

## Water Resources Management due to Climate Change Impact: A Case Study in Asir Region, KSA and Conservation to Combat Environmental Deprivation

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**Abstract:** The Arabian Peninsula is going to experience rise to expected temperature and it is estimated that there is about 10% reduction in the rainfall amount due to global climate change impact according to Inter-governmental Panel on Climate Change (IPCC) fourth assessment report. However, flood occurrences, intensity and frequency will appear in the forms of flash floods rather than classically predictable flood events in this region. It is therefore necessary to develop innovative methodologies for the flash flood predictions under the impact of climate change and especially for arid and semi-arid regions. Works also on early flood warning systems must be intensified with the preparation of flood risk maps so that the people will not make their dwellings at flood risk prone areas. Floods, especially, in arid and semi-arid regions can be rendered into useful sources as groundwater recharge to enrich the aquifers, which are available extensively in arid zones like the Arabian Peninsula. This paper highlights the dams and underground dam network developed by Ministry of Water and Electricity (MOW and E), Kingdom of Saudi Arabia (KSA) in different Wadis of Asir Region, KSA which proves to be an innovative measure to regulate and utilize flash floods in this water scarce country. According to recent British Broad Casting Service, 70 tons of food has been wasted daily during Holy month of Ramdhan in United Arab Emirates alone and 40% of food has been wasted in Gulf Region. Moreover this paper emphasis on people education and practice to conserve the natural resources such as water, food and fossil fuels to stop environmental deprivation according to Arabic Code to eradicate hunger from humanity.

**Key words:** Arabian Peninsula • Climate Change • Asir Region • Dams & Arabic Code

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### INTRODUCTION

The impact of climate change on the Arabian Peninsula and global events is still rather sketchy. The area has not been as investigated as environmental reconstruction is made difficult by the paucity of data base. The lack of observed data (rainfall records, runoff measurements and their greatest magnitudes) unfortunately presents the major problem for runoff modeling in arid regions. These regions have characteristically high rainfall intensity and consequent flash floods with large amounts of sediments.

IPCC, Fourth Assessment Report published in 2007. The report concludes that global temperatures will probably rise by the end of the century will be between 1.8°C and 4°C and that sea levels are likely to rise

by 28-43 cm. The IPCC forecast that by the year 2050 temperatures may have warmed by as much as 1.6°C over the Arabian Peninsula with interior regions warming more quickly than the coasts. However give pessimists forecast about precipitation i.e. to be reduced by 10% over the same period.

Although it is predicted that due to climate change the precipitation in region reduced by 10% floods occurred in the forms of flash floods rather than classically predictable flood events. These floods have been rendered into useful sources as groundwater recharge to enrich the aquifers, storage for water supply and irrigation and safety of human life and property by using dams. It is used as an innovative measure in different Wadis of Asir Region, KSA to regulate and utilize flash floods in this water scarce country.



Fig. 1: Kingdom of Saudi Arabia highlighting ASIR Region (Sketch from Wikipedia)

**Asir Region-Study Area:** Asir is situated on high plateau in the southwest of the KSA and receives more rainfall than the rest of the country. It has an area of 81,000 km<sup>2</sup> and population of 1.6 million (3.5% of total area of KSA and 8% of country's population). Average annual rainfall in the highlands probably ranges from 300 to 500 mm (12 to 20 inches) falling in two rainy seasons.

**Rainfall Pattern:** The Asir region has relatively higher rainfall (the highest rainfall in the country) resulting in 60% of the total surface water of the Kingdom and it seems to offer a better potential for sustained farming. Rainfall is likely in almost any month of the year. In general, rainfall maxima in the region are in winter and spring. The winter rain is the greatest in terms of the number of rainy days, but the largest amounts of rain fall in spring. The summer rainfall is very noticeable in the region, since it rains almost every afternoon (more often during the second half of July and during August) due to local convection. Each seasonal rain is associated with different weather features. The Asir Mountains play an important role in the rainfall occurrences during all seasons, especially in summer. Higher elevations do not necessarily receive more rain: some lower locations have more rain due to the fact that they are on the windward side of the mountains. The source of moisture is the Indian Ocean, the Arabian Sea and the Red Sea. The Mediterranean Sea also contributes some moisture during winter and spring.

**Climate:** The Asir region is characterized by a semiarid climate with high intensity rainfall and flash floods leading to large amounts of eroded sediments. Some of the wadis

in the central part of the region have runoff amounts in excess of 100 Mm<sup>3</sup>/ year. These floods usually wash away Aqums (temporary small earth embankments), sometimes uproot plants, carry away the valuable alluvial soil and , in many cases, lead to loss of livestock and destruction of houses, roads and other utilities [1,2]. It is, therefore, essential that flood control measures are made available, not only for agricultural improvements, but also for further infrastructure developments.

Although the evaluations by El Khatib [3], Noory [4] and Muller [5] for the estimation of surface water resources and the adopted criteria for arability and irrigability are not identical, all of them suggest that the optimum development necessitates the implementation of major projects, such as the construction of flood retention dams, spate breaks, or a series of diversion weirs in the wadis in order to regulate the surface flows.

Therefore during the last 3 decades the maximum dams have been constructed in Asir Region which has been to regulate the flash floods for recharge, water supply, irrigation and flood control.

**History of Dams in Saudi Arabia:** There is a long history of dam construction in the Kingdom, particularly in the Hijaz and Asir. The period of modern dam construction goes back to the 1950s and was triggered by urban growth and agricultural development. Before 1975, there were 16 dams and the number had increased to 180 in 1984.

By 1993, there were 184 dams in total with a total storage capacity of 482 million m<sup>3</sup>. According to the Ministry of Agricultural and Water there are 58 dams in the central region, 23 in the Makkah region, 14 in Madinah region, 51 in the Asir, 14 in Ha'il region and 24 in the Al Bahah region. By 1998 more than 200 dams were in operation and there are many more planned.

The main reason for building dams is to trap runoff and to feed the under ground water system although some dams also supply potable and direct irrigation water for agriculture. Dams also protect settlements from the hazards of flashfloods.

The King Fahd dam located in Wadi Bishah largest dam in the Kingdom and has a storage capacity of 325 million m<sup>3</sup>. Other major dams include: the Mudhiq dam near Najran with a storage capacity of 86 million m<sup>3</sup>; the Wadi Jizan dam with a storage capacity of 75 million m<sup>3</sup>; Wadi Fatima dam on the outskirts of Makkah with a storage capacity of 20 million m<sup>3</sup> and the Jizan dam with a capacity of 15 million m<sup>3</sup>.

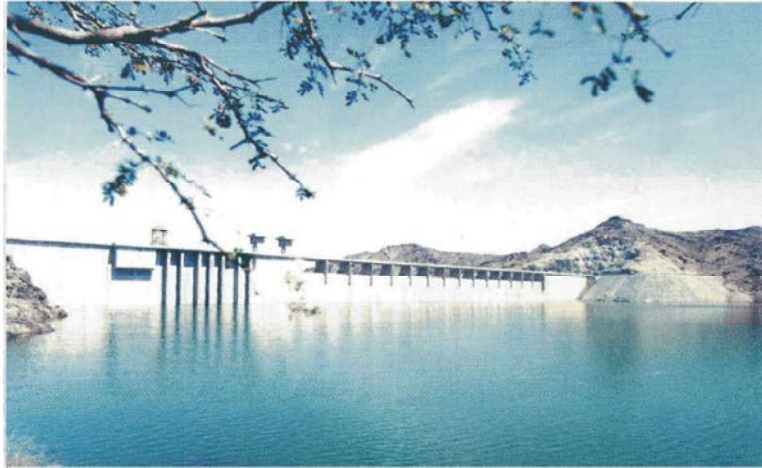


Fig. 2: King Fahd Dam Project (Dams in Kingdom of Saudi Arabia, MoW and E, KSA- 1427 H)

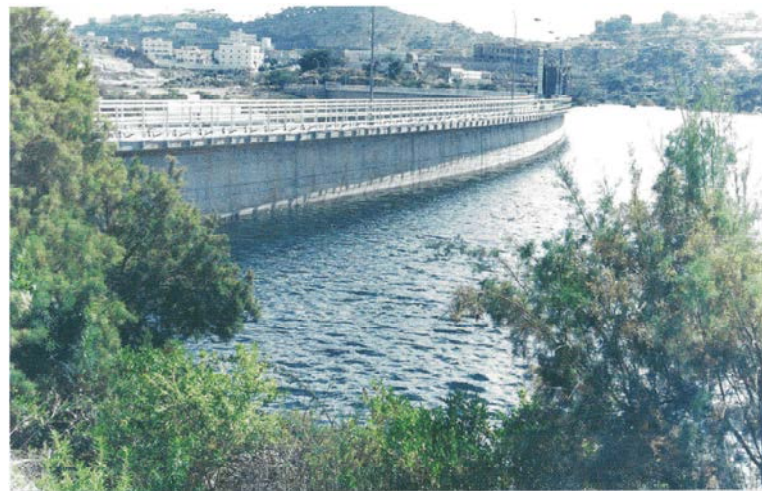


Fig. 3: ABHA Dam Project (Dams in Kingdom of Saudi Arabia, MoW and E, KSA, 1427 H)

**Dams in Asir Region:** Presently in Asir Region a total of 108 dams out of which 70 dams have been constructed and 38 dams are under construction. These dams will provide storage of 600 million m<sup>3</sup> to convert the flash floods into useful way.

**Commissioned Dams:** Out of 70 commissioned dams, 22 dams have a storage capacity of more than 1 million m<sup>3</sup> having total capacity of about 395 million m<sup>3</sup> out of about 407 million m<sup>3</sup> of total 70 dams reservoir capacity. It means that rest of 48 dams which has less than 1 m<sup>3</sup> reservoir has a storage capacity of 12 million m<sup>3</sup>. Mostly these are Concrete Gravity Dams. The total cost of these constructed dams is about 1 billion SAR. These dams have been built near Abha, Khamis Masheet, Bisha, Sirat Abida, Zohra an Janoob and Bilqaran and Rajal u-Mia.

It's important to note that out of these 108 dams the King Fahd dam has a storage capacity of

325 million m<sup>3</sup> which is about 50% of total storage of dams in Asir Region. The King Fahd dam located in Wadi Bishah is largest dam in the Kingdom and the second largest concrete dam in the Middle East and opened in 1998. The dam is some 113 m high and 507 m long and lies across one of the largest wadyan in the Kingdom. The dam is not only important for the supply of water to the Bishah region, which is considered one of the most important agricultural areas in the Kingdom, but also controls dangerous flash floods.

ABHA has its own dam within the actual city limits to provide drinking water with about 2 million m<sup>3</sup> storage capacity. The dam is also a small tourist attraction and has a cable car ride.

Itwad Water Project recently constructed has 2 surface dams with one underground dam for water supply to ABHA city with a treatment plant of 30,000 m<sup>3</sup>/day.

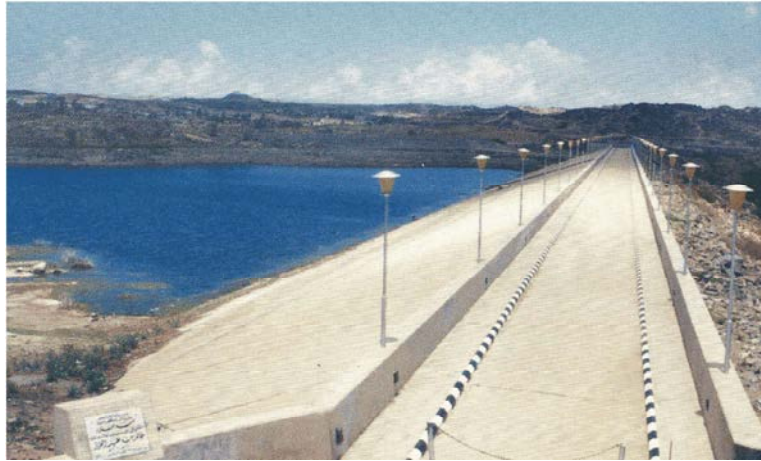


Fig. 4: Itwad Dam Project (Dams in Kingdom of Saudi Arabia, MoW and E, KSA, 1427 H)



Fig. 5: Halba Dam Project



Fig. 6: Terjis Dam Project

**Dams under Construction:** Out of 38 under construction dams, 12 dams have a storage capacity of more than 1 million m<sup>3</sup> with total reservoir capacity of about 178 million m<sup>3</sup> out of about 188 million m<sup>3</sup>. It means that rest of 26 dams have less than 1 million m<sup>3</sup> reservoir capacity with a total reservoir capacity of about 10 million m<sup>3</sup>. Mostly these are Concrete Gravity Dams. Total estimated cost of these dams is about 650 million SAR. These dams have been built near Al Namas, Bisha, Sirat Abida, Abha, Ahd Rafidha and Mahail.

Halba, Terjis, Qoba, Qanoona Aridha are few under construction dams in Asir Region.

According to Simon Atkinson reports (BBC World, Ramadan) on August 20, 2011.

“Although Ramadan is known as a time of moderation, there is growing concern about the amount of food waste. In Abu Dhabi alone an extra 50 tonnes of food is discarded in Ramadan alone and the government says this must change” and about

40% of food has been wasted in Gulf Region which has population of about 400 million. It's an alarming situation which must be stopped because no development can give real fruit to society unless this wastage of food can be stopped on war footing then about 40% water resources can be saved according to virtual water concept which itself is a basic development and help in addition to dams built in the Kingdom. Moreover this food if cannot be wasted can be used to eradicate hunger from the face of the earth where 1 billion people slept under fed every night.

In this regard the people should be educated and the effectiveness of such an educational program in a country like Saudi Arabia could be enhanced by reference to Islamic sources. This would help the local population identify with the environmental issues and the behavioral changes that they entail.



For instance, the Quranic verse of Surah Al A'raaf reads: "Eat and drink but be not extravagant. Surely He does not love wastrel." Likewise, Prophet Muhammad peace be upon him said, "Don't waste water even you are doing ablutions in running water."

Conservation of natural and material resources is the part of excellent management like dams which are also used to effectively use water.

### CONCLUSIONS

- The total number of dams commissioned and under construction will provide a storage capacity of 600 million m<sup>3</sup> for different purposes such as irrigation, water supply and flood control in Asir Region.
- These dams will control dangerous flash floods and in turn converts this water for recharge, irrigation and water supply.
- Water which will be stored for drinking will reduce requirement of energy (usage of fossil fuels) required for desalinization of water.
- The proper operation and maintenance of dams is must for their optimum utilization and will enhance their useful life.
- The benefits and effects of the dams constructed should be studied in detail so that the public or "the common man" can be aware of the benefits gained by the dams in KSA and will not be influenced by propaganda that dams are often ineffective.
- It is noted that that almost all the construction activities of the under construction dams has been carried out by the foreigners therefore Saudis should be trained to be worked as semiskilled and skilled labour at sites e.g. carpenters, steel fixer, batching plant operator, shovel operators and transit mixer drivers which will help the process of Saudisation in the Kingdom.

- Educating people is critical to prevent their wasting water, food and fossil fuels to ensure the sustainable use of environmental resources and their availability to future generations. This will not only stop environmental degradation but also ensure food, water and energy security of the Gulf Region it will help to eradicate hunger from the face of the earth (Biggest challenge for humanity till today).

### REFERENCES

1. Zekai Sen and Khalid Al-suba'i, 2002. Hydrological considerations for dam siting in arid regions: a Saudi Arabian study. *Hydrological Sciences-Journal-des Sciences Hydrologiques*, 47(2) April 2002.
2. Peter Vincent, 2008. *Saudi Arabia-An Environmental Overview* Taylor and Francis, Jan 15, 2008.
3. Soliman Al Shaalan, 2006. *Integrated Water Resource Management CASE Study: it Wad Dam Project* Proceedings of The first Symposium on Dam Management and Operation in the Kingdom of Saudi Arabia-2006.
4. Simon Atkinson, 2011. reports (BBC World, Ramadan)-20 August 2011.
5. Al-Muttair, F.F., S.S. Al-Turbak and U. Sendil, 1989. *Management of water stored behind recharge dams in central Saudi Arabia*. Final report AR-6-18 prepared for King Abdulaziz City for Science and Technology (KACST), Riyadh, Saudi Arabia.
6. Amina Majeed, 2010. *Role of young generation in saving and storing water in Pakistan* March, 2010.