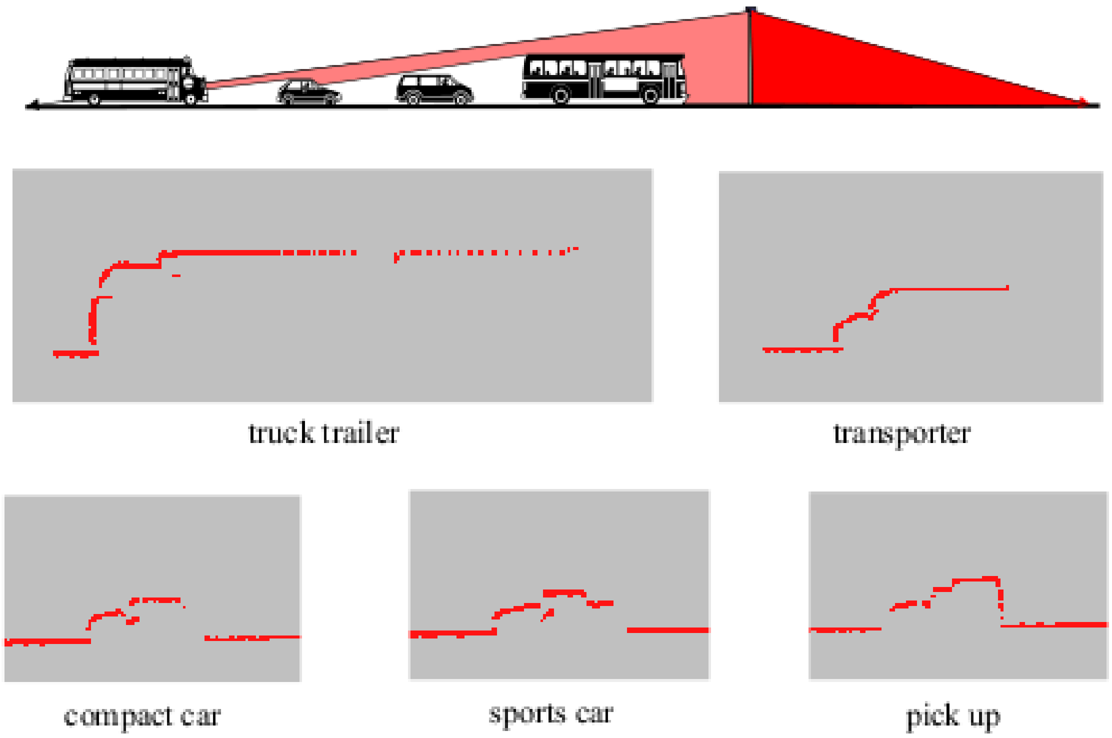
F TRANSPORT

F1 - Road/Rail Freight Volumes from/to the Operation Site	
An estimate of the amount of fret transported to and from a mining site provides information provides information about mining efficiency and sustainability.	
Requirements	• Temporal and spatial assessment of the amount of transported goods. • Characterisation of the transportation efficiency.
Variable(s) to be determined	• Total volume and/or weight transported to and from the operation site. • Ratio of amount of transported goods versus the frequency of these transportations.
Data acquisition	
Source of information	• Information about the amount and the type of transportation provided by operator and/or local authorities. • Automated or manual analysis of high spatial resolution air- or space-borne remote sensing data (optical, RADAR). • Automated or manual Analysis of in-situ measurement devices.
Methods & Standards	• Transportation networks extracted from remote sensing imagery (Lacoste et al. 2010; El Ghoul et al., 2010; Cariou et al., 2010; Peng et al., 2010). • Traffic Type and Intensity extracted from in Situ laser sensors (Fuerstenberg et al., 2010) or optical cameras (Reulke et al., 2011) • Traffic monitoring using airborne and UAV-borne sensors.
Suggested sensor systems	• High resolution RADAR or optical passive data. • In-Situ network measurement devices (optical cameras, Laser sensors, traffic counters).
Pre-processing & auxiliary data	• Need for a pre-characterisation of the transportation network: type of the transportation network(s) used, weight/volume managed by each transportation unit.
Caveats: • Remote Sensing high resolution data temporal availability. • Information about the transportation methods. • In-Situ measurement devices availability and/or installation-maintenance costs. • Reliability of automated analysis routines. • Traffic: Remote sensing is not the ‘simplest’ option, prefer in-situ measurements devices.	

Examples

Traffic Monitoring using laser scanner with vertical scanning plane © IBEO Lasertechnik Gmbh [Furstenberg10].



F2 - Land Fragmentation by Transport Infrastructure	
The land fragmentation due to establishment of transportation infrastructure might lead to drastic ecological changes, especially in relation to animals' habitats and migration-routes.	
Requirements	• Single- and multi-temporal characterisation of the fragmentation: generic land cover classes; no further information about parcels is provided. • Assessment of temporal changes of this fragmentation.
Variable(s) to be determined	• Length or density [km/km2] of transportation infrastructures. • Median and maximum size of un-fragmented patches. • Distance to next undisturbed site. • Measure of the dominant pressure an operation enacts on biodiversity and environment.
Data acquisition	
Source of information	• Existing maps from national or regional mapping agencies. • Visual and/or automated extraction of land-use / land-cover from remote sensing imagery. • Existing information about the local biodiversity and its habitat requirements.
Methods & Standards	• Automated transportation networks extraction from remote sensing imagery (Cariou et al., 2010; El Ghoul et al., 2010; Lacoste et al., 2010; Peng et al., 2010). • Automated computation of fragmentation parameters included in most GIS software. • Automated comparison of time-series of fragmentation levels. • Radio-tracking / Argos localisation of animals and automated retrieval of their displacement [Gillespie01]. • Standardised Land use / land cover classes, preferably referring to international standards (CORINE, IGBP).
Suggested sensor systems	• For transportation network extraction high resolution sensors can be used. • For evolution of transportation networks: time series of high resolution remote sensing data. • For land-cover / land-use: from multi- to hyperspectral high resolution sensors; depending on the land-use and land-cover classes discrepancies.

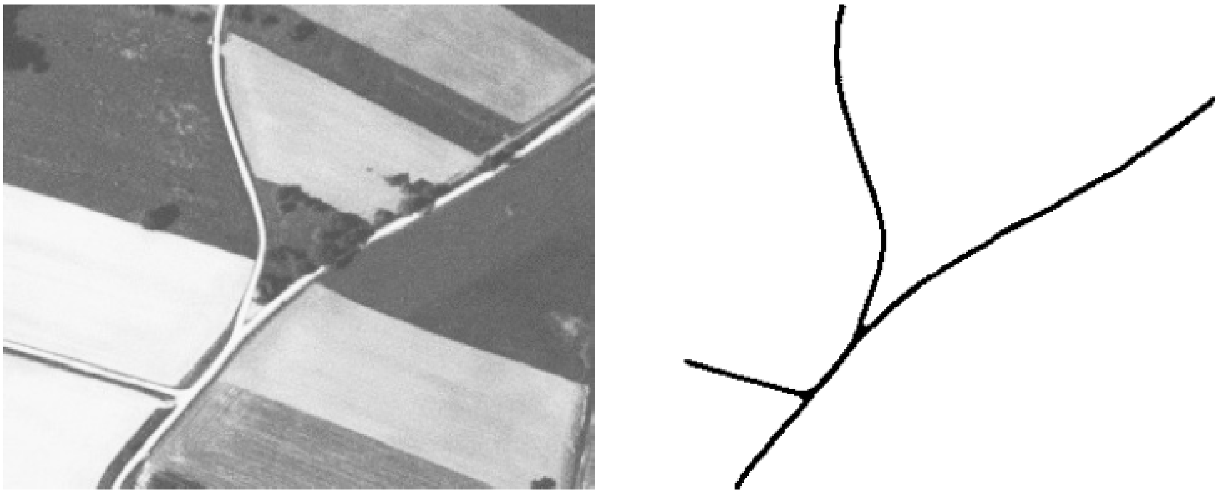
Pre-processing & auxiliary data	• For multispectral / hyperspectral: atmospheric correction might be required.

Caveats:

- Availability of recent remote sensing imagery.
- Availability of time series.
- Setup of radio-tracking / Argos localisations.

Examples

Road network extraction on airborne NIR imagery © IGN and INRIA, taken from [Rochery07]

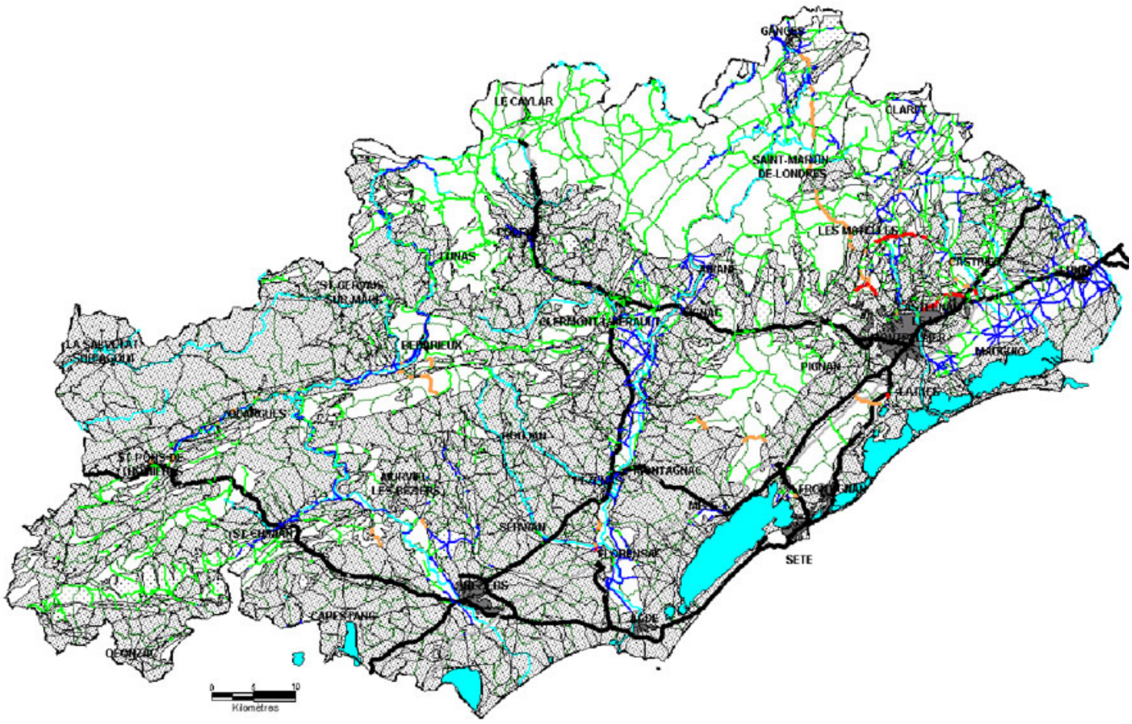


Left: initial NIR image, right: extracted network.

F3 - Local Air, Noise and Accident Impact from Transport	
Impacts from transport outside the operational area (see also D).	
Requirements	• Access the overall amount of air and noise pollution on a regular basis. • Manage the number of accidents linked to mine-related transports.
Variable(s) to be determined	• Air pollution and its variation in time • Accident rates and impacts. • Noise intensity and its variation in time. • Measure of the dominant pressure and operation enacts on biodiversity and environment.
Data acquisition	
Source of information	• In situ monitoring networks (dust, air, traffic) • Local administration data on accidents. • Local administration's / Mining companies' data on transported substances.
Methods & Standards	• Dust measurement • Air pollution measurement • Traffic and accident probability • Substances transported. • Eddy covariance modelling. • GIS software on noise propagation (based on assumption on sources)
Suggested sensor systems	• Air pollution and dust releases can be assessed using dust traps (Žibret & Rokavec, 2009) or atmospheric LiDAR measurements [http://lidar.abct.lmd.polytechnique.fr/]. • Noise levels can be monitored using a sound level meter that is compatible with the IEC 61672:2003. (Beranek,1993).
Pre-processing & auxiliary data	• Measurement grid has to be developed. • LiDAR measurements require pre-processing.
Caveats: • Data availability and/or deployment costs. • Data is usually only 'point-wise'. Need to establish a measurement grid and to invert models/interpolate in-between. • Separate impacts induced by mining industries from other sources.	

Examples

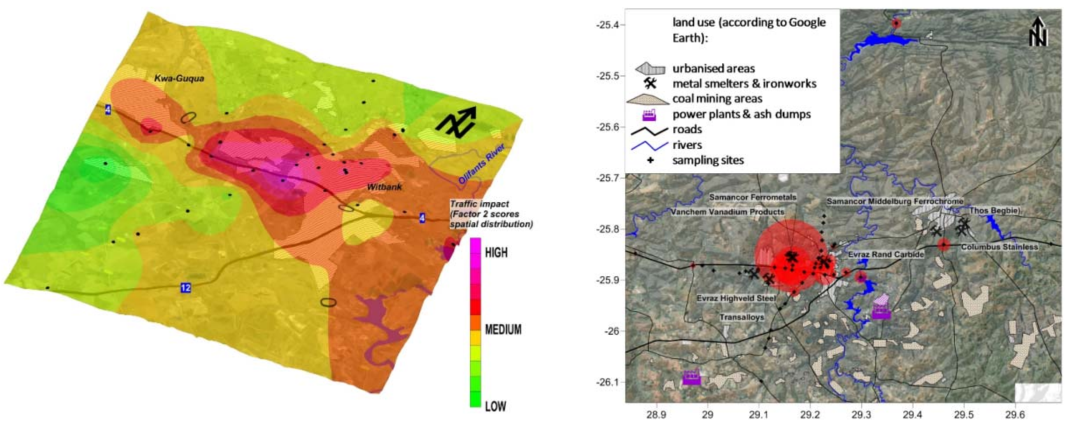
Example 1: Pollution risk related to dangerous substance transportation: Hérault, France, © BRGM.



Legend:
Low risk, moderate risk, high risk, very high risk.
Grey areas: Urban areas; Cyan: Water bodies;
Black lines: Highways; Grey lines: roads; green lines: communal borders.

Inputs: groundwater vulnerability to pollution, road traffic and accident probability, economic importance of water resource, water intakes.

Example 2: Traffic contribution to dust deposits © Geological Survey of Slovenia



Left: Contribution of traffic over the Witbank area (South Africa).
Right: Cartography of the site.

F4 - Transport Infrastructure Quality

Heavy mine traffic may use public transportation facilities and might therefore contribute to their degradation without adequate compensation.	
Requirements	• Multi-temporal analysis of transportation networks quality.
Variable(s) to be determined	• Rate of degradation versus traffic and type of road.
Data acquisition	
Source of information	• Existing maps from national agencies and mining companies. • Visual and/or automated analysis of transportation networks from remote sensing imagery.
Methods & Standards	• Guys from road Surveys Company.
Suggested sensor systems	• Ground penetrating RADAR can be used to map subsurface damages. • High-resolution hyperspectral imagery can map physical surface properties of a transportation network. • Very high resolution single band imagery can provide information about road surface geometry.
Pre-processing & auxiliary data	• In case of use of hyperspectral data, atmospheric and geometric correction might be required.
Caveats: • Availability of remote sensing time series. • Reliability of automated/manual analysis methods. • Distinguish between 'normal' and mine-related degradations. • Link observed degradations to costs.	

F5 - Accessibility Due to Mine-Related Transport Infrastructure	
Mining companies may build transport infrastructure that also can be used by the local population, thus improving overall transportation.	
Requirements	• Multi-temporal analysis of transportation network.
Variable(s) to be determined	• Accessibility improvement thanks to mine-related newly created networks.
Data acquisition	
Source of information	• Time series of remote sensing imagery. • Data provided by local administrations and by mining-companies.
Methods & Standards	• Time series analysis using automated or manual methods.
Suggested sensor systems	• High resolution RADAR or passive (VIS-NIR-SWIR / Thermal) sensors.
Pre-processing & auxiliary data	• None.
Caveats: • Availability of times series of remote sensing imagery. • Difficulty to know whether roads were built from local government of by mining companies.	
Examples	
See F2.	