Chapter 3
Mathematical in daily life

Return Period and Risk analysis
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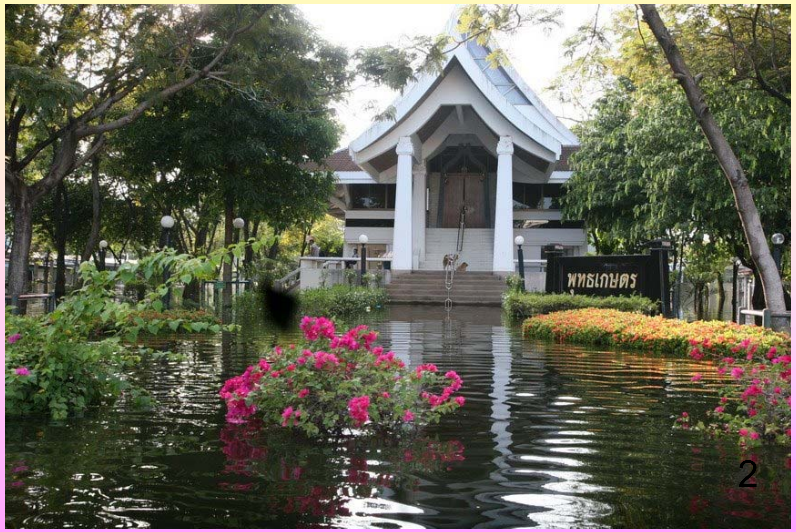
Chapter 3

Mathematical in daily life

Contents



Chapter 3 part1

Return Period and Risk analysis

- 3.1 Return Period
- 3.2 Probability distribution
- 3.3 Risk analysis

3.1 Return Period

- A **Return period** also known as a **Recurrence interval** **Or** **Expected Frequency of Occurrence**

Return period => estimation of likelihood of time of natural occurrence/event **Or** the average recurrence interval (number of years) of Earth quake, Tsunami, Rain, Storm, flood and etc.

3.1 Return Period-2

- Using recorded historical data for risk analysis.

- To design the infrastructure

e.g. Safety and management of the dam using appropriate return period for estimation the Maximum flood.

-to decide whether a project should be allowed to go forward in a zone of a certain risk.

- To manage, plan for relieve the natural disaster.

3.1 Return Period-3

- Probability (p) of historical data

$$p_i = \frac{i}{n+1}$$

Time period of occurrence

$$T = \frac{1}{p}$$

$$T = \frac{n+1}{i}$$

P = probability of event
T = Return period
n = number of year of historical data
i = year

Ex. **Earth quake Magnitude and it's occurrence frequency**

Richter	Level	Effects	Recurrence/Return Period of World
≤1.9	insensible	non effect/ not felt/non detectable	8,000 times/day
2.0-2.9	Minor	Usually not felt, but can be recorded by seismograph	1,000 times/day
3.0-3.9		Often felt, but only causes minor damage.	49,000 times/year
4.0-4.9	Light	Slight damage to buildings and other structures.	6,200 times/year
5.0-5.9	Moderate	Damage to instability buildings and other structures but slightly damage to stable structures.	800 times/year
6.0-6.9	Strong	May cause a lot of damage in very populated areas around 80 km.	120 times/year
7.0-7.9	Major	A lot of damage very populated areas around 80-100 km.	18 times/year
8.0-8.9	Great	Major earthquake. Serious damage in very populated areas around more than 100 km.	1 time/year
9.0-9.9		Great earthquake. Can totally destroy communities near the epicenter.	1 time/20 years
≥10.0	Massive	non evident	Difficult to estimate (not know the time of occurrence)

Ref: adopted from: http://earthquake.usgs.gov/learn/faq/?categoryID=2

Magnitude , effects and earth quake measurement-1

Richter magnitude scale or Richter scale => Local scale

The Richter magnitude of an earthquake is determined from the logarithm of the amplitude of waves recorded by seismographs (adjustments are included to compensate for the variation in the distance between the various seismographs and the epicenter of the earthquake) , Developed in 1935 by Charles Francis Richter in partnership with Beno Gutenberg.

$$M = log A - log A_0$$

M = Magnitude of Earth quake (Richter)
A = maximum Amplitude of earth quake
A_0= reference Amplitude of earth quake

Notice: 5-Richter Earth quake has the wave amplitude 10 times of 4-Richter Earth quake

Magnitude , effects and earth quake measurement-2

Moment magnitude scale; MMS, M_w is the is used by seismologists to measure the size of earthquakes in terms of the energy released.[1] The magnitude is based on the seismic moment of the earthquake, which is equal to the rigidity of the Earth multiplied by the average amount of slip on the fault and the size of the area that slipped.[2] The scale was developed in the 1970s to succeed the 1930s-era Richter magnitude scale (M_L). Even though the formulae are different, the new scale retains the familiar continuum of magnitude values defined by the older one. The MMS is now the scale used to estimate magnitudes for all modern large earthquakes by the United States Geological Survey.[3]

$$M_w = \frac{2}{3}\log_{10} M_0 - 10.7$$

M_0 เป็นแมกนิจูดของโมเมนต์แผ่นดินไหวในหน่วยดายน์เซนติเมตร (10^{-7} นิวตันเมตร) [1] ส่วนค่าคงตัวในสมการนี้ถูกเลือกเพื่อให้สอดคล้องกับค่าแมกนิจูดที่คำนวณได้จากมาตราเก่า โดยที่สำคัญที่สุดคือ มาตราท้องถิ่น (หรือ "ริกเตอร์") เช่นเดียวกับมาตราริกเตอร์ การเพิ่มขึ้นหนึ่งระดับของมาตราเชิงลอการิทึมสอดคล้องกับพลังงานที่ปลดปล่อยออกมาเพิ่มขึ้น $10^{1.5} \approx 32$ เท่า และการเพิ่มขึ้นสองระดับจะสอดคล้องกับพลังงานที่ ปลดปล่อยออกมาเพิ่มขึ้น $10^3 = 1000$ เท่า

Ref: adopted from: http://en.wikipedia.org/wiki/Moment_magnitude_scale

3.1 Return Period-4

- Interpretation

“The 10-year maximum flood with discharge 900 cm^3/s will be occur with a probability p = 1/10 = 0.1 or 10%

=>this event will occur 10 times in 100 times(years) with discharge 900 cm^3/s.

=>or every 10 years, the maximum flood with discharge rate 900 cm^3/s will occur only 1 time

=>or 50-year flood will occur with probability 0.02 or 2%

Those events will be occur with given probability but in real world those event may be or not occur . Any body could not be confirm to predict but only inform the probability of occurrence for preparation the natural disaster and estimate the risk in the future [2].

3.1 Return Period-5

- Notice.
  - the return period is calculated from historical data event base on 100 years , in ideal condition the data with normal distribution. As this reason we assume the error will be 1% form the 100-year event.
  - If we could not record the number of data less than 100 records then we will find the error of estimation from those data.
  - If we collect number of data more than 100 records, for example 400 years or 500 years, it is difficult to compare with data collect from 100 years but we can compare the result by transform to 100-year data.

3.1 Return Period-6

- We could not observe the 1000 years data
- Using statistics of historical data, we could estimate the effect of recurrence1000-year event?

Ex3.1 What does is mean of the1000-year rainfall?

Answer

Ex3.1 the1000 year-rainfall

=> the1000 year-rainfall is the greatest rain fall consume the long duration times with recurrence (probability) 1 time in 1000 year (return period) =1/1000 =0.001

3.2 Probability distribution

- Probability (p) of historical data distribution are Poisson distribution

$$p_i = \frac{i}{n+1}$$

P = probability of event
n = number of year
i = order of data

- Given the probability of event a can occur = p

then the probability of event a non occur q = 1- p

- From Binomial distribution could be estimate the probability of occurrence of r times in period n years as

- Prob = $\binom{n}{r} \times p^r \times q^{n-r} = \binom{n}{r} \times p^r \times (1-p)^{n-r}$

3.2 Probability distribution –Example3.2

- Ex3.2 If the return period of earth quake as 50 years, How much the probability does event occur 1 time/year in 10 years?

$$\text{Prob} = \frac{1}{50} = 0.02$$

Probability of earth quake occur 1 time/year in 10 years

$$\text{Prob} = \binom{10}{1} \times 0.02^1 \times 0.98^9$$

$$= 10 \quad x \quad 0.02 \; x \quad 0.834$$

$$= 0.167$$

3.2 Probability distribution - Example3.3

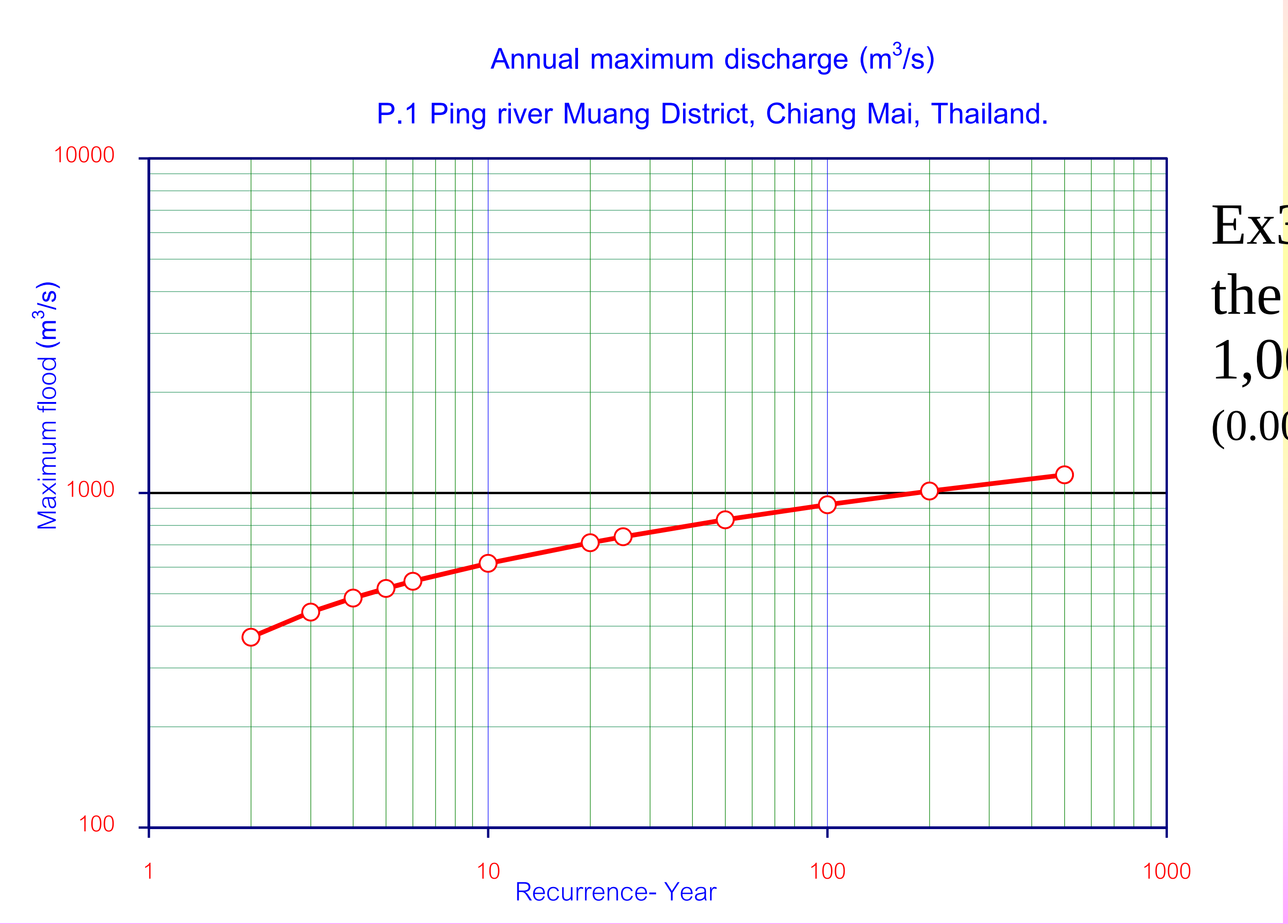
- Ex3.3 **At 8.12 am , April 24,2012 . Bureau of seismology , department of Metrology , Thailand reported the earth quake magnitude 6.6 Richter at Myanmar far from MaeHongSon 438 km (with epicenter 10 km, Lat. 22.93 N ,Lon 95.99 E)**

- **Given return period = 20 years**

  - How much the probability does 6.6-Richter earth quake occur 2 times of every 10 ?

3.2 Probability distribution –Example3.4

Annual data of discharge (m^3/s) at station P.1 Ping river Muang District, Chiang Mai, Thailand.



Ex3.4 How much the probability of 1,000 m^3/s occur ?

(0.005)

3.3 Risk analysis

- Risk analysis uses the Return period to estimate the expectation of structures 'safety or risk of structure/building from natural disaster along design life.

- Risk as the likelihood of occurrence that may occur exceptional only one time to damage the building structure (occurrence less than the minimum design value)

3.3 Risk analysis

- Risk estimation [3]

Risk average = $\bar{R} = 1 - \left(1 - \frac{1}{T}\right)^n = 1 - (P(X \geq x_T))^n$

where $\frac{1}{T} = P(X \geq x_T)$

P = Probability of event
T = Time Return period
n = number of years

3.2 Risk analysis - Example3.5

Ex3.5 from ex3.2 please calculate the average of risk of earth quake occur only one time in 10 years.

Prob = 0.02 then Risk average

$= 1 - (1 - P(X \geq x_T))^n = 1 - (1 - 0.02)^{10} = 1 - 0.98^{10}$

= 1- 0.81707

= 0.18293 ≅ 18.29%

Practice

- The old man stored the treasure in cave, he told that "after he died 50 years ago, the descendant will be use his treasure". The report of department of geological reported that the occasion of cave collapse occur every 200 years. How much does property risk?

- Please form the question by yourself about the application of this chapter with your solution.

Write down your name, section of lecture and lab in one page of A4

References

1 wikipidia :

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Questions?

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