Determination of the seismicity and peak ground acceleration for Lombok Island: An evaluation on tectonic setting

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INTRODUCTION: TECTONIC OF INDONESIA

- Indonesia is one of the most seismically active parts in the world, due to three tectonic plates collide one to the other, creating seismic events almost every day.
- Lombok Island is located at the west part of Sunda Arc that Indo-Australian plate subducts beneath Eurasian plate.
- Earthquake events around the island were generated by two seismic sources: southern subduction mega-thrust and northern back-arc thrust. These two sources fashioned different types of seismic events. The subduction tends to generate deep; conversely the back-arc thrust tends to generate shallow seismic events.
METHODS:

1. To determine the seismicity of Lombok Island, using equations:

   • Gutenberg-Richter relationship (1949):
     \[
     \log N(M) = a - bM
     \]
   • Likelihood :
     \[
     b = \log e / (M_{ave} - M_0)
     \]
   • Esteva & Villaverde (1973):
     \[
     PGA = 5600 \times \exp(0.6M_s)(R+40)^2 \text{ (cm/sec}^2)\]
   • McGuire (1977):
     \[
     PGA = 472.3 \times 10^{0.278M_s}(R+25)^{-1.301} \text{ (gal)}
     \]
   • Joyner-Boore (1988):
     \[
     PGA = 10^{([0.71 + 0.23(M-6) - \log(r) - 0.0027(r)])} \text{ (g)}
     \]

2. The PGA data obtained from three attenuation models were, therefore, plotted on the geological structure map of Lombok Island to reconstruct the tectonic setting of the Island.
RESULTS:
DISTRIBUTION OF EARTHQUAKES AROUND LOMBOK ISLAND

[Map showing the distribution of earthquakes around Lombok Island, with a legend indicating earthquake events between 1973 to 2017.]
RESULTS:
CONCENTRATION OF EARTHQUAKES AROUND 150 Km of LOMBOK ISLAND

• Earthquake events randomly concentrated on northern part of Lombok Island
• Earthquake events occurred at depths of 33 - 400 Km
• Mostly had a magnitude of >3.0 RS
• The $a$- and $b$-values: 3.62 and -0.53
• The maximum likelihood of $b$-value: -0.66
• Category: medium to high seismic events
• The PGA values are between 0.003g and 0.11g
• The Esteva-Villaverde produced low PGA
• The McGuire PGA: 0.01 - 0.72g
• The Joyner-Boore: 0.003 - 0.28g
• The Joyner-Boore equation may indicate the influence of magnitude, distance, and site characterization that is suitable to Lombok Island.
• The PGA data were then plotted on the map, in which the maximum PGA data are concentrated on the south-east part of the island.
• The tectonic pattern of Lombok Island is developed by the south subduction mega-thrust and north back-arc thrust, as a consequence of the compression between Australian Continental Plate and Eurasian Plate [1].
• The south subduction tends to produce deep earthquakes; whereas the north back-arc thrust tends to produce shallow earthquakes.
• The Benioff zone may develop at depths of 150 km, similar to the called Benioff-Wadati zone.
• The zone may be inclined with an angle of 67° downward north.
RECONSTRUCTION OF TECTONIC SETTING OF LOMBOK ISLAND

- Southern megathrust
- Northern back arc thrust
- Subduction-Benioff
CONCLUSION:
GEOLOGICAL STRUCTURE OF LOMBOK ISLAND

- Lombok Island is categorized into medium to high seismicity.
- The attenuation of Joyner-Boore may represent ground motion of seismic event characteristics of the island, since the deep Benioff mixed with shallow back-arc thrust earthquakes dominantly occurred around the island.
- Based on Harding’s tectonic model: Sinistral strike-slip fault may develop on the crustal basement on the direction of NE – SW caused by main horizontal tectonic forces working on the direction of N 171°E – N 351°E.