Original Article

Published: 07 July 2020

Retrospective and forward prediction of next strong earthquakes in oceanic ridges and trenches using probabilistic models

Olaide S. Hammed, Theophilus A. Adagunodo, Tokunbo S. Fagbemigun, Joel O. Amosun, Musa O. Awoyemi & Faith O. Sapele

Journal of Seismology (2020)Cite this article

Abstract

Earthquake occurrence and recurrence depend on number of factors beyond mere observations. These include seismotectonic nature of the region, spreading rate of the ridge or subduction of plates causing the trench, active or otherwise nature of the fault on crust (on land), stress-strain regime, and so on. In this work, the recurrence and expected times of next strong earthquakes ($M \geq 6$) in the oceanic ridges and trenches were computed using gamma and lognormal probabilistic models. Summing the occurrence times of last strong earthquakes and these recurrence times, expected times of the next strong earthquakes were retrospectively and forwardly predicted. The expected times of the next strong earthquakes retrospectively predicted correlated with the recorded strong earthquakes in the earthquake catalog of the Advance National Seismic System (ANSS) hosted by the Northern California Earthquake Data Centre, USA, for the period of 1978–2017 in a readable format. The successful prediction of the expected times of the next strong earthquakes retrospectively is an indication that the expected times of the next strong earthquakes forwardly predicted in the regions of study will be positive. However, since the occurrence and recurrence of earthquakes depend on many factors, it is therefore important to note that it may not always be accurate to predict future earthquakes from retrospective perspective. Nonetheless, this work is a good effort, and it has thrown up some interesting results.

References

Adagunodo TA, Oyeyemi KD, Hammed OS, Bansal AR, Omidiora JO, Pararas-Carayannis G (2018) Seismicity anomalies of M 5.0 + earthquakes in Chile during 1965–2015. Sci Tsunami Hazards 37(2):130–156 http://www.tsunamisociety.org/STHVol37N2Y2018.pdf

Google Scholar

Chen C-H, Wang J-P, Wu Y-M, Chan C-H, Chang C-H (2012) A study of earthquake inter-occurrence times distribution models in Taiwan. Nat Hazards 69:1335–1350. https://doi.org/10.1007/s11069-012-0496-7

Article

Google Scholar

Cluff LS, Patwardhan AS, Coppersmith KJ (1980) Estimating the probability of occurrence of surface faulting earthquakes on the Wasatch fault zone, Utah. Bull Seismol Soc Am 70:463–478

Google Scholar

Cornell CA (1968) Engineering seismic risk analysis. Bull Seismol Soc Am 58:1583–1160

Google Scholar

Devi A, Kalita S (2013) Return period analysis of earthquakes of northeast India and its adjoining region. Int J Eng Sci Invent 2(7):15–28 ISSN (online) 2319–6734, ISSN (print) 2319–6726

Google Scholar

Ferráes SG (2005) A probabilistic prediction of the next strong earthquake in the Acapulco-San Marcos segment, Mexico. Geofis Int 44(4):347–353

Google Scholar

Hagiwara Y (1974) Probability of earthquake occurrence as obtained from a Weibull distribution analysis of crustal strain. Tectonophysics 23:313–318

Article

Google Scholar

Hammed OS, Popoola OI, Adetoyinbo AA, Awoyemi MO, Badmus GO, Ohwo OB (2013) Focal depth, magnitude, and frequency distribution of earthquakes along oceanic trenches. Earthq Sci 26:75–82

Article

Google Scholar

Hammed OS, Adagunodo TA, Awoyemi MO, Arogundade AB, Ajama OD, Sapele FO, Usikalu MR, Olanrewaju AM, Akinwumi SA, Ogunwale EI (2019) Identification of tsunamigenic earthquake zones in oceanic ridges and trenches. Sci Tsunami Hazards 38(2):103–117 http://tsunamisociety.org/STHVol38N2Y2019.pdf

Google Scholar

Isacks B, Oliver J, Sykes LR (1968) Seismology and the new global tectonics. J Geophys Res 73:5855–5899

Article

Google Scholar

Jacoby WR (January 1981) Modern concepts of earth dynamics anticipated by Alfred Wegener in 1912. Geology 9:25–27. https://doi.org/10.1130/00917613(1981)9<25:MCOEDA>

Article

Google Scholar

Knopoff L, Kagan Y (1977) Analysis of the theory of extremes as applied to earthquake problems. J Geophys Res 82:5647–5657

Article

Google Scholar

Ladd JW, Holcombe TL, Westbrook GK, Edgar NT (1990) Caribbean marine geology: active margins of the plate boundary. In: Dengo G, Case J (eds) The geology of North America: the Caribbean region, vol H. Geological Society of America, Boulder, pp 261–290

Google Scholar

LePichon X, Francheteau J, Bonnin J (1973) Plate tectonics. Elsevier, Amsterdam

Google Scholar

Marjorie W (1993) Igneous petrogenesis. Chapman & Hall, London ISBN 9780412533105

Google Scholar

Matias LM, Cunha T, Annunziato A, Baptista MA, Carrilho F (2013) Tsunamigenic earthquakes in the Gulf of Cadiz: fault model and recurrence. Nat Hazards Earth Syst Sci 13:1–13

Article

Google Scholar

McNally KB, Minster JB (1981) Non-uniform seismic slip rates along the Middle American Trench. J Geophys Res 86:4949–4959

Article

Google Scholar

Mishra OP, Zhao D, Umino N, Hasegawa A (2003) Tomography of northeast Japan forearc and its implications for interpolate seismic coupling. Geophys Res Lett 30(16):1850. https://doi.org/10.1029/2003GL017736

Article

Google Scholar

Morgan WJ (1972) Plate motions and deep mantle convection. Geol Soc Am Mem 132:7

Google Scholar

Nishenko SP, Buland R (1987) A generic recurrence interval distribution for earthquake forecasting. Bull Seismol Soc Am 77:1382–1399

Google Scholar

Papadakis G Vallianatos F, Michas G (2013). The earthquake inter - event time distribution along the hellenic subduction zone. Bulletin of the Geological Society of Greece, vol. XLVII. Proceedings of the 13th International Congress, Chania, Sept. 2013

Pararas-Carayannis G (2007) The earthquake and tsunami of 2 September 1992 in Nicaragua. Archived from the original on 17 May 2008. Retrieved 2008-06-09

Pararas-Carayannis G (2011) The earthquake and tsunami of July 21, 365 AD in the Eastern Mediterranean Sea - review of impact on the ancient world - assessment of recurrence and future impact. 30(4):286

Parvez IA, Ram A (1997) Probabilistic assessment of earthquake hazards in the Northeast India peninsula and Hindukush regions. Pure Appl Geophys 149:731–746

Article

Google Scholar

Parvez IA, Ram A (1999) Probabilistic assessment of earthquake hazards in the Indian subcontinent. Pure Appl Geophys 154:23–40

Article

Google Scholar

Rikitake T (1976) Recurrence of great earthquakes at subduction zones. Tectonophysics 35:305–362

Article

Google Scholar

Sil A, Sitharam TG, Syed TH (2015) Probabilistic models for forecasting earthquakes in the northeast region of India. Bull Seismol Soc Am 105(6):2910–2927. https://doi.org/10.1785/0120140361

Article

Google Scholar

Smith WHF, Sandwell DT (1997) Global sea floor topography from satellite altimetry andship depth soundings. Science 277(5334):1956–1962

Article

Google Scholar

Stern RJ (2002) Subduction zones. Rev Geophys 40(4):1012. https://doi.org/10.1029/2001RG000108

Article

Google Scholar

Tsuboi S (2000) Application of Mwp to tsunami earthquake. Geophys Res Lett. American Geophysical Union. 27(19). Bibcode:2000GeoRL.27.3105T. doi: https://doi.org/10.1029/2000GL011735. Retrieved 19 July 2011

Utsu T (1984) Estimation of parameters for recurrence models of earthquakes. Bull Earthq Res Inst, Univ Tokyo 59:53–66

Google Scholar

Yadav RBS, Tripathi JN, Rastogi BK, Das MC, Chopra S (2010) Probabilistic assessment of earthquake recurrence in Northeast India and adjoining regions. Pure Appl Geophys 167(11):1331–1342. https://doi.org/10.1007/s00024-010-0105-1

Article

Google Scholar

Zafarani H, Ghafoori MM (2013) Probabilistic assessment of strong earthquake recurrence in the Iranian plateau. J Earthq Eng 17(3):449–467

Article

Google Scholar

Acknowledgments

We sincerely acknowledge the professional contributions of the handling editor and the reviewers of this article.

Author information

Affiliations

Department of Physics, Federal University Oye-Ekiti, Oye-Ekiti, Nigeria

Olaide S. Hammed & Faith O. Sapele

Department of Physics, Covenant University, Ota, Nigeria

Theophilus A. Adagunodo

Department of Geophysics, Federal University Oye-Ekiti, Oye-Ekiti, Nigeria

Tokunbo S. Fagbemigun & Joel O. Amosun

Department of Physics, Obafemi Awolowo University, Ile-Ife, Nigeria

Musa O. Awoyemi

Corresponding author

Correspondence to Theophilus A. Adagunodo.

Additional information

Publisher’s note

Hammed, O.S., Adagunodo, T.A., Fagbemigun, T.S. et al. Retrospective and forward prediction of next strong earthquakes in oceanic ridges and trenches using probabilistic models. J Seismol (2020). https://doi.org/10.1007/s10950-020-09938-z

Received18 November 2019

Accepted21 June 2020

Published07 July 2020

DOIhttps://doi.org/10.1007/s10950-020-09938-z

Keywords

Recurrence times

Expected times

Gamma model

Lognormal model

Oceanic ridges

Oceanic trenches