Title: *Water Allocation Towards Constructive Engagement along the Jordan River Basin*

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INTRODUCTION

The dispute over the allocation of the Jordan River Basin (JRB) water is among the most intricate and politically sensitive water conflicts due to its direct association with the Arab-Israeli conflict. This basin is shared by five riparians: Israel, Jordan, Lebanon, Palestinian Authority, and Syria (Figure 1). This basin has no multilateral agreement over the sharing and management of its water resources. There are some existing bilateral agreements (Israelis and Palestinians Declaration of Principles of 1993 and Interim Agreement of 1995, the Israelis and Jordanians Peace Treaty of 1994, and the Jordanians and Syrians agreements over the Yarmuk River). However, those bilateral agreements did not succeed so far in addressing the basin's water shortage and environmental stresses manifested in the declining level of the Dead Sea.

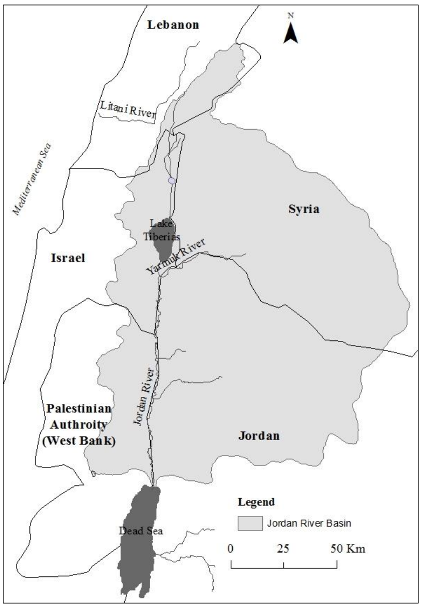

Figure 1. The Jordan River Basin

Experiences across other transboundary basins indicate that a successful agreement is possible if it involves all riparians; achieves equitable water allocation; and has an management framework with conflict resolution mechanisms and flexibility to accommodate potential changes in the basin's conditions (Zawahri, 2009; Haefner, 2013; Atwi and Choliz, 2011; Alam, 2002; Yoffe et al., 2003; Giordano et al., 2005). This study applies the allocation criteria adopted by the 1997 United Nations (UN) Convention on the Law of the Non-Navigational Uses of International Water Courses (referred to as the UN Convention in the rest of the paper) for the water distribution of the JRB with a sensitivity analysis to the criteria weights to anticipate the riparians perspectives regarding significance of reallocation criteria and discuss the potential incentives to motivate them into cooperation under a proposed management framework.

METHODOLOGY

The study applied the criteria adopted by the UN Convention of 1997 to the JRB to define "reasonable and equitable" water allocation entitlements for riparians (UN, 1997). The UN Convention explains that the principle of equitable allocation does not mean equal use, but rather encompasses a variety of criteria (Table 1) that must be considered for allocation of water rights. Unfortunately, the UN Convention never entered into force because only 16 countries ratified or acceded to it (Atwi and Choliz, 2011).

Table 1. Criteria for equitable and reasonable utilization of international watercourses based on the International Law Association (ILA) factors adopted by the UN Convention (Salman, 2007)

Criteria	Definition
F1	Geography of the basin, including the extent of the drainage area in the territory of each riparian.
F2	Hydrology of the basin, including in particular the contribution of water by each riparian.
F3	Climate affecting the basin.
F4	Existing and potential utilization of the waters of the basin.
F5	Economic needs of each riparian.
F6	Social needs of each riparian.
F7	Population dependent on the waters of the basin in each basin state.
F8	Costs of alternative means of satisfying the water needs of riparians.
F9	Availability of other water resources in the basin.
F10	Degree to which the needs of a riparian may be satisfied without causing appreciable harm and substantial injury to a co- riparian.

In this study, the criteria were quantified based on literature review and scores were derived as a percentage contribution of each riparian country to the overall total of the quantified criterion (Table 2) using Equation (1).

$$F_{i,j} = \frac{X_{i,j}}{(\sum_{i=1}^{n} X_{i,j})} * 100 \qquad (1)$$

Where i = riparian country (from 1 to n=5); j = number of allocation criteria (from 1 to m=10); $F_{i,j}$ = percentage normalized score assigned to riparian i with respect to criterion j (%); and $X_{i,j}$ = value assigned to i^{th} country with respect to the j^{th} criterion.

A sensitivity analysis for the relative importance of the adopted criteria in the proposed water allocation schemes was carried by applying scenarios (Table 3) and varying assigned criteria weights between 0 and 50% using increments of 5% for each criterion.

The change in water allocation scheme caused by the variation of the criterion weights was then quantified. The overall score for each riparian was calculated using in Equation (2):

$$S_i = \frac{(\sum_{j=1}^{m} F_{i,j} * W_j)}{(\sum_{i=1}^{n} \sum_{j=1}^{m} F_{i,j} * W_j)} \qquad (2)$$

Where S_i= overall score for i^{th} riparian, ranging between 0 and 100 percent; and W_j = weight assigned to j^{th} criterion with $\sum_1^j W_j = 1$.

Table 2. Evaluation of Jordan River Basin water allocation based on international law equity standards

Criterion	Estimation Approach	Unit	Israel	Jordan	Lebanon	PA	Syria
F1- Basin geographical area	Riparian share of the total basin area (UN-ESCWA and BGR, 2013).	km^2	1,906	7,352	688	1,564	6,775
		Equity score (%)	10.4	40.2	3.8	8.6	37.1
F2- Water flow	Total average annual riparians' contribution to the water discharge of Jordan River basin (Mimi and Sawalhi, 2003).	MCM/year	155	506	115	148	416
		Equity score (%)	11.6	37.8	8.6	11.0	31.0
F3- Precipitation	Average annual rainfall over the riparian areas of the Jordan River Basin (Keyzer et al., 2004).	mm	451	298	773	328	591
		Equity score (%)	18.5	12.2	31.7	13.4	24.2
F4- Existing water utilization	Current reported riparian water abstraction from the Jordan River Basin (Zeitoun et al., 2012).	MCM/year	800	290	11	0	260
		Equity score (%)	58.8	21.3	0.8	0.0	19.1
F5- Economic needs	Represented as the national agricultural contribution towards GDP (for years 2010 and 2011).	Agricultural GDP (%)	2.3 [a]	2.9 [b]	4.0 [c]	5.5 [d]	16.3 [e]
		Equity score (%)	7.4	9.3	12.9	17.7	52.6
F6- Social needs	Represented as the national agricultural workforce (for years 2007, 2008, 2011, and 2012).	Agricultural workers (%)	1.6 [a]	2.0 [b]	7.2 [c]	11.9 [d]	17.0 [e]
		Equity score (%)	4.0	5.0	18.1	30.0	42.8
F7- Within Basin population	Country population living within the basin area as estimated by UN-ESCWA and BGR (2013) for the time period 2000-2012.	Population Number	324,000	5,050,000	105,000	431,000	1,300,000
		Equity score (%)	4.5	70.0	1.5	6.0	18.0
F8- Costs of alternative water sources	Alternative solutions were assumed to include mainly water desalination. Hence, scores for the economic burden incurred by the riparians to secure alternative sources of water were evaluated based on reported desalination costs for these countries.	USD/m^3 of desalinated water	0.65[f]	1.34[g]	0.65[h]	1.11[g]	0.92[i]
		Equity score (%)	13.9	28.7	13.9	23.8	19.7
F9- Availability of other water resources	Water Stress Index is a reflection of each party's water scarcity and, hence, potential for utilizing other water resources. It is calculated by dividing each country's national water demand based on national population and a per capita water demand of 500 m^3/year by the annual riparians' national fresh water supply.	Total Available Water Resources (MCM/year)[j]	2,040	1,020	1,370	244	19,950
		Year 2020 Population Estimate (in millions)	9.10 [k]	8.09 [l]	4.88 [l]	5.14 [l]	25.74 [l]
		Water demand (MCM/year)	4,385	3,785	2,355	2,870	15,235
		Water Stress Index	2.23	3.97	1.78	10.53	0.65
		Equity score (%)	11.6	20.7	9.3	55.0	3.4
F10- Potential for appreciable harm	Water shortage in the basin was considered to cause equal humanitarian harm across all countries since all riparians are water stressed. So equal equity scores of 20% were assigned to all riparians.	Equity score (%)	20.0	20.0	20.0	20.0	20.0
		Total of Equity Scores	**160.8**	**265.3**	**120.5**	**185.5**	**267.9**

[a] ICBS 2013; [b] Jordan Department of Statistics 2013; [c] Lebanon Central Administration for Statistics 2013; [d] PCBS, 2012; [e] SCBS, 2011; [f] Tenne, 2010. Though Elizur (2014) reports seawater desalination cost as low as 0.40 USD/m^3 of desalinated water, the higher limit of 0.65 USD/m^3 reported by Tenne (2010) was used.; [g] Beyth 2007; [h] Desalination cost for Lebanon assumed to be the same as that incurred by Israel due to similarity of coastal areas; [i] Wardeh et al, 2005; [j] Keyzer et al., 2004; [k] ICBS, 2015; [l] UN, 2012.

Table 3. Scenarios and weights assigned to the international water law allocation criteria and used for sensitivity analysis

Scenario	Description		F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
1	No Bias (i.e., equal weights)		0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
2	30% emphasis on:	F1	0.3000	0.0778	0.0778	0.0778	0.0778	0.0778	0.0778	0.0778	0.0778	0.0778
3		F2	0.0778	0.3000	0.0778	0.0778	0.0778	0.0778	0.0778	0.0778	0.0778	0.0778
4		F3	0.0778	0.0778	0.3000	0.0778	0.0778	0.0778	0.0778	0.0778	0.0778	0.0778
5		F4	0.0778	0.0778	0.0778	0.3000	0.0778	0.0778	0.0778	0.0778	0.0778	0.0778
6		F5	0.0778	0.0778	0.0778	0.0778	0.3000	0.0778	0.0778	0.0778	0.0778	0.0778
7		F6	0.0778	0.0778	0.0778	0.0778	0.0778	0.3000	0.0778	0.0778	0.0778	0.0778
8		F7	0.0778	0.0778	0.0778	0.0778	0.0778	0.0778	0.3000	0.0778	0.0778	0.0778
9		F8	0.0778	0.0778	0.0778	0.0778	0.0778	0.0778	0.0778	0.3000	0.0778	0.0778
10		F9	0.0778	0.0778	0.0778	0.0778	0.0778	0.0778	0.0778	0.0778	0.3000	0.0778
11		F10	0.0778	0.0778	0.0778	0.0778	0.0778	0.0778	0.0778	0.0778	0.0778	0.3000
12	50% emphasis on:	F1	0.5000	0.0556	0.0556	0.0556	0.0556	0.0556	0.0556	0.0556	0.0556	0.0556
13		F2	0.0556	0.5000	0.0556	0.0556	0.0556	0.0556	0.0556	0.0556	0.0556	0.0556
14		F3	0.0556	0.0556	0.5000	0.0556	0.0556	0.0556	0.0556	0.0556	0.0556	0.0556
15		F4	0.0556	0.0556	0.0556	0.5000	0.0556	0.0556	0.0556	0.0556	0.0556	0.0556
16		F5	0.0556	0.0556	0.0556	0.0556	0.5000	0.0556	0.0556	0.0556	0.0556	0.0556
17		F6	0.0556	0.0556	0.0556	0.0556	0.0556	0.5000	0.0556	0.0556	0.0556	0.0556
18		F7	0.0556	0.0556	0.0556	0.0556	0.0556	0.0556	0.5000	0.0556	0.0556	0.0556
19		F8	0.0556	0.0556	0.0556	0.0556	0.0556	0.0556	0.0556	0.5000	0.0556	0.0556
20		F9	0.0556	0.0556	0.0556	0.0556	0.0556	0.0556	0.0556	0.0556	0.5000	0.0556
21		F10	0.0556	0.0556	0.0556	0.0556	0.0556	0.0556	0.0556	0.0556	0.0556	0.5000
22	Questionnaire Based (Mimi and Sawalhi, 2003)		0.0800	0.1500	0.1400	0.0600	0.0600	0.1000	0.0800	0.0800	0.0500	0.2000

F1: Geography; F2: Hydrology; F3: Climate; F4: Existing Utilization; F5: Economic Needs; F6: Social Needs; F7: Within Basin Population; F8: Economic Burden; F9: Water Resources Availability; F10: Potential for Harm

RESULTS AND DISCUSSION

The quantification of criteria (Table 3) and the allocation results (Table 4) indicate that 1) the highest percentage of the basin's catchment area and discharge are attributed to Jordan; 2) the highest percentage of rainfall occurs in Syria and Lebanon; 3) the highest within basin population and consequently the highest expected water demand among the riparians are in Jordan followed by Syria; 4) Israel is currently the greatest user of the basin's water resources; 5) though Palestinians are entitled to a share in the basin's water, they are currently allocated none; and 6) irrespective of assigned weights, the current pattern of water allocation does not conform to international water law guidelines. Comparing the current to proposed allocations at equal criteria weights shows that Israel is exceeding its share by ~266%, while Jordan is underutilizing its share by ~20%, Lebanon by ~93%, Syria by ~29%, and the Palestinian Authority by 100%.

The sensitivity analysis shows that Israel enhances its share by assigning most of the criteria weight to existing pattern of water utilization. Jordan's strongest arguments would lie in highlighting the significance of within basin population and its share of the basin area, whereas precipitation is the strongest criterion for enhancing Lebanon's share. The Palestinians strongest arguments would be the burden of securing alternative water resources in addition to their social needs associated with water use, and Syria's would be its socio-economic needs and its contribution to the basin area.

A regional integrated management plan for the JRB is proposed with components that address negotiating agreements, creating a specialized institution for the joint management of the Jordan River Basin, implementing legislative and institutional reforms, harmonizing water pricing and cost recovery policies among riparians, exchanging water demand management experiences, selecting regional water supply development projects, enhancing regional public awareness, and developing a joint river water commission (Table 5). However, conventional approaches relying on international water law for achieving unanimous approval of water allocation and management schemes have often proven difficult to implement and inconsistent with realities on the ground, particularly in arid basins plagued with water scarcity such as the case of the JRB whose riparians face several other challenges that would impede attainment of a comprehensive agreement.

Table 4. Proposed water allocations as per adopted scenarios

Scenario	Assigned Weights		Israel	Jordan	Lebanon	Palestinian Authority	Syria	Total Allocated Water
			Percentage Allocation S_i (%)					
(1)	Equal weights		16.1	26.5	12.0	18.6	26.8	100
(2)	30% of the weight assigned to:	F1	14.8 (-0.3)	29.6 (+0.8)	10.2 (-0.5)	16.3 (-0.6)	29.1 (+0.6)	100
(3)	(Sensitivity for +5%)	F2	15.1 (-0.3)	29.0 (+0.6)	11.3 (-0.2)	16.9 (-0.4)	27.7 (+0.2)	100
(4)		F3	16.6 (+0.1)	23.3 (-0.8)	16.4 (+1.1)	17.4 (-0.3)	26.2 (-0.1)	100
(5)		F4	25.6 (+2.4)	25.4 (-0.3)	9.6 (-0.6)	14.4 (-1.0)	25.1 (-0.4)	100
(6)		F5	14.2 (-0.5)	22.7 (-1.0)	12.2 (+0.05)	18.4 (-0.04)	32.5 (+1.4)	100
(7)		F6	13.4 (-0.7)	21.8 (-1.2)	13.4 (+0.4)	21.1 (+0.6)	30.4 (+0.9)	100
(8)		F7	13.5 (-0.6)	36.2 (+2.4)	9.7 (-0.6)	15.8 (-0.7)	24.8 (-0.5)	100
(9)		F8	15.6 (-0.1)	27.0 (+0.1)	12.5 (+0.1)	19.7 (+0.3)	25.2 (-0.4)	100
(10)		F9	15.1 (-0.2)	25.2 (-0.4)	11.4 (-0.2)	26.6 (+2.0)	21.6 (-1.3)	100
(11)		F10	16.9 (+0.2)	25.4 (-0.4)	13.4 (+0.4)	18.8 (+0.1)	25.7 (-0.4)	100
(12)	50% of the weight assigned to:	F1	13.6	32.6	8.4	14.1	31.4	100
(13)		F2	14.1	31.5	10.5	15.2	28.7	100
(14)		F3	17.1	20.2	20.8	16.3	25.6	100
(15)		F4	35.1	24.2	7.1	10.3	23.4	100
(16)		F5	12.2	18.9	12.4	18.2	38.3	100
(17)		F6	10.7	17.0	14.8	23.6	33.9	100
(18)		F7	10.9	45.9	7.3	13.0	22.9	100
(19)		F8	15.1	27.5	12.9	20.9	23.6	100
(20)		F9	14.1	23.9	10.8	34.7	16.4	100
(21)		F10	17.8	23.6	15.6	19.2	23.8	100
(22)	Questionnaire based		21.1	27.7	11.0	15.0	25.2	100
	Range of water allocation:		10.7 – 35.1	17.0 – 45.9	7.1 – 20.8	10.3 – 34.7	16.4 – 38.3	100
	Existing allocation pattern (Zeitoun et al., 2012)		58.8	21.3	0.8	0	19.1	100

F1: Geography; F2: Hydrology; F3: Climate; F4: Existing Utilization; F5: Economic Needs; F6: Social Needs; F7: Within Basin Population; F8: Economic Burden; F9: Water Resources Availability; F10: Potential for Harm

Table 5. Integrated regional water resource management plan
(adapted from El-Fadel et al., 2001; El-Fadel and Maroun, 2003)

Component	Objective(s)	Implementation
Negotiating agreements	– To allow cooperative water management plans and equitable water allocation of water resources. – To promote regional water security and alleviate the fear among riparians.	– By adopting a regional water charter for distributing water rights equitably among riparians according to the principles of international law.
Creating a specialized institution for the joint management of shared regional water resources of the Jordan River Basin	– To facilitate the resolution of future conflicts. – To prevent uncontrolled and/or over abstraction of shared water resources. – To build a regional database and ensure transparency of data sharing. – To set water quality standards.	– By collecting, assessing and analyzing, data and transforming hydrological and water data into information for planning, decision making and operation of sound management systems. – By installing water gauging stations to monitor water levels (flow rates) and developing a regional water quality monitoring system. The use of automated samplers and gauges that interfaces and communicated with all riparians may alleviate mistrust and encourage cooperation. – By developing a common hydrological model for the JRB that can be operated by riparians, using a common dataset.
Implementing legislative and institutional reforms	– To monitor and enforce laws, agreements, rules, and standards to be adopted in the regional water plan.	– By improving and reinforcing the water sector institutions of riparians. – By agreeing on a common set of penalties on violations.
Harmonizing water pricing and cost recovery policies among riparians	– To recover operation and maintenance costs in addition to a portion of the investment costs. – To encourage efficient resource utilization.	– By establishing cooperative water policies among riparians. – By standardizing water and agricultural subsidies. – By agreeing on a common minimum price on water.
Exchanging water demand management experiences	– To reduce water demand and lessen the problem of water scarcity and potential water conflicts.	– By increasing irrigation efficiency. – By reclaiming industrial effluents (mostly for irrigation purposes) and adopting water saving efforts. – By conserving water at the municipal level through reducing unaccounted-for-water. – By providing incentives for the adoption of high efficiency systems and water saving infrastructure. – By agreeing on a common agricultural plan for the basin that discourages the growing of water intensive crops within the basin as well as in areas that use the basin’s water.
Selecting regional water supply development projects	– Regional water supply development projects to augment irrigation, industrial and municipal water supplies.	– By water harvesting to collect rainfall and storm run-off. – By re-using municipal wastewater and brackish water for irrigation purposes. – By desalination of brackish and seawater for municipal and industrial purposes, such as the Red Sea-Dead Sea Conveyance project. – By exploring inter-basin as well as out-of-basin water transfer projects, such as the transfer of water from the Euphrates-Tigris basin, although this is becoming non-realistic with increased population and development in that basin exacerbated with Climate Change challenges. – By encouraging virtual water trade.
Enhancing regional public awareness	– To expand the knowledge base of decision-makers. – To inform people about water scarcity problems. – To expose the population to the cost of producing, treating, and distributing water to achieve wise water use.	– By increasing public awareness through various promotion and dissemination outlets. – By involving communities in the monitoring of the JRB.
Developing a joint river water commission	– To implement the basin management framework. – To meet potential changes in the basin priorities.	– By having an effective design of the joint water commission with detailed conflict resolution mechanisms.

To motivate cooperation, a positive apportionment framework is recommended to: (1) support a positive-sum (Phillips et al., 2007) arrangement in the water reallocation scheme; (2) create economic incentives for riparians (especially those having to give up water use from the JRB) to cooperate; and (3) generate benefits for third parties who will sponsor this cooperation framework. The positive-sum arrangement proposes development of "new water" mainly through seawater desalination projects to compensate riparians for reallocated water. The economic incentives are secured through relating cooperation over the reallocation of the JRB waters with cooperation over regional solar energy (DESERTEC Foundation, 2014). These regional initiatives require sharing electrical power through establishing cross-border grid interconnections (Meisen and Tatum, 2011). As Israel is the party who will have to mainly reduce its water use from the JRB, it will be provided connection to the Eight Country Grid Interconnection power project in return for its cooperation. Economic incentives and access to partnership in regional water and energy projects imply more prosperity to the Israeli economy and greater development potentials for other riparians. The international community would provide the direct financial subsidies and arbitrate the water conflict negotiations in return for benefits arising from political stability and security to their energy projects.

CONCLUSION

In closure, a successful water allocation benefits from joint management with due considerations to criteria recognized in international guidelines and to the role that the potential connection of water and energy projects can play in creating economic incentives for attracting riparians into cooperation. The role of a third party in supporting the positive apportionment framework needs to extend beyond economic funding to arbitrating potential disagreements especially anticipated perceptions of inequity or of one party benefiting more than another.

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