

Creating Good Management Zones

How to Capitalize On Flexible Data Integration



By Kevin Royal

Precision farming is all about managing different parts of each field differently. Instead of managing each field with one practice or rate, you divide each field into smaller sub fields, or zones of management. You manage each zone as a separate field. Each zone has unique characteristics assigned to it based on several factors you collect. Past yield, soil test, and drainage data are just a few of the factors you may consider when making a plan for each management zone. The challenge is managing these collected information layers in a way that can be used to generate application maps for the next input or management practice planned.

Developing management zones is a popular method of using historical data of a field to project and drive the needs of fertilizer, seed populations, and chemical rates. Many farmers use the previous year's yield map as a guide for locating these different productivity zones within a field. Some normalize several years of yield information to generate these zones. While this is a good method of using past productivity to manage each zone, it is based on only one variable. What if you want to combine several different variables? Would you need different variables for a weed control or herbicide rate map compared to a fertilizer application map? Would remotely sensed imagery be useful for generating an organic matter and weed

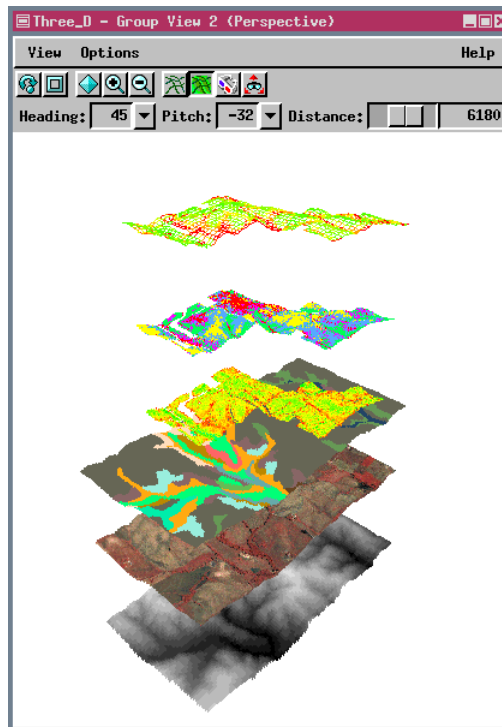
control map? How about combining the variables of remotely sensed organic matter with a grid soil sampled pH level map and weed boundary layer when developing a herbicide application map?

Creating good management zones seems to require some very flexible and advanced GIS capabilities. First of all, you need to be able to combine all collected layers in unique ways. Secondly, you need to be able to generate unique, identifiable, and flexible management zones. Third, you must be able to quickly change the formula controlling the combinations of the different input layers.

There is very little advice out there right now. You must be able to change the influence or weight of all of your hard won field data layers as your individual experience grows. Maybe you see a compel-

ling study that emphasizes past yields over one soil factor you felt was important. You want to be able to change the management formula quickly to evaluate the zone changes geographically within your fields. Finally, you will want the flexibility to export this management layer to either a raster or vector format that is able to drive the variable rate applicator of your choice. You must be able to create these driver maps for fertilizer, seed, herbicide, and insecticide applicators by combining all of your collected layers in unique, easily modified ways.

Field studies using TNT-mips, a full-featured image processing and GIS package from MicroImages, Inc., Lincoln, Nebraska, demonstrate the ad-



Elevations, color IR, soil yield ratings, yield maps, and image classifications can all be used to generate productivity ratings or other application type maps for variable rate applications.

vantages of the flexibility to combine all collected layers in order to generate the relative productivity potential for each management zone. By combining these collected layers of field information into vector or raster application maps, a targeted field profile can result that contains more complete information for driving variable rate application equipment.

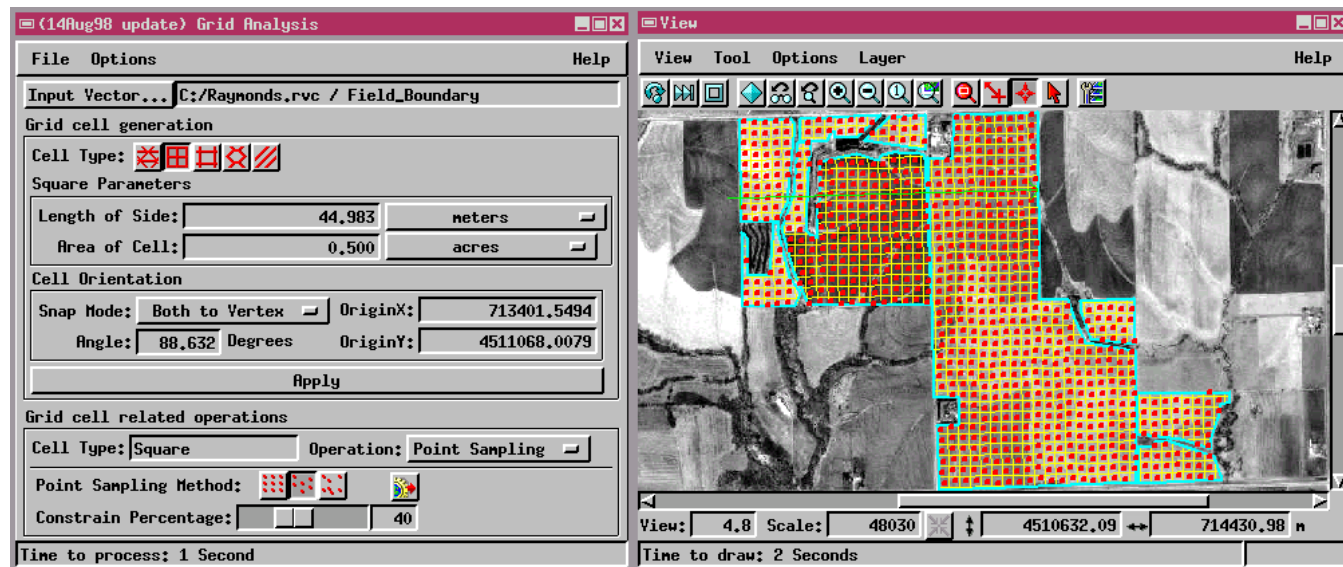
The first step is to generate all of the layers that will influence the management zones you build for your fields. Many people begin this step by collecting yield information that has been contoured or surface fitted into raster form. You probably want the surface raster raw data values to be equal to the yield at each point so you can examine individual sub areas of the field directly. Soil testing on a grid basis or other similar point data can also be contoured to generate the inventory layers showing “what is where and in what amounts” throughout the fields.

Another group of layers you will want to incorporate are any remote sensing images you can collect. Using air photo or satellite images, biomass and organic content rasters can be easily generated, as well as weed and insect pressure raster data. These are important variables that can be easily incorporated into your management formulas.

One thing to consider when getting the input layers lined up is the range of raw data values that the collected data will generate in the contour rasters. You may want to scale each contour raster so that the highest value of the organic matter raster is roughly equal to the highest value of the yield raster. This will make changing the proportion or weight of each layer in the management formula easier.

The second step is to generate some type of management zone or boundary. You can use any type of vector polygon you like. Soil types, direct photo interpretation, or past yield zones can be used for these boundaries. In this article, I will concentrate on a grid management system. Choose a boundary polygon that represents the border of the fields you want to manage. Once the boundary is loaded, TNTmips lets you use an Orientation tool to set the direction and enumeration (unique identifying number) of the grid cells. Enter the grid size you want to generate by entering the area enclosed or length of sides. This is the “Management Resolution” or smallest area you want to manage as a separate unit. Using a multiple of the width of your normal application equipment seems sensible, unless you can control the rate of each individual nozzle or planter box. Save the vector once you like the preview grid on your screen.

You can also generate sample points within each grid while in this process. Set an allowed variation



Use the Orientation tool to orient the management zones to match your fields. Choosing a management resolution you can economically deal with is an important consideration and is independent of the raster layer input resolution. Sample points can also be generated for guiding you back to new sample (soil test, etc.) locations within any zone.



from the center of each grid cell as a percentage of the overall grid area. These can become navigation points for you to collect additional data within each grid management zone.

To get the properties of the collected rasters to the management grid vectors, load all of the raster layers you want to use in your formula to compute the management zones along with the grid vector that forms the boundaries of the management zones. With TNTmips, this is accomplished using the Raster Properties process. The process will generate a separate database table from each input raster layer within each grid that contain the Max, Min, Mean, Mode, Median, Standard Deviation, Cell Count, and a Normalize Factor of the raster for all cells encountered within each grid polygon or management zone.

You can also transfer any other point data you have collected to the management grid. If you have a well, rock, or any other feature marked with a GPS location, that feature can be transferred to the management grid using the Transfer Attributes process.

With the variables from several collected layers attached to the management zones as database records, you can load the grid into the Display program and begin to put together formulas based on several variables. You can combine the variables collected from any input raster in any way you want. The resulting numbers in the computed field change

any time the input raster values in the attached tables change or the expression (formula) changes. You can enter any formula you like, multiplying, adding, dividing, or applying any formulas you find useful for generating a good management zone.

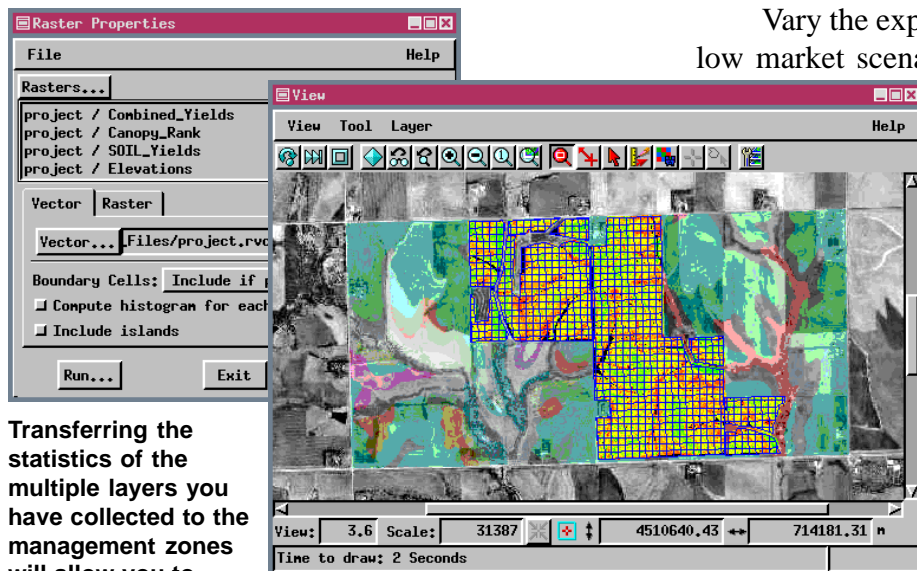
Depending on the type of management zone you want to generate, it's possible to create several computed fields with different combinations of collected layers. This is useful when using different layers to compute a fertilizer variable rate layer compared to a herbicide rate layer. Archive several years worth of attached databases to compare the changes from year to year in the management zones to see if the variable rate applications you have made are having any effect on the fertility, weed pressure, or yield of the managed zones.

With the development of accounting zones, variable rates of seed, fertilizer, and chemicals can be recorded as point data, much like yield information. Using the Surface Modeling and Raster Properties processes, you can surface fit the collected point application rates and transfer the mean application rates per management zone to the polygons that form the zones. Then use the Computed field function to arrive at your expected net income per zone.

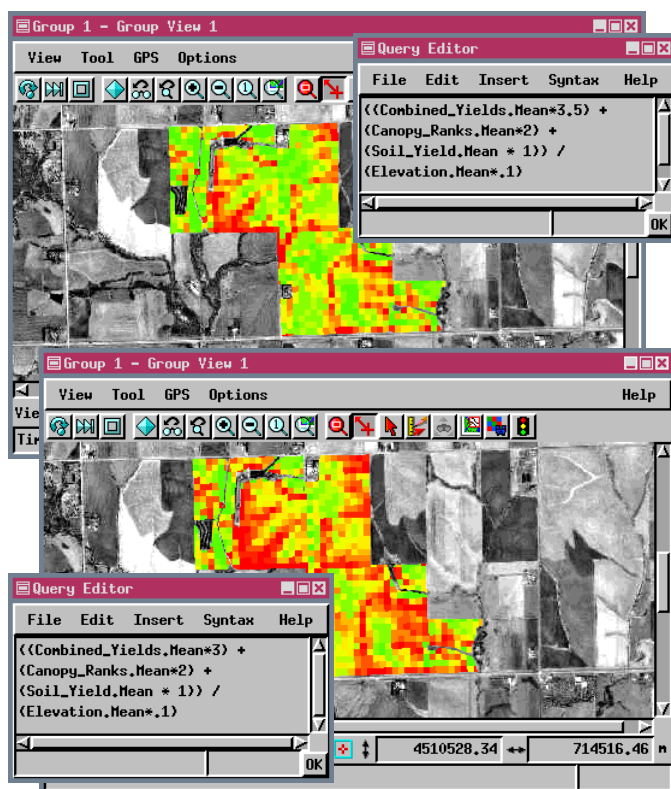
Vary the expected price for high, medium, and low market scenarios. Once quality monitors are

available, this attribute can be surface fitted (contoured) just like any other database field attached to the yield points. Use this quality data as a factor in the net income computed field to influence the value of all production from each management zone. You can set various premiums for the mean protein content of each zone, just as you would with the expected price of non-premium graded crops.

The Display process has several ways of Theme Mapping the computed fields. As you change the formulas or expression that governs the values in the



Transferring the statistics of the multiple layers you have collected to the management zones will allow you to more easily work with several layers as variables when you work up your management formulas. The zones can be any shape, and may be generated from soil maps, photointerpretation, or past yield information.



The values in multiple database tables attached to the management zones are combined by a readily editable script to generate productivity values, which are shown theme mapped into 10 productivity levels. One of the factors used to determine productivity is the previous yield for each zone (Yields.Mean). The effect of changing the weighting of Yields.Mean from 3.5 (upper) to 3 is shown. The altered appearance of the theme map demonstrates the dynamic linking of the calculated productivity and the displayed management map.

computed fields, the colored theme mapped management grids change. This theme is dynamically linked to the expression, so you can get instant visual feedback of the new management zones that result from

your newly entered formula.

Once you have adjusted the computed expression for each management database field, you can make that field permanent to lock in the current values. You can export the management zones to a format understood by a variable rate applicator or planter controller. Some controller software requires CAD like format files such as AutoCad Exchange (DXF) format or possibly the Digital Line Graphic (DLG) formats. The TNTmips export process can also generate MapInfo or Arc-Shape files as well as many raster formats. These formats can be directly exported to with the computed management field as an attached database table or raster cell value. When the controller software senses that the applicator is within one of the grids, it looks at the attached database or cell value and adjusts the application rate according to the data record attached there.

The ability to generate georeferenced application maps in many different formats to drive variable application fertilizer, herbicide, and planting equipment based on the results of the integrated management zone maps is important. All of the layers that you have collected from past yields, soil and plant tissue tests, and remote imaging can be used as variables in the formation of field management maps. To take advantage of the different types of layers requires a tight integration of raster and vector data types and a flexible formula editor to vary the weights of the input layer variables in your application formula. You must be ready to let the researchers and universities sort it out while you are ready to quickly react to findings that make sense for your own farm. Don't underestimate the information management needs of Agriculture, modern crop production requires advanced spatial data analysis software.

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