ISSN 0097-8078, Water Resources, 2009, Vol. 36, No. 6, pp. 731–742. © Pleiades Publishing, Ltd., 2009.

WATER RESOURCES DEVELOPMENT: ECONOMIC AND LEGAL ASPECTS

A Numerical Method to Index the Risk of Conflict around the Transboundary Water Resources. Validation by a Studied Case[1]

Menani Mohamed Redha

Earth Sciences Department, Batna University, Batna, Algeria

Received January 19, 2009

Abstract—The world-wide crisis of water will make that the transboundary water resources will be the object of tensions and litigations increasingly marked. Also, the transboundary conflicts on fresh water intended to the categories of traditional uses are subjected to a growing attention on behalf of national and international organizations. Each case of conflict, related as well to surface water as groundwater, has its accurate characteristics and to appreciate its relative importance, it is necessary to consult a broad documentation based on reports of commissions, organizations or groups of research. According to criteria and data taken into account, the situation is some times appreciated differently.

DOI: 10.1134/S0097807809060128

This note proposes a numerical indexing method of the risk of conflict around the transboundary water resources by taking into account the most representative indicators having weights proportional to their relative importance.

However, each indicator varies in a rating field according to well defined criteria which take different values according to local conditions, thus providing a partial index of risk (multiplication of weight by rate) and the sum of these partial indices provides the global conflict risk index for a given region.

Based on indicators relatively easy to identify, this approach allows:

a standardized qualification of the risk of conflict around the transboundary water resources;

a fast comparison between different regions of the world exposed at this risk; a cartography of the zones at risk according to same indices.

The transboundary conflicts around surface and groundwater are subject to a particular attention on behalf of international organizations in charge of these problems. Each treated situation is the subject of a diversified literature, sometimes very rich in information and the compilation of data can take a considerable time [36, 77, 78]. In addition, criteria of appreciation of the importance degree of the conflict can differ according to situations and interveners.

The objective of this paper is to propose a method of a numerical evaluation of the risk of conflicts around the transboundary water resources based on indicators having fixed weights according to their relative importance. These indicators include:

the degree of dependence to the transboundary water resources of the concerned countries;

the state of the satisfaction needs of each country;

the geopolitical context of the zone of conflict;

the geographical position in relation to the resources;

the water governance in each country.

However, these indicators take different values in rating intervals which depend of the local conditions.

The combination between the fixed weight and the reached rate by each indicator in a given region leads to a partial index of the risk concerning this indicator and the sum of the partial indices provides the global index of the risk of conflict around the transboundary water resources.

This weighted approach is inspired by the DRASTIC method established by Aller et al. [6] with the aim of numerically evaluating the vulnerability to pollution of groundwater. This method was inspired in its turn by the approach of Hutchinson and Hoffman [39] which was elaborated in the same objective.

The rating intervals are based on criteria and standards which take into account results of research works carried out through actions at world scale which target not only the quantitative and qualitative aspects of the resources, but also a broader vision which integrates the economic, social, educational and political aspects.

INDICATORS OF RISK

Little literature is related to the conflict risk indexing around transboundary water resources. Certain approaches were developed in the past to define only the water stress limit for the populations. Among those,

[1] The article is published in the original.

Table 1. Risk Indicators and their respective weights

Indicators	Weights
Dependence degree to the transboundary water resources	5
Satisfaction degree of the water needs	4
Geopolitical context of the zone of conflict	3
Geographical position in relation to the water resources	2
Water governance by parts in conflict	2

Falkenmark [26] proposes the Water Stress Index which is based only on the availabilities of water per person per year to define the critical limit of 500 m^3 per person per year as being that of the chronic scarcity. Gleick [35] identified indices of vulnerability to define regions at risks for international water conflicts. He proposed 4 indices which integrate for the first time space component:

Ratio of water demand to supply;

Water availability per person;

Fraction of water supply originating outside a nation's borders;

Dependence on hydroelectricity.

Wolf et al. [79], on the basis of compilation and treatment of data related with many international basins, and to fill certain omissions, such as cooperative exclusion of events, by considering the basin as unit of analysis either the state and by not focusing only on specific cases, proposes indicators to identify basins at risk of conflict around transboundary water resources. 3 categories of data were treated: biophysics (topography, surface runoff, climate…), socioeconomic (dependence one hydropower, *GDP*…), and geopolitical (style of government, present and historic boundaries…). In general, he found that most of the parameters commonly identified as indicators of water conflict are actually only weakly linked to dispute. Wolf et al. [79] consider that if it is the institutional capacity which conducts, most significant of the indicators are those related to the fast changes which affect both the institutional system and the physical. In his analysis, the author also takes into account the co-operation aspect between states [77, 78] which, in the case of a good agreement, can clearly decrease the tension which can prevail around the transboundary water resources.

Finally, Wolf et al. [79] retain 2 main categories of basins vulnerable to the transboundary water conflicts in the near future (five to ten years):

Transboundary basins between newly independent states.

Basins characterized by the absence of cooperation and by the unilateral development projects.

Approach suggested precisely within the framework of this work, takes account of the degree of changes which can affect as well the institutional system (water governance and cooperation, geostrategical context) that the physical system (dependence degree to transboundary water resources, geographical context, satisfaction degree of the water needs), by distinguishing each indicator by a fixed weight proportionally to its relative importance while affecting cotes for each state of the indicator variation according to local conditions.

The indicators of risk proposed have fixed weights proportionally to their relative importance. They are summarized in Table 1.

The relative weights assigned to the proposed indicators can lend to discussion, nevertheless the following remarks guided these choices. The various factors, which in certain situations can be redundant, are evaluated separately and in an independent way, because it is question of evaluating their intrinsic influences:

The first and the second indicators concern only the transboundary water resources;

They are considered as direct factors;

The third and the fourth indicators do not relate only to water resources but they concern other aspects also. Their influence is implicit;

The last indicator of risk relating to the water governance is of local influence initially, but can act in a favourable and implicit way on the transboundary water resources. This factor is strongly related to the development degree of a country;

The dependence degree of a country to the transboundary water resources for the satisfaction of its various needs is a decisive factor of conflict even if the other indicators have rates of weak risk. Even if a country has a good governance or an effective governance of water resources according to the terminology of the GWP [38], if it has normal relations with riparians, the transboundary water resources are perceived like a vital energy resource on which it has a right of a partial ownership but which is unfortunately always considered to the rise;

The satisfaction of the needs: if the various provisioning potentialities of a country do not satisfy its traditional needs, temptation to benefit more from the transboundary water resources increases, by non consensual adjustments, derivations of river, excessive pumping… i.e. as many arguments of conflicts, this even if the other indicators have rates of weak risk, i.e. even if countries in question have normal diplomatic relations and efficient systems of water governance;

Considered under the conflict aspect, the geopolitical context of a region can be a critical factor. In the case of a political or armed conflict between countries, the management of the transboundary water resources endures the direct consequences.

The cooperative committees of dialogue have then great difficulties in their operation if they are not simply blocked. However, in regions marked by normal political relations, the risk of conflict decreases very appre-

ciably. One perceives better now the difference between the relative importance of the geopolitical context and the risk related to the degree of dependence to the water resources which is more important relatively, even in the case of good relations between the concerned countries.

The influence of the geographical position is related to the fact that a country which is located at the upstream part of a river has more benefits by this situation that the country located at the downstream part, either naturally or by a provoked way (non consensual installations and river derivations, discharge of polluted water, etc…). This factor concerns also transboundary aquifers, by taking into account recharge zones of these aquifers, pumping fields and natural exit zones of these aquifers;

The water governance, which according to the GWP [38] is the source of the worldwide crisis of water, is not only an indicator of conflict, but also an indicator of a social, economic, and political development. According to Rogers and Hall [64] the water governance of a country can be evaluated by basic principles and criteria of performance. Poor governance of water is an undeniable source of local conflicts with a possibility of incidence on the transboundary resources. It would be fastidious to enumerate here the many causes of bad water governance which can lead to situations of local conflicts (inequity in the practical prices, inequity in distribution to consumers…). Reduction of water availability leads to a situation of tension, initially at a local level, but which will end up having a broader incidence when the recourse to the transboundary water resources becomes necessary to make up the deficits. Conversely, an efficient system which has recourse to other forms of resources to satisfy its needs (treatment, desalination…) can decrease the recourse to the transboundary resources.

The incidence of the water governance on the risks of conflicts around the transboundary water resources is necessarily of relative weight weaker than the degree of dependence to this resource and than the geopolitical and geographical contexts of the area which are basically different indicators and intrinsically more incisive. Nevertheless, the degree of satisfaction of the water needs is improved by effective governance, all the more if it presents criteria of performance. In this work, other parameters which are related to rules of integrated water resources management are taken into account to define the ratings intervals related to the water governance indicator, like the degree of knowledge of the resources state and the prevision of their evolution, the management aspect…

Table 2. Rating intervals of the dependence degree to the transboundary water resources

Variation intervals	Rate
Total dependence	10
Partial dependence with difficulties of satisfaction of the needs by other resources (natural and technical difficulties)	8
Partial with possibilities of supplying by other resources but with a high capital cost	6
Partial with possibilities of supplying by other resources with an advantageous capital cost	4
Partial to weak with an effective supply by other resources	2

RATING INTERVALS OF THE INDICATORS OF RISK

According to local conditions, indicators of risk take values varying between 1 and 10; the greatest dimensions indicate a high risk of tension and conversely.

It is obvious that these ratings must be established for each country concerned by the transboundary water resources. The interest of this method is that it is flexible, i.e. that the user can insert intermediate and specific states which are not envisaged here and to affect to them their respective dimensions by taking into account of their relative importance compared with those proposed.

The partial index of risk is obtained by multiplying the fixed weight of an indicator by the rate reached by this indicator according to the local conditions (IPR = I_{iw}, I_{ic})

IPR: partial index of risk;

I_{iw}: indicator fixed weight;

I_{ic}: indicator rate (variable).

THE DEPENDENCE DEGREE TO THE TRANSBOUNDARY WATER RESOURCES

The degree of dependence to the transboundary water resources can be appreciated by the quotation indicated in Table 2.

Partial index of minimum risk (PIR_{min}) = fixed weight. Minimum rate = 5.2 = 10;

Partial index of maximum risk (PIR_{max}) = fixed weight. Maximum Rate = 5.10 = 50.

Zero dependence to the transboundary water resources cannot exist because no country can forsake its quota.

The natural difficulties are related for example to the rainfall deficit which influences negatively the filling-of a dam even if enormous investments were made in this direction. The technical difficulties are for example those which can affect projects of hydraulic transfers or

Table 3. Rating intervals of the satisfaction degree of the domestic needs (litre/inhabitant/day)

	<50	50 < x < 100	100 < x < 200	200 < x < 300	300 < x < 400	400 < x < 500	x > 500
Rate	10	8	6	5	4	2	1

those relating to groundwater withdrawals in certain deep aquifers.

When an investment on other forms of resources becomes advantageous, the tension on water decreases firstly at a local level and it can, by repercussion, decrease the recourse to the transboundary water resources.

THE SATISFACTION DEGREE OF THE NEEDS

The rating intervals for this indicator repose on the evaluation of the satisfaction degree of the needs of the concerned countries in the traditional categories of uses.

According to the report of The Johns Hopkins School of Public Health [43], among the three traditional categories of use of fresh water: agriculture, industry and domestic uses, the agricultural use prevails with a volume estimated on a worldwide scale at approximately 69% of all the annual water withdrawals, the industry at 23% and the domestic uses at 8%. These figures are close to those provided within the framework of the world program for the evaluation of the water resources WWAP [70], which are respectively 70, 22 and 8%. It seems that these proportions did not change much these last years.

It is obvious that the level of economic and social development influences directly the volume of water which is actually used by the inhabitants of a country. Moreover the prevalent use differs from a region to another. If in Africa and Asia, agriculture constitutes the principal use with a rate between 86 and 88% of the withdrawals, against 7 to 8% for industry and 5 to 6% for the domestic uses, in Europe on the other hand, most of water is used for industry with 54%, against 33% for agriculture and 13% for the domestic uses [25]. By taking account of the development degree of countries, those with high incomes present the following concurrent uses: 11% for the domestic use, 30% for agriculture and 59% for industry, as for countries with weak and average incomes, they are respectively of 8, 82 and 10% [70].

According to the region, the tension around the same use differs consequently. What is the use which has more impact on the risk of conflict?

The domestic and agricultural uses seem to be logically most influential on the risk of conflict because the first affects directly the consumption and the daily life of the population while the second affects its needs in food.

The non satisfaction of the industrial needs, whose effects on the populations are later and indirect, can involve a faster intervention of the governmental authority. The lack of water for a hydroelectric station for example is a very alarming situation for a state and if the problem is posed in a frontier context, it unquestionably constitutes a source of conflict.

RATINGS INTERVALS OF THE DOMESTIC USE

The domestic use includes the personal uses, domestic and municipal. Which is the minimum requirement for an acceptable or minimum standard of life? The figures differ according to international organizations and authors. Amongst authors, Falkenmark and Widstrand [27] or Gardner and Engelman [33] propose a standard minimum of 100 litres per inhabitant per day for a standard of living just acceptable. Concerning domestic consumption, differences are very marked between countries with high incomes and those with low incomes. In the first case, this consumption which includes watering of gardens and even the alimentation of the private swimming pools varies from 250 to 600 litres per inhabitant per day in Japan, in North America and in Europe, while in Africa for example, it is in order of 10 to 40 litres per inhabitant per day [22]. In this region, approximately 1.1×10^9 people are not connected to a water supply network and in the sub-saharian region, only 58.5% of the population has an access there.

The Global Water Supply and Sanitation Assessment 2000 Report published conjointly by the WHO and UNICEF [75], specifies that a suitable water supply must rise with 20 liters per inhabitant per day (value guide for countries with low incomes) and that the installation where water can be taken must be located at less than 1 kilometer of the housing of the user.

Gleick [35] proposes a minimum of 50 litres per inhabitant per day to satisfy four fundamental needs: drinking, cleaning, hygiene and cooking. The author argues this figure by the fact that in 1990, the national average did not reach this level in 55 countries which count nearly 10^9 inhabitants. The minimum value proposed by Gleick [35] seems to be a correct average and will be taken as minimum standard in the ratings intervals (Table 3).

Partial index of minimum risk (PIR_{min}) = 4.1 = 4;

Partial index of maximum risk (PIR_{max}) = 4.10 = 40.

Table 4. Rating intervals of the satisfaction degree of the agricultural needs (in relation to the percentage of irrigated surface)

	<10%	10 < *x* < 20%	20 < *x* < 30%	30 < *x* < 40%	40 < *x* < 50%	>50%
Rate	10	8	6	3	2	1

RATINGS INTERVALS OF THE AGRICULTURAL USE EXPRESSED AS A PERCENTAGE OF SURFACE TO IRRIGATE

The irrigated agriculture whose surfaces have almost doubled since 1960, occupies approximately 17% of the cultivated soils by ensuring 40% of the world agricultural production; the agriculture which depends on rainfalls occupies the remainder [22]. In 2030, the FAO predicts that 60% of the potentially irrigable lands will be used [70].

It is obvious that the agricultural techniques, the irrigation systems used, the re-use of water as well as types of cultures have a direct influence on the real needs and consequently on the percentage of surface satisfied. The proposed ratings intervals rest on the percentage of the arable lands irrigated. The needs for virtual water which is the amount of water that is embedded in food or other products needed for their productions are implicitly included in the agricultural water needs (Table 4).

Partial index of minimum risk (PIR_{min}) = 4;

Partial index of maximum risk (PIR_{max}) = 40.

The water needs of cultures have been the subject of many works which it would be fastidious to enumerate here, but for a fast estimation of the water needs of cultures in a given region and independently of the species, one can for example refer to the simple approach suggested by the FAO [28] based on the evaporation, the fraction of ground covered by cultures and rainfalls, whose data are generally available, or works of Doorenbos et Pruitt [23] relating to the water needs of cultures and those of Allen et al. [5]. It is also practical to refer to database as the information system AQUASTAT of the FAO which provides information on the management of water for agriculture throughout the world, more particularly in the developing and the emergent countries [29]. On another side, one can refer to more precise data concerning a particular type of cultures, like those provided by CNRS [17].

In terms of projections, data online of the National Institute of Hydrology of Saint Petersburg [68] provide information on the availabilities and needs of water for many regions up to 2025 for the various uses.

RATINGS INTERVALS OF THE INDUSTRIAL USE

The quantities and qualities of water required depend in particular on the uses of water in an industrial unit which are much diversified. The two principal applications of water resources in industry are the production of hydroelectricity and the use of water at ends of cooling in thermal factories. Concerning the quantification of necessary water volumes to manufacture certain products, CNRS [17] or Planistat [58] provided for example some data in this direction.

Rating intervals are related to the percentage of satisfied needs. From which rate of satisfaction of the water needs one can consider that an industrial unit sees its profitability seriously threatened and thus constitutes an element of conflict? All depends on the branch of activity and the requirements in terms of quality. In term of profitability, all the sectors present common factors, namely that the limit is judged by taking account of the invested capital and the interest rates as well as the risk factors which are related to the branch of activity concerned. Some times, the social cost of a given branch of activity can give her a privilege position, by reducing for example the cost of water or by allowing her a bigger quantity proportionally to other activity branches.

Rating intervals considered in this work are established simply by ascending order, because the direct link between the minimum limit of profitability and the water resource availability, which is considered in this precise case one of the elements of the manufacturing process, can be very variable (Table.5).

Partial index of minimum risk (PIR_{min}) = 4;

Partial index of maximum risk (PIR_{max}) = 40.

The economic development of a country is necessarily accompanied by an increase of the water demand in the three categories of use [71]. The potential tension around a particular use differs from an area to another. Indeed, in developed countries, tension around the industrial use is most significant, whereas in poor countries, it is rather the agricultural use. In the event of prolonged dryness, as consequence of the climatic changes, it is the non satisfaction of the agricultural needs which will be likely the first link of a catastrophic chain which will generate conflicts not only around water but around food also.

If the needs of a country are satisfied by having recourse, in addition to the transboundary resources, to other sources or other forms of water resources, the risk of tension is normally weak. However, less the needs for the various uses are satisfied, more the recourse to the transboundary resources increases and consequently the risk of conflict also, of course if the problem is posed in a frontier context.

The diversity of situations which can occur made that it is preferable to assign initially the same weight to the impact of each one of these uses, i.e. 4. The partial index for this indicator (the satisfaction degree of

Table 5. Rating intervals of the satisfaction degree of the industrial needs (in percentage of the needs)

	<50%	50 < *x* < 60%	60 < *x* < 80%	80 < *x* < 90%	>90%
Rate	10	7	5	3	1

the different uses) is obtained by dividing by 3 the sum of the indices relating to the three uses. However, in regions where industry is almost non-existent (poor countries), the weight of this factor is removed. The partial index is then obtained by dividing by 2 the indices relating to the two existing uses (agricultural and domestic).

Partial index of minimum risk (PIR_{min}) = (3.4)/3 = 4;

Partial index of maximum risk (PIR_{max}) = (3.40)/3 = 40.

GEOPOLITICAL CONTEXT OF THE CONFLICT ZONE

By geopolitical context of the zone of conflict, it is the state of relations which bond countries of the area subject to a problem of transboundary water resources which is aimed here. It is obvious that if it is an armed conflict zone, the problem of water becomes an additional detonator. However, if the concerned states belong to a community space in which there are rules for the integrated water resources management and commissions especially for this type of conflict, the risk becomes weak then (Table 6).

Partial index of minimum risk (PIR_{min}) = 3;

Partial Index of maximum risk (PIR_{max}) = 30.

THE GEOGRAPHIC POSITION OF THE BELLIGERENT COUNTRIES

It is the impact of the geographical position of a country in relation to the water resource which is aimed here. For example a country which is located near the upstream part of a river has more profits by this natural position compared to the country located at the downstream part. This situation can even lead to a provoked dominant situation which one can also describe as an abuse position as that occurred in many places (Euphrate, Danube…) when the country of upstream carries out installations, polluted water discharges, water derivations without taking account or little of riparians states or by not providing in time data relating to the rises of water which can cause grave floods in the downstream part.

This concept is not exhaustive to rivers but also relates to groundwater and it integrates in an implicit way the environmental aspect. For example, pumping in captive aquifers provokes a drawdown in broad zones which exceed the pumping field itself.

A country is considered under "natural dominance" when for example the resources of which it depends are located out of its territorial limits, or when it is under bad hydroclimatic conditions compared to the riparian states (Table 7).

The extreme case is when a country is under the two cases of domination (natural and provoked).

Partial index of minimum risk (PIR_{min}) = 6;

Partial index of maximum risk (PIR_{max}) = 14 + 6 = 20.

THE WATER GOVERNANCE BY PARTS IN CONFLICT

The water governance concerns as well the technical management of water resources that services. Some actions or approaches are based on well defined criteria for the implementation of reforms leading to the good governance of water which is a necessary step in the integrated water resources management [38].

According to Rogers and Hall [64], reforms which lead to an effective water governance include basic principles and attributes. These basic principles and attributes include among others, transparency, inclusion, communication, coherence and integration, equity, ethics, efficiency, responsibility, accountability and sustainable operations and have been used to evaluate the system of water governance in Kenya [44].

Rating intervals proposed here, repose on factors which are inspired, among others, by the criteria of effective water governance proposed by Rogers and Hall [64] and of the Toolbox for the integrated water resources management (IWRM) suggested by GWP [37] which assemble tools at the same time for diagnosis and for assistance to an effective governance.

Within the framework of this work, it is significant to refer to factors which are relatively easy to identify and to classify them by order of relative importance in the system of quotation.

The approach rests on the proposal for 5 groups of conditions which reflect levels of water governance (Table 8). Each group is affected by a dimension proportionally to its importance. Each time that a group of

Table 6. Rating intervals of the geopolitical context

Variation intervals	Rate
Zone of armed conflict	10
Zone of diplomatic tension	8
Zone of ethnic tension	6
Normal relations between states	4
Zone belonging to a communitarian space	2
Existence of treaties, commissions of basins	1

Table 7. Rating intervals of the geographical context

Variation intervals	Rate
Existence of a natural dominant position	3
Existence of a provoked dominant position	7

conditions (or a part of this group) is filled, then the dimension allotted to this group (or to a part of this group) is decreased from the total cote which is 10. Each time that a group of conditions of effective governance is filled, one has a better availability of water, and consequently the tension on the water resource decreases initially and especially at the local level, but it can also have favourable incidences in a frontier context by decreasing the tension.

The weakest dimension for this indicator is 1 obtained as follows: [10 – 9] = 1.

Partial index of minimum risk (PIR_{min}) = 2;

Partial index of maximum risk (PIR_{max}) = 18.

THE TOTAL INDEX OF RISK

It is the sum of the partial indexes:

$$GIR = \sum PIR = \sum I_{iw} \cdot I_{ic}.$$

With GIR: global index of risk of conflict around transboundary water resources According to this procedure, the global index of minimum risk of conflict is 25, whereas the maximum index is 158.

We note generally that two countries or more which are involved in a transboundary water conflict do not present the same global index of risk because conditions which prevail in each one of these countries are different.

APPLICATION EXAMPLE: CASE OF THE JORDAN BASIN

Rating intervals of the indicators proposed within the framework of this work, in term of definition of the satisfaction degree of the various uses, the geopolitical context, the water governance… rest on an analysis of a large literature.

The rating intervals of the dependence degree to the transboundary water resources were established on the basis of literature which describes the actual water availability in each country and this under various forms (surface water, groundwater, reuse water, desalined water) and the recourse to the transboundary water resources for satisfying the national needs [15, 20, 24, 47, 51, 55, 65].

The geopolitical and geographical contexts of the Middle-East are the subjects of many works which describe them under their various aspects [3, 13, 15, 16, 18, 20, 24, 34, 40, 47, 48, 51, 55, 56, 61–63, 65].

TWO PRINCIPAL DIFFICULTIES WERE ENCOUNTERED

One, relating to data concerning the satisfaction of the water needs, with confusions and differences between real, theoretical availability and real consumption. The many documents consulted in this direction, enabled us to note this established fact [2, 3, 7, 8, 11, 13–15, 20, 24, 30, 32–34, 40–42, 45–47, 49–57, 60, 65–67, 69, 72–74, 80, 82–84, 86]. In this case, the approach must be very critical and thorough.

The other, relating to the lacks of data concerning the state of the water governance in certain cases. The consulted documents allowed a relative approach of the current situation as regards of the water governance by the concerned countries [1–4, 7–10, 12, 14, 19–21, 24, 31, 32, 40, 42, 46, 47, 49, 51, 53, 54, 57, 59, 65–67, 69, 73, 74, 80–85].

The synthesis of the consulted data within the framework of this work lets appear that those are countries which are confronted to water shortage which develop the most efforts in term of water governance, except the case of Ghaza due to an exceptional situation.

The final result (Table 9) reflects the current situation in general, with a very high GIR for Gaza and the West Bank, whereas the low index of risk is that of Lebanon. Concerning the case of Israel, the total index of

Table 8. Rating intervals of the water governance

Variation intervals	Rate
Water resource management (general appreciation): Efficiency and Coherence, transparency in the attribution of markets… by water resources agencies (public in general) and their directions (Ministries)	3
Consented efforts in the exploitation of alternative resources and respect of the environment in a perspective of a sustainable development	3
Criteria which are linked to the knowledge degree of the resources: databases updated. Identified and modelled water reserves…	2
Planning concerted with the users within agencies of basins for example, communication with the users (dialogue and cooperation)…	1
Existence of structures which treat territorial or use conflicts and the respect of the ethics of the use of water	1

Table 9. Example of the transboundary water resources of the Jordan basin

Indicators of conflict	Israel	Jordan	The West Bank	Ghaza	Syria	Lebanon
1 – Degree of dependence to the transboundary water resources	Total dependence	Total dependence	Total dependence	Total dependence	Partial with possibilities of supplying by…	Partial to weak
	C = 10	**C = 10**	**C = 10**	**C = 10**	**C = 6**	**C = 2**
(**W = 5**)	**Ip = 50**	**Ip = 50**	**Ip = 50**	**Ip = 50**	**Ip = 30**	**Ip = 10**
	Domestic: $200 < x < 300$ 1/p/d	Domestique: $50 < x < 100$ 1/p/d	Domestic: $50 < x < 100$ 1/p/d	Total < 50 1/p/d	Domestic: >500 1/p/: (Theoretical surplus)	Domestic: >500 1/p/: (Theoretical surplus)
	C = 5 Ip = 20	**C = 8 Ip = 32**	**C = 8 Ip = 32**	**C = 10 Ip = 40**	**C = 1 Ip = 4**	**C = 1 Ip = 4**
2 – Satisfaction Degree og the needs	Agriculture: >50% of the arable lends are irrigated:	Agriculture: $20 < x < 30\%$ of the arable lends are irrigated:	Agriculture: < 10% of the arable lends are irrigated:	**Total Ip = 40**	Agriculture: 16% of the arable lends are irrigated:	Agriculture: $20 < x < 30\%$ of the arable lends are irrigated:
(**W = 4**)	**C = 1 Ip = 4**	**C = 6 Ip = 24**	**C = 10 Ip = 40**		**C = 8 Ip = 32**	**C = 6 Ip = 24**
	Industry: >90% satisfied	Industr: few developed except the tertiary sector (tourism)	Industry: unimportant§		Industry: $80 < x < 90\%$ satisfied	Industry: few developed
	C = 1 Ip = 4				**C = 3 Ip = 12**	**Total Ip = 28/2 = 14**
	Total Ip = 28/3 = 9.5	**Total Ip = 56/2 = 28**	**Total Ip = 72/2 = 36**		**Total Ip = 48/3 = 16**	
3 – Geopolitical Context: (**W = 3**)	Zone of armed conflict and diplomatic tension:	Zone of diplomatic tension **C = 8**	Zone of armed conflict or diplomatic tension **C = 8–10(9)**	Zone of armed conflict **C = 10**	Zone of diplomatic tensio **C = 8**	Zone of armed conflict or diplomatic tension **C = 8–10(9)**
	C = 10 Ip = 30	**Ip = 24**	**Ip = 27**	**Ip = 30**	**Ip = 24**	**Ip = 27**
4 – Geopolitical Context	Under natural dominant position	Under provoked dominant position	Under provoked dominant position	Under provoked dominant position	Under natural and dominant position (Turkey, Lebanon and Israel)	Under dominant position (Hasbani)
(**W = 2**)	**C = 3**	**C = 7**	**C = 7**	**C = 7**	**C = 10**	**C = 7**
	Ip = 6	**Ip = 14**	**Ip = 14**	**Ip = 14**	**Ip = 20**	**Ip = 14**
5 – Gouvernance of water	10 – (2.5 + 2 + 2 + 0 + 0.5) = 3	10 – (1.5 + 0.75 + 1 + 0.25 + 0.5) = 6	10 – (0.5 + 0.25 + 1 + 0.25 + 0.25) = 7.75	10 – (0.25 + 0.25 + 1 + 0 + 0) = 1.5	10 – (1 + 0.25 + 1.25 + 0 + 0) = 7.5	10 – (1 + 0.5 + 1 + 0 + 0) = 7.5
(**W = 2**)	**C = 3 Ip = 6**	**C = 6 Ip = 12**	**C = 7.75 Ip = 15.5**	**C = 8.5 Ip = 17**	**C = 7.5 Ip = 15**	**C = 7.5 Ip = 15**
GIR	**101.5**	**128**	**142.5**	**151**	**105**	**80**

risk can evolve to the decrease in next years if the projects relating to the desalination of sea water, which count on a variable surplus between 500 and 750 million m^3/an, are realized.

CONCLUSIONS

On the basis of the impact of 5 fundamental indicators of conflict characterized by fixed weights and variable rates which translate the local conditions of these indicators, the combination between weights and rates lead to the numerical expression of the risk of conflict around the transboundary water resources. It is obvious that this approach can not be applied, at least with difficulty, to all situations because conditions are much diversified, but it allows an approach of the most common situations.

This weighted method applied in the same way to all concerned parties decreases the risk of error on the final result.

The databases of various organizations working in fields which are on relation with this context facilitate the acquisition of the majority of the data necessary for calculation of the various indices. These indices can be updated like the databases making it possible to follow the evolution of the global index of risk.

If the definition of certain ratings intervals can lend to discussion, the relative order of classification seems correct and the global index of risk of conflict around the transboundary water resources allows a classification of the zones relating to this risk and their cartography.

REFERENCES

1. Allan, J.A. and Mallat, C., *Water in the Middle East: Legal, Political and Commercial Implications*, London: I.B. Tauris, 1995, p. 320.
2. Allan, J.A., *The Role of Drought in Determining the Reserve Water Sector in Israel. School of Oriental and African Studies (SOAS)*, London: University of London, 1995, http://drought.unl.edu/pubs/dnn/arch7.pdf.
3. Allan, J.A. and Karshenas, M., Managing Environment Capital: the Case of Water in Israel, Jordan, the West Bank and Gaza, 1947–1995, in *Water Peace and the Middle East: Negotiating Resources in the Jordan River Basin*, Allan, J.A., Ed., London: Tauris Academic Studies, 1996.
4. Allan, J.A., Water Stress and Global Mitigation: Water, Food and Trade, *Aridlands Newsletter ALN*, 1999, no. 45, http://ag.arizona.edu/OALS/ALN/ aln45/allan.html.
5. Allen, R.G., Pereira, L.S., Raes, D., and Smith, M., *Crop Evapotranspiration, Guidelines for Computing Crop Water Requirements*, Rome: FAO Irrigation and Drainage paper, 1998, no. 56, p. 300.
6. Aller, L., Benett, T., Lehr, J.H., Petty, R.J., and Hackett, G., *DRASTIC: A Standardized System for Evaluating Ground Water Pollution Potential Using Hydrogeologic Settings*, USA: National Water Well Association, 1987, Rapport EPA/600/2-87/035, p. 622.
7. Baroudy, E., Lahlou, A.A., and Attia, B., *Managing Water Demand: Policies, Practices, and Lessons from the Middle East and North Africa Forums*, London: IWA Publishing/IDRC, 2005, http://www.idrc.ca/waterdemand.
8. Bazza, M. and Ahmad, M., A Comparative Assessment of Links between Irrigation Water Pricing and Irrigation Performance in the Near East, *Water Policy Conference* (Agadir, Maroc, 2002).
9. Belloumi, M., Desalination as an Option to Resolve Problems of Water Shortage in MENA Region, *Second French Serbian Summer School* (Vrnjacka Banja, 2007), pp. 97–101. http://waterenvironmentvin.bg.ac.yu/proceedings/11%20Strana%2097101%20B%20water%20desalination_BELLOUMI.doc
10. Bied, C.M., Petit, O., Makkaoui, R., and Requier, D.M., *La gouvernance des ressources en eau dans les pays en développement, Cahiers du C3ED* (Centre dèconomie et dèthique pour l'environnement et le dèveloppement, 2004, no. 04-01, http://www.csf-desertification.org/catalogue/2004_CahierC3ED.pdf.
11. Bou-Zeid, E. and El-Fadel, M., Climate Change and Water Resources in the Middle East: A Vulnerability and Adaptation Assessment, *J. Water Res. Planning Management,* 2002, vol. 128, no. 5, pp. 343–355, http://infoscience. epfl.ch/record/91091/.../Bou-Zeid%20and%20El-Fadel%20-%202002%20-%20JWRPM%20-%20improved%20graphic.
12. Brooks, D.B., Economic, Ecology and Equity: Lessons from the Energy Crisis in Managing Water Shared by Israelis and Palestinians, in *Water and Peace in the Middle East*, Isaac, J. and Shuval, H., Eds., Amsterdam: Elsevier, 1994, pp. 441–450.
13. Bulloch, J. and Darwish, A., *Water Wars: Coming Conflicts in the Middle East*, London: Victor Gollancz, 1993, p. 256.
14. CEDARE/AWC, *State of the Water in the Arab Region*, 2004, p. 65, http://www.idrc.ca/uploads/user-S/11114806841arabstatewater1.pdf.
15. Chesnot, C., *La bataille de l'eau au Proche-Orient*, Paris: L'Harmattan, 1993, p. 222.
16. Chesnot, C., *Un enjeu méconnu des négociations israèlo-arabes Pénurie d'eau au Proche-Orient*, Le monde diplomatique, fèvrier, 2000, http://www.monde-diplomatique.fr/2000/02/ CHESNOT/13213.html.
17. CNRS, *Quantités d'eau nécessaires pour fabriquer certains produits industriels* (Quantities of Water Necessary to Manufacture Certain Industrial Products), 1994, http://www.eaufrance.fr/spip.php?rubrique12&id_article=14.
18. Danino, O., *Les tensions liées au Jourdain, Communication orale au séminaire de geeopolitique de l'ENS-Ulm*, 2008, http://www.geostrategie.ens.fr/impacts/presentation-eau-2.doc.
19. Darmame, K., *Gestion de la rareté : Le service d'eau potable d'Amman entre la gestion publique et privèe,* Report International Water Management Institute, 2008, http://www.iwmi.cgiar.org/Assessment/FILES/word/ProjectDocuments/ Jordan/RapportDarmame(1).pdf.
20. Desch ênes, D., L'eau pénurie, conflit ou coopération?, *Bulletin Le Maintien de la paix*, Institut québécois des hautes ètudes internationales, 2000, no. 48, http://www.hei.ulaval.ca/fileadmin/hei/documents/documents/Section_Publications/Maintien_de_la_Paix/bulletin48.pdf.

21. DGTPE, *Une nouvelle base de données pour "mesurer" les institutions*, 2007, no. 24, http://www.cedef.minefi.gouv.fr/directions_services/dgtpe/TRESOR_ECO/ francais/pdf/2007-018-24.pdf.
22. Diop S, Rekacewicz P., *Atlas mondial de l'eau, Une pénurie annoncée* (World Atlas of Water, An Announced Shortage), Paris: Collection Autrement, 2003, p. 63.
23. Doorenbos, J. and Pruitt, W.O., Les besoins en eau des cultures, Rome, *Bull. FAO d'irrigation et de drainage*, 1986, no. 24, p. 198.
24. El Battiui, M., L'eau au Moyen—Orient: entre gestion et instrumentalisation, *Thése de Doctorat en Sciences économiques et de Gestion*, Bruxelles: Université Libre de Bruxelles, Faculté des Sciences Sociales, Politiques et Economiques Et Solvay Business School, 2008, p. 270.
25. *European Schoolbooks (ES), The Battle for Water: Earth's Most Precious Resource*, UK: Cheltenham, 1994, pp. 1–16.
26. Falkenmark, M., The Massive Water Scarcity Now Threatening Africa: Why Isn't It Being Addressed?, *Ambio*, 1989, vol. 18, no. 2, pp. 112–118.
27. Falkenmark, M. and Widstrand, C., Population and Water Resources: A Delicate Balance, *Population Bulletin*, 1992, vol. 47, no. 3, pp. 1–36.
28. *FAO, La petite irrigation dans les zones arides: Principes et options* (The Small Irrigation in the Arid Regions: Principles and Options), FAO, 1997, http://www.fao.org/docrep/W3094F/w3094f06.htm.
29. *FAO, AQUASTAT Information System of FAO on Water and Agriculture, Developed by the Division of the Land Utilization and Water* (FAO, 2003), http://www.fao.org/ag/agl/aglw/aquastat/main/indexfra.stm.
30. *FAO (AQUASTAT)*, 2008, Databases, http://www.fao.org/nr/water/aquastat/main/index-fra.stm.
31. Ferragina, E. and Quagliarotti, D.L., Le contexte institutionnel et les pratiques sociales visant à une utilisation économiquement efficace et écologiquement compatible des ressources en eau, Istituto di Ricerche sull'Economia Mediterranea (IREM), Consiglio Nazionale delle Ricerche (CNR), *Conference Lyon-Fleuve*, 2001.
32. Fisher, F.M. and Hossein, A., Pour une gestion optimale de l'eau, *Finances et Développement,* 2001, pp. 52–55, http://www.imf.org/external/pubs/ft/fandd/fre/2001/09/pdf/fisher.pdf.
33. Gardner, O.T. and Engleman, R., *Sustaining Water, Easing Scarcity. A Second Update*, Washington DC: Population Action International, 1997, pp. 2–19.
34. Gleick, P., Water and Conflict: Fresh Water Resources and International Security, *Int. Security*, 1993, vol. 18, no. 1, pp. 79–112.
35. Gleick, P., Basic Water Requirements for Human Activities: Meeting Basic Needs, *Int. Water*, 1996, vol. 21, no. 2, pp. 83–92, http://www.pacinst.org/reports/basic_water_needs/basic_water_needs.pdf.
36. Gleick, P., *Water Conflict Chronology*, Pacific Institute for Studies in Development, Environment, and Security, 2008, http://www.worldwater.org/conflictchronology.pdf.
37. GWP, Toolbox for IWRM, in *Global Water Partnership*, 2001, http://www.gwpforum.org/servlet/PSP7iNodeID-15&itemId=448.
38. GWP, Effective Water Governance: Learning from the Dialogues, in *Global Water Partnership*, 2003, http://www.gwpforum.org/servlet/PSP?iNodeID=215&temId=473.
39. Hutchinson, W.R. and Hoffman, J.L., *A Ground Water Pollution Priority System*, Trenton, New Jersey: New Jersey Geological Survey Open-file, 1983, report no. 83-4, p. 32; Aller et al., DRASTIC Method, NWWA, 1987, rapport EPA/600/2-87/035, p. 622.
40. IFAD, *Hashemite Kingdom of Jordan Country Strategic Opportunities Programme*, Document EB 2007/92/R.16, 2007, http://www.ifad.org/gbdocs/eb/92/e/EB-2007-92-R-16.pdf.
41. International Drainage Database, 2008, http://drainage.montpellier.cemagref.fr/.
42. Jarrar, A., *Institutional and Legal Reforms in the Water Sector in Palestine* (A step to Attain Effective Water Governance), Report of Palestinian Water Authority, 2007, p. 20, http://www.gc21.de/ibt/en/site/mena/ibt/down/Abstract_%20Jarrar_E.pdf.
43. *Johns Hopkins School of Public Health, Population Information Program*, USA: Baltimore, Center for Communication Programs, 1998, vol. 26, no. 1.
44. K'Akumu, O.A., Toward Effective Governance of Water Services in Kenya, *Water Policy*, 2007, vol. 9, no. 5, pp. 529–543.
45. Khdier, K., Water Demand Management Options in Islamic Countries, *Proceedings RCUWM Symposium* (Teheran, Iran, 2003), pp. 8–14; International Hydrological Program, IHP-VI Technical Document in Hydrology, no. 73, UNESCO Working Series SC-2005/WS/2, http://unesdoc.unesco.org/images/0013/001385/138521e.pdf.
46. Laamrani, H., El Fattal, L., and Racked, E., *Gestion de la demande en Eau au Moyen Orient et en Afrique du Nord: Enjeux et perspectives*, Centre de Recherches pour le Développement International (CRDI), 2007, http://www.idrc.ca/uploads/user-S/12209481181paper.doc.
47. Lasserre, F. and Descroix, L., *Eaux et territoires. Tensions, coopérations et géopolitique de l'eau* (Québec, Presses de l'Université du Québec, 2003), p. 500.
48. Lipchin, C.D., Antonius, R., Rishmawi, K., Afanah, A., Orthofer, R., and Trottier, J., Public Perceptions and Attitudes Towards the Declining Water Level of the Dead Sea Basin: A Multi-Cultural Analysis, *Seminar on Environmental Narratives in the Middle East*, York, 2004, http://maps.arij.org/deadseaproject/Publications/Lipchinpaper.pdf.
49. Margat, J., *Avancées de la gestion de la demande en eau en méditerranée, Tendances contemporaines et perspectives dèvolution des demandes en eau dans les pays méditerraneans*, Plan Bleu, 2002, http: www.planbleu.org/publications/fiuggi_margat.pdf.
50. Margat, J. and Andrëassian, V., *Allons-nous manquer d'eau ? Paris, Le pommier*, 2005, p. 59.
51. Margat, J., *L'eau des méditerranéens, Situations et perspectives*, Paris, L'Harmattan, 2008, p. 288.
52. Margat, J. and Andréassian, V., *L'eau, Paris, Le cavalier bleu*, 2008, p. 128.
53. MINEFI-DREE/TRÉSOR, *L'eau en Syrie—situation générate,* Rapport Ambassade de France en Syrie, mis-

sion économique, 2003, www.dree.org/documents/57/62783.pdf.

54. Ministry of Municipal and Rural Affairs and the Environment Department of Environment, The Hashemite Kingdom of Jordan/IUCN, National Environment Strategy for Jordan A Resource Book of Information and Guidelines for Action, *Surface and Groundwater*, 1991, pp. 27–46, http://www.unep.org/dewa/WestAsia/data/Knowledge_Bases/Jordan/National%20Strategy/ National%20Environ%20Strategy.pdf.
55. Mutin, G., *L'eau dans le monde arabe, Enjeux et conflits*, Paris: Ellipses, 2000, p. 158.
56. Mutin, G., *L'eau quelle perspective pour le Moyen-Orient arabe?*, Institut d'Etudes Politiques de Lyon, GREMMO, 2008, http://archives.univ-lyon2.fr/283/2/eau_MoyenOrient.pdf.
57. Plan Bleu/PNUE, Politiques de l'eau des pays méditerranéens, Synthése régionale des dossiers pays (Pays du Sud et de l'Est) par Selmin BURAK, 2002, http//www.planbleu.org/publications/synthese_ regionale_eau.pdf.
58. *Planistat France,* Rapport sur la consommation d'eau par les secteurs Industriels, Etude conduite pour le compte du Ministére de l'Ecologie et du Développement durable, Direction des Etudes et de l'Evaluation Environnementale (D4E), Sous Direction des Politiques Environnementales, 2002, http://eaudoc.oieau.fr/IMG/pdf/Eau_industrielle.pdf.
59. *PNUE/PAM/Plan bleu*, Fiches méthodologiques des 34 indicateurs prioritaires pour le suivi de la Stratégie Méditerranéenne pour le Développement Durable, 2006, p. 80, http://www.planbleu.org/publications/fiches_i ndicateurs_smdd.pdf.
60. Potter, R.B., Darmame, K., Barham, N., and Nortcliff, S., *An Introduction to the Urban Geography of Amman, Jordan, Department of Geography*, School of Human and Environmental Sciences, University of Reading, Whiteknights, Reading RG6 6AB, UK, Geographical Paper, 2007, no. 182, http://www.reading.ac.uk/nmsruntime/saveasdialog.asp?IID=26699&sID=48883.
61. Raphaeli, N., The Tigris and Euphrates River Basin—Potential Conflict between Riparian Countries, Memri (Middle East Media Research Institute), *Economic Studies*, 2001, no. 14, http://209.85.135.104/translate_c?hl=fr&u=http://memri.org/bin/articles.cgi%3FPage%Dsubjects%26Area%3Deconomic%26ID%3DEA1401&prev=/search%3Fq%3DPotential%2BWat er%2BConflicts%2Bin%2Bthe%2BMiddle%2BEast%26hl%3Dfr%26rlz%3D1B3GGGL_frF R214FR214&usg=ALkJrhjrYnaKvl8i-YKm0KwT3pj5P5cbv-Q.
62. Raphaeli, N., Potential Water Conflicts in the Middle East, *Memri Inquiry Analysis Series*, 2007, no. 367, http://memri.org/bin/latestnews.cgi?ID=IA36707.
63. Raphaeli, N., The Looming Crisis of Water in the Middle East, *MEMRI Inquiry Analysis*, 2003, no. 124, http://209.85.135.104/translate_c?hl=fr&u=http://memri.org/bin/articles.cgi%3FPage%3Darchives%26Area%3Dia%26ID%3DIA12403&prev=/search%3Fq%3DPotential%2BWater%2BConflicts%2Bin%2Bthe%2BMiddle%2BEast%26hl%3Dfr%26rlz%3D1B3GGGL_frFR214FR214&usg=ALkJrhimS6bWOMDwR-NGdfnP_IIROdF9pQ.
64. Rogers, P. and Hall, A.W., Effective Water Governance, *Global Water Partnership*, 2003, TEC Background Papers no. 7, http://www.gwpforum.org/servlet/PSP?iNode ID-15&itemId=448.
65. Rogers, P. and Lydon, P., *Water in the Arab World: Perspectives and Prognoses,* USA, Cambridge: Harvard University Press, 1994, p. 369.
66. Saleth, R.M. and Dinar, A., *Water Challenge and Institutional Response* (a Cross-Country Perspective), The World Bank Development Research Group Rural Development and Rural Development Department, Policy Research Working paper 2045, 1999, http://www-wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2000/02/24/000094946_99031911113265/Rendered/PDF/multi_page.pdf.
67. Sawalhi, B.I., Mimi, Z.A., and Aliewi, A.S., Multi-Criteria Decision Tool for Allocating the Waters of the Jordan Basin between All Riparians, Globalization and Water Resources Management: the Changing Value of Water, *Awra/Iwlri-University of Dundee International Specialty Conference*, 2001, http://www.awra.org/proceedings/dundee01/Documents/SAwalhiandMimi.pdf.
68. SHI, *Data Bank about World Water Use and Water Availability*, Russia: State Hydrological Institute of Saint Petersburg, Shiklomanov, 2008, http://webworld.unesco.org/water/ihp/db/shiklomanov/.
69. Tal, S., Sustainability in Water Sector Management in Israel, *Presentation by the Israeli Water Commissioner to the World Bank*, 2006, http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2008/06/06/000333037_20080606050433/Rendered/INDEX/411130FRENCH0B1N103110200701PUBLIC1.txt.
70. UNESCO, Water for the Men, Water for the Life, in *World Report on the Development of the Water Resources, World Program for the Evaluation of the Water Resources* (UNESCO, France, 2003), www.unesco.org/water/wwap.
71. UNIDO, *Water and Industry* (United Nations Industrial Development Organization), 2008, http://www.unido.org/.
72. United Nations Organisation (UN), *Comprehensive Assessment of the Freshwater Resources of the World, Commission on Sustainable Development*, Report of the Secretary General, NY, UN, 1997, p. 39.
73. WaDImena, *Water Demand Management: An Adaptive Strategy to Climate Change in the Middle East and North Africa*, 2008, www.idrc.ca/WaDImena.
74. Wagdy, A. and AbuZeid, K., *Challenges of Implementing IWRM in the Arab Region*, WWF4, Mexico City, Mexico, 2006, http://water.cedare.int/filesl5/File2289.pdf.
75. *Global Water Supply and Sanitation Assessment*, New York: WHO/UNICEF, 2000.
76. *Water for Life Making it Happen*, WHO/UNICEF, 2005, http://www.unicef.org/wes/files/JMP_2005.pdf.
77. Wolf, A., Conflict and Cooperation along International Waterways, *Water Policy*, 1998, vol. 1, no. 2, pp. 251–265.
78. Wolf, A., Natharius, J., Danielson, J., Ward, B., and Pender, P., International River Basins of the World, *Int. J. Water Res. Development*, 1999, vol. 15, no. 4, pp. 387–427.
79. Wolf, A., Yoffe, S., and Giordano, M., *International Waters: Indicators for Identifying Basins at Risk*, Dept. of Geosc., Oregon State University, UNESCO/IHP/WWAP. IHP-VI, Technical Documents in Hydrology, PCCP Series, 2003,

no. 20, SC-2003/WS/58, http://unesdoc.unesco.org/images/0013/001333/133306e.pdf.

80. *A Strategy for Managing Water in the Middle East and North Africa*, Word Bank, 1995, Report no. 13469, http://wwwwds.worldbank.org/servlet/main?menuPK=64187510&pagePK=64193027&piPK=64187937&theSitePK=523679&entityID= 000020439_20070709153257.

81. *Urban Water and Sanitation in the Middle East and North Africa Region: The Way Forward*, Washington, World Bank, 1999, www.worldbank.org/mdf/mdf3/papers/finance/Saghir.pdf.

82. *Republic of Lebanon: Policy Note on Irrigation Sector Sustainability*, Washington, World Bank, 2003, Policy Note no. 28766, http://www.worldbank.org/ INTARD/825826-1111470888913/20431980/ LebanonIrrigationPolicyNoteMKWNewESADE.pdf.

83. *Making the Most of Scarcity, Accountability for Better Water Management Results in the Middle East and North Africa, The Quarterly Newsletter of the Group of the World Bank in the Maghreb*, Word Bank, 2007, no. 5, http://www.worldbank.org/WDPAMJ5290.

84. *MENA Countries Can Meet the Water Management Challenges of the Twenty-First Century*, Word Bank, 2008, http://www.worldbank.org/INTMENA/Resources/05-Chap05-Scarcity.pdf.

85. *Governance Matters, Worldwide Governance Indicators 1996–2007*, Word bank, 2008, http://info.worldbank.org/governance/wgi/sc_chart.asp.

86. Word Bank/Metap, *Syrian Arab Republic, Cost Assessment of Environmental Degradation*, Final report, Washington, World Bank, 2004, http://www.worldbank.org/INTMNAREGTOPENVIRONMENT/Resources/Syria-CountryReportEng.pdf.