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The Symposium of the information days of CEDRE
"The environmental impact of an accidental pollution of water".

Environmental Restoration of the Guadiamar River basin affected by the accident of the mine in Aznalcollar, Spain.

The Oceanographic Institute of Paris
Thursday October 17 2.002
Paris

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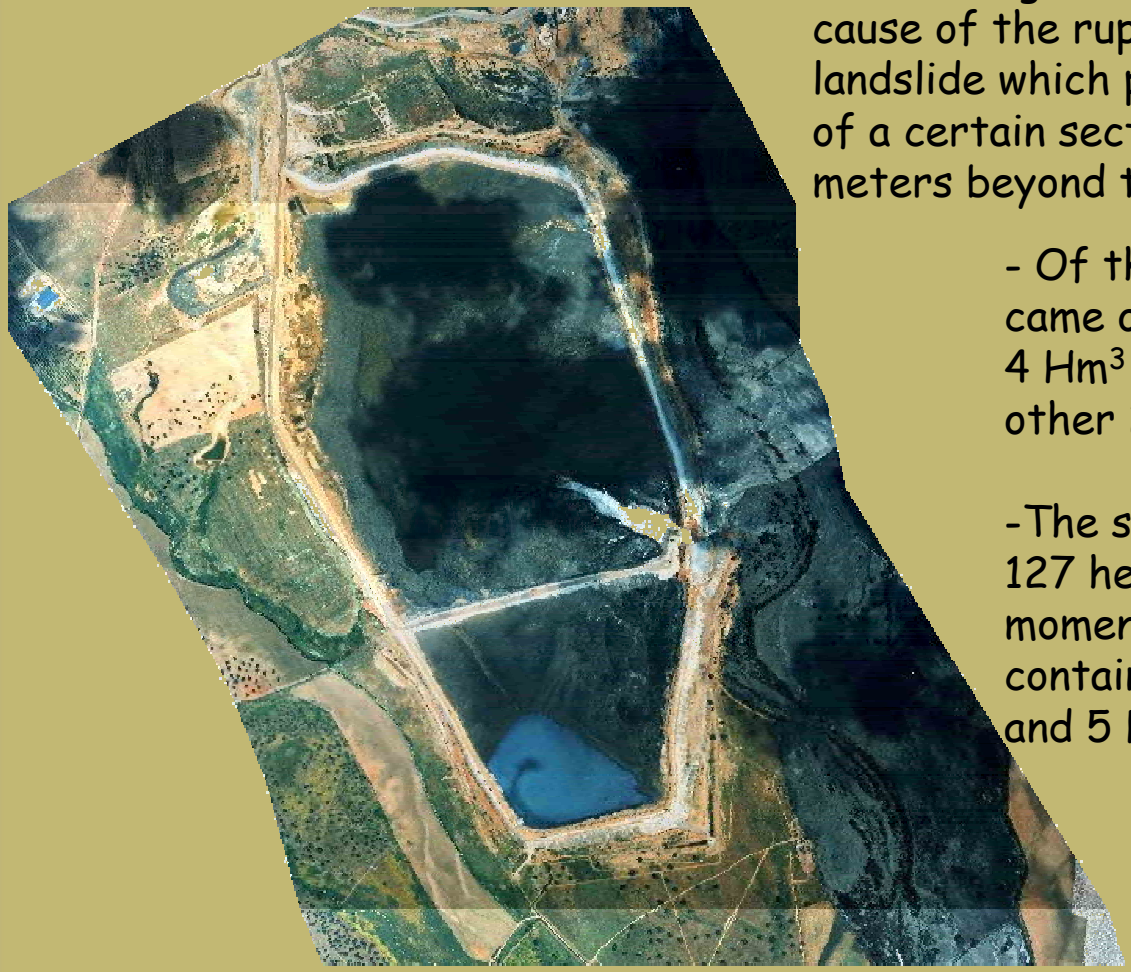
Background

-On the 25th of April 1998, the dam of the mining residual tank of the Aznalcollar mine suffered a rupture and caused the release of 6Hm^3 of sludge and contaminated water.



- According to the technicians, the cause of the rupture was a deep landslide which provoked the movement of a certain section of the wall, 50 meters beyond the tank´s wall.

- Of the 6 Hm^3 of spill that came out of the damaged tank, 4 Hm^3 were water and the other 2 were mining sludge.

-The size of the tank was of 127 hectares and in the moment of the rupture it contained 18 Hm^3 of sludge and 5 Hm^3 of water.

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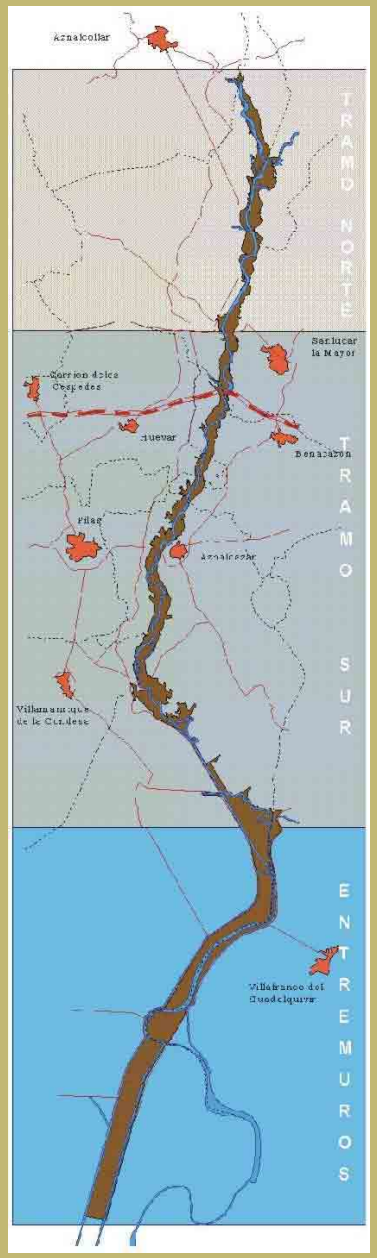
Description of the affected area



-Of the 4,634 hectares affected , 2,703 of them were covered by sludge and 1,931 flooded by acidic water.

-The disaster affected 63 kms of the river downstream and the neighbouring land. The contaminated area occupied 4,634 hectares and drastically affects the cultivation lands and the riparian forest.

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The mining residue

- The mining residue came from the process of pyrite floatation to obtain Pb, Cu and Zn concentrates.

- The original material, having come from the Frailes hole, was made up of the dissemination of sulphades such as galena, chalcopyrite and esphaleryte included in a pyrite matrix.

- After being triturated and finely ground, sizes smaller than 8 microns, the specimens carrying the metals of interest are freed thus obtaining an individual, sequential concentration of each of them.

- The resulting residue, practically 90% of the processed mineral, was confined in the tank which was damaged.

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The mining residue

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Element/Concentration of the pyrite sludge: grams/tonne

Zn	8,000
Pb	8,000
As	5,000
Cu	2,000
Co	90
Tl	55
Bi	70
Cd	28
Hg	15

- High pyrite purity 68-78%

- Very fine granulometry, 50% of the particles are smaller than 8 microns. (Particles smaller than 10 microns can be inhaled).

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Emergency Actions

Water Quality

The water quality worsened drastically starting on the day of the spill, taking one month to recover the initial levels:

Zn from 450 to 5 mg/l
pH from 4 to 7.9
Other significant parameters:
Mn 100 mg/l.
Fe 230 mg/l.
O_2 1 mg/l.
S.S. 30,000 mg/l.

A follow-up and vigilance programme was designed. To begin with, 70 sampling points were installed that controlled zones from the rupture point in the tank to the mouth of the Guadalquivir River. As time passed, the control point network was modified according to two criteria: the evolution of the analytic data and the evolution of the relevant variables.

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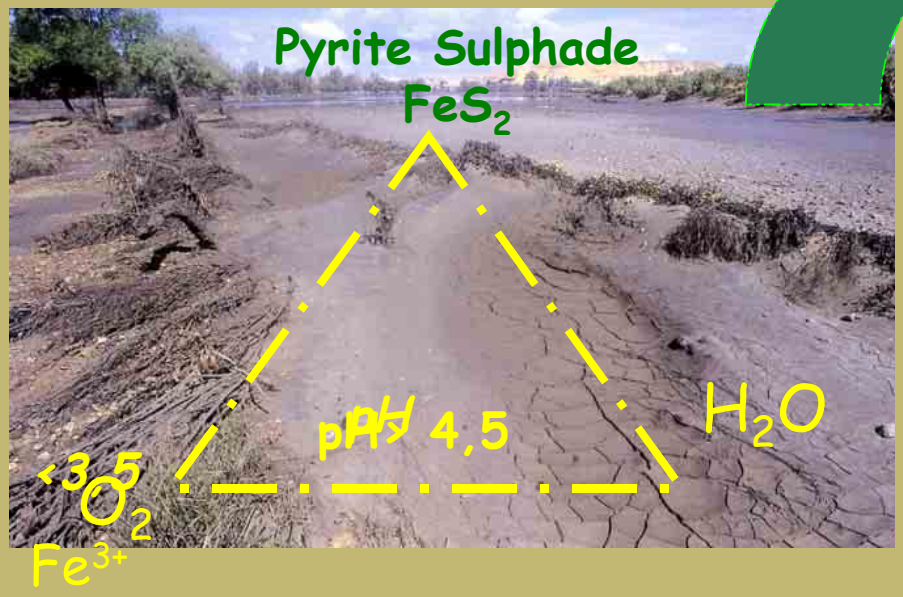
The mining residue

Analysis of the problem

• Strong decrease of the pH



•Increase in the solubility of the heavy metals.

•High quantity of dead vegetation

+ Catalyst Bacteria

"Thiobacilus ferroxidans"

• Surface and underground water contamination.

•Vegetable phytotoxicity.

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The mining residue

Analysis of the problem

- CONCLUSION:

- *The mere presence of the sludge on the soil supposed a potencial acidification risk and the lixiviation of the metals present in the residue.*

The Main Emergency Actions

-The **construction of a transversal containment wall** to prevent the contaminated waters from entering into areas of greater ecological interest.

-**Removal of contaminated sludge**.

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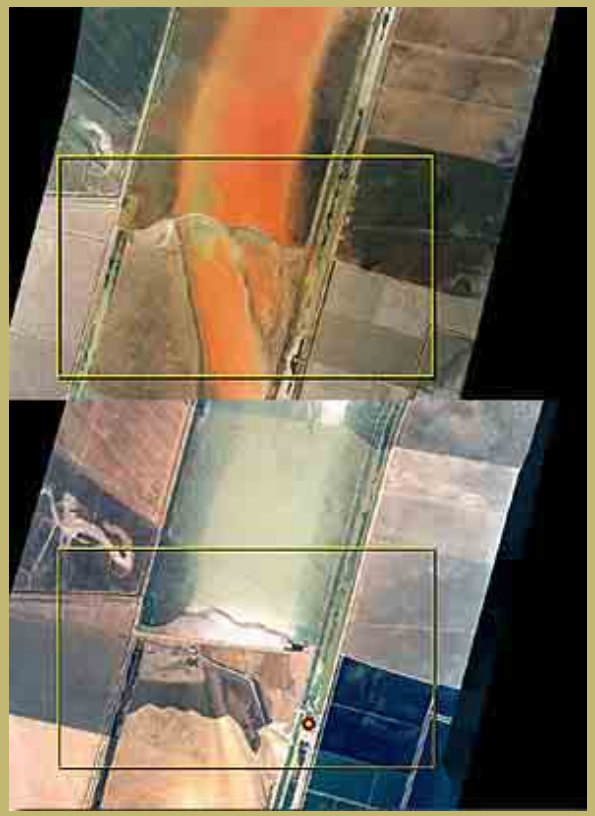
Emergency Actions

Construction of the containment walls



At Entremuros, during the rupture the following were registered:

Zn	300 mg/l.
Mn	80 mg/l.
pH	4

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Emergency Actions

Sludge removal

• The deposit of the sludge along 62 km of fluvial area affected each zone differently, registering levels of 4 metres nearer to the tank and around 10 cm in the southern section.

•In the cleaning works the resources employed were numerous, being simultaneously almost 500 lorries and more than 150 machines among diggers and loading machines, to remove 7 million of m^3 of sludge and countermined water.

•After the cleaning, the soils that had had a greater quantity of sludge were the most affected, containing elevated concentrations of the most harmful elements.

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Emergency Actions

Sludge Removal

•A total of 7 million m3 were removed .

•Given the importance of a greater or lesser presence of S-pyrites in the soils, a system of quality control of the cleaning was implanted, establishing as an indicator the % of this compound in the soils. The norm said that it always had to be lesser than 1.5 % in the first 20 cm of soil.

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Recuperation Activities

Soil Recuperation

Identification of the main problems:

- Potential acidity
- High As concentrations
- High Zn concentrations.
- Low fertility level of the soils.

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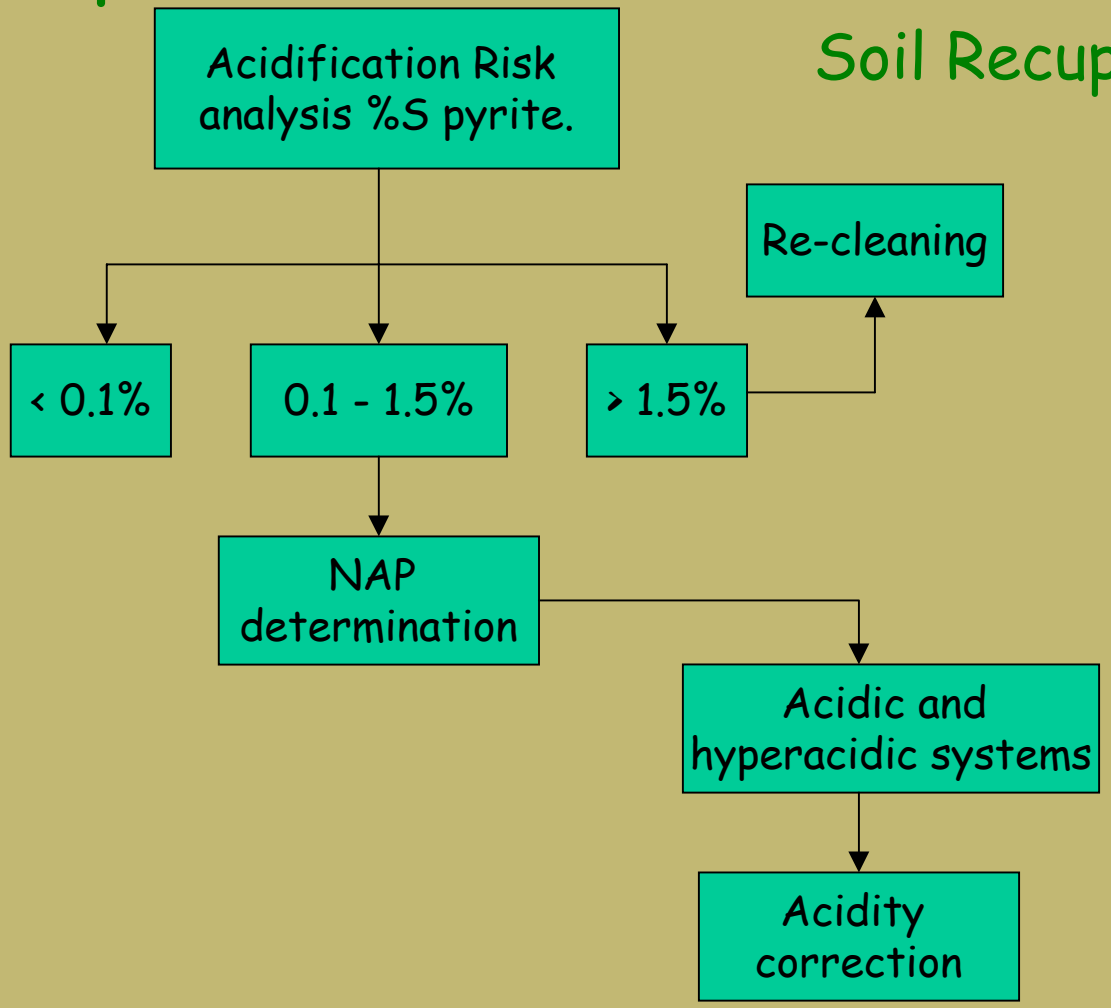
Recuperation Activities

Soil Recuperation



NAP, Net Acidification Potencial

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Recuperation Activities

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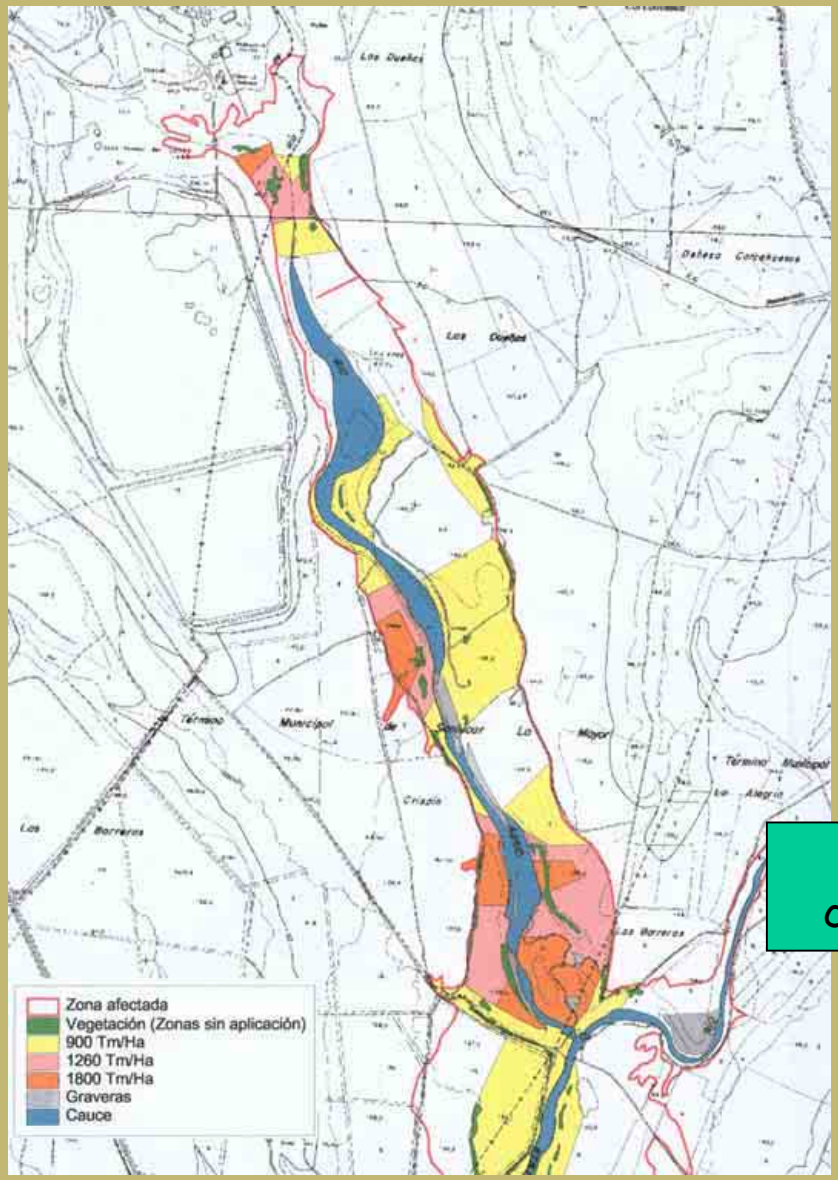

Soil Recuperation

Acidification Risk

Acidity correction

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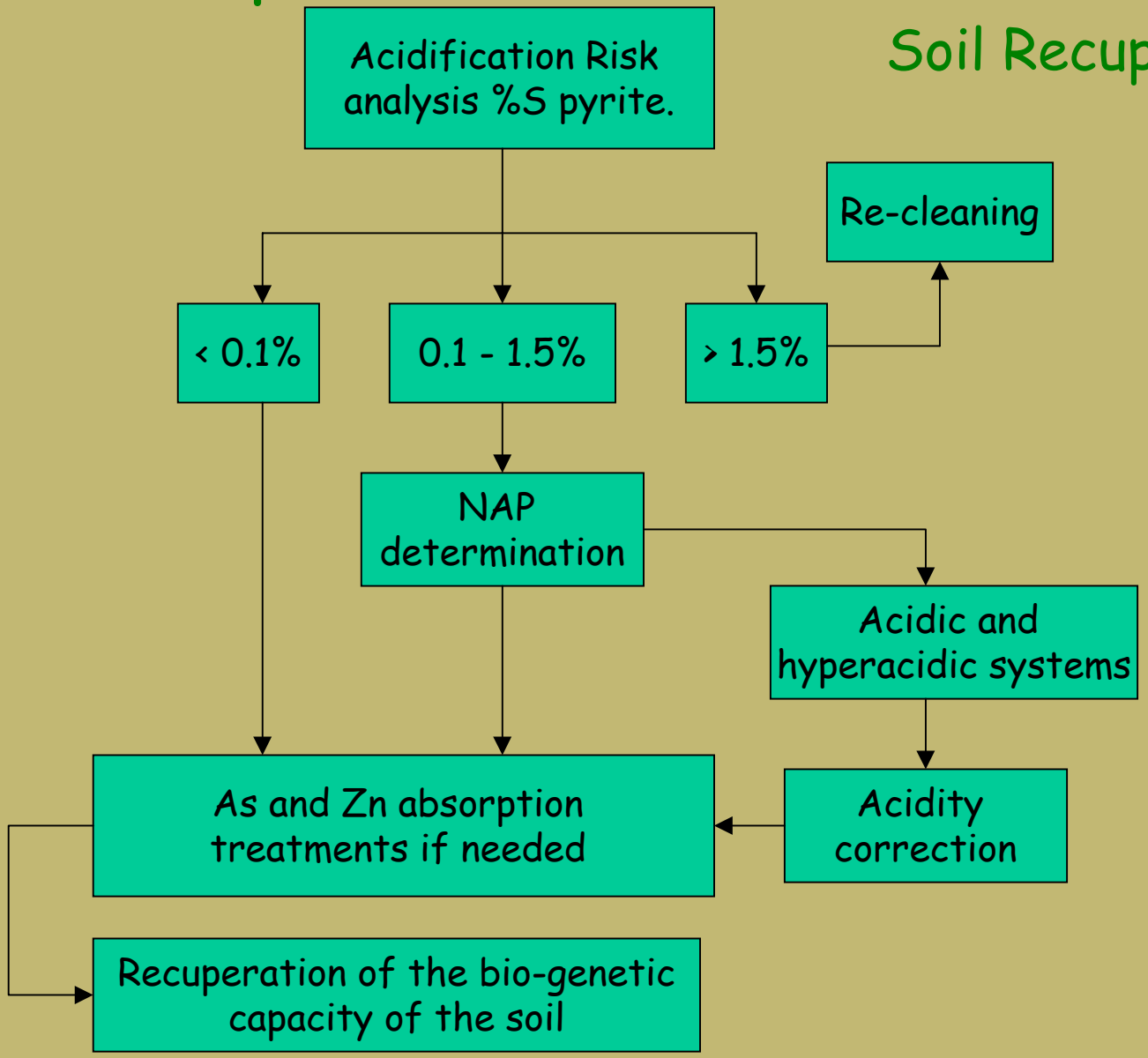
Recuperation Activities

Soil Recuperation



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Recuperation Activities

Soil Recuperation

Acidity correction

- The elevation of the pH of the soil not only makes the re-vegetation of the affected area possible, but at the same time causes a descent in the mobility of the metals, especially starting at pH 6, preventing lixiviation phenomena.

- With regards to As, it shows a minimal concentration in the interval pH 5 to 6, augmenting its solubility above these values. This circumstance demonstrates the scant effectiveness of this treatment when it comes to immobilising As.

- The material selected for the lime treatment was an industrial sugar subproduct. This material has an elevated capacity of neutralisation, rapid reaction and very low cost.

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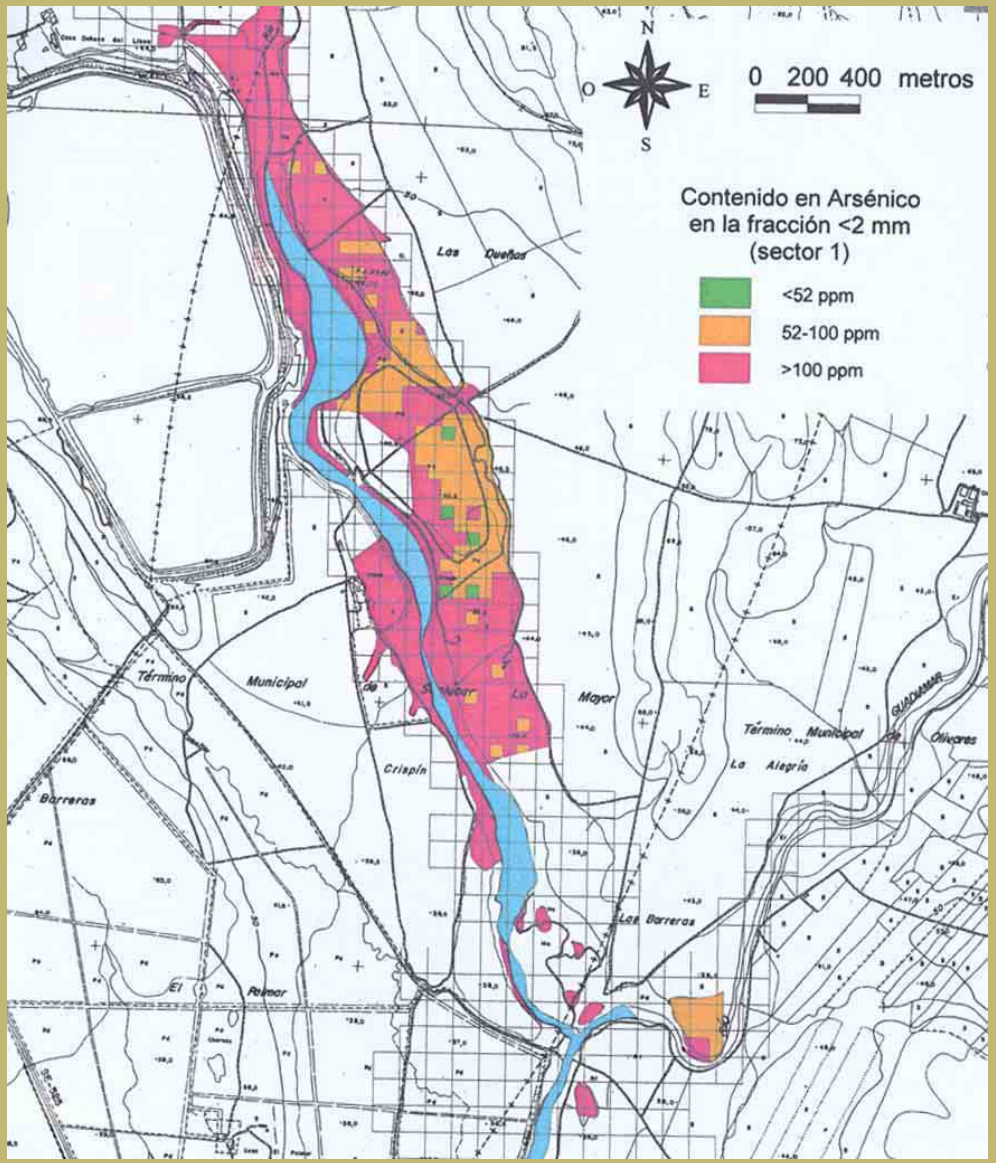
Diagnosis

Arsenic contamination



- A Royal Decree, specifically published for this incident, established the tolerance levels for As in the following way:

Intervention >100ppm
Vigilance 52-100ppm
Tolerance <52ppm

- In the High Section, 38% of the samples were above the intervention level, in the middle section only 7% were above this level, and these cases were practically non-existent in the Low Section.

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Recuperation Activities

Soil Recuperation

Absorption of As and heavy metals

•Many metals, such as As, can be set by other colloidal compounds, mainly organic compounds, Fe and Al oxides, clays and carbonates.

•Finally, the Fe oxyhydroxides clays were chosen.This material does not only have the properties indicated above, but at the same time, in low pH conditions, have a strongly positive charge capable of absorbing to a large extent anions such as arsenate.

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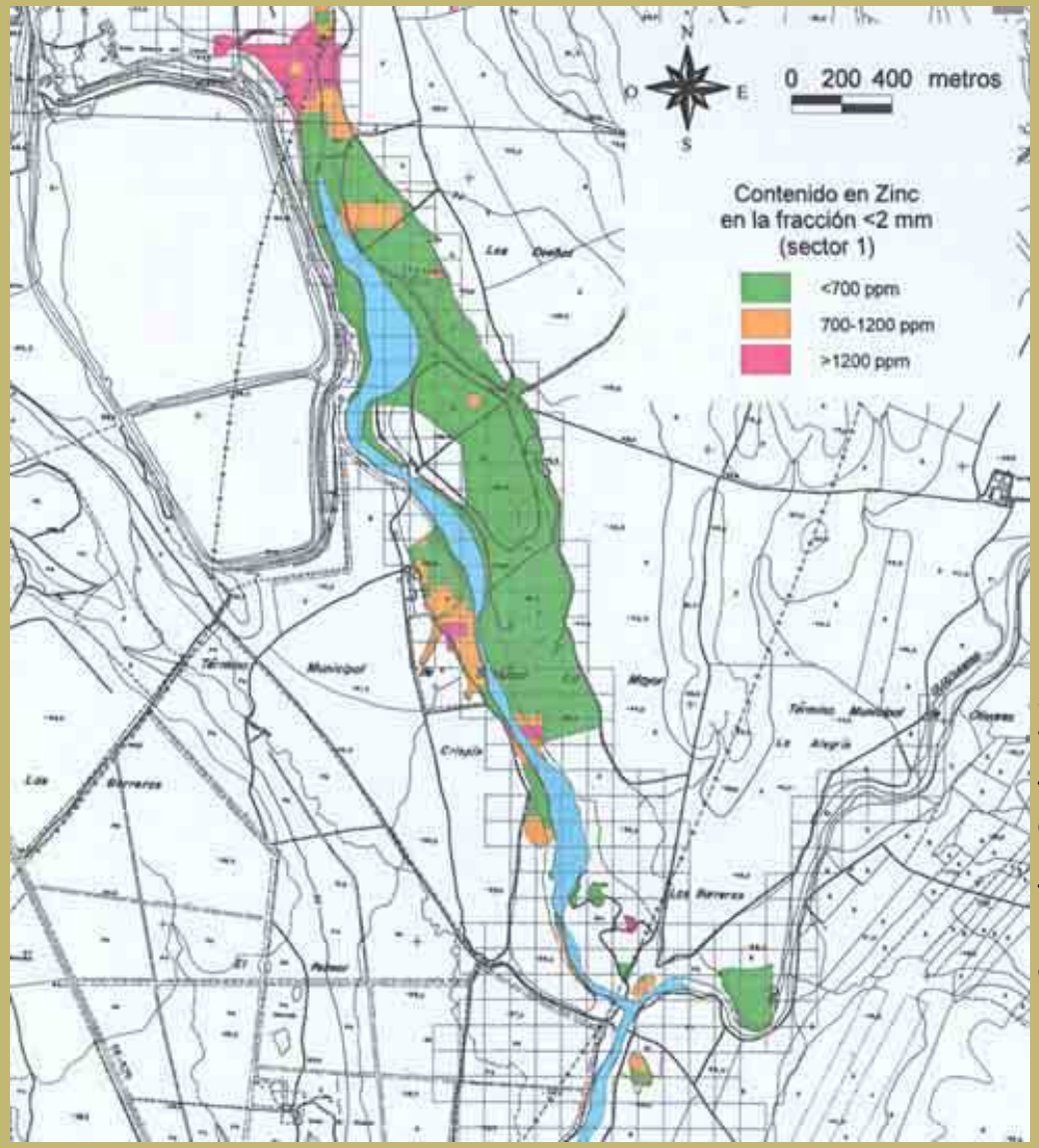
Diagnosis

Zinc contamination



- A Royal Decree, specifically published for this incident, established the tolerance levels for Zn in the following way:

Intervention >1.200ppm
Vigilance 700-1.200ppm
Tolerance <700ppm

- Contrary to what happened with As, the Zn, being much more soluble, affecting overall the Low section. More than 19% of the samples were above the intervention levels.

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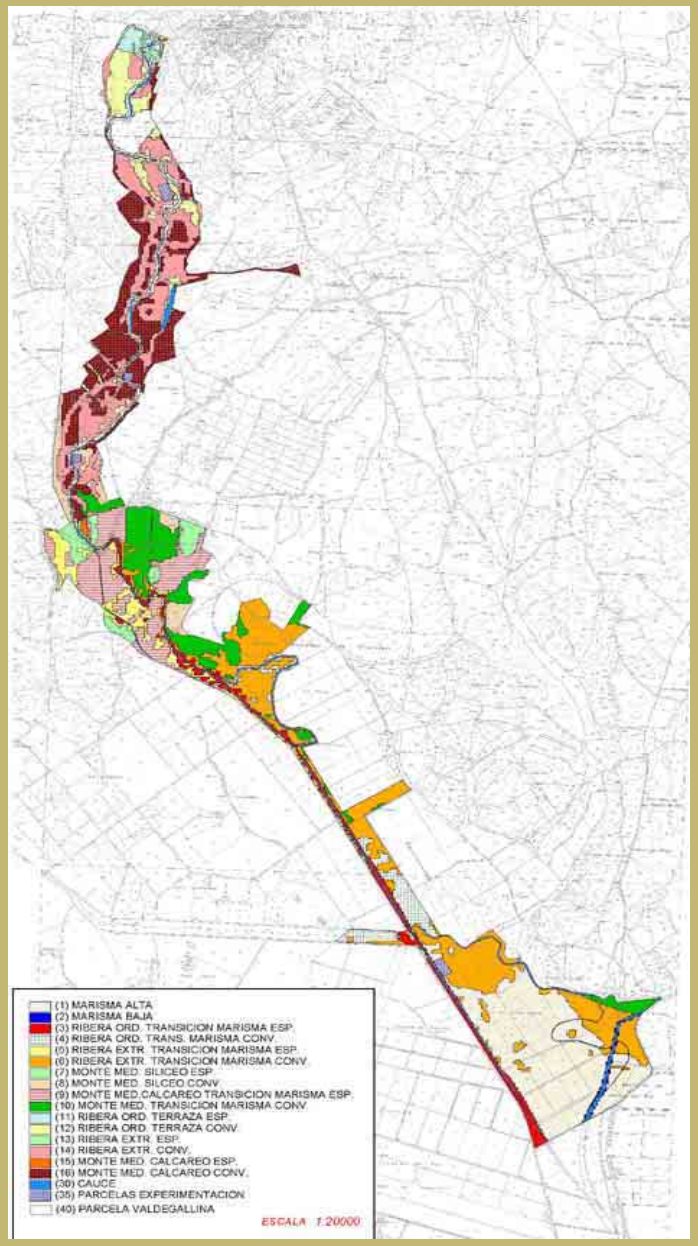
Recuperation activities



Landscape recuperation

In the first place, a phytosociological study was carried out on nearby vegetation, with similar edaphological and climatic conditions. This report, together with the characterisation of the terrain, where, among other variables, the following were determined: the depth of the water table, presence of contaminants, edaphological study, topography, and transversal and longitudinal position with respect to the fluvial section, served to define the sixteen vegetation models based on the use of almost forty species, both underbrush and trees.

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End of the presentation

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