VEGETATION RECOVERY AND SIMULATION OF COLONISATION PROCESS OF DOMINANT SPECIES AFTER OPEN-CUT MINING AT BOGGABRI, NSW, AUSTRALIA

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DECLARATION

I certify that the substance of this thesis has not been submitted for any degree and is not currently being submitted for any other degree or qualification.

I certify that any help received in preparing this thesis, and all sources used, have been acknowledged in this thesis.

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ABSTRACT

Australia has abundant minerals and coal resources with mining operations being carried out across the country. Although mining disturbance is a temporary change in land use, its impact on the environment may last longer than most other disturbances. In particular, open-cut mining entirely removes the previous topsoil, plants and animals, and destroys the previous ecosystem. The deposit of waste materials such as overburden, alters the topography, causes variation in soil chemistry, and may pollute surface and ground waters.

The goal of mine rehabilitation is to return the disturbed area to a stable vegetated and productive condition that is ecologically sustainable over the long term. Recovery involves vegetation colonisation that may take considerable time to demonstrate ecological sustainability, and it is difficult to judge the success of sustainable rehabilitation from short term monitoring. Prediction of vegetation colonisation patterns and rehabilitation efforts will help stakeholders to make sure that the rehabilitation practice satisfies the aims and purpose of the intended land use. Rehabilitation research has been undertaken for decades and, although some models have been developed, there is no appropriate model that can be applied to predict rehabilitation at mining sites.

The aims of this study are to assess the structural and compositional changes of vegetation communities on an open-cut mining site over time; to understand the vegetation colonisation process and dynamic interactions from the individual plant level to the ecosystem level; and then to develop a simulation model to predict vegetation colonisation and subsequent long-term development during the rehabilitation process, so as to determine the potential sustainability of the developing ecosystem and to provide management advice for decision-making.

In this study, a mining site in natural forest at Boggabri, New South Wales in Australia is used as a case study for understanding forest succession after mining disturbance. Fifteen years of historical data of seven species were used to assess the colonisation and community development for species diversity and changes in the community structure and composition.

Parameters were selected and methods were developed for an agent-based simulation model. Agent-based modelling and Geographic Information System were used to describe plant growth and interaction based on life history tracts over both spatial and temporal scales, and to use them for rehabilitation. The parameters and methods applied in the model design were based on the historical data analysis supplemented with information from the literature on the main species. The model was built to represent dynamic interactions between individual plants with different capacities for habitat occupation and competition on two different substrates, one covered with topsoil and the other on bare overburden. Environmental influences and biotic factors were also incorporated into the model.

The simulation results clearly indicate that the natural colonisation pattern after open-cut mining disturbance was mainly influenced by seed source, seed dispersal distance, the distance from and composition of the surrounding forest, and the soil type on the rehabilitation site. Potential applications of this model are also discussed by using different rehabilitation strategies, such as applying different seed mixes of trees and shrubs to different soil types. The strategy of assisting natural regeneration by incorporating seed mixes of different combination can accelerate the recovery process, particularly when matched to specific site conditions and soil types. This allows the forest ecosystems to follow successional trajectories to the desired state. This thesis also concludes that an agent-based simulation model can be used to predict forest succession patterns from both spatial and temporal scales, and will help in rehabilitation decision-making to ensure the development of sustainable and desirable ecosystem.