Research Article

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Assessment of Manning coefficient for Dujila Canal, Wasit/-Iraq

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Abstract: Assessment of Manning's unevenness factor is of critical significance in hydraulic readings of open channel stream. Manning's (n) is obligatory for the computation of releases, water levels, and backwater curves, as well as plan curve additions. The correct value of Manning's roughness coefficient (n), i. H. a value that accurately reflects the observed data, is selected by the calibration process. The current study aims to calculate the Manning coefficient of the Dujila Canal due to this factor helps in developing water management systems, the Dujila Canal (a branch of the Tigris River) was modeled using the Hydrologic Engineering Center River Analysis System steady-flow model to guess the rate of Manning's factor. The information was reserved for seven cross sections for calibration, then another cross section is applied for the verification process. A statistical test on the recorded data must be used to verify the calibration process. It uses the Root Mean Square (RMS) test. The outcomes show that the appropriate Manning's (n) rate was (0.025), providing a reasonable arrangement amid the designed and perceived sketches

Keywords: Manning, HEC-RAS, 1D, Dujila canal, steady flow

1 Introduction

The estimation of Manning's coefficient (n) is necessary for computing the streams in open canals. Manning's n-coefficient is a vital factor in Manning's equation, so its computing needs knowledge and accurateness to compute velocity and discharge from ground dimensions. Hydraulic scheming to evaluate movement in open canals need a calculation of all characteristics influencing channel roughness. Understanding the opposition to flow, known as Manning's roughness coefficient, for various stream circumstances aids in scheming enhanced water administration schemes. The obstacle solutions associated with water resources such as flood organization, backwater curve computation, canal enhancement, marshland stream, and scour concentration associated with deciding of the drag rate. The roughness coefficient has numerous elements that cause power harm in a stream canal. The basic aspect is the roughness of the canal bed, that is decided via the dimension, form, and supply of the grains of material lining the canal bed and edges (the saturated edge). Manning's roughness coefficient (n) is applied to define the stream opposition or roughness of a canal and is a purpose of bed material, stream deepness, cross-sectional geometry, channel differences, stream hindrances, kind and concentration of plant life, and grade of canal twisting. Much research treated the issue of evaluating Manning's coefficient for channels, such as Manning's (n) must be estimated to accurately replicate flow in open channels. The roughness coefficient is an empirical parameter that includes components of surface friction drag, wave drag, form drag, and drag caused by flow discontinuity [1]. When investigating environmental river runs, especially unstable strait grid runs, a direct estimation of the roughness coefficient is practically impossible. When calibrating a model, a trial and error process calculates the roughness coefficient by comparing field data and calculating step and drain. Field measurements of the unevenness factor (n) within normal canals are challenging. Several influences on the standards of the roughness coefficient were obtainable by ref. [2]. By calibrating the Hydrologic Engineering Center River Analysis System (HEC-RAS) model, Hameed and Ali, [3] calculated the Manning's roughness coefficient for the Hilla River in Iraq. Thus, the resistance grade can be considered as a crucial parameter whose value must be carefully chosen. Most work in this field states that using Manning's calculation for stable, unchanging run is sufficient in this situation, even when transient run imitation conditions require special handling of the resistance grade [4]. Awad [5] has estimated the Manning's roughness coefficient for Shatt Al-Rumaith in Iraq through calibration

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using HEC-RAS model. The characteristic rate of (n) is between 0.022 and 0.033 and [7] for natural irrigation channels (0.025). Using the HECRAS model, Prafulkumar et al. [8] calibrated the channel roughness for the Lower Tapi River in India. In their investigation, Parhi et al. [9] attempted to calibrate the channel roughness. Employing HEC-RAS to simulate floods, the river Mahanadi in Odisha was used to determine the Manning's value "n" [10]. Turkey's Sarimsakli Creek was used as a test case for calibrating channel roughness in intermittent rivers using the HEC-RAS model. According to historical data on natural river discharge in Iraq, Manning's (n) could have a value between 0.025 and 0.033 [11–16].

2 Description of the study area

The Dujila Irrigation Project is situated on the right cross of the Tigris River and on the left cross of the Al-Gharaf River, which stretches from (32° 10′–32° 30′ N) latitude to (45° 50′–46° 20′ E) longitude. The projected flow of the canal is 42 m^3/s. The total area of this project is 155,986 hectares (irrigated and non-irrigated land). It starts from 0 km, Nazim Sadr Al-Dujila Gate, the main gate, and continues its flow, passing through the Nazim 8 km (the origin of the Sedukiya Bridge) at the intersection of Hay and Kut Road, then it goes through the Nazim 17 km, after that it goes through the Nazim 29 km (the entrance to the city of Dujaili). Afterward it goes through the Nazim 36 km (the intersection of Dujaili road and the road leading to Sheikh Saad) and then Nazim 41 km (Al-Hindiya district), later after that Nazim 51 km (Al-Dujaili old town) to Nazim 57 km, Branch shakha13, in addition to the presence of 12 shakha to the right and left of the flow in Figure 1.

One of the most significant strategic projects in the Middle East at the time, the Dujaila agricultural and industrial project, was established in the Wasit area, south of the city of Kut. Its construction was started in 1979 by specialized Yugoslav companies, and the project plan included two projects for liquefaction and reclamation (100) thousand dunums for the cultivation of strategic crops (wheat and barley) and fodder crops (jet, alfalfa, and mixtures), which are irrigated, as well as four cow stations, a dairy plant, a meat-packing plant, and two projects for liquefaction.

3 Methods

Geometric and hydrological data are collected. The geometry of the river section and the border situations upstream and

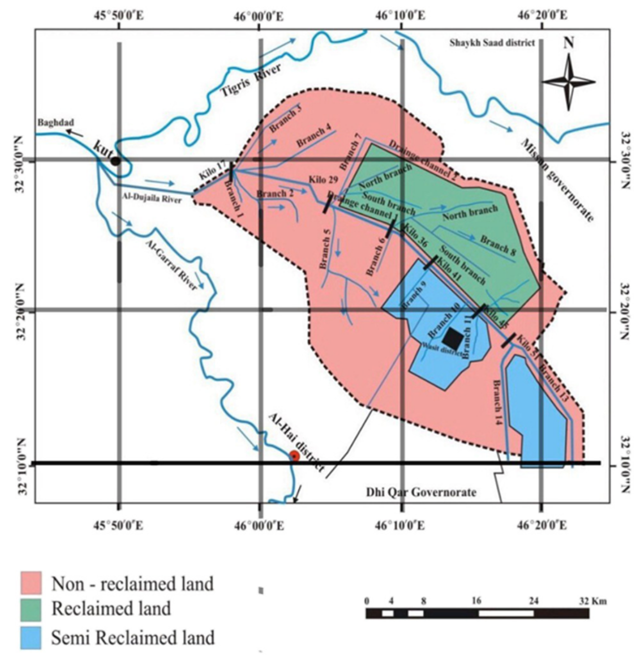

Figure 1: Location Map of the study area [17].

downstream are necessary factors in the implementation of flow modeling with HEC-RAS. A level device was used to calculate the levels of each of the 57 sections of the Dujila river in addition to acoustic Doppler flow profiler (ADCP) tecniq SonTek River Tracker Surveyor (fixed on a boat) to determine cross-sectional area, water speed, and river release. The Van Veens grab was used to collect models of riverbed. The whole amount of cross parts experiential along the stretch was 57 cross-sections, as exposed in Figure 6, at 1 km intervals, covering a total length of 57 km of the river.

Figure 2–4 show the survey work of Dujila Canal using a level device and ADCP technology

Figure 2: Survey work using level and the boat to survey the inside of the river.

Figure 3: Survey work using a level device.

Figure 4: Measuring the discharge and velocity of each section along the channel using ADCP.

3.1 HEC-RAS Model

HEC-RAS was advanced through the US Army Corps of Engineers [18]. In addition, the HEC-RAS program is selected to perform the initial mathematical calculations. There is a long-term use of such software for one-dimensional (1D) river flow simulations [19]. HEC-RAS is a crucial tool for hydraulic modeling and hydrological calculations because it is a professional software and a straightforward 1D model. It is commonly used to estimate 1D water surface profiles for both steady and erratic flow regimes. In addition, it contains elements for numerical calculations related to 1D sediment transport [20]. The central list of the HEC-RAS model is shown in Figure 5.

To develop a mathematical sample in the software, maps of the flow range path were taken and entered into the HEC-RAS geometric information corrector, as shown in Figure 6.

The shape of the river must be represented in a schematic graphic. Starting the trail must be from the direction of the current upstream to downstream. The schematic river system (57 cross-sections) is composed of the lengths of the main channel as well as the section bank stations along the entire route, along with river sections marked by station and elevation points. The editor displays the relevant details for the cross part of the information, as shown in Figure 7.

3.2 Verification and calibration of Dujila Canal HEC-RAS model

In the present study, data for seven cross-sections were taken for calibration, then the verification process was applied through another cross-section. A statistical test on the recorded data must be used to verify the calibration process. It uses RMS. The boundary situation of the stable run sample is a usual depth with dip (0.00007) as shown in Figures 8 and 9 show the height of the observed water level.

Dujila Canals' Manning's roughness coefficient (n) is expected to have values between 0.02 and 0.03 in this simulation model. A value of (n = 0.025) yields values of (n) that are consistent with the model. The Manning coefficients were evaluated at 11 different values ranging from 0.02 to 0.03; the estimated level at 0.025 was closest to the measured values, as shown in Figure 10.

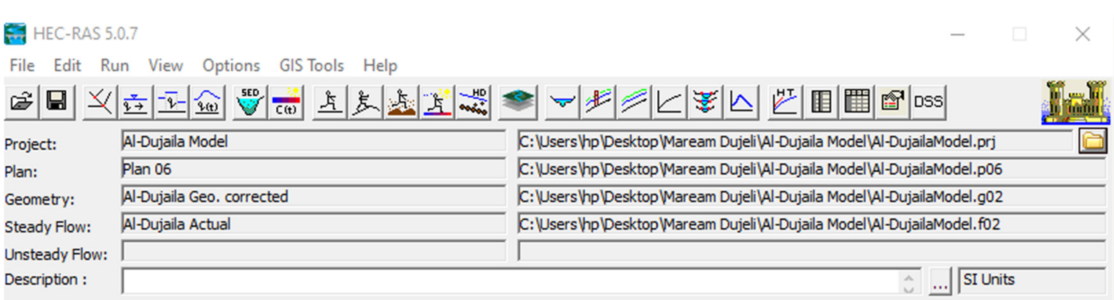

Figure 5: Main HEC-RAS model menu.

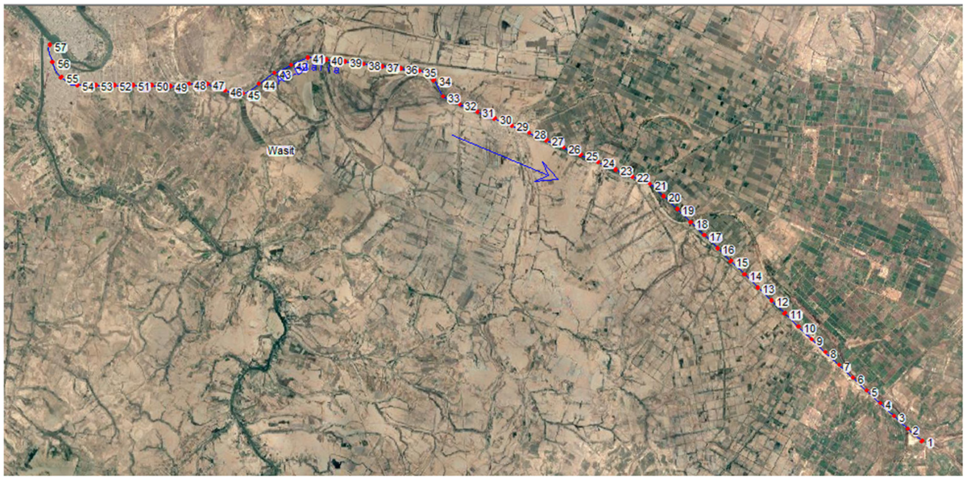

Figure 6: Satellite image for the upper reach of the Al-Dujila River, Google earth.

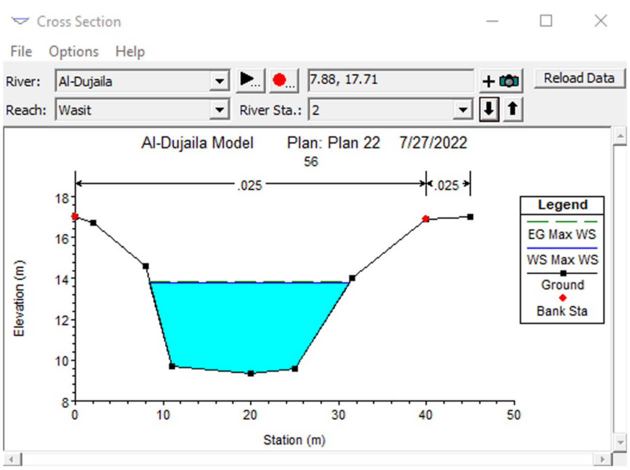

Figure 7: A cross-section of the Dujila Canal.

4 Statistical calibration result test

A statistical test on the recorded data must be used to verify the calibration process. It uses RMSE test. In addition, the RMSE values from the statistical test for calibration results are shown in Table 1. These numbers are the results of comparing the observed phase with the calculated phase.

The process of verification used over a different cross-section is indicated in Figure 11. With the use of parameters (n = 0.025) obtained from the model of the calibration, we can see that it is a crucial test for all simulation models. By comparing observed and comparative data, the model is used to validate the data. The outcomes of the confirmation procedure display that the (n) rate of (0.025) products

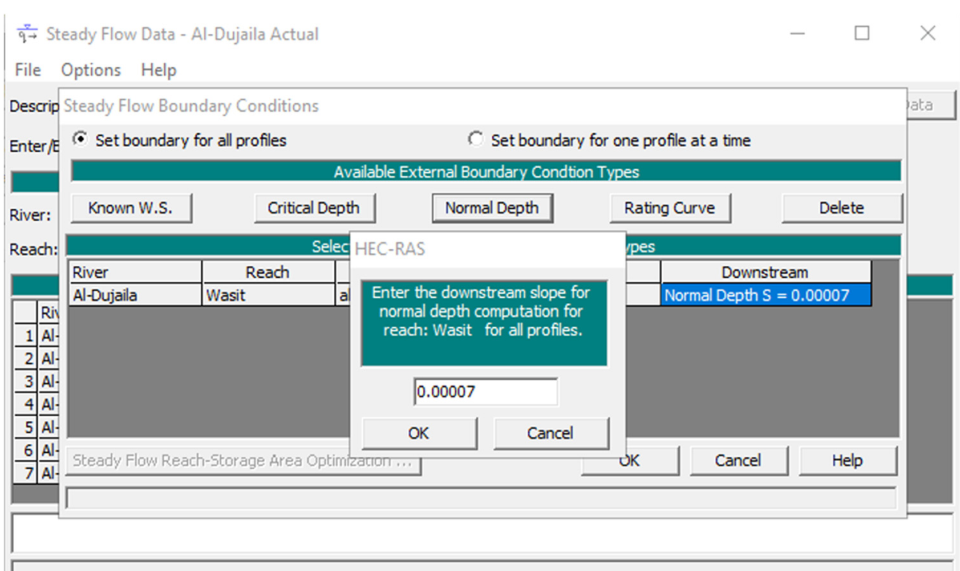

Figure 8: Steady flow data.

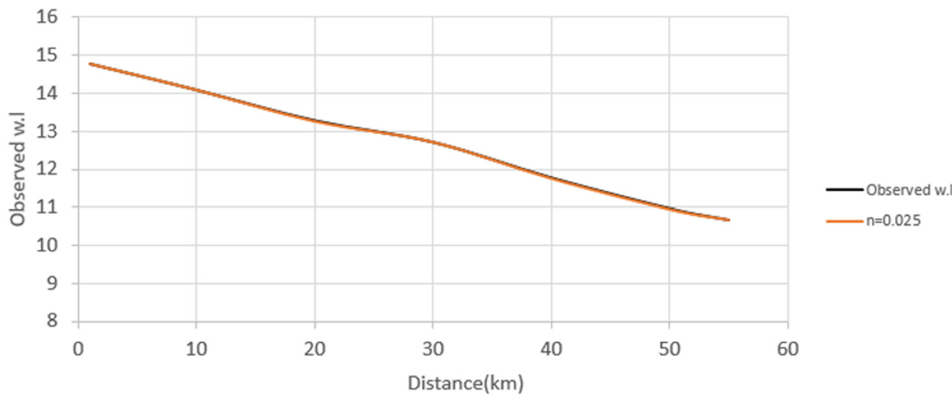

Figure 9: The observed water level elevation.

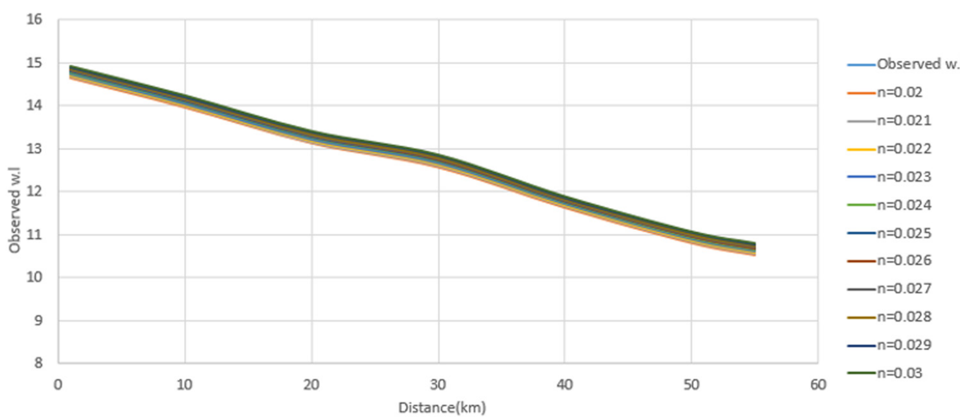

Figure 10: Observed and computed elevation for various (n) values.

Table 1: Calibration results' statistical test

Number of (n) calibrated	Value of (n)	RMSE
1	n = 0.02	0.1302
2	n = 0.021	0.1019
3	n = 0.022	0.0776
4	n = 0.023	0.1251
5	n = 0.024	0.0251
6	n = 0.025	0.010
7	n = 0.026	0.0307
8	n = 0.027	0.0532
9	n = 0.028	0.0772
10	n = 0.029	0.1010
11	n = 0.03	0.1251

information quite similar to the actual information, as can be seen in Figure 12 The RMSE score is 0.016. Examination of the outcomes showed that the sample is appropriate.

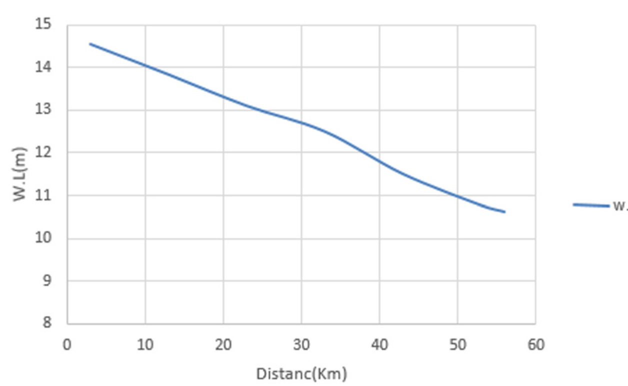

Figure 11: Observed stage for verification process.

Figure 11 shows the measured levels for the verification process, and Figure 12 shows the convergence between the measured and calculated levels at the Manning coefficient of 0.025

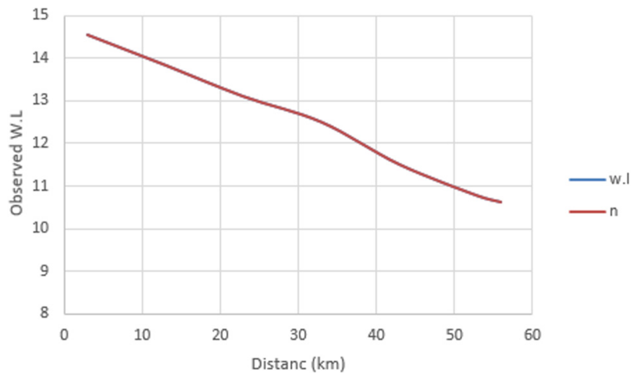

Figure 12: Observed and calculated stage (n = 0.025).

5 Conclusion

By contrasting measured data with model outputs, this study seeks to evaluate HECRAS's capability to compute water surface profiles. The HEC-RAS software program could be applied for hydraulic simulation. As a result, that could be applied successfully in forming and mimicking water external outlines. A hydraulic typical sample was applied via HEC-RAS on the Dujila River in a range of 57 km to find the rate of the coefficient (n). Roughness coefficient (n) is equivalent to 0.025, providing adequate arrangement amid perceived and anticipated water altitudes. The model could be extra boosted via applying GIS with HEC-RAS to create precise canal geometry and therefore precise flow replication. Furthermore, flood danger could be examined with HEC-RAS 2.0 via the use of the outcome like a specific rate of Manning's factor.

Conflict of interest: The authors state no conflict of interest.

Data availability statement: Most datasets generated and analyzed in this study are comprised in this submitted manuscript. The other datasets are available on reasonable request from the corresponding author with the attached information.

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