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Responses of plant available water and forest productivity to variably layered coarse textured soils

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Reforestation is a primary end use for reconstructed soils following oil sands mining in northern Alberta, Canada. Limited soil water conditions strongly restrict plant growth. Previous research has shown that layering of sandy soils can produce enhanced water availability for plant growth; however, the effect of gradation on these enhancements is not well defined. The objective of this study was to evaluate the effect of soil texture (gradation and layering) on plant available water and consequently on forest productivity for reclaimed coarse textured soils. A previously validated system dynamics (SD) model of soil moisture dynamics was coupled with ecophysiological and biogeochemical processes model, Biome-BGC-SD, to simulate forest dynamics for different soil profiles. These profiles included contrasting 50 cm textural layers of finer sand overlying coarser sand in which the sand layers had either a well graded or uniform soil texture. These profiles were compared to uniform profiles of the same sands. Three tree species of jack pine (Pinus banksiana Lamb.), white spruce (Picea glauce Voss.), and trembling aspen (Populus tremuloides Michx.) were simulated using a 50 year climatic data base from northern Alberta. Available water holding capacity (AWHC) was used to identify soil moisture regime, and leaf area index (LAI) and net primary production (NPP) were used as indices of forest productivity. Published physiological parameters were used in the Biome-BGC-SD model. Relative productivity was assessed by comparing model predictions to the measured above-ground biomass dynamics for the three tree species, and was then used to study the responses of forest leaf area index and potential productivity to AWHC on different soil profiles. Simulated results indicated soil layering could significantly increase AWHC in the 1-m profile for coarse textured soils. This enhanced AWHC could result in an increase in forest LAI and NPP. The increased extent varied with soil textures and vegetative types. The simulated results showed that the presence of 50 cm of coarser graded sand overlying 50 cm of finer graded sand is the most effective reclaimed prescription to increase AWHC and forest productivity among the studied soil profiles.