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DOUBLING THE WATER QUANTITIES IN IRAQI MARSHES BY CHANGING ITS TOPOGRAPHY – ENGINEERING SOLUTION FOR A POLITICAL, SOCIAL AND ENVIRONMENTAL DEBATE

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ABSTRACT: The Garden of Adan, which is now known as the Iraqi marshes, is suffering from the lack of water. In the nineties of the twentieth century it was desiccated for political reasons. In the timeframe between 2003 and present date, efforts of re-flooding it to its original area of 20,000 square kilometers were jammed to restore only one third of this area with a poor quality of water. Global climate change and water developing projects in the surrounding countries, Turkey, Syria and Iran had severely violated Iraqi water shares required to supply this area. The environmental destruction in this wetland is not only reflected upon the vanishing of its wildlife but extended to force its inhabitants to flee. In addition to highlighting this Iraqi catastrophe, the aim of this research is an attempt to save a considerable amount of fresh water by the use of the physical phenomena concerning the evaporated water quantity with respect to the surface area. Tests have been done for models of soil totally/ partially covered with water to figure out the amount of water that can be saved by the retardation of the evaporation process. The reduction of the amount of evaporated water with respect to its surface area showed that 50% of water can be saved, if the top surface area of water was reduced to 30% of its original area. Changing the marshes topography by deepening 30% of its area and filling, with the same excavated soil, the remaining 70% might restore it to its original size and environment.
KEYWORDS: Iraqi marshes, Global change, lack of water, Evaporation, Surface area, restoring wetlands

INTRODUCTION

[1] About 20,000 square kilometres of swamps in the southern part of Iraq are called Marshes. These marshlands were created during ancient times when there was a huge quantity of water flowing through the famous two Mesopotamian Rivers, the Tigris and Euphrates. Marshes were the best natural regulator for repetitive floods in these rivers. Moreover, marshes were considered as a great natural wildlife area with high potential of eco-tourism. The region is thought to be where the Garden of Adan was located.

In the nineties of the twentieth century, large portions of marshes were dried for political reasons to force groups of insurgents inhabiting this area to flee away. [2] Fig 1 shows marshes extent in 1985 and in 2000.

Figure 1. Marshes extent in 1985 and in 2000

[3] Marshes were drained and shrank to a-tenth of its original size. Re-flooding efforts after 2003 have restored one-third the original size (with poor water quality due to salinity and pollution), resulting in a wet coverage of an area of only 8,000 square kilometres. Desiccating this area was not easy; it consumed a lot of efforts, time and money to change water paths, construct dikes and burn reeds leaving this area look like a scorched landscape see Fig 2.

The deteriorating marshy environment altered the natural routes of migratory birds that took refuge in this area during their annual migration to complete its life cycle. [4] Fish stocks were reduced to a terrifying level, transforming Iraq from being a producer to an importer. The residents of marshes whom were self dependent upon fishery activities and rearing water buffalo became dependable poor immigrants in their country.

In 2003 a political change happened, one of its concerns was to restore Iraqi marshes as it was. Many national and international meetings, conferences and projects were directed to the rehabilitation of marshes. Till now a limited actual success has been reached due to the emerging of a new factor that is the reduction of water quantities flowing through the providing rivers.

Iraqi rivers which were known of their destructive floods were heavily dammed in the countries of their origin. Turkey, Iran and Syria have built large dams in their territories across the supplying tributaries of both of Tigris and Euphrates. [5] In Turkey alone, by

2006, 208 large dams had been constructed. In total 579 dams have been completed and put into service for irrigation, hydropower and flood control. Almost 210 dams are under construction. The total water holding capacity of all Turkish dams is 651 km^3.

As it was

After draining

Figure 2. Iraqi Marshes before and after desiccating

[6] The discharge of Tigris, before control by modern dams, was estimated at Baghdad of a maximum annual average flow of 70.4 km^3. While the observed average annual flow of Euphrates across the Turkish Syrian border was 29.8 km^3. The ancient shares of Iraqi water were severely violated for the benefit of the mentioned countries. Turkey unilaterally guaranteed that it will allow 500 m^3/s water flows (15.75 km^3/ year) across the border to Syria, but no formal agreement has been obtained so far on sharing of Euphrates water. Unfortunately, neither Iraqi politicians nor international organizations could do anything to solve this Iraqi disaster.

The climate global change towards the increase of heat had augmented the problem more and more. [7] The average maximum temperature degrees during June, July and August are more than 40°C (up to 60°C as a maximum) with an average sunlight of not less than 11 hours per day and an average relative humidity of less than 14%.

The annual rainfall in marshy areas which was 5~8 cm became less year after year due to the climate change. More increase in heat means more evaporated water which increases the problem to the extent that fresh water had been transformed to a salty solution enough to killing fish and blind cattle.

Most of the media, reporters and politicians are talking about the future water wars. According to the writer experience, any inexperienced person can start a dispute but even the most wise men find it difficult to stop it or to estimate how much will it cost. Therefore, there is a real need to look for reasonable and practical solutions for this catastrophe.

The most remarkable topographic feature of Iraqi marshes is its flatness without variation of more than 2m. For 400km, from north to south, the slope is a mere 0.01% and an average water depth of 1m. In this research an engineering solution has been proposed and an elementary test has been performed aiming to figure out the possible procedure that can be followed to save what can be saved for restoring Iraqi marshes from being dried again.

One of the physical phenomena stated that; the evaporation process is increased by three factors Temperature, wind velocity and surface area. While the first two factors are natural and difficult to be changed, the third factor of the surface area is considered as the only factor which can be adapted to reduce the water loss by evaporation.

The surface area of water is decisive regarding evaporation; any quantity of water if sprayed over infinite area will require no time to be evaporated, while the same water quantity can be totally saved if it flows through a sealed pipe.

The expected saved water quantities can be added to the existing water to contribute in reducing the results of the problem. To have an idea about the wasted water by evaporation in the Nile river basin which has a similar problem, [8] The United Nations Food and Agriculture Organization (FAO) estimates that 68 km^3 of water is evaporating each year in Sudan, a quantity that is greater than the amount of water flowing in the Nile.

The same Organization declared that 10km^3 of water is lost each year due to evaporation in Aswan reservoir in Egypt, an amount of water that is equal to 20% of the flowing water in this country. This example is mentioned to delineate the extent of the problem and because there is no official data about the lost quantity of evaporated water in Iraq.

According to an approximate calculating program set by [8] the evaporated water quantity from the existing surface area of Iraqi marshes is more than 20km^3 each year.

MATERIALS USED

The following materials and tools were used to perform the test:

- *Clay soil having the proportions of 82%clay, 12%sand and 5%silt with 1percent of organic impurities. This type of soil is typical in the marshes area.*
- *Three steel pans with inner dimensions of 100x100x10cm. One of them was modified as shown in Fig 3.*
- *Scale.*

TESTING PROCEDURE

Three steel pans with inner dimensions of 100x100x10cm were used. The first and the third pans were filled with clay soil to a depth of 5cm. enough water was added to the extent that all the soil became fully saturated. Both pans contained exactly the same amount of fully saturated soil, this was checked by weight.

The flat top surface of the soil in the first pan was covered with 10 kg of water having 1cm depth. While The soil in the third pan were completely excavated along two edges for 5 cm width in the bottom, then a slop of 1 vertical: 2 horizontal was used leaving the top soil surface in the middle of the pan having the dimension of 64 x100 cm and higher by 1.5 cm compared with the original flat surface, see Fig 3.

This change in geometry did not require any additional soil because of equating the quantities of soil cut and fill as shown below;

Volume of excavated soil equals:

$$100 \text{ x Areas of abed and ghij} =$$

$$\frac{5+15}{2} x5x2x100 = 10000 \text{ cm}^3$$

Volume of filling soil equals:

$$100 \text{ x Area of defg} = \frac{70+64}{2} x1{,}5x100 = 10050 \quad \text{cm}^3$$

Then the same quantity of 10 kg of water was poured to fill the spaces along the two sides of the elevated soil. The top surface area of the water was equal to 30% compared with that of the first pan.

The second pan was fabricated by metal to have the same shape of the third pan and its contents but without soil. The reason for including the second pan was to compare the amounts of evaporated water, having the same free upper surface areas of 30x100 cm. Also, to show the amount of evaporated water through the soil in the third pan. Again the second pan was filled with 10 kg of water which gave a rise of 5 cm.

The average temperature during the test was 23°C. The reduction of weight for the two samples was recorded till the vanishing of the added water of 10 kg for the first pan, see Table 1.

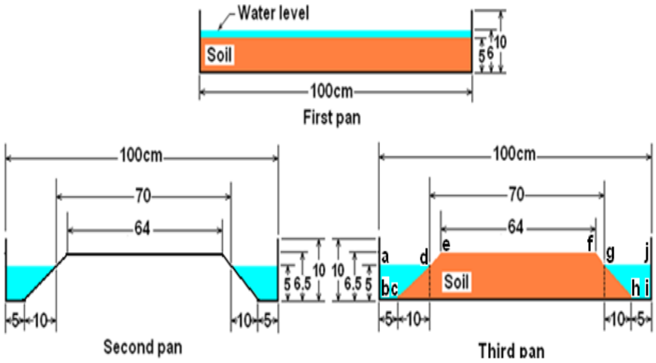

Figure 3. Same quantities of water with different top surface areas

Table 1. Weight of evaporated water measured with time

Time (h)	12	24	36	48	60	72	84	96
Pan #1*	1.1	2.4	3.3	4.3	5.9	7.1	8.5	10
Pan #2*	0.5	0.8	0.9	1.1	1.5	1.8	2.9	4.1
Pan #3*	0.6	0.9	1.1	1.3	1.7	2.2	3.7	4.98
Time (h)	108	120	132	144	156	168	180	192
Pan #1*								
Pan #2*	5.2	6	6.5	6.9	6.7	8	8.7	9.5
Pan #3*	6	7.2	7.7	8.3	8.8	9.6	9.9	10

** Weight of evaporated water (kg)*

TEST RESULTS

It is difficult to assess the exact amount of the evaporated water from Iraqi marshes. Surface area, air temperature and humidity, wind velocity, water temperature, and the soil/ plants properties are all factors affecting the evaporation process. [9] Suggested that; if all the variables were the same there is an approximate direct relation between the quantity of evaporated water and its surface area. That means 70% of the water can be saved by reducing 70% of the surface area.

Test results showed that; if 70% of the surface area is reduced, the amount of the evaporated water will be reduced by 59%. That what was happened to pan #2 after four days, it lost 4.1 kg of water compared with 10 kg for the full surface exposure of pan #1. Pan #3 which had 30% free water surface area and 70% of soil surface, lost about half (49.8%) of its water compared to pan #1. The increase of 8.8% of the evaporated water in pan #3 was due to evaporation through soil top surface area.

Based upon this physical reality, if Iraqi marshes topography can be altered by reducing the top surface area of its water, probably its water quantities can be doubled. The increase of water quantities in Iraqi marshes might make it possible to expand it to its *original area and to skip unnecessary wars. Moreover, the saved water will certainly reduce water salinity to a comfortable level for Marshes inhabitants and to its wildlife species.*

CONCLUSIONS

The following conclusions can be derived:

1- *A reduction of 59% of the evaporated water can be saved by reducing the top surface area of the water by 70%.*

2- *A reduction of 50% of the evaporated water of a submerged land can be saved by dividing the top surface area into 30% of water and 70% of soil.*

3- *Water evaporated through wet soil is 12.5% of the water quantity evaporated directly from a free water surface.*

4- *Adapting the Iraqi marshes topography by cutting soil to deepen 30% of its area and filling, with the same quantity of soil, the remaining 70% might double its water quantities.*

5- *Iraqi marshes (the garden of Adan) could restore its historic area, wild life and environment by changing its topography.*

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