COMPUTER ASSISTED LAND USE PLANNING FOR A STATE PARK*

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ABSTRACT

This paper describes a project presently underway utilizing remotely sensed data and computer assisted procedures for the location and planning of a new state park. Data was collected on an initial study area of 128,620 acres from which several possible park sites were outlined. After a site was selected, similar procedures were used to outline possible locations for various elements within the park. An iterative design procedure will be used to develop an optimum final design for the park. Included is a detailed discussion of the CALUP (computer assisted land use planning) package developed to support the planning procedure.

INTRODUCTION

Mississippi, as well as many other states, is experiencing considerable demands on state-owned outdoor recreational facilities. The state legislature, reacting to these demands, recently funded a program that, when matched with federal funds, will provide approximately 72 million dollars for acquisition and development within the State Park System. Since 1972, when the formal program was established, the State Parks Commission has been hampered in many of their planning and development efforts simply due to a lack of readily available site planning information.

Increased environmental awareness of the public has made the need for sound planning decisions based upon accurate and detailed site information imperative. Such decisions must be based not only on accurate information about the specific site, but also on the surrounding environmental conditions. It has been recognized that decisions concerning relatively small parcels may have a profound impact upon large areas. Conventional methods of survey, while very accurate, are time-consuming and expensive, particularly when site selection is considered.

This paper describes a demonstration project using remotely sensed data for the location and planning of a new state park. This project, coordinated by the Center for Environmental Studies at Mississippi State University and supported by the National Aeronautics and Space Administration, is designed to demonstrate the use of high and low level aircraft imagery and computer-assisted procedures for obtaining discrete site planning at an intimate scale.

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TABLE 1

NATCHEZ STATE PARK - PHASE II

VARIABLE WEIGHTINGS (in percent) FOR ELEMENT SUITABILITY

VARIABLE	SUITABILITY FOR:									
	Lodge	Single Family	Undis-turbed Lands	Trans-port	Group Camp	Marina	Trailer Camp	Beaches	Out-door Fields	Inst. Bldg.
1. Centroid Elevation (ft.)										
2. Aspect	8.7	7.3			10.3	14.3		26.7		9.4
3. Slope Percent Class	8.7	7.3		25.0	10.3	23.8	15.1	23.3	22.2	9.4
4. Topographic Position	11.6	5.5		15.0	10.3	14.3	*		5.6	9.4
5. Soil Character	11.6	7.3		20.0	13.8	14.3	15.1	23.3	13.9	12.5
6. Soil Water Regime				20.0					13.9	
7. Surface Water										
8. Forest Stand Composition	10.1	14.5	16.1		12.1		11.5			10.9
9. Forest Stand Density		12.7	13.5	10.0		9.5	11.5	16.7	8.3	
10. Forest Stand Condition Class	10.1	14.5	16.2	10.0	10.3	9.5	11.5			9.4
11. Agricultural Activity										
12. Minerals & Mining										
13. Structures & Development										
14. Transportation										
15. Rights-of-Way									8.3	
16. Proposed Lake Location			*	*						
17. Centroid Elevation (coded)	11.6				6.9					6.3
18. Existing Activity										
19. Prox. to Proposed Lake	14.5	9.1			6.9	*	9.4	*	*	6.3
20. Prox. to Minerals & Mining			8.1						13.9	
21. Prox. to Unimproved Roads						9.5			5.6	9.4
22. Prox. to Unpaved 2-Lane Roads	4.3		10.8		6.9		5.7			6.3
23. Prox. to Rights-of-Way			8.1							
24. Prox. to Agricultural Activity			8.1							
25. Prox. to Structures & Develop.			10.8						8.3	
26. Prox. to Existing Activity	8.7	9.1			12.1	4.8	11.5	10.0		10.9
27. Prox. to Streams		9.1	8.1				9.4			

*Restrictive Variable

PROCEDURE

The basic format for the study encompasses three major phases: 1) the site selection phase; 2) the detailed planning phase; and 3) the final design phase. Each of the phases require extensive interaction between the project personnel and the planning staff of the Mississippi Parks Commission. Also, each phase is supported by computer-based procedures for processing and analyzing the remotely sensed data. At present, the first and second phases have been completed.

The Site Selection Phase. The objective of this phase was to locate two or more sites in a study area which best met the criteria defined for the state park. Both the study area and the location criteria were defined by planners working with the Mississippi Parks Commission. The study area encompased eighty per cent of the total land area of Adams County, Mississippi -- a total area of 57,600 hectares or approximately 32 square miles.

In order to use computer-assisted evaluation techniques, it was first necessary for the planners to explicitly define:

1) the site selection factors to be considered;

2) variables or attributes relating to these factors; and

3) quantitative relationships between the defined variables and the site selection factors.

The required variables were then collected at discrete points (every 4 hectares) and suitability models developed for computer-assisted evaluation. The models and the computer procedures are described in a later section.

The Detailed Planning Phase. Once the site was selected and approved, the next phase involved the location of suitable locations for the elements within the park. The procedure used for this phase was similar to that used in the first phase. A team of planners first determined the elements that were required in the overall park plan (camping area, cabin areas, undisturbed lands, etc.) and the variables that could be used to define the suitability for such areas. The team was then required to establish quantitative relationships (described later) between the element suitability and the variables. Table 1 shows the elements and variables used in the detailed planning phase and their relative relationships.

The required data variables were then recorded at discrete points (every 1 hectare) and processed using essentially the same computer procedures as those used in the first phase.

The Final Design Phase. Utilizing an "iterative" peocedure between a park designer and a computer evaluation based on the suitability models developed in the second phase, this phase should produce a final master plan for the park. The result of the second phase is a set of grey level maps detailing the suitability of each proposed element within the park. From these maps the designer will derive a specific plan which can be evaluated quantitatively against the second phase models. A revised plan by the designer can then be compared to the first plan and both improved and debased areas can be delineated. Successive "iterations" should lead the designed closer to the "optimum" design.

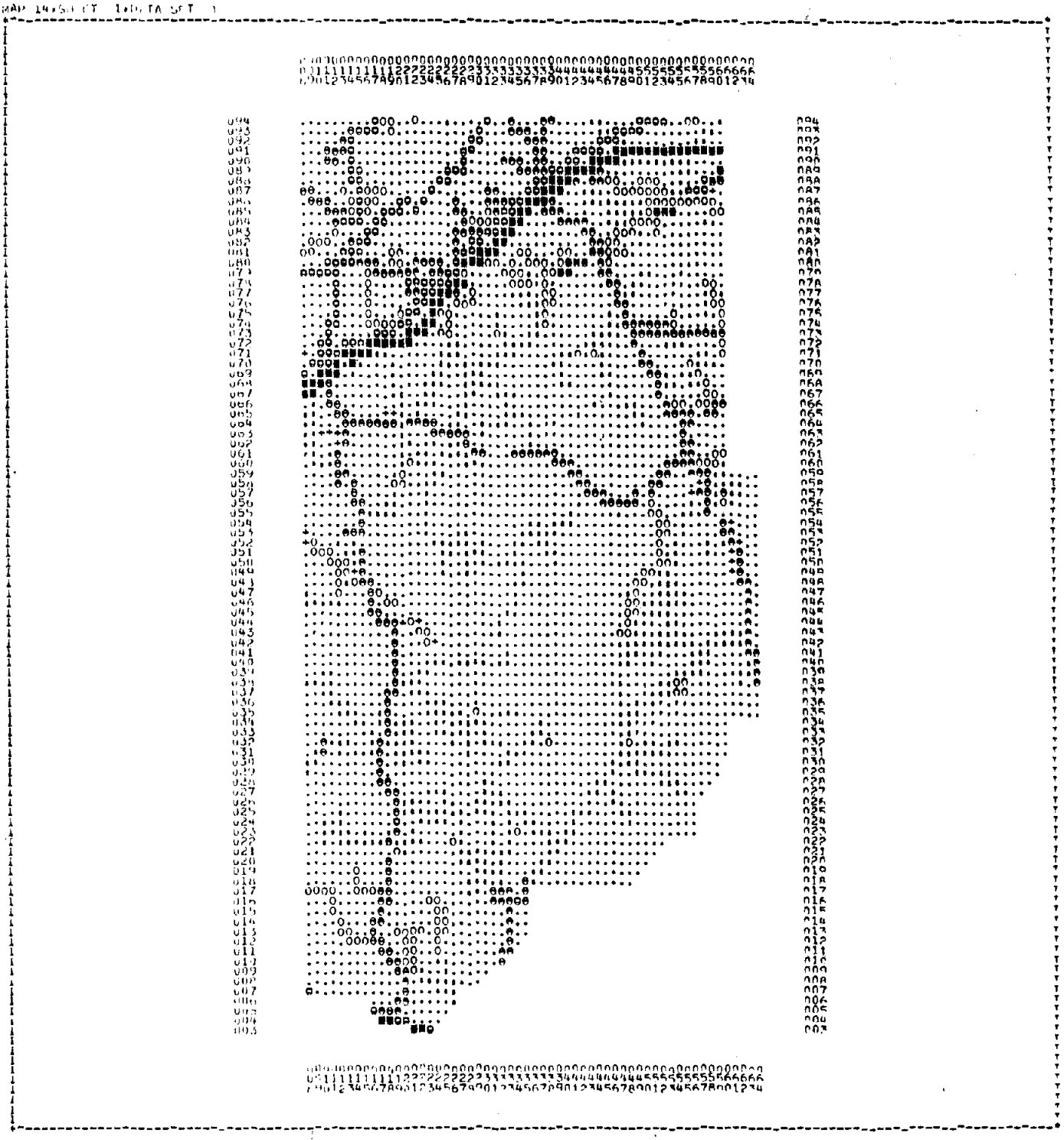

Figure 1. Variable Coding Map -- "Transportation Routes"

THE CALUP PROGRAMS

The computer-assisted procedures used in this project are a modification of those used in the Honey Hill project (1) by researchers at the Harvard Graduate School of Design. CALUP (Computer-Assisted Land Use Planning) is simply a set of programs to support the various computational, evaluative, and mapping requirements of the procedure.

In order to utilize the CALUP procedures, a coordinate data base must first be established. An entry in the data base would be the coordinates of a cell and the coded values of all collected variables. For example, a cell centered at relative coordinates 30N, 23W might have for variable 3 (forest stand density class) a code of 3(50 to 75% closure). The collected variables may then be used to generate new variables which measure distances from, proximity to, or combinations of particular conditions. An example of a generated variable might be "proximity to a second or third order stream" where a coded value of 3 implies that such a stream exists three cells away. Figure 1 illustrates the variable "Transportation Routes" used in the second phase of the state park study.

Once the data base is established, suitability models must be developed. Figure 2 shows the model developed for "Undisturbed Areas" in the second phase of the state park study. The planners involved in the study selected ten variables to define the suitability for undisturbed areas within the park. The relative

Suitability Index Name UNDISTURBED LANDS Study NATCHEZ STATE PARK - PHASE II

Date JUNE 1975

Variable No.	Variable Value 0	1	2	3	4	5	6	7	8	9	Weight	Weight Per Cent
8	0	9	0	7	0	5	0	0	0	0	6	16.2
9	0	9	0	7	0	5	0	0	0	0	5	13.5
10	0	9	8	0	5	3	0	0	0	0	6	16.2
16	1	0	0	0	0	0	0	0	0	0	0	0.0
20	0	0	0	1	2	3	4	5	6	9	3	8.1
22	0	0	0	0	1	2	3	5	7	9	4	10.8
23	0	0	0	1	2	3	4	5	7	9	3	8.1
24	0	0	0	1	2	3	4	5	7	9	3	8.1
25	0	0	0	0	0	1	3	5	7	9	4	10.8
27	9	8	7	6	4	2	1	1	1	1	3	8.1

Rate each value for each variable from 1 (low) to 9 (high).

To reject a cell on a particular condition, code a 0 under those particular variable values.

Figure 2. Suitability Index Evaluation Form --"Undisturbed Areas"

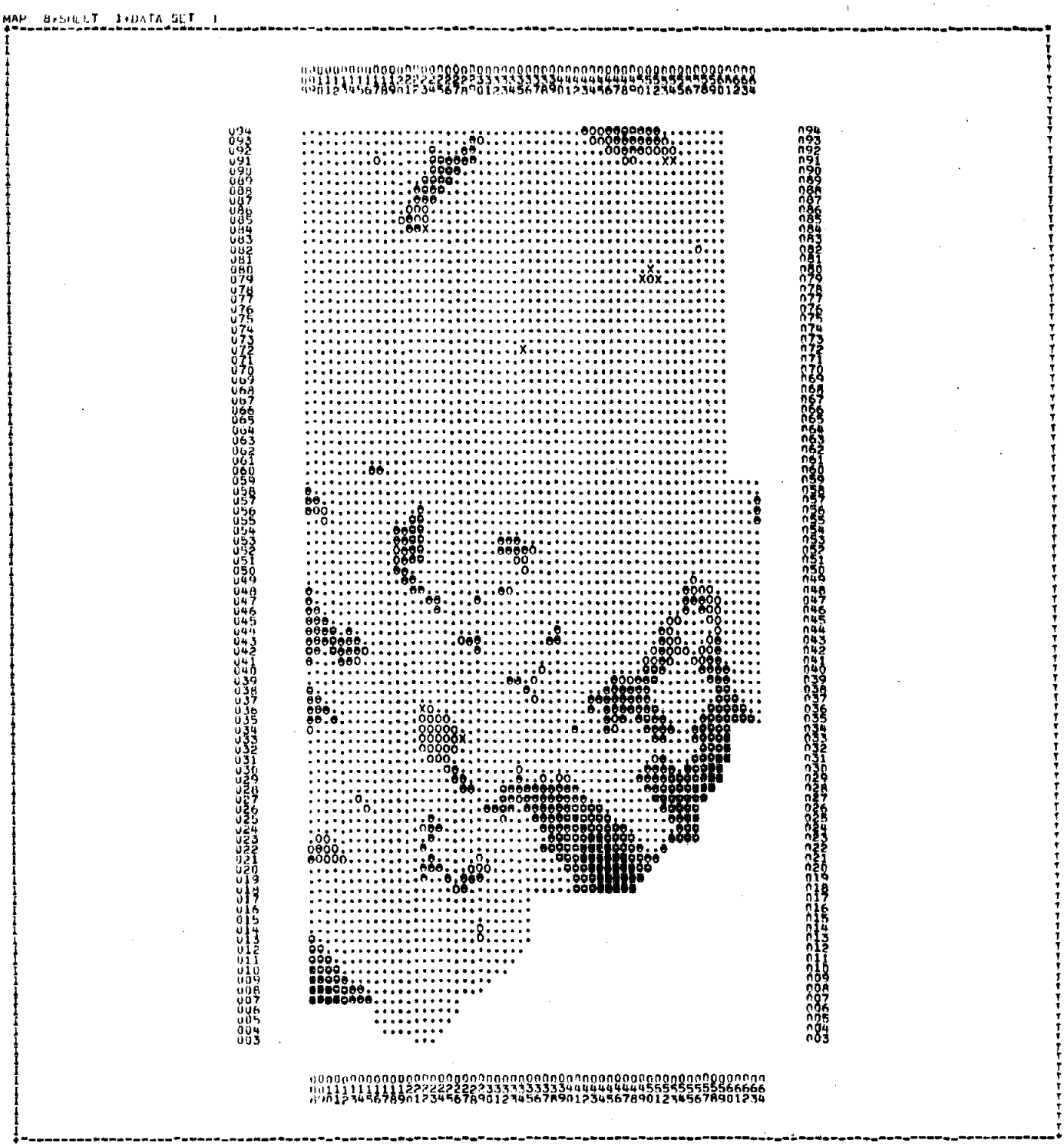

Figure 3. Suitability Analysis Output Map -- "Undisturbed Areas"

importance or weight of each of the variables selected to describe suitability must be established. The next-to-the-last column of the table in Figure 2 shows the weights selected by the planners in this study. The weights are arbitrary and only their relative values are significant. In addition to establishing the relative importance of the variables, the relative significance of each possible value for a variable must be established. Relative weights allowed by the CALUP procedures are integers ranging from 1 to 9. Again from the table of Figure 2, it can be seen that a coded value of 3 (hardwood) for variable 8 (forest stand composition) has relative weight of 7 when only variable 8 is considered in the suitability analysis. The value 0 as a weight indicates that the cell is entirely unsuitable if that variable has that particular code.

Figure 3 illustrates the primary output of the suitability analysis. The darker areas represent those areas which are more suitable for undisturbed lands. Such output may be checked against ground truth information and the suitability model revised if necessary. In the state park study, several revisions of the model were necessary primarily due to the fact that initial models were much too restrictive.

The design phase is supported by a series of programs that take as input the suitability models and the boundary descriptions of all elements to be included in the total plan. Based on the models, a composite map is produced delineating the suitability of the total design. Also a design "score" is calculated. The designer can then accept the results or prepare a modified design for which the procedure will be repeated.

SUMMARY

Although the demonstration project is not yet complete, it is felt that the application of the procedures outlined in this paper have been successful. The large majority of the costs associated with the project were in the initial data collection and future projects will make more use of ADP equipment in this area.

Several extensions and refinements to the CALUP package have been planned, are in development, or have been completed. The programs are being generalized to fit applications of a similar nature and interfaces with both two- and three-dimensional graphics routines are being developed. Also, interactive operation with color displays are being studied for use in data collection, suitability modeling, and design.

In short, it is felt that computer-assisted procedure similar to those supported by CALUP and remotely sensed data can become an effective and efficient tool for the recreational land use planner.

REFERENCES

1. T. Murray, et.al. Honey Hill: A Systems Analysis for Planning the Multiple Use of Controlled Water Areas. 2 volumes. Cambridge, Massachusetts: Landscape Architecture Research Office, Harvard Graduate School of Design, 1971 (Available from National Technical Information Service, NTIS Report No. AD-736-343).

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