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High-throughput landslide modelling using computational grids

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Landslides are an increasing problem in developing countries. Multiple landslides can be triggered by heavy rainfall resulting in loss of life, homes and critical infrastructure. Through computer simulation of individual slopes it is possible to predict the causes, timing and magnitude of landslides and estimate the potential physical impact. Geographical scientists at the University of Bristol have developed software that integrates a physically-based slope hydrology and stability model (CHASM) with an econometric model (QUESTA) in order to predict landslide risk over time.

These models allow multiple scenarios to be evaluated for each slope, accounting for data uncertainties, different engineering interventions, risk management approaches and rainfall patterns. Individual scenarios can be computationally intensive, however each scenario is independent and so multiple scenarios can be executed in parallel. As more simulations are carried out the overhead involved in managing input and output data becomes significant. This is a greater problem if multiple slopes are considered concurrently, as is required both for landslide research and for effective disaster planning at national levels. There are two critical factors in this context: generated data volumes can be in the order of tens of terabytes, and greater numbers of simulations result in long total runtimes.

Users of such models, in both the research community and in developing countries, need to develop a means for handling the generation and submission of landside modelling experiments, and the storage and analysis of the resulting datasets. Additionally, governments in developing countries typically lack the necessary computing resources and infrastructure. Consequently, knowledge that could be gained by aggregating simulation results from many different scenarios across many different slopes remains hidden within the data. To address these data and workload management issues, University of Bristol particle physicists and geographical scientists are collaborating to develop methods for providing simple and effective access to landslide models and associated simulation data.

Particle physicists have valuable experience in dealing with data complexity and management due to the scale of data generated by particle accelerators such as the Large Hadron Collider (LHC). The LHC generates tens of petabytes of data every year which is stored and analysed using the Worldwide LHC Computing Grid (WLCG). Tools and concepts from the WLCG are being used to drive the development of a Software-as-a-Service (SaaS) platform to provide access to hosted landslide simulation software and data. It contains advanced data management features and allows landslide simulations to be run on the WLCG, dramatically reducing simulation runtimes by parallel execution. The simulations are accessed using a web page through which users can enter and browse input data, submit jobs and visualise results. Replication of the data ensures a local copy can be accessed should a connection to the platform be unavailable. The platform does not know the details of the simulation software it runs, so it is therefore possible to use it to run alternative models at similar scales. This creates the opportunity for activities such as model sensitivity analysis and performance comparison at scales that are impractical using standalone software.