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MULTI CRITERIA ANALYSIS OF POWER ASYMMETRY IN ARAS TRANSBOUNDARY RIVER BASIN: DERIVING POTENTIAL HYDRO-HEGEMON COUNTRY

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Abstract

Transboundary rivers are becoming a controversial issue due to the interactions among several players over water. Deriving the relative power of stakeholders in the tranboundary river basin is one of the critical factors that could affect the water negotiations. This research uses the TOPSIS method to derive power asymmetry in the Aras River basin shared among Turkey, Armenia, Iran and Azerbaijan. Power is subdivided into four main pillars, including geographical, material, bargaining and ideational. For each pillar of power, several numerical or linguistic criteria are defined and evaluated between countries. Overall ranking results show that Iran, with the relative power value of 0.79, has the highest potential hegemonic power, followed by Turkey, Armenia, and Azerbaijan with relative power values of 0.72, 0.40 and 0.30, respectively. In the last part, sensitivity analysis of the overall power ranking is also performed based on different weighting the four pillars of power. Results indicate that weight change in bargaining power has the most significant impact on the states' power ranking.

Keywords: Hydro-Hegemon, Transboundary River Basin, Power Asymmetry, TOPSIS.

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1. INTRODUCTION

Water is a shared asset whether at an international level like shared lake (i.e., the Caspian Sea) (Madani et al. 2004) a shared river between riparian countries such as the Nile basin (Dinar and Alemu, 2000), Euphrates and Tigris (Kucukmehmetoglu 2009), Aras River basin (Klaphake and Kramer 2011) or domestic level between different water withdrawal sectors (Kerachian and Karamouz 2007). Due to the urge in nations to reach sovereignty and self-sufficiency, interactions over shared resources between adjacent countries have become rivalry (Earle et al. 2013), leading to either cooperation or conflict (Wolf 1998). Therefore, water management researchers have recently focused on the conflict and cooperation nature of international interactions (De Stefano et al. 2010; Wolf et al. 2003). Whenever a conflict or cooperation arises, the chosen policies of riparian countries toward shared water resources (SWR) become more vital. Scholars refer to Hydro-policy as a framework to define the strategies of riparian countries in water-related issues. However, the concept of "hydro-politics" is poorly formulated and needed to be clarified (Turton and Henwood 2002). Cascao and Zeitoun (2013) have investigated the practical approaches to analyze SWR problems. First, they introduced the two main aspects of water that form an individual's policies: 1) the quantity and quality of water and 2) the fluid nature of water that flows over political boundaries. Then, by mentioning that the principle of inter-relations policies varies from one basin to another, they concluded that there is no constant template to model any transboundary basin. They also depicted that the control over shared waters in transboundary basins varied from cooperative form (shared control) to competitive form (contested form) and named the in-between area as competitive-but-stifled (consolidated form) that favors the hegemon of the basin.

Recently numerous conflict resolution approaches have been adapted to explore SWR problems (Madani 2010). Some have focused on allocation conflict resolution (Herrero and Villar 2001; Mianabadi et al. 2014). Others have explored cooperative approaches to benefit all stakeholders (Madani et al. 2011). In addition to the conflict resolution modeling of SWR, some researchers have paid attention to hydro-political issues that are more sophisticated and need more exploration. Several studies investigate hydro-policy in various geographical areas such as Jordan River (Wolf 1995), Nile valley (Waterbury 1979) and southern Africa (Turton 2003). Bazrkar et al. (2013) and Shahbazbegian et al. (2016) have discussed hydro-policy issues in Hirmand River using System Dynamics method and Dinar et al. (2011) concluded that water scarcity at the moderate level would lead to negotiation and trigger hydro-political interactions. To sum up, due to the complexity of water conflicts, there would be a strong need to understand the hydro-policy issues of the basin, which are manifested and settled through negotiations (Yu et al. 2015).

Furthermore, the power of all involved individuals in SWR problems seems crucial and may play a significant role in the water withdrawal system. It is clear that power is a relative and asymmetric term; in other words, individuals with higher relative power would not tolerate any deviation from normal water cycle conditions. Individuals with less relative power are willing to accept the condition imposed by powers (Yu et al. 2015). In this regard, Allan and Mirumachi

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(2013) discussed the two states in their work that make the research about transboundary rivers challenging. These conditions are 1) asymmetric nature of relative powers of riparian countries and 2) unavailability of international water issues because they have been politicized and securitized.

Recognition and assessment of the main elements of power are other essential factors in this regard. Cascão and Zeitoun (2013) defined four main aspects of power as follows: geographical power, material power, bargaining power and ideational power. They examined Jordan, Nile, and Tigris and Euphrates River basins and showed that the hegemon of the basin utilizes different combinations of power and the power stance of countries is asymmetrical and dynamic. Following their work, Rein (2017) has focused on the Mekong River basin's hydro-hegemony to determine the hegemon and non-hegemon of the river by assessing four pillars of power. This author also mentioned that due to less visibility of bargaining and ideational power, content analysis of speeches, media articles and meetings are scrutinized from 2004 to 2017. Zeitoun and Warner (2006) discussed who gets how much water, how and why. They conceptualized the term "hydro-hegemony" and defined two primary power forms: 1) potential power, which lies in capabilities of an individual such as military and economic power and 2) actualized power, which refers to controlling rules of the game. They also discussed the compliance and non-compliance of the weaker side to the instruction of stronger states.

The most abstract form of power to discuss is ideational power. The study of ideas in political science started simply by emphasizing "ideas matter". Although many scholars have argued that the term "ideas matter" is a general claim in political power (Campbell 1998; Hay and Rosamond 2002), some have tried to theorize ideational power (Béland 2010). Therefore, the ambiguity remained with the exact meaning of the ideational power and its relation to other forms of power (Carstensen and Schmidt 2016). There might be three approaches to define power: the *compulsory* power which is the notion concerning the direct control of interactions by one agent over another (Dahl 1957; Weber 1964), the *structural* power, which discusses the constitution of agents' capacity in structural relation to one another (Barnett and Duvall 2005), and the *institutional* power, which deals with the act of controlling others through formal and informal institutions between them (Bachrach and Baratz 1962; Mills and Wolfe 2000). In any form of power relations, the ideas' central role is inevitable (Lukes 2004). Carstensen and Schmidt (2016) defined the Ideational power as the capacity of actors to influence other actors using ideational elements in the forms of persuasion (power through ideas), imposition (power over ideas), or indirectly influencing the ideational context (power in ideas). They also depicted that ideational power connects to the necessary, structural and institutional forms of power, yet is distinctive enough to form power on its own.

The present work identifies the potential hydro-hegemon in the Aras River basin between four riparian countries through analyzing the power asymmetry in the region by comparing four pillars of power, including geographical power, material power, bargaining power, and ideational power introduced by Cascão and Zeitoun (2013). For each pillar, some criteria are

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defined, and then, using the TOPSIS (for numerical criteria) and Fuzzy TOPSIS (for linguistic form of criteria) method, the power stance of each country against others is derived. In the last section of the study, we discuss the Sensitivity of the power asymmetry to the weights in each pillar of power. Since the power has dynamic nature, all data are considered to be analyzed from the year 2015 to 2019.

2. MATERIALS AND METHODS

2.1. Geographical Power

Being upstream of a transboundary river may seem advantageous; however, it is not the only component in the power asymmetry analysis of the agents (Zeitoun and Cascao 2010). This type of power deals with the geographical specifications of a riparian relative to a shared resource. Geographical specifications include the quantity and quality of the resource under control and the potential quantitative and qualitative vulnerability of a resource affected by others. This research introduces four criteria that well represent the mentioned specifications above; Percentage of the basin confined in each territory, Length and Stream-order of the river available in each territory, Annual Potential Surface Runoff and finally, Qualitative and Manipulative Vulnerability of a country.

2.2. Material Power

This power refers to the Economic, Military, Technology and monetary and/or political support of any state (Cascão and Zeitoun 2013). Measuring the economic strength depends on scrutinizing various parameters forming the overall economic performance of a country. Here, the quality of an individual's life and living standards is an essential factor for comparing economic situations; however, this term is rather difficult to measure. Levels of income, consumption, employment rate, inflation and recession rate, a long and healthy life, development, and quality of education are among several parameters that all matter. Stiglitz et al. (2009) broadly discussed the external factors that affect a human's well-being in a society. They also brought the critical issue that measuring the GNP or GDP as an economic criterion would be very misleading, simply because it does not consider other important factors discussed above. Therefore, several other criteria are developed: Human Development Index (HDI) introduced by the United Nations Development Programme (UNDP), which is a composite index of life expectancy, education, and per capita income; Human Capital Index (HCI), prepared by the World Bank which is a criterion of the amount of capital each country loses through lack of education and health and includes survival rate of children passed the age 5, quality and quantity of education and health parameters; and GDP Per Capita, PPP which is gross domestic product converted to international dollars using the purchasing power parity rates. In this section, we discuss Gross National Product (GNP), Gross Domestic Product (GDP), Purchasing Power Parity (PPP) and Human Development Index

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(HDI) for analyzing economic capabilities and Armed Force Personnel as well as Military Expenditure as a percentage of GDP for analyzing military power of a country.

2.3. Bargaining Power

The criteria used in this section are expressed in two categories: first, the number of signed agreements between countries and second, potential assets that are essential in an issue-linkage dialogue between states. These assets would be the Labor Force, Arable Land Area and Installed and Planned Hydropower Stations.

2.4. Ideational Power

As mentioned before, ideational power is the most abstract and less tangible form of power. Common tools of ideational power are summarized in knowledge structure, sanctioned discourse, securitization and the imposition of narratives (Hajer 1995; Lukes 2004; Zeitoun and Cascao 2010). For knowledge structure, we introduce criteria that represent the knowledge status of an individual. These criteria are Percent of the GDP spent on research and development (available data are for the year 2017), Number of published articles (available data is for the year 2016), the average ranking of each riparian's universities among the top 1000 universities in the world (QS Quacquarelli Symonds 2015), and the world press freedom index (over two-year period 2018 and 2019). For analyzing other ideational tools, based on Rein (2017), the media contents such as reports, articles, and reviews over water-related issues are scrutinized in the recent five years. These media references mainly include policy makers' speech towards the basin's issues and/or discourses in the joint meetings. In this regard, ten online references from official online press and media websites from 2015 to 2020 are chosen for each riparian. Regarding these references, three primary behavior are inferred: conservative manner and/or playing with time and ambiguity that can be categorized as a sanctioned discourse tool, expressing concern for others' activities in the basin that can be categorized as a securitization tool and articulating the policy of total withdrawal of domestic waters that can be considered as an imposition of narratives tool.

2.5. TOPSIS Method:

TOPSIS, the Technique for Order of Preference by Similarity to Ideal Solution, was developed by Yoon and Hwang (1995) and is a branch of the multi-criteria Decision–making method. This technique follows the concepts of compromise solution and chooses the best alternative from measuring the shortest Euclidean distance to the ideal solution and farthest Euclidean distance from the negative ideal solution. Mathematically, TOPSIS is expressed as follows:

Given a set of alternatives (here Countries), $A = \{A_k | k = 1,2, \dots, n\}$, and a set of known criteria, $C = \{C_j | j = 1,2, \dots, m\}$, the numerical values of alternatives in each criterion denoted by x_{kj} and

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the set of weights $W = \{w_j | j = 1,2,\dots,m\}$, the TOPSIS matrix is formed with rows being Alternatives and Columns being weights. The first step is to convert x_{kj} to normalized form r_{kj} as follows:

$$r_{kj}(x) = \frac{x_{kj}}{\sqrt{\sum_{k=1}^{n} x_{kj}^2}} \quad (1)$$

The next step is to determine the beneficial and non-beneficial criteria. For the beneficial criteria, larger values (x_{kj}) are better. Therefore, $r_{kj}(x)$ is written as follows: $r_{kj}(x) = (x_{kj} - x_j^-)/(x_j^* - x_j^-)$, where x_j^* is the ideal point and x_j^- is the worst point. Additionally, for non-beneficial criteria, $r_{kj}(x) = (x_j^- - x_{kj})/(x_j^- - x_j^*)$. The normalized matrix is then converted to weighted normalized (v_{kj}) by multiplying the weight vector $(v_{kj} = w_j r_{kj})$ by the matrix $r_{kj}(x)$. The next step is to calculate the Positive Ideal Solution vector (PIS) and the Negative Ideal Solution vector (NIS) as follows:

$$PIS = S^+ = \{v_1^+(x), v_2^+(x), \dots, v_m^+(x)\} = \left\{\left(\max_k v_{kj}(x) \middle| j \in J^+\right), \left(\min_k v_{kj}(x) \middle| j \in J^+\right) | k = 1, \dots, n\right\} \quad (2)$$

$$NIS = S^- = \{v_1^-(x), v_2^-(x), \dots, v_m^-(x)\} = \left\{\left(\min_k v_{kj}(x) \middle| j \in J^-\right), \left(\max_k v_{kj}(x) \middle| j \in J^-\right) | k = 1, \dots, n\right\} \quad (3)$$

where J^+ and J^- are related to the beneficial and non-beneficial attributes of a criterion, respectively. Euclidean distance from an ideal point is then calculated as follows:

$$D_k^+ = \sqrt{\sum_{j=1}^{m} \left[v_{kj} - v_j^+\right]^2}, k = 1,2,\dots,n \quad (4)$$

$$D_k^- = \sqrt{\sum_{j=1}^{m} \left[v_{kj} - v_j^-\right]^2}, k = 1,2,\dots,n \quad (5)$$

The next step is to calculate the distance to the worst condition:

$$C_k^* = \frac{D_k^-}{(D_k^+ + D_k^-)}, k = 1,2,\dots,n \quad (6)$$

Where $C_k^* \in [0,1]$. Finally, all alternatives are ranked by rearranging C_k^* in a descending order.

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2.6. FUZZY TOPSIS Method:

In this research, the triangular fuzzy number is used for data fuzzification. A triangular fuzzy number is represented as $\tilde{a} = (a, b, c)$ and the related membership function $\mu_{\tilde{a}}(x)$ is given as:

$$\mu_{\tilde{a}}(x) = \begin{cases} \dfrac{x-a}{b-a} & if\ a \le x \le b \\ \dfrac{c-x}{c-b} & if\ b \le x \le c \\ 0 & Otherwise \end{cases} \tag{7}$$

where $a, b, and\ c$ are real numbers and $a < b < c$. We call b the most probable value and a and c are the least probable values, which are also the lower and upper bounds of the available area for the evaluation data. In the Fuzzy TOPSIS method, we need the distance between two fuzzy values ($\tilde{a}$ and $\tilde{b}$) that is calculated as:

$$d(\tilde{a}, \tilde{b}) = \sqrt{\frac{1}{3}[(a-a')^2 + (b-b')^2 + (c-c')^2]} \tag{8}$$

In Multi-Criteria Decision Making (MCDM) problems, every criterion is expressed as linguistic terms like low, high, etc. To analyze this, equivalent fuzzy sets can be assigned. For example, a triangular fuzzy set of (1,1,3) is assigned to linguistic rank of "very low", (1,3,5) is assigned to "low, and so on. These intervals are chosen to have uniform representation from 1 to 9 and also cover the five linguistic weights (very low, low, medium, high, very high) and distances between all alternatives.

Let us consider k decision-maker in one specific problem. Therefore $\tilde{x}_{ij}^k = (a_{ij}^k, b_{ij}^k, c_{ij}^k)$ denotes for the weight of the kth decision-maker about the ith alternative on the jth criterion where $i = 1,2,\dots,m$ and $j = 1,2,\dots,n$. The next step is to calculate $\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij})$, which is called aggregated fuzzy number for alternative (i) and criterion (j) such that:

$$a_{ij} = \min_k\{a_{ij}^k\}, b_{ij} = \frac{1}{k}\sum_{k=1}^{K} b_{ij}^k, c_{ij} = \max_k\{c_{ij}^k\} \tag{9}$$

After constructing a fuzzy MCDM Matrix, the normalized fuzzy decision matrix is equal to $\tilde{R} = [\tilde{r}_{ij}]_{m\times n}$ where:

$$\tilde{r}_{ij} = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*}\right) = (a'_{ij}, b'_{ij}, c'_{ij})\ and\ c_j^* = \max_i c_{ij}\ \ (for\ beneficial\ criteria) \tag{10}$$

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$$\tilde{r}_{ij} = \left(\frac{a_j^-}{a_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{c_{ij}}\right) \; and \; a_j^- = \min_i a_{ij} \;\; (for \; non \; beneficial \; criteria)$$

The normalized components of the above matrix $[\tilde{r}_{ij} = (a'_{ij}, b'_{ij}, c'_{ij})]$ belong to [0,1]. The Fuzzy Positive Ideal Solution (FPIS) and Fuzzy Negative Ideal Solution (FNIS) of the alternatives are defined respectively by A^* and A^- as follows:

$$A^* = (\tilde{v}_1^*, \tilde{v}_2^*, \dots, \tilde{v}_n^*) \; where \; \tilde{v}_j^* = \max_i\{c'_{ij}\}$$
$$A^- = (\tilde{v}_1^-, \tilde{v}_2^-, \dots, \tilde{v}_n^-) \; where \; \tilde{v}_j^- = \min_i\{a'_{ij}\} \quad (11)$$

The distance of each alternative from FPIS and FNIS is calculated as follows:

$$d_i^* = \sum_{j=1}^{n} d_v\left(\tilde{r}_{ij}, \tilde{v}_j^*\right), \qquad i = 1,2,\dots,m$$
$$d_i^- = \sum_{j=1}^{n} d_v\left(\tilde{r}_{ij}, \tilde{v}_j^-\right), \qquad i = 1,2,\dots,m \quad (12)$$

where $d_v(\tilde{a}, \tilde{b})$ denotes the distance between two fuzzy numbers $\tilde{a}$ and $\tilde{b}$. The last step is computing the closeness coefficient CC_i as follows:

$$CC_i = \frac{d_i^-}{d_i^- + d_i^*}, \qquad i = 1,2,\dots,m \quad (13)$$

Here, the alternative with the highest closeness coefficient is the best.

3. CASE STUDY

Aras River basin is shared between Turkey, Armenia, Iran and Azerbaijan. This basin is located in the southern Caucasus Region with a surface area of about 95739 square kilometers. The altitude of this basin changes from 20 meters (reaching a point in the Caspian Sea) to 5000 meters (Mount Ararat in Turkey). This basin's river is called the Aras River, which has two main tributaries, originating from Turkey. One is the Aras tributary, which originates from the highlands of 3100 meters height above the Bingol Mountains of Turkey near Erzurum County. The other is the Akhurian tributary, which also originates from Turkey near the Kars district. The two main tributaries join together and form the borderline of Turkey, Armenia, Iran and

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Azerbaijan. Then, it flows to Azerbaijan's territory and finally discharges to the Caspian Sea. This river's border length is initially 215 kilometers between Turkey and Armenia, 198 kilometers between Iran and Nakhchivan (secluded part of Azerbaijan), 43 kilometers between Iran and Armenia, and 175 kilometers between Iran and Azerbaijan (Figure1). During the Soviet Union era, some essential water-related constructions were made, such as the Akhurian dam (shared project between Armenia and Turkey), the Aras, and the Mil-Moghan Dam (shared project between Iran and Azerbaijan). After the collapse of the Soviet Union, many other projects in all riparian countries were completed, which are mainly hydropower plants and reservoirs for agricultural purposes.

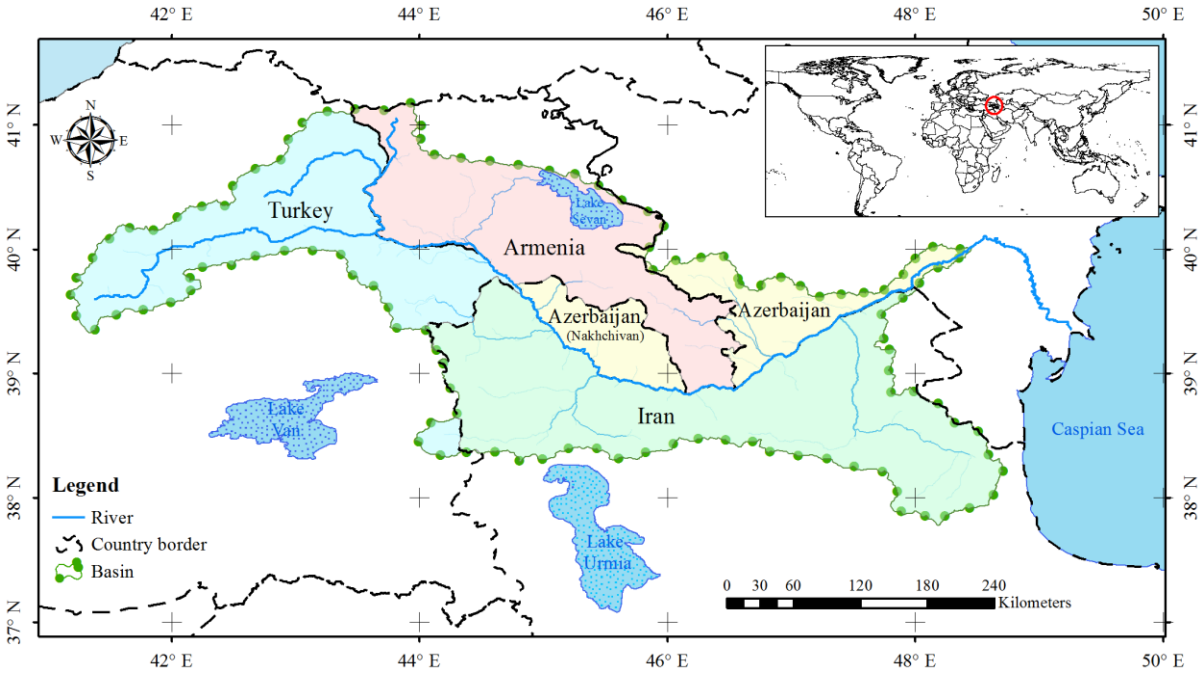

Fig. 1 Map of the location of Aras basin and the riparian countries.

4. RESULTS AND DISCUSSION

The obtained results are represented and discussed in two parts: first, the overall relative power of countries is derived in all forms of the power using TOPSIS and Fuzzy TOPSIS method. Second, the sensitivity of the overall relative power is analyzed based on the weighting of the four pillars of power.

4.1. Measuring power of countries

4.1.1. Geographical Power

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This power stems from the position and geographical aspects of each riparian in the basin. One determining factor is the percentage of the basin confined in a country's territory. In this regard, 37.8% of the Aras basin belongs to Iran's territory, 25% belongs to Turkey and 23.6% and 13.6% belong to Armenia and Azerbaijan, respectively. In addition to the basin's area, the river stream length seems to have paramount importance. It provides a broad geographical range for a country to plan and exploit the river's energy alongside the stream. Therefore, the river's length with its geomorphological importance, i.e., stream order, is defined as the second criterion and is calculated by multiplying the river's length by its stream order in each country's territory. It is worth mentioning that the borderline length of the river is shared equally for adjacent countries. The calculated numbers are 3533 km for Turkey, 2928 km for Armenia, 6133 km for Iran and 3344 km for Azerbaijan (Table S1).

More importantly, downstream countries are negatively affected by upstream water withdrawal and water contamination. This worsens downstream vulnerability status. For each country, the vulnerability assessment is defined by Qualitative and Manipulative Vulnerability criterion. This criterion represents the length of the river prone to water contamination and manipulation before entering the corresponding territory. Table S2 summarizes the river length in two forms for each riparian: the border length of the river and the interior length of the river in upstream territories.

The last criterion of the geographical power is the mean annual renewable surface runoff, which is calculated through hydrological rainfall-runoff modeling of the basin (Rashidi et al. 2020). Table 1 lists the four criteria introduced above and their relative power distance.

Table 1 Criteria for geographical power assessment and the relative power distance

	Turkey	Armenia	Iran	Azerbaijan
Percentage of a Basin confined in each territory	25	23.60	37.80	13.60
Length and Stream-order of the river available in each territory (km)	3533	2928	6133	3344
Mean Annual Renewable Surface Runoff (BCM)	3.40	3.80	2.40	1.20
Qualitative and Manipulative Vulnerability (km)	1030	3556	4208	5761
Relative Power Distance	**0.65**	**0.50**	**0.59**	**0.05**

Relative power distance in geographical form shows that Turkey benefits its upstream condition, followed by Iran and Armenia with relatively equal rank. By contrast, Azerbaijan suffers from being downstream because of having less control over the river and is more vulnerable to quality and quantity of stream flow.

4.1.2. Material power

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In this form of power, GDP per capita as PPP (constant 2011 in international dollars) and HDI are chosen for economic comparison purposes. In addition, Armed Force Personnel and Military Expenditure as a percentage of GDP are criteria of military assessment. The related data are shown in Table 2.

Table 2 Criteria of economic and military power assessment criteria and the relative power distance

	Turkey	Armenia	Iran	Azerbaijan
GDP per capita, PPP index	24341	8563	19813	16225
HDI index	0.74	0.76	0.85	0.85
Armed Force Personnel, Total (thousands)	512	49	563	82
Military Expenditure (Billion dollars)	17.60	0.50	12.50	1.90
Relative Power Distance	**0.92**	**0.01**	**0.78**	**0.19**

In this pillar of power, Armenia and Azerbaijan have significantly low relative power than Iran and Turkey. Besides, Turkey has the strongest economic and military performance amongst others.

4.1.3. Bargaining Power

As discussed earlier in this paper, to compare the bargaining power of countries, we need to assess each country's water-related assets. These assets can be utilized as a bargaining advantage and an issue linkage. Table 3 lists these assets and their corresponding values.

Table 3 Criteria of bargaining power assessment and the relative power distance (("Human Development Reports", n.d.; "World Development Indicators | DataBank" n.d.))

	Turkey	Armenia	Iran	Azerbaijan
Arable Land Area (km^2)	5522	5121	4430	9281
Hydropower Energy Capacity (MW)	441.2	1527	341	312
Labor Force in the basin (Million people)	0.3	1.24	0.69	2.12
Signed Bilateral and/or multilateral agreements	3	4	8	7
Relative Power Distance	**0.10**	**0.59**	**0.31**	**0.54**

Arable land area is obtained through remote sensing techniques in which dry-land farming is excluded. The labor force in the basin is also another potential aspect to consider and is one of the critical components of enhancing manufacturing and agricultural activities. Another useful

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criterion is the Hydropower Energy Capacity. The data relating to this is collected from the official statistical data resources websites of each country ("Armenian Energy Agency" n.d.; "AzərEnerji ASC" n.d.; "Hidroelektrik Santralleri (HES)" n.d.; "Iran Water Resources Management Company" n.d.).

Signing agreements show the high inclination of a country acting cooperatively, highlighting its bargaining power. The Aras River basin has undergone water policy changes during the past several decades. During the Soviet Union period, several important agreements were signed concerning the water withdrawal of the Aras River and water facility construction issues, which all still stand legitimate. Two agreements were signed between USSR and Turkey in 1964 and 1990, which are now legitimate between Turkey and Armenia. The former was about constructing the Arpachay reservoir with a joint commission on operating the infrastructure and allocating the water. The latter concerns technical cooperation, riverbed changes, and joint hydropower facilities (Kibaroglu et al. 2005). USSR and Iran also signed an agreement in 1957 (equal allocation of the Aras River and assessment of constructing the Aras reservoir), 1963 (constructing the Aras and Mil-Moghan dam), 1977 (constructing the Khoda-Afarin and Giz-Galasi reservoirs), and 1988 (equal share of the Khoda-Afarin and Giz-Galasi reservoirs) (Kibaroglu et al. 2005).

Meanwhile, in 1955, Iran and Turkey signed an agreement related to the utilization of inter-boundary Rivers, namely Sarisu and Garasu, which originate in Turkey and flow into Iran (Kibaroglu et al. 2005). Another less noticeable agreement was signed in 1974 between Azerbaijan and Armenia as two Soviet Socialist Republics on the joint utilization of the Vorotan River. This river originates in Armenia territory, flows to Azerbaijan, and finally discharges to the Aras River (Yu et al. 2014). Almost all the agreements are based on equal withdrawal of the river between the parties.

In 1991, Soviet Union collapsed, and therefore, Azerbaijan and Armenia declared independence. In the recent period, three crucial mutual agreements were signed. One is signed in 2018 between Iran and Armenia, which is about installing a hydropower plant with 130 MW capacity in the Meghri district. The two other treaties are between Iran and Azerbaijan and were signed in 2016. One treaty is related to the construction of hydropower plants in Urdubad and Mazarad and the other is about the continuation of construction and technical operation of Khoda-Afarin and Giz-Galasi reservoirs ("Islamic Parliament Research Center Of The Islamic Republic Of IRAN" n.d.). It is clear that Armenia and Azerbaijan possess rich assets and are more inclined to reach mutual agreements than Iran and Turkey.

4.1.4. Ideational Power

One primary approach in assessing this form of power is deducing commonly used ideational tools from scrutinizing the media content that reflects the policy-makers' attitudes over the basin's water issues. The reduction of available fresh water and more importantly degradation of the Aras river's quality have become a growing concern. Untreated municipal wastewaters,

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agricultural fertilizers as well as heavy metal pollutants are considered the main polluting sources (Klaphake and Kramer 2011).

The first tool is securitization, in which policy-makers express concern towards other party's activities relating to upstream water projects and the degradation of water quality. This issue has been exacerbated by the poor tailings treatment, especially from Armenia's mining site near the Aras River (Bidhendi et al. 2007). In this regard, Azerbaijan and Iran have delivered their concern towards stream flow reduction and river contamination especially addressing Armenia. In contrast, Armenia has successfully prolonged preventive measures in a conservative manner and playing with ambiguity. We consider this behavior as another tool named sanctioned discourse. Turkey, on the other hand, has demonstrated its power by declaring the policy of total withdrawal of domestic waters and propelling its development plans. We refer to this behavior as the imposition of narratives. Following, is the summary of some media content containing the aforementioned tools used by authorities.

Azerbaijan has accused Armenia of polluting and cutting down the water on several occasions. For example, Azerbaijan foreign ministry's spokesperson stated on 19 July 2017 that Armenia's policy in transboundary rivers and the Sarsang reservoir in the occupied Azerbaijani lands is to prevent water from entering the Azerbaijan territory, and this proves that Armenia uses water as a means of environmental terror and threat not only to Azerbaijan but to all other neighbors. The head of Azerbaijan's department of economic and political geography also stated that dumping the mining waste into the Aras River by Armenia contradicts the international documents, and the rivers flowing from Armenia through Azerbaijan bring vast amounts of waste.

Iran, however, has occasionally declared a hazardous future for downstream people who rely on the Aras River for domestic and agricultural purposes. For example, Irans' President (Hassan Rouhani) emphasized the importance of the Aras River quality for the downstream population during the meeting with Armenia's deputy prime minister. In his speech to reporters at the end of his tour to Azerbaijan-e-sharghi province (an important industrial county of Iran in Aras River Bain) in 2019, he stated that Iran monitors the pollution and informs the neighboring country to take the required measurements. Mohsen Khadem Arabbaghi, Director of Public Relations and International Affairs of the Aras Free Trading Zone Organization, said on the first international meeting on cross-border environmental protection of Iran and neighboring countries: "Despite numerous efforts by Iran to prevent the entry of Chemical waste from one of the neighboring countries to the Aras River, the international community has remained silent in the face of the danger of water pollution of the Aras River. The region has various ecosystems, Arasbaran forests, historical monuments and numerous sites and therefore the environmental issues are followed with special sensitivity". Yousef Ghafarzadeh, the head of Regional Water Company of Azerbaijan-e-sharghi province, once pointed out that the construction of dams in Turkey can affect runoff quantity of the Aras River. However, we continuously monitor stream flow of the river and will inform authorities in any anomaly conditions, which will damage our water supply.

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In contrast, Armenia has chosen ambiguity and successfully prolonged the procedure of taking practical measurements regarding waste management. For example, during the meeting with the Iranian Ambassador in 2016, the Nature Protection minister of Armenia stated that the Aras River is a cross-border river and it is necessary to carry out the pollution studies in the territories of all five countries to find out the exact sources of the pollution. Additionally, regarding concern over upstream activities, Tigran Avinyan, Armenian Deputy Prime Minister, during his meeting with Fekitamoeloa Katoa, the UN High Representative for the Least Developed Countries, in 2019 expressed concern over Turkey's broad reservoir construction projects. He pointed out that these projects not only affect the lands that are cultivated in Aras River Basin negatively but also substantially upset the hydrological and biosphere balance of the region

Another primary ideational tool reflected in the media relates to the development policy in each territory. Despite some mutual water-related agreements discussed earlier in this study, there is no integrated water resources plan and inclination towards reaching a multi-lateral comprehensive plan. In this regard, the policy is to declare total domestic water withdrawal and future developing program. For example, Recep Akdag, Deputy Prime Minister of Turkey in 2017 declared that besides several dam construction projects, 34728 hectares of agricultural land in the region would flourish after completion of the Soylemez reservoir. The body height will be 113 meters and 1.3 billion cubic meters of water will be regulated. Soylemez Dam will also produce 202.69 gigawatt-hours of electricity. Goksel Gulbey, the head of ASIMDER (International Association for Struggle against Baseless Armenian Claims) in Turkey in 2019, said that there has been important improvement in our country's water policy in recent years. Just as the current wars in the world are over oil and gas, the future wars will be on the water. Therefore, our policy must be towards taking control of the rivers that flow in vain from our region".

In this regard, The Deputy Minister of Jihad for Agriculture in Water and Soil Affairs of Iran in 2019 said that: with the maximum operation of the Khoda-Afarin Dam Irrigation Network Project, at least one million tons will be added to the production of agricultural products and more than 70% of the dry-land farming area in the Moghan region will be irrigated (equal to 37,000 hectares). In 2020, the head of the Management and Planning Organization of Azerbaijan-e-Gharbi province in Iran also referred to the significant capacity of border waters for manufacturing and development in the province. He said: "So far, 58 thousand and 840 billion rials have been spent to control border waters in the province". The head of the Regional Water Company of Azerbaijan-e-sharghi province also mentioned in 2020 that the Aras Exploitation and Development Plan is to make maximum use of the Aras River, supply agricultural water and create irrigation and drainage network of 16170 hectares with a water volume of 102 million cubic meters per year.

A general overview of the media shows that Turkey has remained passive and focused chiefly on domestic development rather than joint cooperative commissions with adjacent countries in the basin. This behavior of the Turkey might be due to its position as a geographically upstream country. On the other hand, Iran seems to be active and uses ideational tools to keep the basin's

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condition in its favor. In contrast, Azerbaijan and Armenia moderately articulate their policy through the press and media.

The results of media content analysis are summarized in Table 4. In this table, the frequency of occurrence of each Ideational tool in media is presented in linguistic form, and the relative numerical equivalent is derived using the Fuzzy-TOPSIS method. The entire media content is then considered as one criterion of ideational power.

Table 4.Ideational tools extracted from media content analysis

Criterion	Turkey	Armenia	Iran	Azerbaijan
Expressing Concern for other 'states' activities (securitization)	Low	Average	Very High	Average
Conservative Manner/Avoiding transparent Political Stance (sanctioned discourse)	Low	Average	Low	Low
Declaring the Policy of total Domestic Water Withdrawal (imposition of narratives)	Average	Low	Average	Low
Relative numerical equivalent	**0.24**	**0.41**	**0.75**	**0.17**

The criteria that are introduced to assess the knowledge structure of a country are representative of the country's ability to disseminate ideas in order to influence other actors in mutual or multilateral political discourses. For example, research and development (R&D) is the first stage of developing any new service or production and therefore, the Expenditure on R&D reflects the eagerness of a country to support ideas. Another criterion developed here is the number of published articles in each country, which shows scholars' ability to explore the new science topics prevailing worldwide. The next criterion is the number of top-ranked (among the top 1000) universities in each state. Turkey and Iran have ten and seven top-ranked universities, respectively, while Azerbaijan has only one and Armenia does not currently have a good university. Freedom of speech is another factor that might be useful in assessing the influence of media activists in disseminating social and political ideas. Moreover, the lower the value of press freedom, the better the circulation of ideas. Table 5 summarizes the relative ideational power distance through all criteria related to knowledge structure along with media content analysis.

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Table 5. Ideational power criteria

	Turkey	Armenia	Iran	Azerbaijan
GDP percentage spent on Research and Development	0.93	0.22	0.62	0.2
Number of Published articles (2016)	33902	521	40975	480
Best Ranking Universities (2019)	10	0	7	1
Freedom of Speech Index (2018 and 2019)	52.8	28.9	64.4	59.1
Media Content Analysis	0.24	0.41	0.75	0.17
Relative Ideational Power Distance	**0.66**	**0.24**	**0.71**	**0.06**

4.2. Overall Relative Power

Finally, to take a broad view of the power asymmetry in the Aras River basin, all four elements of power are aggregated to derive the overall relative power. The result is shown in Figure 2. It is concluded from Figure 2 that Turkey and Iran, having almost equal overall power, could be the potential hegemon of the basin. Although both countries lack some bargaining power, they excel in the other three forms of power. On the other hand, Azerbaijan suffers from being located geographically downstream. This may cause severe qualitative and quantitative water problems when the rivalry water withdrawal sores up in the future. Although Azerbaijan and Armenia both have good assets such as cultivated lands, labor, and installed hydropower plants, it seems that those assets are not sufficient to play a vital role in political discourses between adjacent countries.

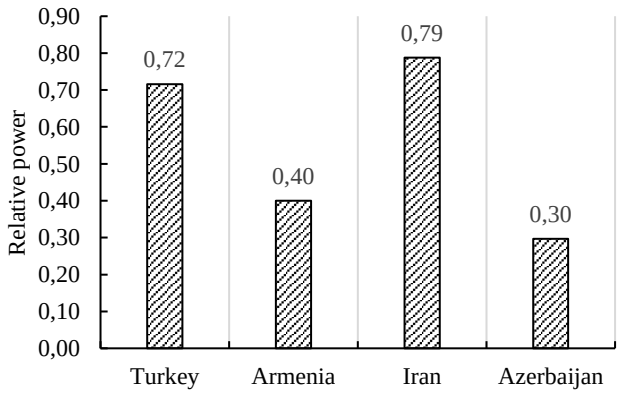

Fig. 2. Power asymmetry in the Aras River basin.

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4.3. Sensitivity Analysis

In the last section of this study, a sensitivity analysis is performed to evaluate the changes in countries' relative power based on the weight factors' variation in all four pillars of the power. To reduce the number of all possible weighting cases, all the weight factors are assumed to take discrete numbers from zero to one with the step of 0.1 so that the sum of all the four weights assigned to power pillars is equal to one. Owing to these presumptions, only 82 cases of weighting allocations are possible. The results are shown in Figure 3. In any studying pillar, the relative power in each riparian country is equal to the average of all possible cases with the same weight factor.

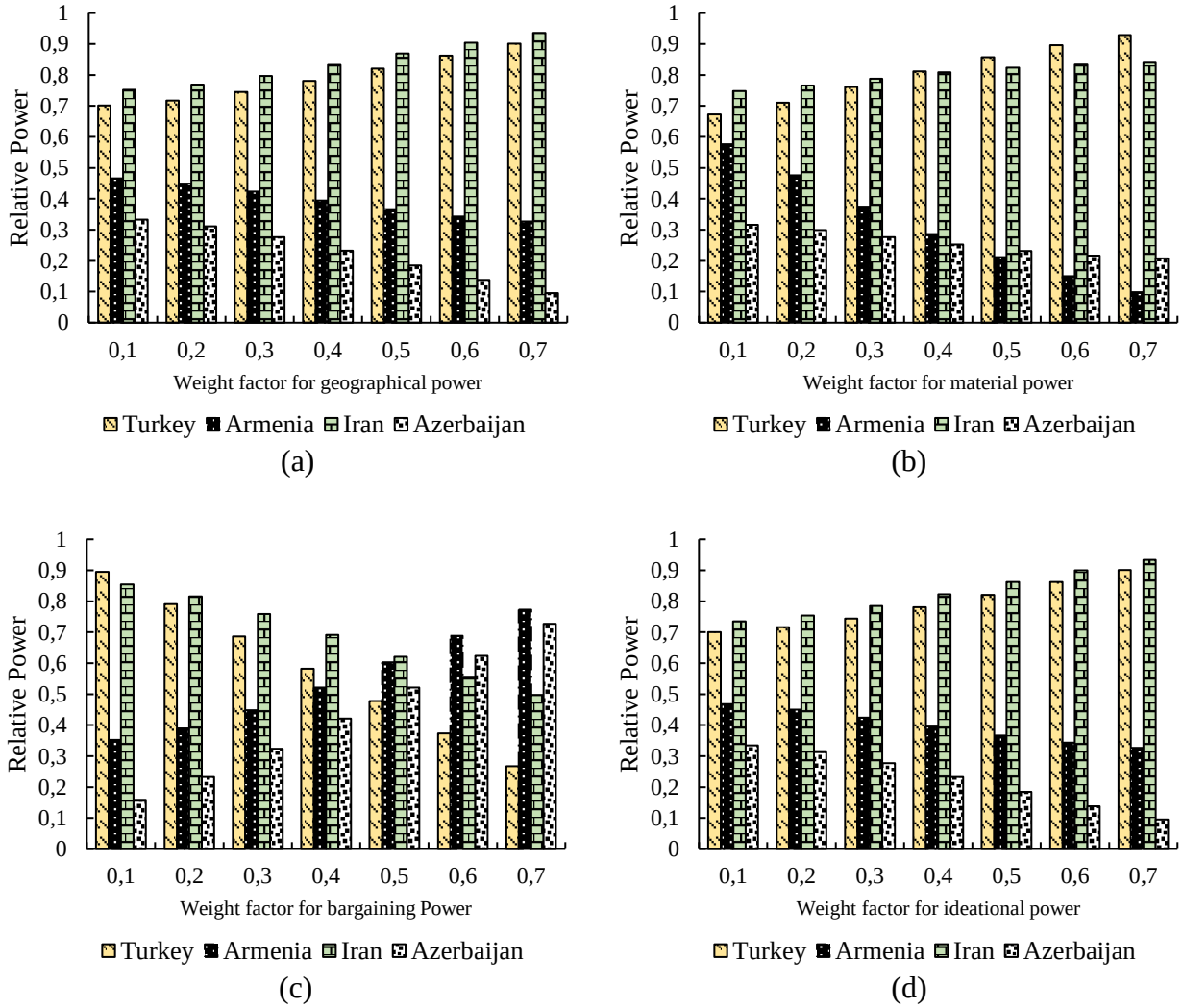

Fig. 3 The bar chart of the countries' relative power distance based on the variation of the weight factors in (a) Geographical, (b) Material, (c) Bargaining and (d) Ideational Power.

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As can be seen from Figure 3. In the case of the geographical, material and ideational power, by increasing the weight factor, the relative power of Turkey and Iran increases while that of Armenia and Azerbaijan decreases. Bar chart (b) shows that Armenia is the most sensitive country to the variation of the weight factor in material power (its relative power changes from near 0.6 to 0.1). As shown in bar chart (c), the variation of the relative power through increasing the weight factor of the bargaining power is significantly different. Giving more weight to the bargaining power, gives Armenia and Azerbaijan the privilege of being potential hegemon of the basin.

5. CONCLUSION

Power asymmetry assessment over an SWR needs a broad range of data and, most importantly, decision-makers' viewpoints in weighting the criteria. This research, offers an MCDM approach to analyze the power asymmetry through defining equal-weighted criteria. Based on the findings of this paper, it is expected that in the water shortage period, the potential hegemon of the basin (Iran or Turkey) will play an essential role in reaching stable cooperation or escalating conflict. In contrast, Armenia and Azerbaijan would possibly act as anti-hegemon individuals.

Since not all forms of power have the same importance in reality, sensitivity analysis is done to compare different weighting scenarios. It is concluded that the relative power between countries is more sensitive to the variation of material and bargaining powers' weight. For example, if Armenia and Azerbaijan focus on bargaining terms, they may reach equality in power despite their relatively low rank in other forms of power. Moreover, the coalition of parties, on the other hand, is an essential factor to consider, and this may totally affect the power asymmetry in the basin.

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Supplementary Information

Tables

Table S6. Length and stream order of Aras River available in each riparian territory (km)

Turkey			Armenia			Iran			Azerbaijan		
Stream Order	Length (km)	Index (km)	Stream Order	Length (km)	Index (km)	Stream Order	Length (km)	Index (km)	Stream Order	Length (km)	Index (km)
1	875	875	1	690	690	1	1361	1361	1	489	489
2	276	552	2	318	636	2	588	1176	2	187	374
3	422	1266	3	184	552	3	275	825	3	136	408
4	210	840	4	210	840	4	259	1036	4	137	548
5	-	-	5	42	210	5	347	1735	5	305	1525
Total		3533			2928			6133			3344

Table S7 Qualitative and manipulative vulnerability for each riparian's territory (km)

	Turkey	Armenia	Iran	Azerbaijan
Border River Length (km)	215	456	631	631
Interior River Length in Upstream Countries (km)	815	3100	3577	5130
Total (km)	1030	3556	4208	5761

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