HIGH FLOODS IMPACTS ON NILE RIVER

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ABSTRACT

Egypt has experienced high floods during the past few years. These high floods have many negative impacts on the Nile River and its hydraulic structures. Many factors including High Aswan dam operating conditions are controlling the effects of these high floods on the Nile River. In some cases, high floods have to be passed to the Nile River due to Lake Nasser operation rules restrictions. The purpose of this study is to compute the water surface profile for the distance between Assiut Barrage and Delta Barrage by using available mathematical models such as HEC-2 to estimate the effect of different flood conditions. Study results and risk regions are illustrated in this paper.

INTRODUCTION

The Nile River from Aswan to Cairo is subdivided into four reaches: 1- The reach between Aswan Dam to Esna Barrage, 2- the reach from Esna Barrage to Naga Hammadi Barrage, 3- The reach from Naga Hamadi Barrage to Assiut Barrage, and 4- The reach from Assiut Barrage to Delta Barrage. The fourth reach, from Assiut Barrage to Delta Barrage, is selected for this study for many reasons such as: 1- This reach is the longest reach, and 2- this reach includes many areas subjected to overtopping because of its banks are considered of lower heights compared to other reaches.

STUDY REACH

This reach study extends from down stream Assiut Barrage to up stream Delta Barrage as shown Figure (1). The length for this reach is about 382 km, the average width is about 500 m. It is considered the longest reach, relatively straight channel and

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meandering occurs locally and its sinuosity is about 1.1. Valley walls, towns on the right and bank protection works on the left in general confine the channel movement. After the construction Aswan High Dam, the water discharge from the Dam Lake came under control to meet the irrigation requirements factories, drinking water, and electricity. This reach affected by hydraulic characteristic changes and some morphological changes occurred such as (scour, deposition and bank erosion). Some islands attached with the main banks and works as a part of the flood plain, the secondary channel blocked and the channel converted to become one main channel at the some region.

GENERAL OVER VIEW THE MODEL

The HEC-2 computer simulation program uses numerical method named standard step method to compute changes in water surface elevation between adjacent cross section on the basis of solving the one dimensional energy equation between the flow cross sections. The standard step iterative method is used to solve the energy equations for the unknown upstream water level starting from a known level at the downstream of the computation reach. For HEC-2 model requirements, the cross-sections have to be arranged from downstream to upstream and sorted in a descending order based on the cross-section number. Each cross-section is defined as three parts, channel, right and left over-banks, each having a different roughness coefficient. One must not interpret, however, flood plains as low or non-contributing areas. Flow over flood plains exists and is taken into account in the model by specifying Meaning's values for these areas. The methodology incorporated in HEC-2 model is mainly based on several assumptions:

1- Steady flow
2- Gradually varied flow
3- One dimensional flow with correction for horizontal velocity distribution
4- Small channel slope
5- Friction slope (averaged) constant between two adjacent cross sections
6- Rigid boundary condition.

Data Used for Model

The information required running any water surface model could be grouped under two main parts, geometric and hydrologic data. All river models interpret an alluvial stream as a series of cross-sections, more or less equally spaced, which describe the actual shape of the riverbed at these locations. The available cross-sections in the reach under study (reach 4) from Assiut Barrage to Delta Barrage) consists of 40 cross-sections with different spacing between series of cross section which have been surveyed in 1997. The cross-sections were first arranged from the upstream to the downstream. The geometric data records used in these runs consists of:

1) Cross-sections profiles description,
2) Roughness coefficient Manning's (n) for each cross-section and
3) Hydrologic data such as flow discharges and water level at gauging stations

1) The hydrologic data for this reach consists of discharge data at Salam which is located downstream Assiut Barrage at kilometer 544.77 from Aswan. The discharge measurements at this site are generally performed about 40-50 times per year. Rating curves are then developed for each calendar year.

2) The second part of the hydrologic data for the reach consists of the water levels at gauging stations. Twelve gauging stations along the reach are available on daily basis. These stations are listed in Table 1.

Water Level Profile

Water levels along the Nile both for the past, present and future are important inputs for project impact evaluation. There are 12 water level gauging stations on the reach study, which are read daily and these data have been assembled to determine present water level profiles.

Table 1: Water Level Gauging Stations along Reach 4

Serial No.	Station Name	Kilometer From Aswan Dam
1	Assiut	544.75
2	Maabda	576.2
3	El Mandra	612.1
4	Qalandool	649.4
5	El Minia	687.55
6	El Sheikh Fadl	735.55
7	Beba	778.9
8	Beni Sweif	808.6
9	El Korimat	839.15
10	El leethy	873.7
11	El Roda	927
12	Delta Barrage	954

Historical Water level at Different Gauging Stations

Since the construction of the Aswan High Dam, water levels have been changing with time. Figure 2 represents water levels at different gauging stations for ten years ago. The maximum water levels are considered at year 1997, 1998. In this study we used 1995 data for the calibration and 1997 data for the verification.

HEC-2 MODEL APPLICATION RESULTS

Calibration Results

The model calibration was performed to simulate, by trial and error, the actual conditions and water levels for different discharges with the measured water levels. The results of this calibration runs represent a table of roughness coefficients Manning's (n) against discharge.

The calibration runs were made for maximum discharges 173 mm^3 /day at year 1995. The computed water levels were compared with the measured water levels at the gauging stations mentioned above.

Figure 3 shows the computed water levels (C.W.L), measured water levels (M.W.L), mean bed levels (M. B.L) and thawleg path. From the graph, it can be noticed that there is close relationship between computed and measured water levels.

Verification Results

Good model performance can be observed as the computed water levels closely match the measured water levels at gauging stations. Consequently, the model can be used safely in the prediction runs for different flow and water level conditions as shown Figure 4.

Terraces lines

These lines can be defined in the field by the top of the old river banks. They are located easily on the 1:10000 map as they follow the contour lines of high ground near the river bank (the starting contour of the agriculture lands). They separate between flat and steep slopes in cross sections. Terraces lines are used for the analysis of the prediction of water surface profiles to study the risk region and to propose some protection for these regions.

Prediction of Water Surface Profiles (WSP)

Different water discharges are considered for this analysis. These discharges are: 350, 400, and 500 million m^3/day. In addition to these discharges, the emergency release from High Aswan Dam, which is 605million m^3/day, is also included in the model analysis. Figures 5, 6, 7, and 8 show the results of the discharges 350, 400, 500, and 605 million m^3/day, respectively. Two operating water levels at Delta Barrage were used for 350 million m^3/day discharge as shown Figure 5. These levels are:

Min. normal operating level	(16.33 m),
Expected max operating level	(17.00 m).

Figure 5, 6, 7, and 8 describe the risk regions for different discharge as mentioned above. It can be noticed that the length of the backwater profile increases along the reach as the control water level at Delta Barrage increases for discharges (350, 400, 500 and 605 million m^3/day. From these graphs, it can be illustrated that the risk regions along the reach increase with the increase of the discharge.

CONCLUSIONS

The effects of high floods on the Nile River are studied in this paper using mathematical models.

The fourth reach, from Assiut Barrage to Delta Barrage, is selected as an example for this study.

The calibration and verification results show close relationship between measured and predicted water levels.

Terraces lines were located for the reach study. These lines are used to study and analyze the risk region and to propose some protection for these regions.

Different water discharges are considered for this analysis. These discharges are: 350, 400, and 500 million m^3/day. In addition to these discharges, the emergency release from High Aswan Dam, which is 605 million m^3/day is considered in the analysis.

The model results for different discharges along the reach are illustrated by graphs.

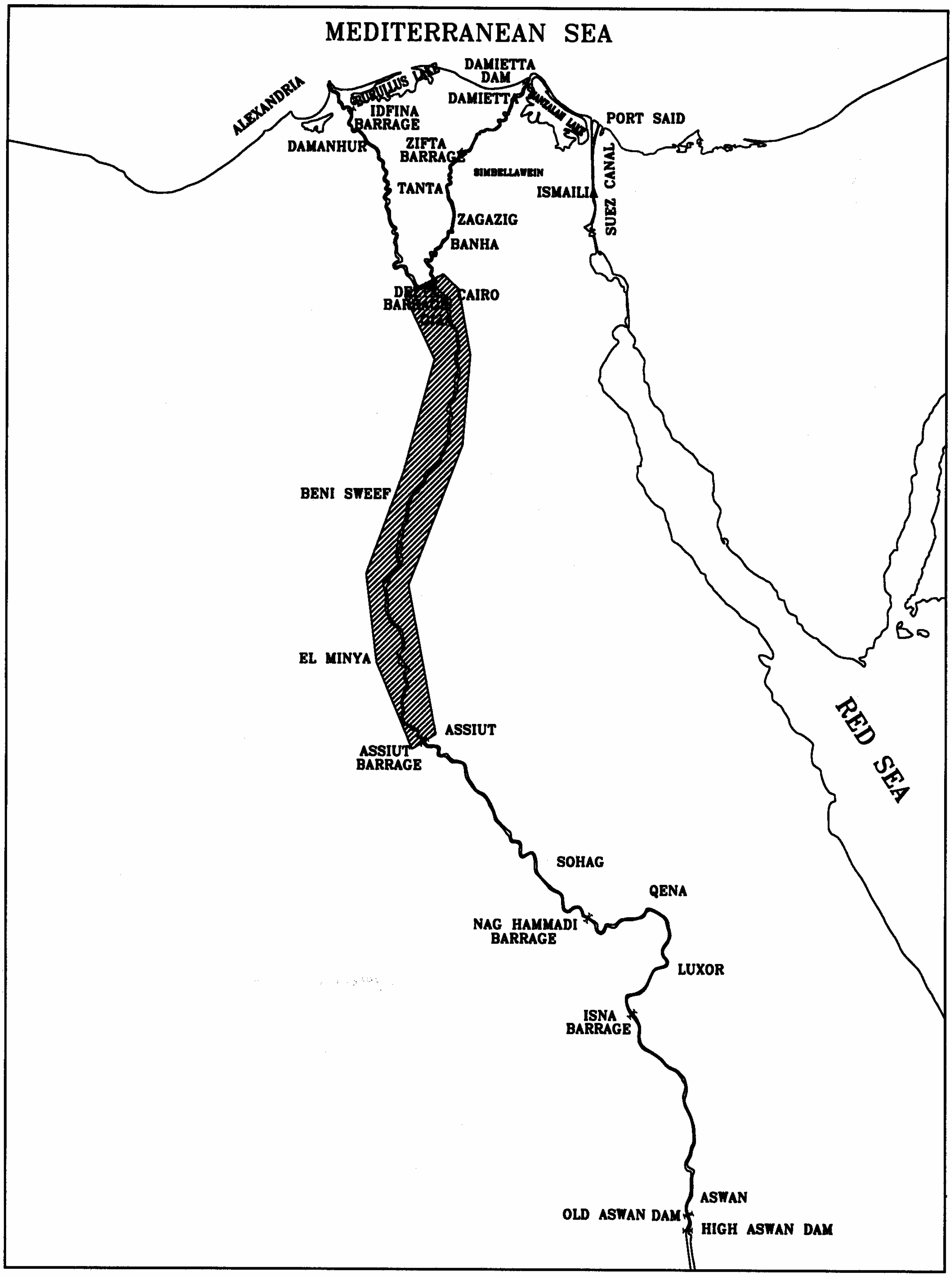

Figure 1. Reach 4 Location

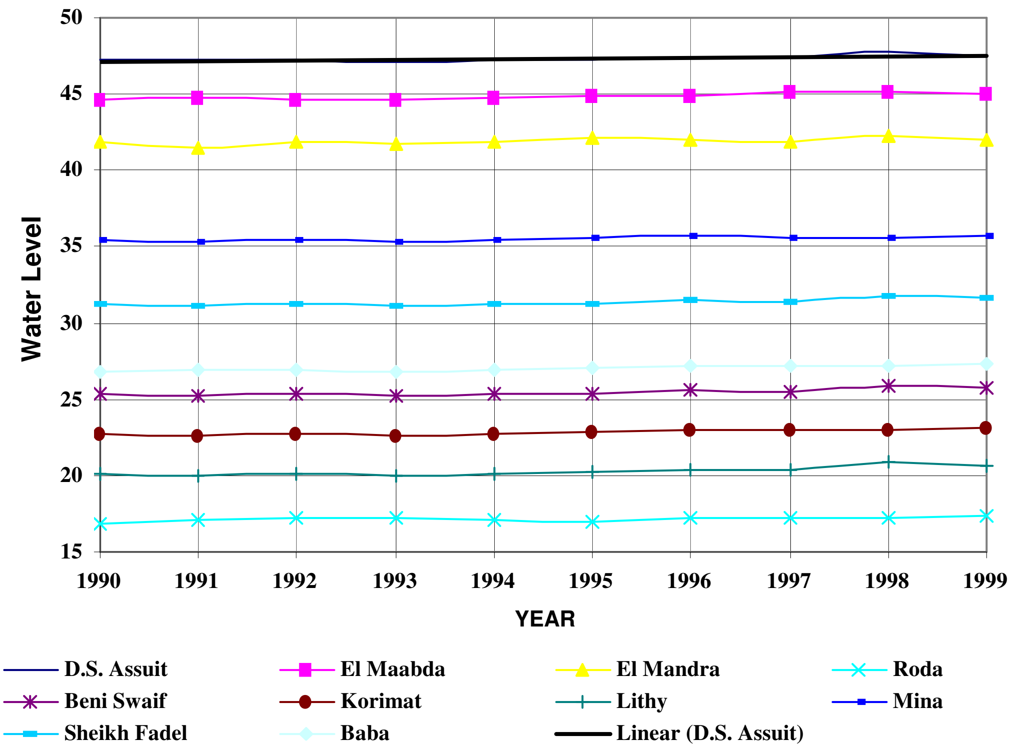

Figure 2. Maximum water levels for different gauging stations

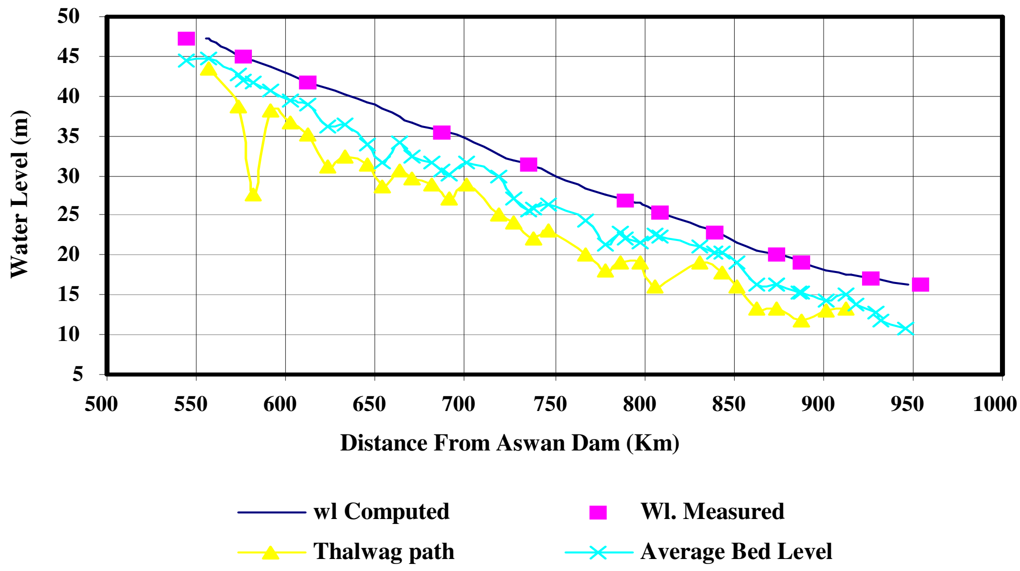

Figure 3. Calibration results

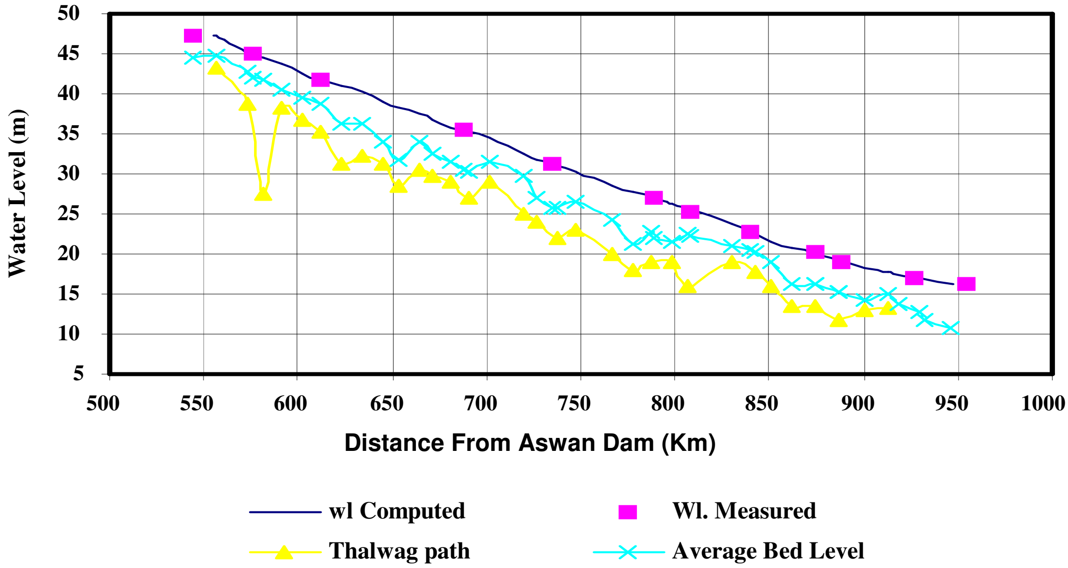

Figure 4. Verification results

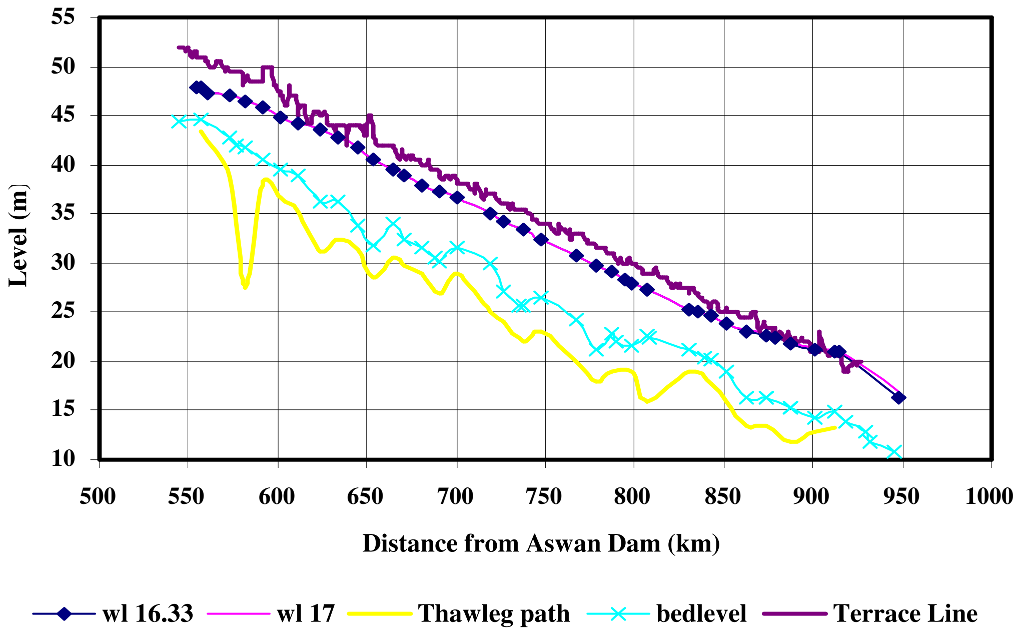

Figure 5. Model results for 350 m.m^3/day

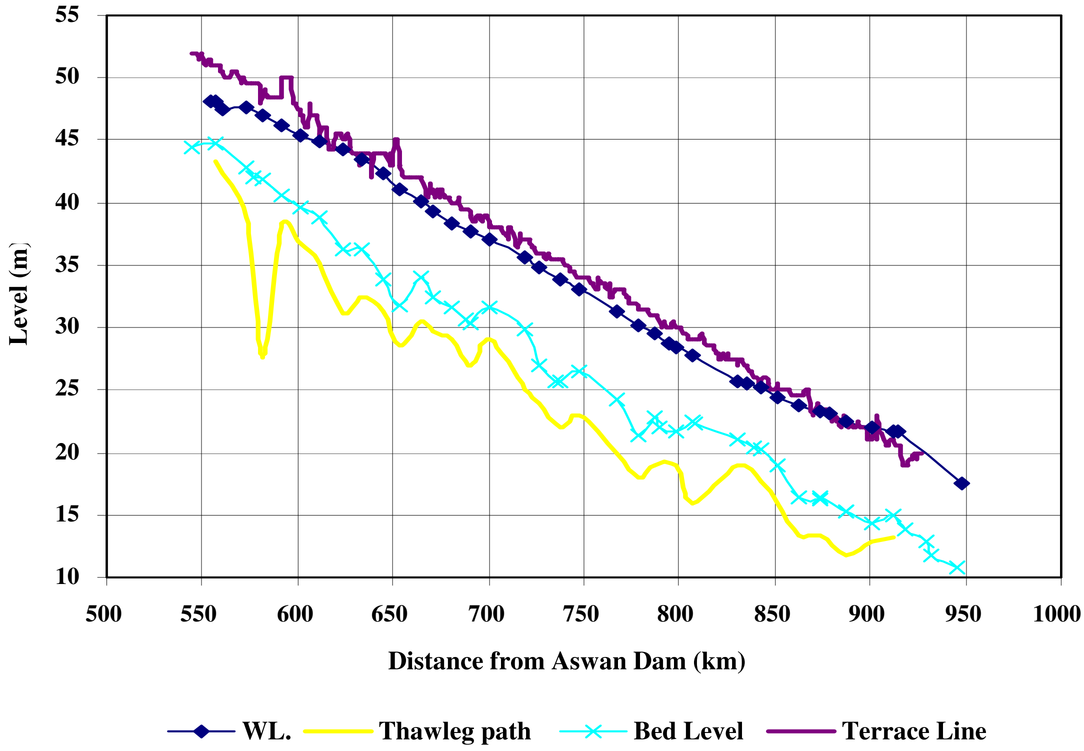

Figure 6. Model results for 400 m.m^3/day

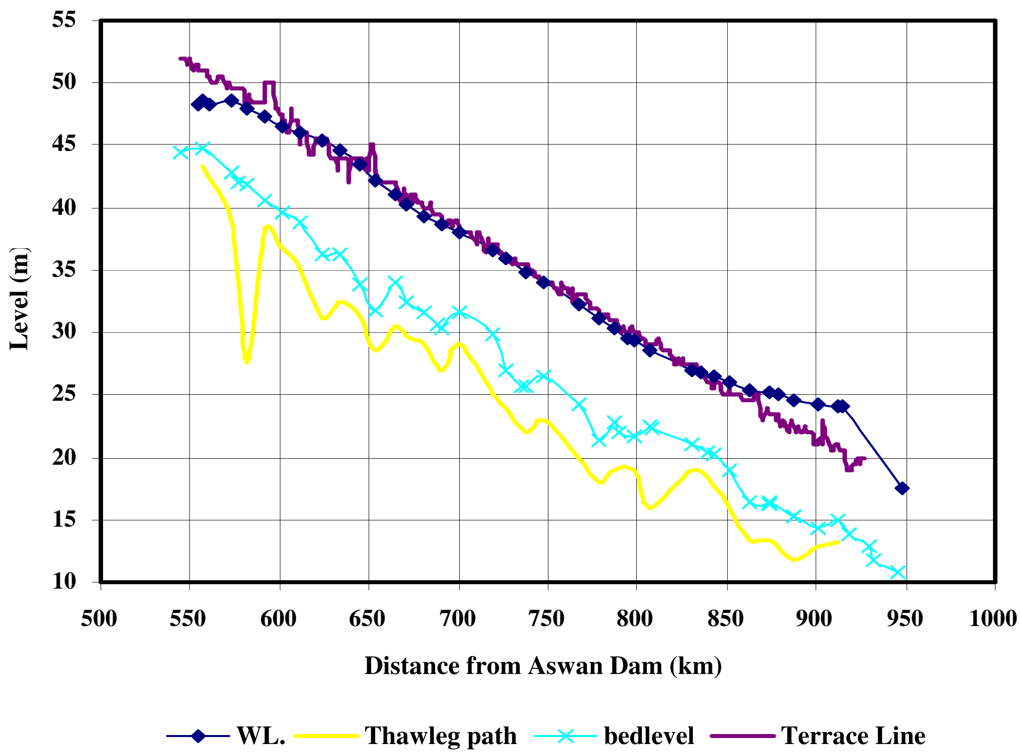

Figure 7. Model results for 500 m.m^3/day

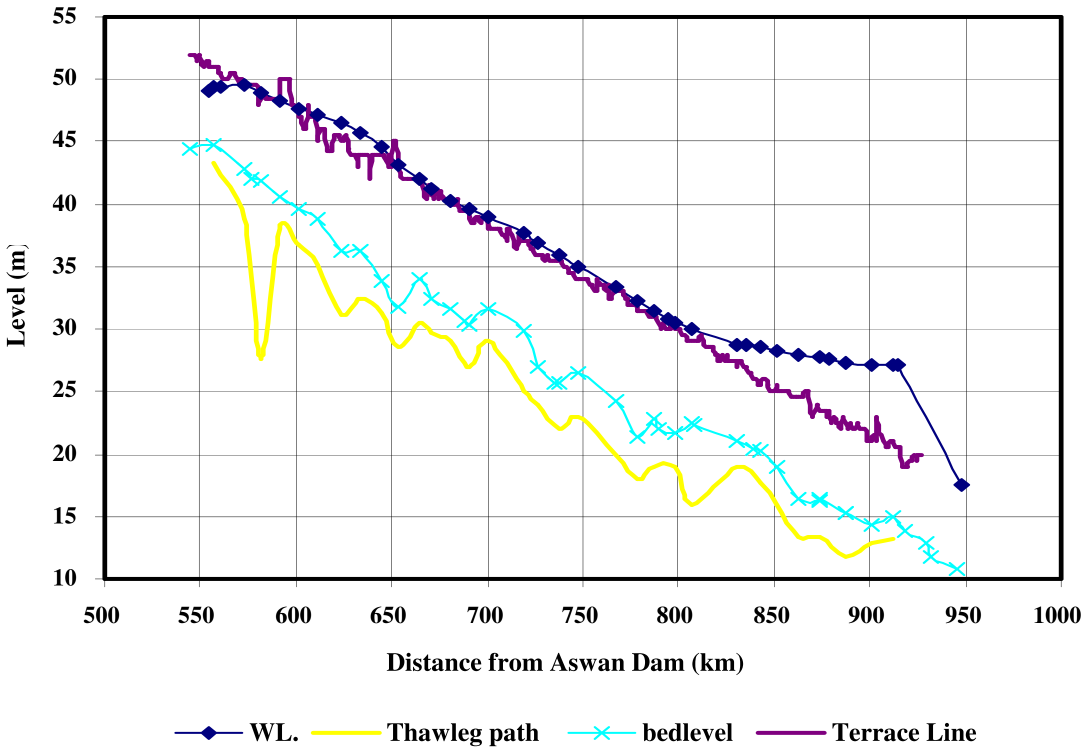

Figure 8. Model results for 605 m.m^3/day