MODEL DRIVEN SCENARIOS FOR WATER QUALITY CONTROL OF BAHR EL BAQAR DRAIN

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ABSTRACT

Bahr Al-Baqar drain receives very high organic load from domestic (point and diffuse sources) and industrial sources. Therefore, Bahr Al-Baqar is considered as one of the most polluted drains in Egypt. Several interventions for water quality improvement Bahr Al-Baqar Drain system have been tested through modelling technique. Many improving interventions are planned and/or under construction at East Cairo and along Bahr Al-Baqar watershed for all the drainage system and for separate drains and clusters. The improving interventions are simulated through several scenarios using the hydrodynamic model DUFLOW, which was selected after careful assessment of a number of alternative modelling packages. The developed model has been used and will further study the technical feasibility for improving the water quality in Bahr Al-Baqar Drain. The main objective of this study is to analyze and quantify the influences of these interventions on the water quality of Bahr Al-Baqar Drain. To identify the water quality characteristics, the pollution loads, and the decay rates of pollutants, a monitoring program has been carried out covering Bahr Al-Baqar Drainage system.

Prior to the application of the model, all available data was analysed in detail. Depending upon the length, continuity and reliability of historical data, the specific time periods for model calibration and validation were identified. , aBahr Al-Baqar drainage system oxygen module was developed and the model parameters were calculated. The developed module includes also the determination of biochemical oxygen demand (BOD) order to predict changes in stream conditions that will follow proposed reductions in plant wastes or to predict the effects of new treatment plants discharging to streams

The developed model was successfully calibrated. Scenario results revealed that the best scenario is in case of operation of all under construction and planned treatment plants. The impact will be on Bahr el-Baqar Drain with average reduction in BOD of 95% and the BOD at outfall reaching almost 9 mg/l. The impact on Qalyubia Drain will be an average reduction in BOD of 85% and the BOD at outfall reaching 14 mg/l. The impact on Belbeis Drain will be an average reduction in BOD of 71% and the BOD at outfall reaching 20 mg/l. By conducting many scenarios using the developed model, decision makers can use the model as a tool for quality management and resource allocation, in order to achieve designated water quality objectives. An economic study and environmental assessment are needed in order to choose the optimum scenario technically and economically.

Keywords: : Bahr el baqar drain, modeling, water quality control

1 INTRODUCTION

Polluted drains are considered one of the most important hazardous elements for the surrounded environment. Therefore, it is direly needed to control the water-quality concentration up to an optimum level to conserve water ecology. Modeling is the appropriate tool to conduct many scenarios to control the water quality of the drains. With advances in computation and processing technology in the twenty-first century, a large number of substantial improvements have been made in the area of surface water-quality simulation tools that have led to the varieties of surface water-quality models. Currently, there are many water-quality models for strategy development and decision-making purposes for different types of water bodies. These models have been improving continuously based

on the latest innovation and studies, (Cox, 2003, Tsakiris et. al., 2012 and Wang et.al, 2013.Recently, several water-quality models, have been constructed for simulating the status of the water quality of lakes, rivers, and estuaries worldwide, 9Kannel et.al., 2011 and Gao et.al., 2014).

One of the most polluted drains in Egypt is Bahr ElBaqar drain (BBD). Many studies have been conducted to study BBD water quality. (Khalil, 1985) studied the effects of sewage and pollution wastes upon el Baqar drain and the southern area of lake Manzala. The results indicate that the high nutrient input to the El Genki region created eutrophic condition in the southern parts the lake and have changed the aquatic biota.(Khalil et.al., 1988) concluded that the biological water quality parameters in the southern area of lake Manzala is greatly affected by the input of Cairo Sewage through BBD and that most of clear-water organisms have disappeared from this area and polluted tolerant species have dominated.

(Ismail, 1994) studied the effect of wastewater discharges on the water quality of BBD and revealed that the major pollution problem is the microbiological health hazards and there is high concentrations of heavy metals., (Ismail, 1997) studied the water quality management of drains in eastern Nile delta and concluded that for restricted use, the secondary treatment of the East Bank of greater Cairo is required. for unrestricted use, partial chlorination after the secondary treatment of the East Bank of greater Cairo is required. (Galal et.al, 1999) studied the environmental evaluation of Bahr el Baqar Drainage water and its optimum utilization for irrigating extension areas. The results reported significant deterioration of the water quality of the lake is due to the direct Discharge of wastewater. The relation between the environmental pollution and the health status of the population inhabiting the area near the lake was established.

(Zhu et.al, 1999) showed that the water quality parameters measured along the drain exceed the legal limit and that the drain water is loaded with considerable amount of heavy metals, high level of Ammonia, organic matter, pesticides, fertilizers and suspended materials. (Abdel-Satar, 2001) studies the effect of the drains effluent on the variations of trace metals and inorganic anions and cations of water were studied in the southern sector of Lake Manzalah during four successive seasons (1999-2000). The study revealed that an obvious depletion of dissolved oxygen has occurred in addition to a high increase in COD and BOD in the area which received the urban and agricultural wastes from BBD. The concentrations of the nutrient salts showed a wide fluctuation and abrupt changes due to irregular influx of different wastes. Also, high and abnormal concentrations of ammonia, nitrate and orthophosphate were recorded. The levels of trace metals in lake water were high in areas received domestic and agricultural effluents.

(Shaaban , 2001) classified BBD into cluster 1 where Highest BOD and TSS levels were recorded and also showed lowest TDS, SAR and DO levels. However, N-NO3 and Fe were generally moderate. (Elshazely, H., 2004) studies the impact of the wastewater effluents on the water quality of Bilbeis drain downstream of the WWTPs El Gabal El Asfar and El Berka east of Cairo and the reuse of the treated effluent in agriculture. (El-Baz et.al., 2005) studied the solution strategies for nitrogen management along with their technical, economic, and environmental implications. Bahr El Baqar) along with the outfall to Lake Manzala. (Elkorashey, 2009) estimated the water quality parameters of BBD using regression analysis techniques.

(Awadallah et.al, 2011) studied the detection of temporal and spatial trends on two main drains in the Eastern Nile Delta (Bahr Hadus and BBDs) The analysis showed improved (lower) salinity levels in the Bahr Hadus Drain. Although the BBD belongs hydrobiologically to the same region, it is subject to fluctuations in salinity levels along the drain mainstream except near the outfall of the drain where the salinity level increased due to the reclamation activities taking place south of the Sahl El Hussania area. On the other hand, operation of the wastewater treatment plants of Greater Cairo have influenced the overall water quality conditions of the BBD.

(Kraman, 2013) has studied the optimizing process of the monitoring network of Bahr El Baker drain system. (Gawad et.al, 2013) studies a re-assessment procedure of the water quality monitoring

locations of one of the main drainage catchments in Eastern Delta of Egypt, namely BBD. It was found that first principal components, mainly salinity, Oxygen budget, and Nitrogen cycle components, explain about more than 70% of the variability of the water quality data in all Bahr-Baqar Drain locations. On the other hand, cluster analysis resulted in a grouping that is totally explained by the sampling location, and helped determine which locations to retain in future sampling campaigns, without losing information of water quality data.

The paper objective is to predict water quality of BBD through carrying out hydrodynamic and water quality modeling of BBD. The developed model will study the technical feasibility study for improving the water quality in BBD . This technical feasibility study will involve management scenarios to control pollution of BBD. Therefore, it can be used by decision makers as a tool to quality management and resource allocation, in order to achieve designated water quality objectives.Several interventions for water quality improvement BBD system have been tested through modelling technique .Many improving interventions are planned and/or under construction at East Cairo and along Bahr El Baqar watershed. The main objective of this study is to analyze and quantify the influences of these interventions on the water quality of BBD. The improving interventions are simulated through several scenarios using the hydrodynamic model DUFLOW.

2 STUDY AREA DESCRIPTION

Bahr El Baqar Drain (BBD) is 106 km long and has two main branches: the 73.2 km El Qalubia drain and the 66 km Belbais drain. Its depth is about 1-3 m and its width is about 30-70 m. The total catchments area of Bahr El Baqar drain system is 760,000 faddans, 300,000 feddan for Qalubia drain, 60,000 feddan for Belbais drain and 400,000 feddan for Bahr El Baqar drain downstream from the intersection of the two main branches Scheme of the Bahr El Baqar Drain system is shown in Figure 1. The total discharge pumped to Lake Manzala from that drain is 2.561 BCM/year with a salinity of 1542g/m3 (DRI, 2013). Bahr El Baqar drain contributes to almost 45% of the total discharge into the lake.

BBD basin is located in a very densely populated area of the Eastern Delta passing through Qalyoubiya, Sharkia and Ismailia Governorates. The water of Bahr El Baqar is used unofficially for irrigation and contributes much to groundwater pollution in the Sharkia Governorate. All sewage and industrial wastewater, treated and untreated, from the eastern zone of Greater Cairo is dumped into the Bilbeis drain through the effluents of both Gabal Asfar and Berka treatment plants. The capacity of Gabal Asfar plant is 1.7 million m3/day while that of the Berka treatment plant is 600,000 m3/day. Table 1 presents the present and future secondary treated wastewater flow effluent from the two WWTPs according to the planning of Cairo Wastewater organization (Water Policy Program, Report No. 20, 1999).

The state of the Qalyoubiya main drain is more serious than the Bilbeis drain. Qalubia's main 14 branches (intermediates) collect treated and untreated wastewater legally and illegally from the heavily populated area of Shobra El-Khemma and its large industrial area including metal production, food processing, detergents and soaps manufacturing, textile finishing and paper production, together with the urban communities Qalyoubiya and Sharkia Governorates. BBD receives very high organic load from domestic (point & diffuse sources) and industrial sources. Therefore, Bahr El Baqar is considered as one of the most polluted drains in Egypt (Abdel-Shafy and Aly 2002). Drainage Effluents discharged to BBD is nearly about 2.369 bcm/year and water reuse is 0.195 bcm/year. The domestic point source wastewater discharge was assumed to be 0.67 bcm/year, Industrial Point Sources was assumed to be 0.023 bcm/year and Domestic Diffuse Sources was assumed to be 0.045 bcm/year.

Table 1. Average Flow from Berka and El Gabal El Asfar WWTP's

Year	2000	2005	2010	2020
El Gabal El Asfar Plant, Mm3/d	1.00	1.30	1.80	2.50
El Berka Plant, Mm3/d	0.45	0.45	0.45	0.60
Total Treated Effluent, Mm3/d	1.45	1.75	2.25	3.10

Source Water Policy Program, Report No. 20, 1999

Eastern Delta

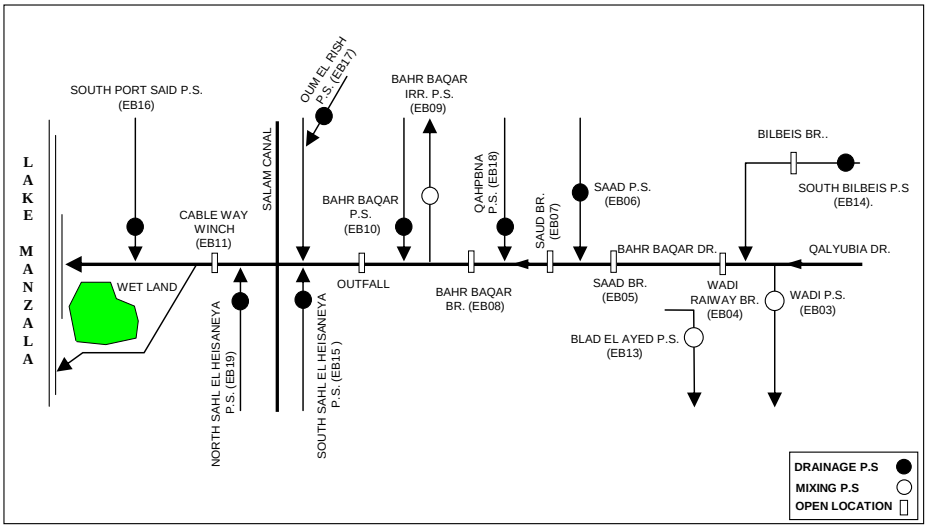


Figure 1. Scheme of the Bahr El Baqar Drain system

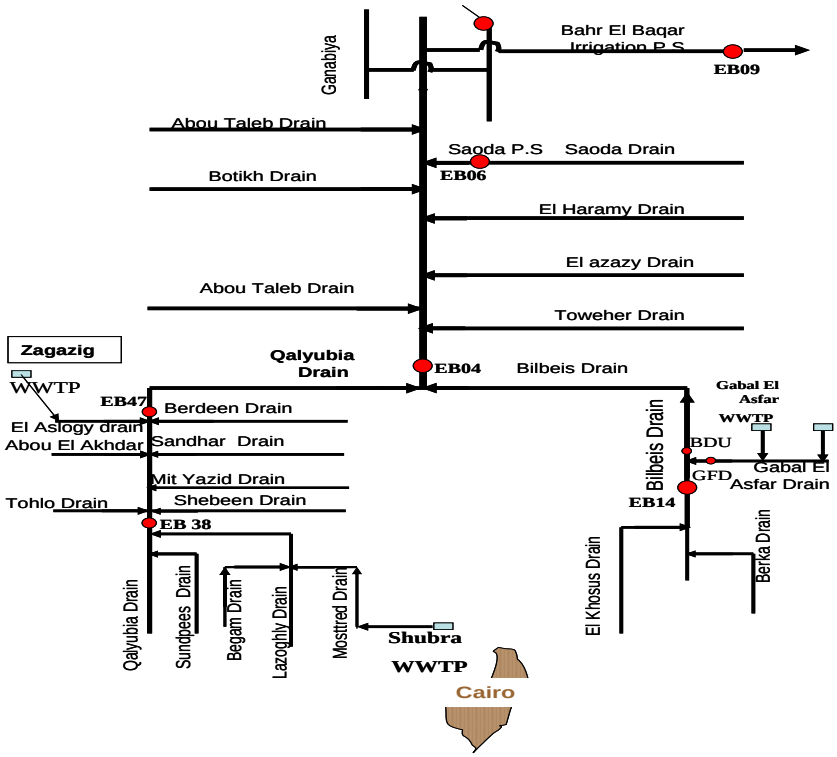


Figure 2. Bahr el Baqar Drainage System

2.1 Bahr El Baqar Drainage System

The BBD system consists of two major drains catchment areas (Figure 2).

2.1.1 Bilbeis drain

Bilbeis south pumping station catchment area

It is irrigated by Ismailia canal and its branches .It is located at the right side of Ismailia canal between the intake and sarayakous regulator. The total area served is 5460 hectares from which 2562 hectares are served by El khosous drain and 2898 hectares are served by Bilbeis south drain till El khosous drain including the area served by El marag and El berka. The Bilbeis drain has a length of 10 km. Most of the water delivered to Bilbeis pumping station is from sewage water of the east bank of Greater Cairo

North Bilbeis drain catchment area

It is bounded by Khaleg El zahfran and El Bahr El shebeny to the west, El wadi El sharkie canal to the north, Ismailia canal to the east and drainage boundary of El khosous and south Bilbeis drains to the south. Bilbeis drain north of the pump srtation which has a length of 56 km, receives also wastewater and drainage water from kafr hamza drain which serves 19740 hectares.

Bilbeis Drain water sources

Bilbeis Drain is 66 km long and has 3 branch drains, El Gabal El asfar drain, Berka drain, El Khosus drain. The Drain originates from the north eastern district of Cairo and flows in the north direction passing through Bilbeis city. The catchment area of the drain is about 25200 hectares. The water sources of the drain are:

Treated wastewater

Bilbeis drain receives treated wastewater from El Berka and El Gabal El Asfar WWTPs. The total received treated wastewater ranges from 1.45 in winter to 1.6million m^3/d in summer.

Raw Wastewater

The raw wastewater is discharged from Bilbeis south the pump station, El Khsous drain and Berka drain. The raw wastewater quantity ranges from 0.36 million m^3/d in winter to 0.48 million m^3 /d in summer.

Drainage water from the catchment area

The drainage rate is 200-400 mm/year i.e. the drainage water quantity from the agricultural area ranges from 0.14 million m^3/d in winter to 0.28 million m^3/d in summer. The total flow in Bilbeis drain varies from 1.95million m^3/d in winter to 2.36million m^3/d in summer as shown in Table2.

Unofficial reuse

In this catchment area there is unofficial reuse from the farmers in summer specially for rice cultivation in not allowed areas where the water duties in the canals are not enough to cover the requirements of the rice .It is estimated that there is unofficial in about 30% of the catchments area and the used water quantity from the drain is about 10 million m^3 /year.

Table 2 Sources of Pollution received by Bilbeis Drain.

	Source	Q (million m^3/d)
1	Domestic Point Sources	1.45 – 1.60
2	Domestic Diffuse Sources	0.36-0.48
3	Industrial Sources	0
4	Agricultural Diffuse Sources	0.14 -0.28
	Total	1.95-2.36

2.1.2 Qalyubia Drain

The second main drain in BBD system is Qalyubia drain which has a length of 73.2 km and its area served is about 300000 acres. The catchment's area is bounded by el wadi el sharkie canal to the north, bahr el shebeny to the east and south and el rayah el tawfikie to the west. Qalyubia drain discharges into bahr el baqr drain by gravity.Some sewage water and industrial wastes from the qalyubia governorate are discharged into the qalyubia main drain. El Wadi pumping station was constructed at the left bank of the Qalyubia main drain to supply El wadi El sharkie canal with a portion of the Qalyubia drain water to be utilized for irrigation and the remainder goes to Bahr El baqr drain .A weir was constructed with crest of an elevation of 4.8 m (MSL) in the upstream side of the pump station to maintain a sufficient water level before the station. The Qalyubia drain has 14 branches (intermediates) collecting treated and untreated wastewater besides the agricultural drain water

Shebeen Drain

Shebeen drain collects the primary treated wastewater from Shubra El Khima WWTP in Cairo and also the untreated wastewater from domestic and industrial sources in Shubra El Khima which is a great industrial district in Greater Cairo. Some sewage water and industrial wastes from the Qalyubia governorate is discharged into the Qalyubia main drain.

Sandahour Drain

Sandahour drain collects domestic and industrial wastewater besides the agricultural drainage water from Qalyubia governorate.

El Aslougy Drain

El Aslougy drain collects domestic and industrial wastewater from Zagazig city and also agricultural drainage water. The other branch drains, which collect also untreated wastewater from domestic sources and agricultural drainage water are Berdeen, Abou El Akhdar, Mit Yazeed, Sandhar and Tahla. The total annual flow in Qalyubia drain varies from 562 million m^3 in summer as shown in Table 3.

Table.3 Sources of Pollution received by Qalyubia Drain

	Source	Q (m^3/d)
1	Domestic Point Sources	675000
2	Domestic Diffuse Sources	90000
3	Industrial Sources	75000
4	Agricultural Diffuse Sources	700000 -1380000
	Total	1,540,000-2,220,000

3 WATER QUALITY MODELING OF BAHR EL BAQAR DRAIN

3.1 Model Description

DUFLOW is a micro-computer package designed to cover a large range of applications, such as operation of irrigation and drainage systems, propagation of tidal waves in estuaries, flood waves in rivers, etc. Basically free flow in open channel systems is simulated where control structures like weirs, pumps, culverts and siphons can be included. DUFLOW is a reasonable tool for simulating the proposed quality improvement interventions of BBD drainage system where the hydrodynamics part includes the structures in the drainage system. Moreover, the formulated water quality module is linked to DUFLOW. This special concept enables to create different types of water quality models that fit with the study objectives and the water quality process in the drainage system. The BBD model was successfully developed and calibrated

3.2 Model Scenarios Analysis

Control scenarios were conducted using the developed water quality model in order to define the quantity and quality of waste loads, the degree of treatment to the wastes which is needed before discharging them into the water, and to predict the effect of proposed waste effluents on the downstream quality.

Scenario 1: Treating the raw wastewater from Obour City

Study the effect of treatment of analysis of Wastewater Flow from Industrial Zone & Residential Zone in El Obour City. The flow is 200,000 m3/day. The flow is discharged from El Obour City direct to Gabal El Asfar Drain without Treatment.

Scenario 2: Involving the under Construction WWTP's

Study the effect of Involving WWTP plants under Construction and consider their effluent will be 20 mg/liter for BOD . 12 wastewater treatment plants in Sharkiya governorate, 3 wastewater treatment plants in Qalyoubiya drain and 2 wastewater treatment plants in Portsaid governorate.

Scenario 3: Involving the Planned Construction WWTP's

Involving WWTP plants which planned to be constructed in the future and consider their effluent will be 20 mg/liter for both BOD and SS. 17 wastewater treatment plants in Sharkiya governorate, 7 wastewater treatment plants in Qalyoubiya drain and 2 wastewater treatment plants in Portsaid governorate.

Scenario 4: Involving all WWTP's on Bilbeis Drain

Involving WWTP plants which on Bilbeis Drain (under construction and planned WWTP's) and consider their effluent will be 20 mg/liter for BOD . In this scenario, the WWTP's on Qalubyia drain will be at their conditions.

Scenario 5: Involving all WWTP's on Qalubyia Drain

Involving WWTP plants which on Qalubyia Drain (under construction and planned WWTP's) and consider their effluent will be 20 mg/liter for BOD. In this scenario, the WWTP's on Bilbeis drain will be at their conditions.

Scenario 6: Involving all WWTP's on Qalubyia and Bilbeis Drain

Involving WWTP plants which on Bilbeis and Qalubyia Drains (under construction and planned WWTP's) and consider their effluent will be 20 mg/liter for both BOD and SS. For under construction, there are 12 wastewater treatment plants in Sharkiya governorate, 3 wastewater treatment plants in Qalyoubiya drain and 2 wastewater treatment plants in Portsaid governorate. For planned, there are 17 wastewater treatment plants in Sharkiya governorate, 7 wastewater treatment plants in Qalyoubiya drain and 2 wastewater treatment plants in Portsaid governorate.

Scenario 7: Involving all WWTP's on Qalubyia Governorate

Involving WWTP plants which located on Qalubyia governorate and consider their effluent will be 20 mg/liter for BOD.

Scenario 8: Involving all WWTP's on Sharkyia Governorate

Involving WWTP plants which located on Sharkyia governorate and consider their effluent will be 20 mg/liter for BOD..

Scenario 9: Involving all WWTP's on Bahr El Baqar Drain

Involving WWTP plants which located on BBD and consider their effluent will be 20 mg/liter for BOD.

Scenario 10: Involving all WWTP's on Bahr El Baqar Drainage system

Involving WWTP plants which located Bahr El Baqar Drainage system and consider their effluent will be 20 mg/liter for BOD.

4 RESULTS AND DISCUSSION

Graphs 1, 2 and 3 show the model for each scenario compared with base condition.

Scenario 1: Treating the raw wastewater from Obour City

The impact will be on BBD with average reduction in BOD (12.6%) and the BOD at outfall reaches 30 mg/L. The impact will be on Bilbeis with average reduction in BOD (4%) and the BOD at outfall reaches 203 mg/L. No impact on Qalyoubiya drain.

Scenario 2: Involving the under Construction WWTP's

The impact will be on BBD with average reduction in BOD (23.3%) and the BOD at outfall reaches 25 mg/L. The impact on Qalyoubiya drain with average reduction in BOD (30.1%) and the BOD at outfall reaches 26.3 mg/L. The impact on Bilbeis drain with average reduction in BOD (54%) and the BOD at outfall reaches 65 mg/L.

Scenario 3: Involving the Planned Construction WWTP's

The impact will be on BBD with average reduction in BOD (28.3%) and the BOD at outfall reaches 20 mg/L. The impact on Qalyoubiya drain with average reduction in BOD (38.9%) and the BOD at outfall reaches 20.3 mg/L. The impact on Bilbeis drain with average reduction in BOD (52.9%) and the BOD at outfall reaches 65 mg/L.

Scenario 4: Involving all WWTP's on Bilbeis Drain

The impact will be on BBD with average reduction in BOD (30%) and the BOD at outfall reaches 25.98 mg/L. The impact on Bilbeis drain with average reduction in BOD (71%) and the BOD at outfall reaches 20.2 mg/L No impact on Qalyoubiya drain.

Scenario 5: Involving all WWTP's on Qalubyia Drain

The impact will be on BBD with average reduction in BOD (40.8%) and the BOD at outfall reaches 25.35 mg/L. The impact on Qalyoubiya drain with average reduction in BOD (85%%) and the BOD at outfall reaches 14 mg/L . No impact on Bilbeis drain.

Scenario 6: Involving all WWTP's on Qalubyia and Bilbeis Drain

The impact will be on BBD with average reduction in BOD (68%) and the BOD at outfall reaches 9 mg/L. The impact on Qalyoubiya drain with average reduction in BOD (85%) and the BOD at outfall reaches 14 mg/L.

Scenario 7: Involving all WWTP's on Qalubyia Governorate

The impact will be on BBD average reduction in BOD (17.2%) and the BOD at outfall reaches 25.8mg/L. The impact on Qalyoubiya drain with average reduction in BOD (44%) and the BOD at outfall reaches 25 mg/L. The impact on Bilbeis drain with average reduction in BOD (78%) and the BOD at outfall reaches 78 mg/L.

Scenario 8: Involving all WWTP's on Sharkyia Governorate

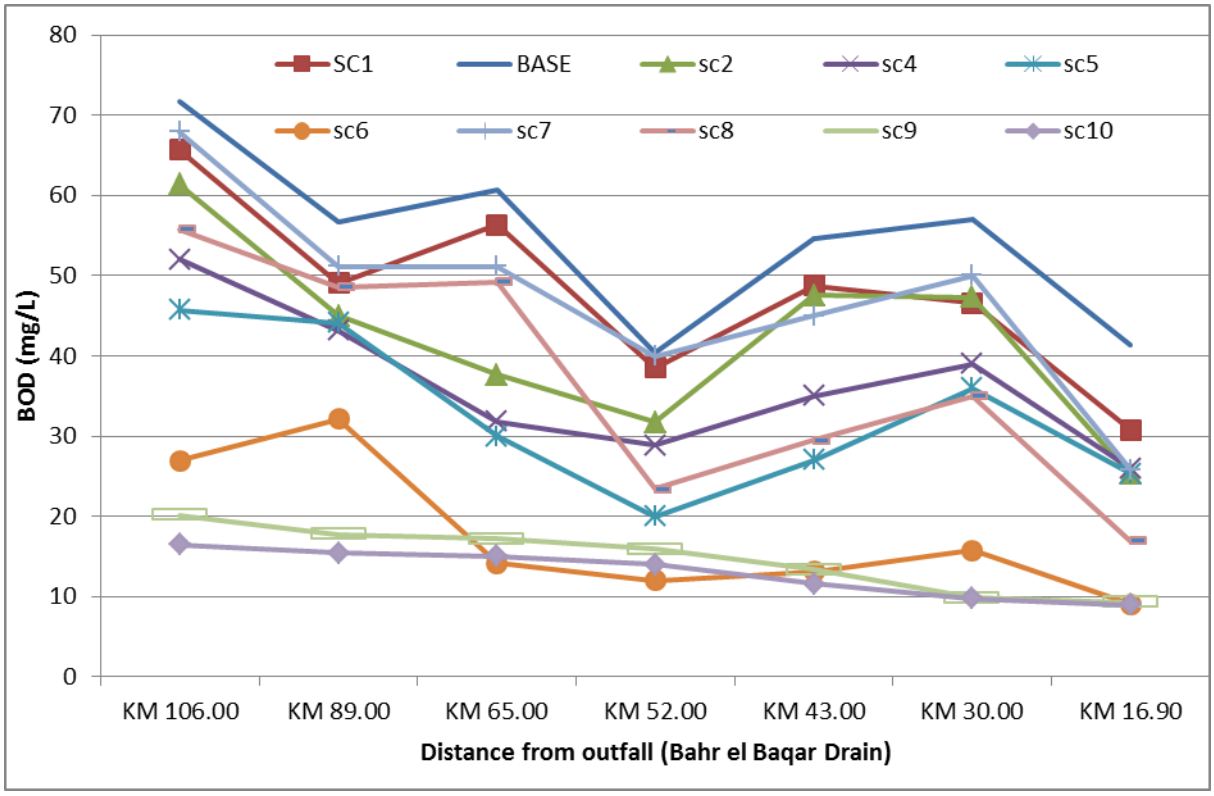
The impact will be on BBD with average reduction in BOD (34%) and the BOD at outfall reaches 16.9 mg/L. The impact on Qalyoubiya drain with average reduction in BOD (16%) and the BOD at outfall reaches 45 mg/L. The impact on Bilbeis drain with average reduction in BOD (71%) and the BOD at outfall reaches 28.7 mg/L.

Scenario 9: Involving all WWTP's on Bahr El Baqar Drain

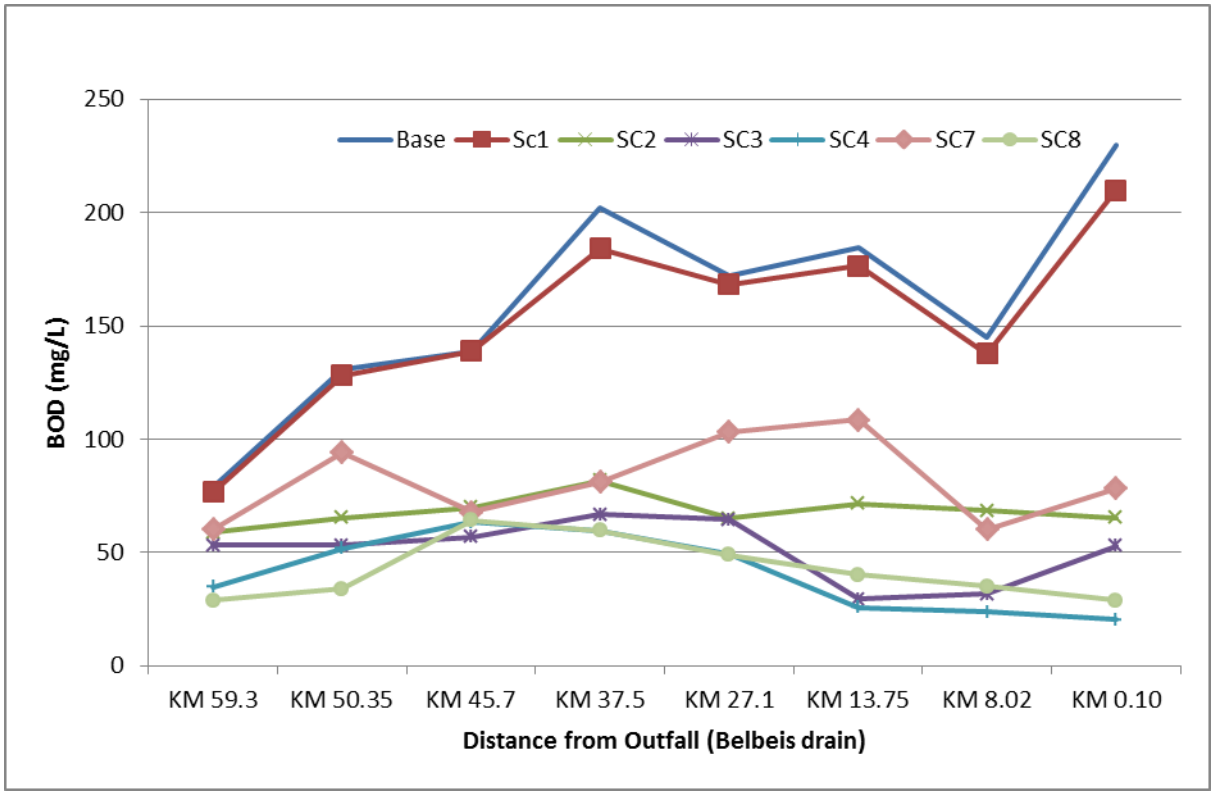
The impact will be on BBD with average reduction in BOD (72%) and the BOD at outfall reaches 9.5 mg/L. No impact on Qalyoubiya drain and Bilbeis drain.

Scenario 10: Involving all WWTP's on Bahr El Baqar Drainage system

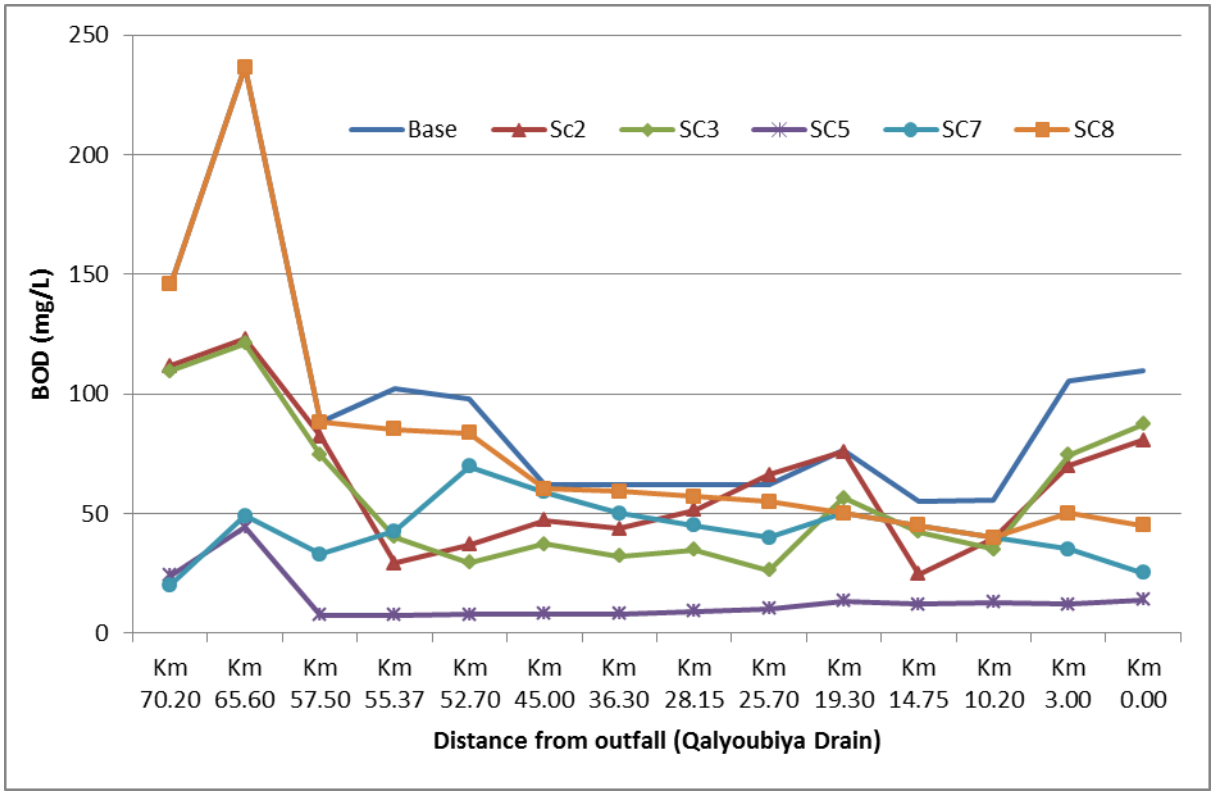
The impact will be on BBD with average reduction in BOD (95%) and the BOD at outfall reaches 8.9 mg/L. The impact on Qalyoubiya drain with average reduction in BOD (85%) and the BOD at outfall reaches 14 mg/L. The impact on Bilbeis drain with average reduction in BOD (71%) and the BOD at outfall reaches 20.2 mg/L.



Graph 1 Model scenarios for water quality control of bahr el baqar drain



Graph 2 Model scenarios for water quality control of belbeis drain



Graph 3 Model scenarios for water quality control of Qaluoubiya drain

5 CONCLUSIONS

Duflow model has been successfully developed and calibrated .Many scenarios have been conducted using the calibrated model in order to water quality control of Bahr el Baqar drainage system. Scenarios include the wastewater treatment plants under construction and planned for all the drainage system and for separate drains and clusters. Scenario results revealed that the best scenario is in case of operation of all under construction and planned treatment plants. The impact will be on BBD with average reduction in BOD (95%) and the BOD at outfall reaches 8.9 mg/L. The impact on Qalyoubiya drain with average reduction in BOD (85%) and the BOD at outfall reaches 14 mg/L. The impact on Bilbeis drain with average reduction in BOD (71%) and the BOD at outfall reaches 20.2 mg/L. Second best scenario is by involving all WWTP's on Qalubyia and Bilbeis Drain. The impact will be on BBD with average reduction in BOD (68%) and the BOD at outfall reaches 9 mg/L. The impact on Qalyoubiya drain with average reduction in BOD (85%) and the BOD at outfall reaches 14 mg/L .Third best scenario by Involving all WWTP's on Bahr El Baqar Drain. The impact will be on BBD with average reduction in BOD (72%) and the BOD at outfall reaches 9.5 mg/L Scenarios of involving wastewater treatment plants on Qalyoubiya and Sharkia Governorates have the same impact on outfall of bahr el baqar drain (BOD reaches 25 mg/l).Involving the Planned Construction WWTP's, The impact will be on BBD with average reduction in BOD (28.3%) and the BOD at outfall reaches 20 mg/L. The impact on Qalyoubiya drain with average reduction in BOD (38.9%) and the BOD at outfall reaches 20.3 mg/L. The impact on Bilbeis drain with average reduction in BOD (52.9%) and the BOD at outfall reaches 65 mg/L. Involving the under Construction WWTP's, The impact will be on BBD with average reduction in BOD (23.3%) and the BOD at outfall reaches 25 mg/L. The impact on Qalyoubiya drain with average reduction in BOD (30.1%) and the BOD at outfall reaches 26.3 mg/L. The impact on Bilbeis drain with average reduction in BOD (54%) and the BOD at outfall reaches 65 mg/L. Finally Economic study must be conducted to choose the optimum scenario technically and economically.

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