Research and Development Project

GMES-based Geoservices for mining to support Prospection and Exploration as well as the Integrated Monitoring for Environmental Protection and Operational Security

The Application of Remote Sensing Data such as Hyperspectral, Multitemporal Multispectral and Radar Data in mining

Remote sensing is used in all phases of the mining life cycle, within prospecting, exploration, mineral extraction as well as mine closure and reclamation.

Prospection – search for mineral resources and deposits

- Exploration of geological and hydrogeological structures with the aim of geological mapping
- Assessment of the deposit reserve
- Determination of the presence of individual chemical components at the ground surface using the spectral signature of rocks and vegetation (search for indicators)

Exploration – detailed examination on the workability of the deposit

- Assessment of the spatial extent of the mining area (Figure 1)

Figure 1: Overview of the Rhenish lignite mining area with the opencast mines Inden, Hambach and Garzweiler 1 and 2 with the currently approved working boundaries [Reference: RWE Power]

- Analysis and evaluation of existing infrastructure in the exploration area
The Application of Remote Sensing Data such as Hyperspectral, Multitemporal Multispectral and Radar Data in mining

- Determination of the first drilling locations
- Analysis of the prospective minerals in the rocks or the percentage distribution of minerals in the deposit
- Exploration of the topography and relief in order to determine the appropriate mining method and appropriate mining technology

Mineral extraction – development and mining of mineral resources

- Detection of ground movements (subsidences and uplifts) within the influence range of mining
- Analysis of ecological impacts of mining (e.g. vegetation changes, water logging)
- Analysis of the changing land use during mining operations
- Monitoring of the stability of opencast mine slopes and dump slopes
- Determination of potential sites for spoil or overburden dumps (Figure 2)

![Figure 2: View of Hambach opencast mine](Reference: RWE Power)

- Analysis of bulk material in opencast mining for targeted operations control in order to guarantee constant composition of main and country rock
Mine closure / Land reclamation

- Monitoring of reclamation measures (Figure 3)
  - Vegetation analysis by recording the spectral signature of vegetation (Determination of chlorophyll content)
  - Investigation on the distribution of soil moisture (directly by image spectra or indirectly by plant indicators)
  - Site analysis for individual groups of vegetation

![Figure 3](image1.png)

*Figure 3: The Rhenish lignite mining area with vegetated zones [Reference: RWE Power]*

- Monitoring of ground movements after cessation of mining operations (settlements, slope monitoring, uplifts due to rerise of groundwater)

Monitoring during the extraction and closure phase

- Monitoring of georisks, detection of ground movements or subsidences, uplifts and landslides (Figure 4) as well as resulting subsidence damages

![Figure 4](image2.png)

*Figure 4: Slope monitoring for early detection of landslides [Reference: RWE Power, DMT]*
• Analysis of ground movement rates, assessment of expected subsidence damages (Figure 5) and prevention of subsidence damages

![Figure 5: Subsidence damage to a dwelling house [Reference: WDR]](image)

• Monitoring of shallow ground water before, during and after mining operations
• Analysis of the overburden material in relation to chemical composition
• Monitoring of the land surface in areas of abandoned mining with regard to sinkholes or other subsidence damages (Figure 6)

![Figure 6: Sinkhole/Shaft collapse in developed area [Reference: WDR]](image)