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Effectiveness of erosion control covers on soil quality recovery, runoff, and sediment production after forest restoration in a fly-ash landfill

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Despite the efforts to reducing residues derived from thermal power stations, as near as 70% of fly-ash and other wastes end up in landfills. Definitive landfill covers are generally limiting for native plant establishment as these materials lack the characteristics of functional soils. This could compromise the success of restoration efforts increasing the risk of erosion. As part of a restoration project, we tested the efficacy of different erosion control covers to enhance soil functions, including C and nutrient cycling, water regulation, and erosion control. First, the fly-ash was encapsulated and covered with a one-meter of sandy-clay sediment mixed with 20 cm pine bark compost. Five native tree species were planted in four plots considering different soil cover treatments (Hydro-mulch, Coconut fiber mulch, Seeded mixed grasses, and no-cover). These were established considering a complete block design with nine replicates for cover treatment. To elucidate what soil function responded more rapidly to these treatments, we measured chemical soil indicators (C, N, and P total and available pools, pH, EC, CEC), microbial (Biomass and C, N, P pools), and physical (bulk density, texture, and infiltration). All these parameters were measured at three sampling intervals (0-20, 20-40, and 60-80 cm) immediately after the plantation and a year later (n=117 per year). Also, we installed triplicated erosion plots for each cover to quantify which cover was more effective in reducing erosion and runoff. Overall, total carbon and nitrogen content increases were found after the first year (p=0.04 and p<0.001 respectively) at 20 to 40 cm.

Similarly, available nutrients such as NO₃⁻, NH₄⁺ showed a significant decrease in the first two depth intervals (p<0.001). Available phosphorus also showed a net decline in the first two depth intervals (p=0.02 and p<0.001). The no-cover treatment showed significantly higher amounts of water runoff and soil erosion (p=0.04) than the other three treatments. No differences were found in runoff and erosion between hydro-mulch, coconut fiber mulch, and grass cover. Our results show that soil's chemical properties (i.e., nutrient pools and nutrient availability) are sensitive to different cover types and respond rapidly after one year of plantation with native species. On the other hand, significant changes in physical properties are not visible yet. The experiment also concludes that all tested soil covers effectively reduced runoff and erosion compared to the control. These covers should be implemented in the initial stages of the revegetation.

