Postprint: MACD Indicator-Based Progressive Landslide Imminent Sliding Prediction Model

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Abstract

Landslide early warning and forecasting represents both a focal point and a challenge in landslide research. The simplicity and effectiveness of the velocity inverse model have established it as a widely utilized imminent landslide forecasting model. The Onset of Acceleration (OOA) of landslide deformation directly influences the forecasting accuracy of the velocity inverse model. This paper proposes a method for accurately identifying the onset point of landslide deformation acceleration, based on the Exponential Moving Average (EMA) extensively employed in economics: (1) absolute value transformation of landslide velocity; (2) definition of a trend change index ω, utilizing a sliding time window approach to identify landslide acceleration trend zones; (3) performing velocity inverse linear fitting on the acceleration trend zone, and identifying the onset point of accelerated deformation based on the correlation coefficient of the linear fit. Building upon this foundation, the accuracy of OOA points identified by the model was validated using a gradual-type landslide in Yunnan Province as a case study. The results demonstrate that the proposed method can accurately identify OOA points for gradual-type landslides; linear regression performed on subsequent data using the identified OOA points yields correlation coefficients exceeding 0.8 and prediction errors within 4 days, indicating favorable forecasting performance.

Full Text

A Framework for Identifying the Onset of Acceleration in Gradual-Type Landslides Using Exponential Moving Average

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Abstract

Landslide early warning and forecasting represents both a critical focus and a significant challenge in landslide research. The inverse velocity model has become widely employed for imminent-slip forecasting due to its simplicity and effectiveness. The onset of acceleration (OOA) in landslide deformation directly influences the predictive accuracy of this model. This paper proposes a methodology for accurately identifying the OOA point based on the exponential moving average (EMA), a technique extensively utilized in economics. The approach consists of three main steps: (1) absolute value processing of landslide velocity; (2) defining a trend change index ω and employing a sliding time window method to identify the landslide acceleration trend zone; and (3) performing inverse velocity linear fitting on the acceleration trend zone and identifying the onset of accelerated deformation based on the correlation coefficient of the linear fit. To validate the accuracy of OOA points identified by the model, a gradual-type landslide in Yunnan Province was analyzed as a case study. The results demonstrate that the proposed method can accurately identify OOA points for gradual-type landslides. Linear regression performed on subsequent data using the identified OOA points yields correlation coefficients exceeding 0.8 and prediction errors within four days, indicating favorable forecasting performance.

Keywords: imminent-slip forecasting; onset of acceleration; gradual-type landslide; exponential moving average; landslide monitoring

Note: Figure translations are in progress. See original paper for figures.