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A lesson from a historic mining site in Italy: when coexistence between contamination and humans is unavoidable

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Global population growth, industrialization, commodity consumption, drive increasing demand for mineral resources. Mining activities cause environmental degradation, releasing heavy metals (HM) to fluvial systems. HM affect human health as well as the terrestrial and marine biodiversity.

River self-restoration requires a time span (10^2 to 10^3 years) incompatible to human timescales. In contrast, a complete remediation of the watersheds is often economically unstainable. In view of the expected higher demand for mineral resources for the “green revolution”, societies are expected to establish specific safety frames for the management of future mine site to preserve downstream river systems and mitigate the risk for humans exposure.

This study shows the implications of a long and intense mining exploitation in the Paglia River (PR) watershed, Italy. The PR drains the east side of the world-class Mt. Amiata mercury (Hg) mining district (active from 1860 to 1980s). Contamination in sediments extends 200-km downstream up to the Mediterranean Sea.

Maps and aerial photos (1883-2019) show that PR underwent a floodplain reduction (> 130%) from 1883 to 2012, changing from a braided morphology to the present-day wandering single-channel river. Mercury is above the law limits (>1 mg/kg) in all the PR floodplain up to the pre-anthropic Pleistocene fluvial terraces.

The distribution of Hg resulted from the interplay of Hg mining, that fed the floodplain with large amounts of Hg-contaminated sediments during the braided stage (end of 1800-mid-1950s), and the subsequent morphological changes of the river after 1960, mostly due to anthropogenic activities (gravel mining), that led to the single-channel morphology. Most of Hg is now stacked in overbank sediments located at a higher level than the present-day watercourse. The nature and the extent of contamination suggest that no clean-up strategies are feasible from an economic and social point of view.

Extreme weather events, expected to intensify for climate change, will contribute to the recurrent distribution of the Hg-contaminated legacy sediments in the floodplain and eventually to the Mediterranean Sea.

In similar mining settings, mitigation strategies should guarantee that the coexistence between humans and HM occur at minimum risk.