resolution and qualitative insights to further our understanding of hydro-politics in volatile regions, given the limits of a short time frame and annual data. Incorporating stakeholder interviews, media analysis, and sub-annual hydrological data could help reveal how specific events, narratives, and political decisions mediate the link between scarcity and conflict. Conflict prevention and collaboration in South Asia will require a sophisticated grasp of how politics, narratives, and perceptions interact with resource dynamics as climate change intensifies environmental stress.

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