CHAPTER ONE

INTRODUCTION AND PREVIOUS WORK

INTRODUCTION

The River Nile is one of the most remarkable geographic features of Africa. Its catchment's area covers 2,900,000 km², it extends from latitude 4° S to latitude 31° N, and experiences a great variety of climate. The river is the longest in the world, being about 6,700 km long. Its source is at an altitude of 5,120 m above m.s.a. in Central Africa while its estuary is in the Mediterranean Sea. Its course traverses the countries of Uganda, Kenya, Tanzania, Rwanda, Burundi, Zaire, Ethiopia, as well as Sudan and Egypt **(Abu-Zeid, 1969).**

In general, the Nile basin can be divided into four main sub-basins: (1) The White Nile, whose head waters rise south of the Equator, and whose runoff is 29 percent of the total Nile runoff. Its water is clear. (2) The Atbara River, which rises in North Ethiopia, is a flashy river. It is dry for half the year, and its runoff is muddy and constitutes 14 percent of the total Nile runoff. (3) The Blue Nile, which also rises in North Ethiopia, has runoff equal to 57 percent of the total runoff of the Nile. The flow is muddy during the rainy season. (4) The Main Nile flows northward to Mediterranean Sea **(Abu-Zeid, 1969).**

A few km to the north of Cairo begins the Delta or lower Egypt, which is composed of three parts. The first, which is the Delta proper, is comprised of the two branches of the Nile. The two branches are the only two now remaining of the seven ancient arms, the Rosetta arm on the west and the Damietta on the east. The five other branches have been modified and included in the system of irrigation canals. The Delta forms a triangle with an altitude of 160 km and a base of 140 km **(Abu-Zeid, 1969).** The second part of the Delta lies to the west of the Rosetta arm, with the shape of an elongated triangle whose apex is a little below the separation of the two arms of the Nile and whose base along the sea extends about 70 km in length. While, the third part stretches to the east of the Damietta branch. It also forms a triangle whose base along the sea is 160 km **(Abu-Zeid, 1977).**

The annual Nile flood varies considerably from one year to the other. Its yield may reach 151 x 10^9 m³ as in 1978 or may drop to 42 x10^9 m³ as in 1913. The flood usually occurs in summer from August to October and during this period, it may vary from 36 x 10^9 m³ to 7 x 10^9 m³. (RPDP,1991)

Some studies on heavy metals and mineral and element in rivers, fish and sediments have been a major environmental focus especially in the last decades. Sediments are important sinks for various pollutants like pesticides and heavy metals and also play a significant role in the remobilization of contaminants in aquatic systems under favorable conditions and in interactions between water and sediment. The direct transfer of chemicals from sediments to organisms is now considered to be a major route of exposure for many species **(Zoumis *et al.*, 2001)**.

The determination of individual contamination factors (ICF) and global contamination factor (GCF) for the various sites were reflected the risk of contamination of a water body by a pollutant especially heavy metals. The number of toxic elements determined in a sediment sample and their respective calculated ICF affected the GCF. The applicability of many toxic elements in calculating GCF is significant because it reflects the overall potential risks posed by the toxic elements to the river environment and to biota **(El-Sokary *et al*., 1990**)

The higher the levels of the mobilizable fractions (i.e. exchangeable species, carbonate bound metals, Fe/Mn oxides species and organic matter bound metals) in the sediments, the higher the potential risk to river water contamination by river sediment. The remobilization of metals from river sediment into the water column will be influenced by factors such as pH, chemical forms of the trace elements, and the physico-chemical characteristics of the water column **(Fawzy, 2000)**

Damietta branch of the River Nile has a great vital importance, since it serves as a source of water for municipal, industrial, agricultural, navigation and feeding fish farms dispersed between El-Serw to Faraskour region.

Damietta branch is passing to cut four governorates of with length about 242 km, average width 200 m and average depth 10 m **(Said, 1981).** It is the main source of drinking and irrigation waters for El-Qalubia, El-Garbyia, El-Dakahlyia and Damietta Governorates **(Elewa and Goher, 1999).** The earthen Faraskour Dam divides this branch at Damietta city 20 Km south of Mediterranean Sea to cut off the flow of the Nile water to the Mediterranean Sea**.** The water characteristics after the Faraskour Dam is completely different compared with the water before the dam **(Ali, 1998)**.

Along Damietta branch, there are about six main industrial plants. These are Talkha fertilizer plant, Talkha Electric power station, Kafer Saad Electric Power Station, Delta Milk, discharge its effluent directly to the branch besides the sewage and domestic wastes discharging from the neighboring villages without any treatment into the branch **(Ali, 1998).**

Also, Rosetta branch of River Nile has a greatest vital importance as an important source of water for municipal, industrial, agricultural, navigational and feeding fish farms. It is passing to cutting six governorates over a length of about 225 km with average breadth of water course 333 m, maximum depth 23 m, average water velocity 0.5 $m.sec^{-1}$, and mean annual discharge at Qanater El-Khyria 29 million m^3 day^{-1}, the water level fluctuates between 10.55 - 13.81 meter above sea level **(Sayed, 2002).**

Rosetta branch subjects to three main sources of pollution which, potentially affects and deteriorates the water quality of the branch; The first source is El-Rahawy drain, which disposes its wastes into the branches. Its wastes are mixture of agricultural and domestic waste and sanitary drainage from large area of Great Cairo. It is thought that the impact of this source on the water quality of the branch is extended to long distance from the source. The second source is Kafr El-Zayat industrial area, which include the industrial effluents from the factories of super phosphate and sulfur compounds, oil and soap industries and pesticides factories. All these effluents are discharged directly from the right bank of the Rosetta branch and their effects on water are very clear. The third source of pollution is several small agricultural drains that discharge their waters into the branch in addition to sewage discharged from several cities and its neighbouring villages that are distributed along the two banks of the Rosetta branch. **(Mancy and Hafez, 1979 a &b)**

Rosetta branch can be divided into two ecological sectors: one of them represent almost fresh water sector extending from branching of the river at El-Qanater El-Khyria Barrage until behind Edfina Barrage (approximately 200 km north Cairo). The other one represent mixed water sector (saline to fresh water) extending from below Edfina Barrage until the branch outlet in the Mediterranean Sea. Nature of the later community depends on time, space and efficiency of barrage operating system. The bottom topography of the estuary is irregular, presenting a succession of depressions, the middle on reaching 18 m in depth. The sill depth at the outlet rises to about 6 m from the surface. **(Mancy and Hafez, 1979 b)**

Changes in the size and gradation of bed material

The median diameter of the bed material has increased in the time period from 1964 to 1978. The average median diameter (D50) before AHD for the total length of the Nile River between Aswan and Delta Barrage, was about 0.22 mm, which after AHD became courser and ranged between 0.23 and 0.42 mm. Similar analysis of the data verifies that the standard deviation of the bed material has become more uniform. Furthermore, there is evidence of coarsening of the bed material to behave as an armor coat inhibiting further degradation in many areas. **(Abul-Atta,1978)**

Changes in bed forms and resistance to flow

Resistance to flow is a function of grain size, bed form, bank roughness and other factors resulting from man activities. At flow velocities between 0.4 m/s and 1.2 m/s the dunes will develop, whilst ripples will form at velocities less than 0.33 m/s. Before AHD the bed of the Nile River was covered with dunes. But due to the reduction in the discharges and velocities after AHD, the energy of the river became insufficient to erase the existing dunes that being formed before AHD. For this reason the dunes are still covering the channel bed but with superimposed ripples caused by low discharges. Records of the river bed indicated that dune with amplitude of 1.0 to 1.5 m and spacing of about 30 m are relatively common. These dunes significantly affect the flow velocity and the transport of bed material **(Abul-Atta,1978)**

As mentioned before, the suspended sediment in the Nile River was reduced from 3000 ppm during flood seasons to about 65 ppm after AHD, and the flow could be considered as a clear water. Consequently, the flow discharge has been reduced from 9300 m^3/s during the flood season to a maximum value of about 2800 m^3/s after AHD. As a result of these two reasons, river bed degradation and bank erosion took place and caused lowering of the water level and a decrease in the bed elevation downstream the existing barrages. Analysis of the available data shows that river bed degradation took place between (1963 and 1978) and the conditions now are almost stable. **(Abul Atta, 1978).**

Siltation and Sediment Trapping of River Nile

Before the construction of the AHD (Aswan High Dam), the discharges passing Aswan were between 600 and 13,000 m^3/s, and are now regulated between 700 and 2800 m^3/s. The water released to the Mediterranean used to be about 32 km^3 mean annually and is now limited to about 300 million m^3 during winter closure to satisfy the needs of navigation, industrial and drinking requirements and the prevention of intrusion of saline water from the sea to northern delta. The Nile transport 90% of suspended matter during the flood season. The continuous monitoring of Nile suspended sediment (SS) year-round led to the conclusion that the SS passing Aswan was about 134 million tons on average **(El-Dardir, 19٨4)**. Siltation of the AHD lake was studied while designing the project. It was estimated that the amount of sedimentation in the reservoir would be about 60 million m^3 annually. Thus, dead storage of capacity of 31 km^3 was allocated for silt deposition (dead storage) for a time span of about 500 years. Since 1968 (when the whole flood was reserved), the suspended sediment has retreated to the upstream reach. Observations have shown that suspended sediment settling is at a distance not less than 250 km upstream of the dam. Monitoring of reservoir sediment has shown that the mean annual rate is about 60 to 70 million m^3 annually, which is within the design considerations. **(Abul-Atta,1978)**

It was predicted during the studies for the AHD project that degradation along the river course would take place due to the fact that the water released downstream of the AHD would be free from suspended sediment and hence the relative geological balance of the river bed would be disturbed. The prediction of degradation rate, its effect over the river's course and the barrages constructed on it was a very difficult task. Comprehensive studies began in 1954 taking into consideration the discharges, velocities, the suspended sediment, river bed constituents, hydrographic surveys and other characteristics of the river regime. Since then, many experts have estimated the overall degradation, its rate and the drop in water levels. The predictions of these experts were extremely different, due to the use of different methodologies and assumptions. The predictions of degradation and drop in water level downstream of each barrage ranges from 10 to 2 m. According to observations, practice and management, the actual drop in water level due to degradation is in the range of 0.7 - 0.3 m. There is no longer any noticeable degradation **(Krom *et al*., 2002)**

Since construction of the AHD, the water released from the dam has been almost free from suspended sediment. The percentage of Azote in Nile sediment is about 0.13%, and only one-third of this amount is useful for feeding the crops. The total amount of useful Azote was estimated, taking into consideration the fact that most of the SS used to settle over the basin irrigation areas which are no longer available since changing the system of irrigation over these areas to perennial irrigation. It was concluded that loss of Azote is about 1800 tons and this was replaced by lime nitrate fertilizers **(El-Dib *et al.*, 1985)**

Nile Estuary Development

The Nile estuary is the classical example of a transitional environment between the river and the sea (Fig. 1). The geographical position and morphometric features of this estuary are influenced by several factors, with the most important being climatic variations, the impact of human activities, and sea hydrodynamics. The annual discharging capacity of a river into an estuarine environment is related not only to the rainfall density in the river catchment area, but also to natural and artificial barriers to river flow encountered between the river source and its point of discharge **(Frihy, 2001)**

Figure (1): A satellite map showing A) the Rosetta and B) Damietta estuaries.

The Nile estuary, also known as the Nile delta coastal area, occupies the central part of the Egyptian northern coastal zone bordering the Mediterranean Sea (Fig. 2), and has a beach and contiguous coastal flat backed by coastal dunes or wide lagoons. The two main Nile promontories at Rosetta and Damietta interrupt the sandy shore line of the delta **(Frihy, 2001).** On account of the high economic, ecological, aesthetic, and recreational importance of this zone, there are increasing levels of environmental stress from both natural (erosion, dune quarrying, and subsidence and rising water levels) and anthropogenic influences (population growth and increasing development) **(Stanley and Warne, 1993).**The coastal zone of the Nile delta is undergoing major contemporary changes due to the natural and anthropogenic activities. Along the Nile delta coast natural influences include tectonic activity, climatic and sea level fluctuations, and fluvial and marine processes. The anthropogenic factors include the construction of Nile barrages, the AHD, networks of irrigation and drainage canals. Erosion has impacted on the agricultural and urban lands along the delta promontories of the Nile delta coast. Sediments accumulate within embayment between the Rosetta and Damietta promontories. A number of coastal protection structures such as jetties, groins, seawalls, and wave breaks have been built to combat beach erosion and to reduce shoaling **(Frihy, 2001).**

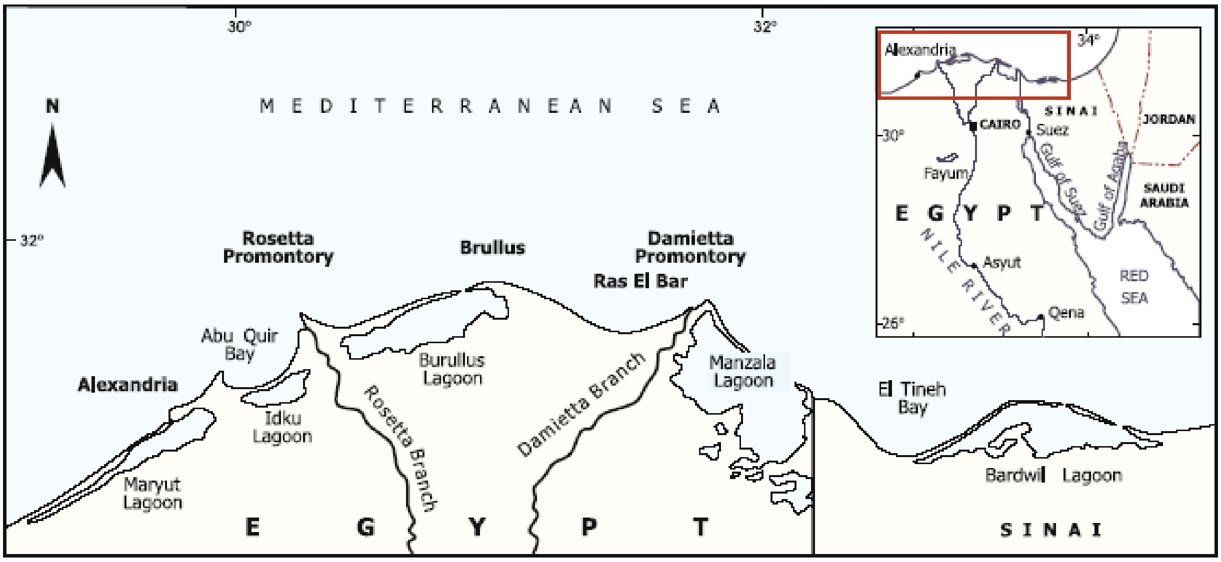

Figure (2): Main discharging branches of the Nile River to the Mediterranean Sea .

Despite the high energy of the hydrologic and hydrodynamic processes of the Nile delta coast, it remains the shallowest part of the Egyptian Mediterranean shelf area. It has been mentioned that the hydrological processes along the Egyptian coastal area are mainly controlled by climatic factors (mainly wind and air temperature) and by the ambient currents in the southern Mediterranean **(Hamza *et al.*, 1996).**

Nile Delta

The Nile delta is situated almost in the middle of the Egyptian Mediterranean coastline (Fig. 3), which extends about 1,000 km (16% of the total Mediterranean coast). It connects to the Mediterranean Sea through its two branches surrounding the delta, the Damietta in the east and the Rosetta in the west. Since 1964, when the High dam was built on the Egyptian Nile upstream in Aswan, Nile water discharge through the Damietta Nile branch has almost stopped, but the Rosetta Nile branch (east of Alexandria) is still discharging into the Mediterranean Sea. The four Deltaic lakes (Mariut, Edku, Burullus and Manzala) could be considered as transitional sinks for the majority of anthropogenic wastes of Egypt. The budget of the pollutant cocktail in these lakes is expected to be exposed to significant alteration in quantity and quality before reaching the sea.

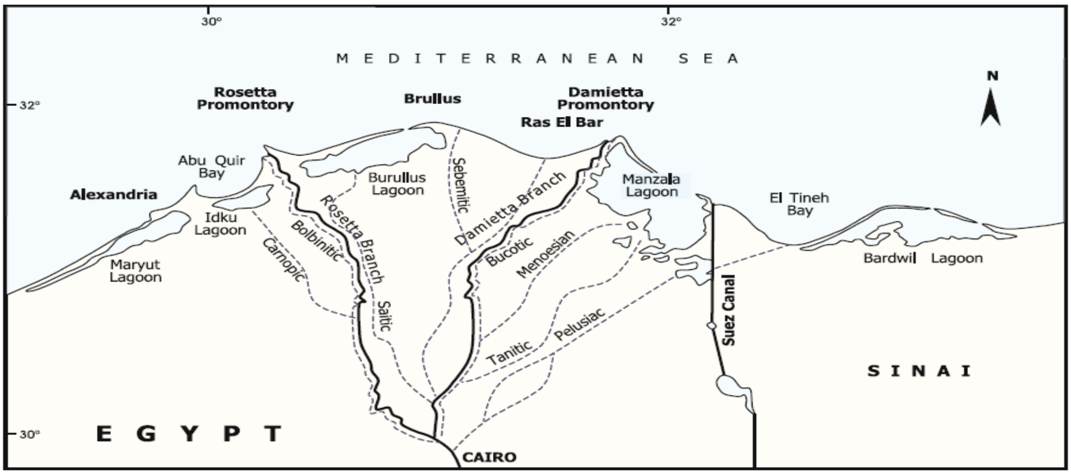

Figure (3): Ancient and recent geographical boundaries of both the direct and indirect discharging outlets of the Nile delta Sinking of Delta.

The Nile Delta is not only the oldest known delta in the world, but also it is the largest and most important depositional system in the Mediterranean Sea. Moreover, it is the unique site in Egypt favoured for accumulation and preservation of Quaternary sediments. From a sedimentological point of view, the Nile Delta is an outstanding example of a elastic wedge prograded into a huge marginal basin **(Frihy et al., 1999)**.

Since the late 19th century, significant changes have taken place in the timing and quantity of sediment delivered to the world's coastal zone. A range of human activities has increased the sediment load in rivers, while others have decreased the load **(Meybeck and Vörösmarty, 2005).** For example, crop farming, deforestation, mining, and urbanization have led to higher sediment yields in some rivers. Conversely, improvements in erosion control have muted the increase during the second half of the 20th century **(GESAMP, 1994).**

The Neogene marine sedimentary record of the Mediterranean basin is characterized by the regular occurrence of organic-rich layers or sapropels.

These sapropels are known to correlate with the precession cycle: their deposition coincides with precession minima. This correlation is thought to be caused to a large extent by a precession-induced increase in the amount of freshwater reaching the Mediterranean Sea. Various sources of this freshwater have been identified and different mechanisms as to how this freshwater flux leads to sapropels have been proposed **(Meijer and Tuenter, 2007).**

Competition for declining water supplies in heavily populated or irrigated basins reduces the conveyance capacity of rivers to transport sediment. Such has been the case in the Nile River where construction of human-made waterways for irrigation and transportation has trapped an already depleted sediment supply to the Nile delta. This entrapment of sediment is a key contributor to coastal erosion and land loss occurring on the Nile delta **(Stanley, 1996).**

According to **(Inman and Scott 1984)** the total sediment load (sand + silt + clay) carried by the Egyptian Nile waters, prior to the AHD construction, ranged between 160 and 178×10^{6} t $year^{-1}$. The suspended fraction (silt + clay) accounted for 112×10^{6} t $year^{-1}$, much of which was deposited on agricultural fields. The remaining sand load of 50 – 66×10^{6} t $year^{-1}$, represents a sediment volume found its way to the sea and compensated wholly or partially for the sediment losses resulting from coastal erosion. The inevitability of erosion of the Nile delta becomes obvious when we compare the original sediment supply rate of 30 – 40×106 m^3 $year^{-1}$ with the delta coast erosion rate of 32×106 m^3 $year^{-1}$ averaged for the period 1919/1922 to 1984 **(Fanos, 1995). (Stanley, 1988)** observed that although sediment is being transported as far as Cairo, virtually no sediment is being supplied to replenish the coastline via the channels flowing into the Mediterranean. This situation results from the diversion of Nile water into more than 10 000 km of irrigation and drainage canals. The water in these canals is either still or very slow moving. Consequently the suspended sediment either settles on the canal floor whence farmers recover it for addition to their fields, or is pumped along with the canal water into the four large freshwater coastal lakes near the outer edge of the delta. The loss of sediment supply to replenish the Nile delta coast is a significant problem related to the construction of the AHD.

During the period 1800–1998 the shoreline of Damietta promontory changed similar to those of the Rosetta. The promontory shoreline gradually advanced until 1895, and since then it has been retreating. The western side of the promontory advanced at a rate of 10m/year between 1800 and 1895. Between 1895 and 1940 it retreated at an average rate of 35m/year. On its eastern side the rate of advance of the shoreline between 1800 and 1912 was about 20m/year. Between 1912 and 1973 the rate of retreat for the Damietta promontory shoreline was about 40m/year, increasing to 100m/year in the period between 1973 and 1995 **(Fanos *et al.*, 1999)**. Finally, the loss of sediment supply to replenish the Nile delta coast is a significant problem related to the construction of the AHD. In a detailed study of the subsidence of the northeastern Nile delta, **(Stanley 1988)** showed that delta areal loss is also due to continued land surface subsidence at rates of up to 40–50 cm per century. He has also warned that eustatic sea level rise, conservatively estimated at 4–8 cm during the next 40 years, and at least 50 cm by the year 2100, may compound the effects of delta subsidence and coastal erosion to submerge the delta region as far inland as 30 km from the present day coast. In this scenario, the Port Said, Northern Suez Canal and Lake Manzalah region, with a population of one million, would become particularly susceptible to flooding because it is located in one of the more rapidly subsiding parts of the delta.

Ericson *et al*,(2006) assessed the contemporary effective of sea-level (ESLR) rise for of 40 deltas distributed worldwide. For any delta, ESLR defined by the combination of eustatic sea-level rise, the natural gross rate of fluvial sediment deposition and subsidence, and accelerated subsidence due to groundwater and hydrocarbon extraction. The sampled deltas serve as the endpoint for river basins draining 30% of the Earth's landmass, and 42% of global terrestrial runoff. Nearly 300 million people inhabit these deltas. For the contemporary baseline, ESLR estimates range from 0.5 to 12.5 mm yr^{-1}.

Literature Review

Five stages in the development of the modern River and refers to them as the Eonile, Paleonile, Protonile, Prenile and Neonile. **Said, 1981** stated that the Eonile formed a deep canyon, the Nile Valley, during the Late Miocene (10 MYBP), a rise of the sea level in the early Pliocene (5 MYBP) caused marine water to enter the canyon and to reach to south Aswan. The Paleonile deposited fluvial sediments at the head of this gulf and progressively filed the valley to the north. This period was followed by an interval of great aridity. When the Palionile caused following the period of aridity, the Protonile occupied the valley and introduced sediments from as far as south as Khartoum. Nile valley. Finally, about 120000 YBP the Neonile deposits sediments similar to those of the modern Nile **(Said 1981).** The sediments of the River Nile during the early Quaternary are of local derivation and are the products of the earliest Quaternary pluvial. The sediments of the rivers which subsequently occupied the Nile Valley during the middle and late Quaternary are derived from sources which lie far beyond the borders of Egypt. Stated also during the Quaternary and late Neogene, there was periodic deposition of organic-rich sediments in the eastern Mediterranean. These cyclic periods of altered sediment deposition represent important indicators of major environmental change in the region. It has been suggested that there was high Nile flow during sapropel deposition. Evidence from the Ti/Al ratio in sapropels suggests that the pattern of erosion and sediment supply from the Nile observed in this study, also occurred during the periods of sapropel deposition throughout much of the Neogene and Quaternary. The reduced inputs of Blue Nile sediment during these periods, are likely to have contributed to the increased primary productivity by reducing the amount of phosphate removed on particles and to the observed switch to N limitation in the Eastern Mediterranean, which are important characteristics of sapropel deposition **(Said 1983).** There are importance to recognize that during humid periods in Egypt, the wadis delivered coarse sediments to the valley. At present time, the wadis appear to contribute only relative fine sediments which can be readily transported down stream **(Said, 1990).**

Under Pre-AHD conditions the mean annual suspended sediments loads between Aswan and Cairo reached in the down stream direction to 49 Mt/Yr (49 Million ton per year) near Cairo. During the first year of AHD construction, the load was more than halved, but increased in the down stream direction, it reached to 52 Mt/Yr near Cairo. This indicates that during 1964 sediments was picked up from the Nile through its length. This could also be attributed to bank erosion, wadi contribution, or human activities. Over final years of dam construction (1964 to 1967) the loads decreased further to approximately one fifth of the 1964 values, reached to 11.3 Mt/Yr near Cairo. Under Post-AHD conditions load reduction continued, it reached to 4.23 Mt/Yr near Cairo **(RPDP, 1991).**

The sediment load of the River Nile is derived from markedly different geological terrains and climatic zones. Since changes in the rate of erosion in a given catchment area are controlled to a large extent by climatic conditions, it is expected that sediment provenance studies can help define changes in paleoclimate in East Africa. The Nile is well suited to Sr isotope tracer studies because the White Nile catchment is dominated by crystalline basement rocks with high 87Sr/86Sr ratios, while the Blue Nile and Atbara drain catchments areas with Cenozoic and Tertiary volcanic rocks with characteristically low 87Sr/86Sr ratio **(Krom et al; 2002)**

Nile islets sediments at Aswan area are mainly silt poorly sorted, near symmetrical to strongly fine skewed and platy to very leptokurtic. Kaolinite is the dominant mineral in all studied samples (70-100%) and quartz is the main light mineral while the recorded heavy minerals include mainly opaques, pyroxene, amphiboles, epidote, zircon, rutile, garnet, biotite and tourmaline. The mineral assemblage revealed that the transported Nile deposits represent the main source of the studied sediment. In addition, sediments are affected by early diagenetic processes as indicated by clay minerals and chemical composition **(El-Dardir, 1995a).** In mud sediments taken from the bottom of the main stream of the River Nile and beach soil showed that iron and lead were found at levels higher in beach soil than in the river sediments at all sites except for iron in sediments of Aswan where the region was subjected to volcanic activities in the ancient geological eras (granites, gabbros, etc.). At some sites, some heavy-metal concentrations seemed to be higher in sediment than in beach soil as a result of weathering of beach soil by the effect of wind and currents of water. In other sites, sediment pollution by these metals might be attributed to inputs from industrial effluents and domestic wastewater drained directly into the Nile **(Awadallah et al., 1996).** The drastically reduced amount of sediment now reaching the sea, discharged primarily from lagoon outlets and several canal mouths, is removed by strong, easterly-directed coastal and innermost shelf currents. The Nile delta is an extreme example of a depo-center which has been completely altered by man, from an active prograding delta to a locally eroding coastal plain **(Stanley, 1996).** The bottom sediments of the Damietta branch change from gravelly sand and sand unites in the beach to gravelly muddy sand and muddy sand unites in the deep zone and northwards. Also it is moderately sorted to poorly sorted, positively to negatively skewed. On the other hand, the carbonate mineral phases in the sediment of Damietta include aragonite and calcite while the major constituents are; Al_2O_3, Fe_2O_3, CaO, MgO, $CaCO_3$ and organic matter. Also the chemical constituents of mollusk shells e.g. Mg, Sr, Fe, and Mn, are increase northwards **(Lotfy, 1997 a & b).** The characters of the recent sediment types of Rosetta Nile branch change from sand, muddy sand, gravelly sand and gravelly mud to medium fine and very fine sand and muddy sand with variation of depth and location. Also, the sediments represent mostly medium to very fine sand size, well sorted to very poorly sorted, positively skewed and mostly leptokurtic **(Lotfy, 2002).**

Compositional and textural attributes of the surficial sediment in deltaic settings typically differ from the sediment load carried by their source rivers. This phenomenon is evaluated by semi-quantitative study of the variability of petrologic characteristics in different delta sub-environments of the Nautla and Tecolutla deltas along Mexico’s Veracruz coast. Sediment composition and texture in the different environments of both deltas are related to processes that involve selective sorting during seasonal flooding and temporary storage after deposition. Displacement of particles of different size, density and shape onto the two tropical delta plains is controlled by fluctuating fluvial discharge that responds to a highly variable seasonal rainfall pattern. These discharge variations induce changes in hydraulic equivalence and, consequently, the release of substantially different proportions of volcanic, mica, heavy mineral and grain-size fractions in the Veracruz delta settings. These phenomena, together with progressive dilution of sediment upon reaching the coast, result in significant modifications to the original petrologic attributes of fluvial loads as they are transported seaward. **(Chen *et al.*, 2000).**

Physicochemical, Organic Matter, and Carbonates:

The main factors which affect water quality characteristics of the River Nile include: (a) upstream changes south of Lake Nasser, (b) changes in Lake Nasser, and (c) localized changes in the river basin. Furthermore, the Nile receives increasing amounts of waste discharges, from point and non-point sources, as the river travels northward. The discharge of waste effluents is usually accompanied by localized effects of water quality deterioration immediately downstream from the waste outfall. South of Cairo, at Helwan, there are iron, steel, coke and chemical fertilizer industries which discharge their waste into drains which finally reach the river. The river exhibits its worst conditions in the Delta. This is due to a combination of factors: (a) reduction of the river velocity in certain locations to complete stagnation (b) industrial and domestic waste discharges and (c) return flow of agricultural drainage water. At Kafr EI Zayat there are three factories discharging their waste directly into the Rosetta branch. These factories are: Salt and Soda Company, Pesticides Company and Superphosphate fertilizer plant. As the river reaches the Edfina barrage, it slows down and bottom septic conditions occur during the summer months. Similarly, the Damietta branch receives industrial waste from the Talkha fertilizer plant, and stagnant waters at the Faraskour earth Dam exhibit septic conditions in the summer months **(Mancy and Hafez, 1979).** Water quality at the Damietta branch of River Nile below Faraskour Dam showed that the pollution of water is due to an impoundment and continuous input of dissolved and solid materials, washed down by the drainage runoff and by domestic waste water outfalls. The channel is anoxic below a very thin photic zone, it has high bicarbonate alkalinity, high ammonia, and high hydrogen sulfide contents. Such conditions in addition to poor oxygen content and rises of the hypolimnetic layer during stagnation periods had bad effect on fish and fish fries causing mass mortality and health hazards to the population **(Siliem, 1984).** The pH of the Rosetta branch of the Nile values showed seasonal changes and was varied between 7.5 - 8.2. The average chlorosity values showed wide variation and was varied between 11 - 24 mg/l, this due to fluctuations in the rate of discharge of the fresh water of the River Nile and its effect on the estuarine sea water. Sharp increase in chlorosity values with depth at the estuarine stations was produced by the less dense river water. Minimum oxygen saturation values occurred in January and the highest values of dissolved organic matter were obtained in July **(Massoud and Abbas, 1985).** Physical and chemical characteristics of Damietta branch after Faraskour dam e.g. the transparency fluctuated between (55 - 145 cm) with a considerable increase downstream, the salinity increased towards the mouth of estuary as well as, towards bottom. The amount of calcium was lower than of magnesium also the pH values were generally alkaline. The surface water of the estuary have dissolved oxygen content up to 22 mg/l, the nitrate content exhibited an extremely wide range of variation 138-2186 µg/l and nitrite contents occur in minute quantities in Damietta estuary. Ammonia was present in excess 178 - 6554 µg/l and increase with depth **(Deyab, 1987).** There were negative relationships between the temperature and dissolved oxygen. The Damitta channel is anoxic below a very thin photic layer. It has high values of bicarbonate alkalinity, ammonia and hydrogen sulfide contents. Such conditions may be due to poor oxygen content and rises from the is hypolimnetic layer during stagnation periods which affect on fish and fish fries causing mass mortality and health hazards to the population **(Siliem, 1993 and**

1994). Diurnal variations in physicochemical condition of the Nile water during different seasons of the year. was observed as most of the chemical characteristics showed an inverse relationship with the water level. Higher values were obtained during low water level (drought periods). While low values were observed during high water level (flood period) **(Siliem, 1994).** The pH value is a reflection many of biological in the aquatic plant, respiration of aquatic organisms, decomposition of organic matter, precipitation, dissolution, variation in temperature, salinity and oxidation reactions take place in the environment **(Siliem, 1995).** Physical and chemical concentrations of the most parameters were increased northwards especially at the region including stations Talkha, El-Serw and Faraskour more than the southern region including stations El-Kanater El-Khyria, Benha and Zefta this is attributed to the extensive industrial, agricultural and sewage wastes pour in the northern region including stations Talkha, El-Serw and Faraskour. Using the branch water as water cooling system of both Talkha and Kafer Saad electric power stations leading to thermal pollution, Excretion of fish in fish cages dispersed in the region between El-Serw and Faraskour cities. The bad effects of Faraskour Dam which cutoff the freshwater passes through it to the estuarine outlet **(Ali, 1998).** Damietta branch has a greatest vital importance; Carbonate showed complete depletion during different seasons at different stations, bicarbonate varied regionally and seasonally with maximum value 311 mg/l during autumn at El-Serw and minimum 197 mg/l during summer at El-Kanater El-Khyria. Chlorosity ranged between 16.32-95.63 mg/l with the lowest value recorded during summer at Benha and highest value recorded during spring at Faraskour. While sulphate and sulphide ranged between 20.48-77.08 mg/l and 0.134-0.667 mg/l respectively. On the other hand, the result show that, the concentration of major metals (Ca^{++}, Mg^{++}, Na^{+} and K^{+}) has the same trend as shown in the concentration of $HCO3^{-}$ and Cl^{-} **(Elewa and Ali 1999).** Physico-chemical parameters of the River Nile at Rosetta branch e.g. the electric conductivity values were fluctuated between 12.5 - 27.3 and 27.6 - 37.8 mS/cm for summer and winter seasons, respectively. The high values of transparency were measured during summer season and ranged between 20 - 215 cm. the pH values were in the ranges 6.90 - 8.56 and 6.95 - 8.25 during summer and winter, respectively. Dissolved oxygen (DO) values varied in the ranges 1.10 - 10.28 and 2.80 - 12.2 mg/l during summer and winter, respectively. The bicarbonate values were in the ranges 120.0 - 270.2 and 140.6 - 300.0 mg/l during summer and winter, respectively. Before Edfina barrage, the Cl^- ion concentrations were varied in the ranges 20.02 - 75.52 and 27.23 - 96.19 mg/l during summer and winter, respectively, while the range were 11.58 - 13.63 and 17.73 - 20.27 g/l after Edfina barrage. Concerning the cationic concentration, the most predominant cation in the Rosetta branch is sodium and ranged between 18.26 - 92.59 mg/l and 3.015 - 11.678 g/l before and after Edfina barrage, respectively. While the potassium concentrations were varied in the range 5.21 - 9.09 mg/l and 0.231 - 0.445 g/l, respectively **(Abdel-Satar and Elewa, 2001).** The change of pH value of water of the Nile at Damietta branch is related to the high activity of phytoplankton and the higher oxygen concentration. Lower pH values recorded in summer due to the bacterial decomposition of organic matter **(Mahmoud, 2002).** The effects of regular and episodic sewage inputs, either domestic or industrial; on the water quality of a small Mediterranean stream (River Magro, eastern Spain). The dissolved oxygen deficit persists all along the water courses of the river Kathajodi and Taladanda canal indicating that the de-oxygenation rate due to biological decomposition of organic matter is higher than the re-oxygenation from the atmosphere **(Das and Acharya, 2003).**

Heavy Metals:

Metals enter rivers from various sources, such as: (1) rocks and soils directly exposed to surface waters; this is the largest natural source, (2) dead and decomposing vegetation and animal matter, (3) wet and dry fallout of atmospheric particulate matter, and (4) from man's activities, including the discharge of various treated and untreated wastes into the water body. Trace metals such as chromium, manganese, cobalt, copper and zinc play a biochemical role in the life processes of aquatic plants and animals, and their presence in trace amounts in the aquatic environment is essential. However, at high concentrations, these trace metals become toxic. Also a further special feature of toxic metals is that they are not biodegradable. Toxic metals constitute a particular risk, because they have a tendency to accumulate in vital organs. Thus, they will exert progressively growing toxic actions over long periods of the lifespan depending also on the cumulative magnitude of the dose as a function of the long term exposure of the individual to its particular environment **(Nurnberg, 1982).** The distribution of trace metals in Aswan High Dam Reservoir and River Nile Ecosystems and trace metals analyses were performed for cobalt, chromium, copper, manganese. lead, and zinc. Chromium and manganese were found to be in the highest concentrations in all sediments. Copper and lead, on the other hand, were found to be in the lowest concentrations in most of the sediments. The increase in mean metal concentrations in analyzed sediment samples followed the order: Mn > Cr > Zn > Co > Pb > Cu**.,** the analyses of water samples of the River Nile indicated that the concentration of the trace elements is increased from south to north direction. The distribution of trace elements in the Nile water is affected by the physico-chemical parameter such as pH, dissolved oxygen, transparency, carbonate and bicarbonate, phosphate and suspended matter, Statistical analysis between the different parameters are given and discussed. The data indicated that the concentration of the different metal ions found is Fe > Mn > Zn > Cu. The level found for all metal ions in the Nile water is below that set by the United States Environmental Protection Agency (EPA) as harmless to the aquatic life **(Masoud, *et al*., 1994).** Heavy metals concentrations were higher in sediment samples depending on the collected season and sediment type. Also, there is a higher metals content in fish during summer more than during other seasons due to the increase fish activities **(Zayed et al., 1994).** Factors affecting the distribution of some major and minor elements in River Nile at greater Cairo in area between Helwan to the Barrage at El-Kanater El-Khyria. The study declared the distribution pattern of the major elements: Na, K, Ca and Mg and trace metals: Fe, Mn, Zn, and Cu. The result revealed that the high concentration of the studied elements were measured in the cold period in both areas affected by industrial effluents at Helwan and sewage effluents in front of El-Rahawy village (Rosetta branch). The study indicates that the physical and chemical characteristics in the water body of Nile environment affect the distribution pattern of the chemical elements. In this investigation, the studied elements show negative correlation with pH, dissolved oxygen, transparency and temperature. The decreasing order of the element concentrations were as follow: Ca > Na > Mg > Fe > Mn > Zn > Cu. Also the results show the distribution mechanism of these elements are affected mainly by industrial and sewage effluents inflow to the river **(Issa *et al.*, 1997).** Distribution of some elements in the River Nile water at El-Qanater El-Khayria. showed a great increase in trace metals, (Fe, Mn and Cu) concentrations at the area opposite to Helwan factories in both water and sediment. However in Rosetta branch in front of El-Rahawy drain, a great increase in the biological oxygen demand (BOD), chemical oxygen demand (COD) and ammonia concentration followed by oxygen depletion in the water was observed **(Abdel-Satar, 1998).** The deposition of heavy metals to the sediment in Damietta branch were depending on several factors; pH values, dissolved oxygen, redox potential, organic matter, salinity and types of the sediment. Where, the type of sediment (clay, silt or sand) have a strong effects on the deposition of elements to sediment, where the fine grain size of sediment have high adsorption of metals than large size and consequently, increase the rate of precipitation. The degree of deposition of the metals was in the order of Fe > Mn > Cd > Zn > Cu > Pb > K > Na > Ca > Mg. Moreover, The organic matter deposition from the above water increase the precipitation of heavy metals, while the decomposition of organic matter in the sediment liberate phosphorus and the trace metal into the water. Organic matter is positively correlated with the most chemical elements in the sediment **(Goher, 1998).** The distribution pattern of heavy metals in the sediment at Rosatta branch is mainly depending; pH values, dissolved oxygen and organic. The organic matter have a major role in the precipitation of heavy metals from water to overlying sediment, while the decomposition of organic matter in the sediment liberate phosphorus and the trace metal into the water. Organic matter in positively correlated with the most chemical elements in the sediment **(Abdo, 2002).** The accumulation pattern of heavy metals in fish inhabiting sediments characterized by varying metal bioavailability. The metal concentrations were found to be greater than the background concentrations of sediments indicating the anthropogenic origin of metals. Good recovery values were obtained for metal contents in sediments and fish. Large fractions of Zn, Cd and Cu were associated with mobile fraction of sediment and showed greater bioaccumulation in fish whereas Ni and Co were least mobilisable. The results clearly indicated that the fish of Kolleru lake are contaminated with metals and not advisable for human consumption**.** The high levels of heavy metals in water and sediments of Damietta branch have a great influence on the macrophytes living in this branch, and high level of heavy metals (Fe, Mn, Zn, Cu, Pb and Cd) in water and two submerged macrophytes, at Zefta and Talkha cities are in the following order; Fe > Mn > Pb > Zn > Cu > Cd and Fe > Mn > Cu > Zn > Pb > Cd respectively. This may be attributed to the different effluents discharges into the branch. Also, the accumulation of heavy metals in macrophytes can be used in biomonitor assay for pollution **(Abdo, 2004a & c).** The high levels of the different heavy metals which recorded in Damietta branch were found at the areas receiving different effluents e.g Talkha, El-Serw and Faraskour. The recorded levels arranged in a descending order as follows: Na > Fe > K > Mn > Cu > Zn > Pb > Cd **(Abdo, 2004 b).** The Nile sediments are slightly enriched with the major cations and the elevated concentrations of heavy metals are often associated with the industrial pollution. Iron and manganese oxides beside organic matter seem to be the principal carrier phases for most studied heavy metals. Comparison of studied metals to freshwater sediment quality guidelines was cited and discussed **(Abdel Satar, 2005).** The increase of DO concentration in River Nile at Damietta branch may be attributed to the increase of photosynthesis activity as a result of abundance of phytoplankton and the increase of BOD due to greater organic load pollution due to untreated domestic sewage into water. The increase of nitrite and nitrate may be due to the effect of agricultural wastes. The concentration of major and trace elements to be (Fe, Mn, Cu, Zn, Pb and Cd) of water in the River Nile at Damietta branch found in the order of Fe > Mn > Zn > Pb > Cu > Cd. The higher values concentration of some heavy metals may be due to agricultural runoff and domestic sewage effluents **(Al-Afify, 2006).**