Remote Sensing Supported Indicators to Facilitate the Stakeholder Dialogue on Contaminated Sites
Spin-offs from the EO-Miners Project

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Enabling Through Information

• Finding sustainable long-term solutions for contaminated sites is a social and not a technical and administrative process.

• Such processes often founder due to the lack of availability to all stakeholder of reliable and commonly accepted information.

• A problem not only for the general public, but also for local or regional authorities.

• Differences in information level on the relevant issues often create mistrust.

• Trust among stakeholders is a key aspect of good governance.

• Reliable and objective information enables stakeholders to participate in a meaningful way.
Information is more than data

- Information is the context that gives meaning to the data, generating understanding and knowledge.

- Providing knowledge is important as stakeholders often do not have the training to understand or interpret (raw) data.

- Meaningful information on complex environmental or social issues often can be provided in the form of indicators.

- Indicators provide a metric of the state of (complex) systems or for their trends when measurements are repeated over time.
Indicators

- Indicators are useful tools to reduce a complex set of diverse data into a manageable set for stakeholder interaction.
- Indicators can be used to monitor changes that remediation may or may not effect.
- ‘Monitoring’ implies repeated, if not regular or continuous, measurements in support of an indicator.
- Therefore, monitoring addresses change, rather than observing a status quo.
- Social processes define what to indicate, for whom and why.
- Scientists and engineers are also stakeholders in this process.
- Indicator development iterates between stakeholder expectation and operational feasibility.
Intensive or extensive properties?

- Indicators must be based on measurable quantities in order to be useful.
- They can be intensive or extensive properties, i.e. Independent or dependent on the size or volume of a system under consideration.
  - e.g. The pH-value is an intensive property of water and can indicate the general state of surface and.
  - e.g. the number of schools in a particular region has to be related to some meaningful extensive property, e.g. the number of people living in that region, in order to be an indicator for the provision of education.
- Indicators can be single parameter values, requiring a single measuring technique only, or may need to be compounded from various parameters that are measured using different techniques from different realms of technology.
Possible pitfalls

• Confusing intensive and extensive properties can lead to oversimplification and misinterpretation.

• 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 mining.
  • 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 larger quantity of well-managed waste.
Candidate Indicators

• A multi-pronged, iterative approach is used:
  • **heuristic development** by expert elucidation, utilising knowledge about mine-site related issue available within the project team;
  • **site-specific conceptual models** for the three study sites developed by other project team members, utilised to corroborate the heuristically developed indicators, and
  • **deliberative approach** elucidating stakeholder input at the three study sites through semi-structured interviews.
  • The expert-derived set was tested for completeness against conceptual site models
Indicator validation process

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

• The resulting set was tested during stakeholder interviews in South Africa and Kyrgyzstan

• 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
• Different stakeholders have different indicator needs.

• Three major groups of stakeholders: at the local, regional/state and international levels.

• Operators would use indicators to monitor their own activities as well to assess, whether they are in compliance with regulatory requirements.

• Regulators are less interested in the operational aspects, but would use the indicators to monitor compliance with a variety of requirements.

• Local public stakeholders may be interested in very much the same variables, but would want to relate them to their home etc.

• National or international institutional stakeholders probably have more an interest in policy-making than in operational aspects.
Local and regional players

- Local and regional level stakeholders include operators (mine, waste management, etc.), administrators and regulators, and civil society.

- They would be broadly interested in aspects of

  - Corporate Sustainability Reporting (CSR) indicators: social, environmental, economic;
  
  - Corporate impact indicators: social, environmental, economic (including employment, resettlements, crime rates, health,...).
National and international players

- National authorities and international agencies may be interested in regulatory and macro-economic aspects, including
  - compliance with environmental standards;
  - compliance with Health & Safety standards;
  - contribution of the sector to GNP, tax revenue and employment (direct/indirect);
  - share of designated mining area already used (future development potential);
  - annual production vs. reserves/resources (life expectancy of operation);
  - carbon/energy balance of the mining operation, including carbon content of the product (re. emission certificates)
Candidate Indicator Categories

A  Land-use
B  Mass and energy flows
C  Soil quality
D  Air quality and other nuisances
E  Water quality
F  Transport
G  Geotechnical hazards and accidents
H  Industrial and other accidents
I  Social impacts
J  Regional development
K  Economic vulnerability/resilience

• These categories largely reflect the needs of the EO-MINERS project.
• In a different context the deliberative process may arrive at different categories or indicators.
Indicator Testing

- The set of candidate indicators was subject to evaluation by the various groups of stakeholders.
- The set of candidate indicators was used as a guidance in the structured interviews at the project’s study sites.
- Semi-structured interviews were conducted on a one-to-one basis,
- The interviews lasted for one to two hours each and were (mostly) tape-recorded and transcribed afterwards.
- During the interviews it was marked, whether issues covered by these indicators were raised by the interviewees.
- As a result an indicator ‘contaminant concentrations’ was added and, hence, a category ‘soil quality’.
Coverage of issues

[Bar chart showing various issues and their coverage levels]
Indicator Application

- There is potentially a large number of candidate indicators that reflect environmental and social issues at relevant sites.
- Not all of these indicators are relevant at each site.
- Certain potentially useful and important indicators are not accessible to EO techniques and in particular remote sensing.
- Due to the time and resources constraints in the EO-MINERS project the application cannot be demonstrated for all relevant and measurable indicators.
Indicators selected for application
Example: A - Land Use

A1 Total land-use by mining and milling - *topographical footprint*

A2 Mining land-use intensity – *topographical footprint vs. amount of marketable product*

A3 Artisanal and Small-Scale Mining – *topographical footprint of ASM sites*

A4 Residential land use - *residential developments around mining areas*

A5 Informal settlements – *sprawl of squatters areas, slums*

A6 Sites set aside, protected areas – *nature reserves, wetlands, sites of spiritual value*

A7 Surface water courses – *percentage area covered by surface waters*

A8 Recultivation success on mined-out areas and waste/spoil heaps

A9 Areas indirectly affected and their potential use - *Impact of mining on the potential use of surrounding areas, impact on land value / prices (opportunity cost).*

A10 Existence and legal status of environmental impact assessments
Mutual Trust Through EO Information

- 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;
  - 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 experience with using the indicators in stakeholder interaction has 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 validating 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.
Conclusions 2

• During interviews in ZA and KYG only some suggestions for amendment to the candidate list of indicators were made.

• This places some confidence into their relevance with respect to scope and coverage.

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

• In an atmosphere of mutual trust it becomes more likely that all stakeholder assume ownership of proposed remediation and other management solutions.
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