Stakeholder-Driven Enablement Through Earth-Observation Information
The project EO-MINERS

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The Golgotha of open-cast mining - © W.E. Falck, 2010
Objectives

To bring into play Earth Observation-based methods and tools to facilitate and improve interaction between the mineral extractive industry and society in view of its sustainable development while improving its societal acceptability.

http://www.eo-miners.eu/
Context

• For centuries mining has been one of the bases of economic and social development.

• Mining increasingly takes place outside Europe as it has become difficult to obtain social license for new operations or the extension of existing ones.

• The underlying reasons are conflicts of land- and resources use, as well as socio-political conflicts.

• Many conflicts can be traced back to environmental issues caused by a nonchalant attitude in the past towards environmental protection.
The Global Dimension

- is increasingly being recognised in the EU and world-wide.

- Various initiatives aim at making mining more sustainable:
  - European Commission Communication in 2011: ‘Tackling the challenges in commodity markets and on raw materials’
  - European Commission Directive on Wastes from Extractive Industries
  - Self-commitment of the industry, for instance as members of the International Council on Mining & Metals (ICMM)
Earth Observation

• The Group on Earth Observations (GEO) is concerned with the responsible management of natural resources.

• Understanding and monitoring the impacts of resources use is of concern to all stakeholders.

• The technology platform for environmental monitoring is diverse, geographically inconsistent, site specific and lacks integration across technologies.

• GEO’s Global Earth Observing System of Systems (GEOSS) concentrates on natural hazards and climate change only.
Specific Objectives

- to introduce innovative EO tools and services to the mining industry;
- to provide accuracy and quality measures for EO products;
- to demonstrate the application of EO in different case studies;
- to foster dialogue between the mining industry and stakeholders based on EO-derived information;
- to generalise the results obtained for use in operational mining applications.

Study sites in the Czech Republic (open-cast lignite mining), South Africa (open-cast and underground coal mining) and Kyrgyzstan (gold mining) provide the focus for the development work.
Partner Countries

Demonstration sites (CZ, ZA, KG)
Scientific Objectives

- to assess policies and strategies of different stakeholders (operators, regulators, public) and resulting information needs;
- to assess environmental, socio-economic and other sustainable development issues;
- to define indicators for issues that can be addressed using EO;
- to demonstrate the capabilities of integrated EO-based methods in reducing environmental and social impacts of mining;
- to provide reliable and objective information as a basis for a sound dialogue between stakeholders;
- to document procedures developed in a compendium of best practices to assist and inform the dialogue between stakeholders.
Enabling Through Information

• Different stakeholders are informed to different levels about mining issues.
• Lack of independent and unbiased information can hinder effective processes of social decision-finding.
• This can also apply to local or regional authorities who are not directly involved in licensing procedures.
• Providing reliable and objective information enables stakeholders to participate in decision finding processes in a meaningful way.
• Information is more than data - it is the context that gives meaning to data.
• Information generates understanding and knowledge for stakeholders who may not have the training to understand or interpret (raw) data.
• Information may often need to be further condensed into indicators.
Indicators

- Meaningful information on complex environmental or social issues can often be provided in the form of indicators.
- Indicators
  - provide a metric of the state of (complex) systems;
  - allow to monitor trends when measurements are repeated over time;
  - are useful tools to reduce complex sets of diverse data into manageable sets for policy making;
  - allow to monitor the effect of policy implementation.
What for and for Whom?

- The development of meaningful indicators is a social and not (only) an engineering process.
- The social process defines what to indicate, for whom and why.
- However: Indicators must be based on measurable quantities.
- Scientists and engineers are also stakeholders in this process.
- Indicator development iterates between stakeholder expectation and operational feasibility.
Possible Pitfalls

• Confusing intensive and extensive properties can lead to oversimplification.

• For instance: The amount of mine waste generated is meaningless as indicator, if not put into relation to e.g. the total ore recovered.

• If related to the ore grade and the mine type, it allows assessing the efficiency of the mining operation.

• It still needs to be related to the quality of waste management: a small quantity of poorly managed waste can pose a higher environmental risk than a large quantity of well-managed waste.
Candidate Indicators

- A multi-pronged, iterative approach is used:
  - heuristic set of candidate indicators by expert elucidation
  - examination of site-specific conceptual models for the study sites
  - a semi-deliberative approach with input from outside stakeholders

- The expert-derived set was tested for completeness against conceptual site models

- The resulting set was tested during stakeholder interviews in South Africa

- The candidate set of indicators is reviewed for measurability by EO-experts

- The final set of indicators will be subject to stakeholder evaluation during site workshops at the end of the project.
Development Flow Diagram

WP2
- Technology Assessment
- Technology Development
- Technology Testing

WP1/WP5
- Expert Elucidation
- Indicator A
- Indicator B
- Indicator X
- Feasibility Evaluation
- Indicator A
- Indicator C
- Indicator G

WP3
- Stakeholder Elucidation
- Indicator 1
- Indicator 2
- Indicator n
- Feasibility Evaluation
- Indicator 2
- Indicator 7
- Indicator 9
- Merge Indicators
- Indicator A
- Indicator 2
- Indicator G
- Indicator 9

Conceptual Site Models
- Process α
- Process β
- Process n
- Feasibility Evaluation
- Indicator γ
- Indicator δ
- Indicator λ

Time
Candidate Indicator Categories

<table>
<thead>
<tr>
<th></th>
<th>Category</th>
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<tbody>
<tr>
<td>A</td>
<td>Land-use</td>
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<tr>
<td>B</td>
<td>Mass Flows</td>
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<tr>
<td>C</td>
<td>Energy Flows</td>
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<tr>
<td>D</td>
<td>Air quality and other nuisances</td>
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<td>E</td>
<td>Water quality</td>
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<td>F</td>
<td>Transport</td>
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<td>G</td>
<td>Geotechnical hazards and accidents</td>
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<td>H</td>
<td>Industrial and other accidents</td>
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<tr>
<td>I</td>
<td>Social impacts</td>
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<tr>
<td>J</td>
<td>Regional development</td>
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<tr>
<td>K</td>
<td>Economic vulnerability/resilience</td>
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Example: A - Land Use

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
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<tr>
<td>A1</td>
<td><strong>Total land-use by mining and milling</strong> - topographical footprint</td>
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<td>A2</td>
<td><strong>Mining land-use intensity</strong> – topographical footprint vs. amount of marketable product.</td>
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<td>A3</td>
<td><strong>Artisanal and Small-Scale Mining</strong> – topographical footprint of ASM sites</td>
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<td>A4</td>
<td><strong>Residential land use</strong> - residential developments around mining areas</td>
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<td>A5</td>
<td><strong>Informal settlements</strong> – sprawl of squatters areas, slums</td>
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<td>A6</td>
<td><strong>Sites set aside, protected areas</strong> – nature reserves, wetlands, sites of spiritual value etc.</td>
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<tr>
<td>A7</td>
<td><strong>Recultivation success on mined-out areas and waste/spoil heaps</strong></td>
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<tr>
<td>A8</td>
<td><strong>Areas indirectly affected and their potential use</strong> - Impact of mining on the potential use of operation and surrounding areas, impact on land value / prices (opportunity cost).</td>
</tr>
<tr>
<td>A9</td>
<td><strong>Soil fertility of remediated mine areas</strong></td>
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<tr>
<td>A10</td>
<td><strong>Existence and legal status of environmental impact assessments</strong></td>
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Example: Mass/Energy Flows

B - Mass Flows

B1 Waste volumes generated – volume (change) vs. amount of marketable product

B2 Erosion – erosional losses on residues heaps

C - Energy Flows

C1 Total energy consumption per ton of coal / lignite / ore produced

C2 EROI (Energy Return on Energy Investment) - amount of energy spent related to the energy content of the product
Candidate Indicator Space

Expert-derived
- Site models
- Stakeholders

EO-accessible
- Czech Republic
- South Africa
- Kyrgyzstan
Opportunities

- EO offers a unique opportunity to collect spatial data for better assessment of mining-related environmental and social impacts.

- Tools and processes under development will help to inform deliberative decision-finding procedures as stipulated by e.g. the Aarhus Convention.

- Sustained and accepted long-term remediation solutions require all stakeholders to be involved in the decision-finding processes.

- Decision-making along the life-cycle of a mining facility faces a number of technical and societal challenges:
  - site assessment uncertainties, e.g. data gaps in the inventory, insufficient site characterisation, integrity of engineering, …
  - uncertainties about the future site development
  - uncertainties over the range of natural phenomena / ‘events’ in the future
  - uncertainty over the internal evolution of the designed structures / ‘processes’.
Mutual Trust Through Information

• Mine managers are faced with the challenge to
  – obtain and maintain public trust;
  – achieve institutional constancy or to ensure continuity of e.g. long-term stewardship activities; and
  – learn from past and ongoing experience as technological and management means for implementation are developed.

• Independent access to site information fosters mutual trust

• It allows the public / regulators to monitor, whether the site develops as anticipated by the operator.

• It also facilitates mediation in the case of dispute.

• This can be crucial in maintaining mutual trust, as often critical changes are not readily visible from the surface or not observable without a dedicated on-site measurement campaigns.
Facilitating Monitoring

- Tailor-made EO-services allow the monitoring of important parameters of site development at relatively low cost and often in near real-time.
- Adequately visualised EO-products allow the general public and often also the regulators to better ‘see’ what is happening at a site.
- GIS-supported visualisation allows stakeholders to better see how site developments might relate to their personal situation, e.g. distances to and possible impacts on their private home or their community.
Conclusions 1

- First experiences with stakeholder interaction and confronting stakeholders with possible EO-services have been gained.

- Some local interest groups expected that the project would help them to achieve their interests and goals.

- This indicates the need for shared information and thus validates the project’s objectives.

- The majority of stakeholders interviewed had not been aware of the possibilities of EO and in particular of remote sensing techniques.

- This clearly indicates the need for a sustained dialogue between EO-service providers and stakeholders outside the project, if the project aim of enabling these stakeholders should be achieved.
Conclusions 2

• During stakeholder interviews in South Africa very few suggestions for amendment to the candidate list of indicators were made - this places a certain confidence into their relevance with respect to scope and coverage.

• Sharing information through EO-services will empower stakeholders and thus create an environment of mutual trust.

• In an environment of mutual trust it becomes less likely that actions will be undertaken that are environmentally or socially detrimental.

• In this sense, EO-services can contribute to make mining operations more sustainable in an environmental and socio-economic sense.
Acknowledgements

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- GeoZS - Slovenian Geological Survey
- MIRO - Minerals Research Organisation, UK
- SU - Sokolovská uhelná, a.s, Czech Republic
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