Bibliographic report on the use of water for agriculture in Egypt from antiquity to modern times

Photo satellite NASA, le Nil

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I. Introduction to the Nile and the dependancy of the egyptian state on its water.

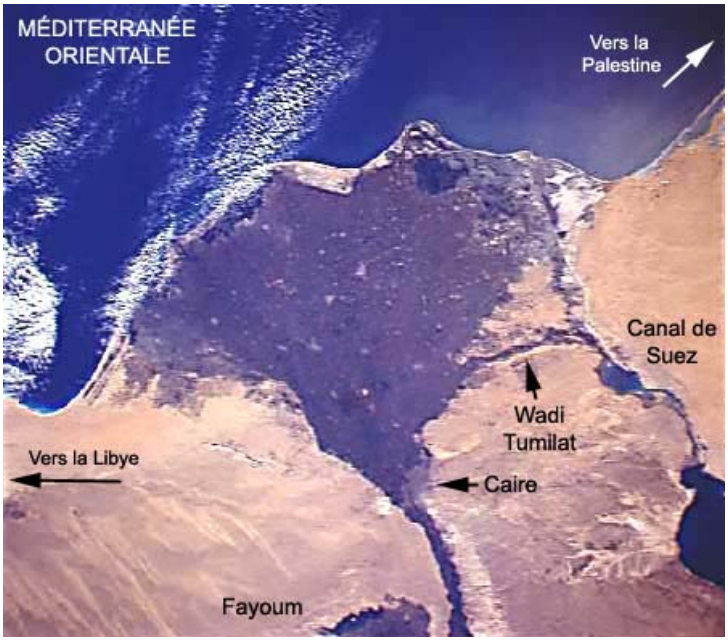
The Nil takes its source in Lake Victoria in Uganda. It starts as two rivers : the Blue Nile and the White Nile. It is the third longest river in the world measuring 6671 km, of which 1200 km are in Egypt. The drainage bassin is only 2 870 000 km². Ten countries are in the drainage bassin (Sudan, Ethiopia, Egypt, Uganda, Tanzania, Kenya, Zaire, Rwanda and Burundi). Egypt is the most downstream country. This area is in fact small compared to the length of the river due to of its small number of tributeries (none of which are in Egypt). 62% of the area is in sudanese territory, 12% in Ethiopia and 10% in Egypt. (source : ONU, "Register of international Rivers", *Water Supply and Management*, vol. 2, 1978).

The average flow rate measured at Khartoum is 2 800 m^3/s but this is quite variable, with flows ranging from 520 m^3/s in May to 8500 m^3/s in September. The majority of the water comes from the ethiopian highlands (tropical climate) which feed the Blue Nile, whereas the White Nile coming from the equatorial region looses the majority of its water via evaporation in the marshes of Bahr-el-Ghazal (14 km^3/an), Kenamuke and Machar (19 km^3/an).

Its North/South orientation means that the Nile crosses four different climatic zones : equatorial, tropical, tropical-boreal and desert.

In Upper Egypt, from the Sudan to the start of the delta, the climate is very warm and dry. At Assouan, on average only 3 mm of rainfall are recorded per year and average monthly temperatures vary from 15 to 33°C. The delta is wetter : 24 mm of rain per year in Cairo, 190 mm in Alexandria and the temperatures are lower. The mediterranean climate becomes more pronounced as one moves towards the cost. (source Mazoyer et Roudart, 1998).

Egypt therefore has a difficult situation : at the downstream end of the river, its dry climate results in heavy losses of water by evaporation and no tributary flows into the river in its territory. This results in a small drainage bassin. However, Egypt is the country that makes most use of the niles' water for millenia.



The nile delta is an important region for Egyptian agriculture. Its is 160km long and 200km wide at the meditarenean coast. Initially composed of 7 branches only 2 reach the sea : the ……arm to the east and the …….arm to the west.
24000 irrigation and drainage canals allow the use of the delta for agriculture. The canals were conolised by hyacintch imported in the 19 century to decotore palaces and luxury hotels. The abondance of this plant causes much water to be lost via……. Furthermore, it deprives the aquatic animal life of water.

A third of the Egyptian population lives in the delta, where the density of population is high 600 to 800personnes/km2.

The water ressorces of Eygpt are the subject of conficts, the countries upstream demanding their share of the water. The downstream position of Egypt puts it in a position of total dependance with regards to the other countries. However Egypt has the largest population, is the richest and has used the Niles' water for 4000 years. These circomstances put Egypt in a contradictory position, since it is the most important country in the region yet totally dependant of the other countries upstream on the nile (princaply Sudan and Ethopia).

Following its independance in 1956 Sudan put in place a programme of large mechanised farms. This considrably increased the countrisè demand for water. The Egyptian – Sudanese conflict was temporarily resolved in 1959 by an agreement to share the Nile's waters. (X percent Egypt, Y percent Sudan). Ethipoia which has the source of the Blue Nile, Sobat and Atbara which provide 80% of the water demands a renegociation of this agreement that currently gives it nothing.

En fait l'Egypte pourrait recevoir au niveau du Lac Nasser l'équivalent de 84 km^3/an en moyenne (entre 34 km^3 en 1947 et 120 km^3 en 1878 selon les année de faible ou forte hydraulicité). La déperdition évaporative est importante, elle représente 53 km^3/an en moyenne, l'apport théorique étant donc de 137 km^3/an (source: OSS-FAO Apport dans les hauts bassins productifs). Le passage des eaux du Nil dans le Lac Nasser provoque une évaporation de 10 km^3/an, ce qui ramènerait donc la disponibilité en eau du Nil pour l'Egypte à 74 km^3/an.On constate qu'elle utilise en fait un peu plus des 55.5 km^3/an prévus dans les accords : en moyenne 57 km^3/an (le Soudan s'est aligné en augmentant sa dotation à 20 km^3/an).
L'Egypte dispose aussi de ressources en eaux souterraines : le Nil alimente une nappe dans la vallée et dans le delta de 2.6 km^3, et l'Egypte pourrait disposer en partie de la grande nappe souterraine du désert occidental (Tchad, Egypte, Soudan, Libye) qui a une capacité de 50 000 km^3, dont 20 000 en Egypte au niveau des oasis (Kharga, Dakhla, Farafra et Bahriyya). Elle n'est exploitée qu'à hauteur de 0.005 km^3/an. Des recherches sur cette nappe fossile sont actuellement en cours.

82% of the water is used for agriculture, 11% for industry and 7% for urbain consommation. Concerning agricultural water the statistics are the following :

- 41km3 from the Nile.,
- 4.7km3 recycled drainage water
- 3km3 salty water pumped up from acquifers.
- 0.7km3 used urbain water

The predictions for the consommation of agricultural water are very alarming and much larger than the 49.5km3 currently used per year.

II. Ancient Egypt, a water based society based on low intensity agriculture in the flood plane of the Nile

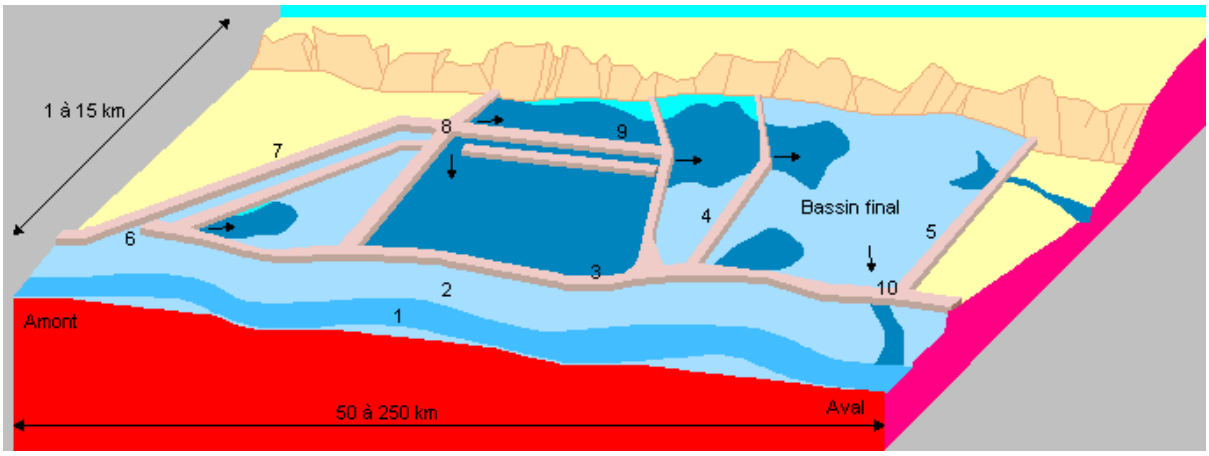
From the 6th century BC agricultural developpement of the flood plane developed in Egypt. This system was based on the annual flood from July to October following which the plnating of crops took place. The Egyptian climate puts the country in a situation where it is totally dependant on the Nile and the floods which bring water and natural nutrients. As such, the Egyptian civilisation was completely reliant on the effective management of this water ressource. With time, a 'water police force' was put in place to be the nerve centre of a sustainable water management system.

The Nile's flood which arrives in mid July reaches a maximum in September and then during the second half of October and November retreats from flood plane. The flow progressively reduces until May where the waters are at their lowest.
The flood saturated the ground, raised the water table and deposited the layer of natural nutrients (1mm per year on average). This layer of fertiliser gave rise to a clayey soil in the valley.

The submersion of the soil resulted in a number of advantages :

- Well watered soils creates favorable conditions for the growth of numerous crops.
- If the flood is sufficientlt long there can be a deposit of natural fertilising agents.
- Desalination of the fields.
- Limitation of the growth of weeds.
- Natural ploughing of the earth : The retraeting water causes the soil to dry. On drying the clay becomes ripe for planting.

The first flood bassins appeared 6000 years B.C.These were rectangular and seperated by dykes. The aim was to direct the Nile's flood waters to desired locations. In some cases the dykes were extra high to provide protection against the highest floods.
Then, the basins started to be organised in 'perpandicular' fashion. This gave rise to an excessive deposit of sediment in the first basin of a chain. To these perpandiculat chaines were added 'longitudinal' chains (upstream – downstream). This increased the flow of water through the basins and hence reduced the excessive sedimentary deposits. The calculation of the gradient of the canals was key : if the slope was to flat there was silting up of the canals, if it was too great the flooded area was too small. Due to the unequal nature of the differnt basins their sharing out was an important affair.



1: Lit mineur du Nil.
2: Lit majeur du Nil.
3: Digue longitudinale {nord-sud} principale.
4: Digue transversale ordinaire.
5: Digue transversale terminale.
6: Prise, mise en eau pendant la crue.
7: Canal d'amenée des hautes eaux.
8: Ouvrage hypothétique de répartition des hautes eaux entre bassins contigus.
9: Chenal de progression des hautes eaux vers les bassins d'aval.
10: Vidange directe dans le Nil à l'étiage {niveau moyen le plus bas d'un cours d'eau}.

(d'après Ruf)

The agriculture was thus enrirely dpendant on the flooding which meant the harvest was unpredicatable : A late or early flood, a flood too high or low, a irregular retreat of the waters, all these factors where vital for the survival of the Egyptain population. This type of agriculture required low labour and few tools.

This organisation of basins leads us to the conclusion that there was a high degree of coordination and management present. Through time, the experience that they acquired in the management of water allowed the society to organise itself more and more efficiently. Hence we can speak of a ‘water based society’. The larger the state was, the greater the possibilities for water coordination were. In the last centuries of the 6th milenium B.C. two kingdoms came into being, Upper and Lower Egypt. Rapidly, Lower Egypt due to its downstream position came under the domination of Upper Egypt and political unification took place with Pharoe Menes being the first of the 30 dynasties to reign over the Egyptian territory.

III. The move towards the use of irrigation in agriculture and its spread over all of Egypt.

Firstly, one must make clear that a culture based on irrigation has always existed in Egypt. In ancient times its presence was of a more marginal nature and underwent a small evolution at the time of the Greek envasions. A boom took place as Egypt became integrated into the global market and cotton cultivation spread across the whole country. It was thus primarily during the 19th century that this rapid growth and transformation from 'flood' based farming to irrigation took place.

Following the period of French rule (1798 – 1801), Mohammed Ali came to power. His ruled from 1805 to 1848 and this period was marked by an important reform of agricultural practice. His aim was to better organise the cultivation of cereal crops to boost the population. He also wanted to remove excess production of cereal to make way for cotton and sugar cane. This allowed exports whos revenues permitted the modernisation of the country. Furthermore, to cope with the financial problems of the peasents who could no longer pay taxes Mohammed Ali introduced a system of consessions. The top civil servents and military officers could acquire the property belonging to a village if they payed the commune's debts. This policy is the origin of the large farms currently in existance.

The cultivation of cotton became obligatory wherever it was possible. It was, therefore, necessary to change the water policy of the state and increase irrigated regions. The most common instrument of pumping water at the time was the 'saqia' (water wheels driven by people or animals).
The first technique to be implemented was the puting to use of the canals formely used in the 'flooding' system. The limits of this method became quickly apparent, as a result efforts became focused on the building of sucessive wiers along the river's course (in the delta region). In 1843 the construction of the damn on the Damitte branch allowed the irrigation of the whole delta.

The available water during the summer was always quickly used and this problem becamse worse over the years as demand for irrigation water rose. The state moved towards the construction of large dams upstream of irrigated areas. The first was built in Aswan in 1902. It allowed some of the flood waters to be stored and released on demand. It constituted a reserve of 5,6million m3 in 1934. This dam facilitated the irrigation of regions upstream of the delta.

In 1952 Nasser came to power and put into place more agricultural reforms. In order to modernise farming and have a continual supply of water his gouvernment organised the construction of the Aswan high dam, allowing the flow to be controlled all year round. The last Nile flood occured in 1964. The volume of water stored behind the dam is 168billion m3. The whole project was a colossal undertaking. The dam permitted total control of flooding and two harvests per year. The cultivated area passed from x million feddons in 1952 to y million feddons in 2002. This was a pivotal transformation in the history of water management in Egypt.

Although the cultivated area and production were greatly increased Egypt was still not in a position of self sufficiency with regard to food, it needs to import. The agriculture remains very manual. 95% of landowners posses less than 5 feddons. .

IV. Consequences of the irrigation

1.
The first thing that one remarks when considering the Egyptian culture is its total dependance on irrigation. Despite the Aswan High Dam that allows Egypt to total control the flow of the Nile, it is not safe from water shortages : From 1979 and some of the 1980s sucsessive small floods gave rise to the reduction of the volume of Lake Nassar. Without the return of normal floods from 1988 Egyptian afarming would have been under serious threat.

2. As a result of the Aswan Dam the cultivated area grew considerably. Two harvests bcame possible instread of one, the cultivated area was seven million feddons in 1988 which corresponded to an 'effective' area of eleven million due to the double harvest. However, Egypt is not self sufficient with regards to food as Nassar wished when he had the Aswan dam built. In 1960 Egypt produced 65% of grain consummed, in 2002 this figure was 25%. The agricultural surface area has not increased since 1970 although the population has risen continuously.This dependancy on foreign food results in a delicate political situation.

3. One of the undesired consequences of the irrigation was the salination of the soil and rising of the water table.
Due to the hot and dry climate the evaporation is intense. A large part of the water in the canals and basins evaporates. The concentration of salt arriving in the fields is thus already high. A fraction of the irrigation water and the salts it contains is absorbed by the plants, but another fraction evaporates : The water that infiltrates the earth therefore has an even higher concentration of salt. The excess of water that reaches the water table brings its salt with it. In the permanetnly submerged areas (near the largest canals and reservoirs) the water table is highest. On rising to the surface the water brings with it its salt. If this phenomenon is not compensated for by a drainage of water to the deep soil a crust of salt can form on the surface. This salinity, if not yet toxic is rendering the fields less fertile.
The gouvernment hence decided at the start of the 20th century to construct a vast drainage network to push the level of the water table down. In 1968 all the farming areas had a drainage network. The draiange permitted the elimination of excess water and salt.

4. Irrigation throught the whole year gave rise to an over exlpoitation of the soil. This is the consequence of continual cultivation during the entire year.

5. The natural fertilisation during the Nile floods has been by man-made fertilisers and manure from animals. Weeds have returned and require chemical treatement. These two operations contribute strongly to the increased pollution of the waters.

6. One can no longer plant the soil without manual labour as was possible before. The workload of the peasents is thus greater.
With the generalisation of the irrigation the peasent society undegone an important restructuring. It is now necessary to maintain the irrigarion canals and change agricultiral practices. The possession of cows has becopme necessary for working pumps, the soil and fertilisation.
Throughout the 1980s the setting aside of fallow land dissapeared, over irrigation is widespread. Motorised pumps are commonplace. The water ressorces are becoming more and more scarce and the soils more and more serilised despite the drainage networks.

Dans un souci d'économie d'eau et de rabattement de la nappe, un système de rotation de distribution de l'eau en période d'étiage est mis en place : 6 jours en eau sur 18.

Conclusion

The rational use of river water requires engineering projects that are only possible in a highly organised society. This social organisation can be either imposed or voluntary. There is therefore a strong link between irrigation and hierachical society. The risk of this system is that if the social organisation breaks down so does the water management. This risk has been reduced by technical progress by the spreading of motorised pumps. Rural Egyptian society aims to subsist indepdantly of external aide. They do so by only cultivating crops that they have use for themselves and raising animals which constitute a kind saftey net for unexpected problems. The history of irrigation and methods of pumpling water show to what extent water is a poloitical matter. The influence of decisions in the management of water on the peasent community is very large, notably the gouvernments' insistance that cotton must be produced. This decision also allows one to explain the current nature of the Egyptain countryside, a coexistance of very large and very small farms.

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