

Evaluation of the Shallow Lake Effect on the Drainage System in the Delta Area of Egypt

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Flooding is an annual event in the northern lake in Egypt. Extreme floods cause cut of roads and transportation troubles. Flood management encompasses many environmental, social and engineering constrains. The main objective of this study is to evaluation of the lake effect on the drainage system by using Node-Branch model. This paper presents simulation of unsteady flow model representing the Edko drain, in the Western Delta area in Egypt. A numerical model is considered for study the Edko Lake effects in the drainage network, where the flow is affected by the released drain flow, the Edko Lake water level, and tides in the Mediterranean Sea. By comparing the models, with and without lake effect it was found that the tidal flow is restricted in the lake and the reflux by tide does not occur in the drain. The Edko Drain is scarcely affected by tide.

1. INTRODUCTION

In January 2002, the largest flood occurred covering the roads, agriculture lands and the lower reaches of the Edko Drain in the costal area of Nile delta, Egypt. Flood occurs every winter season (rainy season in Egypt), because of the high intensity of rainfall. This paper deals with one of the drainage system in Egypt which is called the Edko Drain. This lake is very important not only for drainage purpose but also for fishery wealth. Cumulative sedimentation in the drain, lake and bay are found from the drain side slopes and drain decontamination. A numerical model is considered for flood routing in a drainage network, where the flow is affected by the released drain flow, the Edko Lake water level, and tides in the Mediterranean Sea.

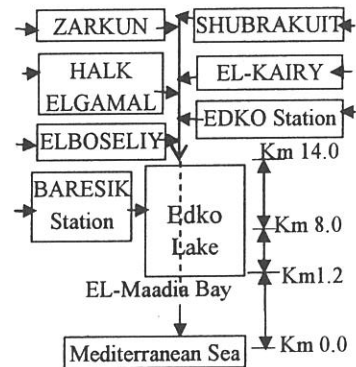


Fig.1 Schematization of the model components.

2. THE STUDY AREA

The drainage system consists of a main drain (the Edko Drain) with seven pump stations, the Edko Lake (average length and width are 13.0 Km and 7.0 Km, respectively) and the El-Maadia Bay (average length and width are 1.2 Km and 50.0 m, respectively) as shown in Fig.1. The length of the drain is about 48.8 Km started from the Shubrakuit station to the mouth of the El-Maadia Bay.

3. APPROACH AND METHODOLOGY

(1) Model setup

A computer program has been developed for computing unsteady flow in drainage networks. An idealized channel network, shown in Fig.2, is analyzed with the computational procedure. The inputs for executing this program are (1) channel characteristics, and (2) boundary conditions for downstream water level and the inflow for the source node in the network as shown in Table 1.

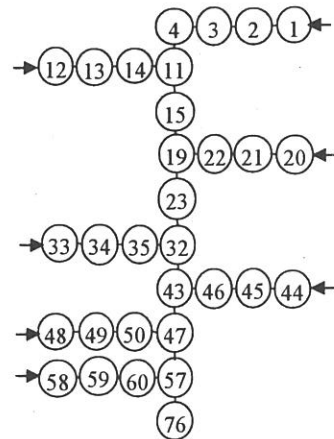


Fig.2 Schematization of the Edko Drainage system.

The Edko Lake is simulated as a rectangular channel with width of 7.0 Km and length of 6.8 Km. The model run was carried out under the tidal water level of the Mediterranean Sea as a boundary condition at the downstream end. The mean water level is 0.0 m and the tidal range is 0.4 m. For the discharge conditions to the source nodes shown in Fig.3, the maximum capacity discharges from the pumps in the rainy month (January) were used as shown in Table 1. The total input discharge to the network is 78.1m<sup>3</sup>/sec. For the numerical stability, difference in time iterations was three minutes and the simulation period was three days. In this paper two scenarios were applied for the network area, and the

simulation procedure can be briefly summarized as follows:

- 1- Design model with lake; unsteady flow with the design cross sections and the design bed levels. In this model the part from km 1.2 to km 14.0 is a lake.
- 2- Design model without lake; unsteady flow with the design cross sections and the design bed levels. In this model, the channel from km 1.2 to km 14.0 has trapezoidal cross sections as the main drain with bed width 50.0m.

#### 4. RESULTS AND DISCUSSIONS

The tidal basin was simulated for free tidal movement. Before everything, the net tidal characteristics in the Edko Lake were examined.

Figure 3 shows comparison between the peak discharges at the high and low tides for the model with the lake and without it. For the model with the lake the maximum upward discharge from the sea towards the lake is 294.0 m<sup>3</sup>/sec and the maximum out flow discharge to the sea is 352.0m<sup>3</sup>/sec. For the model without Lake the maximum upward discharge 15.0 m<sup>3</sup>/sec and the maximum out flow discharge 155.0 m<sup>3</sup>/sec. From the results it was found that the lake works as a buffer. Moreover, the tidal flow gradually decreases and disappears at the end of the lake, Km 14.0. It can be said that the tidal flow is restricted in the lake and the reflux by tide does not occur in the drain.

Figure 4 shows the difference between high and low water levels (tidal range) for the two models with and without the lake. For the model with the Edko Lake it is observed that the tidal effect decreases rapidly during the bay and almost disappears in the lake. However, the small waves with height of 0.03m are remained in the whole upstream area. For the model without Lake the tidal effect decreases gradually in the Drain and the tidal range is linear decrease from 0.33m at km 14.0 to 0.05m at the upstream end. By comparing the tidal range for the two models, it can be said that the Lake restrict the tidal effect.

Figure 5 shows the peak water levels with road level on the bank for the two models. It can be seen that the peak water level for the model with the Edko Lake is less than the peak water level for the model without the lake by 0.15 m. As can be seen, the peak water level for the model without Lake is less than the road level so no flooded area.

#### 5. CONCLUSION

The Node-Branch model has been applied for flood routing in a part of drainage system network in Egypt, from the simulation results it can be said that:

- 1- The maximum upward and downward discharges from and the sea for the model with the lake are 352.0 and 294.0 m<sup>3</sup>/sec, respectively, and are approximately twice for the model without the lake.
- 2- From the results it was found that the lake works as a buffer between the Edko drain and the sea.
- 3- The tidal water level is rapidly decreased in the bay owing to the resistance. On the other hand, the tidal flow is gradually decreased in the lake through the bay.
- 4- Tidal flow is restricted in the lake and the reflux by tide does not occur in the drain.
- 5- The difference between the peak water levels in the two models is 0.15 m.

Table 1 Discharge boundary conditions.

Pump station name	Source node number	Maximum discharge (m <sup>3</sup> /sec)
Shubrakit	1	11.50
Zarkun	12	11.00
EL-Kairy	20	11.25
Halk Elgamal	33	11.46
Edko	44	10.00
ELboselly	47	11.46
Barseaik	58	11.43
Total		78.10

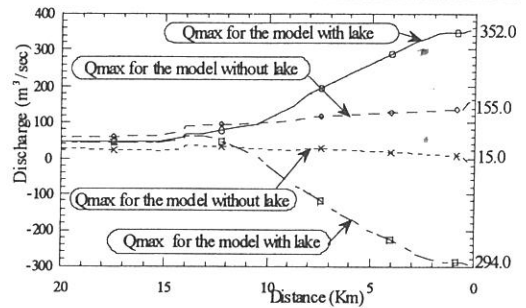


Fig.3 Peak discharges by tides for the two models.

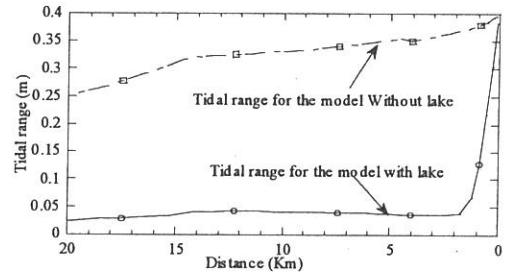


Fig.4 Tidal range variations with and without lake

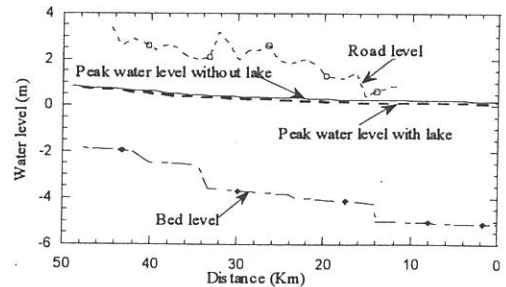


Fig.5 Comparison between the peak water levels.