WATER CONFLICT REVISITED: FRESH WATER SCARCITY AS A KEY PREDICTOR OF CONTEMPORARY ARMED CONFLICT

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Abstract

For over 30 years, scholars have investigated the direct relationship between fresh water scarcity and armed conflict using a wide variety of analytical techniques. However, this body of literature has yet to provide a comprehensive empirical analysis that supports such a relationship for both interstate and intrastate conflicts. The ensuing report fills in the gaps of the existing discourse by closely reassessing the variables under consideration and employing a cross-sectional, time-series analysis of 172 states across the globe. The results from numerous negative binomial regression tests provide evidence supporting a statistically significant positive relationship between water scarcity and armed conflict; states having lower population percentages with access to improved water sources experience more instances of armed conflict – both interstate and intrastate. These findings prompt the conclusion that water scarcity is a significant predictor of armed conflict. As fresh water resources become increasingly limited across the globe, this study will continue to gain relevance, offering evidence to inform decisions about armed-conflict prevention in the international community.

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1. Introduction: Contemporary Water Conflict

Water conflict is not a new revelation; the term refers to water's ability to influence, change, and even prompt armed conflict, and it has gained attention from thought leaders and the international community for the last half-century. An abundance of scholarly literature has been dedicated to studying this concept's historical instances; fully-funded think tanks are devoted to tracking and investigating water's involvement in international security and conflict[1]; and countless media outlets have consistently covered stories of water-related disputes. So why bring even more attention to the subject?

While instances of water conflict persist in modern times, concern for other threats to peace, such as terrorism and nuclear proliferation, have overshadowed those presented by water scarcity. States within the international community preoccupy themselves with concerted efforts to curb other, arguably more tangible, threats to security, and action items to address water challenges fall secondary. Meanwhile, the onset of the Syrian Civil War in 2011 followed years of severe drought, and disputes across the Brahmaputra, Nile, and Tigris Rivers persist today among many other water-influenced conflicts.

This study seeks to bring water conflict to the forefront of political discourse. It confronts the potential challenges of water scarcity by investigating water's direct relationship to various types of contemporary armed conflict. It ventures beyond the analytical limits of past thought leaders to provide compelling evidence for the water-conflict link for both interstate and intrastate armed conflict. To do so, the proceeding analysis will address the following research question: Do higher levels of water scarcity within a state[2] lead to more intrastate and interstate armed conflict? More specifically, do

[1] Pacific Institute, http://pacinst.org/about-us/mission-and-vision/.
[2] State: defined as a sovereign entity with territorial boundaries in the international community.

states in which lower proportions of the population have access to fresh water sources engage in more armed conflict than states with a higher levels of fresh water access?

This question arises at a time when fresh water, an indispensable resource to states and their civilian populations, has become increasingly limited across the globe. With exponential world population growth, especially since the mid-20th century, the global human consumption of water has begun to surpass the sources of water available. Naturally, the competition for this limited resource may be perceived as a threat to both national and individual survival—ultimately leading to armed conflict. Throughout history, armed conflict has risen due to numerous causes including religious hostilities, territorial disputes, ideological differences, and economic competition both within and between states. Perhaps water scarcity also deserves consideration as one of the prominent sources of conflict.

The preceding question is critical due to the increasing relevance of water scarcity in modern times and the subsequent neglect in addressing the challenges it presents. As a guide for the ensuing report, it provides the opportunity to evaluate modern-day causes of conflict. Statistical evidence supporting the propensity for armed conflict over water resources will provide a concrete basis to predict, evaluate, and potentially prevent this type of crisis in the future.

2. Literature Review and Theoretical Framework

Over the last three decades, a growing amount of literature has been dedicated to the investigation of the relationship between water scarcity and conflict[3]. Scholars and world leaders alike have referred to scarcity of water and other resources as known threats to national security and development. Even so, analysts have yet to empirically test this relationship. Most water-conflict literature addresses the issue through basic observations, case studies, and comparisons, rather than explicit empirical measurement and analysis.

2.1 Proponents of the Water-Conflict Link

Environmental scientist Peter Gleick (1993) heeds water scarcity's impact on armed conflict through historical observation. He argues that water shortages tend to lead to competition over the limited resource, which ultimately threatens national security. He also claims that water resources have been employed as "instruments of war" (79).[4] Gleick elaborates on such claims by providing examples of how water scarcity may cause and/or escalate conflict; these examples include conflicts over access to specific water sources, deliberate attacks on water systems during war, use of shared water resources for political and military reasons, military expansion driven by goals of conquering others' waterways, uneven use of waters both regionally and internationally, and finally, the increased demand for water in general as population grows.[5] Ultimately, Gleick provides historical impetus to measure water's impact on armed conflict but fails to collect the data necessary to conduct an empirical analysis of the water-conflict relationships he hypothesizes.

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[3] Gleick 1993, Jury & Vaux 2007, Wallensteen & Swain 1997, Singh 2016, Perkins 2017, Wolf 1999.

[4] Peter H. Gleick, "Water and Conflict: Fresh Water Resources and International Security," *International Security* 18.1 (1993): 79-112, accessed May 31, 2017, http://www.jstor.org/stable/2539033?seq=1.

[5] Ibid., 80.

To complement Gleick's piece, Wallensteen and Swain (1997) assess the water scarcity situation in terms of water's increased usage due to exponential population growth. They emphasize fresh water's influence on conflict historically, and they make predictions for the future based on this relationship. They also detail the world population increase of three billion from 1940 to 1990 and the subsequent 100 percent increase in per capita water usage.[6] The comparison of these numbers allows them to conclude that a large number of countries have been pushed into situations of "water stress" or "chronic water scarcity," and are prone to internal conflict.[7] Although the observations made by Wallensteen and Swain seem logical, like those of Gleick, they lack concrete empirical backing.

Lonegran and Brooks (1994) provide a complimentary argument, contending that states cannot survive "without access to life-supporting water," referring to the conflict in the Jordan River Basin as an example.[8] They also predict the continuation of water scarcity into the future as population increases while water supplies diminish, potentially leading to an international water crisis. Though they provide projections that are beyond the scope that this particular study can address, their predictions add substance to the empirical analysis of water-conflict in the near past.

Some scholars address the water scarcity-conflict link under a broader environmental concept, referring to water scarcity as one of many negative outcomes of climate change – a topic much too broad to cover in this targeted analysis. While it may be helpful to refer to water-related issues in the climate change category for purposes of

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[6] Peter Wallensteen and Ashok Swain, *Comprehensive Assessment of the Freshwater Resources of the World, International Fresh Water Resources: Conflict or Cooperation?* (Stockholm: Stockholm Environment Institute, 1997), 2.

[7] Ibid., 8.

[8] Stephen C. Lonergan and David B. Brooks, *Watershed: The Role of Fresh Water in the Israel Palestinian Conflict* (Ottawa: International Development Research Center, Electronic Edition, 1994), Foreword.

conceptualization, the examination of water scarcity in this light could diminish its viability as an independent inflictor of armed engagement. Singh (2016) also groups water scarcity under the climate change umbrella in his study assessing the most relevant modern-day threats to peace and security in Southern Asia. His arguments support the cause for conflict induced by limited water resources, as he refers to the "California Water Wars" of the past, along with the recent drought in South Asia that has provoked instability (1).[9] Singh also references heightened geopolitical tensions in South Asia due to water shortages and subsequent competition over rivers and aquifers.[10] While his piece alludes to water shortages and their implications, his arguments spiral into an extensive climate change case study that centers on one portion of the world.

In a very recent study, Perkins (2017) examines the relationship between water availability and civil conflict. Her report presents a solid quantitative logit-analysis, followed by specific case studies, in a bold attempt to demonstrate a direct water-conflict relationship. This is one of the only attempts to conduct advanced quantitative analysis within the water-conflict literary repertoire. Perkins acknowledges that water scarcity sits as a subcategory of environmental scarcity (i.e. climate change), but recognizes the need to shed light on the topic as an independent variable. While no statistically significant relationships result from her analysis, Perkins argues that water may be an "indirect contributor" to conflict due to the social situations it promotes, rather than a reliable predictor of conflict.[11] Also, she focuses on both non-violent and violent campaigns of

[9] Abhaya K. Singh, "Climate Change and Conflict for Water a Threat to Peace and Security in South Asia," *Climate Change and its Implications on Crop Production and Food Security* (2016): 1-12, accessed May 30, 2017, https://www.researchgate.net.

[10] Ibid., 1.

[11] Sailer E. Perkins, "The Drier the Land, the Higher the Chance?: An Examination of the Relationship Between Water Availability and Civil Conflict and its U.S. National Security Implications,"

conflict through an ethnic lens, leaving room for further analysis in which general interstate and intrastate armed conflict serve as the primary dependent variables.

2.2 Water and Cooperation?

Aaron Wolf (1999), perhaps the only prominent scholar to take the opposing argument to that of the aforementioned scholars, provides further reason to examine the water scarcity-conflict relationship. He assesses water conflict by studying various cases throughout history and finds that only seven minor disputes have occurred due to water access within the last century, while no wars have been fought over water. Meanwhile, he claims, "149 water-related treaties" were created in the same time period (251).[12] This would suggest that instead of eliciting conflict, limited water sources actually lead to international cooperation. Wolf even claims that war or armed conflict caused by water is not rational, effective, or economically viable, while similar interests along waterways override the potential for conflict.[13] To support such claims, Wolf provides an extensive dataset examining various conflicts in the last century, making his argument quite convincing; however, he fails to present any sound conclusions based on advanced statistical testing methods. In other words, the relevance and validity of his evidence are questionable. Further, Wolf fails to consider the possibility that tension over limited water resources may not be the sole cause leading to war, but can exist as one of many factors in any armed conflict.

(BA Thesis, University of Mississippi, 2017), accessed May 31, 2017. http://thesis.honors.olemiss.edu/806/.

[12] Aaron T. Wolf, "'Water Wars' and Water Reality: Conflict and Cooperation Along International Waterways," *Environmental Change, Adaptation and Security* (1999): 251-265, accessed May 31, 2017, http://link.springer.com/chapter/10.1007/978-94-011-4219-9_18.

[13] Ibid., 251.

2.3 Other Predictors of Armed Conflict

In addition to the literary discourse outlined above, it is critical that this report identify all major predictors of war to apply as control variables in a thorough and accurate analysis. Bremer (1992) does not reference lack of fresh water resources as a concrete cause of armed conflict in his study, but does provide a plethora of other sources of war supported by empirical evidence. After conducting bivariate and multivariate tests on a variety of potential causes of armed conflict, he finds that contiguity of state territory, the absence of a more advanced economy, and the absence of a democratic polity increase the likelihood of war, listed in order of importance.[14] Hence, when measuring for the impact of water access on armed conflict, it is crucial to control for the following factors: geographic location, economic situation, and level of democratization. Though militarization of the state did not play a statistically significant role in Bremer's multivariate analysis, it must be controlled for as Bremer suggests it is widely accepted as an indicator of war. Although Bremer's study only examines the dyadic relationships between states, while failing to include third parties or intrastate conflict, his test results provide an important basis for measuring any variable's impact on armed conflict.

Altogether, a severe lack of reliable, clear-cut statistical evidence exists in the literature covering water's impact on conflict. Two starkly different stances have been taken regarding the relationship between water scarcity and armed conflict, and scholars have yet to properly distinguish this relationship at both the intrastate and interstate levels of conflict. Therefore, it is necessary to reassess the water conflict concept with a fresh eye

[14] Stuart A. Bremer, "Dangerous Dyads: Conditions Affecting the Likelihood of Interstate War," *Journal of Conflict Resolution* 36.2 (1992): 234-249.

and with the proper statistical analysis tools in order to display the true association between these two variables in an unbiased, cross-sectional, international view.\

3. Conceptualization of Water Scarcity and Conflict

A central goal of this piece is to provide a comprehensive reassessment of contemporary water conflict; to do so, a fresh conceptualization of the main variables—water scarcity, intrastate conflict, and interstate conflict—is required. Prior to devising appropriate, detailed concepts for the variables, it is helpful to identify the overarching topic or area of conceptualization in order to assess the level of the concept more efficiently. For instance, the independent variable of concern, water scarcity, can be placed within the broader category of limited resources, while both intrastate and interstate armed conflict can be placed under the umbrella term of armed conflict or warfare. The relationship under consideration (between these variables) can be considered a specific example of warfare incited due to the Earth's limited resources.

With this basic understanding, one can now consider more detailed conceptual definitions for these variables. Apart from concepts like democracy, water scarcity's conceptual definition seems widely agreed upon. Postel (2000) provides an adequate definition, citing water scarcity as the condition in which "human consumption of water exceeds levels necessary for sustainability."[15] Sustainability refers to the ability to conserve natural resources by avoiding depletion. In this case, one is concerned with sustainability in terms of water—maintaining the amount of water necessary for human consumption without damaging or diminishing the water supply. If water resource

[15] Sandra L. Postel, "Entering an Era of Water Scarcity: The Challenges Ahead," *Ecological Applications* 10.4 (2000): 941-948, accessed June 31, 2017, http://onlinelibrary.wiley.com/doi/10.1890/1051-0761(2000)010%5B0941:EAEOWS%5D2.0.CO;2/abstract.

sustainability is breached due to over-consumption of fresh water, damaging of water sources, or geographic situation, water scarcity manifests. This sustainability-breaching occurrence of water scarcity can be observed through indicators like "groundwater depletion, low or nonexistent river flows, and worsening pollution."[16] Though directly measured using these indicators, the presence of water scarcity can also be observed through instances of extremely low percentages of the human population in any given area with access to fresh water, since such scenarios result from the measures mentioned above.

In some cases, water scarcity is so specifically defined that important portions of conceptualization are forgotten; Santos Pereira, Cordery & Iacovides (2009) outline the common definition of water scarcity as "a situation when water availability in a country or in a region is below $1000m^3$/person/year." [17] While this conceptualization is easily operationalized, it does not take into consideration various components that characterize water scarcity, mentioned in Postel's concept above. Other conceptualizations of water scarcity are too broad, specifically when referring to this concept simply as water shortages or the lack of sufficient fresh water sources for survival. While these definitions are easy to understand, they are missing a certain specificity that allows for operationalization.

The conceptualization of the variables on armed conflict can be kept quite simple. Interstate conflict is conceptualized as a conflict fought between two or more sovereign entities in the international community. In other words, when the governments of two or more states engage in any type of warfare with one another, it can be referred to as an interstate conflict. This type of conflict has become quite rare in modern times, as it is

[16] Ibid.

[17] Luis Santos Pereira, Ian Cordery, and Iacovos Iacovides, *Coping with Water Scarcity: Addressing the Challenges*, (Springer Science & Business Media, 2009), Electronic Edition.

uncommon for one state to declare war on another. Armed conflict within the boundaries of a single state are much more common.

Intrastate conflict can then be conceptualized as a conflict fought between multiple entities or groups within a single state's boundaries; such conflict may exist between a state's government or supporters of the governmental regime and a non-state entity against the regime, or it can contain two entities not directly connected to the stance of the state's governmental regime. Intrastate conflict is largely fought within the boundaries of the territory in question (if any). For example, perhaps a specific territory contains a resource (i.e. water) desired by multiple parties; if these parties opt to engage in armed conflict, it will most likely occur in the specific territory with the desired resource, many times within one state. One must also consider the difficulties of measuring territorial boundaries when considering disputes over land and/or resources, which aren't always widely agreed upon—hence the armed conflict. To ensure all territorial disputes are captured in this study, intrastate armed conflict will contain any ground conflict containing at least one non-state entity. These conceptual definitions of armed conflict are inspired by the definitions listed in the Human Security Support Project.

To properly operationalize armed conflict, this analysis will employ a combination of the conceptualizations above with the more specific definition for armed conflict created by Uppsala University's Department of Peace and Conflict Research: "An armed conflict is a contested incompatibility which concerns government and/or territory where the use of armed force between two parties . . . results in at least 25 battle-related deaths."[18]

[18] Department of Peace and Conflict Research, "UCDP/PRIO Armed Conflict Dataset" (2014), accessed June 5, 2017, http://www.pcr.uu.se/research/ucdp/datasets/ucdp_prio_armed_conflict_dataset/.

2. Hypothesis

The debate persists over water's role in predicting armed conflict; scholars have yet to present convincing empirical evidence that supports or refutes this relationship. While Wolf claims that freshwater scarcity evokes cooperation,[19] he fails to consider the possibility that competition over water resources could add to the likelihood of conflict in addition to numerous other variables—it may not necessarily be the only cause, but one that escalates the likelihood even in the slightest way. For the preceding reason, and due to the overwhelming evidence supporting a positive water scarcity-conflict relationship, the following hypothesis will be tested:

> Within a state, the lower the population-percentage with access to improved fresh water sources, the more likely the state will experience both interstate and intrastate armed conflict. In other words, access to improved water sources (as a percentage of the total population)[20] will hold a statistically significance negative relationship with armed conflict.

3. Data and Methods

To operationalize the concepts outlined above, it is critical to employ reliable data sources that present valid and reliable measurement and more importantly, to provide an adequate sample size. Since there are several extensive, well-known data collection projects with indicators relevant to both water scarcity and armed conflict, this study will utilize existing datasets. The main independent variable, which is water scarcity, can be determined by examining the proportion of the population with access to fresh water

[19] Aaron T. Wolf, "'Water Wars' and Water Reality: Conflict and Cooperation Along International Waterways," *Environmental Change, Adaptation and Security* (1999): 251-265, accessed May 31, 2017, http://link.springer.com/chapter/10.1007/978-94-011-4219-9_18.

[20] See Section 4 (Data and Methods) for further operationalization.

sources. Therefore, this study will utilize the World Bank Databank indicators measuring the percentage of the total population with access to improved water sources, from 1990 to 2015 in 172 different countries (n = 172). This indicator will allow simple interpretation of a water-conflict relationship where lower percentages of water access influence the existence of armed conflict.

While this operationalization may seem simple and does not outline specific requirements for the point at which a state reaches a condition of water scarcity, it provides detailed statistical measurements for a large sample over 25 years. Many other options for water scarcity indicators exist, including the Falkenmark Water Stress Indicators, the Water Availability Index (WAI) by Meigh et al. (1999), the Index of Water Scarcity by Heap et al. (1998)[21], and the United Nations Environmental Programme (UNEP) Water Scarcity Index. These datasets present interesting information and contribute greatly to the body of literature concerning water scarcity. However, none are suitable for this particular study, as some focus only on larger regions instead of single states, and most others are too specifically aligned to the purpose of their original assigned study to be generalized to the context of this analysis. Thus, the World Bank's water access indicator quantifies the water scarcity concept in a way that best fits this analysis.

There are fewer options for the operationalization and data collection related to armed conflict. The most well-known indicators of armed conflict can be found in two main datasets: The Correlates of War Project (COW) and the Department of Peace and Conflict Research UCDP/PRIO Armed Conflict Dataset. Both contain extremely detailed

[21] Amber Brown and Marty D. Matlock, "A Review of Water Scarcity Indices and Methodologies," University of Arkansas: *The Sustainability Consortium* (2014): 1-19, accessed June 30, 2017, https://www.sustainabilityconsortium.org.

documentation of the armed conflicts that have existed throughout history. While the COW project is impressive, its classification of armed conflict is not easily divided into interstate conflict and intrastate conflict. Further, the components of the dataset are difficult to interpret at times and are not set up in a convenient fashion, using dyad years and actual conflicts as the units of analysis. Employing this dataset would require extra manipulation of the data to make it fit into the parameters of the intrastate and interstate armed conflict conceptualization described in this analysis.

Therefore, this study will utilize the UCDP/PRIO Armed Conflict Dataset, which provides the following information on intrastate and interstate armed conflicts: geographic location, conflict year, parties involved, start and end dates, conflict type, etc. This dataset does include additional types of conflict including internationalized (conflicts that involve a third party outside of the territory in which the dispute takes place) and extrasystemic (between an entity within a state and a non-state entity within another state). The conceptualization of intrastate conflict in the section above and the relaxed definition of state territory allow for, 1) internationalized conflict to be placed in either of the interstate or intrastate conflict categories depending on the types of groups involved, and 2) extrasystemic armed conflict to be absorbed into the intrastate armed conflict classification.

The dependent variables in this study will be constructed as 1) number of distinct interstate armed conflicts in any given year, and 2) number of distinct intrastate conflicts in any given year, from 1990 to 2015 (to correspond with the available data on fresh water accessibility). The UCDP/PRIO Armed Conflict dataset provides relevant indicators to represent both dependent variables. As touched upon in Section 3 (Conceptualization of Water Scarcity and Conflict) it is crucial to keep the definition of armed conflict as simple

and comprehensive as possible. For this reason, the study refrains from examining the conflict magnitude (i.e. number of fatalities). Instead, the focus is placed on the number of conflicts in any given year. Since the objective of this research initiative is to examine whether limited fresh water resources lead to instances of armed conflict, the magnitude of conflicts does not necessarily matter when concerned initially with the impetus of conflict.

The complete dataset covering the impact of water scarcity on armed conflict contains 16 cases for 172 state entities. Each case contains the following variables: state entity, year (1990-2015), number of interstate armed conflicts, number of intrastate armed conflicts, and a variety of controls. The following variables are widely accepted as key indicators of armed conflict and are included as control variables in the analysis: military expenditure (as a % of military expenditure), GDP per capita (in US Dollars), Freedom House Score (indicator of civil liberties and political rights), status as a major power, and location (Europe, Middle East, Asia, Africa, or Americas). Due to the changing perceptions and technology related to warfare over time, years (1990-2015), representing the progression of time, must also be controlled for in this analysis.

A multivariate regression analysis is utilized to test the impact of water scarcity, along with the control variables, on the quantity of both interstate and intrastate armed conflicts from 1990 to 2015 in 172 countries. Since the dependent variables of armed conflict hold discrete, non-negative properties and result in an excess of zero values, an event-count procedure model through negative binomial regression is employed.

4. Key Findings: Water Scarcity as a Predictor of Conflict

The data in the regression analyses, collected from a sample of 172 countries, include independent variable data representing fresh water resource availability—the percent of the state population with access to improved water sources—as well as military expenditures (as a percentage of total government expenditure), GDP per capita, Freedom House Score, region, and years from 1990 to 2015. The amount of interstate armed conflict and intrastate armed conflict each year from 1990 to 2015 within the selected countries were regressed on the preceding explanatory variables. Due to the presence of multicollinearity, one of the regional control variables, Europe, was removed to reduce the presence of highly correlated predictors from the model. Table 1 displays the results from the negative binomial regression analysis.

Four different models were run to provide a full view of the data analysis. Two models for each dependent variable—one bivariate regression without control variables and one multivariate regression with control—help determine both the relevance of intervening variables and the magnitude of water scarcity's impact on conflict. All four models provide impetus to conclude that water access does impact both interstate and intrastate armed conflict. Model 1 takes the form of a simple negative binomial regression with only the interstate armed conflict dependent variable regressed on the main explanatory variable, population-percentage with access to improved water sources. Model 2 takes the same form as Model 1, but substitutes intrastate armed conflict as the dependent variable. Model 3 incorporates all potential control variables outlined above as explanatory variables alongside the water scarcity independent variable to explain interstate conflict.

Model 4 also incorporates all potential control variables with the water scarcity variable to explain intrastate conflict.

Table 1:
Water Scarcity and Armed Conflict Results, 1990-2015

Explanatory Variables	Model 1 (Interstate)	Model 2 (Intrastate)	Model 3 (Interstate + Controls)	Model 4 (Intrastate + Controls)
Intercept	0.097***	0.58***	-4.66***	-0.53
	(0.02)	(0.07)	(1.22)	(3.47)
Water Access	-0.092***	-0.01***	-0.002***	-0.007***
	(0.03)	(0.07)	(0.00)	(0.001)
GDP Per Capita			0.00	0.00
			(0.00)	(0.00)
Military Expenditure			0.004***	0.011***
			(0.001)	(0.002)
Freedom House Score			0.001	-0.032***
			(0.003)	(0.008)
Region				
Africa			-0.012	-0.06
			(0.01)	(0.04)
Americas			0.01	-0.03
			(0.01)	(0.03)
Asia			-0.05**	0.23***
			(0.02)	(0.04)
Middle East			0.024	0.116**
			(0.02)	(0.05)
Time			0.002***	0.001
			(0.00)	(0.002)

***Significant at .001, **Significant at .01, *Significant at .05

The results in Table 1 provided support for the hypothesized relationship between water scarcity and armed conflict. In both Model 1 and Model 2, the water access

coefficients are negative and statistically significant, meaning that higher percentages of the population with access to improved water sources result in decreased armed conflict, both interstate and intrastate.

It is important to note the difference between the first two models and Model 3 and 4, which incorporate a variety of potential control variables. In the latter two models, the multivariate regression analyses incorporate statistically significant control variables. Military expenditure (as a percentage of total government expenditure) has a statistically significant positive impact on both interstate and intrastate conflict, and thus, is rightfully included in both models. Freedom House Score, indicating the level of political rights and civil liberties for a state, has a statistically significant negative impact on intrastate conflict but not on interstate conflict. This result is to be expected since political rights and civil liberties are mainly domestic concerns that would prompt quarrels within a state, rather than between states. Ultimately, these factors must be incorporated when regressing variables on the intrastate armed conflict dependent variable.

In both models, region also has a significant impact; Asian states are inherently less likely to engage in interstate conflict than states in all other regions, but more likely to engage in intrastate conflict than states in all other regions. Similarly, Middle Eastern states are usually more likely to engage in intrastate conflict than most other regions. Therefore, region is rightfully controlled for in both Model 3 and Model 4. Finally, a year variable to indicate the progression of time is controlled for, and as expected, it has a positive and statistically significant relationship only with interstate conflict. Unexpectedly, as time progresses, interstate conflict increases by 0.002 instances of conflict; this is contrary to the initial prediction that interstate conflict has decreased over time. Perhaps the 25-year

contemporary time-frame indicates a small uptick in interstate armed conflict in more recent times.

With these control variables in place, the magnitude of the impact water access has on armed conflict decreases in both models, indicating that indeed, other variables play a role in predicting armed conflict. More importantly, while holding these variables constant, a statistically significant relationship is observed between water access and both interstate and intrastate conflict. For every one-percentage point increase in the population with access to improved water sources, interstate conflict decreases by 0.002 conflicts, and intrastate conflict decreases by a slightly larger 0.007 conflicts. While the magnitude of the impact may not be very large, these relationships are statistically significant. Therefore, the null hypothesis, stating that no relationship exists, can be rejected to tentatively conclude that water scarcity (the absence of water access) is a statistically significant predictor of both interstate and intrastate armed conflict.

Figure 1 and Figure 2 provide a visual representation of the regression analysis conducted to display the slight but significant relationship between water access and armed conflict. Figure 1 displays a negative trend line for interstate conflict, and Figure 2 displays a negative trend line for intrastate conflict – both reflecting the correlations displayed in Model 3 and Model 4 respectively.

Figure 1: Interstate Conflicts vs. Water Access

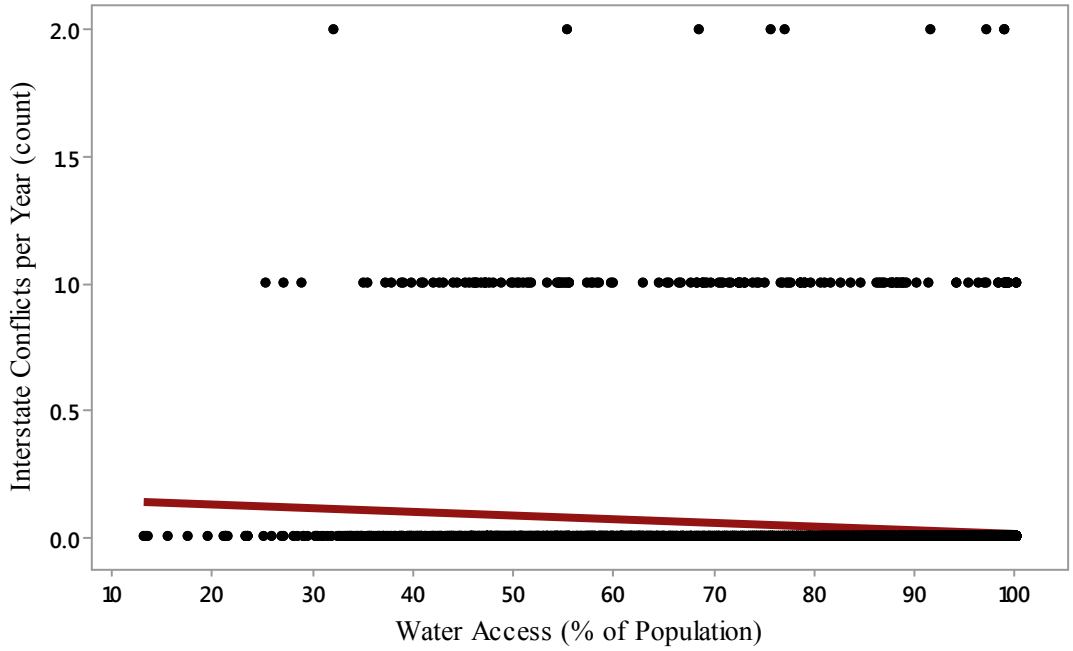
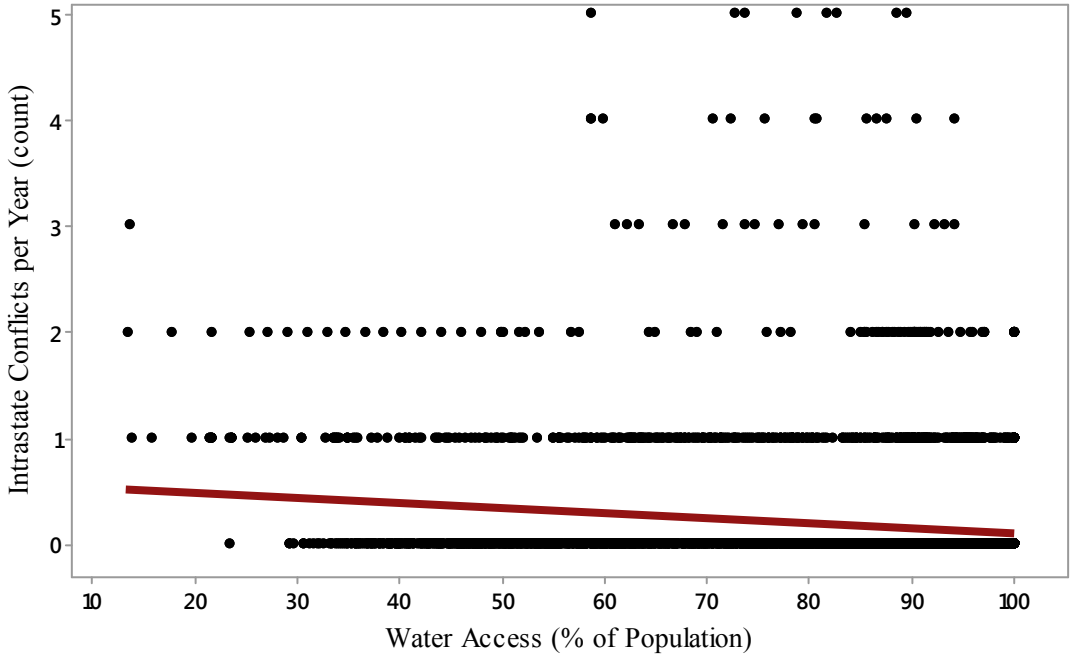


Figure 2: Intrastate Conflicts vs. Water Access



5. Significance and Conclusion

The negative binomial regression results indicate that, after accounting for various controls, population accessibility to improved fresh water sources holds a statistically significant negative relationship with both intrastate and interstate armed conflict in the past two decades. The affirmation of this study's central hypothesis provides various important implications. First, it adds merit to the arguments made by Gleick (1993); Lonergran and Brooks (1994); Wallensteen and Swain (1997). It provides reason to heed their warnings of increasing water scarcity in recent decades that will likely make it difficult to maintain high levels of access to improved water sources and could lead to tension and ultimately, armed conflict over water. The results indicating a legitimate water-conflict relationship also present new challenges for proponents of water-cooperation, like Wolf (1999), who believe that coordination of water source access leads to cooperation, rather than conflict. After the preceding empirical assessment, these cooperation assertions are refuted at the state-level analysis for both intrastate and interstate armed conflict.

The results of this study also provide evidence that the control variables of military expenditure, Freedom House Score, region, and years impact armed conflict significantly and must be considered in studies involving an armed conflict dependent variable. The statistical relevance of these specific variables indicates broader relationships in which economic development, militarization, levels of freedom, and democracy influence the likelihood of conflict. More importantly, this study contributes one more factor that political scientists must account for when testing for the causes and likelihood of armed conflict—fresh water availability.

In addition to offering a compelling argument for water conflict, this report

provides a strong empirical basis on which scholars can expand armed conflict research. One area of opportunity for further examination may be the time period under consideration. The year range selected for this type of water-conflict study may influence the conceptualization and operationalization of the main independent and dependent variable terms, and thus, would most likely impact the final results. In other words, the examination of other time periods may present different results, not only due to the pure difference in time, but because the perceptions surrounding water scarcity and armed conflict tend to shift over time and have varied at different points in history. Even the selected discourse on the topic, thus far, has presented conflicting conceptual and operationalized definitions for the variables at hand. For this same reason, the data manipulation and analysis performed here may not be replicated easily.

Time poses a unique challenge for water conflict analysis since water data seems to be available only for only the most recent decades in the 20th and 21st Centuries, while data on armed conflict extends back hundreds of years. Hence, this analysis presents solely a modern picture of the water scarcity-armed conflict relationship, rather than an historical account. Those who attempt to extend the historical framework of this analysis will be challenged to find new ways to operationalize and collect data for water scarcity to fit the era. As the world's current perception of water scarcity changes, those in the future will be challenged to do the same.

The results presented here provide an empirical framework for testing water-conflict relationships of all kinds; this study fills the gaps of existing water-conflict discourse and takes the first steps in assessing this complex association with statistically sound evidence. Further research might address the severity of the armed conflicts under

consideration and whether it is attributable to the water scarcity source. With the initial water-conflict link distinguished, future exploration of armed conflict severity may be pursued confidently, perhaps by examining the number of deaths or longevity of conflict.

Ultimately, the large amount of discourse and attention gained by the water-conflict phenomenon is warranted. Fresh water scarcity certainly cannot be ignored as a relevant predictor of both intrastate and interstate armed conflict. This analysis provides an empirical basis for informed decision-making regarding the world's fresh water resources, to be utilized by the leaders, organizations, and citizens of states who must cope the possibility of increased water scarcity and ensuing armed conflict in the years ahead.

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7. Curriculum Vita

Amy Feldman was born December 5, 1992 in Amherst, NY. She is currently a Master's Degree candidate at Johns Hopkins University, where she studies Government Analytics. Her work has focused largely on the Statistical Analysis concentration for the program through courses like Advanced Quantitative Methods, Measurement for Government Analytics, Time Series Models and Forecasting, and Survey Methodology. While thriving in this coursework, Amy has pursued a variety of research studies focused on international conflict and cooperation, including the preceding report on water scarcity and armed conflict. She has also completed significant research in U.S. politics, specifically focused on voter turnout in non-presidential elections.

The foundation of Amy's research career was laid during her undergraduate coursework at Elmira College. While pursuing a Bachelor's Degree in Political Science and International Studies, she assumed a three-year research assistantship, supporting the political science department with research and data collection in areas of international relations, democratization, and economic and political development. Amy also served as an academic fellow for an introductory course in international relations. Her undergraduate capstone thesis investigated the effects of renewable energy sources on unemployment rates at the international level. As a culmination of her undergraduate coursework and achievement in political science research, Amy was selected for Elmira College's Pre-Graduate School Internship. Through this program, she produced an original research topic and conducted data analysis to examine the impact of geography on the implementation of political institutions. Amy presented her empirical findings at the 2015 Pi Sigma Alpha Undergraduate Conference.

While pursuing an advanced degree at Johns Hopkins University Zanvyl Krieger School of Arts and Sciences, Amy works full-time as the Managing Director of Research at BarkerGilmore, a boutique executive search and consulting firm in Fairport, NY. While her line of work is outside her area of academic focus, Amy's career has allowed her the opportunity to employ advanced statistical analysis and survey methodology while managing business intelligence projects and advising clients on legal department assessments. Amy also spearheaded the creation and implementation of BarkerGilmore's annual In-House Counsel Compensation Report—a comprehensive analysis of compensation survey data for lawyers at different organizations in a variety of industries.