第Ⅱ部門

# Assessment of Intensity Duration Frequency Curves for Asia Pacific Region

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## 1. Introduction

The Intensity-Duration-Frequency (IDF) curves represent a given non-exceedence probability (or usually in terms of the return period in years) for the variation of the maximum annual rainfall intensity with the time interval length. Obviously, for a given return period, the IDF curves decrease with increasing time interval. Minor attention has been paid in the past to improve current techniques of data analysis. Actually, in most cases design practice is based on unproved or unrealistic assumptions concerning the structure of rainfall in space and time. The traditional method to construct IDF curves has three main steps. Based on the raw data, the first step is to obtain annual maximum intensity series for each time interval length. Then, for each time interval a statistical analysis has to be done to compute the quantiles for different return periods. Lastly, the IDF curves are usually determined by fitting a specified parametric equation for each return period to the quantiles estimates, using regression techniques.

This traditional methodology has an important problem: a high number of parameters are involved, which makes it non-parsimonious from the statistical point of view. Usually, for each time interval there are at least 2 parameters for the fitted distribution function, and two or three for each smoothing curve. Therefore, one of the main objectives of this work is to reduce the number of parameters to be estimated in order to increase their reliability. The other main objective is to reduce the estimation process to one single step. Some regularities in hydrological observations, such as scale invariance, has been detected on storm records in the past. Present study deals with the estimation of IDF curves using the scaling properties observed on data of extreme storm intensities with a few number of parameters. The application for 42 station of nine countries in Asian Pacific Region.

## 2. Methodology

Usually, for each time interval there are at least 2 parameters for the fitted distribution function, and two or three for each smoothing curve using the empirical formulas. Therefore, one of the main objectives of this work is to reduce the number of parameters to be estimated in order to increase their reliability.
The scaling or scale-invariant models enables us to transform hydrologic information from one temporal or spatial scale to another one, and thus, helping overcome the difficulty of inadequate hydrologic data. A natural process fulfills the simple scaling property if the underlying probability distribution of some physical measurements at one scale is identical to the distribution at another scale. The basic theoretical development of scaling has been investigated by many authors, including Gupta and Waymire (1990), Menabde *et al.* (1999), Nguyen *et al.* (2002) and Kuzuha *et al.* (2005). Rainfall intensity $I(d)$ with duration d, exhibits a simple scale invariance behavior if

$$I(\lambda d) \overset{dist}{=} \lambda^{H} I(d) \qquad (1)$$

holds. The equality “ $\overset{dist}{=}$ ” refers to identical probability distributions in both sides of the equations; λ denotes a scale factor and *H* is a scaling exponent. From equation (10), it leads to a simple scaling law in a wide sense

$$E[\{I(\lambda d)\}^{q}] = \lambda^{qH} E[\{I(d)\}^{q}] \qquad (2)$$

where *E[]* is the expected value operator and q is the moment order.
The random variable *I(d)* exhibits a simple scale invariance in a wide sense if Equation (11) holds. If *H* is a non-linear function of *q*, the *I(d)* is a general case of multi-scaling. The moments *E[]* are plotted on the logarithmic chart versus the scale *λ* for different moment order *q*. The slope function of the order moment *K(q)* is plotted on the linear chart versus the moment order *q*. If the plotted results are on a straight line, the random variable shows simple scaling, while in other cases, the multi-scaling approach has to be considered.

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According to the scaling theory, the IDF formula can be derived (see Nhat *et al.* (2007) for more detail).

$$I(d,T) = \frac{\mu^* + \sigma^*[-\ln(-\ln(1-1/T))]}{d^{-H}} \qquad (3)$$

With $\mu^* = \mu_{24}(\lambda d)^{-H}; \sigma^* = \sigma_{24}(\lambda d)^{-H}$

where the $\mu_{24}$ and $\sigma_{24}$ are parameters of 24 hour data series. It is worthwhile to note that the simple scaling hypothesis leads to the equality between the scale factor and the exponent in the expression relating rainfall intensity and duration.

The IDF relationship can be derived from 24 hours data series based on three parameters: scale exponent, the location and scale parameters of EV1 distribution.

## 3. Results

The major findings of the present study can be summarized as follows: The properties of the time and space scale invariance of rainfall quantiles are examined in the Asia Pacific region. The results of this study show that rainfall follows a simple scaling process with two different scaling regimes: 10 minute to 1 hour and 1 hour to 24 hour. Results found from scaling estimates are very similar to the observed data. The benefit of using the principles of scaling is that it reduces the amount of parameters required to compute the quantiles.

If data is missing from a station, then the first order moment of the duration in question is the only parameter required to compute the quantiles. If that station belongs in a homogeneous region, then the regional d minute first order moment can be used to determine estimates. In practical applications, short duration storms and return periods less than 10 years are used to size drainage pipes for minor system analysis.

Results of this study are of significant practical importance because statistical rainfall inferences can be made from a higher aggregation model (ie. observed daily data) to a finer resolution model (ie. less than one hour, that might not have been observed). This is important since daily data are more widely available from standard rain gauge measurements, but data for short durations are often not available for the required site. The findings from this study can be further extended for other regional analysis.

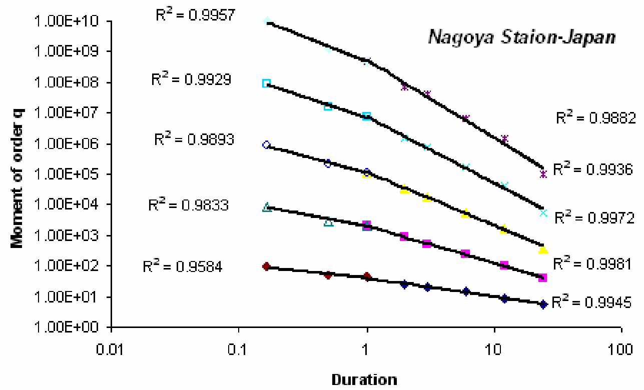


Figure 1 Log-log plot of moment versus duration for the Nagoya-Japan.

## 4. References


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