Geospatial Modelling of Environmental, Social and Governance (ESG) Risks for Mineral Exploration and Mining Feasibility Assessments in Finland

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Mining-related Environmental, Social and Governance (ESG) risks are typically assessed during the advanced stages of mining permit procurement. Delays and disruptions in acquiring these permits due to ESG risks cause increased costs and threaten timely and cost-effective execution of mineral exploration and mining projects. Hence, early identification and mitigation of these risks prevent potential conflicts and guide policy making.

This study presents a conjunctive a-priori evaluation of geological favorability and ESG criteria for mineral targeting and mining feasibility assessments using geospatial data modeling to minimize ESG risks. The integrated approach is applied to Pyhäsalmi-Vihanti Volcanogenic Massive Sulphide (VMS) belt in Finland. The first step involves development of quantitative metrics for ESG-related risks. Next, these metrics are represented as spatially mappable criteria for spatial-mathematical assessments. The spatial mathematical integration is implemented using knowledge-driven inference networks, and data-driven machine learning; utilizing the available data on exploration permits, mines, and mineral deposits for training the algorithms. The outputs show that the highest ESG risks in the study area are associated with the ecological regions conserved by law. Risks emanating from the social factors are primarily over the second homes along the lakes in the southern part of the belt with known cases of mineral exploration disputes. This separates the belt into two domains regarding social acceptance (northern and southern); the northern domain being characterized by old mine sites indicating acceptance towards mining activity. Because the delays in permit approvals occur over the environmentally and socially sensitive zones, the governance risks spatially correlate with the environmental and social risks; hence are strongly controlled by the ES metrics. This study demonstrates that geospatial modelling enhances ESG assessments by providing spatial context, mathematical consistency and hence objectivity, thereby facilitating early identification of potential conflicts, and guiding informed policy decisions in mining project evaluations.

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