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WATER INSECURITY IN THE SOUTH CAUCASUS: A HYDRO-STRATEGIC ASSESSMENT OF THE NAGORNO-KARABAKH CONFLICT

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Abstract

The intersection of water security and geopolitical tensions in the South Caucasus is nowhere more evident than in the Nagorno-Karabakh conflict. This article provides a comparative analysis of the hydrostrategic aspects of the conflict between Armenia and Azerbaijan, emphasizing the duality of water resources as a source of conflict and a potential unifying force. Control over river basins such as the Kura-Araks River and the Sarsang Reservoir, vital for both countries, has become a top priority for Armenia and Azerbaijan. In this regard, the Kura-Araks River basin, which supplies vital water resources to both countries, has often been the source of confrontation and struggle for control, determining not only military strategies but also economic and political stability. Similarly, the Sarsang Reservoir, located in the conflict zone, symbolizes a hydropolitical struggle, where access to water determines the survival of local communities and regional security as a whole. Using a hydrostrategic approach, this article examines the multifaceted impact of water scarcity, control over infrastructure, and climate vulnerability on the escalation of hostilities. The potential of water diplomacy and the possibility that shared water resources will ultimately foster cooperation rather than conflict between these two regional powers is also considered.

Keywords: *hydropolitical struggle, hydrostrategic approach, water security, Nagorno-Karabakh, Transboundary Water Management, water diplomacy*.

Introduction

The South Caucasus is considered one of the most vulnerable regions in the world, facing a serious threat of water shortages. This threat to the region's water security has weighed on the achievement of the Sustainable Development Goals (SDGs), which most nations have set for 2030, as water plays a substantial role in people's livelihoods, involving strategic sectors such as energy, agriculture and industrial production. A drop in water levels in dams and hydroelectric power plants means a decrease in electricity

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production and is a significant threat to every sector. This shows how critical water management has become and how intense the threat of water scarcity is for communities, companies and nations. In this regard, it is essential to take into account the words of Ismail Serageldin, former World Bank vice president. According to his view: "In the 20th century, people fought for oil; in the 21st century, they will fight for water" (Lopes and Gama 2025). In light of the current difficult historical-climatic situation, following a general increase in temperatures and an exponential growth in the urban population, water resources management will play an increasingly decisive role in the near future. Specifically, the peaceful management of cross-border watercourses, as in the case of the numerous rivers between Armenia and Azerbaijan, will represent a very significant political and diplomatic challenge to avoid the triggering of water wars.

Tensions over control of the water supply between Yerevan and Baku began a few years after the fall of the Soviet Union. The first real conflict between the two regional powers emerged in 1988 and, amidst periods of warm conflicts and cold tensions, it continues to this day due to a situation of perennial tension involving the two Caucasian republics that arose following the collapse of the Soviet empire. The main reason for the water conflicts between Armenia and Azerbaijan is Baku's lack of water sovereignty. Azerbaijan is a country with a high level of water insecurity, as more than 70% of the country's water basins originate outside its borders. This makes the Caspian nation subject to the water policies of upstream countries, including Georgia, Türkiye and Armenia. Moreover, the lack of national water policies aimed at limiting wastage makes Baku extremely vulnerable in terms of water supply, not only for private consumption but also for agricultural production, industry and hydropower generation.

In addition to examining the Nagorno-Karabakh conflict from a water security perspective, this article aims to highlight how Azerbaijan's water insecurity has been a fundamental cause for Baku's policy of aggression against Armenia in recent years. The conflict over control of the enclave is often associated with issues of ethnic nationalism in which both nations involved seek to prevail over each other for purely ethnic and cultural chauvinist reasons. While undoubtedly an essential aspect of the issue, the ethnic element is only one interpretative solution to fully comprehend a conflict that has been active for over thirty-five years. Specifically, this article will propose Azerbaijani's water insecurity from a geopolitical and strategic standpoint as a possible interpretative element to comprehend the dynamics associated with the Nagorno-Karabakh numerous political and military crises.

Theoretical framework and methodology

As mentioned, for the purpose of this paper, the concept of Hydro Strategy (HS) will be essential in assessing the water conflict between Armenia and Azerbaijan. Such confrontation between the two nations centres around the control and management of transboundary water resources, particularly in the contested Nagorno-Karabakh region, which will be the centre of the research. Water, considered as a strategic resource for hydropower and agriculture and, also, as a weapon of influence, plays a dual role in this conflict, influencing both military actions and diplomatic relations. The adoption of HS as a theoretical framework will allow for a deeper understanding of the use of

water resources to assert control over territory and influence negotiations. Specifically, in the Armenia-Azerbaijan confrontation, water resources such as the Kura and Aras rivers and critical infrastructure such as the Sarsang Reservoir have been central to the long-standing struggle. For Azerbaijan, control of water in Nagorno-Karabakh is crucial to irrigating agricultural lands and ensuring water security for downstream regions. At the same time, Armenia has used control of relevant water systems to support its energy and agricultural needs, using water as leverage in negotiations.

The theoretical framework centred around Hydro Strategy allows for bridging the epistemological connection between environmental security and political conflict. In order to comprehensively analyse the case of Armenia-Azerbaijan water tensions, some authors (Wolf 2024; Zeitoun 2008; Homer-Dixon 2024) who have produced several works with a hydro-strategic approach will be mentioned in this paper. Concretely, according to the HS theoretical model, water scarcity, exacerbated by climate change and environmental insecurity, intensifies the diplomatic tension between neighbouring countries. Such tension, as in the case under analysis, became a warm political and military confrontation with both Armenia and Azerbaijan facing dwindling water supplies for multiple reasons. Azerbaijan's water insecurity, combined with a long-aged issue of water scarcity, has fuelled competition for control over water infrastructure, such as dams and reservoirs, with water shortages having direct implications for agriculture and energy security. As argued by several scholars, South Caucasian water infrastructures have been weaponized in the conflict, with both sides accusing each other of environmental sabotage and eco-terrorism.

At the same time, just as it can be used as an instrument of political tension and conflict, water can also play a unifying role between nations sharing transboundary waterways. In this regard, despite its role in the conflict, water also holds the potential as a catalyst for cooperation in Caucasian politics. The theoretical framework of hydro-strategy with an environmentally diplomatic approach suggests that shared water resources could incentivize cooperative management and peacebuilding efforts. Concretely, both Armenia and Azerbaijan depend on the Kura-Aras River basin for drinking water, agriculture, and energy production. Establishing joint water management mechanisms could provide a foundation for dialogue, reducing tensions and promoting regional stability. This integrated and peaceful approach to the management of shared water resources could prevent the occurrence of further water conflicts such as the one over Nagorno Karabakh.

In terms of research methodology, this article relies primarily on qualitative methods to explore the water tensions between Armenia and Azerbaijan. These techniques allow for a more comprehensive approach to conflict analysis, especially when used to examine secondary data and official documents issued by regional and international institutions. Such materials are essential for the purposes of this research, offering outlooks on past and present politics that are necessary for elaborating adequate conclusions from a hydro-strategic standpoint. Specifically, secondary data from academic articles, government documents, and, notably, international organization reports such as those from the International Atomic Energy Agency (IAEA), the United Nations (UN), the World Bank (WB), and the European Union (EU), offer authoritative insights into the water dispute in the Nagorno-Karabakh

region. These reports allow to gather critical data and insight on water security issues concerning the countries involved in the dispute. In addition, by confronting official documents with academic papers, the geopolitical magnitude of water conflicts in the region will be fully examined, particularly concerning the shared river basins like the Kura-Aras basin. While the documents allow to trace the evolution of water tensions, showing how the strategic control of water resources like the Sarsang Reservoir has shifted between the two nations over time, the examination of academic papers on the subject provides a detailed historical analysis.

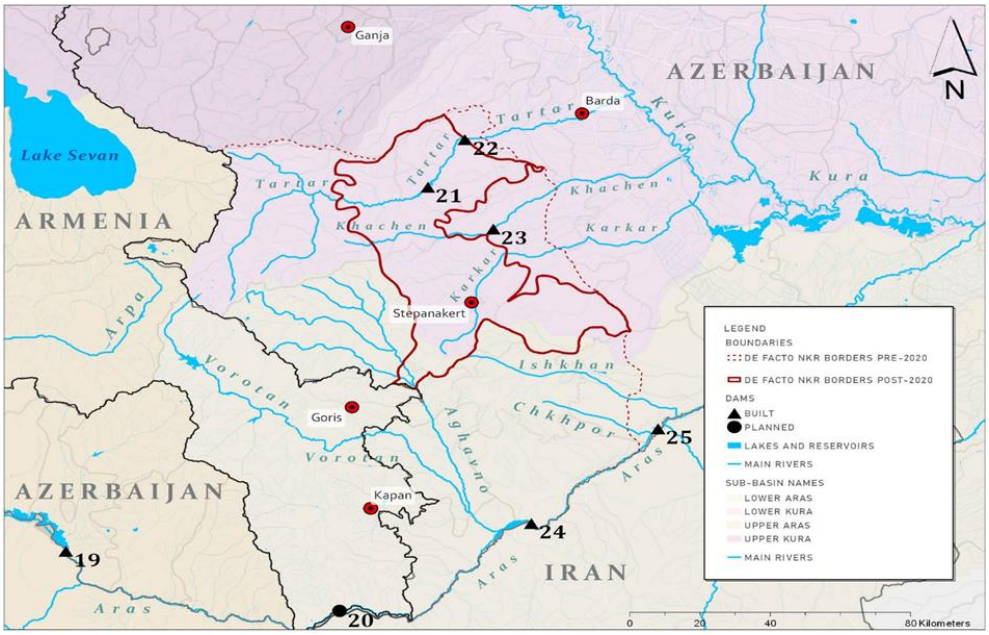
Hydro-strategic tensions between Armenia and Azerbaijan: A historical overview

After the destruction of the Soviet Union, the partition of water resources emerged as a stringent problem in the Eurasian geography (Swain 2004; Stucki et al. 2012). During the Soviet period, the agreements and management systems under the Union ensured its harmonious functioning, in line with a period of domination that facilitated the peaceful resolution of any water-related conflicts. The lack of sovereignty of the various national groups in the Caucasian region prevented water issues from becoming a strategic problem for the various ethnic groups that made up the Caucasian Soviet republics (Hanks 2010). However, in the post-Soviet era, the share of these resources has emerged as an unsolvable problem, like many other problems, as most of the resources satisfying water demand in the region turned into transboundary rivers.

During Moscow's rule, Nagorno-Karabakh had an autonomous status under the Azerbaijan Soviet Socialistic Republic (ASSR), with a mixed population combined of both Armenians predominated in the hills and Azerbaijanis concentrated in the plains (Freizer 2014). In 1921, the Kavburo (the Bolshevik Caucasian Committee), under the leadership of Stalin, decided that the mountainous part of Karabakh would be part of Azerbaijan, and as a result, in 1923, the Nagorno (the Mountainous) Karabakh Autonomous Region (NKAO) was created. Given the significant concentration of the Armenian population in the area, this decision was never entirely accepted and resulted in violent protests in 1945, 1965, and 1977 (Freizer 2014). With the dissolution of the Soviet Union, the Soviet part of the Kura-Araks River basin became transboundary, divided between three countries - Armenia, Azerbaijan and Georgia - that comprise the modern-day South Caucasus. As previously mentioned, the river basin is the lifeline of all these three post-Soviet states as it sustains the socio-economic and sustainable development of the national economies (Abdolvand et. al. 2014; Stucki et al. 2012). Since the beginning of the independence years, several problems emerged due to the overuse of water resources, which led to pollution and a lack of adequate cooperation stemming from the existing political conflict between, mostly, Armenia and Azerbaijan (Abdolvand et. al. 2014). Concretely, in 1988, NKAO declared its decision to secede from Azerbaijan and union with Armenia, which was vehemently opposed by the former that saw Nagorno-Karabakh as part of its territory and national identity. With the dissolution of the Soviet Union, the conflict was transformed into an international confrontation. As a result of the 1991-1994 war between Armenia and Azerbaijan, thousands of people were killed on both sides, and more than half a million were displaced (Sadoff and Grey 2002; Stucki et al. 2012).

After the truce - signed in 1994, following the substantial victory of Armenia - relations between the two neighbouring nations grew tense for a long time but did not result in a real war. For about 20 years, from the mid-90s until 2016, the diplomatic agreements established in 1994 held up with mutual suspicion on the part of Baku and Yerevan (Abdolvand and Mez 2014). In order to try to ensure peace between the contenders, some international organizations were also involved. Specifically, the OSCE established the Minsk Group, which called for mediation of the conflict and assisting in preserving peace (Stucki et al. 2012). In this regard, in the mid-2000s, the Minsk Group proposed a package of principles for a future peace deal, which was officially presented at the 2007 OSCE Madrid Summit and became known as the 'Madrid principles' thereafter. The proposed Madrid Principles included, *inter alia*, the return of the occupied Azerbaijani territories surrounding Nagorno-Karabakh, an interim status of Nagorno-Karabakh and self-governance, and a corridor linking the enclave to Armenia (De Stefano et al. 2017; Hajihoseini 2023). Despite initial positive progress in the talks between the two sides that culminated in the signing of the Moscow Declaration in 2008 reaffirming the intention of both parties to find a peaceful settlement to conflict, the efforts failed, and the talks froze, leaving an environment of tension and distrust between the two nations (Abdolvand and Mez 2014).

Figure 1. A map indicating the river's tributes and hydro plants in the disputed area



Source: Nareg Kuyumjian/Eurasiane 2021

The conflict between the two nations became active again in 2016 with the so-called 4-day war. The fragile truce established in 1994 and reinforced by the Madrid agreements could not withstand the rising tension that had been occurring in the region

since 2007 (Rzayev 2015). Concretely, during the April 2016 clashes, Azerbaijan launched a military campaign aimed at gaining control over territories that could provide vital resources, including those linked to water management, in the disputed area (Turgul et al. 2016; Libiseller 2023). It is essential to consider that it was not an actual conflict but a series of skirmishes and military reprisals between the armed forces of Baku and Yerevan that lasted less than a week. Although the skirmishes were primarily focused on military strongholds and border security, Azerbaijan sought to regain strategic terrain that included areas around the Tartar River, a tributary of the Kura River that is vital for irrigation in Azerbaijani territories, as already pointed out (Libiseller 2023). On the other hand, Armenia wanted to maintain water control in the area, as Yerevan considered the Sarsang Reservoir a key water resource for its internal development and supply. In addition, by keeping the water control, Armenia could exert relevant pressure on Azerbaijan by threatening water supplies. In this regard, it is not a coincidence that Azerbaijani officials frequently pointed to Armenia's control of water infrastructure as a form of "water war" in which water scarcity was used as a tool of coercion (Libiseller 2023; Lawrence et al. 2024). As mentioned, the 2016 skirmishes did not result in significant territorial changes nor in a full-scale regional war. Nevertheless, the limited military confrontations highlighted the ongoing tension over hydro-strategic resources between Baku and Yerevan (Shikhali and Safarova, 2016). Essentially, water infrastructure remained a critical part of the broader conflict, influencing military tactics and long-term political strategies.

In 2020, four years after the 2016 skirmishes, Armenia and Azerbaijan once again clashed militarily in what has been renamed the Second Nagorno-Karabakh War. From a hydro-strategy standpoint, one of Azerbaijan's primary motivations in the 2020 war was to regain control of key territories that housed critical water infrastructure. As mentioned, the lack of reliable access to water, especially from the Sarsang Reservoir, had been a long-standing grievance (Poghosyan 2022; Lawrence et al. 2024). In this regard, Azerbaijan sought not only to reclaim symbolic land but also to secure these critical water resources for its domestic agricultural and drinking water needs. On the other hand, for Armenia, retaining control over water resources in the region had been a significant part of its defence strategy (Libiseller 2023). By holding onto the Sarsang Reservoir and other water bodies, Armenia could ensure a degree of economic sustainability for Nagorno-Karabakh and exercise leverage over Azerbaijan, similarly to the 4-day-war in 2016. The war, which lasted between the 27th of September until the 10th of November 10, 2020, involved intense fighting and advanced military technology between the two opponents (Lawrence et al. 2024). Thanks to its use of advanced military technology, such as, specifically, the Bayraktar TB2 drones and the Israeli Harop loitering munitions, Azerbaijan was able to secure a solid military victory (Libiseller 2023; Poghosyan 2022). The conflict ended with significant territorial gains for Azerbaijan, as Baku regained control of water infrastructures, particularly the Sarsang Reservoir and major rivers. Similarly, the loss of these strategic water assets was a significant blow to Armenia's ability to influence downstream water flows and weakened its economic and military position (Poghosyan 2022; Lawrence et al. 2024).

The military hostilities between Armenia and Azerbaijan reached new heights in September 2023 when a robust defeat occurred for Yerevan's authorities on the war

front after a rapid incursion by Baku's troops. In less than two days, between 19th - 20th September 2023, Azerbaijan conducted a quick attack on the self-appointed Republic of Artsakh. This attack erupted following months of rising tensions, which had included the blocking of the Lachin corridor - the only road connecting Armenia with Nagorno-Karabakh - causing deficits of food, medicine and other essentials for the people of Armenian origins in the region (Libiseller 2023; Lawrence et al. 2024). It is relevant to note that, during the assault, Baku asserted it was not an aggression against the people of Nagorno-Karabakh but an anti-terror operation to neutralize Armenian armed formations in the region. The conflict only lasted for around a day, during which Azerbaijan went on to defeat the poorly equipped Armenian forces (Libiseller 2023). The latter in Nagorno-Karabakh, outnumbered and given no assistance from Armenia's national army, agreed to a ceasefire brokered by Russian peacekeepers on 20th of September. The rapid stabilization of the situation has finally put to rest a historical controversy that had existed over thirty-five years, involving many generations and affecting hundreds of thousands of Armenians and Azerbaijanis. Following Yerevan's defeat, the dismantlement of the Armenian forces in Nagorno-Karabakh was achieved, and the self-state regime in the enclave was obliged to surrender by the 1st of January, 2024. Consequently, nearly the entire Armenian population of Nagorno-Karabakh, around 100,000 people, fled to Armenia, fearing revenge and ethnic cleansing by the Azerbaijani soldiers who remained in the enclave (Libiseller 2023; Lawrence et al. 2024).

The relevance of water management for the Armenia's energy production

The control of water resources is not only a relevant aspect in the geopolitical confrontation between nations sharing one or more waterways but, above all, it ensures economic development, industrial productivity, energy supply and growth in agricultural production. Therefore, reducing the Nagorno-Qarabak water issue to a mere dispute to gain major political control over the opponent is a misleading and incomplete reading. As suggested by two prominent authors who have produced relevant works centred on the concept of Hydro Strategy - Aaron T. Wolf (2024) and Mark Zeitoun (2008) -, water plays a crucial role in creating the preconditions for the internal economic development of a state. The greater the amount of water available to a community, the greater the opportunities for economic growth and integrated development. This situation, in line with the power politics and force dynamics that characterises relations between rival nations, means that national authorities promote control over cross-border water resources, often at the expense of peaceful political and diplomatic relations with neighbouring countries.

Regarding the Armenian scenario, water management is a central issue in many aspects, especially in terms of energy production. The nation receives approximately 592 mm of precipitation per year, or in other words, 18 billion m^3 of annual rainfall (FAO 2016), of which 11 billion m^3 is lost to evaporation (FAO 2016). Its total renewable water resources amount to around 7.7 billion m^3/year (FAO 2016), although 1.4 billion m^3 is the overlap between the renewable surface water (3.9 billion m^3) and the renewable groundwater (4.3 billion m^3), meaning that its annual inner renewable water resources actually amount to approximately 6.8 billion m^3 (FAO, 2016), which is

equivalent to the annual flow of the Kura and Araks River Basins. As shown in Table 1, there are 14 significant sub-basins created through these two main river basins. Essentially, almost 3/4 of Armenia's territory lies within transboundary river basins (Bichsel 2009).

Table 1. River basins in Armenia (FAO 2016)

River Basin	*Area (sq. km)*	*Precipitation (million m^3 per year)*	*Evaporation (million m^3 per year)*	*Flow (million m^3 per year)*	*Reservoirs (2004 in operation*
Debet (within Armenia)	3895	2726	1457	1203	1
Aghstay (within Armenia)	2480	1569	979	445	5
Kura's small tributaries (within Armenia)	810	510	354	199	4
Akhuryan (within Armenia)	2784	1653	972	392	8
Kasakh	1480	979	486	329	6
Metsamor	2240	N/A	N/A	711	25
Hrazdan	2565	1572	876	733	7
Lake Sevan Basin	4750	N/A	N/A	265	4
Azat	952	607	306	232	2
Vedi	998	573	340	110	1
Arpa (within Armenia)	2306	1643	768	764	11
Vorotan (within Armenia)	2476	1828	811	725	7
Voghji (within Armenia)	1341	1097	448	502	2
Meghri	664	470	241	166	-

According to the Falkenmark parameters, which the United Nations accept for the assessment of the clean water situation in certain countries or regions, if the annual water supply is higher than 1,700 m^3 per capita, then the country could be categorized as water-abundant (Falkenmark et al. 1989). On the other hand, any nation with shares below the 1,700 m^3 per capita threshold is deemed water-scarce, and there are several levels of water scarcity depending on the population and the amount of the water drops per capita (Falkenmark et al. 1989). Hydro availability in Armenia for its population of 2.9 million is sufficient to categorize the country as, theoretically, "water-rich". This so-called hydro-wealth, however, is a relative conception, as other significant factors make the water supply index a very volatile and unpredictable variable (Fox et al. 2007; Grey et al. 2003). Factors that contribute to the volatility of these indicators

include transboundary water conflicts, natural disasters, and the water policies of upstream nations.

In the post-Soviet era, in the absence of any mutual agreements, several water-based conflicts have broken out that have profoundly affected Armenia's water security, and the disharmony between Armenia and Azerbaijan is directly related to the transboundary status of the Araks and Kura Rivers (De Stefano et al. 2017; Freizer 2014). Transboundary water conflicts represent a severe dilemma for Armenia, which is faced with two regional solid players such as Türkiye - a real waterpower in the region - and Azerbaijan. Until the Second Nagorno-Karabakh War, Yerevan had maintained significant control over the enclave, being able to count on important water resources on a territory internationally recognized as part of Azerbaijan (Hanks 2010). After the outcome of the conflict, Armenia lost control over the enclave, significantly decreasing its diversification of water supply. Specifically, the Sarsang Reservoir, located within the boundaries of Karabakh, used to provide drinking and irrigation water for many Armenian communities. The reservoir has a capacity of 560 million m^3 and has been under Armenian control for nearly thirty years (1994-2023). Following the defeat in the 2020 and 2023 rapid conflict, Yerevan lost a valid supply source (De Stefano et al. 2017; Freizer 2014).

In addition, beyond the insecurity related to the transboundary nature of its resources, natural disasters play a relevant role in decreasing Armenian water insecurity. In this regard, in 2000, Armenia suffered a severe drought that was devastating to the subsistence farmers inhabiting the mountainous areas who depend on rain-fed irrigation (FAO 2016; World Bank 2017). In that case, the initial losses amounted to $110 million, while the subsequent losses of agriculture products were estimated at $43 million, in a country where agriculture accounts for almost 30% of the GDP and half of the employment (World Bank 2017; Grey et al. 2003; FAO 2016). As a result of low rainfall and high temperatures caused by climate change, precipitation in some areas fell by around 70%. Most of the crops were lost, leading also to a seed shortage the following year. For instance, in 2006, another drought hit, though not as intense, and the resulting crop drop forced Armenia to import cereal to meet its requirements. In recent years, extreme weather events such as droughts, floods, hot, dry winds and hailstorms have become more common, lasting longer and bringing greater devastation. According to a World Bank report (2018), the total damage from 1994 to 2014 is estimated to have reached around $1.5 billion, including severe agricultural damage and industrial losses. Floods caused by climate change and seasonal flows cripple all activities around rivers, particularly in the Araks River Basin, where people have lost their lives, clean water is scarce, and it has not been possible to cultivate sufficient food products (Hettiarachchi et al. 2017; FAO 2016).

As anticipated, water management for Armenia represents an essential driver for internal economic development, especially regarding energy production. In this regard, it is relevant to consider that natural gas, which is Armenia's primary energy source, accounts for almost 60% of the total, while nuclear power provides 22% and hydropower around 10% (IAEA 2019). Regarding electricity in Armenia, nearly 40% is provided by thermal power plants, 30% by hydroelectric power plants and approximately 30% by nuclear power plants (IAEA 2019). Regarding other energy

sources, specifically thermal power, Yerevan can count on an annual capacity of 2.43 gigawatt electrical (GWe) and on the production of around 3.4 billion kWh of electricity (IAEA 2019). Given this scenario, Yerevan faces severe challenges in terms of energy security. First of all, its dependence on foreign resources draws primary attention. More specifically, since it lacks any proven oil or natural gas reserves, three-quarters of the total energy demand in the country is met through imports of oil and natural gas (World Bank 2017; IAEA 2019). Furthermore, it has very limited coal deposits and has no production. Even though nuclear power plants provide a high percentage of the total electricity, the fuel is imported from Russia. Essentially, Armenia has a significant strategic problem, as it must count on other nations for most of its energy imports. In this regard, Armenian authorities are keen to close old-generation nuclear power plants rather than extend their lifespan (Lawrence et al. 2024), seeking more reliable and affordable electricity, and being unwilling to pay millions of dollars only for an extension (Zakhirova 2013; Porkka et al. 2012).

One of the solutions to reduce Armenia's dependence on foreign energy supplies could be to develop hydroelectric power generation through progressive infrastructure upgrades. In this regard, Yerevan's hydropower sector has a total capacity of 1.33 GW (IAEA 2019; World Bank 2018). The Hrazdan and Vorotan rivers are hosts to 10 power plants that generate most of the country's hydroelectric energy. The Sevan-Hrazdan cascade includes seven power plants with a total capacity of 560 MW that are designed to generate 2.3 billion kWh electricity - being the Sevan (34 MW), Hrazdan (81 MW), Argel (224 MW), Arzni (70 MW), Kanaker (102 MW), Yerevan-1 (44 MW) and Yerevan-3 (5 MW) hydropower plants (HPPs). The Vorotan cascade, on the other hand, incorporates three power plants, featuring the Spandaryan (76 MW), Shamb (171 MW) and Tatev (157 MW) hydro-power plants, with a total capacity of 404 MW. In addition to these, there are 187 smaller hydropower plants with a full capacity of 370 MW.

Table 2. Armenian's largest hydroelectric power plants (IAEA 2019)

Name of the plant	*Installed capacity*	*Years of construction*	*General description*
Sevan-Hrazdan	~ 560 MW	1936 - 1962	Integrated system - six total plants
Vorotan	~ 404 MW	1970 - 1989	Armenia's second-largest hydropower system
Tatev	157 MW	1970	Integrated system
Dzora	26 MW	1932	Armenia's oldest water facility
Aragats	25 MW	1948	Armenia's second oldest water facility

It is essential to consider that Armenia has been supplying more than one-third of its total electricity demands through HPPs, and almost three-quarters of the total renewable energy are produced by hydropower (FAO 2016; World Bank 2017). The country's current hydroelectric generation capacity is around 1,325 MW. While the potential water energy resources of Armenia amount to 21.8 billion kWh, the total

electricity generation in 2018 was 2 billion kWh, indicating that the potential is far beyond the current generation. In this regard, production may be enhanced to close the gap between the potential and actual generation. In this respect, hydropower stands as the only domestic resource that could reduce the influence of foreign states in supplying energy sources (World Bank 2018; IAEA 2019). However, it is essential to take into account that the water resources that hydropower in Armenia relies on are mostly fed by transboundary rivers, making them prone to the external effects of nature or other upstream nations' water policies (Zakhirova 2013; Porkka et al. 2012).

Azerbaijan's water insecurity

As mentioned, the severe water insecurity affecting Azerbaijan is one of the primary drivers of Baku's recent (2020 and 2023) military activism in Nagorno-Karabakh. In this regard, although Azerbaijan is the most extensive and most populous country in the South Caucasus, it accounts for only a minimum part - 10% - of the region's total water resources. As previously pointed out, the rivers Kura and Aras are the country's primary water sources, accounting for 80% of overall water use (Oki et al. 2006). Both the rivers are transboundary, meaning that Azerbaijan has no complete control of them and is forced to deal with the water policies of the upstream countries. Specifically, the Kura River originates in northeastern Türkiye and flows through Georgia and Azerbaijan before emptying into the Caspian Sea (Mirumachi 2015). Similarly, the Aras River also originates in northeastern Türkiye. It flows through several countries, including Armenia, Azerbaijan, and Iran, before merging with the Kura River near Azerbaijan's coast, eventually draining into the Caspian Sea (Mirumachi 2015).

In addition to the lack of water on its territory and external control of water flows, Azerbaijan struggles with severe anthropogenic drivers that fuel its water scarcity. One of the main reasons for its water scarcity stems from unsustainable agricultural irrigation practices. Under-maintained canals built during the Soviet era, lack of investment in modern technology and infrastructure, and the bureaucratic nature of local governments all serve as obstacles to improving the irrigation system. According to Hajihoseini (et al. 2024) and Hettiarachchi (et al. 2019), almost 75% of agriculture and irrigation throughout the country had either challenging or poor water supply. As surface temperatures continue to increase (due to global warming), the situation is only expected to worsen in the future. Considering that the primary water sources of the Kura and Aras rivers originate from rainfall, melting snow, and glaciers in the mountains, an increase in the intensity of precipitation resulting in more intense floods and a decrease in snow are expected to cause water scarcity in rivers and aquifers (Hanks 2010). In this regard, throughout the last decade, the country's rainfall has decreased by 30% (FAO 2022). Projections forecast that by the year 2100, water resources will decline by 25% compared to the year 2000. The presence of hydrological infrastructure such as dams and reservoirs on Azerbaijan's rivers cause disruptions in their natural flows, further escalating seawater intrusion and resulting in habitat homogenization. To prevent further harm to their crop fields, many villagers are forced to buy water every two to three days at their own expense, while many people lack access to water due to financial constraints (FAO 2022).

Table 3. Azerbaijan's main water courses (FAO 2022)

Name of the river	*Total length*	*Path length in Azerbaijan*	*Volume flow*
Kura River	1 515 km	900 km - 60% of total length	575 m³/s
Aras River	1 072 km	390 km - 36% of total length	285 m³/s
Qabirri River	320 km	100 km - 31% of total length	50 m³/s
Samur River	216 km	38 km - 18% of total length	70-90 m³/s
Tartar River	184 km	100% of total length	22 m³/s
Ganjachay	98 km	100% of total length	10 m³/s

Moreover, the poor quality of Azerbaijani water resources should be taken into account. In this respect, the primary sources of pollution of rivers and groundwaters in Azerbaijan include the discharge of waste originating in manufacturing, the runoff from the massive use of fertilizers and pesticides in the agriculture sector and the leakage of oil and other chemical substances (Smith 1995) All these factors, among others such the pollutant agents discharged in Azerbaijanis waters from upstream nations, pose severe challenges to the country's water quality. In addition, the pollution of water bodies in the Caspian nation, especially the Kura River, by individuals is one of the unpleasant realities of the current day. Concretely, the most widespread form of pollution by people is the littering of riverbanks with plastic (Sadoff et al. 2005).

Transboundary water management, which, as pointed out, represents a major problem for Armenia, is also a key strategic issue for Azerbaijan. Notoriously and obviously, water recognizes neither political borders nor administrative boundaries. While local pollution is a problem that internally disrupts the quality of water resources, the external challenges stemming from transborder rivers affect not only Azerbaijani citizens but also the lives of people in neighbouring countries (Mirumachi 2015; Libiseller 2023). There are two main aspects regarding these challenges: one deals with the quality and quantity of water; the other is related to the need for internal and shared management of water resources. In this context, 65% of the Kura-Aras basin is located in the South Caucasus, while the rest is split between Iran and Türkiye. Azerbaijan is downstream of both rivers' sources, making it inevitable that all the repercussions of upstream water extraction and contamination pass into Azerbaijan (Libiseller 2023). The main obstacle to the shared management of transborder water resources revolves around the need for an inclusive regional arrangement due to existing political tensions between the states that share the Kura-Aras basin. The conflict between Yerevan and Baku for the control of the Nagorno-Karabakh region, which, as stated, is home to a major reservoir - Sarsang - represent a relevant case in this regard (De Stefano et al. 2017; Freizer 2014).

Azerbaijan places great significance on Nagorno-Karabakh hydro resources as a potential source of hydropower, which can reduce the country's domestic consumption of natural gas and free up more of that resource for export through the recently commissioned Southern Gas Corridor (Lawrence et al. 2024). It is relevant to consider that gas now accounts for 82% of Azerbaijan's electricity mix, but exporting more would improve revenues and support the country in meeting its domestic emissions

targets. As previously pointed out, Azerbaijan's dependence on transboundary hydro politics has constantly worsened water relations with Armenia before, during, and after the Second Karabakh War. Following the positive outcome of the latter for Baku, Azerbaijan gained control of the Khudafarin and Qiz Qalasi dams, two relevant water facilities (Turgul et al. 2024; Libiseller 2023). This allowed for the construction of new power plants, together with Iran - on which Baku and Tehran had already agreed in 2016. The dams gave Azerbaijan some control over the flow of the lower part of the Aras. However, it should be taken into account that the capture of Khudafarin and Qiz Qalasi does not provide Azerbaijan access to new water resources as the flow of the Aras towards the Khudafarin reservoir leans on the water inflow from upstream zones in Türkiye, Armenia and Iran (Turgul et al. 2024; Libiseller 2023).

Discussion

The theoretical framework centred around the concept of hydro strategy allows us to understand how water policies can become a source of tension between states due to its strategic importance as a critical resource for survival, economic growth, energy production and political stability. As claimed by Zeitoun (2008) and Homer-Dixon (2024), in the regions where water is scarce or unevenly distributed, states strive to secure access to as many water sources as possible, leading to competition, and sometimes conflict, over shared transboundary rivers, lakes, and aquifers, as was the case of the Nagorno-Karabakh dispute. The concept of hydro-hegemony, as developed by scholars like Zeitoun, explores how more powerful states can dominate the distribution of shared water resources. In this respect, hydro-strategic policies are often shaped by geopolitical calculations, where control over water is seen as a means to assert dominance over neighbouring states. This can create asymmetrical power dynamics, with upstream states unilaterally dictating water flows and downstream states left in a vulnerable position. Such a situation applies not only in the Nagorno-Karabakh case but in several other scenarios. For example, Egypt's historical dominance over the Nile has been challenged by Ethiopia's construction of the Grand Ethiopian Renaissance Dam (GERD), highlighting how control over water can shift power balances between nations. In some cases, water policies can act as tools of coercion, with states manipulating water flows to exert political pressure. Particularly, this phenomenon is evident in the conflicts between India and Pakistan over the Indus River, where water-sharing agreements are tightly linked to broader geopolitical tensions. Similarly, in the Middle East, control over the Jordan River has been a source of conflict between Israel, Jordan, and Palestine, where water scarcity amplifies territorial disputes (Zeitoun 2008; Homer-Dixon 2024).

It is essential to consider that, according to HS, tensions over water resources are often exacerbated by the lack of effective supranational agreements. The latter, particularly when absent or teleologically weak, leave countries to pursue unilateral water policies that, as mentioned, maximize their own resource exploitation at the expense of shared management and cooperation. This imbalance, predictably, creates a fertile ground for disputes. Water resources, especially those that cross international borders, require coordinated management to prevent over-exploitation and ensure fair distribution. Without supranational frameworks, tensions and conflicts will likely erupt

with severe sociopolitical consequences for many communities and hundreds of thousands of people dwelling near water dispute areas (Zeitoun 2008; Homer-Dixon 2024).

One of the core problems underlying the water tensions in the South Caucasus region is the inadequacy of the current transboundary water resource management system, which is both too complex and-or uncoordinated. For example, Georgia, a country upstream from both Armenia and Azerbaijan, has separate hydro strategic agreements with Yerevan and Baku signed in different years that pursue different objectives. In 1998, Azerbaijan and Georgia signed the Environmental Protection Agreement (EPA) to address environmental issues in the South Caucasus region, particularly concerning shared natural resources like water and air (Freizer 2014). The agreement was mainly aimed at fostering environmental cooperation, joint monitoring, strategic ecological data sharing and transboundary water management, especially regarding the Kura River (Sadoff et al. 2005; Bichsel 2009). Although this was an important agreement between two key nations in the Caucasus region, it was a separate operation and not tied to a regional collaborative approach. In this regard, in 1999, Georgia signed a separate agreement with Armenia that pursued similar objectives but with different strategic goals (Bichsel 2009). Besides generic intentions of environmental cooperation, one of the critical aspects of this agreement focused on transboundary water management, especially concerning rivers like the Debed and Khrami that flow between the two nations (Sadoff et al. 2005; Bichsel 2009). Tbilisi and Yerevan agreed to cooperate to prevent pollution, improve water quality, and ensure sustainable usage of water resources for both national economies (Hanks 2010). In addition, a key element of the agreement was the promotion of joint environmental monitoring and data-sharing efforts, similarly to the Georgia-Azerbaijan agreement signed a year prior. Essentially, both nations committed to regularly exchanging information on environmental conditions, particularly air and water quality, to manage pollution and other environmental risks in a more efficient and joint way (Sadoff et al. 2005; Oki et al. 2006).

Figure 2. Map of the Kura (Mtkvari) - Aras River system in Armenia, Azerbaijan, Georgia, Iran and Türkiye

Source: US Geological Survey: https://www.usgs.gov/

In order to solve the critical water tensions in the South Caucasus region and maintain a sustainable regulatory framework, effective coordination must be assured between government agencies and other stakeholders. The main objective is to eliminate power politics mechanisms that prevent states from cooperating on water issues, as in the case of the various conflicts in the Nagorno-Karabakh dispute. Indeed, other aspects have contributed to fueling tensions between Armenia and Azerbaijan, including identity-based nationalism and ethnic claims (Sadoff et al. 2005; Oki et al. 2006). However, the supremacy of regional water control represents one of the main drivers that have pushed the two nations into repeated military actions and harsh confrontations for over 35 years. A solution that could bring benefit to the region is the adoption of the so-called Integrated Water Resources Management (IWRM), which, according to the UN, is a "process that promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare equitably without compromising the sustainability of vital ecosystems." (Abdolvand et. al. 2014, 907). In the Armenia-Azerbaijan case, one of the main factors of this model is the involvement of water users and interest groups in the management and formation of a peaceful and joint water policy aimed at adopting shared solutions. Identifying joint solutions to common problems could, over time, foster an environment of institutional trust between the two countries and stimulate dialogue, peace, and prosperity (Fox et al. 2007; Freizer 2014).

Conclusion and discussion

The issue of water availability and shared water resource use is particularly acute today in the countries of the South Caucasus. The high hydrological dependence between the countries of the region is characterized not only by the large number of participants but also by the uneven distribution of water resources. The South Caucasus is considered one of the regions with the highest levels of water availability globally. However, inefficient water use, the lack of modern technologies, the need to constantly increase food and industrial production to feed a rapidly growing population, and the deterioration of irrigation structures and water conservation systems have already led to acute water shortages, both in rural areas and desert zones, as well as in industrial centers and foothills.

The breakdown of economic and interdepartmental ties between the former Soviet republics of the South Caucasus region led to a widespread decline in production and a decline in water resources. The well-established operation of reservoirs and energy supply systems began to falter. The South Caucasus states faced the challenge of resolving issues related to the shared use of the region's hydropower resources, which had previously been centrally managed. Changes in the political and economic situation in the region led sovereign states to seek to use water resources primarily for their own national interests.

Water resources in the South Caucasus have always had and continue to have a significant impact on the economic activities of the region's states, as all major rivers cross the territories of two or more countries. Any change in water use by one country, which shares aquatic ecosystems, or any impact on the condition of water bodies through the construction of water management structures, inevitably impacts the interests of others. Moreover, incoordination can lead to conflict, as the consequences are often adverse for downstream countries, both in terms of economic development and social and environmental outcomes.

Certain norms of international law, including regional agreements, have now been established regarding water use and the management of transboundary water resources. However, these agreements are characterized by the specific characteristics of their respective basins, and therefore, attempts to universalize them face significant difficulties. Meanwhile, the need to develop common approaches to the distribution of water resources in transboundary rivers is continually growing.

While the Nagorno-Karabakh conflict is often viewed primarily as a purely ethnic dispute between Armenians and Azerbaijanis, a deeper analysis presented in this article reveals that control over water resources played a decisive role in the Second Karabakh War of 2020 and fueling tensions between the two countries. The region's geography, dominated by crucial transboundary rivers, reservoirs, and irrigation systems, made water a strategic asset in the conflict. Both Yerevan and Baku depend heavily on these water resources for agricultural productivity, drinking water, and energy, especially in an increasingly water-scarce environment influenced by climate change.

With the dissolution of the Soviet Union, the water security matter achieved more significant prominence, as what was once Soviet resources became transboundary. Just like the other regional countries, Armenia and Azerbaijan were left with no laws or regulations related to the sharing of hydro resources, which thus became an obstacle

standing in the way of regional cooperation and the assurance of a broader and regional water security framework. Looking at Armenia's and Azerbaijan's water resources and the annual flow rates, it is important to understand that two factors must be taken into account: the shared status of all of its water resources and the threat of natural disasters or environmental impacts. The absence of a proper, functioning regional cooperation agreement related to water politics clearly makes Armenian and Azerbaijani water security vulnerable, given the potential for conflicts over the share of water or clashes that have consequences on water security. This issue is exacerbated by the suitability of the geography for natural disasters, which makes the situation even more complex.

In order to limit the risk of escalation, it would be desirable to set up a form of institutional dialogue focused on the joint management of transboundary water resources. This solution could include the creation of a supra-national commission composed of experts, politicians and analysts from both countries to oversee the agreements between the two nations to foster fair and sustainable water resource management. For Armenia and Azerbaijan, beyond their survival, food, humanitarian, developmental and agricultural needs, the energy sector is also heavily dependent on water security since both aim to increase their share of hydropower electricity. Armenia, as mentioned, to reduce foreign dependency on the supply sources and Azerbaijan to increase gas exports by reducing internal usage. In the event of any decrease or uncertainty in their access to water, both countries, following a dynamic related to the concept of hydro-strategy, could find themselves in a chaotic situation, with the potential to turn into catastrophes of different extents that could be extremely expensive for Baku and Yerevan. Such a situation could trigger a perilous spiral of water tensions, capable of seriously impacting regional stability. Essentially, Azerbaijan and Armenia's water security is extremely vulnerable to threats, and the insecurity in this area makes the topic of energy security even more important.

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The author affirms this research did not involve human subjects.

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