Geophysical Research Abstracts
Vol. 12, EGU2010-4687, 2010
EGU General Assembly 2010

Low Cost Remediation of Mining Sites with Biosolids

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This paper will present collective results of 25 years of research by the authors into the use of municipal biosolids (sewage sludge) and other residuals to reclaim sites disturbed by a range of mining and construction activities. Loading rate experiments and demonstrations have been conducted on areas drastically disturbed by coal mining, sand mining, heavy mineral mining, urbanization, airport construction and heavy metal processing. At all sites, the post-mining soils were devoid of organic matter, very low in nutrients and frequently quite acidic. At all sites, addition of biosolids at higher than agronomic rates resulted in complete stabilization of the resultant mine soils and vigorous stable vegetation that persisted for > 5 years and has allowed enhanced invasion of native herbaceous species. Application of higher rates is not compatible with establishment of certain native tree species (e.g. Pinus sp.), however, due to adverse effects of soluble salts, nutrient enrichment and enhanced competition by grasses.

An underlying goal of this program has been to develop approaches that use higher than agronomic rates of biosolids while simultaneously minimizing losses of N and P to local ground- and surface-waters. In the early 1980's, working on USA coal mining spoils, we determined that that approximately 100 Mg/ha of secondary cake biosolids was optimal for revegetation with herbaceous species, but water quality monitoring was not a concern at that time. This finding raised concerns, however, that the large amounts of total N applied (> 2500 kg/ha) would lead to nitrate-N contamination of local waters. Subsequent work in the early 1990's indicated that similar rates of biosolids could be mixed with woodchips (high palatable C source) and land-applied to large (> 100 ha) coal mining sites with no losses of nitrate-N to surface or ground-water due to microbial immobilization of the applied N. Follow-up work at three sand mining (sand & gravel and mineral sands) sites in eastern Virginia indicated that non C-amended biosolids could be applied at loading rates of up to 75 Mg/ha without significant local ground-water effects, but that significant elevation of nitrate-N in shallow root-zone (75 cm) percolates was observed the first winter after application. Addition of palatable C (as sawdust) to adjust the applied biosolids C:N ratio to 25:1 significantly reduced nitrate-N in root-zone percolates and would allow for higher loading rates where indicated. Lime-stabilized biosolids (100 Mg/ha; 15 to 25% CCE) have also been used to permanently stabilize and revegetate large areas (> 100 ha) acid-sulfate (pH < 3.5) soils disturbed by construction in eastern Virginia with minimal local water quality effects. Parallel studies at our sites in the USA have indicated no significant heavy metal leaching or plant uptake risks as long as sludge quality and soil pH are controlled. Finally, long-term (10 yr) results from Katowice, Poland, indicate that high rates (> 250 Mg/ha) of biosolids co-applied with waste limes can be utilized to permanently stabilize and revegetate a wide range of phytotoxic and heavily contaminated Pb/Zn smelter slags and processing tailings.

Biosolids are generally available at very low cost for land rehabilitation since their cost of transport and application is usually born by the producer or source municipality. Their use is particularly cost-effective when lime-stabilized materials are applied to strongly acidic or metalliferous sites.