Comparative Evaluation of Sediment Yield from Native and Fluvial Geomorphic-Rehabilitation Watersheds

Mine Rehabilitation Conference 2017
What is Fluvial Geomorphic Rehabilitation?

- The essence of the approach is to identify the type of drainage network that forms over time, given: the site’s earth materials, relief, climate, and slope stability to achieve a stable landform, and to design and build that landform.
Study Background

- From 1999-2008 the San Juan Coal Company (SJCC) reclaimed 743 ha at the *La Plata Mine* using fluvial geomorphic rehabilitation design methods.

- Qualitative evaluations support fluvial geomorphic rehabilitation methods at minimizing erosion and sedimentation rates, in comparison to natural sites.

- In 2011 SJCC began research to quantify sediment yield (t/ha/yr) from geomorphic landforms and surrounding undisturbed lands.

- Three selected sub-watersheds,
  - N - Native, undisturbed by mining
  - MV - Moderately vegetated, top-dressed geomorphic design
  - WV - Well vegetated, top-dressed geomorphic design
La Plata Mine, New Mexico
La Plata Mine, New Mexico

Vegetation cover: 8 years

WV Sediment Dam
Study Methodology Overview

- Temporary dams designed to impound runoff from a 2-yr, 1-hr storm
- Erosion pins used to measure sediment deposition
- Precipitation recorded by the La Plata Mine meteorological station and supplemental site-specific gauges
- Data included multiple precipitation events sufficient to cause sediment transport
Sediment Yield Results

- N - Native, undisturbed site: 10.5 t/ha/yr
- MV - Moderately vegetated, top-dressed geomorphic design: 9.09 t/ha/yr
- WV - Well vegetated, top-dressed geomorphic design: 6.22 t/ha/yr
Installation of Sample Sites

Native site during survey with sediment pins installed

WV site after construction of temporary sediment dam
Sample Sites

N - Site after first sediment event

MV - Site with moderate vegetation

WV - Site with significant vegetation
Factors to Consider

- **Watershed size** - Research shows sediment yields are lower as watershed area increases due to internal sediment storage – smaller watersheds minimise this effect.

- **Watershed type** - Semi-arid regions with relatively high sediment yields versus grassed and forested watersheds with expected lower sediment yield rates.

- **Watershed precipitation** - Differing climatic conditions and site-specific rainfall characteristics and relationships could affect sediment yield rates. This semi-arid site is in the highest sediment-producing precipitation range.

- **Landform maturity** - Designs based on geomorphically *immature* landforms will generate greater rates of sediment; Designs based on geomorphically *mature* reference landforms are expected to generate less sediment.
Recommendations for Future Study

- Contribute to the knowledge base for best practice rehabilitation methods
- Study done in an extremely erosive environment - results are supported by other qualitative and quantitative monitoring, i.e. Mojave desert
- Increase number of sites and study other site types
- Conduct studies in other regions - internationally
Rehabilitation Landform Performance

- Using the GeoFluv method at La Plata,
  “The proposed drainage density design exceeded the pre-mine drainage density (because of loss of bedrock control in channels), helping MMD to recognise that we were negotiating with people who “get it”. The more conservative design then experienced a 200-yr, 2-hr storm event, on freshly soiled reclamation, and did not result in more erosion than would be expected on undisturbed land.”
  (Clarke, D., Mining and Minerals Division, 2008).

- Qualitative observation of San Juan Mine geomorphic rehabilitation,
  “The most remarkable result was that the impounded water resulting from the rain event was clear. This is the first time I have witnessed clear water coming off reclaim in 18 years of inspecting.”
  (Mine inspector, San Juan Inspection Report, New Mexico Mining and Minerals Division, 2002).
Inspection after 200-yr, 2-hr storm
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