GENERALIZED INTENSITY-DURATION-FREQUENCY RELATIONSHIP FOR PRECIPITATION IN THE MONSOON AREA OF VIETNAM

DPRI, Kyoto University, Student member of JSCE ○ Le minh NHAT
DPRI, Kyoto University, Member of JSCE Yasuto TACHIKAWA
DPRI, Kyoto University, Fellow of JSCE Kaoru TAKARA

1. Introduction

The rainfall Intensity-Duration-Frequency (IDF) relationship is one of the most commonly used tools in water resources engineering, either for planning, designing, or operating of water resource projects, or for various engineering projects against floods. Since then, many sets of relationships have been constructed for several parts of the globe. However, such maps with rainfall intensity contours have not been constructed in many developing countries, including Vietnam. There is therefore a high need for IDF curves in the monsoon region of Vietnam. This research is to construct IDF curves for seven stations in the monsoon area of Vietnam and to propose generalization IDF formula using base rainfall depth, and base return period for Red River Delta (RRD) of Vietnam.

The Red River and Thai Binh River systems have a basin area of 169,000 km2. The Red River Delta area is 5,540 km2. Average annual precipitation in Hanoi is 1,830 mm. In this study, 210 rainfall events are available from 7 stations: Lang-Hanoi, Namdinh, Haiduong, Bacgiang, Thaibinh, Ninhbinh, Vanly have been statistically analyzed for the period 1956-1985 in Red River Delta. This research is study the Rainfall IDF relationship equation, determine the parameters of IDF equations, and construct IDF curves for Red River Delta. To study the generalized IDF formula using some base rainfall depth and base return period.

2. Methodology

Frequency analysis techniques are used to develop the relationship between the rainfall intensity, storm duration, and return periods from rainfall data. The Pearson type III is commonly used in Vietnam for frequency analysis and it is utilized in this study.

Four basic forms of equations used to describe the rainfall intensity duration relation are summarized in Table 1. These are empirical equations that show rainfall intensity decreases with rainfall duration for given return period.

Table 1 Empirical IDF equations

Talbot	Bernard	Kimijima	Sherman
$i=\frac{a}{(t+b)^D}$	$i=\frac{a}{t^b}$	$i=\frac{a}{t^D+b}$	$i=\frac{a}{(t+b)^D}$

Where: i is rainfall intensity (mm/hour); t rainfall duration (minutes); a,b,D are parameters.

The least-square method is applied to determine the parameters of four empirical IDF equations which are used to represent intensity-duration relationships. The value of parameters in the Rainfall IDF equations were chosen on the basis of minimum Mean Square Error (MSE) between the IDF relationship produced by the frequency analysis and that simulated by the IDF equation and the correlation coefficient (R). Interpolating the parameter contour map by using Arcview/GIS, the maps are generated for the parameters which can then be used for ungauged rainfall.

Generalized IDF formula The IDF relationship produced by frequency analysis at each recording rain gauge was fitted to the following equation suggested by Bell (1969) and Chen (1983).

$$I_t^T = I_{t'}^{T'}(G + H \log T)\frac{A}{(t+B)^D}$$

Where: T' is a constant return period (year) as the base value, t' a constant rainfall duration as the base value; $I_{t'}^{T'}$ is the rainfall intensity with a T' year return period and t' minute rainfall duration; A, B, D, G and H are constants parameter.

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Contact address : Le minh NHAT (E-mail: nhat2020@yahoo.co.uk); TAKARA kaoru Laboratory,
Disaster Prevention Research Institute (DPRI), Gokasho,Uji, Kyoto 611-0011,Japan.

3. Results.

Rainfall IDF curves was constructed and comparison IDF curves with 4 equations (Fig. 1).

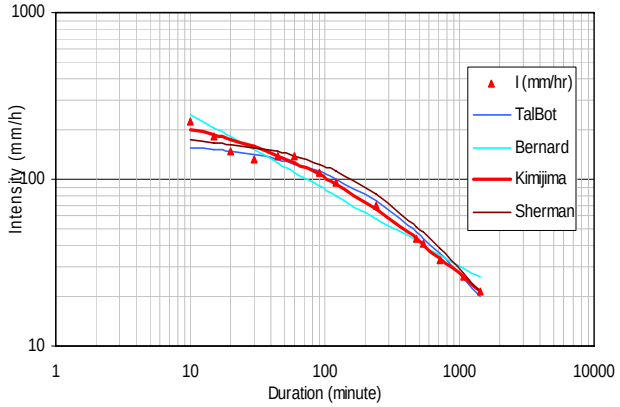

Fig. 1 Comparison of Rainfall IDF equation

Comparison IDF equations with mean square error and the figure 2 showed that IDF curves with Kimijima equation had minimum MSE.

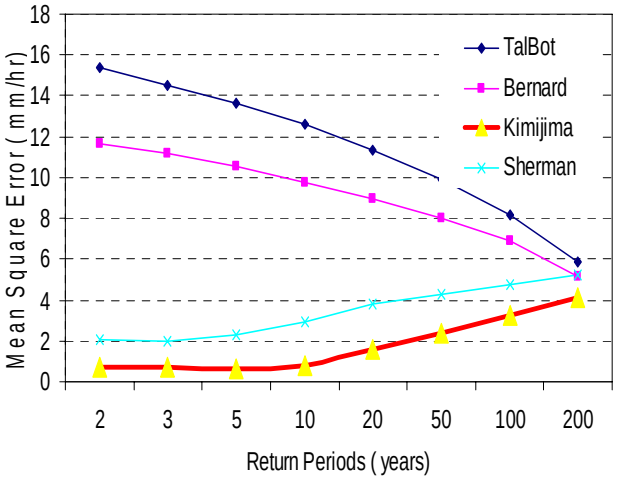

Fig. 2 Comparison Mean square error (MSE)

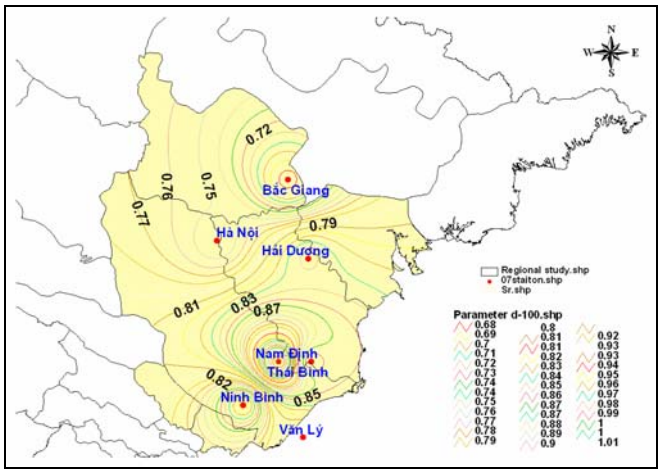

Fig. 3 Contour Map of parameters (Kimijima Equation)

Fig. 3 showed several generated contour maps of parameters by the Kimijima Equation for Hanoi-Lang station with 100 years return period. The contour maps can be used for ungauged points which can then be used for constructs of Rainfall IDF relationship

The generalized IDF formula for each station was then determined for rainfall durations and return period of up to 200 years. Since the parameter in generalize IDF formula had good statistical relationship. Generalized IDF curves at Lang Station (Fig. 4) with rainfall intensity in 60 minutes and 200 year return is 153.81 mm/hr, is generalized at Lang as:

$$I_t^T = 153.81(0.254 + 0.312\log T)\frac{88.938}{(t+76.315)^{0.254}}$$

The value of root mean square error (RMSE) is 5.88 (mm/hr) and correlation coefficient R = 0.99.

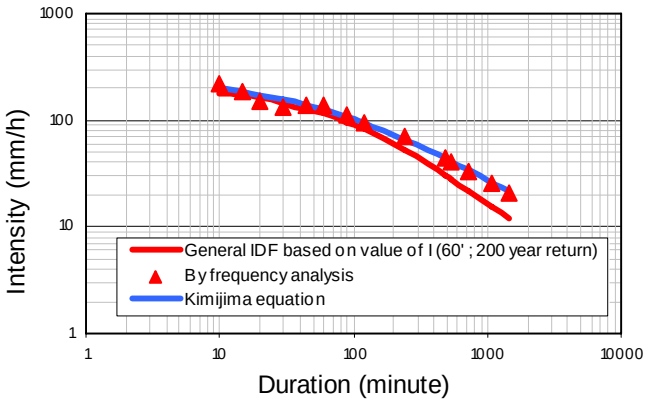

Fig. 4 Generalized IDF relationship for Lang station

4. Conclusion

The Kimijima equation is an acceptable fit to the IDF relationship in Vietnam. The contour maps of parameters of Kimijima equation were constructed, which can be used for ungauged point IDF analysis.

Further research on the regional IDF curves for ungauged point in Red River Delta of Vietnam will be develop. Generalized IDF relationship base on the return period and time duration will be further study.

References

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