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Hendrik Schneider

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Meta AI Framework for catastrophe prevention: Improved Landslide Susceptibility Prediction

Landslides pose a significant threat to people and the environment worldwide. Researchers from the Leibniz Centre for Agricultural Landscape Research (ZALF), together with international partners, have developed a new framework that significantly improves landslide prediction using machine learning methods. The model can analyze data and create precise maps highlighting landslide prone zones. It achieves an impressive 95.6% accuracy in predicting landslide risks. The results were published in the journal *Scientific Reports*.

How does the model work?

To better predict landslide risks, the model uses a combination of six different machine learning methods.

A simple way to understand this is to compare it to a weather forecast. If you want to predict tomorrow's weather, you analyze past weather patterns and look for indicators—like dark clouds and strong winds often signaling rain.

This model does something similar—but for landslides and on a much larger scale. It processes vast amounts of environmental data, such as:

- Rainfall levels: Where does it rain the most?
- Soil composition: Is the soil stable or loose?
- Landscape slope: How steep is the terrain?
- Vegetation cover: Are there trees stabilizing the ground, or has deforestation occurred?
- Human activities: Are there roads or buildings that make the area unstable?

The model compares this information with past landslide events, recognizing patterns that indicate high-risk areas.

A meta-classifier then leverages the strengths of multiple AI models by combining their most accurate predictions to enhance overall performance. It works in three key steps:

1. Training Base Models – Several machine learning models (e.g., Logistic Regression, Support Vector Machine, Random Forest, Extremely Randomized Trees, Gradient Boosting, and Extreme Gradient Boosting) are trained independently on the dataset.
2. Generating Meta-Features – The predictions from these base models are used as new input features.

3. Training the Meta Classifier – A final predictor (e.g., Logistic Regression) is trained on these aggregated predictions to make the final decision.

"With our new prediction models, we can identify landslide-prone areas much more accurately than before," explains Mr. Krishnagopal Halder and Dr. Amit Kumar Srivastava from ZALF. "This is an important step towards better protecting people and enabling sustainable land use."

Why is this model so important?

Landslides often occur suddenly and can cause significant damage. Traditional risk assessment methods are often inaccurate or take a long time to complete. The new model can analyze vast amounts of data quickly and achieves an impressive 95.6% accuracy in predicting landslide risks.

The research team tested the model in the Sub-Himalayan region of West Bengal, India—an area heavily affected by landslides. The analysis revealed that high-risk zones are primarily located in areas with heavy rainfall, unstable geological structures, and intense land use, such as deforestation and urbanization.

By using this new technology, authorities and disaster management organizations can take early action to secure vulnerable areas and issue warnings in advance.

Future Applications and Research Perspectives

The method can be applied not only to landslides but also to predicting other natural hazards such as floods or land subsidence. In the future, the model could be further refined and adapted for global use.

Project partner:

- Leibniz Centre for Agricultural Landscape Research (ZALF), Germany
- University of Bonn, Germany
- Coastal Environmental Studies Research Centre, India
- Columbia University, USA
- Chhatrapati Shahu Ji Maharaj University, India
- The University of Burdwan, India
- Bhatler College, India

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wissenschaftliche Ansprechpartner:

Dr. Amit Kumar Srivastava

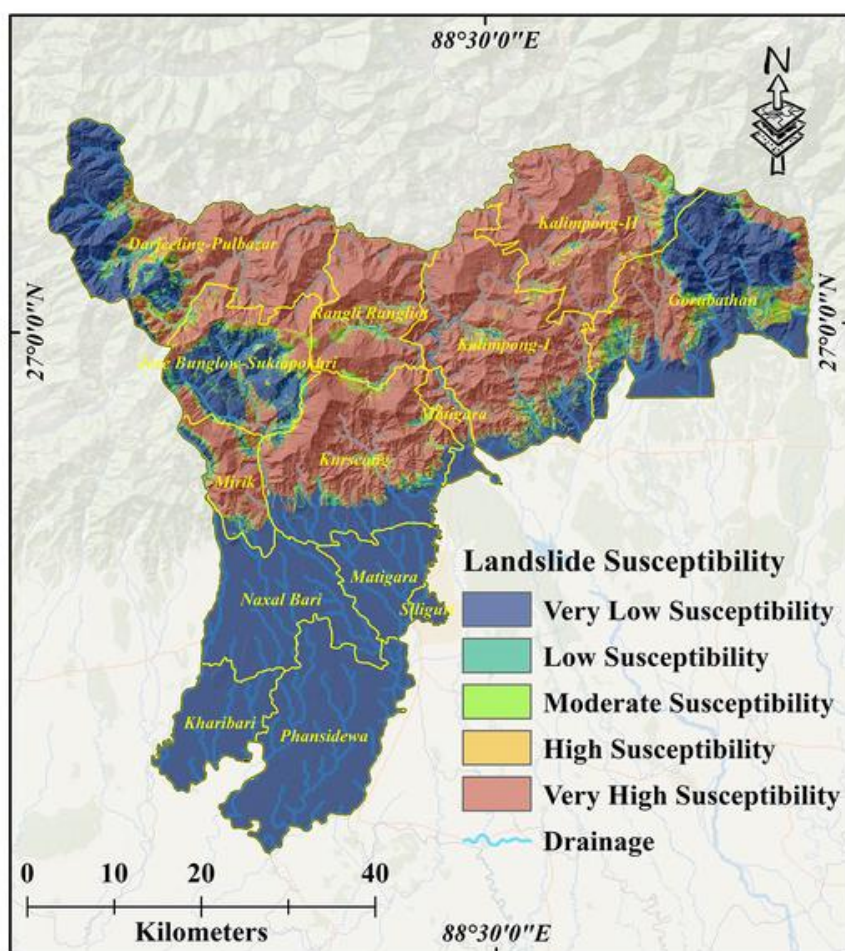
Research Area 4: "Simulation & Data Science".

Phone: + 49 (0) 33432 82-173

Email: AmitKumar.Srivastava@zalf.de

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The map shows the different levels of landslide susceptibility in the study area in the northernmost region of West Bengal, India.]

Amit Kumar Srivastava / ZALF

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