

Stochastic hydro-sedimentary modelling of arsenic mobilization and downstream propagation in a coupled slope-channel-lake system

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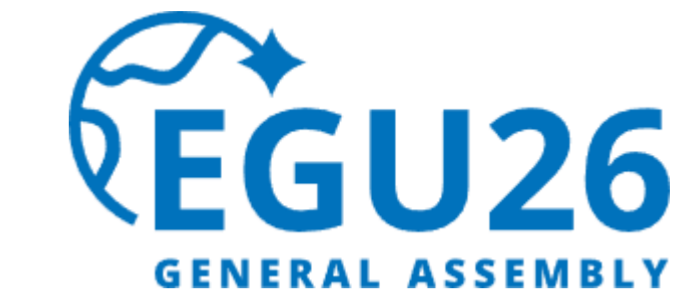
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Introduction:

The presence of toxic trace elements (like Arsenic) in legacy mining sites may pose risks to ecosystems and human health. This work presents a simplified stochastic approach to assess potential impacts on ecosystem services. The method integrates high-resolution digital elevation models (DEMs), data sets of trace element concentrations in soil samples, and Monte Carlo simulations to predict potential impacts on a downstream reservoir caused by potential transport via surface runoff.

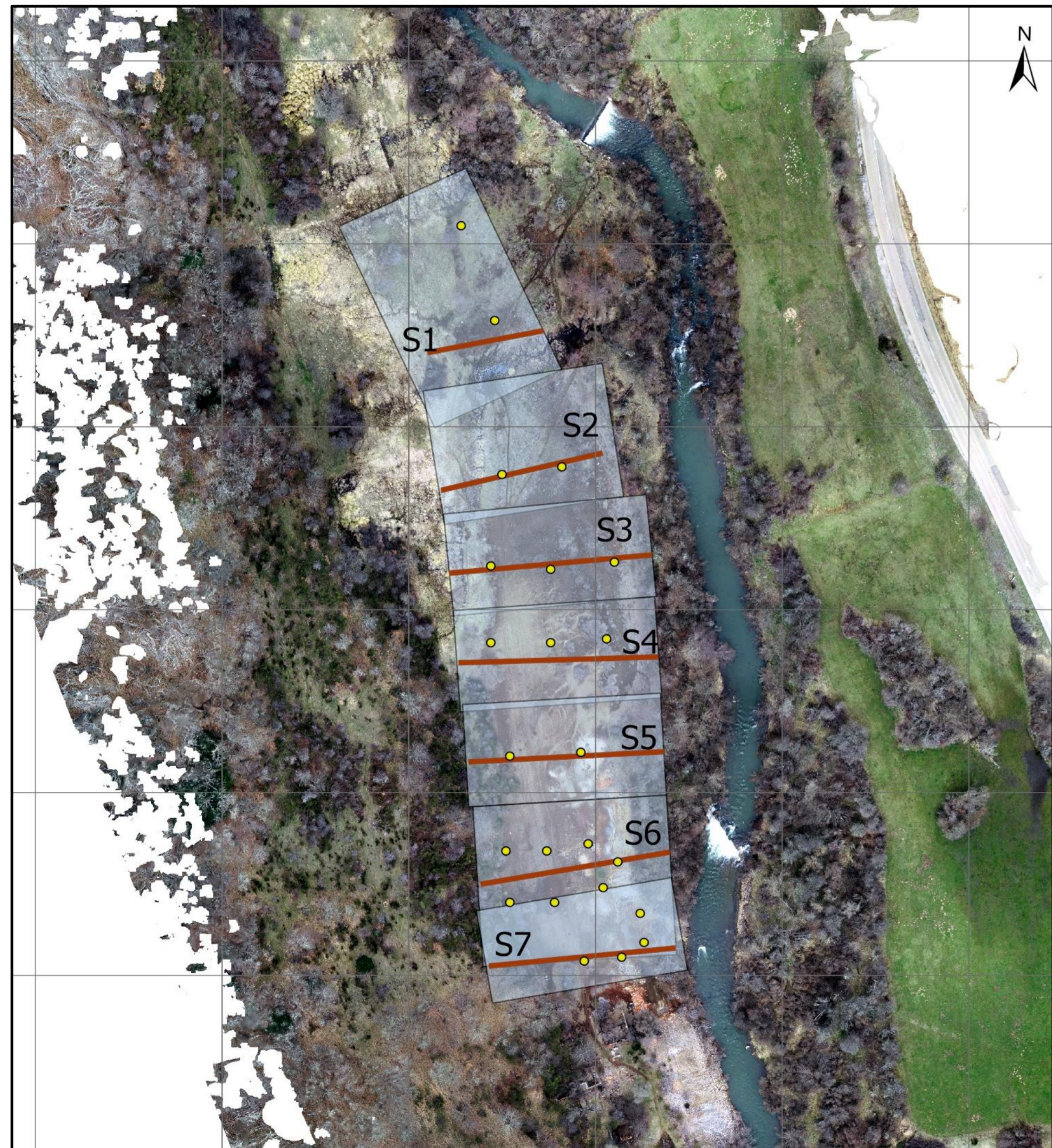


Figure 1. On the left study area map including an orthophoto and a digital elevation model (DEM) with a grayscale altitudinal gradient, distribution of sampling coordinates (yellow dots), and delimitation of the seven slope sections S1-S7 (red lines). The orthophoto and DEM was derived from UAV-based photogrammetry. On the right: Two photographs of the legacy mine wastes close to a river.

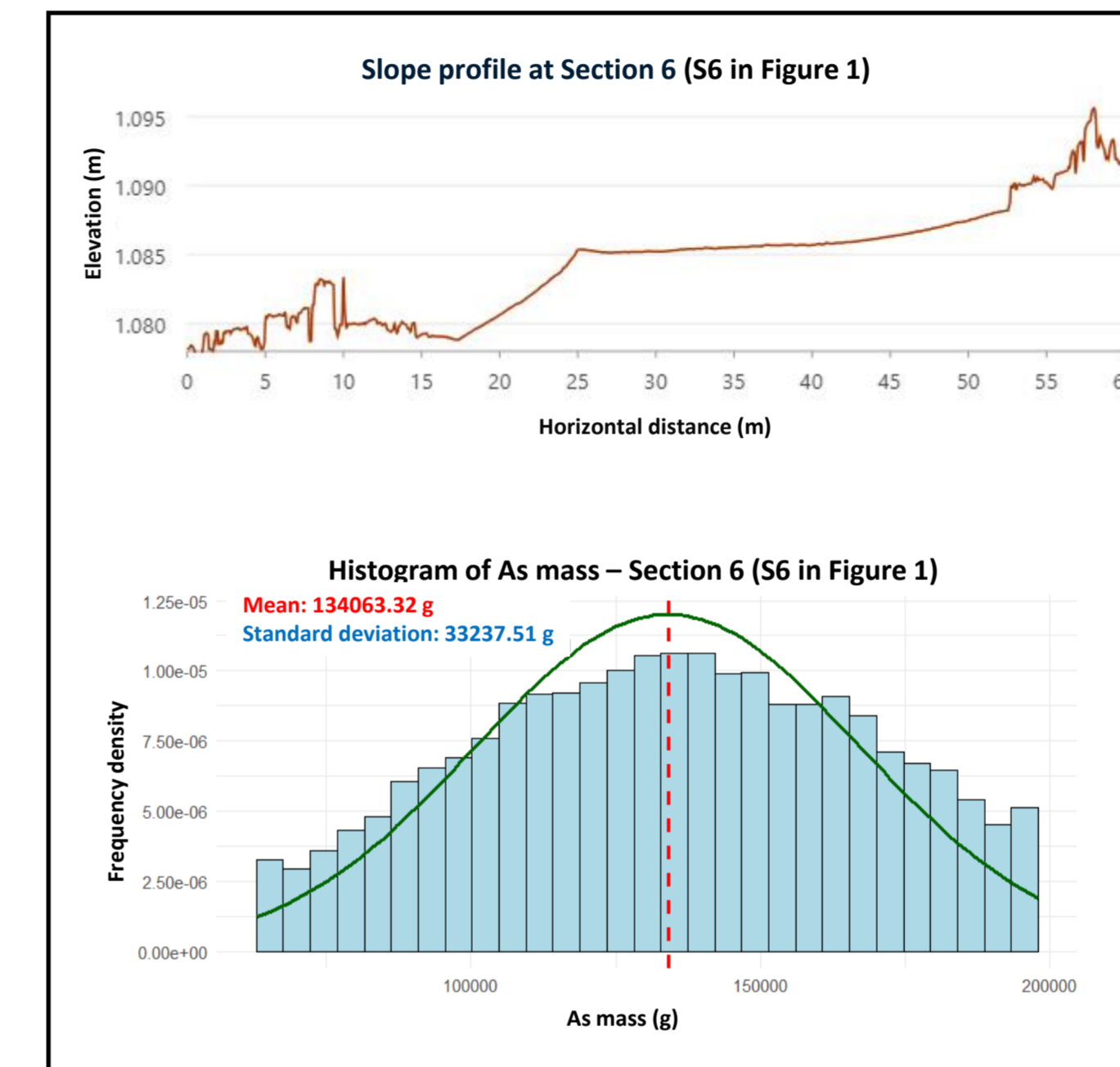


Figure 2. Graphs showing the results for one of the sections (S6): the upper panel displays the slope profile, and the lower panel shows the arsenic mass histogram (exhibiting a Gaussian distribution).

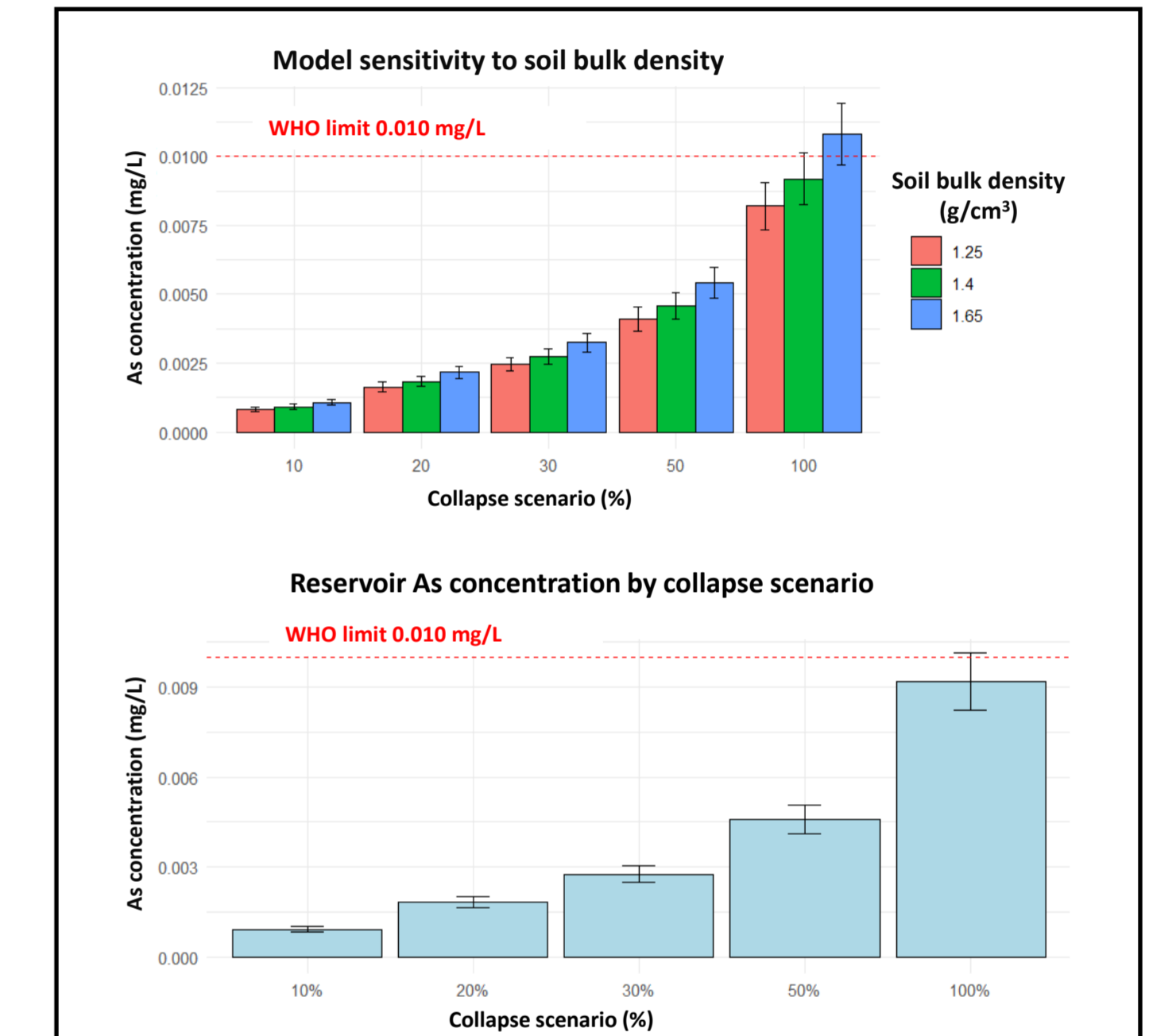


Figure 3. Bar charts show the estimated As concentrations for the different slope collapse scenarios (from 10% to 100%) and the WHO maximum allowed limit (red dashed line).

Results and conclusions:

Modelled slope failure scenarios, ranging from partial to total collapse, were simulated to estimate maximum As concentrations in the reservoir. Results indicated that, under the worst-case scenario analyzed, arsenic concentrations in the recipient reservoir approached but did not exceed regulatory thresholds for potable water (10 µg/L), while partial failures yielded concentrations several orders of magnitude lower.

Although the results indicate that the immediate risk to drinking water quality is low, there may be medium-term effects on ecosystem services such as recreational use, fisheries, and aquatic biodiversity.

The applied methods could be useful as a screening tool to characterize potential ecosystem and human health risks at legacy mining sites.



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