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LAND INFORMATION *Bulletin*

from the National Consortium for Rural Geospatial InnovationS
Great Lakes, University of Wisconsin-Madison

On Solid Ground

Multipurpose Land Information System Ushers In New Era of Land Conservation

This bulletin traces the evolution of the multipurpose land information system (MPLIS) and how it has streamlined land conservation programs in Wisconsin's Dane County Land Conservation Department. Dane County has also played a unique role in the development of MPLIS for applications far beyond county lines. We discuss the county's role in the national CONSOIL (Conservation of Natural Resources through Sharing of Information Layers) project and other related RGIS (National Consortium for Rural Geospatial Innovations—formerly, the National Center for Resource Innovations) projects that helped evolve MPLIS development and use for mutually beneficial goals in local, state and federal arenas.

Land is not a replaceable commodity. And therein lies the purpose of land-use planning and management efforts—to conserve this limited resource that sustains our lives. Dane County's Land Conservation Department (LCD) field office, which includes staff from the USDA Natural Resources Conservation Service (NRCS), helps the county manage the often-conflicting issues surrounding agriculture, economic development and land conservation. The office provides conservation assistance and natural resource data to landowners, policy-makers and units of government in Dane County.

New Era in Data Management

Dane County's Land Conservation Department (LCD) has been a leader in conservation planning and resource protection in the face of a rapidly growing economy. Its responsibilities include:

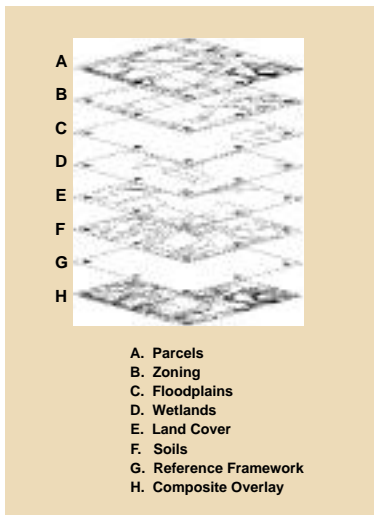
- Developing conservation plans for individual farmers
- Maintaining database of participants in various soil and water conservation programs
- Coordinating conservation efforts in county-wide watershed programs and practices
- Monitoring compliance of landowners enrolled in Wisconsin Farmland Preservation Program
- Reviewing construction site erosion plans
- Identifying significant sources of nonpoint source pollution in priority watersheds
- Providing conservation, soil, and related data to individuals and public and private agencies

All LCD activities rely on data—massive amounts of data. Compiling, coordinating and tailoring such a quantity of land-related data takes commitment, time and money. More than 20 years ago, the LCD, in conjunction with University of Wisconsin-Madison, began exploring LIS/GIS technology to manage and coordinate a growing mountain of land-based data.



**Dane County's Fen Oak Resource Center,
home of the Land Conservation Department**

Figure 1. Thematic layers in a multipurpose land information system



Years of exploring and refining have yielded today’s **multipurpose land information system (MPLIS)**. Think of it as a digital landscape library, arranged in themes such as soils, wetlands, topography and zoning (Figure 1). The themes can be combined and analyzed as needed. The MPLIS has transformed the way that LCD and other agencies use land-based data. It offers efficiency, cost savings and an ease in addressing land use and management issues that was unthinkable a decade ago. It provides new and improved products and service, and assures that they are delivered equitably in a non-biased manner. It enables the LCD office to handle increased responsibilities with minimal staff increases.

How MPLIS Evolved

As new technologies emerged in the late 70s, LCD was quick to identify their potential. But were they economically feasible, especially with the needed education and training? The prevailing assumption was that automating meant spending money that might offer little return. To address the problems and concerns that accompany any new technology, LCD teamed up with UW–Madison’s Land Information and Computer Graphics Facility (LICGF) to explore the potential of MPLIS. Could it streamline operations of the LCD and help protect Dane County’s valuable resource base?

Several pilot studies, launched under the auspices of the Dane County Land Records Project, tested procedures for digitizing map layers for soils, parcels and other important data. An expanded county-wide project explored the new technologies’ capabilities in handling information for a broad base of land and resource programs.

Then, in the early 1980s, the Wisconsin Legislature approved Administrative Rule 160. It specified that soil erosion rates were to be reduced to a specified T-value (the tolerable average annual rate of soil erosion for each soil type) by July 1, 2000. [Ag160.03(16)] The Administrative Rule further specified that erosion control plans for highest-priority watersheds and other cropland areas should provide “sufficient detail to permit identification of individual parcels of cropland which are in need of erosion control practices.” [Ag160.05(4b)]

The implications for the MPLIS were clear. For the first time, a statewide program included a data requirement that linked landowners’ individual areas within a parcel (i.e., farms and fields) with specific resource problems or constraints—a task perfectly suited to the new digital technologies.



Digitizing a map at the Land Conservation Department

DANE COUNTY SUCCESS STORIES

With a legislated “mandate,” Dane County forged ahead in adapting the digital technologies to administer conservation programs. Here are examples of breakthrough technologies and their value in increasing efficiencies for the tasks at hand:

- **Digitizing**

A primary task before LCD was automating 181 hard-copy soil survey maps. Instead of manually tracing soil survey polygons, the USDA Soil Conservation Service (now NRCS) provided a scanner that could capture the intricate line work on the maps. UW-Madison LICGF staff used it to digitize 120 of the maps; for

BENEFITS OF MPLIS

Efficiency

- Able to respond more quickly to policy changes in state and federal programs.
- Faster development of conservation plans for individual farms at less cost.
- Ease in monitoring farm conservation plans for progress and compliance with program requirements.
- Staff has produced a five-fold increase in number of farm plans developed to guide land and water conservation efforts by individual owners.

Effectiveness

- Policy-makers could quickly sift through “what if” questions as they prepared conservation protection programs: What if farmers used conservation tillage instead of conventional plowing? What if they installed terraces and used strip cropping to control erosion? By examining the impacts of such conservation practices, analysts could correct errors involving programs on individual farms and fields based on incorrect assumptions.
- The digital database is available for on-going development and analysis of conservation practices and programs.
- Under the “proof is in the pudding” category: the overall soil erosion rate in the county has been reduced from 10.5 tons per acre in 1985 to 3.9 tons per acre in 1998. This 63% reduction is a clear measure of more effective erosion control plans that have evolved from using the MPLIS.

Equity

The land information technology used in the soil erosion plan provides the means to assemble and use highly detailed land information. Using MPLIS to develop and explain the erosion control plan helped assure farmers that decisions weren't biased in favor of different locations or farm operators:

- Farmers recognized that data for each MPLIS layer was entered in the same way, and that data for entire county was consistent.
- Farmers were satisfied that accumulated data were being analyzed by standardized computer programs, not favoring particular land owners.

comparison, they manually digitized the rest. The result: automating did not affect the editing time, but it slashed the digitizing time by 94%. Overall, it cut total time by 62% (Moyer & Niemann, 1991).

• Converting land cover data

Land cover data are collected by aerial photography or by satellite. Converting land cover data into specific land use categories traditionally has been labor intensive and costly. In Dane County tests, the Land Conservation Department demonstrated that by using LANDSAT Thematic Mapper—an instrument with high-resolution sensors and interpretive software placed on a satellite—the cost per acre of conversion could be reduced by 79% (Ventura, 1988a).

• Global Positioning Systems

Another emerging technology, global positioning systems (GPS) (a technology that can determine spatial coordinates from space via satellite) proved to be a huge time and money saver. While developing a geographic framework for the various MPLIS layers, (see Figure 1) conventional methods of establishing coordinate locations for the PLSS (public land survey system) section corners were compared with the GPS method. The result: GPS reduced the number of monuments required for the survey network and cut costs by 37%. Remarkably, these savings resulted from an early GPS that relied on only a handful of satellites. Today's full constellation of GPS satellites provides even greater efficiencies (Moyer & Niemann, 1991).

The following plans and programs are highlights of additional benefits resulting from successful MPLIS applications throughout Dane County:

A County-wide Erosion-Control Plan

By 1988, having assembled a new library of digital data, LCD and LICGF developed the first digitally based, county-wide erosion-control plan in the state (Ventura, 1988). It was clear that the new digitizing technologies saved both time and money over conventional methods during the database automation process. But as the LCD used the new database to administer the erosion-control plan, additional, far-reaching benefits surfaced: significant improvements in *efficiency, effectiveness, and equity*. (See left)

Watershed Management

• Black Earth Creek

Black Earth Creek, a world-class, naturally reproducing trout stream that winds through western Dane County farmland, is a state treasure. But it wasn't always so. In the early 1980s, water quality was quickly deteriorating from eroding agricultural lands, degraded streambanks, barnyard runoff, and construction site erosion. The LCD used the MPLIS to document the need for priority status for the watershed. In 1985, in response to the grant request, the watershed received \$1.6 million in cost-sharing funds.

Thanks to this priority status, Black Earth Creek Watershed has a protected and improved trout fishery. Sediment from croplands and construction sites has been reduced by 76%, and nutrients entering the stream have been reduced by 86%. Subsequently, the MPLIS has helped integrate other local, state, and federal water conservation programs.

• **Lake Mendota**

Lake Mendota, at 230 square miles, is the centerpiece of a huge watershed in central Dane County. Developing a watershed plan that would identify and reduce pollutants required four steps that relied on the MPLIS:

1. Overlay and integrate the relevant data layers. These included soils, land use, crop management, topography, hydrologic factors, etc. (To manually combine these layers with hard-copy maps and tabular data would have been hugely inefficient and costly.)
2. Integrate data layers with farm and field data for each landowner's conservation plans.
3. Use a computer model to estimate amounts of sediments, phosphorus and other pollutants.
4. Evaluate various management practices and alternatives to reduce water-borne pollution.



The Sugar River winds through southwestern Dane County

• **Sugar River**

The Sugar River Watershed in southwestern Dane County encompasses a mix of agriculture, hilly topography, and increasing development pressures that made it especially challenging to devise a comprehensive conservation plan. Applying MPLIS data to the WINHUSLE water-quality model was an efficient method to measure sediment and phosphorus runoff in a large (171 sq. mi.) area. The results became a baseline for improving management practices; subsequently, sediment has been reduced by 40% annually.

Farmland Preservation Program

The Farmland Preservation Program is one of the state's most visible conservation programs. Administered by the LCD in Dane County, the program provides tax credits to farm owners who follow specified soil and water conservation practices. The annual review of the conservation plans and practices of 1900 farmers enrolled in the program creates a huge workload for LCD staff. The MPLIS allows LCD and NRCS staff to combine data on cropping and tillage practices with soils, contours, land ownership, and orthophotos to develop conservation plans. The result is an annual FPP compliance review that is faster and easier with fewer staff costs. Landowners receive better service and equal treatment.

Farm/Field Database

The LCD maintains a detailed database and corresponding spatial information for each of the 2500-plus farm owners who participate in county, state and federal conservation programs. Thanks to the use of digital orthophotography—a technique that uses detailed data to fine-tune aerial photographs—landowners can follow the results of changing conservation practices on their land and surrounding areas. Compared to databases derived from analog or paper-based map products, the LCD ortho-database is more accurate, more precise and more detailed.



The LCD maintains a detailed database on all farm owners who participate in county, state or federal conservation programs

Infiltration Management Plans

Municipalities are looking at ways to mitigate the effects of increased runoff from impervious areas such as parking lots, and commercial and industrial building sites. The MPLIS provides information about soils, including their locations, physical properties, and position within the landscape. Other MPLIS layers used to model runoff include elevation data, street network, sewershed and storm sewers. A uniform database and analysis ensures that developers, farmers and other landowners are treated equitably. The LCD used the MPLIS to assist the city of Sun Prairie, Wisconsin to develop a sedi-

ment-control strategy. The MPLIS, coupled with modeling techniques, was used to evaluate alternative means of reducing sediment and saved the project tens of thousands of dollars.

Other readily apparent benefits of using the MPLIS when developing IMPs include:

- reduced number and length of storm water sewer lines
- reduced base flow of sewer systems
- less sediment build-up in tile drainage system
- improved field access for farmers resulting from lower water tables during heavy runoff

Dane County's Unique Role in National MPLIS Development

Dane County has played a unique role in the broader scope of state and national MPLIS development efforts. The activities of the Land Conservation Department were directly related to the research and technology transfer that were part of the CONSOIL (Conservation of Natural Resources through Sharing of Information Layers) project.

By the mid-1980s, it became apparent that the MPLIS being developed by the Dane County LCD in Dane County had implications far beyond county boundaries. The geographic and land information systems, satellite positioning systems, orthophotography and new working relationships being developed for Dane County could provide additional benefits in managing state and federal conservation programs.

These programs included: the 1985 Federal Farm Bill (which included the Food Security Act, Swampbuster, Sodbuster, Conservation Reserve Program, and conservation compliance provisions), as well as a number of state conservation programs for soil erosion control, non-point source pollution control, and farmland preservation. In Wisconsin, as in many other states, these programs are often administered by county level offices staffed by both LCD and NRCS employees.

Because of these interlocking relationships, the Land and Computer Graphics Facility (LICGF) at the University of Wisconsin-Madison obtained federal funding from Congress and organized a large number of local, state and federal agencies to work on their mutually beneficial goals for MPLIS development and use. Formal signatories to a 1987 Memorandum of Understanding included:

United State Department of Agriculture

- Soil Conservation Service
(now the Natural Resources Conservation Service)
- Agricultural Stabilization and Conservation Service
(now the Farm Services Agency)

United States Department of Interior

- US Geological Survey
 - Water Resources Division
 - National Mapping Division

United States Department of Commerce

- National Geodetic Survey

Wisconsin Department of Natural Resources

Wisconsin Department of Agriculture, Trade and Consumer Protection

Dane County

- Land Conservation Department
- Division of Information Management
- Department of Planning and Development
- Land Information Office

University of Wisconsin Extension

- Geological and Natural History Survey

University of Wisconsin - Madison

- College of Agriculture and Life Sciences
- College of Engineering
- Institute for Environmental Studies
- State Cartographer's Office

The basic idea of CONSOIL was for each agency to build a computerized database of information needed for the conservation programs for which they were responsible. Then, institutional arrangements would be developed to share these data files among CONSOIL participants, thus avoiding duplication of effort and expense in building and maintaining databases. Using the "custodian" concept, in which project participants willingly maintain data in a structure and format that is compatible for sharing with other agencies, CONSOIL was successful in reaching its objectives.

One of several major applications investigated during CONSOIL was the testing and evaluation of a farm management system that could assist in assuring compliance with state and federal erosion-control requirements, as well as assisting in the development of farm conservation management plans and procedures to monitor compliance with farms plans approved by the LCD. The major involvement of Dane County's LCD was one of the primary reasons for the success of this part of CONSOIL.



Farm Drainage Boards address issues regarding cropland flooding

Farm Drainage Boards

Farm Drainage Boards maintain the network of ditches, channels, and drain tiles that provide adequate drainage on agricultural land. These Boards have taxing authority over landowners to keep the system running smoothly. As might be expected, fair treatment can be a big issue. The MPLIS was first used to digitize the drainage district boundaries from historical records. These data were then adjusted to digital orthophotos and overlaid with current parcel information. Landowners are identified and given the opportunity to attend meetings about any impending actions. With the MPLIS, the LCD can quickly assemble and display information about fields, farms, soils, topography and other information for a particular drainage system.

The MPLIS offers a precise means for outlining and displaying information about needed maintenance and its impact. Landowners learn, up front, where the district boundaries are located. This is in sharp contrast to the old process in which staff had to pour over paper records to determine relevant information, project necessary actions, and decide which landowners should be notified—a process that could take hours or days.

SUMMARY

Dane County's Land Conservation Department, working with the Land Information and Computer Graphics Facility (LICGF) at UW–Madison, has been a pioneer in developing a multipurpose land information system (MPLIS) that has revolutionized the way the department does business. The MPLIS has resulted in land and water conservation programs that are more efficient, more effective, and more equitable. Further, the techniques and applications developed have been used by counties throughout the United States, and also within state and federal conservation programs.

Building a comprehensive land information database has taken time and a lot of effort. But the evolution of Dane County's MPLIS has demonstrated, once again, that substantial benefits can accrue when local governments partner with universities, state governments, and the federal government to tackle land use issues. The final result? A robust land information system that serves many users at all levels of government and in the private sector. And in so doing, it saves time, money and, not least, the natural resources for which it was intended.

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Table 1. Highlights of Benefits Provided by Using the Multipurpose Land Information System in Dane County

Selected Benefits with MPLIS	Efficiency				Effectiveness		Equity		
	Eliminate/Reduce Current Cost	Avoid Future Costs	Faster	Easier	Provide Better Service	Provide New Service	Equal/Improved Access	Equal Treatment	Altered Decision Making
WATERSHED MANAGEMENT									
• Integrate local, state and federal water conservation plans; certify compliance	✓		✓		✓			✓	✓
• Evaluate and develop groundwater management plans and options		✓	✓	✓	✓		✓	✓	✓
• Evaluate management practices and alternatives to reduce nonpoint source pollution	✓		✓	✓	✓			✓	
FARMLAND PRESERVATION PROGRAM									
• Combine data on farming practices with individual conservation plans.			✓	✓	✓	✓		✓	
• Annual compliance review	✓		✓	✓	✓			✓	✓
FARM/FIELD DATABASE									
• Digital ortho-database offers accurate, precise updates on field practices	✓	✓	✓	✓	✓			✓	✓
• Update plans weekly		✓	✓	✓	✓				
INFILTRATION MANAGEMENT PLANS									
• Better information for uniform data-base and analysis procedures		✓	✓	✓	✓			✓	
• Can provide tailored sediment-control strategies			✓	✓	✓	✓			
FARM DRAINAGE BOARDS									
• Can quickly assemble information for fields, farms, soils, topography, etc. for specific drainage system		✓	✓	✓	✓			✓	
• Can notify landowners precisely when, where, and how much any action will cost	✓	✓	✓	✓	✓			✓	

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