RANCANG BANGUN ALGORITME ADAPTIF UNTUK KALIBRASI SISTEM PERINGATAN DINI GEMPA BUMI BERBASIS FLUKTUASI RADON STASIUN BANTUL

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INTISARI

Gempa bumi merupakan pelepasan energi secara tiba-tiba yang sulit diprediksi, terutama karena Indonesia berada di pertemuan tiga lempeng tektonik. Salah satu prekursor potensial adalah fluktuasi gas Radon yang terdeteksi hingga 17 hari sebelum gempa. Stasiun *telemonitoring* Radon di Bantul milik UGM telah dilengkapi algoritme *Early Waring System* (EWS), namun perubahan konfigurasi sensor menurunkan akurasi prediksi waktu, magnitudo, dan lokasi. Oleh karena itu, dibutuhkan pengembangan algoritme adaptif untuk meningkatkan kinerja prediksi gempa bumi.

Penelitian ini menggunakan metode eksperimental dan statistika dengan pengukuran konsentrasi gas Radon di Stasiun *Telemonitoring* Bantul (-7,930389, 110,319417) untuk memprediksi waktu, magnitudo, dan lokasi gempa. Penelitian dilakukan dalam dua tahap, yaitu perancangan algoritme dasar dan algoritme adaptif. Algoritme dasar dikembangkan berdasarkan data fluktuasi gas Radon. Selanjutnya, algoritme adaptif dikembangkan dengan menggunakan *error* sebagai koreksi prediksi dasar.

Algoritme adaptif prediksi gempa bumi telah diimplementasikan dalam bentuk antarmuka di Google Colab untuk memprediksi waktu, magnitudo, dan lokasi berdasarkan data fluktuasi gas Radon. Algoritme adaptif prediksi waktu mencapai *Mean Absolute Error* (MAE) 17,83 jam, sensitivitas 90,35%, dan presisi 83,56%. Prediksi magnitudo adaptif menghasilkan MAE M0,45, *Root Mean Squared Error* (RMSE) M0,62, dan presisi 78,43%. Sementara itu, prediksi lokasi adaptif mencapai MAE 0,79 klaster, RMSE 1,25 klaster, dan presisi 90,59%.

Kata kunci: *Gempa Bumi, Sistem Peringatan Dini, Gas Radon, Algoritme Adaptif.*

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DEVELOPMENT OF ADAPTIVE ALGORITHM FRAMEWORK TO CALIBRATE EARTHQUAKE EARLY WARNING SYSTEM BASED ON RADON FLUCTUATION IN BANTUL

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ABSTRACT

Earthquakes are sudden energy releases that are difficult to predict, especially in Indonesia, which lies at the intersection of three tectonic plates. One potential precursor is Radon gas fluctuation, which can be detected up to 17 days before an earthquake. The Radon telemonitoring station in Bantul, operated by Universitas Gadjah Mada (UGM), is equipped with an Early Warning System (EWS) algorithm. However, changes in sensor configuration have reduced the prediction accuracy for time, magnitude, and location. Therefore, an adaptive algorithm is needed to improve earthquake prediction performance.

This study uses experimental and statistical methods by measuring Radon gas concentration at the Bantul Telemonitoring Station (-7.930389, 110.319417) to predict earthquake time, magnitude, and location. The research was conducted in two stages: the development of a basic prediction algorithm and an adaptive algorithm. The basic algorithm was built using Radon gas fluctuation data, while the adaptive algorithm was developed by applying error correction to the basic prediction results.

The adaptive earthquake prediction algorithm was successfully implemented in a user interface on Google Colab to predict time, magnitude, and location based on Radon gas fluctuation data. The adaptive time prediction algorithm achieved a Mean Absolute Error (MAE) of 17.83 hours, with a sensitivity of 90.35% and a precision of 83.56%. The adaptive magnitude prediction reached an MAE of M0.45, Root Mean Squared Error (RMSE) of M0.62, and 78.43% precision. Meanwhile, the adaptive location prediction obtained an MAE of 0.79 clusters, RMSE of 1.25 clusters, and precision of 90.59%.

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Key words: *Earthquake, Early Warning System, Radon Gas, Adaptive Algorithm.*

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