Priorities for revegetating landscapes disturbed by mining and other activities

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**Abstract**

An outline is given of land disturbance caused by mining and construction of infrastructure, and problems associated with revegetation of this disturbed land. Some selection criteria for developing appropriate adapted cultivars for revegetation purposes are suggested.

**Introduction**

In this paper, issues associated with selection of plant species suited to the revegetation of disturbed lands are discussed. The focus is on land disturbed by activities other than those associated with rural-agricultural uses of lands. The disturbances are, therefore, those associated with construction of infrastructure and with mineral resource extraction.

Revegetating areas disturbed by these activities has some features in common with revegetating degraded rural land. There are also some striking differences, especially in revegetating areas disturbed by mining.

Most of the disturbed lands of this type are naturally revegetated by invasion of hardy species from adjoining undisturbed areas, although this revegetation is gradual and slow. Observation of these naturally invading species provides a significant amount of information about the characteristics of species useful in revegetation of disturbed land. However, the naturally invading species may not be appropriate to the required end use of the disturbed land.

The current challenge is to define the management strategies to speed and enhance the revegetation of these disturbed lands.

**Types of disturbance**

Excluding the disturbance of rural lands caused by mismanagement, the 2 general types of disturbance are that caused by construction of infrastructure and that resulting from mineral resource extraction.

The types of infrastructure construction which lead to land disturbance include:

- roads, cuttings and embankments;
- railways, cuttings and embankments;
- borrow pits, including soil stripping;
- gravel pits;
- quarries;
- dams; and
- general “urban” developments.

These construction activities involve the excavation, movement and, in some instances, placement of earthen materials.

In none of those instances is the “topsoil” used as a construction material as its properties are not physically desirable for load bearing. In some instances, and certainly more commonly in recent years, the topsoil is retained and replaced in the borrow area to assist revegetation.

The value of topsoil is recognised in the construction industry. In urban settings, it is frequently stripped from surrounding areas, creating extensive disturbance, to be replaced on, and so cover up the construction disturbance. This was carried out over large areas around rapidly expanding cities such as Darwin, NT, in the 1970s and 1980s. The irony is that, as the urbanisation expands into previously borrowed areas, the borrowing continues on the new urban fringes.

The disturbance caused by mining may be localised or extensive, depending on the nature of the ore body and the type of mining undertaken.
For example, single open cut coal mines in central Queensland disturb over 100 ha/yr and had accumulated up to 5000 ha of disturbance by 1996.

Mining disturbance involves the excavation and movement of material over distances of a few tens of metres to kilometres. Only in more recent years has the topsoil ahead of the mining been stripped and replaced on the mine area after the mineral has been extracted. In these instances, revegetation can be accomplished more readily. However, revegetation can be extremely difficult if topsoil is not available for respreading.

**Characteristics of disturbed areas**

Disturbed areas have a number of common characteristics. The materials in these disturbed areas are frequently the B horizons or parent materials of the landscape. They are, therefore, low in plant nutrients and organic matter, and have poor physical characteristics. They also frequently have low moisture holding characteristics or are periodically flooded. These characteristics are not conducive to robust plant growth and, in many instances, are so extreme they prevent any plant growth.

Even in areas where topsoil has been retained, the disturbance of stripping, often followed by stockpiling and then respreading, usually causes deterioration in the properties conducive to robust plant growth.

In areas disturbed by mining, the characteristics of the spoil materials can sometimes be deleterious to plant growth. Depending on the nature of the mineral being sought, elevated concentrations of metals may be present, salinity and sodicity can rapidly develop and extremes of pH can also develop. Where pyritic materials are disturbed, acidic leachates may drain from the disturbed area, adversely affecting plant growth. Salts can also readily be leached from disturbed, elevated materials.

The areas disturbed by mining activity can also be extremely variable (Eastment et al. 1989). Table 1 indicates, in general terms, the variability along 18 km of mine spoil on a central Queensland open cut coal mine. There tends also to be variability across the width of these open cut mines due to the changes in strata overlying the coal. This variability implies that adapted species for revegetation will need to be tolerant of widely different soil/spoil characteristics or, more likely, that a suite of species with differing adaptations will be required.

**Table 1.** General spoil characteristics of the Saraji Mine, central Queensland.

<table>
<thead>
<tr>
<th>Pit area</th>
<th>pH</th>
<th>EC</th>
<th>Salinity</th>
<th>Sodicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–2</td>
<td>&gt;8.0</td>
<td>&gt;1.0</td>
<td>Saline</td>
<td>Sodic</td>
</tr>
<tr>
<td>3–4</td>
<td>7.0</td>
<td>0.5</td>
<td>Slightly saline</td>
<td>Slightly sodic</td>
</tr>
<tr>
<td>5–8</td>
<td>5.0–6.0</td>
<td>&gt;2.0</td>
<td>Saline</td>
<td>Highly sodic</td>
</tr>
<tr>
<td>9–11</td>
<td>4.0</td>
<td>0.5–1.0</td>
<td>Slightly saline</td>
<td>Non-sodic</td>
</tr>
<tr>
<td>11–12</td>
<td>4.0–5.0</td>
<td>&gt;1.0</td>
<td>Saline</td>
<td>Non-sodic</td>
</tr>
<tr>
<td>13–14</td>
<td>7.5–8.5</td>
<td>&gt;0.5</td>
<td>Very saline</td>
<td>Sodic</td>
</tr>
</tbody>
</table>

**Specific tolerances**

The species to be used for revegetation purposes generally require adaptability to a number of limiting factors on spoil materials. Some of the materials referred to in Table 1 tend to disperse when wet and then form a strong, thick crust, making seedling emergence very difficult. Many rocky materials drain freely and adequate moisture is not retained for long enough to promote establishment. Borrow pits tend to pond water for periods of several months in wet seasons.

Invariably, plant nutrient levels are too low to sustain plant growth in the materials left after disturbance by mining. Organic matter concentrations, so important in topsoils to maintain physical characteristics and nutrient cycling, are generally almost zero in these disturbed materials.

In metalliferous mines, the materials left for revegetating frequently have elevated concentrations of metals such as zinc, copper, lead, arsenic or cadmium. Some of these may be toxic to many plants. Efforts to find plant species suitable for revegetating such materials rely on identifying rare genetic adaptation to specific conditions which are toxic to most plants.

**Requirements for revegetation**

In recent decades, legal requirements have been imposed on the Australian mining industry necessitating revegetation of mined areas. The first legal requirement to rehabilitate/revegetate a mined area in Queensland came into force in
Since that time, both legislation and mine lease conditions have increasingly required mined areas to be revegetated.

The mining industry has embraced these requirements, being sensitive to the criticism of “historic mining” which has left barren landscapes. Now, considerable resources are applied to rehabilitation of mined land, with some considerable effort going into research to refine rehabilitation techniques in Queensland, New South Wales and Western Australia (Roe 1992; 1993).

Most mining leases have specific requirements or conditions requiring rehabilitation/revegetation of mined lands. There is also an overriding requirement in Queensland, which is defined in a policy developed by the Department of Resource Industries (as it was at that time) and the mining industry. The policy sets objectives of:

- achievement of acceptable post-disturbance land use capability;
- stable post-disturbance landform; and
- preservation of downstream water quality.

There are no similar requirements on other forms of disturbance. There are no legal requirements on road or rail construction authorities to revegetate the disturbance created. Some extractive industries such as quarrying have revegetation requirements but, in general, the other forms of disturbance identified have no formal requirement for revegetation.

However, there is a growing awareness of the community expectation that infrastructure construction areas should be revegetated. Hence, road embankments are now more frequently revegetated and construction areas “landscaped”.

Opportunities

Usual practice in revegetating areas disturbed by infrastructure construction or mining in Australia has been to revegetate with either pasture species or native species climatically adapted to the area. Success with such practices has been variable. Attention to the extreme variability in the materials being revegetated has frequently been lacking. Also, the species available are generally not adapted to the extreme physical and chemical characteristics of the materials.

Revegetation of the materials left after these forms of disturbance requires an ability to establish and persist in adverse physical and chemical conditions. Generally, there is a need to establish robust cover to limit erosion or rapidly cover the barren areas. The rapid development of ground cover is not a common feature of Australian native species.

As these areas being revegetated are generally vulnerable to future degradation, the species used in revegetation should probably be relatively unpalatable to domestic livestock. This will reduce the risks of overgrazing and subsequent erosion. Therefore, in seeking species to revegetate materials derived from construction or mining disturbance, efforts should be directed towards native species which naturally invade the disturbed areas, or towards introduced species which have known tolerances to harsh environments but limited attraction to livestock. Care will need to be taken not to use relatively unpalatable species for revegetation which might cause weed problems in nearby land utilised for grazing or other purposes.

A further challenge in developing revegetation strategies for these areas of disturbance is to increase the rate at which the revegetation occurs on these difficult materials. There could be advantages in developing a sequential revegetation process, with initial stabilisation using a stoloniferous grass, which would improve organic matter and soil structure. This could be followed, after a few years, by establishment of trees, where this was the desired final outcome.

References

