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Simulating the occurrence of shallow landslides and debris flows as a function of rainfall return period.

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For the purposes of hazard assessment and planning of mitigation and relief measures, it is helpful to know the level of landslide and debris flow occurrence, and the associated sediment release, for rainfall events of different magnitudes. The SHETRAN landslide model (a physically based, spatially distributed, catchment hydrology and sediment transport modelling system with a shallow landslide component based on factor of safety analysis) was therefore applied to simulate shallow landslide and debris flow incidence as a function of rainfall duration and intensity for events of different return period. The two study areas, Valsassina in the Italian Southern Alps (180 km^2) and the Ijuez catchment in the central Spanish Pyrenees (45 km^2), are prone to significant soil erosion and landslide hazards.

Until recently, techniques for hazard assessment tended to be approximate (because of lack of data) and gave only qualitative estimates of hazard. Also they could not be used predictively to indicate the effects of possible future changes in land use and climate. SHETRAN can predictively examine shallow landslide and debris flow incidence on a spatially distributed basis, at the scale of a river basin (up to 500 km^2), as a function of land use and climate (including rainfall characteristics).

Rainfall events of different return periods were generated for the two sites based on historical datasets. The 1-, 2-, 3-, 4- and 5-day annual rainfall maxima were extracted and plotted on a Gumbel reduced variate scale and fitted using a Generalised Extreme Value (GEV) distribution to give the 1-, 2-, 3-, 4- and 5-day rainfall totals associated with return periods of 2, 5, 10, 25 and 50 years. As the model requires hourly rainfall time-series, the rainfall totals for each 1-, 2-, 3-, 4- or 5-day event were disaggregated into hourly time steps using depth-duration relationships and assigned a distribution

with a single peak.

The rainfall events were fed into the model and the results analysed to give landslide and debris flow incidence as a function of rainfall return period. The principal product, intended to form a guideline for end-users, is a graph showing rainfall duration-intensity thresholds for different levels of landsliding and debris flow. In addition, relationships between rainfall event, river discharge and sediment yield have been quantified.

The results show that the number of simulated landslides increases significantly with rainfall return periods of between 2 and 20 years. However return periods of 50 years yield relatively few more landslides than return periods of 25 years. It is recommended that field studies are carried out to confirm this pattern. The work was carried out as part of the EC LESSLOSS project (GOCE-CT-2003-505448).