# New Method of Deriving IDF Curve & Analyze Rainfall Intensity

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### ► IDF Curve?

'Intensity-Duration-Frequency Curve' Generally, for the same frequency, the intensity of the rainfall is inversely proportional with duration. To design the hydraulic structures, design rainfall intensity is considered and it is estimated from this IDF curve. It shows regional characteristics, so each region has it's own parameters to derive the IDF curve.

### ► Existing Methods to Derive Rainfall Intensity.

The equations below are the existing empirical formula to derive rainfall intensity.

- Tablot : $I = \frac{b}{t+a}$
- Sherman : $I = \frac{c}{t^n}$
- Japanese : $I = \frac{d}{\sqrt{t+e}}$
- Semi-log : $I = a + b \times \log\, t$
- Sherman : $I = \frac{c}{t^n}$

Nowadays, to get more accurate rainfall intensity, following rainfall intensity formula is used.

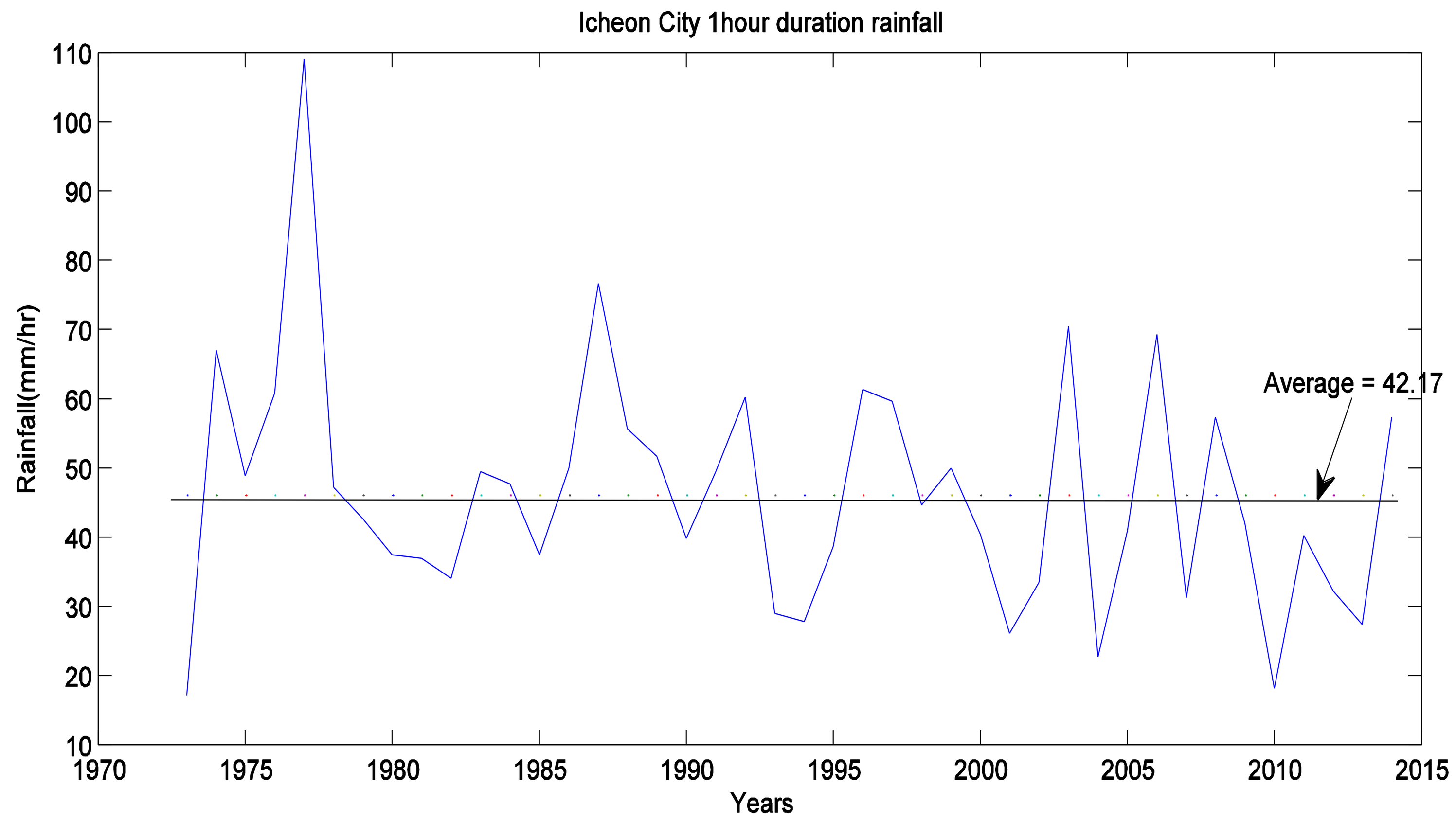
$$I(T,t) = \frac{a + b + \ln T/t^n}{c + d \times \ln \sqrt{T}/t + \sqrt{T}}$$

*I* is the rainfall intensity, *T* is return period(year), *t* is duration(min). duration(min).

a, b, c, d and n are the parameter that are determined by region.

### ► Hydrological Frequency Analysis & Derive IDF Curve

According to the figure below (Icheon City 1hour duration rainfall), the tendency of the rainfall have the skewness, that the data is not normal distribution, there are not many data close to the average. Therefore, to get the rainfall frequency, several methods are used calibrate the skewness and for this application the most recommended method ; GUMBEL and GEV methods are used.




Both methods required specific moment values to apply skewness.

- Probability weighted moment

$$M_{1,0,0} = E[X] = \overline{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

$$M_{1,1,0} = E[XF(x)] = \frac{1}{n}\sum_{i=1}^{n} \frac{(i-1)}{(n-1)} x_i$$

$$M_{1,2,0} = E[XF^2(x)] = \frac{1}{n}\sum_{i=1}^{n} \frac{(i-1)(i-2)}{(n-1)(n-2)} x_i$$

$x_i$ is the (i)th value of the ascending rainfall data

- L-moment

$$L_1 = E[X] = \overline{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

$$L_2 = \frac{1}{2}E\left[X_{(1:2)} - X_{(2:2)}\right]$$

$$L_3 = \frac{1}{3}E\left[X_{(1:3)} - 2X_{(2:3)} + X_{(3:3)}\right]$$

- Gumbel distribution method.

Cumulative Probability Density Function is

$$F(x) = \exp\left[-\exp\left(-\frac{x - x_0}{\alpha}\right)\right] = 1 - \frac{1}{T}$$

$$\alpha(scale\ variable) = L_2/\ln 2$$

$$x_0(positional\ argument) = L_1 - 0.05772\alpha$$

Rainfall by time period derived by

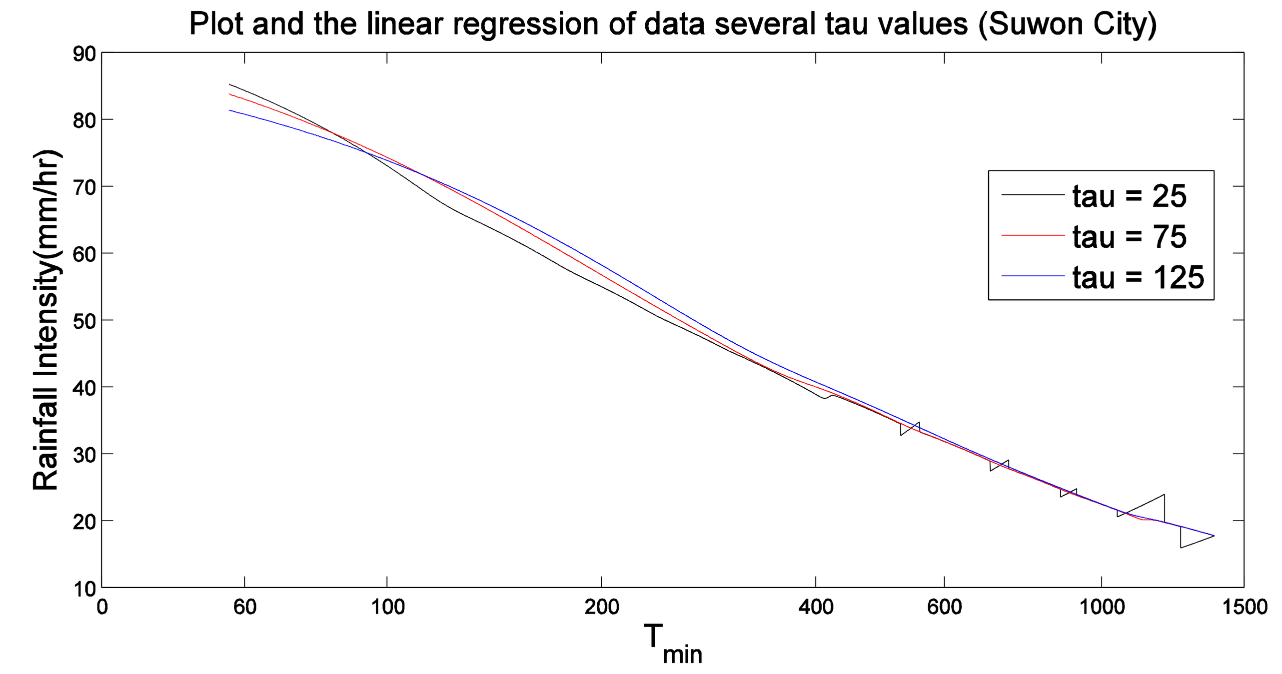
$$x = x_0 - \alpha \ln\left[\ln\left(\frac{T}{T-1}\right)\right]$$

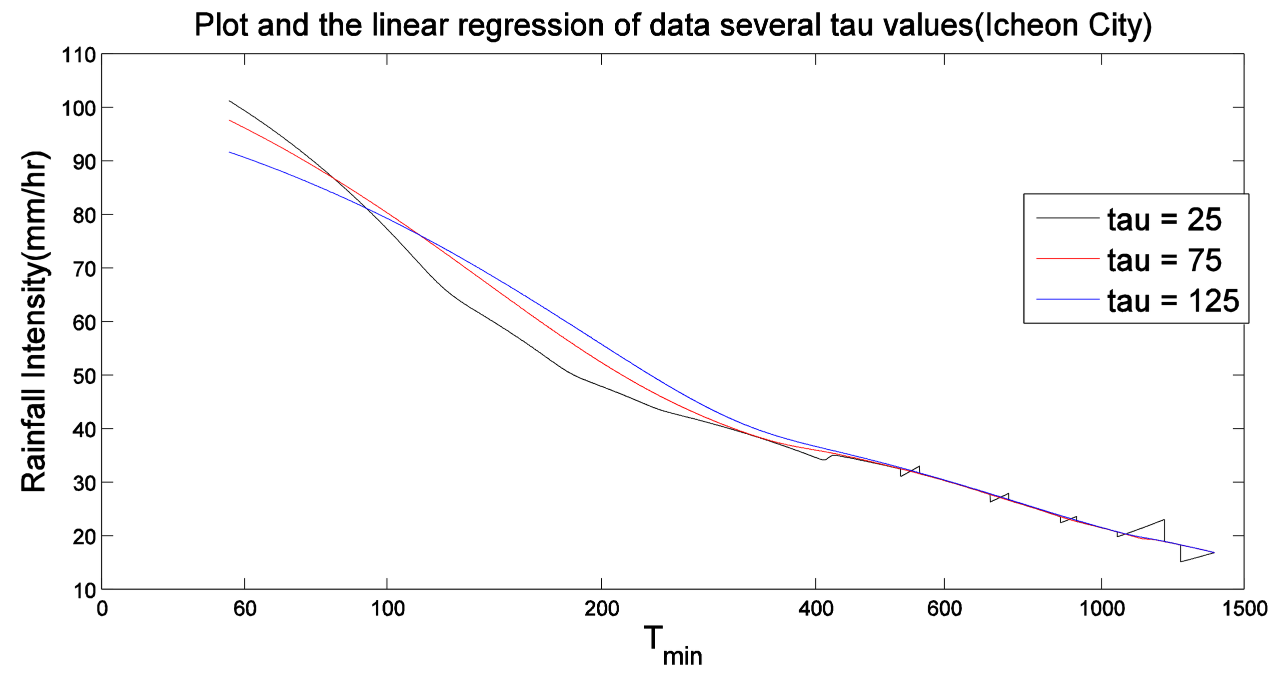
- Applying Locally weighted linear regression

Maximized log likelihood $l(\theta) = \frac{1}{2}\sum_{i=0}^{m}(y^{(i)} - \theta^T x^{(i)})^2$

Standard choice for the weights $w^{(i)} = exp\left(-\frac{(x^{(i)}-x)^2}{2\tau^2}\right)$

### ► Derived IDF Curves by 2 Regions Rainfall Data




The figures above shows the IDF curve of Suwon and Icheon city rainfall data (Korea). The frequency of the rainfall data is 100 years. Comparing the result of the curve by three bandwidth parameter, $\tau = 75$ shows the must fitting curve.

### ► Comparing With Previous Methods

Previous methods need several parameters to derive the IDF curve and rainfall intensity for each region. Moreover, more accurate method needs more complicate and more various parameters. However, this application is independent from those parameter so it is applicable at various regions. Therefore, to derive the IDF only historical rainfall data is needed.

### ► Future Work

The bandwidth parameter needs to be more accurate by comparing the results of other various regions rainfall data. Moreover, it is not sure to apply at the extreme climate regions.

**► References**

**Jea Su Lee, Hydrology, GUMI 2012**

**Ng, A. CS 229 lecture notes. Part I – Linear Regression**