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Effects accompanying the passage of various discharges through Edfina Barrages

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ABSTRACT

The importance of fish production increased recently to fill the gap between the demand and supply of protein and to reduce the prices of meat and poultry. Applying Aquaculture in addition to natural fishing becomes the only way to increase the productivity of fish and reduce the gap of fish food production which estimated by 220 thousand tons annually. The aquaculture share is more than half of the total fish production. Using fish cages inside watercourses becomes nowadays a common aquaculture method. This method is widely used nearby Edfina Barrages. In September 2007, remarkable quantities of fish were dead on the region downstream Edfina Barrages with undefined reason. To identify the reasons of this problem, the technical staff of Channel Maintenance Research Institute (CMRI) carried out an intensive hydraulic and laboratory measurements at the study area to show the resulting change in physicochemical and morphological characteristics and reasons of death of fish due to varied water discharges, Barrages management, and accumulation of fish cages, weed growth and algae.

Appropriate solutions were suggested to maintain and improve fish production and ensure positive social and economic effects.

Key words: Edfina Barrages, , fish cage, morphological changes, physicochemical changes.

INTRODUCTION

The governmental authorities encourage the fish production which is important to fill the gap between the demand and supply of protein and to reduce the prices of meat and poultry. Participation of aquaculture with natural fishing will increase fish production and reduce the gap of fish food production [1], [2]. A common method of aquaculture is the fish cages that are located irregularly and illegally in Rosetta Branch, downstream Edfina Barrage.

Presence of accumulated fish cages downstream Edfina Barrage using bad feed system different from the Egyptian standard specifications, pollution resources in Rosetta Branch, and passing different discharges daily may lead to morphological change, low water quality, and fish death.

An intensive hydraulic and laboratory measurement were applied by the researchers of Channel Maintenance Research Institute (CMRI) in the study area to identify factors that led to the phenomenon of fish death in the past years. Also, appropriate solutions were developed to avoid fish death repetition in the future, improve fish production and ensure positive social and economic effects.

MATERIALS and METHODS

The study area:

This study was carried out nearby Edfina Barrages, 210 Kilometer distance downstream Delta Barrages as described in Figure(1), at the reach between 2 kilometers upstream and 40 kilometer downstream Edfina Barrages. Edfina Barrages have water lock of 12 meter width, 46 openings of 8 meters width, and car road of 12 meter width. The Management of these Barrages is supervised by Edfina Irrigation District, which follows general directorate of Delta Barrage.

Study activities:

These include visual survey for the studied area, collecting data of pollution resources in the Rosetta Branch, structural design of Edfina Barrages, fish cages downstream Edfina Barrages, passing discharges through Edfina Barrages at years of 2001, 2005, 2006, 2007 [3]. Also field measurements were applied during October 2008 as water velocities by using Electro Magnetic Current Meter, morphological surveying of cross sections, collecting and analysis of water, and soil samples by the team work of CMRI [1], and examine the collecting samples of dead fish.

RESULTS AND DISCUSSIONS

1-Analysis of previous data and observations:

Investigation of the studied area at December 2007, and March, April, and October 2008, and analysis of data collection of water distribution through Edfina Barrages [3] at 2001, 2005, 2006, and 2007 indicated the following:

- Sewage network of Rashed City flows into Rosetta Branch U.S. Edfina Barrages as illustrated in Photo (1).
- There are drains, Tala, (Fig. 1) flow into Rosetta Branch and carry direct and indirect pollutants [4], [5]. such as Elrahawy. Ganob Eltahreer, Zawiett Elbahr, Sabal,

- Almost 3500 cages were accumulated in random arrangement at watercourse downstream Edfina Barrages (Photo 2). These cages contain types of fish as (Family: Cichlidae), Monosex, *Oreochromis niloticus*, and *Oreochromis aureus*.
- Remnants of fish feed were accumulated on the bed of watercourse below cages.
- There was floating, cut weeds, and dead animals accumulated directly upstream and downstream the openings of Edfina Barrages as illustrated in Photo (3).
- In April 2008, the water flowed through three openings only and had greening slash foam as illustrated in Photo (4).
- Figure (2) presents the fluctuation of discharge through Edfina Barrages during 2001, 2005, 2006, and 2007. Also indicated that the maximum discharge passing through Edfina Barrages was 85.95m.m^3/day at October, 2007, and the minimum passing discharge was 0.200m.m^3/day which is constant for many months through the year.
- Fish death phenomenon was happened during 2001, and 27-30 August 2007 during passing high water discharges and flushing Rosetta Branch.
- The velocity of maximum discharge through Edfina Barrages openings in years 2001, and 2007 varied from 3.00 m/sec to 4.00 m/sec, which is greater than the stable velocity 0.3 m/s to 0.8 m/s [6], which can cause moving of deposition materials.
- Every opening of Edfina Barrages has two vertical sluice gates, water was distributed by fixed the lower gate to the apron bed, and moving the upper gate as illustrated in Figure (3).

2- Field Measurement

2-1 Water Velocity and Discharges

Water velocities were measured by using Electro Magnetic Current Meter on four cross sections located at 0.500 Kilometers upstream Edfina Barrages, and 0.500, 10.000, and 36.000 kilometers downstream Edfina Barrages as shown in Photo (5). It was noticed that the average actual water velocity varied from 0.06 m/sec to 0.08 m/sec for the cross sections downstream Edfina Barrages. While the average actual water velocity was 0.05 m/sec at the cross section located at 0.500 kilometer upstream Edfina Barrages.

The calculated Water Discharges at locations of 0.500 kilometer upstream Edfina Barrages, and 0.500, 10.000, and 36.000 kilometers downstream Edfina Barrages were 15.17 m.m^3/day, 20.95m.m^3/day, 14.04 m.m3/day, 19.29 m.m3/day respectively.

2-2 Surveying the Cross Sections

Identifying depths of water, depositions, and scouring in the studied reach were carried out at the same locations of measured velocities and surveyed by using Echo Sounder instrument. The results showed that the water depths ranged between 4.00 m to 10.00 m, and the left side of watercourse was more scour directly downstream Edfina Barrages than the right side as illustrated in Figure (4) as a result of passing water through the water lock and a few openings at the left side of the barrages.

2-3 Chemical and Physical Measurements of water

During October 2008, samples of water and soil were collected from six locations at the studied reach, locations 1, 2 at kilometers 1.000, 0.500 upstream Edfina Barrages, and locations 3,4,5,6 at kilometers 0.500, 10.000, 36.000, and 40.000 downstream Edfina Barrages as shown in Photo (5).

Analysis of water samples included temperature, pH, dissolved oxygen, electrical conductivity, total dissolved solid, turbidity, and transparency. In addition to potassium, sodium, ammonia, nitrate, sulfate, phosphate, silica, copper, and iron. Results of the physical and chemical parameters analysis were shown in Table (1). The parameters ratios for all locations were compared by a low of watercourse protection (Law 48/1982) to identify the change of elements concentration upstream and downstream Edfina Barrages. The analysis showed that concentration rate of physical and chemical parameters in water at some locations during different site visits exceeded the permissible limits as listed by Law No. 48 of 1982 such as dissolved Oxygen concentration, dissolved salts, ammonia, sulfates, copper, and iron. In addition, concentration of ammonia ranged between 0.18 to 23.7mg/l and exceeded limits and criteria set out a 0.5 ppm due to the presence of organic pollutants, sewage, and presence of fish waste and feed in water.

2-4 Soil Chemical and Physical Measurements

Samples of sediments were collected from different locations at the studied area. One sample was collected at the beginning of Rosetta Branch and six samples were collected from the same locations of water samples. Analysis of soil samples included the physical characteristics as sediments color, degree of cohesion, pH, electrical conductivity, mechanical analysis of sediments. In addition, chemical characteristics as measuring the proportion of organic matter, and concentration of potassium, sodium, Copper,Iron which are shown at tables (2). The analysis showed that the collected soil samples from locations at the beginning of Rosetta Branch, and 10.000 kilometer downstream Edfina Barrages was sandy soil with low cohesion and low water retention. Otherwise the other samples of soil

nearby Edfina Barrages was silty and silty clay, the color of soil was dark tends to greening due to presence of algae and haumat plant at the soil surface and sever cohesion and strong water retention.

2-5 Water Biological Characteristics

Samples of water were collected for algae estimation from the same locations of water samples. The analysis cleared that concentration of chlorophyll (a) was 5.1 and 13.3 mg / liter at locations 1 and 2, respectively, with an average 9.2 mg / liter, while concentration of chlorophyll (a) were 4.6,0.014,1.9,6.9 mg / liter at locations 3,4,5,6 respectively, with an average 3.35 mg / liter. Concentration of Fayyovian was 55.98, 13.90, 37.00, 31.86, 75.65, 19.03 mg / liter, and percentage chlorophyll/ Fayyovian was 23.8%, 36.7%,18.6%, 6%, 6%, 0.02 at locations 1,2,3,4,5,6, respectively. Also the results showed that existing crop of phytoplankton water at locations 1, 2, 3, 4, 5, 6 were 22, 25, 21, 16, 16, 15x104 units / liter, respectively. The green algae (Chlorophyceae) was more varied, represented by 9 types and the prevalent type is *Pediastrum simplex*. Also, the numerical density varied from one location to another.

2-6 Examination of Dead Fish in Cages

Fish samples were collected and examined from the cages in the affected area, most samples of fish were from Family Cichlidae (monosex) which represented 70% of the fish in the cages, in addition to *Oreochromis niloticus* , as well as tilapia (*Oreochromis aureus*). These fish were examined apparently and anatomically to check its status in accordance with the accepted biological criteria, and the influence of bacteria, fungi, and external parasites. In addition, gills were checked to make sure from the description of the color and the presence of any attached parasites. As these fish were dissected to see changes in the color and shape of the internal organs. Anatomical virtual fish exudes that there are abnormal conditions to the aquatic environment such as presence of some pollutants in water, soil, feed, and sewage may affect the color of fish's skin, gills, and liver.

3- Economic evaluation

Fish farming projects of floating cages are spreading at Rosetta and Damietta Branches in Egypt and characterized by low cost and high profitability relatively to other kind of fish farming projects. These projects require a suitable water environment for growth of fish (temperature, proportion of oxygen, low concentration of ammonia, pollution free), renewable water with suitable velocity in the watercourse with depth not less than 2.50 meters. In addition, cages depth at least 2.00 meters, and the gap between bottom of cages and bed of watercourses not less than 0.50 meter to avoid the effect of

remnants feed on fish. Floating cages vary greatly in materials, shapes, sizes, and production due to purposes, price of raw materials, and the alternatives that are available in each region.

Field survey and data collection helps to estimate the net return of cages downstream Edfina Barrages as in Table (3).

3-1 Calculation of total annual cost for cage (Operating Costs)

Average annual depreciation costs can be calculated as the following:-

- The estimated average cost for cages have 5 years lifetime and dimension 10.00m*15.00m*2.00m is LE 8500, and then the estimated average depreciation cost is LE 1700 /YEAR.
- By estimation the cubic meter contains 120 fish fingers of weight 20gm, and 15% mortality rate, the average cost of fingerlings can be calculated as follows:-
  - 20 thousand tilapia fingers *LE 350 = LE 7000/year
  - 3.5 thousand puri fingers*LE 1300 = LE 4550/year
- The average feed costs can be estimated as follows:-
  - Annually cost of concentrated feed = 60 ton *LE 2800=LE 16800/year.
  - Annually cost of fhorts = 1ton *LE 1400=LE 1400/year.
- The average labor costs can be calculated by estimation that every cage needs 1 permanent labour and 2 seasonal labours as follows:-
  - 1permanent labour *LE 750*8=LE 6000/year
  - 2seasonal labours *LE 100= LE 200/year
  - Other expenses =LE 4000/year

Then the average annual total cost of one cage for the production of tilapia and puri fish is estimated LE 40800/year/cage as shown in table (3).

3-2 Average Production and Revenue

From the average prices traded in the study area, and the questionnaire data which shows that one cage produces 4.50 ton/year of tilapia and 1.20 ton/year of puri fish, The revenues of cage can be calculated as follows:-

- 4.50 ton tilapia * LE 10/kilo = LE 45000/years
- 1.20 ton puri * LE 21/kilo = LE 25200/years

Then the expected average annual total return to produce tilapia and puri fish for one cage downstream Edfina Barrages is estimated LE 70200/year/cage as shown in table(4).

3-3 Average Annual Net Return

From previous results, the estimated average net return per cage is LE 28550/ year/ cage.

3-4 Average Production and Average Annual Net Return of Cages

The questionnaire data indicated that the numbers of cages downstream Edfina Barrages are 3500 floating cages, this means that the estimated average total production of fish for cages are 19.95 thousand tons/year and the estimated average total net return for these cages is LE 99.925 million / year as described in the table(4).

The collected data from the Directorate of Water Nile Protection indicated that the estimated annual cost of maintenance for openings gates (46 openings) is LE 0.63 million / year, which represents less than 0.65% of average total net return for cages downstream barrages.

Many returns have been achieved as a result of the implementation of this investment project, for most of which is the social consequences of the project, which play a major role in achieving economic and social development, where the consequences of this project is to provide 5000 jobs, generate incomes for young and middle-level fishermen, and reduced prices of fish which the consequent increase per capita animal protein and work to narrow the gap fish food, and produce about 20 thousand tons of fish.

Conclusions

Rosetta Branch is characterized by low discharge most days of the year, which leads to decrease water velocity and causes accumulation of rotten deposits nearby the closed gates of Edfina Barrages. During high water discharge, water quality is low [7], most gates of Edfina Barrages were opened, the rotten deposits and contaminants due to outfalls of polluted drains into Rosetta Branch were flushed and pass through Edfina Barrages causing fish death into cages which are accumulated irregularly and illegally in Rosetta Branch, downstream Edfina Barrage.

Also operating minimum numbers of gates and the lock during most days of year at the left side of Edfina Barrages could cause bed erosion at left side of watercourse downstream Barrages.

Accumulation of fish cages downstream Edfina Barrages could restrict water flow and cause erosion and deposition in the same water section, also the high economic and social consequences of this project will be lost as a result of daily water discharges fluctuations and low water quality.

Recommendations

To decrease the accompanied effects of passage of various discharges through Edfina Barrages, the researchers suggests the followings:-

- Controlling the sources of pollution from the drains and sewage network, which cause the presence of contaminants on the Rosetta Branch.
- Periodically removing sediments directly upstream and downstream opening gates of Edfina Barrages before rotting by using mechanical equipments.
- Operating the lower gate of Edfina Barrages and installing the upper one to pass the water and the reserved sediments on the apron continually as shown in Figures (5-a,b).
- During the low water discharge, the water must pass daily interchangeably through openings gates, so do not accumulate sediments U.S. and D.S. gates.
- During the high water discharge, operating most of 46 opening gates, starting from the middle openings to move the deposits and decrease the erosion at the left side of the watercourse.
- The coordination between Edfina Irrigation District and fishermen during months of passage high water discharges to avoid fish death.

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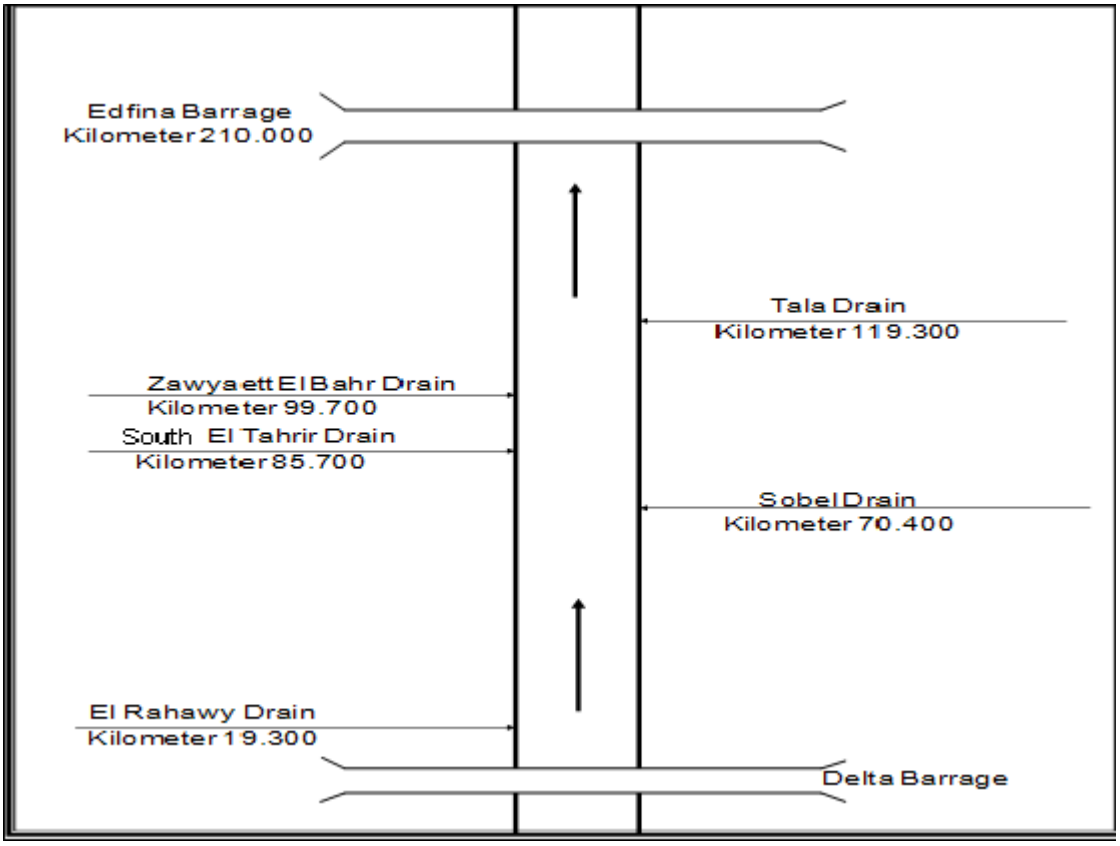

Fig. (1). Sketch of study area and drains outfalls in Rosetta Branch

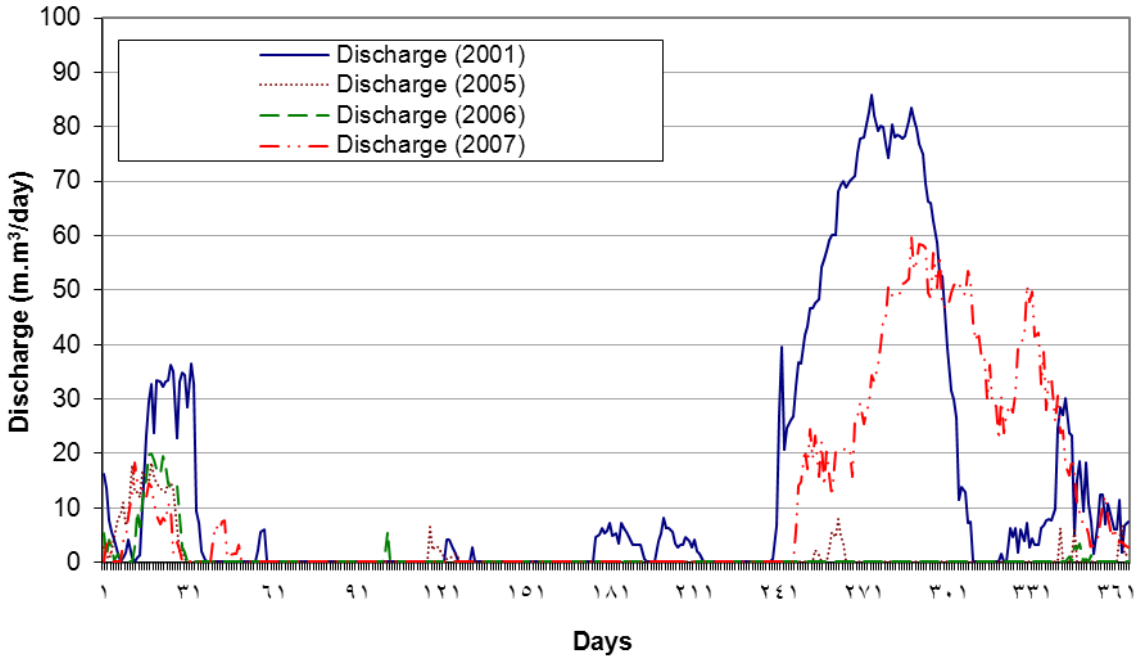

Fig. (2). Discharges through Edfina Barrages

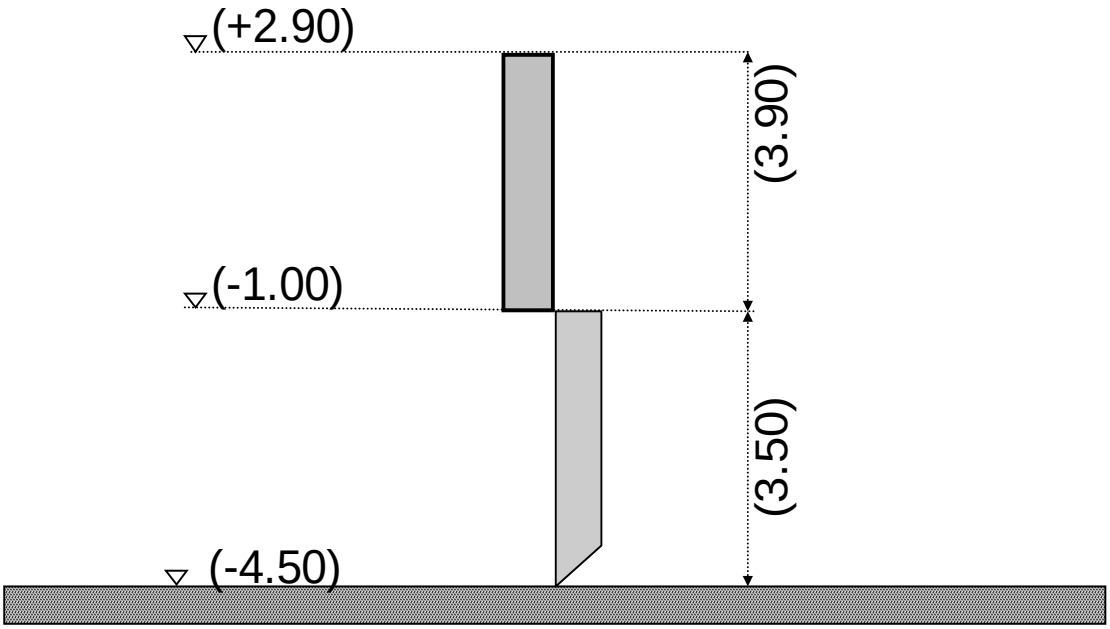

Fig. (3). Levels of Sluice Gate

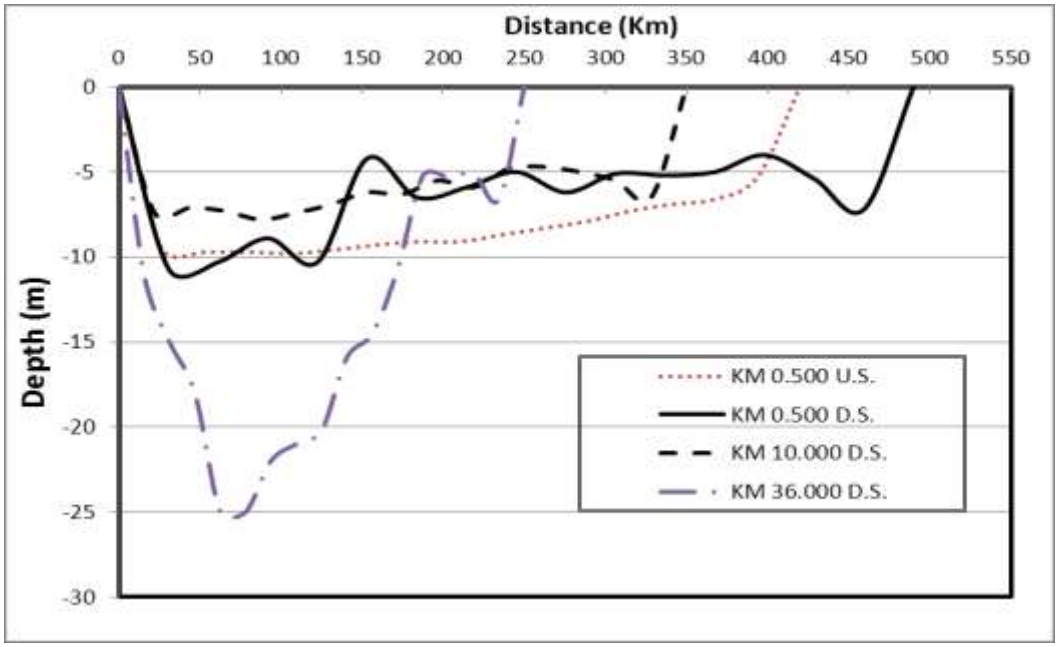

Fig. (4). Cross Sections U.S. & D.S. Edfina Barrages

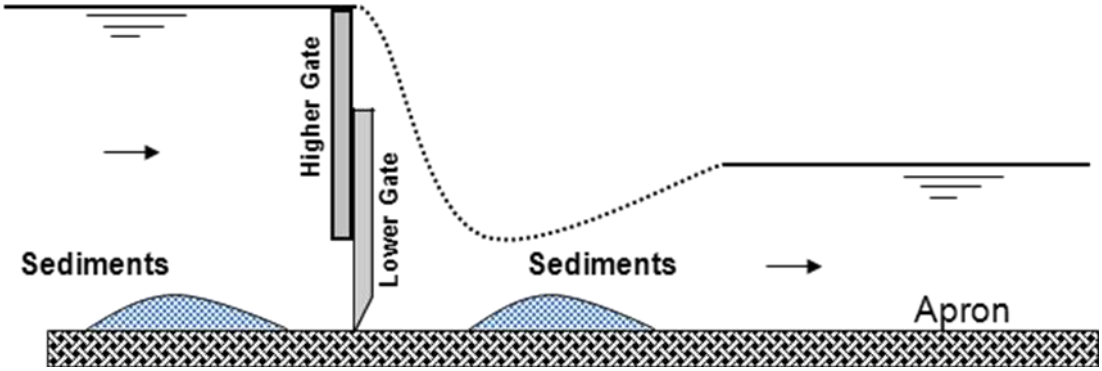

Fig. (5-a). Usual Gate Operation

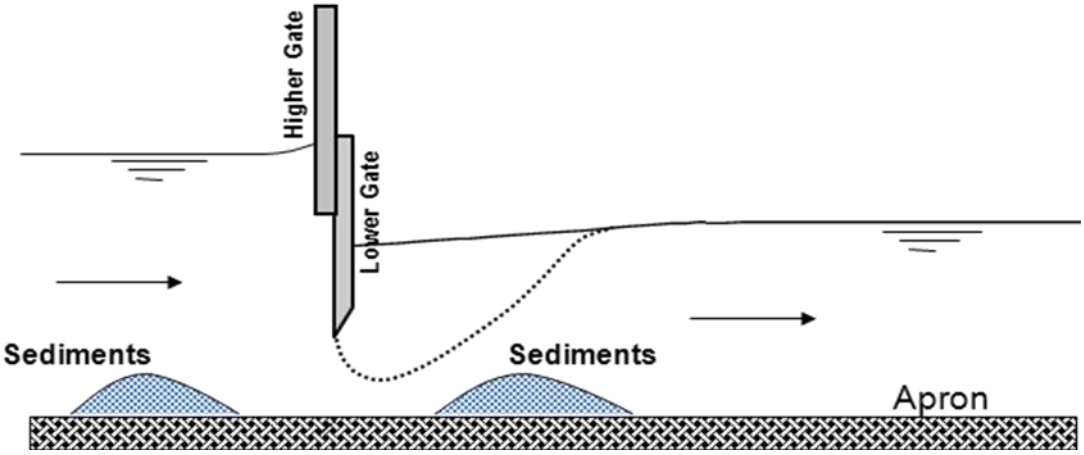

Fig. (5-b). Suggested Gate Operation

Photo (1). Sewage Network Outfalls in Rosetta Branch

Photo (2). Irregularly Cages Downstream Edfina Barrages

Photo (3). Accumulated Weeds Upstream Edfina Barrages

Photo (4). Green Slash Downstream Edfina Barrage

Photo (5). Locations of Water and Soil Samples

Table (1). Analysis of Chemical and Physical Measurements for Water Samples in April 2008.

Location No.	1	2	3	4	5	6	The law (48/1982)
Physical Parameters							
Temperature (c°)	22.3	23.3	21.9	23.4	25.1	26.1	5 °c up to normal
pH	8.36	8.56	8.48	8.91	9.22	8.78	7-8.5
Dissolved oxygen (O_2) mg/l	8.61	10.28	6.86	9.25	12.81	8.21	≥ 5
Electrical Conductivity (EC) mhos/cm	0.597	0.601	11.04	11.88	28.4	25.1	-
Total Dissolved Solid (TDS) mg/l	382	385	7066	7603	18176	16064	500
Turbidity FTU	22	13	16	7	19	38	-
Transparency (cm)	90	90	85	110	100	80	-
Some chemical parameters (mg/l)							
Potassium K	8.60	8.211	74.29	78.2	199.41	164.22	-
Sodium Na	28.52	29.44	750.72	976.35	2208	1987.2	-
Ammonia NH_4	4.86	4.7	12.1	5.14	2.57	23.7	< 0.5
Nitrate NO_3	4.488	4.62	4.356	3.3	0.968	3.784	≤ 45
Sulfate SO_4	46	46	360	360	1260	1380	≤ 200
Phosphate PO_4	5.7	5.34	2.28	2.68	1.00	3.784	-
Silica Si	24	22	25	16	27	53	-
Copper Cu	0.22	0.09	0.72	1.1	0.97	0.95	≤ 1
Iron Fe	0.07	0.04	0.06	0.64	0.92	1.2	≤ 1

Table (2). Analysis of Chemical and Physical Measurments for Soil Samples in October 2008.

Locations (Km)	PH	EC (µmhos/cm)	Organic material %	K* (ppm)	Na+ (ppm)	Fe (ppm)	Mn (ppm)
Roseta inlet	7.32	218.20	0	44	16	84.60	157.50
0.500 U.S. Edfina Bar.	7.53	775	9.40	24	59	76.95	1125
0.500 D.S. Edfina Bar.	7.72	469	6.05	16	36	97.2	225
10.000 D.S. Edfina Bar.	7.42	20660	12.09	76	2940	105.75	544.5
36.000 D.S. Edfina Bar.	7.37	2252	3.39	35	450	1300	585
40.000 D.S. Edfina Bar.	7.20	30500	12.35	79	3960	68.4	666

Table (3). Yearly Costs of Fish Cages Farming Project D.S. Edfina Barrages

Statement of costs	Component costs	Quantity	Unit price in pounds	Value of costs (in thousands of pounds)	Costs for the 3500 cage (millions of pounds)
Annual depreciation is estimated at 20% of the value of the cage			8500	1.7	5.95
fingerlings (in thoudands)	Tilapia	20	350	7	24.5
	Puri	3.5	13.00	4.55	15.925
Feed (tones)	Concentrated	6	2800	16.8	58.8
	Fhorts	1	1400	1.4	4.9
Employment	A large permanent	1×(8 months)	750	6	21
	Seasonal fisherman	2	100	0.2	0.7
Other expenses	Miscellaneous		400	4	14
Total				**41.65**	**145.775**

Table (4). Average Yearly Production and Return of Fish Cages Farming Project D.S. Edfina Barrages.

Type of product	Quantity produced the cage (tons)	Price per Unit (in thousands of pounds/ton)	The value of production per cage (in thousands of pounds)	Cage production number 3500 (in thousands of tons)	Retum cage 3500 (millions of pounds)	3500 cage costs (millions of pounds)	Net income cage 3500 (millions of pounds)
Tilapia	**4.5**	**10**	**45**	**15.75**	**157.5**	**145.775**	**-**
puri	**1.2**	**21**	**25.2**	**4.2**	**88.2**		**-**
Total	**5.7**	**-**	**70.2**	**19.95**	**245.7**	**145.775**	**99.925**

التأثيرات المصاحبة لأمرار تصرفات مختلفة من قناطر ادفينا

امام عنتر عثمان, احمد محمد الفاروق, محمد صلاح عبد المعطى، ياسر محمود على
المركز القومي لبحوث المياه

تزداد اهمية انتاج الاسماك لسد الفجوة بين الطلب والمعروض من البروتين ولتقليل اسعار اللحوم والدواجن. لذا فان استخدم الاستزراع السمكى بالاضافة إلى الصيد أصبح السبيل الوحيد لزيادة الانتاجية من الاسماك وتضييق الفجوة فى انتاجها والتى تقدر بحوالى 220 الف طن سنويا وبخاصة عندما اصبح نصيب الاستزراع السمكى يزيد عن نصف الناتج الاجمالى من الاسماك. ولقد اصبح الاستزراع السمكى داخل اقفاص بالمجارى المائية من انواع الاستزراع الشائعة ولقد تم تطبيقه بالمنطقة حول قناطر ادفينا، وقد تلاحظ حدوث نفوق لكميات كبيرة من الاسماك فى شهر سبتمبر عام 2007 خلف قناطر أدفينا ولتحديد اسباب هذه المشكلة قام فريق العمل بمعهد بحوث صيانة القنوات بأجراء قياسات هيدروليكية ومعملية بمنطقة قناطر أدفينا لتحديد التغيرات الفيزيوكيميائية والمورفولوجية التى تصاحب تغير التصرفات وتشغيل القناطر والكثافة المرتفعة لتوزيع الاقفاص ونمو الحشائش المائية والطحالب والتى قد تتسبب فى موت الأسماك.

تم فى هذه الدراسة اقتراح عدد من الحلول للحفاظ على انتاج الاسماك وتفادى نفوقه وضمان مردود اجتماعى واقتصادى ايجابي للمنطقة.