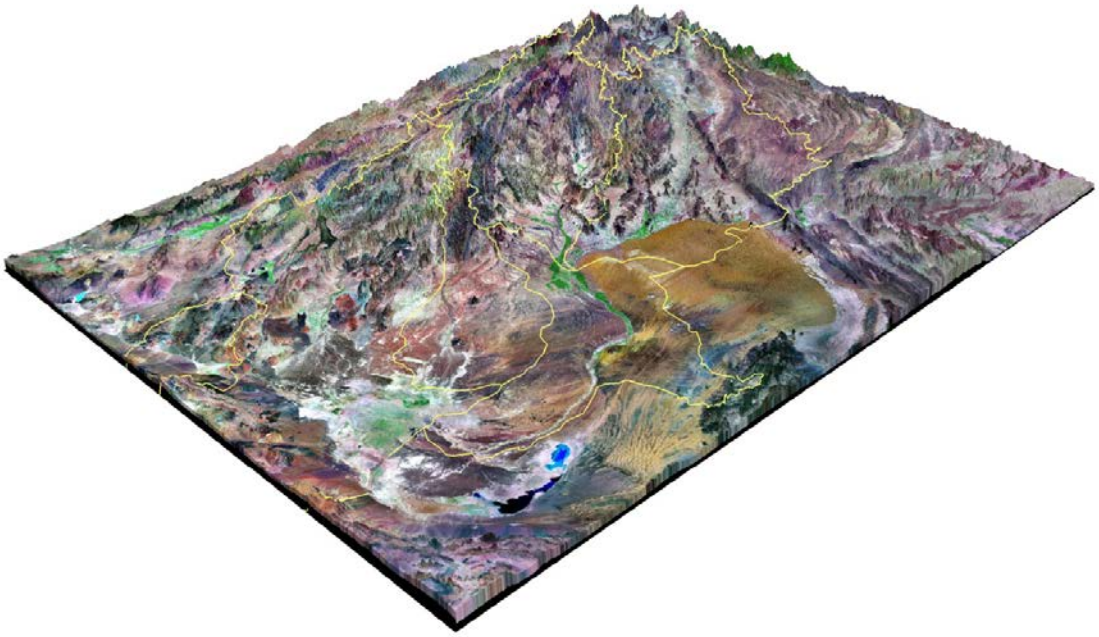
Monitoring Environmental Change in the Sistan Basin



An introduction to the exercise(s) on Change Detection

Dr. Zoltán Vekerdy and Dr. Corné van Elzakker
2012

1. RIVERS BRING LIFE TO THE DESERT

The Sistan area is located in the border area between Iran and Afghanistan in the bottom of a large, closed inland basin in one of the driest regions of the world. It is comprised of three geographic sub-units: (i) the upper plain of the inland delta of the Helmand (Hirmand) river, which is mostly drained and used for agriculture; (ii) the wetlands (Hamoons) covering the lower delta plain and (iii) a hyper saline lake (Gowd-e-Zareh) at the lowest part of the basin, which serves as the collector of the overspill from the wetlands, and in case of extreme floods, from the Helmand river. There is no outflow from this terminal lake; water is lost from Gowd-e-Zareh only by evaporation.

The Helmand river has the largest watershed, but some other smaller rivers also feed the Hamoons, the environmentally most important parts of the Sistan watershed (*Figure 1*).

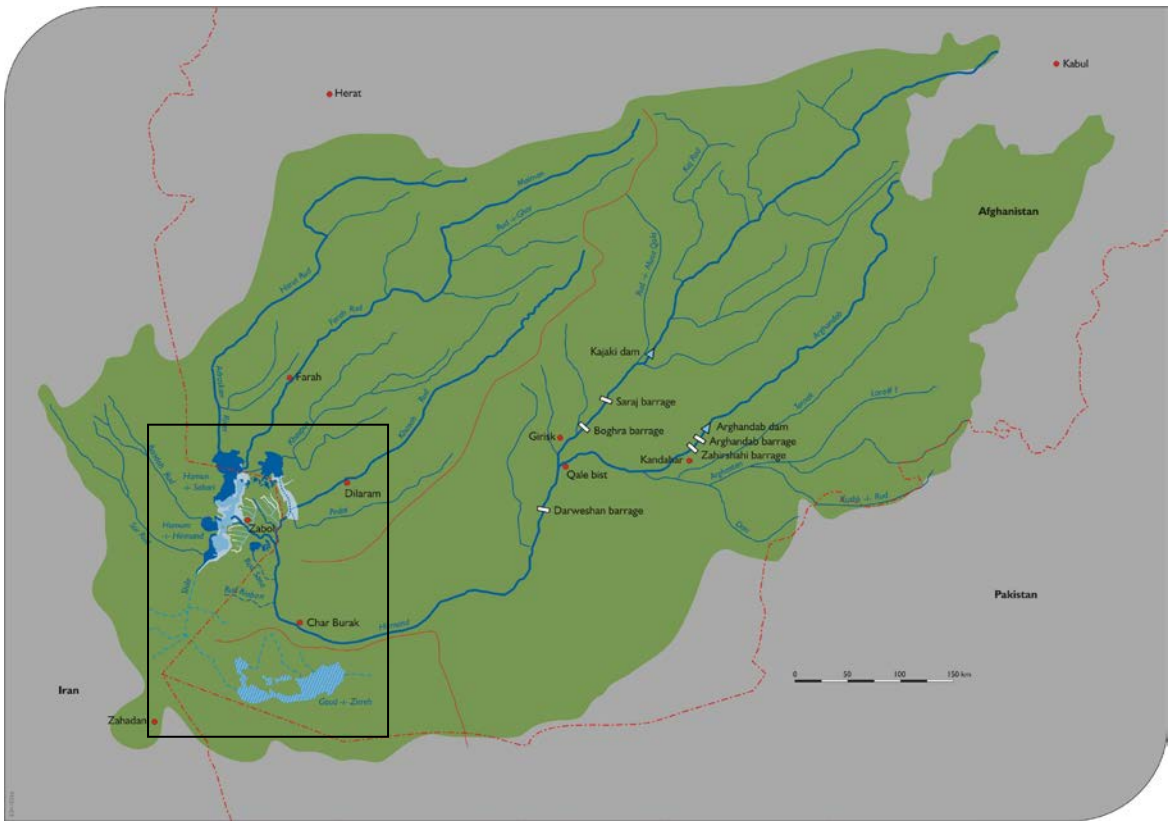


Figure 1 *Sistan watershed (the black rectangle approximates the lowest lying plains with the Hamoons). Source:(Van Beek 2005)*

The annual precipitation in the Sistan basin is about 50 mm (WAPCOS 1975). Under such conditions, life is only possible if an 'external' water source is also available to nourish the region. The Helmand River plays such a major role for the Sistan by draining the snowmelt waters from the mountains of the southern Hindu Kush. Three smaller rivers also contribute considerable flows: the Khash, the Farah and the Arashkan (Harut) rivers, which collect waters from the western part of the Hindu Kush. In this way, the ecology and the economy of the region are based on the snowmelt and rainfall in the high mountains. Water supply is characterized by severe fluctuations, which have historically caused fundamental

problems for human settlement and civilization. Recently, the turn of the second millennium was marked by an extreme drought lasting six years.

In the Sistan, as well as around the lower stretch of the Helmand River, the population depends on agriculture: intensive industrial crop production and horticulture provides the basis for daily existence (ICARDA Assessment Team 2002), especially on the Iranian side. In Afghanistan, the war has severely damaged agricultural production (both infrastructure and human resources) in the last two decades.

2. A VULNERABLE ENVIRONMENTAL SYSTEM

In the Sistan basin, life depends on the inland delta of the Helmand River and the associated wetlands and lakes, the Hamoons. Water cover is extensive but shallow: the average depth of the Hamoons even at the highest water levels, does not exceed 3 m. Shallow water cover with a vast extent in a very dry region where potential evapotranspiration is more than 3 m annually means that the system is and always has been very vulnerable to the climatic fluctuations as well as to the modifications of inflow by humans.

The large water surface with its reed beds has a positive effect on the local climate: the intensive evaporation decreases the enormous heat and increases the humidity of the air. It can be said that without the wetlands life was not possible in the region. Due to its location in the middle of a vast desert, this wetland complex is extremely important for migrant and wintering waterfowl. A large part of the Hamoons in Iran, approximately 60 000 ha, has been designated as a protected site under the Ramsar Convention. The Hamoons on the Afghanistan side are not subject to any official conservation measures or protection status, although it represents the more permanently inundated and vegetated part of the wetlands.

2.1 HISTORY

The Sistan Basin has been continuously inhabited by developed cultures for more than 5000 years. One of the key archaeological sites on the Iranian side is the Burnt City, founded next to an old branch of the Helmand River in 3100 B.C., and abandoned about a millennium later (*Photo 1*). The most probable explanation for this population displacement is a change in climate that resulted in, *inter alia,* an alteration of the watercourse of a nearby old branch of the Helmand River. The historical name of this site is unknown. It is referred to as the Burnt City, since at least three periods can be identified in the ruins, distinguished by the signs of major fires. Intensive agriculture, most probably fruit production, was the main economic activity of the inhabitants. This assertion is supported by an extensive amount of pottery, found at the site (*Photo 2*). The jars were used mainly for fruit conservation. The figural ornaments of the pottery depict goats and fishes (Persian Journal 2005a). These historical relics are evidence of a climate, which was more suitable for agricultural production than the recent one. Only some fragments of the Burnt City's historical puzzle have been discovered so far. The sands still cover many secrets, stimulating continuous archaeological digs. The recent drought has caused damages to this important site too, as reported by the Iranian Cultural Heritages News Agency (Payvand 2005).

On the Afghanistan side, Kang and Zaranj are major cultural centres from medieval times. Now they stand isolated, whilst ruins of settlements and forts dot the surrounding desert (UNEP 2003a).

Photo 1 Archeological site of the 4-5000 years old Burnt City

Photo 2 Broken pottery covers the ground in some parts of the Burnt City

2.2 SOCIO-ECONOMIC IMPORTANCE

Livelihoods in this region are strongly interlinked and dependent on the wetland products and services. The reed beds provide fodder for livestock, fuel for cooking and heating, and raw materials for handicraft and constructions. Fishing and hunting represent an important income for many households.

This fundamental dependence on the wetlands resulted in the collapse of the local economy during the drought period, which started in 2000 and lasts even now. Severe water shortages destroyed the ecological system of the wetlands and caused damages to the agriculture in the delta, which is primarily based on irrigation from the Helmand River. Estimates place the population at several hundred thousand in the region, larger part of them lives in Iran. On the Iranian side, the government invested considerable efforts to stabilize and maintain the

local population in the region by providing food, work and other services to meet the basic needs of the people. However, it was not possible to completely stem emigration. Loss of traditional livelihoods has resulted in a major expansion of the unofficial economy, particularly smuggling of oil products.

2.3 THE ENVIRONMENTAL PROBLEM

Prolonged droughts occurred in the late 1960s, mid 1980s and from 1999 to 2005. The rivers failed to bring sufficient water to fill up the lakes and wetlands and supply the irrigation-based agriculture. The last drought was of an exceptionally long duration, transforming the lake beds into barren desert. In this region, the summers are characterized by the infamous '120 days wind'. By the end of the season, wind-blown sand originating from the lake beds covers the surrounding villages. The MODIS image of 1 September 2004 (*Figure 2*) reveals that the primary source of the dust plume is the bed of the Hamoons. In Iran, local authorities constructed hundreds of kilometres of windbreaks to control sand movement (*Photo 3*). This protection is trapping a part of the sand (*Photo 4*) but has little effect on the finer dust.

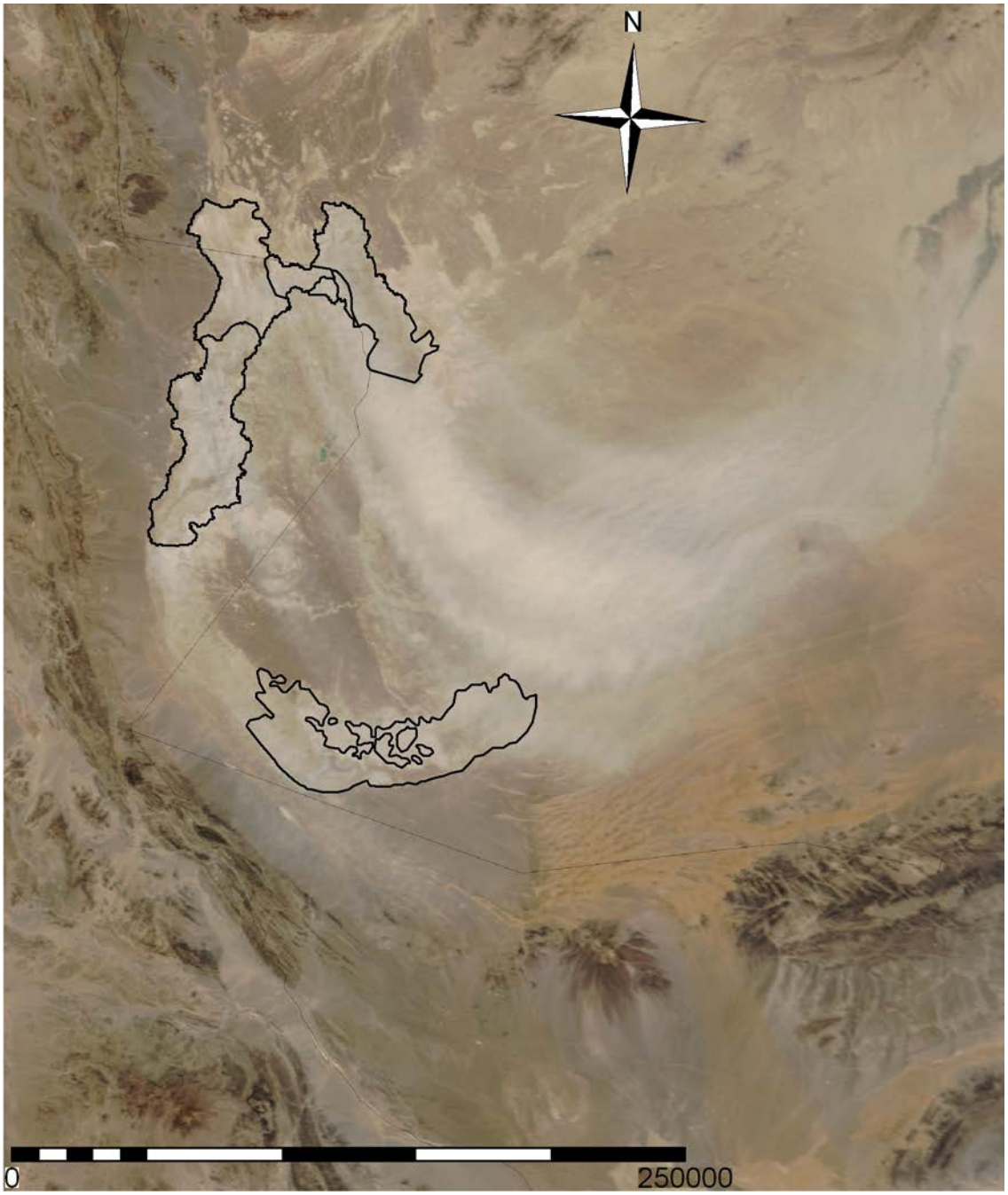


Figure 2 *Wind-blown sand originating from the lakebed of the Hamoons as captured in this MODIS (Terra) image of 1 September 2004. Several satellite images reveal that the sand plumes can cross the Persian Gulf and reach the Arabic Peninsula. Source: (NASA 2005)*
Scalebare shows distances in metres. The black lines indicate the location of the Hamoons.

Photo 3 Windbreak in Baringak. The dune behind the windbreak was formed in a few years by the wind-blown sand.

Photo 4 Hundreds of kilometres of windbreaks were constructed in the lake beds to trap the wind-blown sand

The Hamoons have a natural annual hydroperiod: each year the water level rises in the spring and drops from April to January, and large parts of the wetlands dry out regularly. In this system, the regular drying has an important ecological role, e. g., in maintaining reeds as the dominant plant community in the early succession stage. The population also takes advantage of the changing water levels by adjusting the grazing schedule of their animals. But in extreme cases, both the natural ecosystem and human society are adversely affected by prolonged dry periods. When the wetlands dry out for exceptionally long periods, water birds migrate elsewhere, fishing is not possible (*Photo 5*) and wetland vegetation dries out (*Photo 6*) In order to minimize the negative effects of water flow fluctuations, it is imperative to understand how the system works.

Photo 5 Abandoned fishing net in the dry bed of Hamoon-e-Puzak

Photo 6 Dead reed stems in Hamoun-e-Puzak

2.4 INUNDATION AND VEGETATION COVER DYNAMICS IN 2005-2006

After the last long drought, January 2005 finally brought the first considerable floods from the mountains. In fact, these were the results of an extensive meteorological front that brought rains to the plains and the foot slopes of the Hindu Kush, whilst resulted in snowfall in the higher regions. The rainfall caused direct runoff in the first week, and later, the snowmelt in the mountains contributed to the flow in the rivers.

The change detection exercise focusses on the changes in water (inundation) and vegetation cover in this year and concentrates on the Hamoon (wetlands) system only, excluding the Gowd-e-Zareh.

REFERENCES

This description above has been derived from:

Vekerdy, Z., R.J.J. Dost, G. Reinink and H. Partow (2006). History of environmental change in the Sistan Basin based on satellite image analysis: 1976-2005. Geneva and Enschede, United Nations Environmental Programme (UNEP) and ITC: 56.

http://postconflict.unep.ch/publications/sistan.pdf

Other references:

ICARDA Assessment Team (2002). Afghanistan seed and crop improvement situation assessment, April-May 2002. http://www.icarda.org/Afghanistan/NA/fsummary.htm

Payvand (2005). Sandstorm blocks entrances to Iran's Burnt City. http://www.payvand.com/news/04/aug/1198.html

Persian Journal (2005a). First animation of the world found in Burnt City, Iran. http://www.iranian.ws/iran_news/publish/article_5191.shtml

UNEP (2003a). Afghanistan post-conflict environmental assessment. Geneva, United Nations Environment Programme

Van Beek, E. (2005). Personal communication about the project "Integrated water resources management of the Sistan basin". Delft

WAPCOS (1975). Lower Helmand valley development, Water and Power Development Consultancy Services (India) Ltd. Internet: http://www.wapcos.net/projects_abroad_irrigation.html#afg