"Sustainable reclamation scheme for bauxite mines by implementing GIS tools"

A. Argyriou, A. Adam*, D. Papakonstantinou and K. Cassios

* Assistant Professor, School of Mining and Metallurgical Engineering, NTUA
CONTENTS OF THE PRESENTATION

- Aim of the study
- Study Area
- Criteria for the selection of disposal sites - Methodology employed
- GIS Analysis
- Conclusions - Proposals for further study
1. AIM OF THE STUDY

To examine the potential use of old surface bauxite mines in Fokis and Fthiotis Prefecture, Region of Central Greece, as disposal sites suitable to receive the urban waste produced in the neighbouring communities.

Multicriteria Analysis and GIS Tools used to examine this alternative scheme.

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1. AIM OF THE STUDY, cont.

Feature of the proposed scheme consist the potential transportation of urban wastes collected from the communities with the Tithorea - Lianokladi section of the national railway line, scheduled to be inactivated in 2016.
2. STUDY AREA

✓ located in the Region of Central Greece,
✓ extends around the Fokida, Fthiotida and Viotia Prefect.,
✓ Covers area of 5500 Km\(^2\)
✓ Boundaries set taking into account (a) the location of the old S&B bauxite mines of Giona and (b) their proximity to the Tithorea-Lianokladi (TL) railway section, 69 Km long crossing the Fthiotida Prefecture.
2. STUDY AREA

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TL Railway section scheduled to be inactivated in 2016

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2. STUDY AREA

Bauxite Mines before and after reclamation

Source: S&B S.A

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2. STUDY AREA

Features of the Study area
✓ Mountaineous
✓ Main geological formations: flysch, hard compact limestone, igneous rocks and quaternary deposits, bauxite deposits
✓ Natura site closer to the mines examined, Mount Giona GR2450002
2. STUDY AREA

Demographical Data, 2001 Census

_Viotia Prefecture_, 1 Municipality in the study area
_Fthiotida Prefecture_, 10 Municipalities examined in the study area
_Fokis Prefecture_, 5 Municipalities examined in the study area

Total population of the area examined, almost 131,000 inhabitants.

Waste produced per capita per year in Greece 400-500 kg/y, (Eurostat 2007). Organic circa 45%, Recycling : 20%.

Brallos Railway station selected as Reference Point for the collection of wastes and transport by trucks to the old Mines sites.
3. CRITERIA FOR SELECTION OF WASTE DISPOSAL SITES

Based on Prevailing legislation, Reported studies, Best Available international practice, criteria used to evaluate/select sites appropriate for waste disposal relate to functionality, land use, environmental protection and costs, i.e.

- **Storage Capacity**
- **Distance** from settlements, ecologically sensitive areas, archeological sites, water bodies, main infrastructure
- **Distance** from the waste generation sources
- **Hydrogeology, topography, climate, seismicity**
- **Social Acceptance**

Appropriate measures envisioned to seal the disposal site from the Downstream environment as dictated by relevant legislation.
3. CRITERIA FOR SELECTION OF DISPOSAL SITES

In the present study the aim is not to select the most suitable undisturbed site to create a new waste disposal facility, but to identify with a multicriteria analysis existing old mine voids that could be used as waste disposal facilities, and subsequently reclaimed.

Criteria used:
Geological-Hydrogeological,
Spatial,
Environmental,
Economic

each represented as a layer in a GIS environment. Buffer mapping according to specific criterion(a) suggests exclusion zones.
## 4. GIS ANALYSIS

### Criteria

<table>
<thead>
<tr>
<th>Geological &amp; Hydrogeological Criteria</th>
<th>All mines examined Zone 2, √</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Not located in a seismically active area</td>
<td>√</td>
</tr>
<tr>
<td>- Distance from the main river network &gt;100m</td>
<td>√</td>
</tr>
<tr>
<td>- Low Permeability formations</td>
<td>When not met to be Mitigated with low permeability geological or synthetic barriers</td>
</tr>
</tbody>
</table>

### Spatial Criteria

<table>
<thead>
<tr>
<th>Spatial Criteria</th>
<th>All mines examined √</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Exclusion zone from settlements 250m</td>
<td>√</td>
</tr>
<tr>
<td>- Not close to archeological sites</td>
<td>√</td>
</tr>
<tr>
<td>- Away from lakes, &gt;300m, highways, &gt;300m, airports &gt;3000m</td>
<td>√</td>
</tr>
</tbody>
</table>

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4. GIS ANALYSIS

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Environmental Criteria</strong></td>
<td></td>
</tr>
<tr>
<td>- Not located in an environmentally sensitive area</td>
<td>Buffer zone to exclude mines in Natura sites</td>
</tr>
<tr>
<td>- Only surface mines were considered for evaluation</td>
<td>Surface mines examined ✓</td>
</tr>
<tr>
<td>- Limited visibility from settlements</td>
<td>Of Relative importance , surface mines already present in the area</td>
</tr>
<tr>
<td><strong>Economic Criteria</strong></td>
<td></td>
</tr>
<tr>
<td>- Distance, &lt; 20Km from the Brallos Station</td>
<td>All Mines examined ✓</td>
</tr>
<tr>
<td>- Not applied to already restored mines</td>
<td>Restored mines not examined</td>
</tr>
<tr>
<td>- Operational road network</td>
<td>All mines examined ✓</td>
</tr>
</tbody>
</table>
### 4. GIS ANALYSIS, example

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<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>LANDFILL/WASTE DISPOSAL-BAUXITE MINES</th>
</tr>
</thead>
</table>
4. GIS ANALYSIS, SPATIAL CRITERIA

Buffer Zone around settlements

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4. GIS ANALYSIS, ENVIRONMENTAL CRITERIA

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4. GIS ANALYSIS, SYNTHESIS OF CRITERIA

GIS application indicated 9 Mines as suitable for potential waste disposal, Cumulative capacity circa 9.5 Mm³

Evaluation: Serve Municipalities/Waste sources located in 5, 10, 20 Km zone around the Tithorea-Lianokladi railway section.

<table>
<thead>
<tr>
<th>Radius from the railway section, km</th>
<th>No of settlements</th>
<th>Annual waste production, m³/y</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>46</td>
<td>64,000 m³/y</td>
</tr>
<tr>
<td>10</td>
<td>56</td>
<td>246,000 m³/y</td>
</tr>
<tr>
<td>20</td>
<td>97</td>
<td>333,000 m³/y</td>
</tr>
</tbody>
</table>
4. GIS ANALYSIS, SYNTHESIS OF CRITERIA

Sustainable reclamation scheme for bauxite mines by implementing GIS tools
5. CONCLUSIONS-PROPOSALS FOR FURTHER STUDY

The reclamation scheme proposed was developed in conceptual stage with the application of Multicriteria Analysis and GIS tools along two main sustainable development concepts

• Use of old bauxite mines, after sealing, as waste disposal areas- Backfilling of voids enhances mines reclamation

• Beneficial use of an existing planning infrastructure, scheduled to be inactivated in 2016

Additional potential benefit: Transfer of inert mine wastes back to railway stations for use at construction reducing the needs to operate new aggregate quarries
5. CONCLUSIONS-PROPOSALS FOR FURTHER STUDY, cont.

For the successful development and application of the proposed scheme, a cost-benefit analysis in environmental economics terms is needed taking into account:

✓ the current state regarding bauxite mining, closure and reclamation in the area, in cooperation with the mining companies

✓ Prevailing/evolving legislation regarding (a) the post-closure rehabilitation of old mines, (b) waste disposal, (c) use of inactivated railway infrastructure for the transport of solid wastes

✓ Social acceptance of stakeholders
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Thank you for your attention

katadam@metal.ntua.gr