

## **Transboundary Water Management Improvements, the Way Forward in the Middle East; Case Study: Transboundary Water Management of Iran and Neighbors**

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Received: 05/08/2012

Accepted: 08/12/2012

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### **Abstract**

Human civilizations have been created and developed adjacent water resources such as rivers. The old Mesopotamia Civilization near Euphrates - Tigris Rivers, The Egypt Civilization near Nile River, The India Civilization near Indus River and The Burned City Civilization near Hirmand (Helmand) River and Hamoon lakes are samples of aforementioned civilizations. Demise of old Civilizations occurred according to wars, dangerous disasters and illness, droughts and deficiency of water. Today, with regards to limitation of ancient empires, kingdoms and governments and creation of new small and big countries, new boundaries have been established and the importance of fresh water resources and transboundary rivers has been increased much more and after that several challenges and disputes have been occurred between countries for accessing fresh water over these resources and even some serious disputes and wars between countries have been occurred in 20th century. According to aforementioned, government's consideration and attempts of countries are toward compiling new methods for water resources management specially based on principles of Integrated Water Resources Management (IWRM). Also for decreasing challenges and disputes and prevention of new challenges, water treaties based on international laws, and previous historic water rights and or the necessity to friendship relations between countries could help us achieving to unique and more suitable solutions in Transboundary Waters. Iran and its neighbors have several Transboundary Rivers Basins such as Aras (with Turkey, Armenia and Azerbaijan), Atrak (with Turkmenistan), Arvanad (Shat-Al-Arab) (with Iraq), Hirmand and Harirud (with Afghanistan) and others. In this paper, after a brief survey on Transboundary Rivers of

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Middle East Countries, it is presented the experiences of Transboundary Water Management of Iran and its neighbors in several fields of implementations, challenges, successful and new required process for implementation of IWRM in the Transboundary Rivers.

**Keywords:** Transboundary Waters, Hydropolitics, Integrated Water Resources Management (IWRM), Middle East, Iran.

### **Introduction**

The history of human living shows that his essential needs to water; food and air have not changed since his creation. One of the three basic needs of human, Fresh Water resources is supplied from surface (i.e. rivers, lakes and wetlands) and also ground (i.e. aquifers, wells and springs) water resources. Ancient civilizations have been established besides or near water resources and developed along them. After development territories of civilizations and capturing new boundaries, the challenges for using transboundary waters have been started. Also human activities undertaken to increase the benefits obtained from rivers, wetlands and their floodplains, have increased the potential of costs and damages when the river or wetland experiencing rare or extreme flow conditions. These costs and damages are economic, environmental, and social and result because of a mismatch between what humans expect or demand and what nature offers or supplies. The process of using and operation of Transboundary waters between two or more countries made human to think about water rights of riparian countries and also their economic and social and environmental rights. Today many countries of the world have bi or multi lateral agreements about shared and transboundary water resources and the potential of conflicts are changing to cooperation potential (PC to CP). Also there are many other unsolved challenges in transboundary waters which need new visions and legal frameworks to improve security and peace in all parts of the world all around transboundary waters. One of the main tolls is a new approach for water management in Transboundary waters. Integrated Water Resources Management (IWRM) as a new approach could improve benefits sharing for

all riparian, so it is needed to improve basics and principles of IWRM in transboundary basins. Middle East has many challenges for accessing riparian to fresh waters and many disputes has occurred in its transboundary basins. So IWRM could help Middle East countries promote their implementation on Transboundary waters more efficient.

**Transboundary Water Treaties in the World**

A brief review of world water resources shows more than 270 transboundary water resources are shared between two or more countries. Table (1) shows numbers of transboundary basins in each continent. Table (2) shows factors and parameters of transboundary waters agreements (Wolf et al., 1999). According to numbers of transboundary basins and their scattering between many countries all around the world and also occurring many challenges in previous centuries, the approach for making solutions and avoiding of new conflicts is at center of attentions of legal related departments of governments. The socio-economic and environmental costs of challenges in transboundary waters, unpredictable future (security and peace) and long time reactions for rehabilitation disturbed relations between countries are important parameters which encourage governments to have strong transboundary water agreements with neighboring especially downstream countries.

Table 1: Numbers of Transboundary Basins in Contents\*

Continent	Numbers of Transboundary basins (1987)	Numbers of Transboundary basins (update 1999)
Africa	57	60
North And Central America	33	39
South America	36	38
Asia	40	53
Europe	48	71
Total	214	261

\* Source; Wolf et al., (1999).

Table 2: Factors and Parameters of Transboundary Waters Agreements\*

Principle focus	Water supply	Hydropower	Flood control	Industrial uses	Navigation	Pollution	Fishing	Total
	53	57	13	9	6	6	1	145
percent %	36.55	39.31	8.97	6.21	4.14	4.14	0.69	*
Water allocation	Equal Portions	Complex but clear	Unclear	None/ Not Available	Total			
	15	39	14	77	145			
Percent %	10.34	26.90	9.66	53.10	*			
Information sharing	Yes	No	Total	Signatories	Bilateral	Multilateral	Total	
	93	52	145		124	21	145	
Percent %	64.14	35.86	*	percent %	85.52	14.48	*	

\* Source: Hamner and Wolf (1998)

**Principles of Transboundary Agreement Compilation**

Transboundary agreements subjects are various and cover not only water rights, but also the process of electricity production by hydropower, flood control, navigation, water quality, and fishery and so on. According to the history of transboundary waters conflicts, strong transboundary water agreements are those which are prepared under cooperation between related legal and technical organizations of involved countries and weak transboundary agreements are those which are prepared with less cooperation or interface of other countries which support one (specific) side of transboundary basin. For example in Nile Basin conflicts, upstream countries were in a non-equal situation with downstream country, Egypt, which was supported by Great Britain in last Century. Development international relations have effected on transboundary basin management and caused international community needs following tools for solving conflicts in transboundary waters:

- a) compiling agreements, treaties and organizing methods of developments of all sides and states and relations between them (win-win approach);
- b) legalizing treaties according to defensible principles in international courts (legal approach instead of political approach);

The main factors and issues which should be considered in transboundary water agreements and treaties are: Water quantity (volume and time duration), Water quality, IWRM (Integrated Water Resources Management), Political approaches, Hydropolitical and border rivers issues (Wolf, A. T. (2001)). Long time programming in hydropolitics issues in transboundary waters and Boundary Rivers need to:

- **Education and training:** participation of training courses about technical and political subjects in transboundary waters issues for strengthening related managers and experts
- **Data base resources:** any analyzing needs social, political, economic, agricultural and environmental base information in transboundary waters. Information should be exact, certain and reliable and available at any time.
- **Cooperation between various organizations:** as transboundary water issues are followed by various parts (technical and political), so it is needed to more co ordinations between various parts to get more suitable remedies for different conflicts and more effective results.

### **IWRM and its definition and processes**

IWRM is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. Also IWRM has been defined by the Global Water Partnership (GWP) as “a process which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of

vital ecosystems” (GWP, INBO, 2012).

IWRM is based on the principles defined and adopted by the international community since the Rio and Dublin Summits in 1992. These principles are summarized as follows:

- 1) Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment;
- 2) Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels;
- 3) Women play a central part in the provision, management and safeguarding of water;
- 4) Water has an economic value in all its competing uses and should be recognized as an economic good.

GWP refers to the following pillars that support sound IWRM implementation:

- Management instruments: (Water resources assessment, Information exchange, Socio-economic and regulatory instruments, Plans for IWRM)
- Enabling environment: (Policies, Legal framework, Financing and incentive structures,
- Institutional roles: (Central – local, River basin, Public-private, Capacity building)

Other definitions reflect similar approaches; for example, USAID defines IWRM as “a participatory planning and implementation process, based on sound science that brings stakeholders together to determine how to meet society’s long-term needs for water and coastal resources while maintaining essential ecological services and economic benefits.

IWRM helps to protect the world’s environment, foster economic growth and sustainable agricultural development, promote democratic participation in governance, and improve human health”.

### **Transboundary waters**

Transboundary fresh waters cover 45% of the world’s land mass, connecting two or more countries in water resources above (surface) and below

(groundwater) the earth's surface. This type of resource management faces many challenges and must consider special features of the challenge. In this regard, international water resources management differs from IWRM at the national level in: state sovereignty, national legal and institutional policy frameworks, interests and objectives for water use linked to national development and security objectives, proportion of the country affected by the transboundary basin, conflicts on water resources allocation and benefit sharing, exchange of information and data on water, relationship between water, people and territory (with in a country and also other riparian in a transboundary basin).

### **Examples of challenges of water management in the Middle East**

#### **Nile River and limits in agricultures**

Egypt, a country surrounded in dried and extremely depended to Nile River, has the most accumulate rate of population in the world. According to Stochastic, 97 percent of 63 millions of population of this country in the year 2000 live in Nile River Delta and its banks and it is expected this rate decrease to 2 percent in future. Regards to these conditions, Egypt government tries to develop resident area from 5 to 25 percent and also tries to develop agriculture lands horizontally in which increases agriculture area from 3.4 millions hectares in 1977 to 4.1 millions hectares in 2017. New industrial regions will construct in deserts and stakeholders and donors expect water supply guarantee by government. All of above are in conditions that Nile water balance is constant and according to Sudan and Egypt agreement, Egypt could use only 55.5 Km<sup>3</sup> of Nile River waters. Regards to water resources limitations, any developing program in Nile River riparian countries threatens the vulnerable environment of this basin and therefore integrated water resources management could present solutions for decreasing environmental problems (Van Beek, E. and Meijer, K. (2005)).

#### **Implementation of GAP project by Turkey**

In an operating biggest development program, Turkey has invested capitals

more than 30 billions \$ in Great Anatolia Project (GAP), which is a combination of 22 reservoir dams and 19 hydropower projects. Attaturk Dam is focal point of this project which is recently constructed and after completing its plan, in addition to increasing near 40 percent of irrigated agriculture area, it is expected to supply one forth of Turkey required hydropower electricity. Programmers hope operating of this project affected to 6 million populations (almost Kurds) and in fact decrease their separation movements. This project also has been decreased water flows of Euphrates River to Iraq and Syria, and has had negative effects on international wetland of Hoor-al-Azim (common between Iran and Iraq), so caused drying many parts of this wetland in Iraq and severe destroying of many plants and animals habitats.

#### **Share water resources of Jordan River Basin**

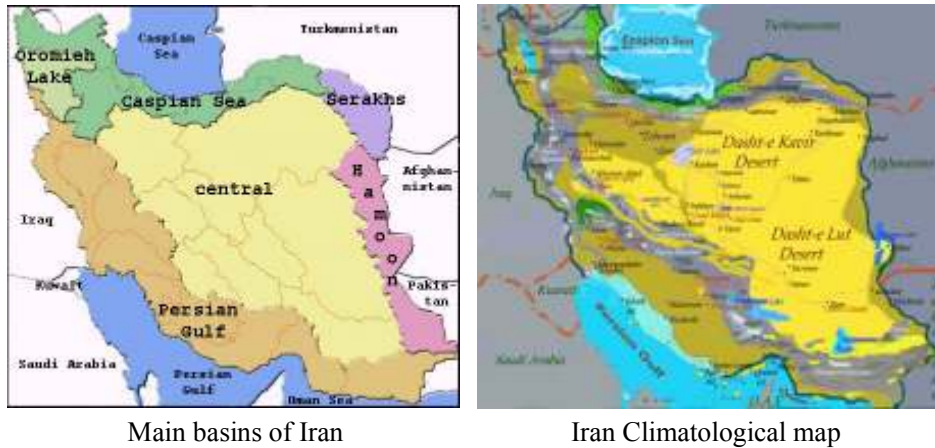
In Jordan River basin, a 12 million growth population and its concentrated economy, demand for rare fresh water of the basin is high. In this basin with 250 mm annual precipitation, from one hand municipal development and agricultural and industrial consumers have more needs to fresh waters and from the other hand pollution of water resources made hard availability to water resources. Changes in water direction by riparian, has replaced river to small canal downstream and entering waste water and sewages caused worse its quality. The discharge of 1300 MCM of flow to the Dead Sea in 1950, small volumes of flows enter to sea now. In the normal years, flow downstream of Tiberias Lake is near 60 MCM (10 percent of normal discharge) which forms of salt springs and waste waters and enters to Yarmouk River and after supplying agriculture water and exceeding winter runoffs; volume of water receives to 200 to 300 MCM which is not suitable, from quantity and quality views, for irrigation. The salt rate of Jordan River has been received to 2000 unit per million which only heavy floods could change it to potable water and all of these shows destroying of environment of the basin.



### Iran Water Resources

I.R.Iran is one of the biggest countries of the Middle East which its area is more than 1.6 million Km<sup>2</sup> and its population is more than 75 million peoples. Annual average of precipitation is near 250 mm which is one third of annual average of the world. Distribution of precipitation (spatial and time duration) is not equivalent in country and causes problems for supplying water in various times and regions especially in populated municipals and regions. Figure (2) shows location of main basins and climatologically map of Iran. Table (3) shows rainfall characteristics of major basins of Iran Najafi, A., and Vatanfada, J. (2011).

Figure 2: Iran climate and basin maps



**Table 3:** Iran watersheds rainfall characteristics.

Basin	Total area (Million km <sup>2</sup> )	As % of total area	Rainfall (mm/year)	Rainfall (km <sup>3</sup> /year)	As % of total rainfall
Persian Gulf and Oman Sea	0.42	26	380	161	39
Orumie Lake	0.05	3	347	18	5
Caspian Sea	0.17	11	423	74	18
Hamoon Lake	0.10	6	107	11	3
Central Plateau	0.82	51	166	137	33
Qara-Qum	0.04	3	226	10	2
<b>Total</b>	<b>1.60</b>	<b>100</b>	<b>253</b>	<b>411</b>	<b>100</b>

### Iran transboundary waters

Iran has shared waters and Boundary Rivers with all of its neighbors. Also Caspian Sea in north and Persian Gulf and Oman Sea in south of Iran are international waters between several countries in Caucasus, Central Asia and Arabian countries in Persian Gulf region. Iran has all kind of transboundary surface and ground waters. Some transboundary rivers flow to Iran, for example Aras Transboundary River flow enters to North West of Iran from Caucasus Transboundary Basin. Harirud and Hirmand (Helmand) Transboundary Rivers enter to eastern parts of Iran from Afghanistan. Some transboundary rivers flow from Iran to neighboring countries such as Nihing River which flows to Pakistan. The length of Iran land, river and coast borders are presented in Figure (3). Any implementation in Transboundary Rivers needs to agreement and cooperation of all riparian countries. Iran and its neighbors have several transboundary Rivers and wetlands and for using their waters, have prepared many agreements and protocols which have helped them for avoiding disputes and also created new space for more cooperation.

**Figure 3: Iran Boundaries Lengths**

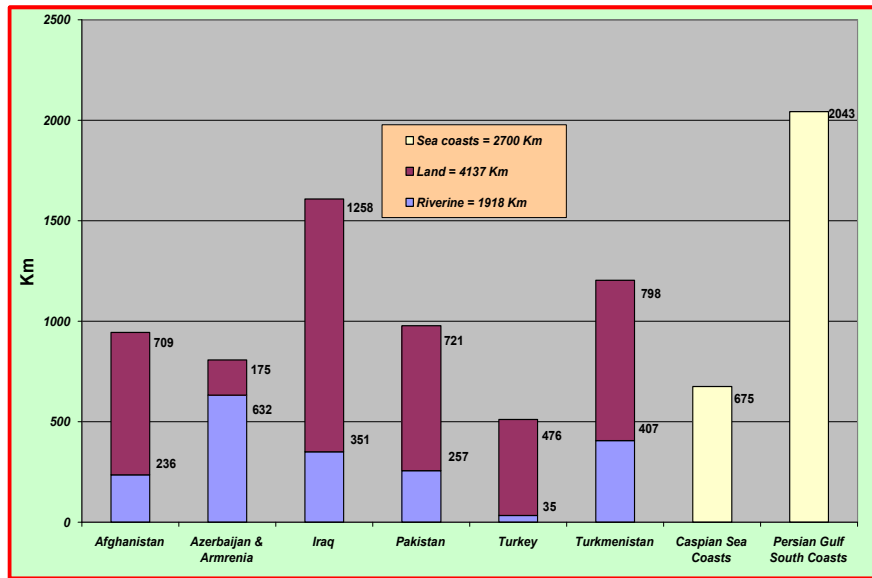


Table (4) shows most important Iranian transboundary Rivers with neighbors. There are some treaties, agreements and protocols about Iran and neighboring countries on transboundary Rivers. The treaties and agreements issues have several articles about water rights, hydropower, navigation, water quality and so on. In table (5) a brief review on Transboundary Water Treaties of Iran and neighboring countries is presented (Najafi, A., and Vatanfada, J. (2012).

**Table 4: Iran important transboundary rivers\***

River	In/Out	Countries situation in transboundary basin			Treaty
		Upstream	Downstream	Boundary River	
Aras	In	Turkey, Armenia	Iran, Azerbaijan	Iran, Armenia, Azerbaijan	Yes
Sari Su and Ghare Su		Turkey	Iran	-	Yes
Harirud		-	-	Iran - Turkmenistan	Yes
		Afghanistan	Iran - Turkmenistan	-	No
Hirmand (Helmand)		Afghanistan	Iran	-	Yes
Astarachai	out	-	-	Iran - Azerbaijan	Yes
Atrek		Iran, Turkmenistan	Turkmenistan	Iran - Turkmenistan	Yes
Nihing		Iran	Pakistan	-	No
Northern Khorasan Rivers		Iran	Turkmenistan	-	Yes
Western Boundary Rivers		Iran	Iraq	Iran - Iraq	Yes

\* Table prepared by Transboundary Rivers and Shared Water Resources Bureau, 2011

**Table 5: Iran important transboundary agreements with neighbors\***

Title of Agreement	Main issues	River	Basin	Signatories	Date
1-Russo-Persian Treaty of Friendship (1921)	Friendship development	-	Caspian Sea	Iran and USSR	February 26, 1921
2- Russo-Persian Agreement about boundary Rivers from Harirud (Tedjen) to Caspian Sea 1926	Boundary Rivers	14 rivers from Harirud to Caspian Sea	Harirud, Atrek, Caspian Sea		February 20, 1926
3- Agreement between Iran and the Soviet Union for the joint utilization of the frontier parts of the rivers Aras and Atrak for irrigation and power generation	Water Quantity, Hydropower	Aras, Atrak,	Aras Atrak		August 11, 1957
4- Treaty between the government of the Union of Soviet Socialist Republics and the Imperial Government of Iran concerning the regime of the Soviet-Iranian frontier and the procedure for the settlement of frontier disputes and incidents		Aras, Atrak, Harirud	Atrak, Aras, Harirud	May 14, 1957	
5- Delta Commission vote, Report of the Hirmand (Helmand) River - Afghanistan and Iran		Hirmand (Helmand)	Hirmand (Helmand)	Iran and Afghanistan	September 7, 1950
6- Hirmand (Helmand) River Water Treaty 1973 Between Iran and Afghanistan					March 13, 1973
7- Algiers Accord 1975 between Iran and Iraq and enclosures protocols	Border Issues Navigation, Water Quantity	Shatt al'Arab (Arvand Rud) and other border rivers	Shatt al Arab (Arvand Rud)	Iran and Iraq	June 13, 1975
8- Iranian-Turkish Protocol on the Use of the Waters of the Sari Su and Kara Su	Water Quantity	Qare Su (Kara Su) & SariSu	Aras	Iran and Turkey	1955
9- Agreement of Dosti (Friendship) Dam Between Iran and Turkmenistan	Construction of Dam	Harirud (Tejen)	Harirud	Iran and Turkmenistan	November 1, 1991
10- Agreement of Dosti (Friendship) Dam Between Iran and Turkmenistan	Operation of Dam				April 12, 2005

\* Table prepared by Transboundary Rivers and Shared Water Resources Bureau, 2011

### **History of Iran transboundary waters cooperation with neighbors**

Although the base of any cooperation in transboundary basin is bi or multi lateral agreements, but any actual improvement in transboundary waters cooperation needs legal, technical and management sections work together. For a suitable and more efficient management, we should consider all of its

elements and dimensions and effects in the transboundary basins. For this purposes, usually a team of different technical, legal and management sections attend on the meeting and sessions between riparian countries of a transboundary basin.

Iran and neighboring countries have wide ranges of cooperation with legal, institutional, technical and management dimensions and also have joint monitoring committees for discharge measurements and river pollution, common water works and so on.

According the principles of IWRM, cooperation of riparian and stakeholders is needed for any improvement in the basin especially in Transboundary Basins. As Iran and neighboring countries have long time of cooperation and based on their agreements and protocols, have experienced many types of cooperation and challenges, but benefits of their cooperation have been more than their losses. For example, construction of Aras Dam over transboundary Aras River (Between Iran and Azerbaijan (Former Soveit Union)), Khoda Afarin Dam over Aras Transboundary River (Between Iran and Azerbaijan) or Dosti (Friendship) Dam over Harirud Transboundary River (Between Iran and Turkmenistan), shows the institutional, technical and management capacities of Iran and neighboring countries for development of benefits sharing in their transboundary rivers and also avoiding new challenges or disputes in the transboundary basins. Table (6) shows briefly Iran and neighboring countries Transboundary waters situations. Table (7) shows characteristics of Iran and neighboring countries common water works (dams, diversion dams).

**Table 6: Iran and neighboring countries transboundary rivers situations\***

Country	Boundary River (Basin)	Water Treaty/Protocol		Transboundary Wetland		Transboundary Rivers Implementation			
		Yes	No	Yes	No	River works	Common water structures	River Pollution Monitoring	Joint Committee
Afghanistan	Harirud		*		*	-	-	-	-
	Hirmand	*		*	*	-	Milak Bridge	- Predicted in Hirmand (Helmand) water treaty 1973	-Hirmand (Helmand) Common Commissioners - Subcommittee of Hirmand (Helmand) River Works
Armenia	Aras	*			*	-Flood control -River Training and changing direction according to boundary protocols	-Hydro powers (Studying)	-Monitoring Aras River	-Technical Aras River Works -Technical Aras River Pollution
Azerbaijan	Astarachai		*		*				
	Aras	*			*	-Flood control -River Training and changing direction according to boundary protocols	- Aras Dam -Mil Moghan Diversion Dam -Khoda Afarin Dam - Qiz Qaleh Si Diversion Dam (Under construction) -Hydro powers (Studying)		-Technical Aras River Works - Technical Aras River Pollution - Technical Aras Dam
Iraq	Western Boundary Rivers	*		*		*	-	-	- Technical and legal committee for 1975 Algiers Accord for boundary rivers
Pakistan	Nihing		*	*		*	*	*	*
Turkey	Aras		*		*	*	*	*	*
	Qare Su	*			*	*	*	*	-joint monitoring committee for discharge measurements
	Sari Su	*			*	*	*	*	
Turkmenistan	Atrak (Atrak)	*		*		-Flood control -River Training and changing direction according to boundary protocols	*	*	-Technical Atrak River Works
	Harirud - Tejen (Harirud)	*			*	-Flood control & River Training and changing direction according to boundary protocols	-Doosti (Friendship) Dam -Shirtappeh Diversion Dam	*	-Doosti (Friendship) Dam Common Management -Shirtappeh Diversion Dam common Management
	Sombar (Atrak)	*			*	-Flood control	*	*	-Technical Sombar River Works

\*Table prepared by Transboundary Rivers and Shared Water Resources Bureau, 2012

**Table 7: Iran and neighboring countries common boundary rivers structures\***

Name of river (basin)	Involved countries	Common Water structure	Date of Construction	Date of Operation
Aras (Aras-Kura)	Iran – Former USSR (Azerbaijan)	Aras Reservoir and HP Dam	1970	1977
		Mil Moghan Diversion Dam	1970	1977
	Iran – Azerbaijan	Khoda Afarin Reservoir and HP Dam	1999	2009
		Qiz Qlaleh Si Diversion Dam	2009	Under construction
Harirud – Tedjen (Harirud)	Iran – Turkmenistan	Doosti (Friendship) Reservoir Dam	2004	2004
		Shirtappeh Diversion Dam	2009	2012

\*: Table prepared by Transboundary Rivers and Shared Water Resources Bureau, 2012

### **Challenges of transboundary waters cooperation between Iran and neighbors**

Iran and neighboring countries have improved their transboundary waters cooperation, but some important challenges exist. Table (8) shows remained challenges between Iran and each neighboring country. According this table, we can find that, by implementation IWRM principles, most of the challenges will be solved in future.



**Table 8:** Challenges in transboundary waters between Iran and neighbors

Country	Challenges
Afghanistan*	<ul style="list-style-type: none"> <li>- Weak water resources management in the Helmand (Hirmand) Basin</li> <li>- Low water efficiency in agriculture sections</li> <li>- Development of diversion dams and canals without attention to downstream required waters</li> <li>- Demise of Hamoon Wetland and the end of the Helmand (Hirmand)</li> <li>- Development of sand storms and wind erosion in lower Helmand (Hirmand) Basin</li> <li>- Opium cultivation and drug traffic</li> <li>- Lacking any agreement for Harirud Transboundary River between Iran, Afghanistan and Turkmenistan</li> </ul>
Armenia	<ul style="list-style-type: none"> <li>- Aras River pollution</li> <li>- Cooper mining factories and tailing dams damages to Aras River</li> <li>- Measurement stations</li> </ul>
Azerbaijan	<ul style="list-style-type: none"> <li>- Some plans of Aras River flood control which ruins bank of the other side of Aras river bank (Iran) and needs coordination with Iran</li> </ul>
Iraq	<ul style="list-style-type: none"> <li>- Demise of Mesopotamia marshes due to GAP project in Turkey and development of dust storm and its damages in western and central parts of Iran</li> <li>- lacking any agreement for Transboundary Aquifers</li> <li>- Low water efficiency in agriculture sections</li> </ul>
Pakistan	<ul style="list-style-type: none"> <li>- lacking any agreement for Nihing transboundary river and Mashkil Transboundary Aquifer</li> </ul>
Turkey	<ul style="list-style-type: none"> <li>- Lacking any agreement for transboundary Aras River</li> </ul>
Turkmenistan	<ul style="list-style-type: none"> <li>- Low water efficiency in agriculture sections</li> <li>- Weak water resources management</li> <li>- Needs for reconstruction of Qare Qum Canal for prevention of more water sinking</li> </ul>

\* Source; King, M. and Sturtewagen, B. (2010)

**Discussion**

According to aforementioned section about IWRM and transboundary waters and also the experiences of Iran and its neighbors, it is clear that some parts of IWRM and Transboundary water management have been done as well. Establishment of several joint committees, compiling and implementations of bilateral agreements and protocols, making several common water structures, flood control plans in boundary rivers, monitoring boundary rivers pollutions and other activities show the existing institutional capacities in related organizations in Iran and neighboring countries (Tables

5, 6 and 7).

Preparation of transboundary waters agreements according benefits of all parties with regards to international laws and legal frameworks show the capabilities and skillful of region which could be used easily by other countries in the Middle East and Central Asia. As most of Middle East people are Muslims and have common religion and according to Islam justice laws and also Holy Quran verses, Muslims should consider human rights and also sharing benefits for all of Muslim community and also their activities should be justified enough for prevention any sins. Using the capacity of Islamic laws for human well being, could improve IWRM and Transboundary Water management in the Middle East and Iran as one of the Muslim countries in the Middle East could deliver its experiences to other Muslim countries in the region. Also Iran has good samples of cooperation with international organizations which some of them are introduced briefly in Table 9.

**Table 9:** Iran and international organizations cooperation in transboundary waters

Title of cooperation	International organizations	Year of cooperation
Rehabilitation of Hamoon Transboundary Wetland and its unique lakes shared between Iran and Afghanistan at the end of Helmand (Hirmand) River in Sistan Delta for implementation of IWRM in the Helmand (Hirmand Transboundary Basin);	UNEP, UNDP and GEF	2005-2007
Reduction of Aras Transboundary River Degradation	UNDP and GEF	2005-2007
Making the Most of Afghanistan's River Basins Opportunities for Regional Cooperation	EWI	2009 - 2010
Second assessment of Transboundary Rivers, Lakes and Groundwaters (as focal point of Caucasus and Central Asia)	UNECE	2009-2012
ET (Euphrates and Tigris) Benefit Sharing Project	SIWI	2010-2012

Iran also has organized some international transboundary seminars in recent year such as Water Resources Management in Islamic Countries (2007) and International Training Workshop on Transboundary Waters, Opportunities for cooperation (2012). This events show that education and training as an important part of IWRM especially in Transboundary rivers have been

improved in Iran. Although Iran has improved its transboundary relation to neighboring countries based on IWRM principles, but it is needed to improve it for solving previous challenges or avoiding new disputes. For example in eastern part of Iran, environment of Hamoon Transboundary Wetland has disturbed severely in recent year and for rehabilitation of its unique environment should implement IWRM in the whole of Helmand (Hirmand) Transboundary Basin with cooperation of Afghanistan and avoiding of more negative effects in the region by controlling development agriculture and opium cultivation and making diversion dams and canal upstream of the basin. Also in Harirud Transboundary River Basin, as lack of any legal framework, the water right of Iran and Turkmenistan is not fixed and any development upstream of the basin, in Afghanistan (such as construction of Salma Dam) will face downstream with several difficulties. By implementation of IWRM in above basins all of riparian countries could develop their plans without ignoring the other parties. In North West of Iran, there are some other challenges in Aras Transboundary River between neighboring countries for water rights, river pollutions and flood control plans and IWRM could help decreasing tensions between riparian countries (UNECE (2011)).

### **Conclusion**

For making the most benefits for riparian countries of any Transboundary basins, IWRM could be used easily and get a numerous results. Some of them are:

- Sustainable development of water supply infrastructures
- Increasing water use efficiency
- Benefit sharing among stakeholders
- International law for equitable water use
- Disaster risk reduction
- Institutional capacity building
- Creation of database for information exchange
- Organization of seminars and training workshops

Iran and its neighboring countries have a lot of experiences in the Middle East which could be used by other countries as real samples for prevention of disputes and challenges. Islamic law in addition to IWRM principles could be very useful for this region and will exceed benefits of IWRM in Transboundary waters of Middle East. Although some challenges exist between Iran and neighboring countries for management of Transboundary basins, but applying IWRM could help riparian countries to solve difficulties and prevent of new disputes in the region. As accessing to fresh water resources in Middle East with low precipitation and growth population, will make riparian countries of transboundary basins get their benefits easily by using IWRM.

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