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Anthroprogenic landscapes: assessing the geomorphological stability of tailings dams using a Landscape Evolution Model

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Tailings are a by-product of the processing of minerals at mine sites and are usually fine grained, contain water and processing chemical residues and are usually very erodible. Tailings are commonly stored in 'tailings dams' and these dams are a feature of many mine sites. These dams are in a geomorphic disequilibrium and have similar risk to that of water storage dams with geotechnical, seismic, hydrological (rainfall) and erosional induced failure concerns. These dams also pose a risk of release of polluted water and the accompanying chemicals and fines. At the majority of mine sites tailings dams will be permanent geomorphological features which do not geomorphologically integrate with the surrounding landscape. A dam has a design life and it has been suggested that closure designs be considered for a 1000 year design life with other sites considered for 10 000 year scenarios. New methods are therefore needed for assessing long-term behaviour of anthropogenic structures such as tailings dams. Computer based Landscape Evolution Models (LEMs) are a new tool to assess tailings dam design. These models provide information on type of erosion and erosion location as well as erosion rates. Models such as CAESAR-Lisflood can also provide information on water quality and stream sediment loads and models the transport of all size fractions. The model can therefore provide guidance on long-term behaviour, which allow designs to be tested and improved accordingly. The work uses CAESAR-Lisflood to examines a series of hypothetical tailings dams subject to a range of different possible rainfall scenarios. The findings demonstrate that without maintenance the dam wall will be breached at a time exceeding the dam life design for average conditions but may breach within decades for an extreme (yet possible) event. For both cases water quality will be reduced for centuries post breach and may never reach background (pre breach) levels representing a permanent change in water quality. The modelling here provides a method for the assessment of not just tailings dams but other anthropogenic structures and their geomorphological behaviour. The work here also raises questions about landscape stewardship for such altered systems.