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Displacement prediction of large slow-moving landslide by means of MT-InSAR and ABC-KELM methods

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Landslide displacement prediction is an essential component in landslide early warning system. The displacement prediction based on in-suit monitoring performs excellently but is expensive, which limited its promotion in less-developing regions. In this study, we propose a cost-effective landslide displacement prediction method with the combination of Multi-Temporal Interferometric Synthetic Aperture Radar (MT-InSAR) technique and Artificial Bee Colony and Kernel-based Extreme Learning Machine (ABC-KELM). Two large slow-moving landslides in the Three Gorges Reservoir area, namely Shuping landslide and Muyubao landslide, are selected as study cases. We first extract the surface displacement sequences of both landslides through the MT-InSAR and the spaceborne Copernicus Sentinel-1 SAR imagery. The original displacement sequences are decomposed into trend terms, periodic terms, and noise using wavelet analysis. The modelling inputs of trend and periodic displacements are determined by analyzing the relationship between their influencing factors and deformation. The trend and periodic displacement are respectively predicted using ABC-KELM, and summing both predicted displacement to get total displacement. By comparing the displacement obtained by the Global Positioning System in both landslides, we find the MT-InSAR can monitor landslide displacement accurately. Prediction results demonstrate that the ABC algorithm can effectively optimize the parameters of the KELM. ABC-KELM outperforms the commonly used algorithms of extreme learning machine and support vector machine. Its root mean square error, relation coefficient, and mean absolute percentage error is 5.460, 0.022, and 0.990, respectively. Our proposed method is cost-effective in landslide displacement prediction, which can be recommended in susceptible regions.