Recovering contaminated soils through phytomanagement in Southwestern Europe

1st PhytoSUDOE Stakeholders’ Workshop – April 2017

Bordeaux INP

PHYTOMANAGEMENT EXPERIENCES OF BASOINSA SL
– ENVIRONMENTAL CONSULTING & ENGINEERING

Phytoencapsulation of waste
Phytoextraction of metals from mining waste
Phytoextraction of metals and remediation of hydrocarbons in brownfield soils
Research needs identified

more than 30 years committed to the environment
SOME PROJECTS WE CARRY OUT RELATED TO CONTAMINATED SOIL, SEDIMENT AND WATER

- Characterization and risk analysis of mining waste and contaminated soil, sediment and groundwater. Environmental hydrogeology
- Investigation and restoration of areas impacted by mining or extractive industry. Waste and sediment management. Environmental quantitative risk analysis in contaminated soil, sediment, groundwater and surface water
- Soil, sediment and water investigation and inspection following the standards of UNE-EN ISO/IEC 17020
- Phytomanagement and remediation of industrial waste, mining-impacted soils and heavy-industry brownfield sites
- Design and environmental control of sanitary landfills and hazmat controlled repositories.
- Forensic and legal assistance on environmental impact assessment to the biota and physical environment (geo-hydrosphere).

SOIL-RELATED ACCREDITATIONS AND REGISTRATIONS OF BASOINSA SL

- ENAC (Spanish National Authority for Accreditation and Certification): UNE-EN ISO/IEC 17020
- WITH BASQUE GOVERNMENT, Department of the Environment:
  - Registered Consultant for investigations of contaminated soil and associated groundwater
  - Registered Consultant for phytoremediation of contaminated soil and associated groundwater
  - Registered Analysts for Environmental Risk Assessment related to human health and the environment
- WITH OTHER REGIONAL GOVERNMENTS: Registered Consultant for investigations of contaminated soil and associated groundwater by regional governments like JUNTA DE ANDALUCÍA, XUNTA DE GALICIA y JUNTA DE EXTREMADURA
RESTORATION AND MANAGEMENT OF WASTE FROM EXTRACTIVE INDUSTRY

Abandoned dump with 31,000 m³ of Industrial waste (lime factory) in Guipúzcoa (IHOBÉ SA, 2002; local Municipality 2004-2006)

- Geological, hydrogeological and waste type mapping
- Borehole drilling, sampling and characterization of waste
- Land management and restoration alternative study. Waste phytoencapsulation and natural confinement
- Works management for waste elimination, revegetation and landscape restoration
- Environmental control and survey planning during and after the works
- Optimal results within 2 to 5 years
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FINAL RESULT

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# PHOTOREMEDIATION OF MINING WASTE

Phytoremediation applied to mine tailings and sludge stocks:

<table>
<thead>
<tr>
<th>DESIGN FACTORS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatments</td>
<td>CONTROL</td>
</tr>
<tr>
<td></td>
<td>+ TREATMENT</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **SPECIES 1**: Species present in the area
- **SPECIES 2**: Species present in the area
- **SPECIES 3**: Species present in the area
- **SPECIES 4**: Species present in the area
- **SPECIES 5**: Species present in the area
- **SPECIES 6**: Species present in the area
- **SPECIES 7**: Control species (commonly mentioned sp. in available bibliography)
Phytoremediation of mining waste

Fitorrecuperación aplicada a balsas de lodos mineros:

<table>
<thead>
<tr>
<th>SPECIES 1</th>
<th>Cd (mg/kg)</th>
<th>Zn (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>20,33</td>
<td>190,33</td>
</tr>
<tr>
<td>Lodos</td>
<td>14,17</td>
<td>169,33</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPECIES 2</th>
<th>Cd (mg/kg)</th>
<th>Zn (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>21,33</td>
<td>137,67</td>
</tr>
<tr>
<td>Lodos</td>
<td>14,00</td>
<td>188,67</td>
</tr>
</tbody>
</table>

Cd and Zn concentrations in plant samples (root).
Effect of different treatments.

<table>
<thead>
<tr>
<th>SPECIES 1</th>
<th>Cd (mg/kg)</th>
<th>Pb (mg/kg)</th>
<th>Zn (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No aditivo</td>
<td>4,5</td>
<td>10</td>
<td>1095</td>
</tr>
<tr>
<td>+Lodo</td>
<td>2,4</td>
<td>6,3</td>
<td>575</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPECIES 2</th>
<th>Cd (mg/kg)</th>
<th>Pb (mg/kg)</th>
<th>Zn (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No aditivo</td>
<td>1,8</td>
<td>2,5</td>
<td>159</td>
</tr>
<tr>
<td>+Lodo</td>
<td>1,8</td>
<td>2,3</td>
<td>111</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPECIES 3</th>
<th>Cd (mg/kg)</th>
<th>Pb (mg/kg)</th>
<th>Zn (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No aditivo</td>
<td>1,6</td>
<td>11</td>
<td>150</td>
</tr>
<tr>
<td>+Lodo</td>
<td>1,6</td>
<td>4,1</td>
<td>106</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPECIES 4</th>
<th>Cd (mg/kg)</th>
<th>Pb (mg/kg)</th>
<th>Zn (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No aditivo</td>
<td>3,3</td>
<td>4,2</td>
<td>1391</td>
</tr>
<tr>
<td>+Lodo</td>
<td>2,6</td>
<td>4</td>
<td>911</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPECIES 5</th>
<th>Cd (mg/kg)</th>
<th>Pb (mg/kg)</th>
<th>Zn (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No aditivo</td>
<td>8</td>
<td>7,4</td>
<td>1157</td>
</tr>
<tr>
<td>+Lodo</td>
<td>4,3</td>
<td>5,2</td>
<td>838</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPECIES 6</th>
<th>Cd (mg/kg)</th>
<th>Pb (mg/kg)</th>
<th>Zn (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No aditivo</td>
<td>0,9</td>
<td>2,4</td>
<td>179</td>
</tr>
<tr>
<td>+Lodo</td>
<td>0,9</td>
<td>2,6</td>
<td>71</td>
</tr>
</tbody>
</table>

Metal concentration (Cd and Zn) in aerial parts of the different plant species.
Effect of the different treatments.
 PHYTOMANAGEMENT APPLIED TO DEGRADED AREAS ("BROWNFIELDS") BY HEAVY INDUSTRY (STEELMAKING, SHIPYARDS) AROUND BILBAO

Former site of Altos Hornos de Vizcaya, 2012-2013
Environmental and landscape restoration of former mining-degraded areas: La Arboleda, from 2005 onwards

- Sediment stock to be reused as inexpensive substratum of rich topsoil in mining-impacted areas restoration.
- Periodic analytical control of solid and liquid materials.

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REUSE OF SEDIMENTS IN LANDSCAPE RESTORATION PROJECTS

USING WASTEWATER PLANT SLUDGE IN BARE ROCK QUARRY RESTORATION
MINING WASTE MANAGEMENT
Characterization and management of sediments from a siltated former mining dam:

- Draining, sediment exposure and initial phases of infill investigation by means of pneumatic percussion drillings for sampling.
- Aspect of the different types of sediment exposed (mining- and non-mining-generated).

- Sedimentological studies for a stratigraphical matching between actual sediment beds and different episodes of dam siltation and infilling.
- Detailed stratigraphy is key for a smart sampling design and for establishing the reusability of every bed of sediment.
What have we learned and what do we need for further R&D?

Especially for mine tailing dumps and brownfield-like poor soils:

- Select the most resistant plant types to stand drought and harsh conditions in poor soils
- For those plant types: irrigation patterns, regular additives, useful industrial byproducts, water retainers and organic matter providers that can assure plant survival in difficult climate conditions
- Best performing species and its best management practices i) to maximize biomass while decomposing phyto-toxic hydrocarbons and ii) to concentrate metals in parts of the plant that can be of most interest (thin harvestable branches? thicker branches? even roots if whole plants can/are to be removed?), all this iii) avoiding non-controlled elements as flowers, leaves, fruits and seeds that can be eaten or spread by wind and fauna
- Best management option for the obtained “contaminated” biomass
- Best systematic options for a representative sequential soil sampling to check progress
Thank you for your attention!

THANKS TO IHOBE SA, BILBAO RIA 2000, FUNDACIÓN LABEIN AND TO DIFFERENT PUBLIC AND PRIVATE ORGANIZATIONS AND CLIENTS FOR THE AUTHORIZATION TO EXPOSE DATA FROM THEIR PROJECTS AND INVESTIGATIONS

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