GIS BASED VISUALIZATION FOR TERRAIN MEASUREMENTS AND DUST DEPOSITION IN THE AREA OF COAL MINES

Luboš Matějíček[1], Tomáš Bodnár[2], Luděk Beneš[2], Eva Gulíková[3]

[1]Inst. for Environmental Studies, Charles University in Prague, Czech Republic
[2]Inst. of Thermomechanics, Academy of Sciences, Prague, Czech Republic
[3]ECOPROGRESS, Most, Czech Republic

In order to support simulation of wind flows and to estimate dust deposition in the neighbourhood of coal mining areas, the geographic information systems (GISs) are used to create complex data structures, to solve advanced spatial analysis and to visualize the results. GISs, formerly utilized by cartographers, are often used for mapping and spatial analysis in environmental science and other research disciplines. Using of new computer technology enables more complex displays for thematic mapping using animation and multimedia (Goodchild, 1996). Environmental issues, like simulation of flowfields and dust deposition, incorporate temporal as well as spatial phenomena that lend themselves to dynamic display. New trends in GIS research empower users to use interactive applications in the framework of visualization, which brings new possibilities into spatio-temporal modelling.

The GIS project in the environment of ESRI's ArcGIS is developed to integrate all the spatial data and simulation outputs in the geodatabse. In addition to the spatial data management, a huge range of ArcGIS extensions is used to provide spatio-temporal analysis and to make up data inputs for flowfield simulation and final visualization.

In case of the GIS project, the digital terrain model (DTM) forms the basic map layer. A few data sources are used to create DTM. The contour lines support mapping of the whole mining area. The terrain measurements with GPS and the data from geodetic survey are used for visualization of a part of the mining area, which contain the temporary coal repository near the residential zones. Finally, the laser scanning enables to obtain clouds of the 3D spatial points. The laser scanning is focused on selected parts that need higher density of terrain measurements. Thus, the zone between the temporary coal depository and a nearest part of the residential area is selected to obtain the highest density of the 3D spatial points with the highest accuracy. The created DTM represents the key spatial data structure that improves accuracy of flowfield modelling in the framework of the developed standalone software tools. In case of GIS visualization, the DTM is used for draping of satellite images, aerial images and thematic map layers.

The image from Landsat 7 ETM+ supports display of the mining areas at the resolution of 30 meters. A true colour composite and pseudo colour composites combine the bands 1-7. The aerial images enable more precise mapping of the local surface objects including the dust emission sources represented by transport routes, temporary repositories and mining excavators. Spatial identification of these surface objects is complemented by the differential GPS measurements.

The basic schema of the GIS project is in Figure 1. All data are included into the GIS project. The visualization methods included mainly in the ArcGIS extensions (ArcScene, ArcGlobe) provide enhanced display of map layers extended by symbols based on the map attributes, Figure 2. Besides visualization, the digital map layers and reports are generated to document all the results and to share selected data structure via Internet.

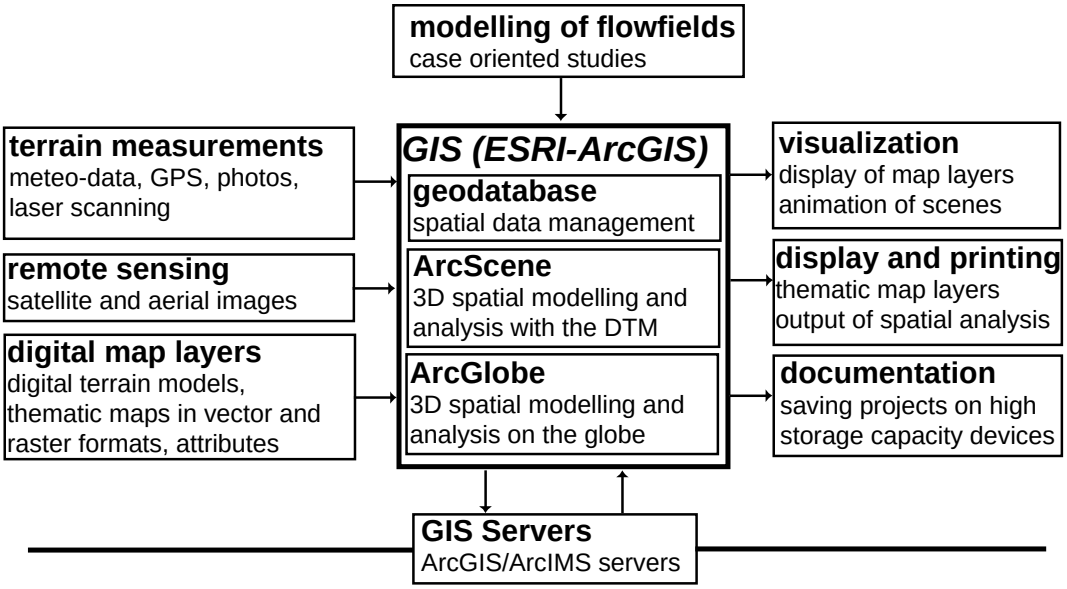


Figure 1. Processing of spatial data and flowfield simulation in GIS

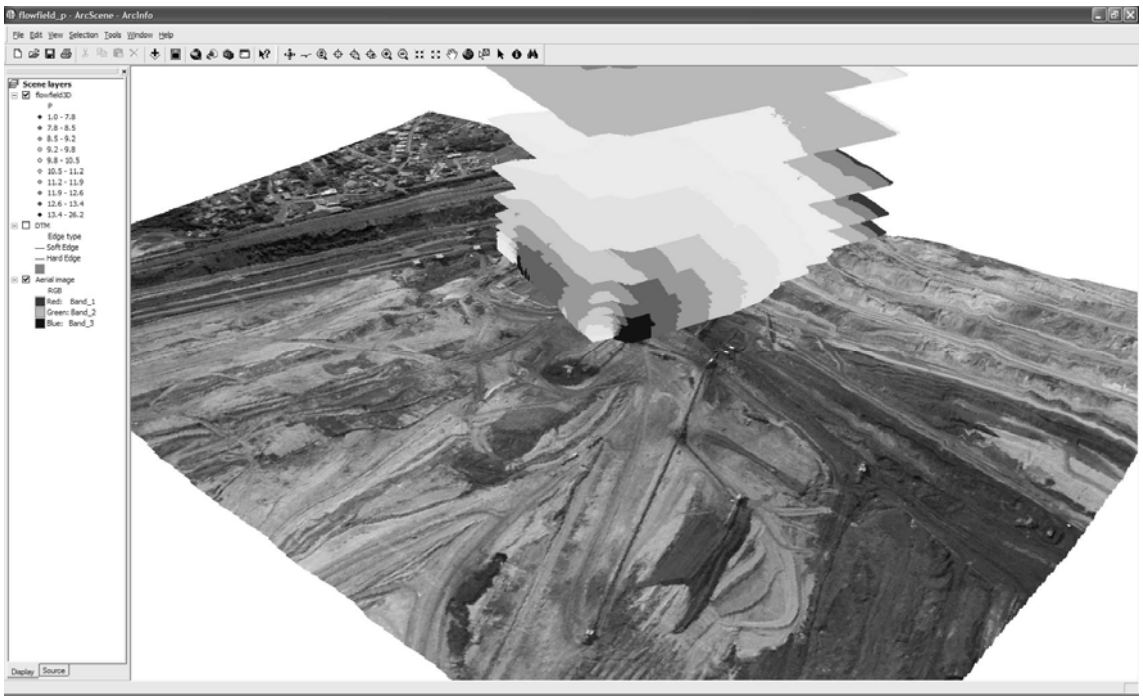


Figure 2. Local visualization of spatial data and flowfield simulation in ArcGIS

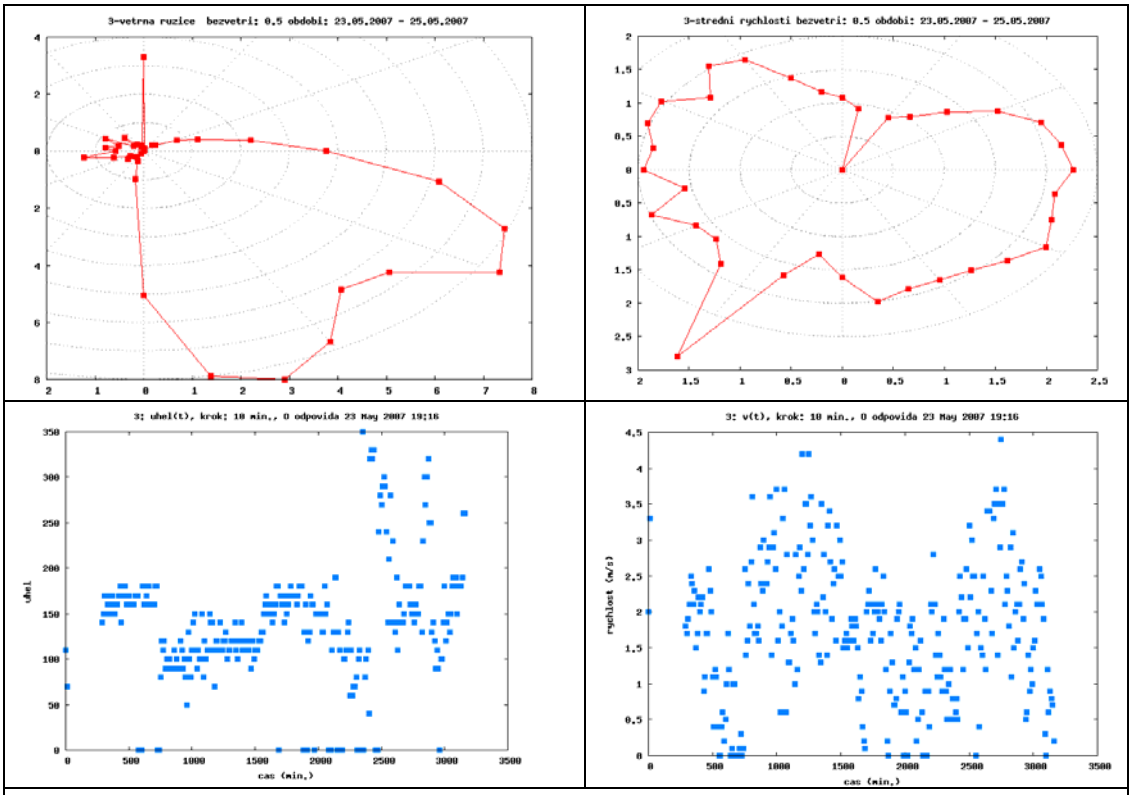
Acknowledgements

The contribution was supported by the grant No. 1ET400760405 and the Research Plan MSM 6840770010. The spatio-temporal data have been processed by ArcGIS, Erdas Imagine and other programming tools in the GIS Laboratory, Faculty of Natural Science, Charles University in Prague.

References

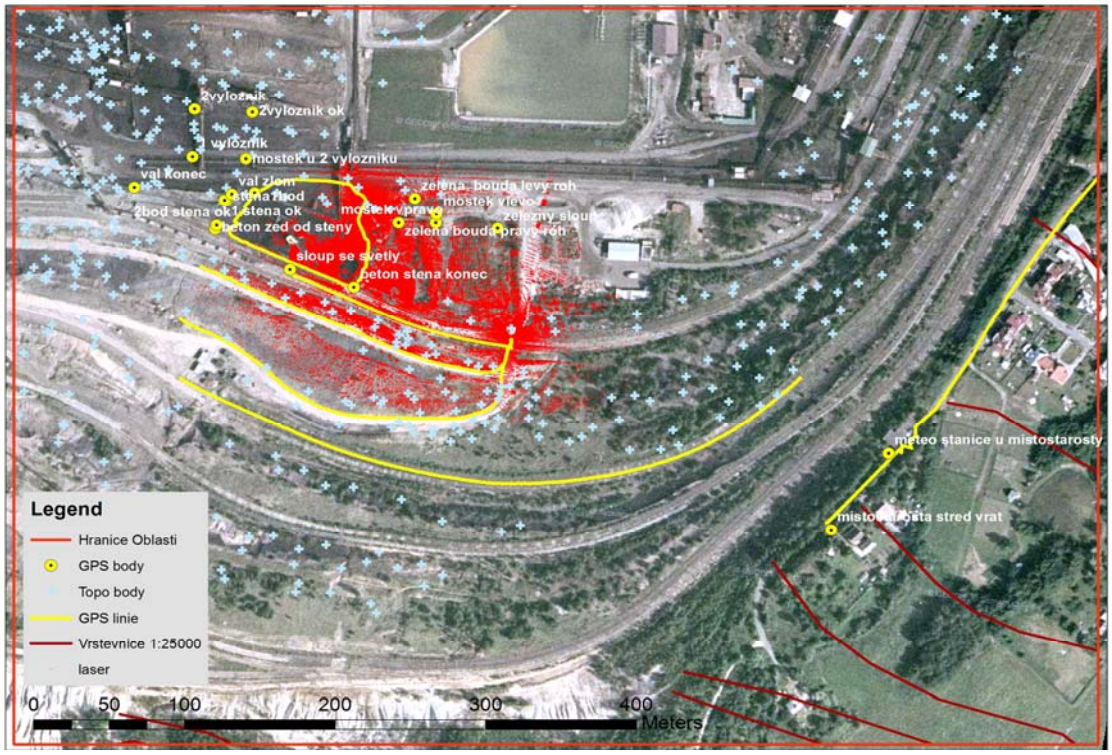
M.F. Goodchild, L.T. Steyaert, B.O. Parks (Ed.), 1996. GIS and Environmental Modeling: Progress and Research Issues. Fort Collins: GIS World, Inc.

Appendix A: Terrain measurements for flowfield modelling: examples



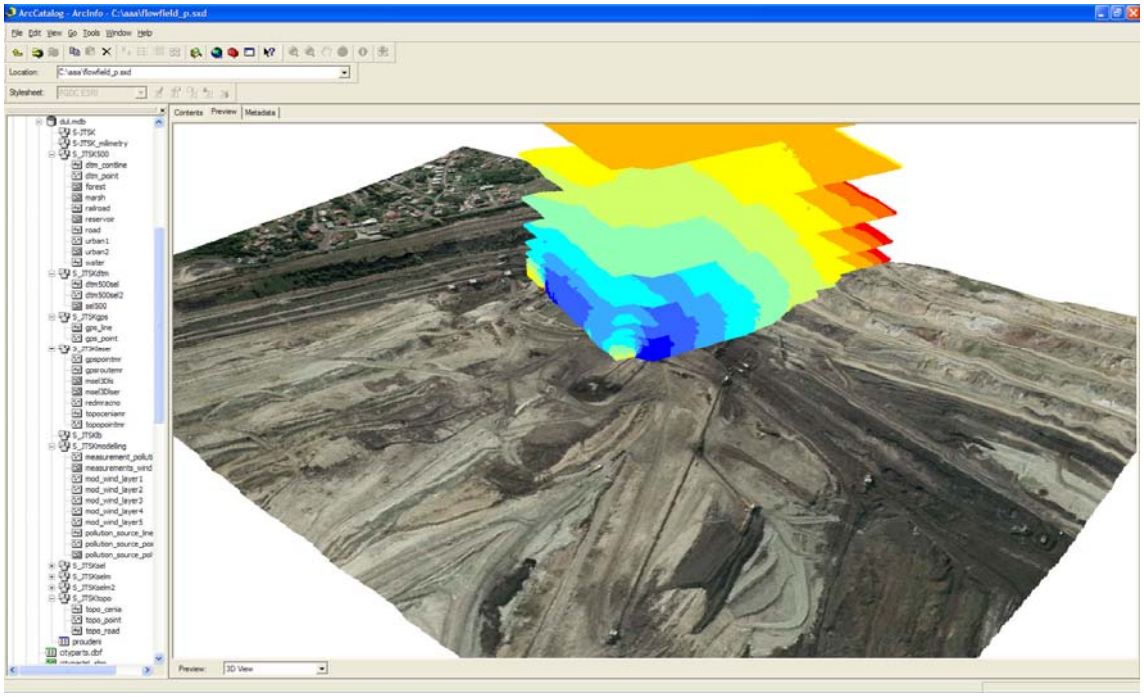
Examples of the graphic outputs for evaluation of wind speeds and wind directions.

Processing of data from meteo-stations by the PHP scripting language

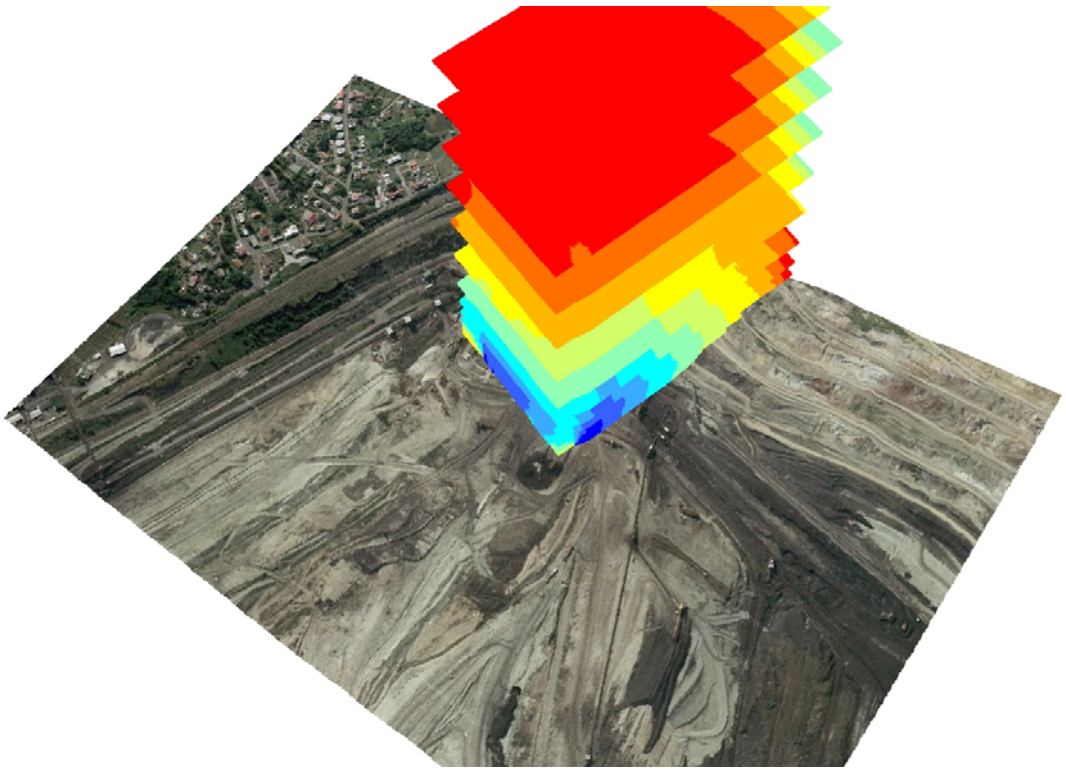


Spatial data from digital thematic maps, D-GPS, geodetic survey and laser scanning in the environment of GIS for construction of the DTM

Appendix B: Visualization of the simulation outputs in the environment of GIS



Display of simulation outputs in the environment of ArcGIS-ArcCatalog (structure of spatial data in the ArcGIS-geodatabase on the left part, a view of the simulation outputs above the aerial image draped on the DTM on the right part)



View of the simulation outputs generated by ArcGIS-ArcScene (a view of the simulation outputs above the aerial image draped on the DTM)