June 2004 No. 2

WHAT'S HAPPENIN'

The Iowa Geological Survey's Geographic Information Systems Bi-Monthly Department Newsletter

The Iowa Geological Survey's GIS Section continues its efforts to better inform users of GIS data of changes and updates. This month's edition of "What's Happenin" will focus on two exciting new datasets recently completed by GIS staff, Land Cover and Ground Truthing. The "Wish List" for this month is presented by our friend The Mapster. Please address questions, concerns, or suggestions to Chris Kahle at ckahle@igsb.uiowa.edu, or Andy Asell at aasell@igsb.uiowa.edu .

Land Cover for the State of Iowa in the Year 2002

The GIS Section has now completed its third Satellite Imagery derived Land Cover product. This product serves a variety of uses. For the majority of users the Land Cover product will be an aid for visual interpretation of what is present on the landscape. It is also useful as an input for mathematical models analyzing the effect of the landscape on various natural processes. Land Cover products were produced for 1992 and 2000, which when used in conjunction with the 2002 product can offer some sense of how land use is changing over time. Future products will make this type of comparison more direct.

Significant improvements were made in what the product offers for 2002. These are described below and easily discernable when one compares the various products.

What are the Improvements?

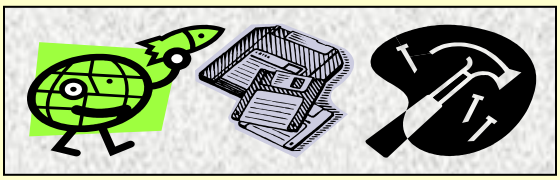
Better Imagery. The 2000 Land Cover product suffered from too many clouds in the imagery. We were fortunate to find a set of nearly cloud-free images for the year 2002 that made it easier to produce a better classification.

More Classes. The 2002 Land Cover product offers 17 land use classes versus only eight in previous products. Differences are that the 2002 Land Cover has four different grassland classes versus only one in the previous products. Also, there are three forest classes split out compared to one and three urban classes versus two for previous products.

Higher Spatial Resolution. Despite the fact that this product is derived primarily from imagery whose native resolution is 30 meters, a variety of special techniques were used that resulted in an end product whose pixel size is 15 meters, and whose spatial accuracy is effectively better than 30 meters.

These improvements alone make the 2002 product more usable because the data is more geographically in line with other photographic data such as the 2002 Color Infrared photography and the earlier 1990's Digital Ortho Quad photography, which when combined with the richer classification scheme can really tell the user what is going on in a given geographic area.

What went into making this product?



Imagery was acquired. Two Landsat images were acquired for each area, one from a spring time frame, the second from a summer date. Using imagery from two separate time frames, both spring and summer, increases the overall amount of spectral information available, enabling a more accurate classification. This is called Multitemporal classification. This procedure was also used for the previous land use products.

The spring time frame offers a lot of information about trees and grasses that are consistently present throughout the year, and helps to distinguish these areas from other areas that are green only during the summer time frame. These are less likely to be cut down to the level of exposing bare soil like what would happen when harvesting crops.

The summer time frame offers much richer spectral depth because the non-coniferous trees are leafed out and grasses are growing, along with whatever might be growing with them. Also the crops are growing and in many cases in the ideal August time frame fully grown, reducing static offered by soils during the classification procedure. The summer time frame is the primary data source for discriminating between corn and beans and other row crops.

Despite the overall quality of the imagery, there are some areas where the quality of the classification was impaired by clouds. This is especially true in southeast and eastern Iowa, where it's greatest impact was in discrimination between corn and soybeans.

Images were processed. This involved stacking the images from different flight dates together in a way that assures the preservation of the spatial relationships of the pixels. Once these were stacked, an automated classification process was started. Basically, the software was allowed to find as many different spectral classes as it could without input from the user.

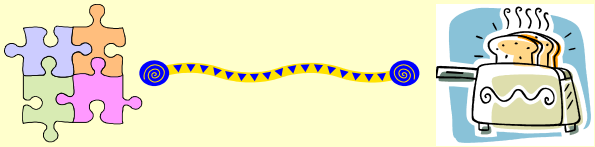
Interpretation. Next the Class Grouping Tool, a component of the ERDAS Imagine Software, was used to interactively group and label the unsupervised classes into their final land use classes, areas of similar spectral character. Ground truthing points, which are discussed in the next section of the Newsletter, were used for separating the most ambiguous data. The 2002 CIR was also used to delineate coniferous forests in the classification. Some post-processing was done with the ERDAS Imagine procedure Fuzzy Recode, to take into account information from surrounding pixels to refine the final assignment of ambiguous pixels to classes. This is probably the first application of these tools, which Pete Kollasch helped design while at Earth Satellite Corporation, on a large scale project anywhere.

Raster Editing. A manual editing step was used to refine certain issues with the data. The first of the two major raster edit steps was to separate the urban commercial/industrial class from the barren class, which consists mostly of quarries and sandbars. A second editing step separated floodplain forests from coniferous tree stands.

Assembly. The six separate pieces that were part of the overall area were pieced together into a state-wide coverage.

This is an oversimplified description, more detailed information can be found at:
ftp://ftp.igsb.uiowa.edu/gis_library/IA_State/Land_Description/Land_Cover/Land_Cover_2002/lc_2002.htm

Final Product



The final product of this process was a Land Cover classification with 17 different classes. The classes are described below. Classes of special note are Ungrazed Grasslands, which also includes most rural roads and ditches, and Other Agriculture, which indicates that no crop was present in what appeared to be a rowcrop area. The user should read and understand what they are looking at before trying to decipher information from any classification but especially these few.

Open water - Spatial/spectral areas of open water, generally without any vegetation present.

Wetland - Spatial/spectral areas of marsh land, and sometimes forested wetlands. Also includes areas of saturated soil. This class generally reflects the presence of both a wetness signature and a vegetation signature.

Wet forest - Edited class of mixed pixels of forest and water. These pixels spectrally appeared with the coniferous forest class, and were manually edited into this class in areas that clearly represented waterways and not coniferous forest.

Coniferous forest - Spatial/spectral areas of evergreen forest with editing. Some conifers (especially cedar) occur frequently in stands too thin to be separated spectrally. Also may include some deciduous forested areas in terrain shadow or in a floodplain situation.

Deciduous forest - Spatial/spectral areas of broadleaf deciduous forest and trees.

Ungrazed Grasslands - Spatial/spectral areas of ungrazed grasses. Includes rural road and ditch complexes, grassed waterways, some grassland/forest edge areas, and some tracts of grasses that are spectrally separable, and appear to be unmanaged. This is the catch-all class for grasslands that are not otherwise separable into more detailed classes. Field observation suggests that areas with more native character are more likely to be assigned to this class.

Grazed grasslands - Spatial/spectral areas of grasslands that show a healthy vegetative signature in spring, generally due to absence of senesced vegetation. Some of the more lush areas of grazed grasses will appear in the Alfalfa class.

CRP - Spatial/spectral areas of unmanaged grasses in heavy stands. This class reflects the presence of senesced grasses in the spring, masking any lush vegetation response. Field observation suggests that planted areas of native grasses and also areas of aliens such as brome grass, etc. are both included this class.

Alfalfa, winter wheat, lush grass - Spatial/spectral areas of very lush vegetation, usually consisting of alfalfa fields, but sometimes including other lush grasses, such as winter wheat, lush areas of grazed fields, and golf courses.

Corn - Spatial/spectral areas of row crop planted to corn in 2002. Will include small amounts of spectrally confused areas planted to soybean or other crops. In the very southeast corner of Iowa where only a single (Spring) date of image was used for the classification, all rowcrop areas are assigned to corn.

Soybeans - Spatial/spectral areas of row crop planted to soybeans in 2002. Will include small amounts of spectrally confused areas planted to corn or other rowcrops.

Other agriculture - Spatial/spectral areas of row crop planted to other crops besides corn and soybeans in 2002. In general these areas were characterized by early harvest (or no crop planted), and presented a bare soil aspect in the summer image. This class may include some areas that are totally barren of vegetation.

Roads - Spatial/spectral areas that are primarily parts of major roadways or city streets. Roadway classes that occurred nearly exclusively in rural areas were generally assigned to the Ungrazed grasslands category.

Commercial/Industrial areas - Spatial/spectral areas that are largely covered with broad expanses of impervious surfaces, such as asphalt and concrete, usually in urban centers. This includes both building roofs, parking areas, and some streets or highways. May include some areas of exposed rock or sand, such as quarries or sandbars that were missed in the edit.

Residential areas - Spatial/spectral areas of mixed pixels containing both vegetation and extensive impervious surfaces, and generally occurring almost exclusively in urban areas.

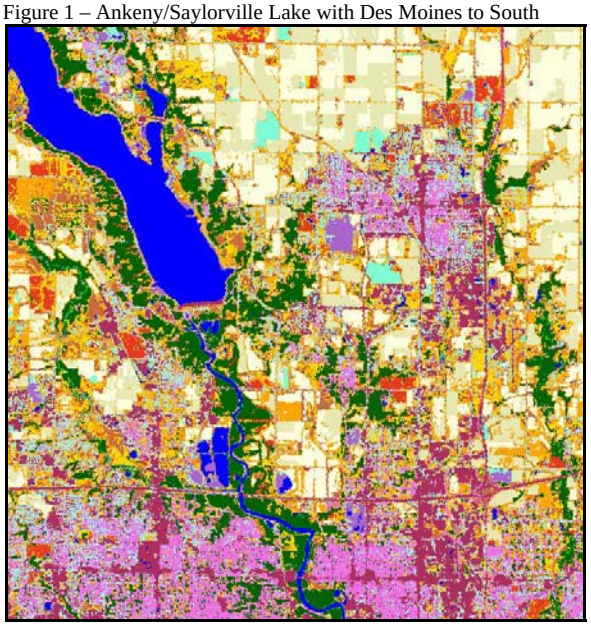
Barren (quarries, sandbars, etc) - Edited areas that are largely covered with exposed rock or sand, such as quarries or sandbars. These classes were spectrally confused with the commercial/industrial class, and were assigned to this class by a manual edit process.

Missing data (clouds, shadows, pixel dropouts) - Edited areas of missing data, usually due to the presence of cloud or shadows in the imagery. Where possible, areas where clouds or shadow were present in one of the multitemporal images, but not both, were filled in with an interpretation derived solely from the unaffected image. These pixels were assigned to this class by a combination of manual editing and automated process.

Table 1 – Percentages of Land Cover in State

Land Cover Type	Percent of State of Iowa
WATER	0.88%
WETLAND	0.51%
WETLAND FOREST	0.19%
CONIFEROUS FOREST	0.23%
DECIDUOUS FOREST	7.51%
UNGRAZED GRASSLAND	13.67%
GRAZED GRASSLAND	7.03%
CRP GRASSLAND	4.39%
ALFALFA	3.18%
CORN	32.15%
SOYBEANS	26.73%
OTHER ROWCROP	0.40%
ROADS	1.58%
COMMERCIAL	0.58%
RESIDENTIAL	0.86%
BARREN	0.09%

Figure 1 – Ankeny/Saylorville Lake with Des Moines to South



Findings of spectral analysis give a breakdown of Land Covers for the State of Iowa (Table 1). Figure 1 shows a 1:100,000 scale view of the Land Cover 2002 product.

The contact for The 2002 Land Cover product is Peter Kollasch. He can be reached via email at pkollasch@igsb.uiowa.edu , or via phone at 319-335-1578. Pete encourages anyone who will be using the data to ask questions, and is very helpful in explaining the more technical aspects of the highly technical process that went into the making of this product. Coming soon is a product Pete is working on using this data to show changes in Land Cover over time.

Where do I find the data?

This dataset can be found on our FTP site at :
ftp://ftp.igsb.uiowa.edu/gis_library/IA_State/Land_Description/Land_Cover/Land_Cover_2002/lc_2002/

Previous datasets can be found at the same site and are at the base directory of:
ftp://ftp.igsb.uiowa.edu/gis_library/IA_State/Land_Description/Land_Cover/

GROUND TRUTH DATA FOR THE YEAR 2002

The spring of 2002 was a busy time for employees of the IDNR-Iowa Geological Survey's Geographic Information Section (IGS-GIS). Prior to the spring of that year, the IGS-GIS had set up a cooperative funding agreement between various local, state, federal, and non-profit agencies to capture color-infrared (CIR) photos of the state. It was at this time that Iowans may have encountered a DNR vehicle pulled off to the side of the road with one person looking through paper printouts or an atlas while another was tapping away on a palm pilot or taking pictures of a seemingly nondescript pasture. This marked the commencement of the 2002 ground truthing campaign.

"Ground truth", simply put, is reference data that aids in the interpretation of imagery. In this case, the purpose of gathering ground truth data was to aid in the location and interpretation of specific features that would eventually be observed in the above mentioned CIR photos as well as imagery captured in 2002 by Landsat satellites. Each of these sets had been earmarked by IGS-GIS as chief components of future land cover and land use mapping projects.

Staff members began the ground truthing process by customizing a hierarchical database that could be built on a desktop computer and then imported into a palm pilot equipped with a global positioning system (GPS) receiver. The data collection software used by staff to build the database, *FieldWorker GPS*, allows users to collect the location of a feature with the GPS component, then link directly to the custom database where one would then assign a feature label and attributes to that particular location (Figure 1).

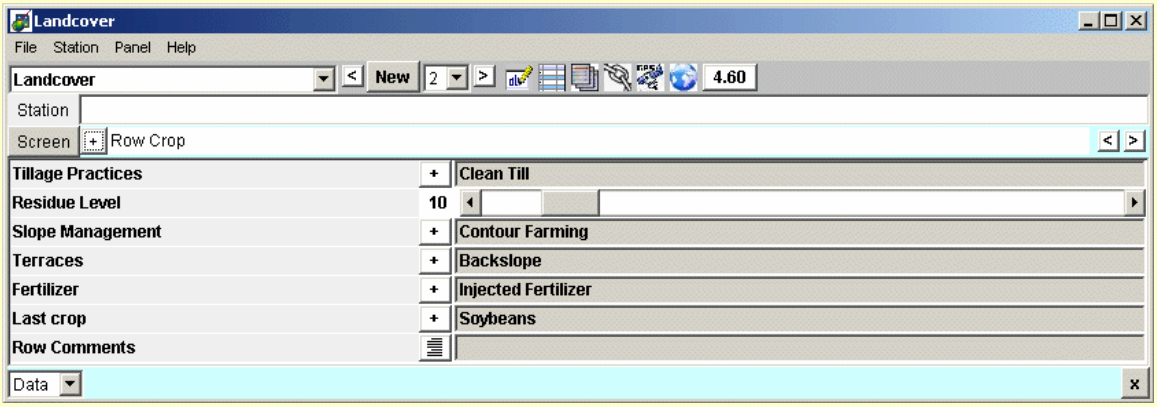


Figure 1. Example of IGS-GIS' database built using FieldWorker GPS. Here one can clearly see the relation between the land cover category "Row Crop" and the attributes measured.

During the spring ground truthing sessions, a team of two IGS-GIS staff members and/or students would select an area to investigate before departing on a ground truthing trip. Priority was given to the areas where photos had been taken during the previous week. This reasoning arises from the importance of, whenever feasible, collecting ground truth information and the imagery over a given area simultaneously. In this way, you can later correlate the ground conditions observed on the photo to the ground truthing information accurately.

Emphasis shifted away from this temporal approach once the CIR photos had been captured and towards gathering as much ground truth data over as much of the state as possible. This data collected in the summer and fall would prove valuable when used with the CIR photos, but would largely be used in projects involving Landsat imagery.

During this summer and fall ground truthing period, the ground truthing teams would typically select a county that had not yet been visited or had little ground truth coverage. If the county was known to be dominated by row crop production, the team would usually survey the county somewhat randomly, looking especially for grasslands. Grasslands were of special concern since they usually prove to be somewhat difficult to categorize in land use classifications due to varying species composition, grazing patterns, and management practices. However if the county had a rolling topography and the land use patterns were highly variable, the team would review pre-existing black and white aerial photos, satellite imagery, and land cover/land use classifications. The team would examine agricultural fields with unusual spectral signatures in the aerial and satellite images or look for troubling classification patterns from older land cover/land use maps. This gave the staff a general idea of the locations that should be investigated.

Once the team had spent the day collecting data, they would return to the office and export the collected data in the form of a text file from their palm pilot to their desktop. The data was then converted into a shapefile and displayed over image layers in order to verify the accuracy of the locational and attribute data. The data was then archived until all ground truthing points had been gathered and were ready to be merged into one file. The resulting ground truth file (Figure 2) was then used to verify that the land cover/land use classification derived from 2002 Landsat imagery was appropriate and also to identify land use practices visible in the 2002 CIR photos. In the future, the IGS-GIS hopes to use this file to create a high resolution land use classification in conjunction with the 2002 CIR photos.

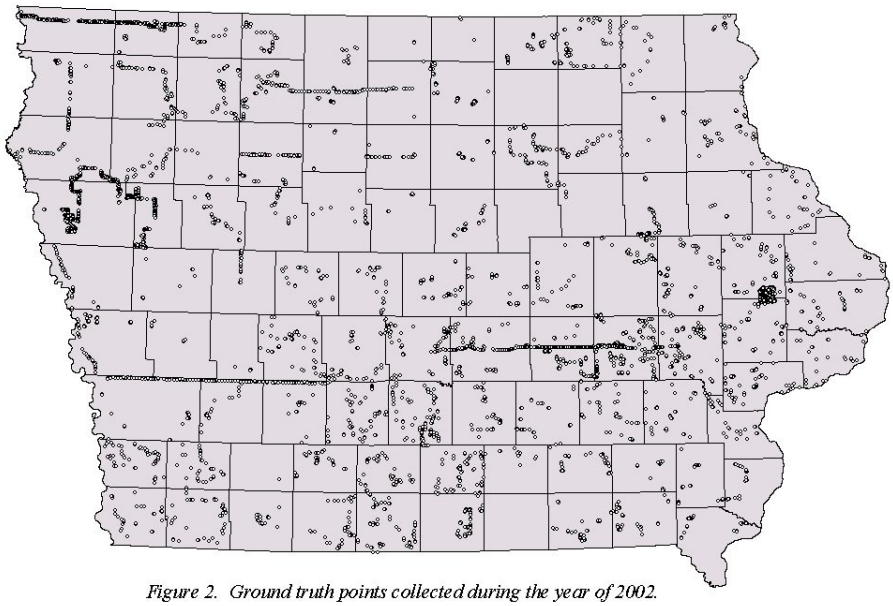


Figure 2. Ground truth points collected during the year of 2002.

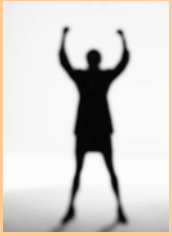
One can access a version of the **ground truth data** by using one of two methods:

- Navigate to the Natural Resources Geographic Information Systems Library at http://www.igsb.uiowa.edu/nrgislibx/ and select "Support data" under the category "Other NRGIS Data". Select the link "Ground-truth shapefile" in the "2002 Color-Infra-Red Aerial Photography Support Data" category.
- This shapefile can also be downloaded by navigating to ftp://ftp.igsb.uiowa.edu/GIS_Library/Support_Data/2002_CIR/ and selecting the file "2002_CIR_groundtruth.zip". Photos that were taken by staff at random sites and were used to assist in the photo interpretation are available in the subdirectory named "2002photo" within the same *.ftp directory. These photos are ready to be hot linked to the shapefile for those who utilize the GIS program ArcView.

If you have questions or requests regarding ground truth data, please contact Andy Asell by phone at 319-335-1578 or via e-mail at aasell@igsb.uiowa.edu or Casey Kohrt by phone at 319-335-1353 or via e-mail at ckohrt@igsb.uiowa.edu.

2002 CIR Photos can be viewed and/or downloaded at:

- The Iowa Department of Natural Resources Natural Resources Geographic Information Systems Library (IDNR-NRGISLIB), http://www.igsb.uiowa.edu/nrgislibx/. Select the link "2002 Color-Infra-Red Aerial Photography County Mosaics" found in the category "County-wide Data".
- The Iowa Geographic Image Map Server, http://ortho.gis.iastate.edu/cir/cir.html
- Iowa Department of Natural Resources Interactive Mapping-Watershed Atlas http://igsims.igsb.uiowa.edu/website/Watershed_Atlas/viewer.htm

For questions regarding the 2002 CIR project, contact Todd Bishop at 515-281-5815 or via e-mail at todd.bishop@dnr.state.ia.us.

This month's Wish List comes from The Mapster. Always working with maps and data that do not coincide, Mapster wishes for a Map-O-Matic Unit in the MapCave. Simply feed data in, add a couple keystrokes and a coherent usable map is the output. The result, as always, a happy end user!