International Journal of Sustainable Studies, Technologies, and Assessments

IJSSTA

Review Article

Aras Basin Model: Strategic Governance under Political Non-Recognition

Eleonora Sala
University of Bologna
eleonorasala.96@outlook.com

Received: 11 Feb 2026 / Revised: 28 March 2026 / Accepted: 04 April 2026 / Published online: 12 April 2026
https://doi.org/10.5281/zenodo.19524605

Abstract: The Kura-Aras Basin passes through five states in the South Caucasus and Central Asia. It represents a hydrogeographic basin of primary importance for the survival and development of local populations. However, uneven relations among the countries involved hinder the coordinated management of water resources, compromising both the quality and quantity of water available in the basin. The countries involved maintain heterogeneous relationships, thereby altering the optimal management of the resource. In a context of increasing water stress, this lack of cooperation generates significant economic, social, political, and environmental critical issues. This paper analyses the Kura-Aras basin, but with particular attention to the Aras course, as a case of legal and diplomatic vacuum in the governance of transboundary waters, highlighting its hydro-strategic implications. This article argues that adopting co-management mechanisms based on next-generation legal and technical instruments can reduce the risk of structural, irreversible degradation of the basin while strengthening regional stability. Specifically, this article aims to provide a new management model inspired by comparative trends and ad hoc systems.

Keywords: Aras-Basin; Armenia; Hydrostrategy; Transboundary Diplomacy; Juridical vacuum; Natural Resources; Caucasus; International Water Law.

1. Introduction

Sustainable management of transboundary river basins is one of the most complex and sensitive challenge at local, regional, and global levels. Watercourses shared among many States, require coordinated governance arrangements, effective legal instruments and institutionalized cooperation practices with the aim of ensure equal, equitable and sustainable application of resources. Such a structure, undoubtedly, makes it possible to prevent conflicts and protect ecosystems in their integrity and quality. In the absence of such mechanisms, water management reflects political and economical power asymmetries, leading to potentially destabilizing effects for the concerned regions. The literature on hydro-politics has extensively analyzed basins characterized by strong geopolitical tensions. Some examples of river basins are the Nile, the Tigris-Euphrates or the Indus.

Specifically, these examples highlight how upstream infrastructure, climate change, and rising water demand can exacerbate conflictual dynamics between riparian States. However, a still largely unexplored part of the debate concerns contexts in which water cooperation is hampered not only by divergent interests but by the

consistent absence of formal diplomatic relations. As well as mutual political recognition and active political relations. In these cases, the traditional instruments of international water law are difficult to apply. Also, they leave significant institutional gaps in the governance of the resource. The Aras River basin fits fully into this critical framework. It is located in a region characterized by fragile structural policies; the basin represents an emblematic case of transboundary water management under conditions of limited and discontinuous cooperation.

In particular, the lack of institutional dialogue raises fundamental questions about the effectiveness of equitable principles, reasonable utilization, and the prevention of significant harm in the absence of shared operational mechanisms. This work aims to deepen the understanding of the Aras basin's structure to analyze the nexus among hydro-policy, international water law, and regional stability. In addition, a focus on the strategic implications of policy non-engagement in transboundary water resources management. The aim is twofold. On the one hand, the aim is descriptive. It concerns highlighting the structural limitations of current legal frameworks in contexts of non-diplomatic recognition. On the other hand, the aim is proactive. It is related to exploring possible alternative governance approaches, including technical tools and mechanisms for indirect or mediated cooperation, that can reduce the risk of irreversible environmental degradation and strengthen regional resilience.

To analyze this issue, the article seeks to answer a research question from two perspectives. The first concerns how cross-border water resource governance can be structured in contexts of political non-recognition and institutional fragmentation, while the second explores which institutional model could reduce hydro-strategic vulnerability in the Aras basin.

2. Literature Review

2.1 Transboundary Water Governance

The issue of transboundary water use should not be underestimated. Current data shows that approximately 60% of freshwater sources are depleted. This evidence requires serious attention. In light of this, the literature on hydro-politics highlights how water resources are progressively securitized and integrated into state power strategies. This is especially true in contexts characterized by political instability, latent or open conflicts, and geopolitical rivalries.

In this scenario, water is not only an essential natural resource but also takes on strategic value, becoming an instrument of political leverage. In transboundary basins, the river's course (upstream or downstream) determines structural asymmetries in control and decision-making capacity.

Hydro-strategy manifests itself concretely through infrastructure interventions, such as dams, reservoirs, and diversion systems, which allow states to regulate the quantity, timing, and quality of water flows. In the absence of effective cooperation mechanisms, such interventions mainly reflect unilateral national interests, reinforcing dynamics of “water dominance” and reducing the scope for shared resource management. This may suggest that water management in conflict areas is not simply inefficient but also structurally politicized, with direct implications for regional stability and human security.

A. Comparative basins

Comparative studies of important transboundary river basins show that the presence of political or military conflicts between riparian States does not necessarily and non-derogably exclude forms of water

cooperation. Although it may seem counterintuitive, there are cases that demonstrate the possibility of developing cooperative relationships through different tools. For example, legal instruments such as agreements or joint commissions, strategic instruments such as technical channels of dialogue, and political instruments capable of maintaining active water management of basins. The use of these tools shares a common goal: the maintenance of water resources in qualitative and quantitative terms. The Nile case, the Tigris-Euphrates case, and the Indus case are examples of cases where effective cross-border governance has been demonstrated through the implementation of these techniques, both individually and jointly.

First, the Nile is shared by eleven countries, including Egypt, Sudan and Ethiopia. Historically, water allocation was managed by colonial era agreement. Notably, treaties signed in 1929 and 1959 that granted Egypt and Sudan the majority of water rights. In consequence, excluding upstream counties. An example of cooperative management was the Nile Basin Initiative (1999), promoting equitable utilization and data-sharing. However, this tentative was destroyed by the intensification of tensions following the construction of the Grand Ethiopian Renaissance Dam, in the western part of the Benishangul-Gumuz region (Ethiopia). Governance mechanism therefore rely heavily on diplomatic negotiations and water principle such as the norm of equitable and reasonable utilization. Secondly, the Tigris and Euphrates rivers originate in Turkey and flow thought Syria and Iraq. Turkey's large-scale hydraulic development program – Southeastern Anatolia Project (GAP), has significantly altered downstream flows with the dam construction and irrigation schemes. Water management in this basin is based on bilateral protocols such as the 1987 temporary agreement between Turkey and Syria.

In the end, the Indus River originated in the Tibetan Plateau and lows trough India before reaching Pakistan. This country is strongly dependent on the basin for agriculture and hydropower. The Indus system is governed by Indus Water Treaty which is a comprehensive and legally binding agreement brokered by the World Bank in 1960. This treaty established a Permanent Indus Commission, which is a bilateral entity responsible for data exchange, inspections and dispute resolution. Notably, the treaty has survived multiple armed conflict between India and Pakistan demonstrating a significant degree of institutional resilience. In case of tensions, which periodically arise due to hydropower project or interpretations of treaty provisions, there is the intervention of tools as arbitration or neutral expert proceedings.

Despite deep geopolitical tensions, historical rivalries and armed conflicts, the existence of agreements, joint commissions or technical channels of dialogue it's strongly proved. The aim of those instruments is proposing the shared management of water resources which also have been developed over time. In case of high conflictual contexts, water cooperation could persist, and it could sometimes serve as a relatively depoliticized sphere or space for functional dialogue, as evidenced by these examples. It's evident how states with greater infrastructural know-how are generally the same that impose a dominant mechanism. This asymmetric dimension is the core of the difficulty of transboundary water management. It isn't entirely due to the conflict, but rather because the cooperation isn't institutionalized and the actors involved don't have formal channels for transparent interaction.

B. Fragmentation and governance voids in the South Caucasus

The literature on the South Caucasus highlights how the management of transboundary natural resources is strongly influenced by the following factors. The first is the structural political fragilities, the second is unresolved conflicts, and the third is the absence of inclusive regional institutional architectures. In these areas, environmental and water cooperation tends to occupy a marginal position to priorities such as security, territorial

sovereignty, and the consolidation of state power. It often results in broader geopolitical dynamics. Water management is a requirement that effectively makes a state *sovereign* by guaranteeing water supply to the population that depends on Riviera resources. In the Caucasian context, the lack of or discontinuity in diplomatic relations between some states severely limits the possibility of developing concrete multilateral water management agreements. According to the literature, institutional fragmentation creates governance vacuums in which the principles of international water law are largely unapplicable. Therefore, it is suspended between the application of operational tools or without them. This framework tends to treat river basin management as a patchwork of independent national policies rather than a coordinated system, thereby exacerbating environmental vulnerability and the potential for transboundary tensions.

The Aras River basin is a case that is particularly relevant. The reason is that political non-recognition and institutional fragmentation combine to limit the minimum forms of water cooperation. The prolonged water blocks in the South Caucasus can be considered a regional "public evil". In addition, under the lens of international humanitarian law, a war crime could be committed if civilian water supplies and irrigation infrastructure of the Kura-Aras basin are disrupted. For instance, as happened during the Nagorno-Karabakh conflict.

3. Proposed Methodology

This work adopts an interdisciplinary analytical framework to capture the complexity of transboundary water governance in contexts of political non-recognition and limited cooperation. The analysis combines international water law instruments, comparative approaches, geopolitical, and strategic perspectives. In order to examine the Aras basin not only as a hydrographic system, but also as a political-institutional space. Its characteristic feature is the asymmetrical power dimension, and at the same time, it is the governance gaps. The purpose is to understand the strategic development of water and the exercise of power over this resource. Moreover, it includes a multidisciplinary analysis that combines quantitative approaches concerning hydroclimatic data with legal, institutional, and geopolitical approaches.

A. Quantitative Analysis

The quantitative component aims to assess the basin's structural hydro-climatic stress and to support the urgent need to establish cross-border coordination and regulatory mechanisms. The objective is not to produce predictive hydrological simulations, but rather to identify long-term variability patterns relevant to hydro-strategic analysis. Hydrological and climatic data for the period 1990–2024 were acquired through national information services and integrated with global open-access datasets. These include satellite products and reanalyses such as CHIRPS, MSWEP, PERSIANN-CDR and GLEAM (1981–2022). Commonly, they are used to assess precipitation and evaporation flows. Due to limited ground-based meteorological data availability in the countries bordering the basin, satellite products were evaluated by comparing them with rainfall data from the Iranian portion of the basin, using 18 validation stations.

Drought indicators (SPI, SPEI) and long-term trend analyses, developed in existing scientific studies and technical reports using non-parametric methods such as the Mann–Kendall test and Sen's slope estimator, are used in this study as secondary empirical evidence. These results are not recalculated here but are integrated into the analysis to support the assessment of the basin's structural water vulnerability.

Climate variability, temperature trends, annual precipitation indices and snow persistence — a crucial element for the recharge of water resources — were examined using zonal statistics in a GIS environment. Anthropogenic pressure was assessed through the geolocation and temporal categorization of the main hydraulic infrastructures, with particular reference to the number of dams built after 1990, the extent of irrigated areas (in hectares), and the timing of reservoir filling. The infrastructure was divided by construction period (pre-1995, 1995–2010, post-2010) to highlight the progressive intensification of anthropogenic regulation of the river system.

B. Regulatory Analysis

Another method of analysis is the regulatory one. The conventions, treaties and cooperation institutions examined were used as regulatory benchmarks. The use of these regulatory and institutional means was not merely explained but analyzed as sources of inspiration for the governance model that this paper aims to present. They are:

- Convention on the Protection and Use of Transboundary Watercourses and International Lakes
- Convention on the Law of the Non-Navigation Uses of International Watercourses
- Principle of International Law of Watercourses
- Bilateral and Multilateral Treaties
- International Organizations

C. Theoretical Framework

The implementation of infrastructure and control of cross-border water resources should also be interpreted as a structural, systemic and political lever. The exercise of control over water resources, which is unevenly distributed among neighboring countries, results from pressure from “stronger” countries on “weaker” ones. This framework is at the heart of this study, as it is not the power of one state that should determine how other neighboring states use the same resource. The strategic levers of states should not be considered legitimate means of imposing their governance on other countries. They are:

- Neo-Functionalism
- Securitization Logic
- Hydro-Hegemony Theory
- Multi-level Governance

Data collection and analysis led to consideration of the correlation between multiple factors. The correlations are: climate trends and increased variability; infrastructure and information asymmetry; governance and reduced systemic vulnerability.

4. The Aras Basin Case Study

4.1 Geographic Analysis

Figure 1. Map of the Aras River basin showing the course of the basin through the riparian states. *Source*: United Nations Development Programme (UNDP), United Nations Office for Project Services (UNOPS), Reducing Transboundary Degradation in the Kura-Aras Basin, Project Document.

The Aras River represents one of the major transboundary watercourses of the South Caucasus and Eastern Anatolia. It rises in northeastern Anatolia, in Turkish territory, and extends for approximately 1,072 kilometers, crossing (or delimiting) the borders of Turkey, Armenia, Azerbaijan and Iran, before flowing into the Kura River and reaching the Caspian Sea. For long stretches, it forms an international border, particularly between Armenia and Iran and between Armenia and Azerbaijan (about 475 km). The Aras basin covers an area of approximately 100,000 km² and is an essential component of the larger Kura–Aras hydrographic system, on which millions of people depend for water supply, agricultural irrigation, energy production, and local economic activities. The annual flow of the river varies considerably as a function of climatic conditions and location along its course. At the Aras Dam, the average annual volume is estimated to be around 8.4 km³/year, while near the confluence with the Kura system and the entrance to the Caspian Sea it is significantly reduced.

Therefore, the average annual precipitation over the entire basin is approximately 565 mm, but presents marked spatial heterogeneity. From a hydrogeographical perspective, the catchment area is characterized by high climatic and seasonal variability. Peak discharge is determined by precipitation in winter and spring, as well as by snowmelt, which has a significant influence on the discharge regime.

In recent decades, these natural processes have been progressively modified due to rising temperatures, the increase in frequency and intensity of droughts, and a decline in per capita water availability. The system's vulnerability to climate change results from these factors, which have significant effects on the environment and on socio-economic and transboundary water governance.

4.2. Treaty Analysis

This level of analysis requires an assessment of bilateral and multilateral agreements between cross-border countries concerning the Kura-Aras basin, in some cases covering the Aras portion of the river basin. A bilateral agreement was signed in 1957 between the Islamic Republic of Iran and the Soviet Union. The subject of this agreement is the joint use of the transboundary waters of the Aras – also known as Arkas – and other rivers for irrigation and energy production. This is undoubtedly the most important bilateral agreement concerning the Aras basin since the Soviet era. More specifically, it regulated the specific transboundary use of water and energy. After the collapse of the USSR, it continued to have de facto influence despite its actual legal inapplicability. This phenomenon occurred because other former Soviet states also maintained the application of these rules in subsequent bilateral relations. From a regulatory point of view, it is not a modern treaty but remains a point of reference.

Since 2016, Azerbaijan and Iran have signed technical and management cooperation agreements for the construction, management and use of the Giz Galasi reservoir, a facility on the Aras River on the border between the two states. This agreement is both sectoral, in that it specifically concerns cooperation on a specific infrastructure, and bilateral, in that it involves only two States and is not multilateral in nature.

From the point of view of water governance, there is no multilateral framework treaty signed by all riparian states, such as the Indus Water Treaty or the Agreement on the Nile Waters. In this regard, it is necessary to analyse the historical territorial delimitation treaties that also cover river banks. These are bilateral agreements that do not directly concern border management but end up regulating it indirectly.

Interstate technical cooperation projects are a separate issue. Although they are not binding agreements, they create a favourable context for the conclusion of international agreements. These programmes have resulted, for example, in technically agreed documents or intervention/action plans. These documents represent, to all intents and purposes, multilateral technical agreements.

Among these programmes, it is worth mentioning:

- SAP programmes aimed at reducing cross-border degradation in the Kura basin, agreed upon within the framework of UNDP-GEF projects;
- Joint Action Plan between Azerbaijan and Georgia;
- Financial cooperation projects promoted by the European Union.

4.3. International Transboundary Water Law Analysis

The legal analysis of the Aras basin falls within the framework provided by international transboundary water law, which defines principles and instruments aimed at ensuring the equitable, sustainable and cooperative use of shared water resources. These principles are not considered in this work as abstract norms. By contrast, they are used as analytical parameters through which to assess the gap between the formally applicable legal framework and actual basin management practices. In particular, the principles of equitable and reasonable use and the obligation not to cause significant harm constitute the regulatory core aimed at governing relations between upstream and downstream states, especially in transboundary river basins. They were created out of the need to discourage unilateral behaviour that could adversely affect the quantity and quality of shared waters. In this way, obligations of diligence, prevention and cooperation are imposed on riparian States. These principles are accompanied by an strong suggestion to cooperate, which includes data exchange, joint monitoring and the

adoption of preventive measures. In view of this. all of them are essential for the integrated management of the entire basin. The main regulatory instruments of reference are the 1992 UNECE Convention and the 1997 United Nations Convention on International Watercourses. Specifically, the following features are noteworthy.

- The UNECE Convention is the most advanced institutional model. It provides for the creation of joint basin organizations and structured cooperation mechanisms; however, its effectiveness is strictly dependent on formal ratification and the existence of functioning diplomatic relations between the States concerned.
- The 1997 UN Convention, while codifying similar principles and largely reflecting customary international law, lacks coercive instruments and binding operational procedures in the absence of bilateral or regional implementation agreements.

In evidence of that, the Aras basin highlights particularly the structural limitations of this regulatory framework. Turkey's failure to ratify the UNECE Convention, combined with the absence of formal diplomatic relations between Turkey and Armenia, prevents the creation of basin agreements and joint management bodies. Consequently, the principles of international law on transboundary waters are formally applicable but essentially lack concrete instruments for their implementation. This misalignment or gap between law and practice creates an institutional vacuum that directly affects water flow management, pollution prevention and the ability of downstream states to protect their water interests.

4.4. Economic Analysis

Water is an essential input for the local economy and agricultural productivity. Specifically, the socio-economic importance of the Aras basin is closely linked to irrigated agriculture and rural settlements with surface water resources. In particular, the areas downstream of the river, in Iran and Azerbaijan, are highly exposed to variations in the flow regime, both in terms of quantity and quality of available water. The main crops, including cereals and vegetables, are highly sensitive to the flow index, with significant economic losses possible in the event of water scarcity. Scarcity or deterioration in quality entails direct costs, such as reduced agricultural production, and indirect costs, such as the need for alternative infrastructure for pumping or treating water. The economic quantification of these effects enables the strategic value of water for communities in the basin to be estimated and guides more efficient management interventions. The sustainable management of river ecosystems is therefore not only an environmental issue, but also an economic one.

With hydro-economic models, it is possible to simulate future scenarios, considering climate change, variations in water demand and management policies. Measures such as adopting more efficient irrigation techniques, improving water quality and protecting river ecosystems can increase the resilience of communities and transform water availability into an opportunity for sustainable development.

4.5. Institutional and Political Analysis

As anticipated, latent tensions and international conflicts, especially between neighbouring states, also significantly damage the management of shared natural resources. The Nagorno-Karabakh conflict means that the Kura-Aras basin remains divided by hundreds of kilometres of fortified trenches, minefields and artillery positions, from the Georgian border, through Azerbaijan and Armenia, to the Iranian border. This situation has resulted in the loss of 20% of Azerbaijan's arable land and prevents any agreement on water distribution with

Armenia. Despite border tensions between Azerbaijan and Iran, the two countries continue to adhere to agreements concluded by the Soviet Union, including provisions on water distribution and the joint management of an artificial reservoir for irrigation. Recent talks between Azerbaijan and Georgia on water distribution have been hampered by disputes over border demarcation, while negotiations between Georgia and Armenia on water distribution still appear unlikely, given the tense situation in some areas of southern Georgia. As a riparian state of the Black Sea basin, Georgia participates in several cooperation projects for the prevention of water pollution and the protection of wetlands.

However, there are no cross-border management agreements for the Rioni, Enguri and other watercourses. The basin is crossed by the Abkhaz conflict lines, making the area unsafe. The previous institutional structures for resource management in the South Caucasus were destroyed by the Soviet system, which remained in place until the separatist wars of 1990–1994. To a certain extent, the conflicts in Karabakh, Abkhazia and South Ossetia can be seen as renewed economic disputes over water resources. Both in the negotiations between Azerbaijan and Armenia on the Nagorno-Karabakh conflict, conducted under the auspices of the OSCE, and in the talks between Georgia and Abkhazia, led by the United Nations, the discussion on the rehabilitation of water resources is limited to areas where internally displaced persons (IDPs) are expected to return. After the failure of the 1999 OSCE Summit in Istanbul, peace negotiations stalled, including the OSCE proposal to assign the Armenian bank of the Aras River to Azerbaijan as part of a complex land swap. However, an extension of Turkish-Azerbaijani control over the entire northern bank of the Aras would exacerbate tensions with Iran and jeopardise the current water distribution agreement between the two countries.

4.5. Strategic Analysis

Added to this picture are the infrastructural pressures exerted by upstream flow regulation measures, particularly through the construction and operation of dams and artificial reservoirs. While formally embedded within national economic development and water security strategies, such infrastructures function as instruments of structural control over basin hydrology. By altering seasonal flow variability, sediment transport and downstream availability, they effectively reshape the hydro-political balance of the basin. In contexts of political non-recognition and limited institutional coordination, upstream regulation acquires a strategic dimension: control over storage and release timing translates into asymmetric adaptive capacity under conditions of climatic stress. This dynamic increases downstream environmental vulnerability while consolidating upstream bargaining leverage. Taken together, these elements position the Aras basin as an emblematic case where environmental fragility, infrastructural asymmetry and institutional fragmentation converge, creating a structurally unstable hydro-strategic configuration prone to escalation under scenarios of intensified hydrological variability.

4.6. Diplomatic Analysis

The absence of formal diplomatic relations between Turkey and Armenia is a structural factor that directly affects the management of shared water resources. More generally, it also affects the balance between riparian states and the balance in the management of this highly sensitive resource. This situation prevents the creation of basin agreements, joint management bodies and mechanisms for the systematic exchange of data, creating an institutional vacuum that enhances the asymmetries between upstream and downstream states. This is a completely asymmetrical relationship between upstream and downstream states, which is one of the most critical potential issues in multinational river basins. In the absence of binding agreements and operational

cooperation mechanisms, upstream states have significant discretion to regulate flows and manage environmental pressures, with cross-border effects that are difficult to challenge legally. It is precisely this combination of structural asymmetries and lack of institutional instruments that makes the Aras basin an emblematic case for analysing the limits of international water law in contexts of political non-recognition.

4.7. Environmental Analysis

A recent study has shown that the average annual flow of the Aras has decreased significantly. In the period prior to 1990, the average annual flow to a large reservoir was approximately 4,500 million cubic metres. In contrast, after 1995, it fell to approximately 3,700 million cubic metres per year. This represents a reduction of approximately 800 MCM/year. This data is very important, and the causes of this decrease must be correctly identified and addressed at their root. Climate change certainly plays a negative role, given the sharp rise in temperatures. Similarly, the construction of dams and reservoirs in Turkey and other countries in the basin is damaging this balance by retaining an increasing amount of water.
1995 is a watershed year and provides an effective benchmark, even though there are no tabular analyses covering the period from 1990 to 2025.

Analysis of the data clearly shows that the time series of annual precipitation, actual evaporation and potential for the entire basin for each country has undergone changes. Annual precipitation has increased in all riparian countries. However, there are significant upward trends. Specifically, the confidence levels are 95% and 90% in Azerbaijan (ZMK=1.99) and Armenia (ZMK=1.71), respectively. The upward trends in Iran (ZMK=0.33) and Turkey (ZMK=1.60) were not significant, but the change was slower in Turkey. The upward trend in annual precipitation in the ARB was also not significant (ZMK=1.63). Actual and potential evaporation s how upward trends in all countries and in the ARB with a 95% confidence level (ZMK>1.96), except for actual evaporation in Iran with a non-significant positive trend (ZMK=1.58). These precipitation and evaporation trends would lead to an analysis consistent with that of the evaporation ratio and aridity index. According to Budyko's model, Turkey and Armenia are located in more humid areas than Iran and Azerbaijan, as the aridity index is mostly below unity in these two countries. Aridity has worsened in Iran, an indicator of a significant increase in temperatures, especially compared to other coastal countries. The evaporation ratio has decreased in Turkey (ZMK=-1.13), Azerbaijan (ZMK=-0.93), Armenia (ZMK=-0.26) and ARB (ZMK=-0.33) and has increased in Iran (ZMK=0.69). The aridity index trend has been downward in Azerbaijan (ZMK=-0.95) and Armenia (ZMK=-0.26) and upward in Iran (ZMK=0.43) and Turkey (ZMK=0.22).

4.8. Integrated Basin Analysis

The absence of institutionalised and concrete cooperation mechanisms in the Aras basin has effects that are not limited to the political and diplomatic sphere, but are directly and cumulatively reflected in the environmental quality of the river system. In this context, environmental degradation cannot be attributed solely to isolated anthropogenic pressures. Althought, as a structural consequence of fragmented governance and unilateral management of water resources. One of the most obvious effects of non-cooperation in the Aras basin is the progressive deterioration of water quality. Intensive agricultural activities, industrial discharges and urban wastewater contribute significantly to the pollution of the river. In the absence of shared environmental standards and cross-border monitoring systems, these pressures remain largely unregulated. Consequently, this makes it difficult to identify responsibilities and prevent damage downstream. The lack of systematic exchange of

hydrological and environmental data also prevents the adoption of early warning systems in the event of accidental contamination or extreme events. This information deficit increases the vulnerability of downstream states and local communities, undermining the *principle of prevention of significant harm* enshrined in international water law.

Infrastructure initiatives aimed at managing upstream water flow. In particular, the construction of dams and reservoirs have significantly altered the natural patterns of water movement in the Aras River. These initiatives affect seasonal flow dynamics, making them less predictable and disrupting the ecological rhythms of river environments. In the absence of coordinated management, the ecological consequences of such infrastructure are assessed only on a national basis, without considering the entire basin. As a result, there is increasing pressure on ecosystems, reflected in problems such as sediment accumulation, bank instability, habitat loss and biodiversity decline. The lack of a comprehensive approach to basin management increases the risk of ongoing and potentially irreversible environmental damage. For a long time, the ecological decline of the Aras basin has directly affected communities living along the river, particularly in the southern regions of Iran and Azerbaijan. Sudden changes in water flow, caused by uncoordinated oversight of water management systems, increase the likelihood of localized extreme events, including flooding or drastic water shortages.

These dynamics have a negative impact on food security, irrigated agriculture and the quality of water for domestic use, with potential repercussions on public health. In this perspective, the environmental dimension is intertwined with the socio-economic one, underscoring that the lack of cooperation in water resource management is not an abstract challenge but a concrete source of human insecurity. In the Aras basin, environmental degradation acts as a threat multiplier. By doing this, amplifying economic fragility, social tensions and perceptions of insecurity among riparian states become more usual than before. In a context that has already been marked by unresolved conflicts and political non-recognition, the pressure on natural resources contributes to hardening state positions and further reducing the space for cooperation. In this context, the environment is not a neutral or secondary dimension, but becomes an integral part of the hydro-strategic dynamics of the basin. The failure to jointly manage water resources thus results in a vicious circle, in which environmental degradation and political instability reinforce each other, compromising the long-term sustainability of the Kura-Aras system.

5. Cooperative Governance Model for the Aras Basin

The Aras Basin (Kura-Aras) represents a structural paradox: principles of international water law are formally applied but without any effective governance mechanism in place. Under these general conditions, hydro-strategic vulnerability is characterised by upstream discretionary flow control, cumulative environmental externalities, absence of basin-wide data symmetry, escalation risks triggered by climatic shocks and securitisation of water resources. Within the framework of "Hydro-Hegemony Theory", upstream states retain structural leverage through infrastructure control. In the absence of binding institutional arrangements, this leverage remains unchecked with the result of symmetric interdependence reinforcement. Simultaneously, from a Neo-Functionalist perspective, the absence of functional technical cooperation prevents spillover into broader institutional stability. Therefore, the basin remains trapped in a low-cooperation equilibrium with increasing systemic risk. The strategic objective of this cooperation model is not diplomatic normalisation but the consolidation of risk in the Aras basin. Inspired by other governance models, this proposal involves several well-structured implementation phases within a framework of economic and societal analysis.

A. Phase I – Transboundary Technical Platform

This phase, defined as the technical platform for managing cross-border relations, involves the creation of a coordination platform. There are five pillars for the experimental operation of this phase: standardised hydrometeorological data exchange, harmonised sampling protocols, shared drought and flood indicators (SPI, SPEI-based thresholds), annual basin vulnerability assessment, and an early warning system for extreme events. In this phase, the actors involved are clearly defined and do not include the diplomatic concept of recognition, transfers of sovereignty, or ratification of binding treaties. It is, in fact, a technical management mechanism that functions as a risk management hub. The main actions are risk observation and data sharing. The strategic impact of this phase of the intervention plan reduces information asymmetries and lowers uncertainty-driven securitisation.

B. Phase II – Coordinated Infrastructure Governance

The second phase begins once confidence in the technical means and reliability of the data has been established. From this point onwards, it is reasonable to consider expanding cooperation. This enhanced cooperation includes prior notification of upstream infrastructure projects, cumulative basin-level environmental impact assessments, coordinated release of water reserves during extreme hydrological events, and cross-border protocols for pollution incidents. At this stage of development, cooperation moves from passive information sharing to active risk management sharing. The strategic impact of this evolution in relations is considerable. It mitigates hydro-hegemonic unilateralism and reduces scenarios of accidental escalation.

C. Phase III – Institutional Consolidation

The third phase involves the actual implementation of institutional cooperation. Firstly, this phase reflects the *principle of increasing institutional resilience* by expanding competences only after functional legitimacy has been well-established. Secondly, it provides, for example, for the presence of formal mechanisms resulting from the gradual evolution of relations and from the legal basis. Finally, the phase consists of recognizing a regulatory authority with limited powers, created through the establishment of a structured mediation body for dispute resolution. Added to this is the creation of shared or communicating financial instruments for adaptation to climate change. Among the entities involved, there is also a neutral third party that serves as a technical data custodian, certification authority for basin indicators, funding intermediary, and mediation facilitator in cases of hydrological disputes. According to the institutional architecture, this presence reduces the possibility of direct exposure to bilateral tensions, protecting and preserving state sovereignty. This system was created by observing the dynamics of non-recognition and residual post-conflict instability between Turkey and Armenia. The role of the neutral third party is that of facilitator. In theoretical terms, this fits perfectly with the theory of interdependence, which reduces mistrust in systematically unstable regional areas.

D. General consideration

The model assumes that “State actors”, even in the absence of formal political recognition, operate according to a logic of systemic risk minimization. In scenarios of high polarisation or identity-based manipulation of water, this rationality could be temporarily suspended. Thereby, slowing down the activation of the progressive

phases of the model, the presence of a neutral technical facilitator is a pillar of Phase III. However, in contexts characterized by structural mistrust, even a formally neutral actor may be perceived as geopolitically aligned, reducing the perceived legitimacy of the mechanism. Since the basin is characterized by concentrated upstream infrastructure control (consistent with Hydro-Hegemony Theory), the model does not eliminate the existing material asymmetry but only reduces its destabilizing effects. In the absence of sufficient economic or reputational incentives, the upstream state may not perceive benefits commensurate with the reduction of its discretion.

5.1. Economic Perspective

The reason why states are driven to cooperate is not normative. Cross-border states must cooperate because the cost of non-cooperation is actually very high. Without joint cooperation, the consequences are significant. These include increased agricultural volatility downstream, increased costs of responding to flood/drought emergencies, expansion of infrastructure redundancy, long-term ecosystem degradation resulting in reduced productivity, and reputational risk limiting access to international climate finance. The issue of climate and its variability across the basin is increasingly intense. Unilateral adaptation of strategies in a cross-border system generates sub-optimal results due to duplication of investment, inadequate infrastructure sequencing and unmanaged downstream externalities. Coordinated adaptation reduces integrated vulnerability and improves systemic resilience. Instead, cooperative governance is once again a prerequisite for external funding: why? It is increasingly common for international climate change funds to require more and more basin-wide planning frameworks, measurable adaptation KPIs and transparency mechanisms. Long-term stability also requires vertical integration of governance. This concerns associations for water use for agricultural functions and activities, local irrigation consortia, environmental NGOs, university consortia for scientific research, and public awareness initiatives. This approach reflects the principle of multi-level water governance, in which resilience is distributed across various institutional levels.

In contexts of political non-recognition and institutional fragmentation, traditional treaty-based river basin organisations may prove politically unrealizable. The Aras basin requires a gradual and technically driven approach to cooperation, separating hydrological coordination from high-level diplomatic normalisation. A technical coordination mechanism, supported by a neutral multilateral facilitator, could be a plausible first step towards reducing hydro-strategic vulnerability. It is clear that, by prioritising data sharing, joint risk assessment and environmental monitoring, such a mechanism would apply the principles of international water law without requiring immediate political reconciliation. The innovation of the model lies precisely in creating an environment of cooperation that is conciliatory and largely free from political pressure and coercion.

Over time, functional cooperation could evolve into structured basin governance, improving regional stability and preventing irreversible environmental degradation. In order to get to the heart of the subject, the model involves: partial transparency obligations, external technical supervision, and reduced unilateral flexibility in infrastructure planning. However, the alternative trajectory is uncontrolled degradation and gradual securitisation.

From a hydro-strategic point of view, the basin faces a choice between: unilateral competitive streamlining and making stable interdependence. The former optimises short-term sovereignty, while the second reinforces long-term systemic resilience. The Aras Basin is a case study where rules exist but institutional enforcement capacity is absent. The formalisation of treaties is hampered by the lack of a clear political recognition relationship, and multifactorial and multi-actor threats act as catalysts for environmental degradation.

In this context, governance innovation precedes political normalisation. The limitations of this model are the inability to develop an effective method in both the short and long term. The reason is the increase in negative externalities, information asymmetries, the degradation and destabilisation of entire communities living along the basin or at its end. Above all, however, is the progressive securitisation of water policy in the South Caucasus.

6. Conclusion

Non-cooperation is not neutral; it is a choice that reinforces asymmetrical power dynamics. The Aras basin is a geopolitical laboratory where international law, infrastructural power, and political fragility intersect. The aim is not to immediately create a grand multilateral agreement, but to progressively reduce systemic vulnerability, limit unilateral actions, and stabilize the water variable. In the context of the region, the creation of a technical-strategic platform, facilitated by a third party and built incrementally, represents a pragmatic solution consistent with regional realities. In the South Caucasus, where sovereignty is an existential issue, water cannot be imposed as a bait for political integration. However, it can serve as a space for functional coordination, moderating competition and strengthening regional dialogue. In a context of political non-recognition, the governance of the Aras should not aspire to legal idealism, but to progressive strategic stabilization.

8. Acknowledgement

The author gratefully acknowledges the contribution of scholars and practitioners working in the fields of transboundary water governance, hydro-politics and environmental security, whose theoretical and empirical insights have informed the analytical framework of this study. Particular recognition is extended to the academic literature on hydro-hegemony and cooperative basin management, which has provided conceptual guidance for the development of the proposed governance model. The author also acknowledges the open-access hydro-climatic datasets and satellite-based products that made the quantitative assessment possible despite limited in-situ data availability across the basin. All interpretations, analytical assessments and policy recommendations expressed in this article remain the sole responsibility of the author.

References

[1] Berrin, B and Campana, M. (2008). Conflict, cooperation, and the new 'Great Game' in the Kura-Araks basin of the South Caucasus.

[2] Dadparvar, A. Mianabadi, H. Mianabadi, S.N. Amoghin and S. Anvari (2025). Assessment of drought trends in the Aras River Basin: Spatiotemporal changes and implications for transboundary water management. Journal of Hydrology: Regional Studies.

[3] De Stefano, L., Petersen-Perlman, J. D., Sproles, E. A., Eynard, J., & Wolf, A. T. (2017). Assessment of transboundary river basins for potential hydro-political tensions. *Global Environmental Change, 45*, 35–46.

[4] FAO. (2009). AQUASTAT *Transboundary River Basins – Kura Araks River Basin*. Food and Agriculture Organization of the United Nations (FAO). Rome, Italy.

[5] Grandi, M. (2016). Hydropolitics in transboundary water management: Conflict, cooperation and governance along the Nile River (Doctoral dissertation, PhD Programme in Politics, Human Rights and Sustainability, Sant'Anna School of Advanced Studies, Pisa, Italy).

[6] Khoshnoodmotlagh, S., Verrelst, J., Daneshi, A., Mirzaei, M., Azadi, H., Haghighi, M., Hatamimanesh, M., & Marofi, S. (2020). Transboundary basins need more attention: Anthropogenic impacts on land cover changes in Aras River Basin, monitoring and prediction. *Remote Sensing, 12*(20), 3329.

[7] Sharifi Garmdareh, A., & Gohari, A. (2025). The role of the Turkish water project in altering water availability in the Aras River Basin. University of Oulu, Water, Energy and Environmental Engineering, Oulu, Finland.

[8] United Nations (1997). *United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses*. Adopted by the UN General Assembly on 21 May 1997.

[9] United Nations Development Programme, United Nations Office for Project Services (Governments of Armenia, Azerbaijan, Georgia) (2016). *Reducing Transboundary Degradation in the Kura-Aras Basin*. UNDP/UNOPS Project Document.

[10] Verre, F. (2020). Water conflicts in Western Asia: the Turkish-Syrian regional rivalry over the Euphrates River. Rivista di Studi Politici Internazionali, 87(3). https://www.jstor.org/stable/27094394.

[11] Verre, F. (2022). The dispute between Ethiopia and Egypt over the Grand Ethiopian Renaissance Dam. Rivista di Studi Politici Internazionali, 89(1). https://www.jstor.org/stable/27273599?seq=1.

[12] Verre, F. (2025b). Water insecurity in the South Caucasus: A Hydro-Strategic Assessment of the Nagorno-Karabakh conflict. *Journal of Political Science Bulletin of Yerevan University*, 4(2(11)), 58–77. https://doi.org/10.46991/jops/2025.4.11.058.

[13] Zeitoun, M., & Warner, J. (2006). Hydro-hegemony – a framework for analysis of transboundary water conflicts. Water Policy, 8(5), 435–460.