Appendix

Probabilistic Modeling of the Post-flood Serviceability of Community Infrastructure Systems

1. Obtaining the Index Hydrograph of the Region under Study

The flood data of the Ahvaz hydrometric station for the last 20 years was used to determine the hydrograph index. Ninety-three hydrographs shown in Fig.A. 1 were extracted from the data published on past floods in the abovementioned area [1]. In Fig.A. 1, these hydrographs are arranged so that the peak discharge is aligned, and the other hydrograph numbers expand based on the time axis of both sides of the discharge. The index hydrograph is obtained from the average discharge [2].

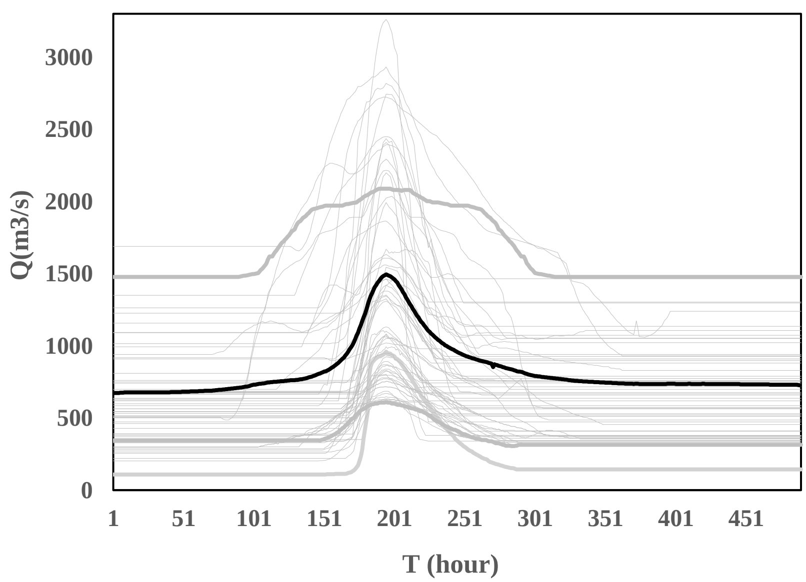

Fig.A. 1: Flood hydrograph of Ahvaz hydrometric station between the years 2000 and 2020

The tails of the index hydrograph in Fig.A. 1 are long. Ignoring the tails reduces the flood time to 151 hours. This hydrograph has a maximum flow rate of 1495 m3/s and a duration of 151 hours. The base discharge of the river is also considered to be 600 m3/s. As shown in Fig. A. 2, by dividing the time axis (t) and the flow axis (Q) by its peak time (tp) and peak flow (Qp) values, the index hydrograph becomes a dimensionless index hydrograph. Finally, by combining index hydrograph and peak discharge generated in each return period, flood hydrographs are generated for each return period [2].

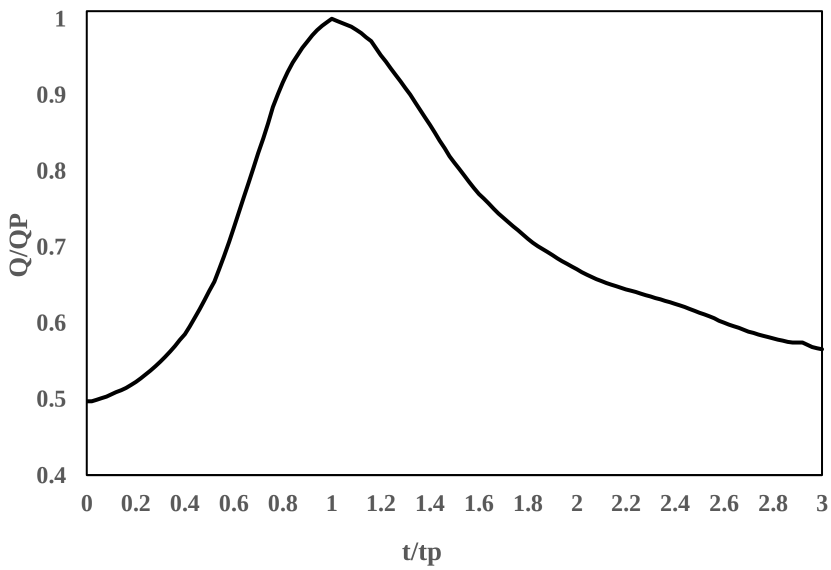

Fig. A. 2: Flood index hydrograph of Ahvaz hydrometric station [1].

The annual maximum instantaneous flow of the Ahvaz hydrometric station has been collected to analyze the frequency of flood peak flow. The occurrence of different flow sizes can be determined through probability distribution techniques of different types [3, 4]. HYFRAN-PLUS (HYdrological FRequency ANalysis PLUS DSS) software was used in this study. HYFRAN-PLUS includes several mathematical tools that can be used for the statistical analysis of extreme events [5]. The most common techniques are normal statistical distributions, two- and three-parameter lognormal, two-parameter Gamma, Pearson type III, log Pearson type III, Gumbel and Weibull statistical distributions [6]. Since the Weibull distribution is more compatible with the observational data and has a lower range of uncertainty, it is considered the statistical distribution of the flood peak discharge, as shown in Fig. A. 3.

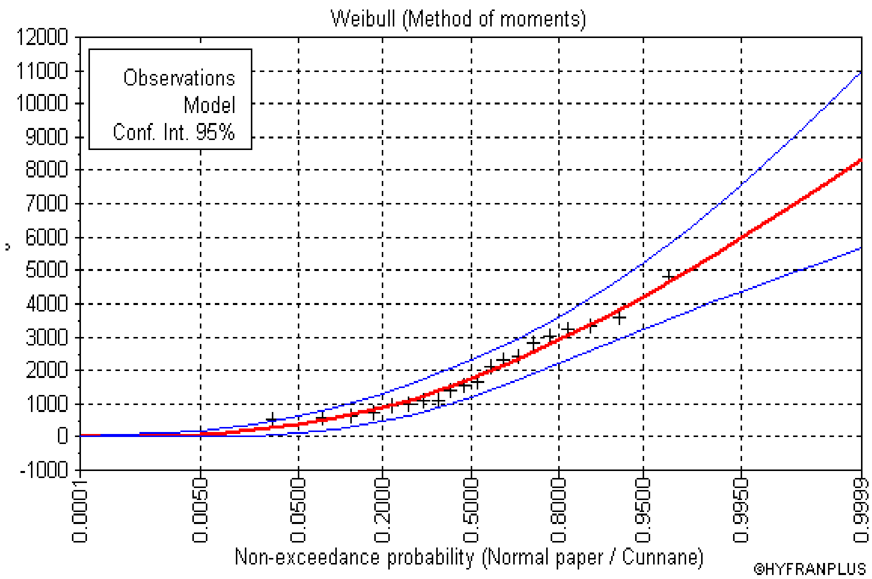

Fig. A. 3:Weibull distribution fitting diagram on peak flood discharge over different return periods (adopted from HYFRAN-PLUS software [5])

According to the fitted distribution on the peak flood discharge, the standard deviation with 95% confidence can be obtained.

2. Hazard model calibration

One of the influential factors in river hydraulics is Manning's roughness coefficient. The roughness of the riverbed affects the flow, speed, and height of the river. Accordingly, the flow model was calibrated for the Manning coefficient. In order to calibrate the flow model, first, the actual flood height data at the Ahvaz hydrometric station for different flow rates were compared with the model outputs by changing the Manning coefficient. The flood depth obtained from the model was the most consistent with the actual data when the Manning coefficient was set at 0.043. This finding was consistent with observations the past studies [7, 8]. Table A. 1 shows observed and predicted flood heights when the Manning coefficient was set at 0.043.

Table A. 1: Hydraulic model calibration in Manning coefficient 0.043

Q (m3/s)	Recorded water height (m)	Water height in the model (m)	Difference (m)	Q (m3/s)	Recorded water height (m)	Water height in the model (m)	Difference (m)
1078	2.4	2.225	-0.175	1370	2.83	2.805	-0.025
1124	2.47	2.355	-0.115	1356	2.81	2.788	-0.022
1169	2.54	2.446	-0.094	1349	2.80	2.774	-0.026
1223	2.62	2.532	-0.088	1363	2.82	2.783	-0.037
1279	2.7	2.619	-0.081	1435	2.92	2.856	-0.064
1335	2.78	2.705	-0.075	1548	3.07	2.990	-0.080
1377	2.84	2.777	-0.063	1731	3.29	3.148	-0.142
1405	2.88	2.829	-0.051	1867	3.46	3.384	-0.076
1420	2.9	2.860	-0.040	1994	3.61	3.552	-0.058
1420	2.9	2.870	-0.030	2113	3.75	3.698	-0.052
1405	2.88	2.859	-0.021	2241	3.90	3.841	-0.059
1398	2.87	2.846	-0.024	2327	4.00	3.949	-0.051
1384	2.85	2.829	-0.021	2390	4.07	4.026	-0.044
1377	2.84	2.815	-0.025	2408	4.09	4.063	-0.027

3. Reference

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