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IMPACT MONITORING
OF MINERAL RESOURCES
EXPLOITATION

CONTRACT Nº
244166

Funded by:
European Commission
Framework Programme 7

Cooperation

Thematic Area
Environment 6.4
Earth Observation and assessment tools for sustainable development

WP6 – TOOLS AND SERVICES

DELIVERABLE D6.3
REPORT ON THE CONTRIBUTION TO RELEVANT GEO TASKS AND GEOSS COMPONENTS

Peter Gyuris, GEO - Geonardo Environmental Technologies Ltd., Hungary

Submitted by:
GEONARDO Environmental Technologies Ltd.
(Project Coordinator)

Project Coordinator name:
Mr. Peter Gyuris

Project Coordinator organization name:
GEONARDO, Hungary

SEVENTH FRAMEWORK PROGRAMME

1. Introduction

The FP7 ImpactMin project has run between January 2010 and December 2012. The current Work Plan of the Group on Earth Observation stretches from 2012 to 2015. The 10-Year Implementation Plan of GEO is closing in 2015. The current work plan is made to achieve the "broad" targets by the end of the period (2015 GEOSS Strategic Targets). GEOSS meant to be user-driven, thus the current activities focus on engaging users especially in developing countries.

The actual GEO work plan has several new or restructured elements compared to the 2009-2011 WP. 26 tasks (2012 - 2015) cover the previous 36 tasks in a new structure where significant steps to achieve the targets need to be taken along three main themes:

1. Infrastructure
2. Institution and Development
3. Information for Societal Benefits

In "Infrastructure" part, the interoperability aspects got the emphasis whereas in the second theme "Institution and Development" the target is to raise awareness among the various scientific communities, engage them and also mobilize available resources in several means. In the "Information for Societal Benefits" theme the main concern is to consolidate and finalize the end-to-end information service systems to exploit the full benefits of GEOSS and its infrastructure.

Since the previous GEO work plan did not have a specific topic for mineral exploitation and raw materials, the ImpactMin project and its activities were for the "interest" of more Societal Benefit Areas and several transverse tasks such as data management and capacity building. "Disasters" and "Ecosystems", etc. were not the proper scientific community to "collaborate with" and exploit the research and scientific potential of the Consortium. Nevertheless, upon the request of the European Commission the Project was involved in the preparatory and dissemination activities for the Beijing Ministerial in 2010 under the "ecosystem" SBA.

As a result of intensive work, the programme partners from the EO-Miners consortium (project under the same FP7 call as ImpactMin) managed to achieve that "geo-resources" and "mining" currently are key words in the GEO WP 2012-2015. This gives the opportunity for both projects fitting their efforts in supporting the GEO community and that both projects can appropriately contribute to this target driven work plan. The grand theme of "Impact Assessment of Human Activities" now contains the component "Impact Monitoring Systems for Geo-Resource Exploration and Exploitation". Generally the focus under this component will be to aid the extractive industry in monitoring their activities with integrated space-borne, airborne and ground based EO data sets.

This report will detail how the project contributed to the indicative list of actions across several themes for instance Institutions and Development with special emphasis in SB-05-C2.

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2. Support of the relevant GEO tasks and GEOSS components

SB-05-C2: Impact Monitoring System for Geo-Resource Exploration and Exploitation - Infrastructure

Since ImpactMin was a small scale research project the available resources and current research infrastructure was used to the limits to achieve the goals and objectives of the project combining space-borne and in-situ capabilities coupled in many case with resource-intensive airborne surveying. The efforts were creative in using existing data and research infrastructure and the participating SMEs exploited their background efficiently to create the targeted tools and services for the benefits of monitoring the impacts of mineral resources exploitation.

In many cases the interaction between man-made and natural processes are not obvious and the monitoring of different aspects of activates that impacts our surroundings can bear great challenges technically speaking. Since remote sensing is generally an indirect measurement technique there is always an uncertainty in the outcomes of those results that try to map the causes and the effects thus quality assurances is a very important aspects of the research (see later).

The activities of the mining industry in most of the cases directly affect the environment and it is many times measuring or control the emitted pollution by law. In Europe there are strict rules apply for instance in the use of cyanide and the Mine Waste Directive (Directive 2006/21/EC(1)) prescribes requirements for the safe deposition of mining wastes. However in many non-EU European countries (e.g. Bosnia and Herzegovina) where the mining industry has great potential and in several other countries mining related activities can cause various effects on environment and human health. Earth Observation techniques that record continuous datasets over significant sized area can largely aid impact assessment studies. Geospatial modelling can reveal connections between variables in the system and bring different data sets into the right context.

One of the demo sites of ImpactMin project was Karabash town in Russia, where the environment impact is so severe and the effects of the activity of the mining industry on the local population was inherent. This environment gave “excellent” opportunities for several research fields to combine available resources and techniques for instance satellite based observations and ground based air quality monitoring. There is still a great potential in establish the correlation between environment degradation (environment impact monitoring) and human health and exposure thus making the outreach of environmental studies performed by ImpactMin consortium for other SBAs to improve health and well being for example. The consortium members kept regular contact with the European Centre for Environment and Human Health (ECEHH) and still looking for opportunities to exploit research results and mutually benefit from joining forces.

Another interesting study came just during the implementation of the project that gives an outlook to climate change investigations. The ImpactMin consortium exploited the data archive of global satellite earth observation products. The SPOT Vegetation systematically

records the land and vegetation changes over huge areas very often (daily). This instrument investigates the dynamic of the vegetation change in shorter and longer periods (e.g 10-day). Since there are sufficient number of image data is available from the past (1998-), the time series analysis of satellite remote sensing product (NDVI) allows to monitor climatic processes (e.g. vegetation increase or decrease in certain areas). ImpactMin partners found that there is a clear trend in the "greening" in the southern Ural mountain area including the close environment of Karabash town.

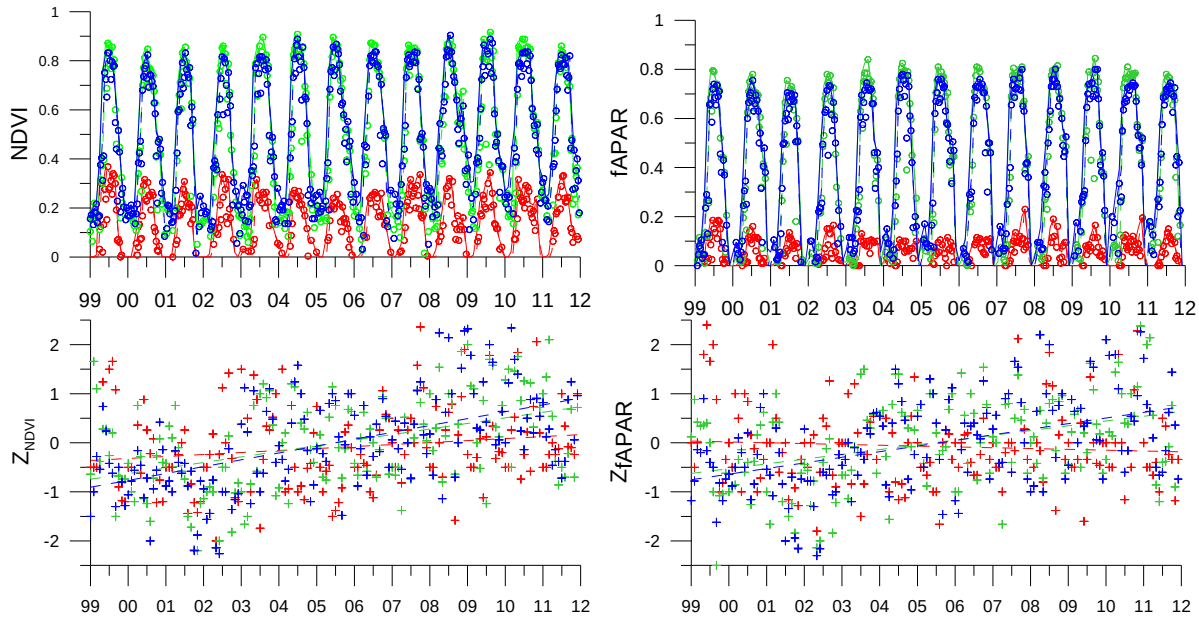

Figure: Trend analysis based on Z profiles derived from S30 NDVI and fAPAR from SPOT-Vegetation for individual pixels in the Karabash area

However, the observations and measurements with other satellite and ground based instruments showed that actually the pressure on the environment is bigger in the past ten years because of the insufficient pollution control by the mining industry. It means that without the integrated analysis of environmental trends, the assessment of the ecosystem would not have been complete and would lack of important conclusions. This study outcome within ImpactMin project emphasises the need for operational (integrated) ecosystem monitoring.

The systematic monitoring of environmental parameters also requires some obligations in terms of data management. One of the tasks of GEO is to support data documentation, calibration and validation etc. Its precursor project was the Quality Assurance for Earth Observation (QA4EO) led by the Committee on Earth Observation Satellites. The ImpactMin consortium also performed quality assurance by documenting its data acquisition according the guidelines of QA4EO. Since GEOSS is tailored towards end-users and supports informed decision making, it is highly important that the information that is resulted from projects should be properly documented. In the appendix, there are examples for the documentation of ImpactMin datasets in order to enable traceability in case of different types of datasets.

In the following sections there is a list of activates how the Project supported the different GEO tasks along the 2012 – 2015 Work Plan structure. We have to note that earlier in 2012 the Project was asked to indicate resources supporting the actual work plan thus we are showing here the ongoing/planned and achieved activities.

SB-05-C2: Impact Monitoring System for Geo-Resource Exploration and Exploitation – Institutions and Development: Capacity building

As many EC funded project ImpactMin has also the element of converting research knowledge (background and foreground) into a digestible scientific learning material. There are more ways of disseminating project information to more specific or to a wider audience. Smaller meeting and workshops can target focus groups to transfer project information. Since lifelong learning and e-training activities are active nowadays one effective method to share project related information is the internet based trainings. ImpactMin had foreseen this opportunity to disseminate knowledge on environmental monitoring techniques, geo-data management and inform the wider scientific community about current framework of organizing earth observation and data sharing.

ImpactMin e-training facility is not only giving insight information on remote sensing and in-situ data acquisition and handling but also shows the operational framework in which data is handled (e.g. INSPIRE on metadata, QA4EO on data documentary and GEOSS on data interoperability and sharing).

Illustration: Snapshots of the ImpactMin e-training (curriculum and learning material)

There are many initiatives that target capacity building especially in developing countries however it is evident that a simple e-based learning material can reach tens and hundreds of scientist, managers that works on the field of environmental monitoring. ImpactMin e-training showcasing how European and/or global initiatives (e.g. INSPIRE or GEOSS) coordinates the "everyday" work of scientists. The people who access(ed) the training facility can have enhanced knowledge on data sharing policies and techniques thus making them able to adopt the provided information into their daily operation, for instance appropriate standards usage. Cross border education and dissemination is very effective with the use of the internet showing also what are the short and longer term benefits of Earth Observation with appropriate case studies.

Ultimately, with the deployment of the ImpactMin e-training facility and through its dissemination (via LinkedIn, via direct emails) the professionals from ImpactMin project are sharing their research methods and results with third parties across the internet. The core of the e-training is about the fundamentals of impact monitoring of mineral resources exploitation and case studies, examples are also included in order to ease the understanding of the training material.

SB-05-C2: Impact Monitoring System for Geo-Resource Exploration and Exploitation – Institutions and Development: Science & Technology

The ImpactMin project partners made efforts in several forms to share information about the greater scope of coordinated earth observation and data management and what role the Group on Earth Observation plays in these activities. ImpactMin facilitated events where the science and technology community could meet and exchange their experience and discuss their possible contribution to Global Earth Observations. Third party science and technology representatives such as public institution (Swedish Mapping Authority) and industrial stakeholders (LKAB - Sweden) and RTD companies (Rikola Ltd – Finland) got information on "open events" like at ImpactMin International Symposium about GEO and GEOSS and its build-up.

The presentation of Stephane Chevrel on the progress of the task "Energy and Geo-resources Management" at ImpactMin International Symposium

Workshop and Exhibition in Lulea during the ImpactMin Symposium, 2012 - Meeting of the scientific community to discuss potential collaboration in supporting Global Earth Observation objectives

At the Symposium ImpactMin and EO-Miners project partners introduced their activity reports to the third party attendants (LKAB, Rikola Ltd., ECEHH, LTU etc.) of the event thus they could familiarize themselves with current technological research supported by the European Commission. At the second day of the Symposium the programme were constructed that the different scientific groups could listen to each other technical capabilities regarding EO. In the presentation about GEO and GEOSS and more specifically the SB-05-C2: Impact Monitoring System for Geo-Resource Exploration and Exploitation, the attendants were informed the latest improvement of this sub-task. In the question and answer section after the presentation the Point of Contact, Stephane Chevrel (BRGM) could answer to couple of questions that have been raised by the audience related to this task.

Eventually, two more end user workshops took place supported by the Project where the consortium members got in touch with third parties in the case of ImpactMin activities related to Global Earth Observation initiatives. Project partners the Babes Bolyai University and Geonardo met with the representatives of Rosia Montana Gold Corporation. This meeting was focused on sharing the project results and inform the representatives of the mining industry on current EU research activities in the field of mineral resources exploitation monitoring.

In Bosnia and Herzegovina the activities and results of ImpactMin project generated interest since the rehabilitation of the Vihovici mine site (one of the demonstration sites of the Project) and adjacent territories are still ongoing. On the 9th of November 2012:

- public authorities (Grad Mostar - PIU Projekt Vihovići)
- third party environment management organizations (Zagrebinspekt d. o. o., Ecoplan d. o. o. – Mostar)

- local industrial representatives (Aluminij Mostar, EPHZHB) and
- university participants (GFMO) – students and lecturers

took part on a workshop where the general concept of ImpactMin project, information on GEO and GEOSS were disseminated by prof. Roko Andricevic (Photon). Amer Smailbegovic held a presentation about Earth Observation techniques (in particular satellite and airborne remote sensing) that aided the investigations of geohazards mapping (Vihovici mine) and environmental impact monitoring of mining related activity (red mud depot, electronic supplier company).

Presentation of GEO(SS) and ImpactMin by Roko Andricevic (Photon)

Workshop settings at the Faculty of Civil Engineering, University of Mostar, 2012

Importantly, the Coordinator, Peter Gyuris (Geonardo), took participate and gave an extensive presentation about ImpactMin project on the workshop that the EO-Miners consortium organized in Ljubljana in 2012 July. The workshop title was “GEO and Minerals” and it aimed to reveal the current observational resources for strengthening the science and technology of GEOSS in this raw material – mineral resources observation sector.

3. Appendix

Documentation for Traceability

This guideline covers all Quality Assurance and Quality Control aspects that can be applied on ―EO data 'on data collection', 'on data processing', 'on data archiving' and 'on dissemination'. The QA/QC has two main goals:

- ✓ Data interoperability for the GEO community
- ✓ Data transparency for end-users.

The fundamental principle of the Quality Assurance Framework for Earth Observation (QA4EO) - "that all EO data and derived products have associated with it a documented and fully traceable quality indicator (QI)".

Acting along this guide allows the product users (analysts/experts or stakeholders/end-users) to assess the 'fitness for purpose' of the product (raw and/or processed). It is a template so it can be extended for specific purposes and state 'not relevant' in case some if its items. The following 'headers' are the core content to describe a process:

1. **Identifier:** Mostar_vihovici_xxx*.tif
2. **Title:** Water quality map of the Mostar area
3. **Author:** Dries Raymaekers
4. **Authority:** VITO
5. **Issue/version number/date**: first version 17/12/2012
6. **Abstract:**

This study focused on the analysis of surface water quality in the surrounding area of the Vihovici Coal Mine. At present time, the open mine is filled with surface water which flows into the nearby Neretva river, via surface or subsurface pathways. In this perspective water quality assessment is an important issue moreover as the water from the Neretva is used as drinking water by the city of Mostar and cities further downstream. The main objective was to apply airborne hyperspectral imagery to identify the zones of increased nutrient load, increase in dissolved solids or other phenomena suggestive of surface or subsurface contamination of the karst watershed. Along with the airborne campaign, which was carefully planned to avoid sun glint phenomena, an extensive field campaign was organized to take water samples for lab analysis and measure water reflectance (Rw) with the ASD spectroradiometer according measurements protocols described in Mobley, 1999 and Knaeps *et al*., 2012. The relationship between the Rw field spectra and the different water quality parameters (WQP) shows clearly specific wavelength regions with high correlation (R^2>0.7) with the WQP under investigation. For TSM, a highest correlation is found for wavelengths 550 nm to 600 nm. For CHL-a these regions are from 480 nm to 575 nm and around 675 nm, corresponding to values found in literature. These are also highly correlated with the regions found for nitrates and total nitrogen, as these nutrients induce the growth of phytoplankton, and thus CHL-a, in the water. As the airborne Rw spectra were found to be very similar to those measured in-situ, the linear regression could be inverted to calculate water quality maps for each parameter under consideration. The validation of these maps showed good correlation and small RMSE for most of the parameters, but were influenced by bottom and adjacency effects.

7. **Overview/scope**: see Mostar Site Assessment Report_water.docx
8. **Terminology/definition:** Hyperspectral remote sensing, water quality, linear regression
9. **Background/context/requirement:** see Mostar Site Assessment Report_water.docx
10. **Outcomes:** see Mostar Site Assessment Report_water.docx
11. **Inputs:**
Airborne data: AISA Eagle hyperspectral datacubes
Field data: GPS, ASD spectroradiometer, water samples
Laboratory data: Chlorophyll "a" [µg/l] Suspended material [mg/l] Thickness [NTU] Nitrites [N mg/l] Nitrates [N mg/l] Total Nitrogen [N mg/l] Cadmium [Cd µg/l] Lead [Pb µg/l] Iron [Fe µg/l]]
12. **Standards and traceability:** see Mostar Site Assessment Report_water.docx
13. **Task description:** see Mostar Site Assessment Report_water.docx
14. **Evaluation of performance:** see Mostar Site Assessment Report_water.docx
15. **Evidence to support a performance indicator:** see Mostar Site Assessment Report_water.docx
16. **Review of Process:** No review performed