Homework Set 5D

1. Assume that the earthquake magnitudes on a fault follow a truncated exponential distribution with a minimum magnitude of 5.0 and a maximum magnitude of 7.0 with a b-value of 1.0. Note: the parameter, α, in the exponential model is given by ln(10) times the b-value. $M_0 = 5$

$M_{max} = 7$

$b = 1 \Rightarrow \beta = 2.3(1) = 2.3$

$A = P[6 < M < 6.5 | M_0 < m < M_{max}] = ?$

If an earthquake greater than 5.0 occurs on the fault, what is the probability that the magnitude of the earthquake is between 6.0 and 6.5? (You can compute this either analytically or numerically)

Eq. 4.11

$$P[6 < M < 6.5] = P[M < 6.5] - P[M < 6] = \frac{\{1 - e^{-\beta(6.5-5)}\} - \{1 - e^{-\beta(6.0-5)}\}}{1 - e^{-\beta(7-5)}} = 0.0691$$

2. Consider a fault that is 70 km long and 12 km wide (down-dip). Assume that the model for the mean characteristic magnitude on this fault is given by

$$M = \log(A) + 4.0$$

fault { 70 km x 12 km down-dip

and that the characteristic magnitude is normally distributed with a standard deviation of 0.2 magnitude units. $\sigma = 0.2$

What is the mean value of the characteristic magnitude? $M_{mean} = \log(70 \times 12) + 4 = 6.92$

What is the probability that the magnitude of the characteristic earthquake is between 6.9 and 7.0? (You can compute this numerically or using standard calls in Mathcad, Matlab or Excel.)

$P[6.9 < m < 7.0]$

$$z_1 = \frac{7 - M}{\sigma} = 0.379$$

$$F(z_1) = 1 - 0.352 = .648$$

$$z_2 = \frac{6.9 - M}{\sigma} = -.121$$

$$f(z_2) = 0.452$$

$P[6.9 < m < 7.0] = 0.648 - .4522 = .1958$

Homework Set 5D

Question 1

1. Assume that the earthquake magnitudes on a fault follow a truncated exponential distribution with a minimum magnitude of 5.0 and a maximum magnitude of 7.0 with a b-value of 1.0. Note: the parameter, α, in the exponential model is given by ln(10) times the b-value.

If an earthquake greater than 5.0 occurs on the fault, what is the probability that the magnitude of the earthquake is between 6.0 and 6.5? (You can compute this either analytically or numerically)

$m_0 := 5$ $\quad\quad$ $m_{max} := 7$

$b := 1.0$ $\quad\quad$ $\beta := 2.303 b$

$$f_M(m) := \frac{\beta \cdot \exp\left[-\beta \cdot \left(m - m_0\right)\right]}{1 - \exp\left[-\beta \cdot \left(m_{max} - m_0\right)\right]}$$

$$CDF := \int_{5}^{m_{max}} f_M(m)\, dm = 1$$

$$CDF := \int_{6}^{6.5} f_M(m)\, dm = 0.069 \qquad \frac{0.069}{1} = 0.069$$

✓

Question 2

2. Consider a fault that is 70 km long and 12 km wide (down-dip). Assume that the model for the mean characteristic magnitude on this fault is given by

$$M = \log(A) + 4.0$$

and that the characteristic magnitude is normally distributed with a standard deviation of 0.2 magnitude units.

What is the mean value of the characteristic magnitude?

What is the probability that the magnitude of the characteristic earthquake is between 6.9 and 7.0? (You can compute this numerically or using standard calls in Mathcad, Matlab or Excel.)

Fault length: 70km

Fault: 12km

So the fault area will be 840 km^2

$$M = \log(A) + 4.0 = \log(840) + 4 = 6.9242$$

$$Z1 = \frac{7 - \mathrm{M}}{s} = 0.379$$

✓

F(Z1)=1-0.352=0.648

$$Z2 = \frac{6.9 - \mathrm{M}}{s} = -0.121$$

F(Z2)=0.4522

$$P(6.9 < M < 7) = 0.648 - 0.4522 = 0.1958$$

This is the probability of the magnitude of earthquake being between 6.9 and 7