Evaluating the Hydraulic Performance of Al Msharah River

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Abstract

Al Msharah River is one of the main controlled feeders of Al Huwayza Marsh in addition to its importance in irrigation of the nearby agricultural areas. A study for evaluating the hydraulic performance of this river has been carried out to develop the ability of the river to accommodate the increase of the required discharge for feeding the marsh and agricultural projects. Achieving this objective require carrying out field hydrological measurements, stage and discharge, at a number of stations distributed along the river for period of six months. A steady one dimensional hydraulic model has been prepared to simulate the flow in this river using the HEC-RAS software (Version 3.1.3). The calibration and verification processes of the model have been carried out by making use of the field measurements. The maximum allowable discharge of this river for the present conditions has been found and the failure, flood, locations have been specified along the river. The required cross sections to develop the capacity of the river have been found considering the marsh and agricultural requirements.

تقييم الأداء الهيدروليكي لنهر المشرح

الخلاصة

نهر المشرح أحد المغذيات الرئيسية المسيطر عليها لهور الحـويزة إضـافة الـى أهميته في إرواء الأراضي الزراعية المجاورة للنهر. تم إجراء دراسة لتقييم الأداء الهيدروليكي لهذا النهر لتطوير قابلية النهر على إستيعاب الزيادة في التصـاريف المطلوبة لتغذية الهور والمشاريع الزراعية. تطلب إنجاز هذا البحث إجراء قياسات هيدروليكية تضمنت قياس التصاريف والمناسيب في عدد من المواقع موزعة على طول النهر ولمدة ستة أشهر. تم إعداد نموذج هيدروليكي للجريان الثابت احـادي البعد لمحاكات الجريان في هذا النهر باستخدام برنامج ال HEC-RAS (Version 3.1.3). وتم إجراء عمليات المعايرة والتحقق من النموذج بالإستفادة من القياسات الحقلية. تم تحديد اعلى تصريف مسموح به في النهر في الضروف الحاليـة وتـم تحديد مواقع الفشل (الفيضان) على طـول النهـر. ولغـرض تطـوير الطاقـة الإستيعابية للنهر فقد تم إيجاد المقاطع العرضية اللازمة اخذين بنظـر لإعتبـار إحتياجات الهور والزراعة.

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Introduction

Al Msharah River is one of Al Huwayza Marsh feeders. The intake of Al Msharah River is located to the north of Al Am'arah barrage on Tigris River,as shown in Plate 1. A head regulator was constructed to control the inflow in this river. The design capacity of this head regulator is $100m^3/s$ and the operating capacity is $50m^3/sec$ [1]

The length of the river reach between the center of Al Am'arah city and the center of Al Msharah city; of about 32.5km, and from the center of Al Msharah city toward Al Huwayza Marsh; of about 16.5km, this part is called Al Malah River. The last part of Al Msharah River which is ended at AsSanna'f Marsh close to AsSodda Bridge is called Al Abttar and has a length of 15km [2].

Fifteen irrigation channels are laterally branched from the right bank of the river along its length. These channels are called Al Ela , Um Al Btoot ,Al Safagi , AjJad'eed , Al Kharaba, Al Kraym'ma ,Al Daghr'ria , Al Malfood ,AjJa'dle, AjJuwaydle ,Al Winsa, Al Bag'a ,Al Mt'affia , Al Hemaily and Al Am'ma [3].

Al Msharah River was ended at AsSanna'f Marsh close to AsSodda Bridge. Currently, the water at the end of Al Msharah River is diverted to re-flooding an area located to the right of its end [3].

2- Hydrological Field Measurements

The hydrological field measurements were carried out at three stations during the study period, from January 2006 to July 2006, as shown in Plate 1, [4].

2-1- Discharge Measurements

Set of twelve discharge measurements, two measurements at each month during the study period, from January 2006 to July 2006, were carried out at the three hydrological measurement stations (Al Msharah Barrage, station 1, Al Msharah Bridge, station 2 and at the end of the river, station 3.

A current meter was used to measure the discharge.

The measured discharges at the three stations during the study period are shown in Fig. 1.

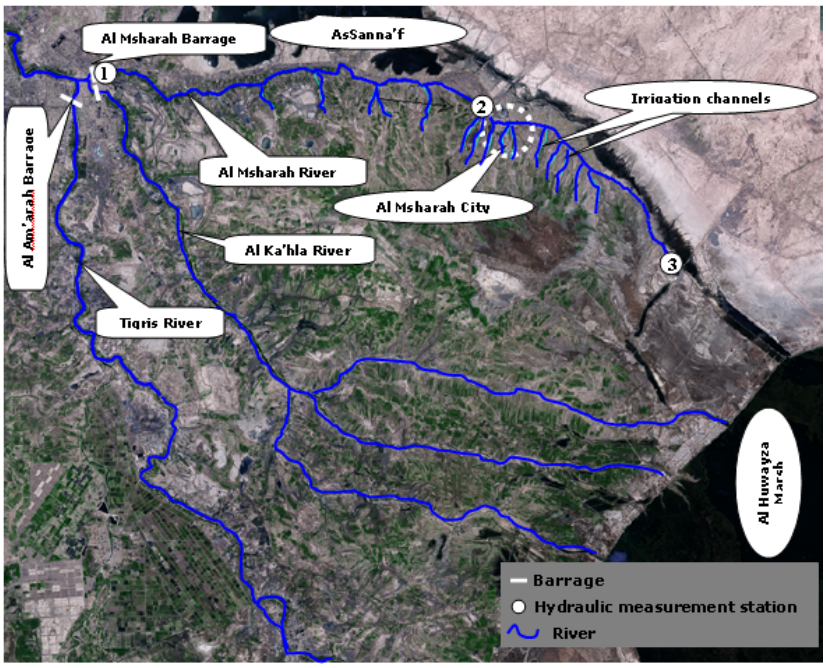

Plate 1. Al Msharah River layout.

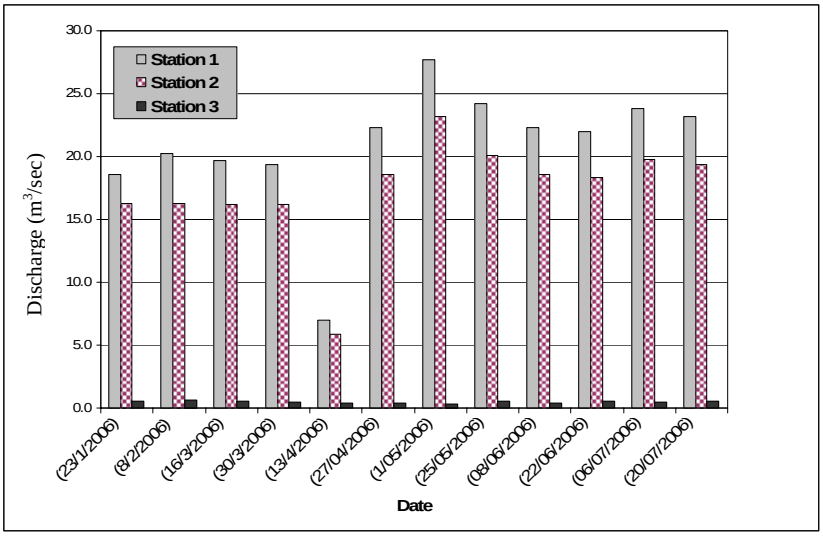

Fig. 1. Measured discharge at the three hydrological measurement stations.

2-2- Stage Measurements

Set of twelve stage measurements, two measurements in each month during the study period, from January 2006 to July 2006, were carried out at three hydrological measurement stations Al Msharah Barrage, station 1, Al Msharah Bridge, station 2 and end of the river, station 3. These measured stages are shown in Fig. 2**.**

3- Flow Routing Hydraulic Models

A steady one dimensional flow hydraulic model was used to simulate the flow in Al Msharah Rive in order to obtain the water surface elevation along the river under a set of steady flow conditions.

The HEC-RAS software (Version 3.1.3) [5] was used to accomplish this target.

3-1 Geometrical Data

The surveyed river cross sections [3], left and right banks, downstream reach length, proposed initial Manning's roughness coefficient, n, of the main channel, and other reaches information were the geometrical data required to run the model. These data were input to the model through the menu of cross section geometrical data.

All the hydraulic structures (bridge, culverts, spillway, weir etc…..) on the rivers were specified and their details input to the model using bridge or culvert geometrical data menu.

3-2 Upstream Boundary Condition

The HEC-RAS model deals with the boundary conditions depending on the flow regime. In a sub critical flow regime, which is the flow regime in the river under consideration, boundary conditions are only necessary at the D/S ends of the river system and deals with its data in a separated window.

The discharges at the upstream boundary required to run the model are shown in Table 1, which were selected depending on the field measurement hydrological data.

Flow change locations were specified and the net flow through the river reaches was inputted to the model using the steady data menu.

3-3 Downstream Boundary conditions

A known constant stage type boundary condition was adopted in all runs of the hydraulic model.

The downstream boundary conditions of a constant stage of the river

are shown in Table 2. The selection of these values was based on the measured hydrological data. These data were input to the model through the menu of steady flow data**.**

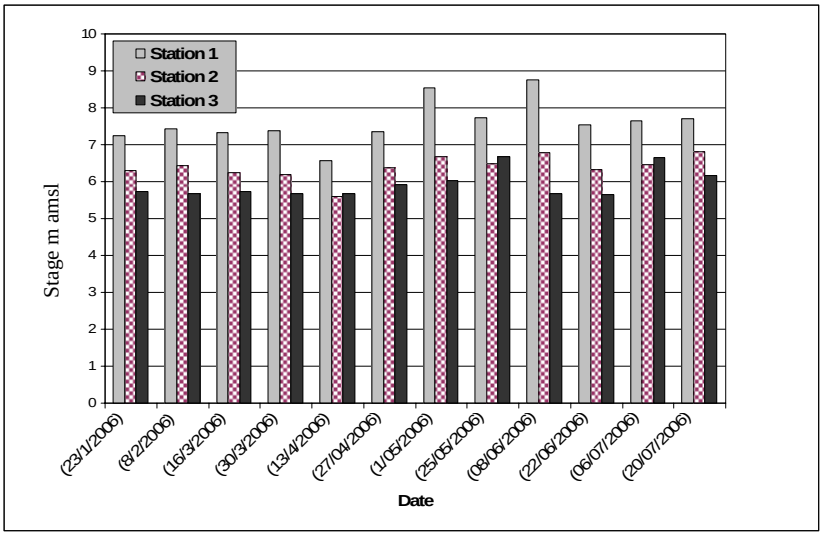

Fig. 2. Measured stages at the three hydrological measurement stations**.**

Table 1. Upstream discharge

Run No,	**Discharge (m^3/sec)**
1	18.6
2	20.2
3	19.7
4	19.4
5	7.0
6	22.3
7	27.7
8	24.2
9	22.3
10	22.0
11	23.8
12	23.2

Table2. Downstream boundary conditions at station 3.

Run no.	**Stage (m amsl)**
1	5.74
2	5.67
3	5.73
4	5.68
5	5.68
6	5.93
7	6.03
8	6.68
9	5.68
10	5.66
11	6.64
12	6.15

3-4 Hydraulic Model Calibration

A calibration process was carried out using stage measurements along Al Msharah River, which were carried out for this purpose, as listed in Table 3. The discharge at the upstream end of the river, at Al Msharah Barrage, station 1, during the measurements was 21.98m3/sec.

Fifteen channels are branched from the left side bank of Al Msharah River and there are two hydraulic structures along its length, bridge and culvert.

The flow change locations and the discharge at each change location are listed in Table 4.

The calibrated Manning's n values along the main channel and its left and right banks are listed in Table 5.

An acceptable agreement was achieved between the model predicted stage values using the calibrated data and the measured stage values as shown in Figure 3.

3-5 Hydraulic Model Verification

Two sets of data were used for the verification process. The first set of data that was used for the verification process is represented by the rating curve that was predicted at Al Msharah Bridge, station 2, Table 6. The comparison between the model predicted rating curve and the measured rating curve is shown in Figure 4, which is show an acceptable agreement.

The second set of data is the water surface profile along Al Msharah River measured for this purpose at a discharge of 27.86m^3/sec at the upstream end of the river. The comparison between these measured values and the model predicted stage values is shown in Figure 5, which is show an acceptable agreement.

Table 3. Measured stage along Al Msharah River.

Cross section No.	Easting (m)	Northing (m)	Stage (m amsl) at Q=21.98 m^3/sec
1	705127	3526502	7.55
4	711877	3525323	7.16
7	718502	3526789	6.85
8	720461	3527138	6.75
9	725746	3525802	6.74
11	729802	3524106	6.40
12	730295	3523388	6.33
14	731302	3523377	6.19
15	731540	3523370	6.16
17	734614	3522434	5.88
18	735362	3521722	5.82
19	735565	3521600	5.81
22	741495	3515027	5.60
23	742216	3513943	5.54

Table 4. Flow change locations along Al Msharah River for upstream discharge of 21.98m^3/sec.

Cross section No.	Easting (m)	Northing (m)	Discharge m^3/sec
1	705127	3526502	21.98
3	708825	3525390	21.62
5	711877	3525323	21.06
6	715226	3525881	20.15
7	718452	3526808	19.23
9	720461	3527138	18.68
10	725746	3525802	18.32
12	730295	3523388	16.49
13	731182	3523345	15.57
14	731302	3523377	14.66
15	731540	3523370	12.82
17	734614	3522434	10.99
18	735362	3521722	9.16
19	735565	3521600	6.41
21	736597	3520396	0.26

Table 5. Calibrated Manning's n values along Al Msharah River.

Cross section no.	Manning's n Value		
	Left overfill bank	Main channel	Right overfill bank
1	0.050	0.038	0.050
2	0.050	0.038	0.050
3	0.050	0.038	0.050
4	0.050	0.038	0.050
5	0.050	0.038	0.050
6	0.050	0.038	0.050
7	0.050	0.038	0.050
8	0.038	0.038	0.038
9	0.038	0.038	0.038
10	0.038	0.038	0.038
11	0.050	0.040	0.050
12	0.050	0.040	0.050
13	0.050	0.040	0.050
14	0.050	0.040	0.050
15	0.050	0.040	0.050
16	0.050	0.040	0.050
17	0.050	0.040	0.050
18	0.050	0.040	0.050
19	0.050	0.040	0.050
20	0.060	0.050	0.060
21	0.060	0.050	0.060
22	0.060	0.050	0.060
23	0.060	0.050	0.060
24	0.060	0.060	0.060

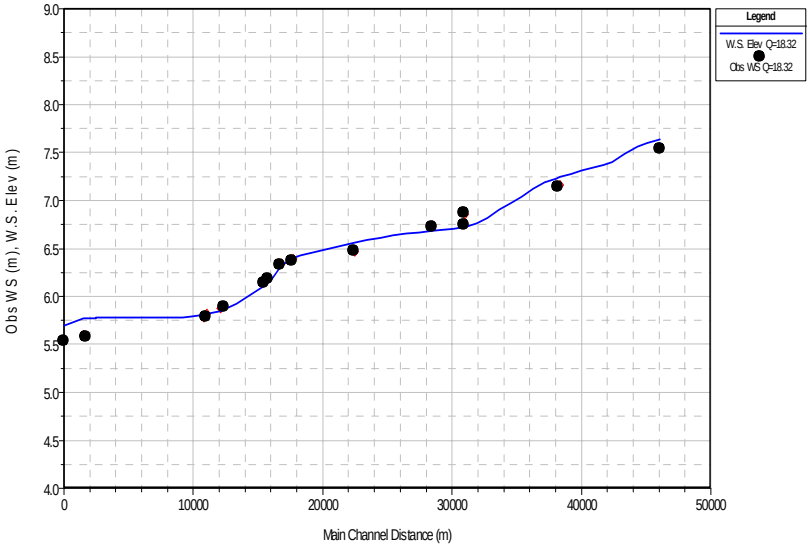

Fig. 3. Comparison between the models predicted stage values using the calibrated data and the measured stage values along Al Msharah River.

Table 6. Measured rating curve data at Al Msharah Bridge station 2.

Discharge (m^3/sec)	**Water Surface Elevation (m amsl)**
5.85	5.59
16.17	6.18
18.62	6.38
20.14	6.48
23.22	6.68
18.32	6.33
19.81	6.46
19.42	6.61

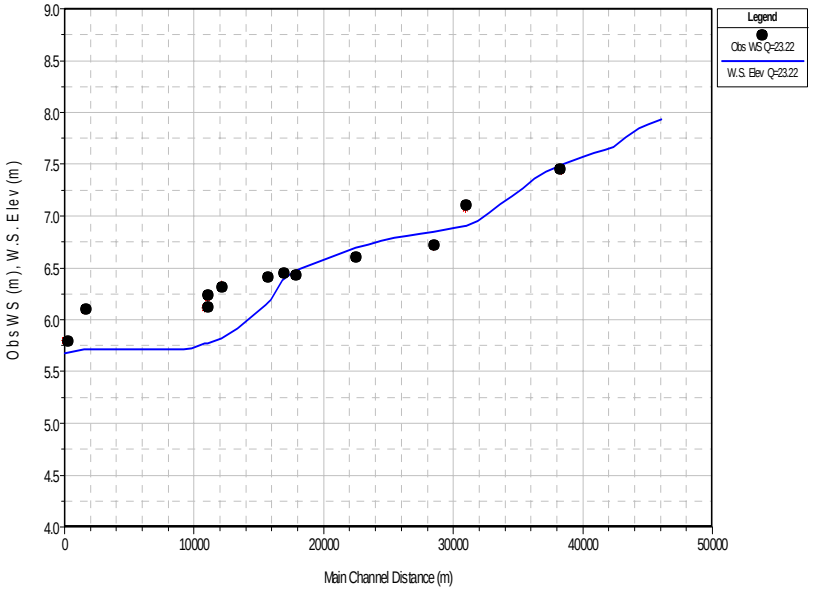

Fig. 4. Comparison between the measured and the model predicted rating curve.

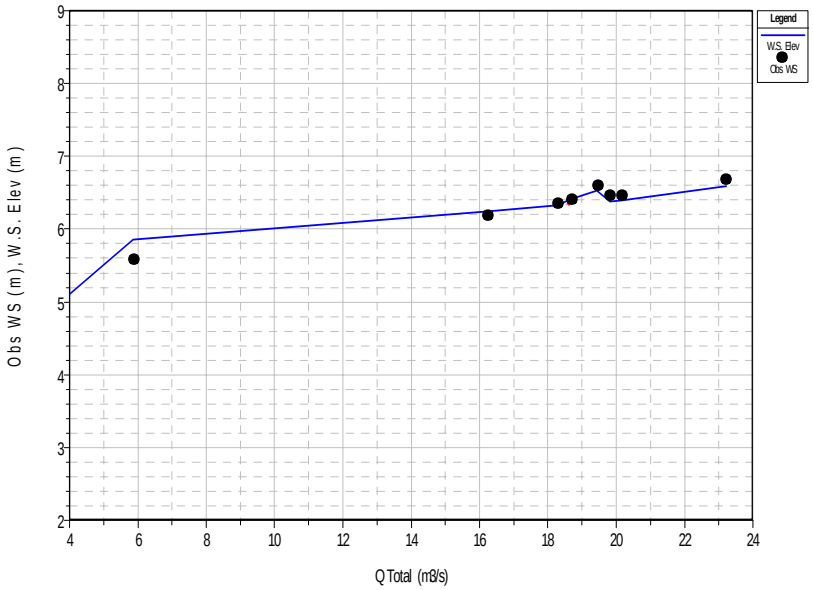

Fig.5. Comparison between measured stage values along Al Msharah River and the model predicted stage values.

4- Maximum allowable discharge of Al Msharah River at the present conditions

The field hydrological measurements which have been carried out during the study period show and that the maximum inflow into the river was 27.68m^3/sec, most of this inflow wasted by flooding the areas nearby the river, and the maximum outflow from this river to Al Huwayza Marsh was 0.62m^3/sec.

The relation between Al Huwayza Marsh water surface elevations and the maximum allowable discharges of the river has been studied by making use of the developed hydraulic model. The water surface elevations of Al Huwayza Marsh have been increased gradually from the minimum allowable water surface elevation of the marsh, 2.8 m amsl, to the maximum allowable water surface elevation of the marsh, 7 m amsl [4]. The inflow discharge of the river was increased gradually for each water surface elevation and the flooded section and discharge and then the maximum allowable discharge of each water surface elevation has been specified for the river at the present conditions. It has been found that the first flooded section is located at 43.68km downstream of Al Msharah Barrage and the maximum allowable water surface elevation at the marsh according to the present capacity of the river is 6.4m amsl.

The relations between Al Huwayza Marsh water surface elevations and the maximum capacity of the river for the present conditions at the flooded section is shown in Figure 6**.** According to this figure the Maximum allowable discharge of Al Msharah River is ranged from 20m^3/sec to 25m^3/sec for the water surface elevation of the marsh from 6.4m amsl to 5.5m amsl.

5- Developing the discharge capacity of Al Msharah River.

According to the proposed hydrological routing of Al Huwayza Marsh [4] and the maximum allowable discharge of the river with the corresponding maximum allowable marsh water surface elevation. The proposed Maximum allowable inflow to the marsh from Al Msharah River was 30m^3/sec.

The present agricultural requirements assumed equal to the maximum total discharge measured at the fifteen irrigation channels during the study period which is found equal to 11m^3/sec. the future agricultural requirements is

4m^3/sec [1]. then the total water required to feed the agricultural projects is 15 m^3/sec. The design discharge of the river represented by the total requirements of the marsh and agricultural projects. So, the design discharge of the river is 45m^3/sec.

According to the above computed design discharges and considering that no lateral outflow the developed cross sections of the river have been found through applying the prepared hydraulic model. It was found that the existing culvert must be developed or removed to prevent flooding of the river upstream of the culvert. It is recommended to replace it by a bridge consists of three circular piers of 0.50m diameter.

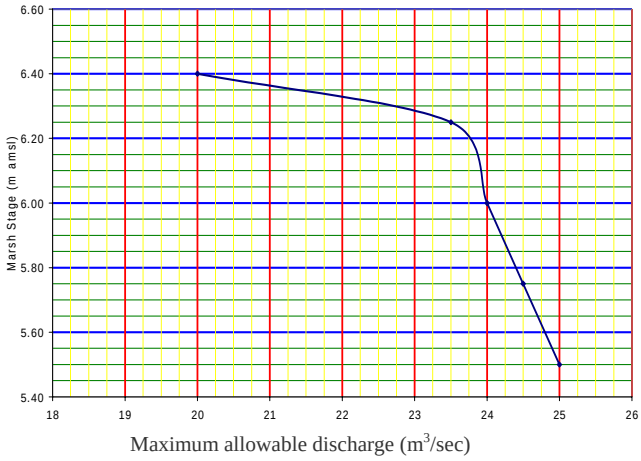

Fig. 6. The relation between Al Huwayza Marsh water surface elevations and the maximum allowable discharges of Al Msharah River at the first flooded section.

6- Conclusions

The following conclusions may be drawn from this study:

1. The value of the maximum allowable discharge of Al Msharah River is affected by the water surface elevation of Al Huwayza Marsh.
2. The Manning's n value for the main channel ranges from 0.038 at the upstream end to 0.060 at the downstream end of the river.
3. The Manning's n value for the Left and right overfill banks ranges from 0.050 at the

upstream end to 0.060 at the downstream end of the river.

4. The first flooded section of the river at the present condition is located at 43.68km downstream of the Al Msharah Barrage.
5. The maximum allowable water surface elevation in Al Huwayza Marsh according to the present capacity of Al Msharah River is 6.4m amsl.
6. The maximum allowable discharge of the river at the present condition is ranged from $20m^3$/sec to $25m^3$/sec for the water surface elevation of the marsh from 6.4m amsl to 5.5m amsl according to the relation shown in figure 6.
7. The computed design discharge according to the present and future requirements of Al Huwayza Marsh and the agricultural projects is $45.0m^3$/sec.
8. The left and right banks elevations of the river must be 11.0m amsl at the upstream end of the river down to 8.0m amsl at the downstream end of the river considering 1.0m as a free board.
9. The existing culvert must be replaced by a bridge consists three circular piers of 0.50m diameter.

7- References

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