New GIS tools and geospatial data sets for surveying and mapping

Information from SMC-Synergy

This article highlights the advantages that the soil surveyor can gain by analysing high resolution imagery and DEMs in a 3D environment.

With ever increasing pressure on South African soil resources the need for more effective use and protection of this scarce resource becomes inevitable. The use and application of soil maps has extended well beyond their conventional role in agriculture and they now support various decision making processes in urban planning, engineering and environmental resource management. Soil surveys and map production, however, remain an expensive and time consuming process – it is therefore crucial that new technology in the field of geo-informatics be investigated to conduct these surveys more cost effectively.

The use of remote sensing and DEMs in soil surveys

The use of multi-spectral remote sensing images and digital elevation models (DEM) in a GIS environment have proven extremely useful over the last 30 years in planning, executing and finalising soil surveys at various levels of detail. A very good example of how DEMs were used in soil surveys was the production of the SOTER (soil/terrain map) map for South Africa in 2003. Currently the use of the 90 m SRTM is part of the standard procedure used by the International Soil Reference and Information Centre (ISRIC) in Wageningen to identify SOTER terrain units. However, the high cost of GIS software and relevant data, combined with the fact that the resolution of imagery and DEM data were not always satisfactory, hampered the wide spread adoption/development of this technology in soil surveys at larger scales. In an attempt to improve on the conventional methods of stereoscopic interpretation of aerial photographic pairs, the use of various pseudo 3D viewing software packages was introduced but rarely became a standard procedure in terrain reconnaissance, planning of the survey (layout of observation points) and delineation/digital capturing of soil boundaries. The reasons for this could be ascribed to unsuitable data quality and the limited functionality and high cost of 3D software.

New geo-informatic tools to assist soil surveyors

The availability of high resolution remote sensing images on internet based systems like Google Earth/Maps and the increased availability of high resolution DEMs have revolutionised the use and need for geospatial information in soil mapping.

This article briefly discusses the potential use of Global Mapper (GM) software in soil surveys. The software provides the soil surveyor with powerful perspective 3D viewing capabilities combined with support to more than 200 file formats at an affordable price. It provides just the right level of GIS functionality to satisfy both experienced GIS professionals and mapping novices. It is equally well suited as a standalone spatial data management tool and as an integral component of an enterprise-wide GIS. The software was initially developed by the United States Geological Survey (USGS).

The main features differentiating it from other software products that can assist soil scientists in planning and executing soil surveys include:

- The ability to link to various online data sources (e.g. World Imagery – high resolution satellite data, ASTER DEM)
- True perspective 3D viewing of imagery draped onto DEM

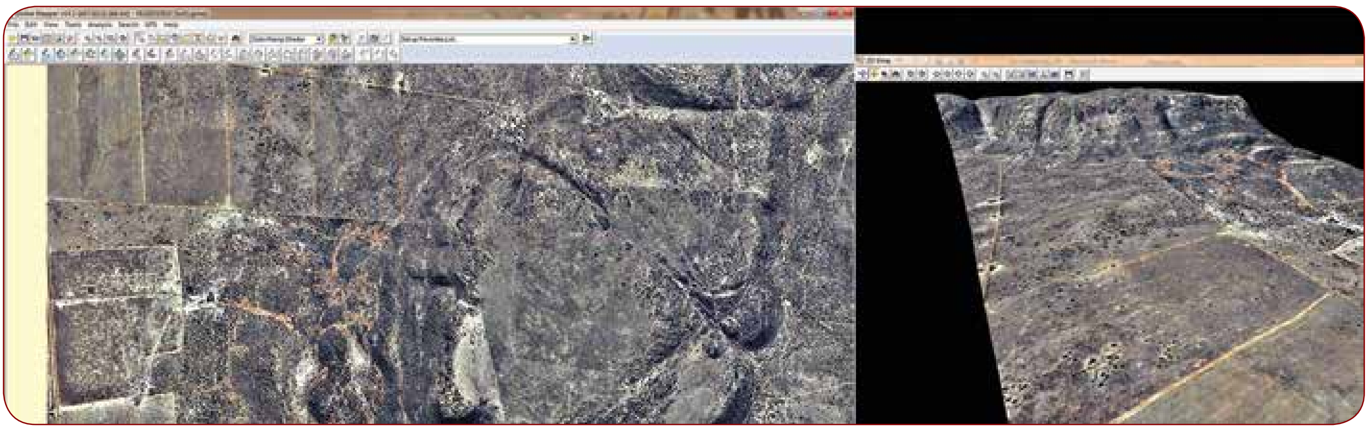

Fig. 1: Digital aerial imagery (0,5 m) draped over 30 m DEM (SRTM resampled) and displayed in a true perspective 3D view in Global Mapper.

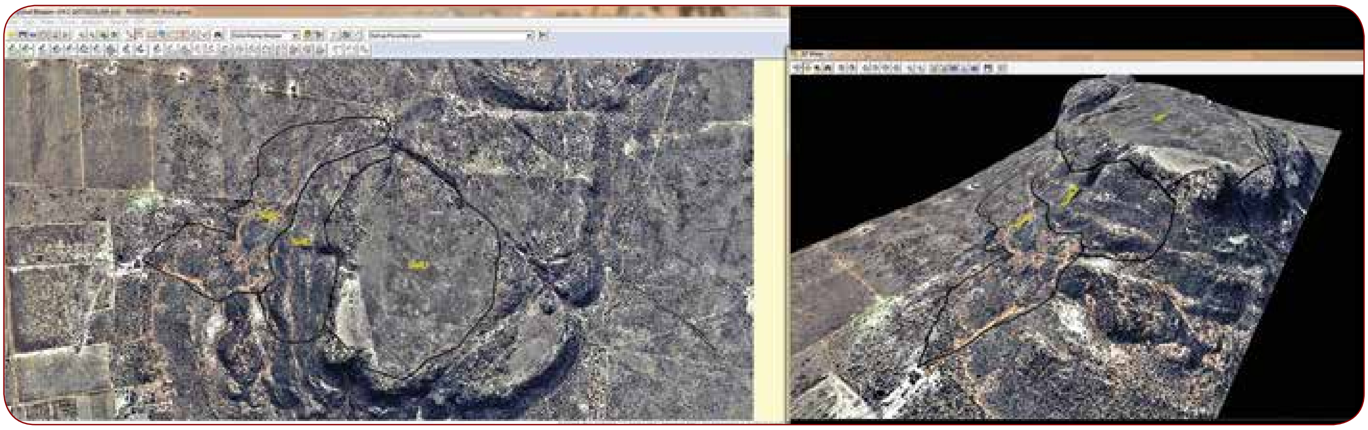

Fig. 2: Digitised soil boundaries in relation to terrain features.

- Dual screen 2D and 3D viewing (mapping in 2D with immediate update of features in 3D)
- Extensive vector editing tools
- Triangulation of point (lidar) and line features (contours) – create elevation grids for 3D viewing and other terrain analysis
- GPS tracking and downloading of images to GPS
- Creation of map catalogues
- Contour generation
- User-friendly image enhancements

The availability of high resolution digital aerial/satellite imagery as well as DEMs at various levels of detail (90 m to 5 m) creates the opportunity for soil surveyors to combine these data-sets in a perspective 3D environment. The resolution of both the imagery and the DEM eventually determines the quality and level of detail generated in the 3D view. The software allows registered users to drape any vector or raster data over a DEM in a true perspective 3D view (see Fig. 1).

Visualising the survey area in 3D enables the soil surveyor to explore, interpret and analyse the soil-landscape that will eventually assist with the reconnaissance of the area, positioning of field observation points as well as the delineation of soil boundaries. Field observation data, enhanced imagery and terrain information (contours or shaded relief) enable the surveyor to identify and delineate homogeneous soil units on the imagery backdrop. Another positive aspect of the software is the user-friendliness of the vector editing tools. Developed in a geological environment, it provides the surveyor with tailor-made functionality to digitise soil boundaries and exporting the results to more than 30 vector formats (shapefiles as default). Digitised soil boundaries are immediately updated in the 3D view allowing the surveyor to assess the accuracy of the boundaries in relation to terrain morphological units (crest, mid-slopes, foot-slopes or valley bottoms). See Fig. 2.

Maps created through the interpolation of soil sample analytical data can be viewed in 3D and exported to relevant formats to be uploaded on supported GPS devices or precision farming implements (formats such as kmz, GPX etc.). In the same way maps generated through precision farming implements (e.g. yield data) can be incorporated and analysed in the software to determine or explain yield differences and to compare with soil analytical data. This allows the land-user to adjust management practices that includes the application of fertiliser.

Due to its functionality and access to freely available datasets of reasonable resolution and quality, the software allows practitioners in farm planning affordable access to actual and timely information for the farm planning activities. It can be used by the land user or extension officers in the entire farm planning process e.g. the placements of fences, watering points and other infrastructure development.

Advanced users can also process lidar data sets as well as generate DEMs from 3D vector data (e.g. contours) in the software. Both these products compliment the use of high resolution digital satellite/aerial images in the generation of the perspective 3D views. Some of these high resolution datasets are, however costly, and sometimes out of reach for the soil surveyor.

Conclusion

The use of GIS for visualisation and landscape interaction by practitioners in various fields or applications can expand dramatically with affordable, easy to use 3D software availability. Prior to visiting a study area, the surveyor can create a mental model of the soil-terrain landscape and start the process of planning a reconnaissance field visit and the layout of observation sites. The excellent perspective 3D viewing capabilities of the software combined with dedicated vector editing tools will assist the scientist to create soil maps in a much more cost effective way.

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