INVESTIGATION OF EL-SALAM CANAL PROJECT IN NORTHERN SINAI, EGYPT

PHASE-I: ENVIRONMENTAL BASELINE, SOIL AND WATER QUALITY STUDIES

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ABSTRACT

El-Salam Canal is one of the five-mega irrigation projects in Egypt that located at the northern Sinai. The Egyptian Government envisage the reclamation of an estimated 620,000 feddans of desert situated along the Mediterranean coast of Sinai by diverting considerable amounts of agriculture drainage water to newly reclaimed areas after blending with Nile water in a ratio about 1:1. The Egyptian Academy of Science and Technology financed a research project namely "Treatment of Nile water of Sinai" aims to prepare the environmental baseline profile that helps in building up database as well as obtaining conclusive scope of the negative impacts that arise from implementation of El-Salam project. In addition, the project aims to investigate the different water resources and actual mixing conditions in order to recognize their quality and what they bear of possible dangers. Finally, this study will propose the suitable measures for control and/or remediation of these hazards, using modern techniques for biological, chemical treatment and membrane separation for canal waters, where two water treatment units will be designed covering small communities for potable and irrigation water production purposes. This paper presents the results of the first phase that implemented during the first year of this project including: database, soil and water quality.

Key Words: El-Salam Canal, Environmental Baseline, Soil, Drain Water Quality.

INTRODUCTION

Egypt total cultivated area is approximately 3.15 million hectare (= 10000 m^2, 2.385 Feddan); comprised of 2.35 million hectare of old fertile high production land and 0.8 million hectare of new reclaimed land. The country has a rapid population growth rate, expected to reach about 85 million inhabitants by the year 2025. Over 85% of Egypt's water resources are used for agricultural. Due to aridity conditions, very low annual rainfall and high vapor transpiration, irrigation is the only way to ensure crop production.

Although improvement of canal and field irrigation systems will result in some overall water savings will be forced, in future to utilize the increased amounts of low quality water. The emphasis of increased reuse of drainage water for irrigation is essential in Egypt, expands its agricultural base to meet food and fiber requirements of a rapidly rising population. In most of the downstream parts of the Nile and horizontal expansion areas, there is a potential to increase greatly the reuse of drainage water for irrigation. Agricultural drainage water in Upper Egypt is discharged back into the River Nile, while the drainage water in the Nile Delta is collected through an intensive drainage network and disposed to the Sea. About 12 billions m^3 of drainage water are discharged to the Sea each year, and only about 5.0 billions m^3 are currently being reused.

Sinai represents 6% of the total area of Egypt. Overall integrated development of Sinai necessitates linking the east side of the Suez Canal with the western side, for the two sides are organically united and constitute one comprehensive strategic area. Horizontal agricultural expansion in Sinai requires providing it with irrigation waters from the Nile, in addition to the other water resources such as drainage water. The Government of Egypt is undertaking major projects to divert considerable amount of drainage water to nearly reclaimed area after blending with the Nile water. One of those projects is El Salam Canal Project.

The Environmental Study of a specific project provides the tool for measurement of the mutual influences, external and internal, affecting the quality of the human environment, as well as the project itself, i.e. negative or/and positive impacts.

The aim of this paper is to present the results of the first year work of the research project namely “Treatment of Nile water of Sinai”. The first year project results consist of two parts: the first part includes Environmental Baseline Profile which is consisted of data base, soil and water quality. The second part concerns with the Environmental Impact Assessment (negative and positive impacts) of El-Salam Canal Project [1, 2, 3, 4, 5].

THE RESEARCH PROJECT

The Research Project namely “Treatment of Nile water of Sinai” is financed by the Academy of Science and Technology in Egypt. The research team based mainly on contribution of three research groups from; the National Research Center - Chemical Engineering and Pilot Plant Department, Water Pollution Department, and one group from Suez Canal University.

THE RESEARCH PROJECT OBJECTIVES

The research project objectives are:

- Preparation of the environmental base line profile for the project of El- Salam Canal, in order to build up database from previous and present updated studies and analyses, to put a conclusive scope of the negative and positive impacts that arise from implementation of El-Salam project.
- The performance of conclusive field survey on El-Salam canal waters after mixing to recognize their quality and what they bear of possible dangers.
- Propose measures for control and/or eradication of these hazards, using modern techniques for biological and chemical treatments for canal waters.
- Design of two treatment units for small communities for potable and irrigation purposes.

PLAN OF WORK

The project including six Phases: the first phase includes the environmental base line profile, the second Phase concerns with field, laboratory analysis and examination of samples of soil and water from the chosen studied locations, the third phase includes laboratory biological and chemical treatment methods to chose the optimum and economical methods to be implemented in Sinai, the fourth phase is dedicated to the design and experiments of a pilot plant for El-Salam canal mixed water, the fifth Phase concerns with the engineering design of a compact treatment unit for potable water and treatment unit for agricultural irrigation and the sixth phase concerns with the feasibility studies of the proposed treatment units. The total project duration is two years.

THE FIRST YEAR ACTIVITIES

Two major parts are implemented in the first year of the project that will be presented in this paper. The two parts are:

Part-1: Environmental Baseline Profile Document

The Environmental Baseline Profile document [6] helped in buildup of the database of El-Salam Canal including Soil and Water quality information. In order to fulfill this part, data collection was carried out from local governmental authorities, institutes and universities, Internet and libraries.

The research team intends to make several field trips for sampling and water analysis along El-Salam canal. Also soil areas nearby the canal course were examined in order to assess the impact of the Nile waters on them. Chemical, biological and microbiological analysis and examinations are done to know the present status of the waters and soil of the El-Salam Project, in order to propose the rightful ways for treatment of the environmental problems that may arise from the introduction of polluted Nile waters into the area as well as to facilitate the suggestion of the treatment measures.

A computerized database for the present status of the area as a reference for the further studies and impacts is built up, which will be available on the Internet. The database of the project consists of basic information and variable information which are shown as block diagrams in Figure (1).

A- Basic Information Data Base of El-Salam Project

The structure of the data base of the basic information consists of the following components: project objectives, project description, the Canal water sources, project phases, the estimated reclamation areas, soil and crops classification, Geology of Sinai and the climatic conditions and air quality of Sinai.

A/1- El-Salam Canal Project Objectives

The project aims at carrying irrigation water to Sinai Peninsula for realization horizontal agricultural expansion, Reuse of drainage wastewater which was discharged into the sea by mixing the drainage water from Bahr Hadous main drain, (the largest drain in the Eastern Delta) and the drain of water delivered by the lower Serw pumping station together with the fresh water from the Damietta branch. Equal volumes of fresh and drainage water will be mixed reaching out to the hope for end of cultivate nearly 620,000 feddans, certainly of newly reclaimed lands, divided to 220,000 feddan west of Suez Canal and about 400,000 feddans east of Suez Canal in Sinai Peninsula.

In addition the project aims to re-charting Egyptian's population map, improving income distribution and generating employments through the settlement of small holders and graduates from among the rural population of the over-populated area of Egypt. In addition the transfer of Nile water into Sinai will help to create new communities along the Canal and use the valuable economic treasures in Sinai, such as the huge natural resources including medicinal plants, animals and valuable rock forms and minerals.

A/2- El-Salam Canal Project Description

El-Salam Canal project as shown in figure (2) is in the Eastern Nile Delta. The total length of El- Salam Canal is 242 km. El–Salam Canal takes its supply of water from the right side of Damietta tributary at km 219, Adlia City before Farskour Dam that was designed to balance the Nile water level before it at 1.7 m to allow feeding the Canal with waters at level of 1.6 m. The Canal extends east Suez Canal for a distance of 87 km from Damietta to the Suez Canal. The Canal takes the south eastern side passing near Al-Attawe drainage to the site of Al-Serw drain where it is possible to benefit from 2 million cubic meters of waters daily and can be mixed with the waters of El-Salam, at km 17.850. According to hydraulic slope the water 5cm/km, the water level of the Canal at km 22 adapts to the topography of the area and the technical needs of designing. The course of the Canal goes eastward behind the station of pumps, parallel to Al-Towel Bahrain drainage. A space of 100 meter was left between the utilities of the Canal and the drainage to cover filtration line. At km 39.150 the Canal intersects with Al-Taweel Bahari drainage where it goes wastewater until it crosses Bahr Hadous drainage at km 51.200 where two stations for pumping and mixing were established. It is then diverted to cross Bahr El-Baqar through the culvert of km 19.650 at the drainage, 77.325 at El-Salam Canal to the east until it meets the Suez Canal at km 27.800. Then the water is transported through a tunnel under the Suez Canal about 1300 meters to extend the Nile water to Sinai. The Canal in West Sinai is named as Sheikh Gabber Al-Saba Canal extending over 155 km long to irrigate the lands of proposed expansion in Sinai amounting to 400,000 feddans in Sahl El-Tina and the coastal area between Romanna, El-Arish, Alsir and Qwareer.

A/3- Water Sources of El-Salam Canal

El-Salam Canal water is a mixture of 2.11 billion m^3/year of the Nile fresh water from the Damietta branch mixed with 1.905 billion m^3/year of the drainage water from Bahr Hadous and 0.435 billion m^3/year of El Serw drainage water. So the total quantity of water is nearly 4.45 billion m^3/year with a ratio of Nile water to drainage water about 1:1 nearly. This ratio was determined to reach to TDS not more than 1000-1200 mg/L. to be suitable for cultivated crops.

A/4- El-Salam Canal Project Phases

The project is being implemented through two main phases; the first serves 220,000 feddan, and the second covers 400,000 feddan. The total cost of such a project hits L.E. 6 billion, in addition to 1.5 billion to establish 55 villages throughout the project, each of which is to be built over a 23 feddans area.

The intake of the Canal was chosen in such a site as to circumvent inhabited areas, averting, as much as possible, dismembering agriculture land, in addition to making use of the current bridges. The project consists of two phases:

The First Phase

The first phase is implemented totally in the west of Suez Canal and included: the construction of Faraskour barrage on the Damietta branch of the River Nile, construction of outlet on the Damietta branch, digging the Canal, 87 km long till west Ismailia/Port Said highway, passing through Damietta, Daqahleya, Sharqueya and Port Said governorates, construction of three pumping stations, besides about 15 siphons at cross points with drains and construction of sub-outlets on the course of the Canal. The infrastructure works of the first stage, however, were completed with an average cost of L.E. 160 million.

The Second Phase

The second phase is partially implemented east of Suez Canal. The work that implemented is construction of a siphon beneath the Suez Canal, 27 km south of Port Said. Such a siphon has 4 tunnels, each of which is 750 m long with an inner diameter of 5.1 m, at a depth of 45m beneath the Canal, fixing a pipeline to transfer the water of the main canal to Beir Al-Abd, Al-Saroe and Al-Quareir, constructing 5 pumping and lifting stations and digging about 35 km east Suez Canal.

The work which are going now to be implemented is the construction of irrigation and drainage sub-network to serve 400,000 feddans, construction of seven lifting stations and three main drainage stations, construction of a preventive barrier to map the borders of that project 3km east of the Canal and erecting bridges and industrial infrastructure in the crossroads and intersections along the Canal's stream.

A/5-The Estimated Reclamation Area

The estimated Reclamation area in West Suez Canal is 220,000 feddans divided as 13,000 feddans for Attwa and Mattaria area, 30,000 feddan for North El-Hussania, 64,000 feddans 47,000 feddans for East Port Said and East Bahr El Bakar and 21,000 feddans for Aum El-Rish Berka.

The estimated reclamation area in East Suez Canal is 400,000 feddan divided to 50,000 for El-Tina plain area. 75,000 South East El-Kantara area, 70,000 feddans for Raba Zoon and 134,000 feddans for Beir El-Abd Zoon and 400,000 feddans for El Sir and El Kwarir area.

A/6- Soil Classification and Crops

The soil of the project area is classified as:
- The Clay Soil that located in East Suez Canal (Tina plain) is 60000 feddans. It is planned to be irrigated from surface water El-Salam Canal to cultivate 42% field crops, 42% vegetables and 16% fruits.
- The Sandy Soil which is 340000 feddans, east Suez Canal (South El-Qantara and Bir El Abd) 205000 feddan and is planned to be irrigated by spraying and it is planed to be cultivated as 37% field crops, 22% animals food 15% fruits crops, 14% vegetable crops, 6% olives crops and 6% oiling crops.
- The Loamy Soil which is 135000 feddan at El-Sir and Kawarir.

A/7- Geology of Sinai

Sinai, the triangular-shaped peninsula of Egypt, is situated between Asia and Africa. The separation of the two continents caused the form and geographical shape of Sinai the way it looks today. Sinai is approx. 380 km long (north - south) and 210 km wide (west - east). The surface area has an extension of 61,000 km^2; the coasts are stretching about 600 km on the west and on the east. On the western part there is the Gulf of Suez (with the Suez channel) and the eastern part of Sinai brings up the much deeper Gulf of Aqaba. The sea in the Gulf of Suez measures approx. 80 meters only, while the profile of the Gulf of Aqaba goes down to approx. 1,830 meters. The latter is a part of the big land rift that extends until Kenya in Africa.

Big seismic activity and the tremendous eruptive phenomena have given Sinai its characteristic looks. The highest mountains are the Gebel Musa (Moses' mountain) with 2,285 meter, and the Sinai's highest mountain Mount St. Catherine (Gebel Kathrina) with 2,642 meter. Many of the Pharaohs got their precious stones from the southern Sinai.

The west coast - reaching from Ras Mohammed to Taba - is filled with rich coral reefs sections, one after another. This under water paradise is giving ideal conditions for flora and marine fauna, and finally nowadays for divers. The northern part of Sinai mainly consists of sandstone plains and hills. The Tih Plateau forms the boundary between the northern area and the southern mountainous with towering peaks.

Sinai geological structure falls within two groups, a Precambrian base that is largely exposed in the south and a triangular area of sedimentary layers in the north that becomes thicker and more pronounced near the Mediterranean coast. Boundary between the two lies on an east-west plane from Gebel Hamman Faraun on the Gulf of Suez to Nuweiba on the Gulf of Aqaba; this coincides with the Tih and Egma escarpments in the high centre of the peninsula. Based on age, the surface geology can be broken into seven groups. From oldest to youngest they are: Precambrian intrusives and metamorphics, Jurassic sedimentary strata, Cenomanian-Turonian limestones and dolomites, Senonian chalk, Eocene chalk and limestones, Oligocene and Miocene sediments and Miocene dikes, and Quaternary alluvium. The Sinai massif is composed of ancient Precambrian rocks dominating the south of the peninsula. 75% of the area is crystallized rock.

El-Salam Canal project occupies the upper most northwest corner of Sinai Peninsula where the Quaternary and recent dry alluvium sediments are dominating, known as Sahl El-Tina (i.e. The Plane of Mud). These complex sediments are composed of mixture of silica sand, calcareous sand, clays, silt and organic matters. The geochemistry of these soils indicated that it is most probably of marine origin or derived from it. The salt content varies from about 3% and up to higher than 15%. Sodium chloride and magnesium sulfate constituting higher than 85% of the dissolving salts extracted from these soils.

A/8- Climatic Conditions and Air Quality

The meteorological information of North Sinai were collected from the Climatologic Section of the Egyptian meteorological authority in El-Abbasia area in Cairo. These information is necessary for cultivation the different crops.

The obtained records represent records of Qantara Shark and Al-Arish stations which are the nearest stations to El-Salam Canal. The average parameters includes: average maximum temperature, average minimum temperature, minimum and maximum recorded temperature, average relative humidity, total rain precipitation, average wind velocity and direction recorded during years 1997-2002 and covers circle area about 50 km.

The climatic conditions can be concluded as follows:

1- For Quantara Shark City the highest temperature is in July and August (35.5ºC and 34.9ºC). The lowest temperature is in January, February (20ºC and 19.3ºC). For Al-Arish City, the highest temperature is in July and August (13.1ºC and 31.9ºC) and the lowest temperature is in January and February (19.2ºC and 18.7ºC).

2- The big amount of rainfall is 11.3 mm / month for Quantara Shark City in February. For Al-Arish, it reaches to 72.1 mm in January, and there is no rain allover June, July, August and September.

3- The highest humidity percent is 73% in January for Quantra Shark and 61% in May and June for Al-Arish City and it is 73% in August and 66% in April.

Wind Roses were collected and studied to determine the speed and direction of air to help in design of the shelters to protect crops from air.

B- Variable Information Data Base of El-Salam Project

It consists of soil and water quality studies.

B/1- Soil Quality Studies

Seven representative washed and natural soil samples were collected during March, April and May 2004 from: El Teina plain East Suez Canal around El Sheikh Gaber Al-Sabah Canal and from natural soil samples from some sits on the west of Suez Canal to study their geochemical properties.

The collected samples were analyzed according to standard methods for examination of water and wastewater [7, 8, 9]. The analysis investigated silicate analysis of soil and chemical composition of water-soluble fraction extracted from soil samples.

Tables 1 and 2 represent the silicate analysis of soil and the chemical composition of water soluble fraction extracted from soil samples for March 2004.

The silicate analysis indicated that the deposition of soil around Suez Canal area is completely different from the Nile valley soil. The samples look like the black Agricultural Nile soil but chemically it is totally different from Delta and Nile valley soil. They are characterized by relatively high sodium and iron oxide, tri-sulfur oxide and chloride and relatively low silicon, aluminum and potassium oxide and low organic matters. In addition, the silicate analyses indicated the high abnormal of titanium oxide which means that the surface settling soil circumstance in areas surrounding Suez Canal is completely different from the areas in the Nile valley.

The results of the chemical composition of water-soluble fraction extracted indicated high concentration of the total dissolved solids (TDS) that ranged from 134280 to nearly 199000 mg/L.

The sodium chloride represents more than 90% of the TDS while sodium sulfate; calcium chloride and magnesium chloride represent about 10%.

The Sodium adsorption ratio (SAR) was considered and calculated for all samples. The sodium adsorption ratio (SAR) represents 120 for washed soil and ranged from 170 to really 200 for natural soil.

The SAR is very high when compared with the accepted value 13, so washing of these soils is recommended. It is also recommended to use the sandy soil first so it will save the fixed capital cost of the saline soil treatment.

B/2- Water Quality Studies

Water analysis were carried out monthly for 12 months including chemical, Bacteriology, Viruses, phraseology, zooplankton, Algae, snails, insects, pesticides and heavy metals, to investigate the situation analysis of El-Salam Canal, while the Agricultural drainage was studied for six months. The analyses was carried out for seven locations: at the beginning of the Canal (Damietta branch), before and after mixing with El-Serw drainage, after mixing with Hadous drainage, before entering Elsahara -under Suez Canal- after Suez Canal and at the end of the implemented part of west Suez Canal (25 km).

a) The Chemical Studies

1. Chemical analysis of the seven locations at El-Salam Canal were investigated and presented in Table (3): the biochemical analysis indicated for high BOD-5 91 mg/L for El-Serw drainage and 115 mg/L for Hadous drainage in June 2004, but it was remarkable that the dissolved oxygen in the Canal and the natural aeration of water decreased the BOD to an acceptable limit at the Sahara and at the end of the Canal.

2. It was remarkable that the increase of TDS is gradually from the beginning of the Canal till the end of the Canal as shown in Figure (3), the TDS reached to 2164 mg/l. at the end of the Canal which is nearly five times that at the beginning of the Canal at Damietta branch.

3. The salinity of water is not only due to the ratio of mixing the drainage water with the Nile water 1:1 but it may be due to the evaporation factor and high wind speed as in the climatic map. The other probability the filtration factor which result from the hydraulic pressure of high salinity water sources. (Red Sea 43,000 mg/L) in the Suez Canal or water of saline lakes, which spread on surface and down this area. The variation in the ratio of mixing of Nile water with the drainage water must be considered other wise it will be negative impacts of the project.

4. The quality of water before El Quanater El Khairia is deteriorated at its arrival to Damietta branch, where the TDS is nearly double increased from 227 to 382 mg/L.

5. The chloride ion and sodium and potassium ions one higher than any other ions then sulfate, carbonate ion while summation of calcium and Magnesium ions one less higher as shown in Figure (4).

6. The Molar ratio of (SO_4/HCO_3) is changed. It is clear that the Nile water at Damietta branch are characterized by the high bicarbonate than sulfate, but by increasing the mixing ratio the sulfate was dominating bicarbonate as presented in Figure (5).

b) Heavy Metals Investigation
Fourteen heavy metals were measured in the investigated water samples, these are: Al, B, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Sr, V and Zn. Generally, the concentrations of these heavy metals are relatively higher than in the River Nile. The highest recorded values are: Al = 1.86, B = 3.74, Cd = 0.08, Cr = 0.06, Cu = 0.06, Fe = 2.56, Mn = 0.61, Pb = 1.71, Sr = 1.31, V = 0.15 and Zn = 0.66 mg/l. These anomalous higher values are mainly attributed to the mixing with the agricultural drains which contain higher levels of heavy metals.

c) Bacteriological Investigation
The total Bacteria counts were $10^3 – 10^5$ at the beginning of the Canal at 37 ºc and 22ºc. After twenty kilometer of mixing point no changes in bacteria counts occurs. But bacteria counts changed from $10^3 – 10^6$ on crossing Suez Canal. No indicators of pollution and pathogenic bacteria. The Canal water is characterized by the existence of colon bacteria, Faecal coli form, Faecal strept and are polluted with pathogenic bacteria.

d) Viruses Examinations
It was remarkable that number of viruses per liter was small which may be due low population near El-Salam Canal and high water salinity which effect on virus activity.

e) Parasitic Examination
The Parasitic Protozoa and living amoebae are detected in most locations. The helminthologic examination detected also the parasitic ascaris.

f) Zooplankton Count Examination
By microscopic examination for all locations at El Salam Canal it was found that zooplankton counts are referring to Rotatoria then to crustacean, which in big amount in Branchiopoda and in small counts in Ostracoda. It was found that as the organic materials and chlorophyll increase the zooplankton count increase.

g) Algae Examination
The results of Algae texa and algae counts indicated the algae in El–Salam Canal are related to three groups: Green algae, Blue green algae and Diatoms. The results of total group counts, total algal counts and the chlorophyll counts indicated the big variety for their number from location to another. The mixing of Nile water with Agricultural drainage led to increase of the Diatoms.

By studying the changes in the neutrient of algae, it was found a great difference in Damietta branch location when compared with other locations. It is remarkable that the increase of phosphate and nitrate in the direction of the begging of the Canal to the end of the Canal.

h) Snails Examination

The snail examination indicated high difference from month to another and from location to another where high percent of snails was in April 2004.

The rich location of snails was at the point after mixing of Hadous drain water with the Canal water.

The higher numbers of snails were Cleopatra cycle stomidus, then Melanoides tuberculta while Succinea Cleopatra snails represent the least number of Snails).

The natural infection with rematoda snails was recorded as very small amount.

k) Insects Examination

The monthly monitoring indicated seven types of insects, Diptera/ chrionmidae, Epherneroptera / canies sp., Odoinata nymph, cleopetra / Larvae and Hemipetra Blastoderma sp.

Their densities differ from location to another. No insects indicated organic pollution indicators.

Part-2 Environmental Impact Assessment

This part presents the results of The Environmental Impact assessment resulted from long operation of El-Salam Canal project in the North Sinai

The environmental assessment was carried out during the period from February 2004 to January 2005. The impacts resulted from the project are:

a) Positive Project Impacts

The project improved socio-economic conditions improve land tenure and land registration, development of new agro–ecological habitats and fixation of moving sand dune.

b) Negative Project Impacts

The project Negative impacts can be summarized as:

1- Project construction Impacts: where Historical and Archeological sites are destructed. The construction work is devastating impacts on archeological monuments and sites.
2- Project location Impacts are: loss of natural habitats and increased pressure on remaining wild land, loss of known and unknown historical and archeological evidence and displacement of existing population and land use activities.
3- Project design Impacts

The project design led to loss of traditional land rights and loss of cultural heritage, and it causes health risks due to transfer of polluted irrigation water.

4- Project operation impacts

The most significant primary impacts related to project operation are:

- The crop yield reduction and salinity due to water shortage.
- Increased seepage of contaminated ground water into Lake Bardawil.
- Increase of bird harvesting.
- Negative impacts on Local agriculture.
- Contamination of Local well used for drinking water.
- Transfer of new human, animal and plant diseases to Sinai.

c) Mitigation Measures

Practically impacts can be presented or can be counteracted by:

- Compensation for loss natural habitats.
- Prevention of new diseases.
- Recognition of existing land use, settlement and land rights.

Monitoring program must be implemented to detect quality irrigation water and drainage effluents, hydrogeology and ground water quality m salinity control, public health, monitoring flora and fauna and crop animal diseases.

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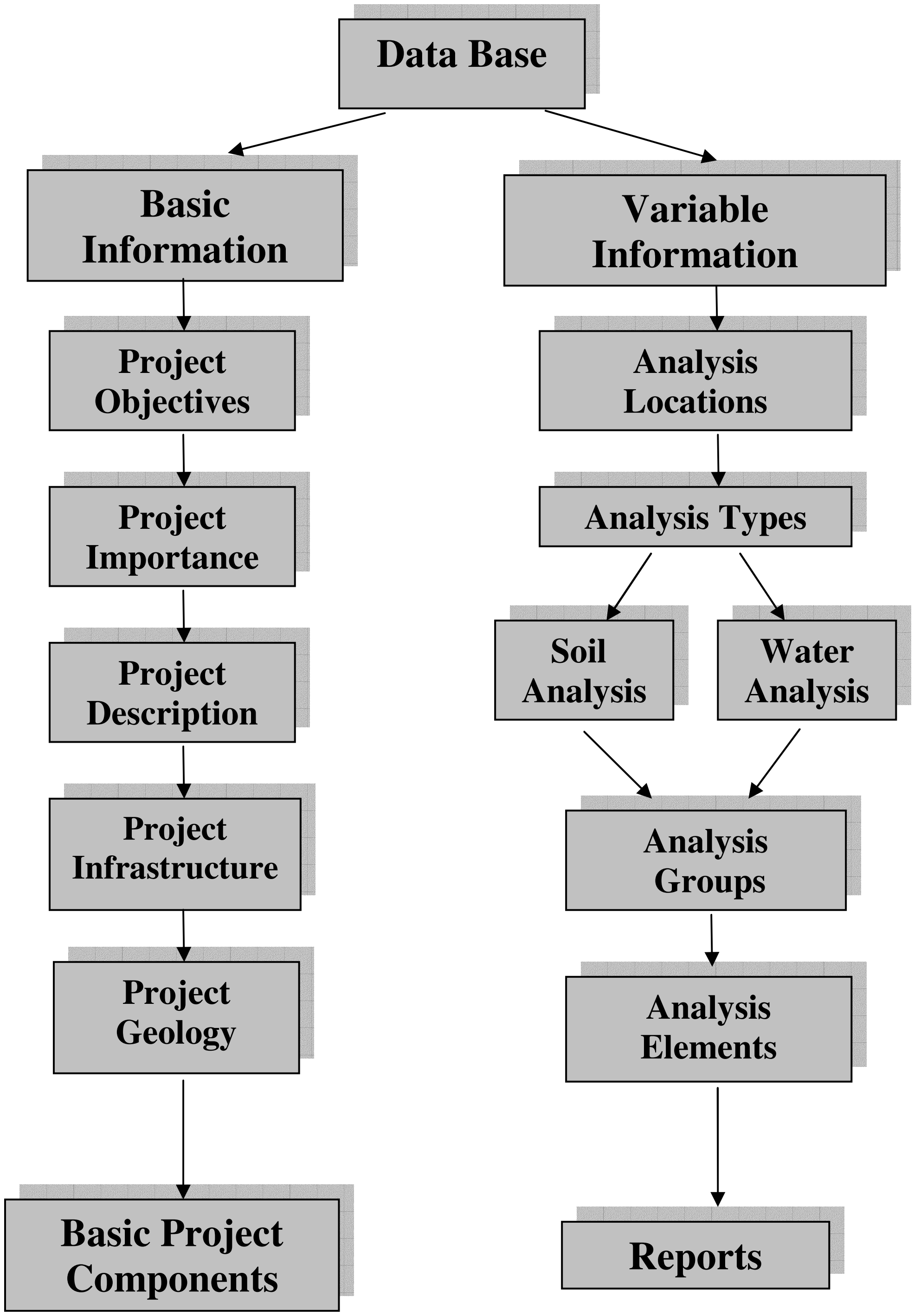

Figure(1) Block Flow Diagram for El-Salam Chanel Proiect Data Base

Figure (2) El-Salam Canal Location Map

Table 1 Silicate analysis of soil-samples collected from El-Salam Canal project (March 2004)

Ser.	Parameter (% wt/wt)	Sample # 1 (Washed)	Sample # 2 (Natural)	Sample # 3 (Natural)
01	Silicon Oxide (SiO_2)	31.414	29.137	23.351
02	Aluminum Oxide (Al_2O_3)	10.584	9.906	12.868
03	Calcium Oxide (CaO)	2.813	2.344	2.811
04	Magnesium Oxide (MgO)	4.667	5.003	5.112
05	Sodium Oxide (Na_2O)	10.243	11.524	12.152
06	Potassium Oxide (K_2O)	0.743	0.801	0.755
07	Ferric Oxide (Fe_2O_3)	5.799	5.849	5.794
08	Manganese Oxide (MnO_2)	0.128	0.569	0.322
09	Titanium Oxide (TiO_2)	1.979	1.361	1.574
10	Phosphorus Oxide (P_2O_5)	0.463	0.421	0.432
11	Sulfate (SO_3)	6.451	8.047	6.184
12	Chloride (Cl)	8.448	9.728	12.541
13	Carbon Dioxide (CO_2)	1.691	1.933	1.787
14	Moisture Content @ 105ºC	11.847	9.281	10.339
15	Organic Matter @ 600ºC	2.728	4.093	3.976
	Total (% wt/wt)	**99.998**	**99.997**	**99.998**

Sample-1: Washed soil from El-Tina Plain, East Suez Canal.
Sample-2: Natural soil from El-Tina Plain, East Suez Canal.
Sample-3: Natural soil from West Suez Canal.

Table-2: Chemical composition of the water-soluble fraction extracted from soil samples (March 2004)

		1	2	3
1	Fraction Type	Water Soluble	Water Soluble	Water Soluble
2	pH value	7.2	7.7	7.6
	Soluble Ions (mg/kg), Dry Base	1	2	3
1	Sodium Ion (Na^+)	41128	58625	67418
2	Potassium Ion (K^+)	1232	1249	1342
3	Calcium Ion (Ca^{2+})	4108	4247	2892
4	Magnesium Ion (Mg^{2+})	3228	2808	3494
5	Chloride (Cl^-)	71757	98155	111746
6	Bicarbonate (HCO_3^-)	0	0	0
7	Carbonate (CO_3^{2-})	0	0	0
8	Hydroxyl (OH^-)	0	0	0
9	Sulphate (SO_4^{2-})	12827	12316	11849
10	Silica (SiO_3^{2-})	0	0	0
11	Iron (Fe^{3+})	0	0	0
12	Manganese (Mn^{4+})	0	0	0
13	Phosphate (PO_4^{3-})	0	0	0
	TDS, mg/kg	134280	177400	198741
	Chemical Indicators	1	2	3
1	Ionic Strength, eq/Kg	3.0725	4.1025	4.6650
2	Total Mole/kg	4.2133	5.7003	6.4580
3	Sodium Adsorption Ratio (SAR)	120	174	203
4	Cl %, molar	48.04	48.57	48.81
5	SO_4 %, molar	3.17	2.25	1.91
6	(Na + K) %, molar	43.21	45.30	45.94
7	(Ca + Mg) %, molar	5.58	3.89	3.34
8	(Cl / SO_4), molar	15.16	21.59	25.55
9	(Na + K) / (Ca + Mg), molar	7.74	11.66	13.74
10	Cl / (Ca + Mg), molar	8.60	12.50	14.60
	Probable Salt Combination	1	2	3
1	Na_2CO_3, %wt/wt	0	0	0
2	K_2CO_3, %wt/wt	0	0	0
3	Na_2SO_4, %wt/wt	1.864	1.799	1.732
4	K_2SO_4, %wt/wt	0.040	0.028	0.025
5	NaCl, %wt/wt	8.922	13.423	15.713
6	KCl, %wt/wt	0.201	0.215	0.235
7	$CaCl_2$, %wt/wt	1.138	1.176	0.801
8	$MgCl_2$, %wt/wt	1.265	1.100	1.369
	Soluble Fraction, %wt/wt	13.428	17.740	19.874
	Non-Soluble Fraction,%wt/wt	86.572	82.260	80.126

Sample-1: Washed soil from El-Tina Plain, East Suez Canal.
Sample-2: Natural soil from El-Tina Plain, East Suez Canal.
Sample-3: Natural soil from West Suez Canal.

Table-3: Chemical analysis of water samples collected from El-Salam Canal (June 2004)

Parameter	1	2	3	4	5	6	7	8
01- Lab. pH-Value	7.5	7.5	7.6	7.7	7.7	7.7	7.7	7.6
02- Lab Conductivity, μmhos	550	1400	950	1400	950	1200	1150	1050
03- COD, mg/l	24	112	92	136	97	66	41	29
04- BOD-5, mg/l	16	91	75	115	81	49	32	19
Ion, mg/l	1	2	3	4	5	6	7	8
01- Sodium (Na^+)	43	192	121	314	102	123	142	121
02- Potassium (K^+)	5	8	6	12	6	10	7	7
03- Calcium (Ca^{2+})	48	61	38	73	62	58	54	55
04- Magnesium (Mg^{2+})	10	34	24	45	19	40	29	29
05- Chloride (Cl^-)	31	295	126	423	147	132	205	188
06- Bicarbonate (HCO_3^-)	172	241	211	322	192	201	213	202
07- Carbonate (CO_3^{2-})	0	0	0	0	0	0	0	0
08- Hydroxyl (OH^-)	0	0	0	0	0	0	0	0
09- Sulfate (SO_4^{2-})	70	95	102	179	87	121	95	85
10- Silica (SiO_3^{2+})	1.42	5.59	3.53	11.77	4.85	8.13	4.97	5.01
11- Iron (Fe^{3+})	0.07	2.38	0.28	1.35	1.27	1.17	1.07	1.06
12- Manganese (Mn^{4+})	0	0.17	0	0.16	0.02	0.04	0	0
13- Phosphate (PO_4^{3+})	1.08	4.54	2.64	4.67	3.24	5.14	3.81	3.54
T.D.S., mg/l	382	939	634	1386	624	799	755	697
Hardness (as $CaCO_3$)	145	237	155	295	202	245	207	210
Total Hardness, mg/l	217	345	263	492	299	380	312	304
Molar - Ratios	1	2	3	4	5	6	7	8
01- (SO_4/Alk)	0.26	0.25	0.31	0.35	0.29	0.32	0.28	0.27
02- (SO_4/Alk)*100	25.85	25.04	30.71	35.31	28.78	31.89	28.33	26.73
03- (Cl/Alk)	0.31	2.11	1.03	2.26	1.32	2.37	1.66	1.60
04- (Cl/SO_4)	1.20	8.41	3.35	6.40	4.58	7.44	5.85	5.99
05- Cl/(SO_4/Alk)	3.38	33.23	11.57	33.79	14.41	29.36	20.41	19.84
06- (Na+K+Cl)/Alk	1.02	4.27	2.59	4.91	2.78	4.89	3.48	3.25
07- (Na+K)/(Ca+Mg)	1.24	2.93	2.80	3.80	1.97	3.22	2.50	2.12
08- Cl/(Na+K)	0.44	0.97	0.66	0.85	0.90	0.94	0.91	0.97
09- Cl/(Ca+Mg)	0.54	2.85	1.84	3.25	1.78	3.03	2.28	2.07

LOCATION POINTS

1- Damietta Branch 2- El-Serw Drain 3- after mixing with El-Serw Drain
4- Hadous Drain 5- After mixing with Hadous Drain 6- At El Assafra Bridge
7- Before El-Sahara 8- After Suez Canal, Qantara Shark

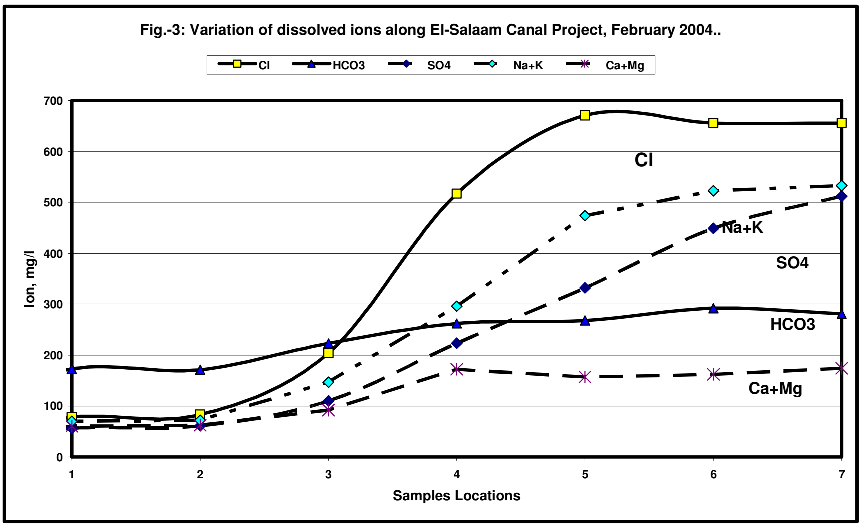

Fig. 3 Variation of dissolved ions along El-Salam Canal Project, February 2004

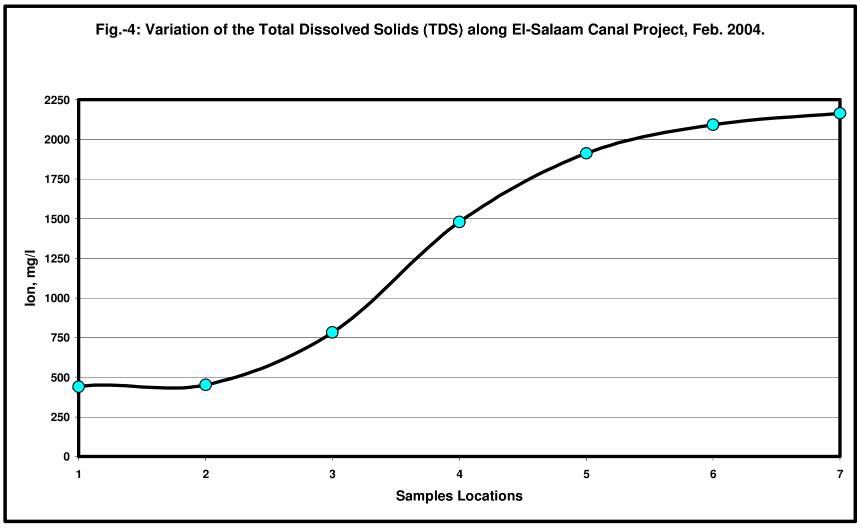

Fig. 4 Variation of the Total Dissolved Solids (TDS) along El-Salam Canal Project, Feb. 2004

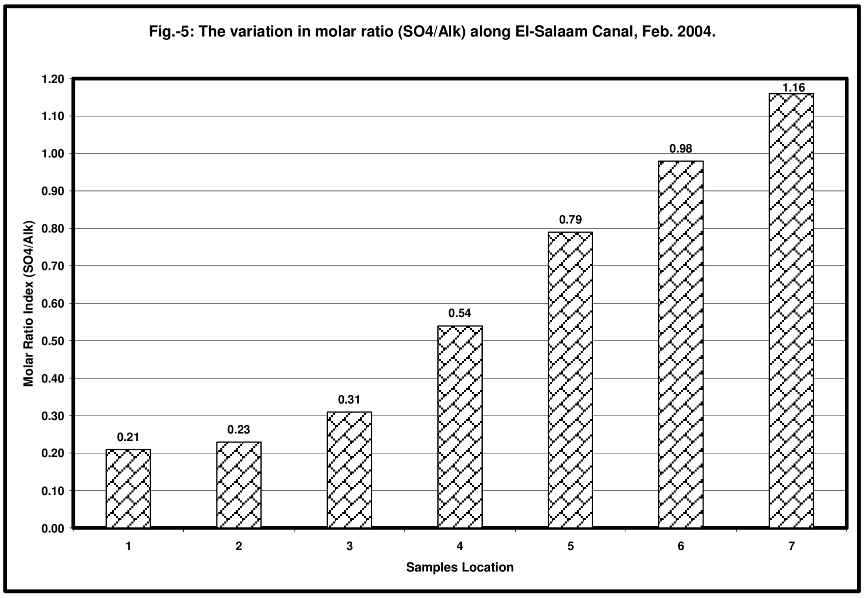

Fig. 3 Variation in molar ratio (SO4/Alk) along El-Salam Canal, February 2004