

USING OF HIGH-RESOLUTION SATELLITE DATA FOR ENVIRONMENTAL HAZARD AREAS MONITORING

¹Karel Pavelka, ²Lena Halounová

¹Laboratory of Photogrammetry, Dept. Mapping and Cartography,

Tel.: +420 224354951, Fax: +420 224310774, E-mail: pavelka@fsv.cvut.cz

²Laboratory of Remote Sensing, Dept. Mapping and Cartography,

Tel.: +420 224354952, Fax: +420 224310774, E-mail: lena.halounova@fsv.cvut.cz

Czech Technical University Prague, Faculty of Civil Engineering,

Thákurova 7, 166 09, Prague 6, Czech Republic

WG V/6 Visualisation and Animation

Key words: Remote Sensing, photogrammetry, ecology, environment, monitoring

ABSTRACT

In the Czech Republic, there are many areas with ecological problems. Old contaminated areas, polluted areas or dumps are meant. In the case of old contaminated or polluted areas, there are old army bases used by the Soviet Army at the end of cold war, polluted by oil products, heavy polluted areas due to uranium mining, large deforested areas as a consequence of air pollution produced by heavy industry in the socialism period. Brown coal mining dumps and areas used by chemical industry for many years are another problem. After revolution time in the 1989 and joining the European Union, the ecology activities in environmentally hazard areas are very important. Very high-resolution multispectral data are used for monitoring and documentation of these areas. We combine old archive satellite data with aerial photos to find changes in the area. This paper is focused on usage of satellite data for environmental hazard areas monitoring in mining areas.

1. STUDY AREA

The northern Bohemia brown coal mining area is situated alongside the Erzgebirge Mountain range forming frontier between The Czech Republic and Germany. Underground mining of various raw materials – mainly brown coal is a characteristic phenomenon of this area. Underground mining of silver can be found already in the 15th century. Industrial development of the 19th century evoked important underground mining of brown coal continuing till 60-ies of the 20th century. Brown coal open casts form another feature of this area after closing the most underground mining activities. These open casts appeared in 70-ies of the 20th century. The mining is still active in large open casts whose size and location has been changing. Abandoned excavated parts have been being reclaimed and new parts are opened to mining.

The area is drained into two rivers – the Bílina River and the Ohře River, both of them flow into the Elbe River. Small rivers and brooks create natural hydrological network of this region together with natural and man-made water basins.

The area belongs to dry regions of the country with about 400 mm of precipitations per year due to the Erzgebirge Mountain precipitation shadow.

1.1 Previous research

This northern bohemian mining area was a matter of previous research activities. Results of these activities showed complexity of the region and enabled us to subdivide the whole region into four different parts:

The model of the area can be divided into model of three different regions:

- undermined areas,
- dumps and open casts,
- neighborhood of mines, and
- other parts

Three temporal phases can be defined for all these regions. These are

- before mining period,
- mining period, and
- after mining period.

1.2 Undermined areas

1.2.1 Previous research

Previous research showed that detection of undermined areas without additional information is not reliable from remote sensing data if used only optical data (Landsat TM and MSS). Results from their processing presented only land use changes - missing villages or their parts in the before-mining period and in several cases new reurbanization after tens of years. Land use changes were from urban areas to vegetation of forest type or non-forest type. If an undermined area was out of urban areas no important changes were discovered. New "mining" railways and roads were temporarily built up to connect mining with the world of users.

1.2.2 Research of this project

Question of stability is an important problem of these localities. The stability comprises 2 phenomena – inbreaks (point subsidence) and land subsidence. Inbreaks appear always in relatively short periods after closing mines after collapsing of supporting constructions in mine corridors. This low size objects (circuit size with diameter of couple

of meters) are not detectable in Landsat data. Their detectability is studied in VHR data. Land subsidence of centimetre heights will be studied by the only possible tool – radar interferometry.

1.3 Dumps and open casts

1.3.1 Previous research

Open casts – their size and changes in time were studied and determined from Landsat data type. Dumps and open casts are reclaimed after closing. The reclamation process comprises technical reclamation and hydric, agricultural or forest reclamation. Development of dump land use was also classified from Landsat data type.

1.3.2 Research of this project

This land use classification and vegetation state characterized by NDVI (normalized differential vegetation index) will be compared with VHR data to define changes. Their comparison will bring spatially more detailed information about individual species – that is not possible for TM data with 30 meters pixel size. Radar interferometry will be used for land subsidence in dump areas and together with VHR data for landslide detection of reclaimed dumps and open-casts. Landslides often occur in reclaimed open casts especially in cases when open casts were hydraulically reclaimed and transformed into water basins. VHR data will be applied also for the water network update, as certain water flows are moved into other places. Reclamation of new open casts were hydric and new water basins were created and the Landsat scale does not allow to detect small water streams.

1.4 Neighborhood of mining areas and dumps

1.4.1 Previous research

These areas can be characterized by land use changes due to closeness of mining where new roads and railways are built up for temporary periods. Other changes of land use do not necessarily occur with the exception of building of a technological base for mining. The stability question does not have to be taken into account in most cases.

1.4.2 Research of this project

VHR data will be used to detect changes in the water network and other changes. They will comprise changes of vegetation state and area extent, changes of urban area spread.

2. PROBLEMS OF VHR IMAGE DATA USED FOR MINING AREAS TOGETHER WITH TM DATA

The mining area studied in this project is not in the centre of interest of VHR imaging as capitals, e.g. Archive images are not available and one ordered image is not cloud free and haze free. The first and important processing step was and is to perform atmospheric correction. Removal of clouds and haze, which was not constant, will be presented in a different paper.

Changes determined from TM data were derived from summer time data (August), changes between TM and IKONOS (VHR) will have to be studied carefully due to seasonal time shift (August of TM's and September of VHR data). It can play important role for the vegetation health state.

To compare results calculated only among TM data with no necessary resampling were easy compared to change detection between IKONOS and TM raster data where data resampling and data recoding (from 11bit to 8bit for IKONOS) have to be done.

3. PROJECT GOAL

The project should verify and confirm that VHR data should prove their ability to provide information about

- vegetation state,
- small water stream network,
- landslide detections in reclaimed areas,
- inbreak detections in undermined areas,

and in combination with previous time step data information about

- changes in land use (quality and extent)
- changes in vegetation state
- changes in slope stability

The problems connected to land subsidence are being derived from radar data using interferometry.

4. CONCLUSION

The project supported by the Ministry of Environment started this summer. It is planned for three years. However, the vegetation state is performable from VHR data, their comparison with TM data from previous years will have to be evaluated carefully. Changes in land use classes will be presented both in raster form, and form of graphs. Detection of inbreaks or landslides in the VHR image data has not yet been confirmed.

REFERENCE

Pravda, L., Halounová, L., Rybář, J.: *Model of Landslide Detection Using Remote Sensing Data and GIS Tools*, Acta Montana. Serie B, Fuel, Carbon, Mineral Processing. 2000, vol. 8, no. AB, pp. 56-60. ISSN 1211-1929.

Halounová, L.: *Landslide risk assessment maps using GIS tools*, 2nd International Symposium on Operationalization of Remote Sensing, Enschede, The Netherlands, 16-20 August, 1999 CD ROM

Halounová, L., Kalát, J., Leden, T., Volf, S., 2003. *GIS for creation of geodynamic model of mining areas*, Digital Earth Conference, Brno, Czech Republic – 21.- 25. 9. 2003, Proc. edited by Milan Konečný, ISBN 80-210-3223-5, pp. 266-271

Halounová, L., Kalát, J., Volf, S., 2003. *Earth surface changes study in the regions in open casts and underground mines of brown coal*. (In Czech) Int. conference “Raw materials and mining activities in the 21st century”, Ostrava, 25. – 27. 11. 2003

Halounová, L., Kalát, J., Volf, S., 2004. *Assessment of region touched by underground mining and open cast mining of raw materials using GIS*. (In Czech) Int. symp. GIS Ostrava 2004, 25. – 28. 1. 2004

ACKNOWLEDGEMENT

This project is supported by the project No SM/10/70/04 of the Ministry of Environment “Usage of multispectral

satellite data of new generation and laser scanning for documentation and analysis of effects in environment, previous mining activities and their influence to surroundings.