FARMING

Geospatial Applications in

Precision Farming

with

TNTmips®
TNTedit™
TNTview®, TNTatlas®

Before Getting Started

TNTmips® provides a variety of tools to assist you with the spatial asset allocation and management tasks referred to as precision farming. An integrated system that handles both raster and vector objects is a necessity for these types of tasks. The purpose of this booklet is to acquaint you with the concepts and tools used in precision farming applications. All of the features required for a robust precision farming system are available in TNTmips, which is used to demonstrate the concepts presented.

Prerequisite Skills This booklet assumes you have completed the exercises in *Getting Started: Displaying Geospatial Data* and *Getting Started: Navigating*. Those exercises introduce essential skills and basic techniques that are not covered again here. Please consult these booklets for any review you need.

Sample Data This booklet does not use exercises with specific sample data to develop the topics presented. You can, however, use the sample data distributed with the TNT products to explore the ideas discussed on these pages. If you do not have access to a TNT products CD, you can download data from MicroImages' web site. Make a read-write copy on your hard drive of data sets you want to use so changes can be saved.

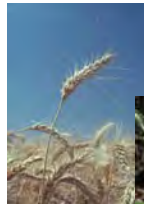
TNTmips and TNTlite® TNTmips comes in two versions: the professional version and the free TNTlite version. This booklet refers to both versions as "TNTmips." If you did not purchase the professional version (which requires a software license key), TNTmips operates in TNTlite mode, which limits the size of your project materials. All of the processes described in this booklet, with the exception of creating your own atlases for distribution on CD-ROM with TNTatlas, can be performed in TNTlite.

Merri P. Skrdla, Ph.D., 2 January 2004

It may be difficult to identify the important points in some illustrations without a color copy of this booklet. You can print or read this booklet in color from MicroImages' web site. The web site is also your source of the newest Getting Started booklets on other topics. You can download an installation guide, sample data, and the latest version of TNTlite.

http://www.microimages.com

Introducing Precision Farming




Precision farming involves the use of spatial asset allocation and management to distribute available time and money where it is most needed and will provide the best return. Data useful for precision farming may come from a variety of sources including accounting packages, spreadsheets, databases, Geographic Information Systems (GIS), calendar schedules, and a variety of web sites. A Geographic Management Information System (GMIS) allows you to pull together all the different pieces of data you generate and publish them as map-based information for all parties with an interest in a particular property.


This booklet is not intended to tell you all about precision farming. It is merely intended to introduce you to one approach to some of the tasks on the digital side of precision farming for crop production using TNTmips and acquaint you with the fundamentals of GMIS. There are other approaches that can be taken in TNTmips and in other software packages. The approach taken in this booklet is fairly simple. More complex approaches, such as using principal components to determine which of your input layers contribute the most to variability or automatic classification to divide fields into management zones, are also possible with TNTmips.


The approach described here divides the data necessary to develop a spatially based decision support system into four types: background, activity, current, and management. Background layers, such as Digital Elevation Models (DEMs) and soil maps, can often be acquired by download from the Internet. Activity layers are created over the background layers. Current layers include recent satellite images and airphotos of your land. Management layers become work orders for day to day operations.

Background Data: DOQQs

a portion of a DOQQ

Background data becomes the base layers for your spatially based decision support system. Typical background layers include Digital Ortho Quarter Quads (DOQQs), DEMs, soil maps, topographic maps (Digital Raster Graphics [DRG] quad sheet maps at 1:24000 scale), and public land survey data. You can build the base layers using inexpensive or free public data. Your base layers will come in many different data formats, but that is not a problem for TNTmips, which imports nearly 90 different raster formats and over 25 vector formats, as well as CAD, TIN, and database, including all the ones discussed here.

DOQQs (also known as DOQs or as COQs or COQQs when compressed) are rectified digital images of aerial photographs processed to remove distortion and displacement resulting from such factors as camera tilt and terrain relief. These images cover one-quarter of a standard 7.5' map quadrangle produced by the US Geological Survey (USGS) in Universal Transverse Mercator (UTM) projection with a 1-meter cell size. Uncompressed DOQQs are available from the USGS EROS DataCenter on a variety of media for a fee that includes a base charge and a per file fee. They also offer CD-ROM sets for entire counties. Your state, if in the USA, may offer these same files for sale and also offer the files in compressed format for free download.

The resolution of DOQQs is sufficient for you to clearly identify many features on your land. You can use this layer as a base over which to digitally draw your fence lines and pasture or field boundaries, which then automatically acquire georeference information from the DOQQs.

USGS EROS Data Center http://edcwww.cr.usgs.gov/dsprod/prod.html

COQQs for the state of Nebraska are available for free download from its Department of Natural Resources (DNR) web site at http://www.nrc.state.ne.us/databank/doqqs/doq.html. Check the Department of Natural Resources in your state or a similar agency in your country.

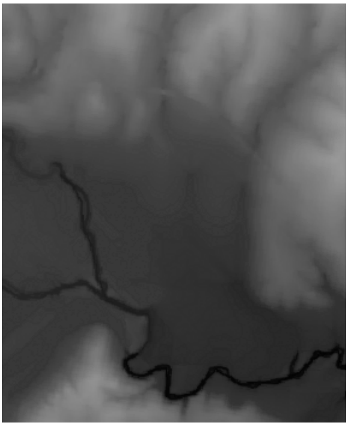
Background Data: DEMs

DEMs are sampled arrays of elevations at regularly spaced ground intervals produced in raster format by the USGS as part of the National Mapping Program. DEMs are produced at a variety of scales. The largest scale available, which is the scale most useful for your background layers, corresponds to a 7.5' map quadrangle at 1:24,000. The newer level 2 DEMs provide a much smoother surface than the original level 1 DEMs. DEMs have traditionally had a 30-meter cell size, but 10-meter DEMs are now available for some areas.

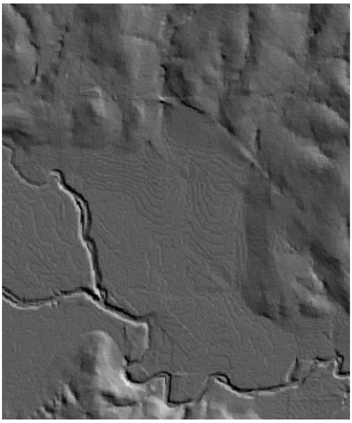
The 30-meter level 2 DEMs are available for free FTP download from the USGS Geographic Data Download page (http://edcwww.cr.usgs.gov/doc/edchome/ndcdb/ndcdb.html). You can also check your state's DNR site for the availability of 10-meter DEMs.

DEMs are useful for calculating drainage patterns and runoff areas on your land. They also let you view your DOQQs and other imagery in 3D perspective and create fly-bys. To find out more about these topics consult the *Getting Started: Modeling Watersheds and Land Surfaces, 3D Perspective Visualization,* and *Operating the 3D Simulator* booklets.

auto-normalized contrast



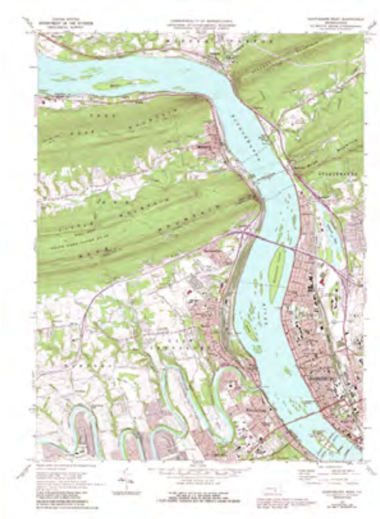
shaded relief



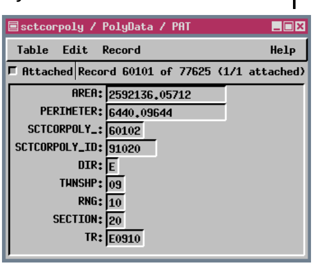
partial 3D perspective view of DOQQ over DEM

Background Data: DRGs, PLS

The Digital Raster Graphics home page (http://topomaps.usgs.gov/drg) provides information on how to order DRGs for $50 plus $1 for each DRG desired.



DRGs of Nebraska are available for free download from http://csd.unl.edu/csd-esic/index.html. Check the designated Earth Science Information Center in your state for free DRG availability.



A unique record for each polygon with the information shown above is attached to each section polygon during import.

A digital raster graphic (DRG) is a scanned image of a USGS standard series topographic map, including all map collar information. DRGs are available at 1:24,000 and 1:100,000 scales. Again, the 1:24,000 scale, or 7.5' map, is most useful for your background layers. These digital maps are in Universal Transverse Mercator (UTM) projection.

DRGs for the majority of the United States, its trusts, and territories are available from USGS, but most of California and part of Tennessee and some of its neighboring states are available only from USGS Data Partners. DRGs may be available for free download in your area. In Nebraska, they are available from the Conservation and Survey Division of the University of Nebraska–Lincoln, which is a designated USGS Earth Science Information Center. A metadata file is also available for download. This file provides such information as the map extents, the date of the paper map, the date the DRG was created, and general information about DRGs.

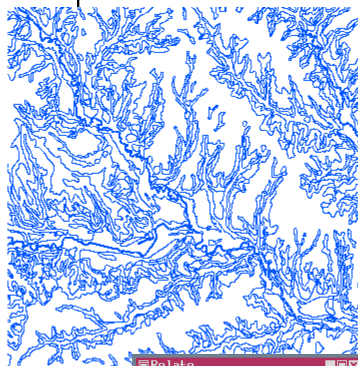
You can import DRGs into TNTmips from the GEOTIFF format in which they are distributed. If your land happens to fall over more than one map quad, TNTmips has a process that automatically trims off the collar area so you can mosaic your maps.

Public Land Survey (PLS) data (section/township/range) can also be obtained by free download to add to the completeness of your background layers. In Nebraska this download is for the entire state (77,625 polygons), so you may want to limit the extents of your import of this Arc/Info Export format (E00) file to the bounding coordinates provided by your DRG(s).

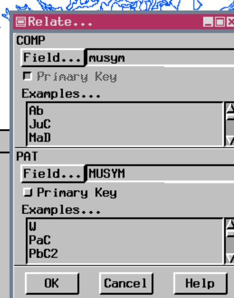
Background Data: SSURGO

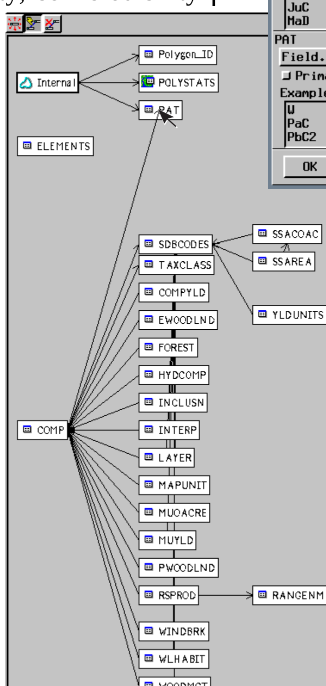
Soils information can also be useful in the decision making process. For example, when planning to spray invasive weed species, you can evaluate your potential return by the suitability of the soil for growing your intended replacement.

Obtain MUIR data from http://soils.usda.gov and SSURGO data from http://ortho.ftw.nrcs.usda.gov/muir.



SSURGO (Soil Survey Geographic Database) is the most detailed level of digital soil geographic data developed by the National Cooperative Soil Survey. SSURGO data is available for download in modified Digital Line Graph (DLG-3) optional or E00 format, which are both imported by TNTmips. Additional attributes for the soil types in an individual survey are available from the Map Unit Interpretation (MUIR) Database. MUIR data contains about 88 estimated soil physical and chemical properties, interpretations, and performance data such as available water capacity, soil erodibility factors, and yields for common crops. TNTmips has a special import for MUIR data that requires the ELEMENTS table, which provides information about all the fields in all the other tables. This table is not included with MUIR data from some download sites. The web address listed at the top of the page includes this table in its download, but be sure to click on Select All Tables and "yes" for Include header rows in tables before you click on the Process button. You can also find the state and survey area ID for the desired area at this site, which you need for the SSURGO download. After downloading the MUIR data, go back to the soils web site and choose to download SSURGO.





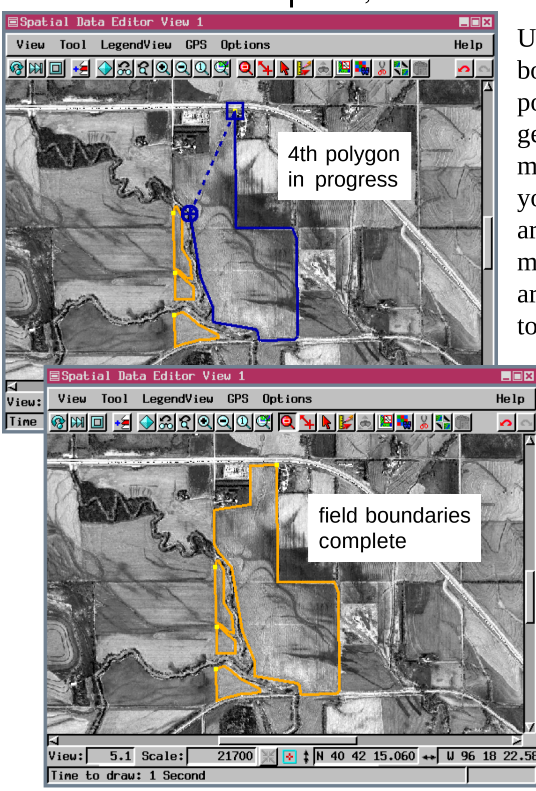
MUIR import is found with the import wizard in the Database Editor. All the connections between MUIR tables are made on import, you just need to establish the relationship between the COMP table and the attribute table from the imported vector file (from E00, the PAT table).

Activity Layers: Heads Up Digitizing

As soon as you have digitized your fences and fields over a georeferenced image and generated standard attributes, measurements of lengths and areas for selected elements can be viewed in the standard attributes table. If you want to know the total length of fences or total area of fields, simply add Sum statistics to your standard attributes table.

By this point you should have accumulated a number of background layers at little or no cost. The DOQQs are all that are really needed before you can start creating data that applies to your individual property, such as fences, field borders, building locations, and so on. It is easiest to create separate vector objects for different themes: the amount you have to learn to assign different drawing styles to the elements representing different themes, such as fences and fields, is minimized by this approach.

Heads up digitizing means you are digitizing data while looking at the computer screen rather than at a digitizing tablet. The Spatial Data Editor in TNTmips lets you create and edit raster, vector, CAD, and TIN data with your mouse or digitizer.



Ultimately, you want your field boundaries in vector format with polygonal topology so you can get accurate, non-overlapping measurements and generate your management grid. If you are covering a large area that has many fields or other areas you are interpreting, you may want to start in CAD format and convert to vector after your drawing is refined. This approach speeds creation of your object because topology does not have to be maintained as you add each line. Consult the Getting Started booklets entitled *Editing Vector Geodata* and *Editing CAD Geodata* for basic information on object creation in the Spatial Data Editor.

Activity Layers: FSA Slides

The Farm Services Administration acquires natural color, section centered slides of agricultural areas each year in mid to late July for the purpose of verifying acreages participating in various farm programs. You can obtain copies of these slides for $1 each from your local extension office and have them transferred to photo-CD. These images can then be imported by TNTmips and georeferenced from the DOQQs you have acquired.

The slides above from two consecutive years show the difference between a wet year (1999) and a dry year (2000). They also clearly show how they can be used as a reference layer to update your existing vectors; the road that curves through the upper right is under construction in 1999 and paved in 2000. Differences in field boundaries because of changing stream margins or other factors should be as apparent when your vectors are overlaid.

The resolution of your imported raster will depend on the resolution at which your slides are scanned. Scanning the slides at 1536 x 1024 pixels produces rasters with an approximate 2-meter cell size. Higher resolution scanning is available but may be such that you begin to see defects in the film, as well as creating a much larger raster file.

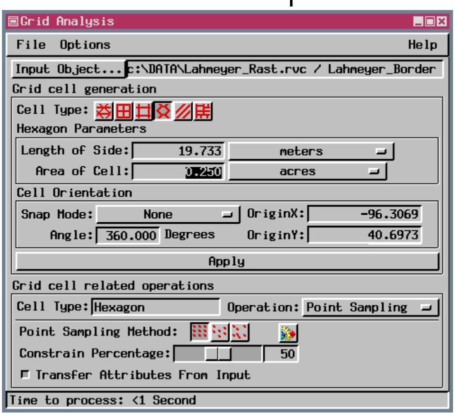
The primary benefit of acquiring FSA slides for your farm is their timeliness—the DOQQs you obtained are likely to be several years old. The FSA slides allow you to update your field boundaries and other features on a yearly basis. If you can obtain the latest FSA slides before digitizing your field boundaries and other features, you will be a step ahead in the process (unless the DOQQs for your area are quite recent).

You can also use the imported FSA slides, which are 24-bit color images after scanning, as input to one of TNTmips' classification processes. One property to look for is canopy cover. This property often correlates well with yield. If you assign class values that correspond to quantitative yield factors (the yield for class 2 is twice as high as for class 1, and so on), you can use these class values in your management formulas. Of course, a season is required to correlate the classes you define with actual yields to validate this approach.

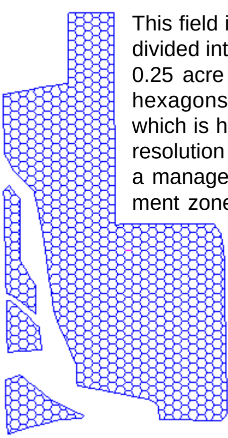
Activity Layers: Management Boundaries

A GPS unit is essential for precision farming and can be shared between your different equipment as can the palm computer you use to program application rates. The controller is likely to be equipment specific.

Precision farming involves managing different parts of each field differently. To achieve this end, you divide each field into smaller subfields, or management zones. You could approach the desired size of your management zones theoretically, but a practical approach is more reasonable. The practical approach takes into consideration the accuracy of your GPS device, the response time of your variable rate application equipment, what you can afford in terms of sampling, and even the width of your normal application equipment. The size of your management zone determines your management resolution. When you first begin precision farming, you can start at a coarse resolution. As you see results, you can increase the resolution by reducing the management zone size.



TNTmips' Polygon Grid process generates polygons representing management zones of the size you specify. There are a number of different shapes, or cell types, to choose from for your zones. Hexagons are probably best for management zones because they better represent the average values for attributes associated with an area. This process has an orientation tool so you can set the direction of the grid cells to align with a field boundary.



This field is divided into 0.25 acre hexagons, which is high resolution for a management zone.

Once your grid is generated, the same process will generate sample points within the grid. These points can be at the cell center, placed randomly, systematically unaligned, or the latter two constrained to be within a specified distance of the cell center. The point coordinates are in decimal degrees. Use these coordinates to direct your collection of soil samples, yields, and other data.

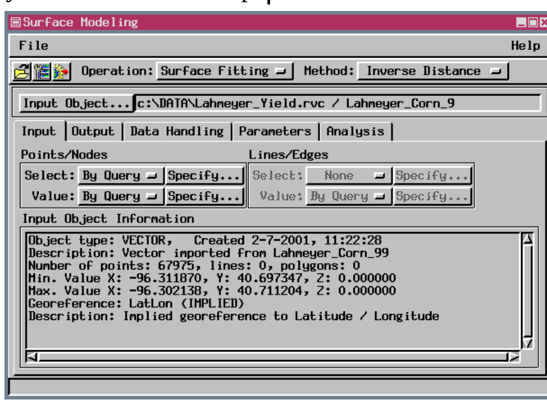
Current Layers: Surfaces

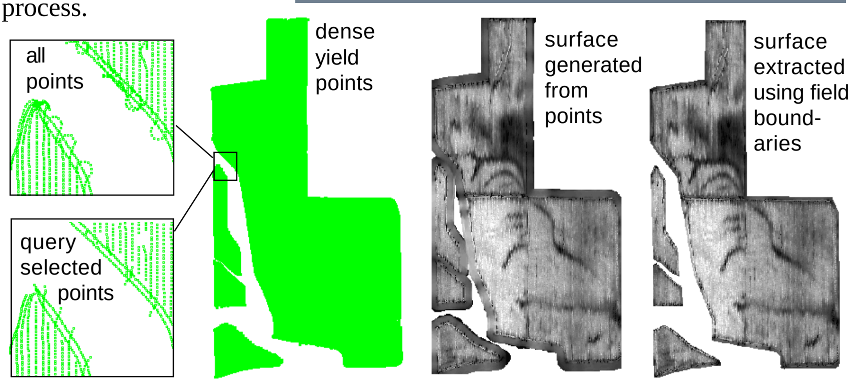
A set of point data, such as soil tests or yield, can be used to produce a surface raster that represents variations in the selected attribute value of the points. These points can be at the sample point locations determined for your grid or much denser, such as yield points collected by your combine.

TNTmips offers a number of different choices for surface fitting to point data. For dense data, such as yield points, the inverse distance method is a good choice. For sparse data sets, such as soil tests, minimum curvature or Kriging may produce better results.

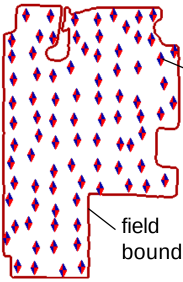
Data collected from a yield monitor, planter, or sprayer, as opposed to data collected at individually specified sample points, may need to be cleaned up prior to generating the surface. You can readily remove points where the combine header was up or there was minimal flow by using a query to select points for surface fitting. The surface created will generally extend beyond the data points and can be clipped to field boundaries using the Raster Extract process.

Using a query to select the points for surface fitting, such as *(Import.PStatus == 1) and (Import.Flow > .2)*, cleans up the yield data eliminating turn arounds and points where there is no flow through the combine. (The PStatus indicates whether the combine header is up or down and cutting. This status is one of the data values routinely reported by a yield monitor.)

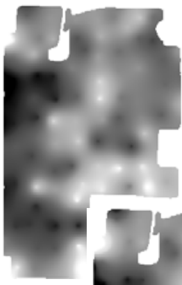


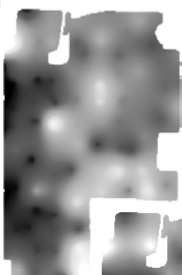


Current Layers: More Surfaces

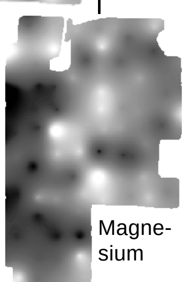


Soil test data is an example of point data that may have multiple attributes you would like to create surfaces from. Standard soil tests include measurements of pH, buffer pH, calcium, magnesium, potassium, and phosphorus. They may include organic matter and micronutrients, such as boron, copper, iron, manganese, molybdenum, and zinc. Recommendations for application of phosphorus and potassium may also be included.

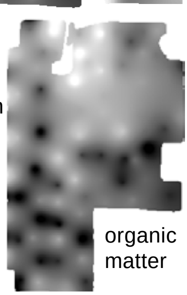

pH level


Calcium

When you have a variety of different attributes for each point, you probably want to construct a surface for each attribute. It would be quite tedious to run the surface modeling process over and over again followed by raster extraction for each result to clip it to the field boundaries. Instead, you can adapt a script already prepared in TNTmips' Spatial Manipulation Language (SML) to create surfaces for all the attributes of interest from the points in a selected vector object and to trim them all using a selected boundary vector. You just run the script once and all your surfaces are created.


Magnesium


Potassium


organic matter

As with many sample SML scripts, it is unlikely that the script will work with your data without some modification. The table and field names are stated explicitly in the script so if your table and/or field names are not the same or you do not have all the fields specified for generating surfaces, you will need to modify the script. You may also want to change the search distance or the tension value in this Minimum Curvature surface fitting script.

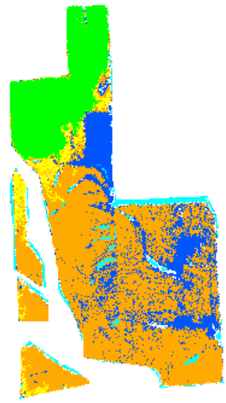
Once you have a series of related surfaces, you can use them to generate raster expression regions to answer questions such as where pH is low and calcium levels are high. Because you are creating a region, you can immediately see how many acres fulfill the expression you've written (see the later discussion on Raster Expression Regions).

Current Layers: Classification

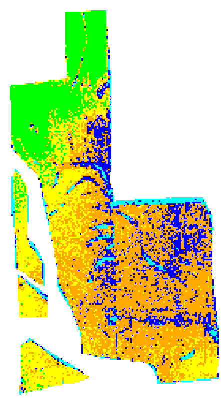
Classification has a different focus in terms of precision farming than it does in general. Classification in general has the goal of identifying different types of ground cover. You do not need to classify imagery of the area you farm to determine what is planted where; you already know what you planted. For precision farming you look at areas with relatively uniform ground cover, such as corn or soybeans, and classify the imagery to provide a relative canopy cover rating. This rating can become part of your management formulas.

TNTmips provides two separate classification processes: Automatic Classification and Feature Mapping. Feature Mapping is an interactive process that works on composite color or multiband data and is suitable for lower quality data, such as air video. Automatic classification requires multiband data of fairly high quality. If you have only a composite color image, you can separate the image into its red, green, and blue components using TNTmips' color conversion process. TNTmips offers a number of unsupervised and supervised automatic classification methods. Unsupervised classification is appropriate for determining relative canopy cover for a single crop type. The ISODATA classification method is well suited for precision farming; it is similar to K Means but incorporates procedures for splitting, combining, and discarding trial classes in order to obtain an optimal set of output classes.

The results of classification using Feature Mapping and ISODATA classification with an equal number of classes defined are shown at the right. The class distribution is fairly similar, although you can see that human guidance in this case results in larger uniform patches than found by purely automatic classification.



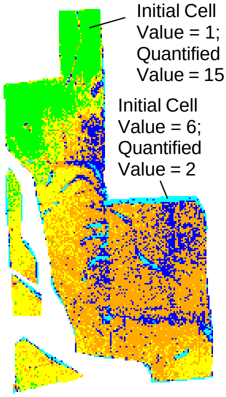
Feature Mapping result

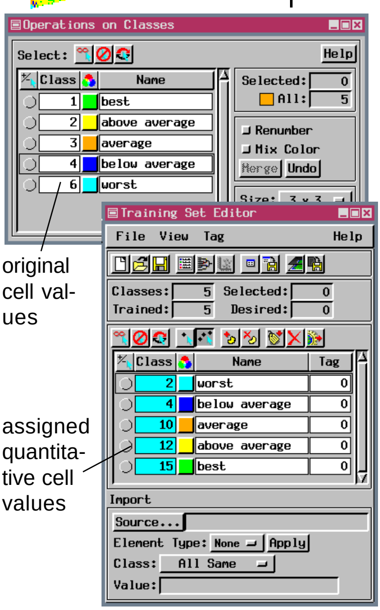


ISODATA classification result

Current Layers: Quantify Class Rasters

The cell values shown are the result of the ISODATA classification processes. The cells with a value of 1 actually have the densest canopy while those with a value of 6 have the least dense canopy. These cells were assigned values of 15 and 2, respectively, in the training set editor.



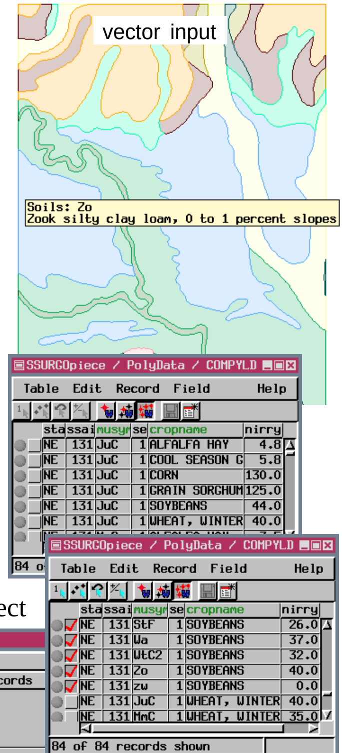


Both Feature Mapping and Automatic Classification produce rasters with arbitrary cell values. To use these classes in a meaningful way in management formulas, the cell values must be quantitative, which means that a cell value of 2 is equivalent to twice the canopy cover as a cell value of 1 and a value of 10 represents five times the canopy cover as 2. In order to make the transition from arbitrary values to quantitative values, you need to use the Training Set Editor, which is part of the automatic classification process.

In general, the Training Set Editor is designed so that you can identify areas known to contain a particular type of ground cover or surface material. One or more training areas are identified for each feature class to be defined. This information can then be used in the supervised classification processes to identify areas with statistical properties similar to the training areas.

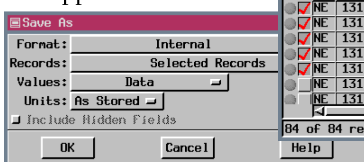
The Training Set Editor can also be used to make classification raster cell values quantitative. You simply select the class raster saved in either Feature Mapping or Automatic Classification as the training set raster and change the cell value for each class from its original arbitrary number to the desired quantitative value, which is entered as the “tag” value. When you apply the tag values and save the training set raster, you will have a raster with the appropriate cell values for use in your management formulas. The magnitude of the values is relatively unimportant—you can use a scaling factor in your management formulas to adjust the values. The relative value is what is important; a value of 10 should represent twice the canopy cover as a value of 5.

Current Layers: Productivity Potential

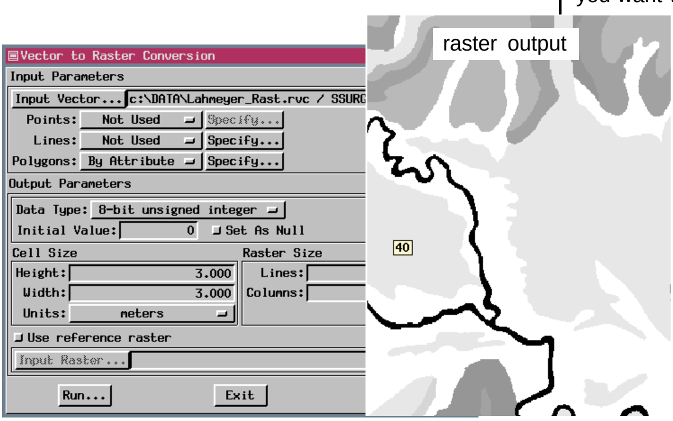


You may also want to have your management formulas take into account the productivity potential for a particular crop of the soil types on the fields you farm. Vector soil maps often have an associated productivity potential table with numeric values. You can use Vector to Raster Conversion to create a productivity potential raster for the desired crop.

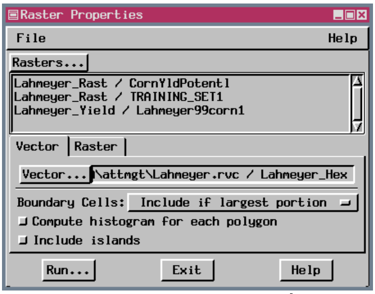
If your soil polygons have productivity for different crops separated into different tables, you can choose to set the value by attribute and select the desired Table.Field (for example, COMPYLD.NIRRG). If, however, each polygon has multiple records attached, as SSURGO data does, some manipulation is required to get the desired values in the output raster. One approach is to write a query that loops through all the attached records until finding the record for the desired crop type. Another approach is to select only the records for the desired crop type (first sort on the crop type field) then to create a new table with only these records attached to the polygons. You can then use this table to specify the desired Table.Field.



Rather than constructing a complicated query to pull out the values you want when multiple records are attached, create a new table that only has the single record of interest for each polygon attached. You then use that table and the desired field for conversion. All of these steps can be done in the conversion process.



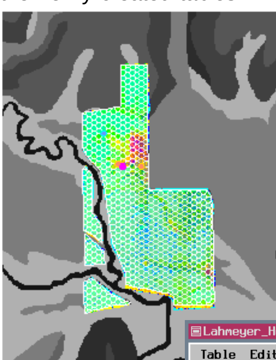
Management Layers: Pull It All Together



Management layers are derived by combining the background, activity, and current layers you have collected and generated. You can also integrate university research, industry trends, and personal experience when you derive management formulas.

Your management boundaries (grid vector) need to be combined with the other data you have collected to be useful for making decisions. The Raster Properties process handles this task. The process creates one or two tables for each input raster (the table that contains a histogram for each polygon is optional and not really useful for management formulas). The statistics table has one record for each polygon that contains the minimum and maximum values of the raster that fall within the polygon and the mean, mode, median, and standard deviation of raster values, the cell count for the polygon, and a normalization factor. The cell count for a polygon will differ from table to table unless your input rasters have the same cell size.

All selected rasters and the vector to which the properties are transferred are displayed in the process. You can view the results without exiting the process by using the Layer Controls to open the newly created tables.



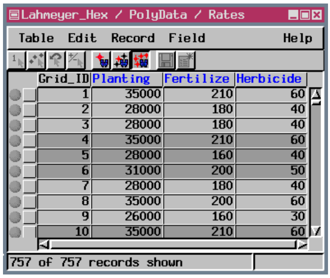
There are a number of choices for how to count cells that fall along the polygon boundary. A good choice for this application is *Include if largest portion*. This option includes a cell in a polygon's statistics if more than 50% of the cell is within the polygon.

Two tables generated by Raster Properties are shown for the same selected polygon.

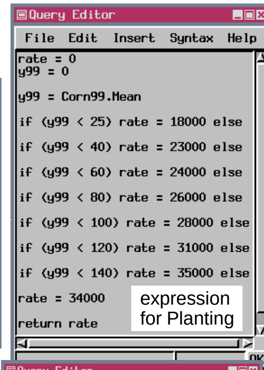
The NormalizeFactor field is calculated by dividing the global mean for the polygons (the means of all the means) by the value for that polygon. It is useful for comparing data for different years with different crops in the same field. If the normalize factor is consistently low from year to year, the grid cell has a consistently high yield whether it is corn (at 200 bushels an acre) or soybeans (at 50 bushels an acre).

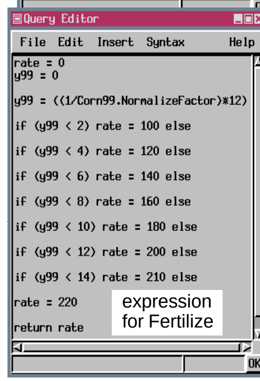
Mgt. Formulas Using Computed Fields

Now that you have raster properties associated with your grid polygons, you can derive your management formulas and visualize the results. A grid enumeration table was generated along with your vector grid. This table is a good place to add the computed fields that contain your management formulas unless polygon grid numbers are not uniquely assigned. If not unique, you should create a new table that has an implied one-to-one attachment type with the first computed field taking its value from the Polygon_ID table.



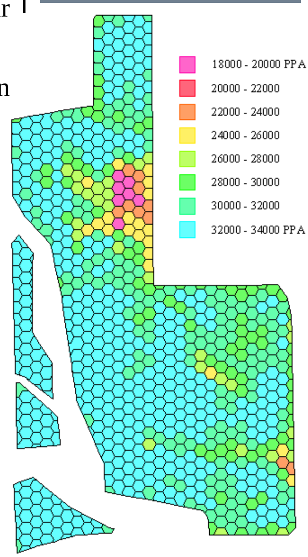
Grid_ID	Planting	Fertilize	Herbicide
1	35000	210	60
2	28000	180	40
3	28000	180	40
4	35000	210	60
5	28000	160	40
6	31000	200	50
7	28000	180	40
8	35000	200	60
9	26000	160	30
10	35000	210	60





Computed fields let you easily vary your management formulas and immediately visualize how changes you make affect the intended action, such as planting, fertilizer, and herbicide rates. Add a computed field for each action you want to model. If application rates are theme mapped, you get immediate feedback when you redraw after changing your management formulas.

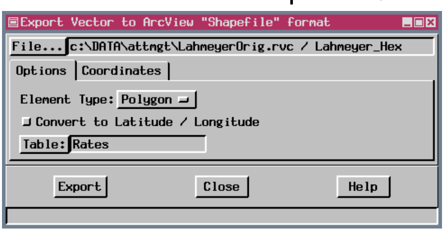
With each new year or set of data collected, you can add more raster properties tables. You can then readily update your management formulas to include this new data if they are kept together in a single table, as shown above.



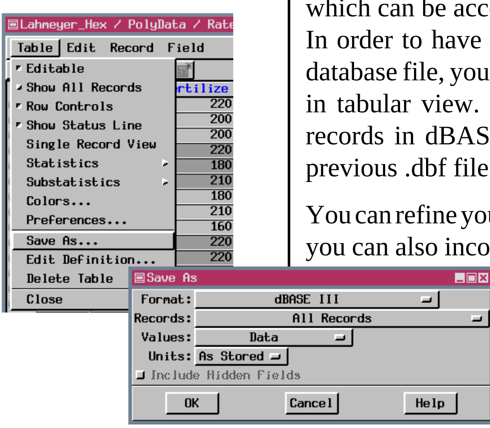
The expressions for two of the computed fields in this application rates table are shown above. Note that one of the expressions makes use of the mean from the rasters properties generated from the yield surface and the other uses the normalize factor. These expressions are fairly simple, each taking only one factor into account. You can include as many factors as you want in your management formulas.

Management Layers: Action Maps

The maps created from your management formulas, such as the theme map at the bottom of the preceding page, are your action maps. If exported to ArcView Shapefile format, these maps can be used directly to control your planting or herbicide / fertilizer application rates in conjunction with Farm Site Mate and variable rate equipment. Farm Site Mate utilizes a palm or handheld computer along with a GPS receiver for precise application of products with most variable rate controllers.



You get four files when you export to Shapefile format, all with the same name but a different extension (.dbf, .prj, .shp, and .shx). You can continue to refine and adjust your management formulas in TNTmips. When you decide you want to update your planting or application rates using your new formula results, you do not need to create a new Shapefile, you simply need to replace the database (.dbf) file, which can be accomplished in the display process. In order to have the Save As choice to create the database file, you must have the relevant table open in tabular view. You then elect to save all data records in dBASE III format and overwrite your previous .dbf file.



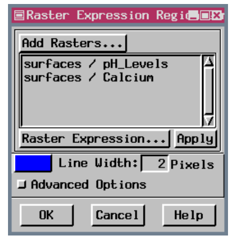
You can refine your model with the original data, but you can also incorporate new data as it is received. When you get yield data for a new year or soil samples you didn't have previously, incorporate this new information. Just use Raster Properties to transfer the new information to your vector grid then edit your computed fields to include the new data in your management formulas. You can also try different management resolutions using the same management formulas.

Mgt. Layers: Raster Expression Regions

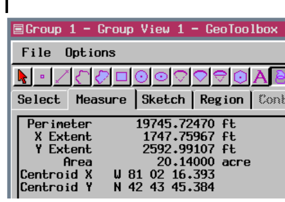
Management analysis is not restricted to your vector grid with associated raster properties. Raster expression regions let you identify areas that meet specified criteria in one or more rasters. You can readily identify areas that satisfy a different query for each raster of interest in a single step. The query can be set up so that the area identified satisfies the expression for all layers, for any one of the layers, or somewhere in between. The query shown on this page identifies areas where the calcium levels are greater than 1,000 parts per million and the pH is less than 7.

To create a raster expression region, click on the Create Region icon for one of the raster layers you want included in the expression, then click on the Add Rasters button and select the other rasters. Rasters must be listed in the Raster Expression Region Generation window in order to be valid in the expression. Rasters are included in the expression by name, which can be inserted in the expression by typing or using Insert / Symbol and choosing raster as the type to list the names of all rasters you selected for use in the expression (see illustration at right). You then use operators, such as >, <=, and ==, to designate the cell values of interest. Enclose the part of the expression that applies to each raster in parentheses and link them with an and or an or. You can also directly compare raster values (for example, Magnesium > Manganese).

Once you have generated a raster expression region, or any other region type, you can open the GeoToolbox and immediately see the area and perimeter of the region, along with other information. If you have created multiple regions, the information will be for the last region created. You can change the region for which measurements are shown by clicking on the Region tab and selecting the desired region from the list. Default region names are the same as the object they are created from.



Query:
(Calcium > 1000) and
(pH_Levels < 7)



Organize Data into Atlases

Otoe County Farms atlas

Adobe Acrobat Search

COOP web site

Iowa State University
weed science page

Nebraska Statewide atlas

When you organize your data into an atlas using the HyperIndex Linker tool in TNTmips, you create point and click access to all your geodata and can include links to external information, such as weather, markets, genetics, and so on. The data also becomes "portable" when burned to CD-ROM along with TNTatlas, which means the atlas can be viewed on any computer—TNTmips need not be installed and there is no license key required.

When you create an atlas in TNTmips, you can choose to bring up a graphic with Install, Browse, and Exit options when the CD is inserted. This information is stored in an autorun.inf file. You can also create this file yourself in a text editor and specify that some other program, such as Adobe Acrobat Reader, run and open a specified file.

This atlas opens when you click on the Farms button

The upper illustration on this page is of an atlas that uses a graphic front end with a number of hyperlinked buttons that let you install TNTatlas if you haven't before, launch the atlas provided on the CD, connect to a variety of related web sites, and use the Acrobat search capabilities for the PDF documents linked to the atlas.

There are a number of Getting Started booklets (soon to be six) that describe construction, design, and use of atlases.

The home page of this atlas also has a number of link buttons. In fact, the link to the more detailed farm layout is from one of these buttons, not from the area of Otoe County where the farms are found, which enables you to find the information without knowing its actual location. The links from the geodata on the home page are for weather (by ZIP code) and soil information (by soil type where you click).

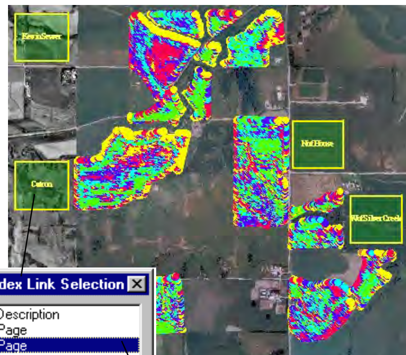
Provide Access to All Materials

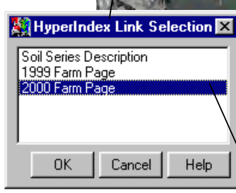
Use your atlas to organize all the data for the areas you farm. Create an Acrobat document for each farming unit and add all the cost related information you have to it, such as seed and spraying costs. This material can simply be scanned invoices. At the end of the season, add your yield data as the first page. Create a similar file for each crop year and add it to your atlas. Creating links to all materials for a new crop year takes little time if you create a directory structure for each year with all files and directories named as they were in the previous year. To create the computed field to use for links by attribute (links that vary according to the attributes of the selected polygon), you need only copy the expression from the previous year and change the date to have the full set of linked polygons.

Links by attribute can also be used to dynamically link to a variety of web sites, such as local weather (from ZIP code polygons), soil details (from soil type polygons), and markets, genetics, and university research (from field boundaries and crop type),

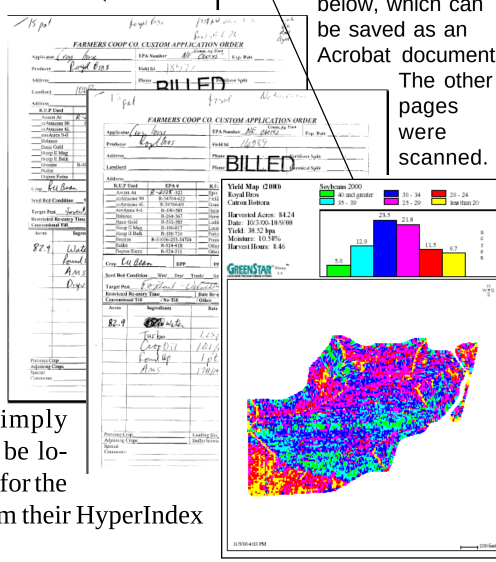
You can either use existing polygons, such as field boundaries, or create new polygons that don't cover your yield points, as shown here, to link to the Acrobat documents. As long as the document contains one page with searchable text (not simply scanned), these documents can be located from the front-end graphic for the atlas by searching, as well as from their HyperIndex links.

The report shown below is for a different crop year than displayed in the atlas.





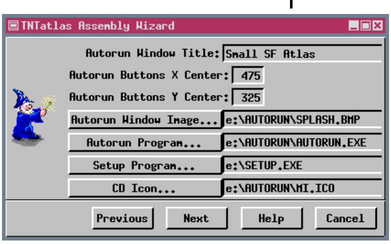
JDmap™ uses the proprietary data from your yield monitor card to create the color page below, which can be saved as an Acrobat document. The other pages were scanned.



Publish Your Atlas

Once you have created an atlas, you can publish it on CD-ROM. It is then easy to distribute among the people you want to have access to the same information, such as landlords, bankers, and crop consultants. You can print and apply CD labels for a more professional looking product if desired. You can readily update atlases for people with whom you share information—just send them a new CD.

If your atlas has an Acrobat front-end as described on the previous pages, people who use your CD will have to have TNTatlas already installed to use the button that takes them to your atlas. If the front-end for your atlas is also the atlas home page, you have the option to have the TNTatlas installer open automatically when the CD is inserted or to have the atlas open automatically in TNTatlas for Windows. If you choose the installer route, the CD recipient installs TNTatlas then launches it from their drive and opens the .atl file on the CD. If you have the atlas open automatically in TNTatlas for Windows, the program runs from the CD.



The choices on this panel of the TNTatlas Assembly Wizard apply only if you want the CD to automatically run the installer when inserted.

The TNTatlas Assembly Wizard is designed to collect all the data for your atlas into a single directory and to package TNTatlas for installation if desired. You can use the wizard to assemble your data whether or not you want insertion of the CD to launch the installer. Simply leave blank the panel shown at the left if you do not want the installer to launch automatically. You will need to create your own .inf file if you want either Acrobat or TNTatlas for Windows to run automatically.

If your atlas is of interest to a wider audience, you may want to consider publishing it on the Internet. Internet publishing requires an additional product, TNTserver™, to serve up the atlas to those that want to view it.

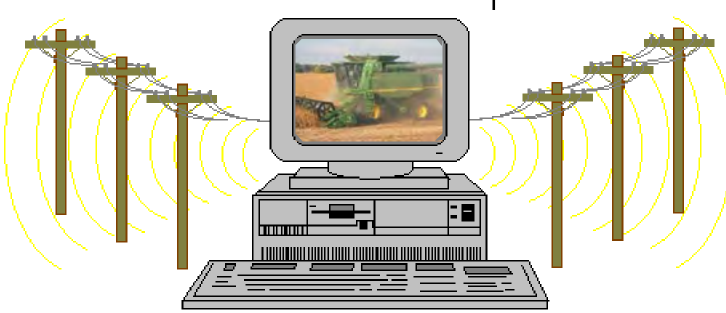
Crop Production Networks

A Crop Production Network is an information based COOP that uses TNTserver to make that information available to all members over the Internet. A Crop Production Network allows groups to pool their resources, such as data management tools, agronomic expertise, background data layers, and wide area imagery. Crop production modeling is easier when pooled over a larger area and, thus, benefits from use by a Crop Production Network.

An atlas can be available for viewing to anyone who visits your web site, or it can be set up to require a password for access. Atlas viewing over the web uses one of the TNTclients: the HTML based client or one of the two Java based clients. One of the Java clients is downloaded every time you choose to view an atlas and the other is downloaded once and installed (Windows only). Use of TNTclient is free.

Your crop pedigree can be maintained and accessed online. You can even provide direct links to web sites for each seed variety. Information can be shared with food processors with trait and crop progress information available as part of your atlas. A crop's production history can be an important selling tool and is readily available for viewing by all interested parties.

Use your atlas for crop identity preservation. You can even link by attribute to the appropriate seed web site.



Advanced Software for Geospatial Analysis

FARMING

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TNTmips TNTmips is a professional system for fully integrated GIS, image analysis, CAD, TIN, desktop cartography, and geospatial database management.

TNTedit TNTedit provides interactive tools to create, georeference, and edit vector, image, CAD, TIN, and relational database project materials in a wide variety of formats.

TNTview TNTview has the same powerful display features as TNTmips and is perfect for those who do not need the technical processing and preparation features of TNTmips.

TNTatlas TNTatlas lets you publish and distribute your spatial project materials on CD-ROM at low cost. TNTatlas CDs can be used on any popular computing platform.

TNTserver TNTserver lets you publish TNTatlases on the Internet or on your intranet. Navigate through geodata atlases with your web browser and the TNTclient Java applet.

TNTlite TNTlite is a free version of TNTmips for students and professionals with small projects. You can download TNTlite from MicroImages' web site, or you can order TNTlite on CD-ROM.

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