Creating global mineral extraction maps

From raw data to consistent accounts

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For creating raw material extraction maps with world-wide coverage, extraction data from different and often highly heterogeneous sources is used, reporting spatially explicit information or national aggregates. This requires handling and integrating various data formats and structures, as well as addressing inconsistent reporting on the same mine or mining region. In this Brief, we describe our methodological approach to achieve highest possible data consistency when elaborating global mining maps.

Introduction

One objective within Work Stream 1 "Extraction" of FINEPRINT is to map the global extraction of abiotic raw materials, i.e. metal ores, non-metallic minerals and fossil fuels. We aim to produce time-series of global extraction maps, starting with the year 2000 and covering at least 30 mineral commodities. Our maps will form the base to assess world-wide spatiotemporal extraction patterns to identify hotspots and shifts of mineral commodity extraction over the past decades. This, in turn, will be a crucial step towards linking extractivist economic practice with its environmental and social impacts.

In the implementation, we demand high consistency of the generated data set with regard to reported national aggregates, calling for a close examination of coverage and completeness of various available datasets on raw material extraction. We have elaborated a methodological approach, which allows combining different data sources - reporting spatially explicit information or national aggregates - in order to achieve best possible data quality and robustness. The following explanations focus on the part of mining, i.e. on metal ores and non-metallic minerals, including coal and oil sands, but excluding other fossil fuels.

Integration of spatial and national accounts

Regarding spatially explicit data on mining, we consider four types of data sources. First, we use information from the Global Metals & Mining database provided by S&P Global Market Intelligence (SNL Metals & Mining). It currently contains profiles on over 36,000 mining properties and covers 4,500 mining companies [1]. The second pillar are company reports available online for a wide range of mining companies, in order to include in our database as much open and transparent data as possible. Third, some countries have either national institutions (such as the Peruvian Ministerio de Energía y Minas, [2]) or are part of non-governmental initiatives (e.g. The Extractive Industries Transparency Initiative - EITI) providing nation-wide information on the exact location of mines and their respective extractions. Lastly, there already exist region-specific data sets used in academia, such as the data by the research group of Gavin Mudd at RMIT University in Australia [3,4].

Figure 1 provides an overview of the FINEPRINT approach for integrating spatially explicit and national extraction data.

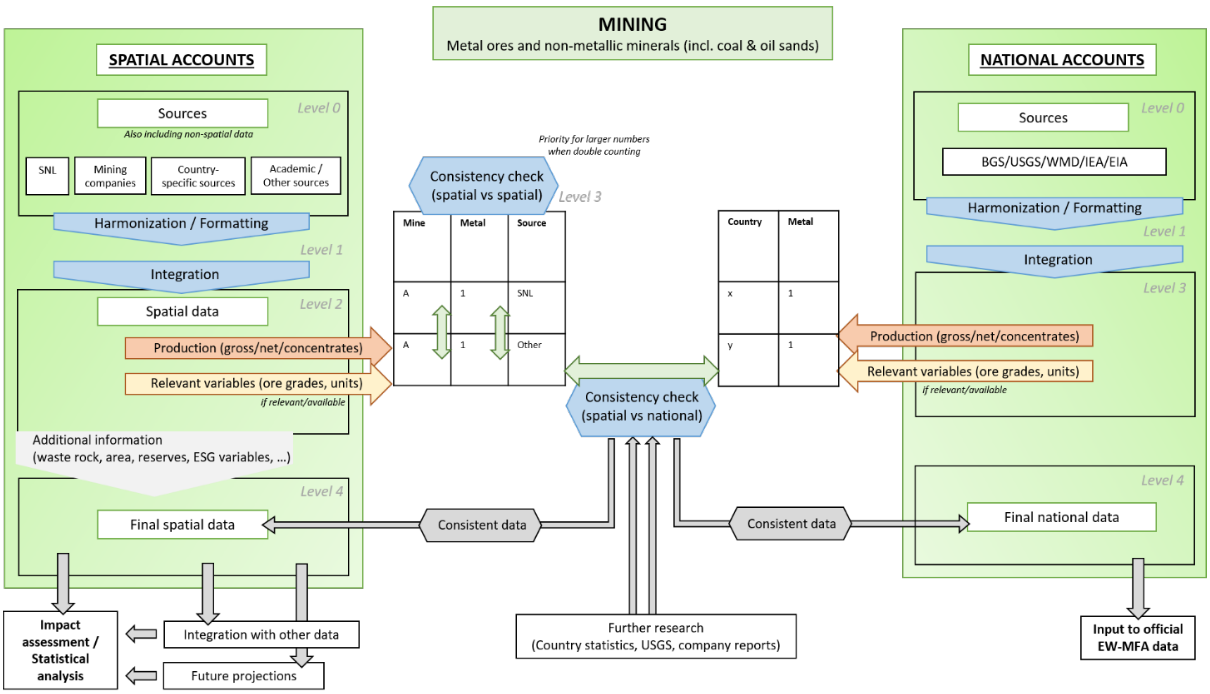

Figure 1: The FINEPRINT work flow for consistently integrating spatial and national mining accounts

As an initial step, we record each data set from the specific sources separately (speaking of raw or level 0 data). We then convert them into a common structure and format that in case of spatial data includes the Coordinate Reference System (CRS). This is referred to as level 1 data and is ready for spatial statistical analysis if no further data modifications (see below) are necessary. Subsequently, we integrate this data stemming from either of the four types of sources into one harmonised dataset (level 2). This data is still subject to double counting and has to be differentiated by its primary source.

Two types of consistency checks

We conduct two major comparisons in order to ensure consistency of the final data set. The first one checks mine-specific data, in particular on production, against each other in case two or more sources are available (resulting in level 3 data). This is done, as sources might cover different years, numbers of mines, variables (e.g. gross versus net production, or even no production, but geographic coordinates), or commodities produced in a mine. But also reliability and accuracy can be increased, as the information reported for a specific mine by various sources may differ, requiring to select the most appropriate data. Although the criteria applied in these cases will be specified and tested at a later stage, one approach would be to rely more strongly on the sources that report larger extraction amounts. Other measures that can be considered include taking the means of reported extraction or applying statistical models to balance the data and estimate uncertainties.

The second major comparison checks aggregated mine-specific data on production and ore grades against the national material flow accounts (resulting in level 4 data). Our group has long-term expertise in compiling national material flow accounts and together with partners developed the Global Material Flows Database for UN Environment's International Resource Panel (IRP). The comparison with the national extraction aggregates is performed, as data on both the mine-specific and the national level might be subject to gaps, e.g. a mine not occurring in a data set, or no proper national accounts existing for a country because of missing infrastructure for statistical data collection. Further, flaws may exist in the numbers reported by either data source. The final data after this step ideally has an increased coverage in various dimensions (time, mines, production) as well as increased reliability of both the spatial accounts and the national accounts.

Gap filling of gross / net production and improved ore grade estimations

One major weakness of the national extraction accounts is that production is often only reported in net production (metals contained in crude ore), with information missing on - the environmentally important - gross production. So far, estimating gross material extraction from reported net contents used relatively simple approximations for average national ore grades. This significantly influenced the robustness of the final dataset due to uncertainty underlying these estimated conversion factors. Based on spatially explicit information on ore grades and production, however, we are able to calculate time-specific and production-weighted national ore grades from several data points and thus improve the national accounts using mine-specific information.

These improved national accounts on production, in turn, serve as estimates for data points where we know about the existence of a mine, but where no production data is available, thus providing an additional benchmark for completing spatially explicit data. In cases where extraction data on the national level exceeds the aggregates calculated from the spatial point data, there might be an issue of non-documented mines, requiring gap filling via additional measures such as consideration of further country statistics or company reports. Vice versa, aggregates from spatial accounts may also contribute to upward adjustments of national accounts whenever extraction numbers are higher than reported by the respective institutions on the national level.

The final product: global consistent extraction maps

The above elaborated methodological approach will allow us to embed consistent accounts of mineral extraction into the broader context of FINEPRINT, where we create global extraction maps not only regarding mining activities, but also covering oil and gas production as well as biomass extraction. This database will be accessible via browser interfaces as map tools and other visualisations in order to analyse extraction patters and their changes over time. In addition, we will provide open access to the data sets (under the restriction of meeting copyright conditions of the primary data sources), following our strong commitment to open science and reproducibility as discussed in Brief No. 1.

Citation

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