Seismic Hazard Assessment

Part 3: Simplified (PSHA) – An Example

Dr. Fawad A. Najam

Department of Structural Engineering
NUST Institute of Civil Engineering (NICE)
National University of Sciences and Technology (NUST)
H-12 Islamabad, Pakistan
Cell: 92-334-5192533, Email: fawad@nice.nust.edu.pk

Prof. Dr. Pennung Warnitchai

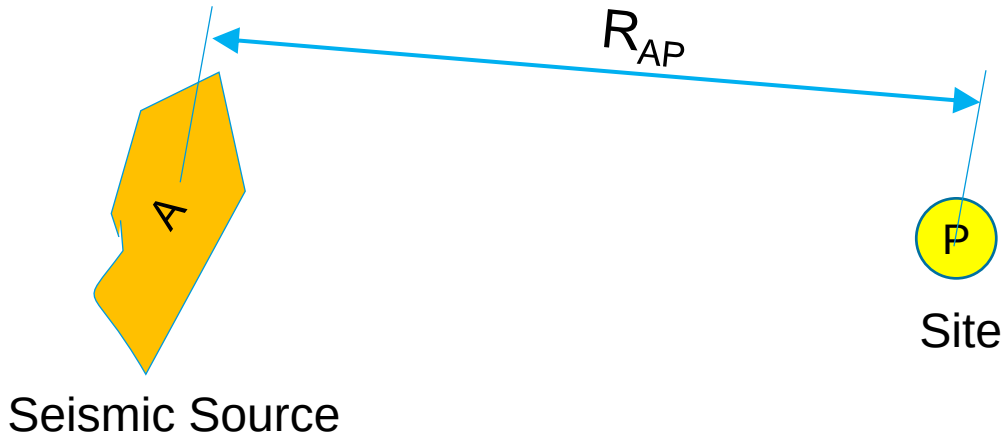
Head, Department of Civil and Infrastructure Engineering
School of Engineering and Technology (SET)
Asian Institute of Technology (AIT)
Bangkok, Thailand

Simplified PSHA – An Example

Simplified PSHA – An Example

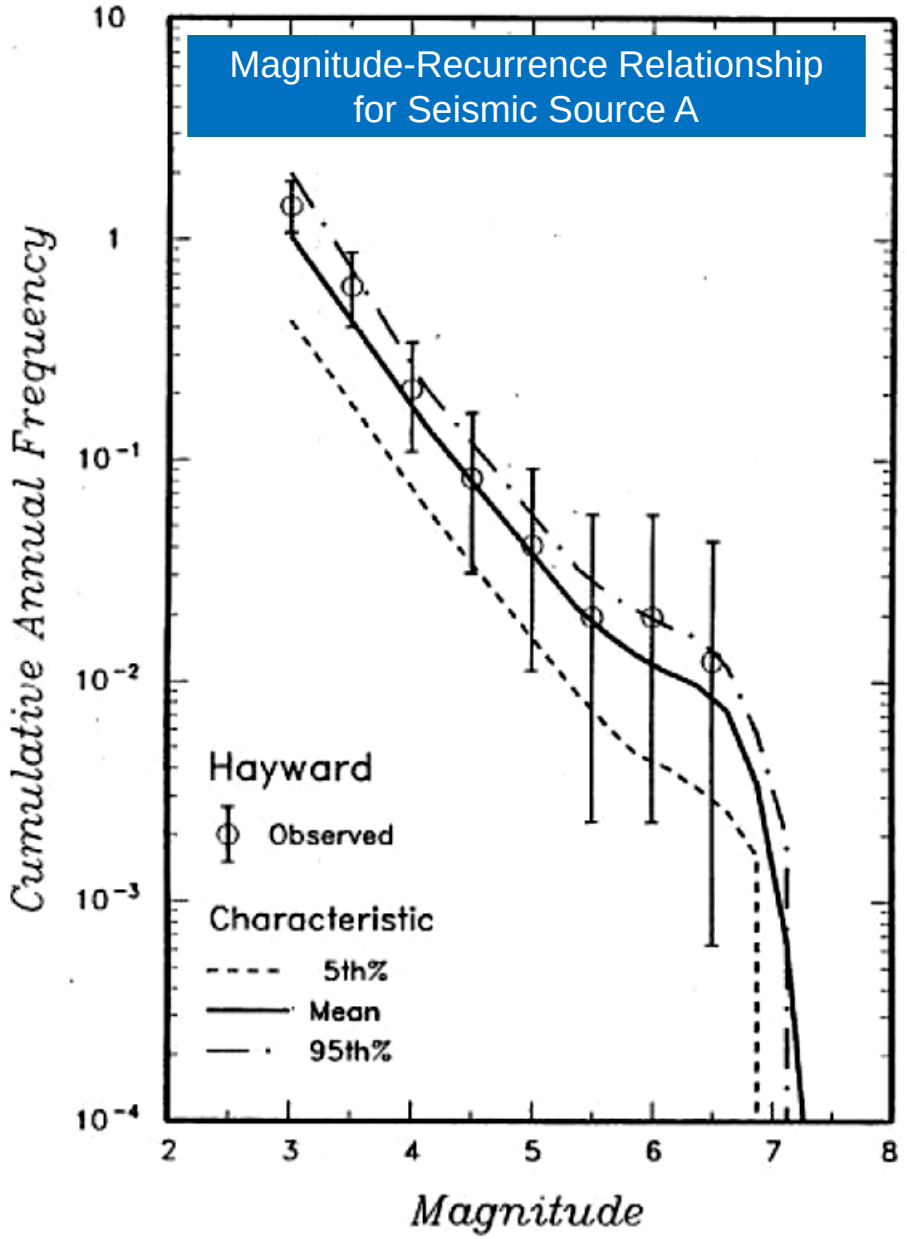
To demonstrate on how probabilistic ground motion is estimated, a simplified calculation of probabilistic ground motion is presented as follows:

Let's consider a simple case where only one seismic source (A) is located near the site of interest (P).

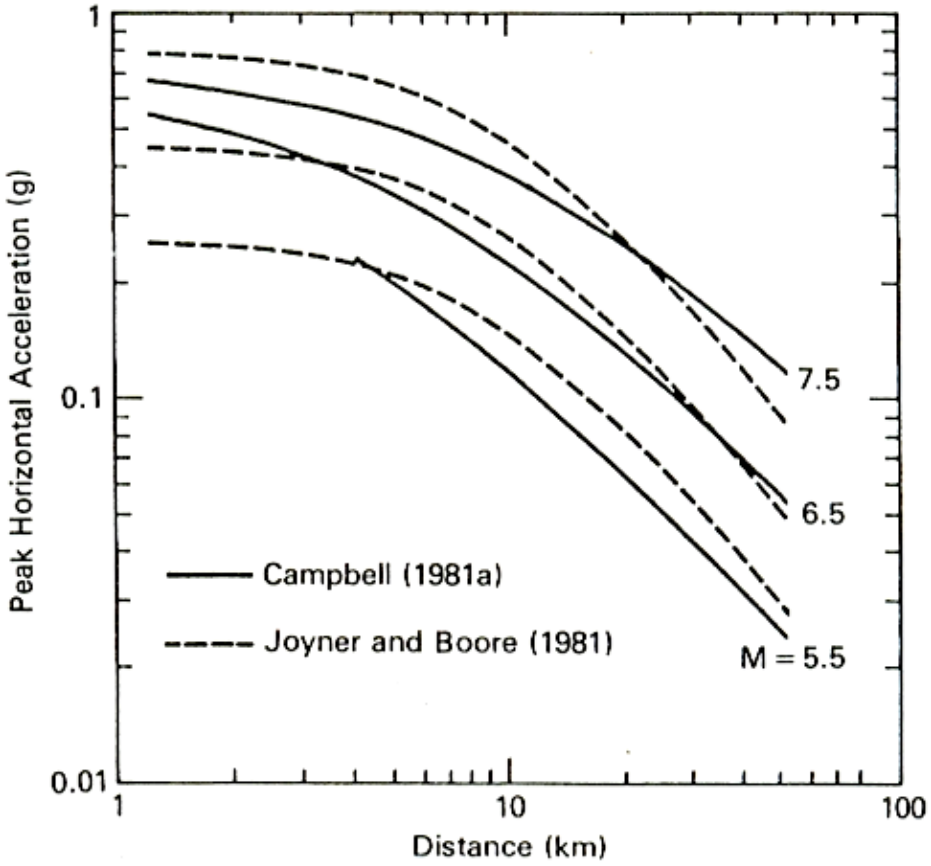


The source-to-site distance = R_{AP} = 30 km.

Magnitude-Recurrence Relationship for Seismic Source A



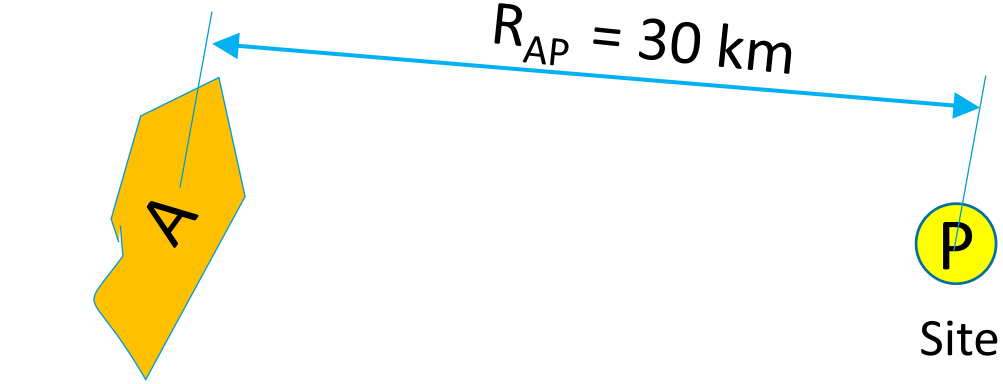
GMPE suitable for the tectonic environment of the site

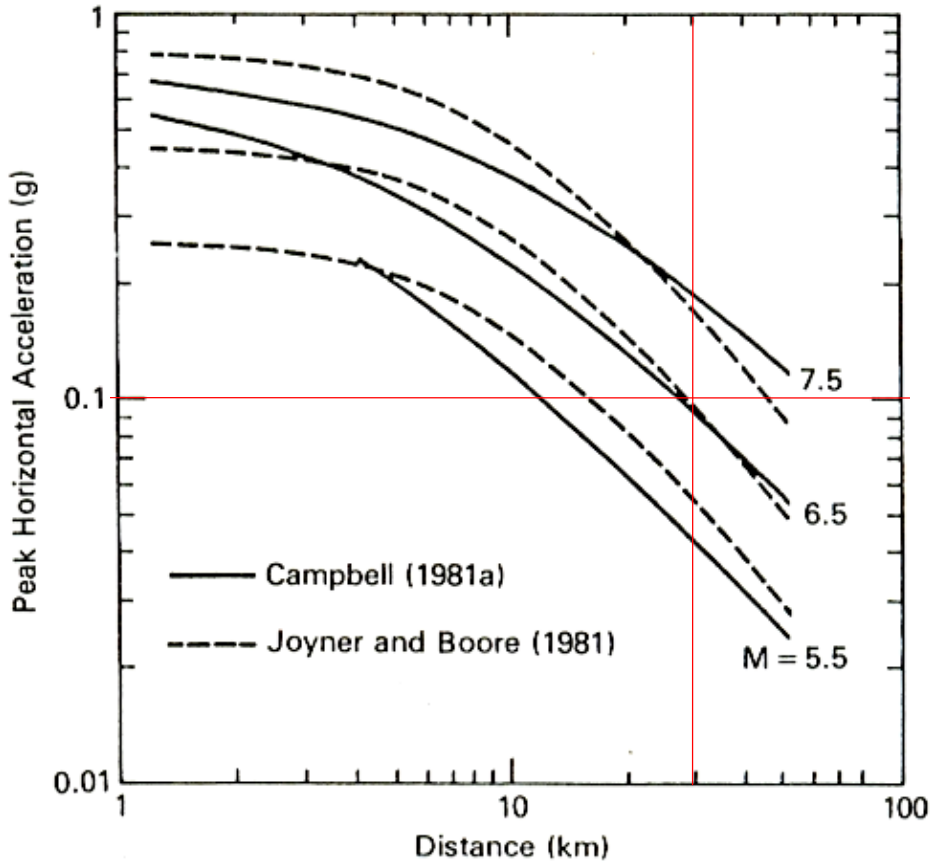


Simplified PSHA

Let's set the PGA level of interest at the site to, say, 0.10 g.

According to the selected attenuation relationship, earthquakes with magnitude greater than 6.6 will produce PGA at the site equal to or greater than 0.10 g.



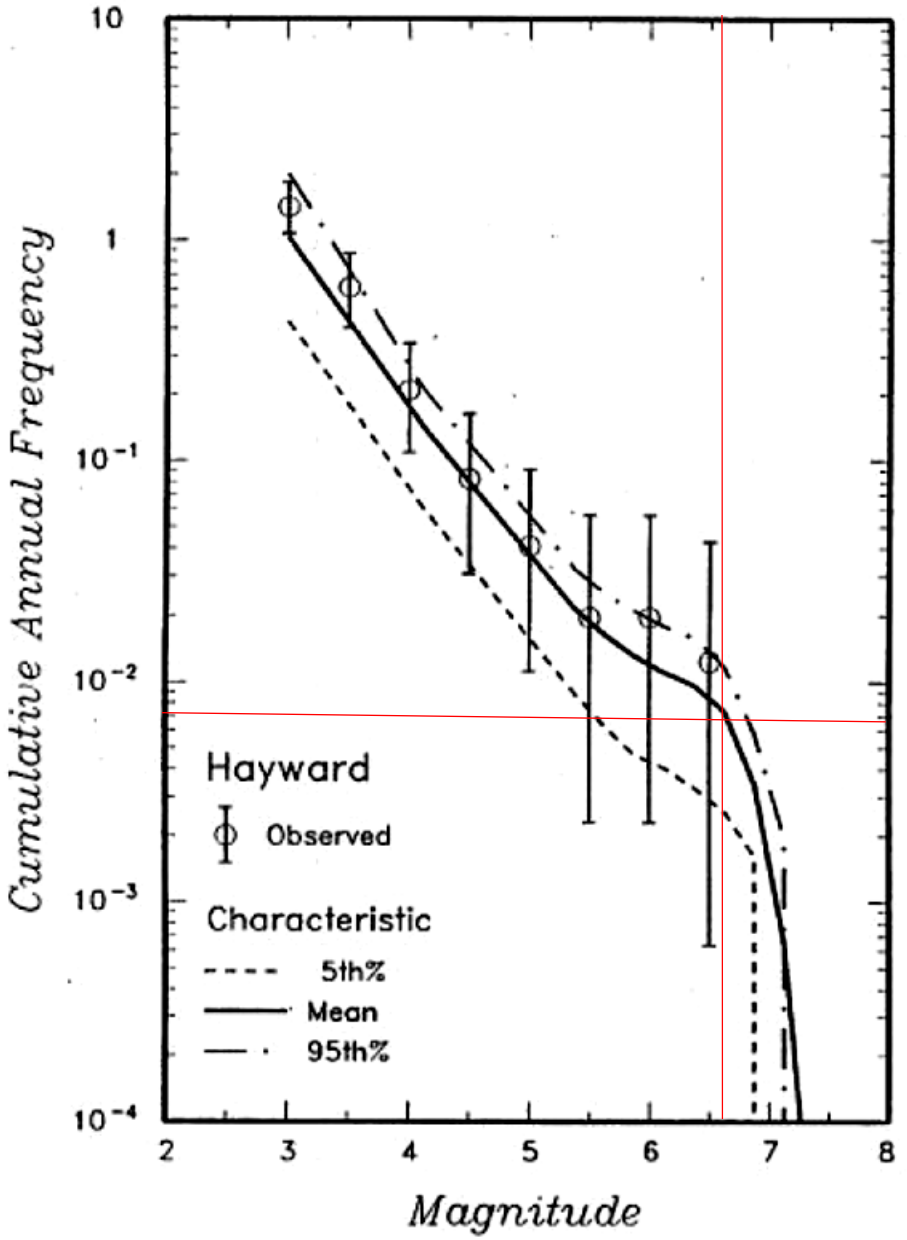


Simplified PSHA

According to the magnitude-recurrence relationship of the source zone A, the annual occurrence rate of earthquakes with M > 6.6 = $N_{(M=6.6)}$ = 0.007 event per year

Hence, the annual occurrence rate of having PGA at the site exceeding 0.10 g = 0.007 (event per year) = annual exceedance rate.

In the other words, the return period for PGA > 0.10 g = 1/0.007 = 143 years.

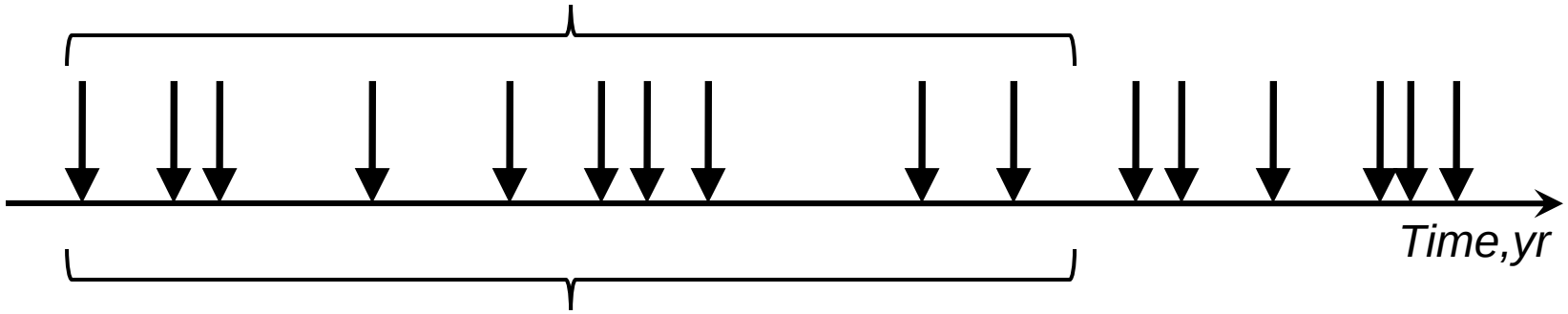


Random Occurrence of Earthquakes in Time:

Poisson Process

Annual exceedance rate = total number of events/time period = 0.007

Annual Frequency of Exceedance



Return Period = time period/total number of events = 143 yr

↓ = *Earthquake Event with PGA > 0.10 g at the site*

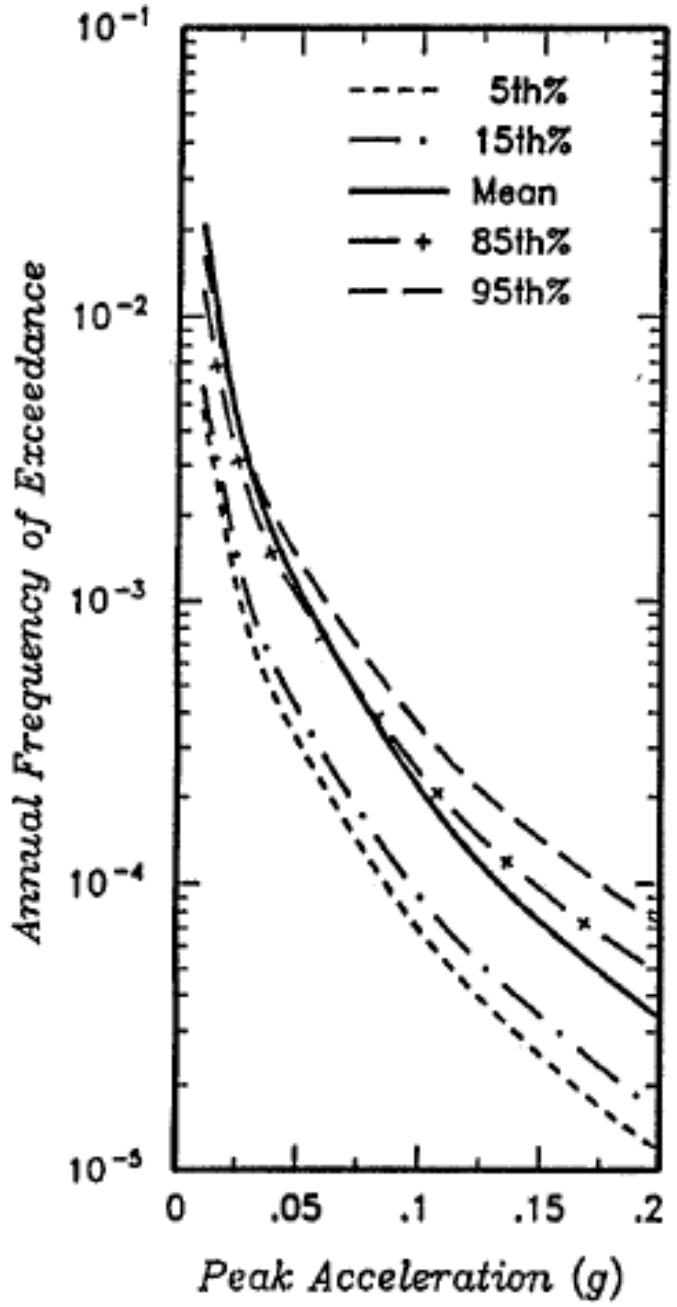
Given a time period of 10 years,
the chance of having such event in this time period
= 0.007 x 10 = 0.07 = 7 %, or
= 10/147 = 0.07 = 7 %

7% PE in 10 Years → **PGA = 0.1 g**

Simplified PSHA

- Repeat the calculation process for many other PGA levels (0.01g, 0.05g, 0.20g, etc.).

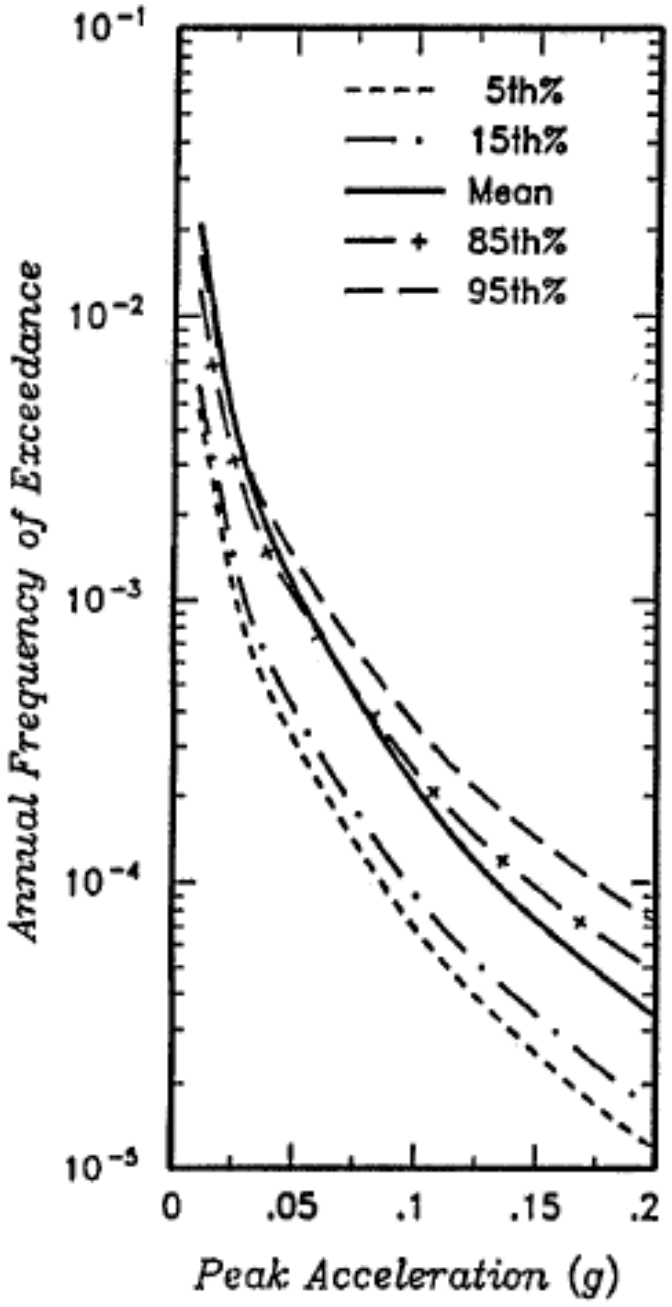
- Draw the relationship between PGA and the corresponding annual exceedance rate.



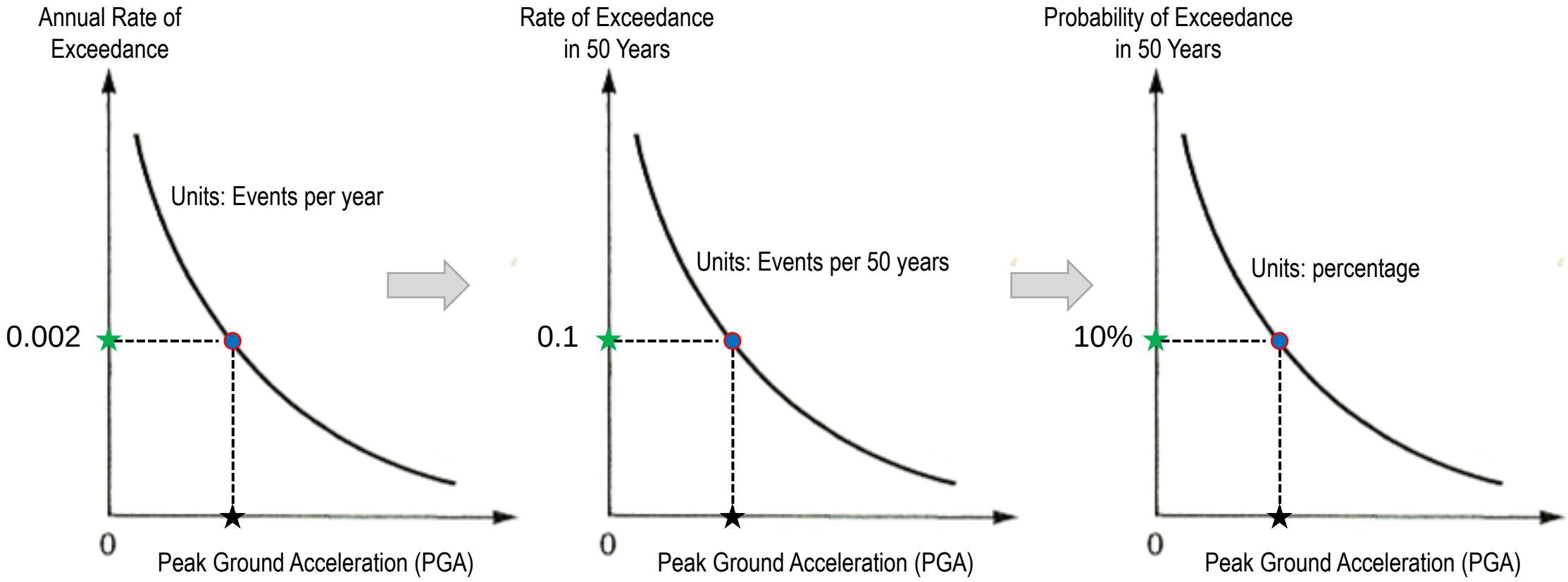
Simplified PSHA

How to read the hazard curve?

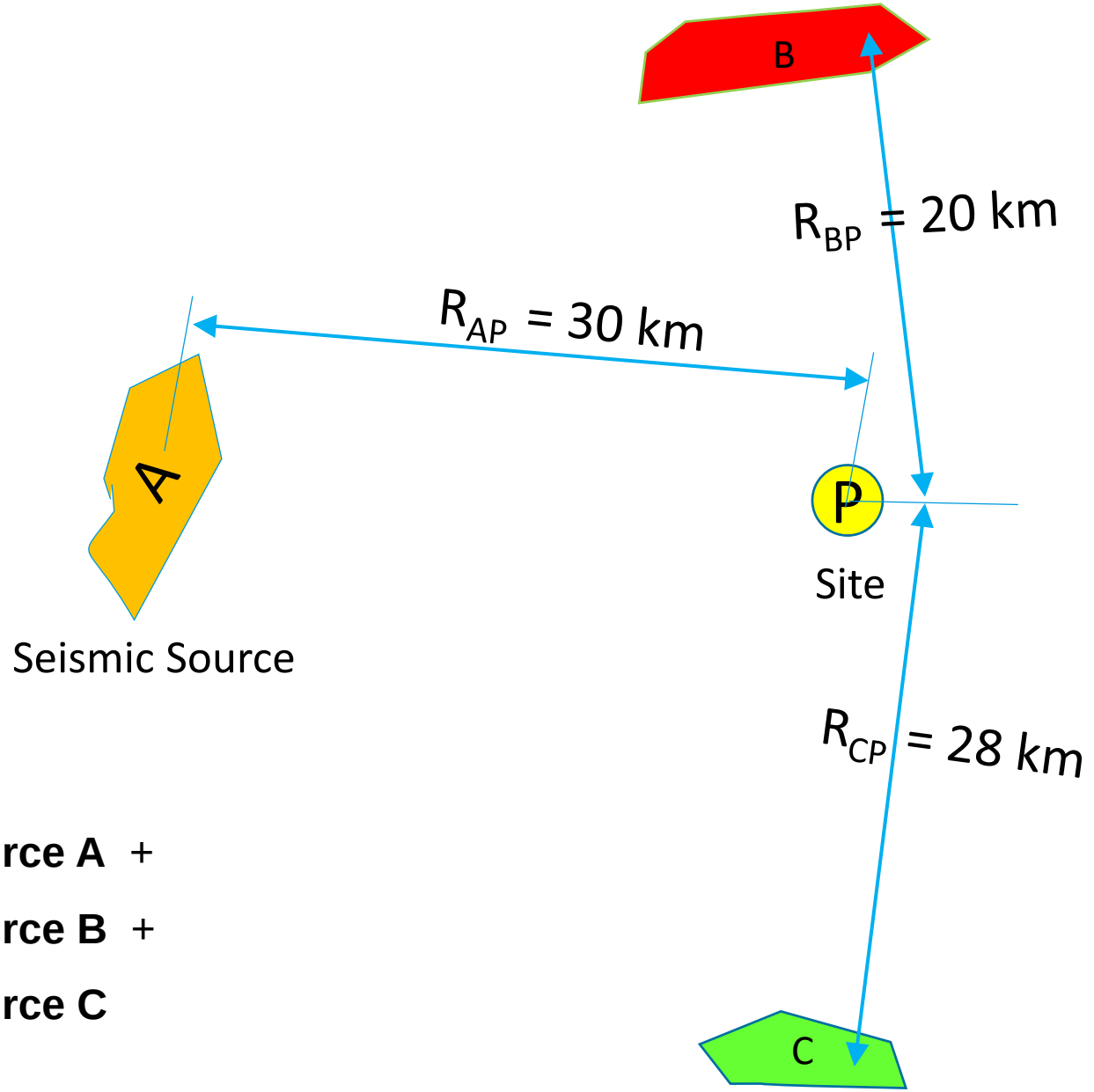
- Determine the PGA level with annual exceedance rate of 0.002.
- This PGA level is equal to, say, 0.22 g.
- The exceedance rate in one year = 0.002. The exceedance rate in a 50-yr period = 0.002x50 = 0.10.
- The chance of exceeding PGA of 0.22g in a 50-yr period = 10%.
- Hence, the PGA level with 10% chance of being exceeded in a 50-yr period is 0.22g.



Different Forms of Hazard Curves



Multiple Sources



Annual exceedance rate at the site P =

Annual exceedance rate caused by EQs in **source A** +

Annual exceedance rate caused by EQs in **source B** +

Annual exceedance rate caused by EQs in **source C**

Thank you for your attention