Earth Observations for Managing Mineral Resources

1. Executive summary

Title: Earth Observations for Managing Mineral (and Non-Renewable Energy) Resources
Short title: GEO4Min
Existing category: Community Activity
Overview: in a global context where a tremendous demand for minerals and raw materials is expected to face the needs for a low-carbon society and renewable energy production, EO data, including in-situ data, can contribute to the production of objective, reliable, affordable and indisputable integrated products and documents that can be used to i) assess mineral resources and ii) educate, demonstrate, inform, alert and reassure the general public and enforce regulation, hence contributing the UN Sustainable Development Goals.

Planned activities: the CA activities will be centred on the development of EO-based tools and services for managing mineral resources and delivering the relevant information to the general public via web-based platforms.

Depending on funding opportunities, the CA key activities will consist in:

- Contributing to the on-going Global Soil Spectral Library (GSSL);
- The development of advanced tools for spectral soil and raw material identification and mapping for future hyperspectral spaceborne missions;
- The development of essential variables for the extractive industry that can serve for the monitoring of their footprint
- The development of tools and services for monitoring the environmental and societal impacts of mining in a Social Licence to Operate (SLO) perspective.
- The development of EO-based early warning systems, at national to trans-boundary scale, to help governments in monitoring illegal mining and enforcing relevant regulations.

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2. Purpose

The exploitation of mineral resources, including non-renewable energy resources, has played, and still plays, a significant role in the development of many countries all over the world. The industry has been, and continues to be an important contributor to both national and regional economies and is critical to national defence. Mining, and the industries it supports, is among the basin building blocks of a modern society.

The benefit of exploitation to those countries has been many, but has come at a cost to the environment. Early mining operations have left a historical legacy of negative environmental impacts that affect our perception of mining. As countries have matured, there has been increasing recognition that environmental protection is as fundamental to a healthy economy and society as is development. The challenge is to simultaneously promote both economic growth and environmental protection.

Social impacts of mineral resource exploitation are complex and controversial. It can generate wealth, while triggering significant disruptions. A project can generate employment, transport infrastructure, education facilities and increase goods and services availability in remote poor areas; however these benefits might be unequally shared. Social tensions and conflict, sometimes riots, can rise from affected communities. Illegal and uncontrolled mining activities can generate environmental disasters, societal disasters including human trafficking, and conflicts, including armed, along with significant

economical losses for the affected countries. It can also imperil the live of workers due to the lack of security precautions. A regularly updated monitoring is essential for those countries.

With respect to the UN SDGs, in particular SDG 7, the development of cleaner energy production towards a low-carbon society will require a tremendous growing demand for raw material and mineral resources, in particular Critical Raw Materials (CRMs). A recent report from the World Bank[1] estimates the rise in demand for metals in low-carbon energy supply scenarii as well as the relevant metals and, alerts on the critical role that mining and metals will need to play in a global zero carbon transition.

Together with other sources of data, EO, including in-situ data, can contribute to the production of objective, reliable, affordable and indisputable integrated products and documents that can be used to educate, demonstrate, inform, alert and reassure the general public and enforce regulation, hence fostering a sustainable dialogue among the stakeholders.

Overarching activities of the EO data for managing mineral (and non-renewable energy) resources will include:

1. Develop tools and Information for the Resource Assessment, Monitoring and Forecasting of Geological Resources (including mineral and fossil resources, raw material and groundwater).
2. Develop tools for impact monitoring of mining operations.
3. Identify and foster implementation of strategic measures for the competitive, reliable and sustainable management of geo-resources exploitation and treatment of re-usable materials.

These activities address all stakeholders of the extractive industry sector, including the operators, governments and regulatory bodies and potentially affected local populations, in a Social Licence to Operate (SLO) perspective.

3. Background and previous achievements

Activities foreseen for the 2017 – 2019 period consisted in:

- A preparatory work for global mineral mapping program using existing (ASTER) or future missions, on the model of the Australian Mineral Map performed by CSIRO using ASTER imagery, to be delivered to the GEO data archive.
  - ☞ A proposal for funding a Global Geoscience Map has been refused by NASA. ASTER mineral mapping over parts of China and Greenland using the ASTER Version 2, using green and dry vegetation unmixed methods developed at CSIRO.
- Developing a global spectral library of soils for future quantitative soil spectroscopy from laboratory to spaceborne applications, towards the definition of possible product standards for global, public hyperspectral satellite mapping of soil surface composition
  - ☞ The Global Soil Spectral Library (GSSL) is going on. Mediterranean SSL under GEO-CRADDLE H2020 project (http://datahub.geocradle.eu/dataset/regional-soil-spectral-library). This SSL consists of 4000 soil samples from Israel, Turkey, Cyprus, Greece, Bulgaria, Serbia, Albania and Egypt. All the samples within the SSL were measured under the CSIRO protocol which enables a merging of SSLs from different spectrometers, laboratories and conditions.
- The definition, or refinement, of a set of area-specific essential variables to be validated by the CoP and GEO in view of measuring and monitoring the status of mineral resources assessment and exploitation.
  - ☞ On going, through the GEOESsential EC H2020 project
- The definition of methodologies and tools to map these essential variables from existing and future sensors, including citizen observatories.
  - ☞ No specific progress made, due to lack of dedicated project over the period.

[1] Arrobas, Daniele La Porta; Hund, Kirsten Lori; Mccormick, Michael Stephen; Ningthoujam, Jagabanta; Drexhage, John Richard. 2017. *The Growing Role of Minerals and Metals for a Low Carbon Future (English)*. Washington, D.C. : World Bank Group

- A global mining waste inventory program by adapting e.g. the PECOMINES project methodology to currently available sensors (Landsat TM, Sentinel -2) and/or future high spectral resolution missions.
    - ☞ No progress made to date. It has not been possible so far to arouse the interest of the competent authorities, despite lobbying efforts

4. Key activities

The CA needs to increase its visibility with respect to the importance of raw materials in every sector of the society and economy. Mineral resource exploitation is far to be popular, despite its unquestionable significance in our daily life. It is necessary to revitalise the CA by proceeding to a reorientation of its scope, focusing on the growing demand in mineral resources for a low-carbon society and the SDGs of relevance.

Informed renewable energy policy planning in developing and developed countries can benefit from the use of Earth Observations and information trough the development of EO-based products and services for energy and mineral management.

There are good hopes that such developments will be supported by relevant projects funded by the current and next EC H2020 calls (2018-2020 Work Programme on Climate, environment, resource efficiency and raw materials) focusing on EO in support of sustainable mining. Depending on the call results, CA's members will either participate in such projects, or work in close collaboration with successful consortia.

4.1. Mapping mineral resources

EO for management of mineral resources can provide global reach, non-invasive, scalable, temporal, accurate maps and models of land surface composition and condition at all stages of the resource development cycle from exploration and discovery through to mine closure and hence help in achieving the UNDP SDGs. Significant gaps however exist in providing current and robust data on mapping relevant mineral/metal resources in developing country regions: Africa, Latin America, and Asia, e.g. survey gaps in Africa.

- ☞ Only institutionally supported international programmes could help filling these gaps using EO.

4.2. advanced tools for soil and raw material spectral identification and mapping

The "mineral community" today lacks dedicated EO system or program and currently use systems and programs from other GEO SBAs. Apart from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) program, global coverage by high-spectral resolution spaceborne sensors in particular is not available yet.

The German satellite mission EnMAP (Environmental Mapping and Analysis Program) is now confirmed for launch end-2020 with a focus on soil and mineral resources. In this frame, generic algorithms are being further developed by the Helmholtz Center Potsdam for global soil and mineral mapping applications from upcoming hyperspectral space missions.

- ☞ The new versions of the EnGEOMAP (EnMAP Geological Mapper) and the ENSOMAP (EnMAP SOil Mapper) algorithms will be until end of 2019 implemented in the "EnMAP-Box 3" in the QGIS environment (now in python, free software) and will be freely available from the web, worldwide.

In addition, several CA's members (University of Tel Aviv, University of Nottingham, Helmholtz Center Potsdam) are contributors to the Advisory Committee for the ESA candidate mission CHIME (Copernicus Hyperspectral Imaging Mission for the Environment), a global mapping hyperspectral mission. An important focus of this mission is on natural resources, recognising the importance of soil and mineral resource mapping. This mission is in phase A/B1, decisions in end of 2019 about further phases.

- ☞ This mission if this is confirmed will contribute greatly to the goals of the CA as it will provide up to date soil & mineral maps all over the world.

The Israeli Ministry of Agriculture has funded a national project to extend the local Soil Spectral Library (SSL) not only with samples but also with spectral coverage. Accordingly, the Israeli SSL is now covering the VIS-NIR-SWIR and LWIR spectral region and consisting in more than 4000 samples. A national project in Brazil to generate a Brazilian SSL is getting a remarkable progress where more than 30000 soil samples have been collected. The CSIRO protocol is also adopted by Brazil. The European SSL of LUCAS (EU Land Use/Cover Area frame Survey) is also getting progress where more samples entering the current SSL. The LUCAS SSL also adopted the CSIRO protocol.

4.3. Raw material specific Essential Variables

The University of Geneva/enviroSPACE Lab is coordinating the H2020 ERA-PLANET / GEOESsential[2] project (sept. 2017-Aug. 2020). One of its work packages is dedicated to (1) the determination of policy needs and indicators/essential variables for extractives; (2) monitoring of the footprint of open mines through time; and (3) improvement of the global Map-X[3] extractive geospatial platform (http://www.mapx.org) linking it to Copernicus and GEOSS.

4.4. Societal and environmental impacts of extractive industries

Illegal and uncontrolled mining activities can generate environmental disasters, societal disasters including human trafficking, and conflicts, including armed, along with significant economical losses for the affected countries, in particular in Latin America and Africa. It can also imperil the live of workers due to the lack of security precautions. EO-based early warning systems, at national to trans-boundary scale, could help governments in monitoring illegal mining and enforcing relevant regulations.

- ☞ Developing such systems would benefit from national to international institutional support.

Recent initiatives for more responsible and sustainable practices in mineral resources exploitation reflect a trend in better addressing the societal acceptability issues of mining. This includes international (e.g. European Industrial Partnership on Raw Materials EIP-RM) and national mineral policy strategies, responsible mining initiatives by exploiting companies, "green mining" initiatives, Social License to Operate (SLO) approaches, etc.

- ☞ Next EC funded H2020 dedicated projects will help addressing these issues by developing relevant EO-based products and services.

5. Relationship to GEO Engagement Priorities and to other Work Programme Activities

5.1. UN SDGs targets

The Columbia Center on Sustainable Investment (CCSI), the UN Sustainable Development Solutions Network (SDSN), the United Nations Development Programme (UNDP), and the World Economic Forum have released a report entitled "Mapping Mining to the Sustainable Development Goals: An Atlas[4]". The report concludes that mining industry has the opportunity and potential to contribute to all 17 UN SDGs and that the scope and nature of mining activities create opportunities to leverage some goals in particular.

5.2. Paris Agreement pillars

Mitigation: limiting forest degradation due to uncontrolled mining, contribution to the supply of material, including CRMs, for low carbon energy production.

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[2] http://www.geoessential.eu/wp5/

[3] www.mapx.org

[4] Mapping Mining to the Sustainable Development Goals: An Atlas, July 2016, http://unsdsn.org/resources/publications/mapping-mining-to-the-sustainable-development-goals-an-atlas/

5.3. Sendaï framework

For the second time in three years, Brazil faced a humanitarian and environmental disaster in the wake of a mining dam collapse. On January 25, 2019, a retaining wall abruptly failed along the edge of a pond of mud-like waste material from a Brazilian mine[5]. This accident comes after many others in several countries.

Target G will be addressed through early EO-based warning systems, potential mud flow extension modelling, and post crisis assessments.

5.4. Initiatives

GEO-VENER: develop close interaction with the GEO-VENER initiative, in particular in linking low-carbon energy production to mineral resources availability. This will be done via an active participation in a revitalised Energy CoP, within the frame of the "Energy and Minerals" SBA.

GEO-CRADDLE: The CA will work closely with this newly introduced GEO-CRADDLE regional initiative in its application-oriented products of relevance and pilot sites for raw materials.

GEO/GEOSS Essential Variable Initiative: should this suggested initiative comes about, the CA will contribute to the definition of the Extractive Essential variables (EEV) and conversely.

6. Data Policy

All the participants and contributions adhere to the GEOSS Data Sharing Principles and GEOSS Data Management Principle. Data collected in CA relevant projects will be open to all non-profit research with the permission of data provider.

[5] https://earthobservatory.nasa.gov/images/144501/another-deadly-dam-collapse-in-brazil