Water Gaps Connecting Neighbours from Conflict to Co-operation by Applying Scarcity Index

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Abstract

According to the latest reports of United Nations, the biggest challenge facing the world at the present and in the next decades is water scarcity. Trans-boundary water resources from history to present either lead to cooperation or to confrontation and conflicts.

For the last six decades, it has not been possible to solve the Arab-Israeli conflict, and the water issue has been raised as one of the keys for solving the conflict or having a successful discussion.

The history of the water conflict in the Middle East began by the foundation of the Israeli state in 1948. Since that time Israelis have tried to secure the state water supplies using different water resources in the area. The rapidly growth of the driving forces (Nexus) has become a source of numerous conflicts with their neighbours.

The whole area has suffered from water shortage and unsuccessful managing of the water resources. Palestinians, Israelis, Jordanians, Syrians and Lebanese are sharing the major part of their water resources, the Jordan River and the aquifer of the West Bank and Garza Strip being the main sources of water resources for Israelis and for the Palestinians. Dividing the land will not be a solution to water gaps. It is likely to make the situation even worse.

Several methods and tools have been developed worldwide to assist the riparians to manage their own shared water resources, part of which are technical and other social -political methods. Scarcity index is one technical numerical method developed to assist the parties to allocate the shared water resources and to assist on recovering the water gaps. Based on the mentioned methods numerous agreements have been made and discussions have been held between the riparians to achieve peace and co-operation. Some of them have been implemented, the other remain open due to the political changes in the area.

Keywords: modelling trans-boundary water resources, water conflict, water balance and scarcity, Middle East water

1. Introduction

Worldwide water resources are unevenly distributed and they are generally scarce in arid and semi-arid zones such as the Middle East. Lack of water, growth of tensions, distrust as a consequence of poor relations, use of force to solve conflicts and inefficient management and use of water resources are the problems besetting water resources and the Arab-Israeli shared natural resources in particular.

This paper aims at contributing to resolve the complex relationship between riparian parties resulting from mutually shared and limited water resources in general, with special focus on the Israeli-Palestinian shared water resources.

The specific purpose of the paper is to find sustainable ways to evaluate and allocate trans-boundary water resources and to determine the scarcity of water resources in the Israeli-Palestinian area.

This paper refers to a model for calculating and evaluating the water scarcity index for the present as well as for the long-term future based on analysing the rules of the international water law and the role of the United Nations in sharing and allocating the shared water resources. The computation is based on evaluating the expected demand as a consequence of population growth.

This scarcity will increase with time due to the rapid population growth, drought, as well as other constraints. With the expected population growth the gap will be approximately some 40 percent in the Palestinian and 60 percent in Israeli areas by 2020. There is an urgent need to maintain a balance in water use between the parties in the area, to reduce water scarcity, as well as to bridge the water gaps.

A joint vision based on sustainable development is formulated for the application at hand as well as alternative scenarios. The one based on joint cooperation is selected. For implementing this scenario, alternative strategic means are presented. They include especially minimizing water use, re-using the water, looking for new options for increasing the total number of water sources, and strengthening the cooperation between the parties. To support the developed model, integrated water resource management, building of institutions and development of human resources are investigated and some alternatives are suggested.

Since the water scarcity around the world can be a result of lack of accessibility, water quality deterioration, fragmentation of water management, decline of financial resources, lack of awareness by decision makers, and endangering world peace and security. The Palestinian and Israeli water conflict is an example including of the two last parameters.

When considering the major driving forces that determine the development of the mankind and its environment, we have to first set the time scale that we want to look at. To put the analysis in the framework of sustainable development, the most appropriate scale would be one generation

backward and one ahead. This scale is typically used in global assessments. In this frame, the following issues are the major driving forces:

- Population growth, especially in the developing countries

One indicator for the water scarcity based on this driving force is explained later in this paper (Asheesh scarcity index), in which the author completed his case study 2002.

- Urbanization and other patterns of migration
- Changes in climate, environment, and nature
- Economy, and human capital, technology, and industrialization.

The main question which should be asked is how we can control these forces and how the international community controlled them during the last three decades.

One driving force of the above mentioned clearly appearing currently in the whole world is the migration to Europe which is a consequence of unsustainability and lack of water resources which is related to domestic use or agriculture in which will effect food production aspects and energy need (the Nexus).

2. Water sharing and riparian rights (international and national level)

The Israeli-Palestinian Water Joint Commission (WJC) announced a joint declaration for keeping the water infrastructure out of the cycle of violence and from becoming a source of conflicts. The Israelis and Palestinians view the water and wastewater sphere as the most important matter and strongly oppose any damage to water and wastewater infrastructure. The two sides are taking all possible measures to supply water and treat wastewater in the West Bank and Gaza Strip, even in the difficult circumstances of the Intifada movement that started in 2001. The two sides wish to bring to public attention that the Palestinian and Israeli water and wastewater infrastructure is mostly intertwined and serves both populations. Any damage to such systems will harm both Palestinians and Israelis.

In order to for this effort to succeed, the joint commission works based on mutual cooperation and support of all the population, both Israeli and Palestinian. The general public is asked not to damage the water infrastructure in any way including pipelines, pumping stations, drilling equipment, electricity systems and any other related infrastructure. The two sides also call on those involved in the crisis not harm water resources, the professional teams that conduct regular maintenance or repair damage and malfunctions to the water and wastewater infrastructure. Both sides wish to take this opportunity to reiterate their commitment to continued cooperation in the water and wastewater spheres.

In the United Nations proposal for water management and international sharing of water resources declared in 2000, the right to water was one of the essentials to be achieved, right to a standard of living adequate for the health and well-being of himself and family" (Universal Declaration of Human Rights Article 25, United Nations 2000). The right was to be for everybody regardless of his/her financial status. In recognition of the absolute need for water for survival, governments should regard the quantity of clean water necessary to ensure a decent standard of living for all people as sacred. An adequate supply of water must also be reserved for preservation and natural regeneration of the environment. Priority should be given to allocating the limited water resources according to the purpose of the use (Asheesh, 2003).

In the Palestinian-Israeli case the inhabitants of Israel and the Palestinian Territories share their main sources for drinking water. The largest resource is the Jordan River. Compared to other rivers in the Middle East like the Euphrates, the Tigris or the Nile, the Jordan River is a rather modest one – in length as well as in flow. Its main tributaries are the Hasbani, Dan, Baniyas and Yarmuk. The first three rivers converge in Israel, north of the Lake of Galilee, to form the upper Jordan River. Only the Dan originates within Israeli borders. The Hasbani springs lie in the part of Lebanon that was until June 2000 incorporated into the occupied Israeli security zone in southern Lebanon, and the Baniyas water drains from the Golan Heights – a territory formerly under Syrian control and since the war of 1967 occupied by Israel (Asheesh, 2003).

A holistic view needs to be taken of the water resources problem in the Arab world including the Israeli territory. The following aspects should be considered: Water requirements are calculated on a minimum basis known as "minimum water requirement" (MWR) which is 1,200 cubic meters/year (CM/Yr). The population of the Arab world is presently nearing 235 million; the quantity of available water per person is about 750 CM/Yr, which is below the MWR. If the population reaches 295 million by the year 2020, then a person's share of water will drop to 575 CM. If the average population growth is 25 per thousand, then the water requirement will reach 295 billion CM by the year 2020, i.e., a deficit of 120 billion CM. (Tamimi 2012).

Water struggles and water resources conflict will be always the key for peace and stability in the area. Using force over water resources undermine these goals in long term. For example the Nile conflict and water allocation have been between the parties. Appeared after almost 100 years. The Kenyan government decided to build a new dam to secure their sustainable water resources and energy. The Arab-Israeli water conflict parties should learn a lesson from this case. The water issue always weave as the most difficult and changeable issue of the five conflict issues in the Palestinian and Israeli the other issues in dispute, Jerusalem, borders, settlements and refugees are not so susceptible to the same effective and often usefully politically silent solutions provided by socio-economic development.

2.1 Framework for negotiation and cooperation

It has been widely accepted that the political, economic, social, technical and environmental (PESTE) and resource problems directly affect regional and international security. Although these PESTE aspects have not been so far sufficiently incorporated into the approaches to reduce the

risk of water conflict, a framework needs to be constructed that encourages scholars and policymakers to apply new tools, to set new priorities, to organize responses, to recognize water rights, share control and monitoring and portioning of water resources and to eliminate a range of environmental threats to peace and security (Asheesh 2001a). Based on the mention the main question is how a Palestinian State should approach the principles of sovereignty and cooperation over water.

In October 1994, a peace treaty between Israel and Jordan was signed which addresses water allocations, sharing of water information, and joint management policies for the Jordan River Basin. The Convention on the Non-Navigational Uses of International Watercourses based on article 6 of the treaty reads as follows:

The Parties agree to recognise the rightful allocations of both of them to the waters of the Jordan River and the Yarmouk River and Araba/Arava groundwater in accordance with principles set in Annex II of the Jordan Intelligence Agency agreement (JIA 1998).

The Parties jointly undertake to ensure that the management and development of their water resources does not harm the water resources of the other party.

The Parties recognise that more water, to meet their needs, should be supplied through various methods, including projects of regional and international cooperation.

Parties agree to search for ways to alleviate water shortage and to co-operate in the following fields:

- Development of existing and new water resources
- Prevention of contamination of water resources
- Mutual assistance in the alleviation of water shortages
- Transfer of information and joint research and development in water-related subjects.

Unless all the people who depend on the resources concerned are included in the agreements, conflicts will pertain. In particular, definitions of equitable utilisation of existing water resources must be negotiated and applied. These negotiations include discussing the priority of using the resources, like in the Israeli-Palestinian and California cases and other cases in other parts of the world, to resolve the wrestling between the demand for domestic and agricultural or urban and rural sector (Gleick 1996). The framework for cooperation will help in the formulation of criteria and prioritisation of the realisation of any of the proposed activities. As the water authority in the area is presently unorganised and the water itself is a quickly diminishing natural resource, direct involvement and efficient cooperative water administration is obviously essential and thus this factor cannot be handled separately from the technical issues.

Based on the above mentioned understanding between the both sides, the Palestinians and the Israelis, the joint water institutional framework could strengthen the management of the operation and maintenance of the shared water resources.

The precondition for formation of such a framework is that the respective parties start to base their understanding of the need to improve the water situation on trust, good faith and respecting each other's sovereignty. In this way using the water resources may happen in a reasonable and equitable way in accordance with the rules of the international joint committees (Israelis and The Palestinians). A joint water framework may be built first through negotiations about allocation the shared water respecting the hydrological distribution of the sources (and not according to geographical areas) and second in spirit of cooperation.

In light of the above, the following joint water framework could be considered in Palestinian-Israeli negotiations over water issues. The joint institutional framework illustrates the future administration and management functions in the area (Figure 1).

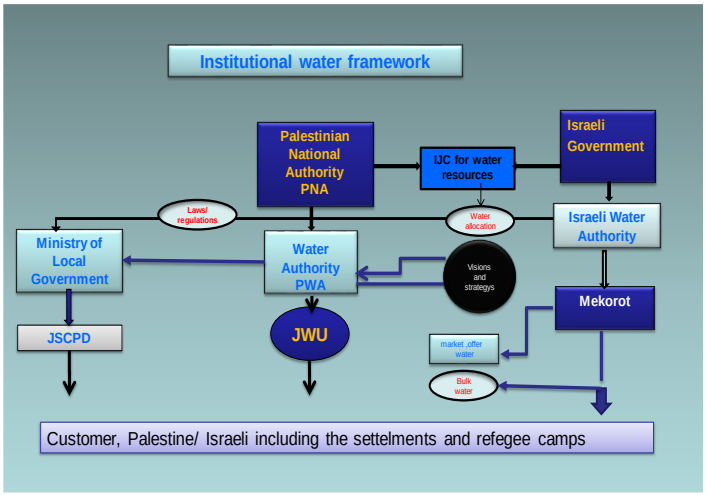

Figure 1 Institutional framework for arrangement of water resources and services

The role of the Water Authorities of both sides is to control and monitor the shared resources, since the sub roles of Jerusalem Water Undertake (JWU) and Joint Services Council Provider Department (JSCPD) to provide the services to the Palestinians side and Mekorot (Israeli water providers) to the Israeli side are essential to the framework.

The framework for cooperation should include the management of wastewater also, which poses a risk to the environment, since the groundwater lies relatively close to the surface and is easily contaminated (Nashashibi 1995). There are only a few wastewater treatment plants in the area, and the wastewater network is not large enough. Consequently, proper planning and locating of treatment plants and expansion of the wastewater network make up an important part of this research. Water re-use, which represents a new possibility to increase water resources in the area, can eventually help conserve significant amounts of fresh water, but much more research is needed to determine how water could be re-used in agriculture and industry.

According to (Kuttab & Jad 2000), three major issues concerning the Israeli-Palestinian conflict have to be analysed and ranked with regard to cooperation in water resources by the Palestinian West Bank and Gaza Strip Territories and the Israeli state.

The first issue relates to water resources that originate and are discharged completely in the Palestinian West Bank and Gaza Strip. The most obvious example of this sort is the Eastern aquifer resulting from rains within the catchment area east of the hydrological line that crosses the West Bank towards the Ghor Valley.

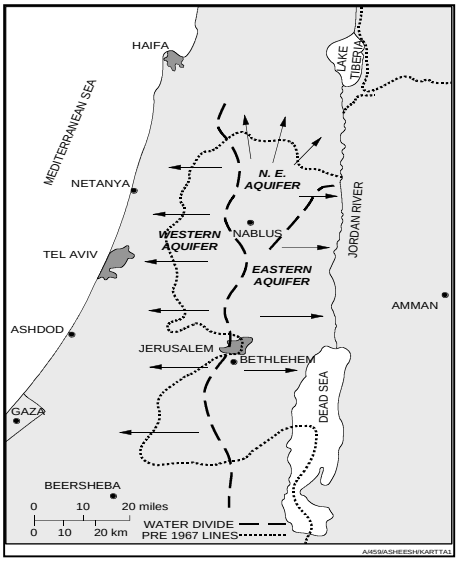

Figure 2 The hydraulic line locates the aquifer basin in the West Bank (Asheesh 2003)

The Israeli West Bank Mountain Aquifers have three general basins. The west aquifer, providing more than a half of the total yield in Israel, is called the Taninim aquifer, the second aquifer is the northern aquifer and the third one is the eastern aquifer. The last one lies on, and enters the West Bank. The second and the third aquifers as well as the most important west aquifer, qualify as trans-boundary basins, and any water distribution solution should be based on principles of sharing the watercourses under international law.

The second issue relates to the riparian waters, which flow into the Jordan River. The Palestinians in the West Bank together with Jordan, the State of Israel and Syria share these resources. Despite the absence of clear precision, there are sufficient guidelines in international law pertaining to surface water.

The third issue pertains to water resources resulting from rainfall in areas west and northwest of the hydrological line and which feed two main aquifers that are shared with the State of Israel. The major portion, about 80 percent, (Asheesh 2000) of the waters in these aquifers originates from the West Bank catchment areas.

The aquifer itself flows and actually straddles the border between the two areas with the majority of it found in the West Bank Territories. The consumption of water based on withdrawal from

those aquifers (the eastern and northern aquifer) it shows that the main and the biggest share is consumed by the Israeli settlements in the West Bank area.

Since the shared water resources between the neighbours are the main issue for peace and security, the cooperation on the operation and maintenance of the water system in general is the main key in the hands of the decision makers on solving the gaps of water in the current situation and securing the demands for long term. The joint institutional water framework to joint water authorities on both sides, water Authorities which can be based on the recognizing the right of both nations and based on the international water right declared by the international water law.

3. Indicators for International Water Gaps and Water Stress

In the past 20 years many indices have been developed to quantitatively evaluate water gaps and needs. Several indicators has been made to avoid conflict and to promote the cooperation and to prevent the conflict, struggles and distrust of controlling of the water resources.

The Falkenmark indicator is perhaps the most widely used measure of water stress. Gleick (1996) developed a water scarcity index as a measurement of the ability to meet all water requirements for basic human needs. Ohlsson (2000) integrated the "adaptive capacity" of a society to consider how economic, technological, or other means affect the overall freshwater availability status of a region. The UNDP Human Development Index (HDI) is a widely accepted indicator used to assess these societal variables. The International Water Management Institute (IWMI) used a similar water scarcity assessment though on a slightly larger scale across the entire globe. They conducted an analysis that considered the portion of renewable freshwater resources available for human requirements (accounting for existing water infrastructure), with respect to the main water supply.

Indicators of physical water scarcity include: acute environmental degradation, diminishing groundwater, and water allocations that support some sectors over others (Molden, 2007). Countries having adequate renewable resources with less than 25% of water from rivers withdrawn for human purposes, but needing to make significant improvements in existing water infrastructure to make such resources available for use, are considered "economically water scarce" (Seckler et al., 1998).

Freshwater scarcity is commonly described as a function of available water resources and human population. These figures are generally expressed in terms of annual per capita water and mostly on a national scale. The logic behind their development is simply that if it is known how much water is necessary to meet the human demands, then the water that is available to each person can serve as a measure of scarcity and these human demands (Asheesh 2003) (water right) can be identified by the riparian themselves. This can be schemed and established the visions and strategies of the shared water resources (the case of the Palestinians and the Israeli shared water).

4. Water Scarcity Based on Papulation Growth (the scarcity index)

Combining the population growth with the minimum water requirement (MWR) water gaps have been calculated, Table 1 illustrated the water gaps for some of the Middle East countries. This estimation was made disregarding the impact of the Syrian civil war. Since the war started in Syria millions of Syrians escaped from their homes to the neighbouring counties like Jordan, Lebanon and Turkey, which most likely escalates the water stress in those countries.

Based on the population growth the prediction equation1 is illustrated as follow:

$$A_n = A_x\left(1+ {}^{p}\!/_{100}\right)^n$$

Equation 1

Where

A_n: number of inhabitants

A_x: Current number

P: Growth percentage

n: Prediction length

To apply the term of minimum water requirement for all parties the following calculation for water projection for 2015 illustrated in Table 1 was carried out.

Water shortage can be calculated according to water minimum water requirement illustrated in the table1. The total water requirement used in the table assumes that the riparian are using the potential water resources in equitable reasonable way. Water uses in the area are divided as follows: domestic use 120 m3/C/Y (Shuval 1994) in addition to the demand for the industrial uses is 10% 25% from the total use, and 70% for the agricultural uses. The Israelis currently are using 300 l/c/d in the settlement areas for different purposes.

Table 1 Minimum water requirement for some of the Middle East countries

Area	*Population in 2013*	*Population in 2025*	*Water resource potential (Million m3/Y)*	*Total water per capita per year in 2013 (m3/P/Y)*	*Total water per capita per year in 2025 (m3/P/Y)*	*Total MWR in 2025 (Million m3/Y)*	*Total excess or shortage (Million m3/Y)*	*Growth rate (%)*
Israel	*8*	*9,5649*	*1500*	*187,50*	*156,823*	*2152,113*	*-652,1127*	*1,50*
Jordan	*8,5*	*13,6088*	*1100*	*129,41*	*80,830*	*1117,621*	*-17,6206*	*4,00*
Palestine	*3,88*	*5,8629*	*300*	*77,32*	*51,169*	*481,494*	*-181,4945*	*3,50*
Syria	*18,2*	*25,3506*	*10500*	*576,92*	*414,191*	*2081,921*	*8418,0795*	*2,80*
Lebanon	*5,8*	*6,8530*	*3700*	*637,93*	*539,906*	*562,806*	*3137,1938*	*1,40*
Turkey	*79,4*	*94,9321*	*105000*	*1322,42*	*1106,054*	*7796,297*	*97203,7027*	*1,50*
Egypt	*89,85*	*135,7695*	*60000*	*667,78*	*441,925*	*11150,072*	*48849,9283*	*3,50*

4.1 Water scarcity and the balance of water resources based on the scarcity index calculation

Balancing of the system is accomplished by covering the gaps or preventing the depletion of water resources and monitoring the relation between the inputs and outputs of the system *equation 2 is* presenting the parameters related to the balancing the system. In the case of depleted national or international river basin aquifers, covering of gaps or controlling and stopping the flow of the shared transboundary aquifer can be an alternative to balancing the situation inside and outside the system on the national and the international level, the scarcity index is an indicator that shows developments in the water situation of a riparian country. It points out the size of the gaps that should be covered or amounts to be returned into the system in order to secure the balance between available water and water demand.

$W_{sci} = (W_{av} / W_{tad}) - 1$

Equation 2

Where

W_{sci}: Water scarcity index

W_{av}: Available water resources in shared basin (in the state)

W_{tad}: Total annual demands for all riparian/states

The scarcity index developed reflects the relationship between the water system inputs and outputs from the system based on population growth in a given time. The scarcity index is expressed as a shortage or gaps (expressed as percentages), as the relationship between the parameters of available water and demands as illustrated in Equation 3. The main element of the equation is population growth, which determines all demand parameters in the water sector.

$$Wsci = \left(\frac{\alpha}{\left(\left[\frac{100}{100-p} \right] \beta \exp^{\lambda \Delta t} (\varepsilon + \gamma + \delta) \left(\frac{100}{100-\kappa} \right) + h + b \right)} \right) - 1$$

Equation 3

Where:

W_{sci} : Scarcity index

α: Input into system (A or B riparian)

ε: Annual domestic demand (m3/c/y)

γ: Demand for green areas (m3/c/y), it depends on population growth

δ: Demand for irrigation (m3/c/y)

λ: = Ln (1+r), population growth rate

Δt: Length of time for which the estimation is made, the period can be calculated as the difference between the present and the future (t-k);

β: Population

t: Present time

h: Yearly evapotranspiration of water, depends on climate of country

b: Water needed to maintain the environment, depends on the length and depth of the water body

k: Estimated losses

p: Industrial demand as a percentage, depends on country structure, its value can be determined as 15-25 percent of the domestic demand

5. Conclusions

Over more than 30 years in conferences and seminars worldwide, experts have been talking about managing the international water resources and improving the cooperation between the riparian parties. All these talks and papers remain a theory. Still the United Nation agreements and conventions remain on paper and not binding any party. The riparian parties are not learning the lessons and there is more and more suffering due to water gaps and water stress. In this paper two Mathematical methods were illustrated to help the parties in allocating the shared water resources, the two methods, the minimum water requirement (MWR) and the scarcity index, are just a tools developed to help the riparian to manage their national water resources also.

While the MWR method gives an indication of the shortages for a certain period, the second tool describes in detail the water gap and the way how to save water and how to control and recover the gap.

Since these two methods and worldwide others methods developed to assist the international community to avoid conflicts but few of those riparian are considering and applying them. Several of the riparian are using water as a weapon and water resources as a good to solve country economic crises in the upstream downstream cases.

In global scale a lot of tools and methods have been developed, water engineers finding them as useful tools, but unfortunately the decision makers are not understanding the means of these tools.

The International Joint Institutional Water Framework in the areas of conflict can be also one tool to push the parties for cooperation, the role of the international community as a mediator is to support the decision makers in being active to support their local water authorities to participate in the established joint Institutional Framework and as well as developing the joint capacity building programme.

Clearly, migration to Europe as a consequence of unsustainability and lack of Nexus is a phenomenon affecting the whole world currently. Water rights and international law should be followed and recognized. Cooperation between the riparian should be continued even when players at high political levels are changing. Exchanging the data related to renewable water, operation, demand and services on all levels should be continued.

Implementation of the United Nations' rules to riparian should be done to all shared water resources without any enforcement limitation.

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