

What is environmentally sustainable mining and why is it important?

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Environmentally sustainable mining addresses people and ecosystems impacted by mineral extraction. The Center for Environmentally Sustainable Mining (CESM) at the University of Arizona (UA) was established in 2011 to address the sustainability of mining and rock products operations in arid and semiarid environments. CESM was developed in collaboration with the University of Arizona Superfund Research Center (funded by NIEHS to study waste containment on legacy mining sites) and the Lowell Institute for Mineral Resources. The specific mission of CESM is to develop research and educational initiatives that elucidate the environmental impacts of mining on adjacent ecosystems. We seek to provide the mining industry with innovative tools to mitigate these impacts and creative post-mining land-use applications. CESM also prioritizes neutral tech transfer to state and national policy makers and regulators. Further, CESM contends that environmentally sustainable mining extends beyond environmental stewardship to focus on the social and economic implications of mine development on affected communities.

The United States is one of the largest consumers of mineral resources and thus is heavily dependent on responsible mining development to meet this resource demand. Impressive technological advances in mining and processing operations have expanded economic access to new mineral deposits; however, the encroachment of mining activities on population centers and highly valued public lands poses important challenges to the sustainability of mining. Comparable technological advances are needed to facilitate improved environmental stewardship and minimize social and health impacts on host communities affected by mining operations.

The UA CESM pursues two avenues to identify critical advances needed to improve the environmental sustainability of mining and to mitigate the negative impacts of mine operations on affected human populations. First, the center is advised by a technical advisory committee (TAC) consisting of environmental professionals from international mining companies and consulting firms. The CESM TAC meets biannually to identify, prioritize and develop environmental research initiatives of critical importance to the mining industry. The second avenue is education. CESM education opportunities extend to both UA undergraduate and graduate students and to communities affected by mining.

Research focused on the ecosystem disturbance caused by mining operations is critical to the sustainability of mining in arid and semiarid regions. Arid and semiarid ecosystems are fragile, particularly vulnerable to disturbance, and challenging to reclaim. Water is a



UA undergraduate student Lia Ossanna samples a mine waste rock reclamation site for her undergraduate honors thesis titled “Nitrogen Dynamics as an Indicator of Mine Waste Revegetation Progress.”

necessary component of mineral processing; however, competition for water supply is significant in these regions not only among regional stakeholders, but also for the fauna and flora disturbed by mining operations. Environmentally sustainable mining requires that mine operations include a productive post-mining, land-use use plan for all lands disturbed by mining. CESM contends that lands disturbed by mining operations must be restored to resilient ecosystem status following mine closure. We propose that Environmental Impact Statements (EIS) include a quantification of the carbon sequestration capacity of all vegetated lands projected to be disturbed by mine operations prior to mine development. Secondly, we propose a new post-mine reclamation metric: ecosystem regeneration of the disturbed lands to a cumulative carbon sequestration capacity comparable to the pre-mining land capacity as defined in the EIS. Post-mining land use must minimally restore lands as global contributors to the ecosystem service of carbon sequestration, if no other application is economically feasible.

Current CESM research projects associated with mine closure focus on the following topics: revegetation and mine waste reclamation; erosion mitigation at reclaimed mine sites; remote monitoring of tailings facilities and

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ground water; and closed site management. CESM supports an industry-academic cooperative research model in which multiple mining companies collaborate with CESM to fund research focused on a specific research objective identified by the participating industries. For example, the Revegetation Research Cooperative includes five mining companies with the specific objective of identifying below-ground biogeochemical indicators of ecosystem development as tools to be used by the mining industry to quantify mine waste revegetation progress, evaluate reclamation management strategies, and identify when a reclaimed site has reached resilient ecosystem status. The CESM research aims to make mine site revegetation a data-driven science. The project facilitates evaluation of different management variables such as the significance of capping material quality or seed mix composition.

CESM education opportunities target two audiences. First, UA undergraduate and graduate students are offered internships and graduate research support to study mine site reclamation and related topics. These education opportunities provide a well-trained work force for the mining, consulting, and regulatory industries. Students work in collaboration with industry Environmental Managers and consultants on reclamation projects at mine sites. The research opportunities expose students to the balance between optimal reclamation strategies and economically practical management practices. Students are also funded to present their research to diverse national and regional conferences including SME, the Society of Ecological Restoration, and the Soil Science Society of America. The second target group are community members

impacted by industrial operations. CESM aims to create tools to creatively engage host communities. Through participatory science opportunities, CESM promotes the Democratization of Science. Projects are organized to train citizens to collect samples and conduct their own risk assessment. CESM contends that a well-informed public can better understand potential risk exposures and engage in practical solutions to mitigate health hazards. Diverse initiatives have been developed under the direction of UA assistant professor, Monica Ramírez-Andreotta. For example, Project Harvest engages communities to test the quality of their harvested rainwater to inform decisions on the suitability of its safe use for diverse applications such as livestock, pets, vegetable gardens or human applications. Community participatory science projects empower members to function from a perspective of knowledge rather than fear.

In the coming months, CESM will publish additional technical information about the research supported by our member industry partners. Stay tuned for follow-up technical papers highlighting aspects of CESM research. Additional information can be found on the CESM website: cesm.arizona.edu. ■

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