REAL-TIME MAPPING AND MOBILE GIS IN SOILSURVEY APPLICATIONS

by Waylon Dwain Daniels

ABSTRACT

Application of ArcPad and ArcGIS on hand-held and tablet computers for Natural Resource Conservation Service soil survey field operations is explored. With increasing GPS capability and its wireless integration into the GIS, the ability to collect accurate spatial data for soil survey components may revolutionize the soil survey field data collection process. Wireless technology such as Bluetooth capability on data collectors and GPS receivers has further increased the usability of this equipment for rugged field use.

BACKGROUND

This is the second paper in a series discussing the GIS related technology improvements in soil survey as accomplished by the Natural Resource Conservation Service. The paper GIS Applications in Soil Survey Updates was presented at the 2003 ESRI Users Conference. It discussed new methods and application of GIS software, particularly for soil survey update and maintenance activities. This paper examines the application of mobile computing devices used with GPS to provide the soil scientist with real-time mapping capability.

SOIL SURVEY FIELD ACTIVITIES

A significant part of the time spent in the production of a soil survey by the soil scientists involved in the project is not in an office but on-site. There are new technological developments that may diminish the necessity for as much on-site work by individuals through predictive models using remote sensing derivatives. As effective as these new tools may prove to be, there will always need to be on-site work performed during the course of a soil survey project, and it is in this area that mobile computing devices are considered to improve production. The two categories of this on-site work are field mapping and supporting documentation.

Field Mapping

The soil occurrence pattern as related to landscape components known as the soil/landscape model should be understood before production mapping is started. Soil mapping consists of delineating areas where the soil has similar properties and characteristics that react the same under different land use practices. These areas are labeled with soil map unit symbols. The soil scientist may have used stereoscopic aerial photo interpretation, topographic maps, and other information to draft a preliminary outline of the landscape configuration. Applying the soil/landscape model, soil map units are temporarily placed on the appropriate delineations. This map is then taken on-site where the model is tested by observations. The number and pattern of on-site observations depends on a large number of variables. The base map for all this work has usually been a print of an aerial photograph. While on-site observations are being performed, the individual is constantly referring to the aerial photo to note the present location and whether or not the preliminary concept of the soil/landscape model as sketched out is standing up to the test of the field observations. Usually this work is performed alone. To make the observations soil excavation equipment is needed to expose the soil for observation. Much of the time the mapper can work out of a truck or all-terrain vehicle, but there will be many times the mapper will have to physically carry the map, digging equipment, and other items needed to make and record the on-site observations. This field work is performed in all kinds of conditions from swamps to deserts, in hot or cold weather.

Figure 1. Soil Scientist engaged in Field Mapping. (Photo source: USDA-NRCS)

Documentation

In addition to the record of on-site soil mapping observations recorded on the soil map, field notes are collected to describe the soil and its position and occurrence in the landscape. The soil description and sampling for laboratory analysis is usually carried out by a group rather than an individual. These notes are usually handwritten and are later input into the pedon database, part of the National Soil Information System (NASIS).

ADVANTAGES OF USING MOBILE GIS

Real Time Mapping

Considerable production time is saved when the mapper is working on the digital version of the soil map rather than on a hardcopy map that would have to be converted to a digital format.

The number of errors that result from processing and converting the hardcopy map to digital are reduced. However, this process needs to be taken out of the office and off the desktop computer and into the field on a mobile computer. Real-time mapping enables the creation or modification of the digital product on-site by the individual who knows the most about that particular soil/landscape model used in the survey. With an application such as ArcPad, that integrates GPS position data into the GIS, the mapper is no longer constantly burdened with having to keep a running count of paces in order to locate the position on the map. The importance of the time savings that occurs cannot be overstated when the location on the aerial photo base can be observed by using GPS integrated with the GIS. The GPS position is viewed on the map display that can include the digital aerial photograph and the location of the soil map unit boundaries. The mapper can actually stand on the map unit boundary as it appears on the map display. Other data layers may also provide the mapper with valuable information while on-site, such as the location of buried utility lines or ownership boundaries.

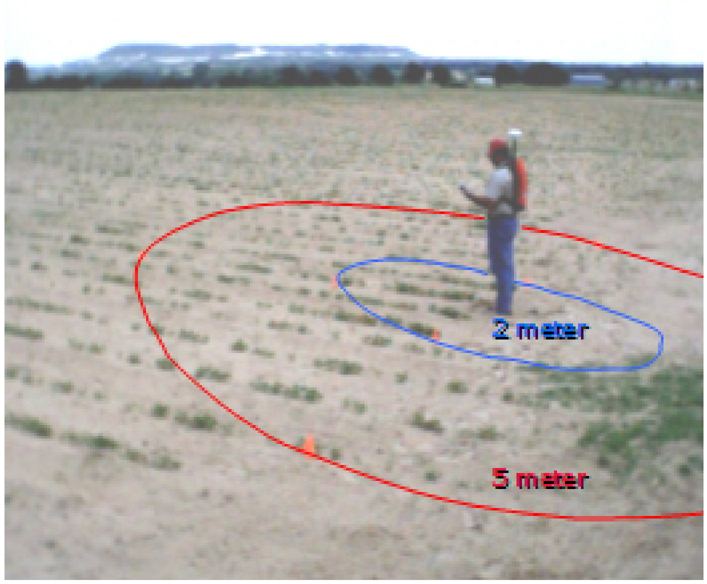

Figure 2. Representation of GPS accuracy.

On-site Documentation

Use of a tablet or PDA mobile device would enable more documentation during field mapping. Each location at which an observation is made can be captured as a point feature using the coordinates obtained from the GPS. Attribute information could include how well the predicted map unit corresponded with the observation. This observation database would provide a clear picture of which landscape components needed to be studied more intensely. This spatial database could also be queried and analyzed to determine map unit composition and to provide a record of what areas have had on-site observations.

Use of a tablet mobile device would enable the mapper to capture detailed field notes in a digital format using the Windows Pedon Program or similar data recording program. This would replace the handwritten form on paper that would have to be input into the computer back in the office. Data entry in the field on a mobile device would save considerable time and reduce possible errors during data entry.

An additional function that mobile devices provide is the capability to have digital reference material available in the field. Information such as soil descriptions and standards and methods frequently reviewed, which would require thick cumbersome three-ring binders, can be accessed digitally whenever needed on the mobile device.

Mobile Device Solutions

A number of mobile devices have been examined for their use in soil survey applications and to identify business requirements needed to develop technical specifications. These devices range from handheld PDA to tablet computers. Potential users want a device that is able to withstand exposure to the elements involved in field work, has a large display area viewable in bright sunlight to near darkness, has a long battery life, and is small, lightweight, and easy to carry. A mobile device must have sufficient data storage processing capacity and to handle GIS analysis and editing.

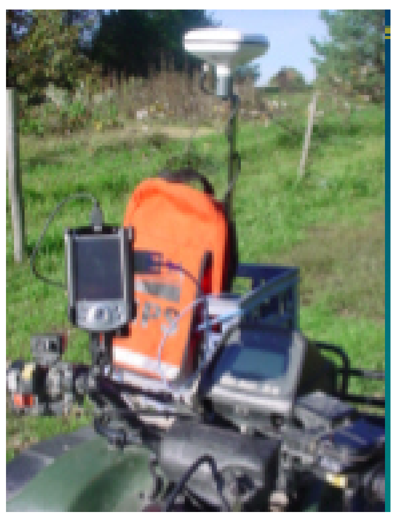

Figure 3. Handheld mobile data collection device mounted on ATV with GPS. (Photo source: Elizabeth Cook, GIS Specialist, NRCS, MO)

Handheld PDA devices with GPS integration have been successfully used for simple field data collection. A disadvantage of handheld PDA devices is that they are not considered suitable for field soil mapping because of the limited size of the display. There is simply not enough area for the mapper to view the area of interest at a desirable scale. The larger display size on tablet computers is considered to be more suitable.

For field mapping, the outdoor viewability on a mobile device in different sunlight conditions must at least meet the level of clarity for photo interpretation the soil mapper has experienced using a hardcopy aerial photo image. Subtle change in tone on the aerial photograph can be shown in many cases to indicate a soil map unit boundary. This level of display capability out-of-doors has not been observed on any of the mobile devices examined. However, this technology is rapidly changing with new products constantly being released. Even without the optimal display capability, the advantages to using mobile devices in regard to time saved on editing map unit line work, field note collection, and the positioning capability provided by wireless GPS integration, will result in a very effective tool for future soil survey projects.

REFERENCES

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AUTHOR INFORMATION

W. Dwain Daniels, C.P.S.S.
USDA-NRCS
National Cartography and Geospatial Center
Federal Center, Bldg. 23
501 W. Felix Street
Fort Worth, Texas 76115
(817) 509-3358
wdaniels@ftw.nrcs.usda.gov