Identifying meteorologically Homogeneous Zones within ASEAN (Malaysia-Indonesia)

and its application for Extreme Rainfall Analysis and Climate Change

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MALAYSIA

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Prof. Dr. Zulkifli bin Yusop

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Dr. Norazlina Ismail

Sharainie binti Sahrin (Master Student)

INDONESIA

Dr. Apip

Trinah Wati

Unggul Handoko


http://www.abc.net.au/am/content/2011/s3335211.htm
Bangkok
4 Nov 2011
Why?


http://nebuchadnezzarwoollyd.blogspot.jp/2011/01/life-during-wartime-queensland-floods.html
Queensland
Dec 2010 - Jan 2011, Jan 2013


Pahang 7 Dec 2013
(http://www.thestar.com.my/)
www.bharian.com.my
Malaysia
Nov 2010, Jan 2011, Dec 2012 ,Dec 2013, Dec 2014


Uji 14 August 2012
(http://www.hungeree.com/)
Japan
Sept 2011, August 2012, Sept 2013

Historical Data

Stochastic and statistical Analysis

Reliable extreme rainfall values

Design & Management for DRR

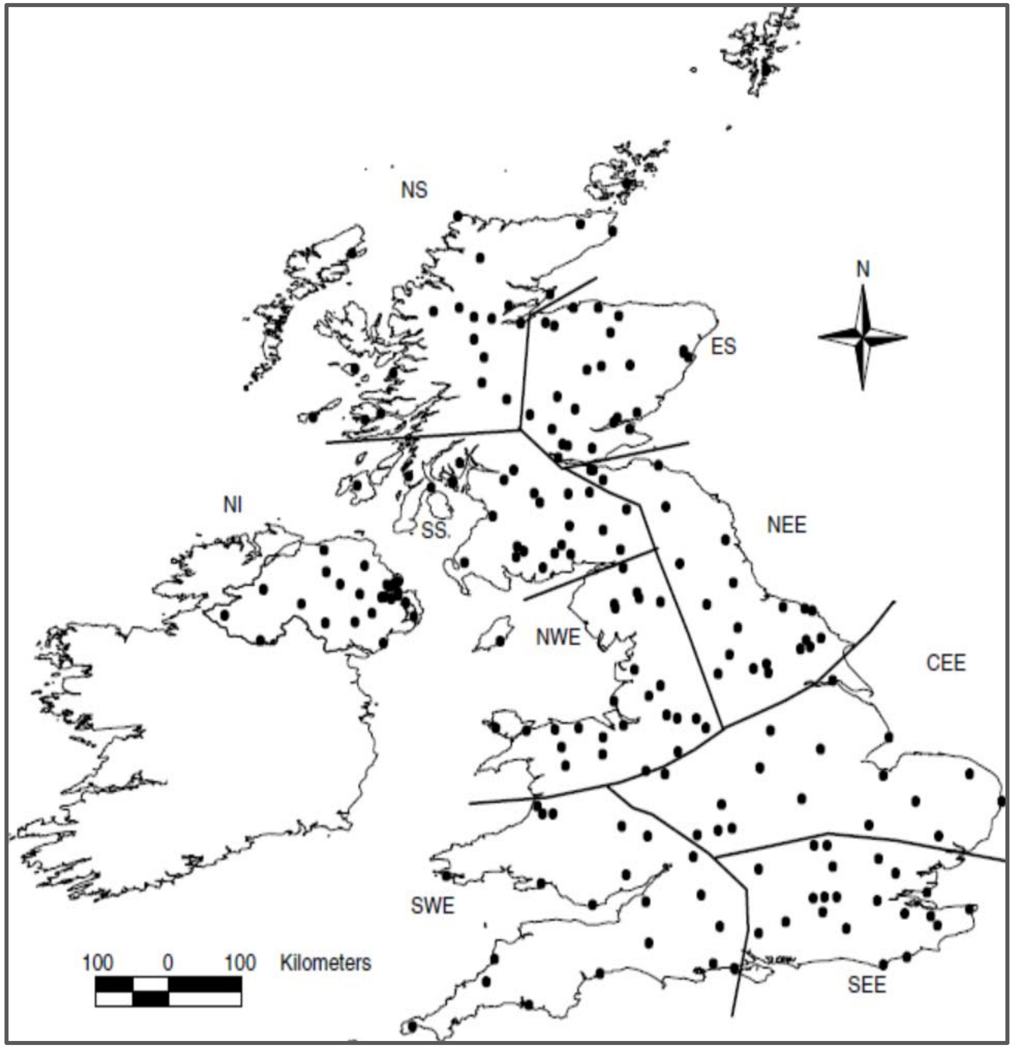
Risks Analysis

Climate Change

Identifying meteorologically Homogeneous Zones within ASEAN (Malaysia-Indonesia)

Homogeneous is *'same or similar nature or kind' (Dictionary)*

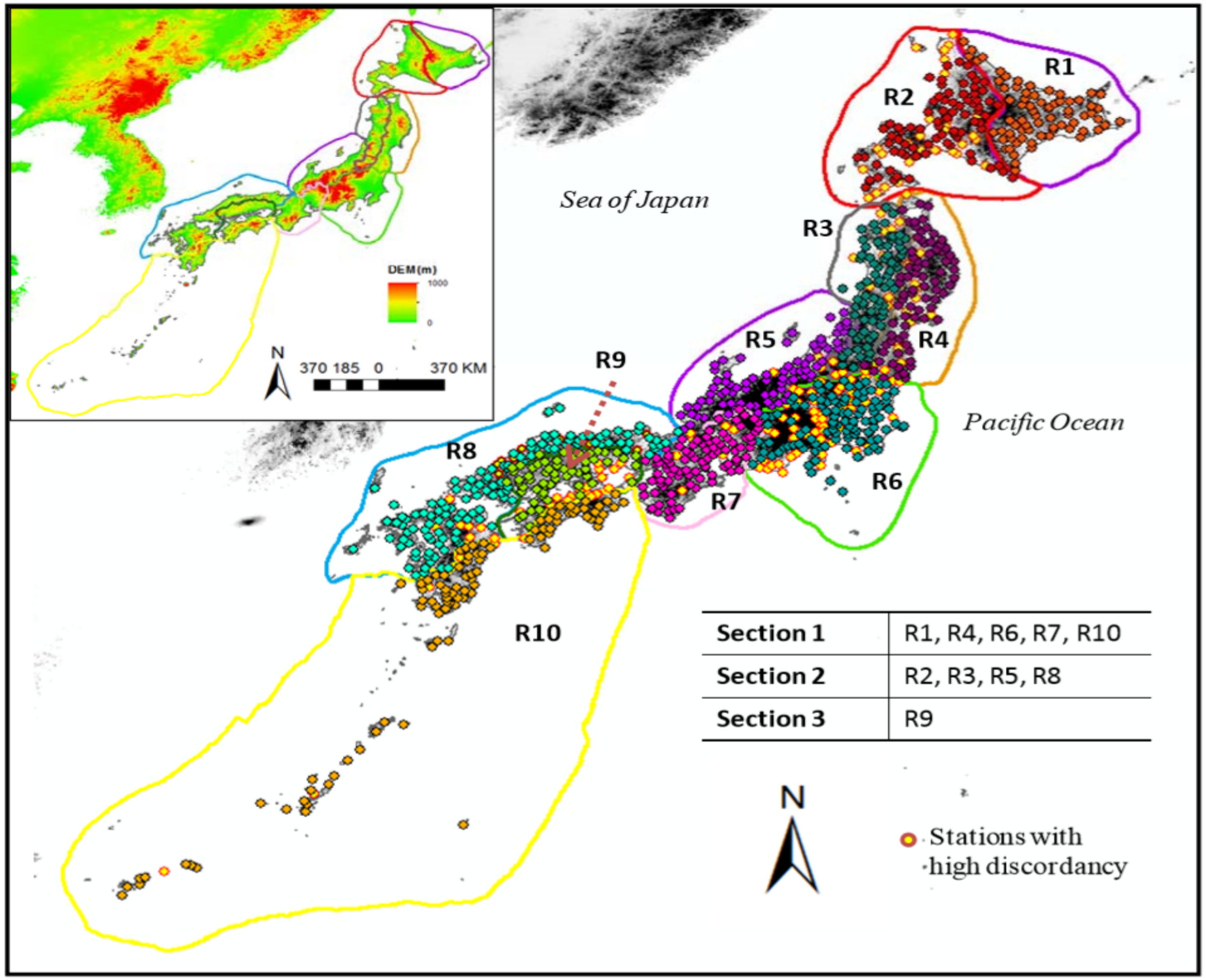
Extreme rainfall homogeneous regions refer to regions with similar extreme rainfall distribution. This means that any areas within the homogeneous region are considered to have similar statistical characteristics of its extreme rainfalls.

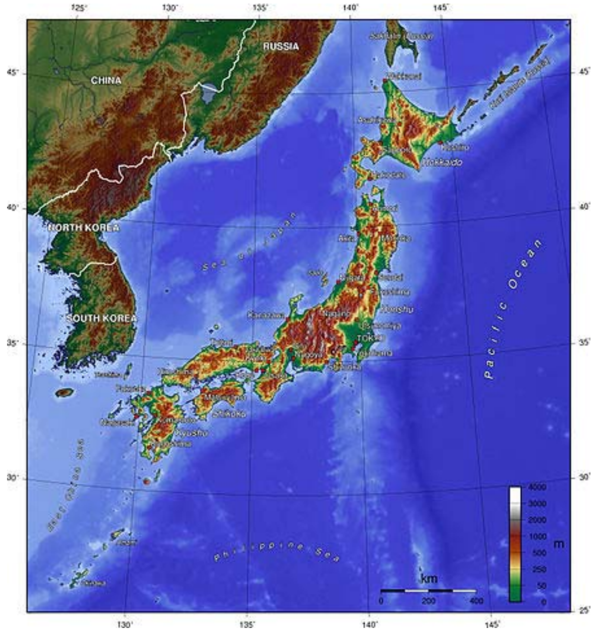


INFLUENCED BY

- Physiographic character
- Spatially coherent rainfall variability
- Annual maximas (distribution characteristics)

UNITED KINGDOM
Fowler et al., 2003
Wigley et al. (1984)

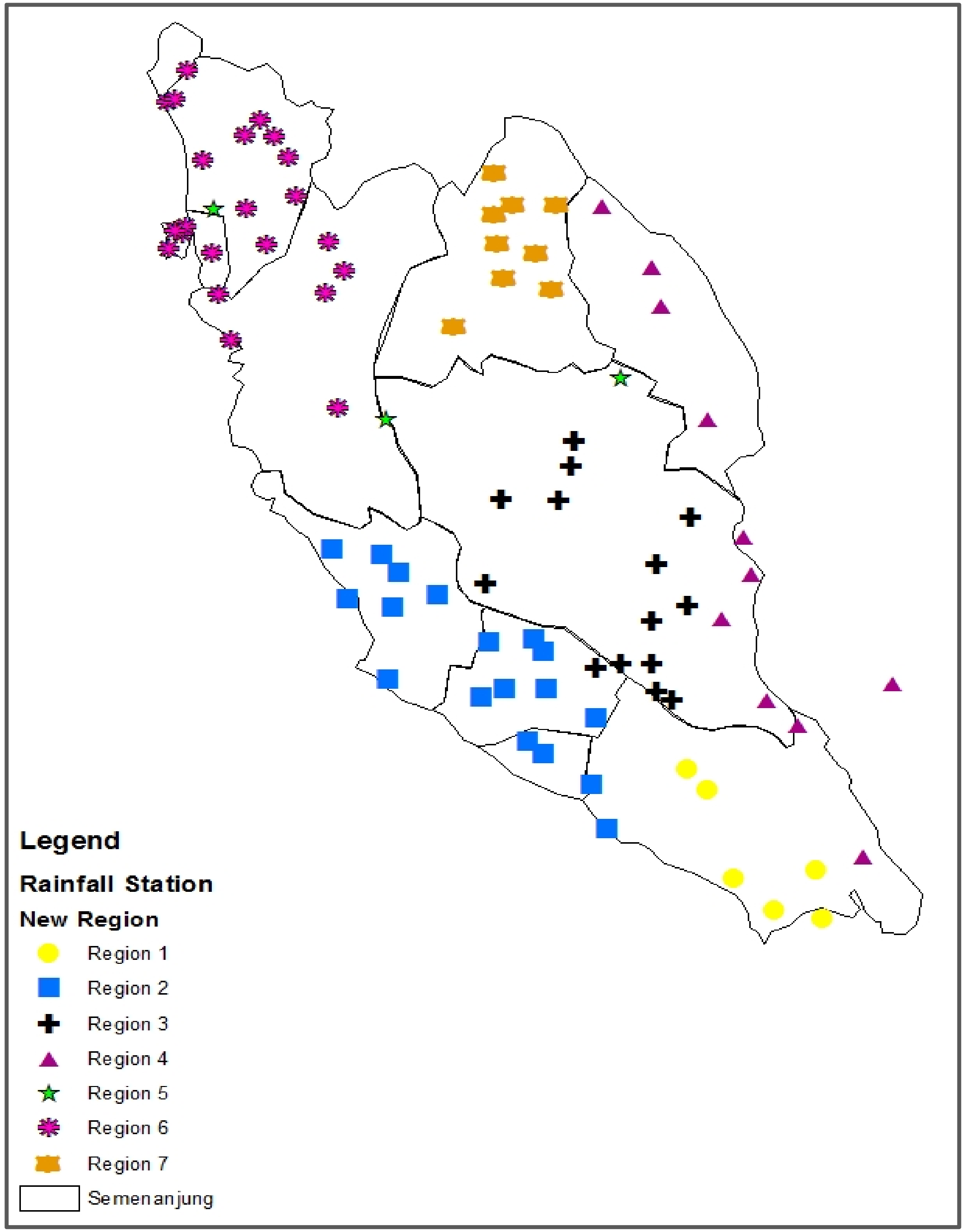




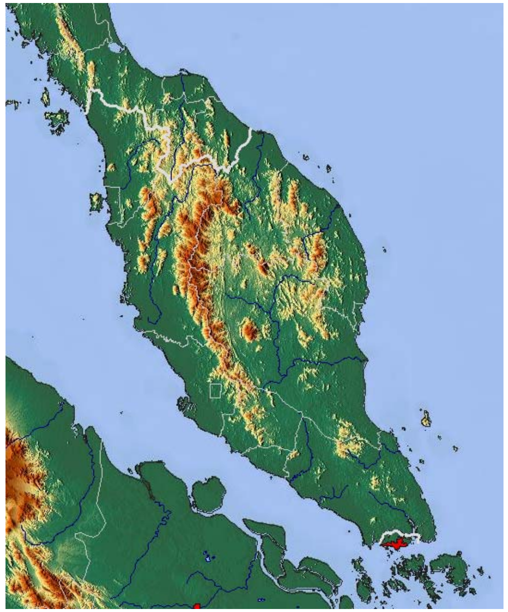
JAPAN
Alias et al., 2014

INFLUENCED BY

- Location (mountainous boundaries)
- Topography
- Annual maximas (distribution characteristics)

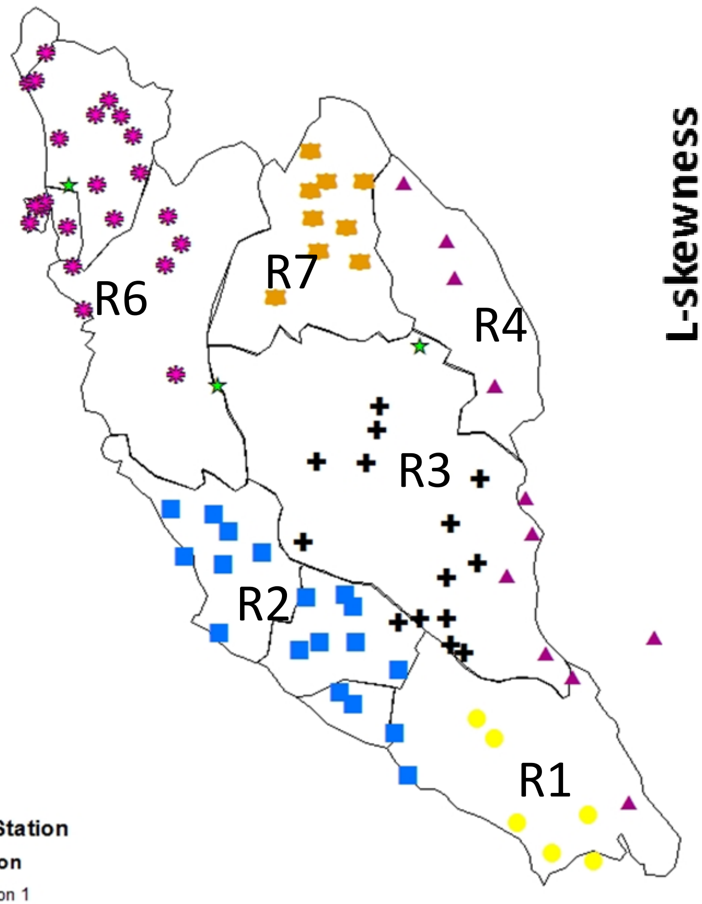


PENINSULAR MALAYSIA
Sahrin, et al., 2017

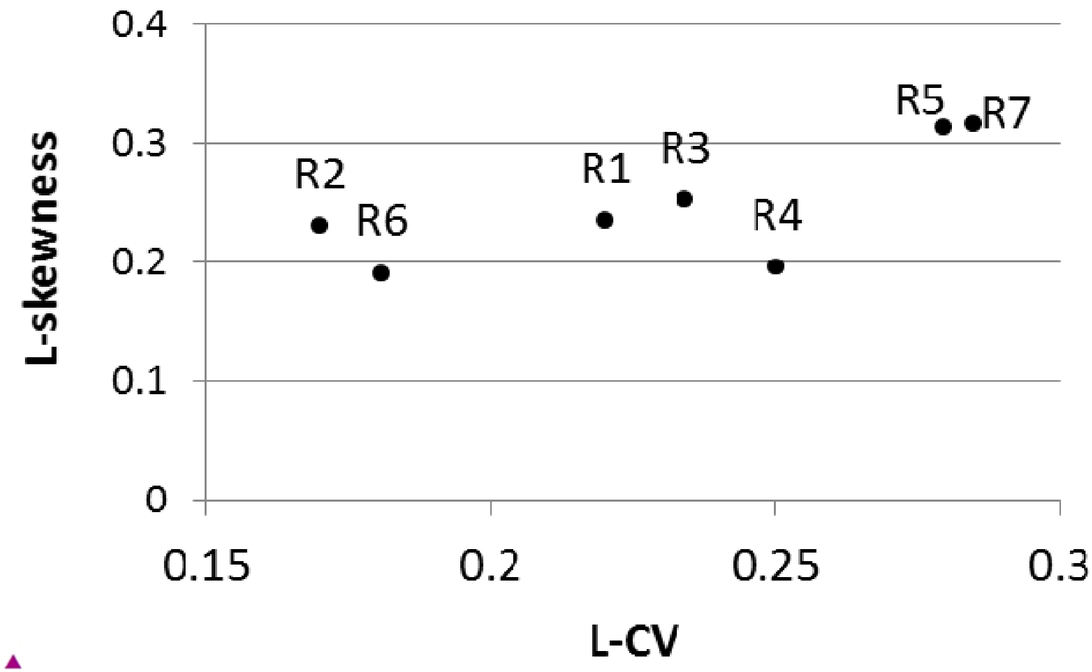


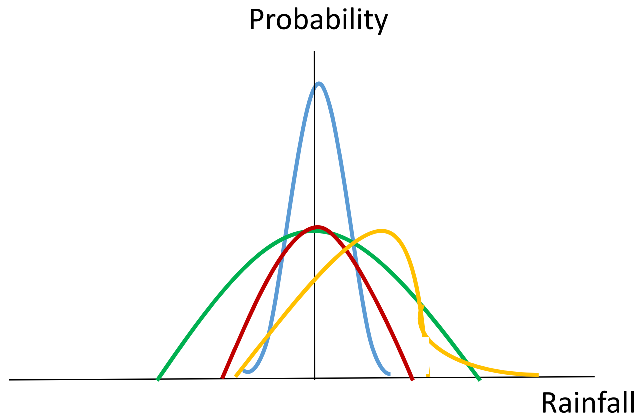
INFLUENCED BY

- Longitude, latitude
- Elevation or Altitudes
- Annual maximas (distribution characteristics)



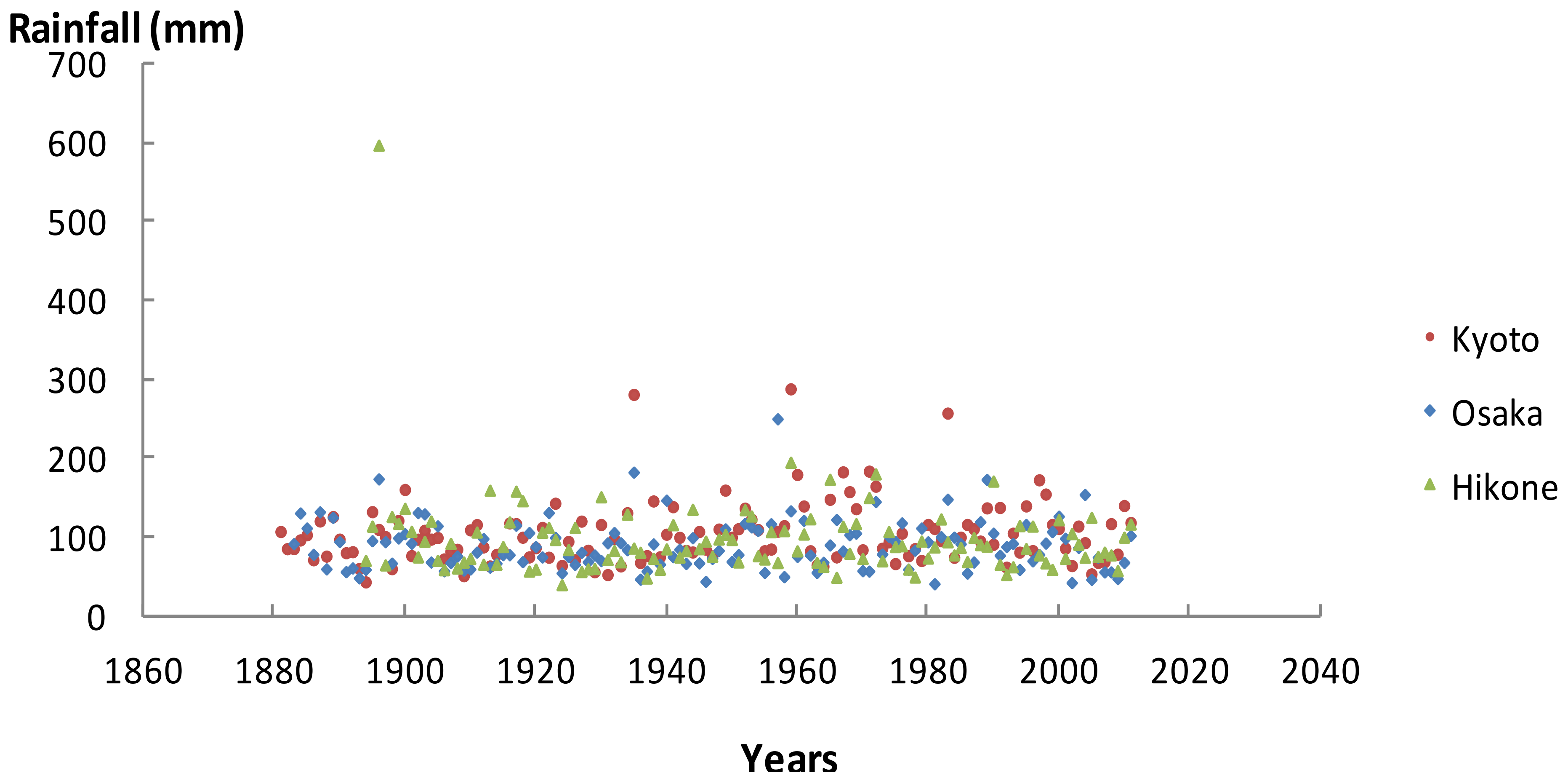
R5: Stations with altitude > 1000m



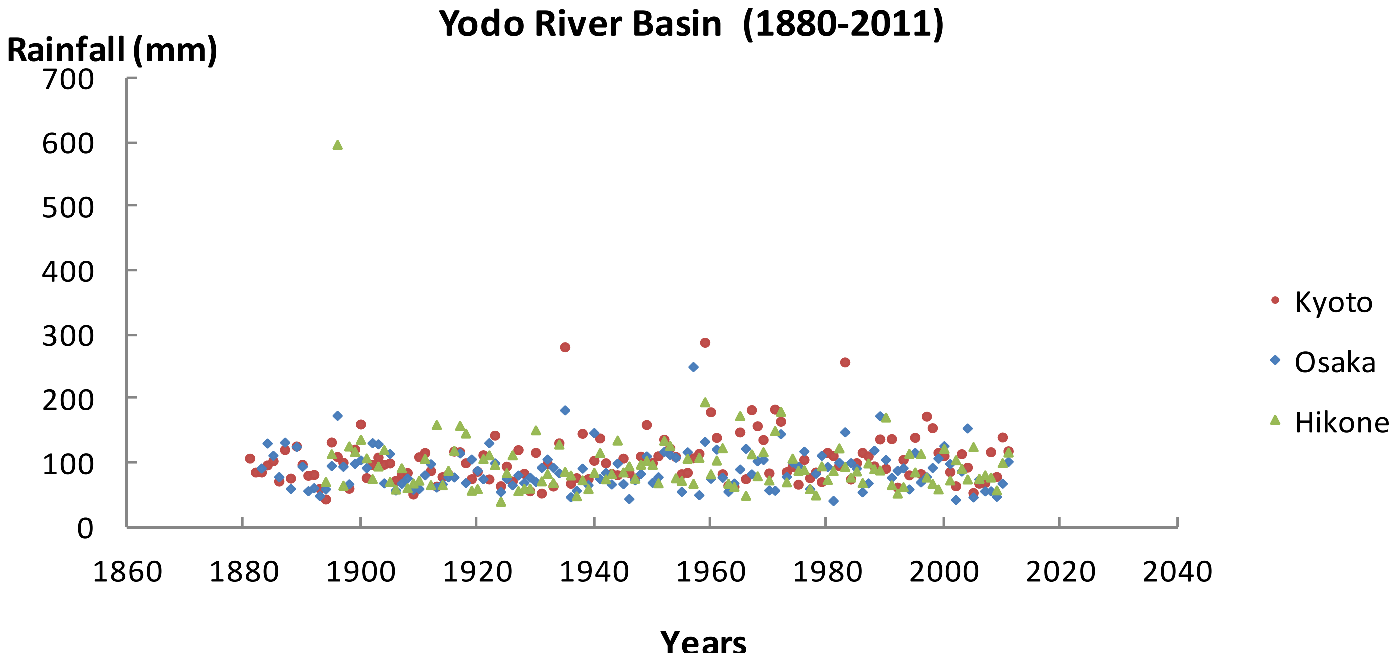


Used of the homogeneous regions?

1) REGIONAL FREQUENCY ANALYSIS

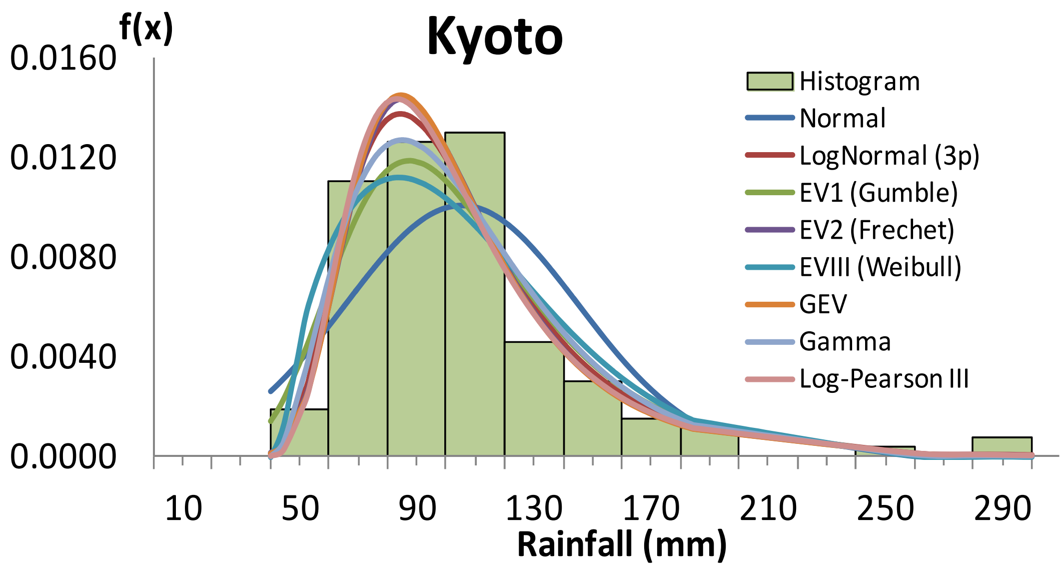


Data: 108 years data



Yodo River Basin (1880-2011)
Rainfall (mm)
700
600
500
400
300
200
100
0
1860
1880
1900
1920
1940
1960
1980
2000
2020
2040
Years
Kyoto
Osaka
Hikone

PDF

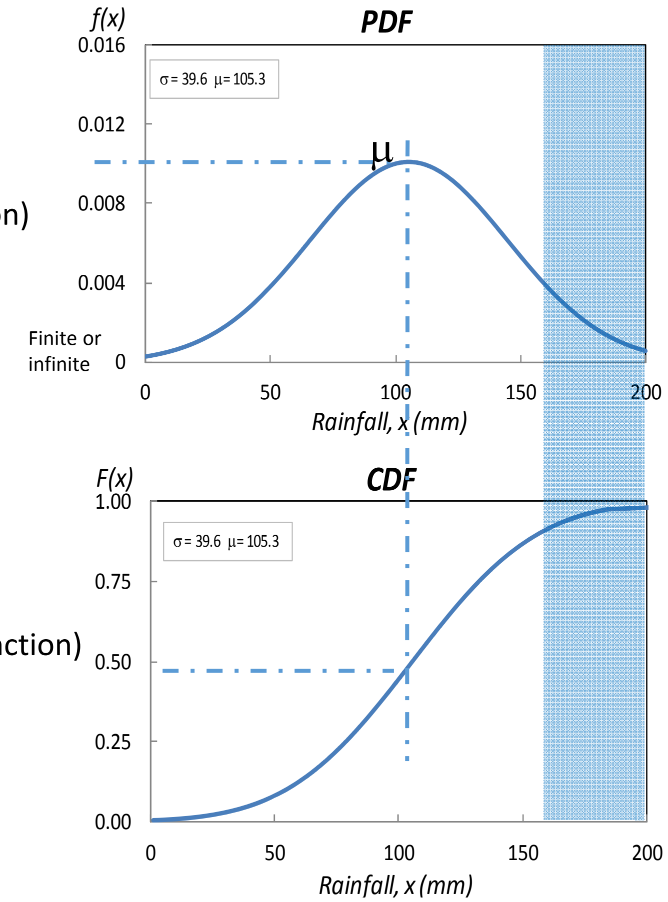


f(x)
Kyoto
0.0160
0.0120
0.0080
0.0040
0.0000
Histogram
Normal
LogNormal (3p)
EV1 (Gumble)
EV2 (Frechet)
EVIII (Weibull)
GEV
Gamma
Log-Pearson III
10
50
90
130
170
210
250
290
Rainfall (mm)

Frequency Analysis

PDF
(Probability density function)

CDF
(Cumulative distribution function)



(1-p) = non-exceedence probability

(1-p) = non-exceedence probability

Frequency Analysis

PDF
(Probability density function)

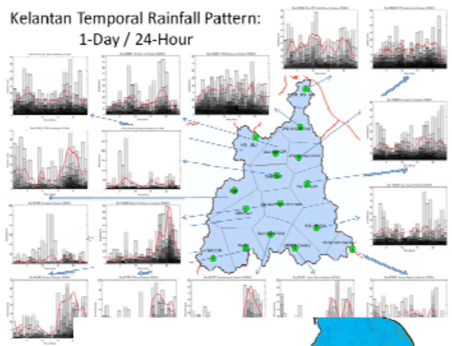
$$f(x)$$

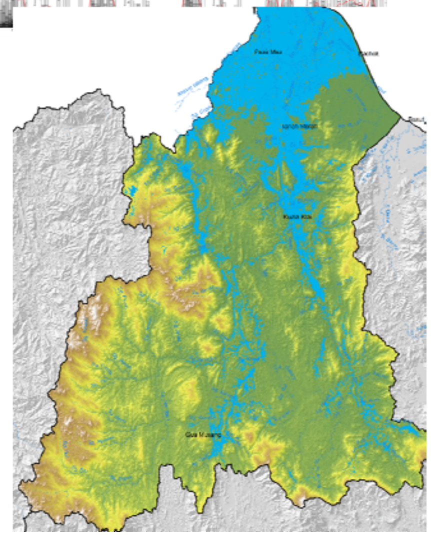
CDF
(Cumulative distribution function)

$$F(x) = \int f(x)$$

RETURN PERIOD
(5-yr, 20-yr, 50-yr, 100-yr)

$$T = 1/(1 - F(x))$$





DESIGN RAINFALL FOR

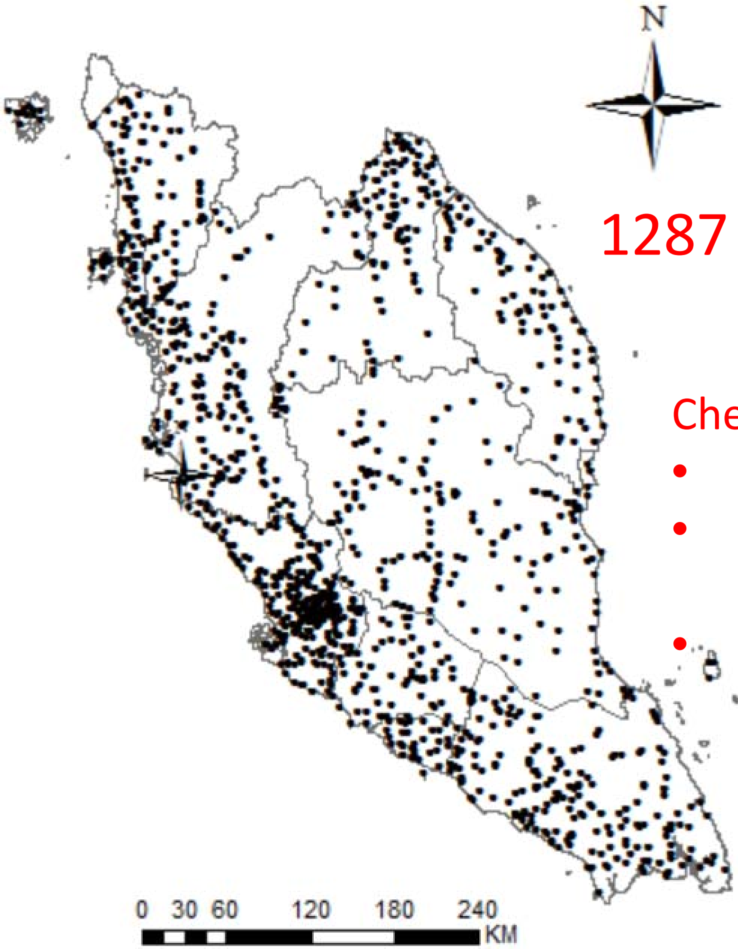
RISK MAPS
FLOOD DEFENCE STRUCTURES
DAMS

RETURN PERIODS ⟷ DESIGN RAINFALL

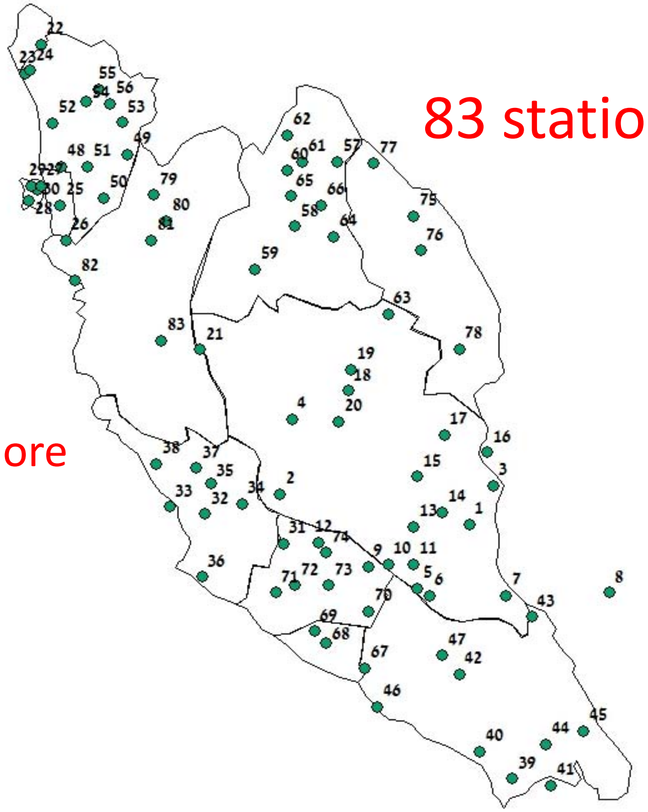
To minimize the risk and maximize design efficiency in design (Smithers and Schulze, 2001).

However, extreme events are rare and their records are often short, estimation of the frequencies of extreme events is difficult.

Reliable estimations require very long station records if single station data are to be used.



1287 stations



83 stations

Checked for:

- Missing data
- Long series (more than 30 years)
- Stationary

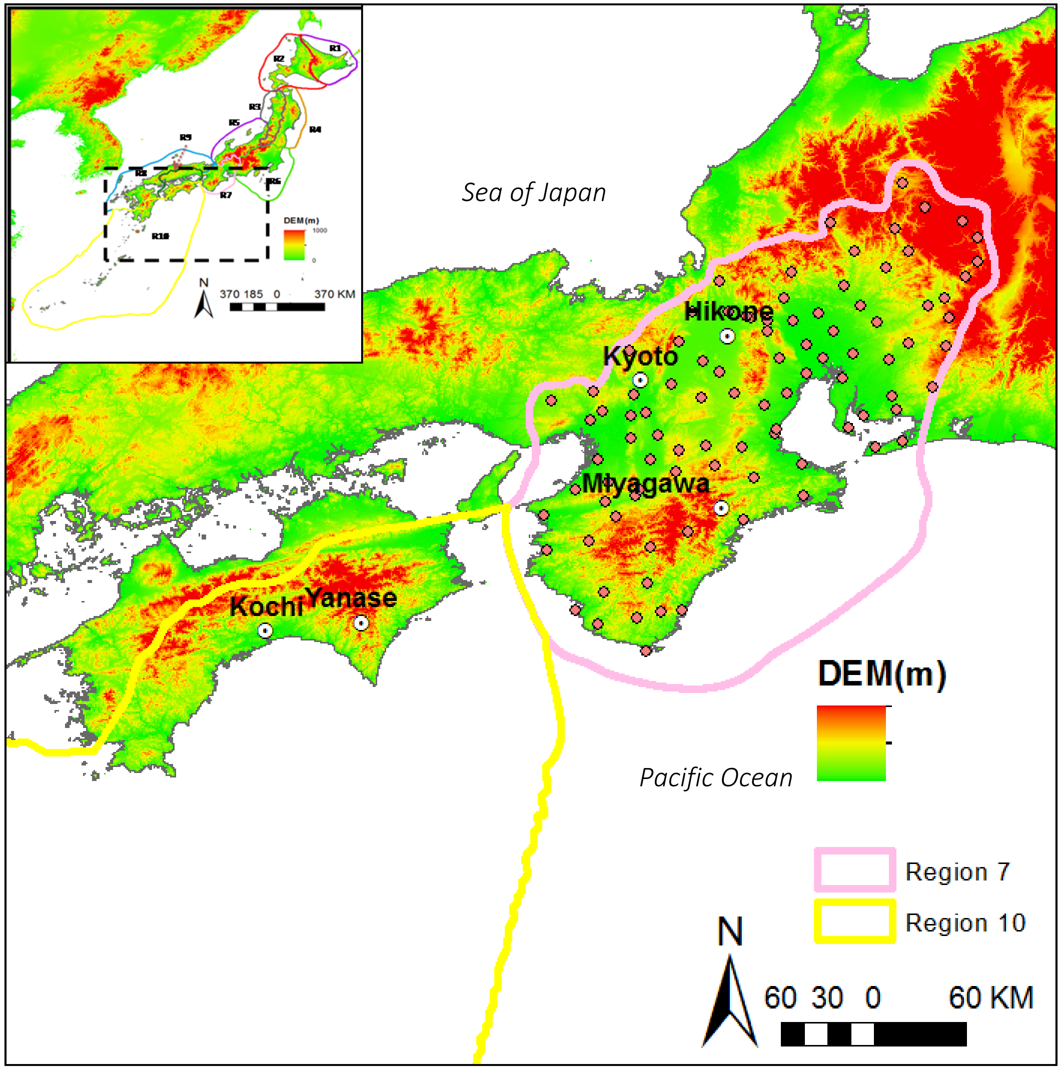
Conventional Freq. Analysis → At site data - Point

In regional frequency analysis

A site must be assigned to a homogeneous region because an approximate homogeneity is required to ensure that a regional frequency analysis is more accurate than an at-site analysis (Hosking and Wallis, 1997).

if different sites have similar event frequencies for different observed quantities, a pooled frequency analysis can be done instead of an at-site analysis

trades space for time thus increases the effective length of the data set which in turn increases the precision of the data (Hosking and Wallis, 2005).

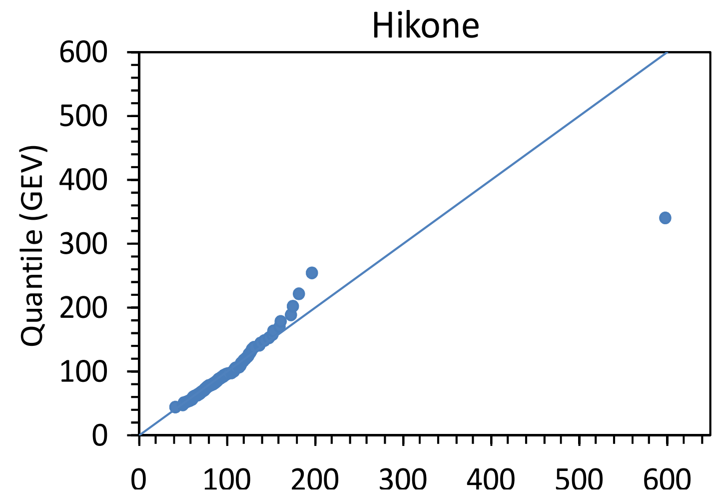


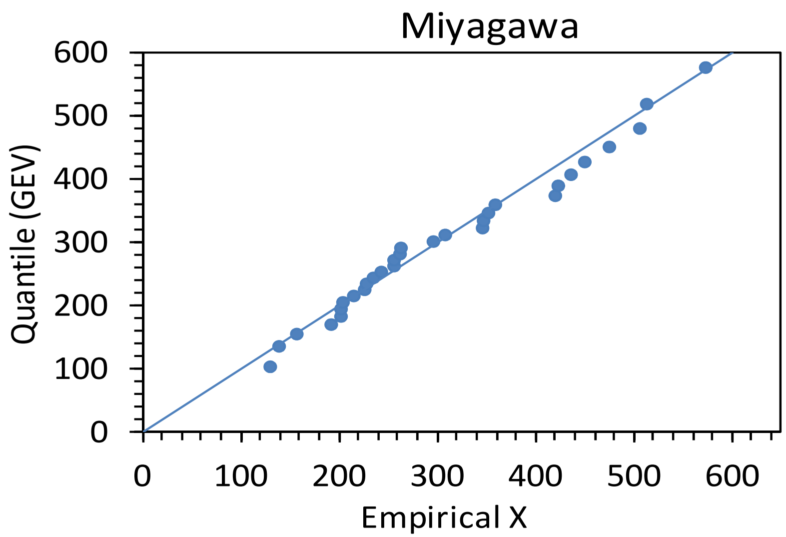
Region 7

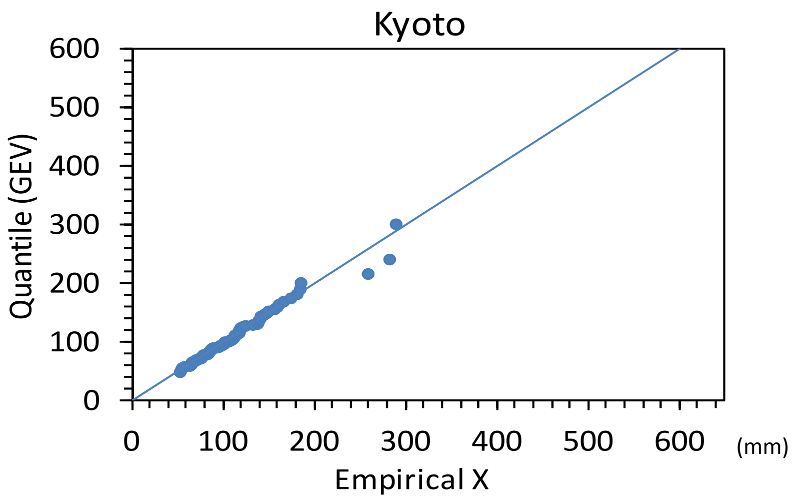
Stations e.g.,

- **Kyoto**
- **Hikone**
- **Miyagawa**

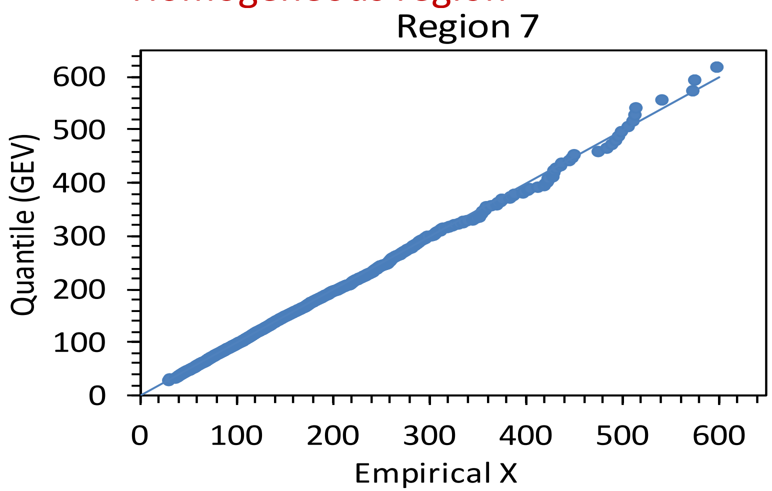
Quantile- Model vs. Empirical Plot







Homogeneous region



Quantiles testing

Quantile improvement

Datasets (*station-years*)	SLSC	Quantiles (mm)					
		30-year	50-year	100-yr	500-yr	1000-yr	2000-yr
Hikone (*115*)	0.1174	199	228	275	419	501	599
Kyoto (*108*)	0.0313	201	224	259	355	405	460
Miyagawa (*31*)	0.0291	619	676	754	936	1016	1096
Region 7 (*4060*)	0.0124	274	315	378	564	666	785

Using the regional frequency approach, the return period for :

1) Hikone extreme rainfall outlier of 596.9 mm was reduced from a **2000-year** rain to a **500-year-rain** when considering it as a region.

2) Kyoto extreme rainfall outlier of 288.6 mm was reduced from a **100-year-rain** to a **30-year-rain** when considering it as a region.

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