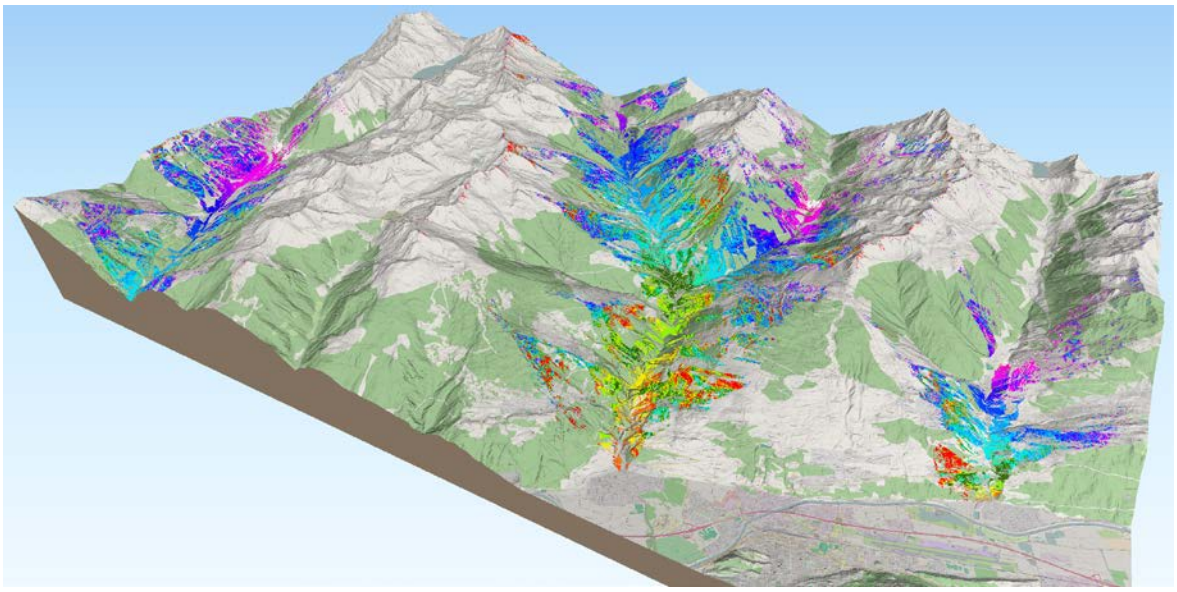
The relationship between large-scale geomorphological processes and local slope instabilities affecting transport networks

Project Framework:
The construction of transportation routes can markedly increase the risk of rockfalls and landslides in Alpine settings. Where forming road and rail routes involves excavation or the construction of embankments in locations already in a state of critical stability, minor changes to slope geometry or groundwater conditions can have a notable impact on local ground conditions. Although it is relatively uncommon that the construction of such routes trigger catastrophic slope failures, we may expect to see an increased frequency of small- to medium-scale rock slope failures and higher maintenance costs on routes crossing pre-existing instabilities or slopes experiencing increased rates of long-term erosion in response to (for example) active fluvial or glacial incision.

In this project we will combine a new catalogue of slope instabilities affecting the road and rail networks in Canton Valais with results of a recent study which provides constraint on the geomorphological evolution of rock slopes and river channels in the region. It is suggested that rock slopes in the lower half of valleys are evolving in response to several hundred meters of river incision that is rejuvenated during interglacial periods. Matching sequences of knickpoints (or waterfalls) from valley to valley provides absolute constraint on the rates of incision, and possibly, rates of ongoing rock slope activity. Better understanding this relationship will allow improved planning and management of infrastructure in the study area, and perhaps more importantly, provide the opportunity to transfer insights from a data-rich region in the Swiss Alps to similar landscapes in data-poor regions such as Asia, South America, and New Zealand.

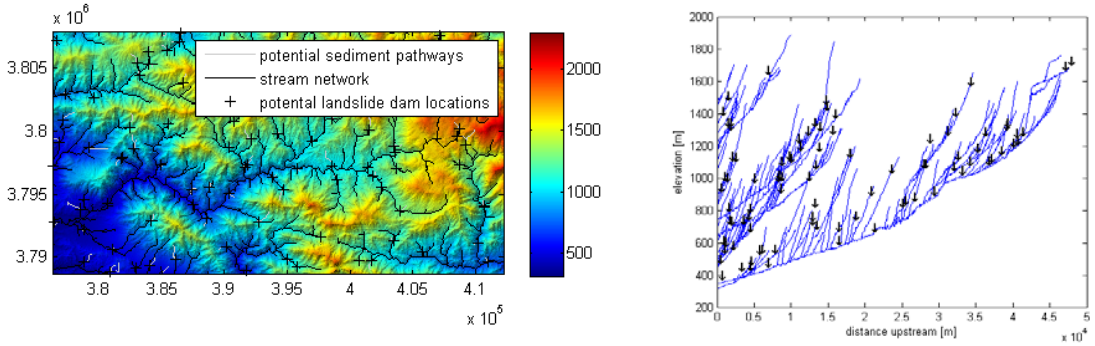


Perspective view of the Hérémence Valley (south of Sion, VS). Hillslopes responding to long-term fluvial incision are highlighted, with increasingly cooler colours reflecting progressively older waves of incision.

Specific goals:
We will clarify the relationship between catalogued instability events in the Valais Alps, and:

a) large ancient creeping landslides,
b) areas expected to be experiencing relatively rapid geomorphic change, and
c) sites in which no driver or pre-existing instability can be identified.

In order to improve existing large-scale landslide inventories for the region, we will make use of combination of GIS (or Google Earth) and satellite-based InSAR analysis produced within a companion project. Then, applying methods similar to those outlined in a recent paper (https://topotoolbox.wordpress.com/2015/05/29/roads-at-risk-traffic-detours-from-debris-flows-in-southern-norway/), we will evaluate the distribution of catalogued instabilities with respect to the river and road networks.



An example of landslide locations mapped onto a river network using TopoToolbox (source: topotoolbox.wordpress.com)

Our unique insight into the timing, key geomorphic drivers, and resulting rates of long-term hillslope erosion in this region offer an entirely new perspective on the progression of slope instability in large alpine valleys. As a result, there are few studies that offer a clear precedent for statistical analysis of such a dataset. The project will include GIS analysis, and limited fieldwork to ground-truth observations derived from the initial stages of the project. Basic knowledge of Matlab and/or GIS software (ArcGIS / QGIS), and some background in statistics would therefore be useful, though is not essential.

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