Predicting Reclamation Trajectory to Support Bond Release (Newsletter)*

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Regulators require mining companies to provide surety, usually in the form of a bond, that reclamation will be successfully completed at no cost to the public. The amounts of money involved are frequently substantial and companies would like to have these funds returned as soon as possible for other uses. Regulators tend to be quite conservative because terrestrial plant succession occurs slowly or very slowly and they do not want to release the bond until they can be confident that taxpayers will not be responsible for incurred costs. The question of interest to both parties is how to determine when the desired reclamation trajectory has been sufficiently established that the bond can be released with confidence.

There is a robust statistical model using discrete Markov chain analysis to quantify the transitions of plant successional stages from bare soil to whatever is the climax vegetation for that area. This model can, with appropriate and sufficient periodic monitoring data, forecast the vegetation on the reclaimed land. Refinement of this process on a coal mine in eastern Germany used 30 years of tri-annual vegetation surveys on the approximately 2200 acres to predict the vegetation types and coverage up to 50 years in the future.

Required data are obtained from gridded plots over the area. Vegetation classes from pioneer grasses to shrubs and trees are determined by regulatory agency staff botanists and other experts. Comprehensive surveys every three years determines the species (or class) of vegetation in each plot and how much of the ground is covered by that species or class. The percentages of plot cover by species/class can be averaged for all plots and times or separated by space and/or time in matrices. Changes from one sampling time to the next reflect the rate and pathways of vegetational succession. Natural (or other) effects such as wildfire and invasive species are accommodated in the model because the transition matrices are based on multivariate ecological time series.

When many mines are in the same eco-physiological region (e.g., semi-arid or temperate environments) where the expected climax vegetation can be defined it would be reasonable to pool monitoring data from a number of reclamation efforts to provide a larger data set for the model. If differences in historic reclamation efforts are sufficiently small (that is, the variabilities within

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each project from one sample to the next is greater than the variabilities among the different project samples) such pooling is justified. Once the model has been created and validated for a mine (or all mines in a sufficiently homogeneous region) forecasts of future states can be made with confidence and used to release reclamation bonds sooner rather than later.

The authors of the scientific journal article reporting results of the German coal mine reclamation effort write that the major achievement of this method of converting vegetation time series into transition matrices is the estimation of probability of events such as future land cover status, a strength not provided by other frequently used statistical methods in reclamation science.

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