

Method	Applications in mining areas and riverbeds	Advantages	Limitations
Ground-penetrating radar drone (GPR-UAV)	Dams and ponds, frost and ice studies, bedforms of ponds and riverbeds, soil layers	Fast and safe across diverse terrains. Drone enables larger coverage than ground-based GPR.	Signal attenuation due to high electrical conductivity (e.g. tailings, mine ponds). UAV payload limits antenna size. Regulatory low flight altitude.
Dual-wavelength laser scanner	Riverbed morphology, vegetation penetration, erosion risk mapping, topography	Two wavelengths → better separation of vegetation, ground and underwater features. Excellent accuracy.	Expensive equipment. Water turbidity and depth constrain use.
Autonomous survey vessel	Pond and riverbed bathymetry, water chemistry stratification, water discharge	Safe, able carry multiple sensors. Accurate across sections. Works in challenging weather (wind, rain).	Not suitable for shallow, rocky or fast-flowing waterways. Ice and vegetation limit use. No data from beneath the sediment. Remote control, must be deployed and retrieved.
RGB comeja (orthophotography)	Erosion, extraction mapping, landslide monitoring, topographic changes, dam edges, surface water extent, flow estimation from imagery	Very precise, affordable and fast. Easy to analyse.	Surface data only, limited by water clarity.
Thermal camera	Leak detection in tailings areas, thermal anomaly monitoring, water leaks and groundwater discharge	Good for indirect detection of moisture and leakage.	Weather-sensitive, no direct chemical information.
Airborne LiDAR	Tailings and water pond dams, morphological changes, riverbed geometry, erosion, landslides	Highly accurate 3D models, penetrates vegetation. Useful for dam stability monitoring.	Surface data only, dust and rain reduce quality.
Traditional ground-penetrating radar	Dams and ponds, frost and ice studies, bedforms, soil layers	Accurate for surface structures, multiple antenna frequencies. High detail. Usable in difficult weather.	Poor performance in conductive and very fine-grained sediments. Slower than UAV-based GPR.