Valuing water from social, economic and environmental perspective

Shatanawi M., Naber S.

in

Junier S. (ed.), El Moujabber M. (ed.), Trisorio-Liuzzi G. (ed.), Tigrek S. (ed.), Serneguet M. (ed.), Choukr-Allah R. (ed.), Shatanawi M. (ed.), Rodríguez R. (ed.).
Dialogues on Mediterranean water challenges: Rational water use, water price versus value and lessons learned from the European Water Framework Directive

Bari : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 98

2011
pages 109-117

Valuing water from social, economic and environmental perspective

Muhammad Shatanawi and Sawsan Naber

Faculty of Agriculture, University of Jordan, Jordan

Abstract. The increasing demand on water due to the growth of both the population and economy has put strong pressure on water quality and quantity. Water is therefore increasingly being valued as an economic resource. The price of water depends on quantity and quality as well as on the behavior of people and market. The value of water for society, people's health and the environment are important factors that should be considered in the valuation process. Water in sufficient quantity and good quality for drinking and sanitation to meet basic needs, is a human right. Water has been treated as an economic good as stated in the 1992 Dublin statement: 'water has an economic value in all its competing uses and should be recognized as an economic good'. This is different from water pricing when pricing is intended to recover the full costs of infrastructure, management and operation. This may lead to economic pricing of water, which will damage the interests of the poor and will make irrigated agriculture unfeasible. Valuing water for domestic purposes in Egypt using different valuation techniques has shown the limits of the end-users' willingness to pay. Water pricing policy in Jordan is aimed at recovering the cost of operation and maintenance and at the same time at water conservation.

Key words: Water – Value systems – Price fixing – Price policies – Costs – Human rights

Valoriser l'eau de la perspective social, économique et de l'environnement

Résumé. *La demande croissante en eau due à la croissance démographique et économique a mis la pression sur la qualité et la quantité de l'eau et est donc de plus en plus apprécié en tant que ressource économique. Valoriser l'eau dépend de la quantité et la qualité ainsi que le comportement des personnes et du marché. Les valeurs sociales, la santé et l'environnement de l'eau sont des facteurs importants qui devraient être pris en compte dans le processus d'évaluation. Fournir de l'eau aux personnes en quantité suffisante et de bonne qualité pour la boisson et l'assainissement pour répondre aux besoins de base est le droit de l'homme. L'eau a été traitée comme un énoncé économique de bonne Dublin selon à 1992: «L'eau a une valeur économique dans toutes ses utilisations concurrentes et doit être reconnue comme bien économique». Ceci est différent de tarification de l'eau lorsque le prix doit faire face à recouvrer les coûts de l'infrastructure, la gestion et l'exploitation. Cela peut conduire à des prix économique de l'eau, qui peuvent endommager les intérêts de l'agriculture irriguée pauvres et fait irréalisable. Valoriser l'eau à des fins domestiques en Egypte et en utilisant différentes techniques d'évaluation a montré les limites des prêts à payer par les utilisateurs finaux. Politique de tarification de l'eau en Jordanie vise à la conservation de l'eau et le recouvrement des coûts de fonctionnement et d'entretien.*

Mots clés: *Formation de prix – Système de valeurs – Coût – Prix – La politique des prix – Droits de l'homme*

I – Introduction

The issue of water is ranked high on the global political agenda as water scarcity has become a threat to human survival and sustainable development. Human activities and development processes have exerted huge pressure on the already exhausted water resources. World leaders, scientists and policy makers have realized that unsustainable management and inequitable access to water resources cannot continue. In many parts of the world such as the Middle East, demand far exceeds supply while in some countries in Africa access to fresh water is limited. According to the UN World Water Assessment Programme (WWAP) (UNDP, 2006) about 1.4 billions people worldwide have no access to clean and drinkable water, while about 2.5 billions including almost one billion children have no or poor sanitation.

The growth in population has created greater pressure on water resources by increasing water demand and pollution. During the last century, the world population has doubled while water consumption has increased five times. Demographic changes like migration and urbanization have increased the demand for water and created a higher need for water services. Social changes such as the improvement of life style and the rise in living standards have influenced the peoples' perception and their attitude toward water. This is illustrated by changing patterns of consumption and production. Furthermore, the changes in global economy and the growth of the international trade of goods and services have increased water stress in some countries, while relieving it in others through the flow of virtual water.

Many countries experience water scarcity, water pollution and the increase of other environmental problems that will hinder the sustainable development and threaten peace and continuity for human beings. Therefore, people have to be aware of the value of water, the environment and healthy ecosystems. In the context of water shortage and lack of access to water, it is important to discuss the issue of valuing water, including its economical, social, cultural and other values. The value given to water is explained with a short sentence 'water is life'. Water is a human right. Therefore, priority has to be given to satisfying human needs. After the basic need is met, water should be allocated to the use that has the highest value or water should be treated as an economic good.

The values of water are many and the economic value is just one of them. The perception of the value of water varies from culture to culture and from individual to individual. For many people, the non-economic values are paramount and they find that charging for water is very difficult to accept. This can be found in the policies of many governments as they do not charge for or price water for political, cultural and social reasons. People living in an arid climate place a higher value on water that those living in wetter countries. The range of value perspectives includes culture, social circumstances, environment and religion. The value of water has been addressed in nearly all religions where it is attributed important symbolic and ceremonial properties.

According to UNESCO (2006), the range of value perspectives varies to some extent on a case-by-case basis and on the stakeholder group involved. Moss *et al.* (2003) has listed the following value perspectives: environmental, social, public health, economic, production, political and gender-related.

II – Global perspective on water value

According to fourth principle of the Dublin Statement on Water for Sustainable Development (2002), 'water has an economic value in all its competing uses and should be recognized as an economic good. Within this principle, it is vital to recognize first the basic right of all human beings to have access to clean water and sanitation at an affordable price. Past failure to recognize the economic value of water has led to wasteful and environmentally damaging uses of the resource. Managing water as an economic good is an important way of achieving efficient and equitable use, and of encouraging conservation and protection of water resources'.

Agenda 21, chapter 18 (UNCED, 1992) has concluded that: 'Water should be regarded as a finite resource having an economic value with significant social and economic implications regarding the importance of meeting basic needs'.

The ministerial declaration of the 2nd world Water Forum (The Hague, 2000) said: 'to manage water in a way that reflect its economic, social, environmental and cultural values for all its uses, and to move towards pricing water services to reflect the cost of their provision. This approach should take account of the need for equity and the basic needs of the poor and the vulnerable'.

Also, the ministerial declaration of the 3rd World Water Forum (Kyoto, 2003) stated: 'funds should be raised by adopting cost recovery approaches which suit local climatic, environmental and social conditions and the «polluter-pays» principle, with due consideration to the poor. All sources of

financing, both public and private, national and international, must be mobilized and used in the most efficient and effective way'. Similar statements were issued after 4th and 5th world forum in Mexico (2006) and Istanbul (2009).

In Europe, water pricing reform is also on the table as part of the EU Water Framework Directive's drive to recover the costs of water services, including the costs imposed on the downstream users by users upstream and the environment. The main objective of the EU Water Framework Directive (WFD 2000/60/EC) is the achievement of the "good" ecological and chemical status of all waters by 2015. As part of WFD implementation, the economic valuation of water can play two specific roles. (i) The WFD requires water utilities in Member States to set water prices to cover the costs of water services (art.9). But it allows for exceptions in order to provide affordable water to poor users. Studies of willingness and ability to pay can determine when full cost recovery water pricing is feasible. (ii) River Basin Authorities are also required to implement cost-effective programs of measures (art. 11) to reach the WFD objectives. However, if the costs of measures are disproportionate to the benefits of achieving the good status, "derogations" can be allowed (art. 4). River Basin Authorities can then implement less costly measures. Economic valuation may be used to determine how large the economic benefits are, and so justify, or not, further measures.

III – Water as a basic need

This part was taken from a presentation by Shatanawi (2009) to the international conference: 'Water and Peace' that was held in the European Parliament, Brussels (12-13 Feb., 2009). 'Water is the source of life and it is the first element of every living thing. Without water there will be no life because human beings, animals, plants, etc… need water every day for their continuity and survival. As water is a common resource, everybody has the right to use it, but water availability is limited to resource constraints. Giving such constraints on water availability, how much water is needed to satisfy this right? The answer to this question came out from discussing the human right issue and the understanding of human needs and uses for water'.

One of the concepts of the 'new world thinking about water' states that water is a human right, but this right to water does not imply a right to unlimited amounts of water, nor does it require that water be provided for free. The concept of meeting basic water needs was strongly reaffirmed during the 1992 Earth Summit in Rio de Janeiro. 'In developing and using water resources, priority has to be given to the satisfaction of basic needs...'.(Gleick 1998) In 2002, water was recognized as a fundamental human right where a General Comment on the right to water was developed by the UN Covenant on Economic and Cultural Rights (CESCR,). This covenant was realized and ratified by 145 countries ensuring that every one has access to safe and secure drinking water, equitably without discrimination. General Comment 15:2, states that: 'the human right to water entitles everyone to sufficient; affordable; physically accessible; safe and acceptable water for personal and domestic uses'. It required governments to adopt national strategies and plans of action, which will allow them to 'move expeditiously and effectively towards the full realization of the right to water.' 'These strategies should be: (i) based on human rights law and principles, (ii) cover all aspects of the right to water and the corresponding obligations of countries, (iii) define clear objectives, (iv) set targets or goals to be achieved and the time-frame for their achievement, and (v) formulate adequate policies and corresponding indicators' (CESCR 2003, GC 15:47).

Generally, governmental obligations towards the right to drinking water under human rights laws broadly fall under the following principles: respect, protect and fulfill (CESCR 2003, GC 15:20).

Respect: Governments must refrain from unfairly interfering with people's access to water like disconnecting their water supply.

Protect: Government must protect people from interference with their access to water by others. This includes stopping pollution or prohibiting unaffordable price increases by corporations.

Fulfill: Governments must, within available resources, take all possible steps to realize the right to water including passing appropriate legislation, implementing programs and monitoring their progress.

CESCR general comment 15:2 also says that: 'An adequate amount of safe water is necessary to prevent death from dehydration, reduce the risk of water-related disease and provide for consumption, cooking, personal and domestic hygienic requirements.' This amount has been defined by the WHO as 40 liters per capita per day. In addition, CESCR, GC 15:1 has stated that: 'water is recognized, not only as a limited natural resource and a public good, but also as a human right'. At the international level this constitutes decisive progress, in terms of the legal protection of the right to water, although it is not a legally binding document.

IV – Value, price and cost

The value of water is measured in terms of its benefit to its users; the price of water is the charge levied from the consumers; while the costs to supply water are defined as the capital and operating costs of abstracting, treating and transferring water to the point of use. Full cost recovery is when users pay the full cost of obtaining, collecting, treating and distributing water, as well as collecting, treating and disposing of wastewater. Defining exactly what should be included in this cost is still an issue of some contention (WWAP).

In addition to the economic values, it is necessary to recognize what values actually fall within the economic analysis and what values are beyond economics. Matthews (2001) has illustrated the different concepts in Figures 1 and 2. A distinction is drawn between efficiency analysis and beyond efficiency (Figure 1). Within the category of efficiency, there are two broad concepts of goods that are valued. Those that are traditionally traded in the market place (private goods: apples, oranges, etc.) and others, which are not typically traded in the market place (non-market or public good: air quality, watershed preservation, etc.). The sum of these can be referred to as full economic value. In addition to the economic value, it Matthews recognizes that there some values are above and beyond those within the domain of economics. These would include, amongst others cultural and religious values.

Figure 2 presents the subject of cost analysis. Full economic costs include aspects such as capital costs and operation and maintenance costs (OM), as well as technological externalities. Technological externalities are described as costs that can be attributed to actions by others; individuals or firms. For example if a factory pollutes the water upstream the downstream users will have to clean the water before using it as drinking water. 'Pecuniary externalities' are those that arise through the price system. 'Complete economic costs' therefore include both 'pecuniary' and 'full economic costs' (Matthews 2001).

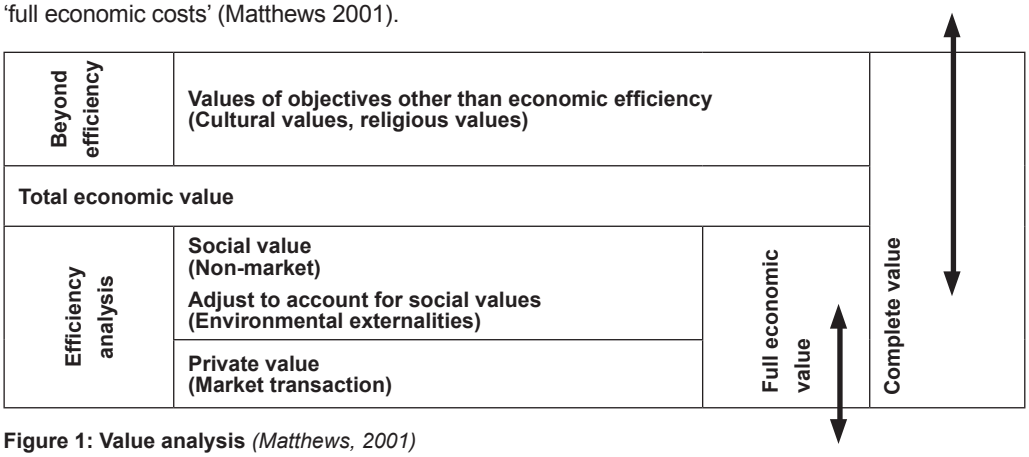

Figure 1: Value analysis *(Matthews, 2001)*

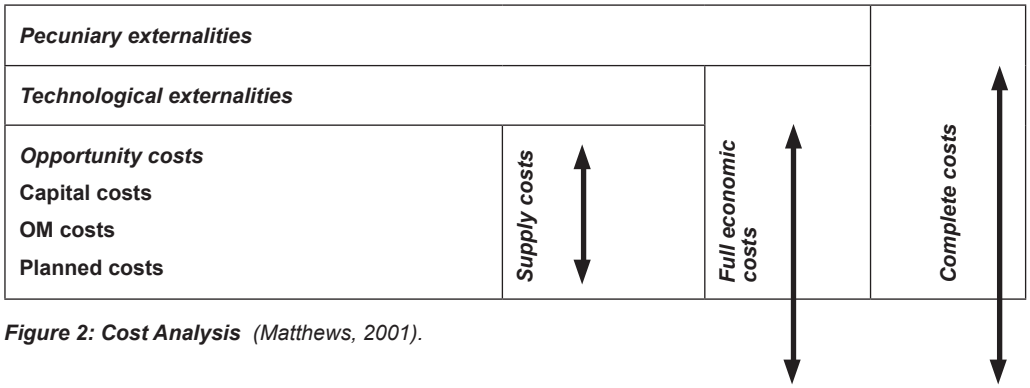

Figure 2: Cost Analysis *(Matthews, 2001).*

V – Value versus valuation

Value and valuation can have more than one meaning. This results in the fact that valuing (giving value to) a resource is not the same as the valuation of resource. Some people believe that water can not or should not be «valued» economically. Value has both a qualitative and quantitative connotation while the valuation of water is usually an indicator, a kind of economic measurement. When the word «value» is used in a subjective sense, it may mean that water is so important (valuable) that is beyond economic measurement. The subjective importance (value) of water is sometime measured by looking at indicators such as people's preferences which can be useful in determining the relative importance of water (Mattews, 2001). Acknowledging that some values can not be taken into account in the valuation the following sections will discuss the economic value and methods to establish this value.

Economic value

It is necessary to value water economically because it provides critical information to decision makers about efficient and equitable allocation of water among competing uses. Allocation can be either within the present generation or between present and future generations. Economic valuation can also provide information on the design of economic instruments such as water pricing, property rights, tradable water rights, markets, resource tax, etc.

Economic value signifies that people are willing to pay for a commodity, rather than go without it. Willingness to pay refers to the maximum amount an individual would be willing to pay, or give up, in order to secure a change in the provision of a good or service (OMB, 1992). Water is an essential commodity and people would pay any price for the basic amount for survival. However, after basic needs are met, people buy water based on its price and compare water with other goods they might buy. Water should be allocated to the uses that have the highest value.

At this point, many questions arise. How much will a household be willing to pay for drinking water? How much will a farmer pay for irrigation water, or a factory for clean water? There are two types of values and benefits from water, namely; use value and non-use value. The use value involves the commodity benefits (such as drinking, irrigation, etc.) and associated benefits (like wastewater services and navigation). The non-use values include recreation, ecosystem preservation and social and cultural values. These values are, however, difficult to measure.

Valuation Techniques

There are two main methods for the valuation of natural resources, namely (i) direct valuation which is based on survey of willingness to pay and is called 'Stated Preference Technique' and (ii) The indirect method of valuation which is based on observed market values and is called 'Revealed Preference Techniques'.

1. Stated Preference Technique

The direct approach, also called the contingent valuation method (CVM), is used to estimate the value of water by asking people how much they are willing to pay for a resource or service. Conducting questionnaires and surveys to give rank or value are used for this. It is used to estimate the value of water use for households, agriculture, industry and recreation. In this method people are directly asked to reveal how much they are willing to pay for good quality water with assured supply for domestic use, as an example. Using this method, Hoehn and Kriager (2000) conducted a survey and analysis for household services in Cairo, Egypt, and found that connection to water services was worth more than the improved reliability of services. They also found that recovering project costs through fixed tariffs, can lead to charges for water and wastewater services that are higher more than people are willing to pay.

2. Revealed Preference Techniques

The indirect method is based on observed market values. The following approaches can be used for evaluation:

Residual value: this is the easiest and most commonly applied valuation techniques. It considers the marginal contribution of water to output. However, this technique requires that the quantity of water used is measured accurately, as well as labor costs, value of land, capital costs and other inputs. The prices of all inputs and output must reflect the true economic value.

Production function approach: This technique requires conducting experiments from which a production function is obtained. The marginal contribution measures the change in output from a unit increase in water input while keeping other input variables constant.

Optimization model: This method is used to estimate the value of water for all users in an economy and involves modeling. The marginal contribution is measured as the change in sector output across the entire country, by the allocation of water. The technique involves using modeling techniques such as linear programming, computable general equilibrium (CGE), GAM and other economic modeling instruments.

Opportunity cost: This approach is based on the difference in costs of production so it is a good technique to estimate water productivity of available alternatives. It calculates the price differential for alternatives such as replacing hydro-electric power plants with thermal power plant.

Demand curves for water: The relationship between the price of water and the quantity demanded can be shown using the economic technique called the demand curve that has been described by Fortin *et al.* (2001). Harris (2002) demonstrates that in typical water demand curves, price and quantity are inversely related. The relation between price and water can be found by determining the variations in the slope of the two demand curves. The use of demand curves in water resources, however, has some restrictions. Demand curves were developed based on the principle of “perfect markets”. In such markets, no individual consumer or no individual producer is large enough to dominate the market. Another assumption is that consumers and producers all have perfect knowledge of both the price and the cost of the goods in the market. To a large degree this holds for most goods and services in a market economy, however, there are notable exceptions, such as a situation of monopoly, in which an individual producer can dominate the market (Harris *et al.*, 2002).

VI – Valuing water in Jordan

Water situation

Jordan is ranked among the countries of the world with limited water resources where demand is

far exceeding supplies. The per capita share of water of renewable water resources is 150 m^3/year and is expected to reach less than 90 m^3 in 2020 (MWI, 2007). Meeting Jordan's water demands, including water supply to the major centers of consumption will require expensive development and conveyance projects, because the most accessible sources and feasible projects have been already developed. No single action can remedy the country's water shortages; rather a program of measures is necessary to increase the overall water availability. The limited options focus on increasing the supply of usable water by improving the amount and quality of treated wastewater; or reducing water demand by adopting water conservation programs and improving water use efficiency. Supply augmentation options might include desalinization of brackish groundwater that is present in different locations.

Water pricing policy

The implementation of water pricing policy as an incentive to improve water management was only very effective when it was coupled with public awareness programs. The government of Jordan has undertaken a package of measures and policy reforms to strengthen the water sector and to assure financial viability (Shatanawi *et al.*, 2006). One of these measures is the application of water-pricing policy to cover the cost of operation and maintenance, and also part of the capital cost, using it as an instrument for the efficient management of water. So recovery of supply costs is the intention. The policy states that water is managed as an economic commodity that has an immense social value. At least, a water price is set. Differential prices are applied to account for irrigation water quality, the end users, and the social and economic impact of prices on the various economic sectors and regions of the country. Due to the increase in marginal costs of collecting and treating wastewater, charges, connection fees, sewerage taxes and treatment fees shall be set to cover at least the operation and maintenance costs. It is highly desirable that part of the capital costs of the services shall be recovered.

Water is relatively expensive in Jordan because of the scarcity and the high cost involved in acquiring, treatment, transporting and distribution. The actual costs of delivering water to consumers are estimated at 1.14 $/$m^3$ for municipal purposes and 0.32 $/$m^3$ for irrigation in the Jordan Valley. Cost analysis show that the government of Jordan has been subsidizing these water services. Water in Jordan Valley is charged according to the principle of price discrimination. The block water rates structure is divided into four steps depending on the level of water usage. The farmer's payment depends on the total water consumption. It ranges from 0.0114 $/$m^3$ to 0.05 $/$m^3$ with an average of 0.027 $/$m^3$. The same principle applies to the charges of water delivered to households, which is also based on a block rate structure. The first block (up to 10 cubic meter per month) is priced at 0.3 $/$m^3$ while the last block is 1.42 $/$m^3$. This means that rich people pay the highest cost, which implicitly means that they support the poor who consume less. To control groundwater pumping and reduce over-abstraction, the government has passed a by-law charging resource taxes on groundwater withdrawals exceeding 150,000 m^3/year. (MWI, 2002).

In the future, the cost of securing additional supply will be higher because all inexpensive resources have already been exploited. Therefore, future options will rely on desalination of brackish and sea water and the transport of fossil water. The medium term plan is to exploit and transport the fossil water of Disi Aquifer over a distance of 325 km at a cost of about 1.20 $ / m^3 before the network. This will increase by almost 50% due to system losses and pumping cost. Short-term plans consider water desalination at some locations. The long-term plan involves mega-projects such as the Red-Dead Seas conveyor which intends to use the difference in level between the Red Sea and Dead Sea to desalinate some 850 million m^3 of water annually by diverting 60-80 m^3/s of open sea water (about 1700 million m^3 annually). The second aim of the project is restoring the drying Dead Sea to its historical elevation. The feasibility and environmental studies will be finished in 6 months, with initial costs estimates ranging between 6 and 7 billion US dollar. This high cost can be justified by securing such a huge quantity of water and restoring the drying lake that has been considered as an international heritage (Shatanawi, 2008).

Economic value return

In the past, social values were the main drive for water allocation. People tended to allocate water to traditional crops such as wheat, olives and forage crops, aiming at self-sufficiency. With the growth of the international market and the implementation of global trade agreements, the trend has become to take into consideration the economical productivity of water. In the process of water allocation within the agriculture sector (related to the cropping pattern), the water production function is used. In an attempt to analyze the relationship between the productive process and the economic trade with water resources, Jabarin and Karabliah (2004) have estimated the amount of water embodied in export crops. The results showed that Jordan utilizes significant amounts of water (50%) to produce certain vegetables and fruits for export. The policy has to be modified in such a way that cash crops with low water consumption are produced while importing water intensive crops.

Environmental value

During the last thirty years, the damage to the environment has been significant due to over-pumping of renewable groundwater aquifers to the extent that many springs have dried out, as the case of Azraq Oasis. The drop of discharge in the springs has affected the ecosystem and the base-flow of some rivers. Over-pumping has caused a significant decrease in water levels, in the yield of many aquifers as well as in water quality. So far, the economical value for such damages has not been calculated, but the water and environmental agencies are carrying out a project to measure the cost of damages and water quality deterioration. The initial estimate of the cost of damages and rehabilitation was estimated by Soir (2009) to range from 320 to 450 million US dollars.

VII – Conclusion

The ways in which water is conceived and valued, allocated and managed, used or abused are embedded within the economic, social, cultural and environmental context of a society. Therefore, the values are the sum of weights assigned to the outcomes of the above factors and their specific policies. Providing water to people in sufficient quantity and good quality to meet the basic needs of drinking and sanitation is a human right.

In some countries, such as Jordan, the implementation of water pricing policy as an incentive to improve water management was only very effective when it was coupled with public awareness programs. The policy of water allocation based on economic and social equity principles was successful. The ratio between financial and opportunity costs is usually quite different for different water uses. If water is to be allocated appropriately and used efficiently, the emphasis for municipal supplies must be on financial costs, and for irrigation on opportunity costs.

References

CESCR (2003) *Substantive issues arising in the implementation of the international covenant on economic social and cultural rights* (2002). http://www.unhchr.ch/tbs/doc.nsf/0/a5458d1d1bbd713fc1256cc400389e94/$FILE/G0340229.pdf

Fortin M., Slack E., Loudon M., Kitchen H. (2001). *Financing water infrastructure*. Toronto. Commissioned by The Walkerton Inquiry.

Gleick P. (1998). The human right to water. *Water Policy* 1 (1998) 487-503

Harris J., Tate D., Renzetti S. (2002). *Economic principles and concepts as applied to municipal water utilities.* Final report. GeoEconomics Associates Incorporated. http://www.ontla.on.ca/library/repository/mon/5000/10311443.pdf

Hoehn J., Krieger D. (2000). Valuing water in a desert city: economic analysis of infrastructure investment in Cairo, *Journal of Water Resources Planning and Management*, 126 (6): 345-350.

Jabrin A., al-Karablieh E. (2009). *The water prospective in the export competitiveness: an analysis of the Jordanian agricultural product.* Presented at the 14th national scientific week (3-8 May 2009), the Higher Council of Science and technology, Amman, Jordan

Mathews D., Brookshire D., Campana M. (2001). *The economic value of water: results of a workshop in Caracas, Venezuela* (November 2000). Publication NOWRP-4, Water resources program, the University of New Mexico, Albuquerque, NM.

Moss J., Wolff G., Gladden G., Gutieriez E. (2003). *Valuing water for better* governance. How to promote dialogue to balance social, environmental and economic values? CEO Panel, Business and Industry.

MWI (2008). *National Water Master Plan. Ministry of Water and Irrigation* (MWI). www.mwi.gov.jo, Amman, Jordan.

MWI (2002). *Groundwater protection by-law. Ministry of Water and Irrigation.* Amman, Jordan.

OMB (1992). Guidelines and discount rates for benefit-cost analysis of federal programs, Circular No. A-94. Office of Management and Budget. Washington D.C., USA.

Shatanawi M. (2009). *Human rights to water.* Presented at the World Political Forum: international meeting on water and environment «Peace with Water», Brussels, 12 and 13 February 2009.

Shatanawi M. (2008). *The status of water resources in Jordan.* Presented at the scientific day of the Faculty of Agriculture, University of Jordan, Amman, Jordan

Shatanawi M., Duqqah M., Naber S. (2006). Agricultural and irrigation water policies toward improved water conservation in Jordan. in: *Options Mediterranean*, Series B: Studies and Research, No. 59, CIHEAM, Bari, Italy.

Soir G. (2009). *The deterioration of water resources quality in Jordan and what to do about it*, presented at the 14th national scientific week (3-8 May 2009), the Higher Council of Science and technology, Amman, Jordan.

UN (2006). *United Nations World Water Development report 2***,** http://www.unesco.org/water/wwap/

UNESCO (2006). *Water a shared responsibility*. United Nations World Water Development Report 2 (WWDR 2), UNESCO, Paris.