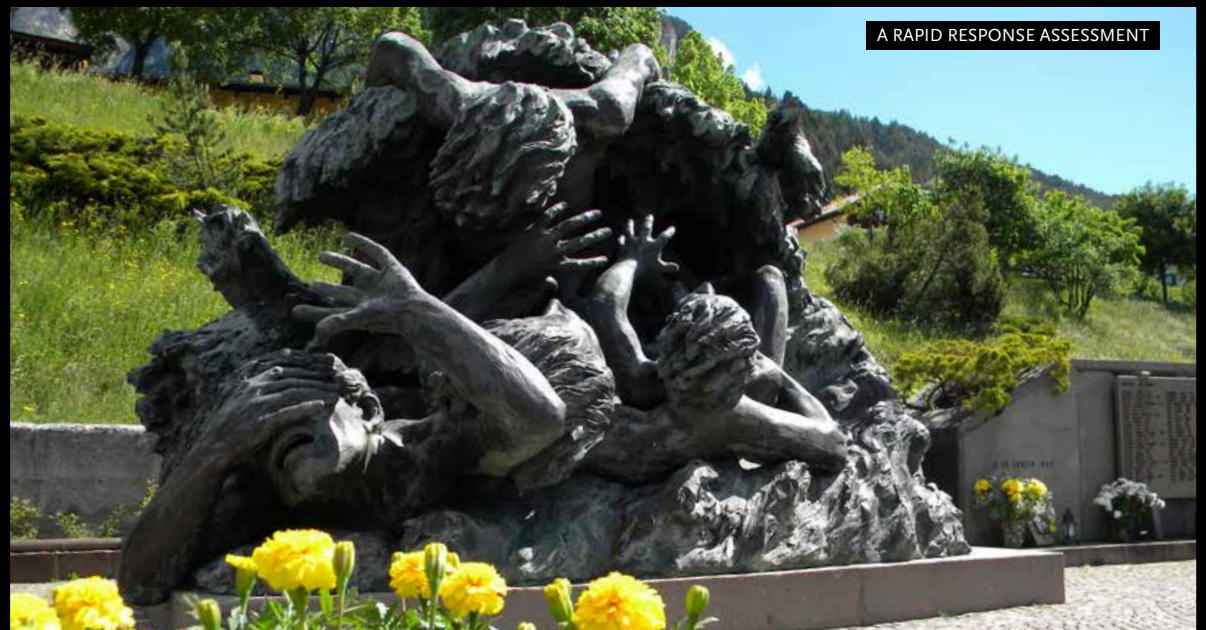
MINE TAILINGS STORAGE: SAFETY IS NO ACCIDENT



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Geological Resources

GRID-Arendal

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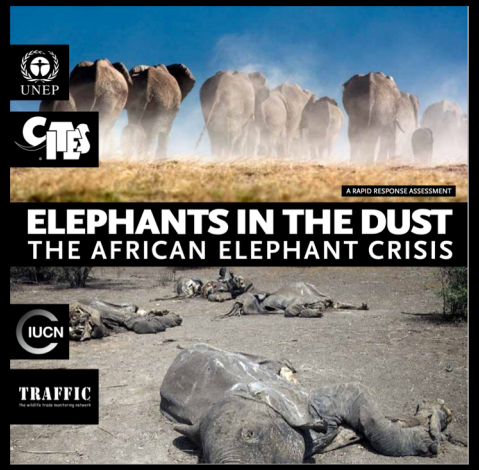
The aim of Rapid Response Assessments

This UN environment report series is designed to:

1. shine light on an issue
2. gather and visualise information and catalyse research
3. develop recommendations for actions

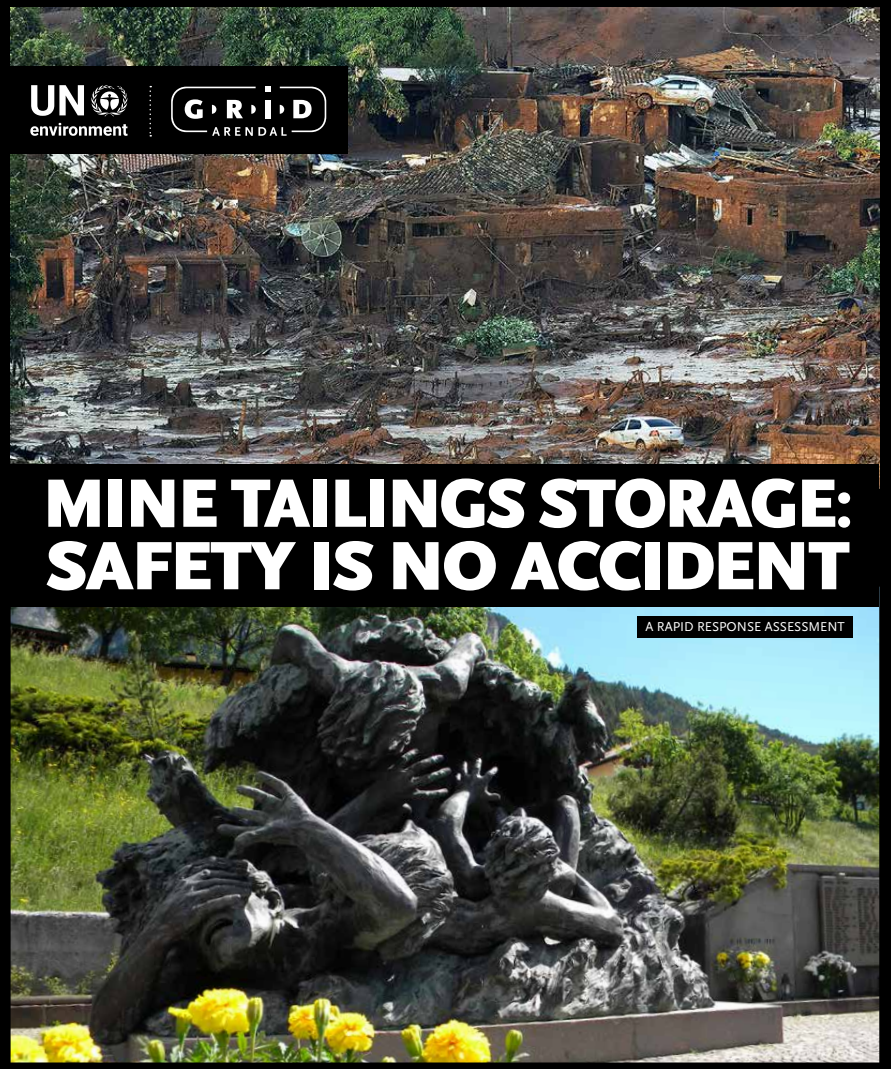


More RRA´s can be accessed here: http://www.grida.no/publications

This Rapid Response Assessment

This report was motivated by community concerns and acknowledges the massive human and environmental costs of continued tailings dam disasters.

This report informs a wider audience of the consequences of failure and importantly, the OPPORTUNITIES to reduce risk and improve safety of tailings storage.



Tailings Dams – size

Photo credit: Northern Alaska Environmental Centre

The Fort Knox gold mine in Alaska.

The tailings are contained behind an gravel and rock embankment.

This tailings storage facility is eventually expected to cover **395** hectares.

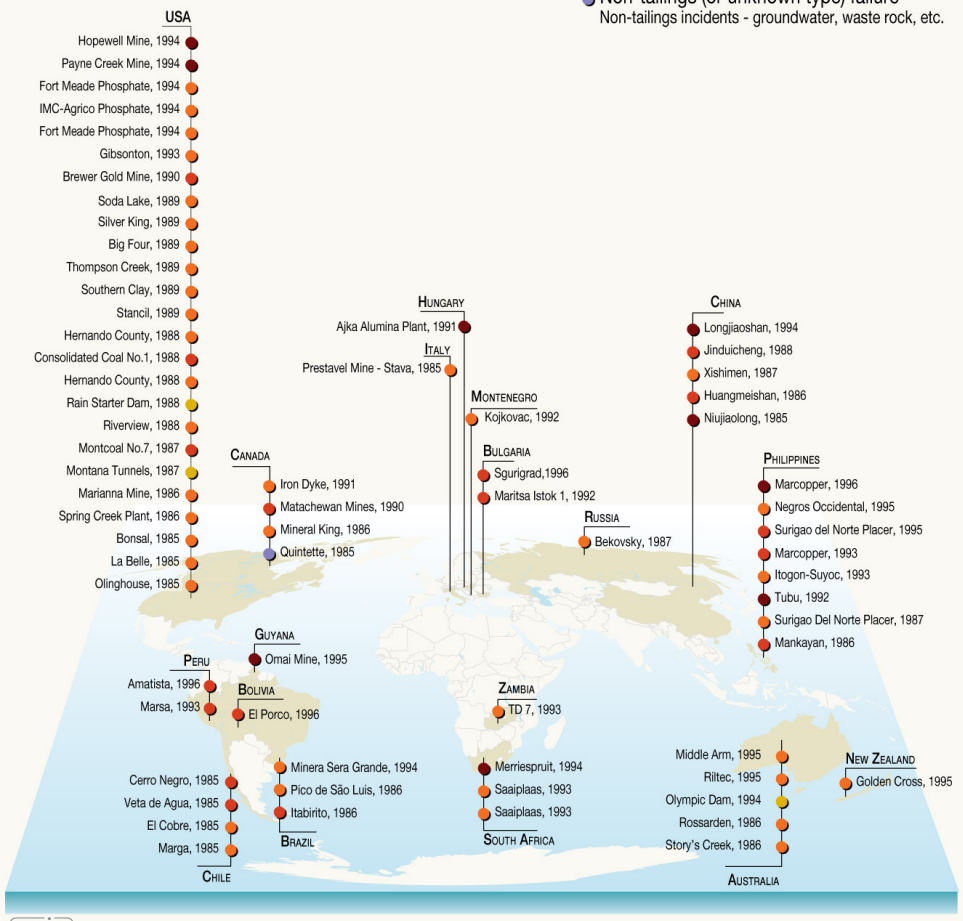
Store approximately **270** million tonnes of tailings (dry weight eq.).

Not all storage facilities follow their plan

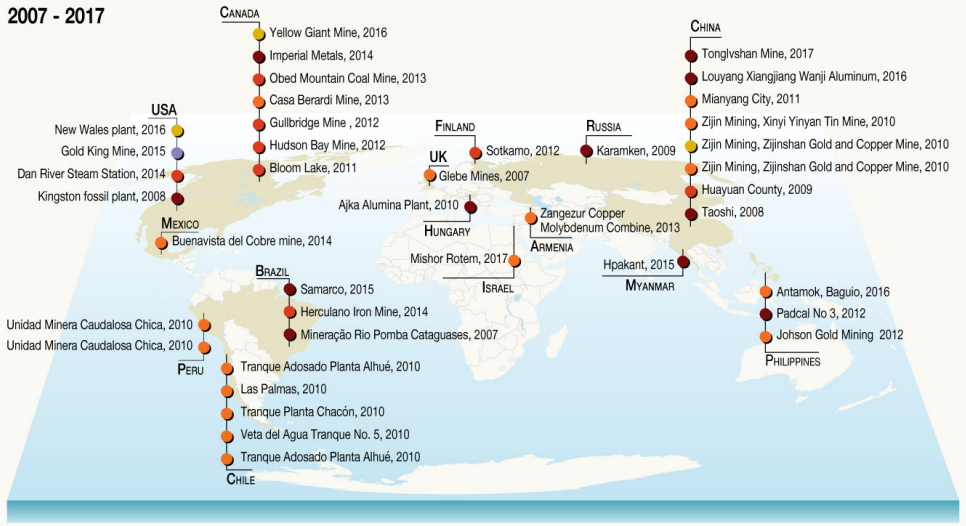
Known mining accidents

- **Very serious tailings dam failures**
  Multiple loss of life (~20) and/or release of ≥ 1 000 000 m^3 total discharge, and/or travel of 20 km or more.
- **Serious tailings dam failures**
  Loss of life and/or release of ≥ 100 000 m^3 semi-solid discharge.
- **Other tailings dam failures**
  Engineering/facility failures other than those classified as very serious or serious, no loss of life.
- **Other tailings-related accidents**
  Accidents other than those classified under the first three categories of dam failures.
- **Non-tailings (or unknown type) failure**
  Non-tailings incidents - groundwater, waste rock, etc.

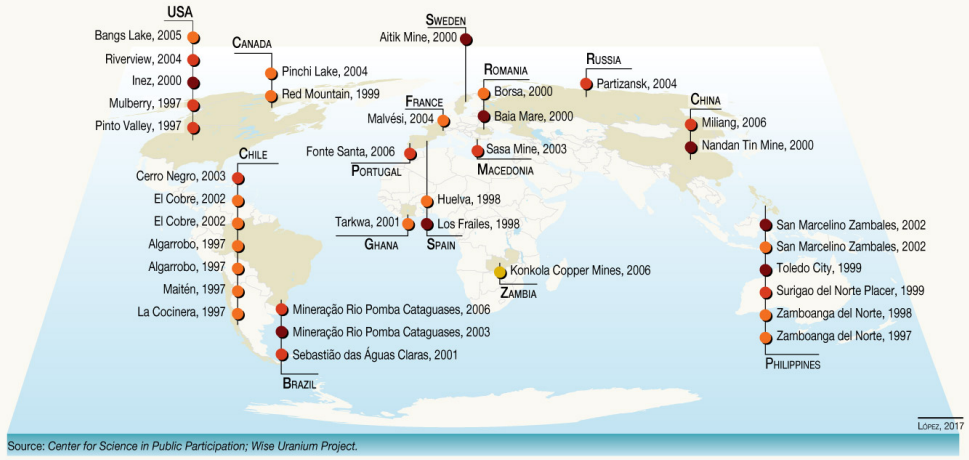
1985-1996



2007 - 2017

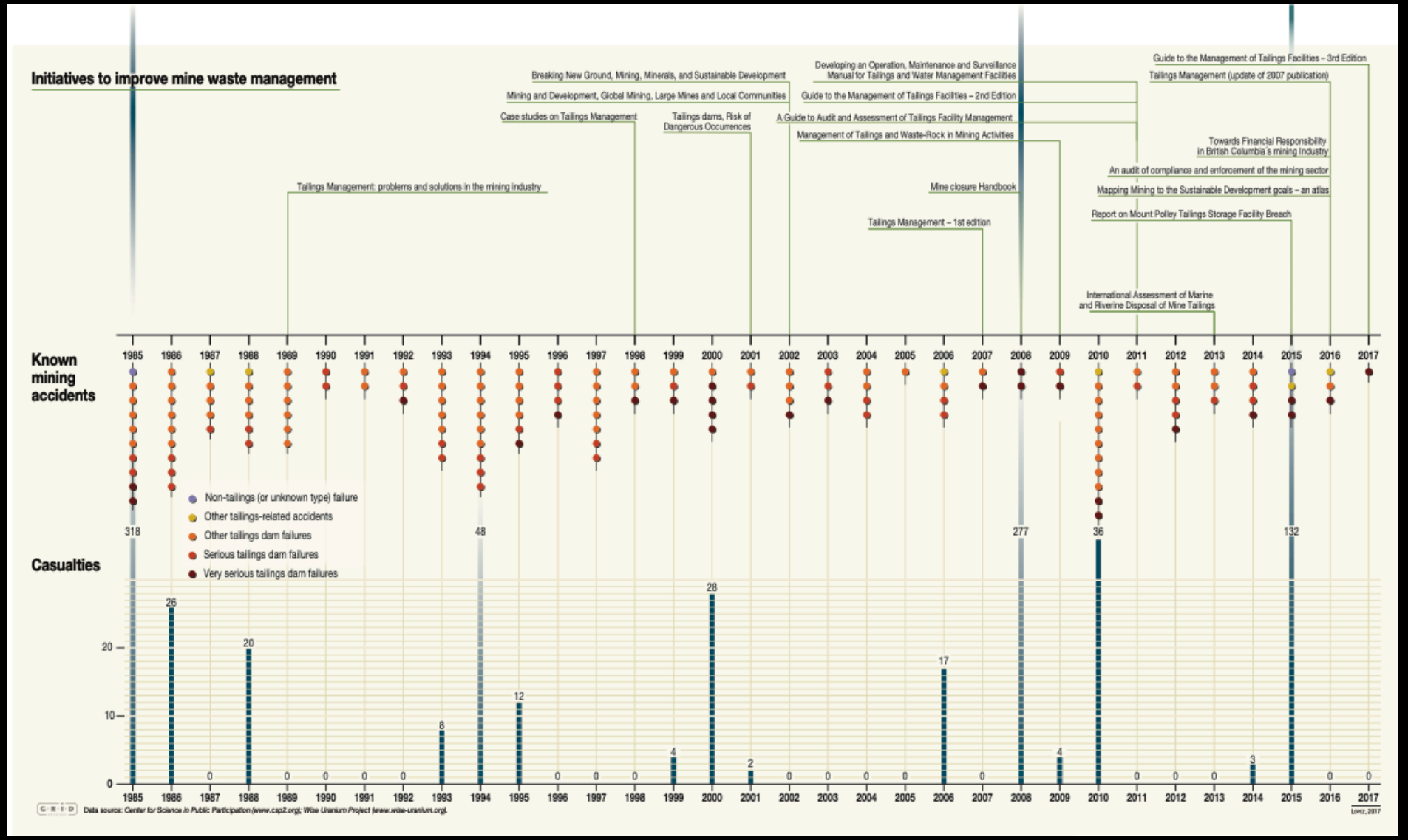


1997-2006

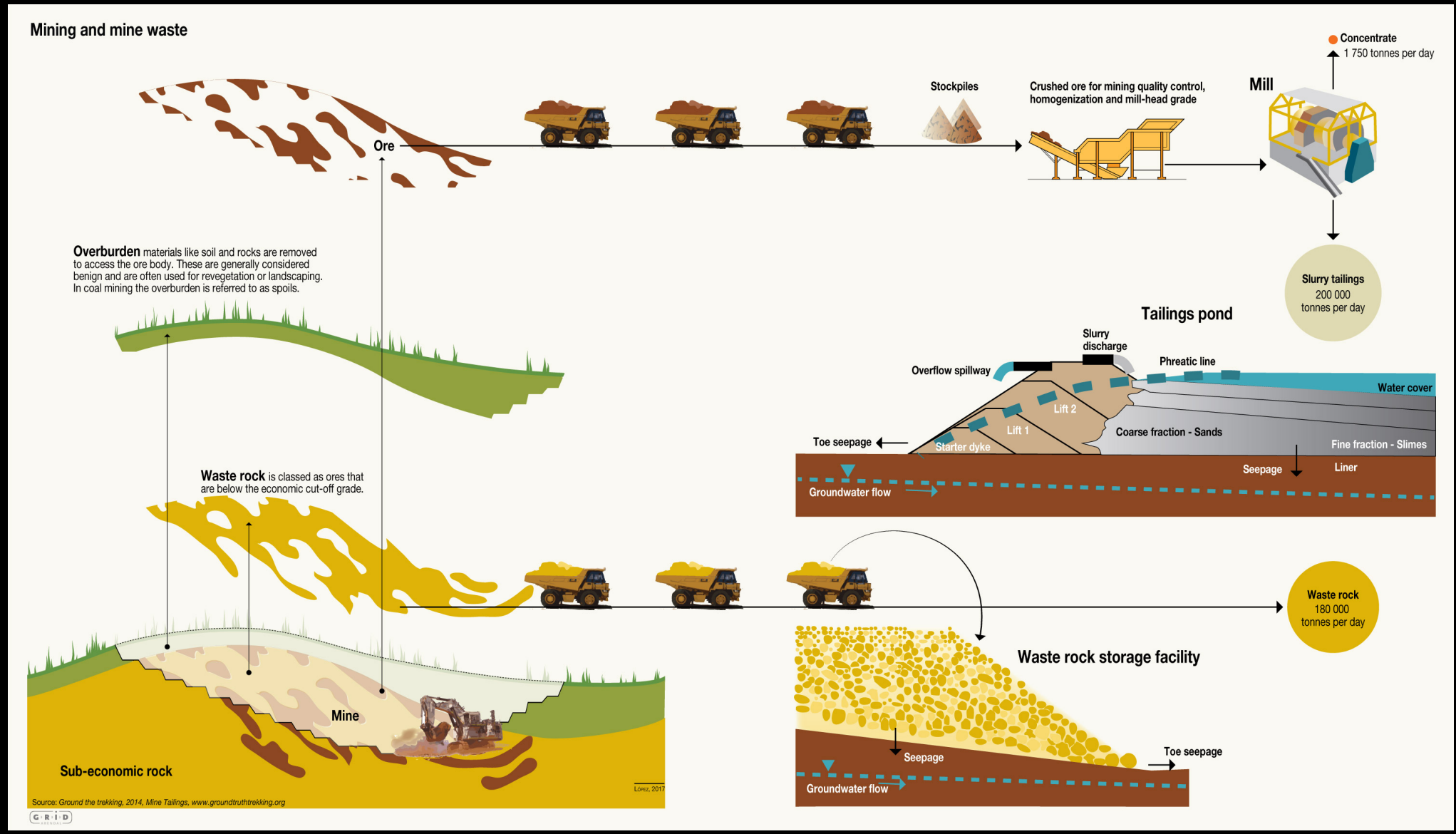


Source: *Center for Science in Public Participation; Wise Uranium Project.*

Accidents between 1985 and 2017



Mine waste at the mine site



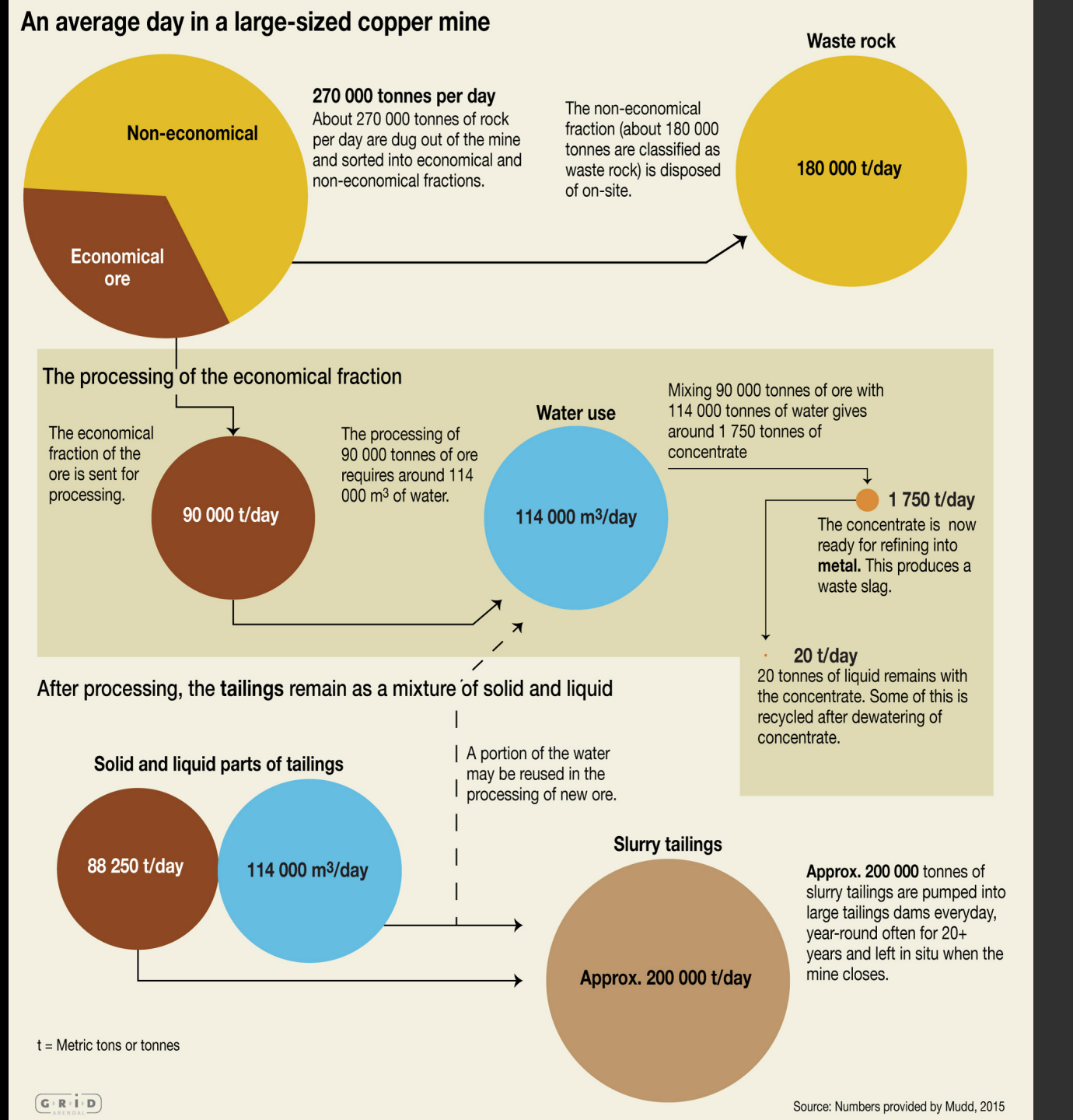
How much waste and is it only waste?

Non-economical waste:

- Useful?
- Polluted or polluting?

Economical ore:

- Adding water – increases mobility
- Is removing the water a solution?



Waste type	Description
Sulphide waste	Not all sulphide minerals are extracted when processing massive sulphide ores (which may contain copper, lead, zinc, gold and other minerals). When this residue of sulphide minerals is exposed to the atmosphere and groundwater in the tailings dam, it oxidizes to form acidic sulphate-rich drainage, commonly referred to as acid mine drainage (AMD).
Heavy metal waste	Depending on the type of mine, the tailings can contain various heavy metals. For example, gold mine tailings may contain elevated concentrations of metals such as arsenic (As), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), manganese (Mn), nickel (Ni), and zinc (Zn).
Cyanide waste	Cyanide waste is generated primarily in the extraction of gold and silver. This waste will occur in the form of heap-leach residues, tailings and spent process water.
Radioactive waste	Radioactive elements are found in tailings generated in the extraction of uranium, some copper deposits and the processing of placer and mineral sands deposits. Uranium extraction is selective and therefore, up to 87% of the radioactivity can remain in the tailings (Mudd 2000).
Phosphate waste	Phosphate waste is generated from mining potash and phosphate ores. The major waste products are brine solution and tailings consisting of salts, clay, sulphides, oxides and evaporative salts.
Bitumen waste	Bitumen waste is generated from oil-sand mining. It can contain elevated concentrations of salts, metals (arsenic, cadmium, chromium, copper, lead and zinc), polycyclic aromatic hydrocarbons, naphthenic acids and solvents that are added during the separation process. Naphthenic acids are toxic to aquatic organisms (Grant et al. 2013).


Samarco 2015

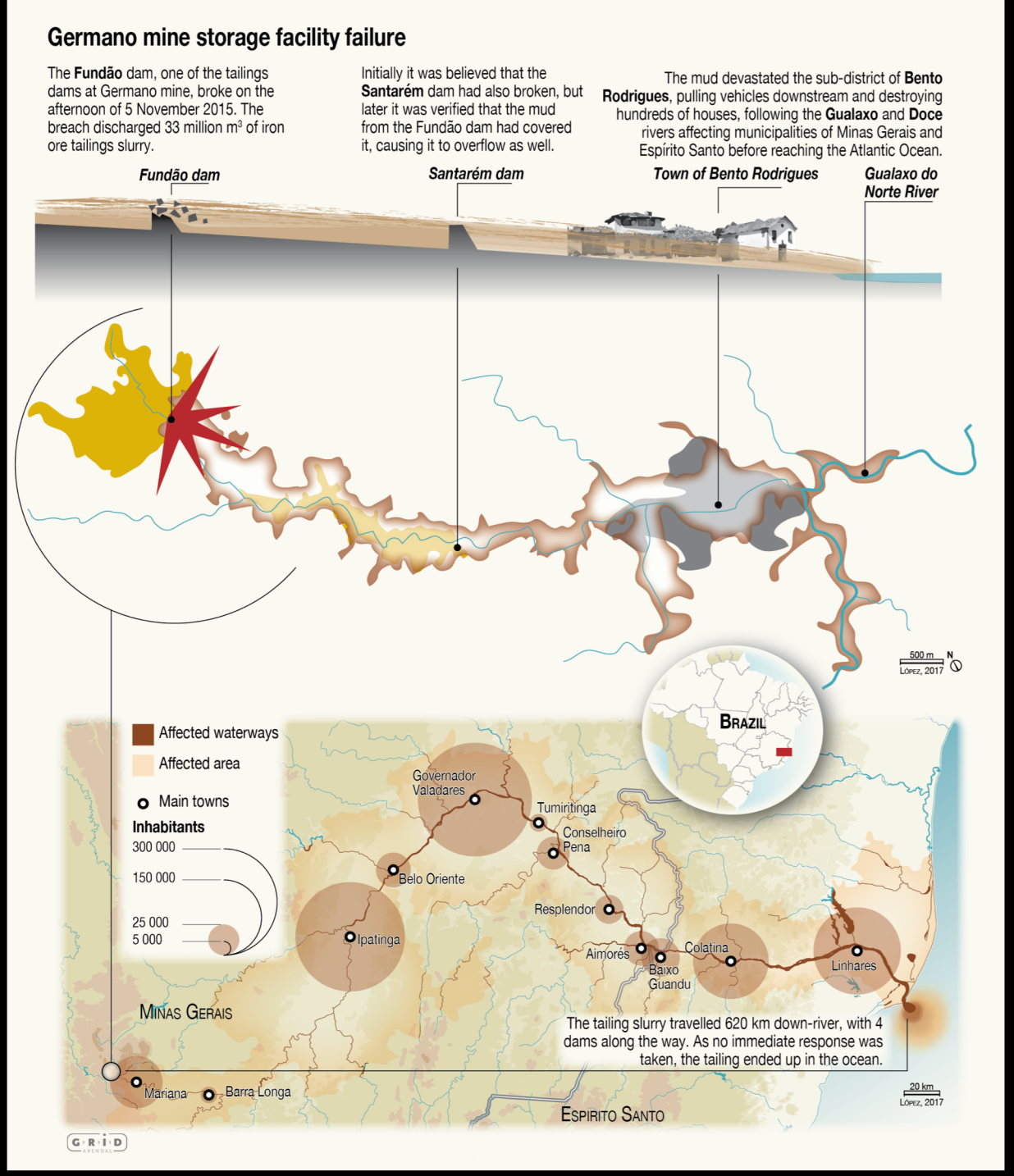
Samarco – Brazil 2015

- 19 people were killed - village residents and Samarco employees.
- 600 families were displaced
- 400 000 lost their water supply

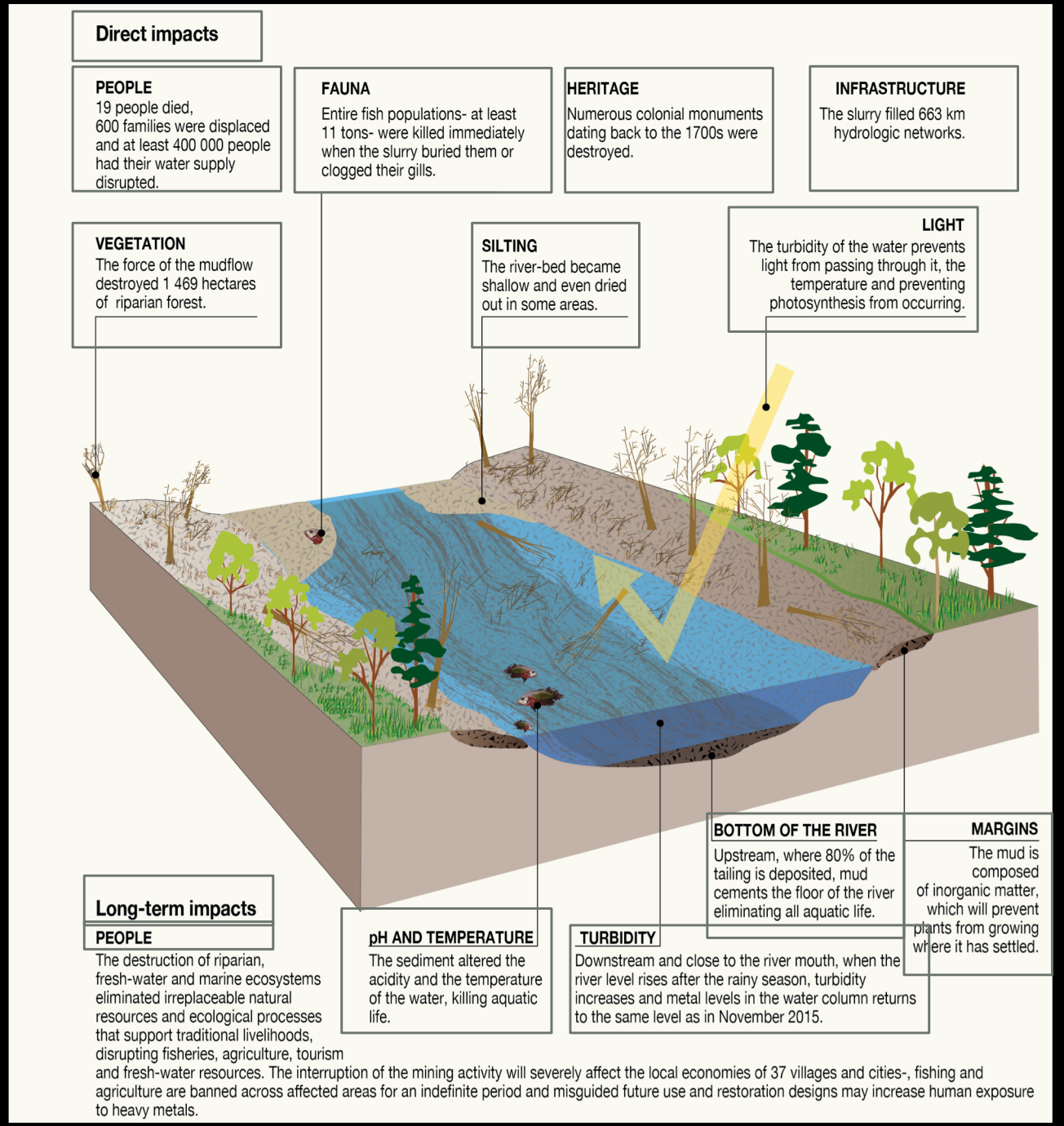
Samarco

5 November 2015, the Fundão dam breached, releasing an estimated 33 million m^3 of mine waste slurry.

The slurry reached the Doce River Valley and travelled for 620 km until it reached the Atlantic coast 14 days later.



Samarco


Direct impacts
PEOPLE
19 people died,
600 families were displaced and at least 400 000 people had their water supply disrupted.
FAUNA
Entire fish populations- at least 11 tons- were killed immediately when the slurry buried them or clogged their gills.
HERITAGE
Numerous colonial monuments dating back to the 1700s were destroyed.
INFRASTRUCTURE
The slurry filled 663 km hydrologic networks.
VEGETATION
The force of the mudflow destroyed 1 469 hectares of riparian forest.
SILTING
The river-bed became shallow and even dried out in some areas.
LIGHT
The turbidity of the water prevents light from passing through it, the temperature and preventing photosynthesis from occurring.
BOTTOM OF THE RIVER
Upstream, where 80% of the tailing is deposited, mud cements the floor of the river eliminating all aquatic life.
MARGINS
The mud is composed of inorganic matter, which will prevent plants from growing where it has settled.
Long-term impacts
PEOPLE
The destruction of riparian, fresh-water and marine ecosystems eliminated irreplaceable natural resources and ecological processes that support traditional livelihoods, disrupting fisheries, agriculture, tourism and fresh-water resources. The interruption of the mining activity will severely affect the local economies of 37 villages and cities-, fishing and agriculture are banned across affected areas for an indefinite period and misguided future use and restoration designs may increase human exposure to heavy metals.
pH AND TEMPERATURE
The sediment altered the acidity and the temperature of the water, killing aquatic life.
TURBIDITY
Downstream and close to the river mouth, when the river level rises after the rainy season, turbidity increases and metal levels in the water column returns to the same level as in November 2015.

Not just Brazil

Mount Polley mine
Canada 2014

Open-pit and underground copper and gold mine

Operation since 1997

25 million cubic meters of tailings

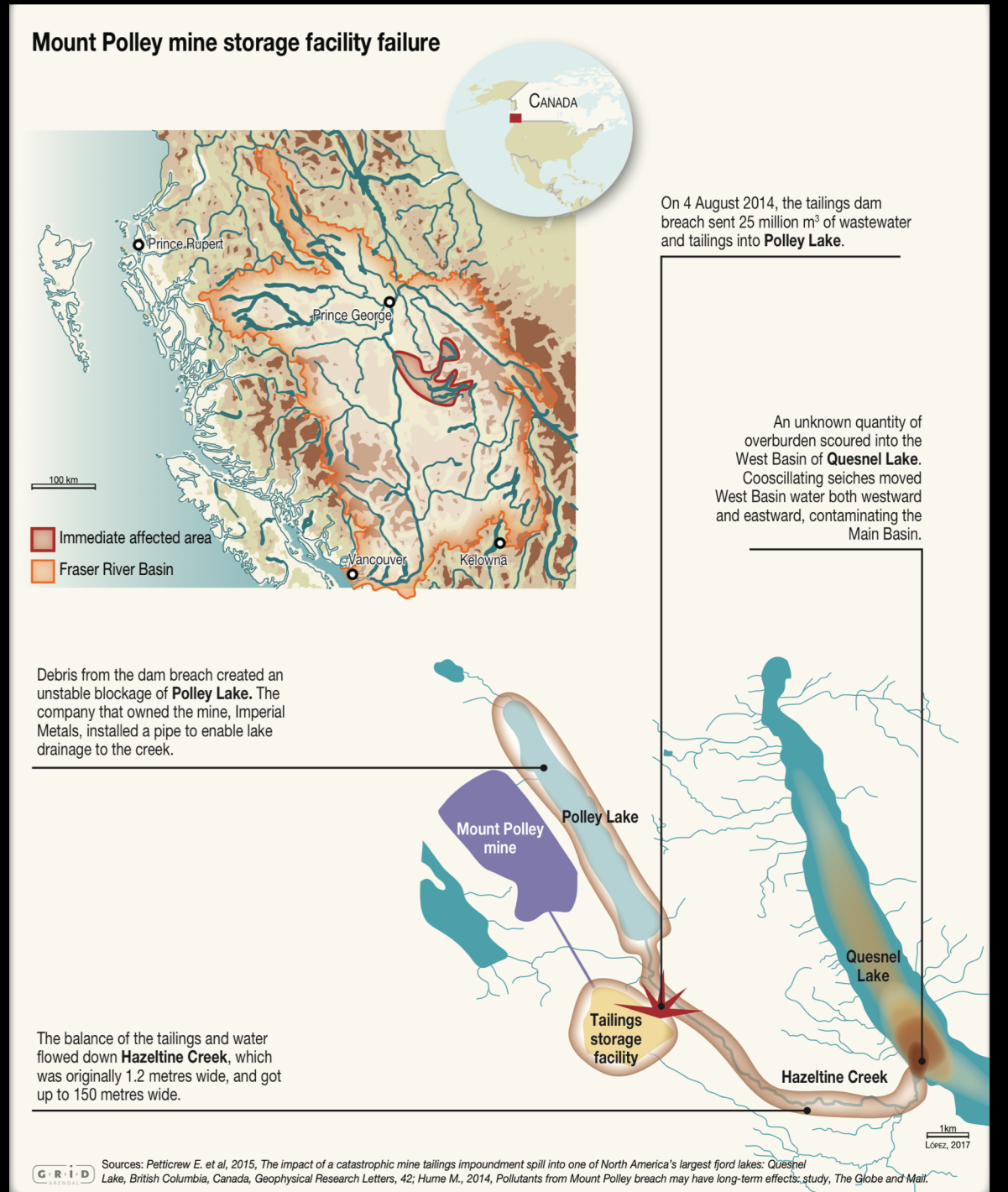
Turned a relative small creek into an over 100 m wide mud flat

Mount Polley
Canada 2014

The largest environmental disaster in Canadian mining history

The collapse resulted in a massive sediment-laden plume scouring Hazeltine Creek and entering the west basin of the Quesnal lake

Quesnel Lake is one of the world's deepest glacial lakes and are important to commercial, recreational and aboriginal fishery.



Maramures County

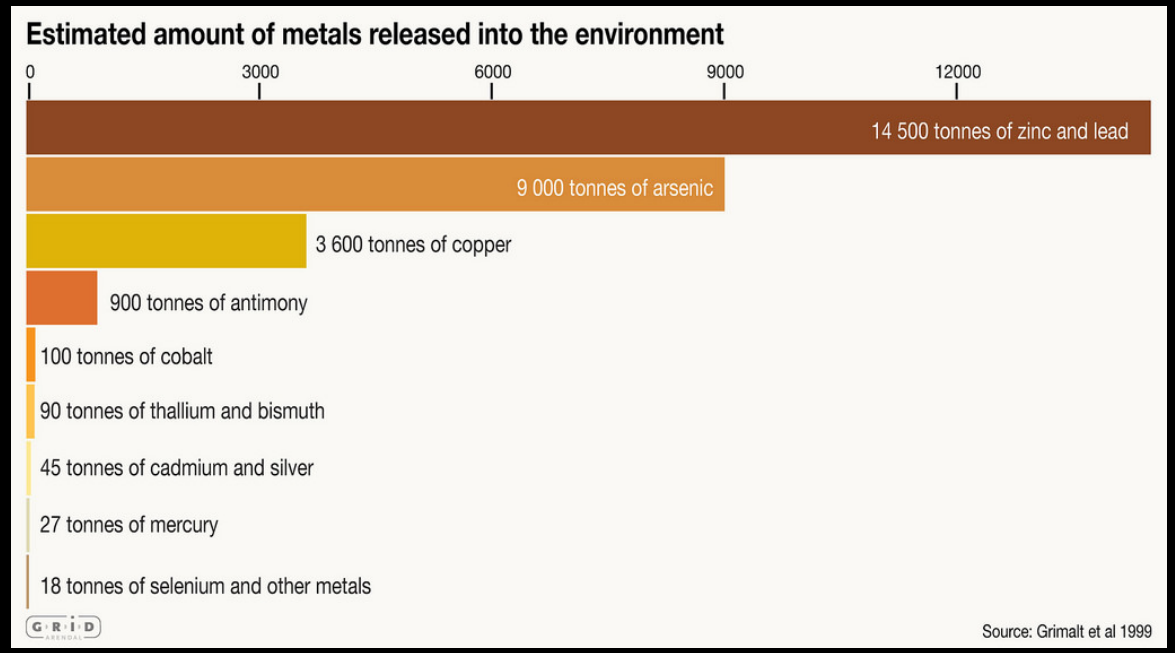
Romania, 2000

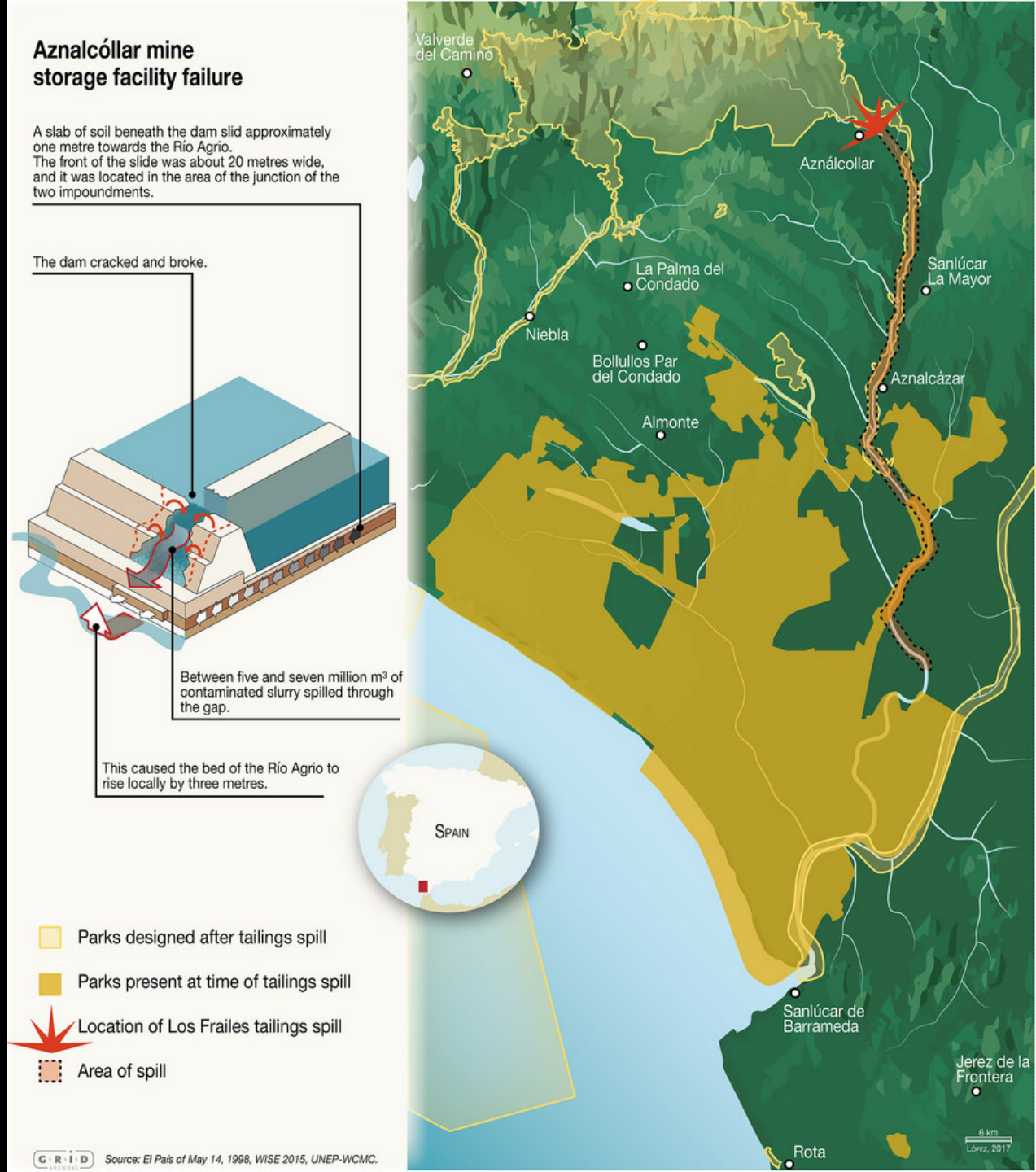
- **Progress of the spill plume**

1. **30 January** — Cyanide spill occurs at Baia Mare, Romania
2. **1 February** — Spill plume reaches Romanian-Hungarian border
3. **5 February** — Cyanide registers in tests at Tiszalök
4. **9 February** — Spill plume reaches Szolnok
5. **11 February** — It crosses the Hungarian-Yugoslavian border
6. **13 February** — It reaches Belgrade (Perlez), Yugoslavia
7. **15 February** — It meets the Romanian border again, at Ram
8. **17 February** — Cyanide registres in tests at Iron Gate, Romania
9. **25-28 February** — The plume reaches the Danube Delta

Sources: *UNEP/OCHA, 2000, The Cyanide Spill at Baia Mare, Romania. Before, During and After.*

Aznalcóllar, Spain 1998





Impacts of tailings dam failures on biodiversity and associated ecosystem services

Immediate environmental impacts	Long-lasting effects	Changes in ecosystem structure and function	Social implications
Directional effect			
Decreased water quality and oxygen content	Loss of regenerative capacity	Altered species composition	More floods
High levels of toxicity	Bio-accumulation of heavy metals	Change in vegetative structure	Reduced fish catches
Decreased populations of aquatic species	Persistence of heavy metals in floodplain sediment	Loss of ecosystem connectivity	Reduced carbon capture
Loss of vegetation and nursery habitats		Increase in bank/bed erosion	Loss of tourism revenue
			Decreased clean-water supply

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Source: UNEP-WCMC

Mine waste

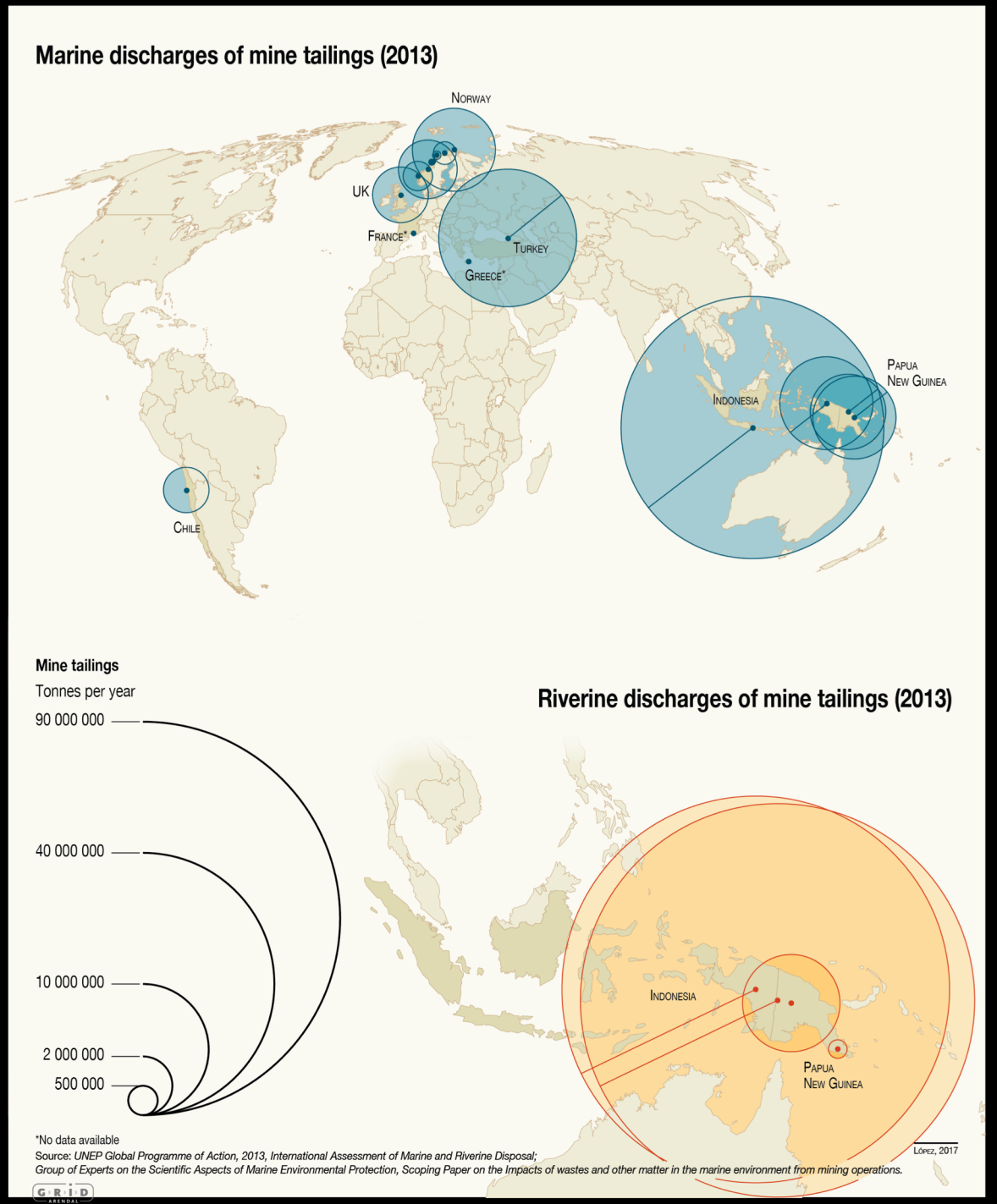
Riverine and offshore disposal

Difficult to build tailings dams

Initially cost effective

Forbidden in many countries

Still used and a new disposal area was permitted last week



2 Recommendations from the report

Recommendation 1

The approach to tailings storage facilities must place safety first by making environmental and human safety a priority in management actions and on-the-ground operations. Regulators, industry and communities should adopt a shared zero-failure objective to tailings storage facilities where “safety attributes should be evaluated separately from economic considerations, and cost should not be the determining factor” (Mount Polley expert panel, 2015, p. 125)

Recommendation 2

Establish a UN Environment stakeholder forum to facilitate international strengthening of tailings dam regulation.

Initial Stakeholder workshop

2 days in December 2018

The **objective** of this workshop was to hear viewpoints and concerns from a wide range of stakeholders in an open discussion, and come up with a plan for the activities that need to take place to achieve the ultimate goal of zero failures.

First day of the workshop:

Expanding the definition of failure

The group decided to expand the definition of failure to include, beyond “a release of tailings”:

failure to prevent and manage environmental risks,
failure to communicate risk to local communities,
failure to plan for accidents,
failure to plan for adequate mine closure,
failure to consider future generations and
failure to look for innovative solutions to the current problems associated with mine waste.

The stakeholder workshop

Second day

Focus was on exploring the future direction of the work on mine waste management and collectively consider establishment of a

Global Mining Initiative.

What would success look like

Have the **long-term goal** of **net zero mine waste**, and a new and transformational mining activity.

Achieve the **short-term goal** of zero tailings storage failures.

Involve **all** mining companies and regulators in **all mining jurisdictions**.

Include **all** mining beneficiaries, such as banks and financial institutions (shareholders).

Target the underperformers in the industry to bring them up to an acceptable standard.

Be transformative, campaign for new technology and innovation across all sectors.

Require **compulsory competent external review** of waste management facilities

Champion ethics over short-term profits.

Instigate a new type of cost benefit analysis that incorporates **all externalities**.

Address **legacy waste** inclusive of re-use opportunities for these materials.


To be continued with a new meeting in 2019

Thanks to every one who has and continually contribute with their knowledge, expertise, time and energy to make positive changes in and related to the mining sector