Peter Lund

# LRIS and MLMIS: A Comparison of Two State Land Information Services

Over the past twenty years, we have witnessed the emergence of a multitude of information systems, both in the public and private sectors. These systems have provided a more effective means, in terms of cost and time, to process large amounts of raw data. Their use has, in many instances, allowed for unrestricted data communication, eliminated redundancy, facilitated updating procedures, provided a method for data standardization and classification, and improved data analysis.

The following article will examine a specific type of information system, namely a land information system, which is institutionalized at a specific administrative level of government, the state. These systems have been primarily utilized by those public agencies and private groups involved in the land planning and management process.

The basis for discussion will be a comparison of two state land information systems: the Minnesota Land Management Information System and the North Carolina Land Resources Information Service. Their selections were based on several factors. First, one represents a well established system while the other is relatively new. Second, different data base formats are employed by each. And third, one system was completely developed by state agencies while the other was developed by and is currently leased from a consulting firm.

The first two sections will present an historical perspective of the two systems and highlight their major features. The final section will discuss the similarities and differences of the systems.

## NORTH CAROLINA LAND RESOURCES INFORMATION SERVICE

The 1974 North Carolina Land Policy Act called for the creation of the Land Policy Council. A major duty assigned to the Council was to rememdy the "lack of a systematic collection, classification, and utilization of information regarding the land resource" (NCLRIS, 1977:1). In September 1977, the Council established the Land Resources Information Service (LRIS) to be based at the North Carolina Department of Natural Resources and Community Development in Raleigh, North Carolina.

LRIS's main function is to provide a system for entering and storing land related data collected by various agencies and private groups in a "consistent and compatible" manner. This system should also enable users to readily retrieve, analyze, and display the stored land information. A system which met these criteria was available from the firm of Comarc Design Systems, California. Although Comarc's system was relatively new, its user-oriented features and analytical capabilities were especially attractive to LRIS. Shortly after its inception in 1977, LRIS obtained the combination software and hardware system from Comarc Design Systems through a third party, five year lease purchase arrangement.

LRIS's initial year of existence was characterized by the undertaking of various pilot projects for government agencies. These projects were primarily intended to demonstrate to potential users the capability of the land information system. At the same time, the LRIS staff was able to become familiarized with the Comarc system and to identify and correct software problem areas.

A major pilot project was performed for the U.S. Department of Agriculture as part of the Soil Conservation Service (SCS) support to North Carolina's 208 Water Quality Program. This project entailed the digitizing of soil, land use and stream data for two sub-basins in North Carolina. Once stored in the system, software programs were applied to these data to determine the sediment loss in the sub-bacins. From these estimations SCS would be able to determine costs for management practices for reducing sediment loss.

Other important pilot projects included the plotting of metes and bounds of state-owned lands for the North Carolina Property Office; storing geographic coordinate references of

*Pete Lund is currently employed as Planner/ Remote Sensor, with the North Carolina Department of Natural Resources and Community Development.*

geodetic control points in the system and plotting their distribution for the Geodetic Survey, North Carolina Department of Natural Resources and Community Development; and displaying and analyzing bougea values, subsurface stratas, cross sections, and contours of various geological beds for the Division of Land Resources, North Carolina Department of Natural Resources and Community Development.

## SERVICES

LRIS's function is to assist federal, state, regional, and local government agencies, along with private citizens and businesses, in utilizing the land information system for land planning and management purposes. The LRIS staff provides users with the training and advice necessary for entering, storing, retrieving, analyzing, and displaying the desired data. This is an improtant duty owing to a basic concept espoused by LRIS that the collectors and users of the information should be the ones to perform the above functions. LRIS (1977:3) believes that "those who actually collect and use a particular type of data are most familiar with it, are able to enter that data into the system more accurately, and with a better understanding of its usage, than can someone unfamiliar with the data."

LRIS has, for certain agencies' projects, executed the entry, retrieval, and display processess without manpower assistance from these agencies. Other duties have included the demonstration of the systems' features to interested groups through tours at LRIS in Raleigh and presentations at formal seminars throughout the state. Research projects involving the identification of potential land planning and management applications and the development of new analysis techniques have been hindered by both a lack of funds and a concentrated effort in completing several pilot projects.

## COSTS AND FUNDING

The original cost for leasing the Comarc Design System's software and hardware was approximately $4,500 per month. With recent expansion of the system, this fee has risen to $6,000 per month. To cover the initial leasing costs, funds were secured from several state agencies, specifically the Department of Natural Resources, Department of Administration, and Department of Cultural Resources.

A user fee system now provides the necessary funds for the system's leasing and operation costs along with the staff salaries of LRIS. The present rate for users of the system is approximately $30 per hour. This charge includes the costs of advice, training, system's operation, and materials for map production. However, LRIS is in the process of revising its user fee structure. Rates will, in the future, take into account the percentage of the system's resources utilized (e.g. digitizer use, CRT use, etc.), time of day one uses the system, and the amount of staff training and advice to the user.

## HARDWARE

The hardware currently being leased by LRIS include the following:

1. A Data General Eclispe S-230 "minicomputer" with a current memory capacity of 320 KB.
2. A Zeta drum plotter, with a plotting accuracy of .005", and four different colored rapidograph pens for map display.
3. Two Talos digitizing tables with a .001" digitizing accuracy and a 60" by 44" dimensions.
4. Two Tektornix cathode ray tubes used for editing and previewing plots.
5. A standard line printer (300 lines per minute) for producing reports on various operations of the system.
6. Three keyboard terminals for software programming use.

The LRIS also has the capability of using the existing computer facilities of the Office of Management Systems in the North Carolina Department of Administration. The Administration Department's facilities consist of a large IBM 370/158 computer which could be used for large econometric modeling and processing and storage of large quantities of data.

*LRIS personnel instruct clients on the techniques needed to use the system.*
*Photo N.C. Dept. of Nat. Res. and Comm. Dev.*

## DATA BASE FORMAT

Four different data base formats, points, lines, polygons, and grid cells have been employed by LRIS for entering and storing information in the system. With its abilities to be converted to grid cells and to enter areal data in its most basic form, polygons have been the most frequently used of the four formats. Data entry in its most basic form ensures other agencies and private groups of being able to utilize the stored information. If interpreted data[1] relevant only to the original users' needs were entered, the stored data's utility for other users would be limited.

The point data base format (a single x-y coordinate) has been used to depict geopogical bougea values and to locate and plot water quality monitoring stations. Meanwhile, the line data base format has been used to incorporate stream, road, and political boundary data into the system. Lastly, when entering land use categories from Landsat digital tapes, the grid cell data base format was employed by LRIS.

## CODING, ENTRY, STORAGE

Automated techniques are utilized for data coding and entry into the system. A manual digitizer is used to determine the x-y coordinates of polygons, points, and lines. These coordinates are interactively entered into the system and temporarily stored on computer disk. Eventually the data contained on the disk will be transferred to computer tapes.

The labeling of the variable categories, which an individual point, line, or polygon represents, is also done interactively either during or after the digitizing process. In the latter case, Comarc's software provides a program for assigning labels to variable categories interactively with keyboard terminals.

The Comarc system enables one to assign an individual point, line, polygon, and grid cell a maximum of five different labels. For example, a polygon may be assigned for its first label a numeric code of "14" which would represent a major soil type. A second label, "5", may accompany the "14" label to indicate that this particular polygon is also on a slope between 10 and 15 percent.

With data being entered into the system by a variety of users, each utilizing a different data source, two geographic reference systems are employed to ensure uniformity and computability. The polygon, point, line, and grid cell data are converted to the State Planee Coordinate System prior to entry into the system. Also for the grid cell data base format, the use of a hierarchical grid structure with cell sizes ranging from very small to very large, has ensured the consistency and compatability of data stored in this fashion.

## GEOGRAPHIC RETRIEVAL OF STORED DATA

Data can be geographically accessed by using the State Plane Coordinate Reference System or by a software program involving the overlaying of two or more data files.[2] The latter method involves overlaying a file containing the political boundary or natural boundary locations with a file, or files, containing the desired variable categories. For example, a file containing the county boundaries of the state may be overlain with a file containing soils data. A map could then be generated which would show those soils contained within the boundaries of the specified counties.

## DATA BASE

Lris did not undertake extensive projects to define user data needs in the state and to collect and store these data into the system. Instead, LRIS decided to create its data base incrementally. They utilize the data collected and entered by various user agencies and private groups for their particular projects. This obviously ensures the usability of the data and also reduces LRIS's manpower needs.

Table 1 indicates the current status of the LRIS data base. County boundaries, subbasin boundaries, enumeration district boundaries, region boundaries, generalized soils (95 variable categories), general topography (50' contours) and 1970 population estimates by enumeration districts have been collected statewide and stored in the system. Land use for the state is currently being entered and will be completed by December, 1980.

Data has also been entered into the system for specific regions and counties in North Carolina (see Table 1). These data types include detailed soils, streams, land use, recreation sites, important farmlands, federally owned lands, and roads.

## DATA MANIPULATION AND ANALYSIS

The Comarc system is based on the software program known as Comarc Planning Implementation System (COMPIS). COMPIS was designed by Comarc specifically to be used in conjunction with the hardware leased by LRIS. The COMPIS software package consists of seven major rountines; data base implementation, arcs, polygons, grids,

## TABLE 1

## LRIS DATA BASE STATUS

### STATEWIDE

| SUBJECT | ORIGINAL SCALE | FORM |
|---|---|---|
| Water Impoundments | 1:250,000 | Points |
| County Boundaries | 1:500,000 | Polygon |
| Subbasin Boundaries | 1:250,000 | Polygon |
| Enumeration District Boundaries | 1:126,720 | Polygon |
| Region Boundaries | 1:500,000 | Polygon |
| Generalized Soils | 1:250,000 | Polygon |
| Land Use/Land Cover (USGS LUDA Data to be available Dec. 79) | 1:250,000 | Polygon |
| General Topography | 1:250,000 | Grid |
| Hydrogeology | 1:250,000 | Polygon |
| 1970 Population Estimates by Enumeration District | 1:126,720 | Grid |
| Zip Code | 1:1,000,000 | Polygon |

### SPECIFIC GEOGRAPHIC AREA

| SUBJECT | | |
|---|---|---|
| Detailed Soils (Wayne Co., New Hanover Co., portions of: Lenoir, Forsyth, Transylvania, Person, Sampson) | 1:20,000 | Polygon |
| Streams (Wayne Co., New Hanover Co., portions of: Forsyth, Person, Transylvania) | 1:24,000 | Lines |
| Land Use Portions of: Wayne, Lenoir, Union, Anson) | 1:24,000 | Polygon |
| Recreation Sites (Regions D, F, G, K, L) | 1:126,720 | Points |
| Important Farmlands (Wayne Co.) | 1:20,000 | Polygon |
| Federally Owned Land (Buncombe Co., Transylvania Co.) | 1:63,360 | Polygon |
| Roads (Portions of: Wayne Co., Lenoir Co., New Hanover, Transylvania) | 1:24,000 | Lines |
| Transmission Corridors (Nantahala-Pisgah National Forest) | 1:63,360 | Polygon |
| Stands and Compartments (Nantahala-Pisgah National Forest) | 1:24,000 | Polygon |
| Endangered Species Habitats (Nantahala-Pisgah National Forest) | 1:24,000 | Polygon |
| Trout Streams (Nantahala-Pisgah National Forest) | 1:63,360 | Line |
| Archeological Sites (Nantahala-Pisgah National Forest) | 1:63,360 | Point |

topography, lines, and points. Each routine is comprised of various options or subroutines for analyzing and manipulating the data. These seven routines and their more important options are discussed briefly below.

1. Data Base Implementation - Data base implementation has two subroutines; the first enables one to digitize raw source data from maps or photographs while the second allows the digitized maps to be scaled to a desired storage size.

2. Arcs[3] - The main purpose of the "edit file" option is to remove operator errors which arose during the digitizing process. This is accomplished interactively by displaying the digitized arcs onto a CRT screen. Operator errors are removed by hitting the proper sequence of characters on the CRT keyboard. The "change map parameters" option allows one to change the minimum x and y values, lengths of arcs, number of nodes[4], number of arcs, file name, and data type. Redundant points, which occur when two arcs share a common border, can be removed by the "thin arc" subroutine. The "ZETA plot" subroutine provides the user with a choice of the scale of the output map, size of the labels, minimum size of arcs to plot, title block, and plotting with labels.

3. Polygon - Similar to the "Arcs" program, the polygon program possesses subroutines which allow one to change map parameters, remove digitizing errors interactively, thin files by removing redundant points and produce a map by use of Zeta Drum Plotter. The polygon has additional options for manipulating and analyzing stored data. A subroutine will calculate the acreage summary of polygons by variable categories. Another option allows one to extract polygons from a file based on five different criteria (sequence number, label number, minimum areas, or user defined area) and to graphically display these polygons.

   The "overlay" subroutine is one of the more important options of the polygon program. This option will find and combine the characteristics of two maps that occupy the same geographic area. The "window overlay" subroutine permits the user to define a geographic window to be overlain on a map. This would reduce the output map to the size of the user defined window. Additional polygon data can be entered into the system with the "update map" option. Finally, a subroutine exists which converts polygon data to the grid cell data base format with the user being able to select the number of columns and rows, and grid cell size.

4. Grid - The Grid program, like the Arc and Polygon Programs, has similar subroutines which enable one to change map parameters (including grid cell size), plot a map at any designed scale, calculate acreage summary of grid cells by variable categories, and overlay two or more grid files to produce a composite map. However, the grid program contains several features not present in arcs or polygons. One subroutine will search for extreme grid cell label values and create a new file representing only this label. Another option allows the user to select a label as a seed and to create proximity rings around the seed label. Other interesting subroutines include the creation of shaded perspectives and three dimensional graphic representations of grid cell files.

5. Topography - The topography program also possesses editing, map parameter change, Zeta plot, overlay and label options. In addition, the topography program has subroutines which do the following:

   Calculate the percentage of slope of a given area.
   Compute aspect.
   Determine direction of sun and wind exposure of a given area.
   Calculate and plot the drainage pattern of any area where topography is known.
   Calculate the "viewshed" from any point or linear feature.
   Perform a cross section of topographic data at any scale between any two points on a site.
   Plot contours at any contour interval regardless of the interval in which the map was originally digitized.
   Calculate "cut and fill" volumes and show the elevation on a line printer map on each point on the site before and after grading.

6. Point and Lines - The point and line programs posses features similar to the above programs. These include the functions of editing, thinning, summarizing lengths, extracting lines and points, plotting, overlaying, and labelling.

DATA DISPLAY

Computer mapping with the Zeta drum plotter represents the primary means for data display. Maps can be plotted at any scale, regardless of the original scale of the digitized map or photograph. The system allows a multitude of different colored shadings and labelling. Maps may also be displayed on the two Tektronix screens for editing and previewing purposes.

## MINNESOTA LAND MANAGEMENT INFORMATION SYSTEM

During the 1960s and 1970s, the legislative climate in Minnesota gave rise to many progressive laws regarding the management of the state's resources. To effectively implement these various measures, resource data needed to be collected, stored, analyzed, and displayed. The most efficient means to handle these vast amounts of data was through the use of a computerized data bank and mapping system.

In 1967, the Minnesota Outdoor Recreation Commission funded the University of Minnessota's Geography Department to collect data on privately owned lakes in the state. The types of data requested by the Commission included location of seasonal and permanent homes, dominant soil and vegetation types, lake ecology, and road accessibility. Two years later, the Geography Department had secured this information for more than 2,000 lakes. This data was encoded on some 38,000 grid cells, with each cell being 40 acres in size. The cell data was then stored in a computerized data bank and, with several software routives, was analysed and displayed as maps.

The success of the data bank and mapping process encouraged other agencies to utilize this system. In 1968, Minnesota's State Planning Agency (SPA) decided to obtain land use information for the entire state and to handle the data in a similar fashion to that of the University of Minnesota's lake inventory. The 40 acre size grid cells were again employed, and by 1971, the state land use inventory was completed and incorporated into the computerized data bank. Over the next few years, additional state funds were appropriated for entering new elements into the ever growing data bank; known as the Minnesota Land Management Information System (MLMIS). These new elements included political, water, highway, geological and planning data.

### SERVICES

In July, 1977 the MLMIS was moved from the University of Minnesota to the State Planning Agency (SPA), where it was situated at the newly created Land Management Information Center (LMIC). The principle function of the LMIC is to train and advise state and private agencies in the use of MLMIS. Other duties of the Center include centralizing the state's mapping and remote sensing information, maintaining the data base, developing new analysis tools, and entering new data. Although the Center will assist local governmental agencies in accessing MLMIS, they have mainly relied on the state's 13 regional planning commissions to provide this service.

### COSTS AND FUNDING

The twelve year development cost for MLMIS was approximately $1,800,000. To cover the cost, funds were secured from a variety of public and private sources. The major contributor was SPA (47%); other sources included the Minnesota Information Resources and Development Fund, the Legislative Commission on Minnesota's Resources, the Land Exchange Review Board, the Rockefeller Foundation and the Center of Urban and Regional Affairs, University of Minnesota.

Beginning with the 1977 fiscal year, the development costs of MLMIS were funded through a state legislative appropriation as a budget item in SPA. Operation costs for a particular project are currently covered by a user fee system. The most recent rate for the user services of training and advice is $10 per hour, while computer and supply time is $15 per hour. Charges are also levied for map production and summary reports. A 50-page computer-generated report costs approximately $100.

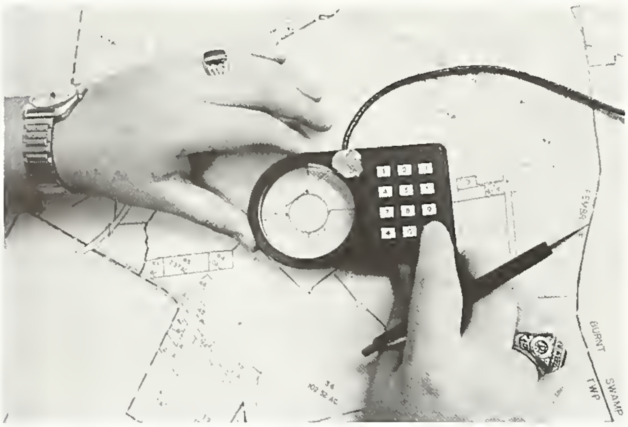
### HARDWARE

MLMIS presently employs the following hardware:

1. An IBM computer for storing and processing land information.
2. Several cathode ray tubes for editing and preview purposes.
3. A standard line printer for generating preview maps and reports.
4. Several digitizing tables for encoding and entering data.
5. A plotter for producing final map versions.

### MLMIS DATA BASE

The grid cell was chosen as the format for encoding and storing data. During MLMIS's existence, the most frequently used grid cell size has been 40 acres. The popularity of the grid cell and the 40 acre size are due to several reasons. First, as a result of the U.S. Public Land Survey, the 40 acre parcel has historically been the basis for allocation of land in the state. Government tax and property records in Minnesota are referenced by the Public Land Survey designations. But



*A data encoder manually digitizes a property map.*
*Photo N.C. Dept. of Nat. Res. and Comm. Dev.*

most important, the 40 acre grid cell approach is a convenient format for computer mapping and analysis of data encompassing statewide and regional areas. Thus, the MLMIS data base format was designed for planning studies at the state, county, and regional levels, and was not intended for planning investigations at the municipal or urban levels.

However, for those users desiring smaller cell sizes, MLMIS possesses the capability of encoding and storing data with cells of 2.5 acres and less. Conversely, users may find the 40 acre grid cell too small for their purposes. MLMIS provides these users with the option of utilizing a 5 kilometer grid cell (approximately 10 square miles).

CODING

To convert raw data to grid cells, a transparency is divided into grid cells and is manually overlayed onto the map or photograph containing the information. Each cell is then examined and the predominant data type under investigation within the cell is recorded as a numeric value on coding sheets. The information on the coding sheets is transferred to computer cards, for eventual entry into the system.

However, because manual coding is a tedious method for data entry, a second process has often been employed, called digitization. A manual digitizer is used to trace the boundaries of the variables data category as a series of polygons. These polygon boundaries are automatically entered into the system and are converted to grid cells by a software program.

In addition to the coding of the variables categories, a geographic referencing system was required for each cell. A fourteen digit number representing the state, county, minor division, section and parcel is assigned to uniquely identify each cell. Also, centroids with latitude and longitude coordinates are situated in each minor civil division, and these are entered into the system.

DATA MANIPULATION AND ANALYSIS

The computer software system which serves as the basis for MLMIS is the Environmental Planning Programming Language (EPPL). A Fortran based language, EPPL was designed specifically for MLMIS. It is comprised of several routines and a number of subroutines which analyze and display data. EPPL's three major routines are file manipulation, map compositing, and geographic relationships.

The two subroutines under file manipulation are "window" and "scale change". The window option enables one to choose a section of a larger map to be used for further analysis. For example, a township file can be retrieved for analysis from the larger county file. The scale change subroutine allows the user to reduce or enlarge the area found within the data cells. With this option, a user can combine four 40 acre grid cells to a 640 acre grid cell. Conversely, one might change 40 acre cells to 2.5 acre cells.

The second major routine, map compositing, consists of three different subroutines. The first two, "bigtab" and "flow", permit the user to create a new map based on the combination of several variables. For example, a map might be constructed which would display all cells that are forested land use, of the oak forest type, and on lakeshore which is not publicly owned. Or a map might be devised to depict only the union of two variable-categories, such as a map displaying a certain soil type on a certain percentage slope. The third subroutine, "score", allows the user to assign a numerical score to various variable categories. These scores would represent the relative importance of the variable category to the particular process in question. A map could then be generated which would indicate the effects of weighing variables.

Finally, the geographic relationship routine enables the user to analyze many variables for large areas and then graphically display the results. This routine allows one to locate an ecological "edge" between covertypes and to find a "viewshed".

DATA DISPLAY

Computer mapping represents the primary means for displaying information of the MLMIS. Several data display devices have been utilized, including the standard line printer, the desk top interactive terminal, and the dot plotter.

Designed primarily for producing output for typical computer programming runs, the line printer has often been used to produce MLMIS maps. Each letter or character on the device represents a data cell. But, because characters and letters possess rectangular rather than square dimensions, the map output is distorted. Therefore, maps generated by this device often serve as an interim map for checking coding errors and for initial inspection of analysis maps. Tabulations and statistical tables are also produced by the line printer.

A second output device is the desk-top interactive terminal or cathode ray tube (CRT). Due to scale distortions in its map display, this device is also used for preview and editing purposes. The dot plotter is the most effective of the devices in terms of map accuracy. It enables one to manipulate dot patterns and thus create grey-tone mapsymbols. The dot patterns can range in size from .01" by .01" to .25" by .25". Besides dot patern type maps, the plotter is capable of generating three-dimensional maps.

DATA

Oata for 13 different variables have been collected for the entire state utilizing the 40 acre grid-cell format. Each of these 13 variables possess numerous characteristics or data levels which are assigned to an individual cell. For example, for the forest variable, a cell may be assigned one of nine different data levels (white, red, or jack pine, spruce-fir, oak-hickory, elm-ash-cottonwood, maple-birch-basswood, aspen-birch, unproductive, reserved, non-forested). Other statewide variables in MLMIS include:

- Township
- Minor Civil Divisions
- Public Ownership Lands
- Type of Acquisition of State or County Owned Land
- Highest Recommended Use of State or County Owned Land
- Recommended Disposition of State or County Owned Land
- Management Unit Status of State or County Owned Land
- Land Use
- Water Orientation
- Highway Orientation
- Soil Landscape Unit
- Geomorphic Regions

For certain areas of the state, data has been collected and stored at grid cell sizes smaller than 40 acres. One such area, the Lake Superior shoreline, has been inventoried with a 2.5 acre grid cell format. The shoreline data collected includes the variables of slope, slope orientation, soil associations, soil series, water system, forest cover, land ownership, and land use. Meanwhile, the larger 5 kilometer grid cell has been employed for encoding and storing data on population distribution, crop and livestock production information, climate data, and watershed boundaries.

DATA SOURCES

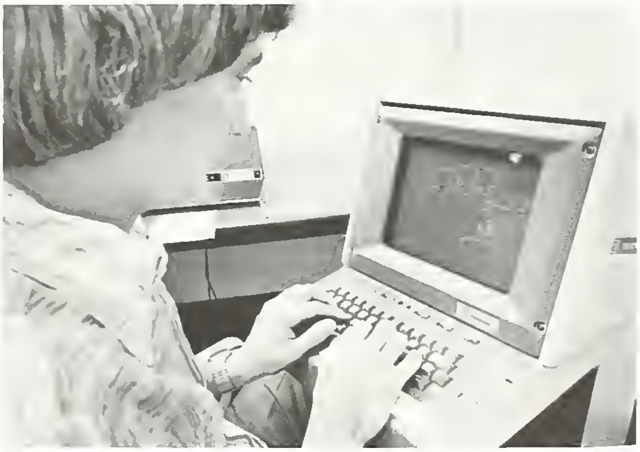
MLMIS designers' policy has been to identify and locate useful data already available within the state rather than undertaking extensive inventories on their own initiative. The major data sources for MLMIS have been data collected by various levels of government including county, state, and federal. However, if a particular data type is highly desirable by potential users, MLMIS will initiate a data collection project.

CLASSIFICATION SCHEME

By accepting data collected by other agencies, the classification schemes employed by these agencies were adopted for MLMIS. This eliminates the bias associated with managing personnel of the MLMIS devising their own classification scheme. Another advantage is that the primary data collector would be in a better position to describe the methods of data collection.

USERS

The users of MLMIS have primarily been those federal, state, local and private agencies involved in the land use planning and management process. Several of Minnesota's



*Operator interactively edits a digitized map on a Tektronix cathode ray tube.*
*Photo N.C. Dept. of Nat. Res. and Comm. Dev.*

state agencies, particularly the Department of Natural Resources and the State Planning Agency, have utilized the system for numerous projects, including an atlas of resources and settlement, a coastal zone management atlas, and studies of cropland resources.

## COMPARISON OF THE MLMIS AND LRIS

After reviewing the preceding two chapters, it is apparent that many differences and similarities exist between the MLMIS and the LRIS. This section will examine the similarities, and will discuss the relative merits of the systems differences.

### SIMILARITIES

*Funding* Initial funding for the development costs of MLMIS and the leasing cost of the COMARC system were secured from state governmental agencies. This similarity stems from the greater potential for use of the system which the state agencies have when compared with smaller agencies and private groups.

*Design and Services* The two systems were designed so as to allow clients with little background in computer programming and information systems to readily enter, retrieve, analyze, and display land related information. By allowing users to perform these functions, data are entered more effectively due to their familiarization with the data's useage. Also with a user oriented approach, staff size and budget needs are less. Service rendered by MLMIS and LRIS similarly consist of training and advice, with the cost of these services being nearly identical in the two states.

*Users* The major users of MLMIS and LRIS have been state agencies for several reasons. First, due to their physical locations in their respective state capitols, state agencies find these two systems readily accessible. More importantly, state agencies have the financial means and necessary personnel to take advantage of the systems' capabilities, which smaller local agencies and private groups often lack. Lastly, state projects usually involve the handling of large amounts of land-related data, thus making processing by a computerized information system economically feasible.

*Digitizing Problems* LRIS and MLMIS share a common problem concerning the digitizing process. Errors frequently arise while human operators move a digitizing cursor around the boundaries of the variable in question. It has been estimated that for every 20 hours of digitizing, nearly 10 hours of editing and redigitizing are necessary to correct these errors.

*Classification Scheme* A MLMIS and LRIS policy has been to adopt the classification schemes developed by the data collecting agencies. Both felt that employing the information collectors' schemes would eliminate potential bias problems which could develop if MLMIS and LRIS staffs were to devise their own schemes.

*Data Collection* With the prohibitive costs of data collection projects, MLMIS and LRIS have made concerted efforts to use existing collected data for eventual entry into their systems rather than securing this information on their own.

*Data Types* Presently land use represents the only similar data type entered into the MLMIS and LRIS on a statewide basis. Given the different geographic areas they serve and associated environmental and land use concerns, it is understandable that only one common statewide data type exists. Both systems have collected data for smaller geographic areas, such as counties and watersheds. Similar data collected at these more detailed levels have included soils, land use, and hydrological information.

*Software* Similar software analysis routines are utilized by the two systems. Both allow the user to generate a plotted map at various scales, to define a geographic window to extract land data, to graphically display the union and weighing of two or more variables, to calculate acreages for a specific variable, and to determine an "ecological edge" (where two vegetative cover types merge) and viewshed.

### DIFFERENCES

*Services* Minnesota's regional planning agencies serve as the main nexus for the local governmental agencies and the MLMIS. Conversely, LRIS staff have attempted to familiarize local agencies with the system. However, due to the vast numbers of local agencies in the state and the small staff size, LRIS finds itself at a disadvantage in trying to inform these agencies of the system's capabilities.

*Software Development* The software programs for entering, storing, retrieving, analyzing and displaying land information and the specialized land information language (EPPL) were designed by MLMIS over a ten year period. The principal advantage in developing one's own system is that the system can be designed to meet particular needs. In Minnesota's case, with the "township and range" land-ownerships being a strong determinant in the cultural land patterns, an information system was designed to take advantage of this phenomena. However, the costs of developing a system from the ground up, as evidenced by the nearly $2 million price tag for MLMIS, are quite high. Furthermore, the lead time to become operational takes several years.

The North Carolina land information system avoided these problems by adopting a previously designed system from a private consulting firm. LRIS was able to undertake pilot projects within several months of the installment of the software/hardware package. LRIS choose this route for several additional reasons. First they felt that a consulting firm would have more experience and expertise with information systems than their newly formed unit; and second, it greatly reduced their need to hire additional staff for system development.

However, the consulting firm approach is not without its drawbacks. At the outset, LRIS had to raise a considerable amount of money for the leasing of the COMARC system. Due to the "secret recipe" of the software programs, LRIS has a continuing dependency on COMARC consultants when modifications are sought.

*Leasing vs. Purchasing* LRIS leases its software and hardware while MLMIS has purchased hardware and developed its own software. When new computer technology advances occur, the leasing approach will allow LRIS to switch to new, more attractive systems. However, over the long run, the leasing costs may exceed the cost of purchasing a total system. With the enormous amounts of money and effort devoted to the development of MLMIS, Minnesota is reasonably committed to using this system for many years, without any real opportunity to change.

*Data Base Format* LRIS possesses four different data base formats, polygon, point, line, and grid cells, while MLMIS relies solely on the grid cell format. The advantages of entering data in polygons rather than in grid cells are as follows:

1. accuracy of the data is retained;
2. variable boundaries are more precise when outputting in map form;
3. polygons can be readily converted to point, lines, and grid cell format; and
4. more subroutines exist for data manipulation and analysis.

The drawbacks in using this format are that polygons are not conducive to mathematical modeling, require complicated software programs for data handling, and digitizing equipment for entering variable categories.

The major advantages in using the grid-cell format include the following:

1. simple data processing involved;
2. change and update accomplished easily;
3. facilitates line printing output maps;
4. modeling is easier for it does not require precise boundary locations;
5. encoding can be done manually; and
6. less computer time and space are needed.

The major disadvantages of a grid cell approach are as follows:

1. poorer appearance of grid cell based maps;
2. adopted grid cell size will be a compromise that might be less suitable for some of the data;
3. imprecise representations of areal boundaries;
4. loss of accuracy and generalizations;
5. difficulty in representing points and lines; and
6. inability to depict dense data effectively without reducing to smaller grid size.

In comparing polygons with grid cells, the polygon data base format is a more effective format for handling land related data. Maps generated from polygons closely resemble traditionally hand drawn maps, which the average individual better relates to than maps produced from a grid cell format. More importantly, more analysis tools can be applied to polygon encoded data. Futhermore, one is able to convert to grid cells from polygons and enjoy its advantages whereas the switch from grid cells to polygons is not feasible.

*Hardware* A small "minicomputer" processes the land related information for LRIS while MLMIS employs a large computer. The MLMIS computer possesses greater storage capacity as well as the ability to process large amounts of data more quickly than the LRIS minicomputer. With this large computer, MLMIS's staff has a better response time to interactively feed commands during the editing phase. LRIS is presently hampered by a slow response to editing commands.

*Geocoding* MLMIS's geocoding procedure consists of assigning a 14 digit code representing the state, county, minor division, section, parcel and centroid number which the grid cell appears in. Meanwhile, LRIS, by utilizing the state plane coordinate system ia able to more rapidly accomplish to geocoding task.

*Software Programs* LRIS has greater analytical capabilities than MLMIS. The data base formats of LRIS lend themselves to a greater variety of analysis techniques and, being a relatively new system, COMARC has incorporated many of the current state of the art analysis tools. These additional LRIS software features include the abilities to: calculate percentage of slope, compute aspect, determine sun and wind exposure of a given area, calculate the drainage pattern, perform cross sections, plot contours, and calulate cut and fill volumes.

*Data Base* MLMIS has undertaken projects to collect and enter land related data without client funding. Once stored in the system, this information is readily available for retrieval by all interested groups. MLMIS was able to fund these projects by virtue of being a budget item in the state. However LRIS does not have this institutional arrangement. Instead they must rely on user fees to cover the data entry costs of projects. Consequently, only those user agencies with the financial means and available personnel are able to readily utilize the system.

Agencies with smaller operating budgets and limited staffs have tended to wait until an agency with the necessary funds and manpower have accomplished the time consuming and expensive tasks of data collection, entry, and editing. Once stored in the system, these smaller agencies would have access to this information and be able to bear the costs of data retrieval, analysis, and display.

As discussed above, MLMIS and LRIS possess particular strengths and weaknesses. For MLMIS, its statewide data base and consulting arrangements with local governments represent the strong points of the system while the grid cell data base format and limited analysis techniques are drawbacks. In the LRIS case, the polygon data base format, software analysis capabilities, and map display comprise its major assets while the slow editing process, few contacts with local governmental agencies, and data base approach are its limiting features.

## NOTES

1. Interpreted data is raw data which has been categorized by the user. For example, major soil types data may be classified according to its erodibility (high, medium, and low) and entered into the system according to its erodibility criteria.
2. A data file refers to stored data on computer tape.
3. An arc is defined as a line between two digitized x-y coordinates.
4. A node is defined as a point where three lines come together.

## REFERENCES


Hicks, Jimmy E., and Tom Hauger. 1977. *Managing Natural Resource Data: Minnesota Land Management Information System.* Council of State Governments.

Minnesota State Planning Agency. 1979. *EPPL's Quick Lookup Guide.* St. Paul: State of Minnesota.

Minnesota State Planning Agency. 1978. "Introducing the Land Management Information Center." St. Paul: Land Management Information Center.

Minnesota State Planning Agency. 1975. *North Shore Data Atlas.* St. Paul: State of Minnesota.

North Carolina Land Resources Information Service. 1977. *Land Resources Information Service: Concept Documentation.* Raleigh, N.C.

North Carolina Land Resources Information Service. 1978. *LRIS General Work Program, 1978-1979.* Interagency Memorandum.

Simmermacher, Carol. Director of Land Resources Information Service. Personal Communications, January, 1979 through April, 1979.

Robinette, Alan, and Earl Nordstrand. 1978. *A resource Information System Developed By User Applications.* St. Paul: Minnesota State Planning Agency.