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EFFECT OF ABSTRACTION PATTERNS ON FLOW FIELD BY USING SOBEK AND ISIS

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ABSTRACT

The present paper investigates the effect of abstraction patterns of the pump stations on the flow filed in El-Kanais distribution canal under effect of continuous flow. Two of the famous simulation models, including ISIS and SOBEK are used to simulate the water surface profile and flow velocity. The simulation models are verified using the designed water surface. The used abstraction patterns during simulation represent the most probably cases that may happen during the irrigation process and the most critical one is detected. The results indicated that the actual sections of the canal are not sufficient to carry the required discharges under continues flow. Three solutions are proposed to solve the water shortage problem for the critical abstraction pattern in the canal. Finally, the most efficient proposal is recommend.

KEYWORDS**:** SOBEK, ISIS, flow filed, continuous flow, canal and simulation

1. INTRODUCTION

Simulation of open channel flows is one of the most important topics in hydraulic and irrigation engineering. Many researches focused on the simulation of flow in either single channel or in the open channel networks. There are many studies presented two dimension-curvilinear grid for open channel flow simulation [1], a 2-D mathematical model to simulate the sediment transport in alluvial shallow-wide streams in order to solve practical problems in the River Nile [2], numerical simulation of turbulent flow in helically coiled open-channels with compound cross-sections [3], simulation of open channel network flows using finite element approach

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[4], simulation of subcritical flow at open-channel junction [5], large eddy simulation of compound open-channel flows with emergent vegetation near the floodplain edge [6] and verification a 1D model using the simulating outputs of the flow field at El-Mahrousa canal by the 1D SOBEK model outputs [7].

The primary objective of irrigation improvement is to rationalize the use of every available drop of water. As a result, the interaction between hydraulics and irrigation becomes more active in the last decade. Some studies investigated impact assessment of an irrigation improvement project in Egypt [8], irrigation- water demands under current and future climate conditions in Egypt [9], remote irrigation monitoring and control system for continuous irrigation systems [10], and a cross-scale performance assessment tool for improving the management of the irrigation water [11].

This paper focuses on the investigation of the suction patterns of the pump stations on the flow filed in one of the Egyptian distribution canals “El-kanais canal”. The paper uses two of the famous simulations models, ISIS and SOBEK to simulate the water surface profile in El-Kanais distribution canal under effect of continuous flow. The canal is fed from El-Kanobia canal, which is fed from El-Mahmoudia canal, which can be considered one of main branches of Nile River.

2. SITE SPECIFICATIONS

The following paragraphs will give a full description of El-Kanais canal.

2.1 Location

El-Kanais canal is fed from El-Kanobia canal at kilometer 6.78 right side [12]. Its length is about 4,317 km. The served area of the canal is about 1620 Fedden. Figure 1 shows the main plan of the studied canal. It is running from west side to the east. At the end of the canal, it drains the excess water into El-kanais drain. It is clear that, the irrigated areas are scattered around the main route of the canal. Some small urban areas are presented in the plan. The plan of the canal is generated by Al-Biherra directorate of irrigation development by GIS software [9]. The served area is divided into 21 zones. Each zone is fed from one lifting point, which is named as pumping station. Some selected pumping stations and their characteristics are listed in Table 1.

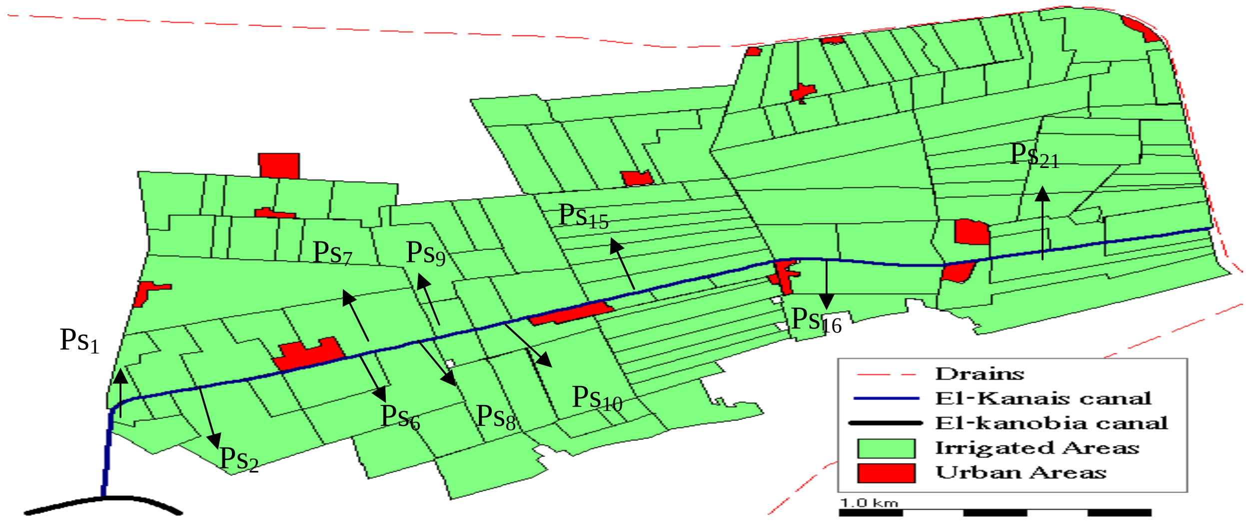


Fig. 1 A schematic layout of the studied canal [9].

Table. 1 Selected pumping station on El-kanais canal [12].

No	Name	Code	Location {Km}
1	El hanfy	Ps_1	0.616
2	Karona{1}	Ps_2	0.91
3	Abdelgwad	Ps_6	1.44
4	Taleh and elmtwaly	Ps_7	1.45
5	El 16	Ps_8	1.67
6	Moh.heba	Ps_9	1.695
7	Mandor and eleslah	Ps_{10}	1.93
8	Hasan{4}	Ps_{15}	2.226
9	Elfakhrany	Ps_{16}	3.055
10	M	Ps_{21}	3.795

2.2 Water structures

Many water structures were constructed on the canal including bridges, regulators and tail escapes. There are a head regulator and two intermediate regulators, Fig. 2. There are three bridges, Fig. 3. All data for the water structures are presented in details as shown in Table 2. The maximum and average design discharges pass through the head regulator are 0.88 and 0.73 m^3/sec, respectively. The canal was modeled using 22 cross-sections with 200 m long each, Fig. 4.

Fig. 2. Different photos for the regulators located in the studied reach head regulator b: intermediate regulator km 2.23, c: intermediate regulator km 3.595.

Fig. 3. Different photos for the bridges located in the studied reach a: bridge no.1 km 1.125, b: bridge no.2 km 1.66, c: bridge no.3 km 2.855.

Table 2. Structures on Elkanais canal [12].

No	Description	Location {Km}	Width {m}	Diameter {m}	Bottom level {m}
1	The head regulator	0.00	2.5	-	0.09
2	Bridge	1.125	3.9	-	-0.76
3	Bridge	1.66	4	-	-0.86
4	Intermediate Regulator {1}	2.23	1.5	-	-0.75
5	Bridge	2.855	4	-	-0.68
6	Intermediate Regulator {2}	3.595	-	0.6	-0.59
7	Tail-escape	4.317	-	1.0	-1.05

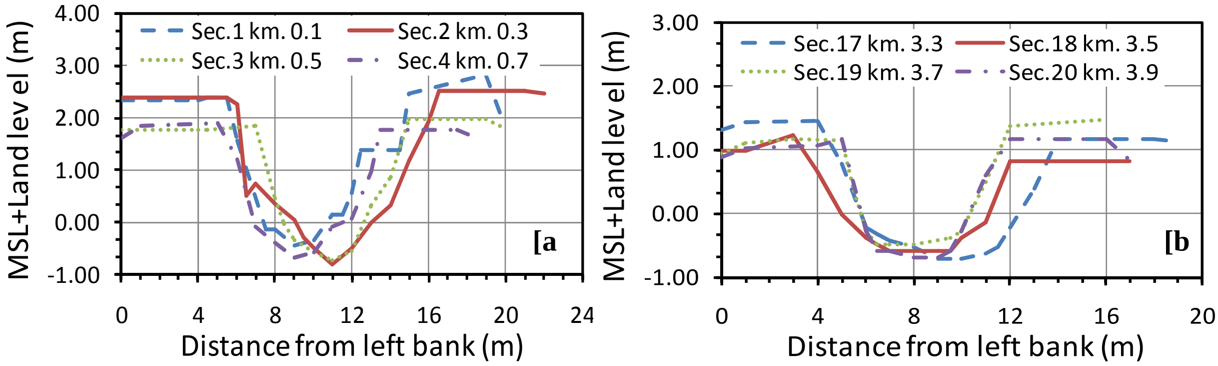


Fig. 4. Some selected cross-sections of El-Kanais canal “a” km 0.0-0.8 “b” km 3.2-4.0.

2.3 Water demands

The main summer crops at the studied command area are rice, cotton, and maize. On the other hand, winter crops are clover, and wheat. Small areas are cultivated with vegetables. The crops area are represented by gardens and trees and it represents about 40% from area and the rest 60% are represented by winter and summer crops. The designed water duty “W.D” is $40m^3$/Fedden/day. The water can be abstracted using bump stations as some were shown in Table 1. The drainage process of the excess water is depending on the surface drains. The subsurface drainage is existed at some small areas, and its effect can be neglected.

3. PUMPING STATIONS

The mesqa pumping stations will be modeled in the model as abstractions point. There is a need to distribute the abstraction along 24 hour of the day. The distribution system is varied from one station to another.

There is no fixed rule available to specify the distribution. Figure 5 shows the abstraction curves for El-hanfy pump station. These patterns represent the most probably cases that may happen during the irrigation process as some irrigation experts proposed. Despite the difference between these patterns, the area under the curve has the same value for all patterns. The following notes can be listed as following:

1- In the first pattern, the farmers like to finish about 40% of the irrigation process during the night hours. The maximum discharge is pumped from the station at 6AM. Actually, the irrigation activities are spread along the day.

2- In the second pattern the farmers finish about 25% of the irrigation process during the night hours. The maximum discharge is pumped from the station at 8 AM. about 60% of irrigation activities are done in 10 hours from 6 AM. to 4 PM.

3- In the 3rd and 4th patterns, farmers finish about 15% and 20%, respectively from the irrigation process during the night hours. The maximum discharge is pumped at 10 AM. These patterns describe the most famous patterns in Egypt. Farmers spend about 6-hours at the night without irrigation and they start the irrigation just after the sunrise.

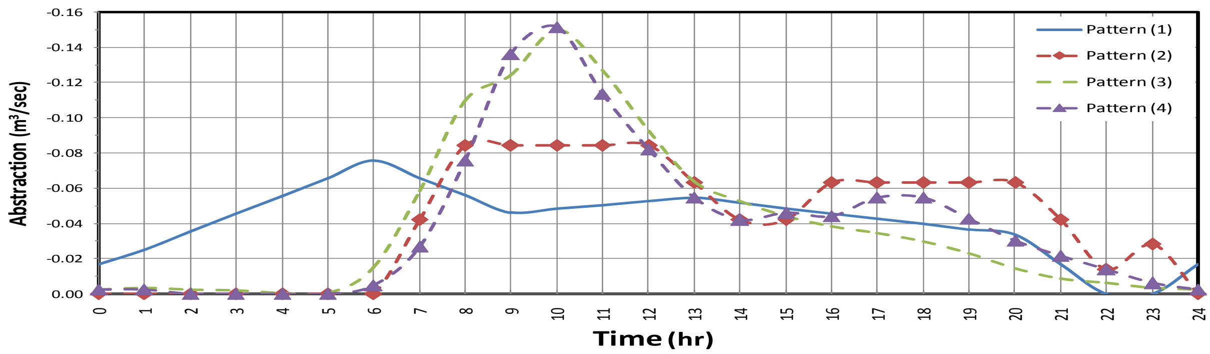


Fig. 5 Distribution of the abstraction over a day.

4. MODELING PROCESS

In the present paper, the flow field in El-Kanais canal is simulated using two models, SOBEK [13] and ISIS [14].

4.1 SOBEK Model

The unsteady-flow simulation software package, SOBEK by Delft Hydraulics, 1993, is used for simulating the flow field. SOBEK is an integrated software package for a river, urban or rural management [13]. Actually, SOBEK can link a river, a canal and sewer systems for total water management solution. SOBEK is able to work with complex cross-sectional profiles consisting of various sub-sections. The flow in one dimension is described by two equations: the momentum equation and the continuity equation. The continuity equation is written as in Eq. 1, while the momentum one is written as in Eq. 2.

$$\frac{\partial A_f}{\partial t} + \frac{\partial Q}{\partial x} = q_{lat} \tag{1}$$

$$\frac{\partial Q}{\partial t} + \frac{\partial}{\partial x}\left(\frac{Q^2}{A_f}\right) + gA_f\frac{\partial h}{\partial x} + \frac{gQ|Q|}{c^2RA_f} - W_f\frac{\tau_{wi}}{\rho_w} = 0.0 \tag{2}$$

Where: A_f is the wetted area {m^2}; q_{lat} is the lateral discharge per unit length {m^2/s}; Q is the discharge {m^3/s}; t is the time {sec}; x is the distance{m^2}; g is the gravity acceleration {m/s^2}, {g=9.81 m/s^2}; h is the water level {m} {with respect to the reference level}; R is the hydraulic radius {m}; W_f is the flow width {m}; τ_{wi} is the wind shear stress {N/m^2}; ρ_w is the water density {kg/m^3}.

Due to limitations of the free version of SOBEK program i.e. max 50 point available, the total number of the pump stations is compacted to about 8- lateral points, Table 3. Only six cross sections are used for modeling; Fig. 6. Structural data were collected about all structures through the studied canal, Table 2. El-Kanais canal has been schematized based on GIS map of the area, Fig. 7. This figure shows the digital nodes of the model of the studied canal. The discharge passes through the head regulator equals 0.5042 m^3/sec. In addition, the crest level of the tailescape is (0.40). The yellow rhombus represents the pump stations, Table 3. The blue trapezoidal symbol represents the modeled cross-sections. The green triangle symbol represents intermediate regulator and the light blue triangle symbol represents the bridges. The total time of the flow simulation in the canal is taken as one week with interval computational time step of 10 min. Manning's Coefficient is taken as 0.03 and initial water level (0.10).

Table 3. Location of pump stations on El-kanais canal.

Pump stations	Code	Location {Km}
1	P_1	0.616
2	P_2	1.05
3	P_3	1.55
4	P_4	1.93
5	P_5	2.22
6	P_6	3.06
7	P_7	3.5
8	P_8	3.8

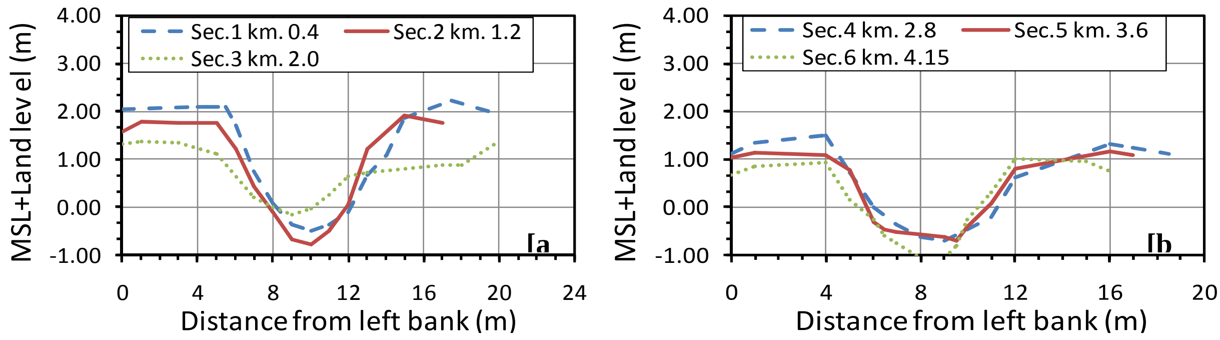


Fig. 6. Modeled cross-sections “a” X-Secs. 1:3 “b” X-Secs. 4:6.

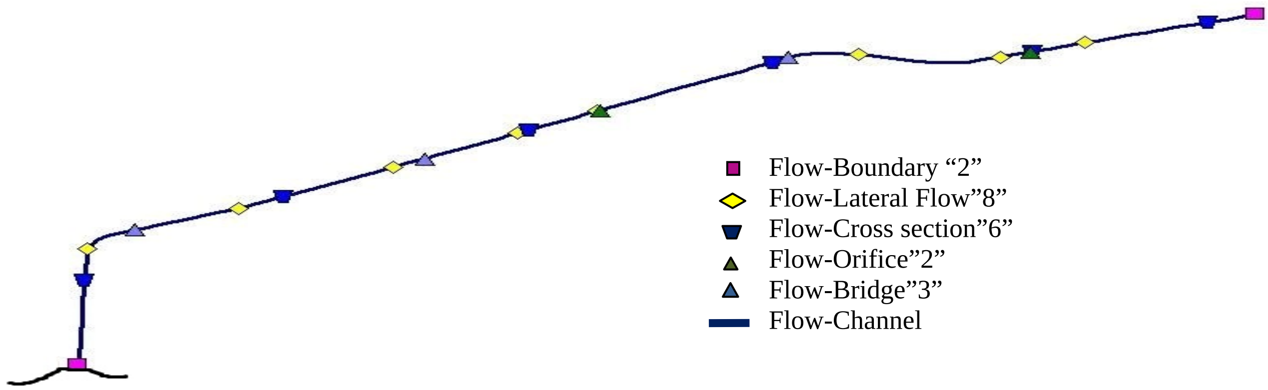


Fig. 7 Schematic map for El-Kanais canal including SOBEK digital nodes.

4.2 ISIS Modeling

ISIS is a hydrodynamic software that simulates the flows in open channels and estuaries. ISIS is capable to simulate the complex networks, and floodplain flows. ISIS simulates steady and unsteady flow solver. The flow in one dimension is described by two equations: the continuity equation, which is similar to Eq. (2) and momentum equation reads as:

$$\frac{\partial Q}{\partial t} + \frac{\partial}{\partial x}\left(\frac{Q^2}{A}\right) + gA\,\frac{\partial H}{\partial x} - g.A.S_f = 0 \qquad (3)$$

Where :

H is depth of flow above the bed {m}; A is the cross-sectional area of flow {m^2}; S_f is the friction slope.

While using the free version of ISIS, there is no problems to use the total number of the cross sections and pump stations which were presented in Fig. 4 and Table 1, respectively. The main reason is that, the free version gives the user about two hundred and fifty nodes. The total time of the flow simulation in the canal is taken as one week with interval computational time step = 10 min. The Manning's Coefficient is taken as 0.03 with initial water level (0.10). El-Kanais canal has been schematized based on GIS map of the area, see Fig. 8. It shows the digital nodes of the model of the studied canal. It can be noticed that, two time boundary nodes representing the head regulator and the tailescape. In addition, the bridge US Bureau of Public Roads "USBPR 1978" nodes were used to simulate the bridges. The vertical sluice nodes were used to simulate the intermediate regulator.

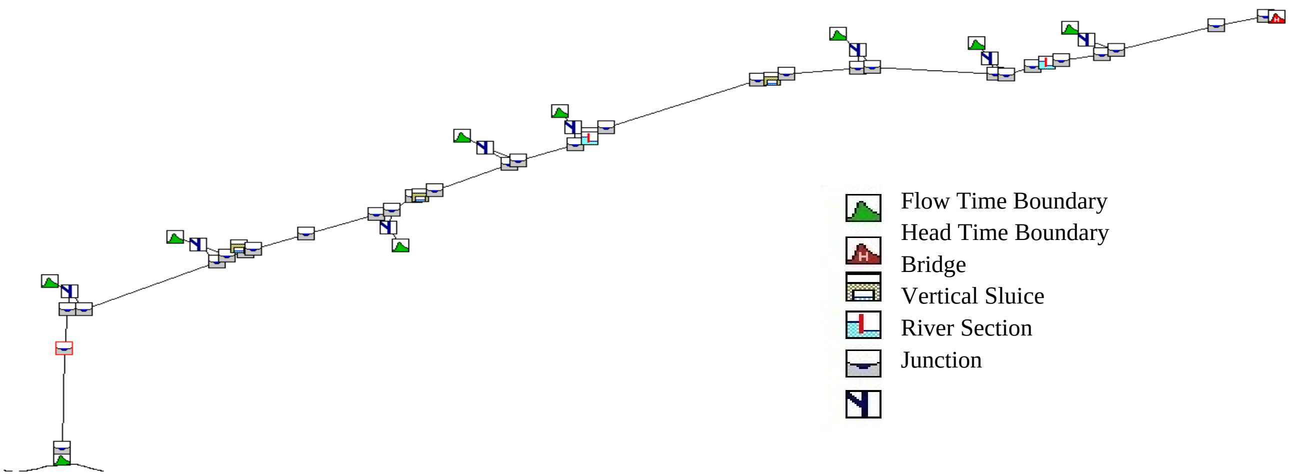


Fig. 8. Schematic map for El-Kanais canal including ISIS digital nodes.

5. MODEL CALIBRATION

The simulation models are calibrated using the designed water surface in El-Kanais canal. The purpose of the calibration exercises was to make sure that the simulation models are used in correct way. Also, it is important to make sure that the model parameters, in the model, are chosen with adjusted values, for example the value of Manning Coefficient was chosen 0.03. If the validation gives an acceptable results, the simulation models can be used as a helping tool for predicting the water surface under different proposed working scenarios. As a result, a relatively number of alternatives may be studied using the models and the best one or two proposals may be investigated physically. The Directorate of irrigation in El-Behera Governorate has a longitudinal section of the canal including the water levels and corresponding passing discharge under the steady flow conditions.

The calibration procedure has been conducted by achieving, an acceptable comparison between the designed water surface in the canal and that obtained by the simulation models. It was very important to calibrate the hydrodynamic model before using it in the prediction process under the unsteady state conditions. A comparison between the models' results and the designed water surface in El-Kanais canal was give as shown in Fig. 9. It was found that the steady state water surface obtained by SOBEK is higher than that obtained by ISIS. The difference is about 5cm along the first 3500 m. Then, the obtained water surface by the both software becomes the same.

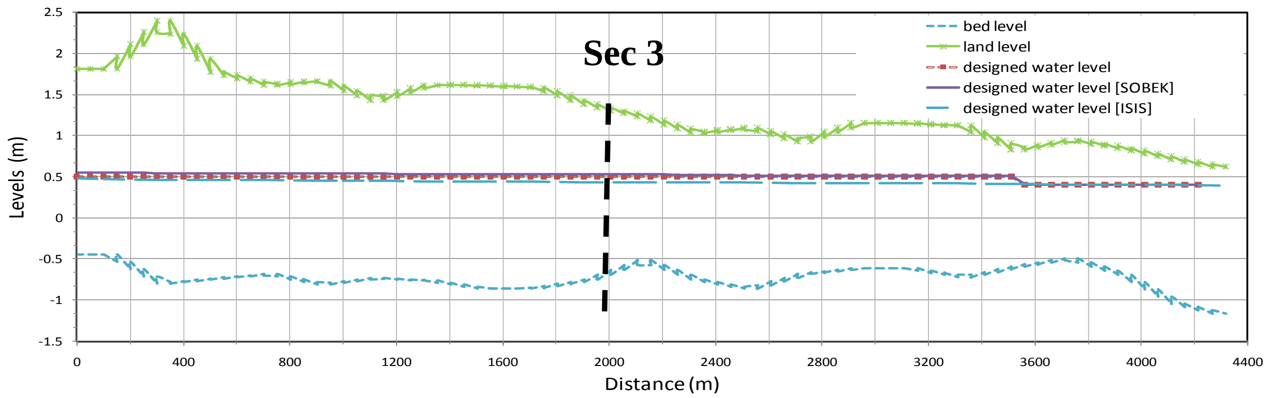


Fig. 9. Comparison between the models' results and the designed water surface in steady state condition for El-Kanais canal.

On the other hand, the water surface predicted by SOBEK is higher than the designed one by about 3 cm for the first 3500 m, this value reduces to be about 1 cm for the last 700 m by error percentage 2% between the results of SOBEK program and the designed water surface. Figure 10 presents the relationship between the average flow velocity and time for sec. 3 at km 2.0, his section was chosen because it is in the middle of the canal. It is clear that, the average flow velocity does not vary with time after about 12 hrs. It means that the water depth reaches the steady condition after this period for both models either ISIS or SOBEK.

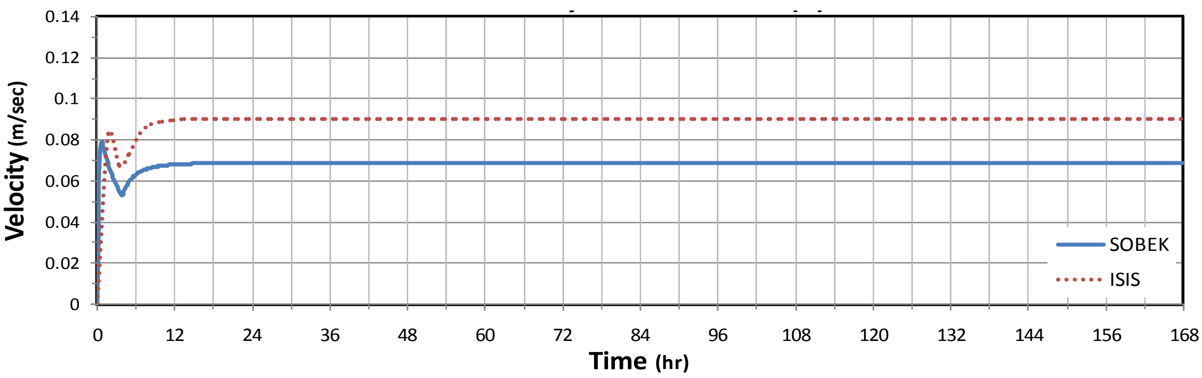


Fig. 10. Comparison between ISIS and SOBEK velocity results
in steady state condition at Sec. 3 at km 2.0.

6. EFFECT OF ABSTRACTION PATTERNS

It is important to make simulation for the different probable abstraction patterns to include all irrigation systems to the farmers, which are presented in Fig. 5. Figures from 11 to 13 show a comparison between the maximum and minimum water surface profiles obtained by SOBEK and ISIS in case of abstraction patterns 1, 2 and 4 respectively. These patterns are chosen to be compared because their results are similar. It can be, clearly seen that, all abstraction patterns give an acceptable water levels. The water surface does not exceed the bank levels in all cases and there is no dryness happened to the canal, that gives sufficient water depth to abstract water from the canal at intakes, the overtopping may not occur. apply the first pattern, the water surface profiles are extracting from SOBEK and ISIS, It can be noticed, the difference between maximum water surface and land levels ranges between 0.9 to 1.9 m, Fig. 11. Generally, SOBEK model gives results equal or less ISIS results with difference about 20 cm. For the second and the fourth patterns, the difference between the maximum water surface and land levels ranges between 0.3 to 1.7 m Figs. 12 and 13. SOBEK and ISIS models give very close values. The maximum difference between the water surfaces is about 10 cm because of the effect of the shear stress in SOBEK model as shown in Eq. (2) but not in ISIS model as shown in Eq. (3). Figure 14 shows the flow velocity for some of sections which are taken at start, middle and end of the canal.

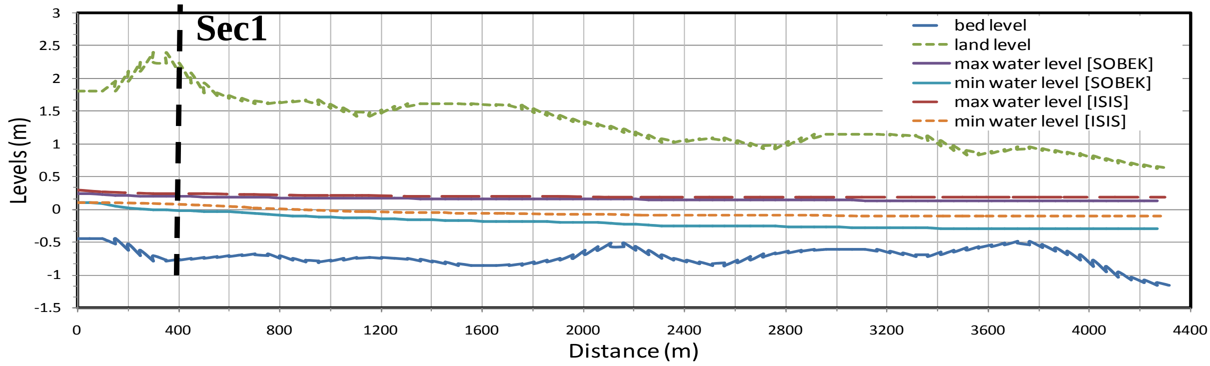


Fig. 11. Land, Bed, Max. and Min water levels using SOBEK and ISIS for the first abstraction pattern.

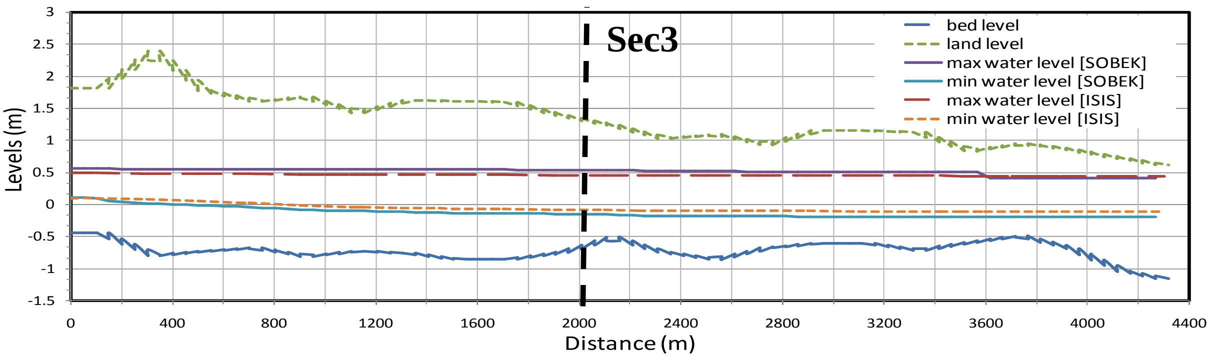


Fig. 12. Land, Bed, Max. and Min water levels using SOBEK and ISIS for the second abstraction pattern.

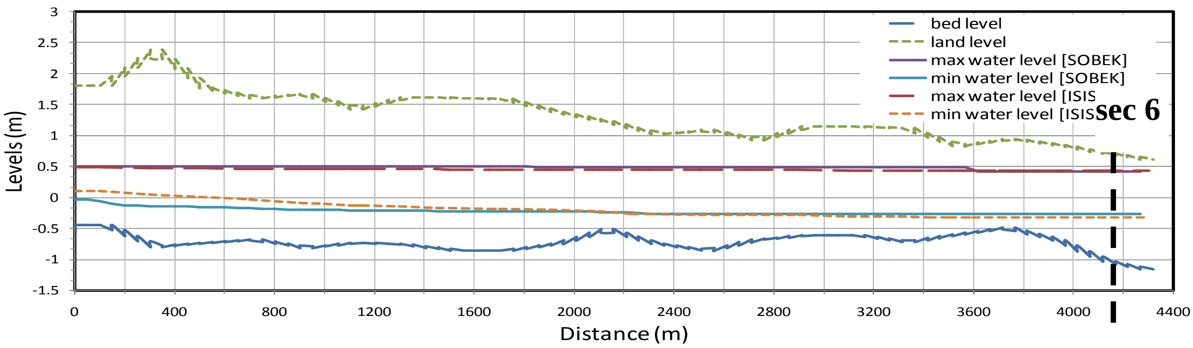


Fig. 13. Land, Bed, Max. and Min water levels using SOBEK and ISIS for the fourth abstraction pattern.

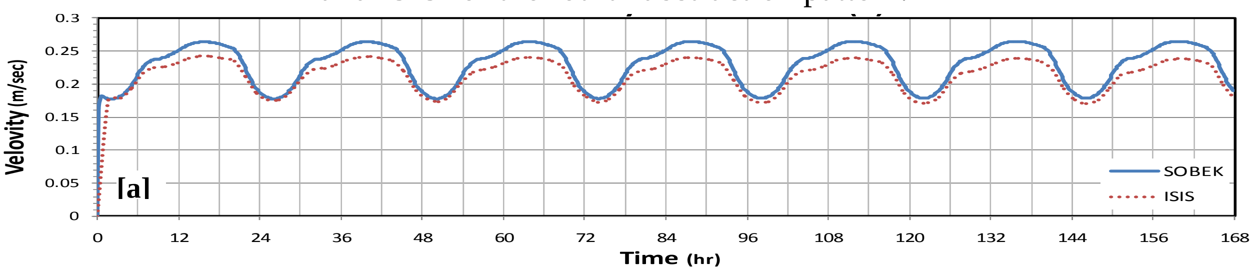


Fig. 14. Comparison between ISIS and SOBEK flow velocity results [a] the first pattern at sec. {1} km 0.4

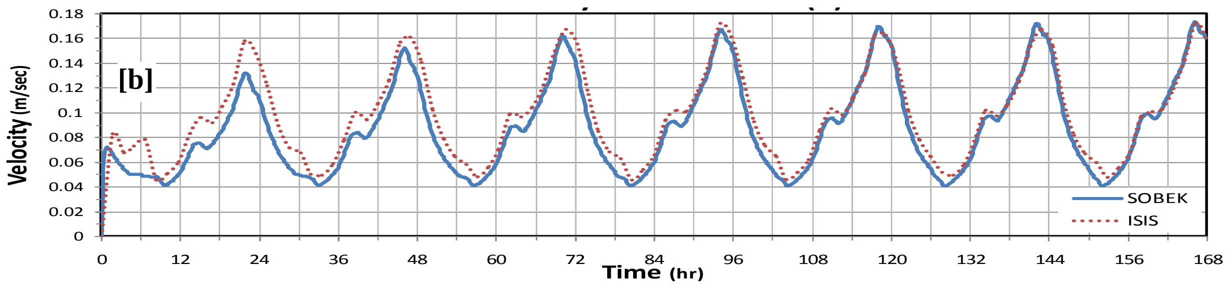


Fig. 14. Comparison between ISIS and SOBEK flow velocity
results [b] the second pattern at sec. {3} km 2.0.

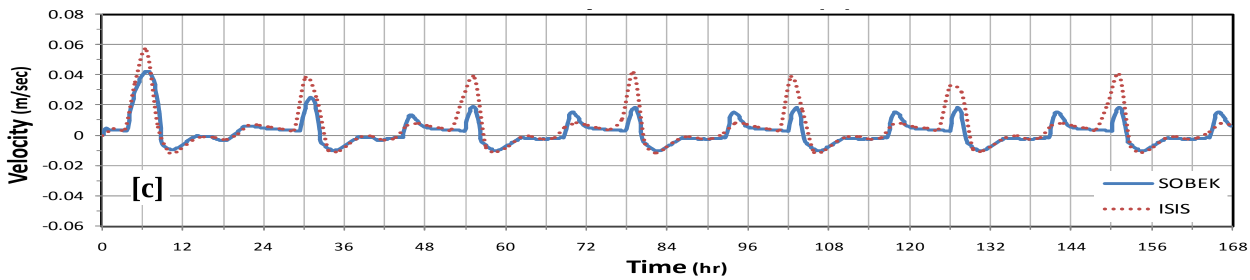


Fig. 14. Comparison between ISIS and SOBEK flow velocity results
[c] the fourth pattern at sec. {6} km 4.2.

For third pattern, Fig. 15 shows the water surface profiles in case of the third abstraction pattern at all lateral points. The minimum and maximum values for water surface are calculated using both SOBEK and ISIS and are compared. It can be noticed that, the difference between maximum water surface and land levels ranges between 0.25 m and 1.8 m. In addition, the canal becomes dry in between km 2.2 and 3.8 for minimum flow case. Generally, for third pattern the water depth in the channel is more shallow than the other patterns. Figure 16 presents the relationship between the flow velocity at km 2.8 and time. The velocity varies periodically with time. It means that the water depth increases at low abstraction during the day and vice versa. This figure proves that, the model reaches the steady state conditions as the velocity varies in same ranges during the study period. It was found that the values of velocity becomes < 0.0 m/sec for some periods. It was very important evidence to change the flow direction in opposite direction, as the canal becomes dry in this reach. It can be concluded that, the applying of continues flow through El-Kanais canal for the third abstraction pattern will cause drying in 1600 m long “from 2.2 to 3.8 km” for 9 hours/day, and therefore pump stations can not abstraction of water in this region and therefore the water will not reach farmers. As recognized, some cross-sections of the canal are subjected to problem under continuous flow. It means that, the served area in El-Kanais canal will suffer from a big problem. The optimal scientific solution for the problem has depended on the investigation of the problem reasons. These reasons may be 1: in this pattern the abstraction rates concentrate about 70% of total discharge rates for canal at period from 8 AM to 2 PM. 2: at km 2.2 , there is P_5 which services about 25% of total area served of canal. 3: the bed levels is raising from km 2.2 to 3.8.

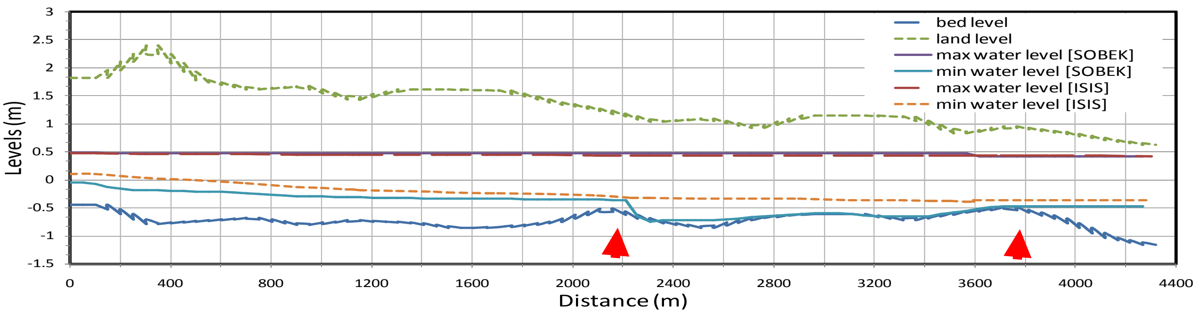


Fig. 15. Land, Bed, Max. and Min water levels using SOBEK and ISIS for the third abstraction pattern.

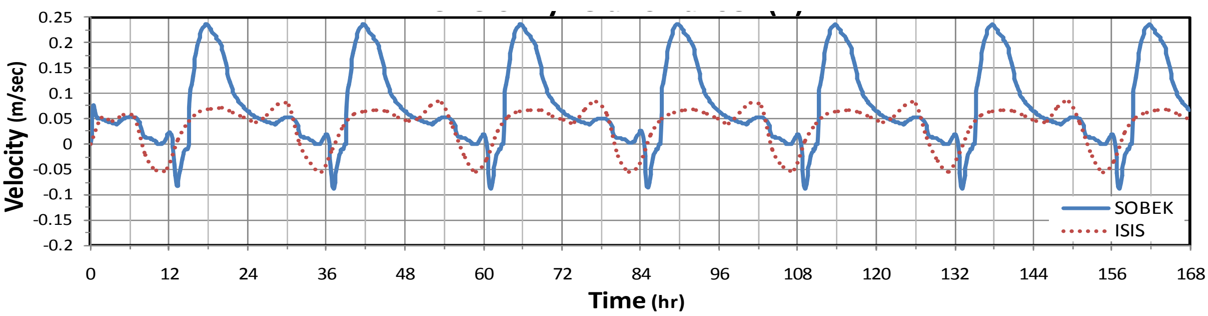


Fig. 16. Comparison between ISIS and SOBEK flow velocity results for the fourth pattern at km 2.8.

7. SIMULATION FOR THE PROPOSED SOLUTIONS

The proposed solutions plan depends on the following three items: 1: modifying of the insufficient cross sections of the canal itself, 2: modifying the tailescape and one cross section, 3: proposing a new water structure and modifying the tailescape satisfying the acceptable water levels. All proposed solution will apply on the worst case of the abstraction patterns, i.e. the third abstraction pattern.

7.1 First Proposal

In the first proposal, the bed slope was modified to be 10 cm/km starting from Km 1.8 until the canal end. The cross sections are modified at many locations along the last 2.517 km of the canal, to satisfy the proposed bed slope. All modified cross-sections are presented as shown in Fig. 17. The initial water level is assumed to be 0.1 m, the discharge passes through the head regulator is equal 0.5042 m^3/sec, the crest level of the tail escape is 0.4. Manning's Coefficient is taken as 0.03. In addition, the total time of the flow simulation in the canal is taken as one week with interval computational time step = 10 min. Note that, the third abstraction pattern is applied at all lateral points. It is proposed that, the bed is excavated up to level (-1.10) with an excavation depth ranging between 0.05 to 0.85 m, Fig. 17. Minimum and maximum values of water levels are computed from both SOBEK and ISIS and they are compared, Fig. 18. SOBEK and ISIS models give good agreement results for the case of maximum water levels. For the minimum water levels, the maximum difference between the water surfaces is about 20 cm because of the effect of the shear stress in SOBEK model as shown in Eq. (2) but not in ISIS model as shown in Eq. (3). Moreover, it can be noticed that, the distance between maximum water surface profile and land levels ranges between 0.3 m to 1.7 m, which can be consider as an acceptable values for the lift irrigation. In the other hand, the minimum water surface in the channel becomes shallow through the main flow path. The average water depth is 50 cm. It may cause an increasing of the running cost, but the water is still available for the farmers comparing to the recent case. Figure 19 presents the relationship between the flow velocities and time for the selected three different cross sections on the main flow path. It is clear that, the flow velocity varies periodically with time for both SOBEK and ISIS. It means that, the models reach the steady state conditions as the flow velocity varies in same ranges during the 8-weeks i.e. the period of calculations.

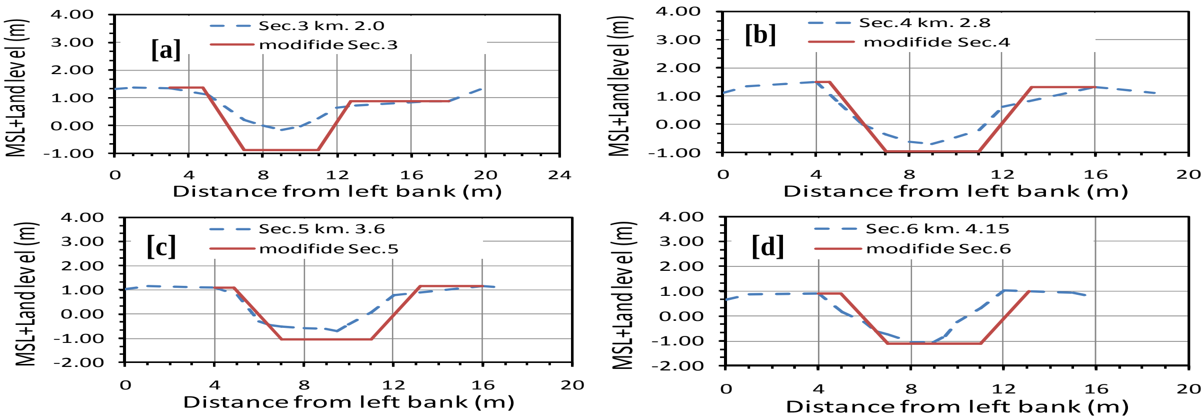


Fig. 17. Modified cross sections at km 2, 2.8, 3.6, 4.15 of El-Kanais canal for 1st proposal.

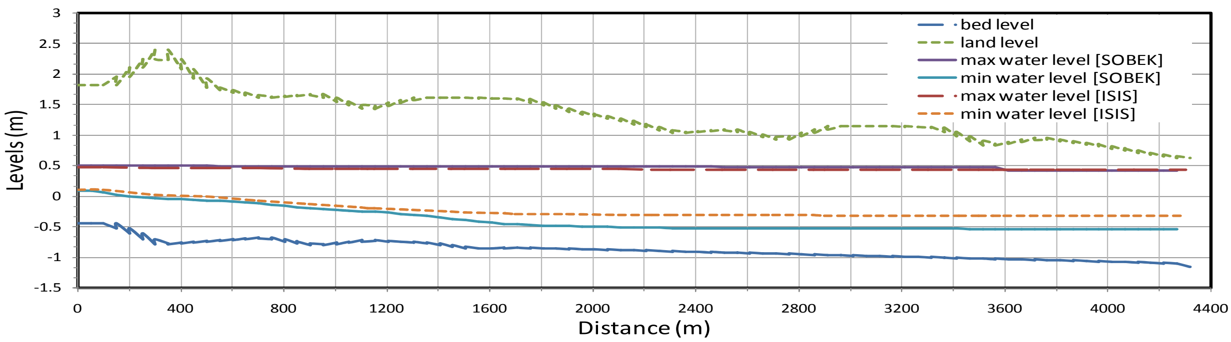


Fig. 18. Land, Bed, Max. and Min water levels using SOBEK and ISIS for the first proposal.

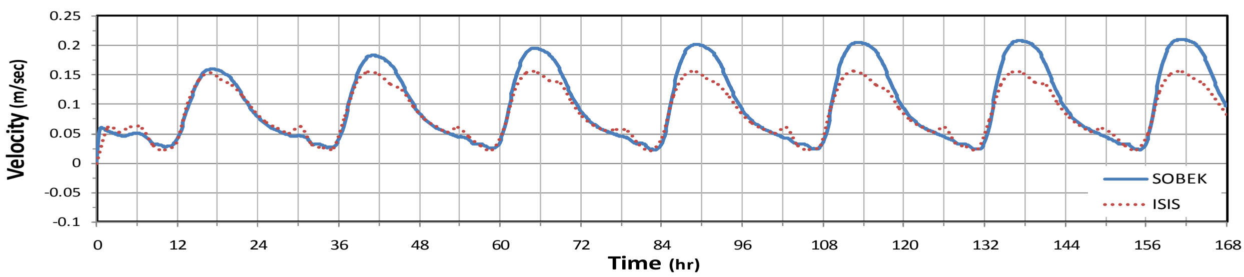


Fig. 19. Comparison between ISIS and SOBEK flow velocity results at Sec. 3 at km 2.0.

7.2 Second proposal

In this proposal, the significance is to reduce the excavation process for cross-sections. The main determination of this proposal is to keep natural conditions as it is. And water surface within optimal ranges for irrigation process. During the filling period at the night where the suction process is low and some of water is drained by the tailescape. As a result, it is proposed to raise the crest level of the tailescape by 5 cm to reduce the drained amount of water. Moreover, the reach located between km 3.4 and 3.8, the bed was neutralization to be a simple adverse slope. The cross section is modified as shown in Fig. 20.

Minimum and maximum values for water levels are computed from both SOBEK and ISIS and they are compared, see Fig. 21. SOBEK and ISIS models give very near values for the case of maximum water levels. For the case of minimum water levels, the maximum difference between the water surfaces is about 30 cm. Moreover, it can be noticed that, the distance between maximum water surface profile and land levels ranges between 0.15 m to 1.7 m. In the other hand, the minimum water depth is covering the bed by about 15 cm from km 2.8 to 3.2. This depth is very small, but it will be exist at the rush hour i.e. the maximum abstraction period.

Figure 22 presents the relationship between the flow velocities and time for a selected cross section at km 0.4. It is clear that, the flow velocity varies periodically with time for both SOBEK and ISIS. It means that, the models reach the steady state conditions as the flow velocity varies in same ranges during 168 hrs.

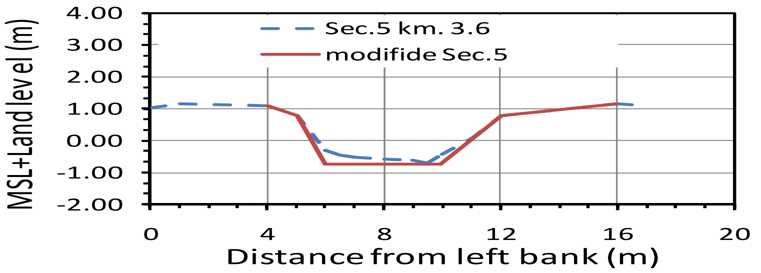


Fig. 20. Modified cross section at km 3.6 of El-Kanais canal for 2nd proposal.

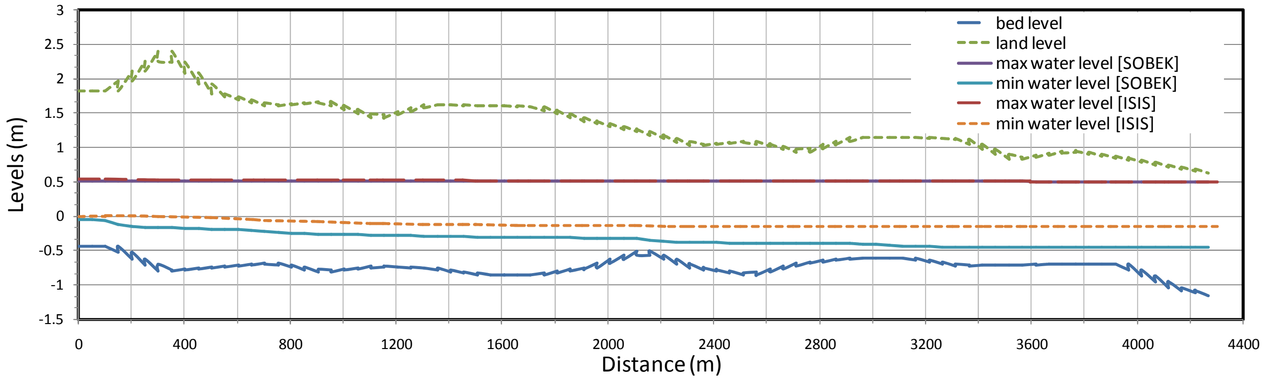


Fig. 21. Land, Bed, Max. and Min water levels using SOBEK and ISIS for 2nd proposal.

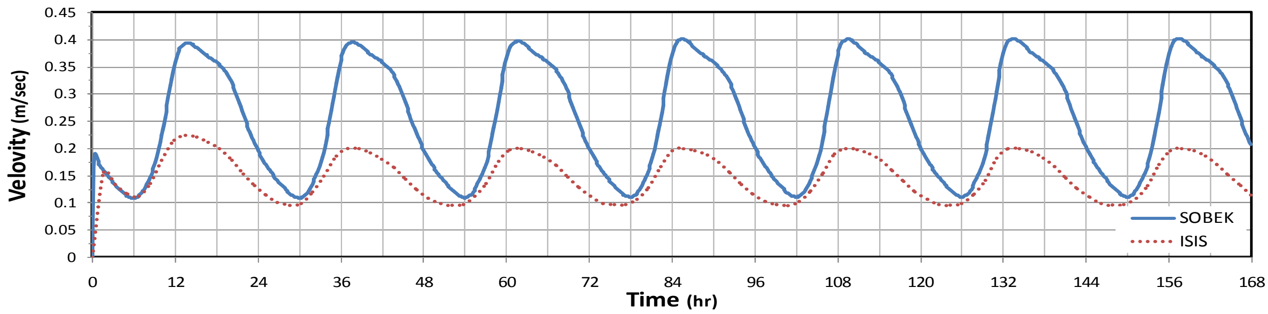


Fig. 22. Comparison between ISIS and SOBEK flow velocity results at sec. 1 km 0.4

7.3 Third Proposal

In the this proposal, the priority is to keep all cross sections as it is. As a result, it is necessary to find another way to rise the water surface at the maximum abstraction period. The proposal adopted two ways to achieve its goal, one of them is raising the crest level of the tailescape by 5 cm to reduce the drained water and the other is construction a sill just downstream the last intermediate regulator km 3.595. The bed level of canal at this location is (-0.70) and the crest level of the sill is (-0.60), as shown in Fig. 23 minimum and maximum values for flow water surface profiles along the canal are presented as shown in Fig. 24 for both SOBEK and ISIS. In case of maximum water levels, the water surface seems to be typical for both SOBEK and ISIS. On the other hand, the minimum water surface calculated by ISIS is higher than that of SOBEK by range from 10 cm to 35 cm. The minimum water depth is above the bed by 10 cm. This depth is very small, but it will be exist at the rush hour i.e. the maximum abstraction period.

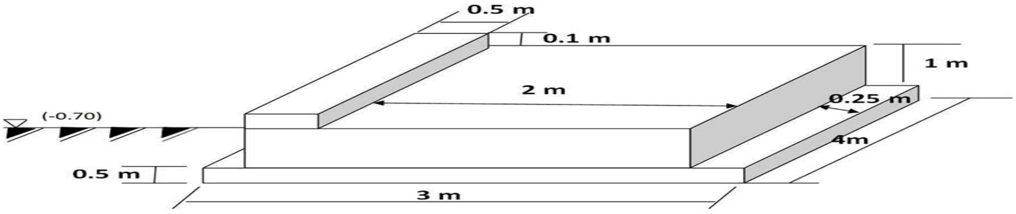


Fig. 23. The constructed sill at Km 3.595

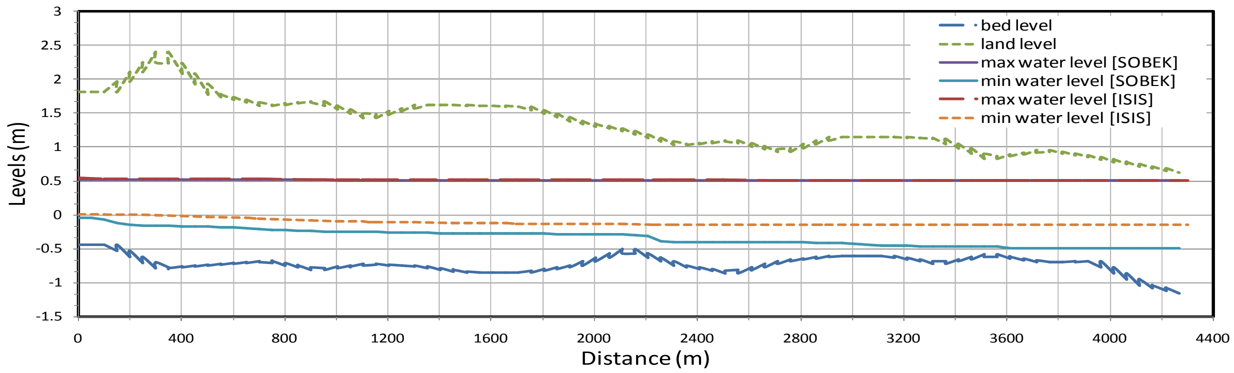


Fig. 24. Land, Bed, Max. and Min water levels using SOBEK and ISIS for the third proposal.

Figure 25 presents a comparison between ISIS and SOBEK for the average flow velocity results at sec. 3. It is clear that, the flow velocity varies periodically with time for both SOBEK and ISIS. It means that, the models reach the steady state conditions as the flow velocity varies in same ranges during the week i.e. the period of calculations.

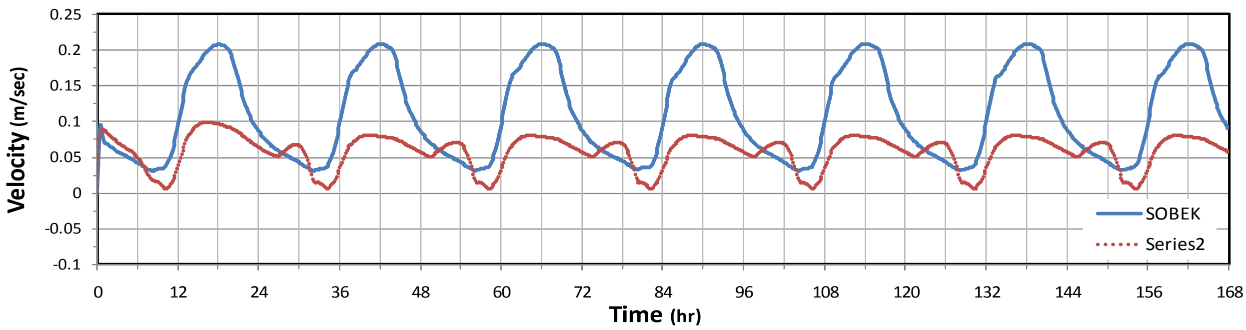
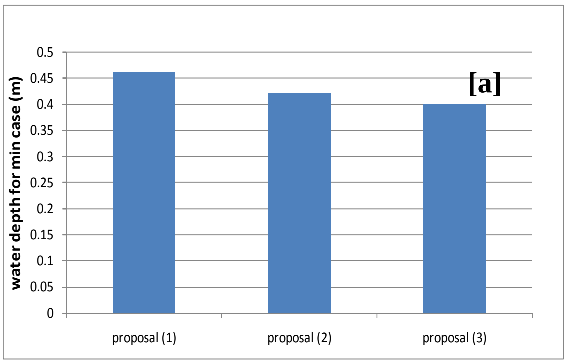


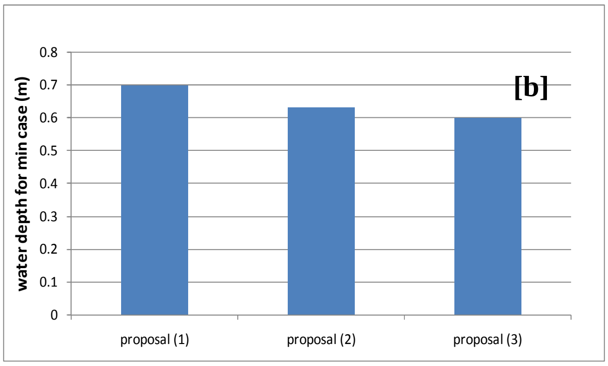
Fig. 25. Comparison between ISIS and SOBEK flow velocity results at sec. 3 km 2.0

7.4 COMPARISON AND DISCUSSION

The three proposals are satisfied the main goal, which need to solve the water shortage problem in the last reach of the canal. As a result, the comparison between the proposals has been investigated depending on many parameters including the water depth for minimum flow case, the cost, keeping the existing cross sections; and finally the time of construction. The water depth in case of minimum flow is considered the very important factor because of shortage of water in the canal is between km 2.2 and 3.8. Figures 26 a, b, c and d give a comparison between the three proposals for minimum water depth at critical sections. From this figure, it can be concluded that the first proposal gives the highest value of minimum water depth. Figure 26 e presents comparison between the three proposals for initial cost. From Table 4, it is obvious from this figure that, the third proposal gives the lowest cost. On the other hand, keeping of the existing cross sections may play better role to keep the stability of the biological life and more safe for irrigation system, the third proposal considers the best one for keeping of the existing cross sections. Figure 26f presents comparison between the three proposals for construction time. The second proposal gives the lowest construction time.

Finally, The results concluded that the third proposal is the more safe {keeping the existing cross sections} and economic proposal. But, the first proposal is considered the best for obtaining highest minimum water level.





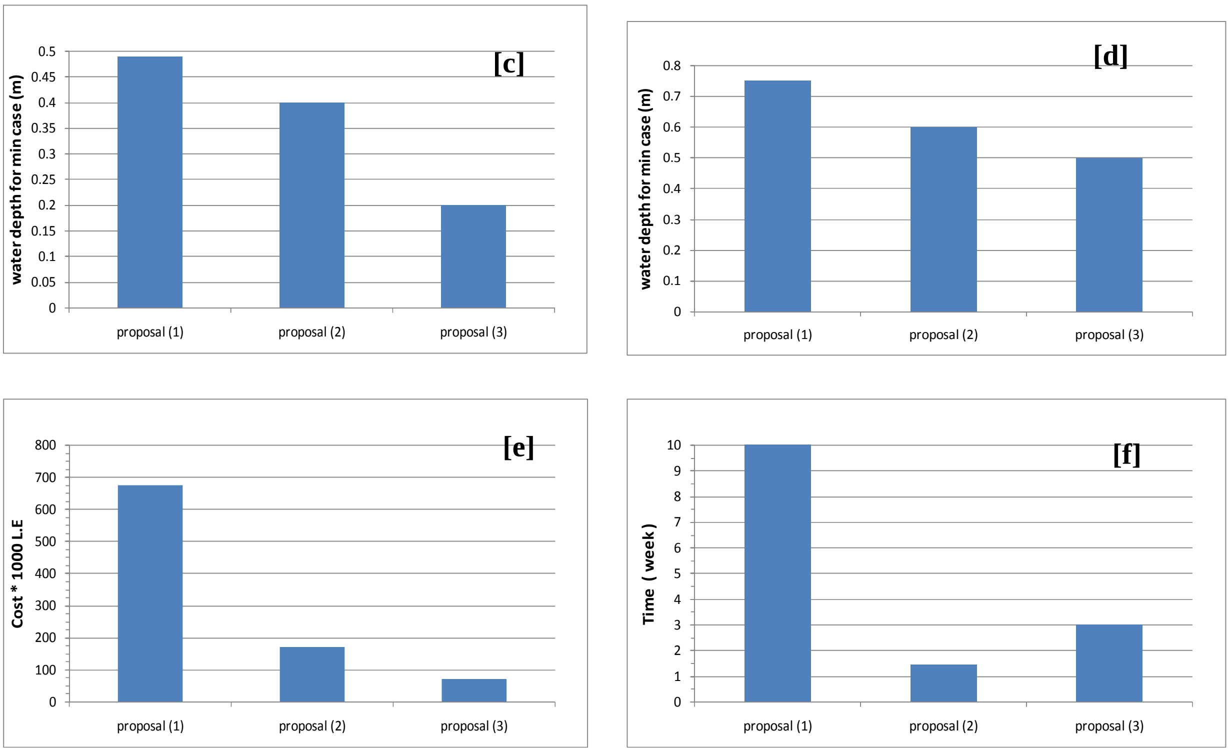


Fig. 26. Comparison between the different proposals [a] water depth for min case by SOBEK at km 2.8 [b] water depth for min case by ISIS at km 2.8 [c] water depth for min case by SOBEK at km 3.6 [d] water depth for min case by ISIS at km 3.6 [e] cost [f] time.

Table. 4 Cost comparison between the proposals.

Item		1st proposal		2nd proposal		3rd proposal	
Description	Rate {LE}	Quantity {m^3}	Value {LE} ×1000	Quantity {m^3}	Value {LE} ×1000	Quantity {m^3}	Value {LE} ×1000
Cut /fill {m^3}	15	12078.43	181.18	575.8	8.64	200	3
Pitching {m^3}	200	3508.2	701.64	799.6	159.92	-	-
P.C. {m^3}	800	-	-	-	-	6	4.8
R.C. {m^3}	2000	-	-	1	2	12	24
Summation			882.82		170.56		31.8

8 CONCLUSIONS

The paper focuses on the effect of the suction patterns of the pump station on the flow filed in one of Egyptian distribution canal. This paper uses two of the famous simulations models; ISIS and SOBEK to simulate the water surface profile in El-Kanais distribution canal under continuous flow condition.

The following main conclusions might be pointed out :

1. The simulation models are calibrated using the designed water surface in the canal. The comparison between the models' results and the designed water showed that the steady state water surface obtained by SOBEK is higher than that obtained by ISIS. The difference is about 5 cm along the first 3500 m;
2. The patterns representing the most probably cases that may happen during the irrigation process are used for the simulation process. The most critical one is the third pattern.
3. The results of the critical abstraction pattern indicated that the actual sections of the canal are not sufficient to carry the required discharges under continues flow;
4. Three solutions are proposed to solve the water shortage problem in the canal. The three proposals satisfies the main goal;
5. The proposals are compared depending the technical and economic aspects.
6. The results concluded that the third proposal is the most safe {keeping the existing cross sections} and economic proposal. But, the first one is considered the best for obtaining highest minimum water level.

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تأثير أشكال منحنيات السحب على الرى الحقلى بإستخدام برنامجى السوبيك والايسيز

يتناول البحث تأثير إختلاف أشكال منحنيات السحب لمحطات السحب الحقليه لترعة الكنايس التوزيعيه تحت تأثير نظام الرى بالتيار المستمر حيث تم تطبيق نموذجين لمحاكاه شكل سطح المياه والسرعات المختلفة بإستخدام برنامجى (SOBEK, ISIS) وتمت المعايرة بإستخدام خط المياه التصميمى للقناه وبحيث تمثل أشكال السحب المستخدمه أثناء المحاكاه الحالات المحتمل حدوثها أثناء الرى حيث أتضح أن منحنى السحب الأول يعطى أفضل مناسيب للمياه كما تم تحديد المنحنى الحرج للسحب (المنحنى الثالث) وظهر أن القطاعات الفعليه للقناه غير كافيه لتحمل التصرفات المطلوبة بإستخدام الرى بنظام التدفق المستمرعند تطبيق منحنى السحب الحرج وتناول البحث كذلك ثلاث مقترحات لتخطى ومعالجة منحنى السحب الحرج حيث تبين أن المقترح الأول يعطى أفضل مناسيب للمياه اما الثانى فهو الأسرع فى فترة التنفيذ بينما الثالث كان الأفضل من حيث التكلفة.