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GLOBALIZATION AND WATER RESOURCES MANAGEMENT:
THE CHANGING VALUE OF WATER

AUGUST 6-8 AWRA/IWLRI-UNIVERSITY OF DUNDEE INTERNATIONAL SPECIALTY CONFERENCE 2001

MULTI-CRITERIA DECISION TOOL FOR ALLOCATING THE WATERS OF THE JORDAN BASIN BETWEEN ALL RIPARIANS

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ABSTRACT: The Jordan River system, which is shared by Syria, Lebanon, Israel, Jordan and Palestine, is a major issue in the current Middle East peace negotiations. Although we believe that the International Water Law is the most suitable basis to solve the disputes between Arab countries and Israel, it is worthwhile developing multi-weighting approximation criteria for determining the water rights for the above riparian countries. The paper provides an overview of current resolution principles and procedures and presents the conflict resolution process in theory. The aim of this paper is to develop multi-criteria decision tool to the problem of allocating the waters of the Jordan River Basin between all riparian parties. The prime principle of the criteria is equitable and reasonable allocation factors identified by the International Law Commission in its draft articles on the non-navigational uses of water. A general mathematical model was derived that found the optimal allocation outcome based on the weight of each factor. The approach presented here should be seen as a trial to deal with the Palestinian-Israeli conflict over water rights in such complex trans-boundary water resources system. It is hoped that, water negotiators review this approach.
KEY TERMS: Jordan River Basin, equitable allocation, riparian water rights, transboundary waters, international river basin, conflict resolution

INTRODUCTION

The Jordan River flows from Lebanese and Syrian territory to the Lake Tabarias and then to its mouth in the Dead Sea. Northern tributaries to the Jordan River, which deliver approximately 540 Mcm/yr to Lake Taberias come from Lebanon (Hasbani River), Israel (Dan Spring), and the Golan Heights (Banias River and Hermon Springs). These flows combine with local runoff and precipitation to represent the total inflow to the Lake, which has a total storage capacity of approximately 4000 Mcm. The National Water Carrier, which is the main distribution system for water from Lake Taberias south to the Negev, draws annually 500 Mcm/yr from the Lake. Roughly 72 Mcm/yr of water passes out of the Lake to the Jordan River, which then combines with the Yarmuok River, the Zarqa River, various salt springs, precipitation and runoff. In summary, the natural flow of the river in the absence of extraction is estimated from 1250 to 1600 Mcm/yr at the entrance to the Dead Sea. (Lonergan and Brooks 1994).

The conflict over water resources between Arab countries and Israel has always been a major reason for wars and bloodshed. Since the majority of the region's water resources are shared by more than one country, allocation and management of trans-boundary water resources assume great importance. Israel, the West Bank and Gaza Strip

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(and hereafter called Palestine) share aquifers (Mountain Aquifer and Coastal Aquifer) and thus need to agree on their water rights. In addition, Israelis and Palestinians (together with other riparian parties: Jordan, Syria and Lebanon) need to reach accommodation regarding the Jordan River basin (Brooks 1994). International laws that regulate riparian rights are not much observed by Israel, and there are no comprehensive agreements between all neighbouring countries, except the bilateral Jordanian-Israeli agreement signed in 1994 and the Interim agreement between Israel and Palestine, which clearly stated that water rights will be settled in the permanent status agreement. The multilateral peace talks aim at regional co-operation and bilateral negotiations between the parties. The water issue is addressed in both sets of negotiations.

Unless all states cooperate and jointly manage their shared water resources they both stand to lose in terms of the long-term viability of their water systems. This paper provides an overview of current resolution principles and procedures, describes the characteristics and dynamics of water resources conflicts, and presents the conflict resolution process in theory. Moreover, it presents the application of those procedures and principles to the case study area and outlines one possible approach to the problem of allocating the waters of the Jordan River Basin between all riparian parties. Allocating the shared aquifers between Israel and Palestine will not be emphasised in the discussions of this paper. The approach depends on the discussion of the principles of a comprehensive water-sharing regime drawn from the international law of trans-boundary waters.

APPROACHES TO RESOLVING WATER CONFLICTS

How can we reduce the risks of water related conflict? International law and international institutions must play a leading role. There have already been some attempts to develop agreeable international law protecting environment resources, but almost all of these focus on attempting to limit environmental damages from conflict and war. No satisfactory water law has been developed that is acceptable to all nations, despite years of effort by various organisations. Developing such agreements is difficult because of the many intricacies of interstate politics, national practices, and other complicating political and social factors (Gleick 1994). Fresh water has been a central focus of almost every international meeting on the environment and economics as far back as, and even before, World War II. Modern approaches to the management of international waters began in 1956 when the International Law Association (ILA) issued the Dubrovnik rules that, among many other things, stated that river basins should be treated as an integrated whole, regardless of national borders. A decade later in 1966, the association adopted what has come to be called “the Helsinki Rules” for rivers and lakes that cross or form borders but for which there is no formal agreement.

The Helsinki Rules were further developed by the International Law Commission (ILC), an organisation created by the United Nations to focus on specific international legal issues. In 1991, the ILC completed the drafting and provisional adoption of 32 articles on the law of the Non-Navigational Uses of International Watercourses. Moreover, the United Nations General Assembly adopted a Convention on the Law of the Non-Navigational Uses of International Watercourses in May 1997. Among the general principles that help to reduce tensions and encourage effective and productive negotiations by the parties involved are (Gleick 1994; UN 1997): equitable allocation, obligation to resolve water related disputes peacefully, obligation not to cause harm to other riparian states and obligation to exchange hydrologic and other relevant data and information on a regular basis.

Questions remain about their relative importance and means of enforcement. It has been often pointed out that the international water law is nonbinding and lacks enforcement mechanisms. This is true, but it may also be the “ What we have got” as a guide for negotiations (Caponera 1994; Elmusa 1994). In some ways, the more challenging task for negotiators is to translate those principles into operating rules and procedures to determine the equitable apportionment of waters from shared water resources.

Equitable Allocation of Trans-Boundary Waters Under International Law

The equitable allocation of trans-boundary waters principle under international law is one of the most important developed by ILC and the Helsinki statements. At the same time, it is one of the most difficult to define, given the multitude of variables that should be taken into account (Gleick 1994). The principle of equitable utilisation means that each basin state is entitled to a reasonable and equitable share in the beneficial use of shared water. “Equitable” does not mean equal use. Rather, it means that a large variety of factors, including population, hydrology, climate, existing uses, economic and social needs, geography, availability of alternative resources, and so on, must be considered in the allocation of water rights. It is to be noted that each factor is not to be considered in isolation, but looked at together with all the other factors, without any of them being given priority. This theory neither purports to

identify fixed criteria in the sharing of international water, nor to protect existing water rights. Rather it aims at establishing a mechanism for cooperation and negotiation with a view to reaching an agreement.

It would be convenient if some rules could be used to allocate water fairly between the parties, but no single clear-cut international standard of water allocation fairness exists. The following lists the diverse factors that the International Law Association associates with equitable water use (Eaton and Eaton 1994; UN 1997):

- Factor A: *The geography of the basin, including in particular the extent of the drainage area in the territory of each basin state.*
- Factor B: *The hydrology of the basin, including in particular the contribution of water by each basin,*
- Factor C*: The climate affecting the basin.*
- Factor D: *The past utilisation of the waters of the basin, including in particular existing utilisation.*
- Factor E: *The economic and social needs of each basin state.*
- Factor F*: The population dependent on the waters of the basin in each basin State.*
- Factor G: *The comparative costs of alternative means of satisfying the economic and social needs of each basin states.*
- Factor H*: The availability of other resources.*
- Factor I: *The degree to which the needs of a basin state may be satisfied, without causing appreciable harm and substantial injury to a co-basin state.*

Quantification of Equitable Allocation Factors

This research translates the principle of equity in the use of a common property resource into a set of procedures to determine entitlements to the shared waters. The methodology is based upon the several factors listed above identified by the International Law Commission (ILC) in its draft articles on the non-navigational uses of international watercourses. For illustrative purposes, it is presented in terms of the water-sharing problem facing Israel, Jordan, Lebanon, Syria and Palestine in the Jordan River. The approach presented here should be seen as a first step in grappling with the problem of trans-boundary water resources rather than as the final word.

While much can be learned from international experience, no single methodology is directly applicable to present situation. In other words, there is no methodology we should try to emulate. The equity factors were operationalized, yielding equity standards that will serve as benchmarks against which various possible allocation outcomes are measured. They are produced along with the operational definitions from which they were derived. An allocation outcome A *(a,b,c,d,e)* specifies the proportional shares of the Jordan River riparian, where *a* represents the Israeli, *b* the Jordanian, *c* the Lebanese, *d* the Syrian shares , and *e* the Palestinian shares. The sum of the five shares equal 100 percent. The nine equity standards used are derived from the following operational definitions corresponding to the ILC factors. The nine factors from which the equity standards are derived were operationalized as follows:

Factor A and B

Catchment Area: The catchment area determines the amount of rainfall caught and, consequently, the total volume of surface and ground water run-off into the main -stream courses. Thus, the proportion of the catchment area laying within each watercourse state represents a measure of the inflow to the basin coming from these states. Table 1 presents an estimate of each riparian state's share of the Jordan -Yarmouk catchment area (Moore 1994).

Table 1. Share per country in catchment area (km^2)

Total area	Israel	Jordan	Lebanon	Syria	Palestine
17655	1955	6795	635	7180	1100
Percent	11	39	4	40	6

Average Annual Discharge: Average annual discharge is used as a measure of the riparian state's shares in the outflow of the basin's main stream courses. Table 2 offers an estimate of the average annual discharge of the Jordan -Yarmouk river system (GTZ 1996).

Table 2. Average Annual Discharge of the Jordan Yarmouk System (Mcm)

Total Discharge Mcm	Israel	Jordan	Lebanon	Syria	Palestine
1340	155	506	115	416	148
Percent	12	38	8	31	11

Factor C: This factor can be operationalized as shown in Table 3 (GTZ 1996).

Table 3. Average Annual Rainfall (mm)

Total Rainfall	Israel	Jordan	Lebanon	Syria	Palestine
1783	184	222	508	508	361
Percent	10	12	29	29	20

Factor D: Israel is currently the dominant user of the waters of the Jordan basin. With the capture of the Golan Heights during the Six-Day War and the extension of the security zone into southern Lebanon, Israel became the virtually exclusive user of the Jordan River. Table 4 presents the existing utilisation of the Jordan and Yarmouk Rivers (GTZ 1996).

Table 4. Existing utilisation of the Jordan and Yarmouk Rivers (Mcm/yr)

Country	Total	Israel	Jordan	Lebanon	Syria	Palestine
Quantity (Mcm/yr)	1340	810	340	5	165	20
Percent]	100	60	25	1	12	2

Factor E: The projected water consumption in the domestic, industrial and agricultural sectors for the five riparian states for the year 2010 is summarised in Table 5 (CES and GTZ 1997; ACSAD 1997; Mimi 1999).

Table 5. Projected consumption for the year 2010 (Mcm)

Country	Municipal Needs	Industrial Needs	Agricultural Needs	Total	Percent
Israel	890	155	1060	2105	9
Jordan	489	129	1088	1706	7
Lebanon	435	348	1705	2488	11
Syria	1488	818	13960	16266	70
Palestine	302	43.5	373	718.5	3
Total	3063.6	612.2	2508	23283.5	100

Factor F: This factor can be operationalized as shown in Table 6 (World Bank 2000).

Table 6. Projected Population for 2015 (millions)

Country	Total	Israel	Jordan	Lebanon	Syria	Palestine
Population	46.3	7.6	6.7	5.2	21.8	5
Percent	100	16.4	14.5	11.2	47.1	10.8

Factor G: Water resources options refer specifically to potential sources such as desalination of seawater and imported water. Desalination technology is available and represents a viable option, particularly for Israel. As for costs, it is reasonable to suppose that the comparative costs both for the national economy and for consumers are far more favourable to Israel. All of this makes Israel more capable of tapping the desalination option than the Arab riparian. Furthermore, Israel already possesses the industry and technology of desalination, while others would have to import it (Kally 1994). Measured in Gross Domestic Product (GDP) per capita, Israel's economy in 1998 was many times more than that of Palestine and other riparian countries (World Bank 2000). This makes Israel more capable of paying for water and tapping the desalination option than all other riparian. Thus, Palestine, Syria, Lebanon and Jordan would be entitled to a larger portion of the common waters than Israel, proportional to GDP per capita as shown in Table 7.

Table 7. GDP per capita (1998)

	Israel	Jordan	Lebanon	Syria	Palestine
GDP per capita (U.S.$)	16754	1478	4307	1160	1196
Percent	2.2	25.4	8.7	32.3	31.4

Factor H: This factor can be operationalized as shown in Table 8 (Bakour and Kolars 1994; Elmusa 1997; Daoudy 1999).

Table 8.Indigenous water resources within each country

	Israel	Jordan	Lebanon	Syria	Palestine
Quantity (Mcm/yr)	695	1240	7780	28814	135
Percent	14.6	8.2	1.3	0.3	75.6

Factor I: Appreciable harm refers to costs that can be objectively measured as result of denial of water rights (Goldberg 1992). The words "appreciable harm" have created definitional problems to both Palestinians and Israelis (Elmusa 1994). Therefore and to be non-allied, this factor will not be included in the alternative equity standards.

Optimal Allocation and Entitlements To Shared Ground Water Resources

The following approach may be one way of addressing the problem of water allocations. Returning to the eight equity standards summarised in Table 9, there is no manifestly "best" definition of entitlements; the standards do not converge on any one particular allocation outcome. The task, then, is to identify that outcome which did the "least violence" to the nine equity standards taken together. (i.e. to distinguish an optimal allocation outcome in which not necessarily the best measured against each equity standard in isolation, is the least worst of all outcomes when all eight taken equally into account). A multi-criterion decision rule, based on the concept of *error distance* is used to determine the optimal allocation outcome. This concept was used by Moore (1994a,b), in which he defined the *error distance* as the absolute linear distance from a given allocation outcome to a particular equity standard. The optimum allocation outcome is the one that minimises the summation of the *error distance* measured outward from itself to each equity point. The optimal allocation outcome *A* (17 percent, 21 percent, 9 percent, 33 percent, 20 percent) was calculated using an optimisation technique and represents the calculated entitlements for each country.

Table 9. Alternative equity standards (share in percent)

	Factor A and B		Factor C	Factor D	Factor E	Factor F	Factor G	Factor H
Share	Catchment area	Avg. Annual discharge	Climate	Existing use	Projected Demand	Population	GDP per capita	Indigenous Resources
Israel	11	12	10	60	9	16.4	2.2	14.6
Jordan	39	38	12	25	7	14.5	25.4	8.2
Lebanon	4	8	29	1	11	11.2	8.7	1.3
Syria	40t	31	29	12	70	47.1	32.3	0.3
Palestine	6	11	20	2	3	10.8	31.4	75.6
Total	100	100	100	100	100	100	100	100

In the above approach, all eight equity standards received equal weight. It could be argued, however, that some factors should be given greater prominence when determining states' entitlements. But which factor? To answer this question, and to facilitate the development of a realistic weight for each factor, a questionnaire has been prepared and sent to water experts all over the world. These experts are individuals who are involved and interested in the various aspects of water resources development, planning, management, and research that work in water institutions, universities, research institutions, non-governmental organizations, and municipalities. The main activity of the experts was to assign weights for each equitable allocation factor. The questionnaire was sent to 100 water experts all over the world. 54 experts answered the questionnaire. Table 10 detail the main findings of the questionnaire. Applying the average weight for each factor, the optimal allocation outcome was (19, 20, 9, 35 ,and 16 percent) and represents the calculated entitlements for each country.

Table 10. Weight of alternative equity standards

	Factor A and B		Factor C	Factor D	Factor E	Factor F	Factor G	Factor H
Share	Catch-ment area	Avg. Annual discharge	Climate	Exist-ing use	Projected Demand	Popu-lationn	GDP per capita	Indigenous Resources
Average Weigh (percent	11	12	12	17	18	13	7	10

RECOMMENDATIONS

The approach presented in this paper should be seen as a first step in grappling with the problem of trans-boundary water resources rather than as the final word. Although seemingly reasonable in principle, this provision can be troublesome in practice. Questions (and controversies) soon arise over the appropriate weight to assign to the various factors identified by the International Law Commission (ILC) in its draft articles on the non-navigational uses of international.

Determination of an equitable allocation outcome must be seen as a dynamic process, taking into account new demands, changing resources, and water quality. It therefore calls for exchange of relevant information and continuing negotiations over the exact allocation in any given year.

The satisfactory resolution of water disputes requires both improved conflict resolution methods and innovative measures such as water marketing and conservation. This combination of decision-making processes and technical or policy solutions is critically important to creating workable solutions to controversial water resource problems.

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