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Geomorphological mapping and analysis using statistically-based distribution modelling: advantages and pitfalls

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In recent years, statistically-based geomorphological distribution models (GDMs) have become more popular among geoscientists as an efficient approach for analysis and prediction. GDMs are empirical models relating field observations to explanatory variables (i.e. environmental variables), based on statistically or theoretically derived response surfaces. Geomorphological data can be simple presence–absence or abundance (e.g. cover, activity) observations on landforms, processes, or feature assemblages. Environmental variables can be acquired from various sources, commonly from geographical information and remote sensing data. Here, I draw attention to the most important advantages and pitfalls of GDMs. Moreover, I highlight some future challenges in the use and application of GDMs. In general, the concept of GDM may provide novel insights into the process-environment relationships and landscape development on the Earth but potentially on other planets as well.

GDMs can be used to simplify complex systems (model reduction), to provide understanding of process-environment relationships (explanatory models), and to predict distributions across space, but also in time (predictive models). More precisely, GDMs are important tools in mapping remote regions, analyzing processes across scales, predicting hazards and exploring the potential consequences of climate change on Earth surface processes and landforms. The possibility to identify the shapes of responses of environmental drivers and geomorphological processes and develop a controlled study setting to test specific hypothesis are considered to be additional strengths and opportunities of the GDM approach.

The issues that may hinder the use of GDMs in geomorphology include, for example, complexity of geomorphological processes, difficulties in compilation of causal spatial variables, geographical properties of data in combination with strict assumptions of several statistical techniques and uncertainty of input data. In future, geomorphological theory and data uncertainties should be considered more seriously in GDM to generate more robust models. Robust models are better transferred in space and time but more importantly, would improve our understanding of geomorphological systems. In addition, the focus of GDM should shift from description and spatial prediction to an emphasis on explanation and hypothesis testing.