Mining towards renewable energies

The waste trail of extractive industries for the energetic transition

Challenge Collaborator: Who is behind this challenge?

The multi-disciplinary team of the research project "The potential for AI in the extractive industries to promote multi-objective optimization" includes TUM's Chair of Land Management, Chair of Resources Economics and the Institute for Ethics in Artificial Intelligence.

Introduction

The climate change and the carbon-neutrality agenda have led to the introduction of clean energy technologies and spurred the demand for alternative (incl. renewable energy) energy sources. The organization of production and supply chains to scale up the new solutions and the development of infrastructure to boost their adoption have become a top priority around the world.

In this context, the demand for renewable energy (RE) generation equipment, transmission lines, and high capacity and efficiency batteries has skyrocketed. Various minerals and metals, such as copper, cobalt, nickel and litthium are required to advance new technologies and accelerate the lowering carbon transition. Yet, the largest reserves for such minerals are located in the Global South, where mining of these critical resources poses environmental, social, and economic challenges. There are large reserves of copper in Chile, Peru and the Copperbelt region in Central Africa (between Zambia and the Democratic Republic of Congo); Bolivia, Argentina and Chile have the largest reserves of lithium; and Indonesia leads the countries with nickel reserves. Mining may aggravate or give rise to local water scarcity, food insecurity and tensions related to land-use changes, social inequality, environmental degradation and other issues associated with migration, lack of economic diversification, disruptions to traditional societal systems or distorted regional development.

Problem Definition

The transition towards renewable energies to face out fossil fuels requires mining for copper, cobalt, nickel and lithium in the Global South. The practices of extractive industries, even when legal and regulated (which is not always the case), entail contesting land uses and overlapping human-land rights, they could bring devastating effects for the environment, and leave a trail of waste and damage. In view of the current energy crisis, we have no time to waste. The extraction of these minerals is already taking place – whether we like it or not – and we must act now for it not to be at the expense of our environment and human rights.

What is the waste challenge

The waste trail of extractive industries for the energetic transition has several dimensions to explore and solve. From farmers with customary tenure being evicted at gunpoint from the lands they have lived in for generations by licensed small-scale miners, to child labor in lithium mines. From accumulated poisonous (lead, zinc and copper) mining lag with serious health effects for residents, to rivers irreversibly polluted due to the use of mercury to separate gold from other minerals.
To face this challenge, we need to give answer to some questions, such as:

- What is the life cycle and "waste trail" of copper, cobalt, lithium and nickel (from extraction, to use, to dispose)?
- What are the environmental, social and economic impacts of the waste trail of extractive industries?
- What are the legal, ethical, governance and cultural restrictions and frameworks for these extractive industries?
- Can we formulate a strategy for these extractive industries to be part of a circular economy for the benefit of the community (e.g. with investments in the environment, making sure the profit gets fairly distributed and reaches the most vulnerable)?
- How can we make sure the extraction of these minerals clean, fair and sustainable (regulations, policies, strategies, action plans, responsible use of AI, innovative out-of-the-box ideas)?
- How can we clean the waste trail they have already left?

Desired Impact of Challenge

Acknowledging, understanding and measuring the challenges and impacts of mining will enable us to advance towards renewable energies sustainably and responsibly. We need to make sure that renewable energies are actually clean from the source!
Under sustainability principles, we could formulate solutions to improve the effectiveness and sustainability along supply chains for raw materials navigating companies mining, providing the guidelines to the governments hosting the mines.

Skills needed/recommended

Knowledge on data mining, policy analysis, geospatial approaches (GIS, Remote Sensing, Machine Learning), responsible AI and environmental planning is desirable but not mandatory.

Relevant considerations for the challenge / theme:

Our team has been working on this topic for a few months, and has been collecting data in different points, with local collaborators (Ghana, Zambia and Indonesia on site, as well as different open access geoportals). The Center of Energy Markets is developing an AI platform for multi-objective optimization to characterize the objectives of the stakeholders involved. The IEAI has close collaboration with the Responsible AI Network and the AI for Earth Observation Future Lab. This means that there are some dimensions to this research project that are already being explored, however, this would be our first incursion on the (environmental, social, economic) impacts of the waste trail of extractive industries.
We would be happy to share the data, and happier to have our database expanded!

Relevant links:

https://www.ieai.sot.tum.de/research/the-potential-for-ai-in-the-extractive-industries-to-promote-multi-objective-optimization/