Site-specific management approach for reclamation of waste deposits generated by alluvial gold mining in Colombia

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Introduction

Approximately 80,000 ha are covered by alluvial gold mining waste in Colombia. Agroforestry systems have been established for reclamation of these areas to support agricultural land use by establishing crops in more fertile areas while bringing non-fertile areas to productivity through the planting of trees.

Methods

Spatial interpolation, spatial PCA and fuzzy cluster classification were performed to delineate homogeneous zones. For validation, multispectral aerial images were used to elaborate maps of vegetation index and integrate them with ground-based measurements of physicochemical soil properties.

Results

Delineation of homogeneous zones (Figure 3) was carried out in areas covered by gold mining waste undergoing restoration through the establishment of agroforestry systems. In spite of the high contents of N and OM, there is a lack of the other required nutrients for almost the entire area, explained by the nature of the alluvial deposits that cover the area. Geostatistical analysis (Table 2) show that spatial variability of soil properties reduces with time period since establishment of the restoration areas.

Conclusion

- The areas undergoing restoration are highly heterogeneous, as shown by geostatistical analysis.
- Heterogeneity represents a challenge for the farmers as identifying areas for crop establishment is difficult.
- High spatial variability of OM, exchangeable cations and P suggests that the application of amendments should consider this spatial heterogeneity, as the nutrient requirements may significantly differ even within areas of few hundreds of meters.
- Identification of homogeneous zones is the first stage to implement site-specific soil management strategies.
- The delineation of homogeneous zones are a helpful approach to support the farmers in their decision making regarding soil fertility management.
- The spatial heterogeneity of soil properties has to be overcome with the use of amendments prior to revegetation, including fertilizer, organic waste, compost or the use of cover crops.

Table 2: Geostatistical analysis result for soil physicochemical properties. Maximum likelihood estimation of the parameters of the theoretical variogram nugget variance (\(\tau_0\)), partial sill (\(\tau_2\)), practical range (\(r_{pr}\)).