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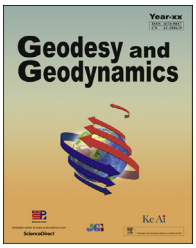

Study of modern seismic zoning maps' accuracy (case for Eastern Uzbekistan)

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ABSTRACT

Influence of uncertainty factors of input parameters on results of the estimation of seismic hazard has been researched. It is found that the largest deviations, from seismic hazard maps designed on the basis of average values of distribution of seismic mode and seismic load parameters, may arise due to the imprecise depth of earthquake sources (H), uncertain estimations of seismic potential (M_{max}) and slope of recurrence curve (γ). The contribution of such uncertainty factors, like imprecise definition of seismic activity A_{10}, incorrect choice of prevailing type of a motion in the source, using regional laws of attenuation of seismic load intensity in distance instead of local once are substantially small. For Eastern Uzbekistan, it was designed the seismic hazard map with the highest value which takes into account every possible factors of uncertainty in parameters of seismic mode and seismic load.

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1. Introduction

Historically and currently in Uzbekistan and neighboring areas, there are many earthquakes with magnitude $M \geq 7$ and intensity at source $I_0 = 9–10$ points. Therefore, seismic hazard is a crucial issue for Uzbekistan.

In modern scientific and practical views, seismic hazard is reflected as probability that seismic effect will not exceed estimated intensity of all possible earthquakes in a given area within a given time interval. Seismic hazard calculations are based on two interconnected models of seismic process: models of seismic sources and model of seismic load from the chosen set of sources. Reliability and accuracy of seismic

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zoning maps is defined, on one hand, by degree of adequacy of these models to real seismotectonic conditions, on the other hand, by accuracy of the input parameters used at their design.

Simulation errors of the first model can be related to a number of assumptions which we have to accept for simplification of mathematical implementation (stationarity of seismic process, linearity of recurrence curves, etc.) as well to incompleted and imperfect initial seismological and seismotectonic data used in calculations. All these lead to discrepancies in identification of geographical location of potentially hazard zones, and insufficient reliability in estimation of seismic potential (M_{max}) and parameters of various power level earthquake recurrence (A_{10} and γ).

Moreover, considerable uncertainties are related to description of seismic load models depending on source depth, type of motion, features of seismic load intensity attenuation by distance that can vary significantly in certain region.

Answer to questions how variable is each input parameter used in seismic hazard calculation and how this variability contributes to a final result, defines reliability of drawn seismic zoning maps, as well provides opportunity to obtain reasonable estimations of seismic hazard in the most hazardous case of seismic process development that is, in our opinion, extremely important for critical infrastructures under high responsibility category.

The purpose of this article is to consider the numerical studies results about influence of various uncertainty factor parameters of seismic process and seismic load on final estimations of seismic hazard.

2. Data and research methodology

For quantitative research of influence of each factor's uncertainty on a final seismic hazard estimation, we chose the area of Eastern Uzbekistan which has been examined widely in seismotectonic and seismology [1,2]. There is enough base to believe that for the Southern and particularly Western Uzbekistan errors' spread range of input data and consequently quantitative characteristics of seismic hazard will be rather wide.

The Eastern Uzbekistan is part of Middle Tianshan Mountain which is exposed to deforming influence of consolidated crustal blocks in various geological periods: there are the Central Kazakhstan shield and Turan plate in the north and the west, Tarim is in the east and the ancient Precambrian Indian platform is in the south. Earthquakes occurring in research region are caused by interaction and deformation of different scaled crustal blocks and are directly related to lithosphere dynamics of whole Pamir-Alay and Tianshan Mountain.

Fig. 1 is the historical map of sensible and strong earthquakes ($M \geq 4.3$) in Eastern Uzbekistan. On this map, active crustal faults and seismogenerating zones [1] are presented.

Calculation of seismic hazard of Eastern Uzbekistan was made in two stages. At the first stage, the shake frequency B_I with given value of macroseismic intensity I was calculated for each point of study area. This calculation is based on following integral:

$$B_I = \int_v N_\Sigma dv,$$

where N_Σ is related to unit of time and volume of the expected number of earthquakes which sources are located in elementary volumes dv, capable to cause shakes with intensity not less I points in observation place.

At the second stage, isolines of design intensity $I = 5–9$ points with average recurrence once in $T = 500$, $T = 1000$, $T = 2500$ and $T = 5000$ years are assigned. These zones are areas in which probability is not exceeding seismic load in time interval $\tau = 50$ years, are $P = 0.9$, $P = 0.95$, $P = 0.98$ and $P = 0.99$ respectively.

For further comparisons, we chose two variants of seismic zoning maps with intensity assessment of seismic load from the viewpoint of macroseismic intensity scale MSK-64 for

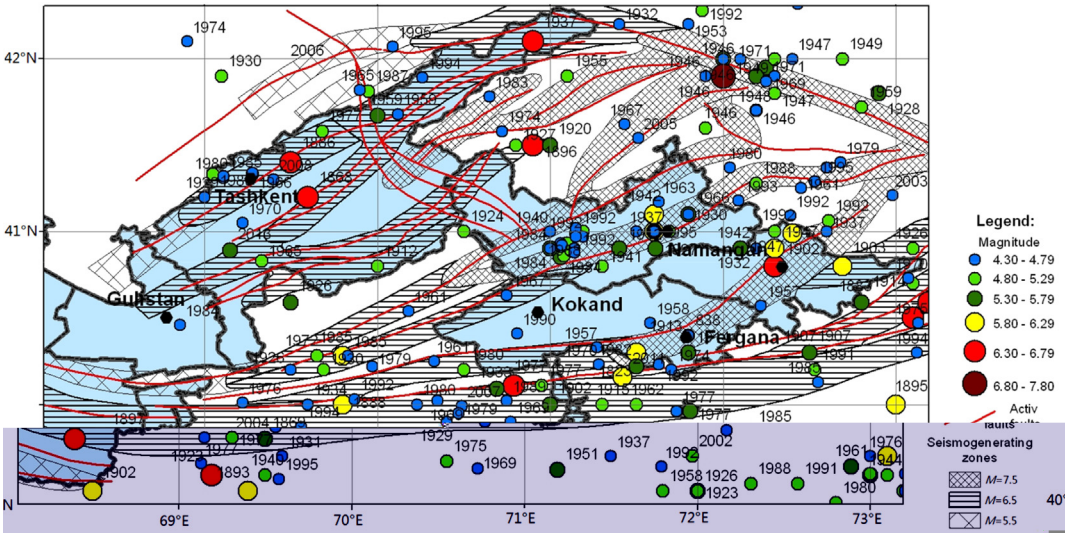

Fig. 1 – Historical map of sensible and strong ($M \geq 4.3$) earthquakes' sources of Eastern Uzbekistan.