RESULTS OF THE DANE COUNTY LAND RECORDS PROJECT: IMPLICATIONS FOR CONSERVATION PLANNING

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ABSTRACT

This paper presents the results of the Dane County Land Records Project, a four year cooperative research venture involving numerous local, state, and federal agency cooperators. The project has developed, tested, and evaluated a concept for a multipurpose land information system. Components of this concept have included reliance on individual data layers maintained by legislatively mandated agencies, and a common mathematical reference system to permit integration of the layers. Results of time and cost comparisons for manual digitizing and automated scanning, for data collection such as agricultural land use detection, and for landscape analyses are presented. Experiments with satellite geopositioning (Doppler Surveying and Global Positioning System), and inertial surveying methods are discussed. Implications for institutions using cooperative agreements are discussed and implementation principles are presented.

LEGISLATIVE MANDATE

For many years, the limitations of mapping technology have set the limits of the information available for the management of the land. The law might require decisions to be carried out with certain information. Planners and other land managers have resorted to the rationale that a plan is based on "best available information". One of the missing elements has historically been ownership information, or an identification of those impacted by planning proposals or those responsible for negative impacts to the environment. In the predigital period, it was possible to avoid the ownership record due to technical limitations that will not apply in the new technology.

Soil Erosion and Conservation Planning in Wisconsin

The case of soil erosion planning in Wisconsin provides an example of the evolution of an environmental management program. In a very few years, soil conservation has moved from an isolated provision of technical assistance for willing farmers to a quasi-regulatory program integrated with many other programs. Information technology has not yet played a direct role in this process. Soil conservation became a national issue over firty years ago during the dustbowl era. Despite substantial efforts, soil erosion is still a major problem.

Wisconsin has taken the approach of incorporating the conservation districts directly into the organization of Wisconsin government at the state and county level (Arts, 1982; 1984). The state has also created a new program with the intention of reducing soil loss. Some district staff see this as a simple continuation of past policies and procedures, but there are some fundamental shifts in the information requirements. The new program is described in Chapter 92 of State Statutes (dated 1981) and implemented in Administrative Rule Ag 160 (dated 1984). The statute gives an overall description of the plan:

> *Each land conservation committee shall prepare a soil erosion control plan which does all of the following: ...*
> *2. Identifies the parcels and locations of the parcels where soil erosion standards are not being met. ... [92.10 (5)a]*

The administrative rule specifies the program goals in greater detail:

> *The goal of the soil erosion control program is to reduce soil erosion caused by wind or water on all cropland in Wisconsin to T-value by the year 2000. T-value means the maximum average annual rate of soil erosion for each soil type (specificed in the SCS Technical Guide) [Ag160.03 (16)]*
>
> *For watersheds or other cropland areas determined by the land conservation committee to be of highest priority, the soil erosion control plan shall include detailed estimates of cropland erosion rates. Estimates shall be sufficiently detailed to permit the identification of individual parcels of cropland which are in need of erosion control practices. [Ag 160.05 (4b)] (emphasis added)*

Cross-Compliance in Wisconsin

After this structure for the soil erosion planning process was put in place, the need for integrated land information was increased by further action at the state level. A major program in the state budget is Farmland Preservation, which provides a state income tax credit for payments of local property tax on agricultural parcels. In return for the tax credit, the farmer must keep the land in agricultural use, enforced by either zoning or contract with the state. In the state budget recently adopted, there is a mandate to integrate farmland preservation with soil conservation. Under the new scheme, a farmer will have to provide a certificate from the county Land Conservation Committee showing compliance with soil erosion standards before the zoning administrator can certify the farmer's tax credit. This requirement could not have been anticipated from a user needs assessment, but the intention to integrate information on resources and parcels was already leading in this direction (see also Sullivan et al., 1984, 1985).

Cross-Compliance in the Federal Farm Bill

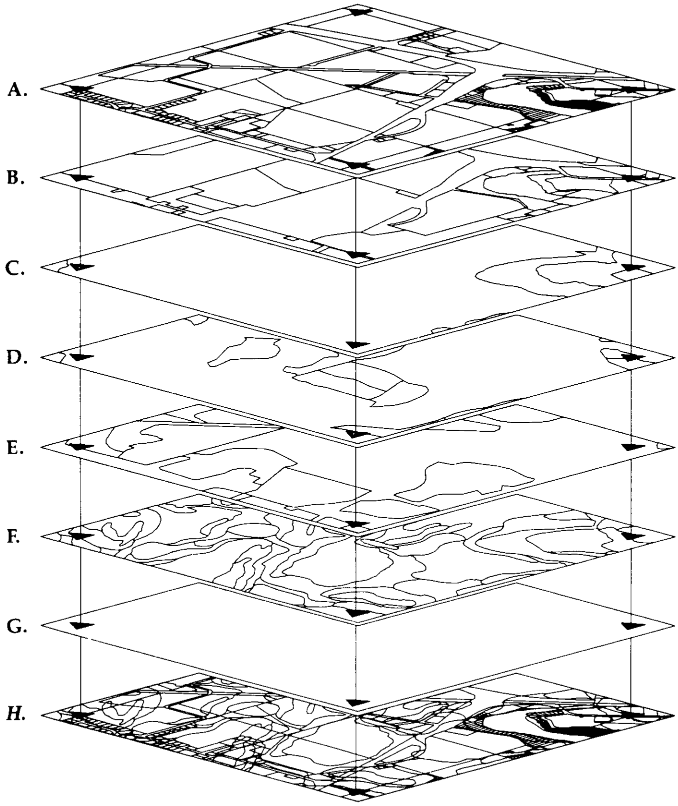
The 1985 Federal Farm Act also includes provisions to restrict poor management of marginal farmlands: "Sodbuster" for the provision adressing highly erodible lands, and "Swampbuster" for the provision addressing drainage of wetlands. These provisions actually require the conservation districts (at the county level) to integrate the resource information on soil capability with the information on owners and land users who receive any farm subsidy. Because the integration which Congress intends is similar to the Wisconsin case, we believe that our study in Dane County provides an adequate demonstration that a multipurpose land information system can efficiently and equitably respond to these requirements.

ORDERS OF MAGNITUDE: GEOPROCESSING, GEOPOSITIONING, REMOTE SENSING

The central components of the DCLRP concept involve the maintenance of individual data layers in a digital form by the agencies mandated with their generation, and the use of a mathematical reference framework for linking individual layers (Chrisman et al., 1984; Chrisman and Niemann, 1985) (see Figure 1). In achieving these goals, the Dane County Land Records Project has utilized advanced geoprocessing software to perform topological polygon overlay (ODYSSEY), and has investigated advanced geopositioning technologies (Doppler, Inertial, Global Positioning System). The DCLRP has also incorporated classified digital remotely sensed imagery through a vectorization process (Ventura et al., 1985, 1986). In the implementation and use of a multipurpose land information system, it appears that order of magnitude efficiencies are possible in geoprocessing, geopositioning and use of remote sensing.

Advanced Geoprocessing Software

Manual digitizing of mylar soil sheets (1:15840, 7 square miles, average 300 polygons), combined with editing time (including automated error checking) to produce a topologically clean sheet, averaged 12 hours (Chrisman, 1986c; Ujke, 1984). The adoption of scanning digitizing (Chrisman, 1986a) was found to reduce combined digitizing and editing time to 4 hours. A photogrammetric technique for removing relief distortion from rectified photobases, as in the case of the SCS soil sheets, using USGS digital elevation models (DEM) was developed by the DCLRP (Barnes, 1984,



Concept for a Multipurpose Land Information System

Section 22, T8N, R9E, Town of Westport, Dane County, Wisconsin

Data Layers:	Responsible Agency:
A. Parcels	Surveyor, Dane County Land Regulation and Records Department
B. Zoning	Zoning Administrator, Dane County Land Regulation and Records Department
C. Floodplains	Zoning Administrator, Dane County Land Regulation and Records Department
D. Wetlands	Wisconsin Department of Natural Resources
E. Land Cover	Dane County Land Conservation Committee.
F. Soils	United States Department of Agriculture, Soil Conservation Service.
G. Reference Framework	Public Land Survey System corners with geodetic coordinates
H. Composite Overlay	*Layers integrated as needed, example shows parcels, soils and reference framework*

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Support provided by the Gordon H Baker Fund of the University of Wisconsin Foundation

1985,1986). A "Zipping" process was developed to automate the edgematching of separately compiled map sheets, using an approach which limits calculations to edges of the maps (Beard and Chrisman, 1986).

Satellite Geopositioning
The individual layers which were brought together were transformed to state plane coordinates (SPC) using section corners and quarter corners for control. Establishment of SPC for the PLSS monuments involved a comparison of traditional manual surveying techniques and satellite geopositioning technologies (Vonderohe, 1984a,b; Vonderohe and Mezera, 1984; Vonderohe et al., 1985; von Meyer, 1984a,b; von Meyer et al., 1985). Our research has demonstrated an order of magnitude difference in both time and cost for these methods of establishing the reference framework. Whereas manual surveying methods required several days and $1000's to establish coordinates for a point, Doppler satellite methods required only two days and $100's, and global positioning system (GPS) methods required only hours and $100's.

Remote Sensing and Digital Image Processing
In conjunction with the University of Wisconsin Environmental Remote Sensing Center, the DCLRP acquired, classified, and vectorized Landsat Thematic Mapper data for agricultural lands in Dane County (Ventura et al., 1985, 1986). Again, an order of magnitude difference was found between the 1/2 hour per PLSS section required for traditional manual photointerpretation of Agricultural Stabilization and Conservation Service (ASCS) 35 mm slides and compilation on the SCS soil photobase, versus minutes per PLSS section to perform the digital classification.

ASSESSING SOIL EROSION POTENTIAL FOR EACH LANDOWNER

The process used for determining soil erosion potential involved an application and automation of the Universal Soil Loss Equation (USLE) for agricultural parcels (Wischmeier and Smith, 1965), as prescribed in Administrative Rule Ag 160.

The accompanying maps portray this application for the Town of Oregon, Dane County, Wisconsin, T5N, R9E. Figure 2 was produced by manually digitizing 36

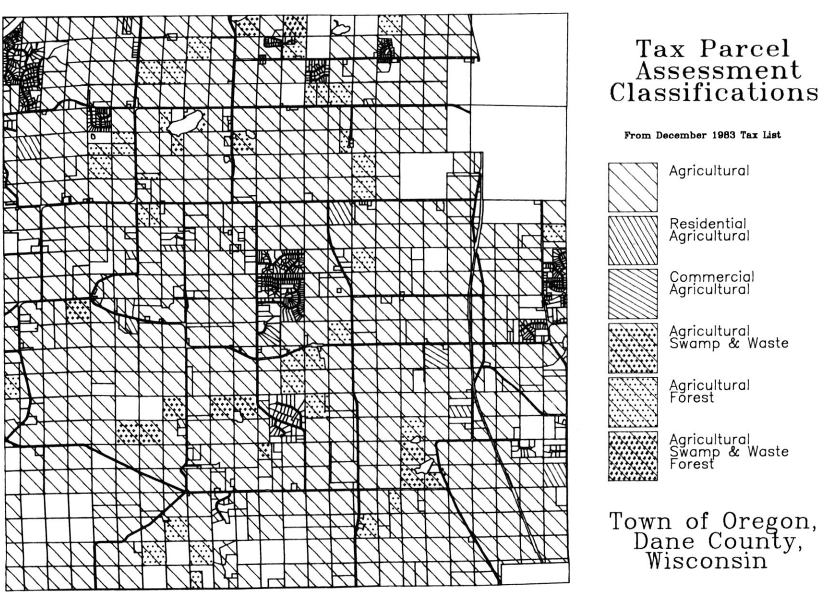

Figure 2: Tax Parcel Assessment Classifications, Oregon Twp., WI

section maps of tax parcels maintained by the County Surveyor at 1:4800, most on linen bases. After editing and edgematching, each tax parcel ploygon was assigned its unique identifier, as recorded on the County Zoning Administrator's section maps.
The identifier permitted access to the tax parcel assessment classifications recorded in the automated tax rolls of the County Tax Lister. Only those parcels having an agricultural assessment classification are shaded on this map; areas with classifications other than agricultural, swamp and waste, or forest were excluded from the study.

The use of an automated system for overlay and analysis of map layers, has provided the County Land Conservation staff with a workable tool for prioritizing their field observations and landowner contacts as they work to implement the soil erosion control plan. Whereas before a manual overlay analysis for a township might take days, the same analysis can now be performed in an hour. Similarly, a manual interpretation of an individual farm's eligibility for a given program might have required hours; the computer assisted interpretation requires only minutes per farm. Through development of automated case files and linkage to the digital layers of land information, the county land conservation staff is moving toward a system for monitoring compliance.

This process of automating existing land records such as ownership, soils and agricultural use and applying the USLE has been demonstrated elsewhere (see Chrisman et al., 1986a,b). The maps on the following pages demonstrate the application of this process. Figure 3 illustrates which parcels and landowners will not be in compilance (A > 2T and T < A < 2T) without employing some additional conservation management procedures.

Figure 4 illustrates the impact to soil erosion by employing conservation tillage practices: all parcels are brought below the level of 2T, and many of those with moderate erosion potential are brought within the acceptabel level and no longer exceed tolerable soil loss.

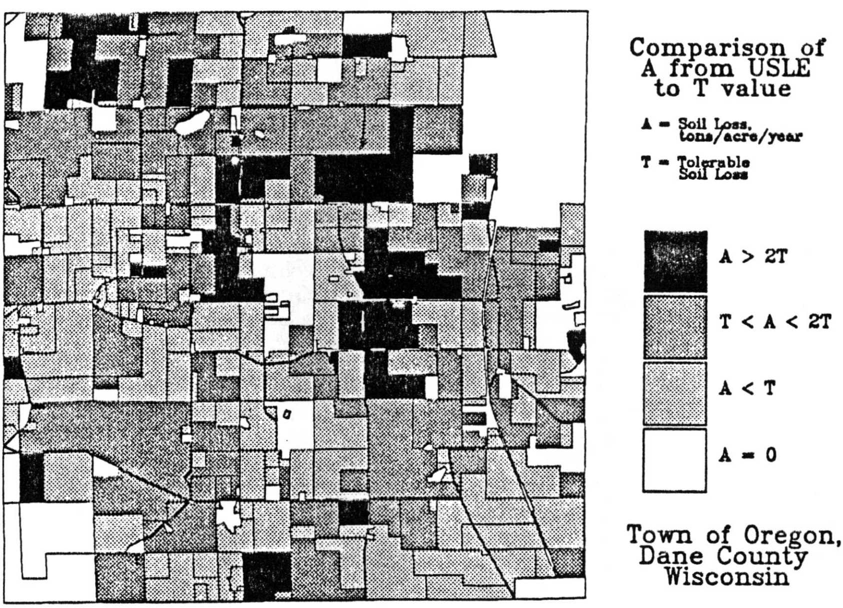

Figure 3: Comparison of A from USLE to T value, Oregon Twp., WI

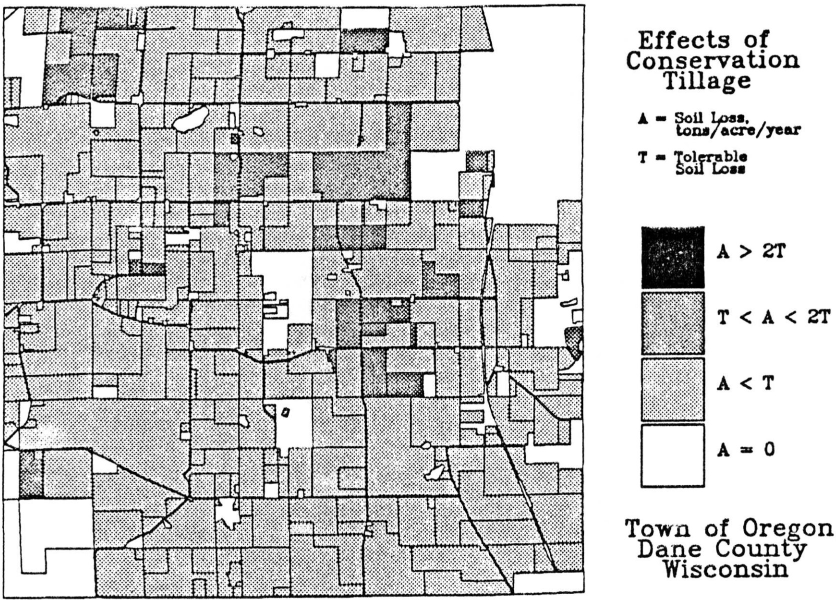

Figure 4: Effects of Conservation Tillage, Oregon Twp., WI

MODERNIZATION PRINCIPLES DERIVED FROM EXPERIENCES GAINED DURING THE DANE COUNTY LAND RECORDS PROJECT

As a result of the project, a number of social, economic, institutional, and technological trends have been identified in the process of addressing modernization issues. Inititally, taking advantage of new land records and information technology requires educational and institutional changes. In bringing about modernization, the following principles for the development and implementation of modern, multipurpose land information systems need attention.

Automation
A system neeeds to be based upon intelligent concepts such as topological vector data structures, in which: spatial locations, attributes, and their relationships (ie, adjacency and connectivity) can be maintained; logical and spatial search as can be conducted; and cross-checking of consistency, closure, and unique identification of areas and attributes are possible.

A system needs to support analytical capabilities such as topological polygon overlay, network analysis, buffer generation, etc.

A system needs to accomodate data capture and conversion (ie. raster to vector and vector to raster) between diverse routine and non-routine land record sources.

Geopositioning
A system needs to be constructed upon a geodetic reference framework.

A system needs to be based upon remonumentation and determination of coordinates for

Public Land Survey System (PLSS) corners and other survey monuments to provide both a spatial reference system and an improved legal system for property description.

Standards for geopositioning need to be established.

Applications
A system needs to be multi-layered, including property descriptors, tax assessment parcel records, and unique parcel identifiers to assure multiple use applications.

A system implementation needs to include a pilot project to test and demonstrate applications. High use, high visibility applications, should be chosen and output examples should be provided early on.

Quality
System evolution needs to include the development and adoption of standards for the various records, including property, resource mapping, remonumentation, and geodetic control.

A system needs to include procedures which clearly documents the source, lineage (original scale, accuracy) and method of automation for each record to assure logical consistency and completeness.

A system needs to automate records at the greatest available detail to assure non-degradation of original positional and attribute accuracy, and therafter perform aggregations for more general applications.

Institutional
System implementation should focus initially on institutional cooperation before addressing technical issues.

System implementation should determine short-term and long-term custodial mandates and maintain responsibilities for each land record in the system.

System implementors must recognize that implementation is a long-term venture and an investment, and will require continuous evaluation rather than merely a one-time experience.

System advocates need to recognize that the approach is interdisciplinary and therefore need to involve a variety of disciplines and professionals in the initial system development and planning stages.

System designers need to insure that the records base is unbiased, politically and institutionally neutral, to assure its broad official and private use for both daily management and policy making functions.

Economics
System designers, implementors and users need to ensure that the record base allows for efficient, yet comprehensive and exhaustive analysis to ensure fair and equitable treatment to all.

System implementors need to incorporate new technologies into the operating system, such as the global positioning system and scanning technologies, to gain needed efficiencies in geopositioning and digital conversion of land records.

System implementors need to recognize that some applications and analyses will be accomplished much faster then formerly, while other applications which were not possible will emerge, and unanticipated benefits will result.

System implementors and managers need to recognize that a learning curve exists in system development and use. Initial costs to convert and use records will be higher than for these same activities after experience with the system has been gained.

In summary, system advocates, implementors, managers and those responsible for overall approval need to recognize that operating efficiencies will result; that timeleness will improve in that analyses can be accomplished faster; that synergism will result in being able to do things that were impossible manually; and that analyses can be accomplished comprehensively and exhaustively, resulting in fair and equitable treatment of all.

SUMMARY: TECHNICAL AND INSTITUTIONAL FEASIBILITY OF LIS

In this evaluation of a multipurpose land information system we have demonstrated that it is technically feasible to identify land ownership parcels where soil erosion standards are not being met. We have demonstrated the utility of combining advanced geoprocessing, geopositioning, and remote sensing technologies. We have also demonstrated the need for flexible data structures, such as layering, and analytical procedures, such as topological polygon overlay, to respond to new land management questions and mandates such as cross-compliance. We have also documented what appears to be institutional interest in these issues.

There is legislative interest both at the state and national level to ensure that society receives equitable returns upon public investments in support of agriculture. As a result, farm supports of various kinds are being linked to reduction in soil erosion and minimization of wetlands destruction. As the public awareness of land management becomes linked to broader concerns, there will be increased needs to integrate diverse information, such as the natural resource and ownership layers used for the Wisconsin soil erosion plan. The same tools and procedures which are essential to multipurpose land information systems may be those mechanisms which stewards of the land need to implement land management programs.

It is possible that these technologies will have the same social impact as the automation of the Census had upon the implementation of racial desegregation in the U.S. The ability to establish defensible indices of segregation, based upon manipulation of the automated Census records, formed the information base that made desegregation an achievable goal. With the advent of modern information concepts and technologies which allow for merger of various records sets, are we at the brink of such an impact on rural land management? Will the application of such technologies provide for sufficient certainty to allow legislative mandate of land management programs implemented at the parcel level? If so, this could have profound impacts on those who own and manage rural America.

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ACKNOWLEDGEMENTS

This work was performed under a cooperative research agreement among the University of Wisconsin-Madison, Dane County, Wisconsin Department of Natural Resources, Wisconsin Department of Agriculture, Trade and Consumer Protection, and the USDA Soil Conservation Service. Additional support and/or assistance was provided by UW-Madison Environmental Remote Sensing Center, Wisconsin's University Industrial Research Foundation, US Geological Survey, Bureau of Land Management, Wisconsin Department of Transportation, Wisconsin State Cartographer's Office, Madison Area Surveyor's Council, and Wisconsin Power and Light.

The co-principal investigators in the Dane County Land Records Project were N. Chrisman, D. Mezera, D. Moyer, B. Niemann, and A. Vonderohe. Special thanks to G. Barnes, K. Beard, K. Cotter, M. Dawood, C. Ghilani, J. Green, D. Krohn, J. LaVerriere, N. MacGaffey, G. Mahun, J. Sonza-Novera, J. Sullivan, M.Thoma, S. Ventura, and N. von Meyer for research assistance. Thanks also to cooperators K. Connors, R. Martin, M. Riggle, J. Ujke, and many others unmentioned.