Statistical analysis of flood hydrographs of Wadi Beihan

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Wadi Beihan is located in the north-western part of the Shabwa governorate of the PDRY bordering the YAR. Similar to the other major wadis in the country, the water resource consists of seasonal floods which are used directly for spate irrigation and which recharge the intensively pumped alluvial aquifer. Until recently there were no reliable quantitative data on the size and volume of the floods in the wadi. However since May 1986 the Wadi Beihan Agricultural Development Project (WBADP) has installed a network of six automatic flood recorders in the wadi and since then all the floods entering the wadi have been recorded.

As the Wadi Beihan project is nearing completion, the main concern of the water resources section of the project is continuation of the flood recording and the monitoring of stations after the project's termination. It is unlikely that the recorder stations could be attended. Therefore it was decided to derive a simple equation to estimate flood volume when hydrographs were not available. It has always been possible to ask the villagers who live near the stations about the time when a flood reaches the location of a particular station and the time when it recedes. This kind of enquiry has been made in the wadi on many occasions and proved reliable and to match fairly well the recorded data from the stations. The peak stage of a flood can be observed from the traces left on adjacent rocks and bushes.

The possibility of using a multiple linear regression equation was tried on data obtained from recorder stations No. 4 at Mahala on Wadi Nahr and it was found that a good correlation existed between the dependent (V) and independent variables (Q_o and T). Since insufficient data are available for the other stations, no further correlations could be made. The recorded data for station No. 4 are presented in Table 1. A computer program was developed to process the data and establish a correlation by linear regression.

It should be noted that the derived correlations are valid only for single peak hydrographs, in which by far the majority of the floods fall.

The correlations derived are:

$$V = 8.712 \times 10^{-4} \times Q_o^{0.653} \times T^{1.306} \quad (I)$$
$$R = 0.985$$
$$V = 0.0105 \times h^{1.2936} \times T^{1.3297} \quad (II)$$
$$R = 0.966$$

where

V = volume of the flood (million m^3)
Q_o = peak discharge (m^3/s)
h = peak water height at the station above the zero of the gauge (m)
T = the time base or duration of the flood (hours)
R = correlation coefficient of the equations

It was reported at the beginning of September 1987 that a small flood had entered Wadi Nahr and that the recorder at station No. 4 failed to function as its float was buried in sediments caused by a previous flood. It was therefore necessary to estimate the volume of the flood.

The first step was to see the farmers at the nearby village of Attaf and enquire about the duration of the flood. It was found that it had reached the station at about 23.00 hours and lasted until 10.00 the next day. The height of the peak flood level at the station reached 0.26 m above the zero level of the gauge.

Using equation II, where T = 11 hours and h = 0.26 m, the estimated flood volume (V) could be calculated as 0.045 million m^3.

It may be difficult to maintain close monitoring of flood recorders in remote areas, particularly after the project has ended and trained technical staff have left. In such circumstances the correlations established earlier may help to estimate flood volumes and maintain flood records when hydrographs are not available or are out of order.

References

1. R. N. Brown, A. A. Konoplyantsew, J. Ineson, V. S. Kovalevsky, eds, *Ground Water Studies, an international guide for research and practice*, Unesco, 1972.
2. Christopher Chatfield, *Statistics for Technology*, Chapman and Hall, 1978.

Table 1: Single Peak Floods Recorded at Station 4 on Wadi Nahr

No.	Date occurred	Flood volume (m^3)	Peak stage (m)	Peak discharge (m^3/s)	Time base (hrs)
1	31.7.86	0.120	0.330	6.221	12.133
2	5.8.86	0.045	0.165	1.607	12.300
3	22.8.86	0.075	0.400	9.550	14.250
4	22.8.86	0.123	0.185	1.950	18.750
5	24 to 25	0.333	0.380	8.610	38.625
6	8.86	2.780	1.700	165.000	40.000
7	23.2.87	0.054	0.265	4.230	09.300
8	13.3.87	0.720	0.740	30.600	22.000
9	13.3.87	0.758	0.610	21.180	28.500
10	16.3.87	0.109	0.280	4.910	17.250
11	16.3.87	0.053	0.450	12.070	06.750
12	17.3.87	0.301	0.850	38.265	14.583
13	17.3.87	0.229	0.820	35.720	17.000
14	30.3.87	0.222	0.520	15.940	16.617
15	9.5.87	1.217	0.690	27.000	51.300
16	6.6.87	0.080	0.250	3.950	18.750
17	28.7.87	0.027	0.250	3.950	9.500
18	9.9.87	0.167	0.300	5.640	28.917
19	18 to 24	0.017	0.180	1.907	6.250
	3.87	0.002	0.080	0.260	3.333
20		0.006	0.100	0.447	6.250
21		0.017	0.160	1.445	7.750
22		0.003	0.090	0.350	7.000