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<h1 dir="RTL" style="text-align: justify;"><strong>&nbsp Earthquake risk assessment using integrated artificial neural network and machine learning with analytic hierarchy process(case study: Khuzestan province, Iran)</strong></h1>

<p> From the beginning of human life on Earth, natural disasters have always been a threat to human life. Every year, earthquakes take the lives of many people around the world and cause devastating changes in the environment. Since earthquake prevention is impossible, it is important to consider immunization and pre-crisis management methods. In previous research to assess the risk of earthquakes, most methods based on artificial intelligence have been used independently. In this research, it is tried to use methods based on artificial intelligence in conjunction with expert knowledge. For this purpose, a combined method based on artificial neural network(ANN) and hierarchical analysis (AHP) has been proposed to prepare an earthquake risk assessment of Khuzestan province of Iran. The neural network model was used probability mapping of earthquake and the hierarchical analysis method was used to map the vulnerability. Then the output of these two methods were combined to obtain an estimate of the earthquake earthquake risk assessment. 393 training data were used to train the neural network and calculate the network parameters. Due to the lack of training data and to prevent over-fitting of the model, three techniques have been used. In the first technique, doup out at rate of 0.2 was performed, in the second technique, the l2 regularization method with a value of 0.001 was used, and in the third technique, the k-fold cross validation method with eight folds was used. To produce a map of earthquake vulnerability using hierarchical analysis method, the criteria were selected through the study of past literature and selected the criteria of infrastructure density, building density, population density, access to water resources, access to hospitals and Access to fire stations. In the hierarchical analysis process, after determining the criteria, the criteria are placed in the row and column of the pairwise comparison matrix and are compared in pairs, and the elements of the pairwise comparison matrix are filled based on expert opinions. Then the weight of the layers is obtained using the eigen-vector method. After calculating the weight by the special vector eigen-vector method, the degree of compatibility of the pairwise comparison matrix is determined and if the pairwise comparison matrix is compatible, the weights obtained by the eigen-vector method are confirmed. Various methods have been proposed to integrate information layers in GIS. Some of these methods are optimistic and some are pessimistic. Pessimistic methods are usually more severe. In this research, the strict method of layer multiplication has been used. In addition, earthquake probability mapping is calculated using four methods of machine learning support vector regression, random forest, decision tree and k nearest neighbor. These models are a spatial analysis based on a spatial information system that is useful for the city scale. The results obtained from this study show that the neural network model with a root mean error of 0.35 squared has better accuracy compared to machine learning methods. Considering the influential factors in earthquake risk assessment, urban areas of &nbsp;Khuzestan province can have several earthquake risk patterns. The findings also show that geological factors have the greatest impact on measuring the probability mapping of earthquake, while social factors such as population density have the largest share in assessing the vulnerability of Khuzestan province.</p>

<p style="text-align: center;"><strong><span dir="LTR" style='font-family:"Times-Bold",serif;'>AKS4</span><span dir="LTR" style='font-family:"Times-Bold",serif;'>&nbsp;</span></strong></p>

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