Advanced Monitoring of Abandoned Mining Sites with High-Resolution UAV Technology

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Abstract

In the past decade, unmanned aerial vehicles (UAVs), or drones, have become invaluable tools in the mining industry, supporting applications ranging from mineral exploration to environmental remediation. When equipped with high-resolution image sensors, UAVs enable high spatial and temporal resolution surveying, making them particularly effective for monitoring abandoned mining sites. This paper presents a case study demonstrating the application of UAV technology for monitoring an abandoned mining site affected by acid mine drainage (the Trimpancho mining complex in the Iberian Pyrite Belt, southwestern Spain).

The study was conducted on two selected waste dumps: one at the upstream and the other at the downstream of the mining complex. The primary objective was to estimate the volume of waste material accumulated in these areas. To achieve this, a DJI Phantom 4 RTK UAV was employed to conduct comprehensive aerial surveys of the sites. The imagery collected enabled the generation of orthophotomaps and digital surface models (DSMs), which provided detailed spatial information for accurately delimiting waste accumulations and identifying dominant runoff zones contributing to the degradation of the Trimpancho stream.

The three-dimensional models and orthomosaics produced from the UAV data provided an in-depth visualization of the waste distribution. This enabled precise volume estimations that are essential for long-term monitoring and management of the mining system. By comparing these models with future surveys, it is possible to track changes in waste dump morphology over time. Additionally, the models offer a valuable tool for assessing the potential valorization of critical materials accumulated in the abandoned dumps.

The results confirm that UAV technology is highly effective in obtaining the detailed and accurate data needed for monitoring abandoned mining sites. This information is crucial for planning and implementing remediation strategies adapted to the site's specific topography, hydrology, and geology. UAVs present an innovative, efficient solution that optimizes safety, accuracy, and cost-effectiveness. By enhancing assessment precision and enabling targeted reclamation strategies, UAVs technology contributes to the restoration and sustainable management of degraded mining areas, while also advancing environmental monitoring efforts.

Keywords: Unmanned Aerial Vehicles, mining, environmental remediation, acid mine drainage, orthophotmaps

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