Tools for Designing Postmining Landscapes with Acceptable Erosion Risk and Discharges on the Receiving Environment

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Waste rock dumps from open cut coal mines at the angle of repose – approximately 75% or 37°
Highly saline & erosive

Legislation and public opinion demand that these must be repaired to an acceptable post-mining landuse (generally a self sustaining native ecosystem) with no off-site pollution
The general Sequence of Rehabilitation is:

- **Reshaping & topsoiling to control erosion:** Major cost of rehabilitation

- **Typical spoil piles from open cut coal mines**

- Currently > 50,000 ha in Queensland
- > Ave cost > $ 22,000/ha
- Thus : Large cost to industry
Background: The Sequence of Rehabilitation

- Typical spoil piles from open cut coal mines

- Reshaping & topsoiling to control erosion

- Major cost of rehabilitation

- But: Soil and overburden varies greatly in their erodibilities

- Thus Minesites need **accurate**, **cost-effective** & **user friendly** methods to
  1. determine suitable combinations slope, length & vegetation cover that will result in acceptable rates of erosion for input into their Landscape Design Models and
  2. determine the potential erosion rates from the Landscapes that they are likely to design and construct.
So we measured erosion at different scales and cost.


<table>
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<tr>
<th>Experimental scale</th>
<th>Experimental - Real world scale</th>
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<tbody>
<tr>
<td>Lab Rainfall Simulation</td>
<td>Field Rainfall Simulation</td>
</tr>
<tr>
<td>Plot 3m x 0.8 m</td>
<td>12m x 1.5 m</td>
</tr>
<tr>
<td>4m x 1.5 m</td>
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<td>Field Catchments</td>
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Inexpensive, rapid, independent of climatic conditions (few weeks)

Expensive, slow few plots/catchments, data collection depends on climatic conditions (minimum 5 years)
Erosion was measured at different scales and cost. (Acarp 1629 & 4011: 1992-1998)

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To meet industry requirements, the relevant question is: Can laboratory scale measurements be used to predict field scale erosion? (either annual or individual storm events)
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MINErrosion 3: a user-friendly hillslope model
to predict annual & potential rainstorm erosion rates and
to design post-mining landscapes (slope length & gradient)

MINErrosion 2: simulates sediment delivery from unconsolidated plots of any
slope length and gradient based on rill and interrill erodibility measurements

MINErrosion 3: rill and interrill erodibilities are combined into a MUSLE
erodibility to predict annual and potential rainstorm erosion events (of known
annual recurrence). A consolidation and (above ground) veg cover is introduced.

\[ A = (0.5 \cdot E_{30} + 0.349 \cdot Q \cdot q_p^{-0.33}) K_M \cdot LS \cdot C \cdot P \]

(Onstadt & Foster, 1975)
Outputs: Annual erosion rates

- Annual erosion rates
- Single event soil loss
- Annual soil loss comparison

$$y = 0.8951x$$
$$R^2 = 0.844$$

Validation

- Annual soil loss comparison
  - $y = 0.8951x$
  - $R^2 = 0.844$

Single event soil loss

- Soil loss values for known recurrence intervals
  - Slope is 15 %, 30 m
  - Slope is 15 %, 30 m 
  - 100 mm/h storm

Although MINErosion 3 can be used to derive suitable combinations of slope length and gradient, it cannot be used to assess erosion from landscapes. Need to combine it with GIS to assess erosion from catchments/landscapes.
MINErOsis 4.1: Linking MINErOsis 3.3 with ArcGIS

DEM of catchment or landscape - divide into raster of grid cells

ArcGIS used to tag gridcells with - Surface hydr char - soil & env char - storm char

MINErOsis 3.3 applied to each gridcell in sequence with sedimentation subroutine

ArcGIS used to express outputs as Maps and files

The outputs were validated against annual and storm events collected from 9 years of data collected from the catchments with very good results (Fig 5 in paper).
Thank you.

**Acknowledgements:**
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