# The impact of privatization of WASH services on post-disaster civil unrest: an assessment.

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Bachelor Thesis

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BAP: Environmental Causes of Conflict

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## Abstract

With increasingly frequent and more extreme disasters related to the climate crisis, the resilience of companies supplying water, sanitation and hygiene (WASH) services will be tested more often. A cut in services such as drinking water has instant and severe implications for people in the supply area with potential for arising grievances and unrest. By combining theories of conflict studies with WASH management and resilience literature, this paper studies the resilience of different forms of water management and its social implications - a nexus that has been widely neglected. It is hypothesised that an increasing number of disasters lead to more civic unrest and that public-private partnerships (PPPs) mitigate this relationship most efficiently. The results of the zero-inflated negative binomial regression model do not indicate a statistically significant association between WASH privatisation and unrest after disasters. Nonetheless privatisation levels in WASH services are highly significant for predicting social unrest outside the disaster context. Based on the data available, this paper concludes that PPPs lead to less unrest compared to exclusively private or public management.

**Key Words:** WASH resilience, water privatisation, social unrest, disaster response

**"*All models are wrong, but some are useful.*"[1]**

**(George Box)**

[1] Box, G. E. (1976). Science and statistics. *Journal of the American Statistical Association*, *71*(356), 792.

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## I. Introduction

As the devastating water war in Darfur shows, water as a resource has developed into something that wars are fought over (Starr, 1991). This highlights the dilemma that a basic need such as water is now a competitive and excludable resource in many parts of the world which is further exacerbated by the intensifying effects of climate change. The problems of water scarcity are also addressed by the Sustainable Development Goals 6.1 and 6.2 which aim at providing clean water, sanitation and hygiene services (WASH) for everyone by 2030 (UN, n.d.). Despite this ambitious goal and increased effort, one in three people, especially in rural areas, still do not have access to drinking water.

Within this dynamic, water management[2] becomes the focal point which determines the supply and regulation of that challenged public good. Water supply is characterised by competing and repeating waves of privatisation and nationalisation over time (Prasad, 2007). Both forms of management have their strengths and weaknesses. Whereas public companies can lack efficiency, private ones are said to prioritise profit over the equal distribution of public goods (Perard, 2009). The difficulty of water management arises from the fact that due purely to the nature of the resource itself, service providers find themselves in a monopolistic position (Wackerbauer, 2008). High fixed costs for the supply make two or more competing networks in the area unprofitable. Due to substantial sunk costs, the water market remains uncontestable (Bhattacharya & Banerjee, 2015). Over the past years, the effort to build and maintain WASH services has been impeded by more frequent and severe disasters due to the climate crisis (Johannessen et al., 2014). On the basis of this dilemma, this research investigates the following question:

*How does the degree of private sector involvement in WASH management influence the likelihood of civil unrest after water-related disasters?*

[2] The following terms are used interchangeably throughout this paper: water management, water company, company regulating water supply. Unless further specified, they refer to the supply of WASH services on a public-private spectrum.

Following this research question, this paper argues that both private and public companies are less resilient which leads to water scarcity and the development of unrest after disasters. It is suggested that a mix of both represented by public-private partnerships (PPPs) is more resilient and decreases the likelihood of unrest development. This argument is tested on cases from eight Southamerican countries ranging from 1996 to 2018, making use of a negative binomial regression.

From a humanitarian point of view, access to clear drinking water and sanitation should be guaranteed at any time, but it is even more crucial in situations of crisis, for example in the aftermath of floods and storms (United Nations, n.d.). In the short term, a resilient water management system that withstands these pressures reduces financial investments needed for rebuilding infrastructure. In many cases where location-specific economic, social and ecological factors were disregarded, inappropriate planning has led to water shortages, upstream pollution as well as contamination of water and flash floods after increased rainfall (Johannessen et al., 2014). According to Sachs, the sufficient provision of water services is also a driver of economic growth in the long-term (World Health Organisation, 2001). Therefore, the need for improvement of water management and increasing efforts for resilience-building also follow an economic imperative. Despite the socio-economic relevance of this problem, the disaster response-civil unrest nexus with regard to water management has been widely neglected, as mentioned in the following literature review. This paper continues with presenting the theoretical argument, the methodology and empirical findings as well as a short conclusion with implications.

## II. Literature Review

This study is located within two fields of research, conflict studies and water resilience. Although each field addresses the problem supported with theories and empirical findings,

there is a significant gap at the intersection which has been largely neglected. It refers to the disaster resilience of water companies as motivated by private and public incentives and has different implications for society. Each of the two fields of research including relevant studies approaching this nexus and their limitations are presented below. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), resource management that is capable of adapting to increasing pressures of the climate crisis is a research area that still lacks attention and understanding (United Nations Educational, Scientific and Cultural Organisation, 2019).

**Water Conflict**

The first field of literature this study addresses is (water-related) conflict studies. Wolf et al. (2005) argue that water conflict is a crucial determinant in the development of conflict. They state that water being the main driver of so-called water conflicts is relatively rare, but pressure on the availability of the contested resource contributes to low-level tensions among the public more frequently. This highlights the fact that water contributes to conflict development more regularly and in more subtle ways than what is observed when studying water wars per se. Kelly et al. (2015) provide an insightful case study in which they illustrate how climate-related groundwater depletion led to exponential numbers of rural depopulation in Syria in the late 2000s. They argue that these rapid demographic changes in combination with severe multi-year drought and mismanaged water policies further contributed to the instability across the country and to the uprisings in 2011.

Böhmelt et al. (2014) provide a more nuanced assessment of the water-conflict association. They examine water through a lens in which society plays a crucial role in determining the development of conflict rather than the absence and presence of water. Nonetheless, their argument starts from a point of water scarcity which sees supply as a

natural phenomenon. Their approach neglects the agency of water companies in channelling natural water resources into water supply that is publically available.

Despite the fact that numerous studies have been looking into the impact of water management in the context of crisis (see Weinthal et al., 2011; Schillinger et al., 2020), most arguments originate from and are therefore restricted to the context of severe and violent conflict. Whereas Schillinger et al. (2020) focus on armed conflict, Weinthal et al (2011), addresses the role of WASH services as part of peacebuilding after wars which assumes a high level of severity. These approaches wrongly disregard a vast number of instances in which lower levels of unrest had severe and long-lasting impacts on society as studies moving beyond conflict indicate: By expanding the notion of conflict to civil unrest, Nardulli et al. (2015) provide a valuable contribution to the existing literature on the impacts of water-related disasters. Rather than basing their argument on the mere presence and absence of (water) resources (like Galaz, 2005; Tyner & Will, 2015), they point towards institutional determinants for conflict development such as government effectiveness (see also Gizelis & Wooden, 2010). Nonetheless, Nardulli et al. (2015) do not further explore how the role of companies supplying basic needs like water and their crisis behaviour can influence the potential for conflict.

**Resilience in Water Management**

The second field of research that this study touches is water governance, and more specifically the subfields of water management and water resilience. In order to build resilience for services providing drinking water and sanitation, Oates et al. (2014) argue that we need to reframe the relationship of ‘climate change and WASH services’ to “WASH governance in an era of climate change” (p.V) which highlights the paradigm shift towards resilience development.

According to Howard et al. (2010), resilience is an interplay of management and technology in place. They argue that resilience for drinking water, for example, varies substantially between larger facilities with more human and financial resources and smaller facilities without much coping capacity. Furthermore, suppliers in an urban environment are less exposed to shocks than in a rural or even communal setting (Howard & Bartram, 2010). Lack of resilience in sanitation infrastructure due to inappropriate management, on the other hand, can be overcome more easily by technological improvements (Howard et al., 2010). They further state that climate-related threats can be a driver of innovation in a place where it is long overdue. Nonetheless, all of these aspects depend on political and public support for certain projects as well as financial resources available which are closely tied to the form of water management (Perard, 2009).

**Ownership of WASH Services**

After centuries of institutionalised water supply, there is neither theoretical nor empirical consensus on which kind of water management brings more financial, social, and ecological benefits (Lall et al., 2008). While some have argued against privatisation as "accumulation of dispossession" (Harvey, 2010, p. 33) after the misguided, neoliberalist expansion in the 1990s, others regard public management as government failure lacking efficiency (Bakker, 2013). Many scholars have been arguing for the partial benefits of either form of management with contradicting findings (Perard, 2009; Wackerbauer, 2008).

Over the past two decades, public-private partnerships (PPPs) have been emerging in an effort to combine the efficiency of private suppliers with the welfare aspect of public companies (Hodge & Greve, 2016; Bhattacharya & Banerjee, 2015). The authors state that, despite joint effort, PPPs remain highly controversial with regard to accountability and increased prices, and a more comprehensive understanding of their performance is still

lacking. According to Auzzir et al. (2014), PPPs can improve disaster resilience, especially in developing countries by supporting the efficient delivery of public services in a situation of crisis. Their argument is limited to general investment strategies as part of disaster management and does not account for the complexity of water supply systems (as mentioned above, p. 3). In a more specific, water-related context, Johannessen et al. (2014) argue for the general involvement of PPPs in order to also improve WASH resilience. However, they do not specify contexts of application and further observe companies in isolation without accounting for potential social impacts. Due to the recent emergence of PPPs in the 1990s, their behaviour in terms of WASH resilience is studied only marginally (Whiteside, 2016), and potential social implications for conflict development even less (Johannessen et al. 2014).

Due to these inconclusive results regarding all three forms of management, influential actors like the World Bank (WB) have adapted a more differentiated stance over time which advocates location and context-specific applications of management forms (Prasad, 2007). Nonetheless, there are still no clear indicators on what form of water management is more suitable for particular contexts (Johannessen et al., 2014). Kirkpatrick et al. (2006), for example, argue that the economic capacity to build water resilience varies, especially in developing countries. They acknowledge the importance of socio-economic and political factors when implementing water management structures but neglect the importance of company resilience.

**Bridging the Gap with a Systems View**

Both literature on water management and water conflict indicate the importance of company resilience and societal implications of water cuts respectively but observe each factor in isolation. This approach bridges the knowledge gap in each field by linking the above mentioned debate on water management to the development of unrest. By investigating the

implications of WASH ownership in the setting of water-related disasters, this paper adds a crucial dimension to the continuing discussion on water companies as well as determinants of conflict onset.

Over the past years, the scholarship has moved towards a systems view on water resilience (Oates et al., 2014). The majority of the literature on WASH resilience investigates the phenomenon in isolation and neglects the broader system in which resilience (failures) take place (e.g. Johannessen et al., 2014). Instead, it is argued for a broader examination of the ecological, economic and social determinants. This does not just refer to context-sensitive application of management as mentioned above but also the awareness of potential areas that will be affected by collapsing water management. Therefore, this paper explores the societal consequences of water (mis)management which has not been explored yet from a systems view standpoint and will become more important over the coming years (Matthew, 2010). They argue that water companies are expected to find themselves exposed to water shocks more frequently with increasing pressure on local water reservoirs and livelihoods of the citizens as a consequence of climate change.

This study contributes to the understanding of conflict dynamics by exploring how the type of ownership of water companies influences low-level pressures and onset factors such as civil unrest. The hypothesis is tested on countries in South America which is a geographical region that has been largely overlooked in WASH resilience and water-related conflict studies. The case selection is further explained in the ‘Sample Selection’ part below (p.17). The aim is to contribute to the literature on indicators for case-specific application by exploring the impact of different management forms through the lens of crisis management and disaster resilience. This research outlook provides a significant contribution to the understanding of resilience of water companies, especially in context of climate shocks which become more frequent. With

water representing a human right and a challenged basic need, findings in this area have become more valuable in supplying the public with this resource.

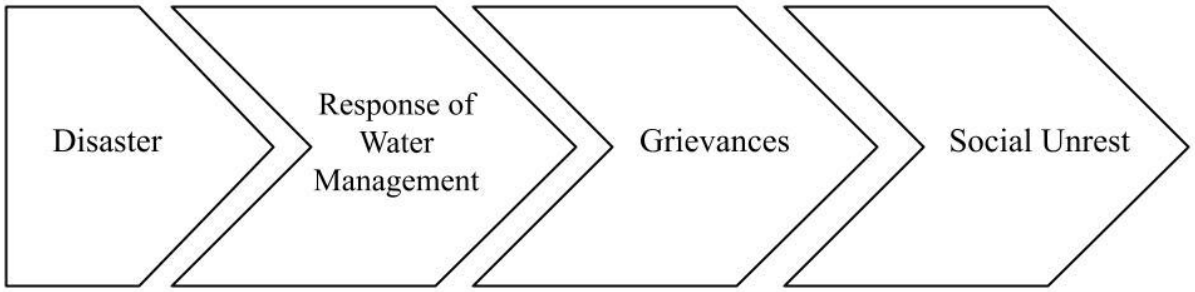
## III. Theoretical Framework

Over the past years, an overwhelming consensus has been reached within climate change literature about significant shifts in weather patterns, and their anthropogenic causes (Hsiang & Kopp, 2018; Oreskes, 2004). Moreover, recently published reports of the Intergovernmental Panel on Climate Change strongly suggest that human-induced greenhouse gas emissions contribute to more frequent occurrences of extreme weather events that are observed around the world (Allen et al., 2018). The next decades are predicted to be more enduring and challenging for many parts of the world compared to pressures like extreme droughts and repeated floodings that are already observed to today (Calow et al., 2011). The main argument of this study is based on a widely researched relationship between environmental consequences of the climate crisis and social violence (Gleditsch, 1998). It is argued that threats to water security increase the risk of violence since water has been described as a main driver of conflict (Bruin et al., 2018). Additional support for this association can be found in the light of rapid-onset disasters and their impact on social unrest (e.g. Gizelis & Wooden, 2010; Wolf, 2007)

This paper disintegrates the above mentioned relationship and explores internal institutional determinants which, in this case, refer to the impact of companies supplying WASH services (see Figure 1. below). The theoretical argument guiding this paper argues as follows: Water-related disasters force water companies to respond. These crisis responses differ depending on the placement of the company along the public-private management spectrum and influence the impact disasters have on society. Each of the factors in the theoretical argument will be discussed below.

**Figure 1.**

*Visualisation of Argumentation Structure*




**Societal Impacts of Water (Mis)management**

As part of the majority of SDGs, resilience has emerged as a new paradigm behind development and strategic planning (United Nations, n.d.) such as the UNICEF 'Strategic Framework for WASH Climate Resilient Development' (United Nations Educational, Scientific and Cultural Organisation & Global Water Partnership, 2014). According to Tai (2015), the resilience of a system against water-related disasters depends on the way it is governed. Depending on the risk perceived by companies, they are forced to respond and adjust their practices as explained below (Schillinger et al., 2020). The resulting lack of water supply has severe implications for local ecosystems as well as citizens' livelihood as basic needs cannot be met anymore.

The lack of water, basic sanitation, and hygiene services is expected to lead to increasing civil unrest through what Gurr (1970) calls relative deprivation. It describes the feeling of deprivation, for example the lack of resources, which is perceived not in absolute terms but relative. Water scarcity, in this case, can lead to relative deprivation when people are aware of their own situation relative across time, others who do better, or other areas which are less exposed or more stable. Drawing from frustration-aggression theories linking

scarcity and conflict risk as described by Homer-Dixon (1999), this can manifest either through instant responses such as protests and civil unrest or longer-term tensions. According to Wood & Wright (2015), during the immediate aftermath of disasters, basic needs such as shelter, access to medical care and to water are challenged which can be as serious as the disaster itself. A cut in water supply at that point in time can have far-reaching implications for the livelihood of people at risk. The UN International Strategy for Disaster Reduction differentiates the so-called social cost of weather-related disasters between direct and indirect impacts (Centre for Research on the Epidemiology of Disasters & United Nations International Strategy for Disaster Reduction, 2015). Whereas direct consequences refer to the destruction of homes and infrastructure, indirect impacts include reparation and rehabilitation costs as well as losses in productivity, displacement, and an overall growing poverty. Although the latter one is harder to measure, both put extreme economic pressures one people's lives and can threaten their subsistence in the long-term. In addition to that, disasters can also have lasting personal consequences on people's health (Lee et al., 2020). Lee et al. (2020) refer to physical effects such as malnutrition and disease but also mental health impacts such as trauma, post-traumatic-stress-disorder (PTSD), and anxiety disorder.

In many cases following a disaster, long-term economic and health-related social costs can appear together with the loss of loved ones, immediate physical harm and disruption of the community (Lee et al., 2020). Linking this point back to the relative deprivation theory introduced above, tensions among the public can arise with the potential for unrest based on severe physical, mental, communal and economic stressors. Especially in these fragile positions, cuts or price hikes for drinking water and sanitation can have far-reaching impacts. They can either add to existing crises by reinforcing grievances or contribute to future escalations by adding another point of contention. This leads to the following hypothesis:

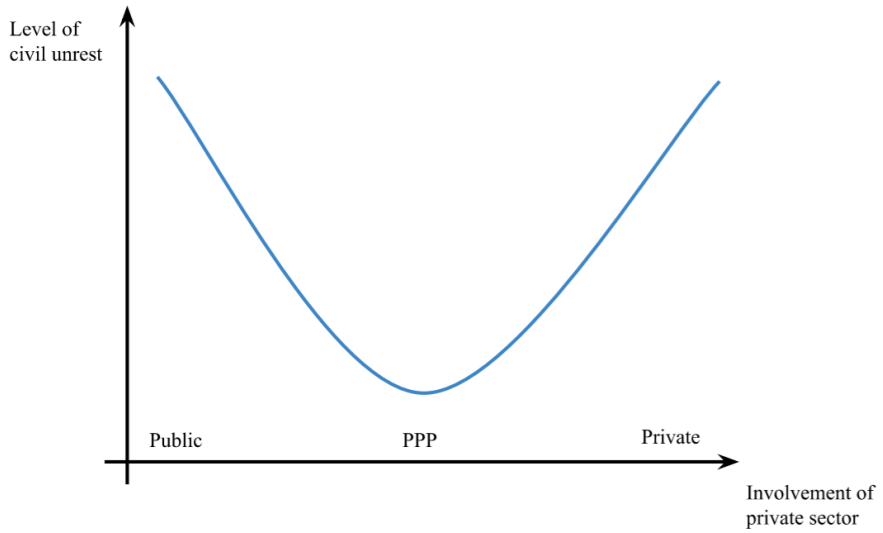
$h_1$: *Increased number of water-related disasters lead to more social unrest.*

**Ownership of Water Supply**

As a main supplier of basic needs the resilience of WASH companies is crucial for securing peoples livelihoods (United Nations & United Nations Water, n.d.). In this paper, company resilience is defined as the ability to recover from large disruptions and quickly regain the status quo of the supply, price and quality of goods (Sheffi & Rice, 2005). Drawing from the water management literature, disaster responses of various kinds of companies to system pressures differ substantially (Bakker, 2013). The association between unrest and private involvement in WASH services is expected to follow a curvilinear pattern in which PPPs are the most resilient and lead to less civil unrest compared to exclusively private or public management (see Figure 2[3]). Details for each form of management are presented below.

**Figure 2**

*Level of expected civil unrest associated with level of private sector involvement*




[3] Figure 2 visualises the argumentation structure, the curve does not resemble the equation of the relationship.

On the one hand, the response of private actors is dominated by market forces since they prioritise profit when calculating the financial costs and benefits of each action. For water management, this implies that private water companies tend to be more efficient in managing water resources but the distribution of such tends to be less equal (Wackerbauer, 2008). In many cases, unprofitable areas such as poorer urban outskirts have no or little access to WASH services (Perard, 2009). During the economic crisis in the early 2000s in Argentina, for example, the private water supplier Aguas Argentinas implemented extensive cuts in the water supply. The business model had become unlucrative under the collapsing economy. The water cuts coincided with a severe heatwave in 2004 which further destabilised the situation (BBC News, 2006). If business becomes unprofitable private companies are expected to withdraw investment, drastically raise prices to maintain profit or cut services (Perard, 2009). This is problematic in the aftermath of a disaster since (high) returns are unlikely given the destruction of infrastructure and supply routes (Auzzir et al., 2014). This is expected to lead to higher levels of civil unrest after disasters, as indicated in Figure 2.

The response of public actors, on the other hand, is expected to be more restricted. Since their service is tied to the regime, the provision of services is expected to become politicised during the uprising or sharply decline if the government faces internal struggles (Bakker, 2013). In an illustrating case study, Tyner & Will (2015) argue that the exploitative reform program for water management in post-conflict Cambodia led to great suffering among the public. While trying to introduce the ‘great leap forward’ to a conflict-shaken country, the newly established Communist Party of Kampuchea (CPK) caused the direct and indirect death of roughly 2 million people in the late 1970s (Tyner & Will, 2015). Although this example does not refer to immediate disaster resilience directly, it highlights the weaknesses of public water management with regard to the constraints of resources after crises. In a context of water-related disasters, a situation of crisis can also arise after a severe

flood or drought which destabilizes the region and hinders the access to resources (Johannessen et al., 2014). Therefore, company resilience is expected to be lower which leads to higher levels of civic unrest (Figure 2).

By combining the strengths of public and private water management, it is argued that partnerships between public and private actors achieve better results in terms of quality but also revenue (Auzzir et al., 2014). This results in more institutional and financial capacity of PPPs to withstand exogenous shocks like water-related disasters (Johannessen et al., 2014). Therefore, PPPs are expected to show higher levels of disaster resilience which implies that services to the public can be upheld at the same or a comparable standard relative to public and private suppliers. As shown in Figure 2, the resulting levels of social unrest are expected to be lower. Drawing from the above mentioned arguments that are further visualised by Figure 2, this leads to the following hypothesis:

$h_2$: *Public-private partnerships in WASH management lead to less civil unrest after water-related disasters.*

Water-related risks such as the lack of access to WASH services will be one of the main challenges in the coming decades as cuts in water supply pose serious threats to people's livelihoods (Organisation for Economic Co-operation and Development, n.d.). According to UN Water, “reducing risk to, and improving the resilience of, water and sanitation services will be key to maintaining access during a climatically uncertain future” (United Nations & United Nations Water, n.d.).

## IV. Research Design

Based on the theoretical argumentation above (p.3), this research follows inductive reasoning to develop the research design. Empirical observations such as the Aguas Argentinas case

suggest a relationship between companies' crisis resilience to water-related disasters and social unrest. More general, theoretical knowledge derived from cases like this can be valuable for future, context-specific applications of water governance. Therefore, this research aims at establishing a theoretically sound and empirically supported assessment of this observed association.

**Research Approach & Level of Analysis**

For this approach, a quantitative analysis is the most suitable fit. Since there is no known study that investigates this nexus, it is important to establish a correlation in the first place. Based on cases reported in the media, a link between the variables can be expected. Nonetheless, one cannot infer an association between water companies and unrest exclusively based on anecdotal data. In each case, interrelated factors such as regime oppression might have influenced a spark of civil unrest. Therefore, a large-n study suits this research outlook by drawing from datasets with extensive geographical and temporal coverage while controlling for stable predictors of unrest. This increases the external validity compared to a small-n or single case study.

The analysis is conducted at the country level. Since this paper aims at bridging different fields of research and empirical findings, it is crucial to test for a general association. A significant correlation at the country level can serve as a baseline for future, more disaggregated approaches. The current lack of sufficient data for a sub-national analysis restrains any disaggregating steps at this point in time. Nonetheless, changes within certain country districts or cities can also be measured on the country level. Although the effect size is smaller, overall variation in variables can be observed as well. Country fixed effects are accounted for by robustness checks. In contrast to working with specific coordinates or lower district levels, this level of abstraction allows for a manageable amount of data.

**Sample Selection**

The theoretical argument of this paper is tested on eight countries in South America covering the years 1996 to 2018. Due to the limited availability of data on water privatisation in certain countries, the analysis will not include Chile, Paraguay, Suriname and Uruguay. The region is chosen for several reasons: With a history of alternating waves of privatisation and nationalisation of the water economy (Castro, 2007), South America provides an insightful and interesting case. Nowadays, the provision and quality of WASH services as well as the forms of water management in place differ substantially across the region (Pinto et al., 2012). Nonetheless, WASH resilience literature is mostly focused on least-developed regions such as sub-Saharan Africa (e.g. Kirkpatrick et al., 2006; Oates et al., 2014) and recently also Southeast Asia (e.g. Calow et al., 2011) which account for the most vulnerable regions of the world.

Despite limited coping capacity in regions of the Global South, South America has been mostly overlooked in studies on WASH resilience and its impacts on society. According to the UNESCO & Centre for Research on the Epidemiology of Disasters (2015), the number of people affected by severe floods in South America has nearly quadrupled over the past decade. However, papers merely address general resilience development (Howard & Bartram, 2010; Castro, 2007) as well as the strengths and weaknesses of each form of management (Perard, 2009). This paper aims at contributing to the debate by providing an approach which investigates resilience along the public-private spectrum and its direct impact on society. With more frequent changes in climate variability and more severe climate catastrophes on the continent like the intensifying droughts connected to El Niño (Field & Barros, 2014), the resilience of WASH services in SA has become more relevant than ever (Howard & Bartram, 2010).

Cases for the analysis were selected from databases that aspire to be complete. It is noteworthy that the case selection of a database depends on how researchers establish criteria and thresholds for recording. Therefore, it has to be pointed out that although one might pursue random selection for their own research, the selection is never truly random.

## V. Operationalisation of Variables

The model used in this study includes two main independent variables and one main dependent variable as well as an interaction effect and several control variables. While the operationalisation can be found below, further details about the (re)coding process as well as descriptives of the variables can be found in the Appendices[4].

### Independent Variable: Hydrological Disasters

As results of interrelated movement patterns in the so-called "ocean atmosphere-land process cascade[s]" (United Nations Educational, Scientific and Cultural Organisation, 2019), water-related disasters are prompt and powerful shifts in distribution patterns or the quality of water with the potential for significant damages. According to UNESCO, these events are not just expected to increase with the advancing climate crisis but also include severe social costs such as exponential urbanisation and a threat to vulnerable livelihoods.

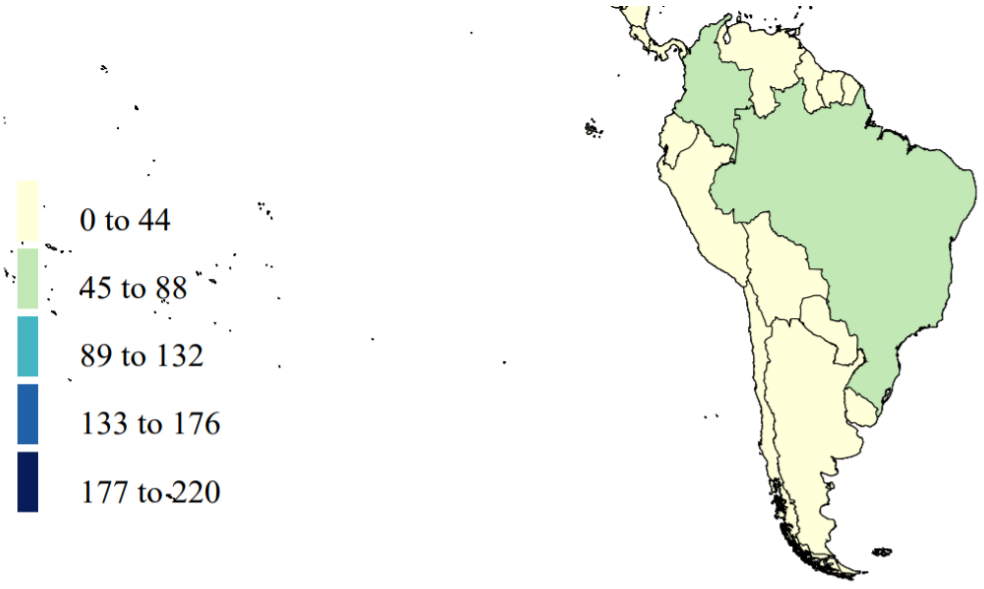
Disaster data is retrieved from the Emergency Events Database (EM-DAT) (Centre for Research on the Epidemiology of Disasters, 2021). In order to be classified as a disaster, instances need to fulfill at least one of the criteria: ten or more people need to be reported killed, a hundred or more people need to be reported affected, the state of emergency needs to be declared, and/ or its needs to be called for international assistance (Centre for Research on the Epidemiology of Disasters, 2021). For the purpose of this research, the water-related

[4] Throughout the analysis section, shortened forms of the variable names are used.

disaster types are further categorised as floods and droughts. As a proxy for measuring the occurrence of disasters, this paper uses the '*number of disasters*'. In contrast to other measures such as the 'number of people affected', 'number of deaths' or the 'sum of total damages', the disaster number is the most reported one with the least number of missing values that does not violate the model assumptions. In order to ensure comparability across cases, the '*number of disasters'* is summed up for each country in a given year. As presented in Figure 3 and Figure 4, Brazil is especially exposed to water-related shocks both drought and floods whereas the Southeast of the continent reports lower number of disasters for the past two decades. Country-specific variation is accounted for as fixed effects in the robustness checks (p. 26).

**Figure 3**

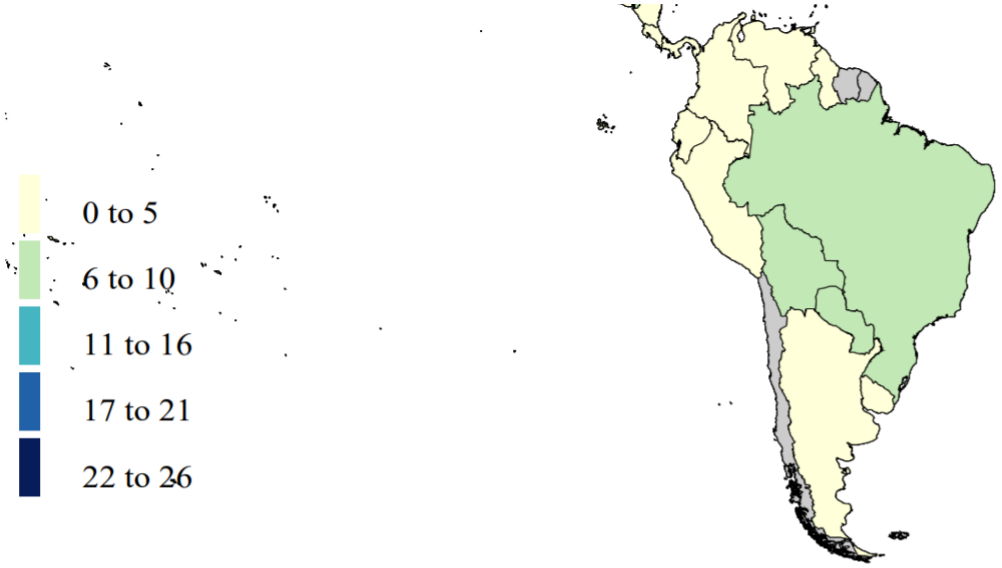
*Occurrences of Flood Disasters in South America, 1996 - 2018*




Source:-EM-DAT,CRED/UCLouvain,Brussels,Belgium - www.emdat.be (D.Guha-Sapir)

**Figure 4**

*Occurrences of Drought Disasters in South America, 1996 - 2018*




Source:-EM-DAT,CRED/UCLouvain,Brussels,Belgium - www.emdat.be (D.Guha-Sapir)

**Dependent Variable: Civil Unrest**

In the context of disasters, the dependent variable civil unrest is defined as a "set of public, disruptive actions initiated by citizens to manifest their unhappiness over some socio-political matter" (Nardulli et al., 2015, p. 2). By providing an important extension beyond the measure of civil war and violent conflict, lower levels of societal feedback can be analysed in a more comprehensive manner. Data on civil unrest is derived from the Mass Mobilisation database which covers citizens movements against the government from 1990 until 2020 (Clark & Regan, 2016). The variable '*number of protests'* is a proxy for measuring the occurrence of unrest. If there are multiple protest events within a country in a given year, they are summed up. Additional details about the coding process can be found in Appendix I.

**Interaction Effect: WASH Privatisation**

As mentioned above, this paper focuses on the presence of companies providing WASH services to the public. Besides contributing to research on water infrastructure such as river basins and dam construction, investigating WASH services bears the advantage of measuring immediate deprivation and development of grievances. A cut in the supply of drinking water implies prompt changes in the lives of citizens and increases the potential for grievances to arise (Food Agriculture Organization of the United Nations & World Bank Group, 2018). Data for this variable is derived from the World Bank Private Participation in Infrastructure Projects (PPI) Database which includes levels of privatisation in the water and sewerage sectors for low and middle income countries (World Bank, 2021). The focus on the '*Level of WASH Privatisation*' allows for a more comprehensive analysis of water providers which also include newly emerged PPPs. This goes beyond the binary distinction of public and private management and further adds to the understanding of the behaviour of water companies. The variable is coded on a scale from zero to four with four representing higher privatisation levels. Further details for the recoding process are provided in the Appendix I.

**Control Variables**

The model includes several control variables which are associated with social unrest. The first control variable is '*gdp growth'* since changes over a short period of time alter people's perception of relative wealth and increase conflict potential (Koubi et al., 2012). In contrast to 'gdp per capita', growth measures account for temporal changes in resources which relates to the relative deprivation theory (Gurr, 1970). The variable is coded in percentage and refers to the annual growth rate of the gdp at market prices in the local currency. Data is derived from the World Development Indicator Database published by the World Bank (2019a). The countries' '*gdp growth'* is assigned for a particular year.

The second control variable is '*regime type*' since studies indicate higher levels of non-violent unrest in democracies (Böhmelt et al., 2014). They argue that democracies facilitate self and mass expression more than non-democratic regimes in which violent conflict is more common. Due to the fact that South America has faced numerous drastic regime changes over the past decades, '*regime type*' is an important factor to control for. The variable '*polity2*' measures political regime authority on a scale from -10 to +10 of which the latter is the most democratic. The variable records the regime type in a given year and is retrieved from the Polity IV dataset published by the Center for Systemic Peace (CSP) (Marshall & Gurr, 2020).

Another control variable is '*ethnolinguistic fractionalisation*' which measures the likelihood of overcoming the collective action problem inherent in protest organisation (Slettebak, 2012). The data is retrieved from the Historical Index of Ethnic Fractionalization dataset and assigns one fractualisation value to a country (Dražanová, 2019). The value runs from zero to one while a higher value indicates more fractionalisation. Each country is assigned one '*ethnolinguistic fractionalisation*' score in a given year. Since the dataset does not cover the most recent years, the values for 2014 to 2018 are taken from the last available year 2013. The values only change in the second decimal over time, adding values with this approach does not introduce major bias into the analysis.

According to Hendrix & Haggard (2015) the government can exercise less control in more densely populated areas which is why '*population density*' is also measured. It is further argued that a larger population size in a given area enhances the organisation of collective action through shared concerns and established network structures (Weinberg & Bakker, 2014). The data is also retrieved from the World Development Indicator Database published by the World Bank (2019b). It measures the number of people per square meter of land in a country for a given year.

In addition to that, the last control variable '*infant mortality*' adds the human welfare component which is left uncaptured by measures of gdp. The practice of using it as a proxy for human welfare has emerged over the recent years (RezaeeDaryakenari et al., 2020). It is relevant for the research purpose of this study since it indicates lower levels of discontent and unrest through sufficient provision of public goods. The data for the variable is derived from the World Development Indicator Database published by the World Bank (2019c). The variable is coded as infant death per 1000 live births and is assigned to each country in a given year.

## VI. Methods of Data Analysis

The final data sheet includes disasters, company presence and unrest for each country in a given year as well as the control variables. To account for the expected direction of cause and effect, several criteria were established in order for a case to be included in the final dataset: A disaster needs to happen before the protest and the protest needs to occur within the year or the following year of the disaster. If there is, for example, no protest recorded after a disaster, it is coded as 0. Moreover, a WASH project needs to be recorded over the whole period of disaster and unrest i.e. it should be present before the disaster, and beyond the date of the unrest. The association between the variables is visualised by the regression equation below. It is tested whether the relationship between disasters and civil unrest is moderated by the level of privatisation of WASH services:

$$\textit{Number of Protests} = ß_0 + ß_1 \times \textit{Number of Disasters} + ß_2 \times \textit{Level of WASH Privatisation} + ß_3 \times \textit{Number of Disasters} \times \textit{Level of WASH Privatisation} + \in$$

The data is analysed through a negative binomial (NB) regression generalised linear model (GLM). In contrast to linear models which assume that residuals of the response

variable follow a normal distribution, GLMs allow for error distribution models. Within that regression family, Poisson models are able to account for the distribution of count variables which is non-continuous, discrete and are restricted to non-negative values (Yang & Berdine, 2015). Since the outcome variable '*number of protests*' is overdispersed, it violates the assumption of equi-dispersion distribution of the Poisson model. In order to avoid deflated standard errors, inflated test statistics, and an overall bad model fit, the NB distribution is used instead. As part of the Poisson family, the NB distribution is similar but overcomes discrepancies between variance and mean through the variation of the distribution parameter which is treated as a random variable (Gardner et al., 1995). As presented in the Appendix, only the assumption of multicollinearity is violated for the NB model.

## VII. Results

Throughout the analysis of the data, three separate models are executed. The first one serves as a baseline model, the second one includes interaction effects, and the third adds additional controls. An overview of the findings can be found in Table 1. All applicable assumptions for GLM are tested of which only the assumption of multicollinearity is problematic. Details of multicollinearity are further discussed as part of model implications. Additional information on assumption testing can be found in Appendix A.

### Baseline Model

The first model which only includes the IV *'number of disasters'* and DV *'number of protests*' indicates a statistically significant relationship. This means that 11 additional disasters lead to one additional protest event ($b = 0.09$, $p<0.05$). These findings align with results in the literature. According to Bhavmani (2006) as well as Wood & Wright (2015),

disasters disrupt the state infrastructure and social systems. This leads to instability from which protests can emerge.

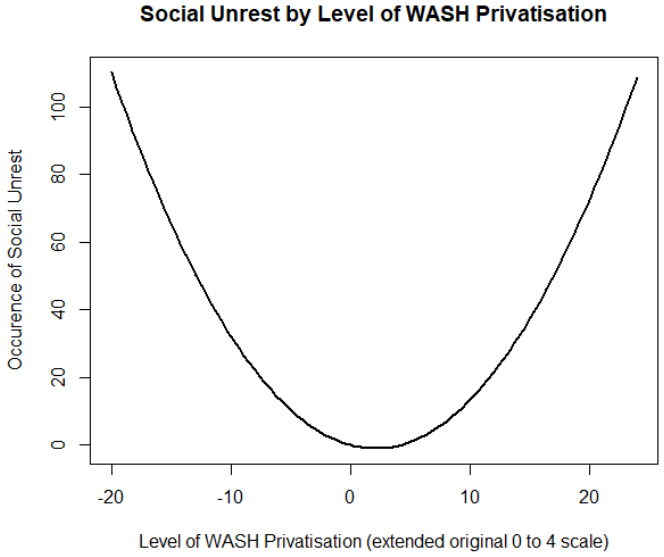
**Interaction Model**

In the second model, interactions are included without controls. To account for the curvilinear relationship between unrest and WASH privatisation hypothesised above (p.14), two interaction types are added. The first interaction term is formed by multiplying '*WASH Privatisation'* with the *'number of disasters'*, whereas the second interaction is a product of the squared value of '*WASH Privatisation*' with the *'disaster' variable*. The effects of both interaction terms are at the threshold of statistical significance ($p<0.1$). This suggests that a potential association is worth exploring further but is not sufficiently captured by the model.

Aside from the significance value of the interaction terms, there is another important limitation. As the main independent variable '*disasters'* becomes insignificant ($b = -0.23996$, $p> 0.05$) it calls into question the calculated effect of the interaction terms. Under this model, the interaction effect does not hold up if one of the variables is not significant alone. It is worth noting that both privatisation variables alone are highly significant ($b = -0.95586$, $p < 0.001$; $b_{squared} = 0.22204$, $p < 0.001$). These effects are also in the expected curvilinear direction by reporting a minimum of protests for middle values on the *'Privatisation'* variable (Figure 5). This implies an effect of '*WASH Privatisation'* on the development of unrest which is independent from the occurrence of disasters and which is further explored below.

**Figure 5**

*Plot of Privatisation Coefficients from Model 3 ($y = 0.228144*x^2 - 0.946576*x$)*




**Interaction Model with Controls**

Model 3 further confirms the findings regarding the curvilinear relationship of WASH privatisation and unrest while accounting for robust predictors of protest as control variables (Figure 5). Out of all control variables, only '*population density'* proves significant which indicates a 1.2 % increase in protest with each additional person per square meter of land ($b = 0.012236$, $p < 0.01$). This further confirms the findings of Hendrix & Haggard (2015) who argue that unrest is more likely in higher populated areas where it is easier to overcome collective action problems for protest. All remaining control variables perform quite poorly in the analysis despite being widely cited predictors of conflict. This can indicate discrepancies in the data selection. In addition to that, both privatisation variables report less significance with slightly reduced effect sizes. Nonetheless, the third model shows the best fit relative to the other two models (AIC = 1187.3). The overall size of standard errors is small which further indicates a good fit since the values are located close to the regression line.

**Table 1**

*Overview of GLM Regression Results*

| Table 1 | **Model 1:** | **Model 2:** | **Model 3:** |
|---|---|---|---|
| (Constant) | 2.205***<br>(0.08746) | 2.979***<br>(0.32795) | 2.847350***<br>(0.517420) |
| Number of Disasters | 0.08746*<br>(0.03851) | -0.23996<br>(0.30016) | -0.065339<br>(0.369426) |
| WASH Privatisation | | -0.95586***<br>(0.28389) | -0.946576**<br>(0.332940) |
| (WASH Privatisation)$^2$ | | 0.22204***<br>(0.06739) | 0.228144**<br>(0.075882) |
| Number of Disasters :<br>WASH Privatisation | | 0.37763<br>(0.22782) | 0.231026<br>(0.274302) |
| Number of Disasters :<br>(WASH Privatisation)$^2$ | | -0.08759<br>(0.04675) | -0.056565<br>(0.53384) |
| Population Density | | | 0.012236**<br>(0.004129) |
| Gdp Growth | | | -0.006600<br>(0.014928) |
| Ethnic Fractionalisation | | | -0.263672<br>(0.401052) |
| Regime Type | | | -0.003516<br>(0.025282) |
| Infant Mortality | | | -0.00469<br>(0.007377) |
| AIC<br>N | 1226.7<br>184 | 1221.1<br>184 | 1187.3<br>180 |

*Note: Standard Errors in Parentheses. ***p<0.001, **p<0.01, *p<0.05*

**Implications for Hypothesis Testing**

Based on the results of the analysis, the null-hypothesis expecting no changes in unrest with increasing number of disasters cannot be rejected (p.13). Although the relationship is

significant in the first model, it cannot be observed in Models 2 and 3. This indicates that the impact of disasters on the number of protests remains unclear and needs to be researched further. On the other hand, the null-hypothesis regarding the curvilinear relationship between WASH companies' disaster response and unrest per se cannot be rejected based on the data available (p.16). Nonetheless, the relationship between '*WASH Privatisation*' and *'unrest'* is very strong when it is not related to the occurrence of disasters which implies that PPPs lead to less social unrest overall. Based on these findings, one could see unrest as a form of social feedback on the performance of WASH companies. This would suggest that the overall performance of PPPs in supplying WASH services is better. Additional prompts and leads for future research are discussed in the conclusion.

**Robustness Checks**

Several robustness checks are performed which test the findings of this paper under different assumptions. First, the negative binomial regression is run again with different types of disasters. The data retrieved from the EM-DAT database includes disasters such as wildfires, earthquakes and landslides (Centre for Research on the Epidemiology of Disasters, 2021). The findings of the robustness check with other disaster types overall confirm results of Model 3 with overall lower significance levels across the robustness model. This includes the non-significant findings for disasters, the interaction effect and the majority of the control variables. Only '*population density*' still reports under a confidence interval of 95% ($b = 0.009279$, $p < 0.05$). Although the unsquared '*WASH Privatisation'* variable still reports at the threshold to significance ($b = -0.563272$, $p < 0.1$), the effects of the independent '*WASH Privatisation'* variables are both insignificant now. This combined with the findings of Model 3 implies that there is an effect of the level of privatisation in water companies on social

unrest, but the model and the data available are unable to capture it or indicate any further details.

Second, running Model 3 with clustered and robust standard errors each further confirms the findings. Both indicate a higher significance for the effect of '*WASH Privatisation'* ($p < 0.001$ each) while the standard error slightly decreases (SE = 0.2963099). This suggests that results remain significant despite accounting for the increased variance by the coefficient estimates in the regression model.

Third, fixed effects for country and year are also tested for. While no country shows significant influence on the number of protests, all other variables including the interaction effects and the IV disaster show significance now. By accounting for fixed effects, the initial relationship is more clearly identifiable. The fixed effects for the years imply a higher number of protests over the past years since the most recent ones indicate higher significance. This observation could stem from the fact that there is better coverage or that the socio-economic situation on the continent has worsened over the past years, or both.

## VIII. Conclusion

By investigating the relationship between water-related disasters and civil unrest through a quantitative lens, this study lays the foundation for a crucial nexus that has not been explored yet. The results do not support a statistically significant impact of disasters on the occurrence of unrest. Regarding the impact of WASH management on the disaster-unrest nexus, interesting findings can be observed. Although the results do not indicate better water management by PPPs specifically after disasters, they show strong support for an overall better performance. Since the curvilinear relationship of privatisation levels is highly significant when predicting social unrest, it can be argued that the social response is substantially less negative when PPPs supply water and sanitation to the public.

This paper is the first step into exploring the complex relationship between economic determinants and direct societal effects illustrated by the disaster response-unrest nexus. Future studies can use this paper as a starting point for retesting the analysis with improved datasets and expand the theoretical arguments. Based on varying incentives of different forms of water companies, particular responses to system pressures are important in carving out the societal, economic and ecological consequences for each form of management. In addition to that, research exploring the contexts in which the advantages of PPPs do not hold up would prove not just insightful for the scholarship but also important for future planning of WASH supply.

Nonetheless, several limitations for this paper need to be elaborated on. The first and most important one is the availability of data, especially for a subnational unit of analysis. Disaster events and unrest rarely occur on a national level, and water supply can differ a lot across national districts or even municipalities. Although the scholarship has been moving towards a more disaggregated form of research over the recent years (Giraudy et al., 2019), comprehensive datasets covering subnational districts are still broadly missing. For this paper, it implies that data for all three main variables are aggregated on the national level which prevents a more clear investigation of the proposed hypotheses. This further impedes an exploration of patterns which are obscured by national-level aggregation.

Furthermore, the database for WASH privatisation covers the private involvement in single projects. Although one can infer about the broader supply area, it remains a suboptimal approach. This is due to the fact that one cannot assume the general completeness of the PPI database and that the database excludes public projects which results in an incomplete assessment of WASH companies. Furthermore, supply areas vary greatly which makes a coherent assessment difficult. Future research could contribute by creating a subnational database or establishing a new direction of work with ‘% of WASH privatisation by number

of supplied people (in a district within a given year)'. Approaches like this were introduced, for example by the US agency Safe Drinking Water Information System (SDWIS) Federal Reporting Services, but lack maintenance and coverage (United States Environmental Protection Agency, 2017). As a final limitation, the violated assumption of collinearity is noted which follows the discussion in the Appendix.

Drawing from the findings of this paper, more accurate data and additional research in the field of WASH resilience will also shape future policy-making. Since water is a highly contested topic in many world regions, it will be important to know what kind of management is preferred in specific contexts. Over the past years, institutional resilience has become a crucial point as a bulwark against climate shocks (United Nations Educational, Scientific and Cultural Organisation & Global Water Partnership, 2014). While facing an increasing number and severity of catastrophic events caused by the climate crisis, new insights in this area will be more relevant than ever.

## References

Allen, M. R., Dube, O. P., Solecki, W., Aragón-Durand, F. (2018). Chapter 1: Framing and Context. *IPCC SR15 2018*. pp. 49–91.

Argentina severs Suez water deal. (2006, March 21). BBC News. http://news.bbc.co.uk/2/hi/business/4830720.stm#:%7E:text=Argentina%20has%20terminated%20its%20contract,of%20the%20water%20it%20supplied

Auzzir, Z. A., Haigh, R. P., & Amaratunga, D. (2014). Public-private partnerships (PPP) in

disaster management in developing countries: a conceptual framework. *Procedia economics and finance, 18,* 807-814.

Bakker, K. (2013). Privatizing Water : Governance Failure and the World's Urban Water Crisis.

Bhattacharya, S., & Banerjee, A. (2015). Water privatization in developing countries: Principles, implementations and socio-economic consequences. *World Scientific News, 10*, 17-31.

Bhavnani, R. (2006). Natural disaster conflicts. *Cambridge, Massachusetts: Harvard University, 14.*

Böhmelt, T., Bernauer, T., Buhaug, H., Gleditsch, N. P., Tribaldos, T., & Wischnath, G. (2014). Demand, supply, and restraint: determinants of domestic water conflict and cooperation. *Global Environmental Change, 29*, 337-348.

Bruin, S., Knoop, J., Visser, H., & Ligtvoet, W. (2018). *Linking Water Security Threats to Conflict* (Background Report). PBL Netherlands Environmental Assessment Agency. https://www.pbl.nl/sites/default/files/downloads/3039_Linking_water_security_threats_to_conflict_DEF.pdf

Castro, J. E. (2007). Poverty and citizenship: Sociological perspectives on water services and public–private participation. *Geoforum, 38*(5), 756-771.

Centre for Research on the Epidemiology of Disasters, & United Nations International Strategy for Disaster Reduction. (2015). The human cost of weather-related disasters, 1995–2015. *United Nations, Geneva.*

Centre for Research on the Epidemiology of Disasters (2021). *The International Disaster Database* [Data set]. Centre for Research on the Epidemiology of Disasters. http:\\emdat.be.

Clark, D., & Regan, P. (2016). *Mass Mobilization Protest Data V5* [Data set]. Harvard Dataverse. https://doi.org/10.7910/DVN/HTTWYL

Dražanová, L. (2019). *Historical Index of Ethnic Fractionalization Dataset (HIEF)* [Dataset]. Harvard Dataverse (V1). DOI: https://doi.org/10.7910/DVN/4JQRCL

Field, C. B., & Barros, V. R. (Eds.). (2014). *Climate change 2014–Impacts, adaptation and vulnerability: Regional aspects*. Cambridge University Press.

Food Agriculture Organization of the United Nations, & World Bank Group. (2018). *Water Management in Fragile Systems : Building Resilience to Shocks and Protracted Crises in the Middle East and North Africa*. Cairo: FAO and World Bank.

Galaz, V. (2005). Social-ecological resilience and social conflict: institutions and strategic adaptation in Swedish water management. *AMBIO: A Journal of the Human Environment, 34*(7), 567-572.

Gardner, W., Mulvey, E. P., & Shaw, E. C. (1995). Regression analyses of counts and rates: Poisson, overdispersed Poisson, and negative binomial models. *Psychological bulletin, 118*(3), 392.

Giraudy, A., Moncada, E., & Snyder, R. (2019). Subnational Research in Comparative Politics: Substantive, Theoretical, and Methodological Contributions. In A. Giraudy, E. Moncada, & R. Snyder (Eds.), Inside Countries: Subnational Research in Comparative Politics (pp. 2-54). Cambridge: Cambridge University Press. doi:10.1017/9781108678384.001

Gizelis, T. I., & Wooden, A. E. (2010). Water resources, institutions, & intrastate conflict. *Political Geography, 29*(8), 444-453.

Gleditsch, N. P. (1998). Armed Conflict and The Environment: A Critique of the Literature. *Journal of Peace Research, 35*(3), 381-400.

Gurr, T., & Woodrow Wilson School of Public International Affairs. Center of International Studies. (1970). *Why men rebel*. Princeton, N.J.: Princeton University Press.

Harvey, D. (2010). *Social justice and the city* (Vol. 1). University of Georgia Press.

Hendrix, C. S., & Haggard, S. (2015). Global food prices, regime type, and urban unrest in the developing world. *Journal of Peace Research, 52*(2), 143-157.

Hodge, G.A., & Greve, C. (2016), On Public-Private Partnership Performance: A

Contemporary Review, *Public Works Management & Policy*, pp. 1–24

Homer-Dixon, T. (1999). *Environment, Scarcity, and Violence.* Princeton, NJ: Princeton University Press

Howard, G., & Bartram, J. (2010). The resilience of water supply and sanitation in the face of climate change--Technical report. *WHO Vision, 2030*.

Hsiang, S. M., & Kopp, R. E. (2018). An Economist's Guide to Climate Change Science. *Journal of Economic Perspectives, 32*(4), 3-32

Johannessen, Å., Rosemarin, A., Thomalla, F., Swartling, Å. G., Stenström, T. A., & Vulturius, G. (2014). Strategies for building resilience to hazards in water, sanitation and hygiene (WASH) systems: The role of public private partnerships. International *Journal of Disaster Risk Reduction, 10*, 102-115.

Kelley, C. P., Mohtadi, S., Cane, M. A., Seager, R., & Kushnir, Y. (2015). Climate change in the Fertile Crescent and implications of the recent Syrian drought. *Proceedings of the national Academy of Sciences, 112*(11), 3241-3246.

Kirkpatrick, C., Parker, D., & Zhang, Y. F. (2006). An empirical analysis of state and private-sector provision of water services in Africa. *The World Bank Economic Review, 20*(1), 143-163.

Koubi, V., Bernauer, T., Kalbhenn, A., & Spilker, G. (2012). Climate variability, economic

growth, and civil conflict. *Journal of peace research, 49*(1), 113-127.

Lall, U., Heikkila, T., Brown, C., & Siegfried, T. (2008). Water in the 21st century: Defining the elements of global crises and potential solutions. *Journal of International Affairs*, 1-17.

Lee, J., Perera, D., Glickman, T., & Taing, L. (2020). Water-related disasters and their health impacts: A global review. *Progress in Disaster Science*, 100123.

Marshall, M. G. & Gurr, T. R. (2020). *Polity5: Political Regime Characteristics and Transitions, 1800-2018* [Data set]. Center for Systemic Peace. http://www.systemicpeace.org/inscrdata.html

Matthew, R. A. (2010). *Global environmental change and human security*. MIT press.

Nardulli, P., Peyton, B., & Bajjalieh, J. (2015). Climate Change and Civil Unrest: The Impact of Rapid-onset Disasters. The Journal of Conflict Resolution, 59(2), 310-335.

Oates, N., Ross, I., Calow, R., Carter, R., & Doczi, J. (2014). Adaptation to Climate Change in Water, Sanitation and Hygiene: Assessing risks and appraising options in Africa. *London: Overseas Development Institute.*

Organisation for Economic Co-operation and Development. (n.d.) *The Water Challenge - Water risks, disasters and climate change. https://www.oecd.org/water/risks-disasters-and-climate-change.htm*

Oreskes, N. (2004). The scientific consensus on climate change. *Science, 306*(5702), 1686-1686.

Pérard, E. (2009). Water supply: Public or private?: An approach based on cost of funds, transaction costs, efficiency and political costs. *Policy and society, 27*(3), 193-219.

Pinto, V. G., Heller, L., & Bastos, R. K. X. (2012). Drinking water standards in South American countries: convergences and divergences. *Journal of water and health, 10*(2), 295-310.

Prasad, N. (2007). Privatisation of Water: A Historical Perspective. *Law, Environment and Development Journal, 3(*2), 217-233.

RezaeeDaryakenari, B., Landis, S. T., & Thies, C. G. (2020). Food price volatilities and civilian victimization in Africa. *Conflict Management and Peace Science, 37*(2), 193-214.

Schillinger, J., Özerol, G., Güven‐Griemert, Ş., & Heldeweg, M. (2020). Water in war: Understanding the impacts of armed conflict on water resources and their Management. *Wiley Interdisciplinary Reviews: Water, 7*(6), e1480.

Sheffi, Y., & Rice Jr, J. B. (2005). A supply chain view of the resilient enterprise. *MIT Sloan management review, 47*(1), 41.

Slettebak, R. T. (2012). Don't blame the weather! Climate-related natural disasters and civil conflict. *Journal of Peace Research, 49*(1), 163-176.

Starr, J. R. (1991). Water wars. *Foreign policy,* (82), 17-36.

Tai, H.S. (2015). Cross-Scale and Cross-Level Dynamics: Governance and Capacity for Resilience in a Social-Ecological System in Taiwan. *Sustainability, 7*(2), 2045-2065.

Tyner, J. A., & Will, R. (2015). Nature and post‐conflict violence: water management under the Communist Party of Kampuchea, 1975–1979. *Transactions of the Institute of British Geographers, 40*(3), 362-374.

United Nations. (n.d.) Sustainable Development Goals - Goal 6: Ensure access to water and sanitation for all. https://www.un.org/sustainabledevelopment/water-and-sanitation/.

United Nations & United Nations Water. (n.d.) *Water and Disasters*. https://www.unwater.org/water-facts/disasters/

United Nations Educational, Scientific and Cultural Organisation. (2019). *Water-related Disasters*. https://en.unesco.org/themes/water-security/hydrology/water-related-disasters

United Nations Educational, Scientific and Cultural Organisation & Centre for Research on the Epidemiology of Disasters. (2015). *The Human Cost of Weather-Related Disasters 1995-2005.*

https://www.unisdr.org/2015/docs/climatechange/COP21_WeatherDisastersReport_2015_FINAL.pdf

United Nations Educational, Scientific and Cultural Organisation & Global Water Partnership. (2014). *A Strategic Framework for WASH Climate Resilient Development And Technical Briefs for Implementation.*

United Nations General Assembly. (2010). Resolution 64/292: The human right to water and sanitation. *64th Session.* http://www.un.org/es/comun/docs.

United States Environmental Protection Agency. (2017, June 27). *Safe Drinking Water Information System (SDWIS) Federal Reporting Services.* https://www.epa.gov/ground-water-and-drinking-water/safe-drinking-water-information-system-sdwis-federal-reporting

Wackerbauer, J. (2008). Public or private water management: Experience from different European Countries. *IOP Conference Series. Earth and Environmental Science, 4*, 012037.

Weinberg, J., & Bakker, R. (2015). Let them eat cake: Food prices, domestic policy and social unrest. *Conflict Management and Peace Science, 32*(3), 309-326.

Weinthal, E., Troell, J., & Nakayama, M. (2011). Water and post-conflict peacebuilding: introduction. *Water International, 36*(2), 143-153.

Whiteside, Heather (2016). *Public-private partnerships in Canada.* Halifax: Fernwood Publishing.

Wood, R. M., & Wright, T. M. (2016). Responding to catastrophe: Repression dynamics following rapid-onset natural disasters. *Journal of Conflict Resolution, 60*(8), 1446-1472.

Wolf, A. T. (2007). Shared waters: Conflict and cooperation. *Annu. Rev. Environ. Resour., 32*, 241-269.

Wolf, A. T., Kramer, A., Carius, A., & Dabelko, G. D. (2005). Managing water conflict and cooperation. *State of the World 2005: redefining global security*, 80-95.

World Bank. (2019a). *GDP per capita (current international $).* World Development Indicators. Retrieved from https://data.worldbank.org/indicator/NY.GDP.PCAP.CD.

World Bank. (2019b). *Population density (people per sq. km of land area)*. World Development Indicators. Retrieved from https://data.worldbank.org/indicator/EN.POP.DNST

World Bank. (2019c). *Mortality rate, infant (per 1,000 live births).* World Development Indicators. Retrieved from https://data.worldbank.org/indicator/SP.DYN.IMRT.IN

World Bank. (2021). *Private Participation in Infrastructure Projects.* [Data set]. World Bank,

IBRD & IDA, https://ppi.worldbank.org/en/ppi

World Health Organization. (2001). Macroeconomics and health: investing in health for economic development: report of the Commission on Macroeconomics and Health. In *Macroeconomics and health: investing in health for economic development: report of the commission on macroeconomics and health.* (pp. 202-202).

Yang, S., & Berdine, G. (2015). The negative binomial regression. *The Southwest Respiratory and Critical Care Chronicles, 3*(10), 50-54.

## Appendix I:

### A) List of Countries included:

- Argentina
- Bolivia
- Brazil
- Colombia
- Ecuador
- Guyana
- Peru
- Venezuela

### B) Recoding of Variables

Most of the recoding is documented in the Operationalisation part of the paper. Two additional specifications for the disaster variable and the level of privatisation:

‘*Number of disasters’* (EM-DAT Database)

If there is no disaster recorded in a country for a certain year, the number of casualties is coded as 0. Although this step assumes completeness and full coverage by the EM-DAT database, it is the more appropriate procedure given the data available. Coding cases without disasters as missing would introduce sampling bias to the dataset since it would be composed of disaster occurrences only.

‘*Level of Privatisation’* (PPI Database)

In order to measure the level of privatisation, the variable ‘*Subtype of PPI’* is used. It records twelve types of contracts, each with an increasing level of private involvement. For the purpose of this research, they were recorded into “low”, “medium-low”, “medium-high” and “high” levels of private involvement on a scale from one to four. The level refers to the operating risk as well as the level of independence in decision-making on management and investments (World Bank, 2021). If there is no privatisation project recorded in a certain year, the case is coded as 0 which indicates no private involvement in WASH services.

### C) Assumption Testing

All assumptions associated with general linear models, and more specifically negative binomial models are tested for. Except for Multicollinearity, none of the assumptions is violated. On that note, it is important to mention that the inclusion of two interaction effects impacts multicollinearity diagnostics. The multicollinearity values indicated by the variance inflation factor (VIF) for Model 2 and Model 3 are relatively high. This refers to the indicators of ‘*disaster’* (VIF = 65 (Model 2); VIF = 104 (Model 3)) as well as the values of ‘*WASH Privatisation’* which range between 15 and 20. Running the model without

interactions does not indicate any multicollinearity since the VIF stays below two for all variables. This structural multicollinearity implies that the ceteris paribus assumption is violated and that the precision of the coefficients is impeded. This is noted as a limitation to this paper.

### D) Descriptives

| Variable Name | Descriptives |
|---|---|
| ISO | Length:184 |
| | Class :character |
| | Mode :character |
| | - |
| | - |
| | - |
| | - |
| Year | Min. :1996 |
| | 1st Qu.:2001 |
| | Median :2007 |
| | Mean :2007 |
| | 3rd Qu.:2013 |
| | Max. :2018 |

| | |
|---|---|
| | - |
| number_disasters | Min. :0.000 |
| | 1st Qu.:1.000 |
| | Median :1.000 |
| | Mean :1.658 |
| | 3rd Qu.:3.000 |
| | Max. :8.000 |
| | - |
| Priv_Levels | Length:184 |
| | Class :character |
| | Mode :character |
| | - |
| | - |
| | - |
| | - |
| Priv_Level_avg | Min. :0.000 |
| | 1st Qu.:2.316 |
| | Median :2.611 |
| | Mean :2.575 |

| | |
|---|---|
| | **3rd Qu.:3.000** |
| | **Max. :4.000** |
| | **-** |
| **number_protests** | **Min. : 0.00** |
| | **1st Qu.: 4.00** |
| | **Median : 8.00** |
| | **Mean :10.58** |
| | **3rd Qu.:16.00** |
| | **Max. :46.00** |
| | **-** |
| **pop_dens** | **Min. : 3.784** |
| | **1st Qu.:12.279** |
| | **Median :22.404** |
| | **Mean :24.854** |
| | **3rd Qu.:34.017** |
| | **Max. :68.789** |
| | **-** |
| **gdp_growth** | **Min. :-11.85478** |
| | **1st Qu.: 0.01888** |

| | |
|---|---|
| | **Median : 2.17976** |
| | **Mean : 1.89041** |
| | **3rd Qu.: 3.95054** |
| | **Max. : 16.26196** |
| | **NA's :4** |
| **eth_frac** | **Min. :0.1210** |
| | **1st Qu.:0.5260** |
| | **Median :0.5775** |
| | **Mean :0.5383** |
| | **3rd Qu.:0.6285** |
| | **Max. :0.6950** |
| | **NA's :40** |
| **regime_type_nr** | **Min. :-3.000** |
| | **1st Qu.: 6.000** |
| | **Median : 7.000** |
| | **Mean : 6.712** |
| | **3rd Qu.: 8.000** |
| | **Max. : 9.000** |
| | **-** |

| | |
|---|---|
| **infant_mortality** | **Min. : 8.70** |
| | **1st Qu.:14.90** |
| | **Median :19.60** |
| | **Mean :22.99** |
| | **3rd Qu.:28.82** |
| | **Max. :67.20** |
| | **-** |
| **eth_frac_imputed** | **Min. :0.1210** |
| | **1st Qu.:0.5260** |
| | **Median :0.5745** |
| | **Mean :0.5379** |
| | **3rd Qu.:0.6285** |
| | **Max. :0.6950** |
| | **-** |