GIS BASED MAPPING FOR MODELLING OF THE FLOWFIELD ABOVE THE SURFACE OF MINING AREAS

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For simulation of wind flows above the complex terrain, the spatial model based on surface mapping in a few scales is needed to provide numerical calculation in a more precise way. Each map scale can be supported by a different spatial data sources. Thus, many software tools are mostly used to solve individual tasks focused on processing of satellite images, aerial photographs, GPS data, laser scans and standard digital map layers. In this case, geographic information systems (GISs) are used to manage complex data structures, to carry out spatial analyses and to visualize results. In order to integrate the flowfield simulation, two concepts of modelling are merged. In spatial modelling, the basic concept is one of spatial distribution and spatial relationship. In temporal modelling represented by numerical models of the flowfield, the basic concept is one of state, determined in terms of wind speed, wind direction or concentration of the pollutant. The resulting projects bring together spatial data and simulation inputs/outputs, which promotes new ways in processing and interpretation. A number of applications are discussed in the book "GIS and Environmental Modeling: Progress and Research Issues" edited by Goodchild (Goodchild et al., 1996).

The attached case study demonstrates GIS mapping of the opencast coal mining areas that are used to support modelling of the flowfileds and dispersion of dust emissions from mining activities. In addition to GIS analysis, the map layers extended by simulation outputs assist to identify the dominant dust emission sources and their influence on surrounding areas. Thus, the GIS spatial data can be utilized by environmental scientists and local authorities in the field of environmental protection.

The basic schema in Figure 1 illustrates the processing of spatial data, terrain measurements and modelling inputs/outputs in the framework of GIS. The upper part represents the spatial data sources. The bottom part contains the key data integration module-GIS, which is extended on the left side by the data connection to modelling tools, environmental statistics and other available spatial data sources. The standalone modules on the right part represent extensions dedicated to the presentation of the GIS data outputs by printed documents or digital data.

The time series of meteorological measurements are pre-processed and included into geodatabase to generate wind rose statistics and plots for several meteorological data formats. In order to improve accuracy of the GPS measurements, the data from reference stations (CZEPOS) are included into estimates of positional data that contain coordinates for georectification of satellite images and aerial images, and locations of surface objects (mining excavators, transport routes, temporary repositories and meteorological stations).

Satellite images from Landsat 7 ETM+ are selected to display and classify the surface of the whole opencast mine at the resolution of 30 meters. The bands 3-2-1 (red, green, blue) create a true colour composite that displays surface objects similar to a colour image. The bands 4-3-2 (near IR: 0.77-0.90 µm, red, green), 5-4-2 (mid IR: 1.55-

1.75 μm, near IR, green), and 7-4-2 (mid IR: 2.09-2.35 μm, near IR, green) are transformed into the visible light spectrum and create a pseudo colour composite. The middle infrared bands can be used for discrimination of geologic rock types, soil boundaries and soil moisture content, which significantly influence the rate of surface emission sources (bare soil, mining areas and larger coal repositories). The aerial images support mapping of local emission sources and surface objects at the resolution of 0.5 meters. All the images are draped onto the digital terrain model (DTM) that is based on terrain measurements and laser scanning.

Laser scanning together with terrain measurements form the input data for building of the DTM in the format of the triangulated irregular network (TIN).

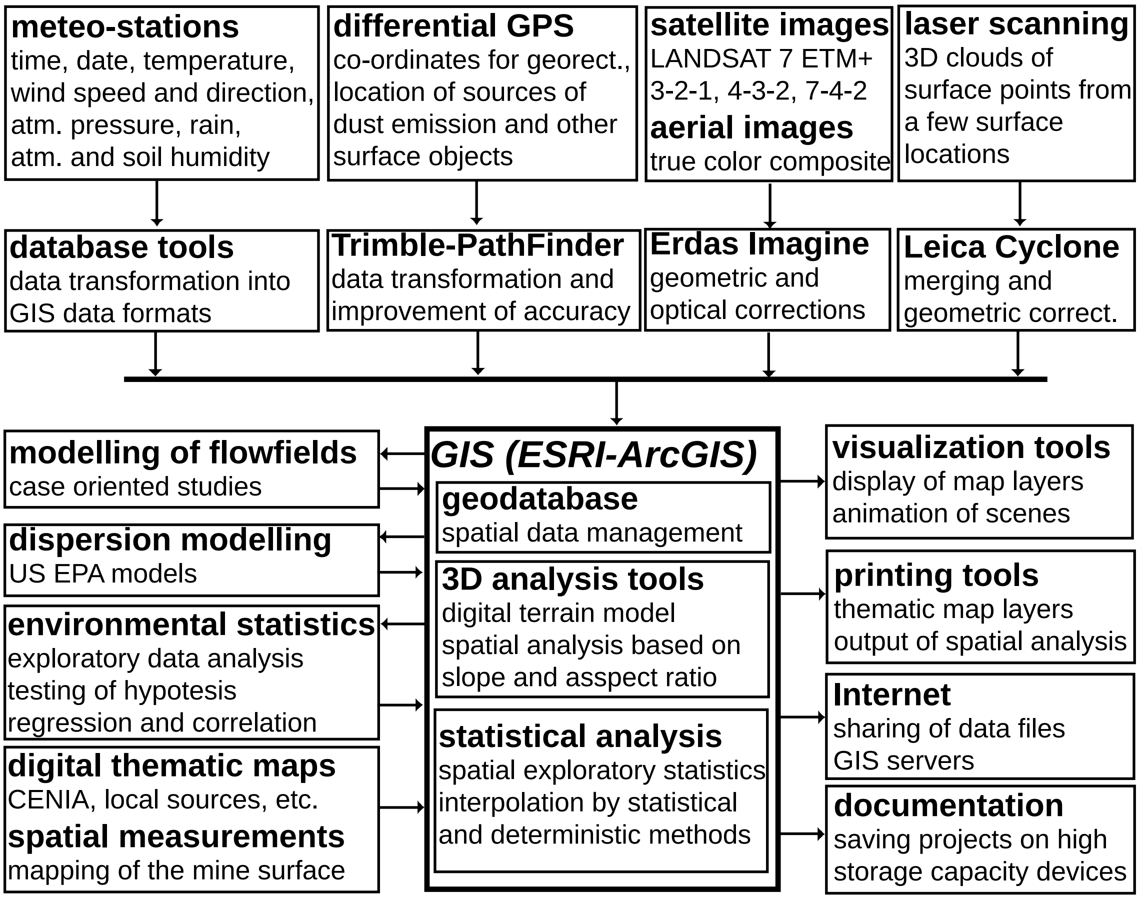

Figure 1. Processing of spatial data and simulation inputs/outputs in the framework of the GIS project (ESRI's ArcGIS)

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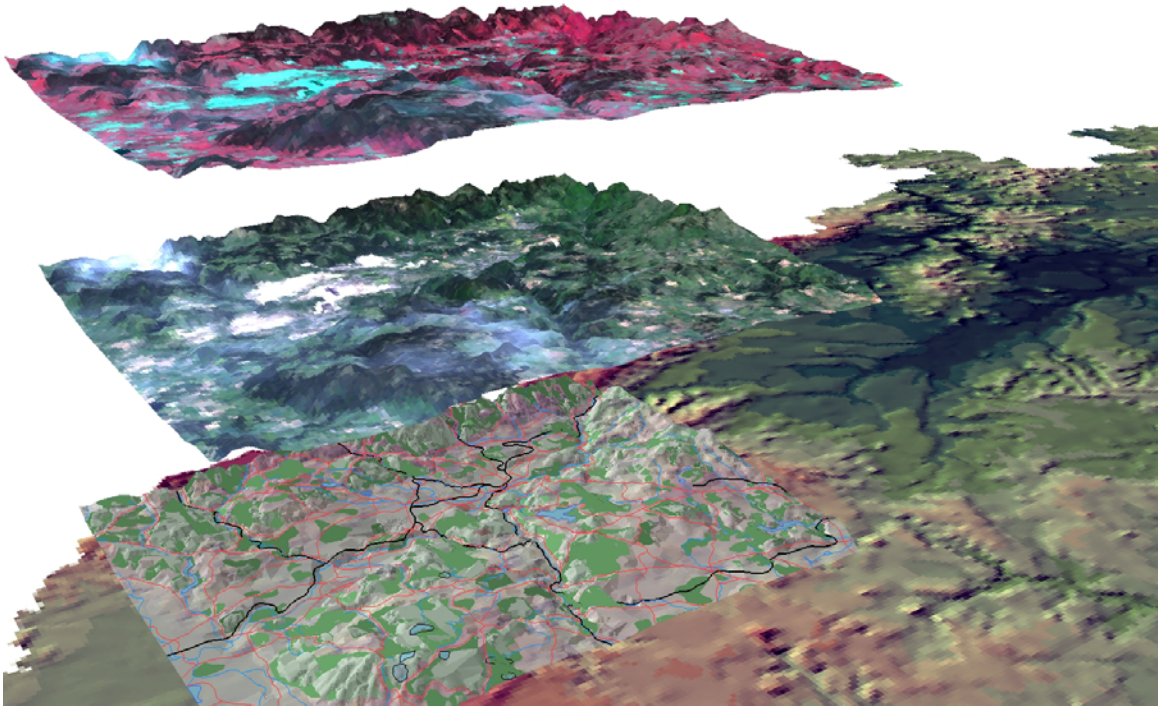
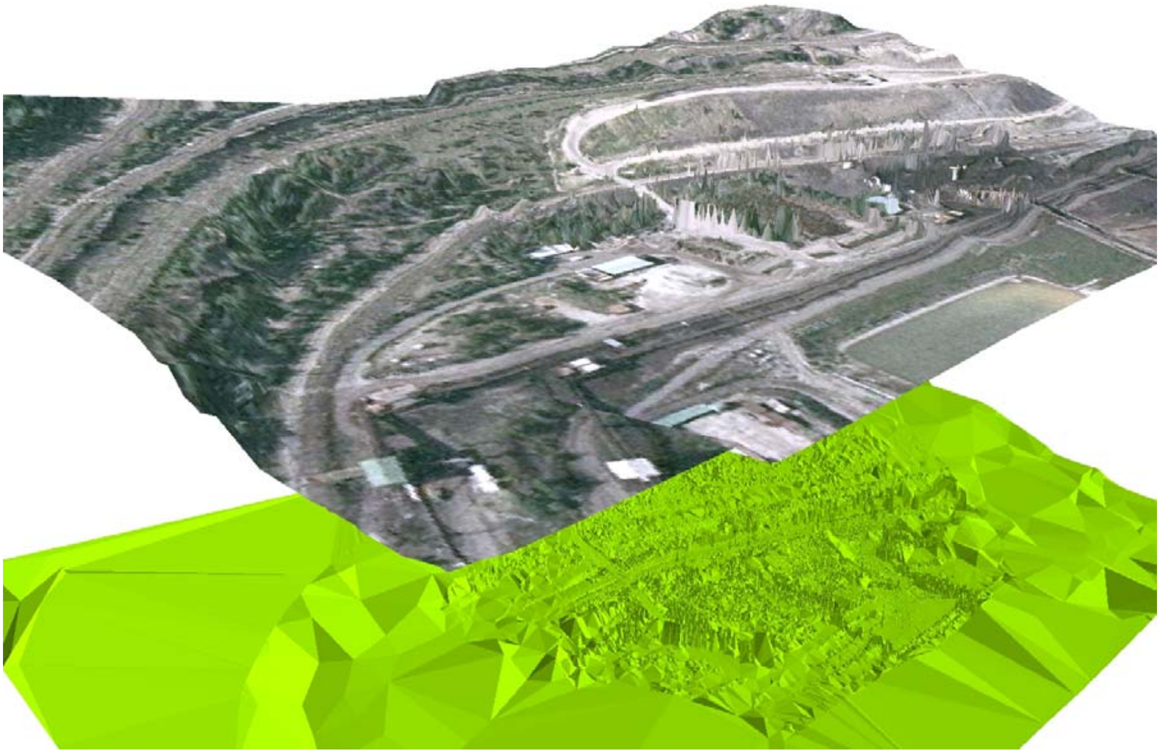
References

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: Data from remote sensing

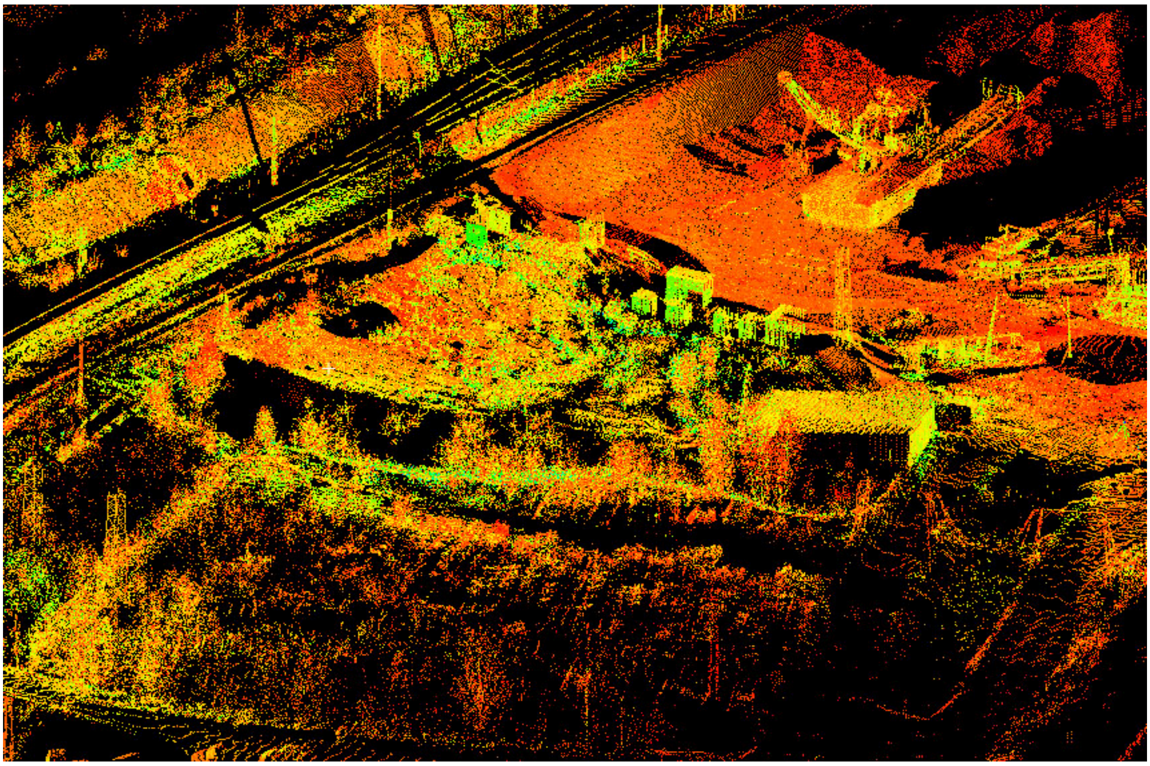


The satellite images of the surface coal mine from Landsat 7 ETM+ draped on the DTM based on contour lines (a pseudo colour composite with bands 4-3-2 above a true colour composite with bands 3-2-1, thematic map layers in the bottom part)



The aerial image of the slope located in the coal mine draped on the DTM based on GPS data, geodetic survey and laser scanning (a true colour composite of the aerial image above the DTM assembled by the TIN data)

Appendix B: Data from laser scanning



The clouds of the 3D points captured by the surface laser scanner from a few positions and merged by software tools for creation of the DTM

The High-Definition Surveying (HDS) scanner for a versatile and very accurate 3D laser scanning, which uses a high-speed laser and a built-in digital camera to rapidly photograph and measure a scene