CHAPTER I

INTRODUCTION

The most important hydraulic project in Egypt was the Aswan High Dam that was designed to continuously store the excess water from the years of high floods to use in the years of drought or low floods. The Dam started to operate in 1964 and created the huge long term, man made reservoir in its upstream side called Lake Nasser which lies between Latitudes 20:27-23:58N and Longitudes 30:07-33:15E. Its northern two-thirds located in Egypt (always called Lake Nasser) whereas the southern one-third is located in Sudan (sometimes called Lake Nubia).

Lake Nasser is located in an arid Zone, where there is almost no precipitation. It is surrounded by barren desert and hilly areas. Therefore, it can be climatically classified as a subtropical, hot, very dry desert. It is quite irregular in shape in comparison with some other large lakes.

The area surrounded the lake are characterized by rocky desert of high relief (hills and mountains). The highest of which are Gebel Nuzo (+355 m) and Gebel Taalia (+300 m) located in Egypt. However, Gebel Saras (+385 m), Gebel Hafida (+387 m), Gebel Alla Mule (+335) are located in Sudan.

Lake Nasser has a large number of khores which are characterized by its shallow water depth compared with the main stream and they are not always fill with water. The khores surrounded Lake Nasser are formed as a result of the intrusion of Lake water into the mouths of the wadies which are drained to the lake. The khores are represented by one third of the total area of the lake. That is mean; khores have a considerable effect on the evaporation processes (shafik, 2004).

There are about 38 islands distributed through out the lake, the largest of them are Abrim Fortress (5 Km^2), Neirol hills (4 Km^2), Sarra East (2.5 Km^2), are located in Egyptian territory, whereas, Gabal El Sahaba (2.5 Km^2), Gabal Shitan Hills (2 Km^2), Tramuki (2.1 Km^2) and Tungoor (1.5 Km^2), are located in Sudanese territory.

The main tributaries feed the Nile upstream are Sobat Blue Nile and Atbara from one side, and the White Nile from the other side. Sobat, Blue Nile and Atbara are considered as the main source of the Nile water (about 85 %), which attains their sources from Ethiopian Heights (Abul-Atta, 1978). So, the variability in Nile discharge mainly related to the changes in the degree of precipitation over the Ethiopian Mountains. After the White Nile merges with Sobat at Malkal, it runs northward to merge with the Blue Nile at Khartoum to form the main Nile. Further north, Atbara tributary, is drained into the main Nile at Atbara village (fig. 1). There is no tributaries feed the Nile with considerable amounts of water along the distance from Atbara to the Mediterranean Sea (about 2766 Km long). Now, after the Main Nile crosses the Nubian Desert, it drains into Lake Nasser.

The annual flow of Nile can be classified into two periods. The flood season characterized with high discharge accompanied by high water level. It is a short period started from the end of July to the end of October to reach its maximum value during September and supplies with about 80% from the total annual discharge. Another lower discharge period occupies the rest of the year and reached its minimum value during May.

The annual discharge of the Main Nile varies largely from high (154 10^9m^3), recorded in 1878-1879, to low (43 10^9m^3), recorded in 1914-1915 (NRI and ASRT, 2005).

The largest amount of water drained to the lake in one year was 119.08 10^9m^3 in the year 1964/65, and the minimum was 34.815 10^9 m^3 in the year

Fig. 1

1984/85 (Aziz et al., 2001). The water contained in the Lake depends upon the amounts of inflow, outflow and the amount of losses by evaporation, seepage and absorption.

In the case of full storage, the water level should not exceed +182 m, at which the lake extends from the Aswan High Dam in Egypt to Dal Cataract in Sudan with length of about 500 km (about 350 km in Egyptian territory and about 150 km in Sudan). In this case, the lake occupies an area of about 6500 km^2 whereas its volume reaches about 162 10^9 m^3 with a maximum width of about 24 km whereas; the maximum recorded depth is of about 110m.

Geological Setting:

The area west of Lake Nasser extending to the south of Kharga depression in Egypt represents what is known as Lower Nubia Plain. The height of this plain is almost +300 m with 100 km wide and 300km long. It rises gently from the river valley and slope gently down into the south of Kharga Depression. It is almost discicated by plains with isolated hills of Nubian sandstone capped with resistant caprocks. The floor of the plain is covered by sand dunes and/or gravels. The best-defined wadies in this area are Wadi Kurkur and Wadi Kalabsha, whereas Wadi Toshka is poorly defined. The wadi valleys are almost perpendicular to the Lake. Now, all the wadies are dry but the presence of gravel terraces existing on several localities may reflects a primarily formed by denudation and later by wind deflation (Abul-Wafa and Labib, 1970).

The area to the east of Lake Nasser is represented by a plateau covered by sedimentary rocks up to +300 m altitude and deeply cut by well-defined wadies. It is relatively narrow in its northern parts but it getting gradually wider in its southern parts near Wadi Halfa. Its Eastern boundary is formed from metamorphic-igneous rocks that form an elongated chain between the Red Sea Depression to the east and the Nile Valley to the west. This mountain chain reaches of about 1500 m elevation above sea level and forms a watershed area between the two depressions. The eastern plateau rises gently from the Lake towards the east, except the area between Toshka East and El Madik where steep plateau looks like ridge is formed.

Depending on the field observations by the author, the study area can be considered as a continuation of the geologic features around the Egyptian part of the lake (fig. 2).

Along the most northern 50 km of the lake and along the southern 150 km in the Sudan territory, the lake is underlain and surrounded by outcrops of Neoproterozoic (550-900 Ma) crystalline igneous and metamorphic rocks (Basement Complex) of the Arabian-Nubian Shield (Sultan et al., 1990; Stern and Kroner, 1993). This basement complex is unconformably overlain by Paleozoic and Mesozoic successions intercalated with minor shale of local extent and/or limited thickness. The lower part of the succession is made of undifferentiated conglomerate, sandstone, and shale (Gilf Formation) of Paleozoic age. The middle part of the succession is made of Abu Simbel Formation coarse pebbly sandstone, Abu Ballas fine sandstone and shale, and El Borg Formation low-permeability sandstone. All of the three formations forming the middle part of the succession are of Upper Jurassic to Lower Cretaceous age. The upper part of the succession composed of Nubian Sandstone Formation that, in turn, composed of a series of sandstone and clay beds of Upper Cretaceous age (Issawi, 1982). The Nubian Sandstone Formation outcrops along the middle 300 Km length of the lake (Abul-Wafa and Labib, 1970). It reaches 600m thick at some locations around Tushka (Sultan et al., 1990). This thickness decreases northward to disappear near Aswan giving rise to the Igneous rocks to outcrop. As well, this thickness decreases southward to reach 200 m at Wadi Halfa, 347 km upstream the dam (Kim and sultan, 2002), and completely disappears at Amaka (364 km fig. 2

upstream the dam) giving rise for the Basement Complex to outcrop (field observations).

The areas characterized by Igneous Rocks at Aswan are represented by Grey and Pinkish Granite belonging to the Basement of the Nubian Basin.

There are two prevalent directions of faults, the first prevailed in the southern parts till Wadi Kalabsha which take E-W direction, whereas the second are prevailed north of Wadi Kalabsha and take N-S direction.

The fault plains are nearly vertical and filled either by siliceous cement or by iron oxides cement. These cementing materials are more resistant to weathering than the Nubian Sandstone. That is why filled and sealed faults represent now conspicuous ridges on the surface, which could be followed for many kilometers. On the eastern side of the Lake such tectonic forms are not noticed (Abul-Wafa and Labib, 1970).

Previous Works:

Many works have been carried out on the studied area and adjacent territories out of them are; Abul-Wafa and Labib, (1970) who studied the data collected before the construction of the Aswan High Dam and estimated the losses from the reservoir (Lake Nasser) through seepage, absorption, and Evaporation. They arrived to conclude that the maximum seepage losses was about 10^9 m^3/year.

Entz, (1972) who made a comparison of some limnological conditions in Lake Volta, and Lake Nasser, where Volta lake is Oligotrophic, entirely within the tropics, while Lake Nasser is Eutrophic, has tropical and subtropical sections. He decided that in lake Nasser a strong water coloration appeared in the second half of the flood season, caused mainly by Volvox: while in Volta Lake, microcystis water-blooms developed shortly after the floods. The level of oxygen saturation in Volta Lake is mainly influenced by the wind. The bottom is covered with decomposing trees, bushes, grass, or soil with high organic matter content, and there is a still continuing oxygen reduction taking place in the water mass. Oxygenation through the surface is the main source of dissolved oxygen. But in Lake Nasser, during winter and spring month's oxygen concentrations near the surface were as high as 110-160% of the saturation level caused by a high photosynthetic rate. Wind is a much more important temperature-regulating factor than it is on Volta Lake. The richness of Lake Nasser, a cause of intensive photosynthesis, is responsible for pH levels that are much higher than those in Volta Lake.

Entz, (1978) who studies the sedimentation processes in Lake Nasser and arrived to conclude that the lake would not be completely filled for 1700 years, if the sedimentation continued without any disturbance, while the strong water level fluctuations and floods could markedly reduce filling time.

Philip et al., (1978) studied the grain size characteristics of the Lake sediments in relation to environmental conditions affecting deposits. They reported the results obtained from the preliminary mechanical analysis and microscopic investigations done during the period between March 1975 and March 1976. The Results showed that the variation in mean grain size, standard deviation and skewness are significant and indicate the differences in the environments of deposition of the main channel and khor sediments. The former have a mean size in the fine silt grade and are strongly coarse skewed, while those of the khors are in the coarse silt, poorer in sorting and strongly fine skewed. Mineralogical composition of the sand fraction showed two main associations; that of the Recent Nile dominating sediments of the main channel; and the Nubian Sandstone association dominating that of khors, the two may be mixed in different proportions in khores. Sediments of Lake Nubian (Sudan) exhibit only the Recent Nile assemblage.

Entz, (1980a) investigated the sedimentation processes in Lake Nasser during the period from 1965 to 1974 to determine the future of the lake the study included the areas of sedimentation, their extension, and their main characteristics, along with the effects of currents. He deduced that the bulk of suspended silt was deposited around the previous second cataract with a layer of 10 to 25 m thick in 1974. He found that the heaviest sedimentation toke place beside the old river channel in the northern part of the lake, while the heaviest sedimentation was in the old river channel itself at the north of Wadi Halfa.

Guariso et al., (1980) produced a salt balance simulation model of Lake Nasser where the salinity is dependent on the pattern of water flowing into the lake. They found a higher salinity during the years of high flood because the evaporation losses are greater when the reservoir is full.

Shalash, (1980) studied the effect of sedimentation on storage capacity of the Aswan High Dam Lake. The study included the movement of sediments along the reservoir. Depending on the records of the suspended sediment concentrations during the period from 1929 to 1955 (before the construction of the High Dam), he arrived to conclude that the average annual total suspended solids passing kajnarity (399 km upstream A.H.D) is 134 10^6 tons and that passing El Gaafra (downstream A.H.D) is 124 10^6 tons. He corrected the specific weight of suspended solids in the Nile water that evaluated in previous studies as varies between 1.774 and 1.864 ton/m^3 with an average value of 1.8 ton/m^3 with another value of 1.4 ton/m^3. He also calculated the specific weight of the bed material after 10 years of continuous burial to be 1.50 ton/m^3, after 50 years to be 1.59 ton/m^3, after 100 years to be 1.63 ton/m^3, and after 500 years to be 1.72 ton/m^3, with an average of 1.56 ton/m^3 for 500 years.

Makary, (1982) carried out a research work on the data collected between 1964 and 1980 to study the sedimentation upstream the Aswan High Dam, trying to estimate and define the suspended and the deposited sediment trends in addition to the actual useful reservoir life. He arrived to conclude that the bed material fractions changed before, during, and after the flood season and also with the distance from the inlet of the reservoir. He estimated the mean annual suspended sediment load as about 130 10^6 tons and that the designed dead storage capacity would be filled with sediments in about 408 years, whereas, the total reservoir life is about 1580 years.

Ahmad et al., (1989) studied the Nile Phytoplankton in Egypt, by investigating some of the physical and chemical characteristics of Lake Nasser during the period from March 1982 to February 1984. The results showed that the seasonal thermal variations leads to a thermal stratification established along the lake during the period between the late spring and early autumn. Oxygen content appeared to vary with the changes in pH value.

Dahab, (1992) studied the drifting and movement of the eolian sediments towards the lake. The wind-blown sediments have been estimated with 10% of the total sediment load arrived to the Lake. He also stated that the sand accumulations seen to be growing at the wadies which are distributed along the western shores of the Lake. He also estimated the quantity of windblown sediments entering the river and the lake downstream of Dongola with about 12.5 million tons per year.

Makary, (1992) carried out a research work on the progress of the actual deposited sediments along the lake (1964-1990) which has been affected with the fluctuations of the Lake water level and annual Nile water yields. He concluded that the sediment depositional pattern delta formation affected to a great extent by the drought situation. It means that the sedimentation front extends towards or far from the dam according to the inlet discharges and water levels upstream the dam.

Saad and Goma, (1992a) studied the seasonal variations of major cations in Lake Nasser. They studied the factors responsible for the irregularity in the vertical distribution of cations such as the movement of water masses, adsorption on and desorption from suspended matter and transport of eroded materials into the lake. They found that the increase in the rate of evaporation in august caused the accumulation of the dissolved salts, indicated by the high seasonal average values of sodium, magnesium and potassium concentration.

Saad and Goma, (1992b) investigated the seasonal and regional distribution of major anions in Lake Nasser. They found that the increase in the rate of evaporation in May-August was accompanied by the maximum seasonal average temperature causing the high and maximum seasonal averages of dissolved carbonate. The highest evaporation rate in May-August was mainly responsible for the highest seasonal average concentrations of chloride. The maximum seasonal average sulphate value in April might be attributed to the increase in dissolved oxygen concentration from the high rate of photosynthesis in spring. The decrease in the regional average values of sulphate and chloride in the southern region of the lake coincided possibly with dilution by the floodwaters.

El-Bakry, (1993) used the meteorological measurements that carried out over the Aswan High Dam Lake through two hydro- meteorological floating stations. He concluded that the maximum wind velocity was 31 m/sec, the annual rate of evaporation was 7.02 mm/day, and the annual water depth due to evaporation was 2.5 m. He also stated that the total water loss by evaporation from the lake at 170 m above mean sea level was 10.7 $10^9 m^3$ equivalents about 11% of the lake water content.

Dahab & El-Mottassem, (1994) studied the Land forms of the Lake Area giving a list for most famous khores and rocky islands. They studied the shore sedimentation, the coastal sand dunes, and the sedimentation at the southern sector of the Lake. They also studied the suitability of the lake for navigation, Agriculture, tourism and fishery development.

Abdel-Aziz, (1997) tried to develop methodology for analyzing the limited collected field data of flow velocity and suspended sediment concentration. He concluded that the deposition of sediments will continue until year 2000 in the first 140km and the bed level will rise 1.5 m in the average to reach level 160 m. This deposition will be followed by an erosion period until year 2010 and the bed level will reach level 150 m. The eroded sediment will move to the next 60 km in the dam direction.

Mostafa, (1997) Carried out a research work on the behavior of the turbid underflow current formed in a reservoir due to a sediment-laden inflow using a mathematical model.

Sonbol et al., (1999) carried out a research about the statistical analysis for different flood cases to obtain the critical floods and their probability of occurrence aiming to achieve a flood forecasting. Hence, different solutions and guide lines for the operation of the Lake under different conditions were presented. This study produced proper water management policies to regulate the lake levels during the year to be able to receive the next high flood.

Aziz et al., (2001) studied the Lake Nasser flood and its relation with the sedimentation processes. They arrived to conclude that at the period from 1904 to 1963, before the High Dam, at El-Gaafra gauging station, the annual suspended sediments load are varied between 50 10^6 ton and 228 10^6 ton with an average 160 10^6 ton. Until May 2000, the deposited sediments in the studied locality (the Nubian part of the lake) were estimated with the range varied between 7.83 and 60.37 m thick.

El Sammany, (2002) defined the basic phenomena that may affect water quality of the lake. He evaluated the existing monitoring program and designed a proper monitoring and assessment program using the state of the art techniques.

Kim and Sultan, (2002) constructed a two-dimensional groundwater flow model to investigate the long-term hydrologic impacts of Lake Nasser and the major land reclamation projects that use excess lake water in south Egypt. The model, constrained by regional-scale groundwater flow and near-lake head data, was calibrated to temporal-observation heads from 1970 to 2000 that reflect variations in lake levels. They stated that the simulations of long-term effects, beyond year 2000, of Lake Nasser on recharge and temporal ground-water head (base case scenario) show that recharge from the lake will continue at a much slow rate than during the (30-yr) period of 1970-2000 (with approximately 86% reduction. They also stated that many of the proposed irrigation areas, especially those with small aquifer thickness, will become fully saturated with introduced water, resulting in potential flooding and salinization.

Shafik, (2004) used a recent and advanced method to calculate the evaporation losses in lake Nasser by using Remote Sensing, and also to discuss the different alternatives to decrease the evaporation losses. Satellite images for Lake Nasser collected by the LANDSAT 5 representing high and low floods issues. Remote Sensing techniques are promoted to analyze the satellite images. Many sets of old and recent field data related to hydrological and metrological information are obtained and utilized.

NRI and ASRT, (2005) focused their work on the evaluation and the analysis of Nile River water resources. Some major discharge and water levels gauging stations were selected and statistical analyses were performed for their discharge and water levels data. Regression equation were developed for this stations for the period 1987-1997. The natural water inflow at Aswan for the period 1900-2004 was analyzed. The different high and low floods Probabilities were evaluated in addition to water inflow forecasting for the year 2004-2005 using statistical models after applying them for the pervious year data.

The aim of the present work is to gather sufficient information about the distribution of Recent sediments in the southern part of Lake Nasser (Nubia Lake) under different hydrographic environmental factors and refer this distribution to their patterns of formation.