European Geosciences Union

Futu RaM

Future availability of secondary raw materials

Urban Mine Platform and European historical mining waste database aligned with Critical Raw Materials objectives

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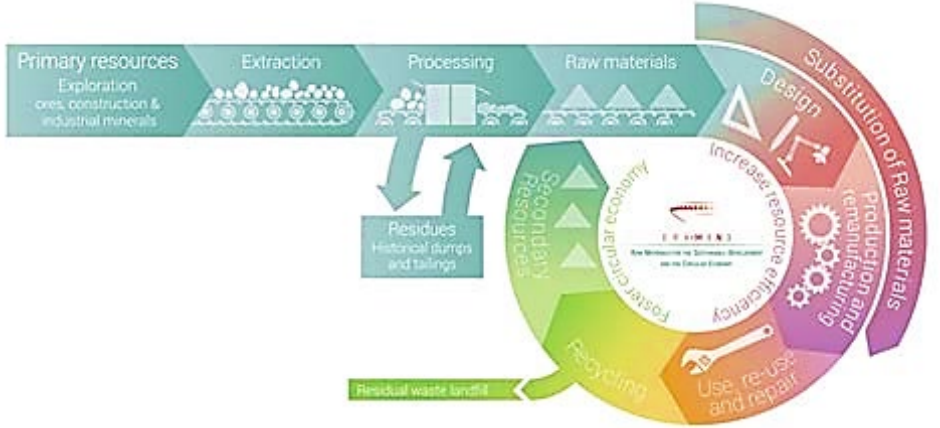
Set the scene *(1)*

- Mining waste is **one of the largest waste streams in the EU**. It comes from **extracting** and **processing** mineral resources and includes materials, such as topsoil overburden, waste rock, tailings, stockpiles and slags (when metallurgy facility is close to the mine)
- Mining waste is located near the underground and open-pit mining sites => visible **changes in the landscape**: artificial hills, tailing dams,…
- The management of tailings is also risky. It is often stored in heaps or in large ponds surrounded by a dam. These can collapse, with **disastrous consequences** and a **lasting impact** on human health, the economy and the environment.
- It contains large quantities of **dangerous substances**, such as heavy metals, the extraction and processing of which can result in acid or alkaline drainage
- Time has come to **exploit historical and present mining waste** with a **Critical Raw Materials perspective**: improve the assessment of the potential and engage in profitable and sustainable industrial processes



Open-pit mine (Sweden)

Copper plates (Spain)

Stockpile (Bulgaria)

Acid drainage (Sweden)

Set the scene *(2)*

- European Critical Raw Materials Act (EU CRM Act – 2024)
  - **Strengthen** EU's critical raw materials **capacities** along all stages of the value chain
  - **Ensure** EU **access** to a secure and sustainable supply of CRMs, enabling Europe to meet its 2030 climate and digital objectives
  - **Diversify supply**, with more recycling & more domestic production.

- **Article 27 *"Recovery of critical raw materials from extractive waste"*** – Active and historical mining wastes. For historical mining waste, milestones:
  - 24 November 2026: **Database** shall be put in place by the **Member States**
  - 24 May 2027: **All information** shall be **introduced** in the national databases
  - 24 November 2027: **Member States** shall adopt and implement **measures to promote the recovery** of CRMs from extractive waste, in particular from closed extractive waste facilities

Mining waste and acid drainage (Sweden)

Old open-pit under rehabilitation (Sweden)

Old open-pit under rehabilitation (Sweden)

CRM recovery pilot process (France)

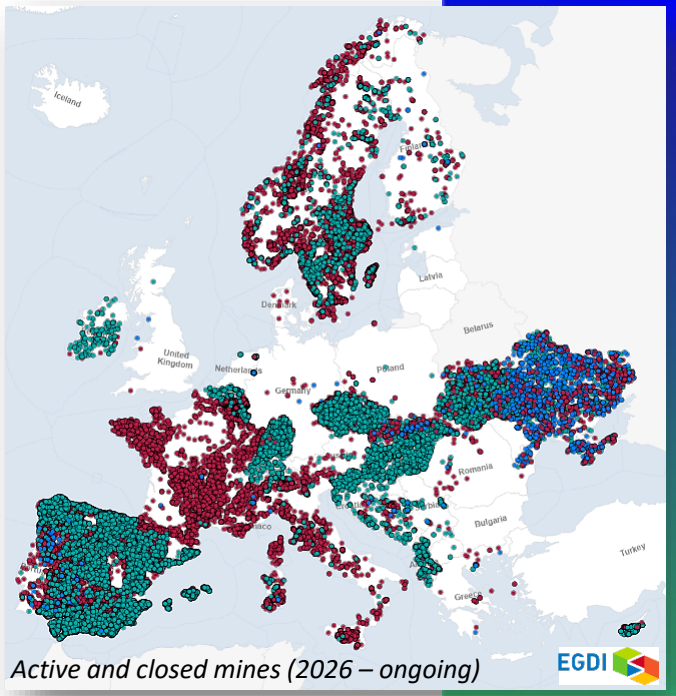
Mines and mining waste inventories

- Extractive Waste Directive (2006) designed to **prevent or reduce any adverse effects on the environment and human health** through the proper management of mining waste: (1) Ensure the long-term stability of disposal facilities; (2) Prevent or minimise water and soil pollution
- EU Member States to establish national inventories: **risk-oriented, not for metal recovery**
- **Inventories**: at **national** level (EU Member States) => consolidation at **EU level**
- Ongoing EU-funded Project: GSEU-Geological Service for Europe *(Consortium within EuroGeoSurveys: Geological Surveys of Europe)*
- Work package on EU primary & secondary onshore and offshore CRM resources
- National inventories in progress: mines and historical mining waste sites
- Challenge: **characterise the mining wastes**: quality, quality, recoverability

- **A portfolio of projects** (2029-2027)

2009 2013 2015 2017 2020 2022 2026 2027

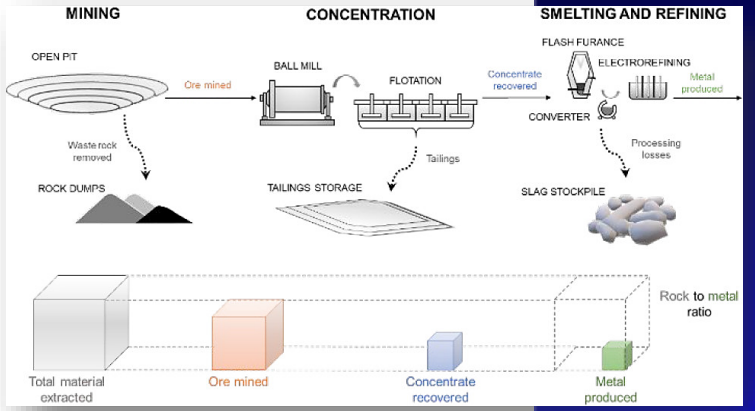
Aznalcollar, 1999 (Spain)



Active and closed mines (2026 – ongoing)

Historical mining waste inventories and databases

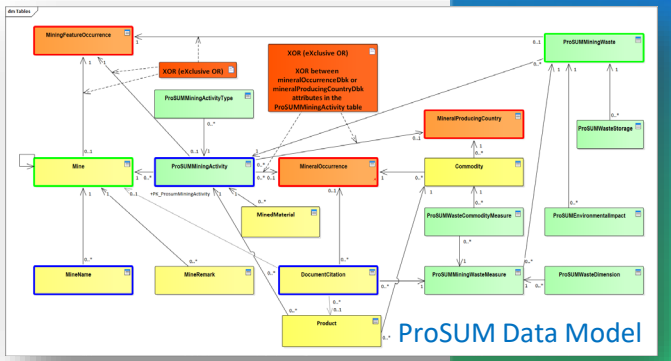
- Short definition: **Mining waste results from the prospecting, extraction, treatment and storage** of mineral resources and the working of quarries
- Waste rock stockpile / Tailings storage facility / slag dump
- **Governance of inventories**
  - National databases by mineral resources authorities (geological surveys, Minerals Commission…)
  - Project-driven => data gaps (European Union, European continent)
  - CRM Act (2024) introduces a legal and temporal framework with obligations to EU mining countries
- **Data models**: national structures and code lists + European data model using INSPIRE-Mineral Resources & IUGS/CGI-EarthResourceML
- **Main descriptors** in the database:
  - Generalities, location, name
  - Metal content
  - Surface, volume, tonnage, resource estimation using standards (e.g., UNFC)



https://pubs.acs.org/doi/10.1021/acs.est.1c07875

Tungsten mine tailing storage (Enguiales, France)

Acid drainage (Enguiales, France)



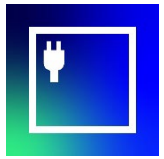
ProSUM Data Model

>> SARA4UNFC: A Holistic approach to assessing mining and extractive waste activities – EGU26-22292
Soraya Heuss-Assbichler – Wed. 06 May 17:35-17:45 Room -2.43

FutuRaM - Future Availability of Secondary Raw Materials

- **FutuRaM** developed datasets, methods and tools to assess Secondary Raw Material availability across Europe's key waste streams
- **Building on ProSUM** project, FutuRaM extended the Urban Mine Platform: a knowledge base on the availability and recoverability of SRMs with a special focus on CRMs
- Geographic extension: **EU27+4** (Iceland, Norway, Switzerland and the UK)
- Duration: **4 years** (2022 – 2026)
- Consortium: **28 partners from 11 countries** – 6 universities, 5 geological surveys, research institutes, industries and associations of industries
- **Complementary communities**: industrial ecology, process engineering, recycling, statistics,
- Analysed **42 elements** contained in **7 waste streams**
- **3 recoverability scenarios** up to 2050: Business-as-Usual | Improved Recovery Systems | Circular Economy

Batteries


Electrical and Electronic Equipment

End-of-life vehicles

Slag and Ashes

Mining waste

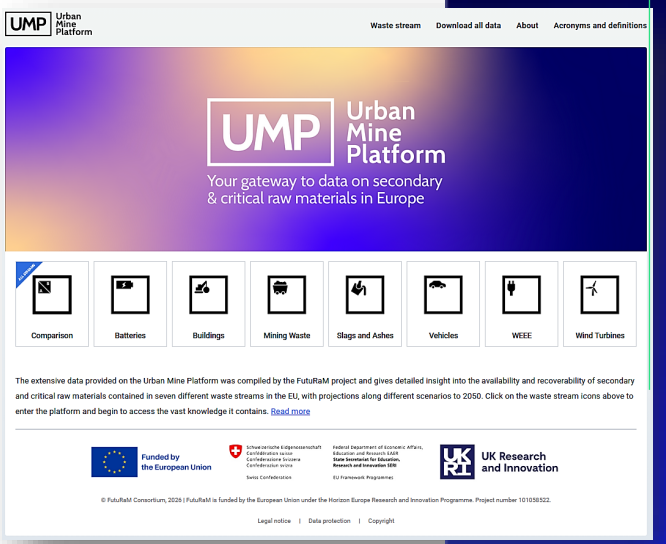
Construction and demolition waste

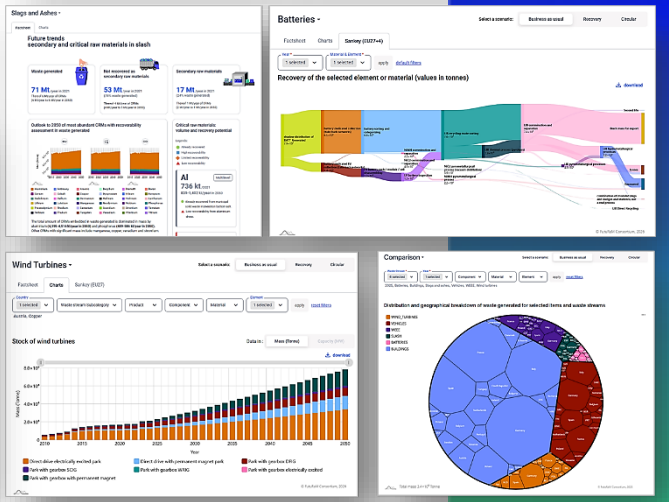
Dismantled wind turbines

Urban Mine Platform

- **Visualise the availability of CRMs across Europe**'s waste streams analysed using a common framework that tracks flows from products and components down to individual materials and chemical elements
- For each waste stream:
  - **Fact Sheet** with key figures on volumes, potential recovery and future trends (2030, 2050)
  - **Interactive Charts** with multiple filters
  - **Sankey Diagrams**
  - **Data Download** (selected subset and complete data set)
  - 3 **Recoverability Scenarios**
- Multi-waste stream **comparison graphics**
- 44 GB database
- **Optimised database** structure and tables to minimise the response time and maximise the user experience

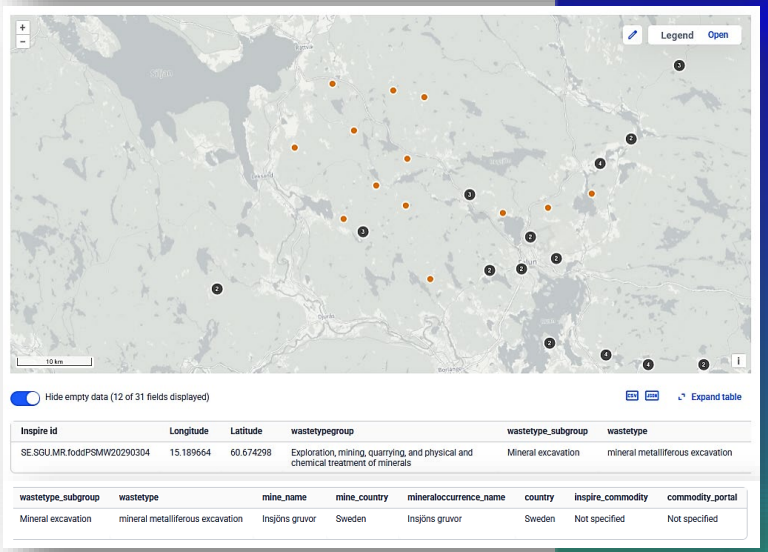
	Number of records (x1,000)
Batteries	7,600
Buildings	743
Slags and Ashes	831
Vehicles	9,747
WEEE	17,522
Wind turbines	8,564





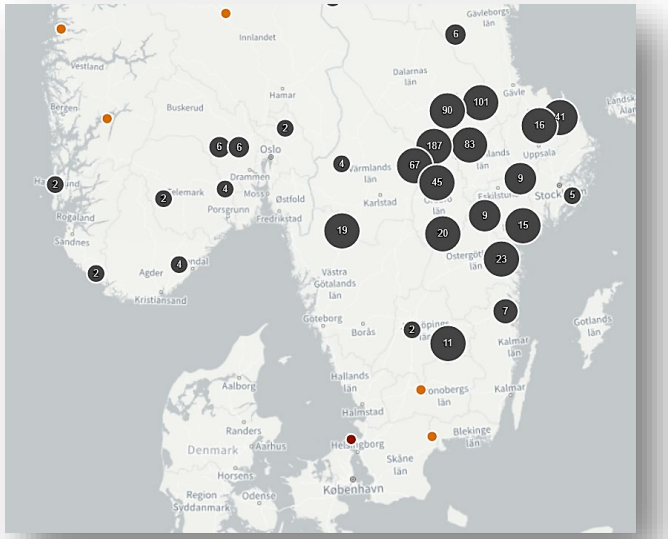
Historical mining waste sites in Urban Mine Platform

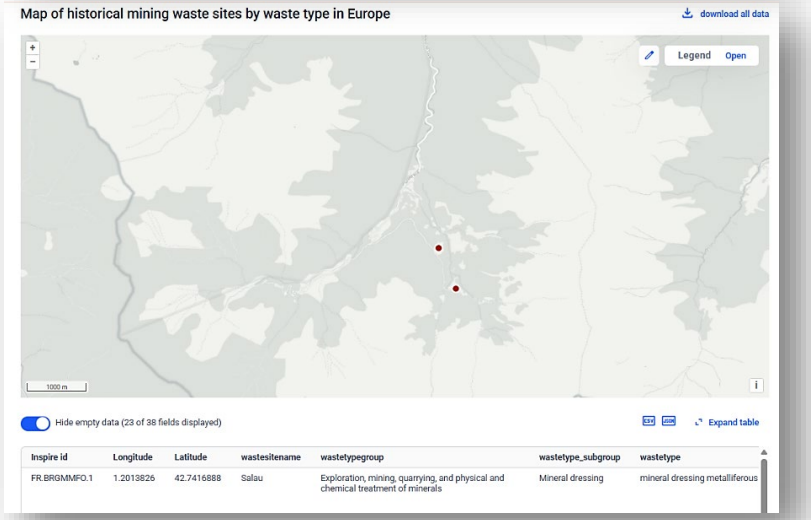
- Mining waste sites are georeferenced => **interactive map**
- Capitalised in the **European Mineral Resource Database MIN4EU** (primary and secondary) created and operated by (GSEU-Geological Service for Europe) EuroGeoSurveys
- **Ongoing inventory** programs at **national level** *(as on date)*:
  - 20 countries (EU and continental Europe)
  - 1,900 single mining waste deposits (clustered points on the map)
  - 4,300 measures (4,300 lines in .csv downloadable files)
- **Web service** exposed by the European Geological Data Infrastructure (EGDI) operated by EuroGeoSurveys
- Contents accessible on **UMP permanently updated**
- **Interactions** with the data set:
  - Tabular display of map-selected sites
  - Multiple filters: Country / Waste type / Commodity
  - Data download

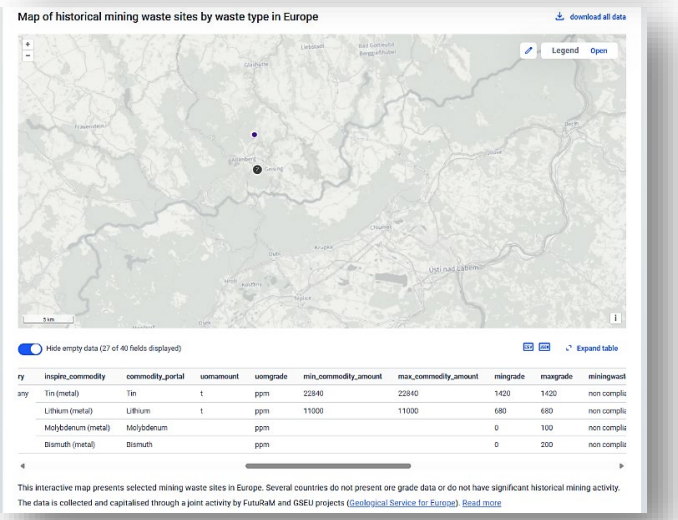


Historial mining waste sites in Urban Mine Platform

urbanmineplatform.eu/waste-stream/mining-waste







Perspectives – Way Forward

- FutuRaM created the UMP, with **the most comprehensive digital map of CRMs** in the EU27+4
- **All data is accessible** at *www.urbanmineplatform.eu* and via FutuRaM's repository on Zenodo
- **Legal framework CRM Act** (2024): anticipating obligations at MS and EU levels; timeline and milestones
- Transition from Project-driven to **Directive-driven**
- National databases in place and **national inventories in progress** in Italy, Spain, France, etc.
- European database **MIN4EU in place and operational**: primary and secondary mineral resources
- National inventories and **database population** are essential for knowledge and transparency
- Plans to **expose APIs to connect with other platforms**
- **FutuRaM worked closely with the European Commission** (e.g., DG GROW, DG JRC/RMIS)
- **Institutionalise the UMP** as a core EU data infrastructure provide a permanent, trusted source of data to:
  - support monitoring, investment planning, and regulatory implementation,
  - prevent valuable materials from being lost through informal channels
- **Project proposal submitted: FutuRaM 2** *"Future availability of secondary raw materials to support circularity and resilience"*

Perspectives – Challenges

- **National inventories** of mineral anthropogenic concentration occurrences: **country specific** (historical mining activity, country size, governance and administration)
- Data standard in place to enable interoperability but **data content is heterogeneous** (description, quantification of wastes, etc.) ➔ harmonisation of methods
- Secondary mineral resource deposits of **very large size** and **scattered** around the countries
- Only a **limited number is quantified** (volumes, chemical content): technical and financial means
- **Confidentiality of data**: national vs. European strategies
- Limits of the **open data** framework: *"as open as possible, as closed as necessary"*
- **CRM Act to boost** the private sector to engage in exploitation of historical and present mining waste ➔ business models for economic sustainability are required
- Common to primary and secondary mineral resource exploitation: **social acceptance**
- Boost in **recovery technique** improvement and innovation
- **Recovery factor modelling** also evolves rapidly to minimise the uncertainties of estimated volumes and trend scenarios
- FutuRaM involves **public and private stakeholders** to maximise the impact of research and development on sustainable mineral resource economy as well long-term environment protection

FutuRaM

Future availability of secondary raw materials

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