Interdisciplinary Assessment of Natural Hazards for Risk Reduction: Tien Shan Mountains, Central Asia

DEREK RUST[1] and ANDREY KORJENKOV[2]
[1] *School of Earth and Environmental Sciences, University of Portsmouth, UK*
derek.rust@port.ac.uk
[2] *Institute of Communications and Information Technologies, Kyrgyz-Russian Slavic University, Bishkek, Kyrgyzstan*

The Tien Shan mountains of central Asia, the northernmost expression of India-Eurasia collision, are characterised by active deformation (GPS measured contraction rates of ~20 mm a^{-1}), and consequent rapid uplift and steep slopes prone to landsliding. In addition to seismogenic structures associated with contraction, the mountain belt is bisected by the Talas-Fergana fault, a poorly-known, historically aseismic, 700-km-long dextral strike-slip structure displaying active faulting and landslide features, including landslide-dammed lakes and assemblages of breached landslide masses and associated lacustrine deposits that contain apparent seismites. Moreover, the mountain front created by Talas-Fergana activity forms the topographic barrier that impounds a 20 km^3 reservoir created by the Toktogul hydro-electric and irrigation scheme, the largest in central Asia. Hazard vulnerability is further increased by the presence of radioactive uranium mining and processing tailings dumps exposed to mobilisation by sudden releases of water farther upstream. The resulting contamination most notably includes the Fergana Valley, the most densely populated region in central Asia, where some 10 million people are dependent on irrigation from the Toktogul scheme. A NATO-funded interdisciplinary research project is in progress to evaluate these hazards, with the aim of establishing hazard scenarios and possible mitigation measures within a GIS format. Seismic, palaeoseismic and archaeoseismic data suggest that the Talas-Fergana structure is presently a seismic gap with the last ground rupturing event occurring between 400 and 500 BP and an average slip rate as high as 15 mm a^{-1}. A future event is thought likely to produce at least 5 m of displacement. Engineering geology assessments are also underway on the slopes bordering the reservoir, where a water-level increase of some 250 metres has significant implications for pore pressures, and tsunami hazard, in slopes exhibiting evidence for large-scale pre-historic instability. Within the Talas-Fergana fault trough a characteristic cycle of fluvial reworking of landslide masses is proposed and perched gravels preserved high on valley walls are interpreted as related to reworking of voluminous ancient landslide deposits. Overall, the evidence suggests a landslide history characterised by large-volume failures, a pattern that may mirror that of seismic strain release along the Talas-Fergana structure. It is suggested that deep-seated landslides are effectively only triggered by major faulting events. The ground shaking accompanying such events is likely to trigger deep-seated landslides at high threshold values, with other landslide-inducing mechanisms unable to attain these threshold values, or significantly lower them, during inter-earthquake periods.

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