



In collaboration with
UN Environment
GRID Geneva

Remote sensing techniques for small-scale mining detection

by

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Presented at: The impact of illegal economies on
the environment: monitoring of illegal mineral
mining



This project has received funding from the Directorate-General for Internal Market, Industry Entrepreneurship and SMEs of the European Commission, a body of the European Union, under grant agreement no. 271/G/GRO/COPE/17/10036.



RawMaterials
ACADEMY

19/04/2023

Small-scale and artisanal mining

Major types:

- underground mining of veins
- alluvial mining of particles that concentrate in water pathways
 - Excavation in water channels
 - Excavation on river banks

Small-scale mining can use large machinery.



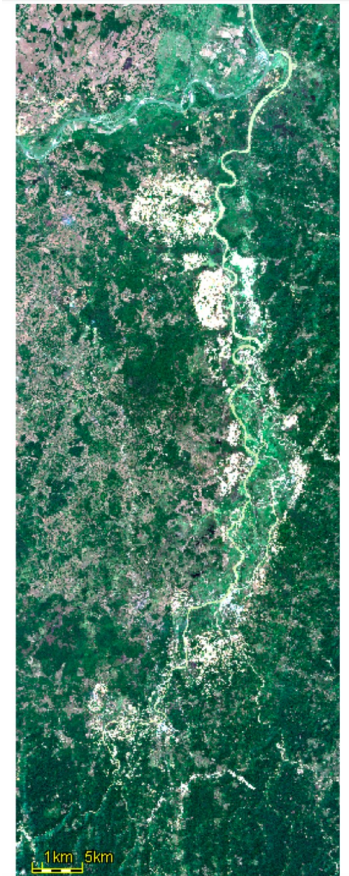
Photo by Elsy Ibrahim/Luisa Lema
El Bagre/ Zaragoza – Colombia, Nov. 2018

The challenges

Small-scale mining provides livelihood to many households

Unfortunately

- has a **large footprint** with low monitoring or regulation
- has **environmental impacts** (e.g. land degradation, wetland destruction, heavy metal accumulation and biomagnification)
- has **health impacts** (e.g. the inhalation and ingestion of mercury, safety of working conditions)
- has **social impacts** (e.g. is in the heart of major armed conflicts)



In the department of
Antioquia, Colombia

Fomal/informal alluvial Mining: the example of Colombia

A small-scale alluvial mining activity is considered formal/legal when:

- the operator obtains a mining title
- the operator provides an approved a program of works (Programa de Trabajos y Obras – PTO)
- activities are required to be less than 150 hectares (Decreto 1666)
- there are required strict measures of land recovery

More than 70% of the gold production in Colombia is extracted from informal activities.



The landscape setting of alluvial Mining

Formal and informal small-scale mining use similar equipment and carry out similar processes



Gratitude to Emijom mining.

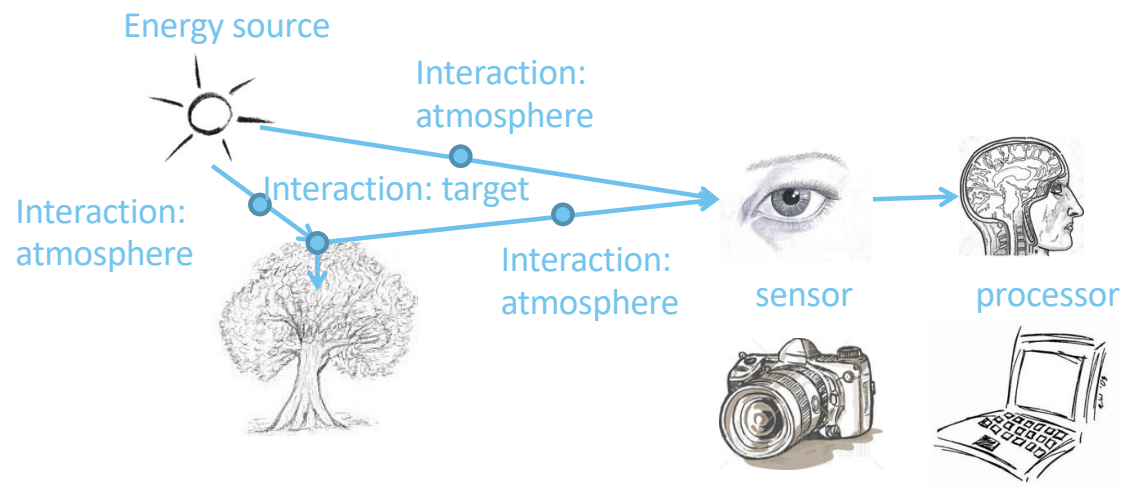
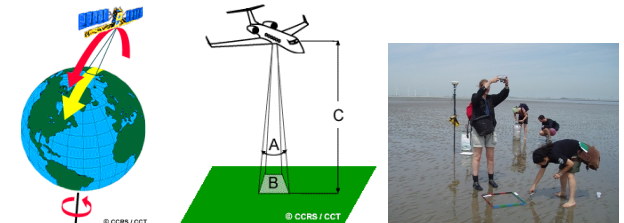
Photo by Elsy Ibrahim/Luisa Lema
El Bagre/ Zaragoza – Colombia, Nov. 2018

Introduction to remote sensing

Remote sensing is the technique of gathering data and knowledge about the Earth's surface without physical contact:

- detecting and recording reflected or emitted energy
- analyzing and processing the data

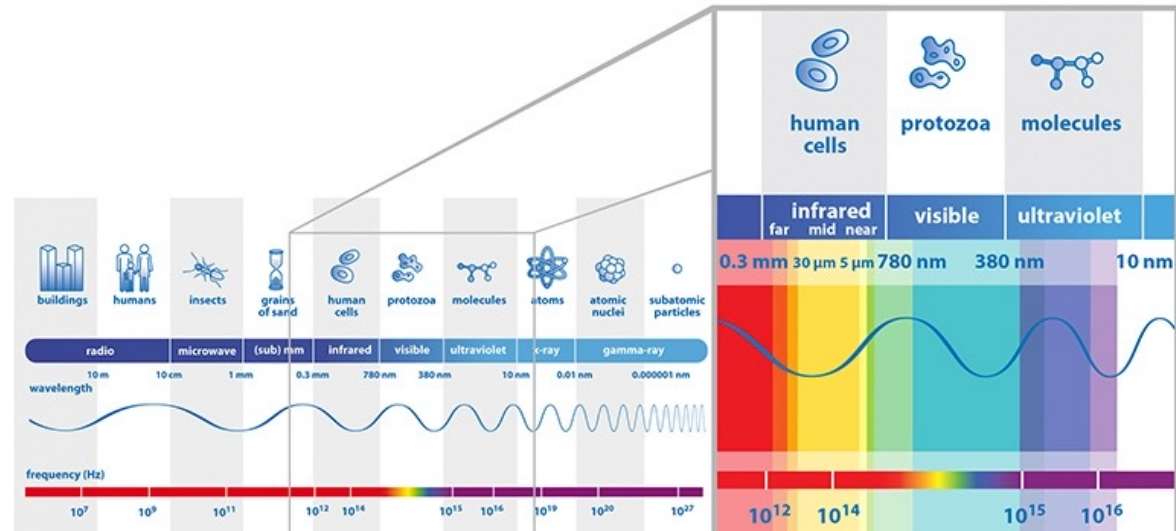
Platforms



Introduction to VIS-NIR-SWIR passive remote sensing

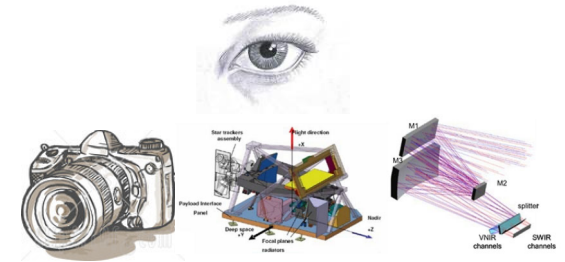
The electromagnetic spectrum

Energy source



Source: <https://sci.esa.int/s/WyP9nXw>

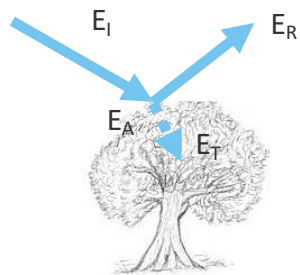
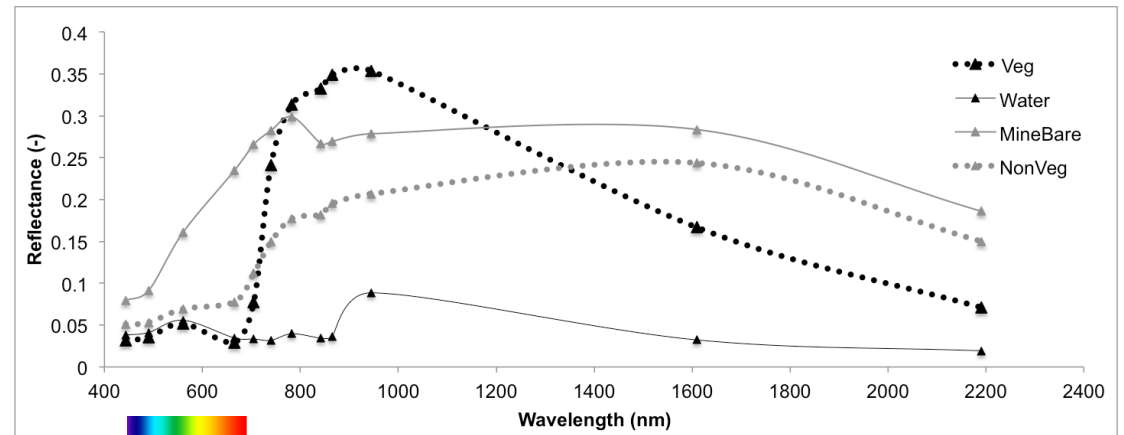
Sensors in VNIR-SWIR



Source: sentinels.copernicus.eu

What we “see” and “image”

The reflectance spectrum



E_i : incident energy
 E_R : reflected energy
 E_A : absorbed energy
 E_T : transmitted energy

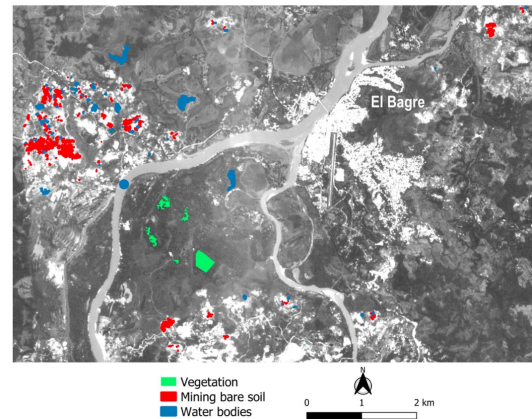
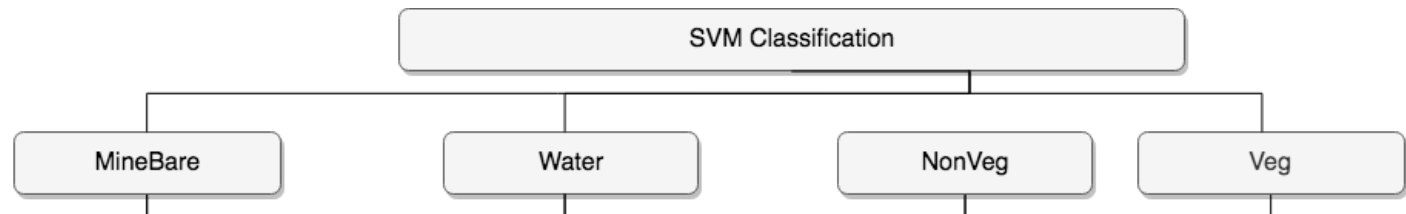


Photo by Elsy Ibrahim/Luisa Lema
 El Bagre/ Zaragoza – Colombia, Nov. 2018

Detecting mining sites on river banks

- Methodology:
 - Classification

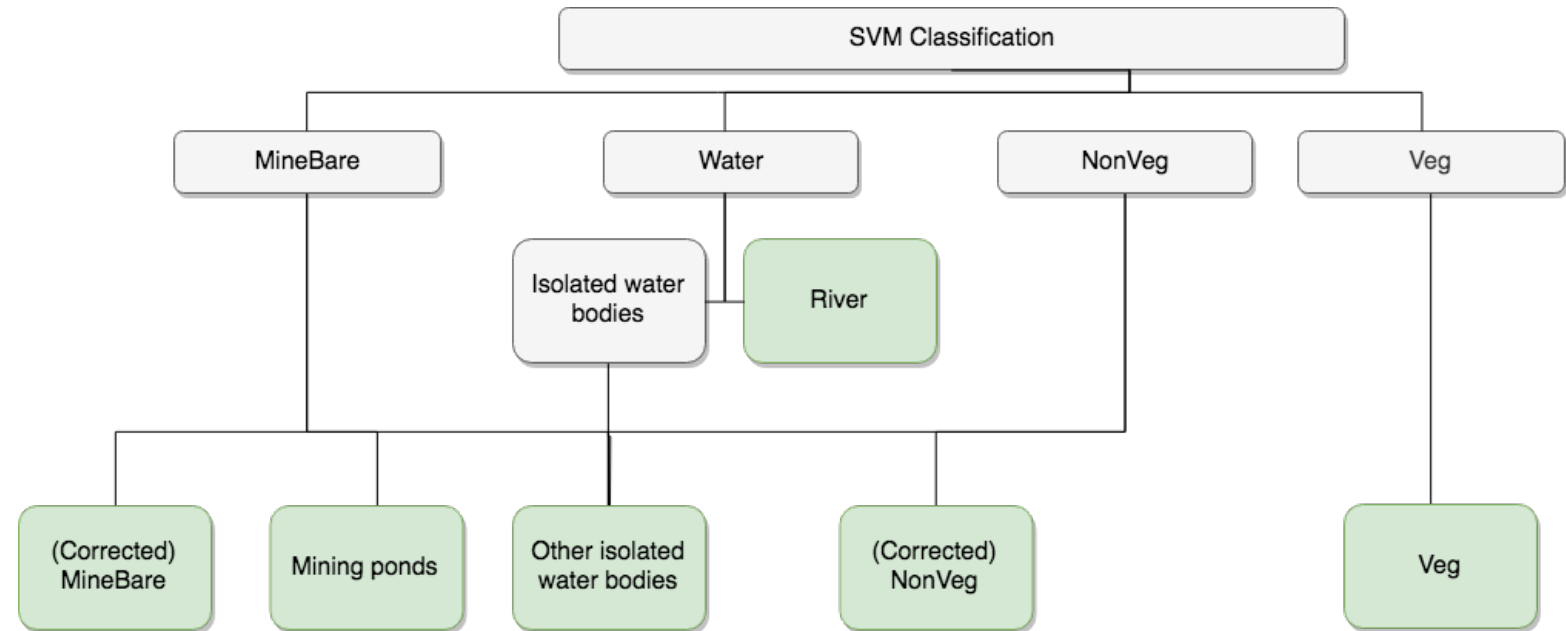


Classification is the process of categorizing or grouping data into categories based on their spectral characteristics.

Detecting mining sites on river banks

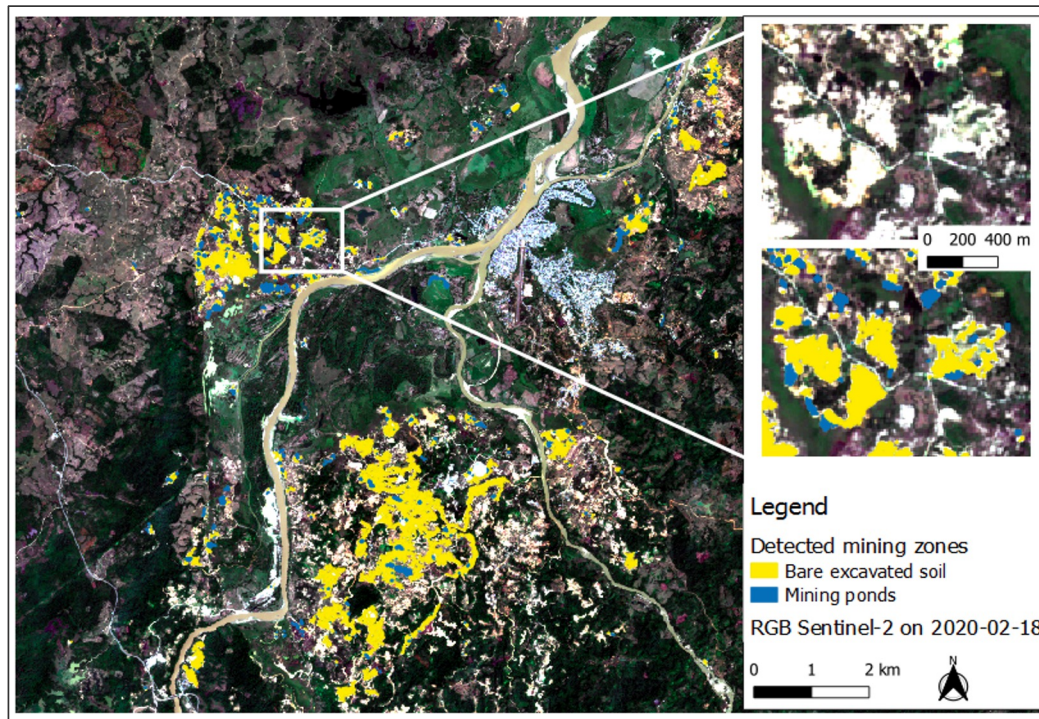
- Methodology:

- Classification
- Post-classification analysis
- Temporal analysis
- Validation by local experts

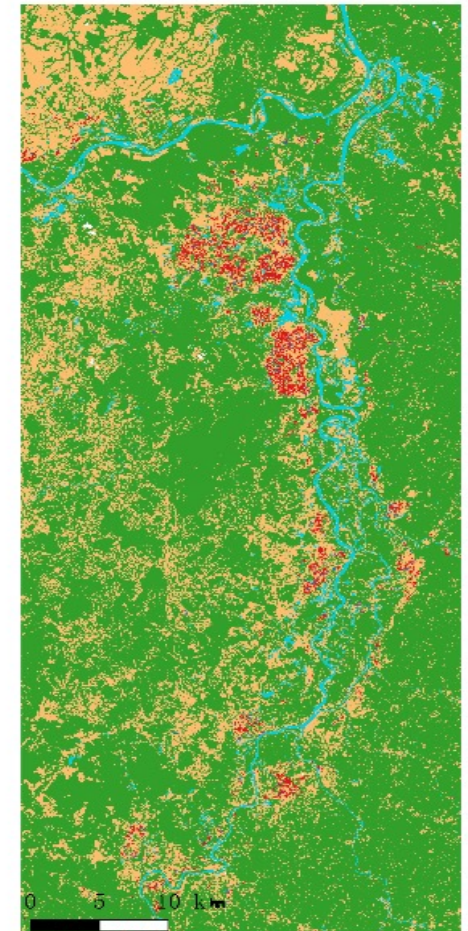


Added value of remote sensing for small-scale mining

- Large spatial coverage with detail reaching 10m resolution



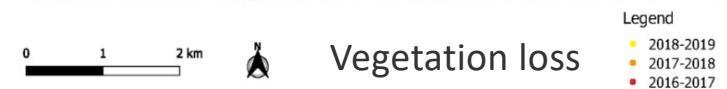
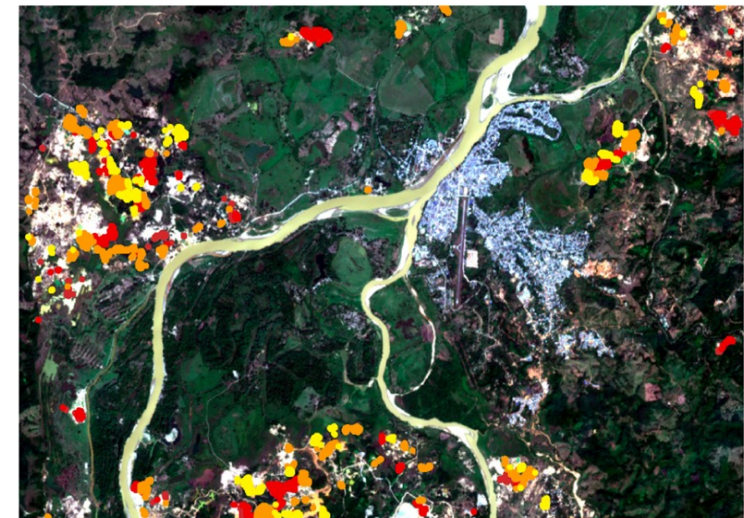
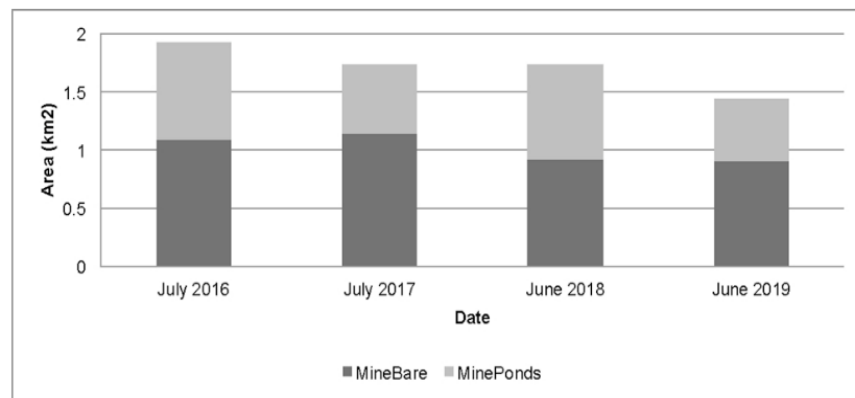
- Mine ponds
- Excavated soil



Added value of remote sensing for small-scale mining

- Continuous monitoring, we can analyze temporal patterns

For a study area in the department of Antioquia, Colombia



Added value of remote sensing for small-scale mining

- High revisit time reaching 5 days, so we can analyze sequences

For a study area in the department of Antioquia, Colombia from 2016 to 2019

- There is **more mining activity in the dry season** than in the wet season
- Areas with **persistent mining were 28%** of the total mined area
- **Recovered land corresponded only to 7%** of the total excavated areas
- For **land to recover, more than four years were required**

How can this be made useful?

- **Early warning:** can we detect trends of spread towards sensitive areas?
- **Intervention:** can this support prioritization of activities?
- **Pollution hotspots:** can we point out areas that have been consistently excavated and their impacts on watersheds (e.g. mercury accumulation)?
- **Remediation:** can we help prioritizing areas for remediation programs?

Conclusions

- Satellite data provides timely information with high spatial coverage - and many of the datasets are free!
- Temporal analysis can allow an understanding of impacts and of mining activities.
- VNIR-SWIR sensors sources are highly affected by cloud cover. Fusion of datasets can be useful.



Photo by Elsy Ibrahim/Luisa Lema
El Bagre/ Zaragoza – Colombia, Nov. 2018

References

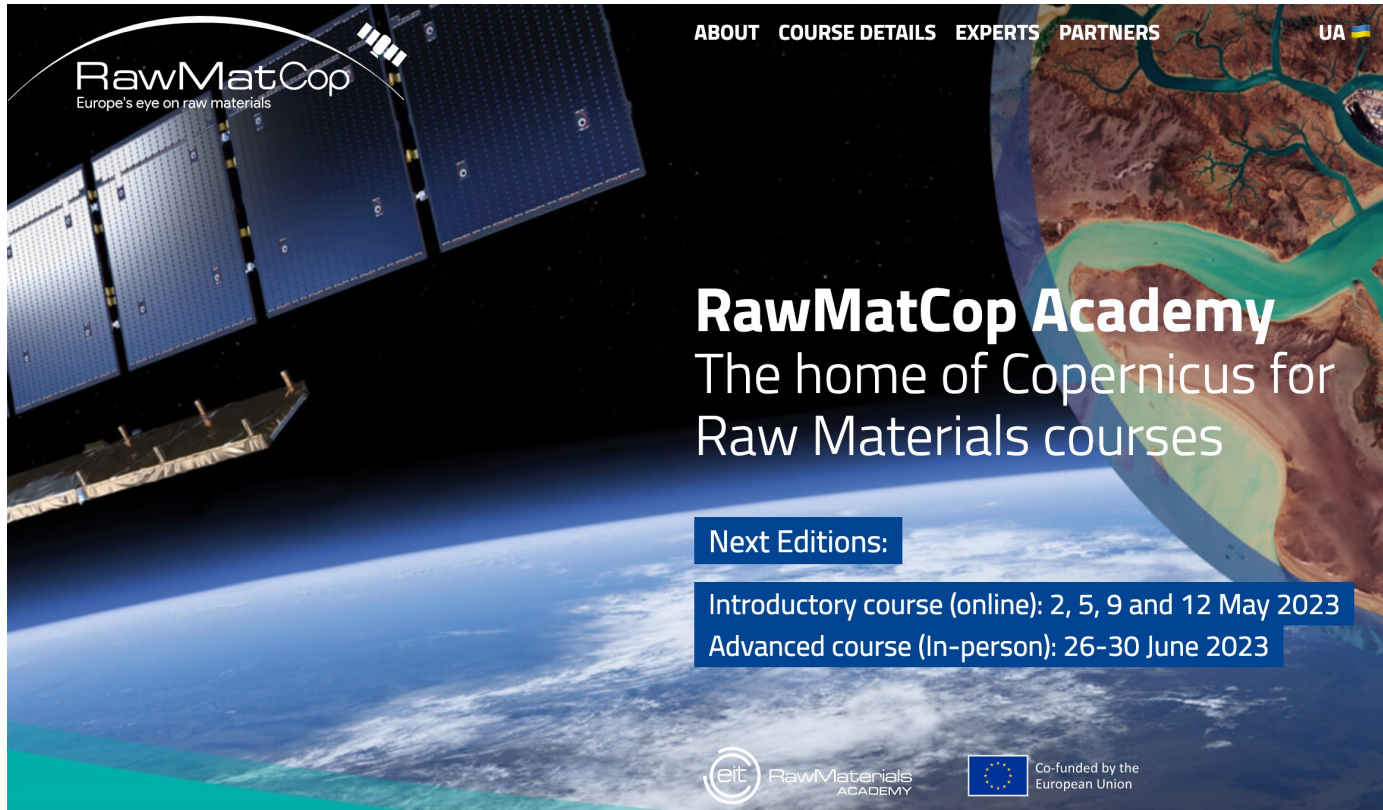
- Eye in the sky – using satellites to better manage natural resources: <https://www.unep.org/news-and-stories/story/eye-sky-using-satellites-better-manage-natural-resources>
- [Storymap in English](#) on MapX
- [Storymap in Spanish](#) on MapX
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Acknowledgements

- **Luisa Lema**
- The secretary of mines at El Bagre **Rafael Sanchez**
- The MapX team especially **Pierre Lacroix and Gregory Giuliani**
- University of Liege especially **Eric Pirard, Pierre Barnabé, Jingyi Jiang**
- The RawMatCop Academy team, especially **Wesley Crock and Irene Bonito**
- UN Environment office Geneva, especially **David Jensen and Inga Petersen**
- UN Environment Bogota Office, especially **Juan Bello, Juliana Ibarra, Silvio Lopez, and Ursula Jaramillo**
- Corantioquia especially **Janneth Zoraida Duque Quintero, Ana Castana**
- All the representatives of **local authorities** who met with us
- **The local community of El Bagre**



Interested a training?

A banner for the RawMatCop Academy. The background features a satellite in space on the left and a satellite image of a river delta on the right. The RawMatCop logo is in the top left. Navigation links (ABOUT, COURSE DETAILS, EXPERTS, PARTNERS) and a UA flag are in the top right. The main title 'RawMatCop Academy' is in large white font, followed by the subtitle 'The home of Copernicus for Raw Materials courses'. Below this, a blue box contains the text 'Next Editions:'. Another blue box below that lists the course dates: 'Introductory course (online): 2, 5, 9 and 12 May 2023' and 'Advanced course (In-person): 26-30 June 2023'. Logos for EIT RawMaterials Academy and the European Union are at the bottom.

RawMatCop
Europe's eye on raw materials

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<https://rawmatcop.eitrawmaterials.eu/>





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