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Site-Specific Management Approach for Reclamation of Alluvial Gold-Mining Waste Deposits with Agroforestry Systems in Colombia

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Abstract

Alluvial gold mining activities generate large amounts of dredged sediments that are deposited in banks and areas near the river. Agroforestry systems have been established for reclamation of these deposits in the gold mining area of El Bagre, Colombia, with the aim to support agricultural land use by establishing crops in more fertile areas of the deposits while bringing non-fertile areas to productivity through the planting of trees. Spatial variability of sediment deposits depends on the type of machinery used for mining and geochemical properties of the exploited alluvial areas.

To support farmer's decision making regarding soil management, the main objective of this study was to understand the spatial variability of the soil properties of the deposit areas that might affect plant growth and crop productivity. For this purpose, site-specific management zones were delineated to identify areas within the field with homogeneous properties. Delineation of management zones allowed to identify areas within the field with homogeneous characteristics such as texture and nutrient levels. Soil samples were taken from 310 locations distributed in four reclamation areas of 50 ha each, established in 2002, 2006, 2010 and 2014. Spatial distribution of soil properties was generated through spatial interpolation with ordinary kriging. Spatial principal component analysis and fuzzy cluster classification were performed to delineate management zones. For validation of the management zones, multispectral aerial images were used. NDVI maps were elaborated with the multispectral orthomosaics and integrated with ground-based measurements of physicochemical soil properties.

This integrated analysis can be used to direct site-specific management for the ongoing reclamation process by identifying areas with high potential for crop establishment and areas that should be revegetated with trees or cover crops to improve soil quality. Combined analysis of NDVI maps and physicochemical properties of each area allowed to classify the studied areas in four management zones. The presence or absence of vegetation cover within these areas was related to differences in organic matter, nutrients content and particle size distribution of the soil. These results suggest that the delineated management zones can help to identify management strategies and inputs required to improve crop productivity and revegetation.

Keywords: Aerial image, geostatistics, reclamation, spatial variability

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