Tools for managing metal contaminated areas: multidisciplinary approach to develop inputs for a more sustainable region

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INCOME

INPUTS FOR A MORE SUSTAINABLE REGION

INSTRUMENTS FOR THE MANAGEMENT OF AREAS CONTAMINATED BY METALS

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INCOME Project (PD23-00013) – 2023-2026

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MÉRTOLA CÂMARA MUNICIPAL

apa agência portuguesa do ambiente

edm Empresa de Desenvolvimento Mineiro, SA

LA SABINA Green Energies

Fundação Serrão Martins

World mining occurrences

World mine extraction (2021): 17.9 **billion** metric tons (WMD2023)

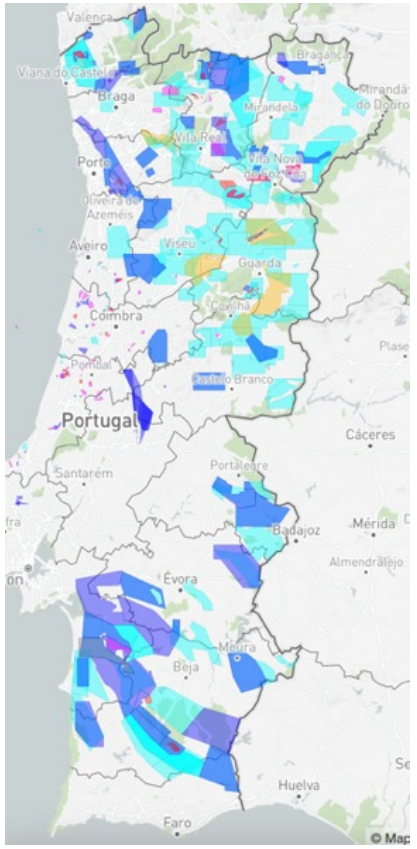
Portugal mine extraction (2021): 1.148.842 metric tons (WMD2023)

Mines in operation:

- Panasqueira (Wolfram)
- Neves Corvo (Copper)
- Aljustrel (Copper)

Abandoned mines (about 100):

- São Domingos (Sulphides)
- Urgeiriça (Uranium)



Contamination problem

- Current solutions: one-off, expensive and time-consuming
- Monitoring with sampling several times a year (samples every 5 ha – imposed by legislation)

Improvements

- Remote Sensing allows a faster management of the contamination with lower costs
- Gains obtained in savings allow resources to be redirected to other recovery actions

Project: LIFE-NoWASTE

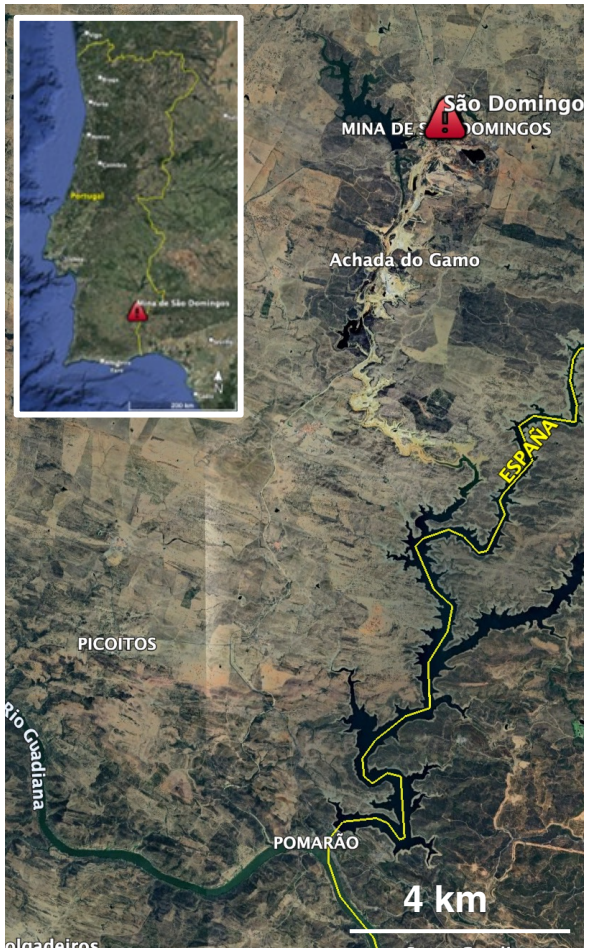
São Domingos mine

Exploration of pyrites

Sulphides - **Iberian Pyrite Belt**

High levels of Cu, Pb, Zn and metalloids such as As and Sb

Heaps in the water line drains into the Chança River whose dam discharges into the Guadiana River



Recovery S. Domingos (EDM – co-financed by the Cohesion Fund at 84%):

3.924.469,41 € (2020) **Total: 7.218.051,35 €**

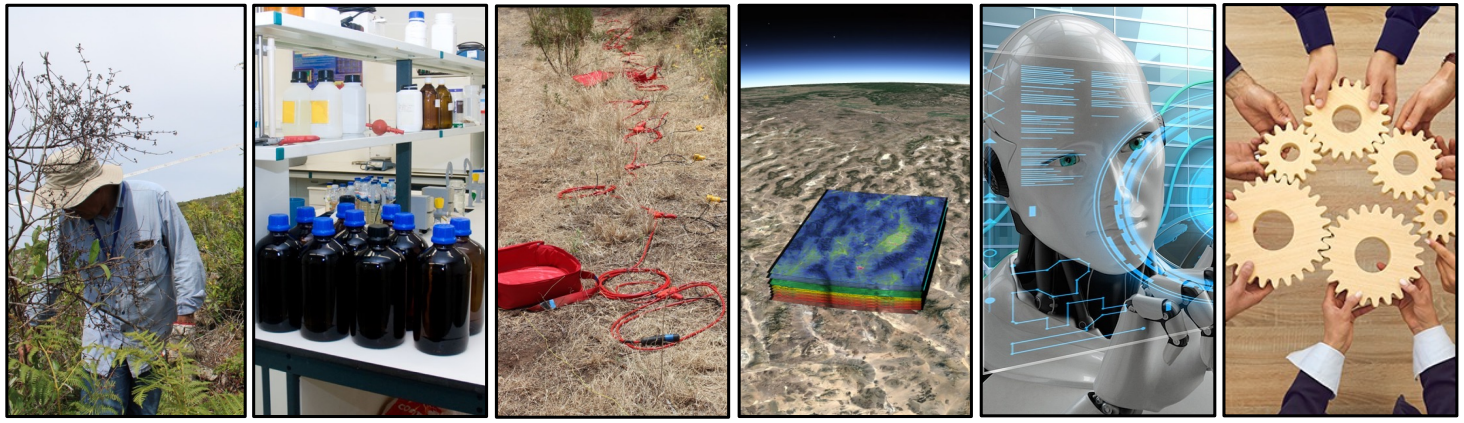
3.293.581,94 € (2022) **(Source: EDM)**

Chemical analysis: 2000 ha

400 samples: 120.000,00 €, by survey

Integrated tool

- Creation of an integrated environmental management model for areas contaminated by Heavy Metals (HMs)
- Using tools from different scientific areas
- Identification of risk areas in an automated way (Artificial Intelligence)
- Downsampling
- Reduction of operational costs and assessment times in the management of contaminated areas

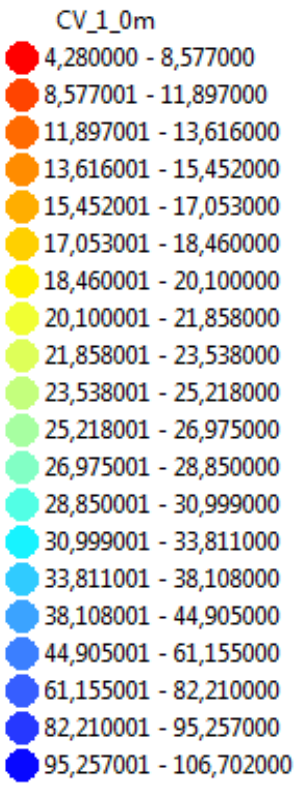


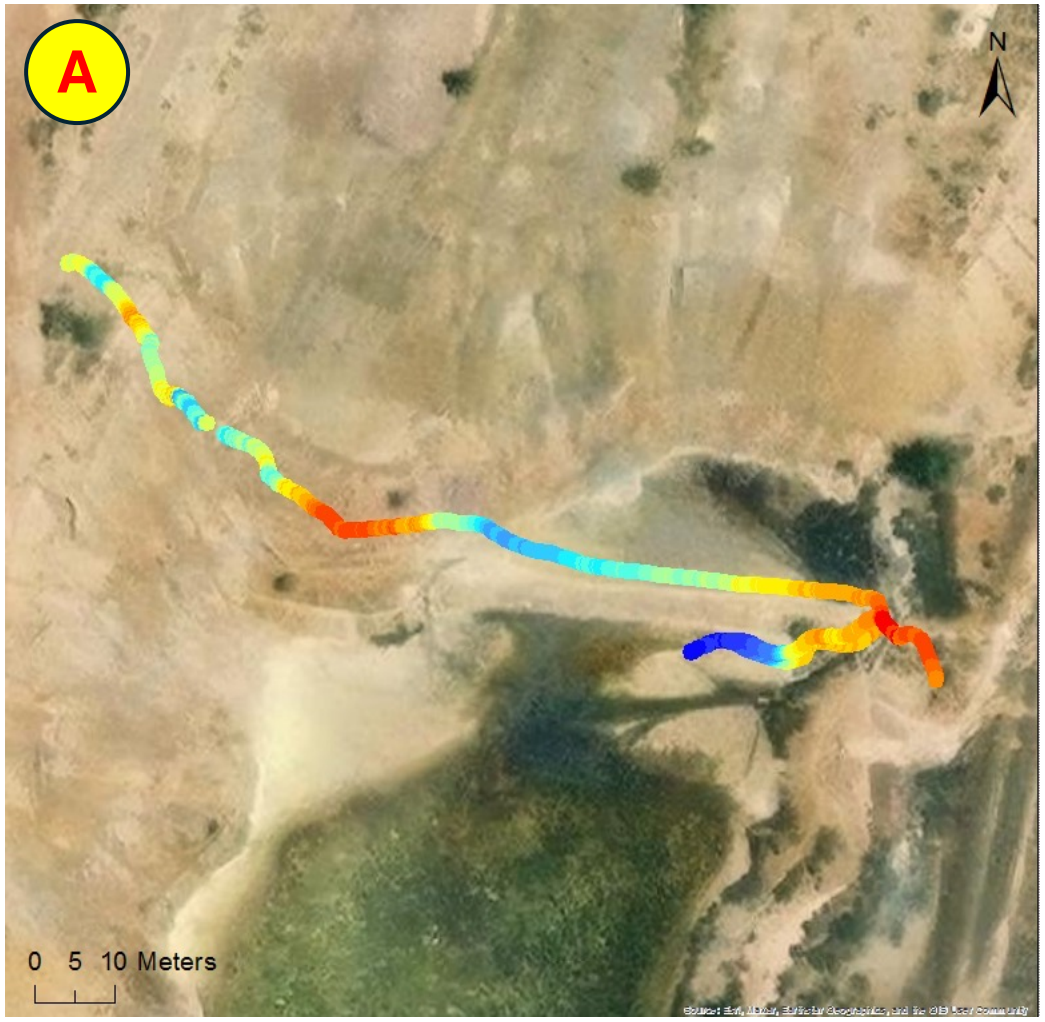
Chemical analysis

Parameter		Soil sampling site		
		A	B	C
As (mg kg^{-1})	Pseudo-total	7955 ± 91	674 ± 22	961 ± 21
	Mobilisable	1225 ± 385 (15%)	311 ± 44 (46%)	259 ± 39 (27%)
	Mobile	157 ± 9 (2%)	56 ± 7 (8%)	87 ± 34 (9%)
Cd (mg kg^{-1})	Pseudo-total	3.38 ± 0.08	1.868 ± 0.003	2.6 ± 0.3
	Mobilisable	0.20 ± 0.01 (6%)	0.23 ± 0.01 (12%)	0.258 ± 0.004 (10%)
	Mobile	0.14 ± 0.01 (4%)	0.16 ± 0.01 (9%)	0.20 ± 0.01 (8%)
Cr (mg kg^{-1})	Pseudo-total	17.0 ± 0.4	8.8 ± 0.3	24.7 ± 1.0
	Mobilisable	<LD	<LD	<LD
	Mobile	<LD	<LD	<LD
Cu (mg kg^{-1})	Pseudo-total	202 ± 12	434 ± 8	224 ± 6
	Mobilisable	2.9 ± 0.6 (1%)	9.8 ± 0.2 (2%)	27 ± 5 (12%)
	Mobile	1.1 ± 0.1 (0.5%)	5.2 ± 0.5 (1%)	16 ± 2 (7%)
Ni (mg kg^{-1})	Pseudo-total	14.2 ± 0.3	10.0 ± 0.1	12 ± 1
	Mobilisable	0.72 ± 0.02 (5%)	0.83 ± 0.02 (8%)	1.51 ± 0.02 (13%)
	Mobile	0.60 ± 0.02 (4%)	0.2 ± 3 (2%)	1.3 ± 0.1 (11%)
Pb (mg kg^{-1})	Pseudo-total	26,975 ± 576	3920 ± 248	1624 ± 160
	Mobilisable	823 ± 68 (3%)	7 ± 1 (0.2%)	5.2 ± 0.3 (0.3%)
	Mobile	72 ± 5 (0.3%)	2.7 ± 0.2 (0.1%)	2.5 ± 0.1 (0.2%)
Zn (mg kg^{-1})	Pseudo-total	84 ± 6	168 ± 9	137 ± 24
	Mobilisable	1.3 ± 0.1 (2%)	8.3 ± 0.6 (5%)	38 ± 2 (28%)
	Mobile	1.1 ± 0.1 (1%)	5.8 ± 0.3 (3%)	35 ± 5 (26%)

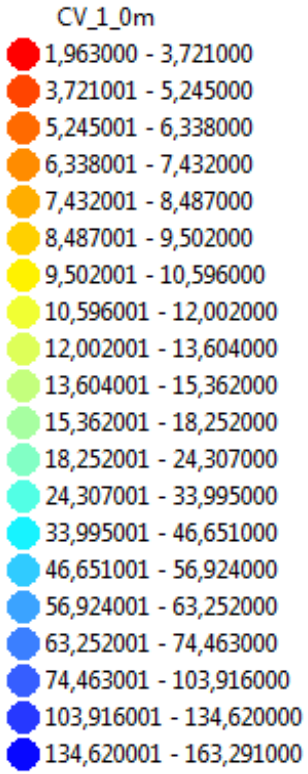
Source: Alvarenga et al. (2012)

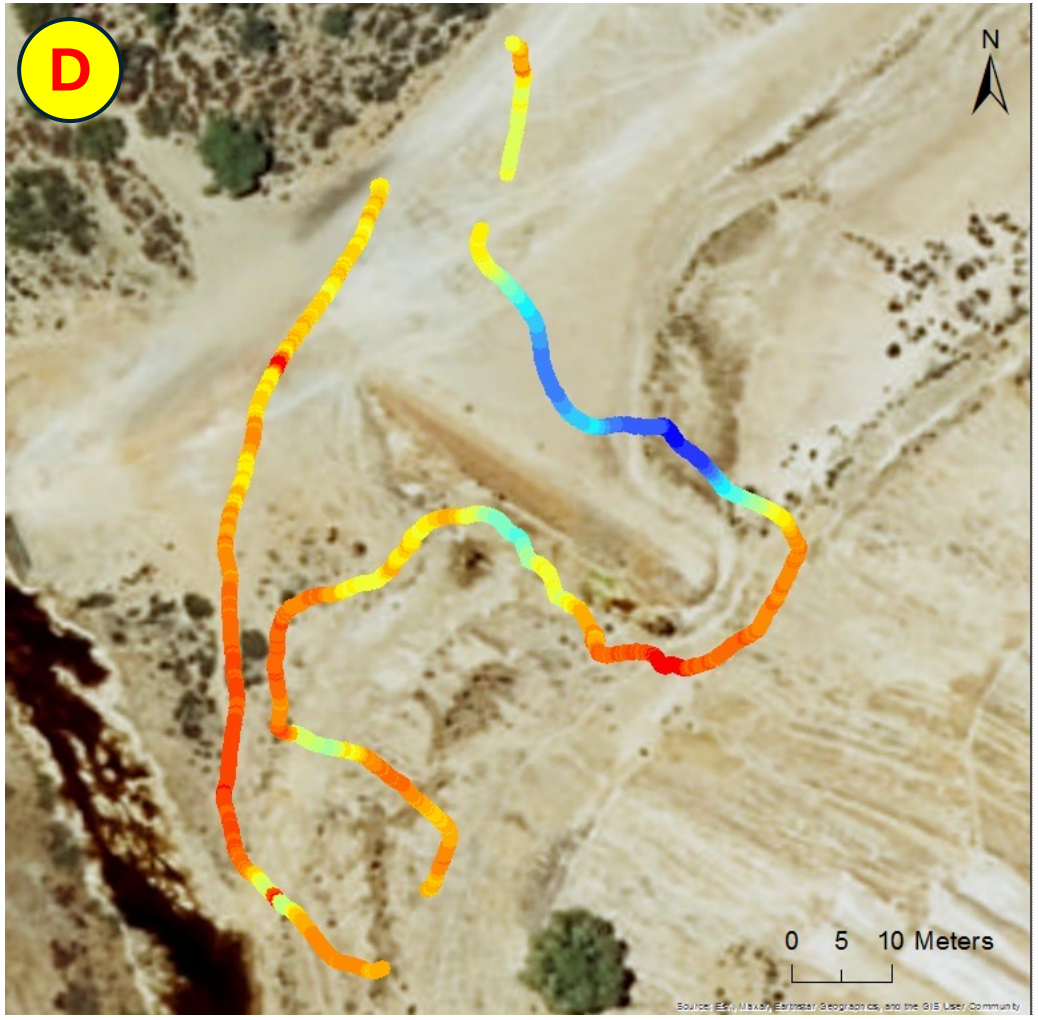
Geophysics
EM Induction





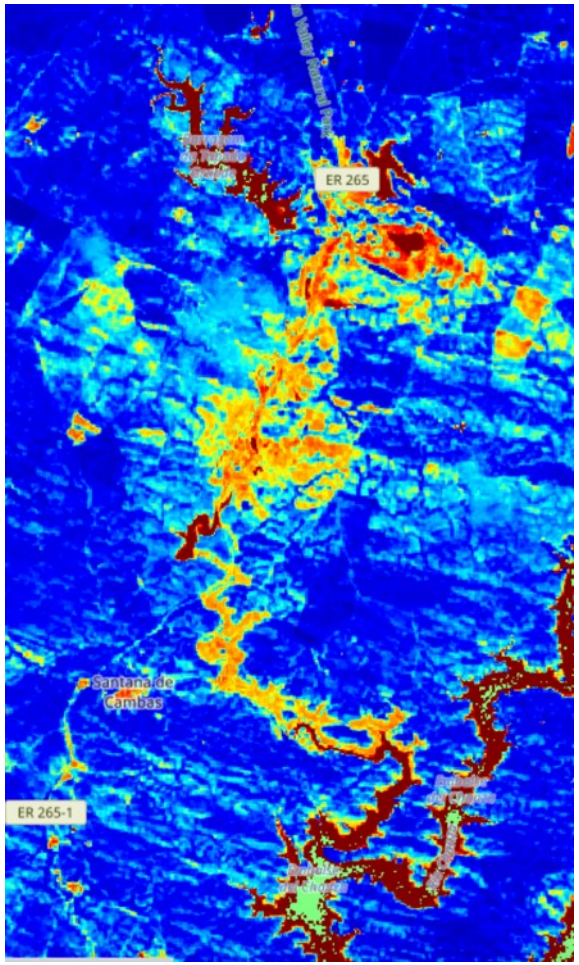
Geophysics
EM Induction

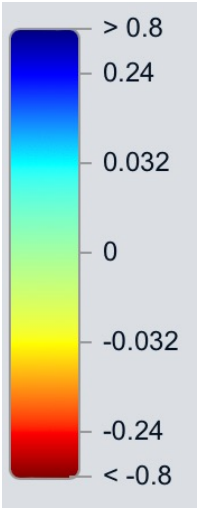




Remote Sensing
Multispectral Satellite Imaging

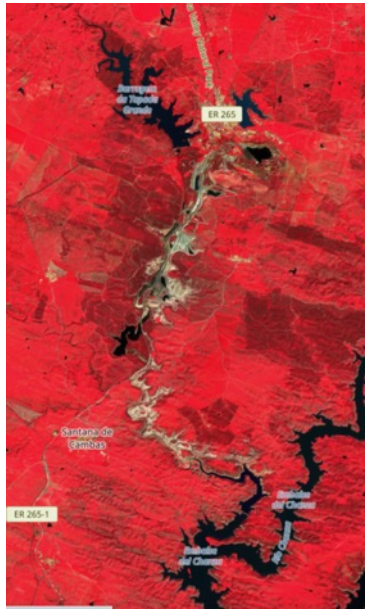
Sentinel-2



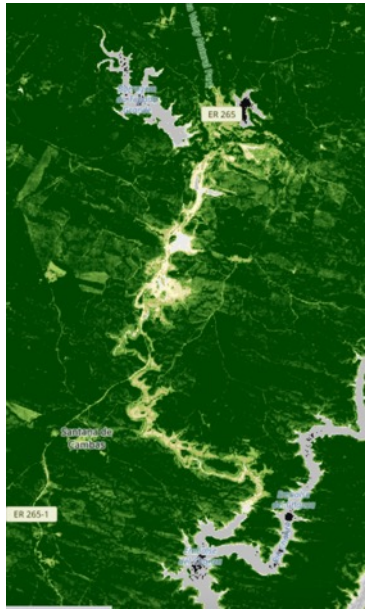


NDMI

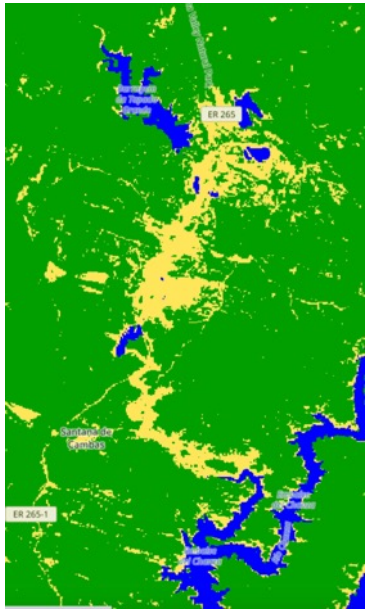
True color



False color



NDVI

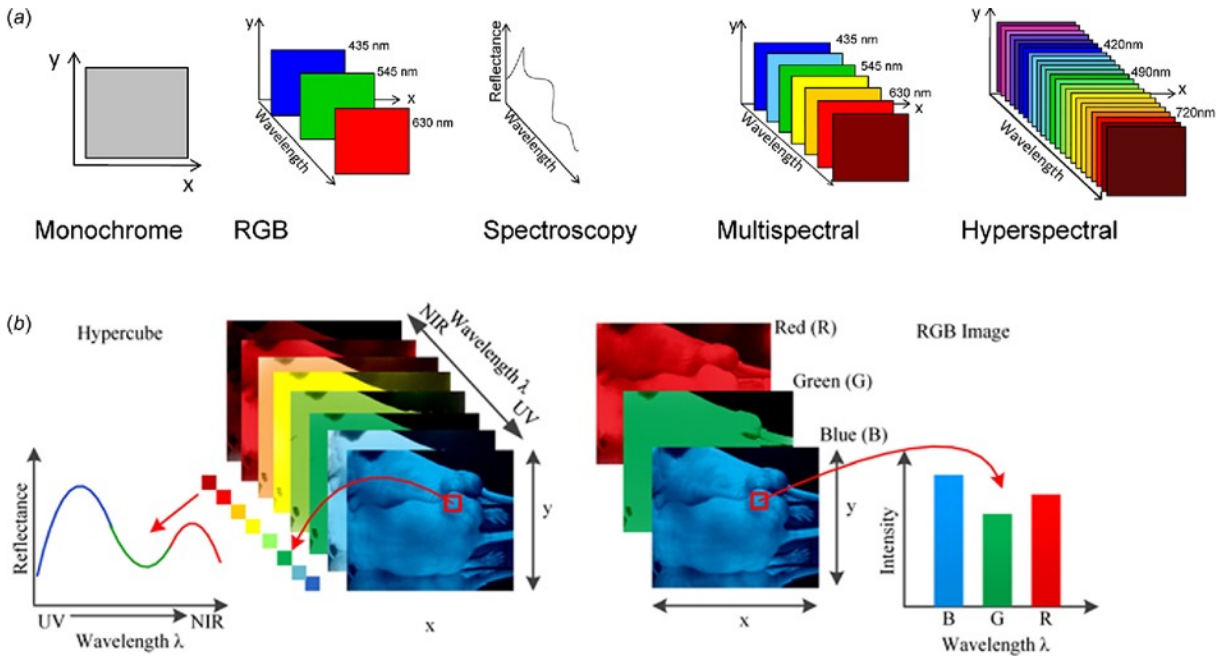


Classification

Negative values of NDMI (values approaching -1) – barren soil
Values around zero (-0.2 to 0.4) – water stress.
High, positive values – high canopy without water stress (approximately 0.4 to 1).

Next steps (in development)

- Soil sampling (Chemistry)
- Geophysical surveys
- Field recognition (vegetation)
- Hyperspectral data (satellite)
- Artificial Intelligence to produce maps of the contamination by HMs, using as inputs all the information available:
  - Vegetation
  - Geophysics
  - Chemistry
  - Remote Sensing



Source: Mehta et al. (2018)

Search for peaks related with HMs (Spectroscopy)

Final remarks

Model replicable to other regions and other environments, that contribute to:

- Improving quality of life and the environment
- Opportunities for development and wealth creation in the regions
- Promotion of mining tourism
- Reuse of waste (circular economy)

UN Agenda 2030 – SDG 15 (Protect Life on Earth)

- Goal 15.1 – Conservation and recovery of terrestrial and freshwater ecosystems
- Goal 15.3 – Combating desertification and restoring degraded land and soils

Thank you!

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