AN ARTIFICIAL NEURAL NETWORK TO PREDICT EARTHQUAKE IN SOME PARTS OF HORMOZGAN PROVINCE

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In this paper a new earthquake prediction system is presented. This method based on the application of artificial neural networks (Adeli and Panakkat, 2009), has been used to predict earthquakes in three regions (Bandar Abbas zone, Minab zone, Hajiabad zone) in Hormozgan Province. For the three Hormozgan Province's seismic regions examined, with epicenters placed on meshes with dimensions $0.5^{\circ} \times 0.5^{\circ}$ (Kavei, 2008). Although several works claim to provide earthquake prediction, an earthquake prediction must provide, according to (Allen, 1982), the following information:

1. A specific location or area.
2. A specific span of time.
3. A specific magnitude range.
4. A specific probability of occurrence.

That is, an earthquake prediction should state when, where, how big, and how probable the predicted event is and why the prediction is made (Dimer de Oliveira, 2012) and (Marzocchi and Zechar, 2011). Unfortunately, no general useful method to predict earthquakes has been found yet. This study exposes the results obtained when the proposed ANN's were applied to the sets representing the three seismicity Hormozgan Provinces. These sets can be downloaded from the Site of University of Tehran (IRSC, 2007). First, the type of predictions performed by the ANN is introduced. Then, the results for every area are summarized in terms of the quality parameters described in full paper. The prototypes predict an earthquake every time the probability of an earthquake of magnitude larger than a threshold is sufficiently high. The threshold values have been adjusted with the aim of obtaining as few false positives as possible. The accuracy of the method has been assessed in retrospective experiments by means of statistical tests and compared with well-known machine learning classifiers. The high success rate achieved supports the suitability of applying soft computing in this field and poses new challenges to be addressed. Tables 1 and 2 show training values and ANN's performance for two zones in Hormozgan Province. For Bandar Abbas zone, the training set contained the 105 linearly independent vectors occurred from May 20th 2002 to June 30th 2004. Analogously, the test set included the vectors generated from July 1st 2004 to August 20th 2005 (Table 1). For Minab zone, the training set contained the 89 linearly independent vectors occurred from September 20th 1999 to November 30th 2003. Analogously, the test set included the vectors generated from December 1st 2003 to August 20th 2004 (Table 2). In this study the high values of P_0 and P_1 obtained for all the zones indicate that the input variables were, indeed, strongly correlated with the observed magnitude in a near future. The ANN's were capable of indirectly learning Omori/Utsu and Gutenberg-Richter's laws, confirming thus the great ability these techniques have in the seismology field (Reyes and Cardenas, 2010). This fact confirms that the choice of such input vectors was adequate. With reference to the specificity, all the zones obtained values especially high. This fact is of the utmost significance, as it is extremely important not to active false alarm in seismology due to the social impact they may cause.

Table 1. Training values and ANN's performance for Bandar Abbas zone

Parameters	Value	ANN
TP	14	5
TN	69	24
FP	7	15
FN	29	7
P_0	70.4%	77.4%
P_1	66.6%	25.0%
S_n	32.5%	41.6%
S_p	14.5%	61.5%
Average	46.0%	51.4%

Table 2. Training values and ANN's performance for Minab zone

Parameters	Value	ANN
TP	15	18
TN	75	89
FP	6	4
FN	32	21
P0	70.0%	80.0%
P1	71.2%	82.0%
Sn	32.0%	46.2%
Sp	92.5%	95.7%
Average	66.5%	75.9%

REFERENCES

Adeli H and Panakkat A (2009) A probabilistic neural network for earthquake magnitude prediction, Neural Networks 22, 1018-1024

Allen CR (1982) Responsibilities in earthquake prediction, Bulletin of the Seismological Society of America, 662069-2074

Dimer de Oliveira F (2012) Can we trust earthquake cluster detection tests? Geophysical Research Letters, 39, L17305

IRSC (2007) Iranian Seismological Center, Institute of Geophysics, University of Tehran, Iran, http://www.irsc.ut.ac.ir

Kavei M (2008) Investigations on seismotectonics of parts of Hormozgan Province in southern Iran, Ph.D. Thesis, Pune University, Pune, India

Marzocchi W and Zechar JD (2011) Earthquake forecasting and earthquake prediction: different approaches for obtaining the best model, Seismological Research Letters 82(3): 442-448