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SEMINARS IN NATURAL RESOURCE INVENTORY AND GEOGRAPHIC INFORMATION SYSTEMS: A DOMINICAN REPUBLIC APPLICATION

prepared for and presented to the

SISTEMA DE INVENTARIO Y EVALUATION
DE RECURSOS AGRICOLA

by

Stephen McRae, Weldon A. Lodwick, and Pat Nischan
as part of the Dominican Republic
Comprehensive Resource Inventory and Evaluation System Project

U.S. Department of Agriculture

and

Michigan State University

In Cooperation with the

U.S. Agency for International Development

March, 1981

INTRODUCTION TO THE USE OF THIS MANUAL

The training manual is a document intended to be used in conjunction with a series of seminars. Alone without the seminars they offer someone already familiar with the procedures a good basis to work from, but are otherwise not complete enough to offer someone else sufficient guidance. Thus, the intended distribution of this document is to the audience of the seminar series. This document represents a set of "lecture notes" which need augmentation to "stand alone". Moreover, this document, originally prepared in April 1980, has not had its contents substantially revised, so that our more recent improvements have not been incorporated.

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FOREWORD

This Report is one of the Working Series reports developed by the Comprehensive Resource Inventory and Evaluation System (CRIES) project for use of the Sistema de Inventario y Evaluacion de Recursos Agricolas (SIEDRA) staff of the Secretaria de Estado Agricultura of the Dominican Republic. This activity was funded by the U.S. Agency for International Development, the U.S. Department of Agriculture, and Michigan State University. Participation of the USDA is covered under PASA # AG/TAB-236-14-17. The participation of Michigan State University is covered under Research Agreement No. 12-17-07-5-1955.

The CRIES project staff, constituted of personnel from the Soil Conservation Service, the Science and Education Administration, and the Economics, Statistics, and Cooperatives Service of the U.S. Department of Agriculture and personnel from the Center for Remote Sensing, Department of Resource Development, and Department of Agricultural Economics of Michigan State University, began participating in 1976 with Dominican Republic technicians in the conduct of an agricultural resource assessment. The project has been conducted in two phases. During the 15 months of the first phase relevant information on soils, climate, major land use, crop use of agricultural land, agricultural production, production techniques, crop yields, production inputs and costs, and social institutional factors were gathered or developed and then reported in working reports and incorporated into an information management system and a preliminary analytical model.

During the second phase, the CRIES staff and its resident advisor, Gary Kemph, provided technical assistance and training to the SIEDRA staff on issues of relevance in expanding that staff's capacity to address agricultural resource planning issues. Other efforts have been directed at refining, expanding, and improving the initial information sets. Summarized in this working series report

are training activities provided to Dominican technicians in September, 1980. Materials appended to this report cover training session on general aspects of resource inventories and geographic information systems, geocoding, and the use of the geographic information system for analytical and developing purposes.

Members of the CRIES project staff instrumental in the development of the training modules and associated materials were Stephen McRae, Weldon A. Lodwick, and Pat Nishan. The training of the Dominican technicians was conducted by Weldon Lodwick and Mark Simon during sessions held in Santo Domingo, Dominican Republic, September 14 to 27, 1980.

John W. Putman
Head, Comprehensive Resource Inventory
and Evaluation System

INTRODUCTION

The Comprehensive Resource Inventory and Evaluation System (CRIES) project had the responsibility for conducting an agricultural resource inventory, assessment, and evaluation of the Dominican Republic. The CRIES project and the Sistema de Inventario y Evaluacion de Recursos Agricolas (SIEDRA) worked closely on the conduct of these activities. The activities were completed in two phases.

The first phase was conducted over a 15 month period in 1976 and 1977. During this phase the CRIES project staff developed preliminary information sets, an information management system, and an analytical model that embodied relevant information on soils, climate, major land use, crops, agricultural production, production techniques, crop yields, production inputs and costs, and social institutional factors derived largely from existing secondary sources.

During the second phase, conducted from October, 1977, through September, 1980, the CRIES project staff and its resident advisor, Gary Kemph, provided training and technical assistance to the SIEDRA staff. Technical assistance was directed primarily towards improvement of the preliminary information sets. Considerable progress was made by SIEDRA with CRIES collaboration in refining and expanding the land resource information set and in acquiring crop use of land, production technique, and cost of production inforamtion by SEA region. Additionally, obtaining current and reliable major land use information was a major concern. Three coordinated technical assistance activities were planned to address this concern. These were:

1. To develop an up-to-date, comprehensive national land cover/use inventory of the Dominican Republic using low-cost appropriate technology methods of image enhancement and visual interpretation of Landsat imagery;[1/]

[1/] Another portion of this objective called for training of Dominican technicians in the methods of interpretation. This training was completed in March, 1980.

2. To conduct a feasibility test using light plane photography as a ground truth data acquisition method; and

3. To investigate the use of the Dominican Republic quarterly survey plots as test sites to coordinate data gathering of special and quarterly surveys by resource planning units.

The first two technical assistance activities (and associated training) were completed as planned. The scope of the third activity was substantially revised. Training was provided in lieu of the technical assistance activity.

Limiting the investigation of the use of quarterly survey plots (segments within the existing area frame) as test sites to coordinate data gathering by resource planning units was the ongoing redesign of the area frame under a separate technical assistance activity.[2/] As new segments were not expected to be delineated prior to project culmination on September 30, 1981, a joint decision was reached to provide the SIEDRA staff and other Dominican technicians with the shills needed to reference area frame segments by RPU when the new segments were delineated.

In September, 1980, SIEDRA and SEA personnel were trained in the use of GEOMAST and GEORAP computer programs, and in the use of geographic information systems in the conduct of natural resource inventories.[3/]

TRAINING ACTIVITIES

During the first phase of the CRIES project an RPU map was developed by the CRIES project staff for the Dominican Republic. Data from this map was geocoded and placed on the master file of the geographic information system. Subsequent to this activity the SIEDRA staff made several revisions and

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2/ See memo on subject: Locating Area Frame Segments by RPU, Jim B. Johnson to Gary S. Kemph, April 2, 1980.

3/ See the official trip report of Weldon A. Lodwick and Mark Simon for a chronological summary of the training sessions.

refinements in the RPU delineations. A new RPU map was developed. Geocoding of the new RPU map was incorporated in the training activities conducted in September, 1980.

Computer programmers of the SIEDRA staff were familiarized with the GEOMAST and GEORAP programs of the geographic information system. Additionally, training sessions were presented to members of the SIEDRA staff, and to technicians from other units within the Secretariat of Agriculture, on manual geocoding techniques. Four 100 km by 100 km blocks of the twelve blocks of the new RPU map were used to demonstrate the manual geocoding techniques. The checking of the digitization was demonstrated through the use of pertinent GEOMAST programs. The use of GEORAP to continue the RPU information with other mapped information on political boundaries and land use (derived from the visual interpretation of Landsat imagery) was demonstrated through selected exercises.

TRAINING MATERIALS

Materials used for this Dominican Republic training session and for uses elsewhere are provided in modular form.[4/] The modules are designed for presentation to different audiences.

The first module, "Material Resource Inventories and Geographic Information Systems: An Overview," is designed to be presented in a one or two day seminar to resource planners, resource analysts, and technicians. This module has three sections: objectives and goals of the module; content outline of the module; and illustrations (See Appendix A).

The second module, "Techniques of Manual Grid Geocoding and the Use of GEOMAST", is designed to be presented in a week-long seminar a geocoding

---

[4/] Development of these modules was initiated for training presented at the Instituto Technologico de Costa Rica. They have subsequently been used for training provided to the Inter-American Institute for Cooperation in Agriculture (IICA) personnel and participants invited to IICA from member countries.

technicians and analysts. This module has four sections: objectives and goals of the module; content outline of the module; illustrations; and exercises (See Appendix B).

the third module, "The Use of GEORAP", is designed to be presented in a week and one-half seminar to analysts and computer technicians. The module has three sections: objectives and goals of the module; content outline of the module and illustrations; and exercises (See Appendix C).

For each of the modules, the seminar participants receive all sections except the objectives and goals section. The objectives and goals section is designed for the use of the seminar instructor. The CRIES project has on file for the use of seminar instructors materials to amplify the content outlines provided to seminar participants. The materials include slides, overheads, and detailed descriptions of the illustrations and worksheets and supporting materials for the exercises included in each module.

CURRICULUM GUIDE

Title: Training Program in Natural Resource Inventories and Geographic Information Systems.

Unit Title: Natural Resource Inventories and Geographic Information Systems: An Overview

Unit Description: Participants completing this unit will develop an understanding of the role of natural resource inventories in the resource development planning process. They will learn how natural resource inventories are designed and implemented. In the process they will be introduced to the idea of a geographic information system and how such a system supports a natural resource inventory. Finally, they will be shown some specific examples of natural resource inventories and associated geographic information systems drawn from experiences in the U.S.

Major Goals: In this unit we are attempting to accomplish the following:

1. To establish an understanding and awareness of what a natural resource inventory is and what its uses are.
2. To provide alternative models for designing, implementing and applying natural resource inventories.
3. To introduce the basic concepts associated with describing and choosing a geographic information system.

Major Objectives: Upon successful completion of training, the participants will be able to:

1. Explain what a natural resource inventory is and how it may be used.
2. Read and understand flow charts showing natural resource inventory procedures.
3. Discuss the role of maps as data sources.
4. List the types of data typically found in a natural resource inventory.
5. Identify some of the analytical techniques used in the application of natural resource inventories to planning problems.

6. Relate natural resource inventory procedures to their own resource problem context.

7. Explain what a geographic information system is and how it can be used in conjunction with other information systems to store, process and retrieve data.

8. Relate support requirements for natural resource inventories and geographic informaiton systems to their own situations.

Evaluation: This normally includes each participant showing demonstrated ability to carry out each objective listed above. In the present informal presentation, this requirement is relaxed. Therefore, specific measures are not listed.

CONTENT OUTLINE

I. The Resource Conservation and Development Planning Process

A. Problem identification

B. Evaluation of available techniques, tools and analytical methods

C. Specification of data requirements and information classification categories

II. Natural Resource Inventories

A. Collection of information regarding natural and related cultural resources to support the above process.

B. Natural resources — loosely defined as resources (utility to humans) existing largely in natural state, i.e., not heavily modified by humans. Contrast with human or cultural resources, or even agricultural resources.

III. Items Typically Included in an Inventory

A. Natural Resources

1. Soils
2. Climate
3. Land cover, vegetative cover, forest type, biomass, etc.
4. Minerals
5. Water resources such as depth to ground water, acquifer recharge areas
6. Geological resources other than minerals such as depth to bedrock or geologic information types
7. Environmentally sensitive areas such as flood plains or steep slopes

B. Associated cultural resources

1. Administrative and political boundaries
2. Ownership
3. Transportation network

C. Derivative categories

1. Resource Planning Units (RPUs)
2. Travel times to commercial centers

IV. Data Sources

A. Maps – Some U.S. examples

1. National topographic map series
2. Geological survey maps
3. National cooperative soil survey maps
4. Hydrologic atlases of water availability, flood inundation
5. Climate maps and charts

B. Tabular -- frequently has to be interpolated to be used spatially

1. Depth to ground water from well hole records
2. Climate information from various ground stations

C. Special surveys – frequently needs to be correlated with mapped information

1. Questionnaires to land owners regarding extent of specific natural or agricultural resources on their property.

V. Types of Data

A. Form

1. Point
2. Linear
3. Areal

B. Class

1. Nominal
2. Ordinal
3. Interval
4. Ratio

VI. Analytical Techniques Applies to Resource Inventories

A. Statistics

1. Summary, descriptive – cross tabulations, mean, range, etc.
2. Inferential – factor analysis, regressions, cluster analysis

B. Indexing, derivative mapping including suitability analysis

1. Overlay techniques
2. Multidimensional scaling

C. Modeling (frequently leading to an impact analysis)

1. Simulation models - qualitative and numerical
2. Linear programming models
3. Cross impact matrix

VII. Procedures for Doing Natural Resource Inventories -- Two Examples

A. Shelton and Hardy -- New York State

B. Baxter -- Tennessee Valley Authority

C. McRae -- Summary or overview

VIII. Geographic Information Systems

A. Definitions

1. Data vis a vis information
2. System
3. Geographic

B. Referencing systems

1. Map projections
2. Polygon referencing
3. Grid referencing

C. Products

1. Map file
2. Master file
3. Graphics
4. Tabular information
5. Opportunities for analysis (see VI)

D. Utility of geographic information systems

1. Allows easy access and storage of information, especially where multiple maps (i.e., multiple types of information) are being processed. Note that if only one type of information is being considered, a map remains somewhat more desirable.
2. Allows quantification of information in some cases. This may or may not be desirable depending on the class of information and the quantification operations performed upon it.
3. East to update the data file (depending upon the format and the available hardware and software).
4. Rapid production of maps in a variety of forms.

5. Rapid production of derivative maps.

6. Provision of a data base readily applicable to certain types of analysis.

IX. Logistical Requirements

A. Hardware

B. Software

C. Human

D. Institutional

1. Continuity

2. Support

3. Horizontal as well as vertical integration

X. Examples of Integrated Approaches to Resource Planning

A. The Holling Approach

B. The Steinitz Approach

XI. Examples of Application

A. Iowa

B. Michigan

C. New York

D. CRIES work in the Dominican Republic

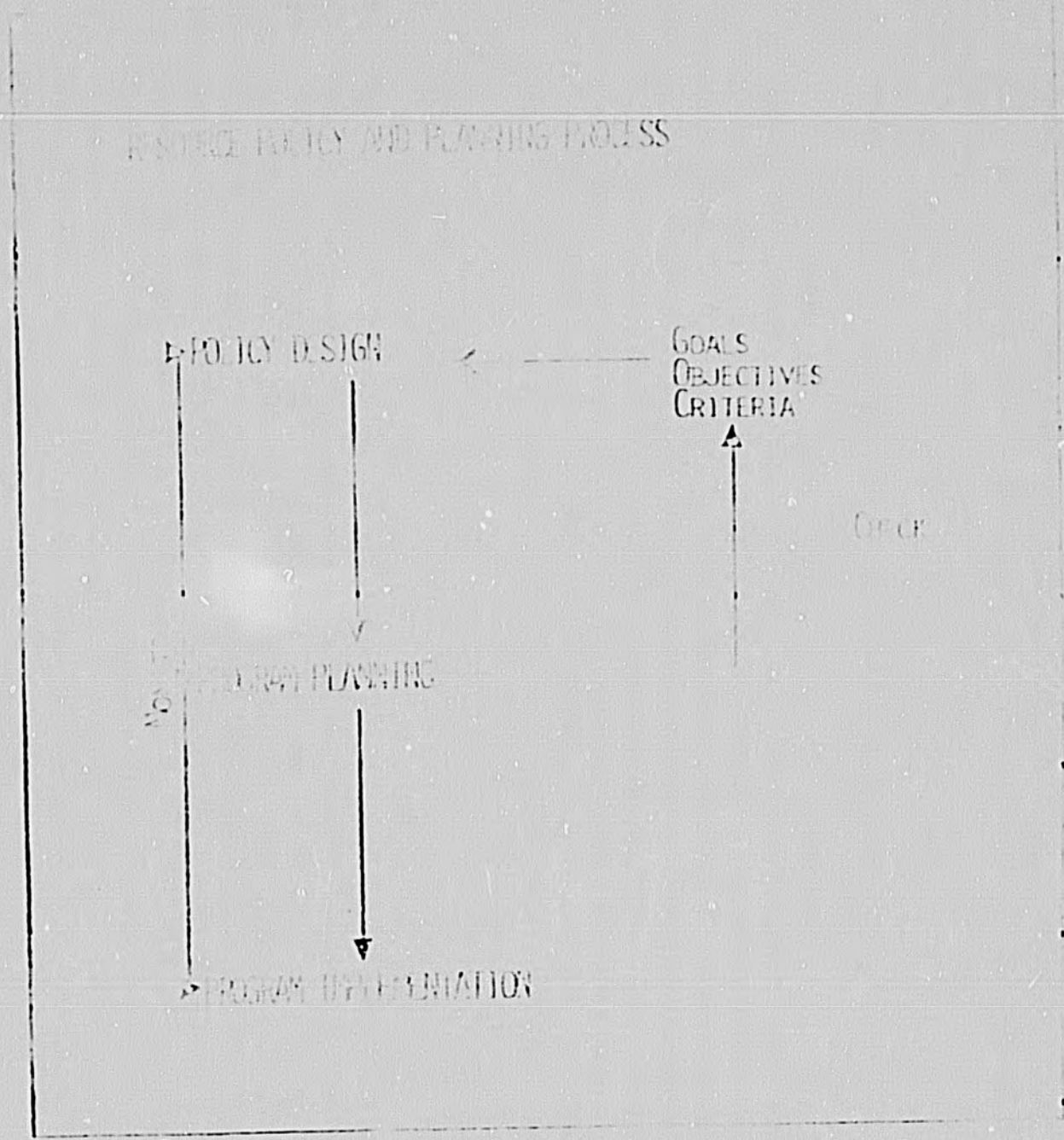

POLICY DESIGN
GOALS
OBJECTIVES
CRITERIA
PROGRAM PLANNING
PROGRAM IMPLEMENTATION

Table ___. Data Sources

1. Land Use and Natural Resources Data Sources

A. Land Use

State-initiated mapping at various scales and 1:250,000 nationwide mapping of the Federal Land Use Data and Analysis (LUDA) program of the United States Geological Survey (USGS).

B. Land Resources

1. Topography -- National Topographic Map Series -- quadrangle maps at:

1:24,000	(1" = 2000')
1:62,500	(1" = approximately 1 mi.)
1:250,000	(1" = approximately 4 mi.)
1:500,000	(1" = approximately 8 mi.)

showing relief (by contour lines), water bodies, vegetation and cultural features (USGS).

There also exist 1:24,000 orthophotoquads and other planimetric base maps, including county highway maps at 1:126,720 (1" = 2 mi.)

2. Geologic structure/mineral resources -- Geological survey maps and atlases at 1:24,000 to 1:250,000 (USGS).

3. Soils/soil resources -- National Cooperative Soil Survey --detailed or reconnaissance maps of soil classifications and interpretations, published at 1:15,840 (1" = 1,320'), 1:20,000 (1" = 1,666'), 1:125,000 (1" = approximately 2 mi.) and 1:250,000 (Soil Conservation Service).

4. Vegetation/plant resources -- Nationwide Forest Survey -- reports and data files on timber inventory and ownership (Forest Service).

-- Census of Agricultural and Statistical Reporting Service -- statistical data on land in crops and other agricultural uses.

C. Water Resources

1. Surface and subsurface hydrology -- hydrologic atlases of water availability and flood inundation at 1:24,000 to 1:250,000 (USGS).

2. Water quality -- computer files of data samples from 200,000 stations (Environmental Protection Agency -- Storage and Retrieval for Water Quality Data, EPA-STORET).

D. Air Resources

Table _____. Data Series, continued.

1. Climate and meteorological information -- charts, maps, tabulations and reports including historical weather information, surface observations, upper air sample and satellite data (National Oceanic and Atmospheric Administration).

2. Air quality -- computer files of data monitored from about 9,000 reporting sites (Environmental Protection Agency -- Storage and Retrieval of Aerometric Data, EPA-SAROAD).

II. Socio-Economic Data Series

A. Ownership

1. Cadastral and land status maps at 1:31,680 (1" = 0.5 mi.) for many public lands (Bureau of Land Management) and at various scales for private lands.

B. Census and other data contained in computer files and census reports for census tracts, cities, urban areas, counties, standard metropolitan statistical areas (SMSA's), states and other aggregations (Bureau of the Census).

C. Other social and economic data produced by Federal and state agencies and by private firms.

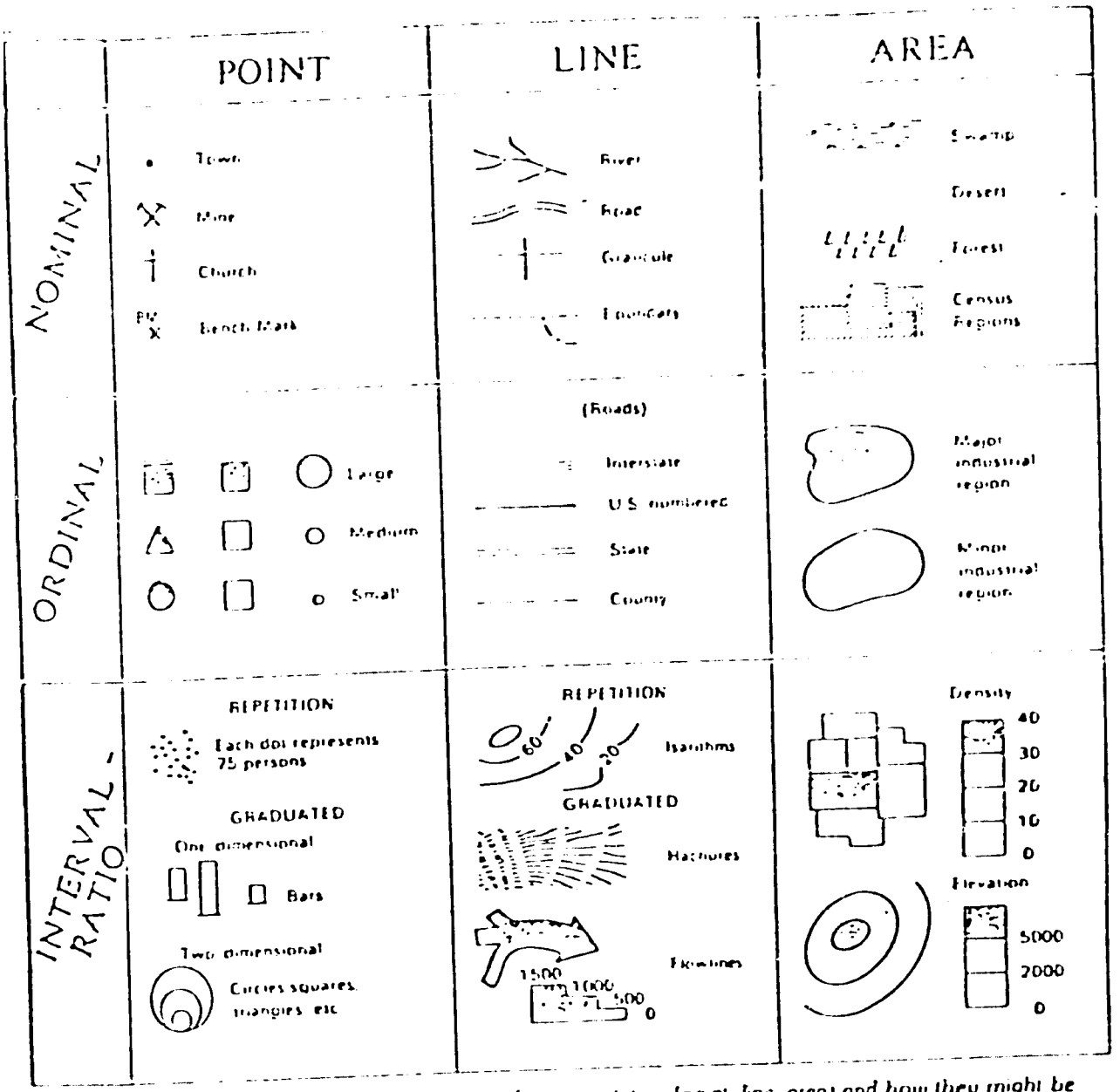


FIGURE 5.6 Some examples of the three classes of representation (point, line, area) and how they might be used to portray nominal, ordinal and interval ratio data

SUITABILITY COMPONENTS

CAPABILITY

HAZARD

REGULATION

ATTRACTIVENESS

SUITABILITY ANALYSIS

OVERLAY

MULTIDIMENSIONAL SCALING

FACTOR ANALYSIS

CLUSTER ANALYSIS

IMPACT ANALYSIS

CROSS IMPACT MATRIX

QUALITATIVE SIMULATION

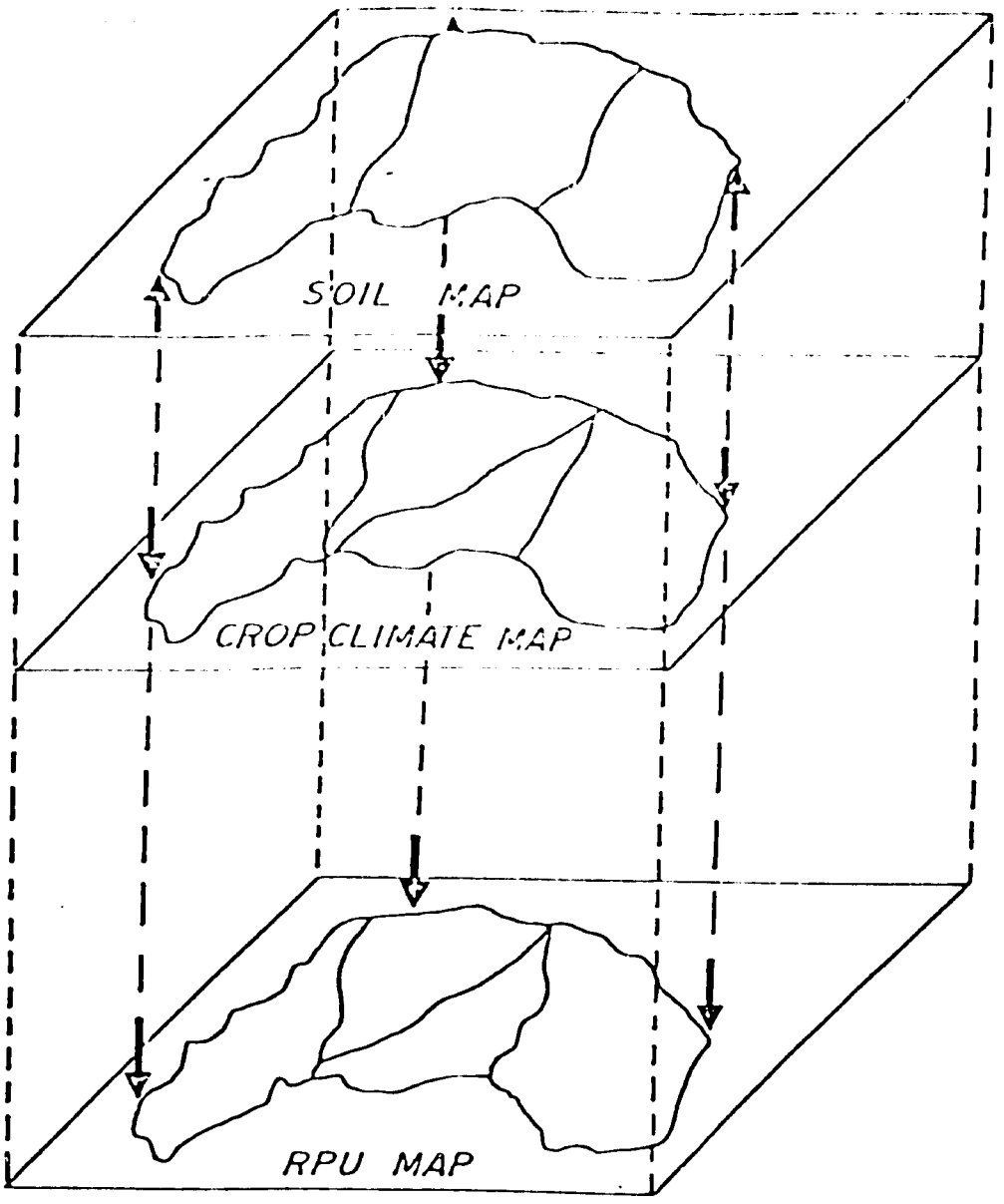
NUMERICAL SIMULATION

OPTIMIZATION

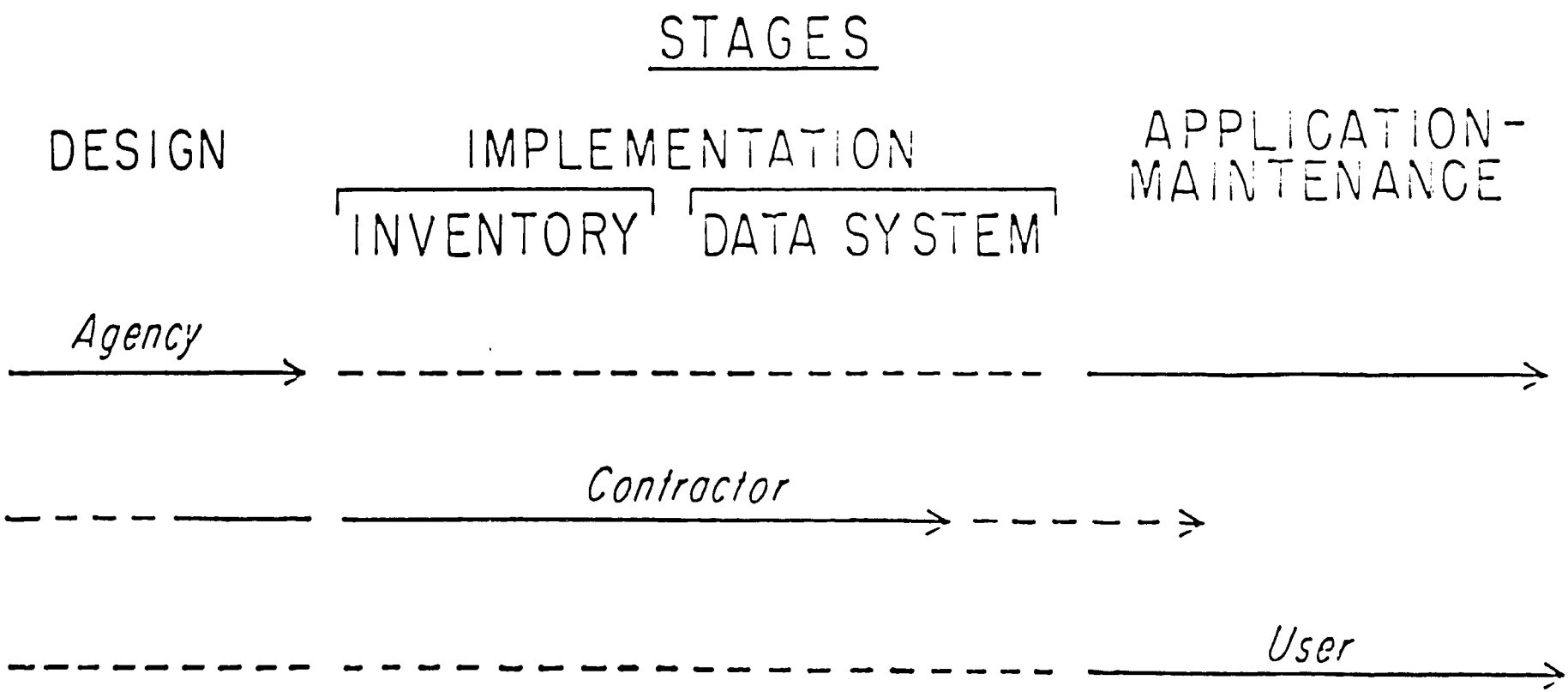
CRITERIA MATRIX

INFORMATION	OBJECTIVES		
	Camp Sites	2nd Home Development	Openland Wildlife
Soil Suitability for Openland Wildlife Habitat	N.A.	N.A.	Excellent to Fair
Minimum Required Acreage	20 Acres	30 Acres	40 Acres
Scenic Quality	Excellent	Excellent to Good	N.A.
Slope	15%	25%	N.A.
Septic Tank Restrictions	Slight to Moderate	Slight to Moderate	N.A.
Erodibility	Slight to Moderate	Slight to Moderate	N.A.
Cover	50% of Area in Forest	N.A.	Interspersed Areas of Pasture, Old Field and Cropland

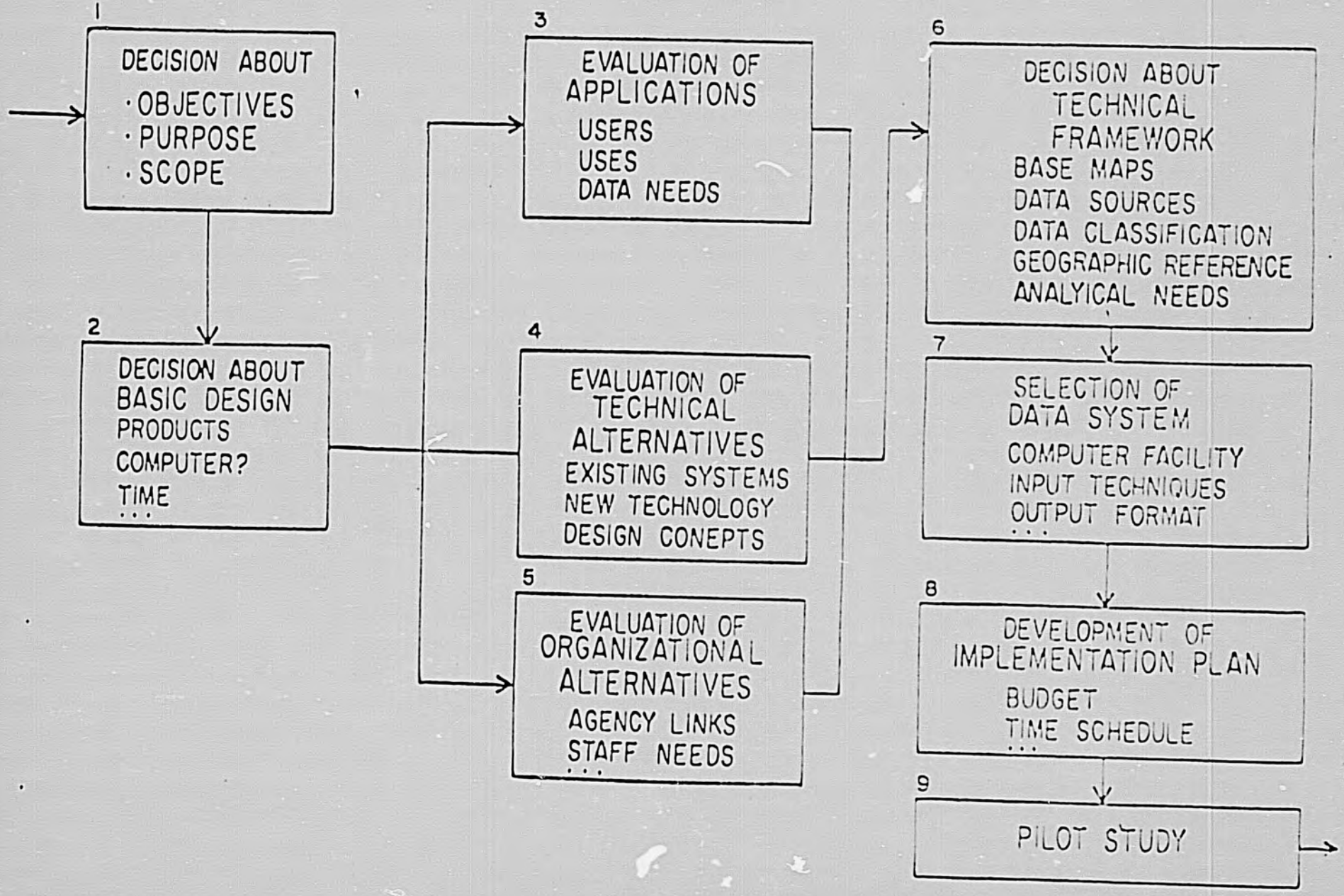
N.A. Not Applicable


SOIL MAP
CROP CLIMATE MAP
RPU MAP

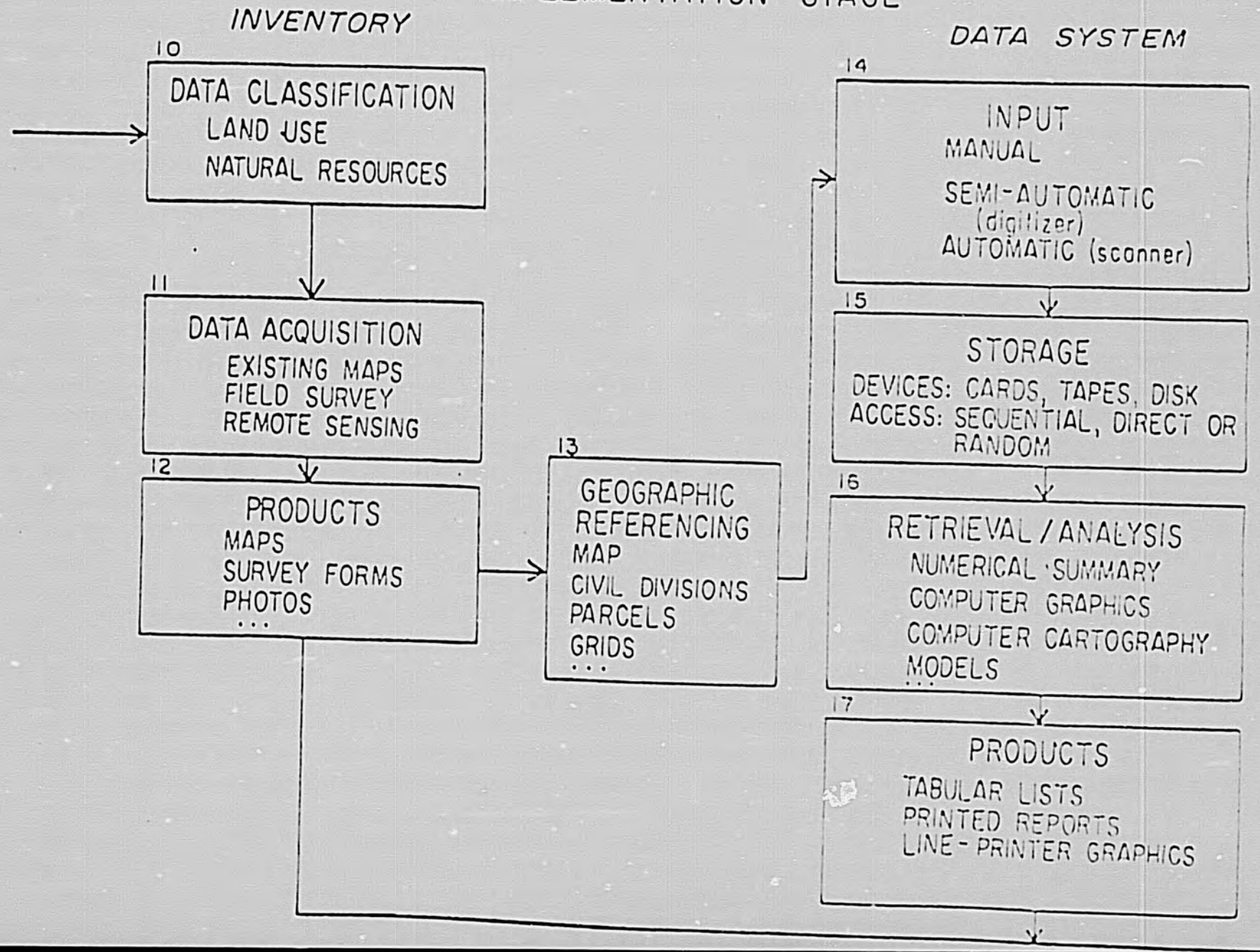
LAND USE AND NATURAL RESOURCE INFORMATION SYSTEM DEVELOPMENT



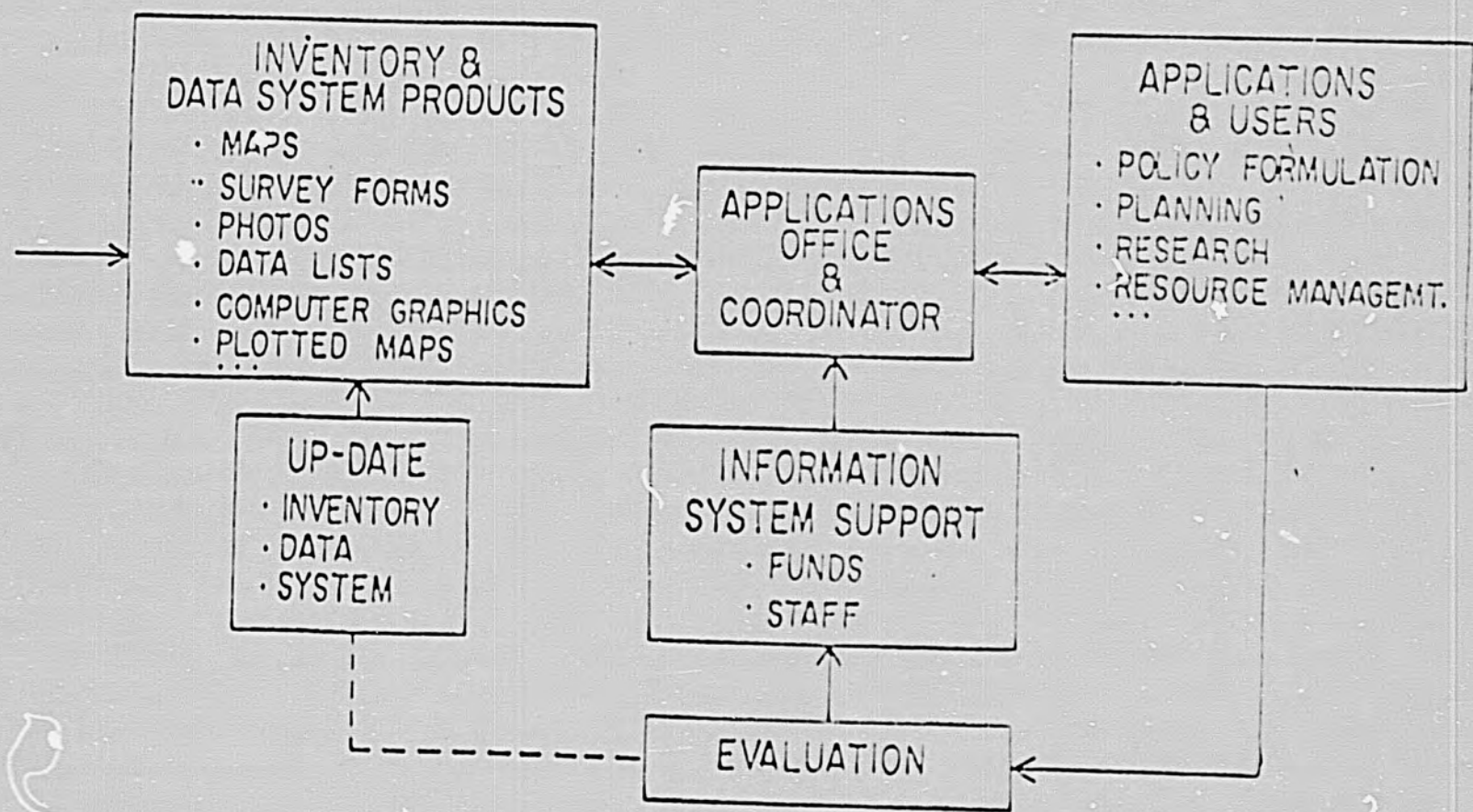
DESIGN STAGE



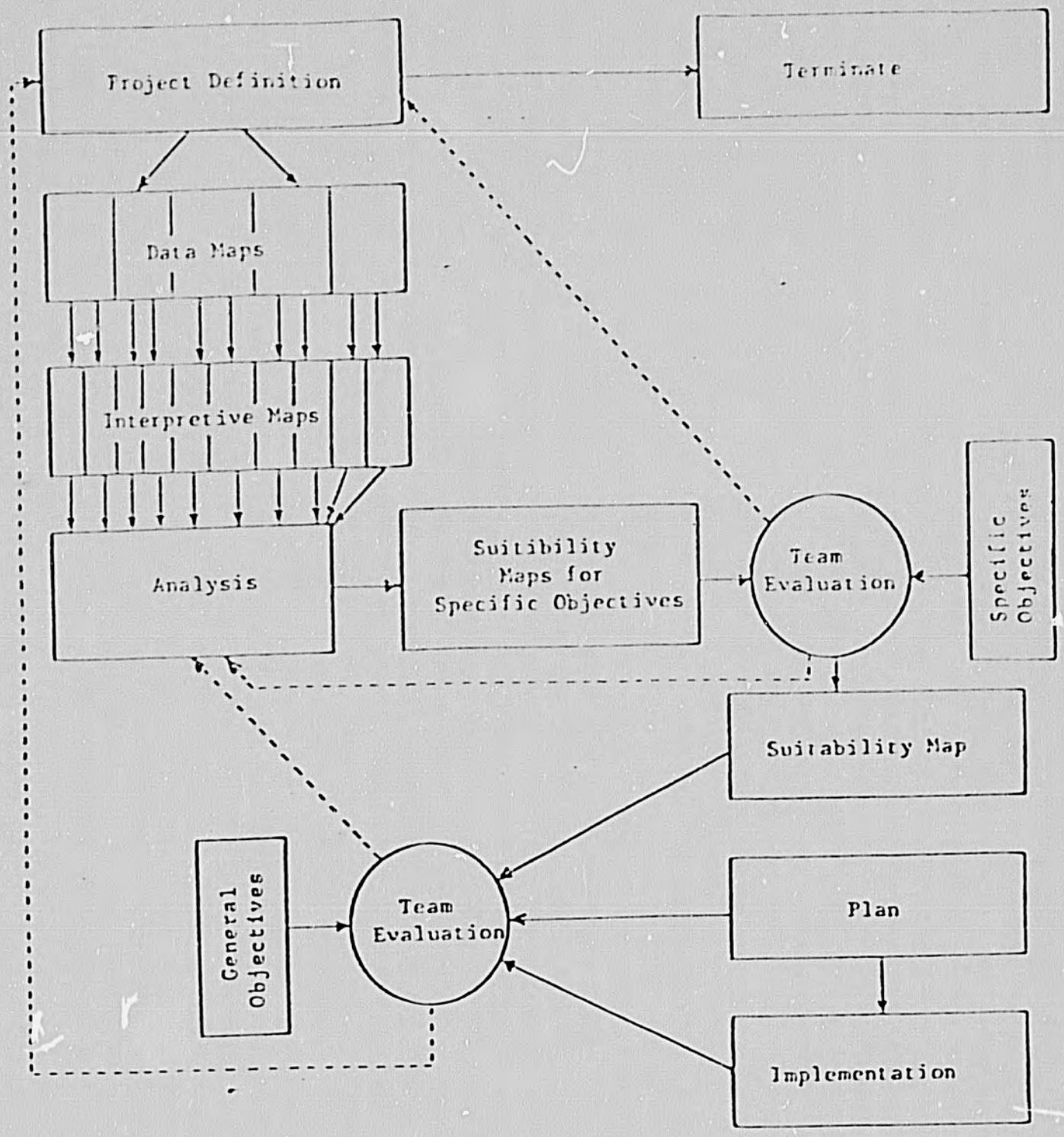
IMPLEMENTATION STAGE

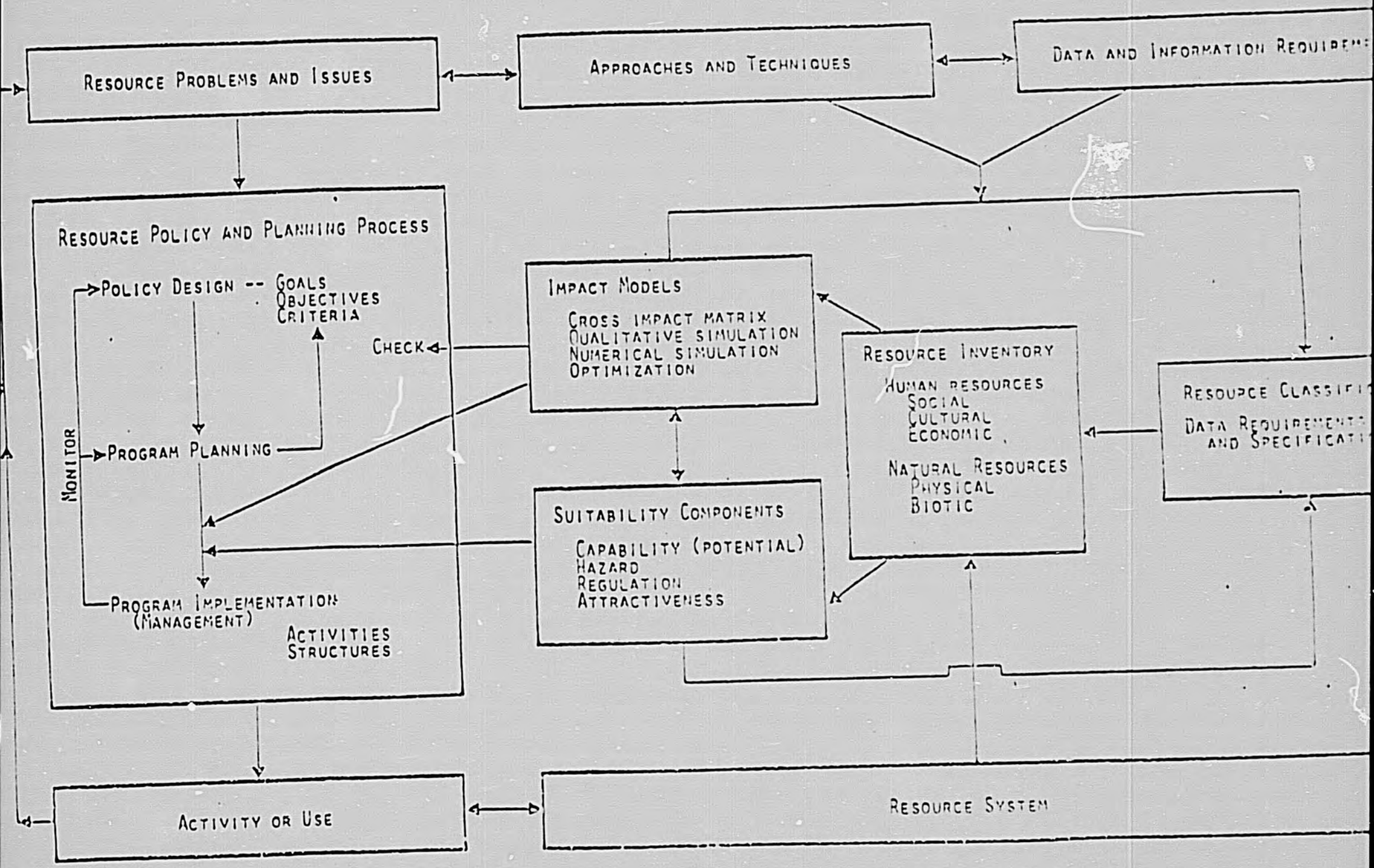


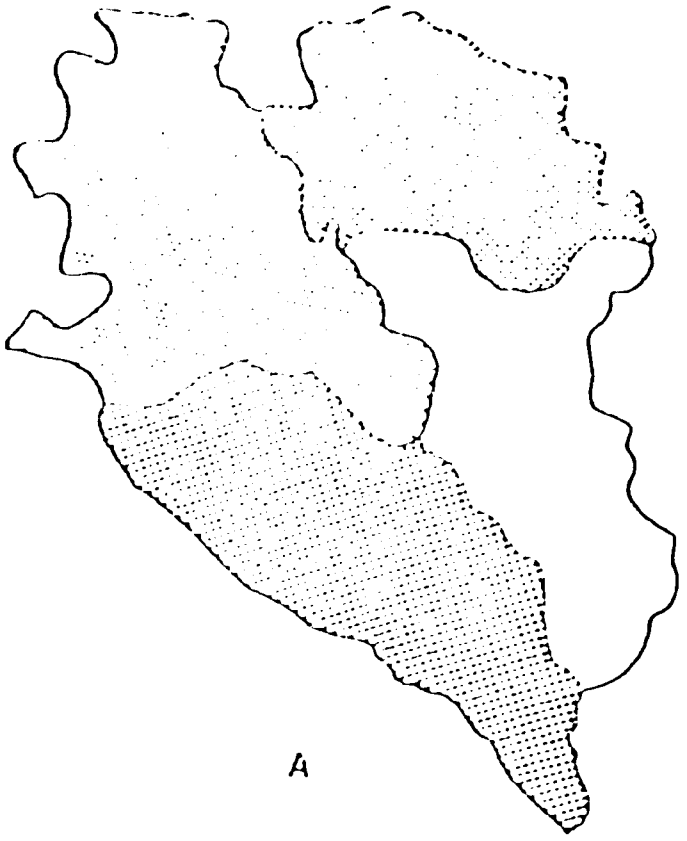
APPLICATION - MAINTENANCE STAGE



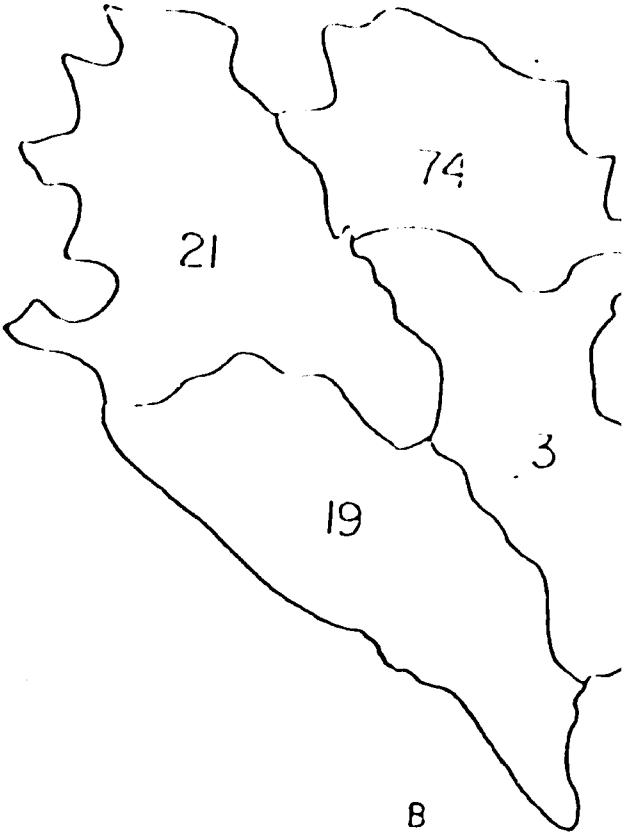
General Schematic of the Resource Management Decision Process




Resource Problems and Issues
Approaches and Techniques
Data and Information Requirem
Resource Policy and Planning Process
Policy Design -- Goals
Objectives
Criteria
Check
Program Planning
Program Implementation
(Management)
Activities
Structures
Monitor
Impact Models
Cross impact matrix
Qualitative simulation
Numerical simulation
Optimization
Resource Inventory
Human resources
Social
Cultural
Economic
Natural Resources
Physical
Biotic
Resource Classifi
Data Requirements
and Specificati
Suitability Components
Capability (potential)
Hazard
Regulation
Attractiveness
Activity or Use
Resource System

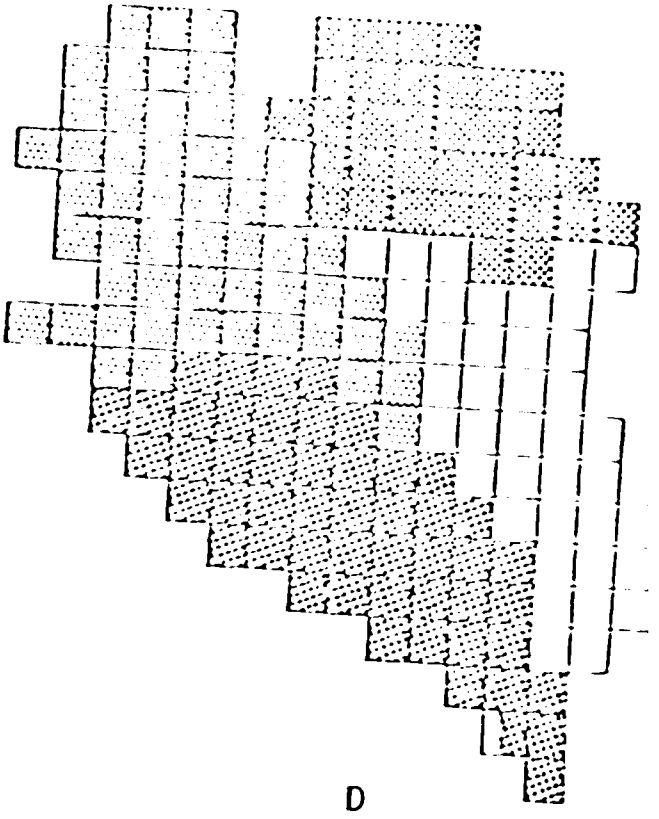


A



B

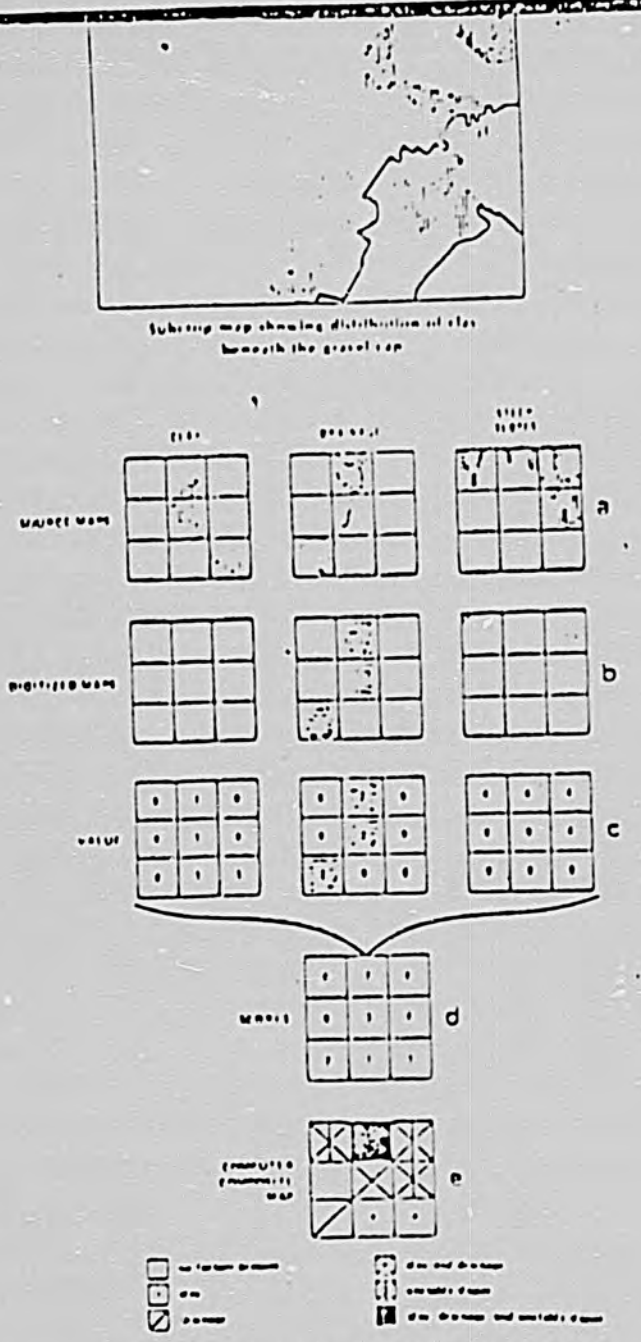
C



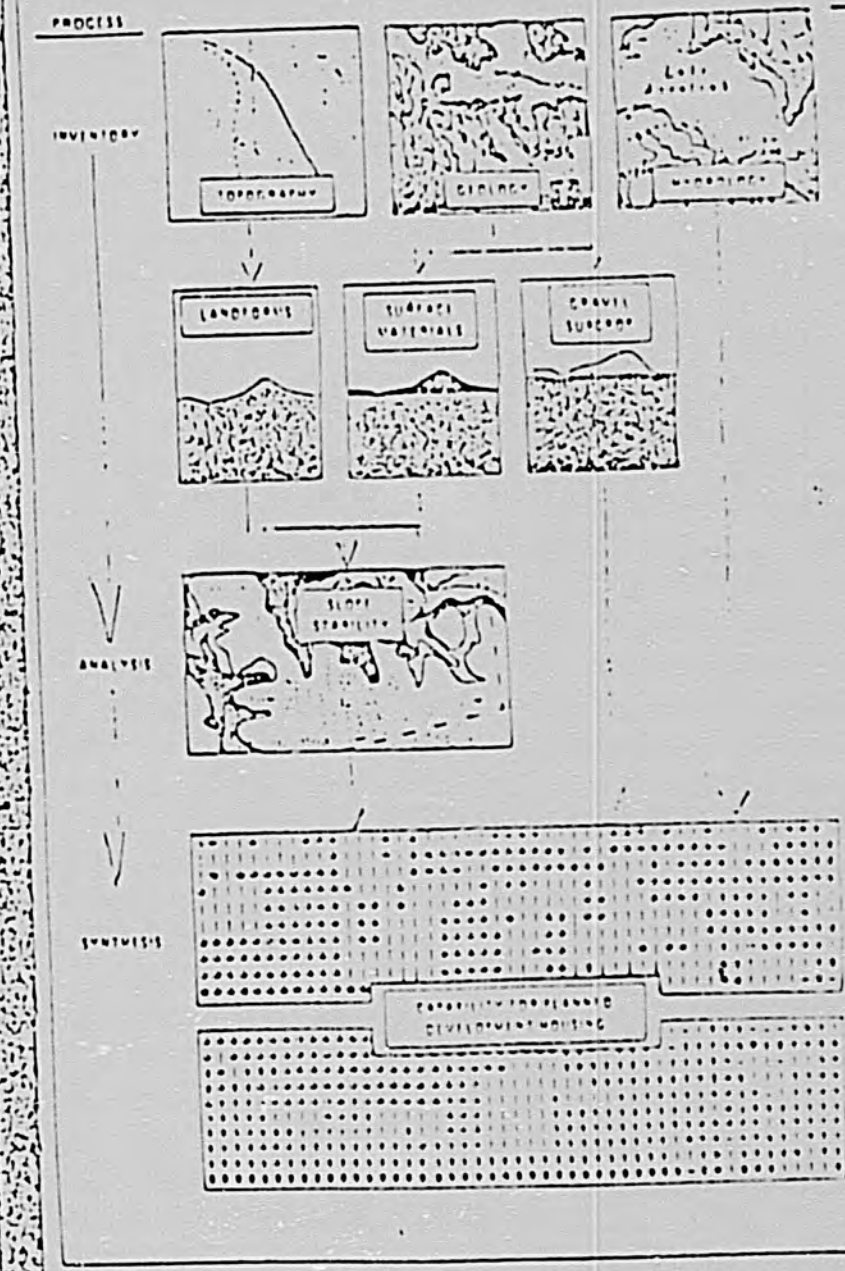
D

UTILITY OF GEOGRAPHIC INFORMATION SYSTEMS

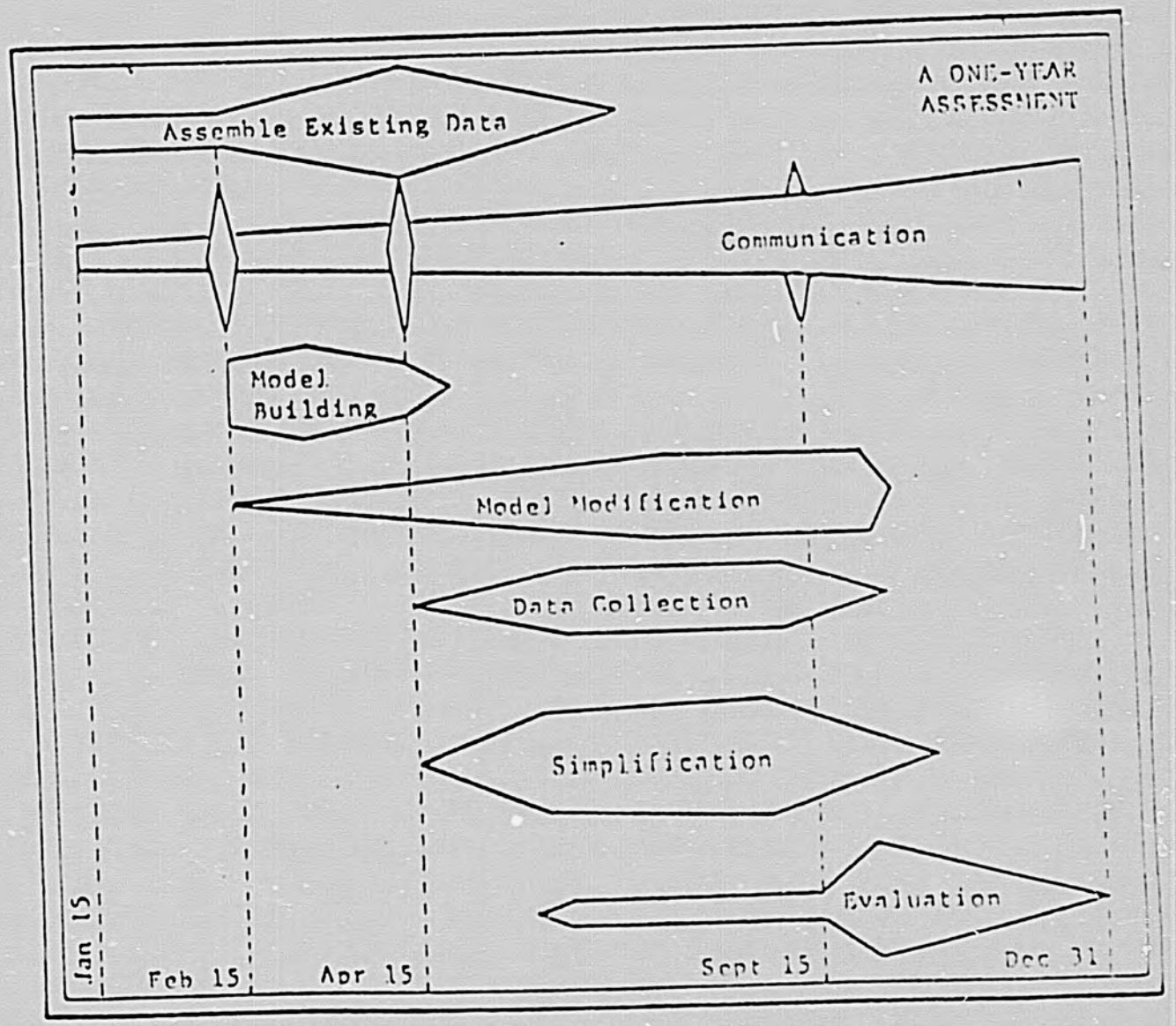
- Allows easy modification and retrieval of information for decision making
- Allows quantification of spatial information
- Allows rapid production and modification of map products
- Allows rapid production of derivative map products



Computer composite mapping technique for a hypothetical area



Flow chart showing the use of earthscience data in the Tennessee area



The Helling Approach

THE TREND PROJECTION

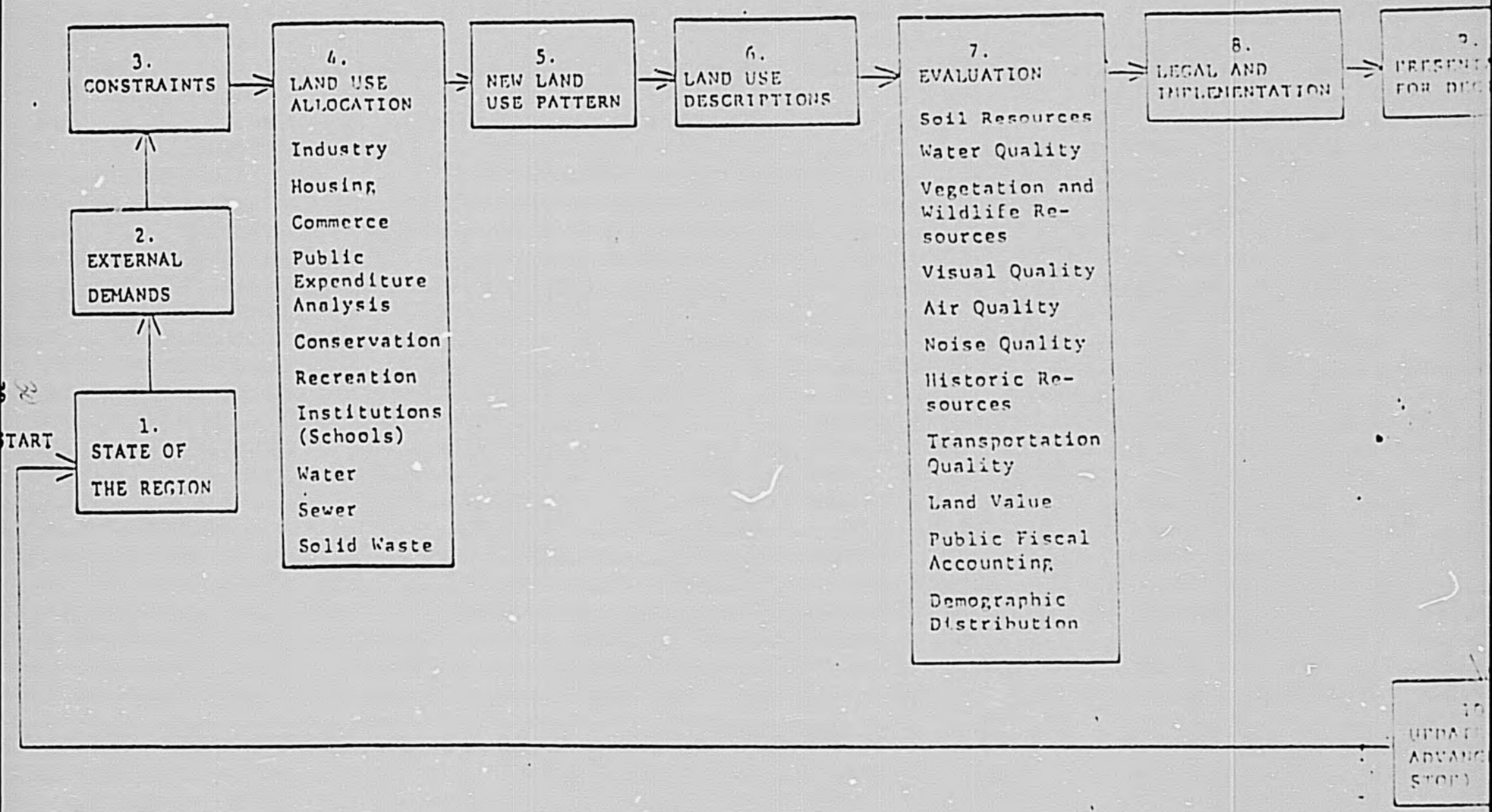
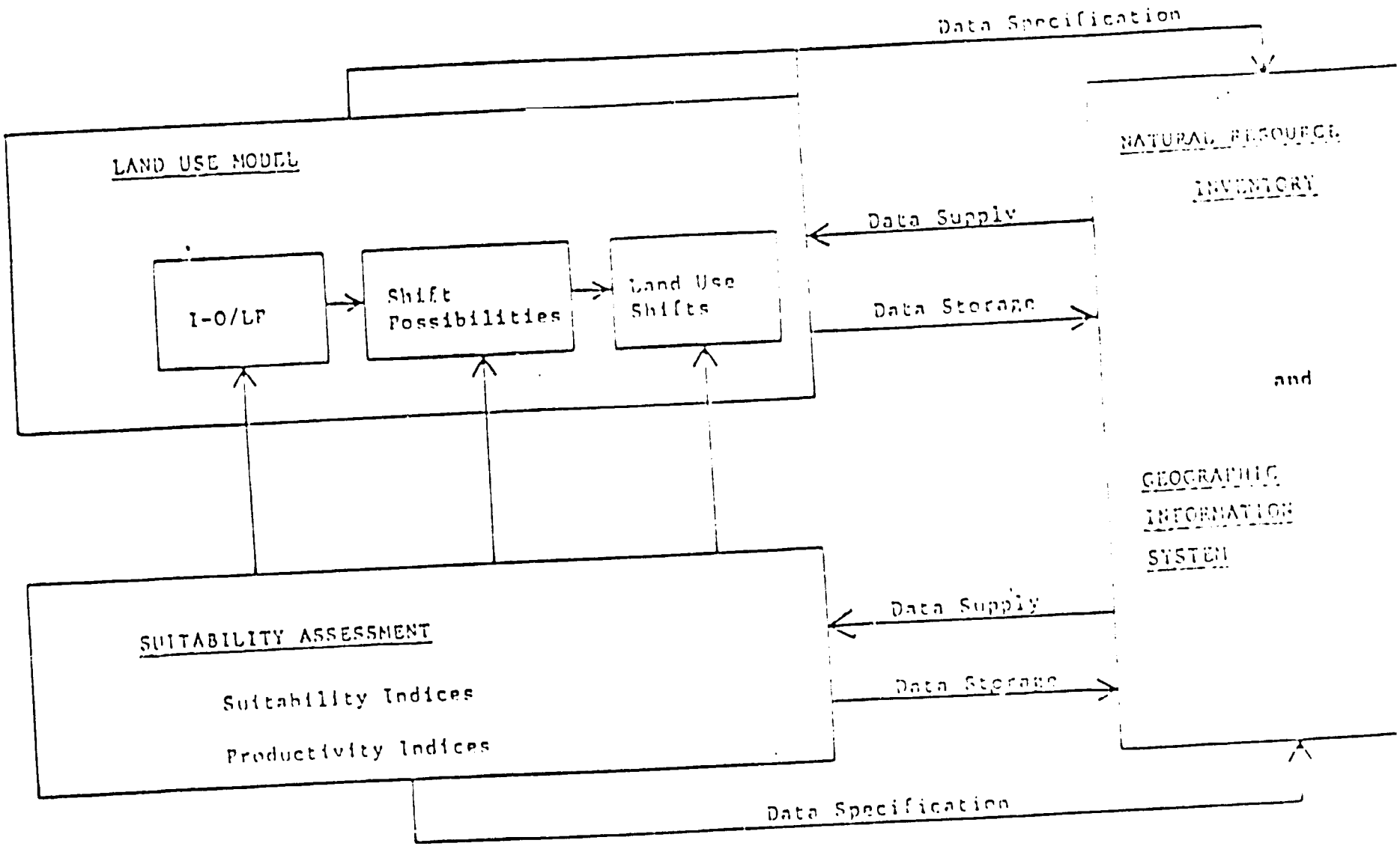


Figure The Trend Projection (from Managing Suburban Growth: A Modeling Approach. Summary. Carl Steinitz, et al. Landscape Architecture Research Office, Graduate School of Design, Harvard University, Cambridge, Massachusetts, 1980, p. 20.



The Emmet County and Land Use Model
and Geographic Information System

Ten Acre GIS

Soils	--Management Group Drainage Slope
Land Cover/Use	--Level II - Michigan Classification
Ownership	--Private, Public, etc.
Zoning	--Zoning categories
Municipal Sewer and Water Service	--Status categories

Square Mile GIS

Section Sizes	- Area
Proximity to Commercial Areas	- Travel time
Major Roads and Highways	- Presence
Community Facilities	- Facility type
Housing Density	- Number
Potential Industrial Sites	- Presence
Recreational Resources	- Recreation categories
Shoreline	- Length
Wildlife/Fisheries Resources	- Type and extent
Drainage Basins	- I.D.

FIGURE 3.17 SUITABILITY ASSESSMENT WORKSHEET

USE	BIOPHYSICAL CAPABILITY	ENVIRONMENTAL LIMITATION	GEOPOLITICAL REGULATION	SOCIO ECON. FEASIBILITY	MAP SEQUENCE AND COMMENTS
AGRICULTURAL PRODUCTION					
FOREST PRODUCTION					
SECOND HOME DEVELOPMENT					
ETC.					

B.1

CURRICULUM GUIDE

Title: Training Program in Natural Resource Inventories and Geographic Information Systems.

Unit Title: Principles and Techniques of Geocoding and the Use of GEOMAST (Geographic Masterfile Creator)

Unit Description: Trainees completing this unit will develop the ability to take natural resource data from a variety of sources (primarily maps) and put it into a form suitable for computer processing. In the process they will learn how to use the software package named GEOMAST which is designed to facilitate this process. Whenever possible, examples from the on-going natural resources inventory associated with the existing projects will be used.

Major Goals: In this unit we are attempting to accomplish the following:

1. To establish an understanding and awareness of the advantages and disadvantages of a computer-based information system.

2. To develop the trainee's ability to select appropriate materials for geocoding, carry out the geocoding, check the resulting produce for erros, and document his or her activities.

3. To develop the trainee's ability to manipulate already established files and to add newly created files to the Master File.

Major Objectives: Upon successful completion of training, the trainees will be able to:

1. List the advantages and disadvantages of manual vs. automated coding.

2. Select and prepare maps and grids for geocoding.

3. Carry out the geocoding process.

4. Check the resulting file for errors and correct errors where found.

5. Merge the resulting map file with an existing map file.

6. Identify and correct errors in files they themselves have not geocoded including already existing map files.

7. Use the software package GEOMAST as appropriate in carrying out the above activities.

Evaluation: This will include each trainee showing demonstrated ability to carry out each objective listed above. Specific evaluative measures will include:

1. Given a map and identification of the map factor to be inventories, successful implementation of the various steps involved in geocoding resulting in the addition of an error-free map file to an existing Master File using a previously specified format.

2. Successful debugging of an existing map file containing six or more of the commonly found error types.

3. Documentation of activities sufficient for someone else to replicate same.

COURSE OUTLINE

I. Geographic Information Systems - Overview

A. Concepts -- Review

1. Spatial referencing system and data structures

a. Grid

b. Polygon

2. Advantages and disadvantages of grids vs. polygons

3. Geocoding or digitizing data structures

4. Map files and Master files

B. Utility of geographic information system -- review

II. Coding Procedures

A. Coding schemes

1. Sequential cell

2. Compressed boundary

3. Geocode

4. Raster

B. Prepare maps and grids

1. Register grid to map

a. Identify and draw principal grid reference lines on the map. These usually will correspond to a standard map referencing system such as latitude-longitude or the UTM grid system. Each system has implications for the representation and handling of data.

b. Draw in coding squares on the map. Where a square kilometer grid system is being used, 100 km by 100 km is a typical size. Note references row-col. coordinates on the map. The necessity for coding squares is a function of the map size to grid cell size and the amount of geocoding that could be accomplished in a single sitting.

c. Where multiple maps are being geocoded, inter-map registration may be a problem. One solution is to use an overlay system with pin registration of overlay elements. Overlay elements used on the CRIES project include:

(1) Latitude/longitude grid

(2) Geocoding grid

(3) Country borders

(4) Legends

(5) Political units

(6) Maps

2. Prepare acetate grid or other gridding materials

   a. These can be drawn on white paper and acetate overlays made with a thermofax machine.

   b. Or, the lines can be drawn directly on acetate.

   c. The grid should fit one coding square. It is useful to number the rows and columns of the grid.

   d. An alternative scheme is indicated in Figure 6. This is particularly useful when recording only boundary changes.

   e. In preparing grids, the map scale should be double checked to make sure it is labelled.

3. Prepare a table of codes to be used when coding the map unit symbols.

4. Highlight the boundary between map units. Especially necessary on a "busy" map or one with indistinct lines between units.

5. Decide on decision rules for breaking ties when coding on the basis of a dominant unit in a cell.

6. Prepare coding forms. Exactly how this is done depends on the recording format being used. A checklist should be prepared (on the coding form) to remind the coders to write down:

   a. Who did the coding

   b. How long it took

   c. When it was done

   d. What map was used, what portion of the map was completed

   e. Comments

C. Geocode the map (see supplement 1)

1. Register the acetate grid to the coding square on the map. Tape it down if needed. Double check the row-col. coordinates on the map and on the recording form. Fill out as much information as possible on the coding form, documentation section.

2. Divide the coding team into a reader (who calls out the cell coordinates) and a recorder (who writes coordinates and code on the recording form). Note, files may also be created interactively.

3. Create the header record (see figure). The exact information to be included depends on the nature of the map and amount to be geocoded.

4. The reader scans along the first row from left to right calling changes to the recorder.

5. Assuming the geocode format is being used, the reader calls out the column coordinate and mapping unit code each time the mapping unit changes. It is not necessary to call out the termination point of the row. This and othr essential information has been recorded in the header record. If a map boundary runs east-west within a row, the boundary is recorded in the first cell of the row in which the boundary occurs. The dominant map unit in each cell is recorded. A decision rule is used to break ties. All entries are written in five column fields, right-justified, unless otherwise specified. Blank records may be needed to fill out the maximum record length of each row as specified in the header record. When using batch mode, an end of file marker (/*) is required to signal the end of the mapped information. The resulting data file is called a map file.

6. While recording the data, avoid distracting noises and situations. Complete one coding square of work at one sitting. Call out the information clearly. Avoid abbreviations that may be confusing or ambiguous. Double check coordinates to verify position on the map - frequently.

7. At the conlusion of the session, finish documenting the coding sheet. Carefully return materials to their storage palces if you will ot be getting back to them soon or have a communal work space. You may want to write a note to yourself on what has to be done the next session.

D. Have the data keypunched (if coding forms are used).

1. Make a note of what has been handed over to the keypuncher (and when) in case it gets lost (or photocopied if necessary).

2. If you can afford it, have the keypuncher verify their work. This is done by punching the deck twice on a special keypunch.

3. Note this costly, time consuming step is avoided if a digitizer or an interactive terminal is used.

III. Verification and Data Aggregation Procedures Using GEOMAST

A. Have a printout of the punched deck or interactively created map file made and visually scan for obvious errors. This printout will also be useful in the following steps.

B. Through the use of EDIT, correct any error detected in Step 1.

C. Using CHECK, check for syntactical errors in data files. CHECK checks for valid row, column, and attribute values. If errors are encountered, CHECK allows the user to correct the data file (if it is stored on disk or tape), or prints error messages only.

D. Use MAP to check for valid symbol placement and rough boundary alignment. This can be accomplished by making a scaled map and overlaying it on the original map. Boundary alignment to a standard map is accomplished by use of the BOUND phase described below.

E. If several different maps are used to build the data base, it is advised to reconcile the boundaries of these maps to a given standard map. BOUND will adjust the boundaries to a given standard if alignment can occur within a 2% change in map area. If more than 2% must be changed to reconcile the boundaries, a major incompatibility between the maps is the probable cause and further automatic adjustment is stopped.

F. After using the BOUND phase it is advisable to obtain a scaled map using the MAP phase and overlay it to the standard to check for correction accuracy and boundary alignment validity. Area totals should also be checked.

G. After all the correction have been completed, use MERGE to create a master file or add the map to an existing master file.

H. Add further codes to the file as necessary. For example, a soil group code may have a number of associated soil property codes (such as slope suitability for a given use, permeability, etc.) that could be added to the file with a simple program. GEOMAST currently does not include the capability.

I. Document activities. Produce a corrected listing with sufficient annotation that someone unfamiliar with the file would be able to interpret the contents. A clean copy of the printer map and a one-way cross tab are also valuable documentation aids.

IV. Computer Implementation of GEOMAST

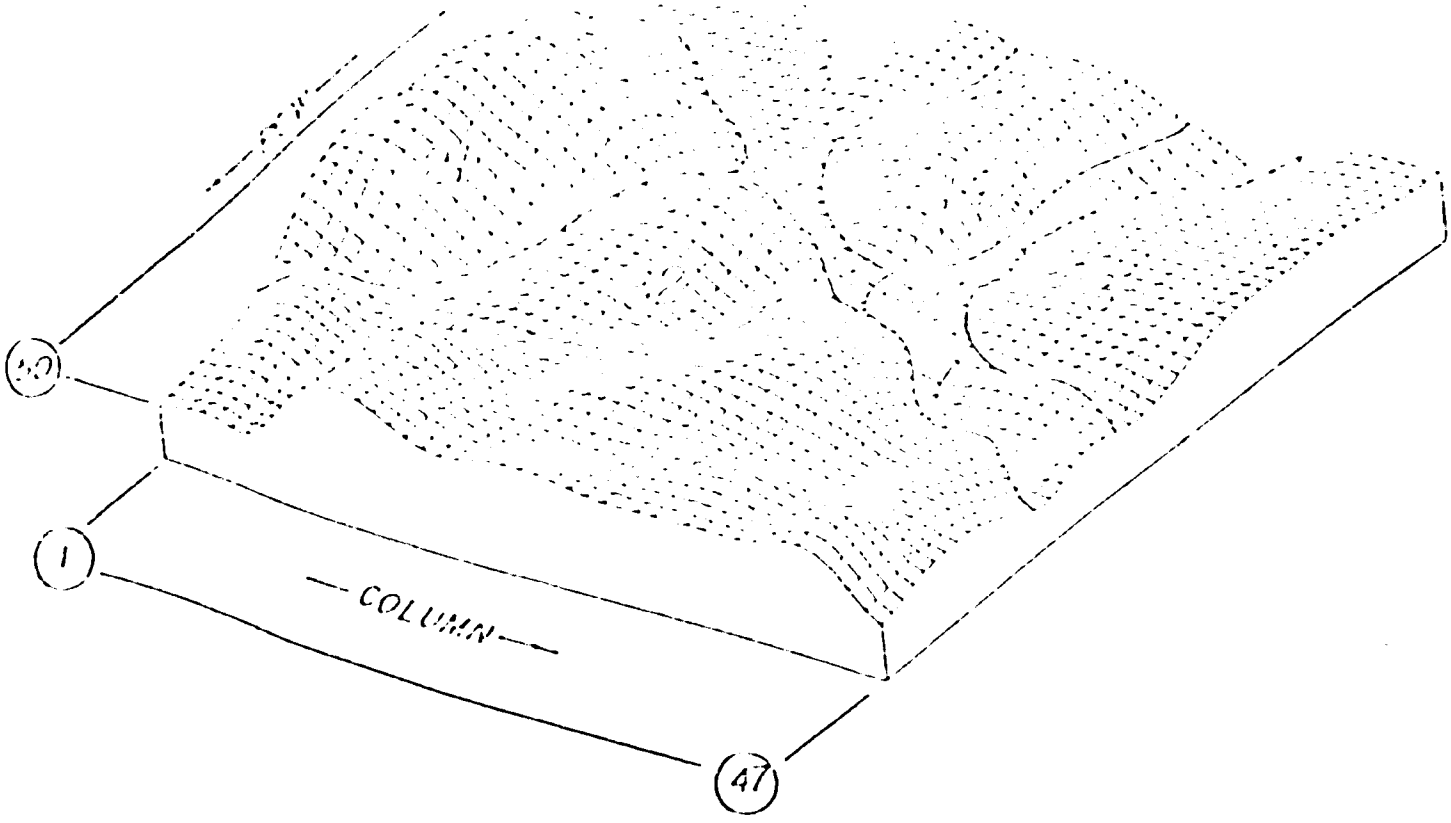
A. Files used

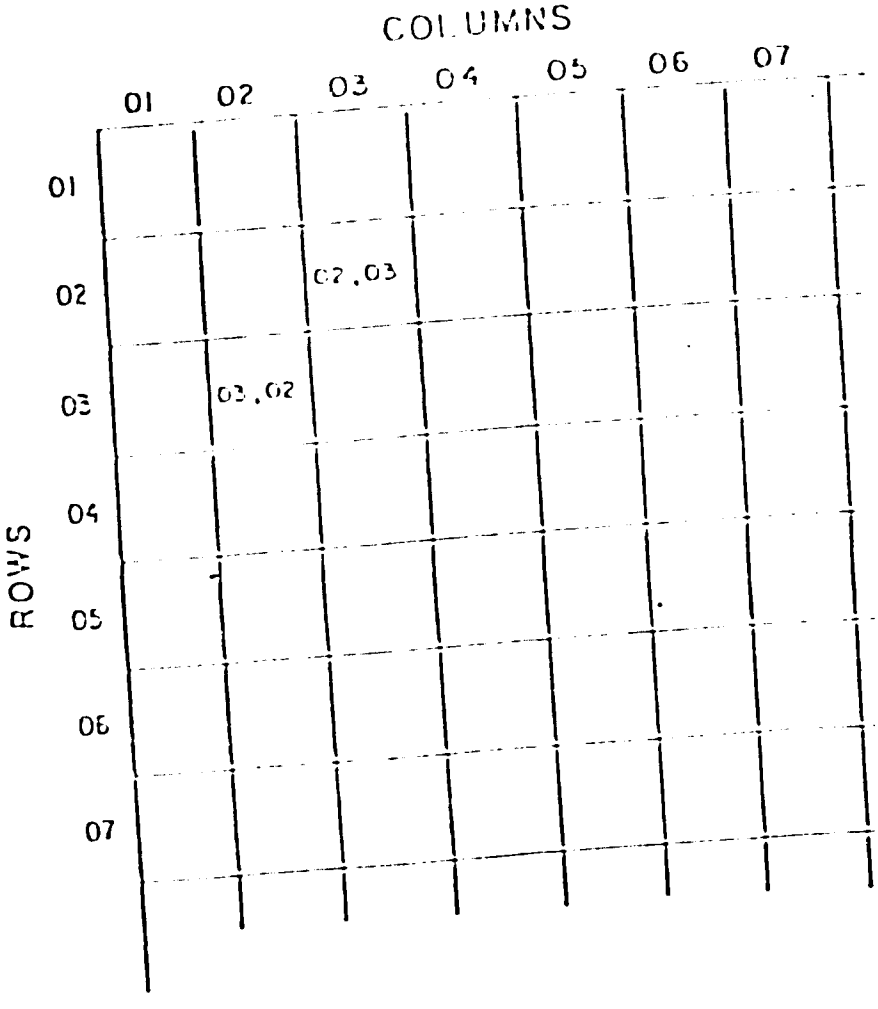
B. Saving files

C. Job control language of GEOMAST

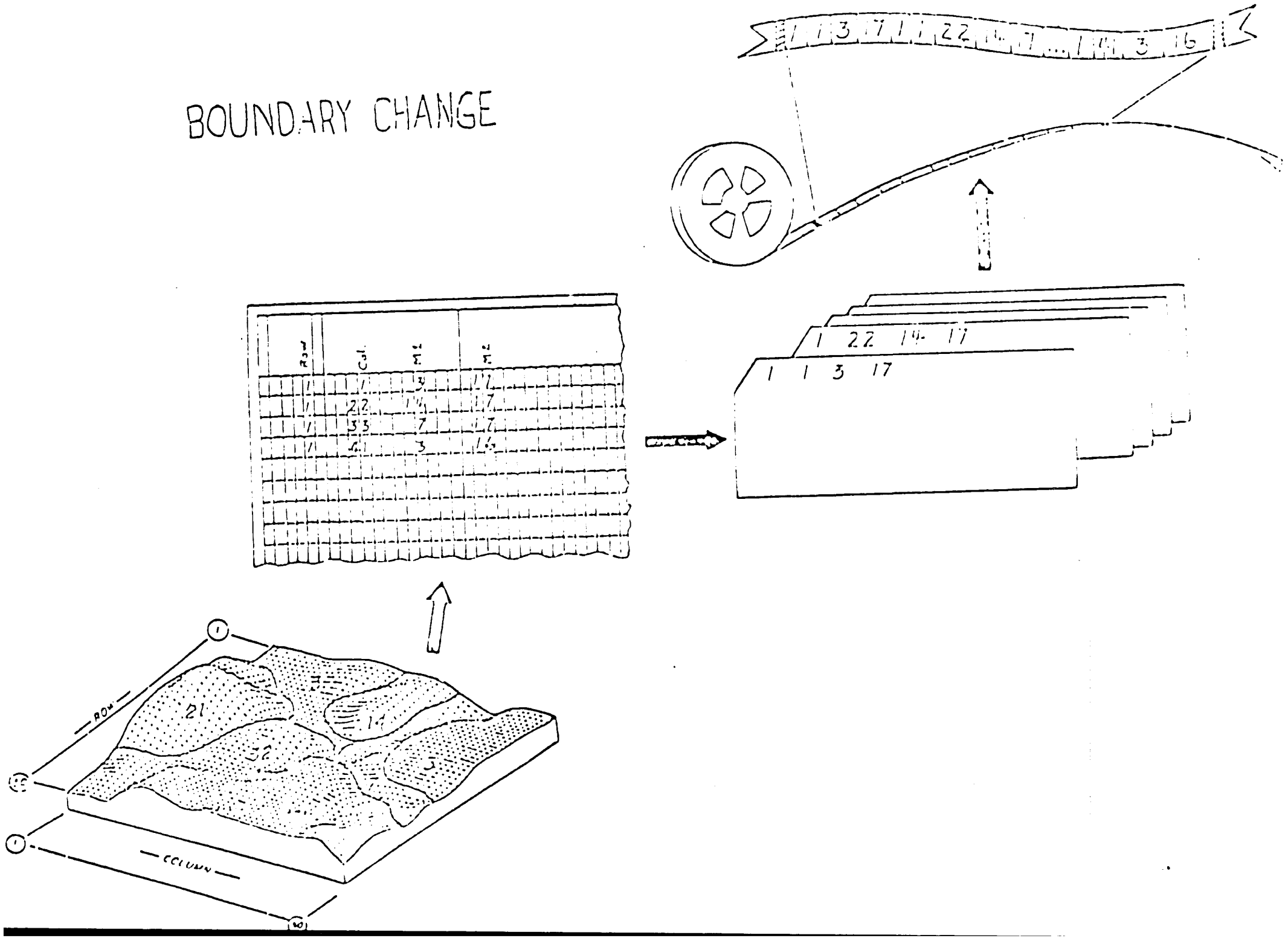
D. File structure

V. Linked Phases

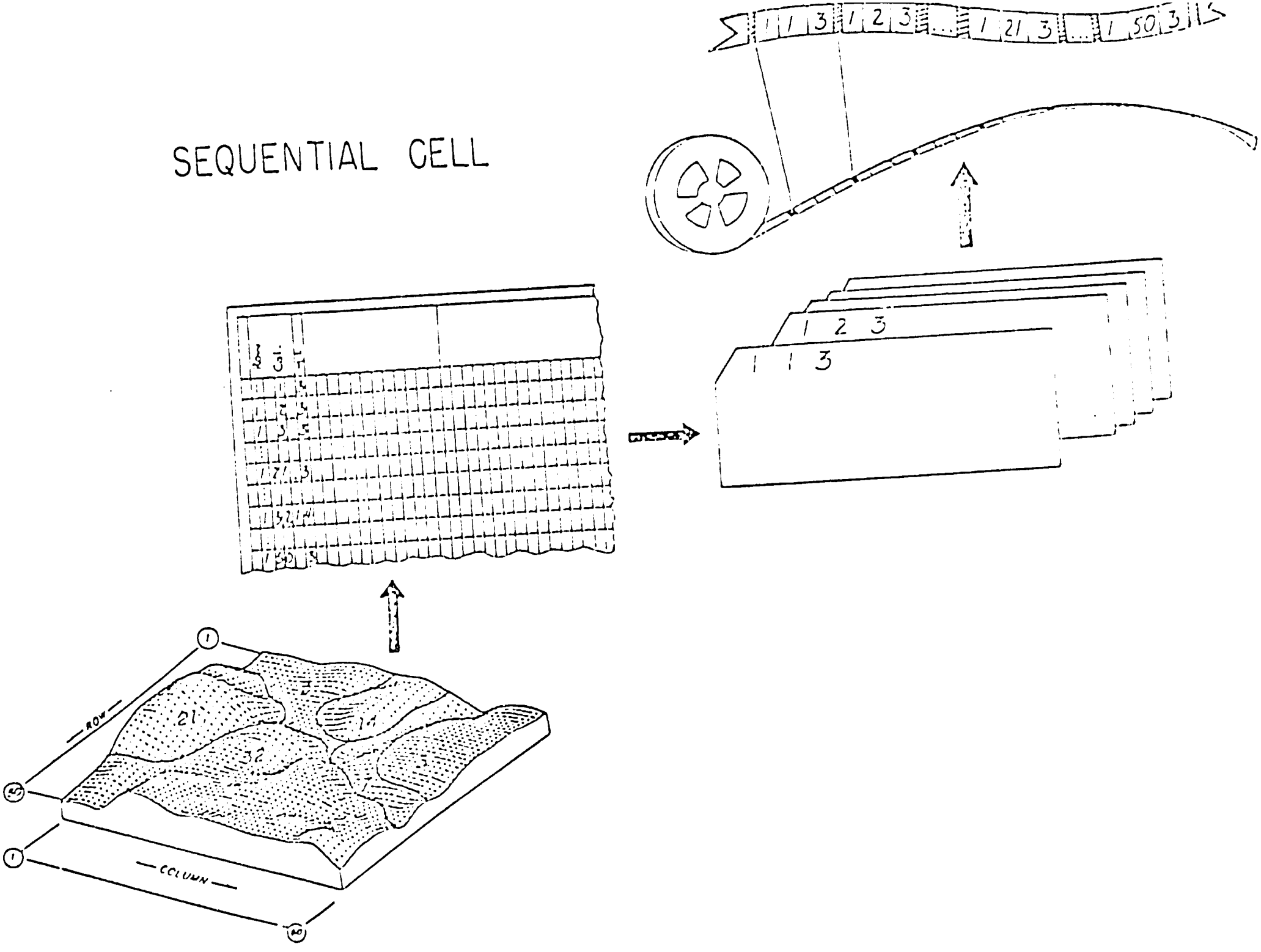

1
COLUMN
47


COLUMNS
01
02
03
04
05
06
07
ROWS
01
02
03
04
05
06
07
02,03
03,02

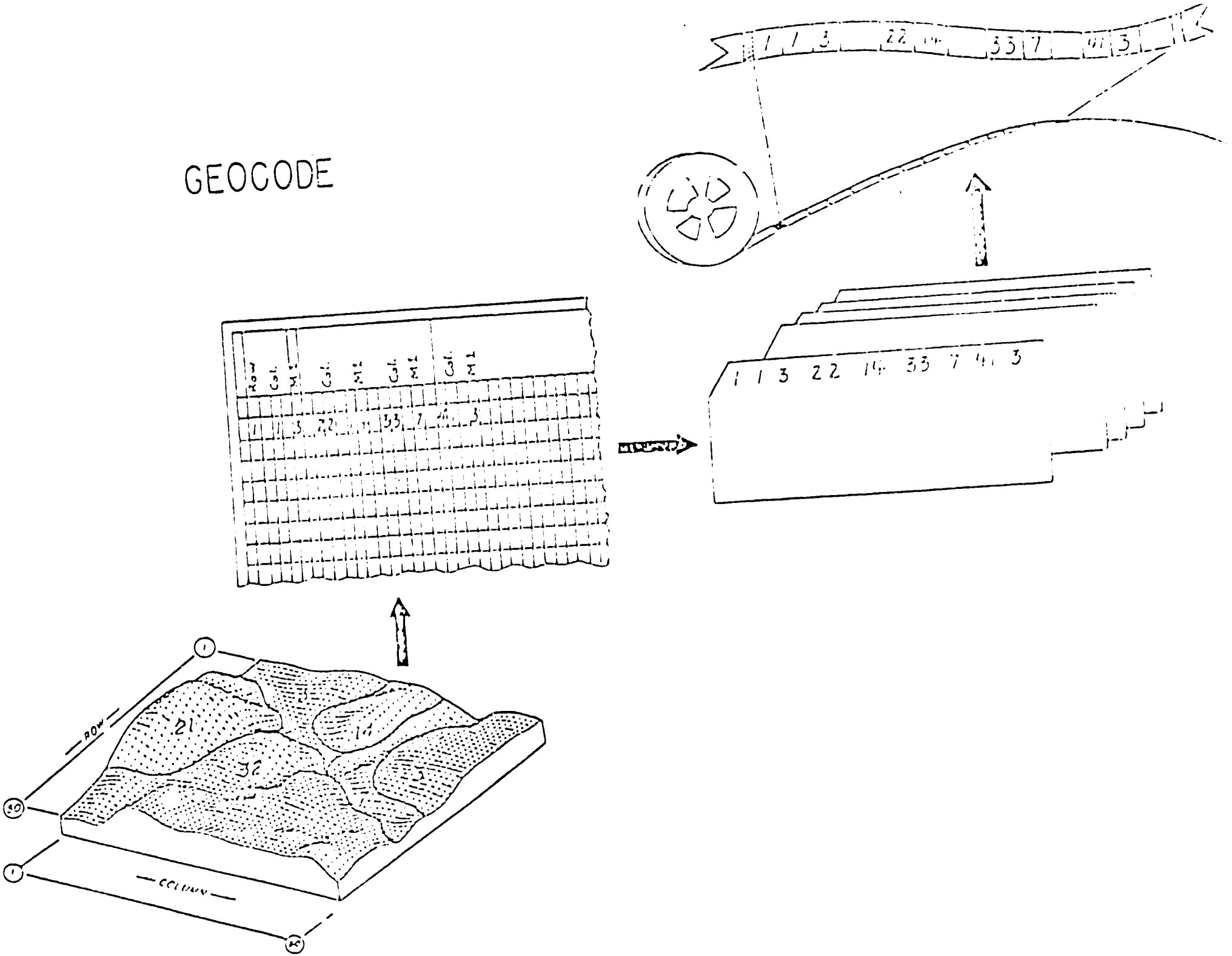
BOUNDARY CHANGE



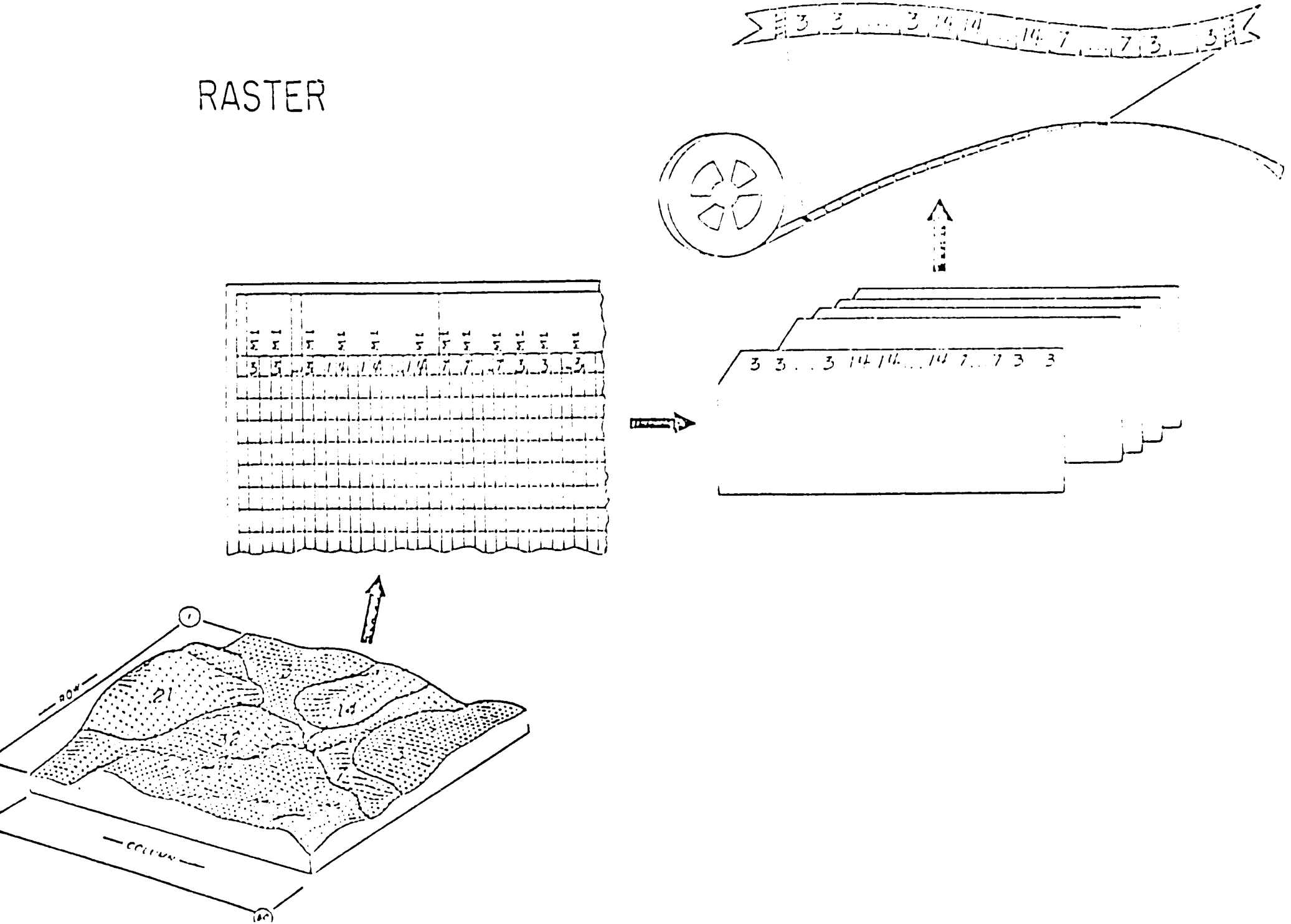
SEQUENTIAL CELL



GEOCODE



RASTER



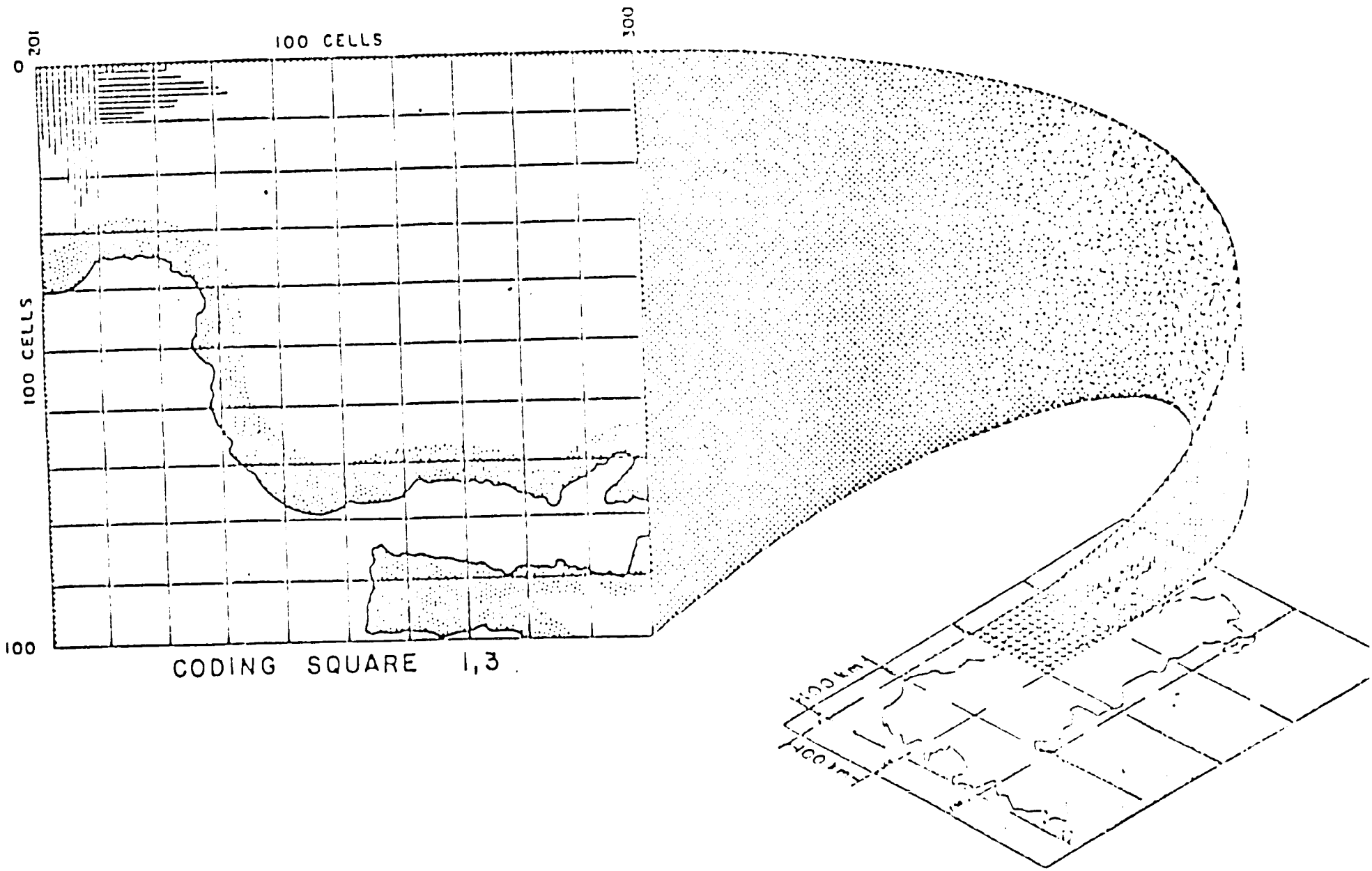
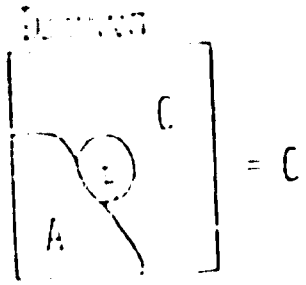
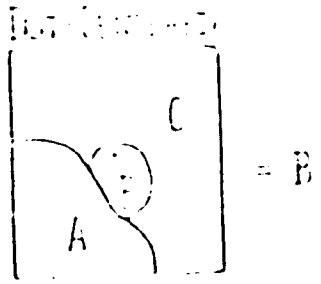


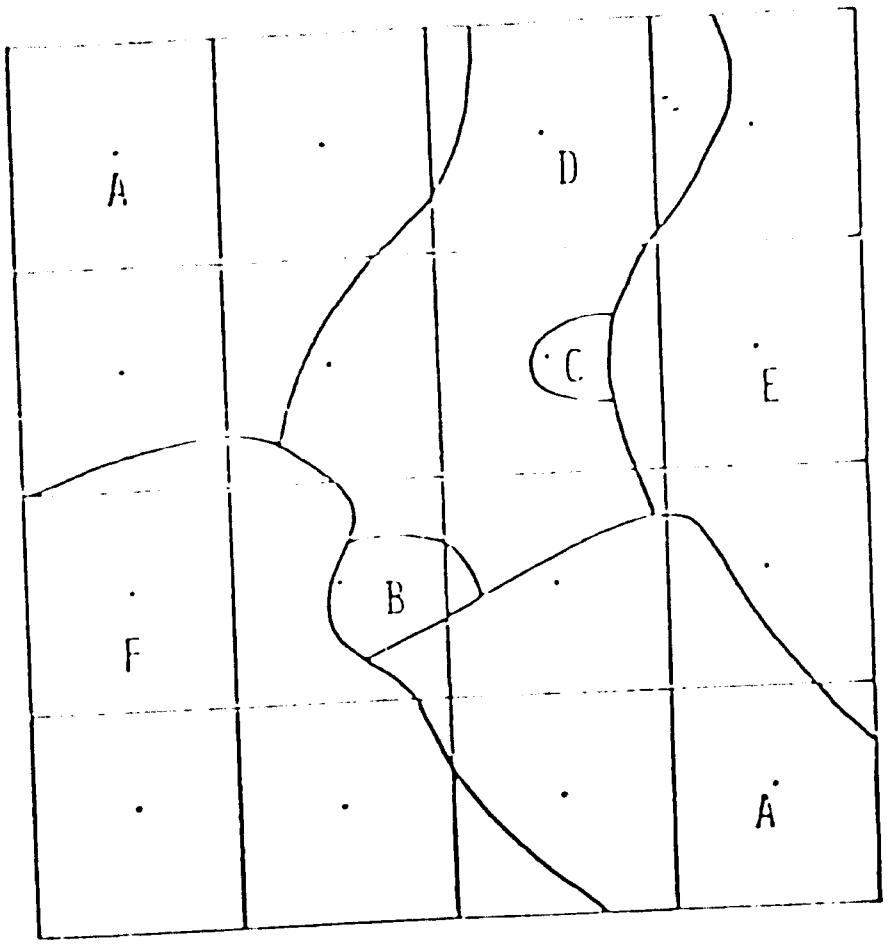
Figure .--Expanded view of coding square 1,3 for the Dominican Republic.

Documentation of Mapping Codes--An Example

Map Code	Land Cover/Use Type	Description
1	Intensive Agriculture	Areas with multiple cropping, usually under irrigation
2	Extensive Agriculture	Areas normally cultivated with single crop, usually dry land farming
3	Range	Areas where the potential natural vegetation is predominantly grass-like plants, forbes or shrubs that can be used for grazing
4	Water	Areas covered by water year round, i.e., lakes, ocean, reservoirs
5	Urban	Areas in intensive use with much of the land covered by man-made structures
6	Forest	Areas of mixed deciduous and evergreen trees
7	Orchards	Areas of cultivated fruit, olive and nut trees, primarily non-irrigated
8	Barren	Areas of land with limited ability to support vegetation (less than one-third vegetation cover), primarily salt beds





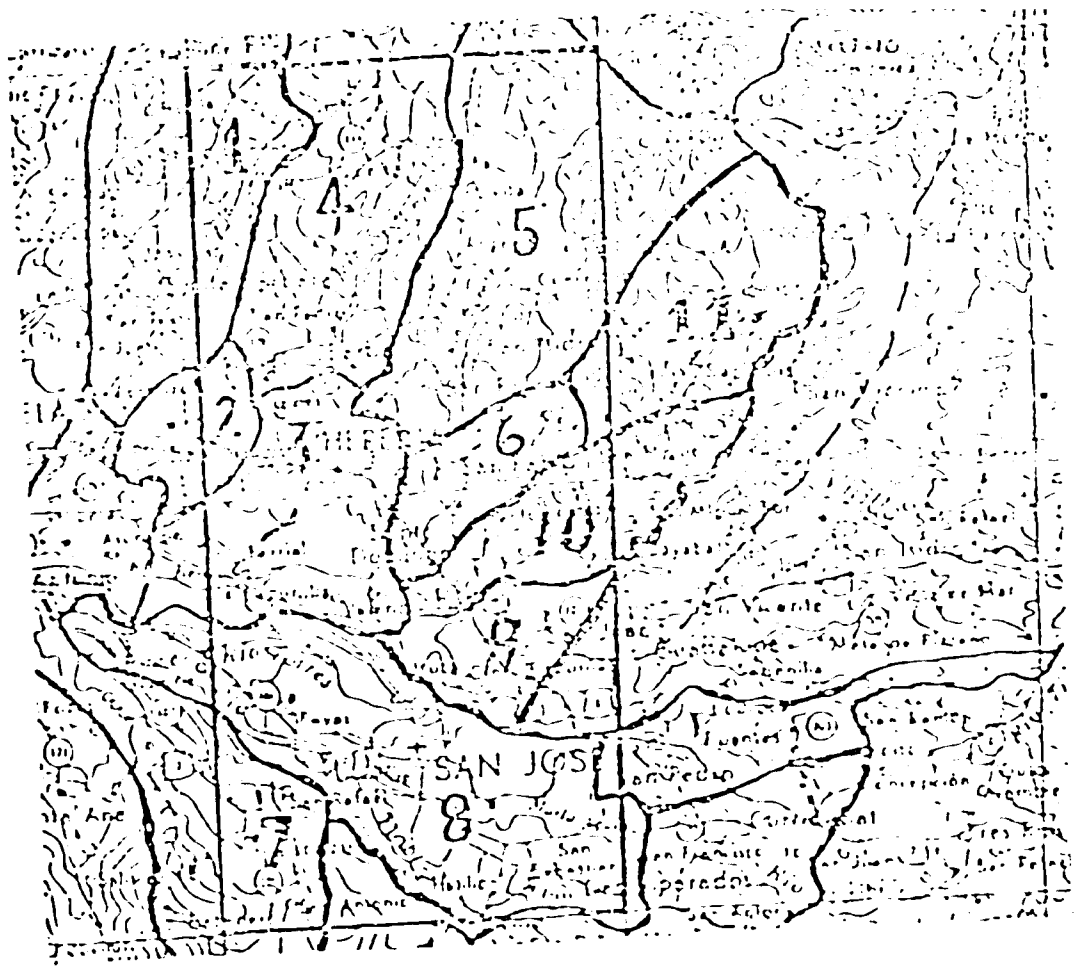


Dominant

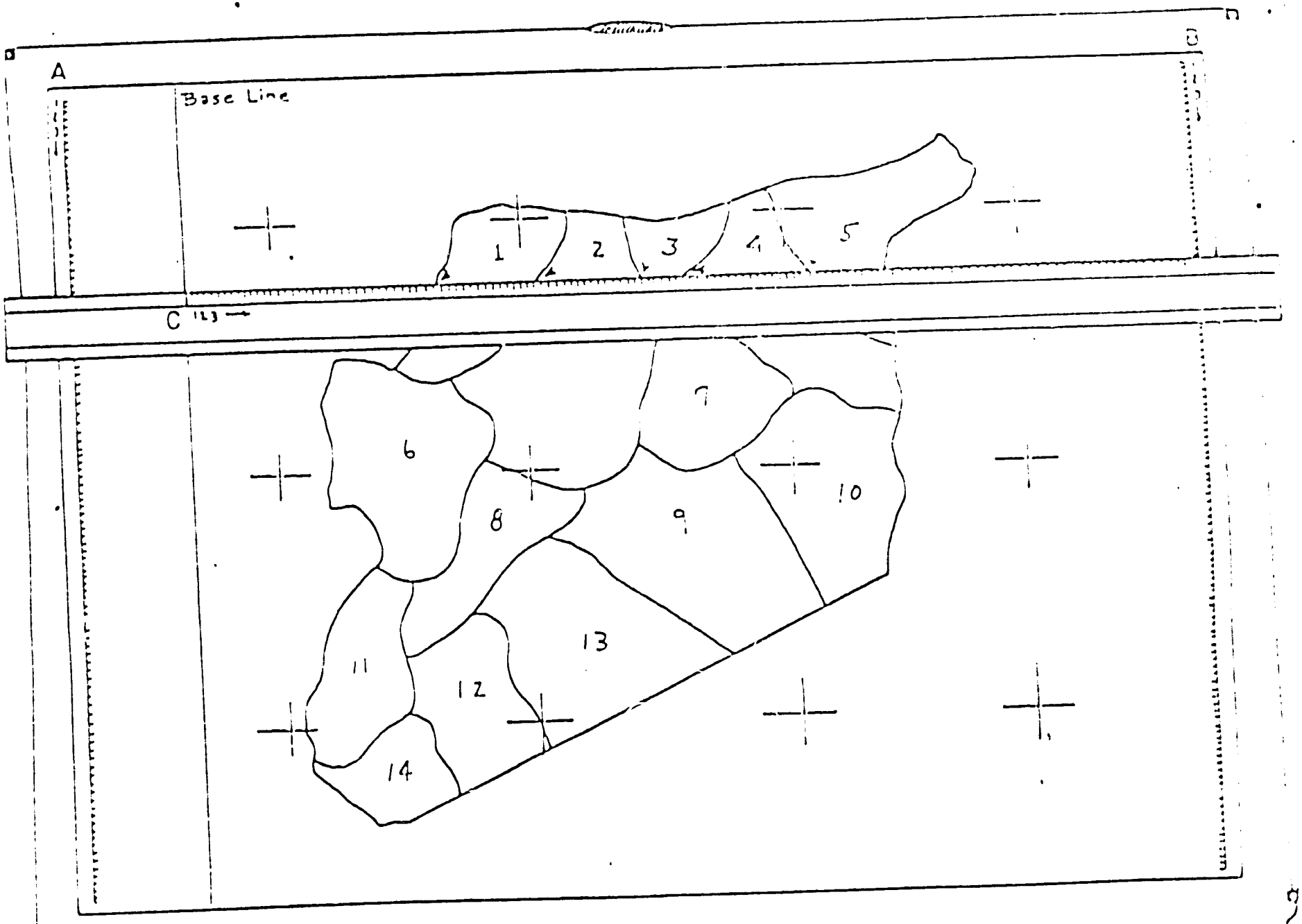
Map Unit	Count (km^2)	%
A	6	37.5
B	0	0.0
C	0	0.0
D.	3	18.75
E	3	18.75
F	4	25.0
	16	100.0

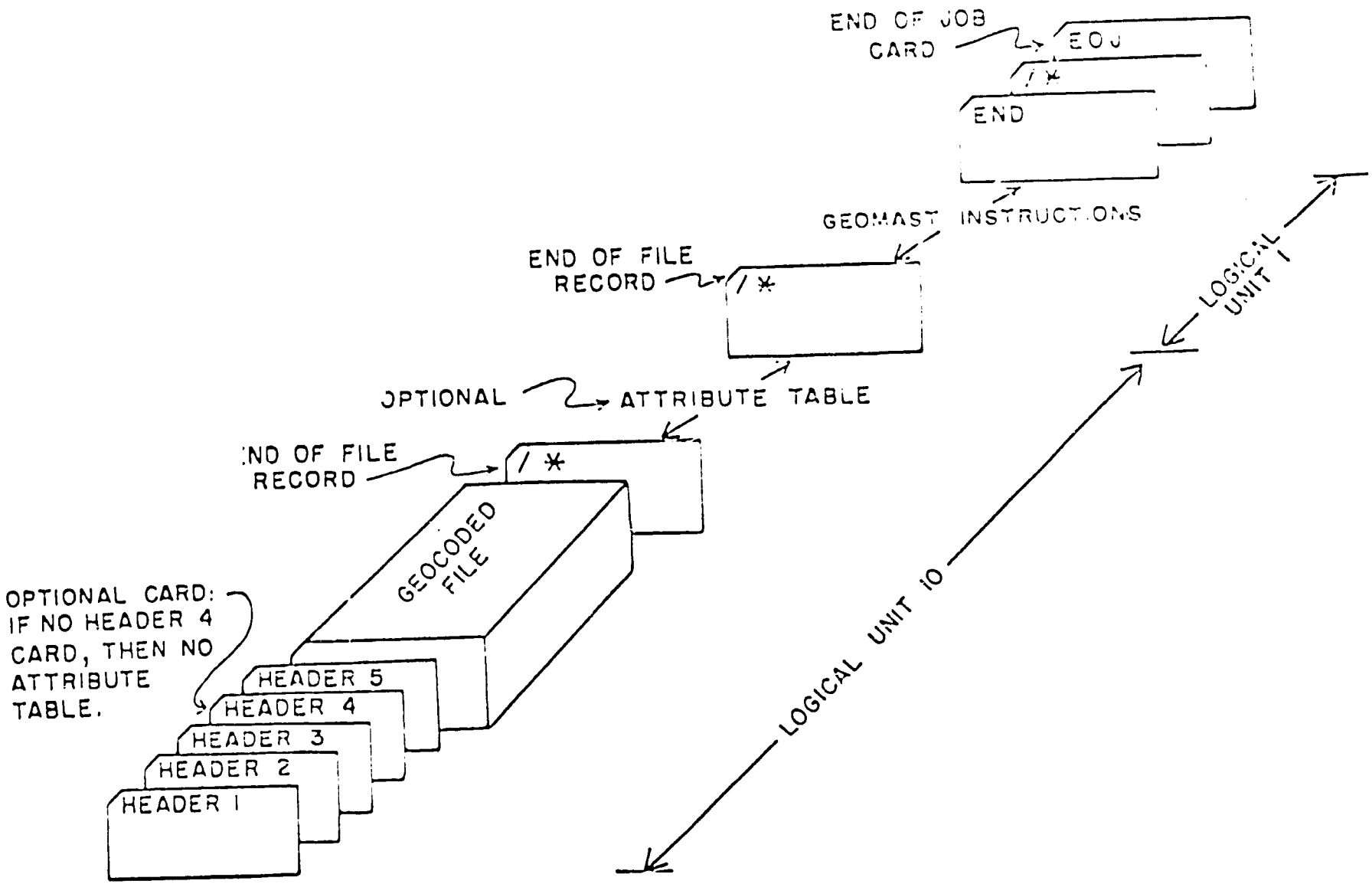
Dot Centered

Map Unit	Count (km^2)	%
A	6	37.5
B	1	6.25
C	1	6.25
D	2	12.5
E	3	18.75
F	3	18.75
	16	100.0


4
5
6
10
12
SAN JOSE
8
7

130
130
D

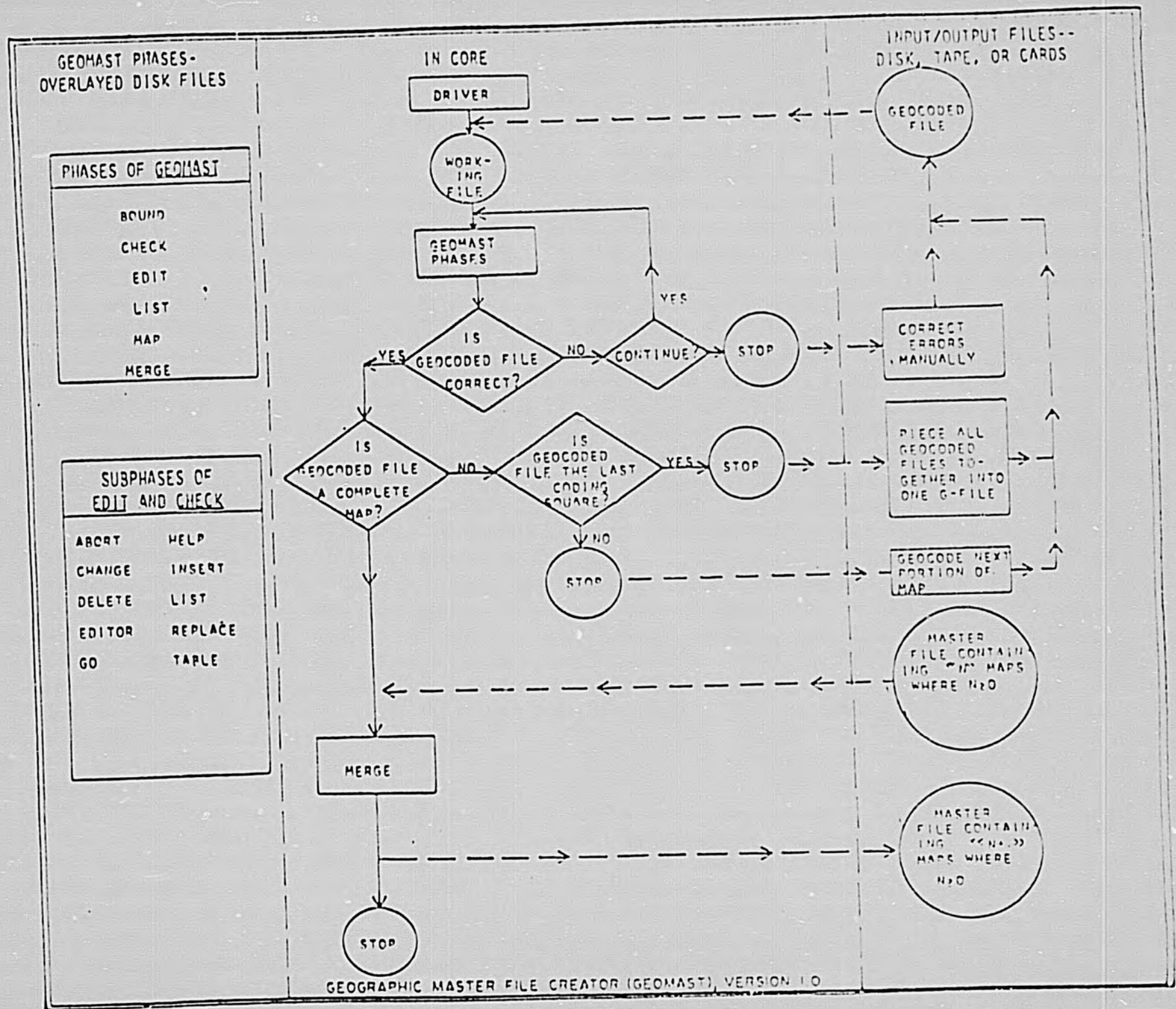

A
Base Line
C
1
2
3
4
5
6
7
8
9
10
11
12
13
14



DATA REQUIRED BY GEOMAST

CODERS:	DATE START:	MAP SOURCE AND SCALE:
TIME TO GEOCODE BY CODING SQUARE:	DATE FINISH:	
	COMMENTS:	

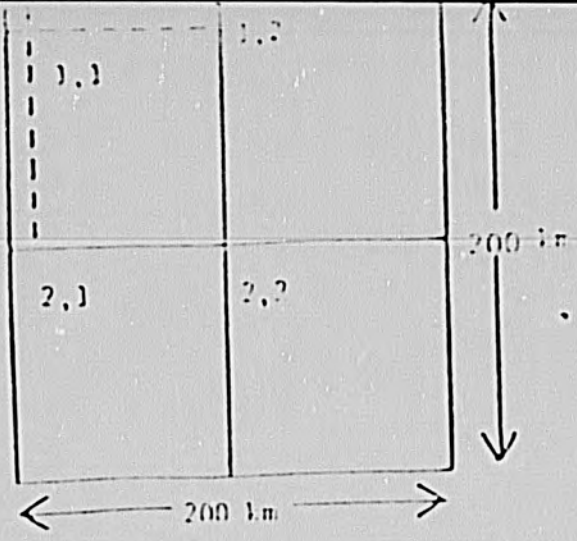
	Line	Card columns 1–80 (entries as written)
HEADER 1	1	0
2	2	[illegible] 7 I 5 . I I 7 7 . 4 I Z 2 4 1 :
3	3	[illegible] 1 6 I 5 2 1 6 1 6 7
4	4	[illegible] 6 I 2 2 1 x 1 2
5	5	2 1 2 0 1 1 0 0 0 2 2 2 3 EXPERIMENT STATION NO. 4 - TEST PLOT, 20
	6	6 9 - - 5 0 L L 5 - - FEBRUARY 15, 1980
	7	1 1 1 2 1 2 2 6 3 0 2 2 4 5 2 0 5 3 0 5 7 7 4 0
	8	7 6 7 0 2 6 7 6 7 0 2 2 4 7 2 0 5 7 7 7 3 0 7 4 7
	9	1 2 1 2 1 2 2 6 2 9
	10	0
	11	1 3 1 2 1 2 2 6 2 9 2 2 4 9 2 0 5 7 7 6 1 0
BLANK CARD	12	
	13	1 4 1 2 1 2 3 6 2 9 2 2 4 8 2 0 5 7 7 6 1 0
BLANK CARD	14	
	15	1 5 1 2 1 2 3 6 2 5 2 2 4 8 2 0 5 6 7 8 5 0 6 7 7
	16	0
	17	1 6 1 2 1 2 4 6 2 5 2 2 4 9 2 0 6 1 7 9 0 0
BLANK CARD	18	
	19	1 7 1 2 1 2 4 2 2 3 0 2 0 5 6 7 9 7 0
BLANK CARD	20	
	21	1 8 1 2 1 2 4 2 2 5 0 2 0 5 6 7 9 3 0 9 5 7 7 8 0
BLANK CARD	22	
	23	1 9 1 2 1 2 3 2 2 5 3 2 0 5 6 7 1 0 0 0
BLANK CARD	24	
	25	2 0 1 2 1 2 3 2 2 5 3 2 0 5 5 7
BLANK CARD	26	
END OF FILE	27	/ Y
	28	0 6 7 2 0 2 1 2 2
END OF FILE	29	/ Y
	30	



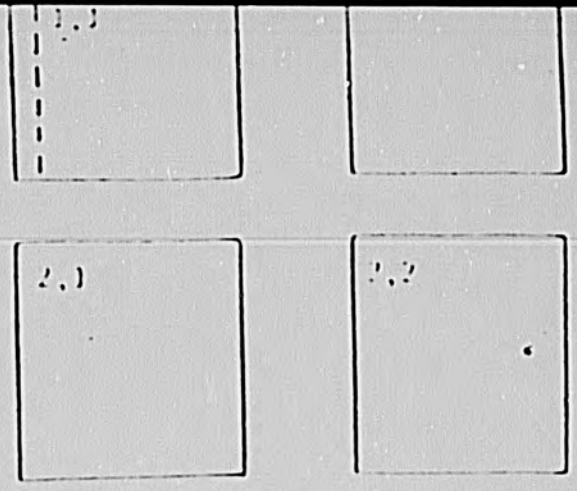
GEOGRAPHIC MASTER FILE CREATOR (GEOMAST), VERSION 1.0

Table 1.1.-- Phases of GEOMAST and Their Functions

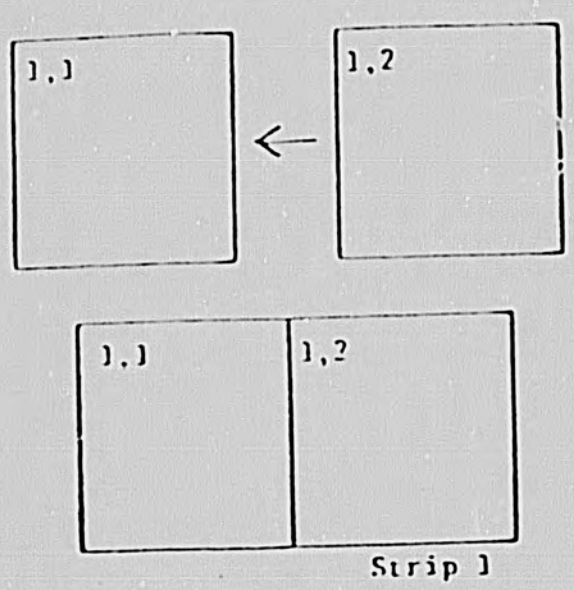
PHASE	PHASE NAME	FUNCTION
1. BOUND	BND	Adjusts the boundaries of a given geocoded file to that of a standard file.
2. CHECK	CHCK	Checks for syntactical errors in geocoded data files. Produces an error listing and editing capabilities.
3. EDIT	EDIT	Allows editing of individual elements in a given row.
4. END	END	Produces a copy of the working file on logical unit 12 and stops execution of GEOMAST.
5. LIST	LIST	Lists all or part of the current working file.
6. MAP	MAP	Constructs a variable scale or simple unit character per cell map.
7. MERGE	MRGE	Creates a master file or merges the working file into a given master containing one or more factors.



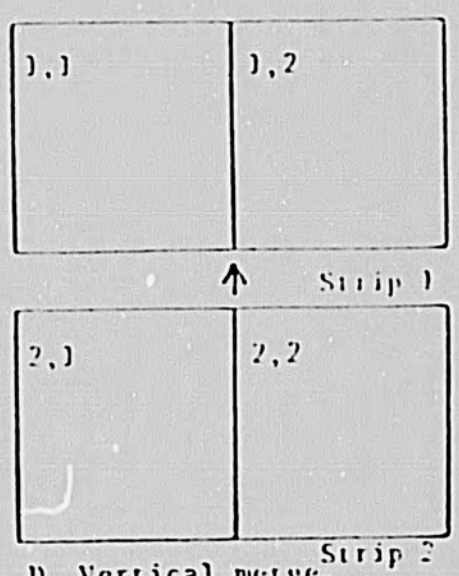
A.



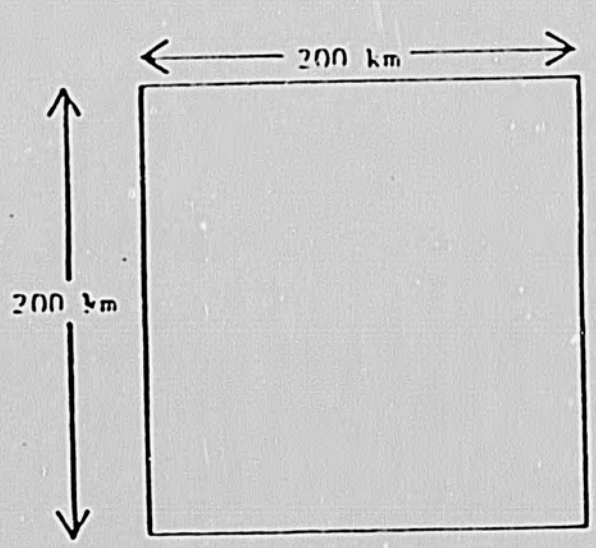
B. Map procoded in four sections



C. Horizontal merge.

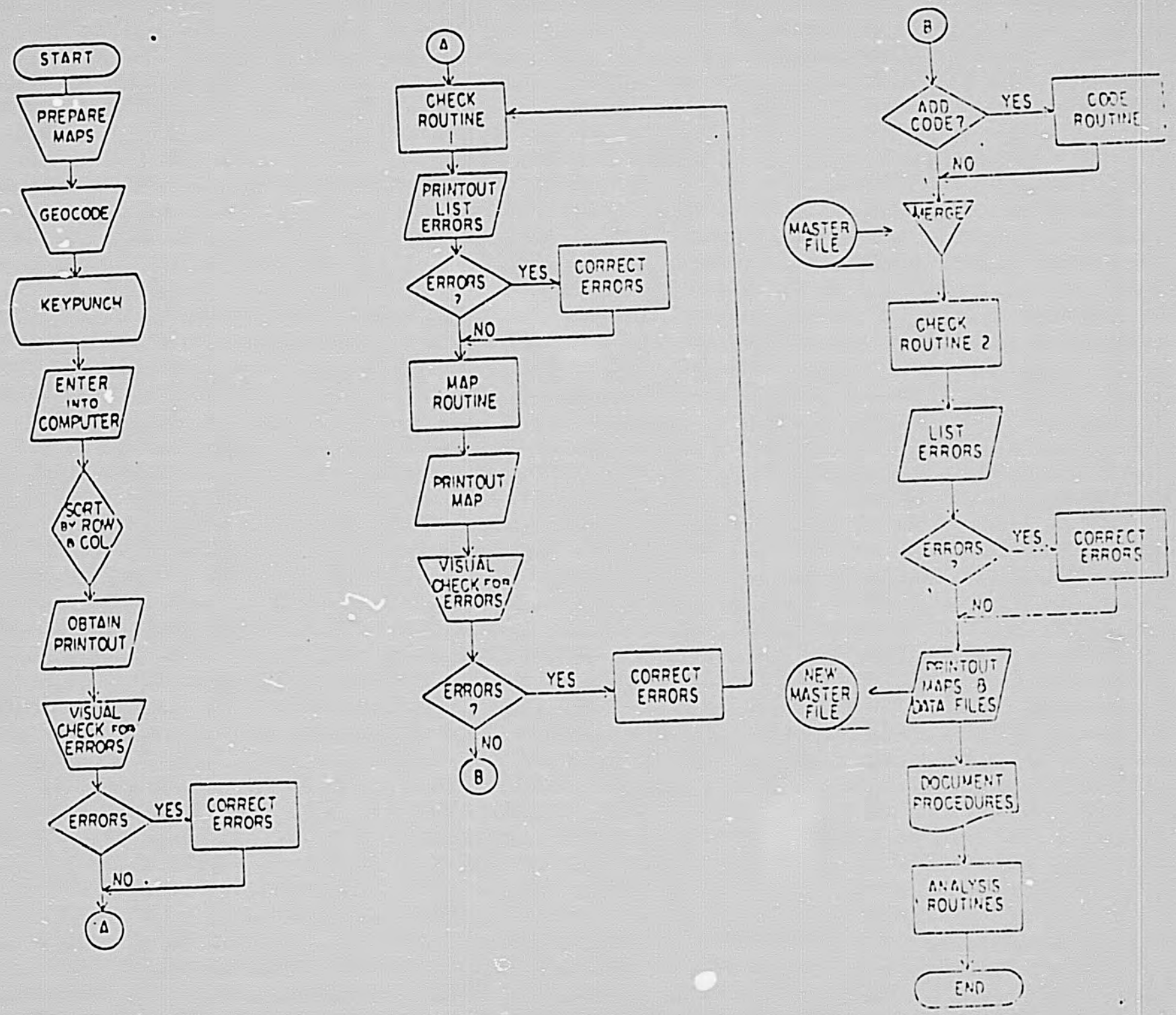


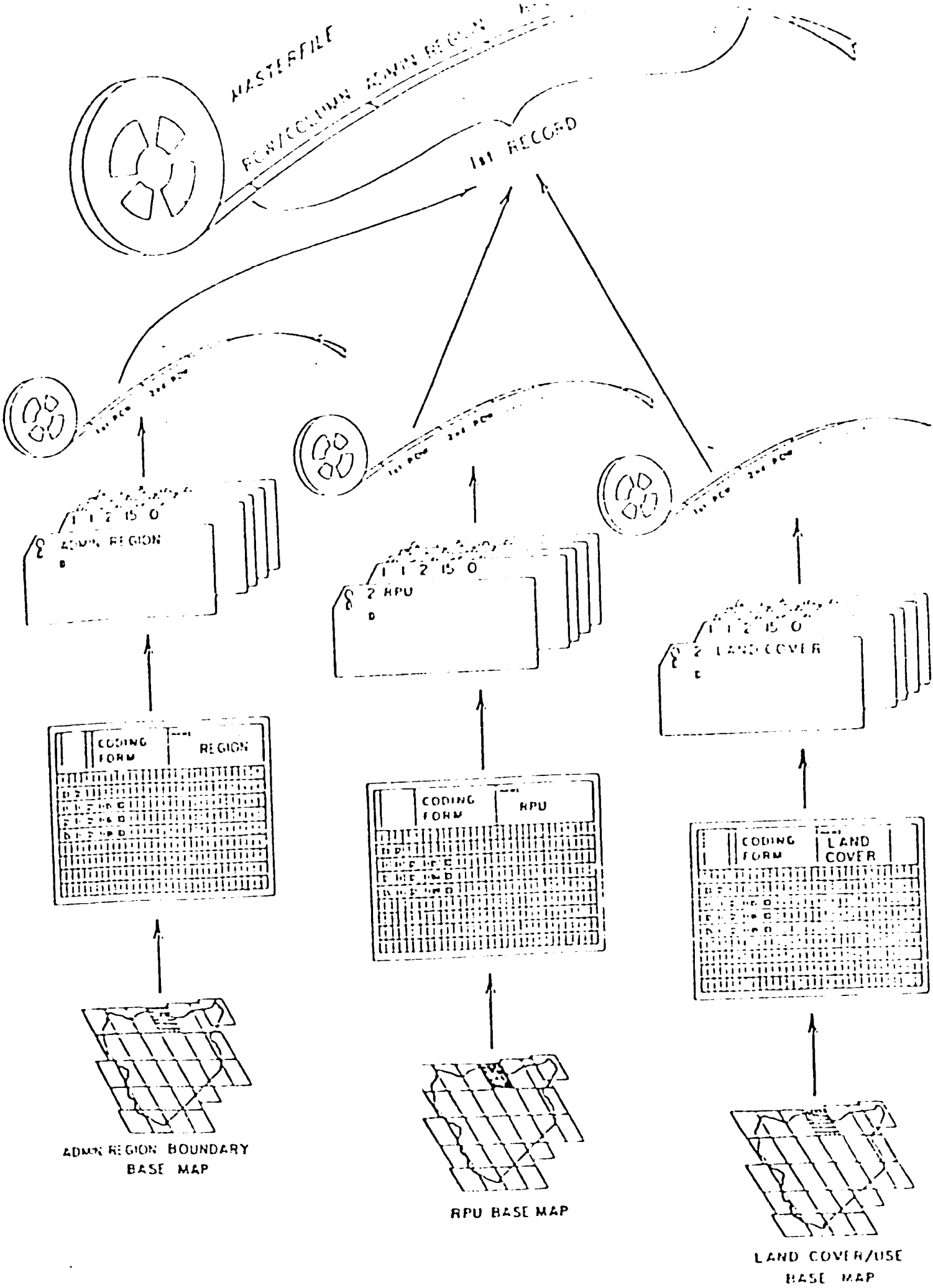
D. Vertical merge.

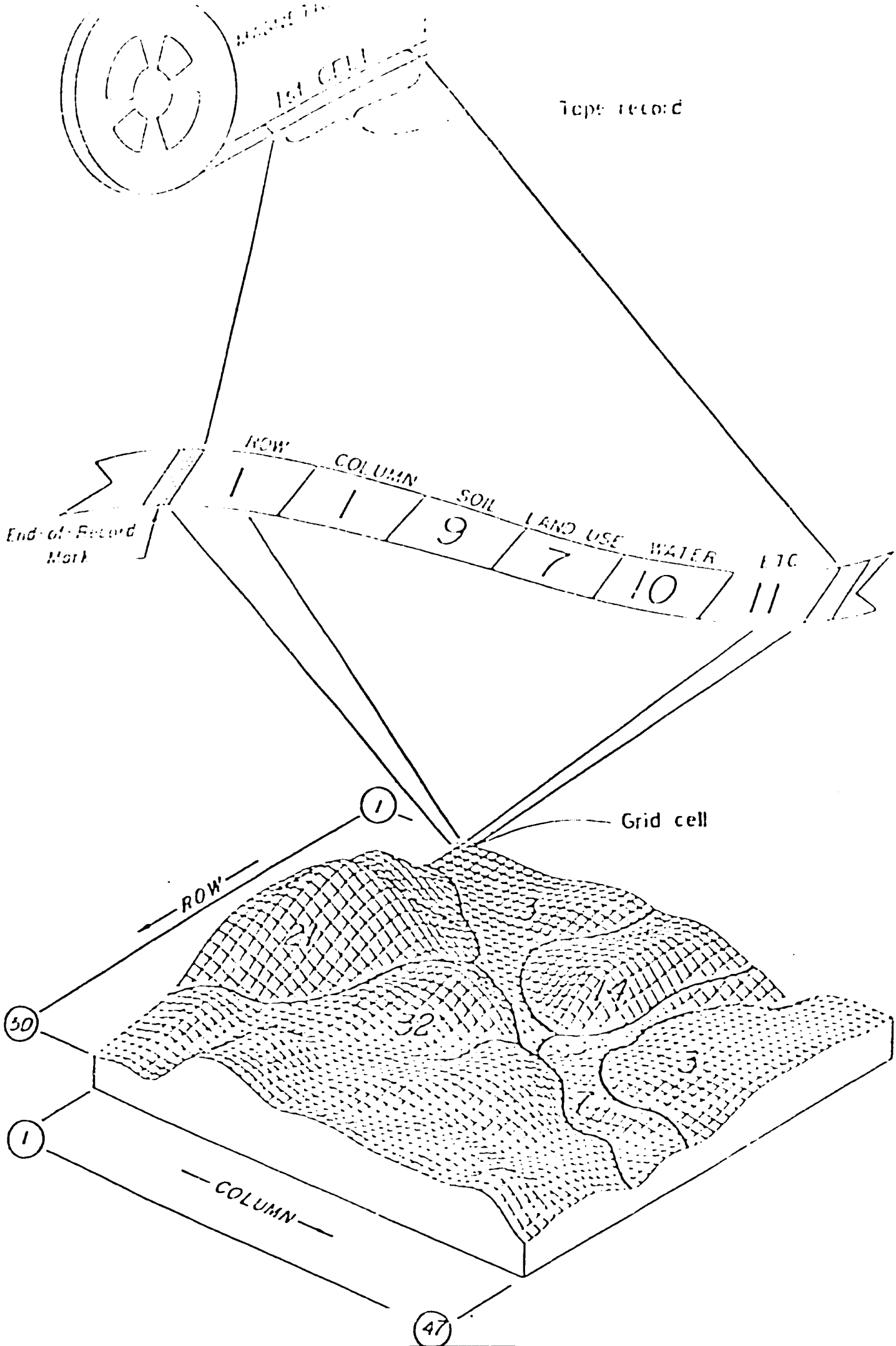


E. Final data file.

Schematic diagram STRIP/STACK process.


START
PREPARE MAPS
GEOCODE
KEYPUNCH
ENTER INTO COMPUTER
SORT BY ROW & COL
OBTAIN PRINTOUT
VISUAL CHECK FOR ERRORS
ERRORS
YES
CORRECT ERRORS
NO
A
A
CHECK ROUTINE
PRINTOUT LIST ERRORS
ERRORS ?
YES
CORRECT ERRORS
NO
MAP ROUTINE
PRINTOUT MAP
VISUAL CHECK FOR ERRORS
ERRORS ?
YES
CORRECT ERRORS
NO
B
B
ADD CODE?
YES
CODE ROUTINE
NO
MASTER FILE
MERGE
CHECK ROUTINE 2
LIST ERRORS
ERRORS ?
YES
CORRECT ERRORS
NO
NEW MASTER FILE
PRINTOUT MAPS & DATA FILES
DOCUMENT PROCEDURES
ANALYSIS ROUTINES
END


MASTERFILE
ROW/COLUMN ADMIN REGION
1st RECORD
ADMIN REGION
RPU
LAND COVER
CODING FORM
REGION
CODING FORM
RPU
CODING FORM
LAND COVER
ADMIN REGION BOUNDARY BASE MAP
RPU BASE MAP
LAND COVER/USE BASE MAP


Tape record
1st CELL
ROW
COLUMN
SOIL
LAND USE
WATER
ETC
1
1
9
7
10
11
End-of-Record Mark
Grid cell
ROW
COLUMN
1
50
1
47
21
32
3
17
5

EXERCISE 1. Geocoding Formats

I. Purpose:

To gain familiarity with the digitizing process and coding formats used during digitization.

II. Materials:

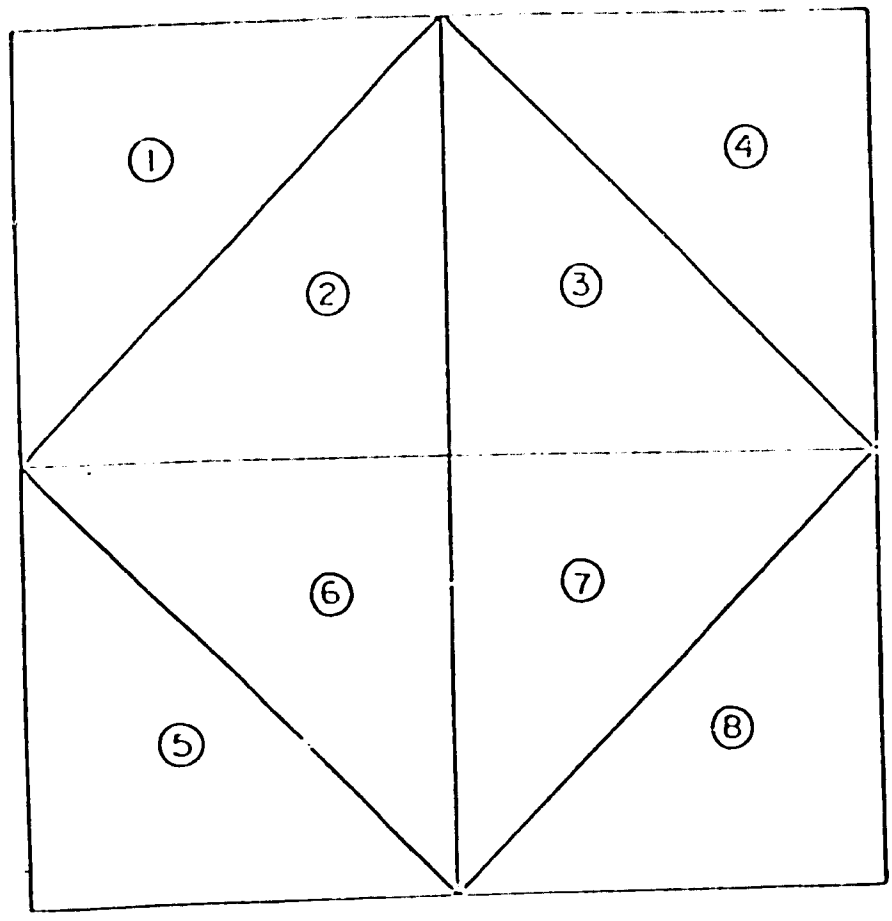
- Pencil, eraser, ruler
- Coding form
- Figure to be coded

III. Procedure:

- Prepare symbol table (on coding form)
- Code upper left quadrant using three formats:
  1. Sequential cell
  2. Geocode
  3. Raster
- Compare formats in terms of:
  1. Time to code
  2. Amount of space used

IV. Discussion:

Discuss advantages and disadvantages of each format.



GEOCODE TESTING
EXERCISE 1 (GEOMAST)

EXERCISE II. Geocoding a Simple Map

I. **Purpose:**

To gain experience in the manual geocoding process; to observe the differences between actual and gridded maps.

II. **Materials:**

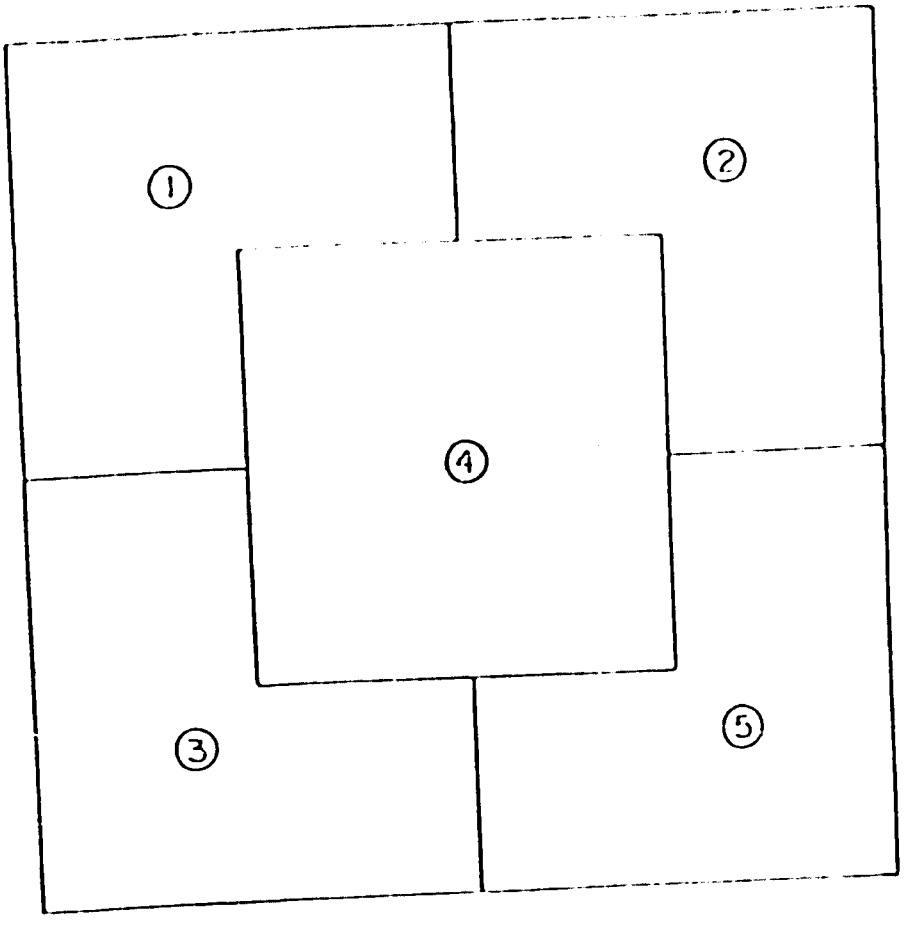
- Pencil, eraser, straight edge
- Coding form
- Map figure to be coded
- Computer time
- Proper JCL
- Disk File Space

III. **Procedure:**

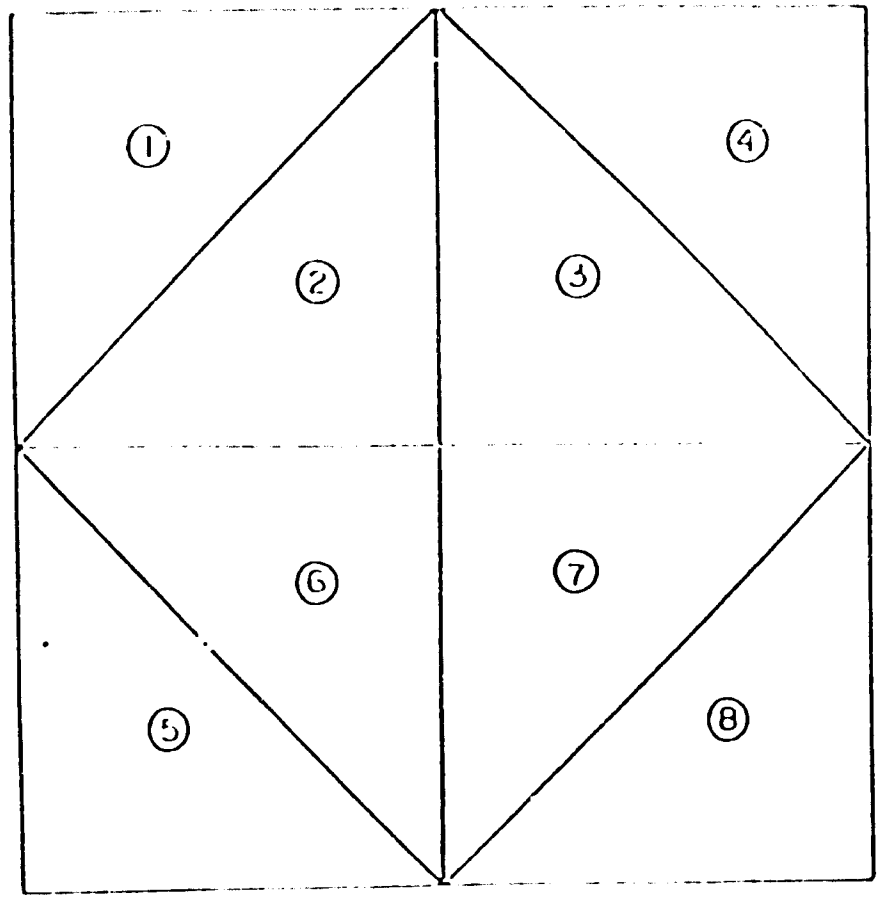
- Prepare symbol table, decide on decision rules.
- Prepare grid on map.
- Code (in teams of two, see supplement 1.) First example in four sections and second in two sections.
- Verify using GEOMAST.
  - a. Edit routines
  - b. The printer map to scale

IV. **Discussion:**

1. Discuss difficulties encountered
2. Discuss influence of decision rules on results
3. Discuss procedures for documentation and storage



GEOCODE TESTING
EXERCISE 2 (GEOMAST)



GEOCODE TESTING
EXERCISE 2 (GEOMAST)

EXERCISE III. Geocoding an Actual Map

I. Purpose:

To gain further practice in manual geocoding, to observe the difference between actual and gridded maps, to gain practice in the use of GEOMAST.

II. Materials:

- Pencil, eraser, straight edge
- Acetate grid
- Political boundary map of the San Jose/Cartago region
- Soil map of the San Jose/Cartago region
- Coding forms
- Disk file containing the two geometric map master file
- Computer time
- Proper JCL

III. Procedure:

- Prepare symbol table, decision rules.
- Mark of the same 20 km by 20 km area on both maps and outline map unit boundaries if necessary.
- Make 1 square kilometer coding squares on both maps. The political boundary map has the Costa Rican grid drawn on it. For the purposes of this exercise, one of the coding squares could be 20 km by 10 km and the other 20 km by 20 km.
- Code the two maps, one in two sections and one in one section.
- Verify using GEOMAST (including hitching the coding squares together).
- Use Merge to make a four factor Master File of these two maps along with the two geometric examples.

IV. Discussion:

1. Discuss difficulties encountered
2. Discuss anticipated problems in constructing large scale files (including management problems)
3. Discuss the influence of decision rules on the results. Also discuss the influence of using dominant vs. dot centered coding on the results

4. Discuss procedures for documentation and storage

V. Comments on Grid Size and Map Scales

1. A map scale of 1:500,000 means that one map unit equals 500,000 real or on-the-ground units.

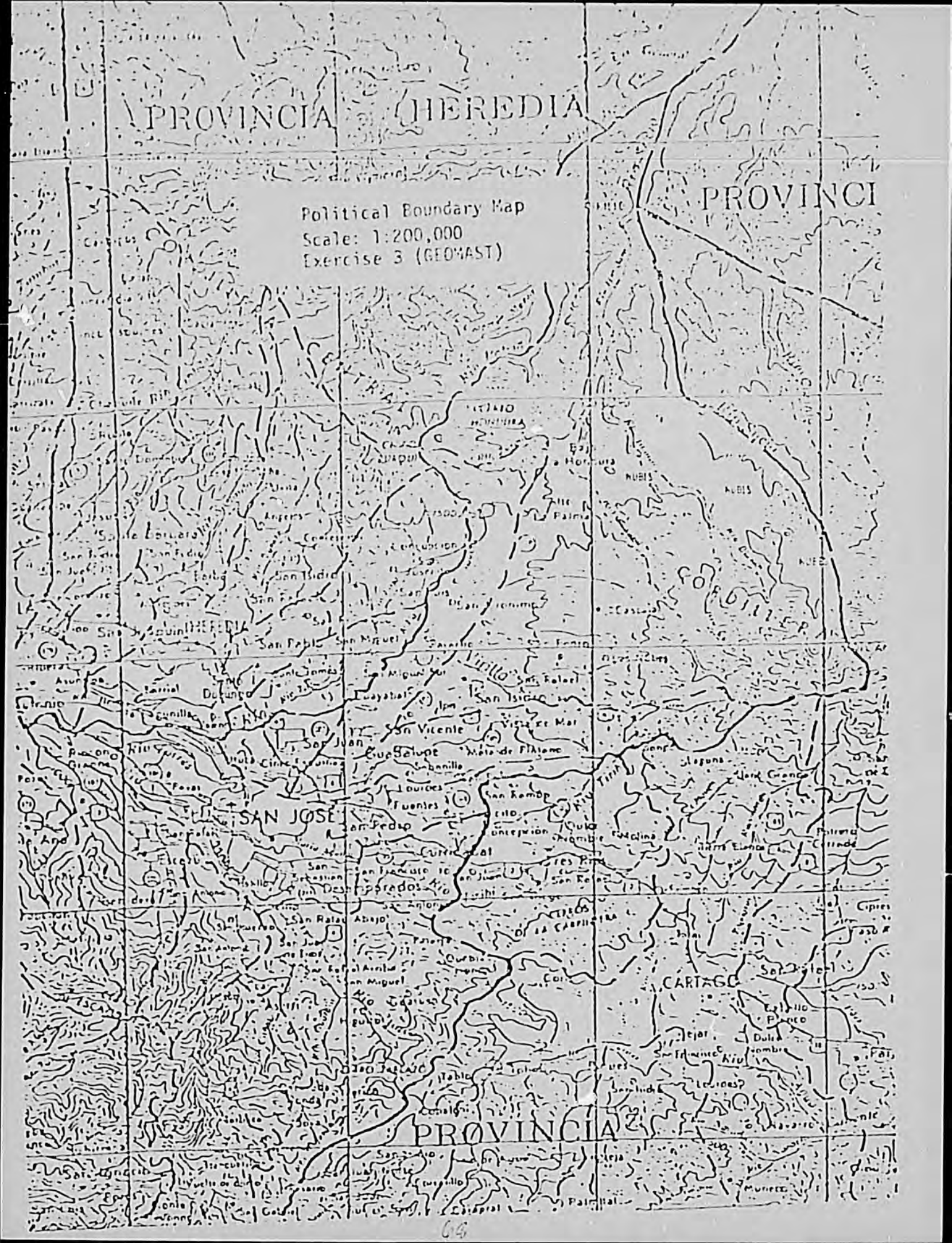
Thus, 1 cm on the map equals 500,000 cm or 5 km on the ground.

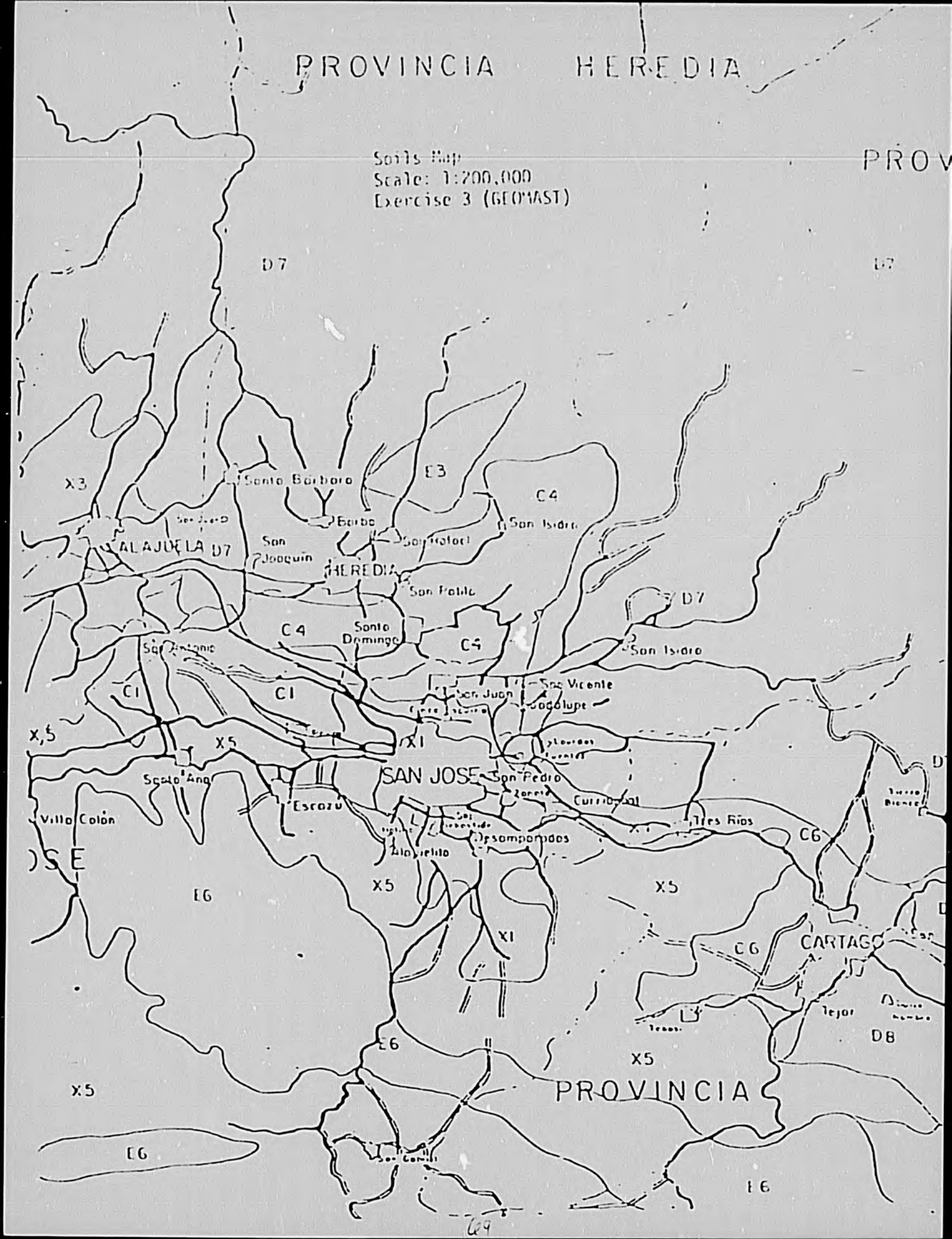
And, 1 km on the ground equals 2 mm on the map.

This information can be used to construct a grid of the proper size for a given map scale.

2. Similarly, a map scale of 1:200,000 (for example, the Costa Rican soils map) means each km equals 5 mm on the map. How does one arrive at this result?

3. GEOMAST saled printer map phase required knowledge of the scale of the original map and a desired scale to obtain a scale factor. For example; if the original scale were 1:500,000 and the printer map scale were at 1:100,000 then the scale factor would be assuming that each grid cell was 1 km on the side. If the grid cell were 2 km on the side the scale factor would be 10.


PROVINCIA HEREDIA
PROVINCI
Political Boundary Map
Scale: 1:200,000
Exercise 3 (GEOMAST)
SAN JOSE
CARTAGO
PROVINCIA


PROVINCIA HEREDIA
Soils Map
Scale: 1:200,000
Exercise 3 (GEOMAST)
PROV
D7
X3
Santo Bárbaro
E3
C4
San Isidro
ALAJUELA
D7
San Joaquín
HEREDIA
San Pablo
D7
C4
Santo Domingo
C4
San Isidro
C1
C1
San Vicente
San Juan
Guadalupe
X,5
X5
X1
SAN JOSE
San Pedro
Santo Ana
Escazú
Villa Colón
Curridabat
Tres Ríos
C6
Desamparados
X5
X5
E6
X1
C6
CARTAGO
Tejar
DB
E6
X5
X5
PROVINCIA
E6
E6

EXERCISE IV. Geocoding Errors

I. Purpose:

To gain experience in correcting common errors which occur when manually geocoding.

II. Materials:

- A disk file containing no larger than a 20 km by 20 km map and no less than six common errors
- A disk file containing the 20 km by 20 km base map
- A map of the area and mylar overlay
- Computer time
- Proper JCL

III. Procedure:

Using GEOMAST identify and correct the errors that are present. Be sure that scaled printer maps are overlayed on the "original" mylar and area totals match.

IV. Discussion:

Review and discuss computer output.

CURRICULUM GUIDE

Title: CRIES Training Program for Natural Resource Inventories and Geographic Information Systems.

Unit Title: Spatial Data Analysis Using GEORAP.

Unit Description: Trainees who complete this unit will acquire the ability to take spatially oriented data (such as that found in natural resource inventories) existing in a computer file and process it using the grid based program, GEORAP. This means they will be able to store, retrieve and otherwise manipulate spatial data files. In-country project examples will be used whenever feasible. The trainees will be able to perform an analysis using a Master File containing two or more maps in the context of a specified resource problem.

Major Goals: In this unit, we are attempting to accomplish the following:

1. To establish an understanding of the need for and capabilities of spatially based information and analysis systems.

2. To develop the trainee's ability to prepare materials for an analysis session. This includes developing an understanding of the structure of the input data file (Master File) and an ability to plan effectively for the session by appropriately linking software routines.

3. To develop the trainee's ability to access, use, obtain output, interpret error messages, and make necessary correction from the GEORAP system.

Major Objectives: Upon successful completion of training, the trainees will be able to:

1. Describe the analytical capabilities of each phase of GEORAP.

2. Develop a series of error-free GEORAP instructions to solve a natural resource problem.

3. Deduce the format of an undocumented Master File.

4. Plan in advance for a GEORAP session.

5. Interpret and correct errors as encountered.

6. Given a resource-analysis problem, independently apply GEORAP to this problem and list the strengths and limitations of the application.

7. Effectively seek assistance for unanticipated problems with the software.

Evaluation: This will include each trainee showing demonstrated ability to carry out each objective listed above. Specific evaluative measures will include:

1. With reference only to a list of GEORAP subroutines, list the analytical capabilities of each, defining terms where necessary.

2. The trainee will be presented with 2 or 3 novel resource analysis problems whose solution will require him or her to be able to do all of the objectives listed above. The trainee will be presented with a Master File where the content of the file is known, but where the format needs to be deduced. He or she will be asked to solve this problem (to the satisfaction of the instructor) and to present the results to his or her fellow trainees.

CONTENT OUTLINE AND ILLUSTRATIONS

1. Purpose of GEORAP

   A. Process geographically identifiable (grid based) data

      1. Area data
      2. Point data (wells, gravel pits, etc.)
      3. Linear data

   B. Updating geographically identifiable data

   C. Retrieval of geographically identifiable data

      1. Maps - printer or plotter
      2. Graphs
      3. Tables
      4. Lists

   D. Reformatting of geographically identifiable data

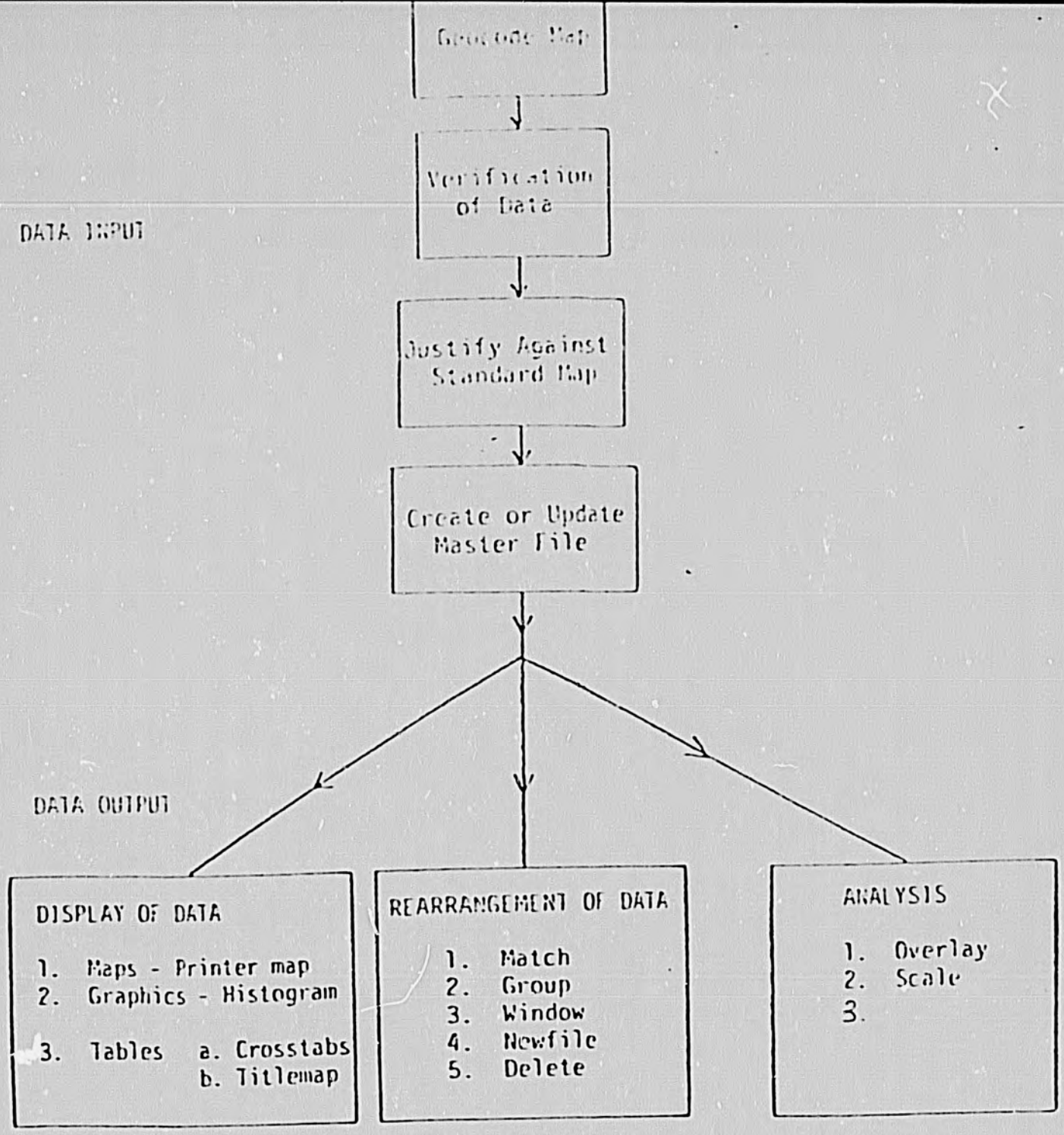
      1. Grouping - can insert numerical data or alphabetic (with quotes) data
      2. Matching - can insert numerical or alphabetic data
      3. Deleting

   E. Analysis of data

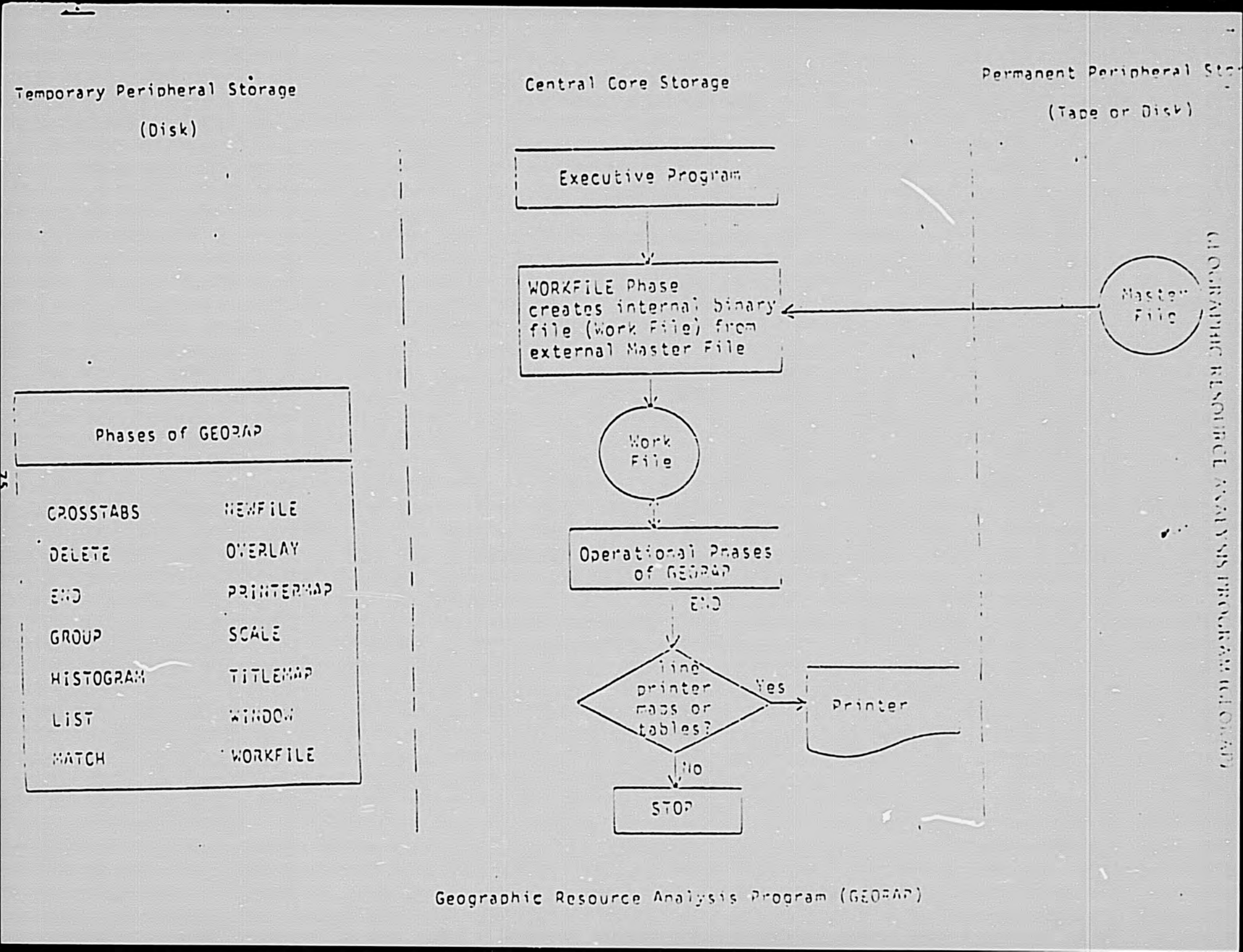
      1. Percentages (such as area) and statistics (Chi sq., Sommers, Tau A., Tau B.)
      2. Accounting of total areas
      3. Indices - overlay and scale

   F. History

      1. Developed to make it inexpensive for a user to develop and analyze a geographic data base. Thus, it is built using a grid system, manual geocoding and line printer maps. The system will run on grid base outputs from digitizers and can produce quality map with a table or drum plotter.
      2. Developed in conjunction with mapped and LANDSAT information for the CRIES project countries (Dominican Republic, Nicaragua and Costa Rica and Syria).



LAND INFORMATION SYSTEM - PROCESS FLOW



Geographic Resource Analysis Program (GEORAP)

II. Structure of GEORAP

A. Anatomy of GEORAP

1. Master File - is in any one of eight fixed formats. The Master File is the input data file external to GEORAP. All geographic data are on the Master File(s).

2. Work File - is always in binary compressed boundary format. The work file is the input data file internal to GEORAP.

3. Phases - are the processors of the data. Each phase consists of:

a. Phase call - (always)

b. Options - (most of the time)

c. Others - names of variables, legends, scales, max/min values and the like (as needed)

B. Interactive/batch versions of GEORAP

1. Promptings

2. Errors

3. Where to chane from batch to interactive

C. Where GEORAP fits into GEOMAST

III. Uses of GEORAP in resource evaluation

A. Inventory of resources - quick input, output and update

1. Maps - soils, landuse, climate, irrigation, etc.

2. Map from LANDSAT showing aggregated landcover categories

3. Low level aerial photography - detailed landuse

B. Display of geographically based resource information

1. Maps - printermaps, plotter maps

2. Lists

3. Tables

a. Titlemaps

b. Histograms

c. Crosstabs

C. Rearranging of data

1. Grouping

2. Matching

3. Windows

a. Rectangular

b. Data

c. Circular

D. Analysis

1. Crosstabulation - meaning of statistics given by minitabs

2. Overlay

3. Scale

EXAMPLES:

— How GEORAP overlays maps

Suppose the following indices have been developed:

LANDUSE AGRICULTURE

1 = inactive agland, idel
2 = moderately cropped agland
3 = intensively cropped agland

SOIL EROSION INDICES

1 = stable soils
2 = moderately stable soils
3 = highly unstable soils

SOIL FERTILITY INDICES

1 = fertile
2 = moderately fertile
3 = not fertile

SLOPE INDICES

1 = flat
2 = moderately sloped
3 = highly sloped

OVERLAY PHASE - overlay landuse and soil erosion

Not normalized

Landuse, Soil Erosion	Result
1,1	2
1,2	3
1,3	4
2,1	3
2,2	4
2,3	5
3,1	4
3,2	5
3,3	6

Normalized

Landuse, Soil Erosion	Result*
1,1 → 1,1 (1+1)/2=1	1
1,2 → 1,50.5 (1+50)/2=25.5	25
1,3 → 1,100 (1+100)/2=50.5	50
2,1 → 50.5,1 (50+1)/2=25.5	25
2,2 → 50,50 (50+50)/2=50	50
2,3 → 50,100 (50+100)/2=75	75
3,1 → 100,1 (100+1)/2=50.5	50
3,2 → 100,50 (200+50)/2=75	75
3,3 → 100,100 (100+100)/2=100	100
1,1 → 1,1 1+1/2=1	1
1,2 → 1,50.5 (1+50.5)/2=25.75	26
1,3 → 1,100 (1+100)/2=50.5	51
2,1 → 50.5,1 (50.5+1)/2=25.75	26
2,2 → 50.5,50.5 (50.5+50.5)/2=50.5	51
2,3 → 50.5,100 (50.5+100)/2=75.25	75
3,1 → 100,1 (100+1)/2=50.5	51
3,2 → 100,50.5 (100+50.5)/2=75.25	75
3,3 → 100,100 (100+100)/2=100	100

Normalization

1		2		3
1	49.5	50.5	49.5	100

*GEORAP Version 3.0
rounds nonintegers in OVERLAY phase.

— How the SCALE phase works

SCALE PHASE - scale soil fertility and slope indices, the target or ideal is the point 1,1 (fertile, flat)

fertility, slope - not normalized*		result		
1,1 to 1,1	$= \sqrt{(1-1)^2 + (1-1)^2}$	= 0		0
1,2 to 1,1	$= \sqrt{0^2 + 1^2}$	= 1		1
1,3 to 1,1	$= \sqrt{0^2 + 2^2}$	= 2		2
2,1 to 1,1	$= \sqrt{1^2 + 0^2}$	= 1		1
2,2 to 1,1	$= \sqrt{1^2 + 1^2}$	= 2	1.414	1
2,3 to 1,1	$= \sqrt{1^2 + 2^2}$	= 5	2.232	2
3,1 to 1,1	$= \sqrt{2^2 + 0^2}$	= 2	1.414	2
3,2 to 1,1	$= \sqrt{2^2 + 1^2}$	= 5	2.232	2
3,3 to 1,1	$= \sqrt{2^2 + 2^2}$	= 8	2.828	3

Normalization

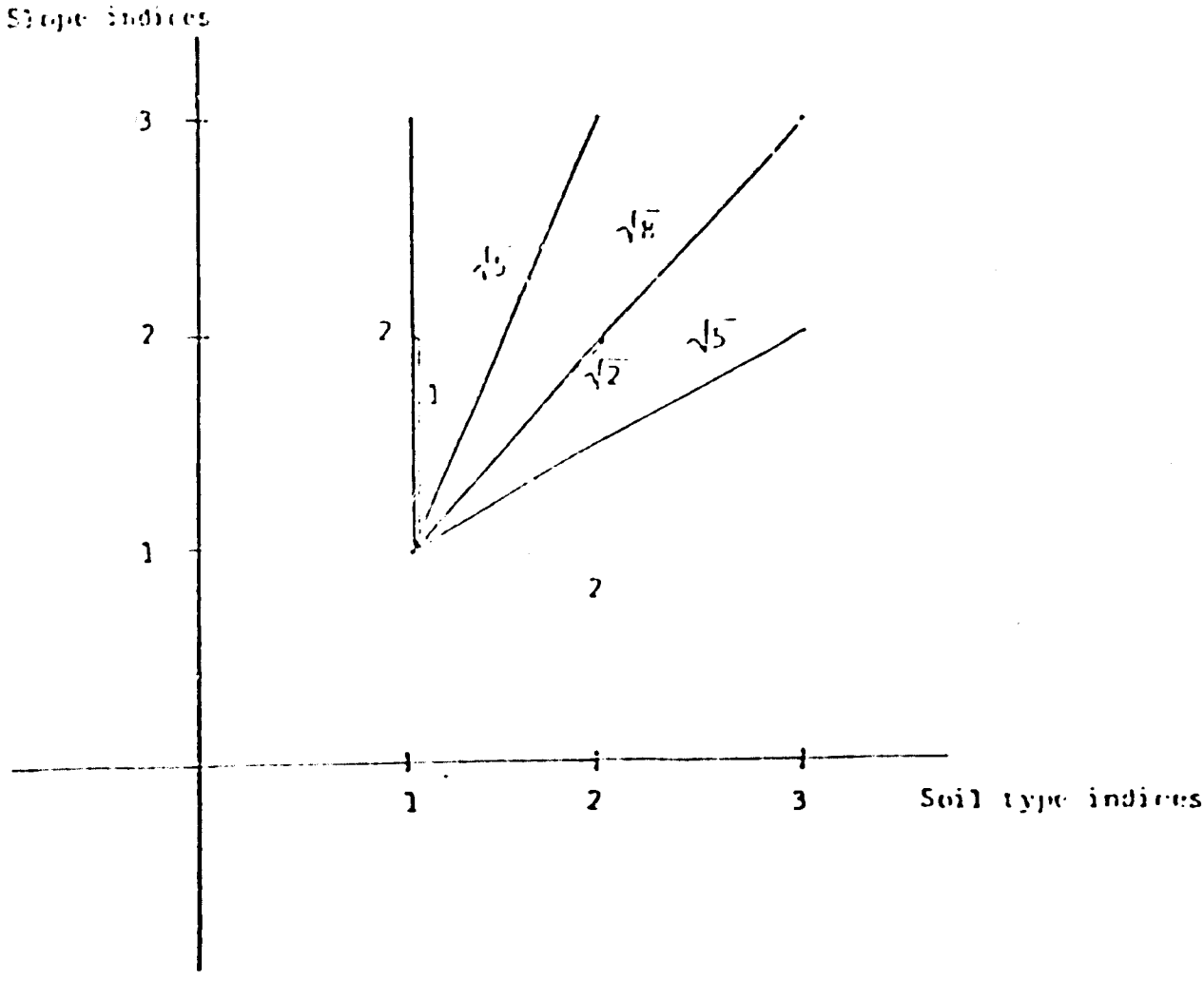
$\frac{1}{1}$ ——— $\frac{2}{50.5}$ ——— $\frac{3}{100}$

fertility, slope - normalized*			
1,1 = 1,1 to 1,1	= 0		0
1,2 = 1,1 to 1,50.5	$= \sqrt{0^2 + (49.5)^2}$	= 49.5	50
1,3 = 1,1 to 1,100	$= \sqrt{0^2 + 99^2}$	= 99	99
2,1 = 1,1 to 50.5,1	$= \sqrt{(49.5)^2 + 0^2}$	= 49.5	50
2,2 = 1,1 to 50.5,50.5	$= \sqrt{(49.5)^2 + (49.5)^2}$	= 70.00	70
2,3 = 1,1 to 50.5,100	$= \sqrt{(49.5)^2 + 99^2}$	= 110.69	111
3,1 = 1,1 to 100,1	$= \sqrt{99^2 + 0^2}$	= 99	99
3,2 = 1,1 to 100,50.5	$= \sqrt{99^2 + (49.5)^2}$	= 110.69	111
3,3 = 1,1 to 100,100	$= \sqrt{99^2 + 99^2}$	= 140.01	140

Note: There are more categories when normalizing. Rounding occurs after addition and square root. After these operations rounding takes place.

---

* Scale phase rounds after taking the square root.



SCALE — Example

Soil type	Slope indices
1 = fertile	1 = flat
2 = moderately fertile	2 = moderately sloped
3 = not fertile	3 = highly sloped

E. Limitations of GEORAP

1. Size of data set that can be efficiently processed - the system is I/O bound
2. Types of analysis - currently GEORAP is mainly a data storage and retrieval system
3. It is a geographic system and data must be geographic in nature
4. Grid cell based as opposed to polygonally based - UTM Zones
5. Map quality from line printer is not suited for publication. Need a plotter to produce quality maps.

IV. A Typical Session

- Find the area of each soil type by each RPU and make a soils map to 1:50,000 scale an unscaled landuse map. Save the workfile containing soil type and three other factors (Soils, RPUs and landuse).

Master File - Dajabon

A. Steps for obtaining desired results:

1. Master file description
   a. Content - row, column, province, RPU, soils, and landuse
   b. Size - 56 km x 42 km (1 kilometer squared) 1:1,000,000 scale
   c. Format - 615 coded compressed boundary.
      215,5X,315
2. Desired output
   a. Crosstabs of soils by RPU
   b. Soils map at 1:500,000
   c. Map of landuse, unscaled
   d. New binary Master File
3. Files to be saved - catalogued
   - Logical Unit 9 (LUN9) - Work File
4. Phases to be used and the order in which they are to be used
   a. WORKFILE
   b. CROSSTAB - SOILS x RPU
   c. RPINTERMAP - 1:500,000 (twice as large as original)
5. Coding commands

B. Typical outputs from GEORAP

Data Description: EJEMPLO 1

ARCHIVO MAESTRO - DATADON

GIS, SG42, Computer Technology

```
1 USER, 4, 1, 1, 1
2 SG, 42
3
4 CPU
5 VIL
6 UC Ø
7 (2I5, 5X, 3I5)
8 XTAB
9     EJEMPLO 1, MAPA CLASIFICACION SUELOS x RIU
10 1
11 RIU, 25, 1
12 UCU, 0, 1
13 USO, 11, 1
14 2
15 SUEL: RPU
16 PMAP, 1, 1, 1, 0
17 SUEL
18 B.4
19 YES
20     EJEMPLO 1 - MAPA DE SUELOS - DATABONX
21 END
22 PMAP, 1, 0, 1, 0
23 USØ
24 YES
25     EJEMPLO 1 x MAPA DE USO DE TIERRA x
26 END
27 END
28
29
30
```

Escala 1:100.000 ⇒ 1 km = 1 [illegible] 1 km = 100.000 × 100 = 100.000 cm

V. Preparation for GEORAP Session

A. Setting up GEORAP commands

1. List contents, size (for inputting into WORKFILE and determining scale on maps), and format of input file (Master File).
2. List desired output
3. List what files are to be saved - catalogued
4. List, in order, the necessary phases to obtain desired output
5. Fill out worksheets

B. Set up on the computer

1. Write up and punch or obtain necessary JCL
2. Punch the input data from worksheets
3. Assemble the deck and submit the job

C. Post session

1. Document contents, size, format and creation date of any newly created Master File through cataloging the WORKFILE or results from NEWFILE
2. Fit overlays to printer maps
3. Interpret output
4. Outline possible ensuing steps.

VI. Files & JCL - Logical Units (LUN) & JCL used by LIS

A. Files used*

1.	SYS005 - LUN8	Master File
2.	SYS006 - LUN9	Work File
3.	SYS007 - LUN10	Phase File
4.	SYS008 - LUN11	Scratch File
5.	SYS009 - LUN12	Buffer File
6.	SYS010 - LUN13	Line Printer (Map File)
7.	SYS011 - LUN14	New File

B. Saving files

1. SYS006 (Work File) LUN9
2. SYS011 (New File) LUN14

C. Job Control for GEORAP (see GEORAP Manual, Section 3)

---

*Card Reader LUN5 - GEORAP Commands

VII. Master File

A. Formats

1. Sequential Cell: row/column and factors for every grid
2. Non-indexed: Factors for every grid cell
3. Raster Scan: One factor for every grid cell
4. Compressed Boundary Cell: row/column and factors for only change points

B. Headers - Up to 80 characters per line. Though it is advisable to have headers, they are not required. The header record must be composed of the following attributes (and only these attributes) in the order listed:

1. Total Number of Rows (15) - fixed, 5 digits right justified
2. Beginning Row Number (15) - fixed, 5 digits right justified
3. Ending Row Number (15) - fixed, 5 digits right justified
4. Total Number of Columns (15) - fixed, 5 digits right justified
5. Beginning Column Number (15) - fixed, 5 digits right justified
6. Ending Column Number (15) - fixed, 5 digits right justified
7. Maximum Character Length (15)* - fixed, 5 digits right justified
8. 5 blank spaces (5X) - fixed, 5 digits right justified
9. File Title - up to 30 characters
10. Date of Creation (DD/MM/YY) - 10 characters

The format of the header record will be 715,5X,10A4.

C. Factors - Mapped units. Must be consistent in use of names first declared during WORKFILE phase.

1. Numeric
2. Alphabetic - can be created using MATCH phase or inputted directly onto a Master File.

VIII. Phases - Individual

A. Overview

1. Phase call - every phase <u>must</u> have a phase call, a four character phase call name; e.g.,

   WORKFILE -- WORK
   PRINTERMAP -- PMAP

2. Option - most phases have options that describe types of possible formats, types of maps (scaled/unscaled) etc.
3. Other - Legends, scale size, number of records to be listed, headers, min/max values, overprint characters, boundaries of windows, etc.

4. Errors - When an error in the input stream of the batch version of GEORAP is encountered, the error is written on the output and the program is terminated.

B. Structure of phases

1. Adds new information
   a. GROUP
   b. MATCH
   c. OVERLAY
   d. SCALE
2. Deletes information
   a. WINDOW
   b. DELETE
3. Outputs of information
   a. LIST
   b. PRINTERMAP
   c. CROSSTABS
   d. NEWFILE
   e. HISTOGRAM
   f. TITLEMAP
   g. WORKFILE

C. Individual phases - (see manual)

1. WORKFILE
2. LIST
3. PRINTERMAP - how to calculate scale, print characters
4. CROSSTABS
5. NEWFILE
6. HISTOGRAM
7. TITLEMAP - *not meant for a large data set
8. GROUP
9. MATCH
10. OVERLAY
11. SCALE
12. DELETE
13. WINDOW
14. END

IX. Linked Phases

A. Example - DAJABON Session

Test area: Dajabon province, Dominican Republic and surrounding areas. 1:1,000,000 scale, 1sq.km. grid

File Location: Cards

Grid Size: Rows = 56, Column = 42

File type: Row/column indexed (type 4), no header records, coded (card image).

Sample to be produced:

1. RPU map at scale of 1:250,000 (RPU #16 - for rice)
2. Major landuse map (ag) at scale of 1:250,000
3. Two-way crosstab of ag land by RPU and a three-way crosstab of RPU x LANDUSE x POTENTIAL RICE AGLANDS

Detailed explanation:

1. Produce a map showing location of RPU #16 which is suitable for rice and mixed ag (fertile valley soil).
2. Produce map showing two categories of ag land use (intensive and extensive - "using large areas of land with comparatively little cultivation")
3. Overlay printer maps onto acetate map of Dajabon
4. Produce a crosstab. Questions: How much of RPU #16 is being used for intensive ag. In affect the stats of overlapping previous maps.

Materials: Acetate map of Dajabon province

WORKSHEET

PROGRAMMER	DATE	MAP SOURCE MASTER FILE ID
JOHN WHITE	3/13/64	ARCHIVO MAESTRO - DATABON 1:1,000,000

FORMAT SPECIFICATION: 6I4, 6F4.2, COMPRESSED BOUNDARY

COMMENTS

```
1  4  1  1  1
2  5  4  2
3
4
5
6  2  5  1  1  1  5  A  3  5  D
7  E  N  D  1  1  0
8  E  N  D
9  0  1  0
10 3  6  1  1
11 E  N  D
12 2  1
13 A  R  Q  Z
14 P  M  A  P  3  2  1  0
15 A  P  Q  Z
16 1  0  B
17 A  V  T
18
19 E  N  D
20 Y  E  S
21   E  D  I  M  P  S  2  A  M  A  P  A  D  E  P  Q  T  E  N  C  I  A  P  A  F  A  M  E
22                        W  W                A  P  R  Q  Z              W  W
23 E  N  D
24 M  E  R  1  0
25 D  E  C
26 D  0
27 2  3
28 3  2
29 E  N  D
30 5  1
```

WORKSHEET

PROGRAMMER

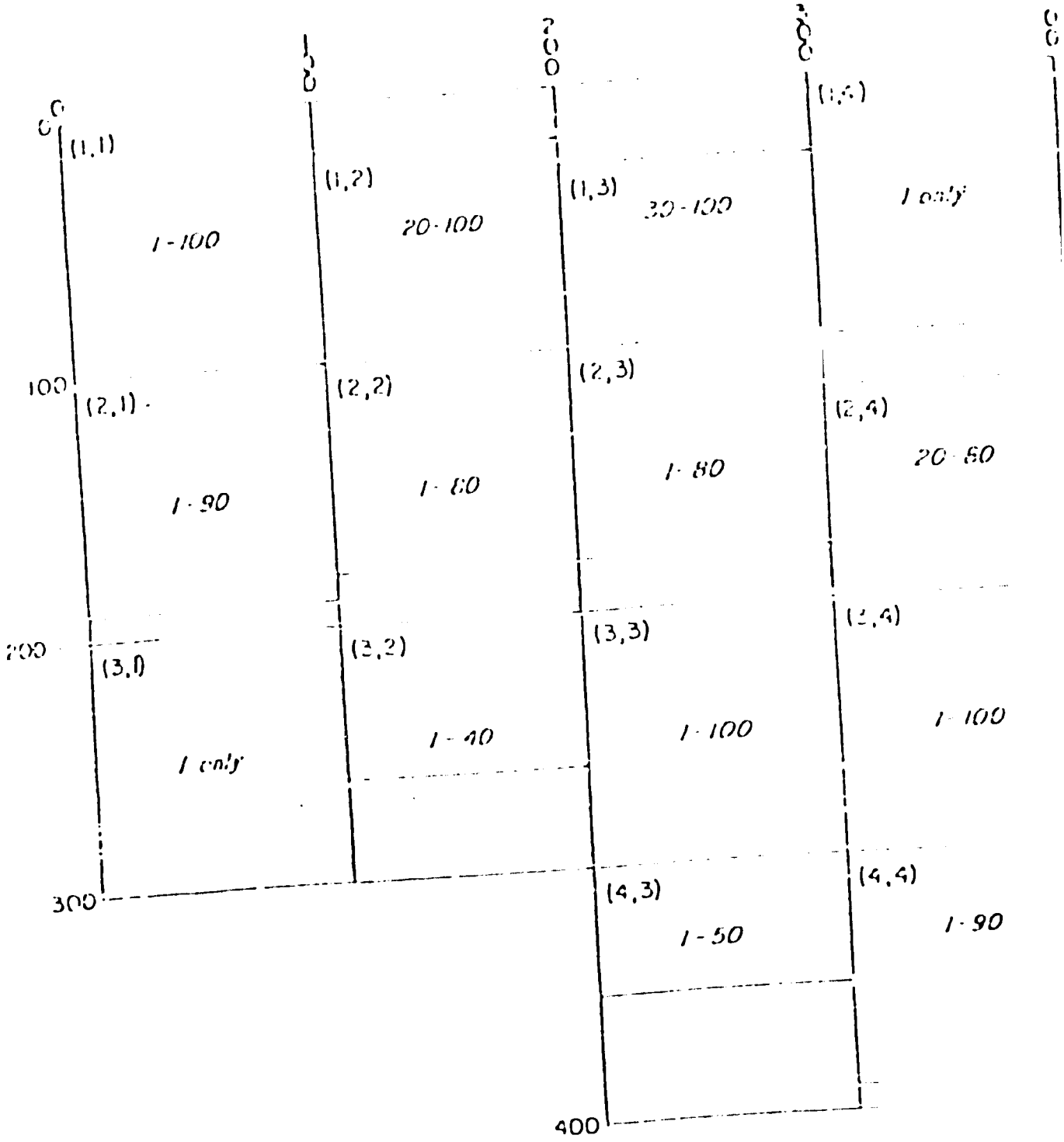
DATE:

MAP SOURCE - MASTER FILE I.D.

COMMENTS: * FIRST TABLE IS A 2 WAY CARD
SECOND TABLE IS A 2 WAY CARD

FORMAT SPECIFICATION:

```
1 A3RI
2 PMAP, 3, 2, 3, 0
3 AGRI
4 J16 B
5 A V, T
6 X
7 .
8 END
9 YES
10   EXAMPLO 2 ** MAPA ** DE AGRICULTURA **
11
12 END
13 XTAB
14   ** MESA CRUZADA - ARRAIZ X USO AGRICULAR
15 2
16 RPU 36, 1
17 SUELO 9, 1
18 USO 2, 1
19 ARPZ 2, 2
20 AGRI, 3, 2
21 2, 3
22 ARPZ, AGRI
23 RPU, USO, ARPZ
24 END
25
26
27
28
29
30
```

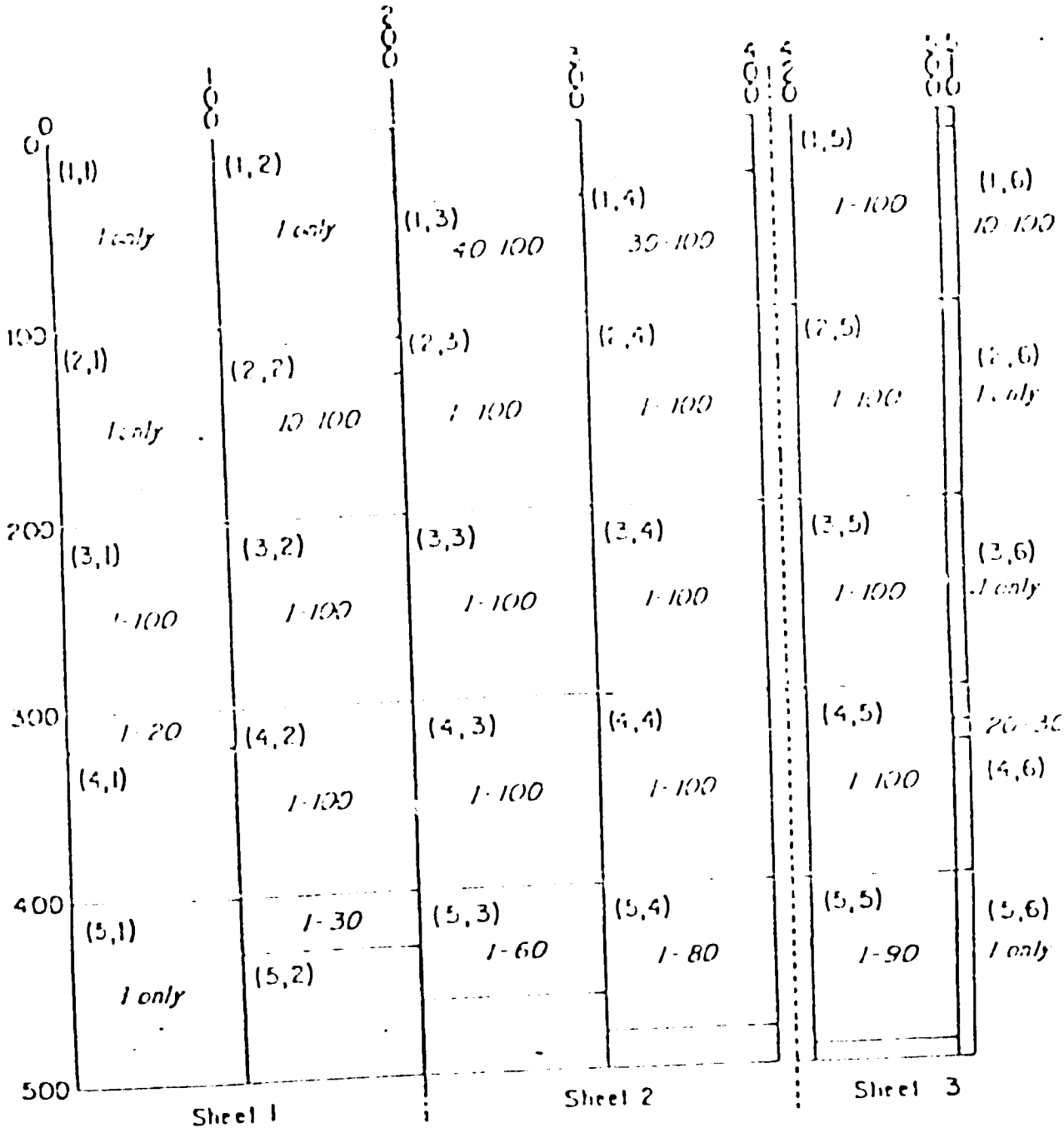


Row Ranges for Costa Rica
Coding Squares

(1,1) Coding Square Number

1-100 Row Range

Area not Included



Row Ranges for Nicaragua Coding Squares

(1,1) Coding Square Number

1-100 Row Range

Area not Included

```
1
(713)
(1313)
(11)
  1 20  1 20  0  3 13  BAND FILL (WITH LABORS)
  1  1  0
  2  1  0
  3  1  0  0  1  7  0
  4  1  0  3  1  8  0
  5  1  0  4  1 10  2  9  0
  6  1  0  4  1 11  2 14  0
  7  1  0  4  1 11  2 14  0
  8  1  0  4  1 11  2 14  0
  9  1  0  4  1 11  2 16  0 21  0
 10  1  0  4  1 10  2 15  3 17  0
 11  1  0  4  1 10  2 13  3 18  0
 12  1  0  5  1  9  2 11  3 11  2 17  0
 13  1  0  5  1  9  3 17  0
 14  1  0  5  1 10  3 17  0
 15  1  0  5  1 12  3 17  0
 16  1  0  4  1 13  3 19  0
 17  1  0  4  1 14  3 19  0
 18  1  0  5  1 14  3 20  0
 19  1  0
 20  1  0
 21  1  0
```

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	1	1	1	1	1	2	2	2	2	2	2	2	2	0	0
0	0	0	0	1	1	1	1	1	1	2	2	2	0	0	0	0	0	0	0
0	0	0	0	1	1	1	1	1	1	2	2	2	0	0	0	0	0	0	0
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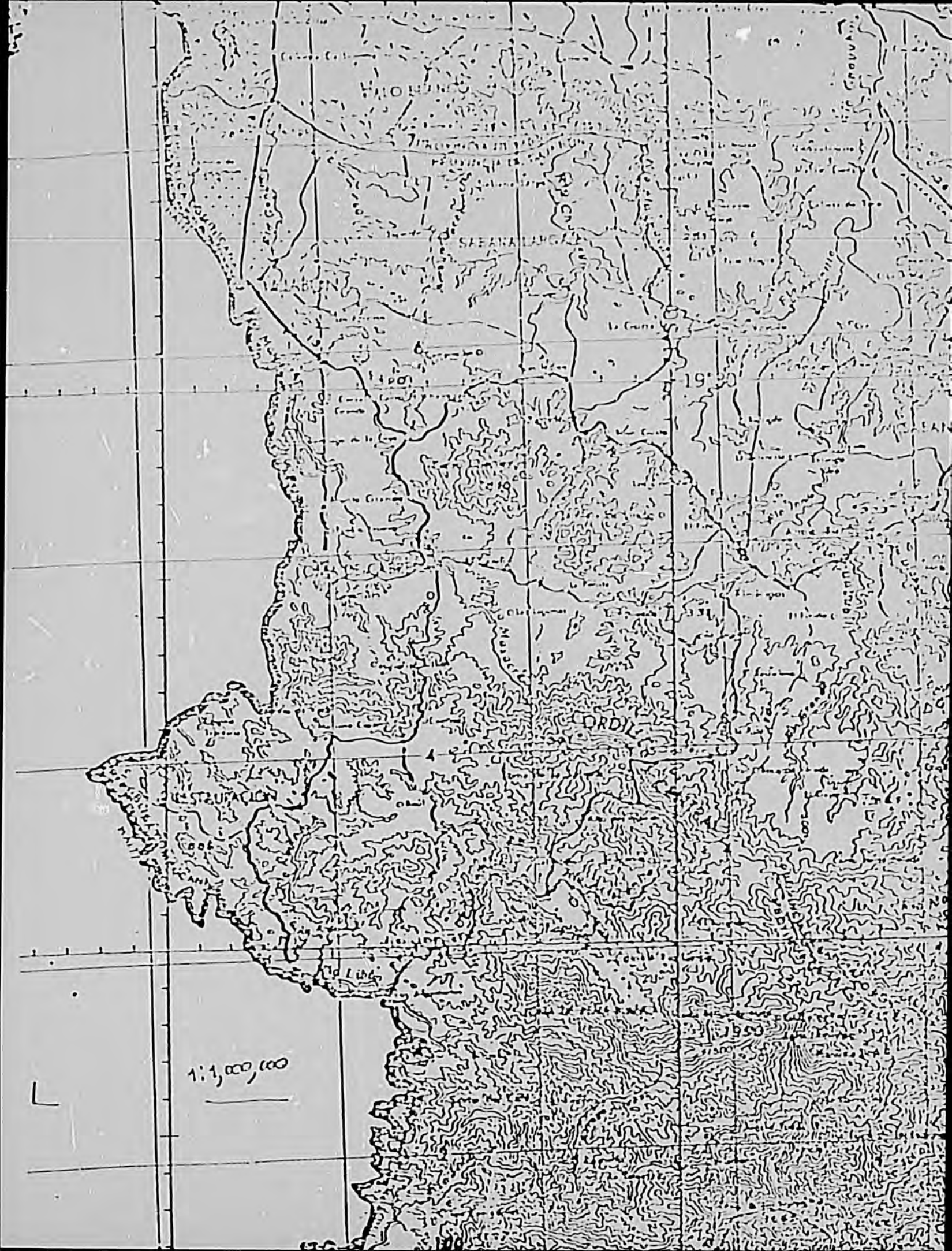
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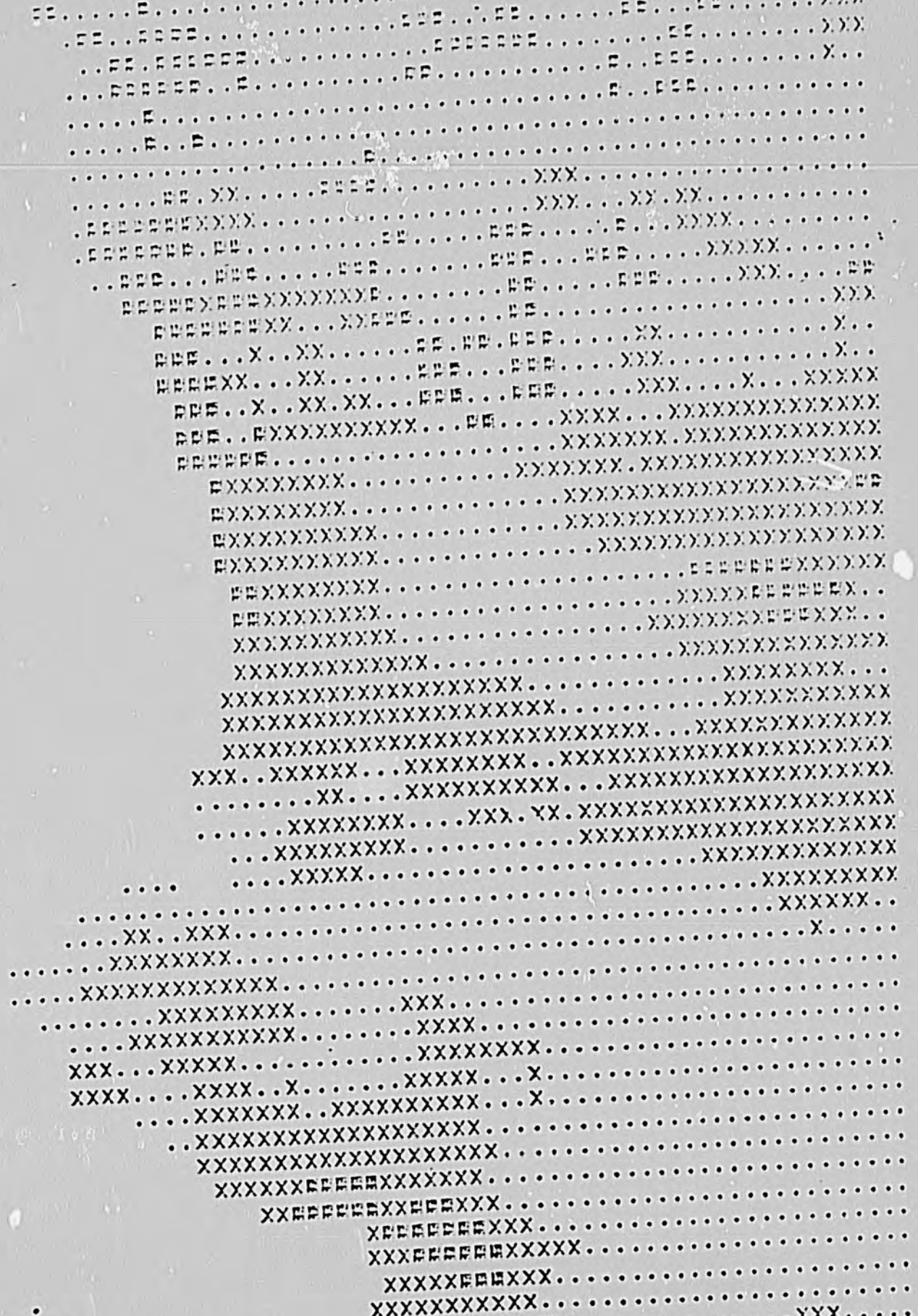
PETINE AGLINES



EXERCISE 1. Geocoding Formats

I. Purpose:

To calculate the proper East/West length in centimeters to obtain a desired scale from a scaled printermap in GEORAP.

II. Materials:

- Paper and pencil

III. Procedure:

Using the example below calculate the East/West length in centimeters to obtain the following scales for a scaled GEORAP printermap with the given information:

A. Want a printermap at 1:250,000 when the original map is 100 km X 100 km and the grid size is 1 sq. km.

B. Want a printermap at 1:500,000 when the original map is 150 km X 100 km and the grid size is 1.5 sq. km.

C. Want a printermap at 1:100,000 when the original map is 50 km X 100 km and the grid size is 2 sq. km.

D. Example: Want a printermap at 1:500,000 when the original map is 300 km X 200 km and the grid size is 2 sq. km.

At 1:500,000 $\frac{1 \text{ km map}}{500,000}$ = 1 km on land

1 km = 1000 meters X 100 cm/m = 100,000 cm

Therefore, 1 km on the ground is

$\frac{1 \text{ km}}{500,000}$ X 100,000 = 1/5 cm on map.

The grid is 2 X 1/5 cm on the side so that the East/West size in centimeters is

300 X 2/5 = 120 cm.

If the grid size is 3 sq. km. then

300 X 3/5 = 180 cm

However, in either case when the map is outputted, it will be 60 cm. wide because GEORAP assumes the cells to be in units of 1.

IV. Discussion:

Discuss the reasonableness and validity of the calculations.

EXERCISE II. GEORAP - Users

I. Purpose:

To gain familiarity with using an existing Master File containing at least three maps in implementing the work file, list, scaled printermap group, and one way and two way crosstab phases and to save the resultant work file.

II. Materials:

- Existing Master File catalogued with at least three maps on disk
- A description of the Master File
- Keypunched GEORAP instructions
- Proper JCL
- Computer time

III. Procedure:

Using the Dajabon or a suitable geocoded Master File with at least three maps:

1. Retrieve three factors - (RPU, soils, landuse)
2. List Work File contents - 25 records
3. Produce two maps
   a. Map 2.5 times larger than original (say RPU)
   b. An unscaled map (say soils)
4. Group landuse using automatic grouping option
5. List Work File contents - 25 records
6. Find the area of one map (RPU) using a one way crosstab
7. Use the HISTOGRAM phase to calculate the area of one map (RPU)
8. Do two crosstab tables:
   a. A two way specifying own categories (say RPU X soils)
   b. A three way using autocategorization (say RPU X soils X landuse)
9. Save the Work File

IV. Discussion:

Discuss and interpret the resultant computer output.

EXERCISE III. GEORAP Users

I. Purpose:

To gain familiarity with using a catalogued workfile containing at least two maps as the input file to GEORAP and implementing the match, delete, window, and scaled printermap with background phases.

II. Materials.

- Existing catalogued workfile with at least two maps
- A description of the Master File
- Keypunched GEORAP instructions
- Proper JCL
- Computer time

III. Procedure:

Retrieve the Work File catalogued in exercise 1 and use it to:

1. List the contents of the Work File - 25 records
2. Match two factors - (e.g. forest with forest potential = 1 say RPU and landuse)
3. List the contents of the Work File - 25 records
4. Delete one factor (say soil)
5. List the contents of the Work File - 25 records
6. Do a data window (say RPU #16)
7. List the contents of the Work File - 25 records
8. Make a map at half the scale of the original with background (say RPU)
9. Purge the Work File

IV. Discussion:

Discuss and interpret the resultant computer output.

EXERCISE IV. GEORAP - Users

I. Purpose:

To gain familiarity with using an existing Master File with at least two maps to implement the coordinate window, title map, overlay, scale, unscaled printermap with highlighted borders and a four way crosstab.

II. Materials:

- Existing Master File with at least two maps catalogued on disk
- A description of the Master File
- Keypunched GEORAP instructions
- Proper JCL
- Computer time

III. Procedure:

Using the Dajabon or a suitable geocoded Master File with at least two maps:

1. Retrieve two factors (RPU and landuse)
2. Do a coordinate window (13,11 to 22,20) renumbering the coordinates
3. List the contents of the Work File - all records
4. Group a factor (RPU) into three quality classes suitable for a particular activity (say land quality suitable for corn).
5. Group another factor (landuse) into four quality classes (currently in active agricultural, inactive agricultural, potentially suited for agriculture, other).
6. List the contents of the Work File - all records
7. Print a titlemap of four factors
8. Overlay one grouped factor (RPU) onto another grouped factor (land use)
9. List the contents of the Work File - all records
10. Scale one grouped factor (RPU) with another grouped factor (land use) - normalized to 10
11. List the contents of the Work File - all records
12. Make an unscaled map of the overlayed factor with the borders highlighted.
13. Make an unscaled map of the scaled factor with overprint.
14. Make a four-way crosstabs (RPU x landuse x overlay x scale).

IV. Discussion:

Discuss and interpret resultant computer output.

EXERCISE V. GEORAP - Users

I. Purpose:

To gain familiarity with using an existing Master File with at least two maps to implement a two factor scale, match of two factors, histogram of a factor and the NEWFILE phases to save the augmented work file.

II. Materials:

- Existing Master File with at least two maps catalogued on disk
- A description of the Master File
- Keypunched GEORAP instructions
- Proper JCL

III. Procedure:

Using a geocoded Master File with at least one map:

1. Do the following with selected factors
   a. Scale of two factors
   b. Using the MATCH phase, do a two way match on two factors
   c. Obtain a histogram using overprint of the factor obtained in the SCALE phase.
2. Save the resultant Master File in binary compressed cell format with a standard GEORAP header.
   a. Use the NEWFILE phase
   b. Keypunch the proper JCL to catalogue the newly created file.

EXERCISE VI, GEORAP - Programmers/Analysts

I. Purpose:

To be able to develop a set of JCL pertaining to the logical units (LUNs) used by GEORAP and be able to calculate the space in bytes and format required by each LUN.

II. Materials:

- A Master File with at least two factors on cards
- Pencil
- Coding Sheets
- Keypunch and computer cards
- Computer time
- Listing of GEORAP

III. Procedure:

1. Catalogue on disk the Master File
2. Code and keypunch the JCL pertaining to the LUNs GEORAP uses, saving as much space as possible if a maximum of two addition factors will be created during the session and the NEWFILE phase will be involved where the new Master File and the Work File will be catalogued.
3. Use the disk Master File and JCL developed for a GEORAP session consisting of:
   a. GROUP one factor
   b. OVERLAY two factors
   c. Save Work File using the NEWFILE phase
4. Get a listing of the first fifty records of the catalogued Master File, Work File and the New File.

IV. Discussion:

1. Discus and interpret the computer outputs.
2. Write down (without looking at the GEORAP manual or computer listing) the LUNs and their respective formats GEORAP uses within five minutes.
3. With a GEORAP computer listing write down which LUNs are used by each phase within twenty minutes.

EXERCISE VII. GEORAP - Programmers/Analyst

I. Purpose:

To be able to change limiting dimensions of GEORAP.

II. Materials:

- Computer listing of GEORAP
- Red markers

III. Procedure:

1. Find and mark changes on the computer listing the lines that need changing when 105 groupings are required in the GROUP phase.
2. Find and mark changes on the computer listing the lines that need changing when 68 match keys are required in the MATCH phase.
3. Find and mark changes on the computer listing the lines that need changing when a four way crosstab consisting of 8, 12, 9 and 7 categories respectively.

IV. Discussion:

Write down at least three major programming constraints of GEORAP and discuss ways of dealing with them. Discuss the reasons why GEORAP has three constraints.