Present Situation of the Sustainable Management of Water Resources for Human Survival and Bio-production, and the Role of Agro-environmental Education Today in Afghanistan

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1. Background

The three topics of this year seminar, "sustainability", "management" and "water Resources" are the most challenging issues of the current century; amongst, the water resources. Water is a precious natural resource. It is vital for the human dignity, essential for health, well being and crucial substances for development. It is imperative for maintenance of agricultural productivity and alleviation of poverty and hunger. The world industrial development is indebted to this precious resource. And the present decorated earth landscape is the fine art product of water.

The trend of world development is closely tied with water. The present world population needs and the magnificent agricultural and industrial demands for water demonstrate the water as one of the most crucial commodity of the current century. According to Richter et. al., (2003), during the 20th century, the global human population has increased fourfold, but the water withdrawal from natural freshwater resources is eightfold. Because of critical role of water in human life, TSD, (2005) has predicted that in twenty first century if there is any world war, it would be on water. Kofi Anan has noted this threat and advised that "the water resources need not to be a source of conflict; instead it can be means for cooperation". acknowledging the importance of water in human lives, United Nations during its 60 years of age, specified 2 separate international water decades: Water and Sanitation, (1981 -1990) and Water for Life (2005 – 2015) decades.

One of the commitments of present water decade is achieving one of the Millennium Development Goals; i. e., to reduce the proportion of people without access to safe drinking water by 2015 to half and to stop unsustainable exploitation of water resources (http://www.un.org/waterforlifedecade/). In 2002 the World Summit in Johannesburg added another one to this: to bring to half by 2015 the proportion of people who do not have access to basic sanitation. However, several challenges are ahead for attainment of this goal; as an example, the lack of awareness on the importance of safe drinking water and safe sanitation means.

To overcome with problem of water scarcity, several countries have strengthened their fresh water with treated wastewater and/ or desalinated waters. Bakir (2001) has reported that in some of these countries, desalinated and recycled wastewater reaches to 20 to 50% of total water withdrawal from natural resources. He has proposed a shift from the present supply-driven approach to demand-driven approach; as one of the strategies for increasing the water efficiency.

2. Water Resources in Afghanistan

As a landlocked country, Afghanistan is encountered with a scarcity of water resource. This scarcity is mainly due to the unequal spatial and timely distribution of precipitation. In Afghanistan 80% of winter precipitation happens at places at elevations higher than 2000 m above sea level (asl); in the form of snow. This amount is estimated to about 150 billion m^3. The remaining 20% of annual precipitation (i. e., 30 billion m^3) takes place in places lower than 2000 m asl

(MIWRE, 2004). From the annual surface water, an estimated volume of 84 billion m^3 (i. e., 47% of total precipitation) is discharged out of the country.

Assuming an infiltration rate of 10% of the winter precipitation, the total amount of groundwater recharge in normal years is about 15 billion m^3. An effective groundwater volume in Afghanistan is estimated to 15.351 bcm. It forms the essential source of domestic water supplies and agricultural demands. An accurate estimation of discharge and recharge of groundwater sources in Afghanistan is currently unavailable. Water availability for irrigation purpose is dependent on seasonal variation of stream flow. The snowmelt and heavy rainfalls result to significant amount of stream flow in spring season; while small amount of flow is observed in late summers. Evidently, the crop water requirements are high at summers.

The land suitable for farming or horticulture in Afghanistan is limited, i. e., about 10% of the country. More than half of all irrigated arable land lies in the north (the northern foothills and plains of the main Hindu Kush ranges); while most of the remaining irrigated land lies in the Helmand river basin. Wheat cultivation is practiced even on rain-fed agricultural lands of very steep slopes and the high mountains.

In Afghanistan the water-dependent land cover can be divided into irrigated land, intermittently cultivated land, rain-fed land, rangeland and forest. Out of total land area of 382,135 km^2, 4.08% is covered by irrigated land, 4.31% intermittently cultivated, 11.82% by rain-fed land, 76.36% by rangeland and 3.42% by forest (calculated from data released by MIWRE (2004). The remaining (212,865 km^2) of the areas are the mountains and deserts. The percentage of land cover for each watershed in Afghanistan is shown in Figure 1.

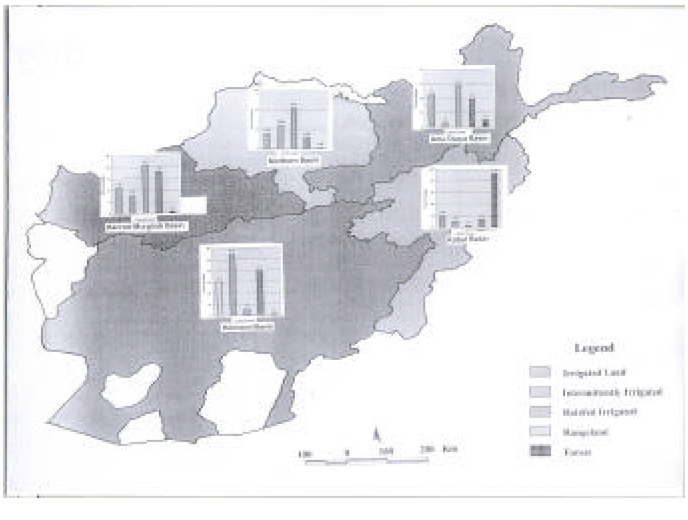

Figure 1. Land Cover of Watersheds in Afghanistan.

Groundwater quality in Afghanistan is depending to the type of geology of the area. Fresh and saline water exist in all places. Saline water is found mainly in the northern region of the country; while the bacteriologically contaminated water exists is in most urban areas. This is due to the absence of sewage system in the country. The absence of sewage system in the country has resulted to gradually deterioration of fresh water sources; even in Kabul city. The problem is critical especially in congested areas; where the discharge of different types of wastes finally reaches the water bodies. In case decisive action is not taken, the groundwater pollution in the country would induce great disaster for the inhabitants of Afghanistan.

Drought and mismanagement of groundwater have dropped the water table to fall down almost all over the country, including Kabul city. However, Japan International Cooperation Agency (JICA) studying groundwater resources in Kabul as a program of the Ministry of Mines and Industries (MMI) identifies this as vague; because of incomplete feasibility study and lack of monitoring system (MMI, 2005).

The damages incurred in production wells in the provinces during the war, has retarded the development of water resources. Moreover, the above-mentioned report has found the agencies currently involved in groundwater extraction affairs, either with technical or operational problems. However, due to the lack of technical know-how, lack of adequate management; and in addition, the low level of coordination between theses agencies has resulted the groundwater development to takes place in unprofessional manner. The uncontrollable extraction of groundwater in rural areas of the country by the Ministry of Rural Rehabilitation and the national and international NGOs are some of examples. In addition, apart from engineering-oriented projects, the local communities are exploiting groundwater through usage of private well drilling firms; which are cheap and available almost everywhere, but, with no sound groundwater knowledge Therefore, groundwater faith in provinces remains as an unresolved issue in the context of rebuilding of Afghanistan scenario.

In order to launch an integrated water management in Afghanistan, MIWRE has initiated the River Basin Management (RBM) approach in the country. Under this program, the country is divided into five major river basins; namely: the Amu Darya, Northern, Harirod-Murghab, Helman and Kabul River Basins. The Amu Darya Basin covers about 14% of area, but holds about 60% of water flowing; whereas, Helmand with 40% of area holds only 11% of water flow. Kabul River Basin in the east of the country has a coverage area of about 12% and holds about 26% of flow. The River Basins in Afghanistan is shown in Figure 2.

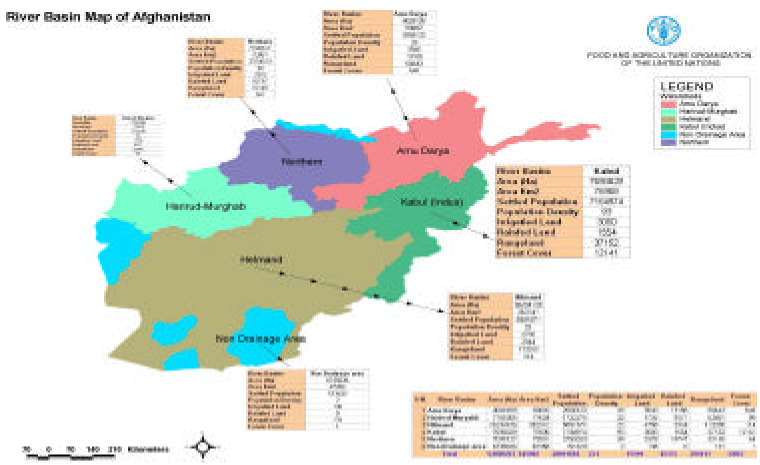

Figure 2. River Basins of Afghanistan (MIWRE, 2004).

3. Sustainability of Water Resource Management

Sustainable water resources management is the approach of meeting the present water demand without putting the future such needs in challenges.

It is reported that in 2000, world widely, an amount of 5000 km^3 of fresh water was used. Out of this global consumption, about 70 % is the agricultural consumption, while 20 % the industrial and 10 % for domestic uses (http://www.nap.edu/books/0309092000/html/66.html). It is seen therefore, that agriculture is the main water consumer from natural water bodies. However, the water usage percentages vary from the developing countries to developed ones.

Attaining a sustainable water resource management strongly relies on coordination between the major water users; namely, domestic, agricultural, industrial and ecological. This intervention among the water users is shown in Figure 3.

3.1 Sustainability of Domestic Water Supplies

Water and sanitation along with the hygiene education are the complements of health of human being. According to World Health Report (WHO, 2002), 88 % of all disease in the developing world is related to usage of unsafe drinking water and inadequate sanitation. Unfortunately, more than one billion people are presently without safe drinking water and half of the world population without safe sanitation facilities. Because of this, as an example; about 2.2 million people die from diarrhea (water-borne disease) every year; 90% of them children, less than 5 years of age.

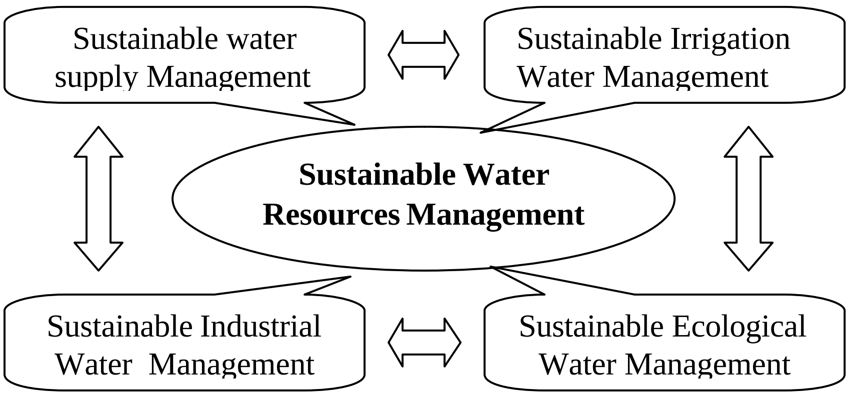

Figure 2. Sustainable Water Resources Components Interventions.

In another scenario, 300 million people suffer from malaria (vector-borne disease) each year. In this case as well, large majority are children. Vectors responsible for transmission of this disease pass parts of their lives in stagnant water bodies. Environmental management significantly reduces the spread of this disease.

Similarly, trachoma; (a water-washed disease), is the leading cause of preventable blindness. An estimated number of 6 million people suffer from loss of sight and there are about 146 million acute cases worldwide. This can be prevented by improving sanitation, reducing the breading sites of flies and teaching children to wash their faces with clean water.

As can be realized, all these incidents of human losses and suffering are preventable and economically feasible. The health risks associated with water- and sanitation-related diseases incur economic burden on human and making them unable in taking part in economic activities. It can be understood therefore that the absence of safe drinking water and safe sanitation facilities are the major contributor of poverty on the earth.

According to MIWRE (2004), the annual volume of water consumed for drinking purposes in Afghanistan is no more than 0.346 billion m^3. This amount is less than 1.5 % of total water consumption in the country. It is imperative to note that currently Afghanistan is one of the countries with the lowest safe drinking water coverage. As an average, in urban and rural settlements, this coverage was estimated in 1999 to only 24.6 %.

3.1.1 Approaches (strategies) toward Sustainable Domestic Water Supply Management

Generally sustainable domestic water supply systems can be attained by a number of interventions. These are: adopting policies toward water conservation, usage of non-conventional water sources, water reclamation and recycling, adopting appropriate water treatment technologies, and control on water wastage.

3.1.2 Sustainable Water Supply Management Indicators

A sustainable water supply system shall generally be capable of fulfilling the purpose of its establishment. Moreover, there are certain measurable indicators that enable one to examine its sustainability. Among other indicators, the followings can be taken into consideration:

a. National water supply coverage: in Afghanistan, the present domestic water supply coverage is about 30% and of sanitation below 20%.
b. The mortality and morbidity rates of water-borne diseases: the mortality rate (mostly due to diarrheal disease) is 257 per 1000 (UNICEF, 2001)
c. The ratio of water withdrawal with the annual recharge of the sources
d. The changes in the level of contaminants in water sources
e. Ratio of recycled water usage to the amount of water extracted from the water sources.

3.2 Sustainable Agricultural Water Management

Today more than 250 million ha are irrigated world widely. This is nearly five times more than at the beginning of the 20th century. In connection to the water demand for this purpose in future, TSD (2005) has estimated that in 2030, about 14 % more water would be withdrawn from the natural water sources than today.

The inappropriate water and agricultural policies and poor or inefficient irrigation management have affected water resources, damaged soils, deteriorated the water quality and have retarded the agricultural production. In addition, an increase in crop production is associated with the use of nitrogen, phosphorus and pesticides. All these substances at the end are added as impurities to natural water bodies. Based on these, in case the condition continues, it is predicted that agriculture will be a major cause for environmental degradation over the next 50 year (http://www.umweltbundessamt.org).

Based on FAO (2003) report, Shobair and Alim (2004) also have found that presently agriculture is the major water consumer in Afghanistan. In this context, out of approximately 21.91 bcm agricultural water consumption, 19.07 bcm (87.04%) is met by surface sources and 2.89 bcm (12.96%) from groundwater. It shall be mentioned that the total annual groundwater extraction is estimated to around 3 bcm which 2.654 bcm of this amount is used for agriculture. Fig. 4 shows a breakdown of agricultural water that is furnished from groundwater sources.

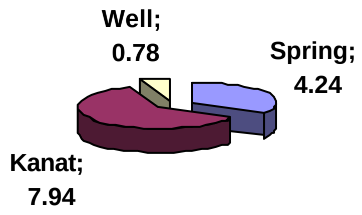

Figure 4. Irrigation in Afghanistan extracted from groundwater sources.

3.2.1 Approaches (Strategies) toward Sustainable Irrigation Water Management

Sustainable irrigation water management would be achieved by choosing the following strategies:

- Sustainable extraction of water from water sources
- Improving water use efficiency
- Introduction of efficient and appropriate methods of irrigation such as drip irrigation
- Minimize downstream environmental damages
- Usage of the non-conventional water sources, e. g., water recycling
- Utilization of appropriate water treatment technologies, e. g., water desalination
- Putting emphasize on rain-fed agriculture with the possibilities of limited number of supplementary irrigation
- Capacity building of farmers on efficient water use

3.2.2 Sustainable Irrigation Water Management Indicators

Cai, et. al., (2001) has introduced the following indicators for measuring the sustainability of irrigation water management:

a. System reliability (probability of the system success against risks), reversibility (the probability of system recovery from failure) and vulnerability (the severity or magnitude of a system failure)
b. Environmental system integrity (minimizing the interference of irrigation system with the associated environmental systems)
c. Equity in water sharing (no one should be disadvantaged), and
d. Economic acceptability (beside food self sufficiency achieving net profit over the long term)

In addition, following measurable indicators can be accounted for analyzing the sustainability of irrigation water systems:

a. Improving the water use efficiency: in Afghanistan this rate is as low as 25%
b. Release of pollutants with the irrigation water discharge
c. Amount of sediments at the downstream discharge from the agricultural lands

d. Ratio between utilization of water from the non-conventional and the water from the conventional sources
e. Percentage of farmer's awareness in efficient irrigation methods and timing for irrigation
f. Type of irrigation method.

3.3 Sustainable Industrial Water Supply Management

Industry extracts fresh natural resources and returns back products and wastes back to the environment. Beside the diffuse of toxic wastes, industry discharges an ever-increasing amount of gaseous, liquid and solid pollutants into the air, water and soil. In the rapidly growing population of third world, the increasing industrial activities imply considerable pressure on the energy and natural resources and result in source depletion; introduce industrial waste into the environment and cause accidents.

According to Bhasker and Nalco (2004), the industrial water demand for industrialized countries (like USA, Germany, France and Canada) is significantly higher than the agricultural demand. However, for the developing nations as was seen, the agricultural water is the dominant one. As example, in India and China, respectively, 93 and 87 % of fresh water is used for agriculture; whereas industry currently use 4% and 7%.

With regard to industrial water consumption in Afghanistan, it shall be mentioned that at present the country is in a post war era and no major industrial plant is in operation. Therefore, industry cannot be counted for sometime as a major water consumer here. However, for the minor industrial activities, it is estimated that 0.5% of total fresh water of the country is used in this sector.

As a summary, the water consumers in Afghanistan are respectively the agriculture, domestic and industry: 98.0%, 1.5% and 0.5% respectively. The percentages of water consumption for agriculture, domestic and industry in the world, India, China and Afghanistan are shown in Figure 5.

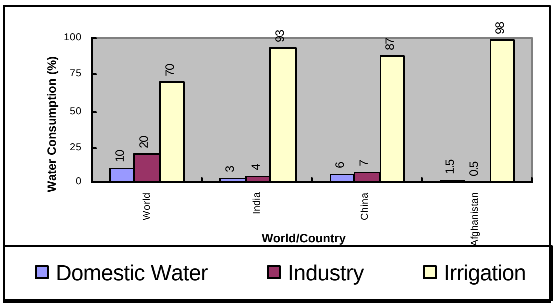

Figure 5. Global freshwater consumption.

3.3.1 Approaches (Strategies) toward Sustainable Industrial Water Management

A sustainable industrial water management could be achieved by observing the following strategies:
- Efficient water usage
- Control of water wastage
- Recycling of treated wastewater
- Desalination of sea/ saline water
- Water pollution control.

3.3.2 Sustainable Industrial Water Management Indicators

Sustainable industrial water management can be examined through the following indicators:

a. Ratio of discharge of treated industrial wastewater released to the environment to the total amount of water extracted from water source
b. Ratio of water extraction from non-conventional water source to the amount extracted from conventional sources
c. Temporal changes in biochemical oxygen demand (BOD), pH and temperature of natural water bodies where the industrial effluents are discharged
d. Annual water table drop in production wells in the area where the industrial plants are located
e. Percentage of water loss in the industrial plant
f. Living condition of fishes and other living species in open water bodies where the industrial effluents are added.

3.4 Sustainable Ecosystem Water Supply Management

The goal of ecological sustainable water management is to protect first, the ecological integrity of the fresh water ecosystem, and second, to meet the inter-generational human needs for fresh water ecosystems. This importance has only been recognized recently.

Ecological integrity is protected when the compositional and structural diversity and natural functioning of the ecosystem is maintained (Richter, et. al., 2003). To retain the ecological integrity of fresh water systems, certain critical aspects of flow need to be maintained. These aspects are including the base flow, regularly recurring higher flows, floods and droughts.

3.4.1 Approaches toward Sustainable Ecosystem Water Management

For achievement of a sustainable ecosystem water supply, among others, the following approaches can be taken in mind:

1. Ecological heritage conservation
2. Maintaining ecosystem flow requirement
3. Control of intrusion of pollutant into the ecosystem
4. Controlling other causes of environmental degradation, e. g., soil erosion

3.4.2 Sustainable Ecosystem Water Management Indicators

Unfortunately the negative impacts of unsustainable ecosystem water management can only be measured over a long span of time. This examination is possible by performing an environmental auditing. However, in relatively short period of time, the following points can be the typical indicators:

1. Degree of existence of ecological integrity in the area
2. Changes in the inter-generational human water requirements
3. Degree of survival of water-dependent species
4. Changes in environmental quality of the area
5. Vulnerability of main environmental elements, e. g., water, air, soil, vegetation, etc.

4. Challenges ahead of Sustainability of Water Resources in Afghanistan

4.1 Weak Water Resources Institutional Infrastructure

The two and half decade of armed conflict has imposed a number of negative environmental impacts in Afghanistan. The negative impacts on water resources can be listed as below:

1. Intrusion of pollutants into water bodies etc.
2. Flood generation/ intensification; because of deforestation and prolong drought
3. Change of river morphology in the upper streams site
4. Uncontrolled boring of deep wells without a study on groundwater recharge
5. Water resources contamination across the country due to poor solid waste management

Moreover, MIWRE (2004) has noticed that 47% of surfaces water of Afghanistan (84000 million m^3) flows to the neighboring countries and fulfills their numerous needs. According to the above reference, from Amu Dary, out of annual discharge of 9 km^3 of water that Afghanistan is entitled to use, it uses only 2 km^3 (63.42 m^3/sec) . Only part of water from HariRod and Murghab rivers remain within the country; the remaining is used for irrigation or dried up in Turkmenistan. Similarly, Helamd River originating from the western side of Paghman Mountains covers about 43 % of the territory of the country finally drains in Iran. In a same token, Kabul River with 26% of mean annual flow is crossing the Afghanistan boundary; and after irrigating vast agricultural lands in Pakistan, finally is discharged to Indian Ocean.

4.2 Low awareness Level of the communities on the importance of water resources:

- Low level of public awareness regarding the environment in general; and on the significance of water resources in particular. This is a major barrier in sound water resource utilization for domestic and irrigation purposes
- Lack of knowledge on safe usage of pesticides and fertilizers (chemical and animal fertilizer)

4.3 Existence of Traditional Irrigation Methods

- Inappropriate methods of irrigation practice ponding, e. g., and furrow irrigation
- Disregarding the crop water requirement in irrigation practices

4.4 *Shortage of Human Resources in the Field of Environmental Protection and Resources Conservation*

- The long lasting war in Afghanistan has enforced a human resource shortage in the country. This shortage is observed in all aspects, from the academic institutions to office and field.
- Lack of human resource for conducting the environmental impact assessment
- Lack of environmental auditing system in the country

4.5 Impact of long lasting war on Water Resources

- Desertification/ flood generation in the country
- Unlawful ownership of water rights by influential personalities
- Degradation of natural resources: in Afghanistan also the past two and half decades of war has led to huge and partly irreversible negative impacts on natural resources. Massive destruction/ cutting of trees and intentional burnings

of forests, degradation of rangeland for fuel collection and changing of pastureland to rain-fed cultivation have resulted to soil erosion, (MIWE, 2004).

5 Conclusions

Sustainability of water source can be evidenced by:

- Water conservation, water recycling and efficient water usage practices
- Rehabilitation/ upgrading of water utilization systems
- Mitigation of environmental problems such as drought and flood disasters
- Recharge of groundwater: natural and artificial
- Keeping balance between groundwater recharge and discharge
- Respecting the water right of the downstream users, including the ecological requirements
- Protection of environmental resources, prevention/ reduction of pollution
- Raising public awareness toward importance of water resources and proper usage of water in their daily activities.

6 Recommendations

- Raising awareness on efficient water usage and encouragement habitual changes of water users by launching "water education" programs through various communication channels is highly efficient
- For water conservancy and enhancement of groundwater recharge, construction of water management infrastructure such as check dams and rain harvesting structures are necessary
- Capturing water by making storage reservoirs where the topography of the country is appropriate with consideration of downstream water needs.
- Promotion of water uses from the non-conventional water sources, such a s rain harvesting, recycling of wastewater, and effective usage of water for irrigation shall be encouraged,
- Making the existing systems more efficient by reforming water management and policy and investing on improved technology and infrastructure
- Limitation on the usage of groundwater by industrial plants for conserving it for domestic purposes and hence imposing limitation on groundwater extraction through laws and regulation and awareness of water users
- Enforcement of national by-laws and regulations in connection to watershed protection

7 Acknowledgment

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8 References

Bakir, Hamed, 2003.

Water demand management and pollution control: keys to securing and safeguarding the water supplies of the Eastern Mediterranean Region in the 21st century."

Proceeding of Joint WHO/UNEP First Regional Conference on Water Demman Management, Conservation and Pollution Control, Amman, p. 14-32.

Bhasker, D., and O. Nalco, 2004
Sustainable Development: the Role of Industrial Water Management.
(http://www.nap.edu/books/0309092000/html/66.html)

Cai, X., D. C. McKinney and M. W. Rosegrant, 2001.
Sustainability Analysis for Irrigation Water Management: Concepts, Methodology and Application to the Aral Sea Region.
International Food Policy Research Institute, Washington D. C., 48 pp.

(http://www.un.org/waterforlifedecade/).
International decade for water for life, 2005

(http://www.dianet.org/water/waterfact.htm).
Sustainable water management - Water Facts

(http://www.umweltbundessamt.org)
Economically and Ecologically Sustainable water supply-Illustrated by the example of the Haltern Lake

Ministry of Irrigation, Water Resources and Environment (MIWRE), 2004
Watershed Atlas of Afghanistan-First Edition- Working Document for Planners
MIWE, Kabul, 183 pp.

Ministry of Mines and Industry (MMI), 2005
The Five Year Action Plan on the Groundwater Development Sector in the Ministry of Mines and Industries in FY 2005-2009.
Department of Geo-engineering and Hydrogeology, MMI, Kabul (unpublished),

Richter B. D., R. Mathews, D. L. Harrison and R. Wigington, 2003
Ecologically Sustainable Water Management: Managing River Flows for Ecological Integrity. Ecological Application, 13(1): 206-224.

Sharif, S. S., and A. K. Alim, 2004
The effect of Calamities on Water Resources and Consumption in Afghanistan.
Country paper presented in TASAE2004, Japan.

Technology and Sustainable Development (TSD), 2005.
Integrated approaches for Sustainable Development in Water Resources Sector,

UNICEF, 2001
The State of The World's Children 2001.
The United Nations Children's Fund, New York, 116 pp.

WHO, 2002
The World Health Report 2002-Reducing Risks, Promoting Healthy Life.
World Health Organization, Geneva, 248 pp.