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Environmental Challenges in Trans-Boundary Waters, Case Study: Hamoon Hirmand Wetland (Iran and Afghanistan)

Alireza Najafi[1] and Jabbar Vatanfada[2]

[1]Expert of Boundary Rivers and Share Waters Bureau, Ministry of Energy Tehran, Iran
[2]Counsaltant of Water Affair Deputy of Iranian Ministry of Energy
and Secretary of Boundary Rivers Coordination Committee, Ministry of Energy, Tehran, Iran

Abstract: During past decades surface and ground water were resources for supplying agricultural, municipal and industrial consumers. Rivers are the most important supplier of people water requirements, such as Hydro powers, water transportation and fresh water. Several kinds of animals and special aquatics spices live in wetlands and groups of migrated birds could spend their winter periods in wetlands; also wetlands have specific vegetations covers (i.e Reeds). Hamoons are transboundary wetlands between Iran and Afghanistan which get their water from Hirmand (helmand) River and form a unique freshwater wetland ecosystem of outstanding local, national and international importance. As such, it has been designated as wetland of international importance under the Ramsar Convention by the Iranian Government in 1975. The wetlands have a great ecological, economical and cultural value and offer a livelihood to a significant proportion of the human population in the Sistan basin. Over the last decade's drought seem to have occurred more frequently than before and the vegetation cover has dramatically decreased. The degradation of the ecosystem is of great concern to the authorities and the local people, who see their livelihood threatened. Between 2001 and 2005 the lakes have been completely dry most of the time. People lost their income from fisheries, reed harvest, grazing and bird harvesting and agriculture suffered from severe shortage of water. Reasons for the degradation may be increased occurrence of droughts, decreased discharge of the Hirmand River due to increased water use in Afghanistan, over-exploitation of natural resources by the growing local population and the introduction of exotic herbivorous fish which may have prevented re-growth of reeds after the droughts of the mid-1980. In this paper recent condition of Hamoon wetlands, implemented works and suggested solution for conservation and rehabilitation of Hamoons will be presented.

Key words: Hamoon • Sistan basin • Transboundary Rivers • Wetland

INTRODUCTION

Over the centuries surface and ground waters have been a source of water supply for agricultural, municipal and industrial consumers. Surface waters resources such as rivers and wetlands have provided ways of transporting bulk cargo between ports, cities and villages along their banks. They have provided people water-based recreational opportunities and have been a source of water for wildlife and their habitats. They have also served s a means of transporting and transforming waste products that are discharged into them. The quantity and quality regimes of streams and rivers and wetlands have been a major factor in governing the type, health and biodiversity of riparian and aquatic ecosystems. In addition to the economic benefits of that can be derived from rivers and wetlands and their floodplains, the aesthetic beauty of most natural rivers and wetlands have made lands adjacent to them attractive sites for residential and recreational developments. Rivers and wetlands have generated and if managed properly can continue to generate substantial economic, environmental and social benefits for their inhabitants. Human activities undertaken to increase the benefits obtained from rivers, wetlands and their floodplains, may also increase the potential for costs and damages when the river or wetland I experiencing rare or extreme flow conditions. These costs and damages are economic, environmental and social. They result because of a mismatch between what humans expect or demand and what nature offers or supplies. The process of using and operation of share waters between 2 or more countries is a result of challenges and problems especially during recent century and problems of operation also caused to war sometimes.

Corresponding Author: Alireza Najafi, Expert of Boundary Rivers and Share Waters Bureau, Ministry of Energy Tehran, Iran

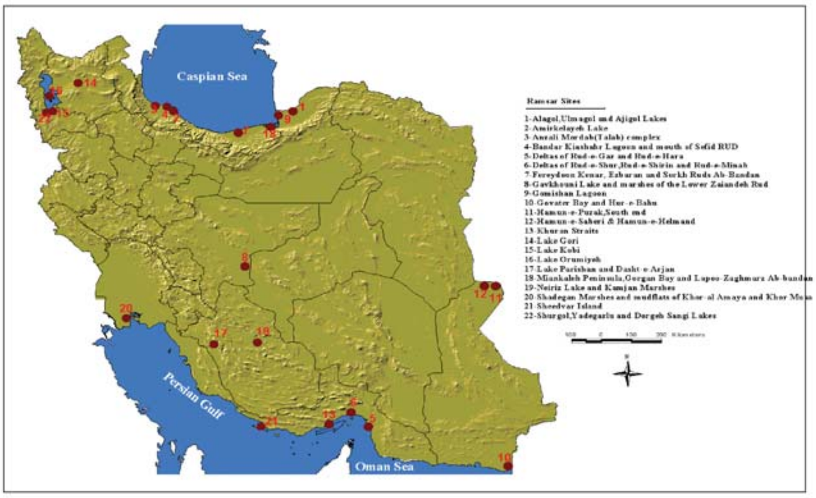

Fig. 1: Iranian recorded international wetlands in Ramsar convention

War and water are words which together and gradually their related challenges in 21st century will increase. Therefore human programming and implementations in surface water resources and its floodplain especially in share water resources basins should considers conditions and various climatologically, political, social, lawful and specially environmental factors. In addition to limits of surface and ground water consumptions, entering pollution to these resources, has increased problems. For management and controlling surface water resources in share waters basins, especially in transboundary wetlands, Integrated Water Resources Management (IWRM) interim could avoid of stresses and challenges between countries, prepare more and suitable cooperation's in surface waters resources operation. In this paper with a brief reviewing of international wetland definition and its specifics and presenting some of environmental challenges in transboundary waters basins in Middle East, conditions and location of Hirmand international wetland and existing problems and solutions will be discussed.

Definition of Wetland: Wetland has several definitions and meanings, but Ramsar convention (1971) defines wetland as: "lower marsh, swamp, natural or individual ponds, permanent or temporary with flowing or stagnant water, fresh, semi-salt and also sea regions which their depth in fully tide will not be more than 6 meters". Aim of Ramsar convention is conserving and wise usage of wetlands by applying national and international cooperation to act as a method for sustainable development in whole of the world. The mind of wise usage is sustainable development for human in a form which is adapted to natural elements of ecosystem. Iran wetlands commission (1984) defined wetlands as following: "Wetland is a region granted by God which during its formation process, its soil is saturated by surface and ground waters and is formed in an adequate and normal time stage and has a continuity life. This collection has communities of specific plants and animals which are adapted to this ecological condition such as marsh, pond, swamp and etc. In a wetland water regime changes, controls environmental and vital characteristics and in the other hand has a main role in vital characteristics of wetlands. In fact wetlands are considered as vital systems which have not absolute substitutes. There are several classifications for wetlands like their definition. Some of these classifications observed in Covardin (1979), Larsen (1989), Scot (1989) and Dogan (1990) works which Ramsar classifications for wetlands derived of aforementioned methods. In Ramsar Convention method, wetlands classify to 5 classes: Lacustrine, Riverine, Palustrine, Marine and Estuarine. A wetland is known important from international view which at least adapts to one of followings:

- Criteria related to indexes or individual wetlands, b) General criteria according to plants or animals and c) Specific criteria according to marine birds.

In Iran more than 20 wetlands have been recorded as international wetlands. I.R.Iran government is undertaken to universe community and other government members to keep ecological balance of wetlands introduced in list and attempts for keeping variety of livings of these wetlands. Hamoon wetlands recorded as international wetland in Ramsar Convention on 1975.

Examples of Environmental Challenges in Transboundary Waters of World

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^3 of Nile River waters. Regards to water resources limitations, any developing program in Nile River riparian countries threats the vulnerable environment of this basin and therefore integrated water resources management could present solutions for decreasing environmental problems.

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 Yarmoul 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 1648195 million Km^2 and its population estimates more than 70 million peoples. Annual average of precipitation is near 250 mm which is one third of annual average of the world. Distribution of precipitation is not equivalent in country and causes problems for supplying water in various regions especially in populated municipals. In following table precipitation conditions of major basins of Iran is presented.

Table 1: Iran Watersheds Characteristics

Basin	Total area (km^2)	As% of total area	Rainfall (mm/year)	Rainfall (km^3/year)	As% of total rainfall
Persian Gulf and Gulf of Oman Sea	424 209	26	380	161	39
Orumie Lake	51 801	3	347	18	5
Caspian Sea	175 051	11	423	74	18
Hamoon Lake	103 169	6	107	11	3
Central Plateau	824 356	51	166	137	33
Qara-Qum	44 165	3	226	10	2
Total	1 622 751	100	253	411	100

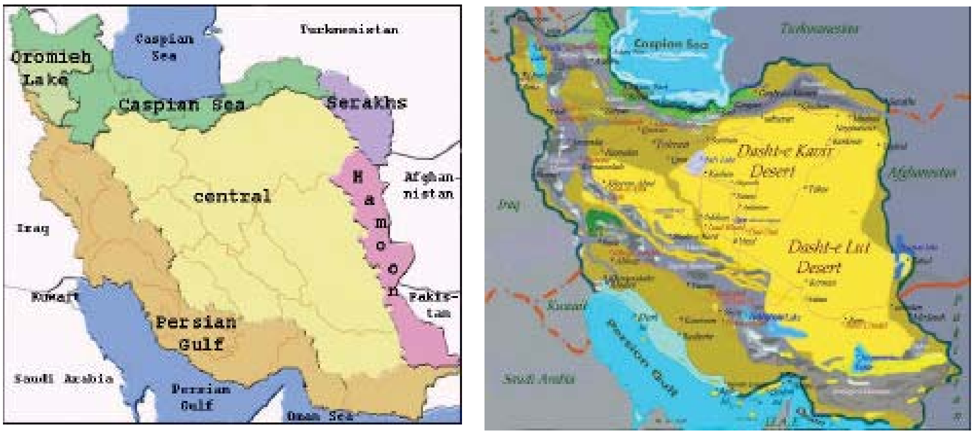

Fig. 2: Iran climate and basin maps

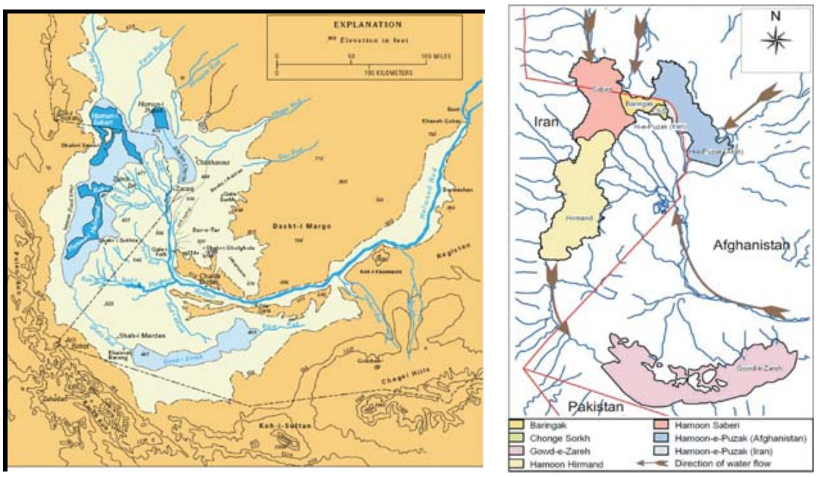

Fig. 4: Geography of the lower Hirmand (Helmand) Basin and Hamoon inflows

Introducing of Hirmand Transboundary River Basin: The Helmand River drains the southern one-half of Afghanistan and supplies about 80 percent of the waters that empty into the Sistan depression. The headwaters of the Helmand River originate about 90 kilometers west of Kabul on the southern flank of the Koh-i Baba and on the western slopes of the Paghman Ranges, where individual mountains reach altitudes of 4,400 meters. The river steadily increases its volume from the steep headwaters to its junction with the Arghandab River, the Helmand's largest tributary. Downstream from the junction, the volume of stream flow steadily diminishes because of irrigation diversions, evapotranspiration losses and ground-water seepage. Previous investigators have stated that ground-water seepage was the major reason for decreasing annual downstream discharges; however, water diversions for domestic use and agriculture are the main siphons of water from the river. There are more than 750 kilometers of irrigation canals maintained by the Government of Afghanistan in the Helmand Basin. About 78 kilometers downstream from Chahar Burjak, 45-55 percent of the Helmand's discharge is diverted into Iranian Sistan at the Band-i Sistan. The balance of the discharge flows toward Zaranj in what was once called the Nad-i Ali channel and at Zaranj, the Helmand flows into the Shelah Charkh channel, which empties eventually into the Hamoon-i Puzak. The river is 1,100 kilometers long if one considers the Hamoon-i Puzak to be the terminus; but in years of exception-ally high flows, the Helmand waters spill from the Hamoon Puzak into the Hamoon Sabari, which in turn merges with the Hamoon Helmand in Iran and subsequently overflows to the south into the Gaud-i Zirreh, the lowest and normally dry, hamun basin. When the Helmand floodwaters reach the Gaud-i Zirreh, the river has increased its length another 200 km. Local residents in Sistan stated that the Hamoons over-flow into the Gaud-i Zirreh once every 20-25 years.

Sistan and Hamoon Lakes Climatology Conditions: Sistan plain area is 15000 Km^2 and locates in north of Sistan and Baloochestan province of Iran and has 2 cities, 6 parts, 6 townships and 937 villages. Its population estimated about 420000 persons in 2008 which half of them work in agricultural and domesticated fields. Climate of region evaluated totally dry. Mean annual precipitation is 52.3 mm and in fully rain years this rate reaches to 120 mm rarely and in dry year there is no precipitation (such as 9 mm for water year 2001-2002). This little precipitation makes impossible any kind of dry farming. Even regional natural vegetations, seldom grow, if do not locate near ground water. In this condition only an external water resource could make alive region and Hirmand Trans Boundary River has such role. Totally could say environment of Sistan is very vulnerable and depends on Hirmand River. Wetlands or Sistan Hamoons as main and unique ecosystems are directly affected by Hirmand River. Area of Hamoons is wide, but their depth is low and average depth is about 3 m. Annual evaporation is more than 4 meters and this rate shows vulnerability of region under any kinds of climate changes such as drought or decreasing flow discharge to Hamoons. Other climatologically characteristics of this region are: high differences in temperatures during year, low related humidity (mean 38%), high evaporation and radiation (more than 4469 mm annual evaporation in (summer)). Climatologically classification according to Koppen and De Martounne methods is dry type, Ivanove method is saharan type and Amberge is mild desert. Today decreasing if water flow to Sistan, threatens extremely Hamoons and their ecosystems and finally people livings is affected. Most of Sistan population lives near Hamoons and are employed in several agricultural, fishery, handicrafts and other jobs. By droughts occurrence Iranian government prepares facilities such as food and flour supplying, medicine and health services and employment in region for prevention of forcing immigration of people, but continuous and extreme of droughts had forced some people migrated Sistan region. Long droughts at the end of 1960 decades, middle of 1980 decades and 1999 to 2005 affected Sistan region extremely and bed of Hamoon dried and its land became saline and its soil fertility disturbed heavily and some places became barren. A Sistan wind, which calls 120 days storms, also causes wind sediment transportation from beds of Hamoons to adjacent villages. Although Iranian regional responsible have been revented developing of sand movement by kilometers of windbreakers, but fine grains pass through these windbreakers and disturb human livings.

The Process of Drying Hamoon Lakes in Sistan: The Government of Afghanistan became interested in expanding agriculture in the 1930s and a few ancient canals were rebuilt by German and later Japanese engineers in the middle Helmand Valley. The Afghan Government continued canal construction during World War II and hired the American firm of Morrison-Knudsen, Inc. in 1946 with U.S. Government funding to build two diversion dams on the Helmand and Arghandab Rivers, to enlarge canals and to build roads in the valleys. The Afghan Government put a strong emphasis on the project in hopes of resettling a large portion of the nomad population and augmenting agricultural exports, as well as supplying electrical power to the southern provinces in order to modernize the country. Work in the Helmand and Arghandab Valleys, known as the Helmand Valley Project (HVP), was the largest agricultural development project in the country and in the early 1950s was financed by U.S. Technical Assistance Grants. Morrison Knudsen, Inc., completed the 44.2-meter-high (145 feet) Arghandab Dam with its storage capacity of 388,000 acre-feet of water (18 miles northeast of Kandahar) in 1952. A few months later in April 1953 the Kajakai Dam (72 miles upstream from Lashkar Gah) was finished. The rock-fill dam was 91.4 meters high (300 feet) and 26.5 meters long (87 feet) with a 51.5-kilometer-long (32 miles) reservoir and a capacity of almost 1.5 million acre-feet of water. Before the dams were constructed, appropriate soil and topography studies were not conducted before designing irrigation tracts on new (previously not irrigated) lands designed for agricultural development (Michel, 1972). A 1950 United Nations report (cited in Zakhilwal, 2004) cast doubt on the economic sound-ness of the project and later Bureau of Reclamation engineers cautioned that the project would require "extraordinary (that is, expensive) protective installations (soil drains) and maintenance and extensive releveling of the newly irrigated lands" (Bureau of Reclamation, 1954). Two negative effects occurred relatively quickly when irrigation waters were spread across both new and traditional agricultural lands. A strongly cemented conglomerate under-lies the newly irrigated lands and impeded infiltration of irrigation waters which in turn caused the local water table to rise 4.9 meters (16 feet) within 3-4 years of opening the main Boghra canal. Because of high evaporation rates and lack of persons experienced in irrigation management, large areas of the new lands became salinized and unsuitable for farming. In other areas, especially on traditional agricultural lands, increased water on the land resulted in waterlogging and loss of crops. Results of Afghanistan government implementation has been decreasing Hirmand (Helmand) river flows, loss of water quality in river, destroying ecology and environment of basin specially in middle and lower basin. The principal Helmand Valley cash crop during the early years of the 21st century is opium. Since the late 1990s, Afghanistan is the world's largest producer of opium (more than 80 percent of 2004 world supply) and has become the major supplier of heroin to Europe. In 2003 opium brought in $1.2 billion to Afghanistan, roughly one-half its gross domestic product. In 2002 the Helmand Province had 30,000-35,000 hectares under poppy production (which its water needs is five times more than wheat), the most of any province in the country. No HVP provisions or plans were made for improved irrigation on the Helmand delta in Sistan, site of several former civilizations. The foremost effect in the valley was increased incision by the Helmand River into its flood plain due to decreased sediment delivery and lower discharges in the river. Villagers and farmers were forced to extend their irrigation canals several kilometers upstream in order to bring water up onto the flood plain. Water and sediment trapped behind the dams has also affected the delta. Smaller volumes of water to the delta have resulted in shrinking Hamoons and adjacent wetlands, especially in drier years when a greater proportion of the annual discharge has been with-held upstream. Less water also results in lower water tables on the main delta and poorer water quality. More lands have experienced salinization and lack of fresh annual sediment has decreased soil fertility. Another consequence of less water on the delta is less vegetation holding the soil: local residents interviewed in 1977 claimed that sand movement across deltaic agricultural lands had increased since the dams were completed. These negative environmental effects in the lower valley, along with waterlogging and salinization downstream especially in Hamoon lakes and their unique environment and developing of sand storms and other negative effects, have not been calculated as indirect costs of the Helmand Valley Project.

Negative Effects of Drying Hamoon Lakes to Environment of Sistan: Negative effects of drying hamoon wetland and lakes are as following:

- Changing process of birds immigrations and destroying habitats of immigrated animals and fishes
- Destroying unique reeds and land covers of Hamoon wetland and threatened animals of region such as Sistan Cow
- Changing quality of wetland fresh water and salinization of water because of developing sand storm movement and prolongation of drought in wetland
- Developing sand storm and 120 days wind of Sistan time and area (Some references reported about prolongation of time duration of winds about 180 days)
- Increasing various diseases such as heart, respiratory, optic and even intestinal and other sickness of Sistan residents
- Negetive economic and social effects in Sistan regional people
- Impossibility of long time programming for sustainable development of Sistan region
- Changing people livings ways and increasing fields for fuel and goods smuggled from Iran to Afghanistan and opium smuggled from Afghanistan to Iran
- People immigration

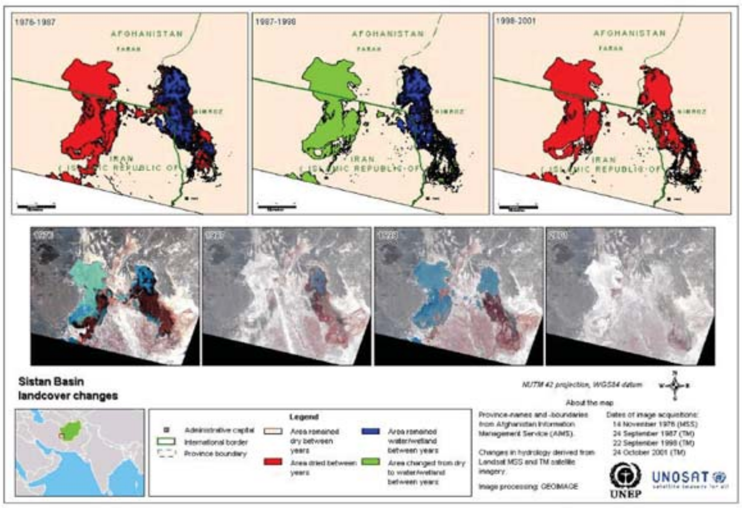

Fig. 5: Extremely changes in water volumes of Sistan region during 1976-2001

Damages Effects of Sand Storms to Sistan Basin: Winds of Sistan, 120 days, cause dust and sand storms. Problems of desertification and development of moving sand due to 120 days wind in Sistan has caused sever threats to natural resources of region like forests, pastures, agriculture lands and ground water resources and also building and infrastructures. Total desert site of Sistan and Baloochestan province is 6.3 million hectares which 1 million hectare of its consists of arenaceous regions and 500000 Ha of these regions is active arenaceous. Process of desertification in this province is developing more than 50 m^2/s, (but the average rate of desertification in world is 36 m^2/s and if the process continues, area of deserts and arenaceous will reach to 2.5 times more than today until 20 next years. The most important damages effects of developing Sands flowing are:

- Rushing wind sand to houses and roads of 200 villages
- Closing villages and municipal roads, streets and alleys
- Closing irrigated channels, water ways and river beds and damages to infrastructures
- Destroying and ruining agricultural fertile lands
- Extremely decreasing in vision less than 100 m and severe cars accidents
- Cancellation of flights and closing governmental offices
- Severe respiratory, pulmonary, optic and even intestinal acute diseases and twice references to hospitals in 2007

Implementations Steps for Stabilization of Sands Flowing Shrub and Tree Planting: In suitable regions for planting shrubs and trees, some resistant types to drought plants. During 2003 to 2006 shrubs and trees planted in 4000 Ha.

Wind Breaker: During 2003-06 constructed 360 km of dead windbreakers which most of it has done in Hamoon bed and its sediment deposited estimates 7 MCM.

Mulching: Because of acute condition of region and rushing sand movement to houses and roads, mulching has done in more than 2835 Ha of lands.

Waste Water Management: For activating lands planting and prevention of soil erosion by wind, waste water management is necessary. Only during 2004, waste water management has done in near 400000 m^3 in Sistan region.

Sands Flowing Cleaning: Reconstruction and recovery steps in municipal and villages roads, houses, water channel have been done which estimates more than 1 million $ every year.

Implemented Steps for Rehabilitation of Hamoon Wetlands: For rehabilitation of Hamoon wetland and its lakes several steps have been implemented since resent years which are presented here:

- Lawful steps (according to Hirmand (Helmand) water treaty 1973 between Iran and Afghanistan)
- National implementation (stabilization of sand flowing in Sistan plain and Hamoon lakes, water resources and consumptions in Sistan plain, changing agriculture and irrigation patterns, creation and management of Chah Nimeh reservoirs for supplying the least volume of potable waters and as a complementary wetland for continuing animal and plants livings)
- Moving toward Integrated Water Resources Management (IWRM) in Hirmand (Helmand) Transboundary River Basin
- International implementation (preparing and executing cooperation programs of Iran, Afghanistan and international organizations such as UNEP and financial agencies like GEF for assigning environmental water right rehabilitation of Hamoon wetland, proposal of bilateral cooperation in studying and execution of common agricultural, economical and social projects in Nimrooz province (Afghanistan) and Sistan basin (Iran) and stabilization plans for sand flowing)

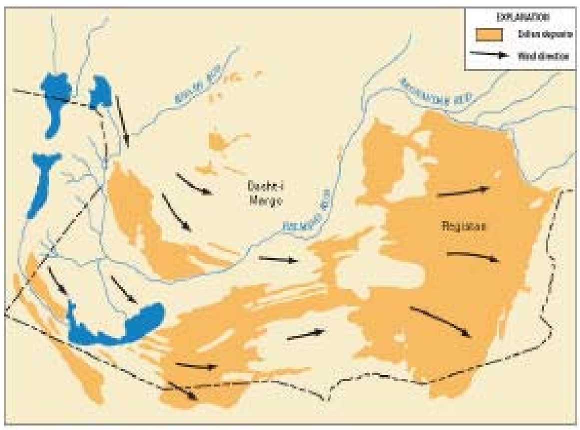

Fig. 6: Sand storm and winds direction in Sistan, dried Hamoons and lower Helmand basin

Dried bed of Hamoon lakes

Houses buried by sand

Buried water canal by sand

Sand entrance to infrastructures

Fig. 7: Dried Environment of Hammon lakes and Damages to infrastructures and houses

RESULTS AND SUMMARIES

Individual environment of Hamoon international wetland and its lakes is a great heritage of nature which should keep suitable and transfer to future generation for continuing human, animals and plants living. Any kind of explanation such as agricultural development upstream, increasing derived canals, poverty and people interests to benefits plants such as narcotics and opium productions, interior problems and lack of security in Afghanistan could not and should not cause destroying Hamoon wetland collection, because by continuing present condition and drying Hamoon lakes, sand flowing will develop to all of lower Helmand basin and all of structures and agriculture lands in south west of Afghanistan will buried under sands.

I.R.Iran has paid heavy costs for protecting and rehabilitation of Hamoon wetlands and even distributes its water at Chah Nimeh reservoirs for supplying potable water of Zaranj people (Afghanistan), but cooperation of Afghanistan in rehabilitation of Hamoon lakes could increase results and accelerate all of implementation for Hamoons rehabilitation.

I.R.Iran with regards to international experiments of Integrated Water resources Management (IWRM) in transboundary rivers of the world and also Iranians worth experiments in environment, agriculture, water resources and tourism, is ready studying and executing common economic, social, agricultural, fishery, making scientific and researches center and training experts, studying and execution of stabilization of sand flowing, building of ecotourism places projects in Hamoon wetland with cooperation of Afghanistan, or by any other activities and suitable plans for rehabilitation of some parts of Hamoon wetland. For achieving above purposes international cooperation will accelerate rehabilitation of Hamoon wetland.

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