THE EFFECT OF CLOSING SECONDARY CHANNELS ON THE MORPHOLOGY AND THE ECOLOGY OF THE RIVER NILE

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ABSTRACT

The River Nile alters through time as a result of climate, geologic and hydrologic changes. Considerable variability of its channel morphology, as an alluvial river, along its length takes place. Thus new paths are formed and old ones are abandoned, forming what is called khors. A khor (secondary channel) is an expression used by the Ministry of Water Resources and Irrigation (MWRI) in Egypt to describe the Nile valley wetlands, which were part of the main river and are now secondary parts. There are about 103 khors along River Nile from Aswan to Delta Barrage their length changes from 400 to 6500 meters. Secondary channels along the River Nile are considered riverine wetlands. These wetlands have been noted for their high value in providing habitats for a variety of wildlife where different species of mammals, birds, reptiles, amphibians, fish and invertebrates use them for breeding, food or shelter. They also have quantifiable economic value, where money is spent on hunting, fishing, bird watching, tourism, as well as other activities. In general, wetlands provide tremendous economic benefits to humanity through fishery production, the maintenance of water tables for agriculture, timber production, water storage, and reduction of natural hazards such as flood. Wetlands also contribute to shoreline stabilization, waste disposal, and water purification and provide critical habitat for many species of fauna and flora. However, they are among the most threatened habitats due mainly to drainage, land reclamation, and pollution. The objective of this research is to study the effect of closing these secondary channels on the morphology and the ecology of the River Nile.

Key words: Wetland, evaluation, ecosystem components, biological resources, and secondary channels.

I- INTRODUCTION

The River Nile alters through time as a result of climate, geologic and hydrologic changes. Considerable variability of its channel morphology, as an alluvial river, along its length takes place. Thus new paths are formed and old ones are abandoned, forming what is called secondary channels. There are parts of the main river and are now secondary parts.

Secondary channels functions involve physical, chemical, and biological transformations within the ecosystem. These functions can be measured in quantitative terms along with an assessment of changes over a finite period of time.

The relevant information will be used to evaluate the secondary channels along the River Nile. This is including data specific to the uses and resources of the area under study such as: uses of the secondary channels, biological resources (living species) in the secondary channels. Other measurements include hydraulic data, and ecosystem component data.

The objective of this research is to describe data collection, field investigations, and data analysis, which were used to study the effect of closing these secondary channels on the morphology and the ecology of the River Nile.

II- THE STUDY AREA

Secondary Channels are extended from the northern part to the southern part on both sides of the River Nile. Although increasing population pressures, limited water resources, and water pollution pose a potential for significant difficulties, the use and the conservation of the secondary channels is among those opportunities that could provide considerable benefits. The necessary steps to promote the wise use and the ecological status of these secondary channels are to identify them and their boundaries, to provide a framework for their management, then to implement an action plan for their use.

Over the century a number of barrages and dams have been constructed along the River Nile which divides it into the following four reaches as defined by the barrages, Figure (1).

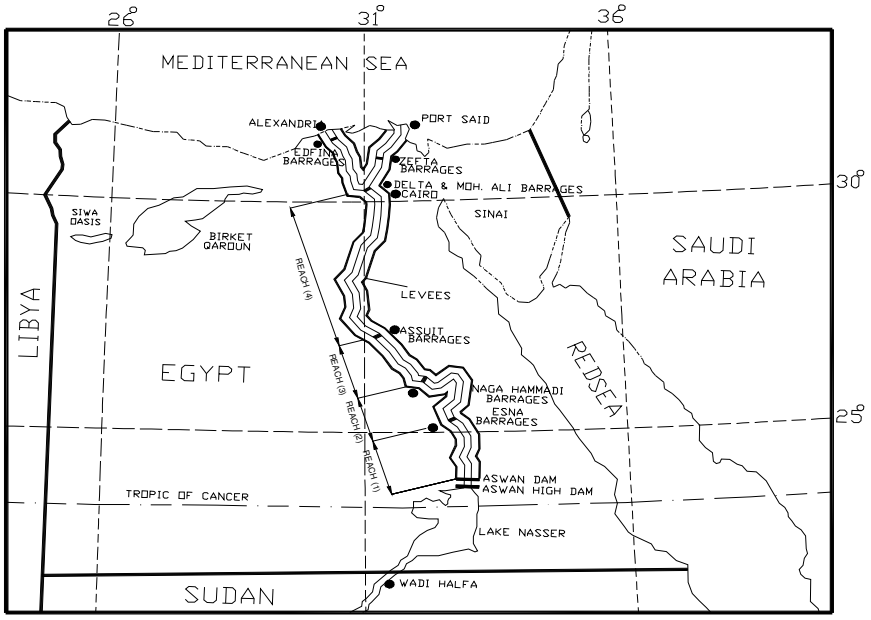


Figure (1): River Nile Extended from Aswan to Mediterranean Sea

Reach 1:	Aswan-Esna	(km 0.00 to km 166.65)
Reach 2:	Esna-Nag Hammadi	(km 166.65 to km 359.45)
Reach 3:	Nag Hammadi-Asyut	(km 359.45 to km 544.75)
Reach 4:	Asyut-Delta Barrage	(km 544.75 to km 953)

There are about 103 Secondary Channels along River Nile from Aswan to Delta Barrages their length changes from 400 to 6500 meters. The area of study extends 144 km from Beni-Suef to Delta Barrages. It is located within reach 4 from Asyut to Delta Barrages (km 544.75 to km 953). It contains a large number of secondary channels that were originally parts of the River Nile itself, which was determined from the topographic maps (scale 1:10000). A survey was conducted along the River Nile length in 1994 where it was found that there are about twenty-eight secondary channels between Beni-Suef and Delta Barrages.

A second survey was conducted for eight secondary channels, which were selected from the twenty-eight secondary channels along the River Nile length between Beni Suef and Delta Barrages. These secondary channels were selected according to the difference in geometrical shape, hydraulic characteristics, usage, and activities such that these secondary channels represent the other secondary channels in the area of study.

III- SECONDARY CHANNELS DATA ANALYSIS

A comprehensive review of the maps, as well as the field investigations showed that the area of study includes 28 well-defined secondary channels. Table (1) demonstrates the elementary data obtained from the maps as well as the field investigations such as location, area, and geometric properties. The table includes also the general uses of these secondary channels as were perceived from the field investigations.

For the detailed studies, eight secondary channels were selected from the twenty-eight ones according to classification that considers the difference in geometrical shape, hydraulic characteristics, usage and activities. The investigated secondary channels are representatives of the twenty-eight ones.

Table (1) and Figure (2) show that:

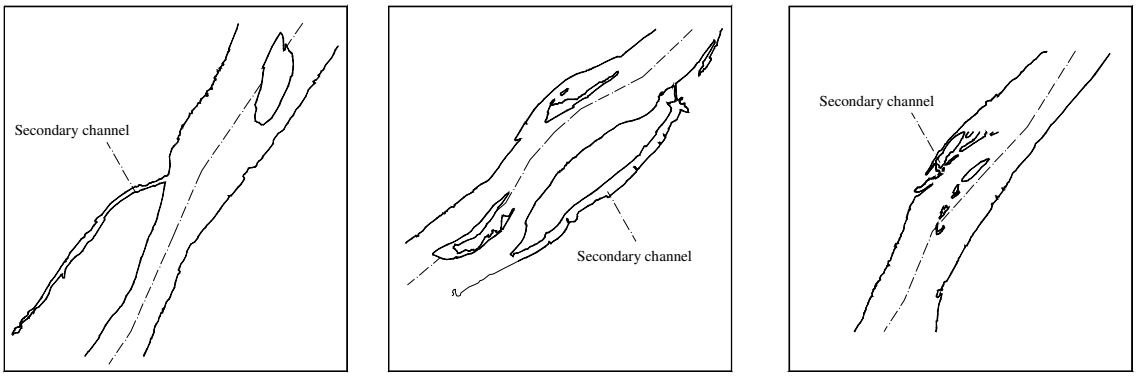
Secondary channels which are connected to the River Nile from one end, ranges from 520 meters to 2900 meters and their widths varies largely from 8 meters to 100 meters. In the meantime, the water depth varies from very shallow, 0.2 meters, to relatively deep, 8 meters. Also it is noticed that these secondary channels form about 44% from all secondary channels.

Secondary channels which are connected to the River Nile from two ends are having their length varies from 1000 meters to 5300 meters, their width varies from 30 meters to 250 meters, and their water depth ranges from 0.5 meter to 6 meters. These Secondary Channels constitute about 37% from all secondary channels.

The remainders, about 19% of the secondary channels, are connected with the River Nile from three or more ends. This type has length ranges from 1000 to 4500 meters; width varies from 20 meters to 140 meters, and water depth ranges from 1 meter to 6 meters.

Table 1: Secondary channels their geometrical characteristics and their uses

Khor No.	Khor name	Km from Aswan	Length (m)	Width (m)	Depth (m)	Area (Fed.)	Connected with the River Nile from			General Uses
							1 end	2 ends	>2 ends	
1	Der El Azraa	809.7	2500	30-100	2.5-5.0	38.69		*		Fishing, recreation, irrigation,
2	------	812.6	520	8-50	0.2-0.3	3.59	*			no use
3	Abo Sleem	814.5	2200	30-70	0.5-7	26.19	*			Fishing, irrigation, nesting,
4	El Alalma	816.1	5300	200-250	0.5-4	283.92		*		breeding for birds
5	El Shenawia	822.8	1900	20-50	1-2	15.83			*	
6	El Sorka	826.1	1000	35-140	1-3	20.83			*	
7	Abo Saleh	828.8	1450	60-100	0.5-1	27.62	*			
8	-------	829	backfield and cultivated							
9	-------	833	2600	50-150	0.5-2	61.9		*		Fishing, irrigation, nesting,
10	El Korimat	834.1	1000	60-100	2-3	19.05			*	breeding for birds, drainage
11	-------	841.6	1230	15-80	1-2	13.91	*			
12	Zawyt El Maslob	842.7	2000	30-60	5-8	21.43	*			
13	-------	842.4	1800	100	0.5-1	42.86	*			
14	Kafer Girza	861.8	2900	30-70	0.5-2.5	34.52	*			
14'	Kafer Barakat	864.5	4100	30-80	2-3	53.69		*		
15	El Makatifia	869.5	4500	30-80	2-6	58.93			*	
16	-------	875.8	2400	90-105	3-6	55.71		*		Navigation
17	-------	876.8	1400	70-100	5-6	28.33	*			
18	Nazlet Elian	886	1000	50-80	1.25-4	15.48	*			Recreation as duck catching
19	Kafer Tarkhan	890.2	2200	50-70	2-3	31.43		*		nesting breeding for birds
20	-------	892.6	1700	40-60	2-8	20.24	*			fishing, irrigation
21	-------	894.8	3700	70-100	1-4	74.88		*		
22	El Shobak	899.5	700	20-30	1-3	4.17	*			
23	El Marazik	902	3200	40-60	1.5-4	38.1			*	
24	-------	905.2	5000	70-150	1.5-3	130.9		*		
25	-------	910.6	1700	30-60	1.8-3.5	18.21		*		nesting, breeding for birds,
26	-------	915.5	1000	40-60	1-4	11.9		*		fishing, irrigation and waste
27	------	919	1600	30-100	1-5	24.76	*			disposal



(A) Secondary channel connected at one end (B) Secondary channel connected at two ends (C) Secondary channel connected at more than two ends

Figure (2): The types of secondary channel connected to the River Nile

IV- Hydrologic and Hydraulic Data Analysis

Before the construction of Aswan High Dam (AHD), the River Nile in Egypt experienced an annual flood starting in July and peaking in September. Figure (3) shows that prior to the AHD, the peak mean monthly discharge of about 8180 m^3/s (707 x 10^6 m^3/d) occurred in September and the minimum discharge of about 810 m^3/s (71 x 10^6 m^3/d) occurred in April. Now a day, Due to operation of the dam to meet the needs for irrigation, municipalities, industry and navigation, the peak discharge of about 2560 m^3/s (221 x 10^6 m^3/d) occurs in July and the minimum discharge of about 1300 m^3/s (112 x 10^6 m^3/d) occurred in January. It shows the dramatic reduction in peak flows, because of the construction of Aswan High Dam.

The lowlands are interlaced with secondary channels, which were active before the Aswan High Dam was built but some of them are now silting in and generally clogged with weeds. Very few weeds and grasses extend beyond the bars and islands into the main channel of the River Nile.

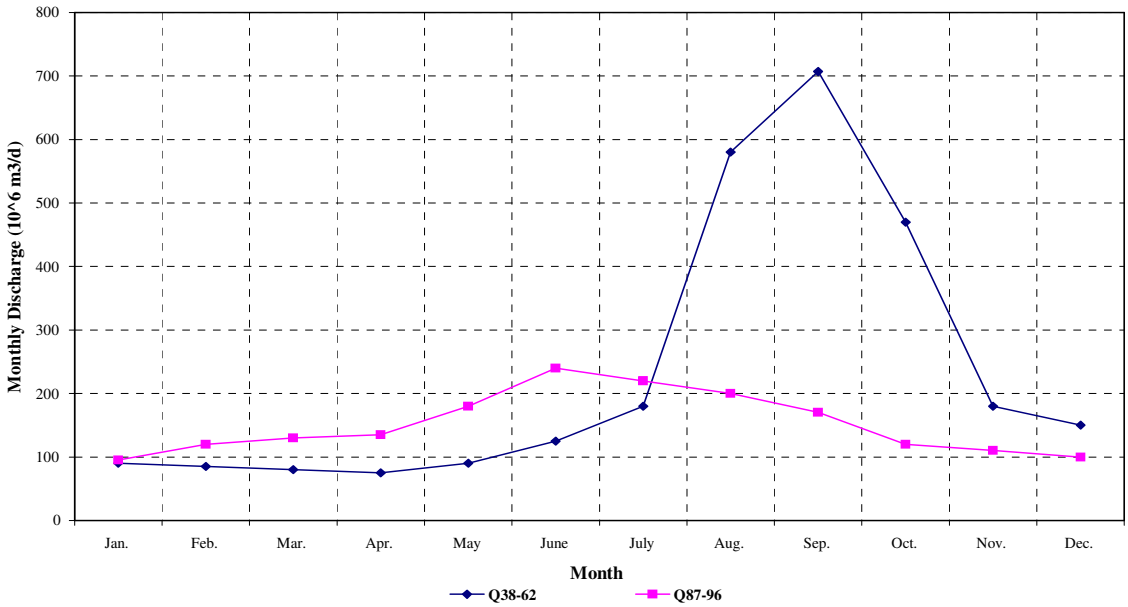


Figure (3): Pre-and Post- AHD Discharge at Aswan

Hydrology, climate, and releases from Aswan High Dam are the factors affecting the quantity of water coming into and out of the secondary channels. Water coming into the secondary channels as precipitation, surface runoff from surrounding uplands, diffuses groundwater inflow, and River Nile flow.

The discharges were measured during the field survey for the selected eight secondary channels. The discharges were measured during low flow period; therefore, some of the secondary channels had shallow depths with velocity almost zero.

Table (2) presents the discharges in the selected secondary channels as were found from the field survey. It was found that secondary channels number 6 and 7 have zero discharge because they were extremely shallow at the time of

measurements, which is not always the case for their flow conditions. Secondary channels number 3 used for aquaculture. The discharge enters this secondary channel through a pipe; therefore the discharge calculated by measuring the pipe diameter and the velocity through it.

Table (2): Presents the discharges in the selected secondary channels.

NO.	Km from Aswan	Site Name	Connected with the River Nile	Discharge (Q) $M.m^3/day$
1	**809.7**	**Der EL Azraa**	**2 ends**	**0.499**
3	**814.5**	**Abo Sleem**	**1 end**	**0.011**
4	**816.1**	**EL Alalma**	**2 ends**	**0.674**
5	**822.8**	**EL Shenawia**	**More than 2 ends**	**2.98**
6	**826.1**	**EL Shorka**	**More than 2 ends**	**-**
7	**828.8**	**Abo Saleh**	**1 end**	**-**
19	**890.2**	**Kafer Tarkhan**	**2 ends**	**0.264**
22	**899.5**	**EL Shobk**	**1 end**	**1.04**

Figure (4) shows the hydraulic and geometry of secondary channel cross sections, which are, part of River Nile flood plain. The effects of constructed dike to close secondary channels on river morphology and hydraulics vary greatly from location to location according to their connection with the River Nile. The side encroachment affects river functional parameters; they change the water levels, velocities and riverbed morphology. The cumulative lists of effects are bed degradation and increased thalweg depths (Beckett, 1983). Also, they decreased width and water surface area at normal and low stages, (Bengham, 1982).

These effects may be offsetting, for example, reduction in channel width reduces flow conveyance, but the resultant scour increases conveyance. River Nile floodplains should be kept clear from any random development to be ready to hold for any rise in water levels due to obligatory releases of emergency discharges downstream AHD in case of flood occurrence.

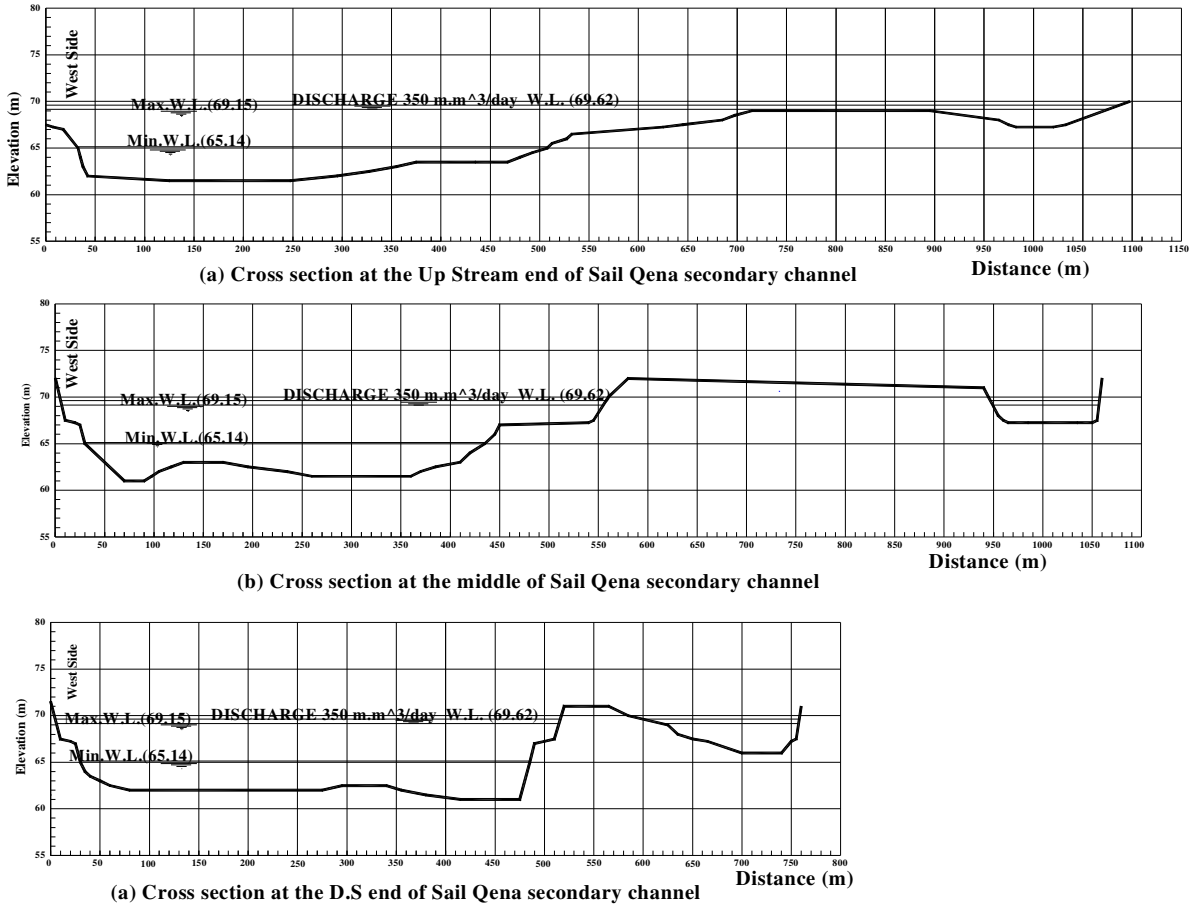


Figure (4): Cross sections along the secondary channel

V- ECOSYSTEM DATA ANALYSIS

The River Nile from Aswan to Cairo has a high degree of uniformity in natural characteristics and in the degree of development. As a result, the ecosystem findings in reach three between Nag Hammadi and Asyut barrages (RNPD, 1992) are considered to be generally applicable, to the entire River Nile. Thus, it is applicable between Asyut and Delta barrages (reach four), which is the area of study.

From the point of view of the ecosystem data, the River Nile watercourse runs through flat floodplains, which are almost entirely under irrigated agriculture. The only uncultivated areas on the floodplains are banks of canals and secondary channels where, in some of them, weeds, reeds and shade trees flourish. Around the secondary channels are the lowlands, which have been created by the River Nile in the form of sandbars and on which vegetation has taken place. Some of these lowlands are covered with sand dunes, some are under cultivation with winter crops during low flow periods and the margins are generally covered with weeds, reeds, and shrubs. The lowlands are interlaced with secondary channels, which were active before Aswan High Dam was built but some of them are now silting in and generally clogged with

weeds. Very few weeds and grasses extend beyond the bars and islands into the main channel of the River Nile.

Benthos and plankton

Plankton is important components of the aquatic systems in that they are the primary and secondary producers in the trophic food chain. Moreover, plankton often serves as indicators of water quality. The species composition of the plankton is often used not only to classify the water as polluted or free from pollution but also to suggest the quantities of various naturally occurring substances, such as nitrogen and phosphorus.

Plankton and benthic samples were collected at 22 stations at the wetlands between Nag Hammadi and Asyut, which are considered of the same characteristics as the area of study as mentioned before. The objective of the sampling was to identify the organisms present. It was not possible at that time to quantify these categories or to relate the distribution to the conditions of the sampling sites.

The surveyed data indicates the abundance of the river biota, such as the phytoplankton, zooplankton and benthos. An abundance of periphyton-algae attached to the river bottom-along the shore was observed. These periphytons play an important role as a nutritive source for fish, either directly or indirectly through insects or crustaceans. Zooplankton, based on preliminary observations, consisted of cladocerans, copepods and large rotifers. Benthos was comprised of chironomid and chaolorus larvae, polychaeteworms, corophium, leander and balanids.

Aquatic Weeds

The survey identified dominant communities of aquatic weeds along the River Nile and, more specifically, in the wetland areas. The survey was carried out during the low-flow period when the depth of water was about 0.5 to 1 meter. This condition is a key factor for observing both the plant community distribution and the growth along the secondary channels.

From field observations, it can be concluded that there is aquatic weed uniformity along the area of study. Meanwhile, submerged weeds were scarce in the River Nile itself and were growing mainly in the secondary channels. Several studies have demonstrated that aquatic weeds play a major role for fish habitats, waterfowl, water quality improvement, and erosion protection. As a whole, wetlands sustain production of micro-organisms (invertebrates), which enter into the food chain of fish and birds. For instance, it was noted during the survey that major fishing areas, recognized by the presence of fishing boats, were located close to secondary channels. Secondary channels heavily used by birds for nesting, breeding and as rest areas during migration period.

Fauna

The important species of fish found in the River Nile down stream AHD are Tilapia nilotica, Tilapia galilaeo, Hydrocynus forskalii, Alestes dentex, Alestes baremose, Lates niloticus, Bagrus bayad, Bargus docmoc, Synodontis schall, Synodontis serratus, Barbus bynni, Labeo horie, and Labeo coubic.

Egypt is located along a major bird migratory pathway between North-Eastern Europe and Central-South Africa. The northbound migratory movements peak in January and February, depending on the species. However, this can extend until May. The southbound migration normally takes place in the autumn period, mainly in September and October. The River Nile secondary channels are heavily used for resting during the migration period.

The birds, which inhabit the River Nile secondary channels, were identified and categorized into 27 migrant species, 26 resident breeding species, 4 migrant and resident breeding species and one migrant breeding species. Four of the identified bird species are considered to be rare birds. They are the White Stork, the Spoonbill, the Purple Gallinule, and the Glossy Ibis. Most of the other species have special importance in the field of nature conservation. More than 50% of the birds, which were observed, were of the migrant species, thus confirming the major role played by River Nile wetland areas.

In terms of abundance, the presence of more ducks during the survey especially in secondary channels 18 was very remarkable in that several thousand birds consisting mostly of Shoveler, teal and widgeon confirmed the importance of the area for wintering ducks. Also, the presence of Egyptian Geese was noticed with at least one thousand birds roosting on secondary channels.

VI- USAGES AND ACTIVITIES

The investigated secondary channels indicate that there are several uses for them, which can be illustrated as follows:

Fishing

Most of the secondary channels are used for fishing (about 96%) because they are clogged with aquatic weeds, which serve as fish habitat. Fishing is done by gill-nets, trammel nets and boats. Some of the secondary channels are used as fish farms.

Irrigation and drainage

Most of these lowlands are used for winter cropping such as peanuts, sesame, and carcadih. It is also used as pasture land especially during low flow period. Some of these secondary channels are used as drainage channels for cultivated high lands and wastewater disposal, especially at secondary channels close to communities.

Navigation and recreation

From the survey it has been found that two out of 28 secondary channels are used as navigation channels for medium boats. Some of them are used as recreation areas like religious tourist sites by using the attracting constructions and others are used for duck catching.

Natural Habitat

The secondary channels and their wetlands are used as natural spawning areas for fishes and as sanctuaries for the many species of birds, which were sighted. During migration period's birds use these areas for nesting, breeding and as rest areas. Since migrant birds have become protected by international agreements, it has also become very important to protect their habitats located along the River Nile.

VII- CONCLUSIONS AND RECOMMENDATION

* It can be concluded that secondary channels are a sub-channels separated from the main channel by a bar or island. There are three aquatic habitat types of secondary channels as follow; sub-channel connected with the main channel by an inlet and outlet and carries flow all year, sub-channel connected to the main channel by a single inlet or outlet and flow is occurring at the high stage, sub-channel connected to the main channel by more than two ends.

* Secondary channel areas are recognized as environmentally and economically valuable aquatic habitats. Closing them alter flow velocities and sedimentation patterns, thereby affecting river morphology and the amount and quality of aquatic habitat.

* Secondary channel areas used for, fishing, irrigation, drainage, navigation, as a natural habitat and recreation areas.

* The secondary channels and the river floodplains should be kept clear from any random development to be ready to hold for any rise in water levels due to obligatory releases of emergency discharges downstream the AHD in case of flood occurrence.

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