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Intelligent Landslide Hazard Mapping Method Integrating SSGAN and GIS Spatial Modeling

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Abstract:

With the advancement of computer technology, the integration of machine learning-based landslide identification and GIS mapping techniques has provided new solutions for spatial visualization and management of disasters. However, in the process of landslide identification and mapping, insufficient sample size and class imbalance—where landslide samples are significantly outnumbered by non-landslide samples—often constrain mapping accuracy, leading to biases in disaster mapping results. To address this issue, this study takes the main urban area of Lanzhou City as a case study and combines a semi-supervised generative adversarial network (SSGAN) model with GIS spatial analysis techniques to propose a landslide identification and mapping method that integrates machine learning and geospatial visualization. The goal is to achieve high-precision spatial distribution mapping of landslides using limited labeled samples.To comprehensively represent the environmental spatial characteristics and optical texture features of landslide development, the research constructs three sets of feature sample datasets based on a GIS platform: a spatial dataset of landslide influencing factors, a Sentinel-2A remote sensing image dataset, and a spatially integrated feature set combining both. Using GIS-based spatial overlay analysis and feature extraction techniques, these three sample sets are input into the SSGAN model for training and comparative mapping. The results demonstrate that the integrated feature set, through the synergistic effect of the discriminator and generator, effectively enhances the spatial feature representation capability of landslide mapping. The proposed method outperforms traditional unsupervised models in mapping accuracy evaluation metrics (accuracy, F1-score, Kappa coefficient, and MIoU), with the final landslide spatial distribution map achieving an accuracy of 83%.GIS-based spatial statistics reveal that a total of 160 landslides were identified in the study area, covering a total area of 10.328 km², with spatial distribution characteristics showing high consistency with field survey results. This method fully leverages the spatial correlations of unlabeled environmental features, and the combination of SSGAN and GIS technology significantly improves the classification accuracy of landslides and non-landslides in complex geographical environments. The research outcomes not only provide reliable landslide spatial distribution maps but also offer scientific support for spatial decision-making in landslide disaster prevention and mitigation..

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