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Tien Shan geohazards database: Landslides versus other geomorphic features, seismic versus climatic triggering

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Recently, we compiled a new landslide inventory for the Tien Shan, Central Asia, containing about 3500 mapped mass movements within a target region of 1200 km (E-W) by 600 km (N-S). While compiling this inventory, we met several problems: which features need to be combined to identify a landslide – combination of scarp and depositional area? Are all deposits below scarps landslide deposits? Should we map scarps as a landslide feature even if no deposits are found below it? How to clearly distinguish landslide from moraine deposits in the higher mountain areas? ... and finally, as the Tien Shan is prone to strong earthquakes (and comparatively less to severe climatic events), can we consider that most giant landslides are triggered by large seismic events .. and, then, could they be used a paleoseismic markers?

Identification problems are partly due to the low resolution of imagery that was used for the landslide mapping (mainly based on Google Earth imagery); the other main reason for related uncertainties is the likely great age (> 1000 years) of the mapped features (even though conservation of geomorphic features can be considered as good in those semi-arid areas – much better than in the Alps). For some of those 'old' features, the uncertainty of their origin remained even after having visited the sites. The tendency was that 'landslide geologists' generally considered the mapped features as landslide deposits while some other geoscientists preferred the moraine hypothesis. The problem of the possible seismic origin of proved landslide morphologies is either directly solved if the triggering earthquake event is known (in recent historical times, after 1885) or indirectly in the other (more frequent) case. We consider that most giant landslides (>107 m3) in the Tien Shan had been triggered by earthquakes – while most occurred in 'pre-historic' times (here, before 1885) and a direct proof is thus missing. Actually, several hard rock slopes and many soft rock slopes failed without any particular (climatic or seismic) trigger – however, some of them may be considered as post-seismic effects (after several days or weeks) and only one case of a giant rockslide without any triggering event is known. The indirect proofs for the seismic triggering are: a) absence of any particular other types of trigger due to low precipitation rate, at least in present times, and the weak local influence of river erosion); b) most 'giants' are located near or even on seismically active faults (or assumed to be seismically active) – this spatial relationship is also statistically proved for the entire area by landslide susceptibility maps; c) head scarps formed near mountain tops where seismic shaking is the strongest during earthquake events; d) some similarities appear between size-frequency relationships of landslides and earthquakes in those zones of the Tien Shan hosting the largest mass movements.