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Microzonation of Johannesburg: Impact of uncertainties associated with earthquake catalogue on seismic hazard assessment

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Seismic hazard assessment requires calculation of recurrence parameters such as the *b*-value and activity rate using the earthquake catalogue [1]. It has been observed that these parameters are sensitive to uncertainties associated with such catalogues. Uncertainties are usually introduced by errors in earthquake magnitude [2] and location as well as completeness levels of the catalogue. Other processes conducted whilst preparing catalogues inadvertently introduce more errors. These include the homogenisation and declustering processes. Therefore it is necessary that such errors be assessed and their impact on recurrence parameters, thus seismic hazard, be investigated and accounted for. In compiling the earthquake catalogue used in the microzonation of Johannesburg, an effort was made to incorporate uncertainties introduced as indicated above. It is clear that large errors in earthquake locations contribute massively to the identification and characterisation of earthquake sources, especially fault sources. The sparsity of the South African National Seismograph Network (SANSN) resulted in such large errors (about 10km). As a result it was not possible to conclusively identify active faults that could be used as linear sources in the hazard assessment. Instead area source zones were created using the seismicity locations and tectonic information.

In this study, a three-step approach was implemented to quantify the uncertainties of the recurrence parameters estimated using the Gutenberg−Richter (GR) relations of seismic area source zones in logic tree-driven probabilistic seismic-hazard analysis. This first involved the assessment of completeness levels of the areas source zones which were then used to create sub-catalogues that were subsequently used to estimate the parameters. These obtained alternative parameters were all used in the PSHA through a logic tree technique. The uncertainty associated with the declustering of the catalogue was also assessed. This uncertainty mainly exists because there are several methods one can use to decluster the catalogue, all of which can lead to the production of two or more different versions of catalogues. The different versions of the catalogues can yield different results when calculating recurrence parameters. In this study an effort was made to decluster the catalogue using the window methods with [3] parameters and cluster methods with [4] parameters. However, an assessment of the results showed that some of the techniques resulted in too drastic a change where events that are not dependent events were removed. Consequently, only the cluster method from 'CLUSTER' code on SeisAn was used producing only one version of the catalogue.

References:

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