Modelling, Analyzing & Interpreting Reliability of the Probability of an Earthquake

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ABSTRACT--- Earlier issue of paper focused on the reliability of probability of the earthquake, in a theoretical manner. This can be further analyzed and calculated in a more practical way through various mathematical models and techniques. This paper targets on calculating the reliability of occurrence of an earthquake by Empirical formula. Repeated readings of an earthquake are taken into consideration in order to formulate a mathematical equation. Precisely, this paper concludes that how reliable is the probability of an earthquake is through a mathematical model.

KEYWORDS--- Empirical, Consistency, Standard Deviation, Variance, Regression

INTRODUCTION

It is important to state that according to the Gutenberg-Richter relation, the probability distribution of the seismic magnitude can be modeled by an exponential distribution. So, identical exponential distributions are mixed by the probability distribution of the correct points. This can be taken into account while calculating and analyzing different mathematical values.

We are taking into consideration the earthquakes from 2005-2017 in India. The magnitude taken into consideration is above 5 i.e, Magnitude >5, are taken. Corresponding energy released from the same is calculated and taken as y values.

The relation betweem the two i.e. magnitude of the earthquake and the energy released can be given as:

Me=2/3 * log10E - 2.9

Therefore, the given table shows the magnitude and the energy released during earthquake from 2005 to 2017.

S. No.	Time	Magnitud e (M_w)	Energy Released (E) {in ergs}
M1	Mar., 2017	5.7	7.94328E+12
M2	Jan., 2016	6.7	2.51189E+14
M3	Oct., 2015	7.7	7.94328E+15
M4	May, 2015	7.3	1.99526E+15
M5	Apr., 2015	7.8	1.12202E+16
M6	May, 2013	5.7	7.94328E+12
M7	Sept., 2011	6.9	5.01187E+14
M8	Aug., 2009	7.5	3.98107E+15
M9	Nov., 2007	5.1	1E+12
M10	Mar., 2006	5.5	3.98107E+12
M11	Feb., 2006	5.3	1.99526E+12
M12	Dec., 2005	5.1	1E+12
M13	Oct., 2005	7.6	5.62341E+15

Table 1: List of Eathquakes in India of Magnitude > 5 from the year 2005 till 2017

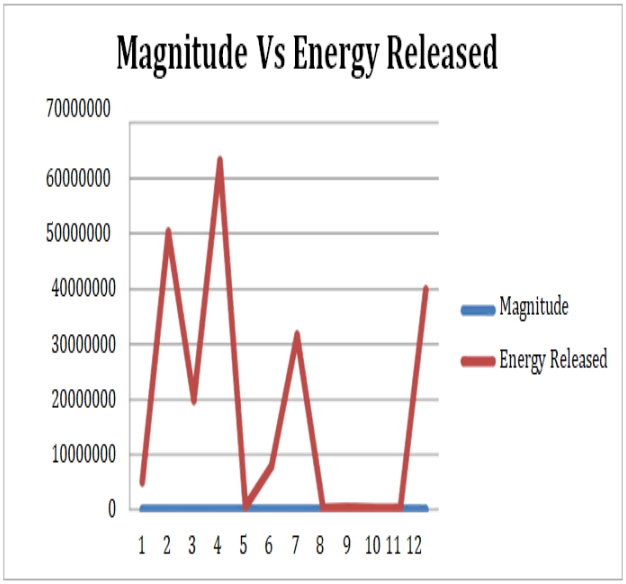

Figure 1: Magnitude Vs Energy Released Graph

FORMULATION OF MATHEMATICAL MODEL

If only Magnitude is taken into consideration, then the following statistical data can be calculated:

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Standard Deviation= σ

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2}$$

where,

μ=Mean
N= No. of events

x_i= individual events
μ= (M1+M2+…M13)/13
=(5.7+6.7+7.7+7.3+7.8+5.7+6.9+7.5+5.1+5.5+5.3+5.1+7.6)/13
=(83.9)/13
=6.45
= $(13.7923/13)^{1/2}$ =1.0721

Variance (var) = $\frac{\Sigma (x_i - \mu)^2}{n-1}$

=13.79/13-1 = 1.14

Skewness = $\frac{\Sigma (x_i - \mu)^3}{(n-1).\ \sigma^3}$

= $\frac{-0.4871}{(13-1).\ (1.0721)^3}$ = -0.0329

But, if we consider both X and Y values, i.e., both magnitude and energy reased simultaneously, the following data could be obtained.

RESULTS & DISCUSSIONS

The equation of the regression line is:

y=-1.51520469158E + 16 + 2.7236715691E + 15. X

The graph of the regression line is:

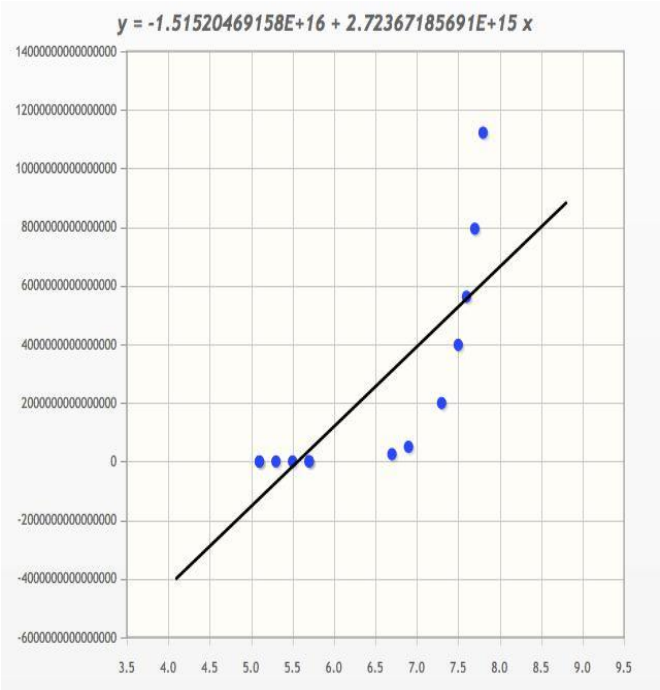

Figure 2: Magnitude Vs Energy Released Regression Line Graph

The corelation coefficient **r** =

$$\frac{n.\ \Sigma XY - \Sigma X.\ \Sigma Y}{[n.\ \Sigma X^2 - (\Sigma X)^2\ ].\ [n.\ \Sigma Y^2 - (\Sigma Y)^2\ ]^{1/2}}$$

= 13* 2.41116535755E + 17 – 83.9 * 31539458890000000

[13*555.27 – 83.9^2]. [13 * 2.40755738383E + 32 - 31539458890000000^2]

=0.7893

Probability can be calculated as:

$t = \frac{r * (N-2)^{1/2}}{(1-r^2)^{1/2}} = \frac{0.7893 * (11)^{1/2}}{(1-0.62299449)^{1/2}} = 4.2634836$

Now, using t-distribution, p would be calculated as 0.00133518.

CONCLUSION

The linear regression line graph (Figure 1) assumes that there is a basis of historically observed data on which to base future predictions. The purpose of thiss paper is to calculate and analyze how uniformly, or consistently, the events are carried out and how reliable their future predictions would be. As the value of r is positive and lose to 1, so the level of strength also reaches to 1 and hence the Reliability reaches to 1.

REFERENCES

1 Preethi G.,Santhi B.; "**Study on Techniques of Earthquake Prediction",** International Journal of Computer Applications (0975 – 8887) Volume 29– No.4, September 2011.

2 Raschke Mathias," **Modeling of magnitude distributions by the generalized truncated exponential distribution**", submitted minor revision.

3 "**Evaluation of Earthquake Predictions",** Recommendations to the USGS Earthquake Hazards Program from the National Earthquake Prediction Evaluation Council (NEPEC), September 2016.

4 David Vere-Jones**, "Forecasting earthquakes and earthquake risk",** International Journal of Forecasting 11 (1995) 503-538.

5 Da-Gang Lu, Peng-Yan Song, Xiao-Hui Yu and Guang-Yuan Wang, "**Global seismic reliability analysis of building structures based on system-level limit states** ", The 14th World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China.

6 Ishibashi Katsuhiko, "**Two categories of earthquake precursors, physical and tectonic, and their roles in intermediate-term earthquake prediction",** Springer, June 1988, Volume 126, Issue 2–4, pp 687–700.