Estimate stage-discharge relation for rivers

case study: Dost Bayglu hydrometry station over Gara Su river

KH. Nezamkhiavy[1], S.Nezamkhiavy[2], H.Abioghli [3], K.Nezamkhiavy [4]

[1,2,3] *Azad University instructor, Meshgin Shahr, Iran.*

[4] *The expert of water and waste water network, Meshgin Shahr, Iran*

Paper Reference Number: 1811-121

Name of the Presenter: Khosro nezamkhiavy nezamkhiavy@yahoo.com

Abstract

Forecasting discharge and it's changing in a river is basic concept in surface water management.Whereas direct discharge measurment in rivers is time consuming and expensive, and sometimes it is impossible, for this purpose the relation between discharge and stage as rating curve is estimated by using of measured datum. The Gara Su river in Ardabil province, make damages with its floods every year. Informing of flood discharge's value in upstream for management activity in downstream is necessary. In this study product stage-discharge relations by using of the results of direct discharge measurment in Dost Bayglu hydrometry station over Gara Su river during 30 years statistic period, which among them the polynomial relation to estimate discharges give best result.

Key words: Stage-Discharge curve; Gara Su river; Dost Bayglu hydrometry station

1. Introduction

In hydrometry stations, stage value was usually being read while measuring the discharge value of river. At the present time engineers read the stage value by advanced devices and send it to the reference centers by using modern. If we measure the discharge and the stage value several times, we would find a mathematical relation between them, which was called the stage- discharge relation. Measuring the river discharge constantly, is very difficult and expensive task, even in normal conditions. However, it will be more difficult, sometimes impossible one, in floody situation or in unfavourable climate condition. In some rivers, when there is a reasonable mathematical relation between discharge and stage, we can use stage value, be reed and be send it to the center, to obtain the discharge value. The stage- discharge relation refer to all possible concepts explaining ; how calculate discharge based on measuring the flow parameters. Stage- discharge relation can be defined by determining discharge measuring points and stage parallel points on x and y axis, respectively. Forming of the stage-discharge curve is a function of control station geometry. At the mathematical point of view, the most of stage- discharge curves have parabolic form. But, at the regressional point of view, the stage- discharge curves could have various forms such as; Polynomial, Power, Linear and etc.

2. Background

Bhattacharya and Solomatine studied the water level and discharge by using 9 years obtained datum from hydrometry station in Bagirathy river, India, by using artificial neural network. The results showed that the power model is the best, which its determination coefficient is about 0.988. Validation test showed that the error in this model is insignificant.
Jain and Chalisgaonkar studied stage- discharge relation by using artificial neural network in India. In this study, they used three informational layers in artificial neural network model for making stage- discharge curve. The results showed that there is high correlation coefficient in stage- discharge relation by this mrthod.
Chubak and McGinn studied the outlet flows and stage- discharge relations in Clear Lake, Canada. They use lake and channel water level datum and measured discharge datum in their researchs. The results showed that there is significant relation between the shape of stage-discharge curve and flow geometry and hydraulic parameters.
Hemadi studied the stage- discharge relations on the river system of Karoun. In this study, with using the results of direct discharge measurement in rever in 6 hydrometry station during 30 years statistics period determined that, in the most results, parabolic relation is the best.

3. Research Methodology

In order to perform the research, we collected information and statistics related to discharge-stage on Dost Bayglu hydrometry station, by referring to regional water organization in Ardebil. Then, we analyzed the information and data. By employing simple regression, we obtained the relation between stage and discharge. To do this, in start by dividing data to four parts, we used 3/4 of data as a calibrated data and 1/4 as a validating data.

4. Specifications of hydrometry station

Gara Su watershed basin is one of the vast in Ardabil province, its area is about 11126.3 Hectares. Dost Bayglu hydrometry station established in 1351 and 840 meters high from the sea level. It is in 47 – 31 longitude and 38 – 32 latitude. The upstream basin station has area about 7311.1 Kilometers and discharge and stage datum are available, until 1384. The station's equipments are: Stage, Limnogragh and etc.

5. Model efficiency scale

There are different scales to evaluate the efficiency of the model. In this research , we use Root Mean Square error and Determination coefficient.

$$R^2 = \frac{\sum_{i=1}^{n}(Q_i - \overline{Q}_i)^2 \quad \sum_{i=1}^{n}(Q_i - \hat{Q}_i)^2}{\sum_{i=1}^{n}(Q_i - \overline{Q}_i)^2} \qquad (١)$$

$$\mathrm{RMSE} = \frac{\sqrt{\sum_{i=1}^{n}(Q_i - \hat{Q}_i)^2}}{n} \qquad (٢)$$

5. Conclusions

As determination coefficient tended to one, it means there is more precise relation between stage and discharge. Data have been divided to two parts, calibrated and validating in this method. It have been used %70 and%30 of data as a calibrated and validating data, respectively, (It means that in this research Data consist of %70 calibrated data and %30 validating data). Calibrated data were used to fitting curves. So by applying regression relation on validating data, we obtained the validation correlation coefficient.The evaluation process was applied on curves and functions then, they were selected based on having the favourable determination coefficient. In this research, polynominal curve provide the best result for Dost Bayglu station. Validation and calibration correlations coefficient are shown in table(1).

model	calibration correlation coefficient	Validation correlation coefficient
Rating curve	0.90	0.88

Table 1. Validation and calibration correlations coefficient.

Diagrams related to calibration and validation process and ,also, time series of predicted and observed data are shown in the following section.

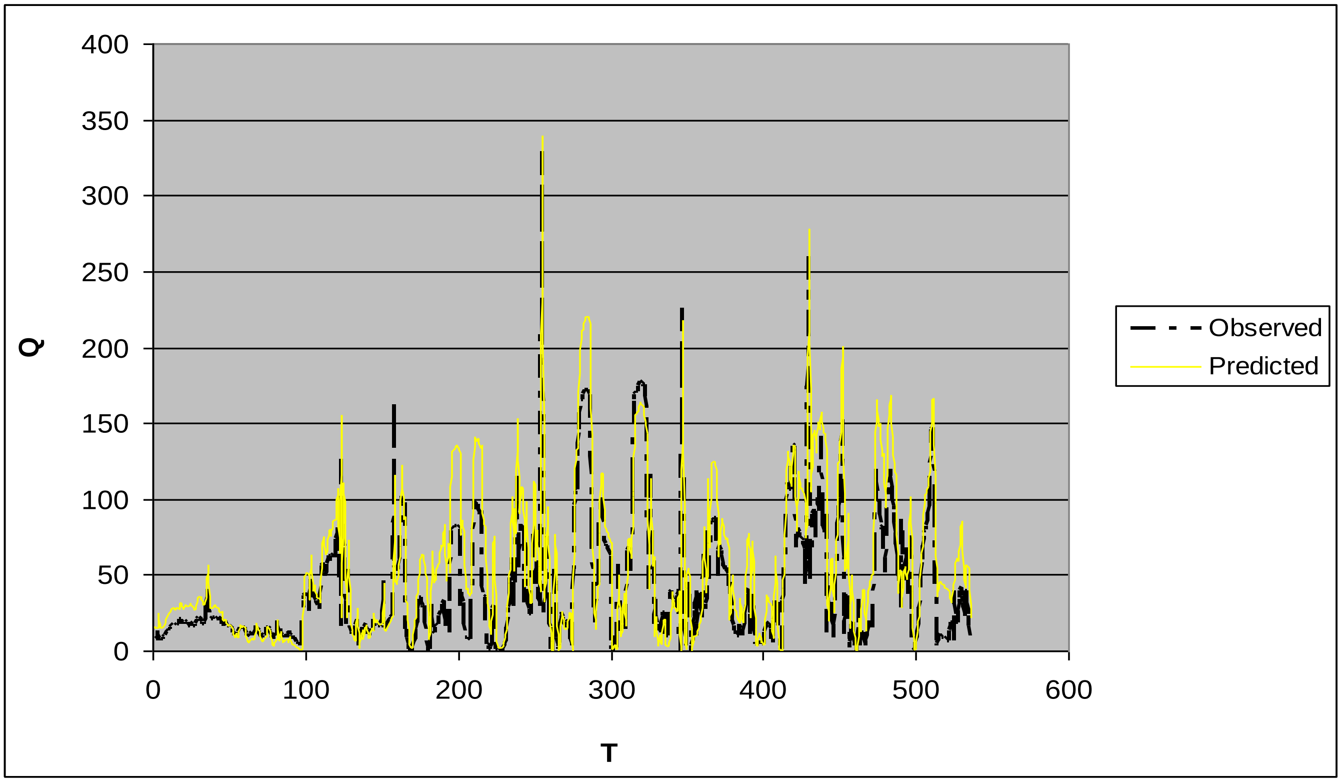

Fig 1: time series of predicted and observed data.

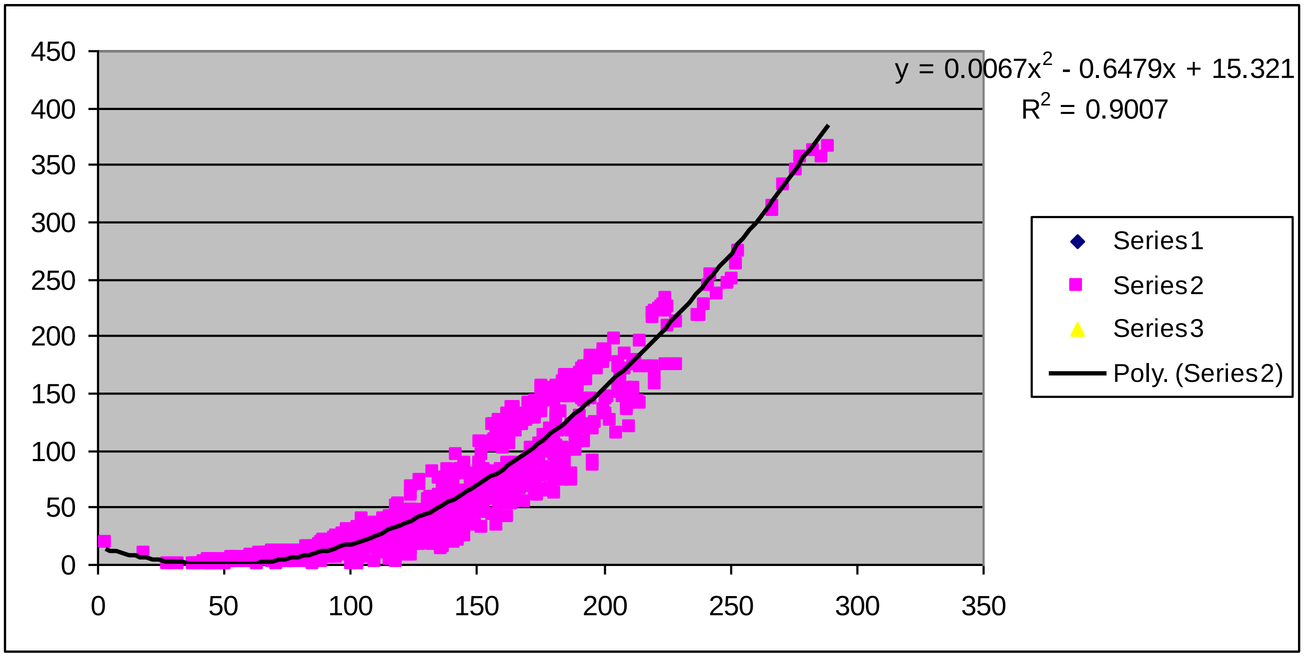

Fig 2: Rating curve - calibration process.

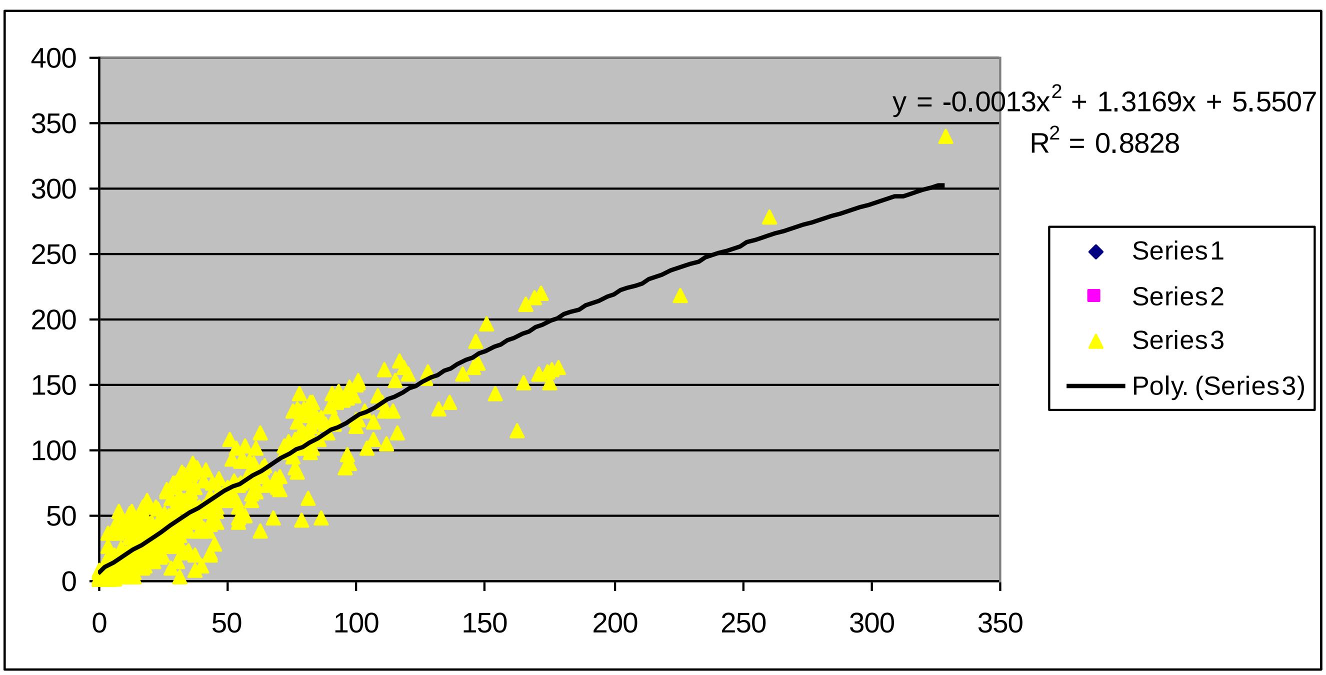

Fig 3: Rating curve - validation process.

References

1. Hemadi, k.1381. Evaluation stage-discharge relation and studying their constant influence on river system of Karoun. 6th international seminar on river engineering. Bahman 1381. Shahid Chamran university, Ahvaz.
2. Movahhed Danesh, A. 1366. Introduction on Hydrology and statistic Hydrology. First volumn. Amidi publication. Tabriz.
3. Vafakhah, M. and SHojaei, GH. 1386. Determining the most suitable stage- discharge relation on Zayandeh Roud river hydrometry station. Agriculture and natural resource science and technology. 11th year. Number 42, B.
4. Alizadeh, A. 1382. Principles of applied hydrology. 16th edition. Emam Reza university, Mashhad.
5. Bhattacharya, B. and D. P. Solomatine. 2000. Application of artificial neural network in stage-discharge relationship. 4th International Conference on Hydroinformatics, Iowa City, USA.
6. Chubak, N. J. J. and R. A. McGinn. 2002. Evaluating outlet flow for Clear Lake, Riding Mountain National Park, Manitoba: A rating curve based on lake levels. Annual Meeting of the Canadian Association of Geographers, Toronto, Ontario.
7. Jain, S. K. and D. Chalisgaonkar. 2000. Setting up stage-discharge relations using ANN. J. Hydrol. Eng. 5(4): 428-433.