MINISTRY OF MINES AND ENERGY

TERMS OF REFERENCE FOR EXPRESSION OF INTEREST

DISCRIMINATION OF NATURAL SEISMICITY AND MINE BLASTING IN ERONGO REGION

Contents

1. NTRODUCTION.

The Geological Survey of Namibia runs an ongoing expansion project of Namibia's National Seismological Network with the aim of improving the national seismic network coverage. The Geophysics Division under the Geological Survey of Namibia operates and manages the National Seismological Network of Namibia. Currently, the network consists of ten (10) permanent seismic stations. The seismic data is recorded and transmitted in real time from the regional seismic stations to a centralised server, at MME headquarters. Thereafter, the data is analysed and processed daily. The main objective of the seismological network is to record and monitor seismic occurrences countywide and regionally to identify areas that are prone and vulnerable to earthquake activities for hazard mitigation and civil scientific applications.

The seismic data recorded aids in improving the understanding of the earth subsurface for land-use planning, earthquake preparedness and response and decision-making. Subsequently facilitating future research works in the field of seismology in Namibia. Following public outcry and the frequent occurrence of seismic events in the country, the GSN plans to continuously deploys temporary seismic stations around the to discriminate natural and anthropogenic events. Moreover, the Erongo region hosts most of the mines in the country and it is imperative to acquire seismic data in the region that will subsequently enable the discrimination of induced from natural events. The data acquisition will run for a period of 12 months. The data will be downloaded every two months, which will result in a huge accumulation of dataset. Due to the high volume of seismic data to be recorded in such projects, machine learning in seismic processing is required to speed up the data processing and come up with conclusive results from the analysed seismic dataset. Additionally, the successful processing and interpretation of the seismic data will assist in the completeness of the seismic catalogue that is required in creating products such as hazard maps, velocity models and tomography which are valuable tools for seismic risk assessment and for hazard recurrence estimates.

2. SCOPE OF WORK.

The primary objective of this project is to conduct a seismic risk hazard assessment using data acquired from a seismic temporary network to establish a seismic profile of the Erongo region. Following public outcry and frequent seismic occurrences of seismic events in the country, the GSN has deployed ten temporary seismic stations around Erongo region to discriminate natural and anthropogenic events. Moreover,

the Erongo region hosts most of the country's active mines and it is imperative to acquire seismic data in the region that will subsequently enable the discrimination of induced seismic events from natural events. The work is expected to be completed on or before the 31st of December 2024. The specific tasks to be undertaken are outlined in the subsection of this item from section 3.1 through 3.10.

The work to be undertaken may be summarised as follows:

2.1 Process and analyse micro earthquakes acquired from the temporary deployment in Erongo Region.

- Data cleaning (removal of noise and artifacts).
- Preparation of station0.hyp.
- P-wave and S-wave Arrival Time Picking.
- Hypocentre location of earthquakes.
- Determination of local magnitude.

2.2 Analysis of seismic catalogue parameters.

- Selection of a comprehensive catalogue.
- Spatial distribution analysis.
- Frequency magnitude analysis.
- Gutenberg-Richter law fitting for determination of a- values and b-values.
- Determination of maximum expected magnitude (Mmax) for the area).
- Determination of magnitude of completeness (Mmin) for the area).
- Selection of a comprehensive catalogue.
- Spatial distribution analysis.
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2.3 Creation of the Velocity models (1D and 3D models).

- Selection of high accuracy dataset.
- Relocation of the selected dataset.
- Construction of a preliminary velocity model.
- Refinement of the constructed velocity model.
- Determination of the accuracy of the velocity model Uncertainty analysis.

2.4 Focal mechanism correlated with the fault systems where applicable.

- Selection of the earthquake with good azimuthal coverage.
- Picking of polarities on events with clear first motion.
- Computation of focal mechanisms.
- Comparison and validation.
- Verification of the focal mechanism solutions.

2.5 Verification of the focal mechanism solutions.

- Selection of waveforms with good signal to noise ratio.
- Moment tensor inversion of applicable events.
- Preprocessing of seismograms.
- Computation of moment tensor inversion.
- Verification of the moment tensor solutions.

2.6 Development of ground motion prediction equations (GMPE).

- Selection of a comprehensive ground motion recordings.
- Selection and processing of seismograms with good signal to noise ratio.
- Selection of appropriate functional models.
- Estimation of model parameters.
- Validation of the GMPE model.
- Analysis of uncertainties of the developed model.

2.7 Seismic Hazard mapping for seismic risk assessment.

- Compilation of a seismic catalogue for the area from previous earthquakes and available data.
- Preparation of a seismotectonic model for the area.
- Determination of the seismic sources.
- Computing seismic parameters for each source.
- Site effects analysis.
- Seismic hazard computation.
- Post processing of hazard map.

2.8 Intensity Map/ShakeMap of significant events where applicable.

- Identification of appropriate seismic events with reasonable ground motion.
- Selection of ground motion parameters.
- Development of intensity maps.

2.9 Discrimination of man-made and natural seismic events.

- Selection of appropriate seismic events.
- Processing of the seismic events.
- Applying the pattern recognition functions.
- Determination of source mechanism of the selected events.
- Comparison with data from the identified mines.
- Discriminating the whole catalogue using pattern recognition.

2.10 Interpretation of the data.

- Interpretation of the catalogue.
- Interpretation of the velocity model.
- Interpretation of the focal mechanism and moment tensor solutions.
- Comparison with available geological and geophysical data.
- Interpretation of seismic hazard results.
- Report writing.

3. PROJECT DESCRIPTION.

3.1 Project Duration.

Ten seismic stations have been deployed in the Erongo region to characterize natural and anthropogenic seismicity. The project is planned to run for a period of 12 Months. The seismic data acquired during this period will be downloaded every two months and transmitted to the selected consultant for further processing and analysis as stipulated in the Scope of Work, section 2.

4. CLARIFICATIONS.

CLARIFICATION REGARDING ASPECTS OF THIS TENDER CAN BE ADDRESSED TO:

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Enquiries should refer to 'Discrimination of natural seismicity and mine blasting in Erongo Region'**.**

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