Irrigation & Drainage Systems Engineering
ISSN: 2168-9768

Zainudini and Sardarzaei, Irrigat Drainage Sys Eng 2014, 3:2
DOI: 10.4172/2168-9768.1000123

Research Article Open Access

Analysis of Short Duration Rainfall Intensity Data of Makoran Region-Iran

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Rec date: Apr 03, 2014; **Acc date:** May 20, 2014; **Pub date:** May 27, 2014

Abstract

This research conducted over the extreme rainfall intensity - duration - frequency (IDF) relationship, covering return periods from 2 to 100 years. Therefore, this paper presents an analysis of extreme rainfall data from Makoran region, for durations from 15 minutes up to 12 hours. 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. The statistical analysis of shorter duration rainfall data indicated considerable flood alleviation purposes to that particular study area. The results show the success of both short-term rainfall analysis models for forecast floods in real time. However, study aims to forecast monthly rainfall using time series models and determine appropriate observation data according to different districts rainfall conditions. The flood in Makoran showed conclusively that flood hazard in the area poses a large and yet, untamed problem for both the regulatory body (public) and the local authorities. With increased development in the floodplain the economic implications are likely to grow significantly therefore, a number of mentions the issues are paramount to the area of Makoran.

Keywords: Catchment; Duration; Frequency; Flooding; Intensity; Rainfall; Runoff

Introduction

The study area 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 [1], which is relevant to peak runoff calculations for drainage and flood alleviation purposes. A location plan is shown in figure 1A. The climate of the region varies from sub-tropical arid and semi-arid to temperate sub-humid in the plains of Makoran.

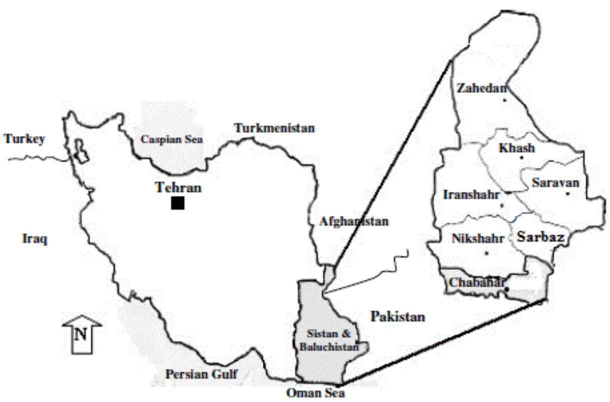

Figure 1A: The area of study in south of Iran (Sistan and Balochistan).

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 [2] considered the monthly rainfall totals for the Iranian Province of Sistan and Balochistan.

Methodology

The 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 derivation of a preliminary intensity duration frequency relationship is important as it enables us to assign a return period that a flood storm will recur and also allows to analysis the intensities for the short duration rainfall for a range of return periods which could subsequently be used in the flood protection works. Generally, three steps are required to the formulation and construction of IDF curves using data from the recording stations [3]. A Pearson type III distribution is usually used for frequency analysis.

Citation: M.A.Zainudini, A. Sardarzaei (2014) Analysis of Short Duration Rainfall Intensity Data of Makoran Region-Iran. Irrigat Drainage Sys Eng 3: 123. doi:110.4172/2168-9768.1000123

This research showed extreme rainfall intensity durations ranging from 15 minutes to 12 hours indicated that statics analysis responding clear result for water resources into Pishin dam and arid zone of the Sistan and Balochistan which is investigated for relationship covering return period from 2- 100 years rainfall. However, it could be important that also forecast the inflow to the Pishin reservoir at daily and monthly time scales using static artificial neural network model and simple linear regression model based on discharge from hydrometric stations located in Pishin reservoir [4].

Results and discussion

The combined data set yielded between 18 and 36 annual maximum values for each of 6 durations. The short duration data would be much more useful for flood alleviation. Therefore, the ranked data are illustrated and used in Figure 1B and 1C; durations down to 15 minutes were used to undertake rainfall intensity-duration-frequency analysis. The IDF curves are most often used to express the severity of a single rainfall event. They are required for the design and risk assessment of dams and bridges, for flood plain management systems, design of roof and storm water drainage systems, design of storm sewers, design of storage structures and runoff canals, etc.

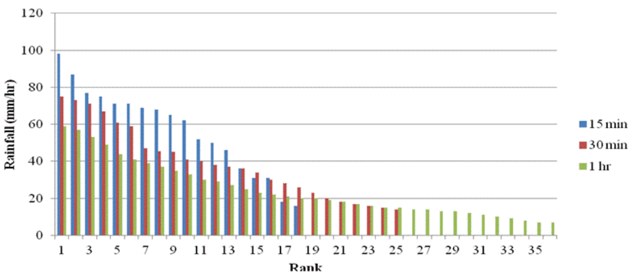

Figure 1B: Rainfall Intensity for 15, 30 and 60 minute Duration in Balochistan Area.

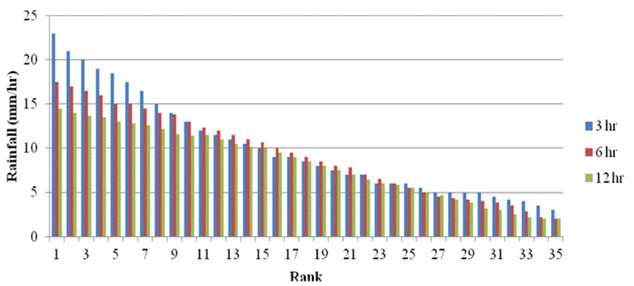

Figure 1C: Rainfall Intensity for 3, 6 and 12 Hours Duration in Balochistan Area.

The ranked values are plotted in Figures 2A and 2B against the Gumbel reduced variant, using the Gringorten plotting position formula. For more detail of the formulae involved, refer to standard texts, such as [5]. Intensity values for each return period are then calculated from the resulting best fit straight line, using the appropriate values of the reduced variant.

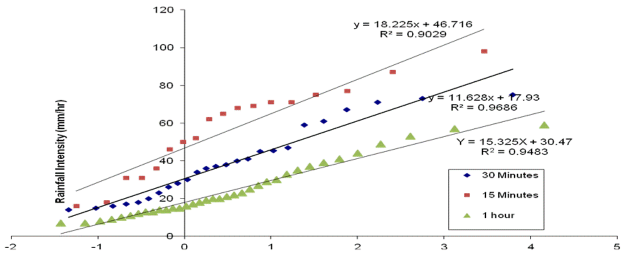

Figure 2A: Gumbel distributions for 15, 30 and 60 minute duration rainfall in Sistan and Balochistan.

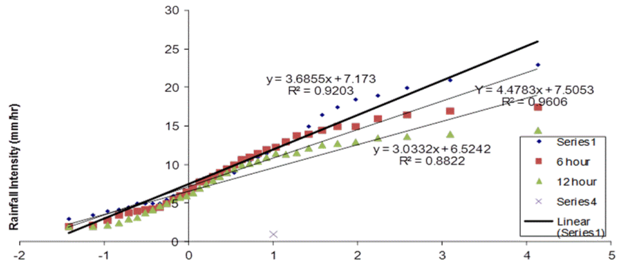

Figure 2B: Gumbel distributions for 3, 6 and 12 hour duration rainfall in Sistan and Balochistan.

The results are summarized 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. It could be important to use flash flood and attendant water qualities of mountainous stream on Pishin dam. Therefore, the results should be predictive performance of artificial network for estimation of stream flow is improved; rainfall data and evapo-transpiration are important [6].

Duration Return Period	15 min.	30 min.	1 hour	3 hour	(6 hour)	(12 hour)
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.

Importantly on the top of the excessive rainfall in the study area other factors affecting exacerbated the flood event in Sistan and Balochestan, increasingly flooding was not uniform meaning different areas were subject to various flood characteristics and levels of risk. In order to classify rainfall and inflow data set into Pishin dam so initial

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weights and biases are allocated to input data by their entry the data analysis should be outcome according to Figure 1B. Therefore, forecast is carried out for the new data test as well and by modifying the rainfall data and biases the effect of output, it mentioned cycle is repeated until possible error [4].

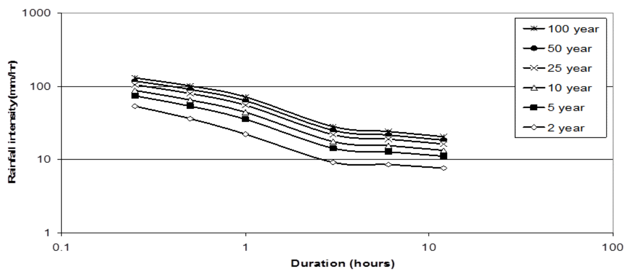

Figure 3: IDF Relationship for Sistan and Balochistan in which the 6 and 12 hour values are considered to be anomalous.

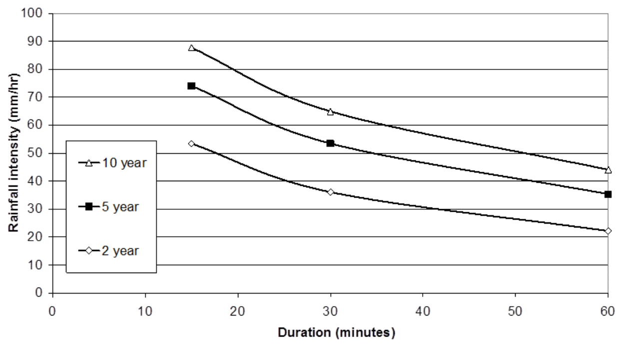

Figure 4: IDF Relationship for Sistan and Balochistan for shorter durations and lower return periods.

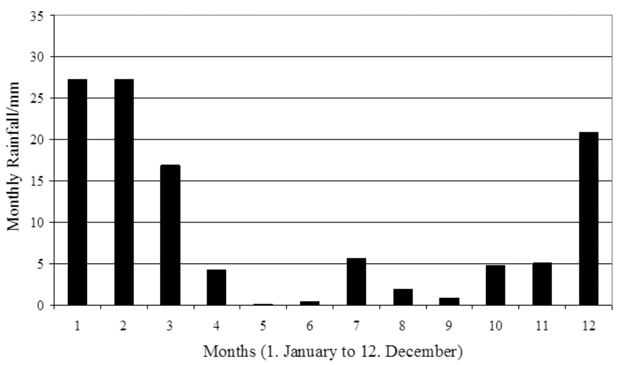

Figure 5A: Chahbahar monthly mean rainfall totals.

The analysis of short duration rainfall and river flow into the Pishin reservoir is one of the most important factors for appropriate performance of subsurface water resources and drainage systems is having adequate discharge for drains. The most amounts of Sarbaz river water flow and the amount of change in drain discharge for one percent increase or decrease in each of drainage parameters was owned by depth of water level in drain below soil surface equal to 4.0%. Also about maximum and minimum of obtained drain discharge for drainage parameters has been valuable [7].

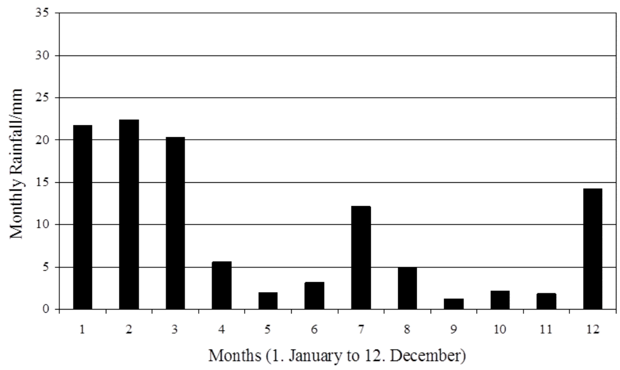

Figure 5B: Iranshahr monthly mean rainfall totals.

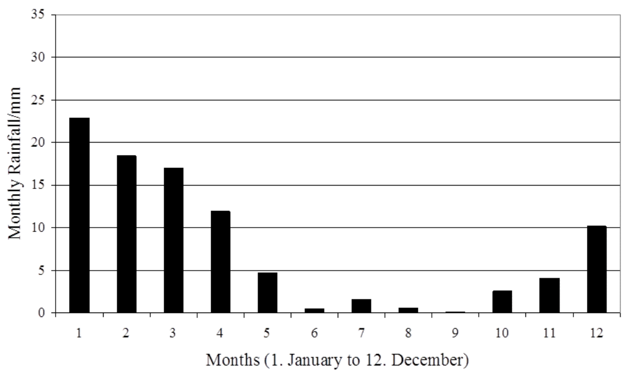

Figure 5C: Kaserkand monthly mean rainfall totals.

Increasingly research suggested that the level of monthly and short duration rainfall are useful for water resources. Time series models have forecasted monthly rainfall in four different sites in four different districts see Figures 5A to 5D. This research indicated a modular class of multi-sites monthly rainfall generators for water resources management and impact studies. The result of study point out that the model can capture several characteristics of the rainfall series. In particular, it enables the simulation of low and high rainfall scenarios more extreme than those observed as well as the reproduction of the distribution of the annual accumulated rainfall. The results show the success of both short-term rainfall analysis models for forecast floods in real time. However, study aims to forecast monthly rainfall using time series models and determine appropriate observation data according to different districts rainfall conditions. More accurate forecasting of monthly rainfall is significantly important in water resources management. Time series models are appropriate tools to forecast monthly rainfall forecasting in arid and semi-arid area [8].

An example is shown in Figure 6 of the Chahbahar January data. Note that a slightly different formula for the trend line is produced by the method of moments. Reasonable results were also obtained by this method for February, March and December (R^2 values of 0.85, 0.85 and 0.77 respectively), but not for the dryer months.

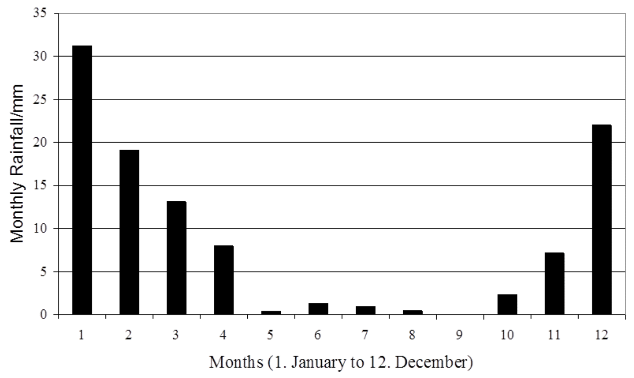

Figure 5D: Sarbaz (Rask) monthly mean rainfall totals.

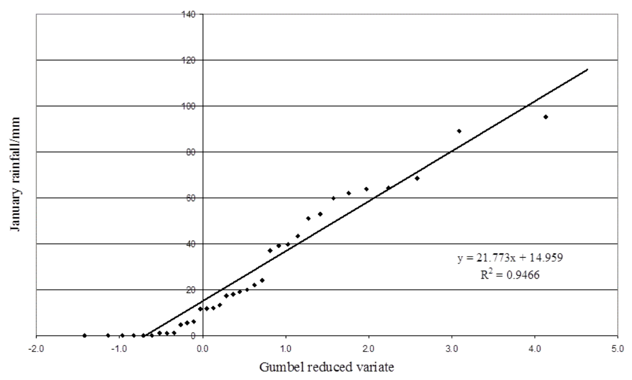

Figure 6: Chahbahar January data.

The analysis indicated that flood water under conservative but realistic assumptions, would be determined to be under control by dykes and diverted canal. The overall results showed the global artificial neural network model is support and meaning full for achieving certain goal over the local prediction models. Design of dynamic neural network structure in environment then effects of out-put is increasingly would be a reasonable result. Due to importance of flood water control and its discharge into the dam water management, effect of drainage parameters change on amount of drain discharge investigated in surface drainage systems. The most amount of change in drain discharge for one percent increase or decrease in each of drainage parameters was owned by depth of flood water level [7].

Although summarizes short duration rainfall data for statistical analysis for flood alleviation gives a realistic identification for that particular study area during various storms [2]. To accompany the above definitions requires descriptions of the various physical facts and damages to the regions, however some hydrological management aspects rely on flood return periods in order for decisions to be made, it must be re-iterated that these are not scientific boundaries and may be subject to margins of error, return periods of floods refer to the outer limit of that area, and positions closer to the river will have a higher return period. Thus 100-years flood plain is calculated on past events, and thereafter may not be applicable to current or future flood events due to fastest global warming and climate change [9].

The results of statistical analysis of monthly totals and shorter duration rainfall data indicated considerable flood alleviation purposes to that particular study area [2], though the feedback of processes of the results analysed investigation of impacts of flood in Balochistan showed conclusively that flood hazard in the area poses a large and yet, untamed problem for both the regulatory body (public) and the local authorities. Furthermore, with increased development in the floodplain the economic implications are likely to grow significantly then a number of issues are paramount to the area of Sistan and Balochistan. Therefore using short duration rainfall data for the Sistan and Balochistan correlations and curves of intensity-duration-frequency (I-D-F) are determined, which are thus used to produce intensities for short duration rainfall over a range of return periods. The intensity duration frequency correlations and curves for Balochistan are useful to illustrate that the return period of storms over the Balochistan region is of the order of 100 years, Intensity values for each return period are calculated from the resulting best fit straight line, using the appropriate values of the reduced variant.

Flood risk zones deemed acceptable in remain unsafe as they have a 1% chance of being flooded according for changes in climate this is likely to increase to 4% or 5% chance within a decade, thus if a 1 in 100-year (1% chance of occurrence) is likely to occur as a 4% or 5% chance (1 in 25 year flood), then the costs associated with this increase by the respective factors [10].

Conclusions

It might be concluded that the localization of rainfall is quite significant, therefore the data availability of short time rainfall during heavy rainstorms for analysis of flash floods. For many hydrological analyses, planning or design problems, reliable intensity estimates are necessary. When local rainfall data are available intensity-duration-frequency (IDF) curves can be developed using frequency analysis. 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. 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 reanalyze 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.

Acknowledgements

The authors acknowledge 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 authors are grateful for the data obtained from Meteorological Organization (Chababahr).

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