Author(s): Zainudini, M.A. and Marriott, Martin John
Title: Short duration rainfall in the Iranian province of Sistan and Balochistan
Year of publication: 2010
Citation: Zainudini, M.A. and Marriott, M.J. (2010) 'Short duration rainfall in the Iranian province of Sistan and Balochistan.', Proceedings of Advances in Computing and Technology, (AC&T) The School of Computing and Technology 5th Annual Conference, University of East London, pp.157-162.

SHORT DURATION RAINFALL IN THE IRANIAN PROVINCE OF SISTAN AND BALOCHISTAN

M.A.Zainudini[1] and M.J.Marriott[2]
[1]*Faculty of Fisheries, Chabahar Maritime University, Iran*
[2]*School of Computing, Information Technology and Engineering, University of East London*
zainudini@cmu.org.ir; m.j.marriott@uel.ac.uk

Abstract: This paper presents an analysis of rainfall data from Sistan and Balochistan, for durations from 15 minutes up to 12 hours. This information is useful for drainage or flood alleviation work, depending on the time of concentration of the catchments involved. The results are compared with analysis by others of data from other countries, which served to highlight an anomaly in the longer duration results. The shorter duration results are still considered plausible, and potentially useful pending more detailed analysis of longer data sets.

1. Introduction:

To calculate runoff from catchments by methods such as the rational or modified rational method, data connecting rainfall intensity, duration and frequency (IDF) is required. The duration of rainfall to provide peak runoff is usually selected as the time of concentration of the catchment, although for storage analysis longer durations and hydrograph methods would be required. The durations relevant for local drainage and flooding are likely to be measured in minutes or hours, rising to days for larger river catchments. Longer duration data than this would be more relevant to water resources considerations, and a previous paper (Marriott and Zainudini, 2006) considered the monthly rainfall totals for the Iranian Province of Sistan and Balochistan. The area of this study is near the border of Iran and Pakistan, extending south from Afghanistan to the Gulf of Oman. This paper now extends the analysis for this region to include shorter duration rainfall, as obtained by Zainudini (2007), which is relevant to peak runoff calculations for drainage and flood alleviation purposes.

2. Methodology:

A limited amount of short duration data was located from 12 different stations in the study area, for durations ranging from 15 minutes to 12 hours. Since insufficient data was available at the time from any one site for conventional frequency analysis (which should be revisited in the future), the data were combined taking a station-year approach to extend the effective record length. The assumption made in this approach is that data are independent and from a meteorologically homogeneous zone, and so may be regarded as equivalent to a single long record. The annual maximum values for each duration were ranked, and fitted to a Gumbel distribution, using the Gringorten plotting position formula. This was the approach taken by Wheater and Bell (1983) in their analysis of Northern Oman data. Nouh (1987) mentioned this approach, but favoured an alternative method for analysis of rainfall in Saudi Arabia. Nouh produced growth curves for return periods of 5 to 100 years, and presented areal reduction factors for areas greater than 10 km^2. Wheater and Bell presented an IDF

relationship for return periods of 2 to 500 years, with the latter dotted as a more tentative result. Note that results for a 1 year return period result are not possible to obtain by this method, since the Gumbel reduced variate is undefined at a value of return period T = 1 year. .

3. Analysis of Sistan and Balochistan data:

The combined data set yielded between 18 and 36 annual maximum values for each of 6 durations. The ranked values are plotted in Figures 1 and 2 against the Gumbel reduced variate, using the Gringorten plotting position formula. For more detail of the formulae involved, refer to standard texts, such as Marriott et al. (2009). Intensity values for each return period are then calculated from the resulting best fit straight line, using the appropriate values of the reduced variate. The results are summarised in Table 1, and illustrated in Figure 3 for all values, and Figure 4 for the shorter durations and lower return periods likely to be of use for local surface water sewerage design. These lower return periods are also likely to be more reliably predicted being less than the length of the data set.

4. Comparison with data from other countries:

The results from this study show plausible agreement at shorter durations with the Northern Oman data referred to above, but not so for longer durations where the IDF curves from this study kink and flatten out as shown in Figure 3. To investigate this further, data from different locations were plotted together, and Figure 5 shows for example 5 year return period data for comparison. The Northern Oman data is from Wheater and Bell (1983), and London data is derived from the Wallingford Procedure (NWC 1981). The Kuala Lumpur (KL) data comes from the Malaysian Urban Stormwater Management Manual (DID 2000), based on data from 1953-1983.

Not surprisingly, the tropical Malaysian data shows the highest intensities, but Figure 5 also serves to show the likely anomaly in the longer duration results from this study, since the Sistan and Balochistan values for 6 and 12 hour durations tend across towards the KL line, against the general trend of results. However the shorter duration results up to 3 hours appear plausible, so may be useful pending more detailed analysis of longer data sets.

5. Conclusions:

Rainfall data from Sistan and Balochistan have been used to produce an intensity-duration-frequency (IDF) relationship, covering return periods from 5 to 100 years, and durations from 15 minutes up to 12 hours. The information has been presented in both tabular and graphical format. This is one of the outcomes arising from work carried out by the first author (Zainudini, 2007) in a preliminary study covering data of various durations, which could usefully be extended with larger sets of data. The results for shorter durations appear plausible and pending other results may be useful for the design or analysis of facilities to alleviate flooding, particularly by provision of protection or increased conveyance. Flood alleviation by means of providing increased storage would require additional hydrograph data, to give not only the peak discharge but also the volume.

It is planned to reanalyse the IDF relationship with more extensive data,

particularly to check the anomalous longer duration results, and also to compare with recent flooding events. Authorities are therefore encouraged to maintain and make available records of both rainfall and runoff data, to assist in such analyses.

6. Acknowledgements:

The authors acknowledge their employers' support for their research activities, but note that opinions expressed in the paper are the authors' personal views, and not necessarily those of the organizations mentioned.
The first author is grateful for the data obtained from Iran for his research work carried out at University of East London, and for the checking and comparisons provided by the second author.
Colleagues at Kolej Linton, Legenda Education Group, Malaysia, are thanked for their assistance regarding data from Kuala Lumpur.

7. References:

Drainage and Irrigation Department (DID) Malaysia, *Urban Stormwater Management Manual (Manual Saliran Mesra Alam, MSMA)*, 2000. http://www.water.gov.my; www.msmam.com

Marriott M.J. and Zainudini M.A., "A Review of Rainfall Data from the Iranian Province of Sistan and Balochistan", *Proceedings of the Advances in Computing and Technology Conference, London*, January 2006, ISBN-0-9550008-1-5, pp.113-118.
www.uel.ac.uk/act/proceedings/index.htm

Marriott M.J., Nalluri & Featherstone's *Civil Engineering Hydraulics*, 5th edition, Wiley-Blackwell, Chichester and Oxford, 2009. http://www.wiley.com/go/marriott

National Water Council (NWC), *Design and Analysis of Urban Storm Drainage, the Wallingford Procedure, Volume 4: The Modified Rational Method*, National Water Council Standing Technical Committee Report No. 31, London, 1981.

Nouh M.A., "Analysis of rainfall in the south-west region of Saudi Arabia", *Proceedings of the Institution of Civil Engineers, Part 2*, Volume 83, March 1987, pp. 339-349.

Wheater H.S., Bell N.C., "Northern Oman flood study", *Proceedings of the Institution of Civil Engineers, Part 2*, Volume 75, September 1983, pp. 453-473.

Zainudini M.A., *Sistan and Balochistan Flood Study*, M.Res. Dissertation, University of East London,,2007

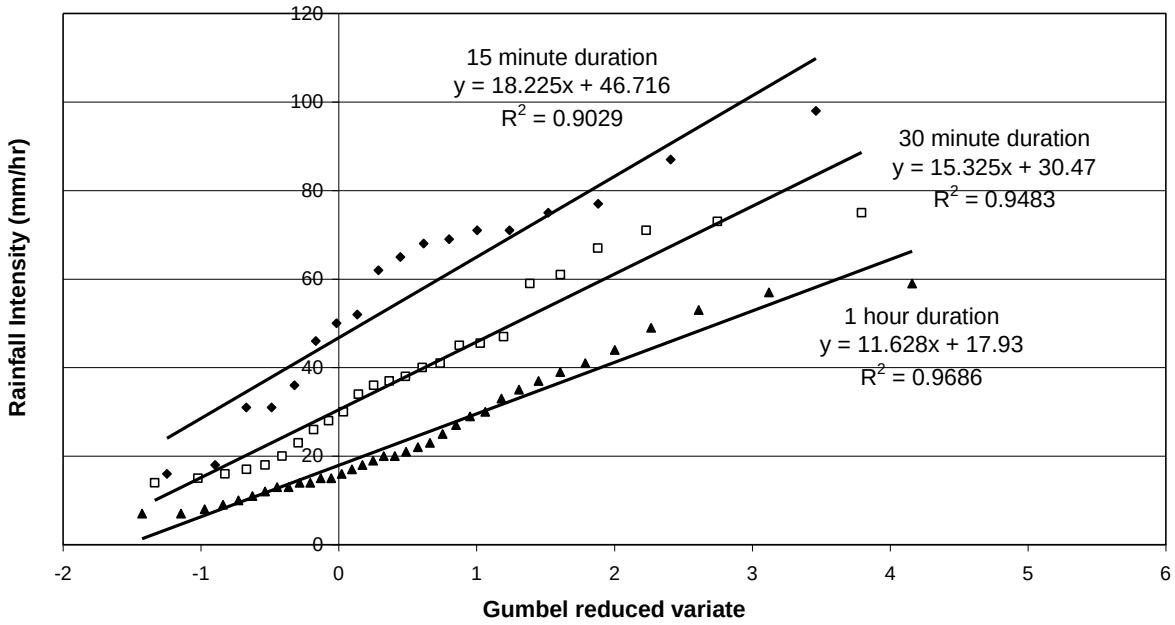

Figure 1: Gumbel distributions for 15, 30 and 60 minute duration rainfall in Sistan and Balochistan

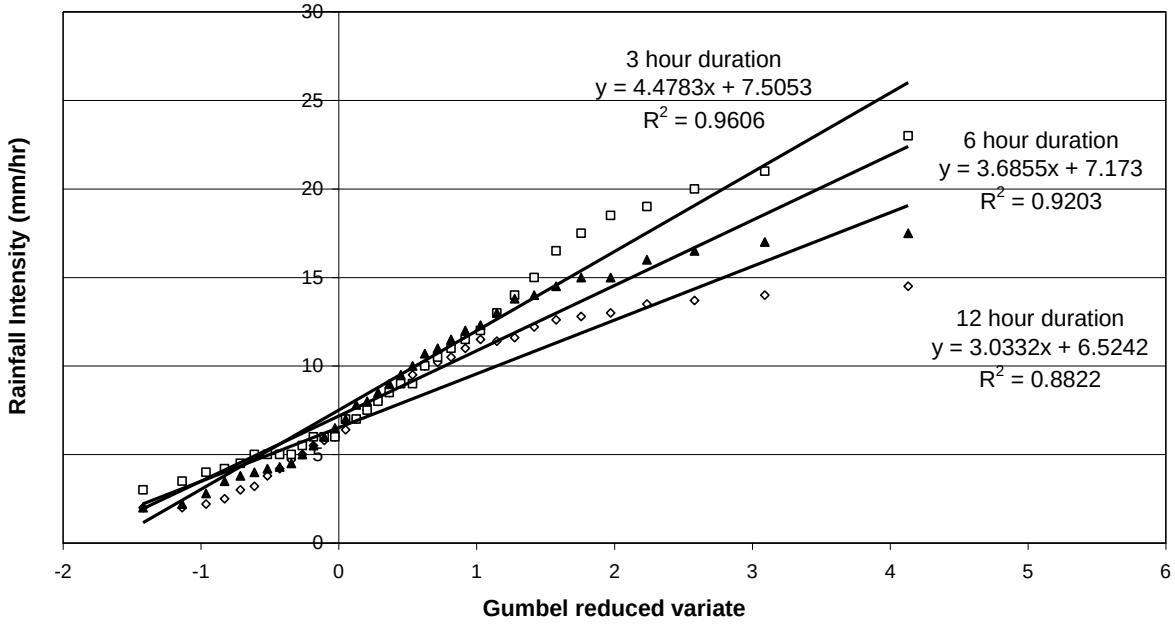

Figure 2: Gumbel distributions for 3, 6 and 12 hour duration rainfall in Sistan and Balochistan

Duration	15 min.	30 min.	1 hour	3 hour	(6 hour)	(12 hour)
Return Period						
2	53	36	22	9	(9)	(8)
5	74	53	35	14	(13)	(11)
10	88	65	44	18	(15)	(13)
25	105	79	55	22	(19)	(16)
50	118	90	63	25	(22)	(18)
100	131	101	71	28	(24)	(20)

Table 1: Sistan and Balochistan IDF values (mm/hr), with suspected anomalous figures in brackets

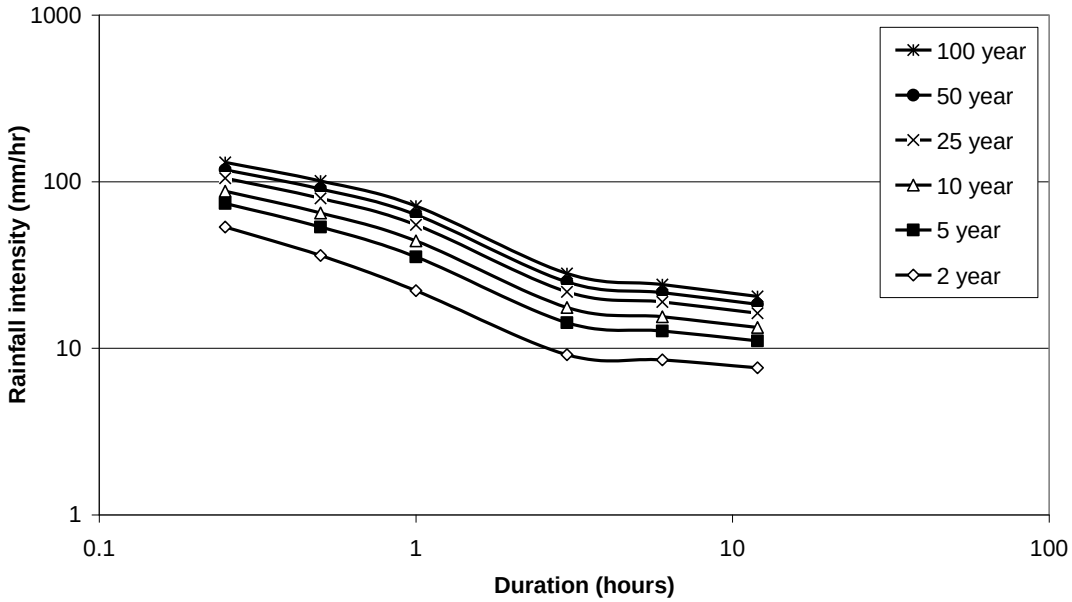

Figure 3: IDF Relationship for Sistan and Balochistan
in which the 6 and 12 hour values are considered to be anomalous

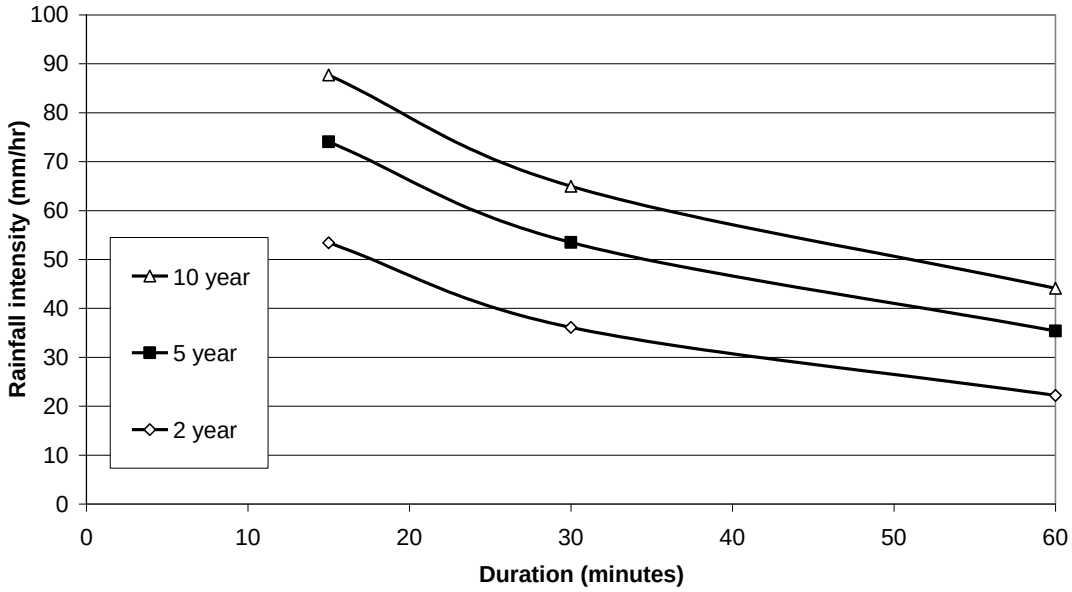

Figure 4: IDF Relationship for Sistan and Balochistan
for shorter durations and lower return periods

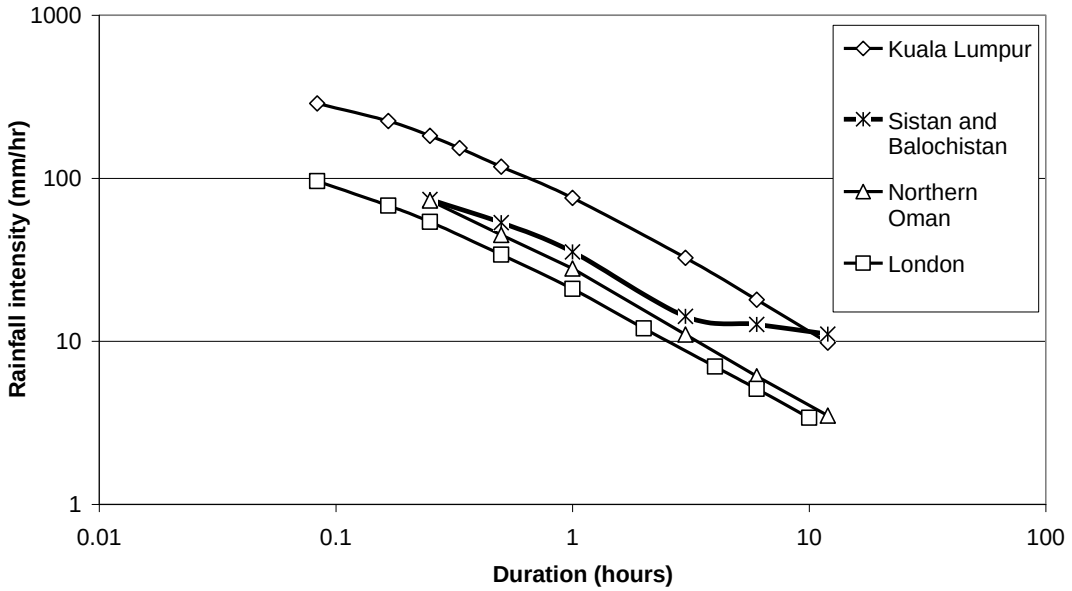

Figure 5: Intensity Duration Relationships for 5 year return period from various locations
showing plausible Sistan and Balochistan values up to 3 hour duration,
but anomalous values for 6 and 12 hours