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Living with global uncertainty

# Urban landslide mitigation in developing countries works and pays – new evidence

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The School of Geographical Sciences[1] is recognised for developing numerical models of physical processes. CHASM, Combined Hydrology and slope Stability Model (developed by MG Anderson), dynamically simulates rainfall-triggered landslides and provides the scientific basis for risk reduction projects around the world. Collaboration with economists in CMPO (Centre for Market and Public Organisation)[2] – specialists in public service evaluation and delivery – has resulted in a new cross-disciplinary platform for measuring the effectiveness of landslide mitigation in vulnerable urban communities.

## Quantitative landslide risk assessment

The occurrence and impact of rainfall-triggered landslides is increasing, especially in tropical developing countries where the majority of landslide fatalities are in urban areas.

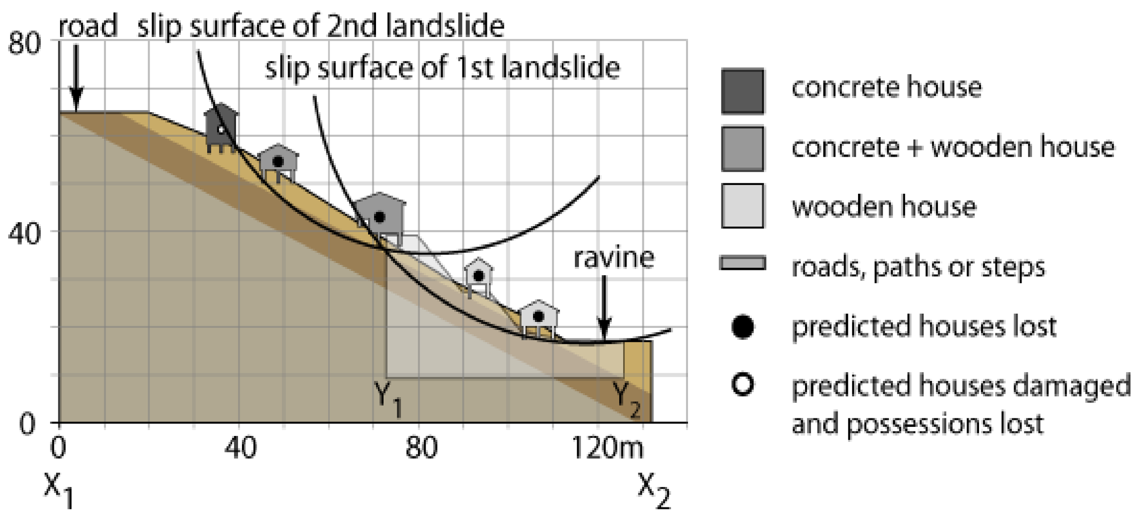
Construction of landslide hazard reduction measures in such locations is extremely rare, yet researchers from Geographical Sciences have shown that modelling localised landslide triggers allows appropriate measures to be implemented (MoSSaiC project).

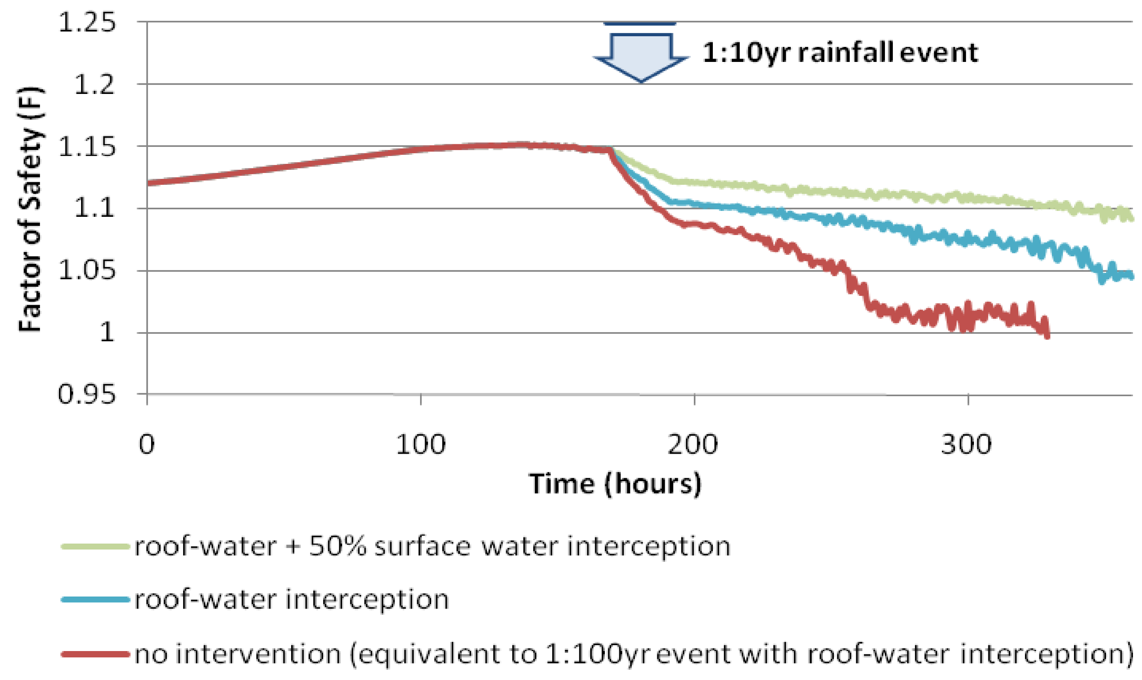
This study evaluated the effectiveness of such a project in an Eastern Caribbean community by integrating physically-based numerical modelling of landslide risk before and after the intervention, with a new 'community-focused' cost-benefit analysis method, developed by researchers in Economics.

It was shown that landslide frequency was reduced by an order of magnitude leading to avoided landslide costs and an overall benefit-cost ratio of 2.7 to 1. This adds to the evidence base that this form of landslide mitigation both 'works' and 'pays', and strengthens the argument for ex-ante disaster risk reduction measures.

Figure 1 (above) Urbanisation in developing countries can destabilise slopes. Changing loading, geometry, vegetation or drainage affects slope material strength and hydrology. By understanding identifying the driving stability mechanisms it can be possible to address landslide causes (e.g. by improving drainage and reducing infiltration into the soil)

Figure 2. (below) Slope cross-section $X_1$-$X_2$ used for CHASM simulation showing predicted location of sequential 'type A' landslides and houses damaged




## Modelling and mitigating urban landslide risk

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CHASM modelling of a typical unplanned community located on a steep slope in St Lucia indicated two landslide scenarios: A, failure of the whole slope, B, failure of multiple cut slopes.

Before construction of new drains, a rainfall event with a probability of 1 in 10 years was predicted to cause type A landslides (cross-section, figure x), while a 1 in 5 year event triggered type B slides. The graph in fig x shows factor of safety over time (red line), F>1 indicates a landslide.

After constructing new drains and capturing household water, less water was available for infiltration and slope stability was improved (blue and green lines, fig. x). The predicted probability of the two landslide scenarios was reduced to 1 in 100, and 1 in 50 years respectively.

The expected damage to houses of different construction types was calculated from predicted magnitude and location of landslides.

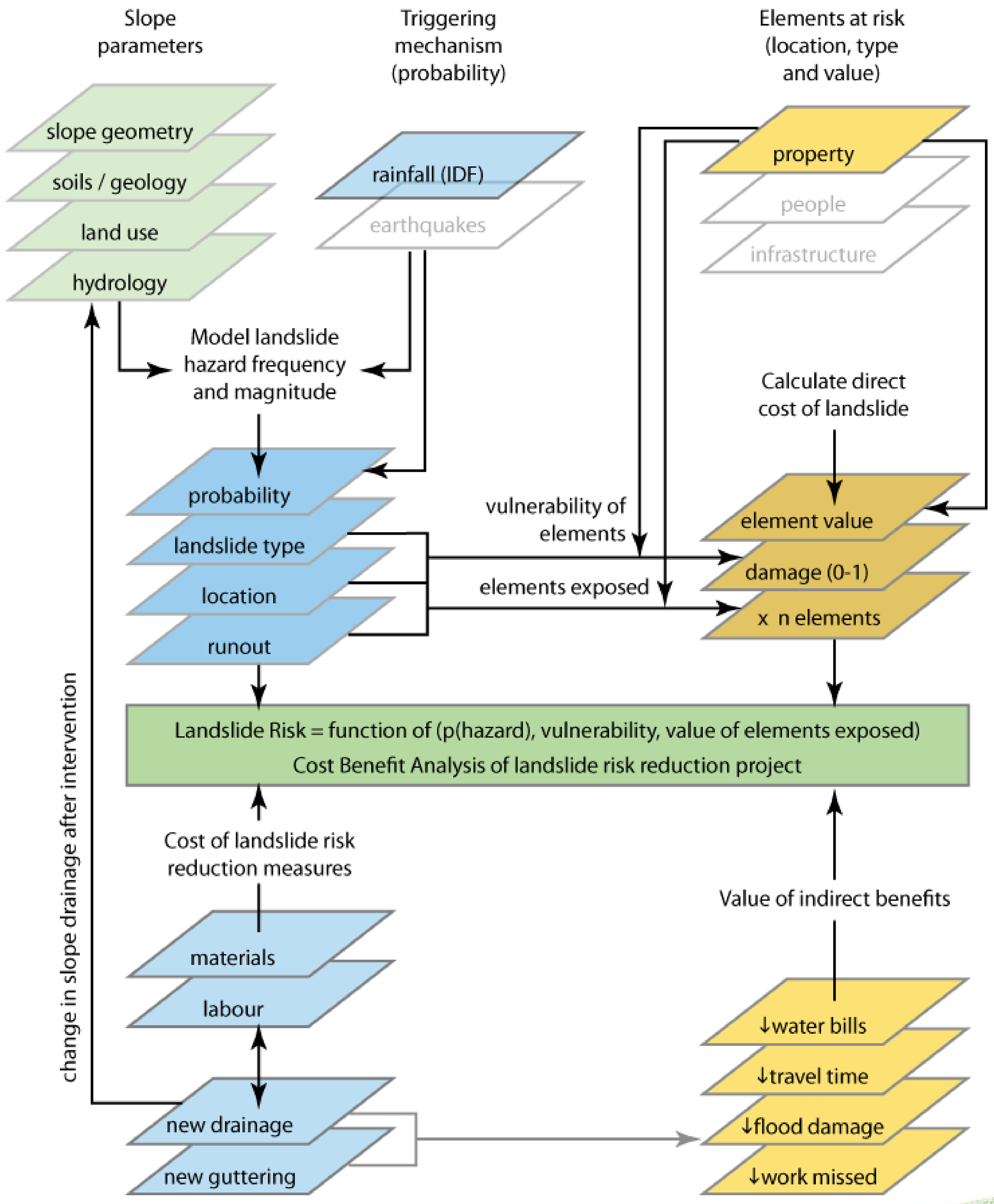


Figure 3. (left) The integrated landslide hazard, exposure and vulnerability (damage) assessment framework for calculation of the physical and economic effectiveness of landslide mitigation measures

## Cost-Benefit Analysis shows community-based landslide mitigation pays

Prof. S. Smith (sarah.smith@bristol.ac.uk) and E. Wright

The direct benefits of the landslide mitigation project were calculated from the probability of avoided future costs, expressed in today's values using a process of discounting.

Indirect benefits to the community, relating to improved drainage and installation of roof-guttering, included: improved access (less flooding/debris blocking paths), shorter travel times to work, reduction in minor damage to homes from flooding/debris, and saving in water bills (through harvesting of rainfall from roofs).

The value of indirect benefits to the community was assessed using stated and revealed preference methods (a household questionnaire) to determine willingness to pay (WTP) for such benefits. These benefits comprise a substantial part of the overall project benefit.

The benefit-cost ratio of the landslide hazard reduction project was 1.7 without drain maintenance (assuming a 7 year drain design life), rising to 2.7 with proper maintenance (conservatively assuming a 20 year design life).