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CRIES WORKING SERIES REPORT

A USER'S GUIDE TO THE CRIES GEOGRAPHIC INFORMATION SYSTEM

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Comprehensive Resource Inventory
and Evaluation System Project

U.S. Department of Agriculture
and
Michigan State University

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A USER'S GUIDE TO THE CRIES GEOGRAPHIC INFORMATION SYSTEM. By Weldon Lodwick, Stephen E. Tilmann, Eriks Zusmanis, and Mark Simon, Department of Resource Development and Center for Remote Sensing, Michigan State University, East Lansing, Michigan, 48823.

ABSTRACT

This report documents the two major components -- the Geographic Master File Creator Program (GEOMAST) and the Geographic Resource Analysis Program (GEORAP) -- of the Comprehensive Resource Inventory and Evaluation System (CRIES) Geographic Information System. GEOMAST provides the capability to process and store digitized data from maps and create the master data base (tape, disk or card files) used in GEORAP. The GEORAP system provides the capability to input mapped information, to retrieve all or parts of individual data sets, to add data to the data base, and to display the results in the form of statistical summaries and computer printer-maps. Typical products include area measurements of single maps, area measurements of combinations of two or more maps, and computer printer-maps of various scales for single or combined mapped data.

Key words: Computer system; computer map; geographic; map storage.

* *
* This paper was prepared for limited distribution to the research *
* community. The views expressed herein are not necessarily *
* those of the U.S. Department of Agriculture or Michigan State *
* University. *
* *

CONTENTS

	PAGE
FOREWORD	i
LIST OF FIGURES	iv
LIST OF TABLES	v
GEOMAST: A USER'S GUIDE TO VERSION 2.1 OF THE GEOGRAPHIC MASTER FILE CREATOR	1-1.1
SECTION ONE: AN OVERVIEW OF GEOMAST	1-1.1
1.1 System Introduction	1-1.1
1.2 Phase Directives and Options	1-2.1
1.3 GEOMAST Input Formats and Procedural Descriptions	1-3.1
1.3.1 Phases Used for File Verification and Correction	1-3.1.1
1.3.2 Master File Creation and Updating	1-3.2.1
1.3.3 Working File	1-3.3.1
1.4 File Description	1-4.1
1.4.1 Logical Units for IBM/OS	1-4.1.1
1.4.1.1 Unit 5 System Input	1-4.1.1
1.4.1.2 Unit 6 System Output	1-4.1.1
1.4.1.3 Unit 7 Working File	1-4.1.1
1.4.1.4 Unit 8 Scratch File	1-4.1.1
1.4.1.5 Unit 9 Lift Output File	1-4.1.1
1.4.1.6 Unit 10 Geocoded Data File	1-4.1.1
1.4.1.7 Unit 11 Secondary Working File	1-4.1.2
1.4.1.8 Unit 12 Program Output File	1-4.1.2
1.4.1.9 Unit 13 Master File Input	1-4.1.5
1.4.1.10 Unit 14 Boundary Base File	1-4.1.5
1.4.1.11 Unit 15 Master File Output	1-4.1.5
1.4.2 Logical Units for IBM/DOS VS	1-4.2.1
SECTION TWO: PHASES OF GEOMAST	2-1.1
2.1 Bound Phase	2-1.1
2.2 Check Phase	2-2.1
2.3 Edit Phase	2-3.1
2.4 End Phase	2-4.1

2.5 List Phase 2-5.1
2.6 Map Phase 2-6.1
2.7 Merge Phase 2-7.1

SECTION THREE: EDITOR

3.1 Abort 3-1.1
3.2 Change 3-2.1
3.3 Delete 3-3.1
3.4 Go 3-4.1
3.5 Help 3-5.1
3.6 Insert 3-6.1
3.7 List 3-7.1
3.8 Replace 3-8.1
3.9 Table 3-9.1

GEORAP: A USER'S GUIDE TO VERSION 3.1 OF THE GEOGRAPHIC RESOURCE ANALYSIS PROGRAM 1-1.1

SECTION ONE: THE CAPABILITIES OF GEORAP (GEOGRAPHIC RESOURCE ANALYSIS PROGRAM) 1-1.1

1.1 System Introduction 1-1.1
1.2 System Components 1-2.1
1.2.1 Technical Phase 1-2.1.1
1.2.2 Data Restructuring Phase 1-2.2.1
1.2.3 Data Display Phase 1-2.3.1
1.2.4 Data Analysis Phase 1-2.4.1
1.3 Developing an Analysis Strategy 1-3.1
1.4 Normalization 1-4.1

SECTION TWO: GENERAL OPERATING PROCEDURES 2-1.1

2.1 Operating Principles of GEORAP 2-1.1
2.2 Phase Directives and Options 2-2.1
2.3 Master File and Formats 2-3.1
2.4 Data Input 2-4.1

SECTION THREE: PHASES OF GEORAP 3-1

3.1 CROSSTABS Phase 3-1.1
3.2 DELETE Phase 3-2.1
3.3 END Phase 3-3.1
3.4 GROUP Phase 3-4.1
3.5 HISTOGRAM Phase 3-5.1
3.6 LIST Phase 3-6.1

3.7 MATCH Phase 3-7.1
3.8 NEWFILE Phase 3-8.1
3.9 OVERLAY Phase 3-9.1
3.10 PRINTERMAP Phase 3-10.1
3.11 SCALE Phase 3-11.1
3.12 TITLEMAP Phase 3-12.1
3.13 WINDOW Phase 3-13.1
3.14 WORKFILE Phase 3-14.1

SECTION FOUR: GLOSSARY OF TERMS FOR GEOMAST AND GEORAP 4-1

GEOMAST APPENDIX I: OPERATING INSTRUCTIONS FOR GEOMAST ON AN IBM SYSTEM Appendix I-1

GEOMAST APPENDIX II: DEMONSTRATION OF INTERACTIVE SESSION WITH GEOMAST Appendix II-1

GEOMAST APPENDIX III: THE GEOCODING PROCESS Appendix III-1

GEORAP APPENDIX I: OPERATING INSTRUCTIONS FOR GEORAP ON AN IBM SYSTEM Appendix I-1

GEORAP APPENDIX II: AN EXAMPLE RUN Appendix II-1

FOREWORD

This report is part of a broad effort by the Comprehensive Resource Inventory and Evaluation System (CRIES) Project to develop, adapt, and document general procedures for classifying, inventorying, and analyzing the extent, current use, and development potential of agricultural resources for national planning. The work is a joint effort between the U.S. Department of Agriculture and Michigan State University in cooperation with the U.S. Agency for International Development under PASA #AG/TAB263-14-76. Participation of Michigan State University is covered under Research Agreement #12-17-07-8-1955 between the U.S. Department of Agriculture and Michigan State University.

CRIES has two general objectives:

1) to apply a consistent approach to land resource classification which is adaptable to many countries and suitable for agrotechnology transfer, and

2) to provide the training and technical assistance necessary to classify and inventory resources, to evaluate crop adaptability and productivity, and to assist in developing food strategies in participating countries.

To meet these objectives, the CRIES staff collaborates with representatives of participating governments to design information acquisition and analytical techniques tailored to the country's unique problems and needs while retaining a consistent approach to inventory procedures used to acquire the basic resource information so that transfer of agrotechnology information among countries is feasible. Efforts are focused on the use of existing data, supplemented by primary data collection and informed judgement. The underlying theory is designed to use

reconnaissance-grade data sets to establish a single, nationally-consistent resource information system to develop the in-country capability for systematic collection, refinement, and analysis of agricultural resources in agricultural planning and policy analyses.

The need for nationally-consistent resource information predicates the design of an information management system for the creation and maintenance of basic resource information in a retrievable manner. In addition to these basic features, the system has been expanded over time in response to individual country needs. CRIES information management and analysis capability as it currently exists is divided into two systems -- the Geographic Information System (GIS) and the Agroeconomic Information System (AIS). GIS uses a grid cell identification and storage system to capture and maintain mapped information (point and/or boundary) with geographic definition. AIS maintains all tabular information. The two systems are interactive through the use of common geographical codes whenever relevant.

GIS is composed of two major components -- GEOMAST and GEORAP. GEOMAST constitutes the computer software for creating a geographic data base from gridded map information. Its primary use is to aid the processing, correction, and verification of a grid geocoded map data base for input to GEORAP. GEORAP constitutes the computer software for the mapping and analysis system. This report documents the function and uses of GEOMAST and GEORAP.

Many people participated in the development and adaptations of GEOMAST and GEORAP. Weldon Lodwick, Department of Resource Development, coordinated the entire effort. Steven E. Tilmann, Eriks Zusmanis, and Mark Simon, all previously with the Center for Remote Sensing, authored many of the individual programs. Portions of this manual were adapted from the Control Data Corporation version of GEORAP written by Stephen Tilmann. The crosstab phase was

adapted from MINITAB, a computer program written at the University of Chicago. Weldon Lodwick was responsible for this documentation. Daniel E. Kugler, Economic Research Service, U.S. Department of Agriculture, contributed to the discussions on applications for resource evaluation and analysis. James B. Johnson, Economic Research Service, U.S. Department of Agriculture, coordinated the review and editing of this report. Susan J. Perkins, secretary to the CRIES project staff, typed this report.

The authors wish to acknowledge the review comments submitted on a earlier draft of this report by the following: Richard E. Suttor, U.S. Agency for International Development; Mike Abkin, Department of Agricultural Economics, Michigan State University; and, David Langemeir, Economic Research Service, U.S. Department of Agriculture. The detailed review provided by David Langemeir was extremely useful to the authors in their attempts to improve the technical content and readability of this report.

LIST OF FIGURES

PAGE

FIGURES IN GEOMAST:

1.	Sample of GEOCODED map	1-1.2
2.	Map Codes for One Information Cell	1-1.3
3.	Schematic Diagram of the Geographic Master File Creator Program	1-3.3.2
4.	Card Deck Structure for the Geographic Master File Creator Program	1-4.1.3

FIGURES IN GEORAP:

1.	Sample of GEOCODED map	1-1.2
2.	Schematic Diagram of the GEORAP System	1-2.3
3(A-C).	Data File Structure Used for GEORAP Master File	1-3.3
4.	Sample of a Cross-tabulation Table Produced by the CROSSTABS Phase	3-1.4
5.	Sample Map Before and After GROUP Phase	3-4.1
6.	Sample Bar Graph Produced by HISTOGRAM Phase	3-5.3
7.	Sample Maps Before and After MATCH Phase	3-7.2
8.	Example of Printer Map	3-10.7
9.	Example of a Map Produced by the TITLEMAP Phase	3-12.2
10.	Sample Maps Before and After WINDOW Phase	3-13.2

LIST OF TABLES

		PAGE
TABLES IN GEOMAST:		
1.1	Phases of GEOMAST and Their Functions	1-1.5
1.2	Phase Directives	1-2.1
1.4.1	File Utilization	1-4.1
1.4.2	File Use	1-4.2
3.1	Editing Routines	3-1
TABLES IN GEORAP:		
1.1	Phases of GEORAP and Their Functions	1-2.2
3.1	Mapping Directives for Single Character Symbols of the PRINTERMAP Phase (Option 1=1)	3-10.4
3.2	Mapping Directives for Multi-Character Overprint Symbols of the PRINTERMAP Phase (Option 1=2)	3-10.5

GEOMAST: A USER'S GUIDE TO VERSION 2.1 OF THE GEOGRAPHIC MASTER FILE GENERATOR

SECTION ONE: AN OVERVIEW OF GEOMAST

1.1 System Introduction

This users' manual describes the Geographic Master File Creator (GEOMAST) computer program which supports the Geographic Resource Analysis Program (GEORAP). As described in the Foreword, GEOMAST and GEORAP are the two major computer components of the Comprehensive Resource Inventory and Evaluation System's Geographic Information System The primary purpose and use of GEOMAST is to create a single merged master file of mapped data for input to GEORAP so that mapped and spatially identified resource information can be integrated, interpreted, statistically summarized and graphically displayed.

In the process of inventorying, assessing and analyzing agricultural resources, many types of data and information are best developed and presented in the form of a map. These maps, although they offer a simple visual means for data display, are cumbersome to measure and compare when information from two or more maps must to be integrated. GEOMAST's master file and computer program provides the capability to simulate geographic information from a set of maps and store them in computerized form.

GEOMAST may be used to process and store individual maps of virtually any phenomena with geographic identity... whether point or boundary in the form of either identification or magnitude.

The basic process for data capture with GEOMAST is to reference the data system with a standardized base map and record for boundaries those grid cells, to the closest square km^2 grid cell, those cells which are on the boundaries

between region of mapped phenomena.[1/] It is very important for the user to understand that geocoding data capture from any map is a mechanical generalization of reality.[2/] A boundary line as geocoded is a geometric approximation of the smooth continuous line depicted on the original map (Figure 1).

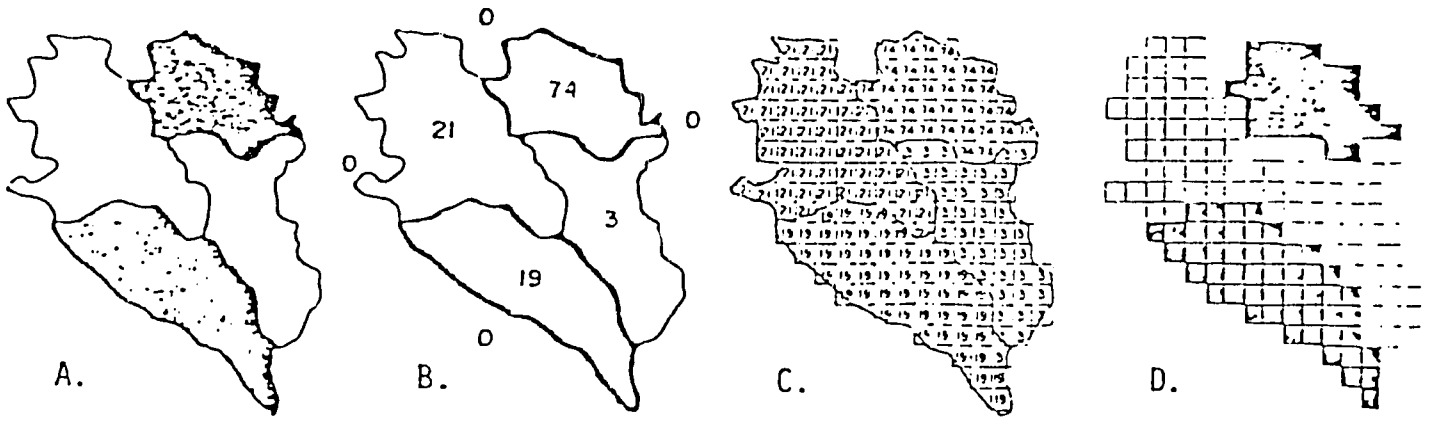


Figure 1.--Irregular shaped map units can be represented by a system of grid cells. A: Map units as they appeared on the original map. B: Each map unit is assigned a number code; areas outside the study are are assigned a zero code. C: Map units are approximated by a system of grid cells, each cell containing the code of the underlying map unit. D: Map units as they would be reconstructed by a computer.

Once the data map boundaries have been geocoded, the coded map can be checked and edited. Verification of the computer map can also be undertaken by generating a printer map which simulates the boundaries of the study area, then comparing the printer map with the original referenced data map.

Data sets are usually in two forms -- contiguous and discontiguous. Contiguous data shares a common, usually encompassing, boundary for each

---

[1/] The individual row-column addresses for the grid typically represent the lowest level of areal aggregation common to the Geographic Information System. CRIES has used a one square kilometer (1 km^2) grid cell, unless otherwise specified.

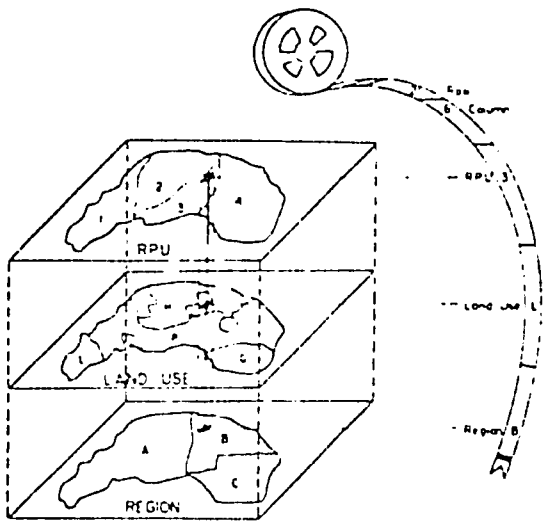
[2/] The geocoding process is summarized in Appendix III to this report.

individual factor unit in the system. Discontiguous data may occur only in discrete areas and generally occupy a smaller part of the total study area. For example, only cells with urban areas or irrigated cropland might be coded and the remainder left blank.

Data sets are generally of two types, identification or magnitude. Identification sets usually refer to a particular variable or name but have no arithmetic properties. Identification sets provide cross-linkage code capability to associate geographic data with tabular information in the Agroeconomic Information System (AIS). Magnitude data sets are in the form of measurement or dimension of some variable, e.g. depth to ground water, yields for corn, average annual precipitation, etc. Such data represent the average or most typical value of the particular measured parameter, generalized to the entire cell.

The final phase of GEOMAST creates a Master File by merging the set of referenced data maps into one file. Theoretically, there is an individual record for each grid cell and a code for each of the maps in the system (Figure 2). In fact, the Master File is compressed and only contains records for those cells which contain map boundaries or bits of information. Any geocoded map can be included in the Master File.

Figure 2--Map Codes for One Information Cell



The map coding process used by CRIES emphasizes the use of manual data capture and verification. Usually a two-person team is sufficient to conduct all activities involved in map coding and verification. Occasional support assistance may be required in the keypunching and program operative steps. Map preparation will involve some limited cartographic support for transferring grid lines, changing map scales and similar graphic tasks. Hardware requirements are limited to those associated with a basic operating computer facility.

In utilizing the Geographic Information System (GIS), the user will find that coupling identification map data sets with tabular storage in the Agroeconomic Information System[1/] file is an efficient way to use the system. The GEORAP document describes many configurations and combinations that can be made from a few identification data sets and accompanying tabulated data storage in AIS. For example, a single computer coded map can geographically locate soil map units in the GIS system. Each and every grid cell will have a code for some soil and the sum of the contiguous cells with the same code will form a soil map unit(s). The system need not be burdened with codes for every soil parameter. Depth of topsoil, slope, pH, etc. can be stored in a single table per soil in AIS and retrieved by map unit and cell for working purposes. Tabular census data may be handled in the same way.

The GEOMAST system consists of seven separate phases (Table 1.1) with each phase performing a specific function on the geocoded file. Using the phases in an appropriate sequence will create a GEORAP compatible Master File. The phases are invoked through the use of phase cells via a terminal (interactive) or

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1/ See the Foreward to this document for a brief explanation or for a detailed discussion see "Agroeconomic Information System", Comprehensive Resource Inventory and Evaluation System, U.S. Department of Agriculture and Michigan State University, January, 1981.

Table 1.1. -- Phases of GEOMAST and Their Functions.

	PHASE	PHASE NAME	FUNCTION
1.	BOUND	BND	Compares the boundaries of a given geo-coded file to that of a standard file.
2.	CHECK	CHCK	Checks for syntactical errors in geo-coded 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 number 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 single print 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.

cards (batch) and the system can operate in both a batch and timesharing environment.

The remainder of this section describes the file structure and general operating procedures. Section 2 describes specific operating procedures for using the individual phases. Section 3 contains operating procedures for using EDITOR. Section 4 contains a glossary of terms and the user is advised to preread or at least reference this glossary in order to gain sufficient grasp of the vocabulary used in this manual.

1.2 Phase Directives and Options

The phase directives may be completely spelled out or just the first two letters can be used. An option is used in several of the phases which follows the phase directive delineated by a comma. In the summary shown in Table 1.4 material enclosed in parentheses is optional.

Table 1.2 -- Phase Directives

PHASE	DIRECTIVE	OPTIONS
BOUND	BND	None
CHECK	CHCK (, M)	M = 1 error message and edit prompt
		M = (blank) error message only
EDIT	EDIT	None
END	END (, N)	if N is 0 or blank the working file is not copied to logical unit number 12; otherwise it will.
LIST	LIST, M, N	M = starting row value or = ALL for complete listing of working file N = ending row value
MAP	MAP, M	M = 0 or blank unscaled map on output (logical unit 1 DOS, logical unit 5 OS)
		M = Non-zero or non-blank scaled map on PFILE (logical unit 9).
MERGE	MRGE, M	M = O or blank signifies that merging into an existing master file.
		M = 1 signifies that a new master file is to be created.
		M = 2 signifies merge horizontally adjacent map sections.
		M = 3 signifies merge vertically adjacent map sections.

Complete phase descriptions are contained in Section 2.

1.3 GEOMAST Input Formats and Procedural Descriptions

The initial input file used with GEOMAST is constructed from a grid-based geocoding process. Each grid cell is assigned a unique row and column coordinate, based on a matrix row/column coordinate system. The geocoded file must be in geocoded format which consists of recording on a coding sheet the row number, first column number, attribute (see glossary) for first column, column number where the first change in the attribute occurs, its attribute, ..., column number where the last attribute change occurs and its attribute. If more than 1 record (card image) is needed for a row put a 1 in column 80 to indicate the row is continued on the next record. There is a limit of 254 attribute changes or section geocoded (coding rectangle) or 509 elements per row (logical record) per section geocoded (coding rectangle); i.e., (2x254)+1 = 509*. More than one continuation record is allowed. Each row of the map being geocoded must be recorded in the same format for the entire coding rectangle that is being verified by GEOMAST. For example, if the format for each element is I5, then the maximum number of elements per record (card image) is 78/5 = 15 since column 79 must always be blank and column 80 is for continuation. Thus the format would be (15I5,4x,I1). Assuming an I5 element format, a row with 5 attribute changes would have (5x2)+1 = 11 elements and thus would fit on one record (card image). A row with 10 attribute changes would have (10x2)+1 = 21 elements and would require 2 records, 15 elements on the first record with a number 1 in column 80 and 6 elements on the second record. There is a current limitation, a maximum of 4,000 rows and 4,000 columns that can be coded per map. This is easily changed by redimensioning the variables. Thus, the largest map that GEOMAST can handle is 4,000 grid cells by 4,000 grid cells.

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*The reason for this is that DOS FORTRAN IV has a fixed record length of 256 words/record with one byte being used to describe the record. Thus there are 255 words of information that are "disposable". Thus, up to two of these fixed length records can be linked. Fixed length FORTRAN logical record is not a problem if operating under OS and the software may be modified by the user.

1.3.1 File Verification and Correction

The CHECK phase is the primary verification phase of GEOMAST. This should be the first phase used in any GEOMAST session, since it checks for numerical validity as well as correct sequencing of the row of column indices. CHECK produces a series of diagnostic messages for any errors encountered and the capability to correct these errors.

The EDIT phase can be used to correct errors encountered by the phase CHECK or as a result of visually checking the data. This phase allows for the modification of individual elements within a given row, and is suited for interactive use though it can be helpful to the batch user as well.

The MAP phase allows for visual verification of map data and relative cell frequency counts. A scaled map can be overlayed on the original map base for internal boundary verification as well as classification accuracy.

If a boundary base file is available, the BOUND phase will adjust the external land boundaries of a given working file to that of the base. It is advisable to use the MAP phase to verify the changes made as well as check for internal boundary alignment after the BOUND process has taken place.

1.3.2 Master File Creation and Updating

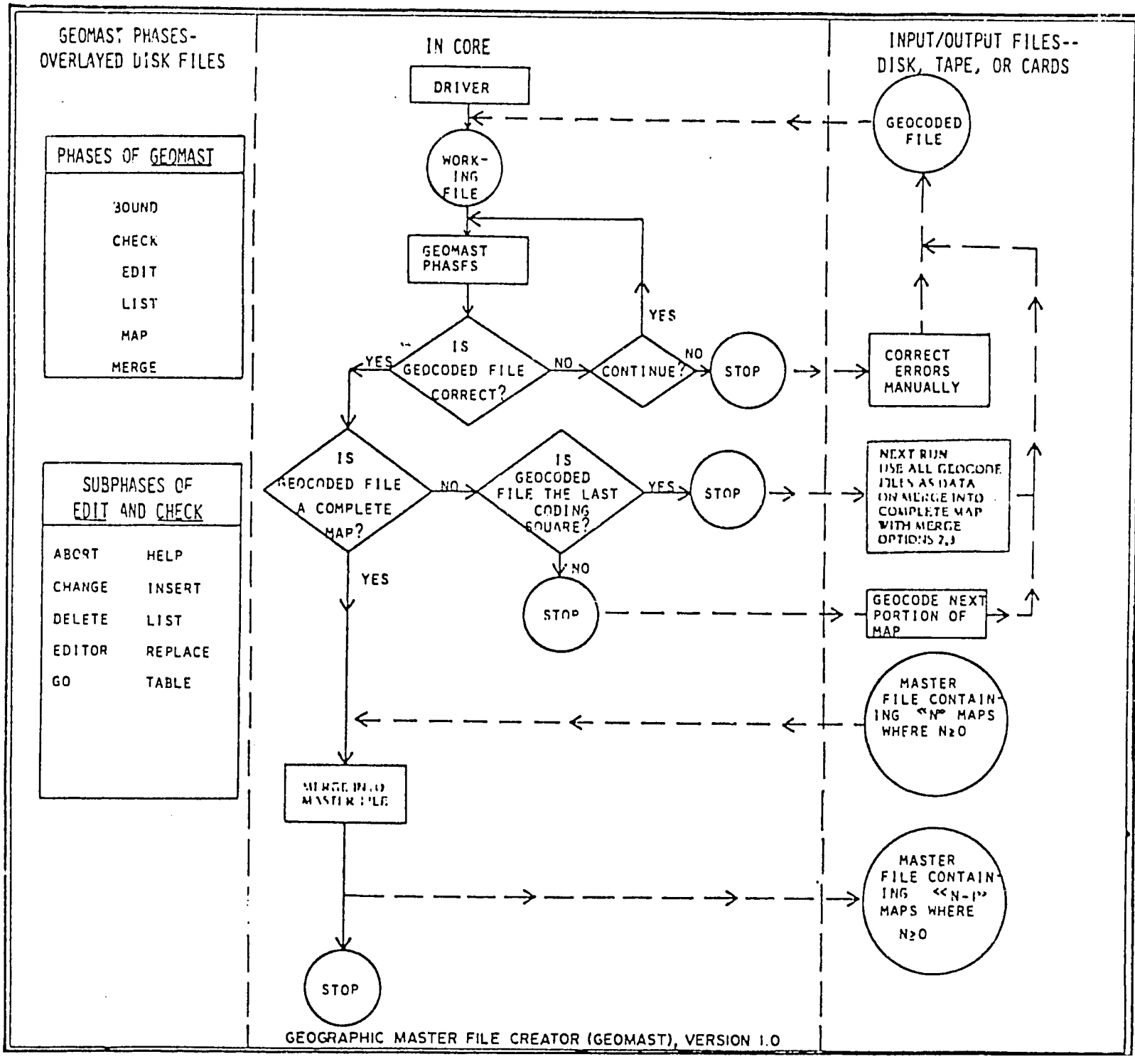
After a file has been corrected and verified, the MERGE phase can be used to convert the working file to master file form or append the working file to an existing master file. The working file is assumed to be error free and need not be of the same dimensions as the existing master file.

1.3.3 Working File

Logical Units 7 and 11 are the files used for the working file (WORKF and WORKF2). Phases CHECK and EDIT interchange the working file between these two units (7,11). Data is always read from file WORKF and written to file WORKF2. The Logical Unit numbers for WORKF and WORKF2 are then switched so that WORKF always contains the most up-to-date working file.

When using GEOMAST in batch mode it is best to put control cards in to save both units 7 and 11, since it is not known which unit will contain the current working file at the end of GEOMAST. At normal termination, GEOMAST prints a message informing the user which unit the current working file is on.

Figure 3. -- Schematic Diagram of the Geographic Master File Creator Program



1.4 File Description

The following section describes the file structure and use in the phases of GEOMAST. The grid geocoded data files are in the initial form of input data used with GEOMAST. The master file must be retained at the end of a creation run. If corrections are made to the working file during execution this file should also be saved for future work.

Table 1.4.1 -- File Utilization

Phase Name	Unit DOS / OS	1 / 5	2 / 6	7 / 7	8 / 8	9 / 9	10 / 10	11 / 11	12 / 12	13 / 13	14 / 14	5 / 15	4* / 10*
BOUND		C/I	C/O	B/I	B/IO						B/I		
CHECK		C/I	C/O	B/I					C/O				
EDIT		C/I	C/O	B/IO	B/IO			B/IO					
END			C/O	B/I					C/O				
LIST		C/I	C/O	B/I		C/O							
MAIN PGRM		C/I	C/O	B/O			C/I						C/I
MAP		C/I	C/O	B/I		C/O							
MERGE		C/I	C/O	B/I						C/I		C/O	

KEY: B - Binary : I - Input file
C - Display coded : O - Output file

*Attribute table.

Table 1.4.2 -- File Use

Unit DOS	Unit OS	Use	Name	Usual File Type	Type
1	5	System Input	INPUT	CARDS (terminal interactive)	C
3	6	System Output	OUTPUT	LINE PRINTER (terminal Interactive)	C
7	7	Internal Working File	WORKF	D	B
8	8	Scratch File	SCRATCH	D	B/C
9	9	Output File for list (batch mode)	PFILE	LINE PRINTER	C
10	10	Geocoded data Input File	IFILE	D or CARDS	C
11	11	Secondary Working File used in EDIT, CHECK	WORKF2	D	B
12	12	Display coded copy of Working File, error messages from CHECK	OUTFL	LINE PRINTER	C
13	13	Input Master File for merging	MASTER	D	C
14	14	Boundary Base File	BASEF	D	B
5	15	Output Master File	NEWMST	D	C
4	10	Attribute Table	ATTIN	CARDS	C

KEY: C - Display coded
B - Binary
D - Disk or tape

1.4.1 LOGICAL UNITS FOR IBM/OS

1.4.1.1 Unit 5 System Input

This file is used for program communication input.

1.4.1.2 Unit 6 System Output

This file is used for program communication output.

1.4.1.3 Unit 7 Working File

This file is the GEOMAST internal working file. It is a binary file with fixed length of 255 elements or words (1020 bytes) per record. The first element is the row identifier and the remaining 254 elements contain the column-attribute pairs. A row requiring more than 127 column-attribute pairs (255 elements) is continued on the following record of the working file.

1.4.1.4 Unit 8 Scratch File

This file is used to store intermediate data by various phases in GEOMAST.

1.4.1.5 Unit 9 List Output File

This file is used by LIST when a total listing is requested, the listed material is outputted to this unit.

1.4.1.6 Unit 10 Geocoded Data File

This is the main input file for GEOMAST containing the geocoded data file as well as auxiliary information. The input file structure is as follows:

record	description		
1	Mode of Run:	1	interactive
		0	batch
2	File Header Record Format		
3	Attribute Table Format		
4	Geocode File Header Record		

position	description
1	minimum row (values must be between 1 and 4000)
2	maximum row (values must be between 1 and 4000)
3	minimum column (values must be between 1 and 4000)
4	maximum column (values must be between 1 and 4000)
5	minimum attribute
6	maximum attribute
7	maximum number of elements per row (logical record), the maximum is 509.
8	number of card spaces per element, minimum is 3 maximum is 30.
9	run name

Note: The maximum number of elements per card equals 78/POS(8); e.g., if POS(8) = 5 then 78/5 = 15.

6 through M — Geocoded file is inserted here.

For each card column 80 is reserved for a continuation Flag. If the row continues on the next card a "1" must be in column 80 and the card must have as many elements as possible on it.

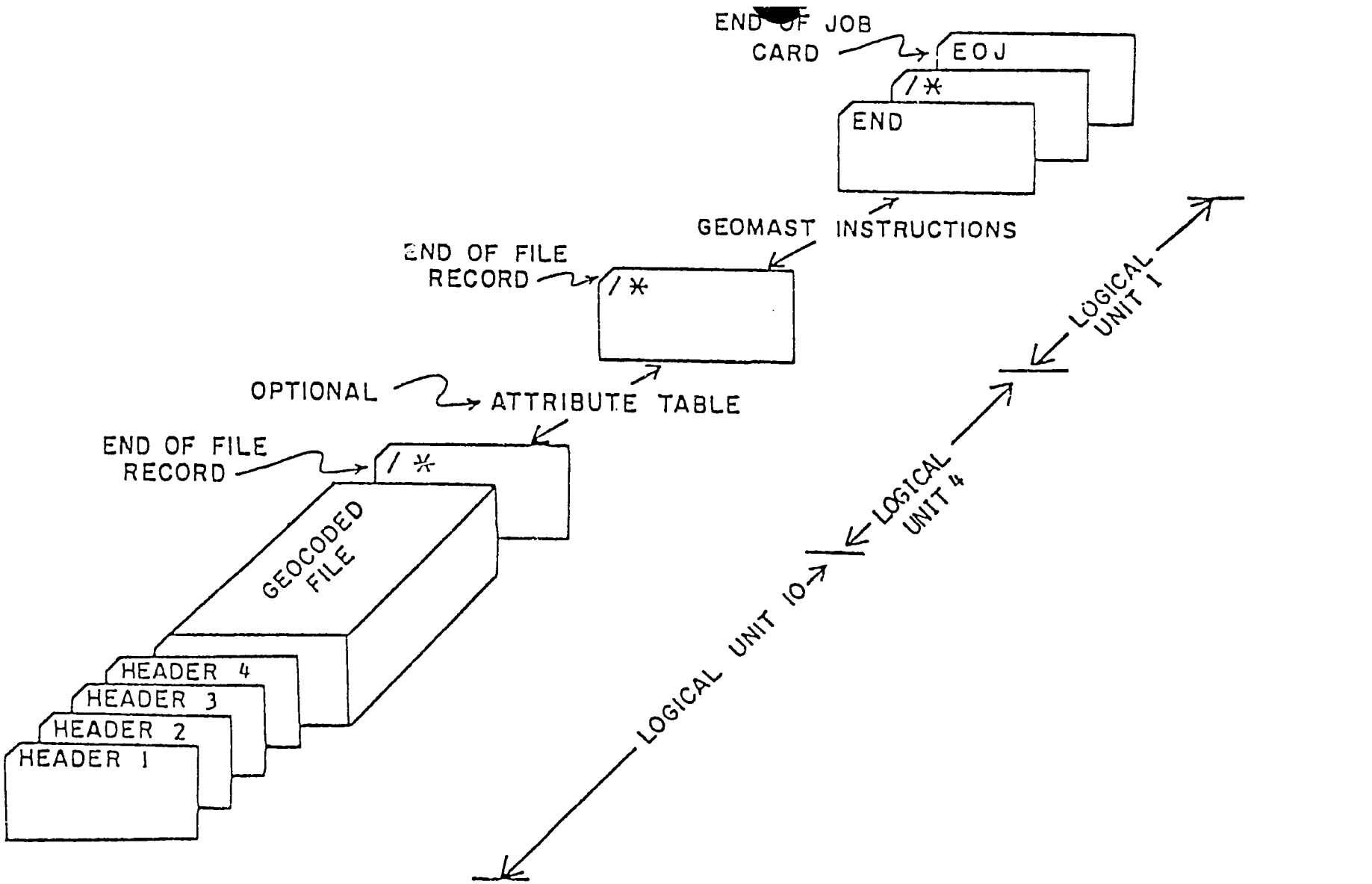
M+1 — end-of-file

1.4.1.7 Unit 11 Secondary Working File

This file is used as an intermediate working file in the EDIT and CHECK phases. It has the same structure as the Unit 7 description.

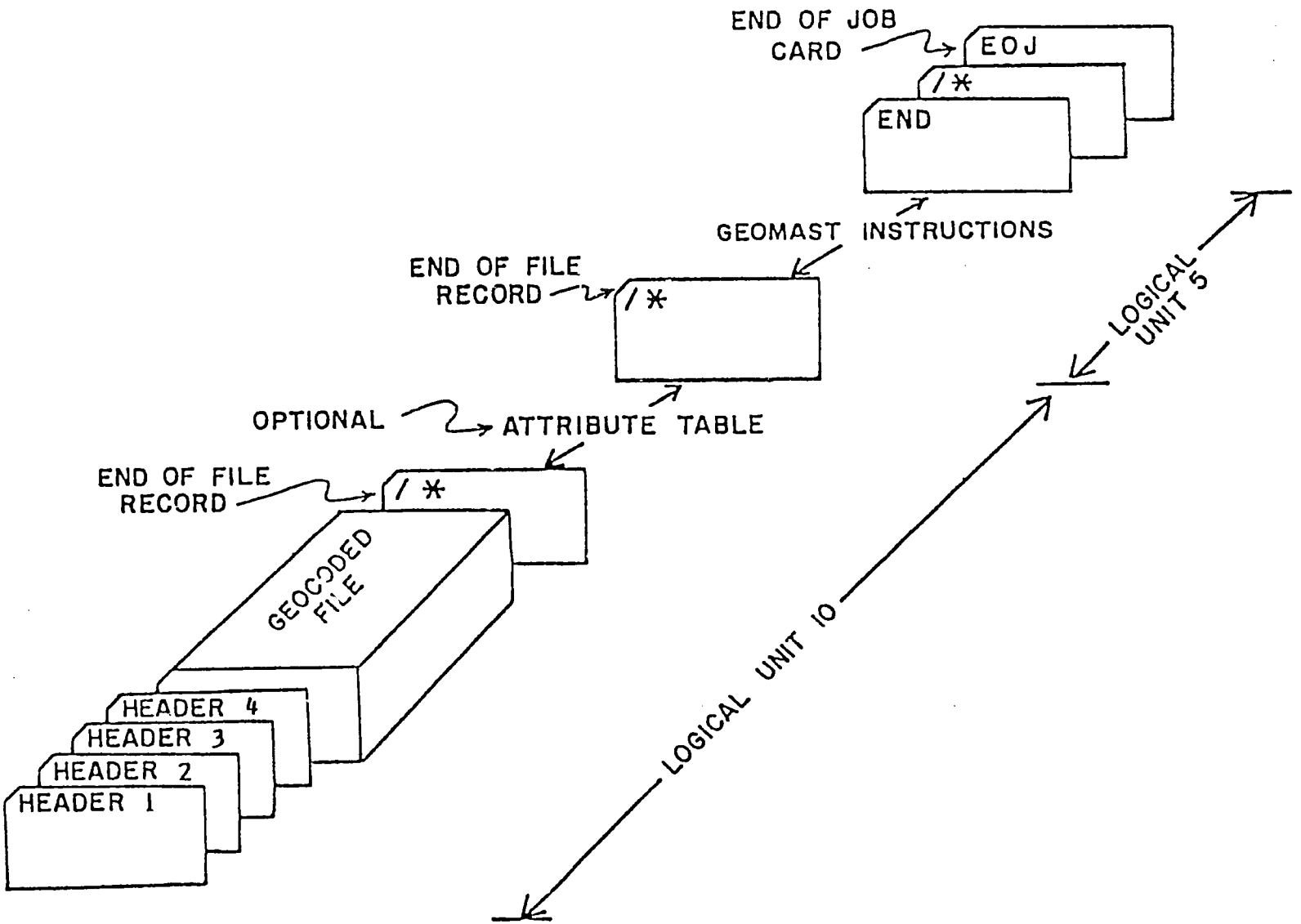
1.4.1.8 Unit 12 Program Output File

The current working file is written to this unit at the end of a GEOMAST session. Its structure is the same as that of Unit



DATA REQUIRED BY GEOMAST
IBM / DOS

Figure 4. -- Card Deck Structure for the Geographic Master File Creator Program



DATA REQUIRED BY GEOMAST
IBM / OS

10, and can be used in a later GEOMAST run if this file is catalogued. However, if EDITOR routine CHANGE is used, then this unit contains error messages produced by CHECK phase and can be listed on the printer.

1.4.1.9 Unit 13 Master File Input

This is the existing master file into which the working file can be merged. It is assumed to have one header in the following form:

Col	Information
1-5	minimum row
6-10	maximum row
11-15	minimum column
16-20	maximum column
21-25	minimum attribute value
26-30	maximum attribute value
31-35	number of factors on the master file
41-80	alphanumeric information describing the file

The first element denoting the row, the second containing the column number, and the remaining elements containing the factor values of the row/column. The master file is in compressed cell record format (see figure 2.C of GEORAP, page 1-3.3).

1.4.1.10 Unit 14 Boundary Base File

This file is used to check the boundaries of the working file. The structure of this file is the same as for the working file.

1.4.1.11 Unit 15 Master File Output

This file is the new Master File with the geocoded map factor added to the old Master File via the MERGE phase. It has the same structure (with an additional factor) as Unit 13.

1.4.2 LOGICAL UNITS FOR IBM/DOS VS

The unit descriptions are the same as those used by OS except that logical unit number 5 is logical unit number 7 and logical unit number 10 is logical unit number 4.

SECTION TWO: PHASES OF GEOMAST

2.1 BOUND Phase

The BOUND phase has no options and will flag boundary misallignments of a given working file to that of an existing base file. The base file contains the official base map either in its entirety or in sections. However, both work file and base file must be of the same area of course.

The base file must be available on Unit 14 in working file binary format with the same dimensions as the working file, where the working file is the file being reconciled to the base (standard) map file.

Phase Directive: BND

2.2 CHECK Phase

The CHECK phase, which has one option, checks the working file for correct row sequencing, correct column sequencing and for valid attribute values.

CHECK can be used in conjunction with EDITOR (OPT1=1) or alone (OPT1=blank) in which case the whole working file is scanned for errors. Row values are checked by comparing the first row to the minimum row value in the header record and subsequent row values for consecutive order starting with the minimum row value and ending with maximum row value from the header record.

Column values for each row are verified by checking the first column value against the minimum column value in the header record. The remaining column values are checked so that they are greater than the previous column value and less than the succeeding column value, and less than or equal to the maximum column value from the header record.

Attribute values are checked against the attribute table if present. If an attribute table is not present the values are checked against the minimum and maximum attribute values from the header record as described above.

A message is written onto Unit 6 (ouput) explaining the error if an error is encountered for the given row being checked. If CHECK has been called with the editor option (Option = 1) the EDITOR routine will be executed after each row that contains an error. For EDITOR usage see Section 3.0. If CHECK has been called without the editor option, only error messages are written, and the processing continues.

An error summary is written after the last row of the working file has been processed. The summary contains the number of row errors, column errors, and attribute errors.

Phase Directive: CHECK, OPT1

Option = Blank : error messages only (default)

Option = 1 : error messages and EDITOR

2.3 EDIT Phase

EDIT phase, which has no options, allows for making changes to the working file through the use of EDITOR (see Section 3.0) without going through the checking process. This can be useful if upon inspection of the data, errors are detected.

Once EDIT is called, the row number of the row to be edited must be entered. Any number of rows up to the total number of rows can be edited with one call to EDIT. The rows to be edited must be in sequential order, but not necessarily consecutive.

To end EDIT a "0" (zero) is entered for the row to be edited.

Phase Directive: EDIT

2.4 END PHASE

END phase which has one option, terminates execution of GEOMAST.

By using the option, a display coded copy of the working file is written to LUN12, which is compatible for reuse in GEOMAST. The option is helpful when errors have been corrected on the working file, and one wishes to save the corrected working file.

Phase Directive: END,OPT

Option	= 0 or Blank	: No display coded copy
	= 1	: Display coded working file on LUN12

2.5 LIST Phase

The LIST phase, which has two options, will list the working file with a 132 column (batch mode) or 72 column (Interactive mode) format. LIST can list a single row, a range of rows, or the entire working file. When listing the entire working file, it is written to Unit 9.

Phase Directive: LIST, OPT1, OPT2

Option 1 = starting row values (for partial list) or

= All (for entire working file)

Option 2 = Ending row value (for partial list)

= (Blank) (for entire working file)

NOTE: In regard to a partial list, it is assumed that the working file is sequential and all intermediate rows are present.

Examples:

1. Phase Directive List 1,5

   will list rows 1 through 5.

2. Phase Directive List 15,20

   will list rows 15 through 20.

3. Phase Directive List 5,5

   will list just row 5.

4. Phase Directive List, ALL

   will copy the entire working file on Unit 9.

2.6 MAP Phase

The MAP phase, with a prompt for designation of a scaling factor, will produce a line printer map with a fixed symbol character set. The map may be unscaled with one symbol per grid cell or the map may be scaled to a user specified scaling factor.

The map is printed in up to 100 character strips with cell indices printed along the outside border of the strip.

At the completion of the final strip, a table is printed of the printer character-attribute correspondence and frequency of occurrence. Note that the frequency is relative but not absolute when doing a scaled map.

Phase Directive: MAP, OPT1

Option 1 = 0 Map on OUTPUT file

= 1 Map on PFILE

Enter scaling factor (or 0)

User scaling directive: 0. = unscaled

n.m = scaling factor

2.7 MERGE Phase

The MERGE phase using four options will create at Master File from the existing working file (OPT1 = O, Default), merge the working file into an existing Master File (OPT1 = 1), merge horizontally adjacent sections of a map (OPT1 = 2), or merge vertically adjacent section of a map (OPT1 = 3).

OPT1 = O uses the working-file and outputs to the logical unit (file) NEWMST a Master File with one factor (map).

OPT1 = 1 uses the working-file, Master File (with data in compressed cell format; See Section 1.3.1.9) and creates the new Master File on the logical unit (file) NEWMST (Unit 5 DOS, Unit 15 OS) with one more factor.

OPT1 = 2 or 3 uses the working-file, a geocoded Master File (with data in geomast format; See Section 1.3.1.6) and outputs the merged file back into the working file for further processing.

Using OPT1's 2 or 3, it is possible to merge two files starting at different row numbers or two files starting at different column numbers. For example, one file may contain rows 1 through 10 while another contains rows 11-30. The resulting file would contain rows 1 through 30. Similarly, if one file contains columns 10-40 while another contains 41-60, the resulting file will contain rows with columns 10-60 specified. If no Master File is present, one is created for the given working file.

Any number of map sections can be merged using the correct sequence of OPT 2 and 3 with the files being separated by end-of-file marks. Then the merged file can be outputted creating a new Master File format (OPT1 = O) or can be merged with an existing Master File (OPT1 = 1) all in the same run.

When merging horizontally or vertically, one geocoded file is attached in the normal way as Logical Unit 10. The geocoded file(s) to be merged are on Logical Unit 13 in geocoded format. If more than one merging is to take

place during a GEOMAST run, end of file mark must separate the files on Logical Unit 13 if running under DOS or attached as FT13001, FT13002, ... if running under OS. Thus, if the resulting merged sequence is a complete map and it is desired that this newly merge map be used in creating a new Master File in one running of GEOMAST, the last file is the old Master File in compressed cell format.

Should the merging be done in separate runs of GEOMAST, attach the first section to be merged in the usual way as Logical Unit 10 and the second section to be merged as Logical Unit 13 (one file). After merging takes place the new merged file is on the working file. It can be saved (catalogued) in geocoded format by using the option on the END phase, OPT1 = 1 and making sure that Logical Unit 12 is properly saved (catalogued).

The files which are to be merged horizontally or vertically (OPT1 = 2 or 3) must contain the following information and must be on each geocoded file to be merged which are on logical unit number 13. See below.

1st record HEADER 2 format of geocoded file header record.

2nd record HEADER 4 the geocoded file header record.

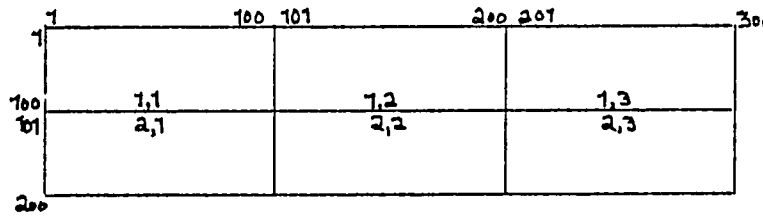
3rd - nth records the geocoded file to be merged.

last record /* (end of file mark)

Note that interactive or batch indicator HEADER 1 and the format for the attribute table HEADER 3, is not part of the geocoded file(s) to be merged since it is assumed that the geocoded file to be merged has been checked. Normally this information would be HEADER 1 and HEADER 3 (see pages 1-4.1.1 and 1-4.1.2) and these must be removed from the geocoded file on Logical Unit 13 which is (are) to be merged with the geocoded file on Logical Unit 10. Note that geocoded file on Logical Unit 10 does have HEADER 1, HEADER 2, HEADER 3 (optional), HEADER 4 and geocoded information. It

is wise to include all attribute codes being used in the merged file in the attribute table so that after the merge is performed a check can be made on the entire merged file.

The next step for the subsequent merging would have the two sections to be merged and Logical Unit 13 saved (catalogued). For example, if there are six sections of 100 grid cells by 100 grid cells which have to be checked and verified where the mapped area is 200 grid cells long by 300 grid cells wide designated as sections 1,1 through 2,3 as shown below.



Attach section 1,1 as Logical Unit 10 and section 1,2 as Logical Unit 13 and merge horizontally. Logical Unit 12 is saved and contains sections 1,1 - 1,2. Next attach section 1,1 - 1,2 as Logical Unit 10 and section 1,3 as Logical Unit 13 and merge horizontally. Logical Unit 12 is saved and contains section 1,1 - 1,2 -1,3. Next attach section 2,1 as Logical Unit 10 and section 2,2 as Logical Unit 13 and merge horizontally. Logical Unit 12 is saved and contains section 2,1 - 2,2. Next attach section 2,1 - 2,2 as Logical Unit 10 and section 2,3 as Unit 13 and merge horizontally. Logical Unit 12 is saved and contains section 2,1 - 2,2 - 2,3. Finally, attach section 1,1 - 1,2 - 1,3 as Logical Unit 10 and section 2,1 - 2,2 - 2,3 as Logical Unit 13 and merge vertically. Logical Unit 12 is saved and contains the whole map. It is attached as Logical Unit 10 for merging into an existing old Master File.

Of course it would be easier to perform the above in one running of GEOMAST in the following way. Attach section 1,1 as Logical Unit 10 and

have Logical Unit 13 contain (in the following order) section 1,2, section 1,3, section 2,1, section 2,2, section 2,3 and the old Master File separated by an end of file mark under DOS or as FT13001, FT13002, FT13003, FT13004, FT13005 and FT13006 respectively under OS. Then call the MERGE phase six times. First, merge horizontally (obtaining section 1,1 - 1,2 on the working file). Second, merge horizontally (obtaining section 1,1 - 1,2 - 1,3 on the working file). Third, merge vertically (obtaining section 1,1 - 1,2 - 1,3 - 2,1 on the working file). Fourth, merge horizontally (obtaining section 1,1 - 1,2 - 1,3 -2,1 - 2,2). Fifth, merge horizontally (obtaining section 1,1 - 1,2 - 1,3 - 2,1 -2,2 - 2,3). Sixth, merge into old Master File.

The old Master File (if present) must be available on Logical Unit 13 (FT13006 in this case) with the resulting Master File, including an updated header record written by the MERGE phase, outputted onto Logical Unit 15.

The format of the old and new Master File is coded and compressed cell. The user must specify FORTRAN format in which the new Master File is to be written and/or in which the old Master File is to be read. Since the Master Files are compressed cell, the row and column codes must be included as the first two elements of the FORTRAN format. Recall that an execution time FORTRAN format must have a beginning right parenthesis and an ending left parenthesis as the first and the last characters coded on the record. See the glossary for definitions of terms. When no old Master File exists, Unit 13 must be assigned. Up to 50 maps can be merged into a new Master File.

The new map is always the first map (left most) on the New Master File.

Phase Directive: MERGE, N

where N = O. Create a new Master File (Default).

1. Merge with an existing Master File.
2. Merge horizontally adjacent map sections.
3. Merge vertically adjacent map sections.

If MERGE, O one additional record must be inputted:

1. The FORTRAN format in which the new Master File is to be written.

If MERGE, 1 three additional records of information are required:

1. The FORTRAN format of the old Master File.
2. The new Master File descriptor (up in 40 characters) to be put on the new Master File header record.
3. The FORTRAN format in which the new Master File is to be written.

SECTION THREE: EDITOR

EDITOR is a subphase of CHECK and EDIT. It is designed to facilitate editing of the working file. EDITOR is a set of subphases of CHECK and EDIT; no other phases can call tne EDITOR subphases. Only the current row being processed by CHECK or designated by EDIT is modified by EDITOR.

Through EDITOR the user has access to nine (9) editing routines (Table 3.1).

Table 3.1

ROUTINE	EDITOR Command	FUNCTION
ABORT	A	Aborts checking, all previous editing is lost.
CHANGE	C	Allows error messages to be written to separate file.
DELETE	D	Deletes an entire row, or a column-attribute pair.
GO	G	Ends processing of current row.
HELP	H	Lists available EDITOR commands and function.
INSERT	I	Allows insertion of a new row or a column-attribute pair.
LIST	L	Lists current row.
REPLACE	R	Replaces a row, column or attribute value.
TABLE	T	Lists attribute table.

EDITOR routines are accessed by entering the proper EDITOR command (Table 3.1) when prompted by EDITOR. EDITOR allows for any number oi changes to be made to the current row as the user desires. To end processing of the current row the user enters "G" which then reverts control back to the calling phase (either EDIT or CHECK). If changes are made to the working file, this corrected version of the map data should be saved for future processing so that corrections do not have to be made every time the data file is used.

3.1 ABORT

ABORT routine is used when EDITOR is called from CHECK, and the user wants to terminate the checking process. Any processing that was done to the working file is lost.

ABORT serves no function when invoked by EDITOR via EDIT.

EDITOR Command: A

3.2 CHANGE

CHANGE routine is used when EDITOR is called from CHECK, and the user wants to end the output of error messages. CHANGE routine rewinds the working file and resumes error checking, but writes the error messages to a separate logical unit (Unit 12). The user must assign this file to the line printer or save it if the user wishes to inspect the errors. Only error messages are written to the separate file; the error summary produced by CHECK is always written to the line printer (output).

CHANGE serves no function when invoked by EDITOR via EDIT.

EDITOR Command: C

3.3 DELETE

EDITOR routine DELETE will delete an entire row or delete a given column-attribute pair. DELETE is executed by entering a "D" when prompted by EDITOR.

To delete the current line, enter "R" when prompted for delete command. To delete a column-attribute pair in the current row enter "C, column number" when prompted for DELETE command. To end DELETE enter "E" when prompted for DELETE command.

EXAMPLES:

1. ENTER DELETE COMMAND R

   Deletes entire current row.

2. ENTER DELETE COMMAND C,3

   Deletes column-attribute pair associated with column 3.

3. ENTER DELETE COMMAND E

   End DELETE.

3.4 GO

EDITOR routine GO completes editing of the current row. If EDITOR was called by the CHECK phase, checking continues with the next row. If EDITOR was called by the EDIT phase, control is reverted back to EDIT.

EDITOR Command: G

3.5 HELP

EDITOR routine HELP produces a list of available EDITOR commands along with a brief description of each command.

EDITOR Command: H

3.6 INSERT

EDITOR routine INSERT is used to insert an entire new row, or a column-attribute pair in the current row.

INSERT is executed by entering "I". INSERT will then prompt the user:

ENTER INSERT COMMAND: ALPHA, INT,INT

To insert a new row enter "R, OPT1". When OPT1=1, the new row to be specified will be inserted before the current row. When OPT1=2, the row to be specified will be inserted after the current row and the current row is written on the working file and the new row becomes the current row.

To specify the new row enter: Row number, column, attribute, ... 0,0. The 0,0 is required to terminate the row being entered.

To insert a new column-attribute pair enter "C, column number, attribute value" when prompted by the INSERT command.

To end INSERT enter "E" when prompted by the INSERT command.

EXAMPLES:

1. ENTER INSERT COMMAND: ALPHA, INT,INT

   R,1

   Enter New row

   5, 1, 0, 6, 15, 0, 0

   The new row is written to the working file before the current row is written.

2. ENTER INSERT COMMAND: ALPHA,INT,INT

   R,2

   Enter New Row

   7, 1, 0, 6, 15, 0, 0

   The current row is written to the work file, the new row becomes the current row.

3. ENTER INSERT COMMAND: ALPHA,INT,INT

   C,6,15

The column-attribute pair will be inserted between the appropriate columns.

4. ENTER INSERT COMMAND: ALPHA,INT,INT

   E

This command ends the INSERT subphase.

3.7 LIST

EDITOR routine LIST prints the current row in the working file being edited. This list is printed to the output file (line printer or terminal).

3.8 REPLACE

EDITOR routine REPLACE is used to replace an erroneous row, column, or attribute value.

Execution of REPLACE is done through EDITOR by entering an "R". REPLACE will then prompt the user:

ENTER REPLACE COMMAND: ALPHA, INT,INT

To REPLACE the current row value enter "R, new row value" when prompted by the REPLACE command.

To REPLACE a column value enter "C, old column value, new column value" when prompted by the REPLACE command.

To REPLACE an attribute value enter "A, column value, new attribute value" when prompted by the REPLACE command.

To end REPLACE enter "E" when prompted by the REPLACE command.

EXAMPLES:

1. ENTER REPLACE COMMAND: ALPHA,INT,INT

   R,3

   Replaces current row value with 3.

2. ENTER REPLACE COMMAND: ALPHA,INT,INT

   C,5,6

   Replaces column value 5 with 6.

3. ENTER REPLACE COMMAND: ALPHA,INT,INT

   A,7,8

   Note: "A" associated with the REPLACE command means "replace attribute" <u>not</u> ABORT.

   Replaces attribute value associated with column 7 with a new value of 8.

4. ENTER REPLACE COMMAND: ALPHA,INT,INT

   E

   Ends REPLACE.

3.9 TABLE

EDITOR routine TABLE produces a list of appropriate attribute values. If none are present, minimum and maximum attribute values are listed, and minimum, maximum row and column values.

EDITOR Command: T

GEORAP: A USER'S GUIDE TO VERSION 3.1 OF THE GEOGRAPHIC RESOURCE ANALYSIS PROGRAM

SECTION ONE: THE CAPABILITIES OF GEORAP (GEOGRAPHIC RESOURCE ANALYSIS PROGRAM)

1.1 System Introduction

This User's Guide describes the Geographic Resource Analysis Program (GEORAP). GEORAP is the display and analysis component of the Geographic Information System (GIS). GEORAP requires as input a master data file from the Geographic Master File Creator Program (GEOMAST).

The GIS provides the capability to capture information from mapped materials, to retrieve either all or portions of the data set, to add new data to the information base, and to display the results in the form of statistical summaries and/or computer maps. Typical products include area measurements of single maps, area measurements of combinations of two or more maps, and computer printer-maps of various scales for single or combined mapped data.

Virtually any phenomena located on a map or assigned to a map location, either at a point or within a boundary (map unit), may be incorporated into data system in the form of either identity codes or measurement parameters. GEOMAST uses a grid cell concept to geocode, process, and retain geographic identity in computer format. It is important for the user to understand that the information captured on the computer is a geometric approximation, in units equal to the cell size used, of smooth boundaries and/or continuous data sets (see Figure 1). While GEOMAST is independent of cell size, applications to date have used a one km^2 grid cell. Hence, in this case, points are located no more precisely than within a single km^2, and magnitude data refers to the average or most typical of the population of a measurement variable within a km^2 and/or a map unit.

Users of this document should refer to the glossary for the precise meaning of special terms used in this report. Some terms are so important that an

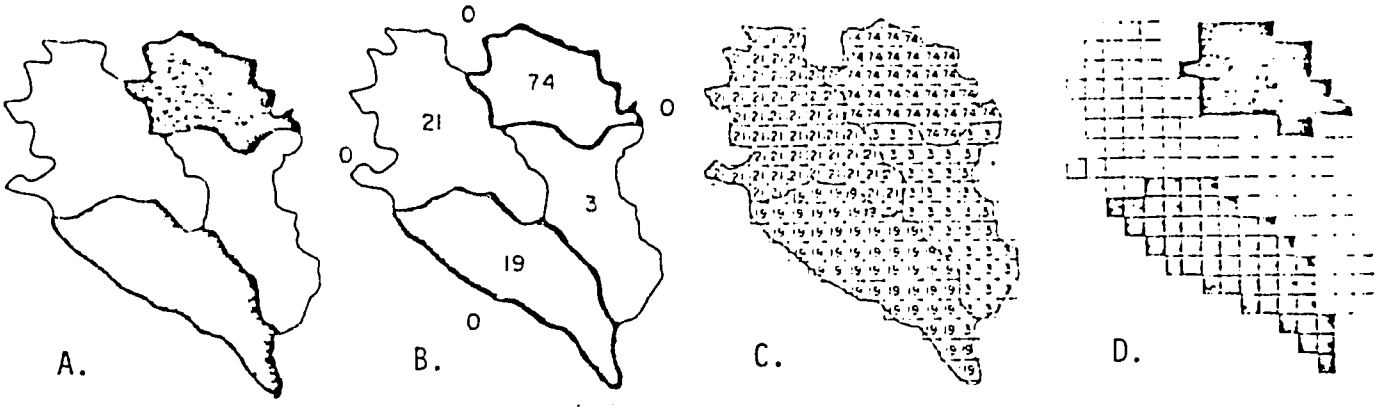


Figure 1.--Irregular shaped map units can be represented by a system of grid cells. A: Map units as they appeared on the original map. B: Each map unit is assigned a number code; areas outside the study are are assigned a zero code. C: Map units are approximated by a system of grid cells, each cell containing the code of the underlying map unit. D: Map units as they would be reconstructed by a computer.

explanation is repeated here. Since GEORAP is a geographic information system, data are derived from a particular area of the earth's surface and is called here the study area -- frequently defined in terms of administrative boundaries. Within a study area, each type (map) of information included is called a factor. Each factor may have many values and/or codes assigned which are called attributes.

Factors are usually captured in two forms -- contiguous and discontiguous. Contiguous factors refer to mapped data that share a common boundary for each map unit. The sum of contiguous factors is equal to the surface area in the study area. An identifying code is associated with every grid cell. Discontiguous data may occur only in discreet areas and/or individual grid cells. Only part of the grid cells in the study area have codes. For example, only irrigated land might be coded by map unit or weather stations might be coded by the grid cell in which they occur.

Attributes are generally of two types -- identity and magnitude. Identity attributes are merely identification codes and have no arithmetic properties; e.g., soil codes or region codes. Magnitude data sets are in the form of measurement or dimension of some variable; e.g., average rainfall or crop yields.

The GIS system is initiated by geocoding the "best", "official" base map of the area to determine single, standard dimensions for the data system. Normally, the data system is established to conform to the outside boundaries of the study area -- frequently official administrative boundaries. Usually, sub-administrative boundaries are also geocoded as part of this map factor. In any event, one map and its map factor must be chosen as the standard base to dimension the outside boundaries of the data system. As subsequent factors are geocoded, they are cartographically calibrated to the boundaries of the base map and then computer checked and adjusted to ensure identical data dimensions for every factor.

The geocoding process is initiated by over-laying maps with an acetate grid divided into regular rows and columns to form grid cells. The cell constitutes the minimum spatial area of geographic definition. Each cell has a unique address in the data system. The cells are numbered in a row and column matrix. Rows are numbered 1 to [illegible] from north to south. Columns are numbered from 1 to n from west to east. Cell ([illegible] 01) would be the first cell in the northwest corner of the data system. The data system is usually registered by UTM coordinates.

1.2 System Components

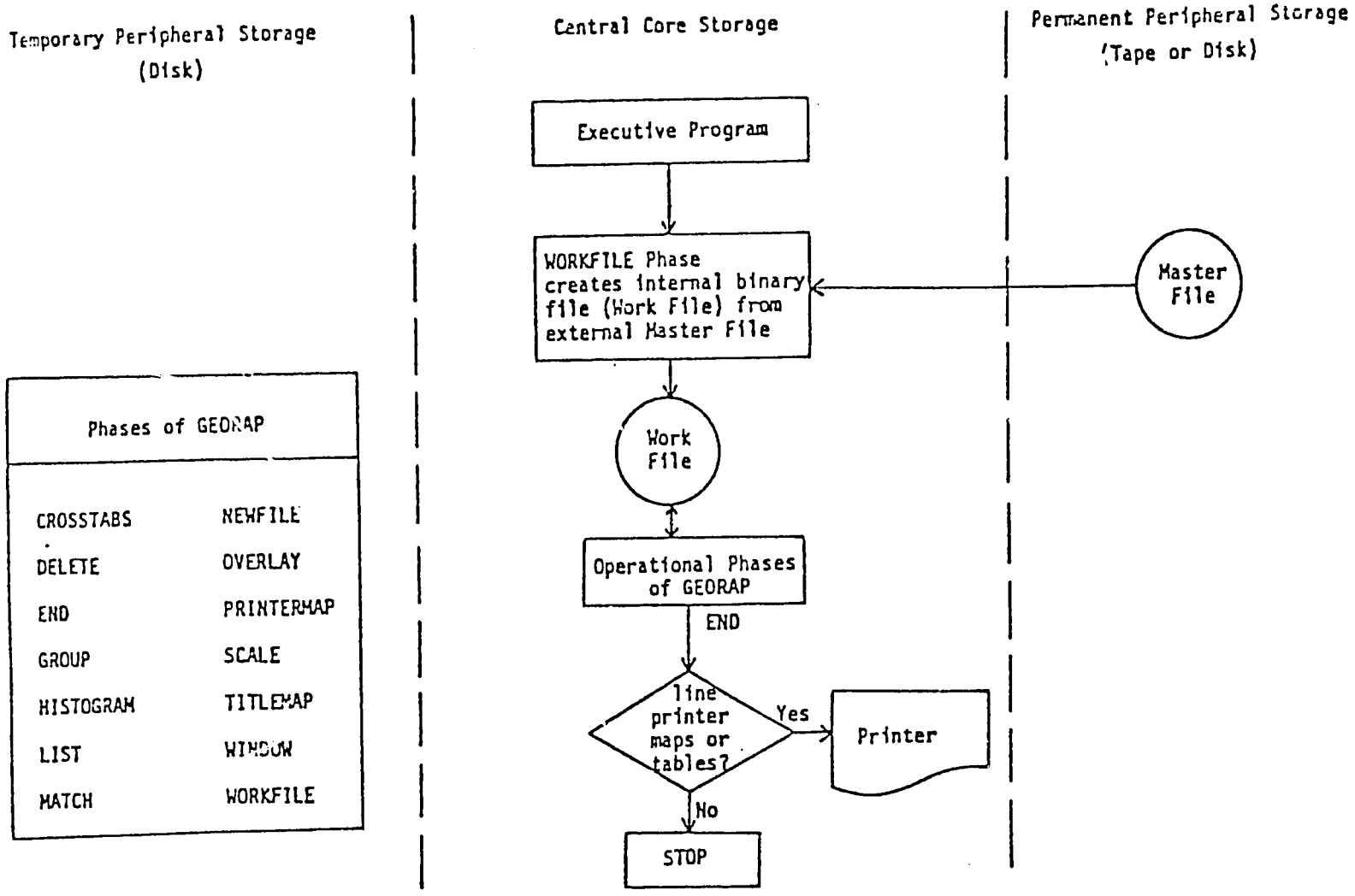
GEORAP consists of fourteen separate phases as summarized in Table 1.1. The program is modular, with each phase operating on a mutually compatible internal data file (Work File). Each phase performs a specific operation on the data, so that by linking the phases in a particular order, the user is capable of performing a variety of analyses from a limited number of computer runs. In general, there is no restriction to the sequencing of the phases other than that imposed by a few program requirements and the objectives of the computing session. A Schematic diagram of GEORAP is presented in Figure 2.

Detailed descriptions, data formats, program specifications, and operating instructions are presented in Section III for all phases. Analysts, however, should be knowledgeable of the general capability and characteristics of the system as well as general analytical strategies before diving into the program details.

Table 1.1 - Phases of GEORAP and Their Functions

Phase	Phase Name	Function
Technical		
DELETE	DLTE	Deletes a factor from the Work File.
END	END	Stops execution of GEORAP.
WORKFILE	WORK	Retrieves factors from Master File and constructs a Work File.
NEWFILE	NFYL	Writes a coded or binary copy of the Work File onto disk.
Data Restructuring		
GROUP	GRP	Factor is grouped into numeric ranges and each range is assigned an integer number (mapping directive).
MATCH	MTCH	Assigns values (mapping directives) to one, two or three combinations of factors.
WINDOW	WNDO	Develops a new Work File based on row-column or data window of previous Work File.
Data Display		
HISTOGRAM	HGRM	Constructs a histogram for a user specified factor.
LIST	LIST	Lists current attributes of Work File.
PRINTERMAP	PMAP	Constructs variable scale, single or multi-character symbol maps using line printer.
TITLEMAP	TMAP	Constructs title maps on the printer of data within the study area.
Data Analysis		
OVERLAY	OVER	Adds factors together using user specified weighting values.
SCALE	SCLE	Performs multidimensional scaling analysis on a set of weighted or unweighted factors.
CROSSTABS	XTAB	Generates 2- to 9-way cross-tabulation tables.

Figure 2. -- Schematic Diagram of GEORAP (Geographic Resource Analysis Program)



1.2.1 Technical - Input, Output and Program Communication

The technical phases of GEORAP are DELETE, END, WORKFILE and NEWFILE. These phases are fairly self-explanatory and are discussed in detail in Section Three. Basically, they provide the capability for data retreival, file editing and program control. The NEWFILE phase writes a new master file from the current workfile and is used to save data created during a GEORAP session or to create a new data set from one of the data manipulation phases. These phases are technical in nature. WORKFILE transfers user specified factors (data) from the Master File to the Work File for further manipulations.

1.2.2 Data Restructuring

The GROUP, MATCH, and WINDOW phases provide various data manipulation and reconstruction features for the analyst.

GROUP is used to group attributes of a factor automatically into six equal classes or into user specified (maximum and minimum values) groups. The new groups are assigned an integer number which can be used in other phases and as a mapping directive in a single session or used with NEWFILE to create a new factor map in the data system. GROUP enables an analyst to manipulate the level of aggregation within a factor data set. For example, administrative sub-regions can be aggregated to regions or continuous data sets such as slope percentage can be grouped into ranges.

MATCH permits the creation of a new factor and attributes based upon a specified match of attributes from one, two, or three other factors. MATCH may be used to create a map from tabular data or used to create a new factor map (derivitive map). For example, if the study area included a land use factor and a soil map factor, MATCH could be used to identify matches of appropriate and/or inappropriate combinations of soil and land use. Moreover, MATCH could be used to transfer tabular information from the Agroeconomic Information System (AIS) to GIS in the form of maps e.g., a factor map of soil map units in GEORAP could be matched to tabular storage of soil characteristics to produce maps of slope, texture, etc.

WINDOW permits the user to create a new (reduced) map from a portion of an existing factor or map. The WINDOW may be specified by geographic row-column addresses of the WINDOW borders, by data values, or by a radius from a discrete cell. For example, a WINDOW of a particular region could be created by specifying row-column coordinates of a square which included the region or by specifying the single region code.

1.2.3 Data Analysis

Data Analysis features of GEORAP are the OVERLAY, SCALE and CROSSTAB phases.

The OVERLAY phase performs an operation on a set of factors which in analogous to overlaying factor maps. OVERLAY takes two maps and delineates the land areas of commonality in an uncontrolled process. It is quite similar to the data restructuring MATCH phase, except MATCH is a controlled process based on pre-selected map unit factors. OVERLAY is particularly valuable for CRIES to create a composite soils map/climate map in the process of developing the Resource Planning Unit map.

SCALE performs multidimensional analysis on a set of weighted or unweighted factors. Multidimensional scaling consists of establishing an n-dimensional Euclidean space, where n is the number of factors in the analysis. The numerical values of attributes of each factor establishes a point for that attribute in the n-space. The Euclidean distance (ordinal or cardinal) between any point in the n-space and a pre-selected point representing an optimum or desired condition is a measure of the comparative site index (in a geographic sense) or a similarity index in an ordinal sense.

For example, suppose a user had factor maps for soils, rainfall, and urban areas and wanted a site index for the production of vegetables. Using GROUP, the rainfall and soils could be restructured into five groups where codes 1 through 4 were assigned the values of highly suitable to marginal while unsuitable was weighted with a code of 8. Similarly, distance classes of each data cell from the closest urban area would be computed for the third factor and assigned codes of 1 through 5. The optimum combination of soil, rainfall, and distance would be represented by a three-dimensional vector (1,1,1). SCALE starts with this optimum 3-dimensional point and computes a vector to any other n-dimensional point, such as, (3,1,4). The Euclidean distances are computed between soils of those point and the cell by cell results may be

displayed and/or retained. Single factors may be emphasized by weighting and socioeconomic data may be intermingled with map factors.

CROSSTABS produces frequency matrixies for up to nine factors. In addition to the frequency count of cells by factor combinations, row and column percent or totals for each cell or for th data system are given. Also, statistical information such as Chi-Square, Gamma, Sommers D, Tau A, Tau B, and Partial Gamma are printed for each table. The program may be used with GROUP to reduce continuous integer attributes to n categories or to compress row attribute data. For example, factors for administrative area, soil, and land use (in that order) could be crosstabulated to generate a count (and percent) of cells of cropland by soil within region for all regions within the data system total.

1.2.4 Data Display

The display features of GEORAP are included in the HISTOGRAM, PRINTERMAP, TITLEMAP, and LIST phases of the program.

HISTOGRAM constructs a histogram of cell count by attribute (or classes of attributes) for a factor. It is very useful as a tabular display of data on printer maps. HISTOGRAM uses either a single symbol or can be coded with the same characters (and combination of characters) used in PRINTERMAP.

PRINTERMAP is a variable scale mapping program that uses a high speed line printer as a display device. Unscaled maps print one attribute code per data cell in the data system. Since line printers print 10 characters per inch horizontally and 6 or 8 characters per inch vertically, an unscaled map will be distorted (stretched) in the north-south direction. The program prints maps in continuous vertical strips (north to south) 100 characters wide (west to east). Hence, maps of data systems more than 100 cells wide must be taped together for display purposes. Such maps, however, are extremely useful for editing and displaying row data systems. Alternatively, different scale options may be executed by specifying new map dimensions. If this is done, duplication or deletion of rows and columns of data to remove distortion is conducted so that statistically consistent distribution among the map units is maintained, although individual data cell validity is destroyed. These latter scaled maps are useful for cosmetic purposes but should be carefully labeled to avoid misrepresenting map symbols as data pertaining to individual cells.

TITLEMAP permits the user to list attributes of a factor by cell count, computed area total (cell count x actual cell area), and attribute name. The grid created on the printout allows 5 lines of 10 character wide data and descriptive names and/or terms to be printed for each cell. Detailed descriptions and data for attributes of a single factor or selected attribute codes and data for combinations of factors may be printed by TITLEMAP.

LIST produces a list of factor names and the relative position of each factor in the Work File.

1.3 Developing an Analysis Strategy

An analysis strategy is the specific linking of GEORAP phases in order to achieve some analytical goal. The user can link the various phases in any order (within the limitations and data requirements of the phase). The final product depends upon this order, as well as the criteria selected during phase execution. Thus, the analysis strategy actually consists of phase linking and phase criteria selection.

Phase linking controls the general direction of analysis. For example, if the user wishes to develop a cross-tabulation table based of soils and regions, then produce a map of grouped soils, the following phase linking could be used:

Sequence	Phase	Function
1	WORKFILE	Retrieves soil data and regional codes from the Master File. Creates the Work File.
2	CROSSTABS	Generates the cross-tabulation tables.
3	PRINTERMAP	Produces a map of the grouped soil classes.

Phase criteria for this example could be selected as:

Sequence	Phase	
1	WORKFILE	Grid size, factor names, Master File format.
2	CROSSTABS	Identify factors to be used for cross-tabulation. Establish maximum numerical range of each factor.
3	PRINTERMAP	Selection of mapping symbols to be used (use of default symbols is possible); map scale and legend writing.

A sample of a GEORAP run necessary to produce the above cross tabulation matrix and printer map is shown in Appendix I.

SECTION TWO: GENERAL OPERATING PROCEDURES

2.1 Operating Principles of GEORAP

The user must call the WORKFILE phase at the beginning of each GEORAP session. With this phase, the user instructs GEORAP to retrieve various data (factors) from the Master File by entering the object time FORTRAN format statement for the desired data. Each factor retrieved is assigned a name by the user. All subsequent reference to this factor during the GEORAP session is by this name.

Each phase of GEORAP is called by the user via a phase directive statement. The phase directive statement consists of the phase name (spelled exactly as given in Table 1 in this documentation). This phase directive statement may include up to five integer option values, depending upon the phase. The options control certain aspects of phase execution as explained in each phase description (section three).

Depending upon the phase chosen, the user may have to enter various data, instruct the program to retrieve specific factors, or to conduct other program communication. GEORAP will prompt the user when input from the user is needed.

Factors can be recombined (e.g. when using the GROUP, MATCH, etc. phases) in number of ways and are assigned a name by the user in a similar fashion as when the factors are retrieved from the Master File. In this manner, the user may develop new factors, which can then be used for input into another phase, can be used to update or restructure a new Master File. These composite factors are available for use as a mapping directive or in other geographic analysis following their creation.

GEORAP produced maps utilize the mapping directive concept. The mapping directive is an integer number ranging from 1 through the number of symbol characters available for the chosen mapping phase option. Mapping directives are data values, one for each grid cell, that are read directly from the Master File or generated through a GEORAP phase. Each factor code gets translated into a mapping directive number which has an associated symbol type depending on the options selected for the

PRINTERMAP. A mapping directive of 0 (zero) will produce a blank for that cell. The user may use default character sets or he may specify a particular set of symbols for the mapping directives.

Various phases of GEORAP can be used to develop a mapping print symbol. For instance, the GROUP phase divides the factor into numerical ranges and each range is assigned a mapping the desired print symbol. The cell is then assigned a symbol (mapping directive) depending into which range the data value occurs. The MATCH phase permits the user to assign a mapping directive to a particular three-way combination of factor values, say a certain soil and land use combination.

A new Master File can be created by the NEWFILE phase. The user may delete factors from the Master File with the DELETE phase prior to creating a new Master File. The new Master File must be allocated sufficient disk space or tape space as to contain the new Master File.

The user ends the GEORAP session by using the phase directive statement: END (no option values required). If printer maps or title maps have been created during the session, they may be intermixed with the program prompts on the same peripheral unit if assigned to general output for the program. This will not occur when the logical unit number (LUN) for MAPFIL is given a different LUN than the default LUN for the printer. The normal procedure is to assign an LUN other than the default LUN to MAPFIL.

2.2 Phase Directives and Options

Each phase of GEORAP is called by entering a phase directive statement. A phase directive statement consists of a phase name (spelled exactly as given in this documentation) and up to five integer options values. The options control various aspects of phase execution and are required when called for in the phase documentation (section three). The correct form of a phase directive statement is:

PMAP,1,1 (valid)

where the options are as described in section 3 of this documentation.

Null entries are allowed and are interpreted by the program to either a zero (for integer and real variables), blank (for alphanumeric variables), or default values (when specifically mentioned in the documentation). Null entries may be separated by commas, or the phase name may stand alone:

OVER,, (valid, options = 0)

or

OVER (valid, options = 0)

2.3 Master File and Formats

The Master File is the permanent record of map boundaries and/or points for a study area. This file is maintained external from GEORAP, usually as a system disk or tape file. Resource and/or soil boundaries and land use types, are typical of a Master File.

The data on a Master File must be grid geocoded according to one of three general formats: sequential cell records, raster scan, and compressed cell records. The data is either in coded or binary files form with unique factors occurring in the same column field of each records. The Master File may contain as the first record(s), a header.

An optional header record can be read in by WORKFILE or written out by NEWFILE. This header is actually the first record of the file and not a tape or disk label. The general form for the header when used must be as follows:

Position	Information
1-5	beginning row
6-10	ending row
11-15	beginning column
16-20	ending columns
21-25	minimum attribute value
26-30	maximum attribute value
31-35	number of unique factors on file
41-80	file description or comments

The header is not required for operation of the GEORAP program and the header, if used, is not updated when used in the NEWFILE phase. The formats of the Master File is discussed next.

Sequential Cell Records

This is the most general file format for a Master File. In this configuration, there is one record for each cell within the geographic grid matrix (Fig. 3A). Each record is required to be fixed format, so that it can be read using a standard FORTRAN format statement entered by the user in the WORKFILE phase. The row-column numbers of the cell record need not be contained on the record, but if present,

the coordinates must be the first two data items read from each record. When the row-column coordinates are not present, the format is called sequential cell with row-column suppressed format. There may be any number of factors represented on each record. The row-column numbering and file sequencing is similar to standard matrix notation, so that the first grid cell must be (001, 001) and lies in the northwest (upper left) corner of the study area.

Raster Scan

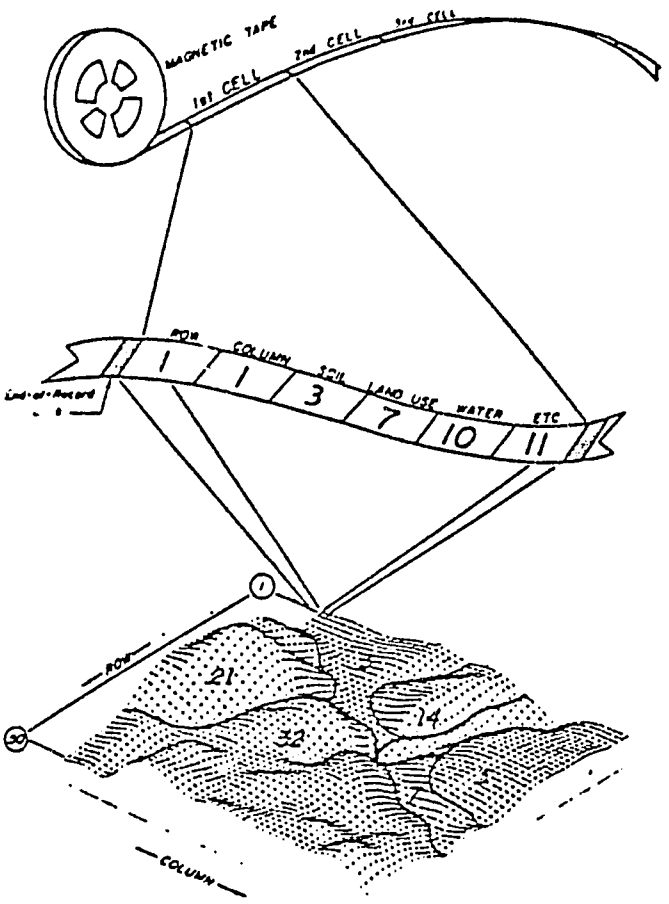
Raster scan is a file structure in which only one map factor is present. There is a number code for each cell in the file (Fig. 3B). The map data is recorded by scanning the area along each row, from west to east (left to right). Each data record contains the codes from an entire row, or part of the row, depending upon the row's length. Typical sources of raster scan output are processed LANDSAT tapes and output from some electronic digitizers. The row/column indices are implied from the file structure which expects one complete row per record and therefore are not specifed on the input records.

Compressed Cell Records

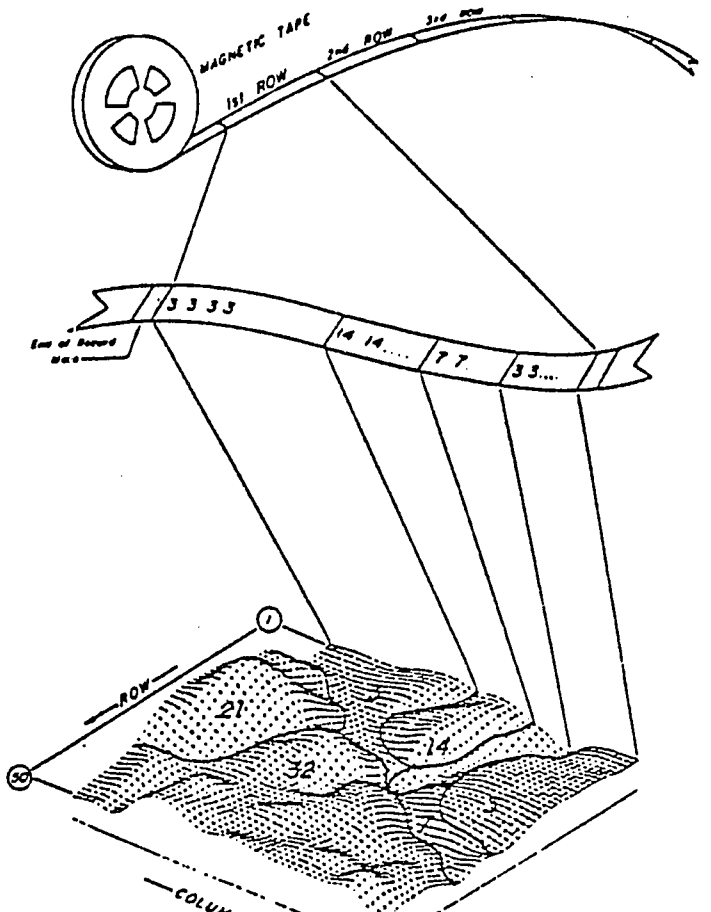
Files containing records of the row column coordinates of mapped factor boundaries (Fig. 3C) are in what is called compressed cell format. This is often preferable structure for the Master File since it saves storage. This method is sometimes referred to as the change-point technique, and can permit substantial reduction in the number of records required to digitize a map. This is also the structure of the binary Work File of GEORAP.

GEORAP requires integer data for analytical processing. Therefore, the Master File is constructed by assigning integer codes to each mapping unit prior to digitization. These same codes are then used during the program for assigning symbols to the printer maps or conducting cross-tabulation frequency counts.

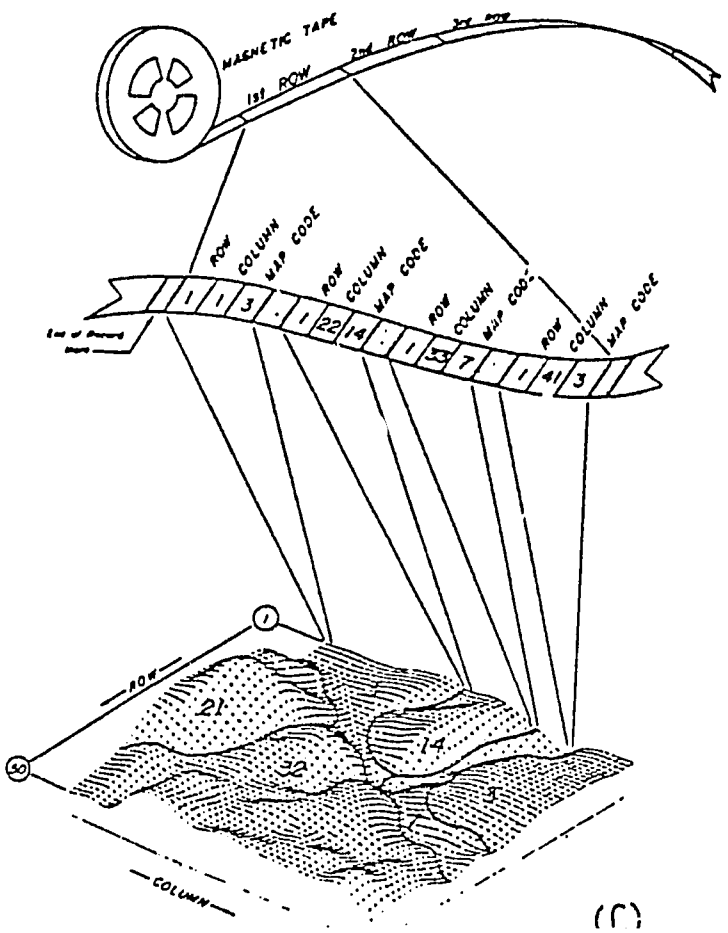
Figure 3 (A-C) — Data File Structure Used for GEORAP Master File.



(A)



(B)



(C)

A variety of data file structures may be used for the GEORAP Master File. Multiple map files can be structured with one record per grid cell (Fig. 3A). Each record contains map codes from more than one map; the row column address may or may not be included on the record. Raster scan files are normally structured with one record per row and only one map code per grid cell (Fig. 3B). The gridded data files may also be compressed where a record is entered only for those cells in which a map boundary occurs (Fig. 3C). More than one map may be included in compressed files. All data files entered into GEORAP are converted into a binary Work File in the compressed format.

2.4 Data Input

The Master File is the permanent geocoded computer file of the data for a geographical area created in GEOMAST. This file can be a coded file or binary file and is maintained external to GEORAP. Users must designate the Master File as logical unit 8,SYS005 or FT08F001, prior to execution.

Inputted real numbers (floating point) must contain a decimal point and are indicated in the prompting statement as (RE.AL). Inputted integer numbers must not contain a decimal point and are indicated in the prompting statement as (INT). Recall that the left parenthesis (and right parenthesis) are used as documentation delimiters and not part of the input stream. Therefore (RE.AL) is inputted as 5.7 for example <u>without</u> the parenthesis.

Alphanumeric data, such as factor names, yes or no responses, and phase names are indicated in the prompting statement as (NAME), (YES or NO), (DIRECTIVE), or other similar appearing statements. Most alphanumeric entries are limited to four characters or less and must begin with an alphabetic character. Numeric characters may follow the first character of an alphanumeric entry. Those entries that are used for titles and formats are inputted as (20A4) in which case the entries may exceed four characters, in fact, the (20A4) specification may contain up to 80 alphanumeric characters.

Multiple entries are allowed on one line when called for in the prompting statement, though each entry must be separated by a comma. Multiple entry prompting statements have the general form of:

(NAME, INT, RE.AL, RE.AL)

This prompting statement indicates that the user should enter a name, an integer number, and two real numbers in that order. A proper response could be:

NAME, 5,6., 1.5 (valid)

Notice that the real numbers need not contain significant digits to the right of the decimal place, i.e., 6. is the same as 6.0. Numeric characters are allowed in the alphanumeric strings, as long as the number does not occur as the first character:

FCT1 (valid)

and

1FCT (invalid--a number appears as first character)

Periods ".", commas ",", and minus signs "-" are interpreted as alphanumeric entries <u>if delimited by spaces</u>. In this form they are useful as user-specified mapping symbols. Null entries are allowed, and are interpreted as zero values (for integer and real variables) or blanks (for alphanumeric variables). In certain instances, a null entry may be set to a default value. It must be noted that if a character string is entered that is more than four characters long, only the last four characters are processed as data. Phase descriptions (section three) describe these instances when they occur.

SECTION THREE: PHASES OF GEORAP

Each phase of GEORAP is described in this section and the phases are offered in alphabetical order to expedite user referencing.

The worksheets provided after each phase description section are an abbreviated form of the prompting statements for each phase. These are provided to assist the user in planning a GEORAP session. The user can use the worksheets for both interactive and batch operations, thus developing an outline of the analysis strategy and obtaining a permanent record of the session.

The space below each prompting statement on the worksheets is used to write the required response. In most cases, this response should not exceed the number of spaces provided on the worksheet. A brief description of the option values are provided at the top of each worksheet as is the phase directive statement.

Following the worksheet in each section is an example listing of the output produced for that phase. These are provided for user reference.

3.1 CROSSTABS Phase

The CROSSTABS phase produces a cross-tabulation frequency matrices for up to nine factors read from the Work File. In addition to the frequency count, row percent and column percent are given for each matrix cell. Row totals, column totals and a grand total are given for each matrix printed. Also, statistical data is calculated and printed after each matrix, these include Chi-Square, Gamma, Sommers D, Tau A, Tau B,Partial Gamma, and units excluded from the table.

The user is first requested to enter the number of complete cross-tabulation tables to be produced during a single execution of CROSSTABS. A maximum of 10 tables per CROSSTAB phase called is allowed. The second item entered is the header that is to be printed at the top of each page, one header for each table. Each table header can be up to 80 characters long. The factors to be used in each table is entered after each factor is defined to the CROSSTABS phase.

Every factor currently defined on the Work File must be identified in the CROSSTABS phase. This identification may take one of two forms. The first entry consists of three input elements; the first is the factor name defined in the WORKFILE phase, the second describes the number of specific categories the user wishes to look at (this may be inclusive for all possible categories or groups of the possible categories), and the third specifies whether the user wishes automatic categorization ("1" entry) which includes all possible categories or specifying the minimum and maximum of the category ("0" entry). If automatic categorization was selected, the factor definition is complete. If the user specifies the categories to be selected, several more items of information must be entered. First, the user must enter the minimum, maximum, and "other" value for each category with one category description per record. After this, the user will be prompted for a title for each category which is entered in one input line, exactly eight characters per title.

After all the factor information has been entered, the number of factors per table is entered on one line (record) separated by commas. The factor names for the cross-tabulation the user desires are entered, next, separated by commas. The user must enter one line (record) per table specified in the second prompt statement. For example, if two tables were specified (a two-way and a three-way crosstabulation table), then three lines (records) are required. The first record contains 2,3 specifying that for the two tables a two-way then a three-way crosstabulation is desired. The second record contains two factor names separated by commas and the third record contains three factor names separated by commas.

CROSSTABS uses the first variable for the matrix rows (i.e., the frequency count for this variable is printed horizontally). The second variable will be used for matrix columns, and the rest as control variables. A cross-tabulation matrix will be produced for each subdivision of each control variable (if any), with statistics being printed after each.

Range information may be entered via minimum, maximum, and "other" value (i.e., the range of subdivision 1 of a factor may be 25-50 with the user also wishing to include 54. The user would enter 25 as the minimum, 50 as the maximum, and 54 as the "other" value). The user also has the option of using automatic categories. For example, if a factor were to be subdivided into three groups and automatic categories were used, the first subcategory would have a minimum, maximum, and "other" value equal to 1, the second subcategory would equal 2 and the third subcategory would equal 3.

The total number of cross-tabulation cells currently available is set at 5,000. For example, if a three-way cross-tabulation table is desired and there are 8, 10 and 15 categories respectively that are to be calculated, then there are 8x10x15 = 1,200

*Refer to CRIES Special Report "Comprehensive Resource Inventory and Evaluation System", July 1980 for definitions and an overview.

cells required. To change this limitation, check with a programmer and the GEORAP computer program documentation.

A one way crosstabulation is not allowed with version 3.1 of GEORAP and if attempted, will result in an empty table. A frequency of a factor can be obtained by crosstabulating a factor with itself.

The CROSSTABS PHASE IS PARTICULARLY USEFUL FOR CRIES activities in developing countries. For example, when a general land use map for the country has been incorporated in the Master File of GEOMAST, the CROSSTABS phase of GEORAP can be prompted to compute the surface area of each land use category. With compatible definitions, the computer area totals can be compared with the total published in census materials to do a cross-sectional check for consistency.

A second example pertinent to CRIES work is a two-way cross-tabulation between Resource Planning Units (RPU)* and administrative regions. In general administration and implementation of agricultural planning policies occurs by administrative region. Since RPUs are physiographic regions, whose boundaries seldom correspond with administrative boundaries, planners need to know the extent of RPU land areas within each administrative region. Such knowledge is instrumented to correctly assessing the productive potential of a region's agricultural lands as well as the areas within the region where cropland expansion may be possible.

MINI-TAB CROSS-TABS
TABLE [illegible] MAJOR GROUP 1 TEST OF MINI - TABS

SUB-TABLE 1 OF - TOTAL OF 1
SUB-TABLE OF THE CATEGORY. 001 VARIABLE 3

VARIABLE 2

VARIABLE 1		TOTAL	001	002	003
TOTAL	PERCENTAGE	100.0	42.5	35.2	22.5
	FREQUENCY	71.0	30.0	25.0	16.0
001	PERCENTAGE	19.7	46.7	0.0	0.0
	FREQUENCY	14.0	14.0	0.0	0.0
002	PERCENTAGE	0.0	0.0	0.0	0.0
	FREQUENCY	0.0	0.0	0.0	0.0
003	PERCENTAGE	11.3	0.0	32.0	0.0
	FREQUENCY	8.0	0.0	8.0	0.0
004	PERCENTAGE	0.0	0.0	0.0	0.0
	FREQUENCY	0.0	0.0	0.0	0.0
005	PERCENTAGE	0.0	0.0	0.0	0.0
	FREQUENCY	0.0	0.0	0.0	0.0
006	PERCENTAGE	23.9	0.0	68.0	0.0
	FREQUENCY	17.0	0.0	17.0	0.0
007	PERCENTAGE	0.0	0.0	0.0	0.0
	FREQUENCY	0.0	0.0	0.0	0.0
008	PERCENTAGE	0.0	0.0	0.0	0.0
	FREQUENCY	0.0	0.0	0.0	0.0
009	PERCENTAGE	22.5	53.3	0.0	0.0
	FREQUENCY	16.0	16.0	0.0	0.0
010	PERCENTAGE	0.0	0.0	0.0	0.0
	FREQUENCY	0.0	0.0	0.0	0.0
011	PERCENTAGE	0.0	0.0	0.0	0.0
	FREQUENCY	0.0	0.0	0.0	0.0
012	PERCENTAGE	22.5	0.0	0.0	100.0
	FREQUENCY	16.0	0.0	0.0	16.0

CHI-SQUARE 142.000 WITH 22 DEGREES OF FREEDOM
GAMMA 0.509
SOMERS D 0.509
TAU A 0.334
TAU B 0.461
PARTIAL GAMMA= 0.509
UNITS EXCLUDED FROM TABLE 10

Figure 4. -- Sample of a Cross-tabulation Table Produced by the CROSSTABS Phase.

BEST AVAILABLE DOCUMENT

CROSSTAB PHASE WORKSHEET

_____ (no options)

Minitab Phase Called

1. Enter the number of tables.

   _____

2. Enter header for each page (20A4), one header record for each table.

   _____

3. Enter information about variables (factors). The lines below are repeated for each factor that is currently on the Work File as indicated below.

   3.1. _____ (factor name, number of categories for the factor, autocategorization = YES=1 or NO=0. First factor on Work File)

   If autocategorization is chosen, YES=1, go to line 3.2.

   3.1.1. Enter ranges and "other" value: (minimum, maximum, "other" value).

   _____ (first category)

   3.1.2. Enter ranges and "other" value: (minimum, maximum, "other" value).

   _____ (second category)

   ⋮

   3.1.n. _____ (minimum, maximum, "other" value - nth category)

   3.1.n+1. Enter the category names (category 1*, category 2,..., category n).

   _____

   3.2. _____ (factor name, number of categories for the factor, autocategorization - YES=1 or NO=0. Second factor on Work File).

   If autocategorization is chosen, YES=1, go to line 3.3.

---

*Exactly eight characters are required for each category name with no commas. If more than 10 categories are required, more than one record is needed since the record that is read is 80 characters.

3.2.1. Enter ranges and "other" values: (minimum, maximum, "other" values) - (first category)

_____

3.2.2. Enter ranges and "other" values: (minimum, maximum, "other" value) (second category)

_____

⋮

3.2.m. _____ (minimum, maximum, "other" value - mth category)

3.2.m+1 Enter category names (category 1, category 2, ..., category m).

3.3.

⋮

4. Enter number (up to 9) of variables (factors) for each table specified in line 2 separated by commas.

4.1. _____ (number of variables (factors for table number 1), (factors for table number 2), ..., (factors for table n)

4.1.1. Enter variable (factor) names for table number 1.

_____ (factor 1, factor 2, ...)

4.1.2. Enter variable (factor) names for table number 2.

_____ (factor 1, factor 2,...)

⋮

5. Enter next phase directive and options (NAME,INT,INT).

```
ENTER PHASE DIRECTIVE AND OPTION (NAME, INT, INT):
XTAB
```

```
MINITAB PHASE HAS BEEN CALLED

TEST OF MINI-TABS:  FAC1 X FAC2 X FAC3
TEST OF MINI-TABS:  FAC3 X FAC1
ENTER NUMBER OF TABLES:
2

ENTER HEADER FOR EACH PAGE (20A4):

ENTER INFO ABOUT VARS
     1. NUX- FIELD WHEN READ (A8)
     2. NCODI-NO. OF CATEGORIES,2-100 (I3)
     3. MC- AUTO CATEGORIES (1  YES, 0  NO),(I1)
FAC1,5,1

VARIABLE NUMBER    1 SEQUENCE    1 SOURCE    1
     CATEGORY  1 MIN        1 MAX        1 OTHER VALUE        1 001
     CATEGORY  2 MIN        2 MAX        2 OTHER VALUE        2 002
     CATEGORY  3 MIN        3 MAX        3 OTHER VALUE        3 003
     CATEGORY  4 MIN        4 MAX        4 OTHER VALUE        4 004
     CATEGORY  5 MIN        5 MAX        5 OTHER VALUE        5 005

ENTER INFO ABOUT VARS
     1. NUX- FIELD WHEN READ (A8)
     2. NCODI-NO. OF CATEGORIES,2-100 (I3)
     3. MC- AUTO CATEGORIES (1  YES,  0  NO),(I1)
FAC2,3,1

VARIABLE NUMBER    2 SEQUENCE    2 SOURCE    2
     CATEGORY  1 MIN        1 MAX        1 OTHER VALUE        1 001
     CATEGORY  2 MIN        2 MAX        2 OTHER VALUE        2 002
     CATEGORY  3 MIN        3 MAX        3 OTHER VALUE        3 003

ENTER INFO ABOUT VARS
     1. NUX- FIELD WHEN READ (A8)
     2. NCODI-NO. OF CATEGORIES,2-100 (I3)
     3. MC- AUTO CATEGORIES (1  YES,  0  NO),(I1)
FAC3,1,1

VARIABLE NUMBER    3 SEQUENCE    3 SOURCE    3
     CATEGORY  1 MIN        1 MAX        1 OTHER VALUE        1 001

ENTER NO. OF VARIABLES PER TABLE
3,2

ENTER VARS FOR EACH TABLE
FAC1,FAC2,FAC3

TABLE 1 CONSISTS OF FAC1 by FAC2 CONTROLLED BY FAC3
ENTER VARS FOR EACH TABLE
FAC3,FAC1
```

TABLE 2 CONSISTS OF FAC3 BY FAC1 CONTROLLED BY

ELAPSED TIME FOR PHASE EXECUTION:4.07 CP SECONDS

3.2 DELETE Phase

The DELETE phase allows the user to delete a factor from the Work File. The user may instruct this phase to delete as many factors as is desired.

User Options: None

Phase Directive Statement: DLTE

DELETE PHASE WORKSHEET

(no options)

— — — — — — — — — — — — — — — — — —

Delete Phase Called

1. Enter name of factor to be deleted from the workfile (NAME).

   — — — — — — — — — — — — — —

2. Do you want to delete another factor (YES or NO)?

   — — — — —

   If yes, go to line 1. If no, go to line 3.

3. Enter next phase directive and options.

   — — — — — — — — — — — — — — — — — —

```
ENTER PHASE DIRECTIVE AND OPTIONS (NAME,INT,INT):
DLTE
```

```
DELETE  PHASE CALLED

ENTER  NAME OF FACTOR TO BE DELETED FROM THE WORK FILE (NAME)
CROP

FACTOR  CROP  WILL BE DELETED

FACTOR CROP HAS BEEN DELETED.  THERE ARE                57 RECORDS ON THE
                                                           WORKFILE

WITH   3 FACTORS/RECORD

DO YOU WANT TO DELETE ANOTHER FACTOR  (YES OR NO)?  NO

DELETE PHASE ENDS

ELAPSED TIME FOR PHASE EXECUTION:  .23 CP SECONDS
```

3.3 END Phase

The END phase initiates the normal termination of the GEORAP program. All files are closed and rewound. This phase should be the last one called in the GEORAP session.

User Options: None

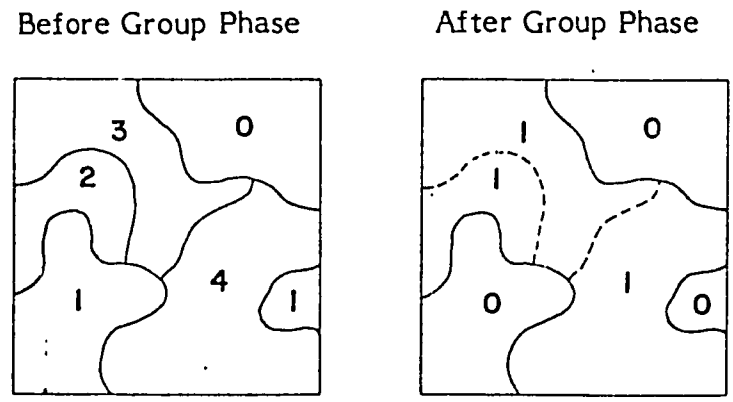
Phase Directive Statement: END

(Notice: There is no worksheet for this phase.)

3.4 GROUP Phase

The GROUP phase will automatically group the factor into numeric ranges of six equal classes (Option 1=1) or user specified grouping ranges (Option 1=2). (Fig. 5). Each group is assigned an integer number (default or user specified) which is placed on the Work File under a user specified name. The integer number can be used in other phases and as a mapping directive.

The default grouping boundaries are calculated by dividing the numerical range of the factor into six equal groups. The upper boundary of the last group is assigned an interval twice that of the other groups, in order to insure an all-inclusive grouping boundary.



Phase Parameters: Group values 2, 3, and 4
into a single group with assigned value of 1.

Figure 5. -- Sample map before and after GROUP phase.

User specified boundaries need not be inclusive of the factor range. Values encountered which do not fall within a grouping range are assigned a default value of zero (0). With Option 2=2 the user will be informed of the lowest and highest factor value before boundary values are entered. The phase will list the maximum and minimum factor value prior to the request for group ranges when Option 2=2.

Each group is assigned the grouping value (mapping directive) according to the conditional test:

Lower Boundary (i) "less than " Factor Value "less than or equal" to Upper Boundary (i) where i = 1.2,... up to the number of groups. Notice that this test requires that the lower boundary for the first group be less than the lowest factor value.

At present, the maximum number of groups that can be formed is 100. If this value needs to be modified, the following must be changed in subroutine PH3:

on common block G1	change ....UPPER(100), LOWER(100), IGRP(100).... to ....UPPER(xxx), LOWER(xxx), IGRP(xxx)....
and the do loop	change ....DO 10 I=1,100 to DO 10 I=1,xxx

User Options:

Option 1 (Grouping Interval Option)

1 = Factors are grouped into six equal interval categories. Lowest group is assigned a value of 1, the next group is 2, etc.

2 = User specified grouping intervals and assigned values for each group (maximum = 30)

Option 2

1 = Do not list maximum and minimum factor values.

2 = List maximum and minimum factor values.

Phase Directive Statement: GRP,(1 or 2),(1 or 2)

The GROUP phase of GEORAP enables the analyst to manipulate the level of aggreation of mapped data in the Master File. If, for example, the administrative boundaries for the country are stored at the parcel level, the GROUP phase can be prompted to assign parcels to subregions, subregions to regions and all regions to the country.

Suitability indices could also be created using the GROUP phase. If a Master File contains a soils map with Soils Taxonomy classifications, grouping of soils by certain characteristics which represent suitability can occur. In this manner the analyst may explore land areas for expansion of particular crops or crop groups according to soils properties.

GROUP PHASE WORKSHEET

Option 1 = 1 Grouped into 6 equal ranges
2 User specified (MAX = 100)

Option 2 = 1 Max/min values not listed
2 Max/min values listed

_____

Group Phase Called

1. What is the name of the factor on the Work File to be grouped (NAME).

   _____

   If option 1 is equal to 1 go to step 3.

2. Lower boundary, upper boundary, and assigned value will be required for groups (INT, INT, INT) OR (END).

2.1	_____	2.6	_____
2.2	_____	2.7	_____
2.3	_____	2.8	_____
2.4	_____	2.9	_____
2.5	_____	2.10	_____
		⋮	
		2.100	_____

3. What name do you want to call the grouping values (NAME).

   _____

4. Enter next phase directive and options.

   _____

ENTER PHASE DIRECTIVE AND OPTIONS (NAME,INT,INT) :
GRP,2,2

GROUP PHASE CALLED

WHAT IS THE NAME OF THE FACTOR ON THE WORKFILE TO BE GROUPED (NAME)?
STYP

LOWER BOUNDARY, UPPER BOUNDARY, AND ASSIGNED VALUE WILL BE REQUIRED FOR 4 GROUPS (INT,INT,INT) OR (END) :

GROUP 1 ?-1,0,0
GROUP 2 ?0,12,1
GROUP 3 ?12,23,2
GROUP 4 ?23,35,3
GROUP 5 ?35,42,4
GROUP 6 ?42,55,5
GROUP 7 ?55,60,6
GROUP 8 ?END

GROUPING PARAMETERS:

NUMBER OF GROUPS: 7

LOWER BOUNDARY	UPPER BOUNDARY	ASSIGNED VALUE
-1	0	0
0	12	1
12	23	2
23	35	3
35	42	4
42	55	5
55	60	6

GROUPING COMPLETED

WHAT NAME DO YOU WANT TO CALL THE GROUPING VALUES (NAME)?
GRPS

FACTOR HAS BEEN ADDED TO THE WORKFILE UNDER THE NAME OF: GRPS
THERE ARE NOW 6 FACTORS ON THE WORKFILE

GROUP PHASE COMPLETED

ELAPSED TIME FOR PHASE EXECUTION: .94 CP SECONDS

3.5 HISTOGRAM Phase

The HISTOGRAM phase will construct a histogram for a user specified factor (Fig. 6). The histogram symbols can either be a default set or a user-defined symbol set. The histogram class intervals are specified by the user, with the zero value class either being displayed by itself, included in the first class interval, or not tabulated at all. The number or observations for each class is printed at the right-hand side of the histogram, and the total number of observations is printed at the bottom of the tally column. Users may include a legend.

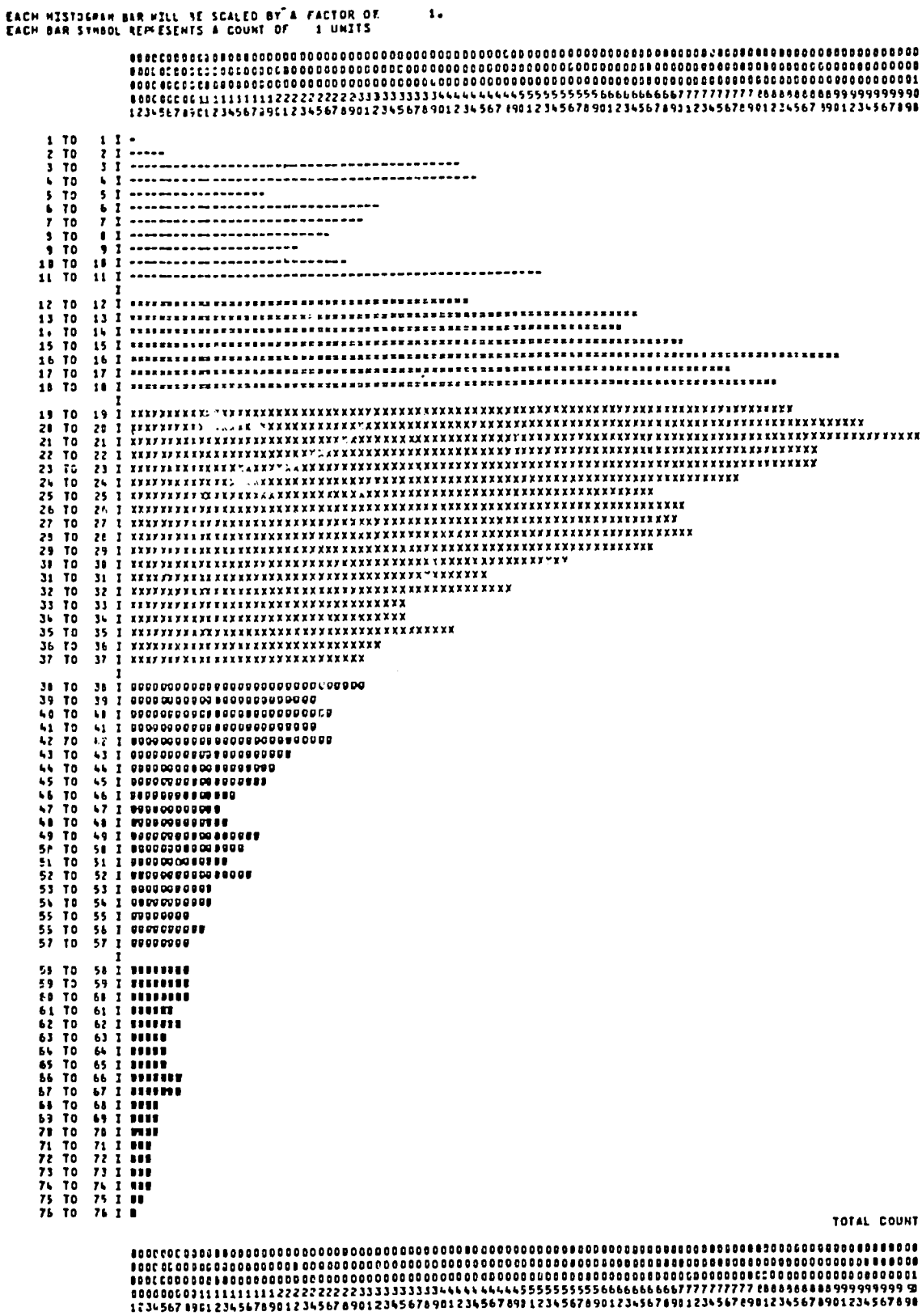
The user has three choices of tabulating zero factor values. With Option 1=1, the zero factor values are not tabulated. The zero factor values are tabulated in a separate class when Option 2=2. Alternatively, the zero factor values are included in the first class interval when Option 2=3. The user specifies the histogram class interval. The interval may be chosen so that up to 200 histogram classes are produced. Any factor value greater than the minimum value in the highest class is counted in the last class interval.

The default, single character histogram symbol is an "X". The user may also select a default multi-character symbol set that graphs each histogram bar with overprint characters (Option 2=2). The symbols in the overprint set are the same as those used in the PRINTERMAP phase (Table 4-2). Therefore, the histogram bars can be displayed with the same symbol as used in a printer map of the data. Finally, the user may specify the overprint symbols (Option 2=3). Up to 12 symbol sets, of up to three characters each, may be defined in this manner.

Multi-character histogram bar symbols (Option 2=2 or 3) must be assigned to specific factor ranges. The user specifies this range by entering the maximum factor value for the symbol range and either the default symbol directive number (Option 2=2) from Table 4-2, or up to three alphanumeric characters (Option 2=3). The range should be chosen so that it is an even multiple of the histogram class interval.

The HISTOGRAM phase of GEORAP is fairly self-explanatory. Basically the phase offers the analyst a means to visually display a two-way or two-factor cross-tabulations of mapped data. For example, if the analyst wants to display the area land considered suitable for citrus production by administrative region, a histogram can be produced with administrative regions designated along the horizontal axis and land area suitable for citrus production along the vertical axis. A second type of histogram could be presented which would show distributions suit as the area of regions by slope range or by rainfall range.

Figure 6. -- Sample bar graph produced by HISTOGRAM phase.



User Options:

Option 1 (Zero Tabulation Option)

1 = Do not tabulate zero factor values (default)

2 = Tabulate zero factor values in a separate histogram class

3 = Tabulate zero factor values in the first histogram class

Option 2 (Histogram Symbol Option)

1 = Default single, character symbol (=) default

2 = Default multi-character symbol (maximum of twelve groups)

3 = User-specified symbols (maximum of twelve symbols, three character each)

Option 3 (Lines Per Inch)

0 = 8 lines/inch (default)

1 = 6 lines/inch

Phase Directive Statement: HGRM, (1, 2 or 3), (1,2 or 3), (0 or 1)

HISTOGRAM PHASE WORKSHEET

Option 1 = 1 Do not tabulate zeros
2 Tabulate zeros separately
3 Tabulate zeros in 1st class

Option 2 = 1 Default single character symbol
2 Default overprint symbols
3 User specified symbols

Option 3 = 0 8 lines/inch printer
1 6 lines/inch printer

_____

HISTOGRAM phase called

1. Enter name of factor to be used for histogram (NAME).

   _____

2. Enter maximum factor value (INT). If unknown, enter zero (0).

   _____

3. Enter histogram class interval (INT).

   ___

4. If Option 2=1, go to line 5. Otherwise, go to line 4.1.

   4.1 Enter number of symbols groups (maximum = 12) for histogram (INT).

   ___

   4.2 In order of increasing class boundaries, enter uppr class boundary and symbol(5) for histogram groups (INT,INT) (if OPT 2=2) or (INT,CHAR1,CHAR2,CHAR3) (if OPT 2=3).

   4.2.1 _____

   4.2.2 _____

   4.2.3 _____

   4.2.4 _____

   4.2.5 _____

   4.2.6 _____

   ⋮

HISTOGRAM Phase (cont'd.)

5. Do you want to write a legend (YES or NO) If no, go to line 6.

___

5.1 Enter legend line or end (20A4) or END).

5.1.1 _____

5.1.2 _____

5.1.3 _____

⋮

6. Enter next phase directive and options (NAME,INT,INT).

_____ _____

```
ENTER PHASE DIRECTIVE AND OPTIONS  (NAME,INT,INT) :
HGRM ,2,1,0
```

```
HISTOGRAM PHASE CALLED

ENTER NAME OF FACTOR TO BE USED FOR HISTOGRAM (NAME):
LUSE

ENTER MAXIMUM FACTOR VALUE (INT) IF UNKNOWN, ENTER ZERO (0): 21

ENTER HISTOGRAM CLASS INTERVAL (INT) 1
LUSE FACTOR WILL BE USED TO CONSTRUCT A HISTOGRAM OF 21 CLASSES
WITH A CLASS INTERVAL OF 1
     OPTION 1=2 AND OPTION 2=1
HISTOGRAM WILL BE PRINTED AT 8 LINES PER INCH

EACH HISTOGRAM BAR WILL BE SCALED BY A FACTOR OF .50
EACH BAR SYMBOL REPRESENTS A COUNT OF 2 UNITS

DO YOU WANT TO WRITE A LEGEND (YES OR NO)?   YES

ENTER LEGEND LINE OR END (20A4 OR END)

LINE 1: SAMPLE BAR GRAPH PRODUCED BY HISTOGRAM PHASE
LINE 2: LANDUSE FOR BELLEVUE TOWNSHIP
LINE 3: END

     2 LEGEND LINES WRITTEN ON MAP

HISTOGRAM PHASE COMPLETED

ELAPSED TIME FOR PHASE EXECUTION:          .44 CP SECONDS
```

3.6 LIST Phase

The LIST phase will produce a list of the factor names and the relative position of each factor on the Work File. The contents of the Work File are not altered.

User Options:

Option 1 (Record Listing Option)

n = Number of records of Work File list

Phase Directive Statement: LIST, (n) (where n = number of records listed)

(Notice: There is no worksheet for this phase.)

```
ENTER PHASE DIRECTIVE AND OPTIONS (NAME,INT,INT) :
LIST,10
```

```
LIST PHASE CALLED

THERE ARE 57 RECORDS ON THE WORK FILE

THERE ARE 3 FACTORS/RECORD ON THE WORK FILE

POSITION     NAME

  1          LUSE
  2          SOIL
  3          SLPE

THE FIRST 10 RECORDS OF THE WORKFILE LOOK LIKE THIS:

1  1  3  10  2
1  2  3  11  1
1  4  3  10  2
1  5  1  10  2
1  6  1  16  2
1  7  1  44  1
1  8  1  10  3
2  1  3  12  1
2  2  3  10  2
2  3  3  11  1

THERE ARE CURRENTLY 13 VALID PHASE NAMES FOR GEORAP

WORK, LIST, GRP, MTCH, WNDO,
XTAB, DLTE, NFYL, PMAP, OVER,
SCLE, TMAP, HGRM,

LIST PHASE COMPLETED

ELAPSED TIME FOR PHASE EXECUTION:          .04 CP SECONDS
```

3.7 MATCH Phase

The MATCH phase permits the assignment of a new factor value (mapping directive) based on the match of one, two, or three factors read from the Work File. The number of match factors to be used in the MATCH phase is controlled with Option 1. A one-factor match (Option 1=1) is a simple table look-up procedure which is used to change one factor value to another. A two-factor match (Option 1=2) or three-factor match (Option 1=3) is a multiple-key sorting routine used to identify the co-occurrence of a specific combination of factor values.

The user enters the numeric value (matching key) for each factor, or factors, to be used in the MATCH phase. For each match key set, an assigned value is also entered. This value is returned to the Work File if the match occurs on the Work File record. If no match is found, then the user-specified default value is returned (Fig. 7). The assigned values are placed on the Work file under a user-specified name. The program can accommodate up to 60 match keys. If more than 60 match keys are required, the following in the original FORTRAN deck must be changed in subroutine PH4:

dimension statement	change ....K1(60) K2(60), K3(60), ASSIGN(60)....
	....K1(xxx), K2(xxx), K3(xxx), ASSIGN(xxx)....
do loop	change ....DO 20 I=1,60 to DO 20 I=1,xxx

The assigned value can be either an integer number or an alphanumeric variable. Integer assigned values are specified with Option 2=0; this is the default option value. Alphanumeric assigned values are specified with Option 2=1. Alphanumeric values are used to assign descriptive titles, such as qualitative ratings, legend names, or mapping symbols.

User Options:

Option 1 (Key Number Option)

1 = One factor to be used for match

2 = Two factors to be used for match

3 = Three factors to be used for match

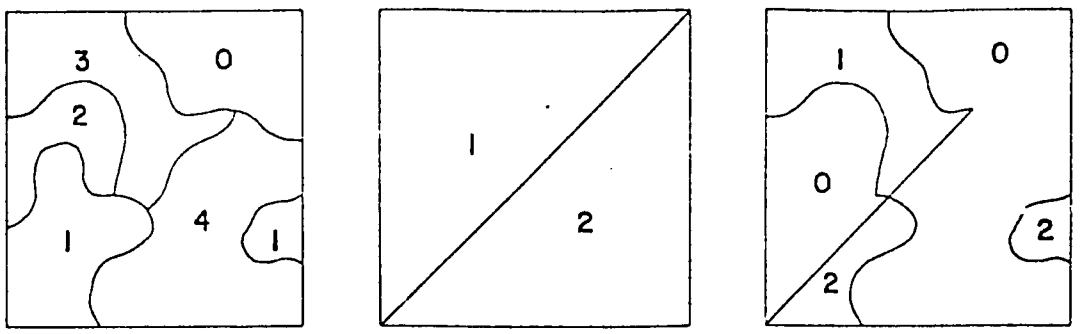
Option 2 (Assigned Value Type Option)

0 = Integer assigned value (default option value)

1 = Alphanumeric assigned value

Phase Directive Statement: MTCH, (1, 2 or 3), (1,2 or 3), (0 or 1)

Map 1 Before Phase | Map 2 Before Phase | After Phase



Phase Parameters: 2-way sort with match 3,1 assigned a value of 1, match 1,2 assigned a value of 2, and default value of 0.

Figure 7.--Sample maps before and after MATCH phase.

The MATCH phase of GEORAP provides the analyst with two capabilities, the capability to introduce new information into the existing Master File and the capability to create new maps (derivative maps). The first capability opens the Gegraphic Information System (GIS) for linkage routines with the Agroeconomic Information System (AIS) and the Plant Adaptability Information System (PAIS). New data which is significant relative to the mapped delineations expressed in the Master File may be introduced and used in conjunction with the remaining phases of GEORAP.

The second capability allows the analyst the lattitude to create new maps. The new, created maps are called derivative maps, and control an overlaying process. In a manner similar to the existing methodology employed by CRIES to delineate RPU's, MATCH can prescribe matching soil A with climate B to generate a third composite map.

MATCH PHASE WORKSHEET

Option 1 = 1 One factor match
2 Two factor match
3 Three factor match

Option 2 = 0 Integer assigned value
1 Alphanumeric assigned value

— — — — — — — — — — — — — — — — — — —

MATCH Phase Called

1. Enter name of factor to be the first sort key (NAME).

— — — — — — — — — — — —

If Option 1=1, go to line 4. Otherwise, go to line 2.

2. Enter name of factor to be the second sort key (NAME).

— — — — — — — — — — — —

If Option 1=2, go to line 4. Otherwise, go to line 3.

3. Enter number of factor to be the third sort key (NAME).

— — — — — — — — — — — —

4. Value of sort key(s), and assigned value for each match combination is required (INT,INT or NAME) for Option 1=1; (INT,INT,INT or NAME) for Option 1=2; (INT,INT,INT,INT, or NAME) for Option 1=3 or (END).

— —

5. Default value is assigned if no match is found. Enter default assigned value (INT) FOR Option 2=1; (NAME) for Option 2=2.

— — — — — — — — — — — —

6. The workfile has been sorted. What name on the workfile do you want to call its assigned values (NAME).

— — — — — — — — — — — —

7. Enter next phase directive and options (NAME,INT,INT).

— — — — — — — — — — — — — — — — — —

ENTER PHASE DIRECTIVE AND OPTIONS (NAME,INT,INT) :
MTCH,2,0

MATCH PHASE CALLED

ENTER NAME OF FACTOR T BE THE FIRST MATCH KEY (NAME): SOIL

ENTER NAME OF FACTOR TO BE THE SECOND MATCH KEY (NAME): LUSE

VALUE OF FIRST MATCH KEY, VALUE OF SECOND MATCH KEY AND ASSIGNED VALUE FOR EACH LOOP WILL BE REQUIRED. ENTER (INT,INT,INT OR NAME) OR (END)

MATCH 1 ?
10,9,1
MATCH 2 ?
11,9,2
MATCH 3 ?
10,10,3
MATCH 4 ?
11,10,4
MATCH 5 ?
0,14,0
MATCH 6 ?
END

DEFAULT VALUE IS ASSIGNED IF NO MATCH IS FOUND.
ENTER DEFAULT ASSIGNED VALUE (INT): 0

PARAMETERS USED FOR THIS MATCH

NUMBER OF MATCHING LOOPS: 5

MATCHING KEYS AND ASSIGNED VALUES.

KEY 1	KEY 2	VALUE
10	9	1
11	9	2
10	10	3
11	14	4
0	14	0

DEFAULT ASSIGNED VALUE: 0

THE WORKFILE HAS BEEN MATCHED.
WHAT NAME ON THE WORKFILE DO YOU WANT TO CALL THE ASSIGNED VALUES (NAME): SLND

FACTOR HAS BEEN ADDED TO THE WORKFILE UNDER THE NAME OF SLND
THERE ARE NOW 11 FACTORS ON THE WORKFILE

MATCH PHASE COMPLETED

ELAPSED TIME FOR PHASE EXECUTION: .93 CP SECONDS

3.8 NEWFILE PHASE

The NEWFILE phase will copy the contents of the Work File onto logical unit 14 (SYS011) under a user-specified record format. This phase is used to create a new Master File, which either has been changed from the original Master File through some type of GEORAP processing.

The new file structure may be sequential cell format (Option 1=1) with row and column indices or without row column indices (Option 1=2). Raster scan formats (Option 1=3) imply that the file will contain only one data element (the indicated factor on the Master File); no row and column indices occur on raster scan files. Compressed cell format (Option 1=4) is the internal file structure (on the Work File).

If Option 2=2 then the new file will be written in binary. Otherwise, if Option 2=1, the user is asked to supply an execution time FORTRAN format statement for writing the coded records. This format must provide for row and column numbers, except when Option 1=2 or Option 1=3 (raster scan). The format must also provide fields for all data currently on the Work File, except for raster scan formats which only use the indicated data element.

Option 3 controls the number of header records written on the new Master File. If a non-zero value is provided for Option 3 then the user is asked to supply that number of data entry records. Each header record (if requested) is written on the file as hollerith strings. The default value for this option is 0 (no header records).

User Options:

Option 1 (File Structure Format)

1 = Sequential cell records

2 = Sequential cell records, without row-column indices

3 = Raster scan format

4 = Compressed cell records (default)

Option 2 (File Type Option)

1 = Coded file (default)

2 = Binary file

Option 3 (Header Record Option)

0 = No header record (default)

n 0 = Number of header records

Phase Directive Statement: NFYL,(1, 2, 3 or 4), (1 or 2), (0,n, or blank)

NEWFILE PHASE WORKSHEET

Option 1 =
1 Row-columan indexed sequential cell format
2 Non-indexed sequential cell format
3 Raster scan format
4 Compressed format (default)

Option 2 =
0 Coded file (default)
2 Binary file

Option 3 =
0 No header records (default)
n>0 header records

_____

NEWFILE Phase Called

1. If Option 3 is not equal to 0, enter header record (20A4).

   1.1 _____

   1.2 _____

   1.3 _____

   1.4 _____

   1.5 _____

2. If Option 2=2, go to line 3.

   Enter the new file format (20A4).

   _____

3. If Option 1 is not equal to 3 go to line 4.

   Enter name of factor to be written on the new raster scan file (NAME).

   _____

4. Enter next phase directive and options (NAME,INT,INT).

   _____

```
ENTER PHASE DIRECTIVE AND OPTIONS (NAME,INT,INT) :
NFYL,1,1,1
```

```
NEWFILE CALLED

ENTER HEADER RECORD 1 (20A4)
BELLEVUE TOWNSHIP - SECTIONS 8, 9, 17, 16

ENTER FORMAT FOR NEWFILE (20A4). THIS FORMAT MUST PROVIDE FOR ROW-
COLUMN INDICES (IF ANY) AND 5 FACTORS
(212,1X,A4,13,216,1X,A4)

A NEW FILE WILL BE WRITTEN ON TAPE 3 USING OPTION 1=1 AND OPTION 2=1
FORMAT:  (212,1X,A4,I3,2I6,1X,A4)

     2305 RECORDS WRITTEN ON LUN 14

END NEW FILE PHASE

ELAPSED TIME FOR PHASE EXECUTION:          6.33 CP SECONDS
```

3.9 OVERLAY Phase

The OVERLAY phase performs an operation on a set of factors which is analogous to overlaying factor maps. The factor values for each cell will be combined together (the result of which is an integer) using user-specified weighting values. The factors may be normalized before summation in order to eliminate unwanted weighting. This implies that ordinal ranking can be made of the result. The summation value is added to the Work File under a user-specified name.

If the OVERLAY technique with option 3=1 is used, factors are added. Thus, the factors used in this analysis should be "interval" or "ratio" scale. Option 3=1 is a computerized version of superimposing mapped boundaries on each to obtain a composite mapped boundary. This process can be performed correctly on nominal data.

If the factors are normalized (Option 1=1 or 2), both the factors and the summation value will be normalized to the same upper normalization limit. Up to thirty map factors may be used in the OVERLAY analysis.

User Options:

Option 1 (Normalization Option)

1 = Factors normalized to a maximum value of 100 (default).

2 = Factors normalized to a user-specified maximum.

3 = Factors are not normalized.

Option 2 (Weighting Value Option)

1 = Factor weighting values equal 1 (one) (default).

2 = Factor weighting values are user-specified.

Option 3 (Non-communitative or Analytical)

1 = Analytical

2 = Non-communitative (default)

Phase Directive Statement: OVER,(1, 2 or 3), (1 or 2)

The OVERLAY phase of GEORAP is similar to MATCH phase except that it is essentially an automatic process. OVERLAY takes two maps and delineates land areas of commonality whereas MATCH selectively designates the areas of commonality on the basis of pre-selected map unit factors. If land use is classified by 5 mutually exclusive categories (1 = irrigated cropland, 2 = nonirrigated cropland, 3 = range, 4 = forest, 5 = other) and soils are indexed by erosiveness (1 = stable, 2 = moderately stable, 3 = highly unstable), OVERLAY can assign to each grid cell a new code. Then, for example, each time forest land on moderately stable soils is encountered, OVERLAY can assign a new code, say 6, to those cells and delineate land areas where 6 is the common code and map then using PRINTERMAP phase or compute area statistics using CROSSTABS phase or exercise other phase options.

OVERLAY phase is particularly valuable to create composite map units in the process of developing the crop/climate zone maps. It is also useful to display current land use/land cover by administrative region.

Reference: Tilmann, S.E., 1976. "Principles of derivative mapping". MSU Remote Sensing Project, Technical Paper 76-1.

OVERLAY PHASE WORKSHEET

Option 1 = 1 Normalize data to maximum of 100 (default)
2 Normalize data to user
3 Do not normalize data

Option 2 = 1 Weighting values = 1 (default)
2 User specified weighting values

Option 3 = 1 Analytical
2 Non-communitative (default)

— — — — — — — — — — — —

OVER Phase Called

1. How many factors do you want to use (INT).

— —

2. What is the name of the factors (NAME).

2.1 — — — — — — — — — — —

2.2 — — — — — — — — — — —

2.3 — — — — — — — — — — —

2.4 — — — — — — — — — — —

2.5 — — — — — — — — — — —

⋮

3. If Option 1=2,

3.1 Enter upper normalization limit (INT) for all factors being overlayed.

— — —

4. If Option 2=2,

4.1 Enter weighting value for factors (RE.AL) (Note: Enter in same order as in in line 2).

4.1.1 — — —

4.1.2 — — —

4.1.3 — — —

4.1.4 — — —

4.1.5 — — —

⋮

OVERLAY PHASE (cont'd.)

5. If Option 1=2,

   5.1 Enter upper normalization limit (INT) for the overlay (summation) factor.

   ___

6. Enter name for summation value (NAME).

   _____

7. Enter next phase directive and options (NAME,INT,INT).

   _____

```
ENTER PHASE DIRECTIVE AND OPTIONS (NAME,INT,INT) :
OVER,1,2
```

```
OVERLAY PHASE CALLED

HOW MANY FACTORS DO YOU WANT TO USE?        (INT) 3

WHAT IS THE NAME OF FACTOR 1:               (NAME) CRLD

WHAT IS THE NAME OF FACTOR 2:               (NAME) SOIL

WHAT IS THE NAME OF FACTOR 3:               (NAME) ERO

RETRIEVING FACTOR,    1 (CRLD)

RETRIEVING FACTOR,    2 (SOIL)

RETRIEVING FACTOR,    3 (ERO)

FACTORS HAVE BEEN RETRIEVED AND PLACED ON PHASFYL.

LARGEST AND SMALLEST DATA VALUES

FACTOR 1                    LARGEST =   5                    SMALLEST = 1

FACTOR 2                    LARGEST =   6                    SMALLEST = 2

FACTOR 3                    LARGEST = 234                    SMALLEST = 0

NORMALIZATION BETWEEN 0 AND 100 IS COMPLETED

ENTER WEIGHTING VALUE FOR FACTOR CRLD (RE.AL) 1.

ENTER WEIGHTING VALUE FOR FACTOR SOIL (RE.AL) 0.5

ENTER WEIGHTING VALUE FOR FACTOR ERO (RE.AL) 2.0

PARAMETERS USED FOR OVERLAY ANALYSIS:

        FACTOR   WEIGHT
        CRLD       1.0

        SOIL        .5

        ERO        2.0

LARGEST AND SMALLEST DATA VALUES

FACTOR 1   LARGEST = 279    SMALLEST =  7

NORMALIZATION BETWEEN 0 AND 100 IS COMPLETED
```

OVERLAY PHASE DIRECTIVE AND OPTIONS (cont'd.)

```
ENTER NAME FOR SUMMATION VALUE (NAME):    OVLY

SUMMATION VALUE HAS BEEN ADDED TO WORK FILE UNDER THE NAME OF:  OVLY

THERE ARE NOW 9 FACTORS IN THE WORKFILE

OVERLAY PHASE COMPLETED.  ELAPSED TIME FOR PHASE EXECUTION 3.82 CP
SECONDS
```

3.10 PRINTERMAP Phase

The PRINTERMAP phase will produce a spatial display line printer map with a wide range of symbol characters and mapping formats. The user may select between single character symbols or multi-character overprint symbols. The maps may be unscaled, with one symbol per grid cell, or the maps may be scaled to a user-specified map dimension. Discrete, non-contiguous map data may be displayed against a background depicting the boundaries of the study area. The maps are scaled at six lines per inch by default.

Through Option 1, the user may select one of two standard character sets for the mapping directives. The single character symbols used if OPT1=1 are derived by taking the lower six bits of the mapping directive in binary form to reference the code-character table in Table 3.1. For example:

If the mapping directive is 985, the following process is used -

985 decimal -- 1111011001 binary -- 011001 are the lower six bits -- which is 25 decimal

A directive of 25, according to the table, prints the letter "Y".

If the mapping directive never exceeds 62, then the mapping directives can be used to directly reference Table 3.1. The characters used for the printermap from the factor codes is reproduced at the end of any printermap produced using OPTI=1.

With Option 1=2, the user may select up to 12 multi-character overprint symbols, with each symbol being assigned to the mapping directive given in Table 3.2. Alternatively, the user may construct his own multi-character symbol set (maximum of 25 symbols) with Option 1=3. In either case, mapping directives which equal zero (0) or exceed the number of maximum symbols will be mapped to a blank.

Through Option 2, the user may select the scaling for the map. With Option 2=0, the map will be unscaled, with one symbol per grid cell. Because of the inherent distortion in the size of the line printer characters, (10 characters/inch horizontally, 6

or 8 characters/inch vertically) an unscaled map will be stretched in the north-south direction. Unscaled maps are useful for preliminary and intermediate viewing of data and analytical results.

The maps may be scaled to a user-specified value with Option 2=2. With this option value, the user is asked to enter the map dimension (in centimeters) in the east-west direction. This value establishes the cell size, which in turn is used to determine the map dimension in the north-south direction. The east-west dimension is also used to establish a sampling interval by which rows and columns are added and/or deleted in order to print a map of the proper size. Spatial fidelity of the map is not changed by the scaling (sampling) procedure. Note that if the scale size in the east-west direction is less than or equal to 1 cm. then an error message is written and the program is halted.

The area equivalent of each mapping symbol may be determined by calculating the east-west and north-south dimension represented by each symbol. These dimensions may be calculated given the size of the geographic grid and the number of symbols on each side of the map. The east-west representative cell size is determined as:

$$\text{East-West cell size} = \frac{\text{Grid Size in East-West}}{\text{Number of cells on map in east-west}}$$

and the north-south dimension is determined as:

$$\text{North-South cell size} = \frac{\text{Grid Size in North-South}}{\text{Number of cells on map in north-south}}$$

The area represented by each cell is simply:

Area of cell = East-West cell size * North-South cell size

Spatial display of discrete, non-contiguous factors may be facilitated by using a background to outline the study area. Such backgrounds help to highlight the mapping feature of interest and also help to orient the observer toward the spatial relationship of the feature (see Figure 8 for an example of a map using a background). With Option 4=1 users enter the name of the background factor on the Work File. Every cell in which the background value is non-zero is assigned a display character that is a period (".). Zero valued background cells are left blank. Then the principle mapping factor is, in effect, overlayed upon the background. Areas which contain a non-zero value are displayed according to the character set selected in Option 1. Zero values allow the background symbol to be displayed. The default value for option 4 is 0; i.e., no background will be used.

In certain cases when the user is making a map with single character symbols (Option 1=1), it is desirable to highlight the borders of the map units. To accomplish this, the user may invoke Option 5, which causes single character symbols to be overprinted three times whenever a mapping line changes symbol type (also at the beginning and ending of the symbols in the line). With Option 5=0, no border highlighting will occur; with Option 5=1, the borders will be highlighted. Note: Option 5 can only be used when Option 1=1 (single character symbols); other values for Option 1 will be rejected.

Finally, the user is asked if a map legend is desired. If so, then the user may enter as many legend lines as are desired, each line being up to 80 characters in length. The end of the legend is signalled by entering the word END, beginning in column 1 of the line. The legend is printed after the last map strip.

The map and legend are printed directly to the line printer, logical unit 13 (SYS010 in DOS), and therefore logical unit 13 must be assigned to the line printer.

Table 3.1 -- Mapping Directives for Single Character Symbols of the PRINTERMAP Phase (Option 1=1)

Mapping Directive	Symbol	Mapping Directive	Symbol
0	Blank	32	5
1	A	33	6
2	B	34	7
3	C	35	8
4	D	36	9
5	E	37	Z
6	F	38	@
7	G	39	#
8	H	40	$
9	I	41	%
10	J	42	&
11	K	43	*
12	L	44	(
13	M	45	)
14	N	46	_
15	O	47	-
16	P	48	+
17	Q	49	=
18	R	50	:
19	S	51	;
20	T	52	"
21	U	53	'
22	V	54	
23	W	55	,
24	X	56	
25	Y	57	.
26	Z	58	?
27	0	59	/
28	1	60	A
29	2	61	Y
30	3	62	Z
31	4		

NOTE: The above set of symbols can be rearranged should the character set of a particular computer require it. It is assumed that a QN print is being used. See the DATA CHAN statement in sub-routine FILLIT of the program GEORAP.

Table 3.2 -- Mapping Directives for Multi-Character Overprint Symbols of the PRINTERMAP Phase (Option 1 = 2)

Mapping Directive	Overprint Character(s)	Symbol	Mapping Directive	Overprint Character(s)	Symbol
0	(blank)	(blank)	7	O	OOOOO OOOOO OOOOO OOOOO
1	.	....	8	Z-	ZZZZZ ZZZZZ ZZZZZ ZZZZZ
2	-	----- ----- ----- -----	9	O-	OOOOO OOOOO OOOOO OOOOO
3	=	===== ===== ===== =====	10	AV	AVAVA VAVAV AVAVA VAVAV
4	/	///// ///// ///// /////	11	OX	OXXXO XXXXX XXXXX XXXXX
5	+	+++++ +++++ +++++ +++++	12	AVT	AVTVA VTVTV VTVTV VTVTV
6	X	XXXXX XXXXX XXXXX XXXXX			

User Options:

Option 1 (Symbol Character Option)

1 = Single character symbols (default)

2 = Standard multi-character, overprint symbols

3 = User-specified multi-character, overprint symbols

Option 2 (Scaling Option)

0 = Unscaled map

1 = Scaled Map

Option 3 (Lines per Inch)

0 = 8 lines/inch

1 = 6 lines/inch (default)

Option 4 (Background)

0 = No background (default)

1 = Background

Option 5 (Border Highlight)

0 = Do not overprint borders (default)

1 = Overprint borders

Phase Directive Statement: PMAP, (1,2 or 3), (1 or 2), (0 or 1), (0 or 1), (0 or 1)

Figure 8 -- Example of a printer map using a background to outline study area.

PRINTERMAP PHASE WORKSHEET

Option 1 = 1 Single Character Symbols
2 Multi-Character Symbols
3 User-Specified Multi-Character Overprint Symbols

Option 3 (lines per inch)
= 0 8 lines/inch
= 1 6 lines/inch

Option 2 = 0 Unscaled
= 1 Scaled

Option 4 (background)
= 0 No background (default)
= 1 Background

Option 5 (Border Highlight)
= 0 No
= 1 Yes

— — — — — — — — — — — — — — — — — —

Printermap Phase Called

1. Enter name of factor to be mapped (NAME):

— — — — — — — — — — — —

If Option 4 = 0, go to line 3.

2. Enter name of background factor (NAME):

— — — — — — — — — — — —

3. If Option 2 = 0, go to line 4.

Enter east-west size of map in centimeters (RE.AL): (must be bigger than 1.0 cm.)

— — — — — —

If the decimal point is not inserted, an error message is printed and the program is terminated.

4. If Option 1 ≠ 3, go to line 5.

Three characters will be required for each nonzero attribute (CHAR1,CHAR2,CHAR3, or END). The characters can be separated by a comma or a space.

4.1	— — — — —	4.7	— — — — —
4.2	— — — — —	4.8	— — — — —
4.3	— — — — —	4.9	— — — — —
4.4	— — — — —	4.10	— — — — —
4.5	— — — — —	4.11	— — — — —
4.6	— — — — —	4.12	— — — — —

PRINTERMAP PHASE (cont'd)

5. Do you want to write a map legend (YES or NO)?

___

If no, then go to line 6.

5.1 Enter legend line or END (20A4 or END).

_____

(Repeat line 5.1 until end-of-legend entry.) A maximum of 49 lines is allowed.

6. Enter next phase directive and options (NAME,INT,INT).

_____

```
ENTER PHASE DIRECTIVE AND OPTIONS (NAME,INT,INT)
PMAP,1,1,0,0,1
```

```
PRINTERMAP PHASE CALLED

ENTER NAME OF FACTOR TO BE MAPPED (NAME):
SOIL

ENTER EAST-WEST SIZE OF MAP IN CENTIMETERS (RE.AL):
25.4

DIMENSIONS WILL BE  25.4 BY 25.4 CENTIMETERS
(OR 60 ROWS BY 100 COLUMNS)
SAMPLING INTERVAL ROW - 0.165  COL - 0.100
OPTION 1 - 1  OPTION 2 - 1
FACTOR - SOIL - MAPPED AT 2.4 LINES PER CENTIMETERS

DO YOU WANT TO WRITE A MAP LEGEND (YES OR NO)?
NO

MAP PRINTED IN 1 STRIP

END PRINTERMAP PHASE

ELAPSED TIME FOR PHASE EXECUTION:  1.07 CP SECONDS
```

3.11 SCALE PHASE

The SCALE phase will perform a multidimensional scaling analysis on a set of weighted or unweighted factors. Multidimensional scaling consists of establishing an n-dimensional Euclidean space, where n is the number of factors in the analysis. The numerical values of each factor establishes a point for that grid cell in the n-space. The distance between that point, and a point representing an optimum or desired set of conditions (user specified) is the comparative site index. As this index decreases (the distance between the points decrease), the conditions for that cell approach that of the desired or optimum conditions. The distance index may also be thought of as a similarity index. Factors used in a SCALE analysis may be either ordinal, interval or ratio scale data.

The user may specify weighting values for each factor axis. The factors may be normalized, in which case the resulting distance index is also normalized.

The user will be required to enter the coordinates in n-space of the optimum point (those conditions representing the desired or ideal conditions). If the data are normalized, then the optimum coordinates must be entered in the normalized coordinate system.

User Options:

Option 1 (Normalization Option)

1 = Normalize factors and distance index to a maximum value of 100.

2 = Normalize factors and distance index to a user specified maximum value.

3 = Do not normalize factors or distance index.

Option 2 (Weighting Value Option)

0 = Weighting Value Equals one (1).

1 = User-specified weighting values.

Phase Directive Statement: SCLE (1,2, or 3), (1 or 2)

For those familiar with multidimensional scaling the uses the SCALE phase of GEORAP are readily apparent. For those who are not, a brief example will help illuminate the versitility of SCALE. If the user is interested in locating regions of a country which would be most agronomically suitable for the production of coffee, three interpretative maps may first be created, one for average annual temperature, one for average annual rainfall and one for soils. Each of these interpretative or derivative maps could have been generated using MATCH, GROUP or OVERLAY or could have been an original map entered into GEOMAST's Master File. For instance, using GROUP, the rainfall levels characterizing areas of the country can be grouped into regions of agronomically relevant rainfall ranges for the coffee plant e.g. less than 1000 mm., 1000 - 1400 mm., 1400 mm. -1750 mm., greater than 1750 mm. Once relevant temperature ranges and soils types have been established, each variable range is ranked, beginning with the number 1 as the best (most suitable) and increasing by one integer units to the worst (least suitable). In this manner the unnormalized optimum conbination of temperature, rainfall and soils would be represented by a three dimensional vector (1,1,1). What SCALE does is start with (1,1,1) the optimum 3-dimensional point, "draw" a vector from (1,1,1) to any other 3-dimensional point like (3,1,4) and compute the linear distance from (1,1,1) to (3,1,4). The linear distances are computed for each grid cell and the cell by cell results can be displayed for example, by the HISTOGRAM phase or by the PRINTERMAP phase.

What does this do for the analyst? It presents the analyst with the capability for undertaking suitability analysis. Using the example from the preceeding paragraph, one can use the GROUP phase of GEORAP to rank the attributes of all grid cell land areas for the factors of temperature, rainfall and soils. The factors would be prioritized (ranked) in the agronomic sense for coffee production. Two other points follow. First, certain factors can be emphasized or enhanced by using weighting

values. Second, socioeconomic as well as physical data and information may be introduced in SCALE phase.

Reference: Tilmann, S.E., 1976. "Evaluating limitations to ground water recharge by a multidimensional scaling model." Remote Sensing Project, MSU, Technical Paper 76-2.

SCALE PHASE WORKSHEET

Option 1 = 1 Normalize data to maximum of 100
2 Normalize data to user
3 Do not normalize data

Option 2 = 1 Weighting values of 1 (unweighted)
2 User specified weighting values

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

SCLE Phase Called

1. How many factors do you want to use (INT).

_ _

2. What is the name of the factors (NAME).

2.1 _ _ _ _ _ _ _ _ _ _ _

2.2 _ _ _ _ _ _ _ _ _ _ _ _

2.3 _ _ _ _ _ _ _ _ _ _ _ _

2.4 _ _ _ _ _ _ _ _ _ _ _ _

2.5 _ _ _ _ _ _ _ _ _ _ _ _

⋮

3. If Option 1=2,

3.1 Enter upper normalization limit (INT) for factors being scaled.

_ _ _

4. If Option 2=2,

4.1 Enter weighting value for factors (RE.AL) (Note: Enter in same order as in in line 2).

4.1.1 _ _ _

4.1.2 _ _ _

4.1.3 _ _ _

4.1.4 _ _ _

4.1.5 _ _ _

⋮

5. Origin values will be required for factors. You must enter normalized origin values if Option 1=1 or 2.

   Origin of factor (INT)

   5.1 _ _ _ _ _

   5.2 _ _ _ _ _

   5.3 _ _ _ _ _

   5.4 _ _ _ _ _

   5.5 _ _ _ _ _

   ⋮

6. If Option 1=2,

   6.1 Enter upper normalization limit (INT) for the scaled factor.

   _ _ _

7. Enter name for scaled (map) factor (NAME).

   _ _ _ _ _ _ _ _ _ _ _ _

8. Enter next phase directive and options (NAME,INT,INT).

   _

ENTER PHASE DIRECTIVE AND OPTIONS (NAME,INT,INT):
SCLE,1,2

SCALE PHASE CALLED

HOW MANY FACTORS DO YOU WANT TO USE? (INT)3

WHAT IS THE NAME OF FACTOR 1? (NAME) CRLD

WHAT IS THE NAME OF FACTOR 2? (NAME) SOIL

WHAT IS THE NAME OF FACTOR 3? (NAME) ERO

RETRIEVING FACTOR, 1 (CRLD)

RETRIEVING FACTOR, 2 (SOIL)

RETRIEVING FACTOR, 3 (ERO)

FACTORS HAVE BEEN RETRIEVED AND PLACED ON PHASFYL.

LARGEST AND SMALLEST DATA VALUES

FACTOR 1	LARGEST = 5	SMALLEST = 1
FACTOR 2	LARGEST = 6	SMALLEST = 2
FACTOR 3	LARGEST = 234	SMALLEST = 0

NORMALIZATION BETWEEN 0 AND 100 IS COMPLETED

ENTER WEIGHTING VALUE FOR FACTOR CRLD (RE.AL)1.

ENTER WEIGHTING VALUE FOR FACTOR SOIL (RE.AL)0.5

ENTER WEIGHTING VALUE FOR FACTOR ERO (RE.AL)2.0

ORIGIN VALUES WILL BE REQUIRED FOR 3 FACTORS

IF DATA HAS BEEN NORMALIZED (OPTION 1=1 or 2), THEN NORMALIZED ORIGIN COORDINATES MUST USED

ORIGIN OF FACTOR 1 (INT)? 1 ORIGIN OF FACTOR 2 (INT)? 1 ORIGIN OF FACTOR 3 (INT)? 1

SCALE PHASE DIRECTIVE AND OPTIONS (cont'd.)

PARAMETERS USED FOR SCALING ANALYSIS:

FACTOR	WEIGHT
CRLD	1.0
SOIL	.5
ERO	2.0

LARGEST AND SMALLEST DATA VALUES

FACTOR 1 LARGEST = 279 SMALLEST = 7

NORMALIZATION BETWEEN 0 AND 100 IS COMPLETED

ENTER NAME FOR SUMMATION VALUE (NAME) INDX

SUMMATION VALUE HAS BEEN ADDED TO WORK FILE UNDER THE NAME OF INDX
THERE ARE NOW 12 FACTORS IN THE WORKFILE

SCALE PHASE COMPLETED.

ELAPSED TIME FOR PHASE EXECUTION: 3.92 CP SECONDS

3.12 TITLEMAP Phase

The TITLEMAP phase permits the user to list a set of factors by grid cell on the printer (Fig. 9). The grids are placed on the printer where each cell of the map is 2.54 cm. (1 inch) on a side, and up to five factor titles, factor descriptors, or lines, may be included in each cell. By using a mapping directive, selected cells may have the title information printed while others will not.

The user specifies the size of the window (see WINDOW phase) for each map, using a maximum of 10 rows and columns per map. The grid is divided up into windows of the specified size. If the grid is not an even increment of the window size, then a smaller map will be printed for the "left over" portion.

The user can enter the name of one factor (mapping directive) on the Work File which if the factor value is non-zero for a cell, then the title information will be printed. If a zero value is encountered for a cell, then no titles are printed. In certain cases, the user may not wish to use a factor in the above manner, for example, if data for all cells are to be printed on the map. In these cases, the user may enter NONE for the name of the mapping directive (factor).

This phase will print up to five titles per grid cell block (utilizing 5 factors from the Work File). The user is asked to supply the name of the factors on the Work File to be inserted as cell titles on the map. The first cell title goes on the first line when Option 1=1 (6 lines/inch printer) or on the second line when Option 1=2 (8 lines/inch printer). If no title is to appear on the line, then the user enters the name NONE for the respective cell title name.

The final step of user entry specifies the title types and lengths. Title types may be one of two forms, alphanumeric or integer. Alphanumeric titles (type = A) normally consist of alphabetic letters; names, qualitative rating (slight, moderate, severe, etc.) and other descriptors. Alphanumeric titles must either be read from the Master File

WINDSOR TWP LAND VALUES - AG (BASE=$700) AND PASTURE (BASE=$280)

JOLLY HWY.

	41	42	43	44	45	46	47	48
1	1791. 25 A D PASTURE	2597. 25 B A PASTURE	2800. 25 C A PASTURE	2388. 25 A B PASTURE	2388. 25 A B PASTURE	2388. 25 A B PASTURE	2597. 25 B A PASTURE	2597. 25 B A PASTURE
2	2597. 25 B A PASTURE	2800. 25 CSA PASTURE	2597. 25 B A PASTURE	*****	2388. 25 A B PASTURE	2800. 25 C A PASTURE	2388. 25 A B PASTURE	2597. 25 B A PASTURE
3	2800. 25 C A PASTURE	2597. 25 B A PASTURE	2388. 25 A B PASTURE	2388. 25 A B PASTURE	*****	2597. 25 B A PASTURE	2800. 25 C A PASTURE	2597. 25 B A PASTURE
4	2597. 25 B A PASTURE	2388. 25 A B PASTURE	1977. 4 C A PASTURE	*****	2800. 25 C A PASTURE	2800. 25 C A PASTURE	2388. 25 A B PASTURE	2597. 25 B A PASTURE
5	2388. 25 A B PASTURE	2388. 25 A B PASTURE	2388. 25 A B PASTURE	*****	2597. 25 B A PASTURE	2388. 25 A B PASTURE	2388. 25 A B PASTURE	2800. 25 C A PASTURE
6	2388. 25 A B PASTURE	2597. 25 B A PASTURE	2388. 25 A B PASTURE	*****	7002. 25 C A CROPLAN	6493. 25 B A CROPLAN	6493. 25 B A CROPLAN	5971. 25 A B CROPLAN
7	2388. 25 A B PASTURE	2388. 25 A B PASTURE	2800. 25 C A PASTURE	2597. 25 B A PASTURE	2597. 25 B A PASTURE	2800. 25 C A PASTURE	2597. 25 B A PASTURE	2388. 25 A B PASTURE
8	2597. 25 B A PASTURE	2388. 25 A B PASTURE	2388. 25 A B PASTURE	2388. 25 A B PASTURE	2388. 25 A B PASTURE	2597. 25 B A PASTURE	2597. 25 B A PASTURE	2597. 25 B A PASTURE

WILLIAMS RD.

WAVERLY RD.

ESTIMATED ASSESSMENT VALUE
FOR LAND IN AGRICULTURE

WINDSOR TOWNSHIP, EATON COUNTY

SECTION 1

```
+----+----+
I 5703. I
I 3 2A B I
I CROPLAN I
+----+----+
```

LAND VALUE FOR 10 ACRE PARCEL ($)

SOIL MANAGEMENT UNIT

CURRENT DOMINANT LAND USE

```
+----+----+
I        I
I *****  I
I        I
+----+----+
```

INSUFFICIENT SOIL INFORMATION OR NON-AGRICULTURAL LAND USE

0 ¼ MILE

Figure 9 -- Example of a map produced by the TITLEMAP phase. Each cell contains labelled information for one grid cell of the Master File.

under an "A" format specification, or generated internally with one of the GEORAP phases (MATCH phase). Integer titles (type = I) are comprised of just numeric integer data, either read from the Master File under an "I" format specification or generated internally with one of the GEORAP phase.

Title lengths can be up to four characters, nine digits or spaces long, since there are nine spaces within a map cell available for title information. Title strings less than nine characters (integer, four alphanumeric) will be centered within the map cell, that is the title string will be preceded and followed by a number of spaces. For example, a title length of five will result in a title string with two preceding and two spaces following the title. A title length of six will result in a title string with one space preceding and two spaces following the title.

Title type and length will be requested for only those cell titles given a valid factor name in step four (i.e., title names other than NONE). The user entry takes the form of: "Type, Length", where type is either an A or I, and length is an integer number greater than 0 and less than or equal to 9 (integer or four alphanumeric). Examples of valid title specifications are:

A,4	alphanumeric title, four characters long
I,6	integer title, six digits long.

Note: The comma between the A or I and the number is <u>necessary</u>.

User Options:

Option 1 (Printer Type Option)

1 = 6 lines/inch printer

2 = 8 lines/inch printer

Phase Directive Statement: TMAP, (1 or 2)

TITLEMAP PHASE WORKSHEET

Option 1 = 1 6 lines/inch printer
2 8 lines/inch printer

_____

TITLEMAP Phase Called

1. Enter map title (20A4).

_____

2. Enter row and column size (max = 10) of map windows (INT,INT).

_____

3. Enter name of the mapping directive on the Work File (NAME or NONE).

_____

4. The names of the cell titles on the Work File will be required (NAME OR NONE).

4.1 _____

4.2 _____

4.3 _____

4.4 _____

4.5 _____

5. Enter title type (A = alphanumeric, I = integer) and title length (max = 4) for the title strings (TYPE,INT).

5.1 _____

5.2 _____

5.3 _____

5.4 _____

5.5 _____

6. Enter next phase directive and options (NAME,INT,INT).

_____

```
ENTER PHASE DIRECTIVE AND OPTIONS (NAME,INT,INT):
TMAP,2
```

```
TITLEMAP PHASE CALLED

ENTER MAP TILE (8A10)
BELLEVULE TOWNSHIP APPRAISED FARMLAND VALUES (BY AGVALUE PHASE)

ENTER ROW AND COLUMN SIZE (MAX = 10) OF TITLEMAP (INT,INT)
8,8

ENTER NAME OF THE MAPPING DIRECTIVE ON THE WORKFILE (NAME OR NONE)
AGVL

THE NAMES OF THE CELL TITLES ON THE WORK FILE WILL BE REQUIRED
(NAME OR NONE)

TITLE 1?  NONE
TITLE 2?  AGVL
TITLE 3?  SOIL
TITLE 4?  LTLE
TITLE 5?  NONE

ENTER TITLE TYPE (A=ALPHANUMERIC, I=INTEGER) AND TITLE LENGTH
(MAX=9) FOR THE 3 TITLE STRINGS (TYPE,INT)

TITLE 2?  I,4
TITLE 3?  A,5
TITLE 4?  A,7

SPECIFICATIONS FOR TITLE MAPS:

THERE WILL BE 4 MAPS.
EACH MAP WILL BE 8 ROWS by 8 COLUMN

THE MAPPING DIRECTIVE IS AGVALUE

THE CELL TITLE SPECIFICATIONS ARE:

TITLE     TITLE   TITLE
NUMBER    TYPE    LENGTH

1         NONE
2         I       4
3         I       5
4         A       7
5         NONE

BEGIN MAP CONSTRUCTION

TITLE MAP PHASE COMPLETED

ELAPSED TIME FOR PHASE EXECUTION:   1.71 CP SECOND
```

3.13 WINDOW PHASE

The WINDOW phase permits the user to create a new Work File from a portion of the old Work File. The window may be specified by either the row-column coordinate of the window borders (Option 1=1), by using data values read from the Work File (Option 1=2), or by a radius from a given row-column coordinate (Option 1=3) (see Fig. 10). The old Work File is destroyed and a new Work File is written upon each cell to the WINDOW phase. All of the factors originally specified on the Work File are retained after WINDOW constructs a new one.

There are three row-column indexing option values available with this phase. When Option 2=1, the original map size remains unchanged and all areas outside of the window are zeroed (null); only the geographic area inside the specified window will contain non-zero data. The original row-column coordinates remain unchanged. When Option 2=2, the grid size is reduced so that the upper-left and lower-right occurrences of significant data (not including zero cells) delimit the area. Furthermore, the row and column coordinates are translated so that the northwest corner of the window has the coordinates of (1,1). When Option 2=3, the map size is reduced (as in Option 2=2), and the row-column indices remain unchanged. In this case, the first record on the Work File may begin with a row-column index other than (1,1).

When Option 1=1, the window is generated from the row-column coordinates of the northwest (upper left) and southeast (lower right) corner coordinates of the window. When Option 1=2, data values read for the window factor are used to generate the window. If the factor value read from the Work File matches one of those specified by the user, then the matching record is written onto the new Work File. Otherwise, the data record is skipped. If no match is found, the missing factors are printed and the original workfile is returned. When Option 1=3, all cells within a fixed user specified distance (measured in cell units) from a specified cell are included on the new Work File. A radius which intersects the boundary of the geographic grid is

truncated at the edge; there is no window permitted beyond the edges of the original grid.

User Options

Option 1 (Window Type Option)

1 = Row-column coordinate window (default).

2 = Data value window (maximum = 100 data values).

3 = Circular window.

Option 2 (Coordinate Translation Option)

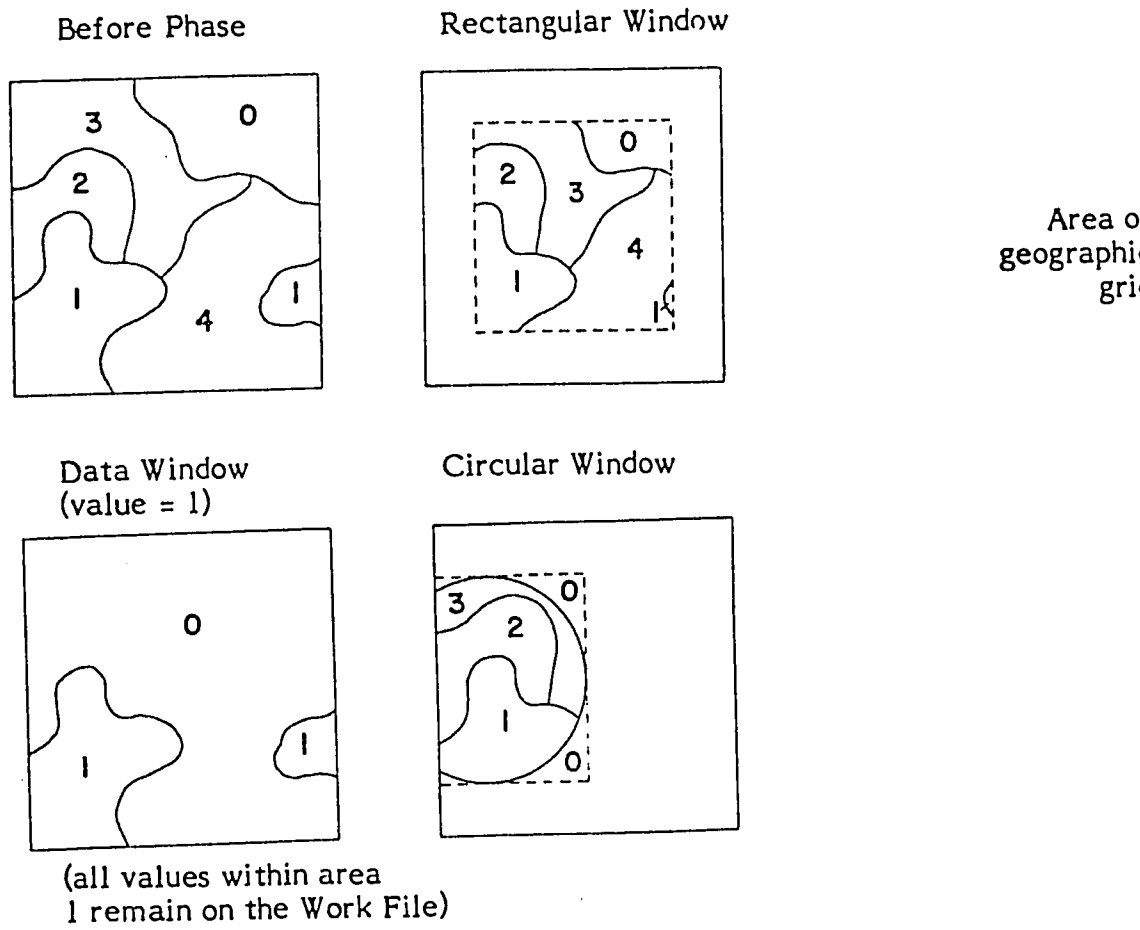
1 = Keep original row-column coordinates & map size.

2 = Translate row-column coordinates (default) & minimize map size.

3 = Keep original row-column coordinates and minimize map size.

Phase Directive Statement: WNDO,(1, 2 or 3),(1, 2, or 3)

Figure 10 -- Sample map before and after different options of the WINDOW.



WINDOW PHASE WORKSHEET

Option 1 = 1 Row-column window
2 Data window
3 Circular window

Option 2 = 1 Keep original coordinates
2 Translate coordinates (default)
3 Keep original coordinater and minimize map size

— — — — — — — — — — — — — — — — — —

WINDOW Phase Called

1. If Option 1 ≠ 1, go to line 2.

   1.1 Enter northwest (upper left) row and column coordinate of window (INT,INT).

   — — — — — — — —

   1.2 Enter southeast (lower right) row and column coordinate of window (INT,INT).

   — — — — — — — —

   Go to line 4.

2. If Option 1 ≠ 2, go to line 3.

   2.1 Enter name of factor to be used for data window (NAME).

   — — — — — — — — — — — —

   2.2 Enter number of factor values to be used (INT).

   — —

   2.3 List the specific value for each of the number of factor values specified in 2.2 above (INT).

   2.3.1 _____

   2.3.2 _____

   2.3.3 _____

   2.3.4 _____

   2.3.5 _____

   ⋮

   Go to line 4.

WINDOW Phase (cont'd.)

3. Option 1 must be 3.

   3.2 Enter radius of circle (INT).

   ___

   3.3 Enter row-column coordinates of original (INT,INT).

   _____

4. Enter next phase directive and options (NAME,INT,INT).

   _____

```
ENTER PHASE DIRECTIVE AND OPTIONS (NAME,INT,INT):
WNDO,1,1
```

```
WINDOW PHASE CALLED

            WINDOW SELECTION OPTION = 1 COLUMN INDEXING OPTION = 1

ENTER NORTHWEST (UPPER LEFT) ROW AND COLUMN BORDER OF WINDOW
(INT,INT) 1,1

ENTER SOUTHEAST (LOWER RIGHT) ROW AND COLUMN BORDER OF WINDOW
(INT,INT) 5,5

THE WINDOW BORDERS ARE TOP =  1 BOTTOM =  5
LEFT =  1   AND   RIGHT =  5

THE WORK FILE CONTAINS  19 RECORDS WITH  3 FACTORS/RECORD

THE WORK FILE GRID IS 5 ROWS BY 5 COLUMNS
THE ROWS ARE NUMBERED BEGINNING AT 1
THE COLUMNS ARE NUMBERED BEGINNING AT 1

WINDOW PHASE COMPLETED

ELAPSED TIME FOR PHASE EXECUTION:  .12 CP SECONDS
```

3.14 WORKFILE PHASE

The WORKFILE phase transfers user specified factors (data) from the Master file, logical unit 8 (SYS005) to the Work File, logical unit 9 (SYS006). This phase must be called first upon initial execution of GEORAP although it may be called at any additional time during program execution. The old Work File (if any) is destroyed and a new one created on each call to the WORKFILE phase.

Option 1 instructs the program on the format type of the Master File. The sequential cell record format (Option 1=1) consists of a single record per grid cell. The first two data elements (numbers) are the row and column index of the cell, with the remaining elements being the map attributes for that cell (more than one may be on one record). The non-indexed format (Option 1=2) is similar to the sequential cell record format, except that the row-column numbers are not required on each record. A raster scan format (Option 1=3) consists of a record which has map data for one row, or part of one row, depending upon the number of cells along a row. There are no row-column indices and there is only one map per Master File. Compressed boundary cell format (Option 1=4) requires a similar structure as row-column indexed files, except that only cells in which a factor changes (i.e., a map unit boundary) are recorded on the Master File. Each record in this form contains all the factors at that boundary change.

Option 2 instructs the program on whether the Master File is coded (card-image) (Option 2=1) or binary (Option 2=2).

When the binary Work File is created through the WORKFILE phase, this file will be in a compressed cell format. Therefore, using a Work File which was created in this fashion for a Master File (logical unit 8) in subsequent GEORAP sessions, the user must select Option 1=4 and Option 2=2 for the WORKFILE phase.

For coded, card-image files, the user must enter the execution time format statement for reading the data from the Master File. This format statement may be

of three general forms, depending upon the options values chosen for Option 1. The sequential cell and compressed cell formats require that the read format provide for the first two data items read from the Master File be the row-column integer index numbers. The remainder of the format fields must provide for the number of factors to be transferred from the Master File to the Work File.

A raster scan format requires that a single data factor be read in gridded fashion. Normally, an entire row of data is read in one record, however, the row may be divided into more than one record. Also, raster scan formats are typically repetitive, such as (50I5), or other similar appearing formats.

A non-indexed sequential cell record format is similar to a row-column index format except that fields are not provided to read in row-column coordinates from each data record. However, multiple factors may be read from the same data record.

Data may be read from each record in either I-fields or A-fields. All numeric data is read under I-fields. Alphanumeric data, such as titles and names, can be read under an A-field. However, data entered in this fashion cannot be used for any numerical analysis.

The Master file is read under the user specified input format. This format is entered by the user as an execution time format, with beginning and closing parentheses. Examples of valid format entries are:

(2I2,1X,3I5)	row-column index or compressed form (Option 2=1 or 4)
(38I8)	raster scan form (Option 2=3)
(5X,I3,A4,I1)	non-indexed form (Option 2=2)

Option 3 controls the echo printing of user entries. Echo prints (Option 3=1) are usually used when running the program from cards; the user entries are printed on the phase listing as they are encountered. This permits an accurate record of all program

entries and is particularly useful when debugging the program control stream. Echo print is not normally required when running from the terminal (interactive), since the user entries are printed on the program listing as they are typed in. The default mode for this Option is echo print (Option 3=1).

The number of header records read from the Master File is controlled with Option 4. If Option 4=0 (the default value), then no header records are read and the first file record is assumed to be map data. If Option 4=n, where n is a non-zero positive number, then that number of header records are read from the file and printed on the program listing under a card image format.

User Options:

Option 1 (File Format Type Option)

1 = Sequential cell records

2 = Sequential cell records, without row-column indices

3 = Raster scan

4 = Compressed cell records (default)

Option 2 (File Type Option)

1 = Coded, card-image file (default)

2 = Binary file

3 = Binary workfile file (attached as logical unit 9)

Option 3 (Echo Print)

0 = No echo print

1 = Echo print (default)

Option 4 (Header Record)

0 = No header record (default)

n > 0 = Number of header records

Phase Directive Statement: WORK, (1,2,3 or 4),(1 or 2), (0,1, or blank), (0,n, or blank)

WORKFILE PHASE WORKSHEET

Option 1 = 1 Row-column sequential cell indexed format
2 Non-indexed sequential cell format
3 Raster scan format
4 Compressed cell format (default)

Option 2 = 1 Coded file (default)
2 Binary file
3 Binary workfile attached as logical unit 9

Option 3 = 0 No echo print
1 Echo print (default)

Option 4 = 0 No header records (default)
n Read "n" header records

— — — — — — — — — — — — — — — — — — — —

WORKFILE PHASE Called

1. Enter row and column size of the Master File (INT,INT).

— — — — — — — —

2. Enter the number of factors to be retrieved from the Master File (INT).

— —

3. Enter name for each factor (NAME).

3.1 — — — — — — — — — — — —

3.2 — — — — — — — — — — — —

3.3 — — — — — — — — — — — —

3.4 — — — — — — — — — — — —

3.5 — — — — — — — — — — — —

⋮

4. If Option 2 = 2, go to line 5.

Enter master file format (20A4).

— —

5. If Option 2 ≠ 3 go to line 6.

Enter record count for binary file (INT).

— — —

6. Enter phase directive and options (NAME,INT,INT).

— — — — — — — — — — — — — — — — — — — —

```
WELCOME TO GEORAP (GEOGRAPHIC RESOURCE ANALYSIS PROGRAM)


ENTER PHASE DIRECTIVE AND OPTIONS (NAME,INT,INT) :
WORK,1,1

-------------------------------------------------------------------------------

WORKFILE  PHASE CALLED

ENTER  ROW & COLUMN SIZE OF MASTER FILE GRID (INT,INT):
 8,9

ENTER  NUMBER OF FACTORS TO BE RETRIEVED FROM THE MASTER FILE (INT):
3

ENTER  NAME FOR FACTOR   1 (NAME): LNDU

ENTER  NAME FOR FACTOR  2 (NAME): SOIL

ENTER  NAME FOR FACTOR  3 (NAME): SLOP

ENTER  MASTER FILE FORMAT (20A4):
(4X,2I5,8X,I1,15X,2I2)

            3 FACTORS TO BE RETRIEVED WITH FORMAT:  (4X,2I5,8X,I1,15X,2I2)
            ANTICIPATED ROW,COL SIZE:  8 BY 8
            DATA TYPE - 1      CONVERSION OPTION - 1

            57 COORDINATE PAIRS HAVE BEEN WRITTEN ON THE WORKFILE

END  WORKFILE PHASE

ELAPSED  TIME FOR PHASE EXECUTION:   .19 CP SECONDS
```

SECTION FOUR: GLOSSARY OF TERMS FOR GEOMAST AND GEORAP

An Attribute is an integer variable associated with each grid cell. It is used to identify that cell with a particular classification and it is used in the MAP phase of GEOMAST in order to select which map symbol is to be printed for each cell.

Binary data file is a data file internal to the computer in which all variables are represented in binary code (zeros and one). A binary file can only be read by a computer, which need not translate the data before reading.

Card-image refers to the record format of a data file. In card-image format, the data is entered or occurs as numbers and letters, such as would appear if the data were punched onto a computer card. Coded files always contain card-image records. Normally, card-image also implies that the record is 80 columns long, although for this program such a restriction need not apply.

A Coded data file is a data file in which the cards (or records) appear to consist of numbers and letters. When displayed on a terminal or at the printer, the user can read the data. Coded files are generally used to store the map data for permanent keeping, such as on cards, disks, or magnetic tape. A coded file must be converted to a binary file before being used in the program. This task is accomplished in the WORKFILE phase of GEORAP.

A Compressed cell record format refers to a Master File configuration in which a data record only occurs when a map boundary is located in the cell. Thus, intermediate cells, those occurring between boundaries and repeat information in the cell to the left, are not contained in this type of file. By eliminating duplicate records, the physical size of the Master File can be considerably reduced. All GEOMAST

files use this format whereas the GEORAP work file uses a sequential cell record format.

Contiguous data refers to map data that share common boundaries for each mapping unit. The total area of contiguous data is equal to that of the study area since there is always an identifying code associated with each grid cell. Provincial codes are examples of contiguous data.

Discontiguous data refers to map data that do not necessarily share common borders. Discontiguous data occur in discrete areas and generally occupy a smaller area than does the study area in general. Irrigated farmland is an example of discontiguous map data.

Execution time format statement is a description of the columns in which specific data occur. The format statement also indicates whether that data are integer, real, or alphanumeric. These format statements are entered by the user to direct retrieval of specific factors in the WORKFILE phase from the Master File or the writing of a new Master File using the NEWFILE phase of GEORAP. The statement does not contain the word FORMAT, but begins and ends with parentheses (see the WORKFILE phase, section three of GEORAP).

A Factor refers to the data from one map stored on the map file. A factor may have many different values, where each value would represent a mapping unit or attribute code. In GEORAP, each factor is assigned a name, usually descriptive of the source map.

Floating point variable (see real variables)

The Geocoded format refers to a compressed cell record file which contains all the boundary information for a given row in one record. Every row is specified with a table of relevant attribute values at the end. For a more detailed description, see section 1.3.6 of GEOMAST.

A Geographic data grid refers to the network of rows and columns used when grid geocoding map data. Usually, the grid is registered to some known or readily identifiable map feature, such as UTM coordinates or latitude-longitude lines.

A Grid cell refers to the particular row-column intersection of the geographic grid. The cell constitutes the minimum spatial area for which map data are geocoded. Normally, each grid cell is square. Cells are addressed by their unique row and column coordinate.

Grid geocoded refers to a method of digitizing map data. The method consists of dividing the study area into grid cells of equally spaced rows and columns. Usually the grid cells are square. Each cell is numbered according to its row and column address, similar to matrix algebra. Beginning in the northwest corner of the study area rows run horizontally, west to east, while columns run vertically, north to south. Thus, cell (093,047) is the grid cell intersection of row 93 with column 47.

Index numbers refers to the row and column coordinates of grid cells. By convention, index numbers are always given in pairs, with the row coordinate being first and the column coordinate being second. Thus, the index 023,225 refers to the cell on row 23 and column 225. The index numbers start in the northwest corner of the

study area with rows incrementing to the south and columns incrementing to the east.

Interval scale data - (see scale data).

A Lexical analyser is a program subroutine that converts a string of numbers or alphabetic characters into individual computer words. Normally, each number or variable is separated by commas, referred to as delineators. A lexical analyzer permits the user to enter data into the program without having to count columns or otherwise column justify the data. GEORAP contains a lexical analyser (see section 2.4).

Literal string refers to a sequence of alphanumeric characters. Strings are used to enter yes or no responses, titles and formats.

A Logical unit number refers to a numerical input/output identifier in FORTRAN that can be assigned to a unit such as a reader or printer for I/O communication between the program and computer system.

Map factor value (see attribute).

A Master file format refers to a compressed cell file which contains one record per boundary change. For a more detailed description, see Section 1.3.9 of GEOMAST.

A Map file refers to a coded or binary file on which the map data are stored. This is also referred to as the Master File.

A Mapping directive is an integer variable associated with each grid cell of the data matrix. While mapping, the program uses mapping directives in order to select which map symbol is to be printed for each cell. There may be a variety of symbols available for each mapping directive, depending upon the options chosen for the mapping phase. Mapping directives may be generated with a phase of GEORAP (such as the MATCH or GROUP phase), or the directive may be read from the data file (see section 2.1 of GEORAP). Mapping directives are the values of a factor.

The Master File is the permanently stored file which contains the map data for the study area. The Master File can be stored either on cards, tape, or disk. The contents of the Master File are not altered by GEORAP.

Nominal scale data - (see scale data).

Ordinal scale data - (see scale data).

Overlay refers to the linear combination of factor values using user-specified weighting values for each map factor used.

A Phase is one sub-program of the GEORAP system. Each phase performs a specific task on the map data or the data files. Phases are called through the phase directive statement, which consists of the phase name and integer options values, if any.

A Raster scan format is a Master File configuration in which only one map factor occurs. Furthermore, one file record contains all the data for one grid row (this is the usual case, although there may be exceptions) with no row/column identifiers.

Raster scan files are sometimes referred to as gridded files. Typical sources of raster scan files are processed LANDSAT tapes (See section 1.3 of GEORAP).

Ratio scale data - (see scale data).

Real variables are numbers which contain a decimal point. The numbers may, or may not, have significant digits to the right of the decimal. For example, the real variable 1.0 is the same as the variable 1 (without a zero). Real variables are sometimes referred to as floating point numbers.

A Record is the smallest fixed size block of data that can be read in or written out on a particular unit. For example, the block size for a record on a card reader or punch is 80 words.

Scale data* can be in one of four forms, nominal, ordinal, interval or ratio. Whenever a user makes observations of any kind, the user employs some scheme for classifying or recording what is observed. Any phenomenon will have many distinguishable characteristics or attributes, but the analyst must first single out those properties relevant to the question(s) being studied. When this is done to observations or data, one has a scale data set.

1. Nominal scale data - The process of grouping individual observations into qualitative classes. For example, a data set of plants can be classified into family, genus, species, variety. Note that arithmetic operations on nominal data are meaningless and impossible.
2. Ordinal scale data - The process of ranking nominal data. For example, soils can be numerically ranked as to their produtivity yields for a certain crop. Note that while arithmetic operations can be performed on ordinal scale data, the results are meaningless.

3. Interval scale data - When the qualitative classes of ordinal scale data are in a linear relation (ax + b) then the data set is an interval scale data set. For example, soils can be classified as to their temperature 5 cm. below the surface. Note that arithmetic operations are possible and meaningful. However, one cannot say that $20^{o}C$ is twice as hot as $10^{o}C$.

4. Ratio scale data - When the qualitative classes of internal scale data are in an affine relation (linear and b=o, i.e., ax, the classification is ratio relation), the data set is a ratio scale data set. For example, if one collected data on the length of the stock for corn, the data setwould be a ratio scale data set. Note that in this case a 20 cm. stock is twice as long as a 10 cm. stock. If temperature were measured in relation to absolute zero (kevin temperature scale) then classifying soil temperature in kevin would generate a ratio scale data set.

A Scaling factor is the decimal number equal to the ratio of the desired map scale divided by the original map scale.

A Sequential cell record format refers to the method of geocoding a Master File. In this configuration, there is one data record for each grid cell in the study area.

Each record may contain data from several maps, although the codes for each map may or may not contain the new column coordinate of the cell, since the order of the records imply the grid cell address (see section 1.3 of GEORAP).

---

*see: William L. Hays, Statistics, Chapter 3, Holt, Rinehart and Winston, New York, 1963.

Spatial analyses are any one of a set of manipulations of map data. The analyses may or may not consist of numerical techniques, but in the context of this documentation, the analyses consist of an algorithm performed on a set of map data so that the data is either transformed, changed or displayed visually.

A Symbol is the graphic character which represents a data value in the map. A symbol may consist of a graphic character (A,B,C,...) or may consist of an overprint of characters in order to achieve a grey-tone shading effect. The symbol is selected according to the option selected for the mapping phase, and the mapping directive associated with each cell.

Two-key matching refers to a computer technique of identifying specific co-occurrence of data values. In two-key matching, the computer uses two factors in-searching for a match, which the user has identified in the MATCH phase of GEORAP. Each match is assigned an integer identification code, that can be used as a mapping directive or another factor.

A Window consists of a subset of map data extracted from the entire study area data base. A window is always rectangular. Windows may be specified by either the row and column boundaries of the rectangle or by data values read from the Work File. When using data values for a window, only those areas which have a factor-value matching those values specified by the user are included. Otherwise, the

area is left blank. Thus, for example, a window may be created that only contains data from a certain region of the study area. Data windows are selected with the WINDOW phase of GEORAP (see WINDOW phase, section three of GEORAP).

The Work File is the binary equivalent of the Master File, except only those factors specifically retrieved by the user are contained on the Work File. This file is the actual working file for GEORAP, from which map data are read and intermediate data results are stored.

The Working file is a binary representation of the inputted geocoded file. This file is used for editing and manipulation purposes in the GEOMAST program.

GEOMAST: APPENDIX I

OPERATING INSTRUCTIONS FOR GEOMAST ON AN IBM SYSTEM

OPERATING INSTRUCTIONS FOR GEOMAST ON AN IBM SYSTEM

I. IBM DOS/VS

Version 2.0 of GEOMAST has been adapted to run on an IBM DOS/VS system. Below is the job control language necessary for running GEOMAST.

Certain aspects of the job control language can only be specified after the program is installed on the computer system, since items such as track numbers, unit numbers, and data set names will be established at that time. These items are shown in lower case letters where appropriate. The below assumes that the GEOMAST system resides on the computer's core image library under the name GEOMAST.

It is assumed that the disk serial number is "CRIES 1" and that on this disk there are contiguous tracks. The number of tracks used here are merely an estimate and the user must increase/decrease the number of tracks depending on specific maps being processed. Moreover, the geocoded file is assumed to be on cards. If the geocoded file is on disk, then appropriate EXTENT and DLBL cards are required for LUN10(SYS007).

```
                                                        Logical
                                                        Unit
                                                        Number

//    JOB
//    ASSGN   SYS001,SYSIPT                   ATTRIBUTE TABLE   4
//    ASSGN   SYS002,Xcuu                     NEW MASTER FILE   5
//    EXTENT  SYS002,CRIES 1,1,0,1000,200
//    DLBL    IJSYS02,'NEW.MASTER',0
//    ASSGN   SYS003,Xcuu                     GEOCODED MASTER   6
//    EXTENT  SYS003,CRIES 1,1,0,1200,200
//    DLBL    IJSYS03,'GCDD.MASTER',0
//    ASSGN   SYS004,Xcuu                     WORKING FILE      7
//    EXTENT  SYS004,CRIES 1,1,0,1400,300
//    DLBL    IJSYS04,'PRIME.WORK.FILE',0
```

```
//    ASSGN   SYS005,Xcuu                        SCRATCH FILE      8
//    EXTENT  SYS005,CRIES1,1,0,1700,200
//    DLBL    IJSYS05,'SCRATCH.FILE',0
//    ASSGN   SYS006,SYSLST                      PRINT FILE        9
//    ASSGN   SYS007,SYSIPT                      GEOCODED FILE    10
//    ASSGN   SYS008,Xcuu                        2ND WORK FILE    11
//    EXTENT  SYS008,CRIES1,1,0,1900,300
//    DLBL    IJSYS08,'SECOND.WORK.FILE',0
//    ASSGN   SYS009,SYSLST                      OUTPUT FILE      12
//    ASSGN   SYS010,Xcuu                        OLD MASTER FILE  13
//    EXTENT  SYS010,CRIES1,1,0,2200,300
//    DLBL    IJSYS10,'OLD.MASTER',0
//    ASSGN   SYS011,Xcuu                        BOUNDARY FILE    14
//    EXTENT  SYS011,CRIES1,1,0,2500,200
//    DLBL    IJSYS11,'BDRY.FILE',0
//    EXEC    GEOMAST
                  GEOCODED FILE
/*
                  ATTRIBUTE TABLE
/*
                  GEOMAST COMMANDS
/*
/&
```

II. IBM OS/MFT

Version 1.0 of GEOMAST has been adapted to run on an IBM 360 OS/MFT system. The load module when overlayed requires roughly 64k of core memory to fit the root and longest phase stored on disk. The load module is assumed to be named GEOMAST in what follows and is a part of a partitioned data set whose DSN is assumed to be CRIES.EXEC which would normally contain the load modules of GEOMAST and GEORAP as well as other geographic analysis computer program load modules. Lastly, in the sequel it is assumed that the volume label on the 2314 disk unit is CRIES1.

The GEOMAST commands are assumed to be from cards. It is also assumed that the default logical unit number (LUN) for the card reader is 5 and the default LUN for the line printer is 6. The geocoded data input file to be processed by GEOMAST is assumed to be a coded card image sequential disk file whose DSN name is GEOCODE.SQUARE.(*). If the geocoded data input file is on cards, LUN10 would be //FT10F001 DD . The old master file is assumed to be a coded card image sequential disk file whose DSN is OLD.MASTER. (*). If there is no old master file, the following is the type of cards that need to be present:

```
// FT13F001    DD  UNIT=SYSSQ,
//                SPACE=(80,(10,5))
//                DCB=(RECFM=FB,BLKSIZE=80,LRECL=80)
```

Likewise the new master is assumed to be a coded card image sequential disk file with a block size of 800 whose DSN is NEW.MASTER. (*). The standard map containing the official outer boundary lines is assumed to be a binary sequential disk file with up to 255 words (1020 bytes) per record and whose DSN is STDRD.BASE. (*).

---

*Further descriptors as necessary.

```
// CEXECGMT JOB
// GEOMAST   EXEC  PGM=GEOMAST,REGION=100K
// STEPLIB   DD  DISP=SHR,UNIT=2314,VOL=SER=CRIES1,
             DSN=CRIES.EXEC.
// FT06F001  DD  SYSOUT=A,                      OUTPUT
// FT07F001  DD  UNIT=SYSSQ,                    WORKING FILE
//           SPACE=(400,(400,80)),
//           DCB=(RECFM=VBS,BLKSIZE=1024)
// FT08F001  DD  UNIT=SYSSQ,                    SCRATCH FILE
//           SPACE=(1024,(400,80)),
//           DCB=(RECFM=VBS,BLKSIZE=1024)
// FT09F001  DD  SYSOUT=A,                      BATCH OUTPUT
//           DCB=(RECFM=UA,BLKSIZE=133)
// FT10F001  DD  UNIT=2314,VOL=SER=CRIES1,      GEOCODED FILE
//           DISP=(OLD,KEEP),
//           DSN=GEOCODE.SQUARE.(*)
// FT11F001  DD  UNIT=SYSSQ,                    2ND WORK FILE
//           SPACE=(1024,(400,80)),
//           DCB=(RECFM=VBS, BLKSIZE=1024)
// FT12F001  DD  SYSOUT=A,                      OUTFILE
//           DCB=(RECFM=UA, BLKSIZE=133)
// FT13F001  DD  UNIT=2314,VOL=SER=CRIES1,      OLD MASTER FILE
//           DISP=(OLD,KEEP),
//           DSN=OLD.MASTER.(*),
// FT14F001  DD  UNIT=2314,VOL=SER=CRIES1,      BOUNDARY FILE
//           DISP=(OLD,KEEP),
//           DSN=STDRD.BASE.(*),
// FT15F001  DD  UNIT=2314,VOL=SER=CRIES1,      NEW MASTER FILE
//           DISP=(NEW,KEEP),DSN=NEW.MASTER,
//           SPACE=(800,(500,80),RLSE),
//           DCB=(RECFM=FB,BLKSIZE=800,LRECL=80)
// FT15F002  DD UNIT=2314,VOL=SER=CRIES1,       GEOCODED MASTER
//           DISP=(NEW,KEEP),DSN=NEW.GMASTER,
```

* other alphanumeric descriptions

```
//              SPACE=(800,(500,80),RLSE),
//              DCB=(RECFM=FB,BLKSIZE=800,LRECL=80)
// FT05F001     DD                                  GEOMAST CMDS
                  GEOMAST COMMANDS - INSERT CARDS HERE
// FT10F001     DD *                                ATTRIBUTE TABLE
                  ATTRIBUTE TABLE (if any) CARDS
/*
//
```

GEOMAST: APPENDIX II

DEMONSTRATION OF INTERACTIVE SESSION WITH GEOMAST

II. DEMONSTRATION OF INTERACTIVE SESSION WITH G E O M A S T

```
G E O M A S T  VERSION 1.0  04-01-80

PHASE DIRECTIVE  >CH,1
  COLUMN ERROR  ROW=     5PREVIOUS COLUMN=    10 CURRENT COLUMN=     9 NEXT COLUMN=
ENTER EDITOR COMMAND OR H(ELP)
>H
  HELP --  LINE EDITOR COMMAND INFORMATION
 A(BORT)  - ABORT THE CHECK RUN
 C(HANGE) - CHANGE TO BATCH MODE CHECKING
 D(ELETE) - DELETE A ROW OR COLUMN
 G(O)     - HALT EDITING AND CONTINUE CHECKING
 H(ELP)   - GET COMMAND INFORMATION
 I(NSERT) - INSERT A ROW OR COLUMN
 L(IST)   - LIST THE CURRENT ROW
 R(EPLACE)- REPLACE A ROW OR COLUMN
 T(ABLER) - LIST THE ATTRIBUTE TABLE

ENTER EDITOR COMMAND OR H(ELP)
>R
 ENTER REPLACE COMMAND: ALPHA,INT,INT
>C,9,14
 ENTER REPLACE COMMAND: ALPHA,INT,INT
>E
ENTER EDITOR COMMAND OR H(ELP)
>L
 ROW=    5
     COL=    1  ATRIB=    0
     COL=    4  ATRIB=    1
     COL=   10  ATRIB=    2
     COL=   14  ATRIB=    0
ENTER EDITOR COMMAND OR H(ELP)
>G
COLUMN ATTRIBUTE TOO LARGE
MAXCOL=   20  COLUMN VALUE =   21
ENTER EDITOR COMMAND OR H(ELP)
>D
 ENTER DELETE COMMAND: ALPHA,INT,INT
>C,21
 ENTER DELETE COMMAND: ALPHA,INT,INT
>E
ENTER EDITOR COMMAND OR H(ELP)
>L
 ROW=    9
     COL=    1  ATRIB=    0
     COL=    4  ATRIB=    1
     COL=   11  ATRIB=    2
     COL=   16  ATRIB=    0
ENTER EDITOR COMMAND OR H(ELP)
>G
  COLUMN ERROR  ROW=    12PREVIOUS COLUMN=    11 CURRENT COLUMN=    11 NEXT COLUMN=    17
ENTER EDITOR COMMAND OR H(ELP)
>D
```

```
 ENTER DELETE COMMAND: ALPHA,INT,INT
>C,11
 ENTER DELETE COMMAND: ALPHA,INT,INT
>E
ENTER EDITOR COMMAND OR H(ELP)
>R
 ENTER REPLACE COMMAND: ALPHA,INT,INT
>A,11,3
 ENTER REPLACE COMMAND: ALPHA,INT,INT
>E
ENTER EDITOR COMMAND OR H(ELP)
>L
 ROW=   12
     COL=     1  ATRIB=     0
     COL=     5  ATRIB=     1
     COL=     9  ATRIB=     2
     COL=    11  ATRIB=     3
     COL=    17  ATRIB=     0
ENTER EDITOR COMMAND OR H(ELP)
>G
  ROW VALUE ERROR   EXPECTED VALUE=     15  ACTUAL VALUE=     10
ENTER EDITOR COMMAND OR H(ELP)
>R
 ENTER REPLACE COMMAND: ALPHA,INT,INT
>R,15
 ENTER REPLACE COMMAND: ALPHA,INT,INT
>E
ENTER EDITOR COMMAND OR H(ELP)
>L
 ROW=   15
     COL=     1  ATRIB=     0
     COL=     5  ATRIB=     1
     COL=    12  ATRIB=     3
     COL=    17  ATRIB=     0
ENTER EDITOR COMMAND OR H(ELP)
>G
 ATTRIBUTE ERROR  ROW=     17 COLUMN=     14 ATTRIBUTE=      5
ENTER EDITOR COMMAND OR H(ELP)
>R
 ENTER REPLACE COMMAND: ALPHA,INT,INT
>A,14,3
 ENTER REPLACE COMMAND: ALPHA,INT,INT
>E
ENTER EDITOR COMMAND OR H(ELP)
>L
 ROW=   17
     COL=     1  ATRIB=     0
     COL=     4  ATRIB=     1
     COL=    14  ATRIB=     3
     COL=    19  ATRIB=     0
ENTER EDITOR COMMAND OR H(ELP)
>G
ERROR -- MORE DATA THAN MAXROW  ROW=    21
ENTER EDITOR COMMAND OR H(ELP)
```

```
>D
 ENTER DELETE COMMAND: ALPHA,INT,INT
>R,21
 ENTER DELETE COMMAND: ALPHA,INT,INT
>E
ENTER EDITOR COMMAND OR H(ELP)
>G
      CHECKS ERROR SUMMARY
             2  ROW ERRORS
             3  COLUMN ERRORS
             1  ATTRIBUTE ERRORS
PHASE DIRECTIVE  >CHECK
      CHECKS ERROR SUMMARY
             0  ROW ERRORS
             0  COLUMN ERRORS
             0  ATTRIBUTE ERRORS
PHASE DIRECTIVE  >MAP
ENTER SCALING FACTOR ( OR 0) >0

    0000000000000000000000000000000
    0000000000000000000000000000000
    0000000000000011111111112000000
    0000012345678901234567890000000
0000                                0000
0000                                0000
0000                                0000
0001                                0001
0002                                0002
0003          A                     0003
0004         AAA                    0004
0005        AAAAAABBBB              0005
0006        AAAAAAABBB              0006
0007        AAAAAAABBB              0007
0008        AAAAAAABBB              0008
0009        AAAAAAABBBBB            0009
0010        AAAAAABBBBBCC           0010
0011        AAAAAABBBCCCCC          0011
0012         AAAABBCCCCCC           0012
0013         AAAACCCCCCCC           0013
0014         AAAAACCCCCCC           0014
0015         AAAAAAACCCCC           0015
0016        AAAAAAAAACCCCCC         0016
0017        AAAAAAAAAACCCCC         0017
0018         AAAAAAAAACCCCCC        0018
0019                                0019
0020                                0020
0000                                0000
0000                                0000
0000                                0000
    0000000000000000000000000000000
    0000000000000000000000000000000
    0000000000000011111111112000000
    0000012345678901234567890000000
```

```
  VALUE  PRINT CHARACTER  FREQUENCY
    0                       224
    1          A             98
    2          B             28
    3          C             50


PHASE DIRECTIVE  >END
 BEGIN BOUNDRY ALIGNMENT

CELL (      4,    18 ) COULD NOT BE CLASSIFIED
       8 ALIGNMENT ERRORS FOUND
NET CHANGE IN CELL COUNT =      3 CELLS
END BOUNDRY ALIGNMENT

PHASE DIRECTIVE  >MRGE,1
BEGIN MERGING
MERGED FILE WRITTEN TO UNIT 8
END OF MERGE
PHASE DIRECTIVE  >END,NOCOPY
BINARY WORKING FILE ON UNIT  11
```

```
1
(7I3)
(13I3)
(I1)
  1 20  1 20  0  3 13  DEMO FILE (WITH ERRORS)
  1  1  0
  2  1  0
  3  1  0  6  1  7  0
  4  1  0  5  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
 10  1  0  5  1 12  3 17  0
 16  1  0  4  1 13  3 19  0
 17  1  0  4  1 14  5 19  0
 18  1  0  5  1 14  3 20  0
 19  1  0
 20  1  0
 21  1  0
```

```
1
(7I5)
(11I3)
  1 20  1 20  1  3 11  BASE FOR DEMO FILE
  1  1  0
  2  1  0
  3  1  0  6  1  7  0
  4  1  0  5  1  8  0 13  1 19  0
  5  1  0  5  1 19  0
  6  1  0  5  1 14  0
  7  1  0  4  1 14  0
  8  1  0  4  1 14  0
  9  1  0  4  1 16  0
 10  1  0  4  1 17  0
 11  1  0  4  1 18  0
 12  1  0  5  1 17  0
 13  1  0  5  1 17  0
 14  1  0  5  1 17  0
 15  1  0  5  1 17  0
 16  1  0  4  1 19  0
 17  1  0  4  1 19  0
 18  1  0  5  1 20  0
 19  1  0
 20  1  0
```

II. Data Files Associated with Demonstration Session

A. Data Containing Errors

B. Corrected Data File for Merging

C. Merged Data

GEOMAST: APPENDIX III

THE GEOCODING PROCESS

I. GRID GEOCODING CONCEPTS

Maps are incorporated into the GEOMAST Master File using a grid geocoding technique. Usually a grid referencing system is first established by selecting a "window" from the UTM international earth coordinate system grid used for topographic base maps. The "window" isolates the county or study area and is divided into regularly spaced rows and columns at one kilometer intervals forming a grid where each grid cell covers a 1 km^2 area.

Each grid cell is assigned a row-column coordinate that serves as a unique cell address. Such notation is similar to standard matrix notation, with row numbers increasing from north to south (top to bottom) and column numbers increasing from west to east (left to right). The cell address is written as a coordinate pair. As a convention, the row coordinate is always given first. For example, the grid cell in the northwest corner of the grid in Figure A-III-1 has the coordinate (1,201) (row=1, column=201).

Map data are recorded in the grid geocoding technique by assigning to each grid cell a number code representing a single map unit that occurs within that cell. Cells which contain a mapping unit boundary must be assigned a single code, based on the dominant mapping unit within that cell. By recording map data for each cell, the irregular shape of the map unit is approximated by a gridded polygon with step-like boundaries (Fig. A-III-2). The smaller the cell size relative to the mapping unit size, the closer the original map unit shape can be approximated in computer produced maps. Also, the confidence limit for area statistics is narrowed because the sampling error is decreased (i.e., more cells occur within each map unit).

An example of the grid geocoding concept can be seen in Figure A-III-2. A typical configuration of map units (Fig. A-III-2A) could be spatially complex, with interlocking borders of many "bays" and "peninsulas". Each map unit is assigned a number legend (Fig. A-III-2B), with the area outside the map area assigned a zero (0)

Figure A-III-1
Expanded view of coding square (1,3)

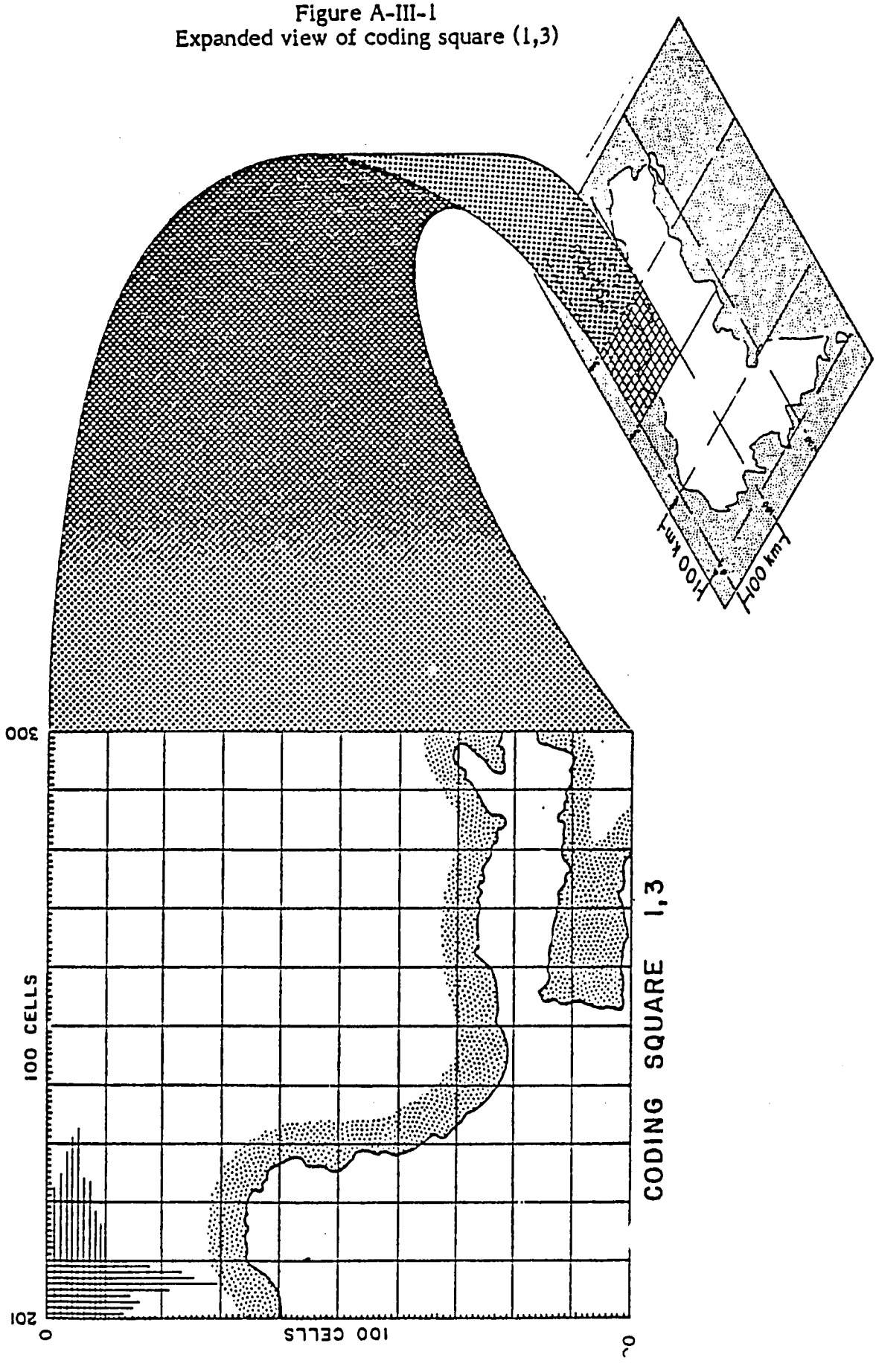
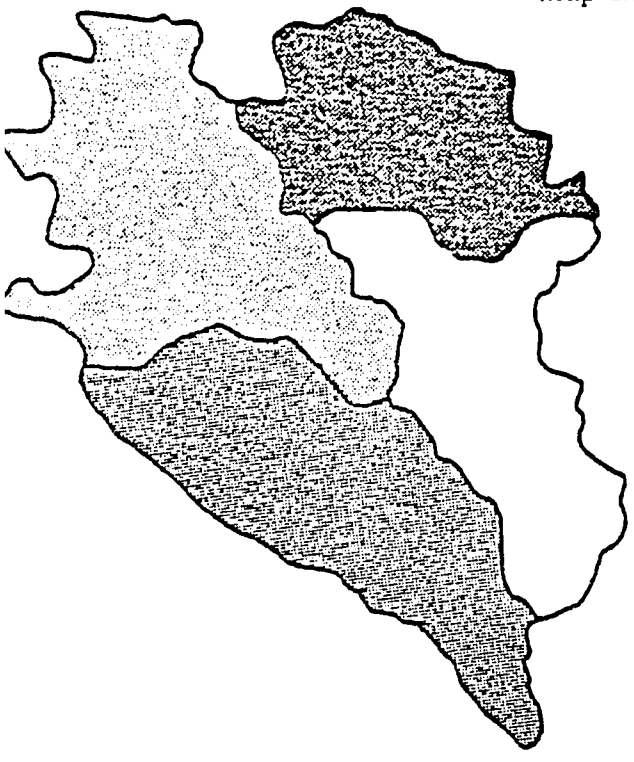
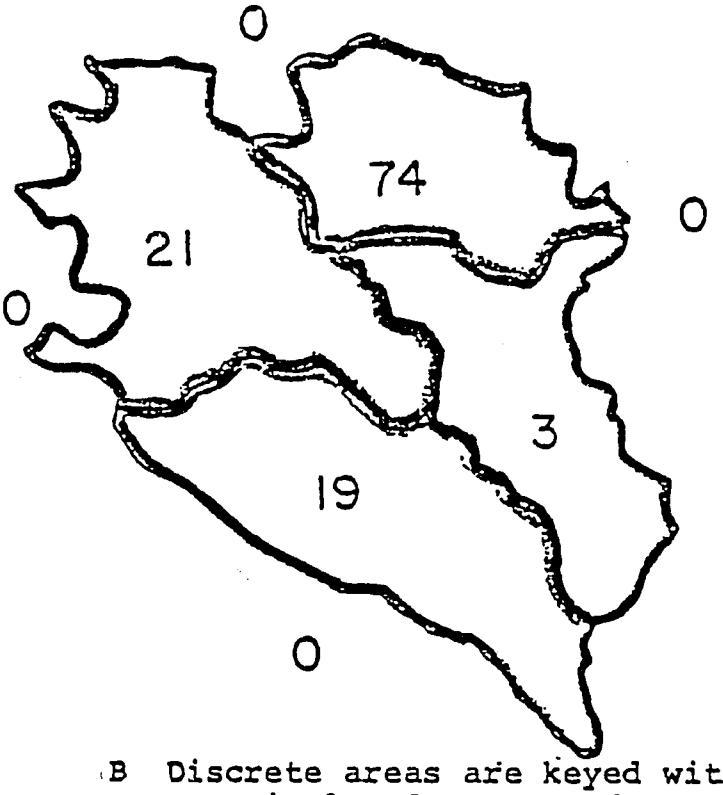


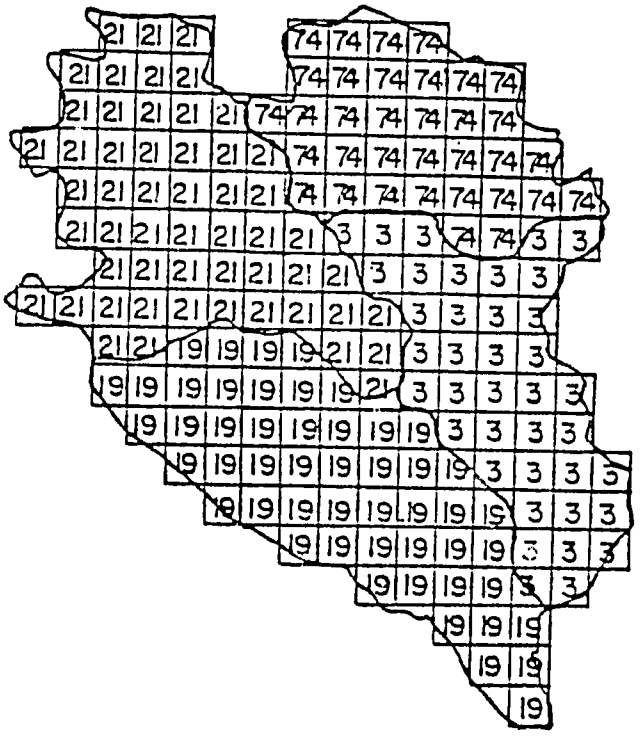
Figure A-III-2
Map units are represented by grid cells.



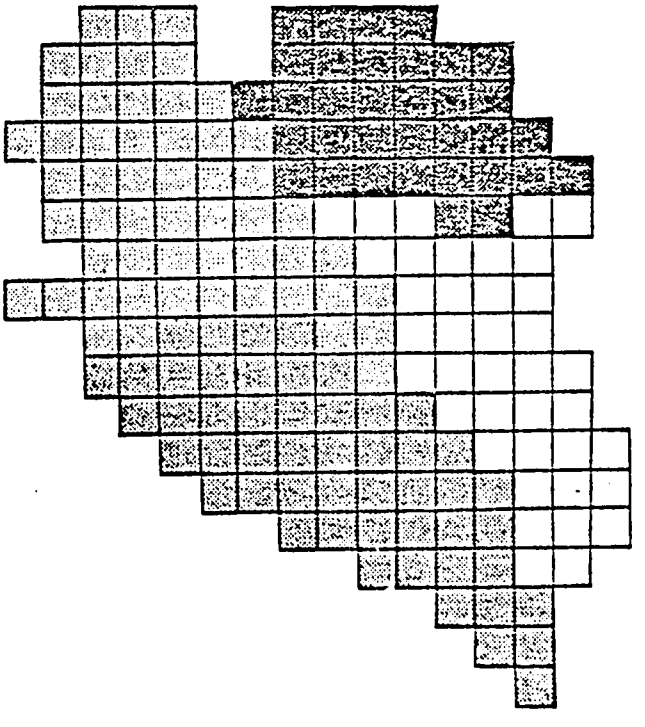
A. Uncoded base map.



B Discrete areas are keyed with numerical codes. Non-features are keyed as zero.



C. Approximation of map by cells.



D. Reconstructed base map.

code. A grid is superimposed over the map and the number code of the dominant map unit falling within the grid cell is assigned to each cell (Fig. A-III-2C). Thus, the original shape of the map units are generally approximated by the configuration of grid cells shown in Figure A-III-2D.

The full potential of a mapping system can be realized when a series of maps are incorporated with each map introducing different types of data. Since the grid serves as a coordinate system that can be located on different maps, it serves to relate the characteristics of a particular cell from map to map. Therefore, for each cell, data from many different maps can be entered into the master file and later retrieved for cross-classification, integration, interpretation and analysis.

II. DATA COMPRESSION

Since the area of the "window" used to isolate the study area is large, the typical grid file requires a substantial amount of computer storage capacity and processing time for even simple transformations. For example, a county isolated within a 200 km by 400 km window would require 80,000 records, one for each grid cell, to store information. The storage and transfer of such a data base can be problematic. Therefore, a method of data compression is used.

The 1 km^2 grid cell is small compared to the average size of mapping units being recorded. Consequently, there are many cells between map unit boundaries with duplicate map codes. Only the grid cells intersecting a map boundary are needed to record the necessary information (Fig. A-III-3). Through the elimination of duplicate records, the size of the data base can be substantially reduced.

III. PREPARATION OF MAPS AND GRIDS

A manual process was developed to geocode the maps. This overall procedure of data capture, verification, and storage consists of a series of discrete steps; each step must be completed before the next step is undertaken (Fig. A-III-4). A two-person coding team records on coding forms the row and column coordinates of grid cells in which a map boundary is located. Coding forms are keypunched for subsequent data verification and mapping. Data are verified by comparing each map to a standard map to establish a consistent land total and a national boundary location. The data files are used to produce a computer map for visual comparison against the original map. Errors detected in the verification process are corrected and the procedure repeated until all detectable errors are located and corrected. Finally, each verified map file is combined with other map files in order to create the Master File.

Figure A-III-3
Areas are encoded only at transition cells as map is scanned from the left to the right

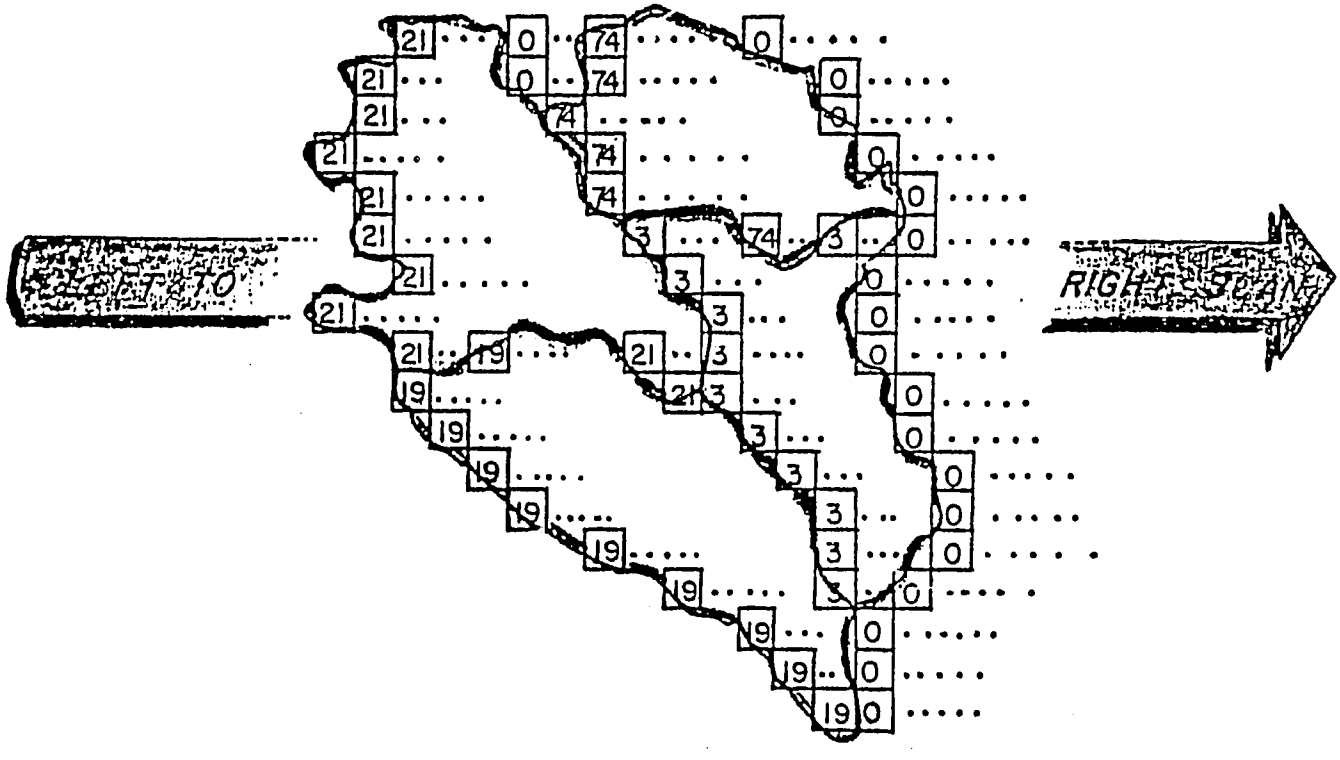
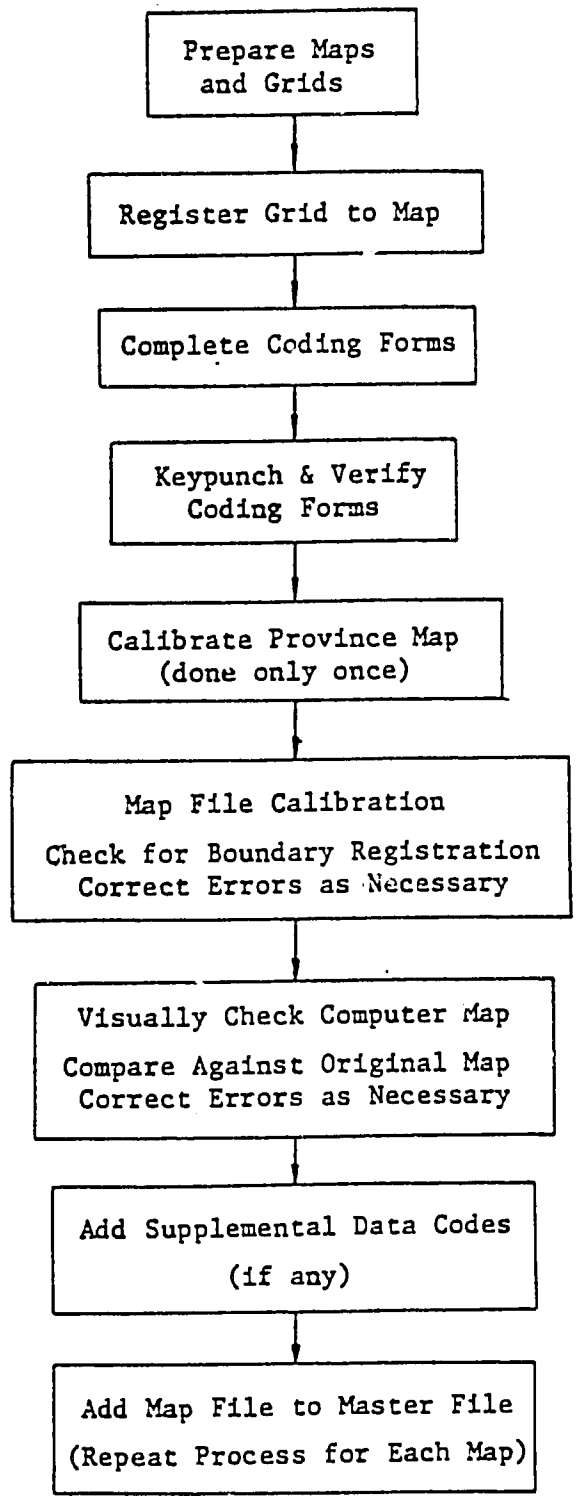


Figure A-III-4
Flowchart of procedures used to assemble the digital map files



GEORAP: APPENDIX I

OPERATING INSTRUCTIONS FOR GEORAP ON AN IBM SYSTEM

OPERATING INSTRUCTIONS FOR GEORAP ON AN IBM SYSTEM

A. IBM DOS/VS

Version 3 of GEORAP has been adapted to run on an IBM DOS/VS system. Below is the job control language necessary for running GEORAP, retrieving the map data files, and retaining the workfile.

Certain aspects of the job control language can only be specified after the program is installed on the computer system, since items such as track numbers, unit numbers, and data set names will be established at that time. These items are shown in lower case letters where appropriate. The job control language given in this section assumes that the GEORAP system resides on the computer's core image library under the name GEORAP.

The job control language for an IBM DOS/VS system is as follows:

```
//  JOB
//  ASSGN SYS005,Xcuu            master file - MSTRFY (coded or binary)
//  DLBL IJSYS05,dataset id,date,code
//  EXTENT SYS005,serial#,type,,initial track #,# of tracks,split cyliner
    tracks
*
//  ASSGN SYS006,Xcuu            work file - WORKFY (binary)
//  ASSGN SYS007,Xcuu            buffer area - PHASFY (binary)
//  ASSGN SYS008,Xcuu            scratch file areas - SCRATC (binary)
//  ASSGN SYS009,Xcuu            buffer file areas - BUFFER - (binary)
//  ASSGN SYS010,SYSLST          map file, line printer - MAPFIL (coded)
//  ASSGN SYS011,Xcuu            new master file - NEWFIL (coded or
                                 binary)
//  EXEC GEORAP
.
.                                GEORAP phase directives and other
.                                program data
```

---

*Or if the MASTER FILE is on cards, the following card replaces the above three:

```
//  ASSGN SYS005, SYSIPT
```

```
/*
/&
```

Some DOS operating systems have default DLBL and EXTENT. However, it is usefule to insert DLBL and EXTENT cards.

```
// DLBL IJSYS05, 'MSTRFY'
// EXTENT SYS005,,,, 1290,10
// DLBL IJSYS06, 'WORKFY'
// EXTENT SYS006,,,, 1300,10
```

The lower case letters in the job control language are defined as:

cuu	c = 0 for the multiplexor channel 1-6 for the selector channels uu = the unit address
dataset id	name associated with data set on the volume
date	indicates either the retention period or absolute expiration date retention period as: d to dddd absolute expiration date as: yy/ddd
code	is the type of data set label to be used (usually SD)
serial #	is the volume serial number (1 through 60 numeric characters)
type	is the type of extent to be used 1 = data area (no split cylinder) 2 = data area (split cylinder) 1 is assumed if this parameter is omitted
split cylinder tracks	is the upper tracks number(s) for split cylinder extent

<u>SYS005</u> is the Master File (LUN 8), MASTRFY. Its size will depend on the size of the data file created. Note that if SYS005 is assigned to be the card

reader (the Master File is on cards), the REWIND MSTRFY statement in the main program must be removed.

SYS006 is the Work File (LUN9), WORKFY.

SYS007 is the Phase File (LUN 10), PHASFY. Whenever a phase is processed the factors called by that phase and their associated row/column coordinates are written on LUN 10. Thus, the disk space allocated to SYS007 is usually less than that allocated to SYS006.

SYS008 is the Scratch File (LUN 11), SCRATC.

Used by WINDOW phase as scratch File - binary

Used by DELETE phase as scratch File - binary

Used by SCALE phase as scratch file - binary

SYS009 is the Buffer File (LUN 12), BUFFER.

Used by GROUP phase - binary.

SYS010 is the Map File (LUN 13), MAPFIL.

Used by PMAP, HIST, TMAP phases, MAPFIL is a formatted, printer image (132 characters) file. Thus, it can be fixed record length of 133 and blocked.

SYS011 is the NEW Master File (LUN 14), NEWFIL. This can either be a coded or binary file depending on user option. In general the same amount of space as that used for the Work File should be allocated unless Work File is binary and New File is coded in which case one generally needs more space.

B. IBM OS/MFT

Version 3 of GEORAP has been adapted to run on an IBM 360 OS/MFT system. The load module when overlayed requires roughly 98K of core memory to fit the root and longest phase and stored on disk. The DD name for this load module is assumed to be GEORAP in what follows and is a part of partitioned data set whose DSN is assumed to be CRIES.EXEC which would normally contain

the load modules of GEOMAST and GEORAP as well as other geographic analysis computer program load modules. Lastly, in the sequel it is assumed that the volume label on the 2314 disk unit is CRIES1. See Section A above for a discussion of the logical units used for input/output and processing.

The GEORAP commands are assumed to be from cards. If the Master File is also on cards (here it will be assumed to be on a disk file whose DSN is CRIES.MASTER), logical unit 8 would be. // FTO8F001 DD *. It is also assumed that the default LUN for the card reader is 5 and the default LUN for the liner printer is 6.

```
// CEXECRAP   JØB ....
// RAP        EXEC PGM=GEØRAP, REGIØN = 100K
// STEPLIB    DD DISP=SHR, UNIT=2314, VØL=SER=CRIES1,
               DSN=CRIES.EXEC
// FT06F001   DD SYSØUT=A                          ØUTPUT
// FT08F001   DD DSN=CRIES.MASTER, DISP=(ØLD,KEEP), UNIT=2314,
               VØL=SER=CRIES1
// FT09F001   DD UNIT=SYSSQ,                       WØRKFILE
//            SPACE=(400,(400,80)),
//            DCB=(BUFNØ=1,RECFM=VBS,BLKSIZE=400)
// FT10F001   DD UNIT=SYSSQ,                       PHASE FILE
//            SPACE=(400,(400,80)),
//            DCB=(BUFNØ=1,RECFM=VBS,BLKSIZE=400)
// FT11F001   DD UNIT=SYSSQ,                       SCRATCH FILE
//            SPACE=(400,(400,80)),
//            DCB=(BUFNØ=1,RECFM=VBS,BLKSIZE=400)
// FT12F001   UNIT=SYSSQ,                          BUFFER
//            SPACE=(400,(400,80)),
//            DCB=(BUFNØ=1,RECFM=VBS,BLKSIZE=400)
// FT13F001   SYSØUT=A,                            MAP FILE
//            DCB=(BUFNØ=1,RECFM=UA,BLKSIZE=133)
// FT14F001   DD UNIT=2314,VØL=SER=CRIES1,         NEWFILE
//            DISP=(NEW,KEEP),DSN=CRIES.NEW.MASTER,
//            SPACE=(1600,(500,100),RLSE),
//            DCB=(RECFM=FB,BLKSIZE=1600,LRECL=80)
```

```
// FT05F001      DD *                                GEØRAP CMDS
                 GEØRAP CØMMANDS CARDS
//
```

Note: The spaces allocated are estimated for relatively small problems and would have to be changed for larger applications. Moreover, if a new master file is not going to be created, then the FT14F001 sequence of control cards can be changed to the following:

```
// FT14F001      DD UNIT=SYSSQ,                      NEW FILE
//               SPACE=(400,(400,80)),
//               DCB=(BUFNØ=1,RECFM=FB,BLKSIZE=400,LRECL=80)
```

Note: If OPT 2=2 in the NEWFILE phase is specified, a binary file is required. Thus RECFM=VS or VBS must be specified for the DCB parameter on the DP card(s).

The description of the various logical units, their contents and types of records written or read of section A of this Apppendix apply to the OS/MFT system and ought to be consulted. For a discussion on record formats and format control see pages 69-75 of IBM System/360 Operating System Fortran IV (G and H) Programmer's Guide.

GEORAP: APPENDIX II

AN EXAMPLE RUN

```
*****************************************************************************

nFI[redacted]E TL KAP (RESOURCE ANALYSIS PROGRAM)

ENTER PHASE DIRECTIVE AND OPTIONS (NAME,INT,INT):

WORK,4,1,1,1
```

```
*****************************************************************

WORKFILE PHASE CALLED

ENTER ROW & COLUMN SIZE OF MASTER FILE GRID (INT,INT):
20,20

ENTER NUMBER OF FACTORS TO BE RETRIEVED FROM THE MASTER FILE (INT):

2

ENTER NAME FOR FACTOR     1 (NAME):
PROV

ENTER NAME FOR FACTOR     2 (NAME):
SUEL

ENTER MASTER FILE FORMAT (20A4):


    2 FACTORS TO BE RETRIEVED WITH FORMAT:  (4I5)
    ANTICIPATED ROW,COL SIZE:      20 BY   20
    DATA TYPE -  4    CONVERSION OPTION -  1

HEADER RECORDS
   20    1   20   20    1   20    2     MERGED MASTERFILE...TEST1+2... 12/04/79

    94 COORDINATE PAIRS HAVE BEEN WRITTEN ON THE WORKFILE

END WORKFILE PHASE

ELAPSED TIME FOR PHASE EXECUTION:      4.61 CP SECONDS

ENTER PHASE DIRECTIVE AND OPTIONS (NAME,INT,INT):

XTAB
```

```
*****************************************************************

MINITAB PHASE CALLED
ENTER HEADER FOR EACH PAGE (20A4):

    DGRAPHIC ANALYSIS PROGRAM EXAMPLE RUN-------
 ENTER NO OF TABLES
1

ENTER INFO ABOUT VARS
    1.)  NUX- FIELD WHEN READ
    2.)  NCODI-NO. OF CATEGORIES,2-100
    3.)  MC- AUTO CATEGORIES(1 YES, 0 NO)
PROV,5,1

VARIABLE NUMBER     1 SEQUENCE    1 SOURCE    1
    CATEGORY    1 MIN          1 MAX          1 OTHER VALUE          1       001
    CATEGORY    2 MIN          2 MAX          2 OTHER VALUE          2       002
    CATEGORY    3 MIN          3 MAX          3 OTHER VALUE          3       003
    CATEGORY    4 MIN          4 MAX          4 OTHER VALUE          4       004
    CATEGORY    5 MIN          5 MAX          5 OTHER VALUE          5       005

ENTER INFO ABOUT VARS
    1.)  NUX- FIELD WHEN READ
    2.)  NCODI-NO. OF CATEGORIES,2-100
    3.)  MC- AUTO CATEGORIES(1 YES, 0 NO)
SUEL,8,1

    ABLE NUMBER     2 SEQUENCE    2 SOURCE    2
    CATEGORY    1 MIN          1 MAX          1 OTHER VALUE          1       001
    CATEGORY    2 MIN          2 MAX          2 OTHER VALUE          2       002
    CATEGORY    3 MIN          3 MAX          3 OTHER VALUE          3       003
    CATEGORY    4 MIN          4 MAX          4 OTHER VALUE          4       004
    CATEGORY    5 MIN          5 MAX          5 OTHER VALUE          5       005
    CATEGORY    6 MIN          6 MAX          6 OTHER VALUE          6       006
    CATEGORY    7 MIN          7 MAX          7 OTHER VALUE          7       007
    CATEGORY    8 MIN          8 MAX          8 OTHER VALUE          8       008
ENTER NO. OF VARIABLES PER TABLE
2
ENTER VARS FOR EACH TABLE
SUEL,PROV

TABLE    1 CONSISTS OF     SUEL BY     PROV CONTROLLED BY
```

MINI-TAB CROSS-TABS
TABLE NUMBER 1 MAJOR GROUP 1 GEOGRAPHIC ANALYSIS PROGRAM EXAMPL

VARIABLE 1

VARIABLE 2		TOTAL	001	002	003	004	005
TOTAL	PERCENTAGE	100.0	18.8	18.8	18.8	25.0	18.8
	FREQUENCY	400.0	75.0	75.0	75.0	100.0	75.0
001	PERCENTAGE	13.8	73.3	0.0	0.0	0.0	0.0
	FREQUENCY	55.0	55.0	0.0	0.0	0.0	0.0
002	PERCENTAGE	11.3	26.7	0.0	0.0	25.0	0.0
	FREQUENCY	45.0	20.0	0.0	0.0	25.0	0.0
003	PERCENTAGE	13.8	0.0	40.0	0.0	25.0	0.0
	FREQUENCY	55.0	0.0	30.0	0.0	25.0	0.0
004	PERCENTAGE	11.3	0.0	60.0	0.0	0.0	0.0
	FREQUENCY	45.0	0.0	45.0	0.0	0.0	0.0
005	PERCENTAGE	13.8	0.0	0.0	73.3	0.0	0.0
	FREQUENCY	55.0	0.0	0.0	55.0	0.0	0.0
006	PERCENTAGE	11.3	0.0	0.0	26.7	25.0	0.0
	FREQUENCY	45.0	0.0	0.0	20.0	25.0	0
007	PERCENTAGE	13.8	0.0	0.0	0.0	25.0	40.0
	FREQUENCY	55.0	0.0	0.0	0.0	25.0	30.0
008	PERCENTAGE	11.3	0.0	0.0	0.0	0.0	60.0
	FREQUENCY	45.0	0.0	0.0	0.0	0.0	45.0

CHI-SQUARE 1138.046 WITH 28 DEGREES OF FREEDOM
GAMMA 0.780
SOMERS D 0.749
TAU A 0.598
TAU B 0.715
UNITS EXCLUDED FROM TABLE 0

```
ELAPSED TIME FOR PHASE EXECUTION:      3.68 CP SECONDS

ENTER PHASE DIRECTIVE AND OPTIONS (NAME,INT,INT):

PMAP
```

```
PRINTERMAP PHASE CALLED

ENTER NAME OF FACTOR TO BE MAPPED (NAME):
SUEL

DIMENSIONS WILL BE      8.5 BY      5.1 CENTIMETERS
  (OR     20 ROWS BY     20 COLUMNS)
SAMPLING INTERVAL  ROW- 1.000  COL- 1.000
OPTION 1 -  1  OPTION 2 -  0
FACTOR -SUEL- MAPPED AT 2.4 LINES PER CENTIMETER

DO YOU WANT TO WRITE A MAP  LEGEND (YES OR NO):
NO
MAP PRINTED IN      1 STRIPS
```

```
   000000000000000000000000000000
   000000000000001111111111200000
   000012345678901234567890000000
000                              000
000                              000
000                              000
000                              000
001      AAAAAAAAAACDDDDDDDDD    001
002      AAAAAAAAABCCDDDDDDDD    002
003      AAAAAAAABBCCCDDDDDDD    003
004      AAAAAAABBBCCCCDDDDDD    004
005      AAAAAABBBBCCCCCDDDDD    005
006      AAAAABBBBBCCCCCCDDDD    006
007      AAAABBBBBBCCCCCCCDDD    007
008      AAABBBBBBBCCCCCCCCDD    008
009      AABBBBBBBBCCCCCCCCCD    009
010      ABBBBBBBBBCCCCCCCCCC    010
011      EFFFFFFFFFGGGGGGGGGG    011
012      EEFFFFFFFFGGGGGGGGGH    012
013      EEEFFFFFFFGGGGGGGGHH    013
014      EEEEFFFFFFGGGGGGGHHH    014
015      EEEEEFFFFFGGGGGGHHHH    015
016      EEEEEEFFFFGGGGGHHHHH    016
017      EEEEEEEFFFGGGGHHHHHH    017
018      EEEEEEEEFFGGGHHHHHHH    018
019      EEEEEEEEEFGGHHHHHHHH    019
020      EEFEEEEEEEGHHHHHHHHH    020
000                              000
000                              000
000                              000
000                              000
   000000000000000000000000000000
   000000000000001111111111200000
   000012345678901234567890000000
```

CHARACTER ASSIGNMENT TABLE

CODE	CHARACTER
1	A
2	B
3	C
4	D
5	E
6	F
7	G
8	H

```
END PRINTERMAP PHASE


ELAPSED TIME FOR PHASE EXECUTION:      4.77 CP SECONDS

ENTER PHASE DIRECTIVE AND OPTIONS (NAME,INT,INT):

END
```

E N D R A P .

PROJECT NUMBER:

PROCESS:	ACTION:	DATES:	INITIALS:
CATALOGUE	shelf list - 1656		
ABSTRACT			
FICHE	RANDD		

COMMENTS:

DS/DIU