Title

INTERACTIVE THEMATIC MAPPING ? A REPORT

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Publication Date

1976-10-01

Presented at the Urban and Regional
Information Systems Association,
Atlanta, GA, August 30 - September 2, 1976

LBL-5362
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October 1976

Prepared for the U. S. Energy Research and
Development Administration under Contract W-7405-ENG-48

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LBL-5362

Interactive Thematic Mapping -- A Report

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ABSTRACT

An interactive thematic mapping program is being developed which emphasizes base file dictionaries, interactive techniques, and a data management interface. The data base variables are stored in an explicitly inverted structure, providing fast access to a particular variable across all geo-regions. Built to aid choropleth map design, the program is device independent and part of a larger information system.

INTRODUCTION

Information systems are built to help solve human problems. Once a problem has been defined, information is gathered, analysed, and displayed to provide an aid for decision-making. The effective use of such systems has been limited in part by the amount of effort required to collect the data and to produce and to understand the results.

The thematic mapping techniques developed in recent years have proven valuable as a complement to tabular computer output, as shaded maps can communicate relationships within a geographical region much more easily than tables of numbers. Printer and plotter mapping programs have proliferated. More recently, programs have been developed which can efficiently produce film for multi-color printing [8,10]. Perhaps the best known example of this type of output are the maps of the Urban Atlas Series, a joint project of the Geography Division of the Bureau of the Census, the Department of Labor, and Lawrence Berkeley Laboratory.

However, significant hindrances in making thematic maps are encountered in both the amount of effort required to prepare input to mapping programs and in the turnaround time between runs while refining a map design. Making the mapping process interactive is one step that can be taken to improve mapping use.

Interactive thematic mapping is being developed by the Computer Science and Applied Mathematics Department of the Lawrence Berkeley Laboratory, supported by the Energy Research and Development Administration and the Department of Labor.

SCOPE

The initial goal of this effort has been to significantly enhance the capacity of a person to design choropleth maps while reducing user effort. (A choropleth map is one where shading is done by geographic entity, eg. Census tract.) We have not included in this discussion the design and implementation of a comprehensive geographic information system. Some of the issues involved, e.g., polygon or cell orientation, registration of geo-regions, and contour or 3D mapping are discussed in [2,3,9]. Existing geographic information systems are surveyed in [5,6].

This paper focuses on the approach used in developing an initial interactive thematic mapping module. Four aspects of the internal workings are discussed -- 1) dictionary building, 2) operation flow, 3) inset definition, and 4) shading and titling capabilities. Then the systems environment is described, including 5) device independent graphics, and 6) a data management system interface. An in depth treatment of computer graphics can be found in Newmann and Sproull [8].

DICTIONARIES

One key to successful interactive mapping is having dictionaries of the map and data base files which support efficient retrieval of geographic entities (polygons) and data values, and other common operations for the geo-application. These dictionaries can either be supplied to or compiled by the program.

Desired operations involving the base files were

- polygon retrieval by window and by geocode
- data variable retrieval by name
- direct access to the data value for a map polygon

the dictionaries contain
    for each polygon
        pointer to points
        geocodes of interest
        rectangle defining polygon xy limits
        pointer to corresponding data value
    for each data variable
        name
        pointer to location

Terms - a window is a rectangle defining a neighborhood of interest on the base map. Data variable refers to categories such as income or land use, while data value refers to the value of a variable for a specific area. (See the section on data management interface.)

In general, the dictionaries enable efficient in core searches and minimize disk accesses. The value of the data dictionary is that a variable can be selected for mapping by simply choosing its name from a list displayed on the screen. Only the record selected is retrieved. When drawing a map, the points of a polygon are retrieved only if its xy limits and geocode are not outside the window and geocode of the inset. If the polygon is to be shaded, the shade number (generated from the data value) can be retrieved directly with no need for geocode matching. Including these operations in the design increases the power and efficiency of the program.

PROGRAM OPERATION

One aim of this implementation was to minimize keyboard input. This was done by displaying a menu of commands to the user, one of which is selected at each functional step with the light pen. If appropriate, the next level of commands is displayed. Figure 1 diagrams the initial menu (1a) and the next (1b) if INSET were chosen. Prompts are displayed at each step to guide the user. The tree of functions and possible cross connections is diagrammed in figure 2.

CREATING INSETS

Creating an inset is selecting part of the base map for viewing on part of the screen. Inset selection can be a very powerful tool. Common uses of insets in computer mapping are to enlarge a subarea of interest and to ensure room for titling. Multiple insets allow in additon the display of one variable for several areas and of several variables for one area. Selection by geocode can also be specified for an inset. These options give the interactive user powerful control in designing a map. Figure 4 was composed from a base map of the counties of Federal Region IX.

SHADING AND TITLING

In inset selection, the user selects areas of interest from a display of area outlines. In data selection the user selects a variable of interest from a display of variable names. The user can select shades from a supplied variety or define ones of his choosing and assign them to the intervals of the map. Supported types of choropleth shading are -- character at centroid and parallel or cross-hatched lines. Text is either hardware or vector characters, with various fonts, sizes, orientations, and typing conventions.

DEVICE INDEPENDENCE

Device independence in this system is achieved by accessing different device drivers thru standard calling sequences. Terminal devices include storage tube and refresh displays and hardcopy devices include calcmp plotters and the Stromberg Carlson 4460 microfilm recorder. An intermediate file can be produced which can be displayed on any interactive or hardcopy device.

An important consideration for mapping is ensuring that the designed map appears as much the same as possible on different devices. This is accomplished by the use of vector characters and choice of work space common to all displays.

DATA BASE INTERFACE CONCEPTS

The data base interface is an integral part of the design of interactive CARTE. The geographic base file manager has been described elsewhere [4]. Figure 3 diagrams the selection of data variables for mapping. A study area is defined and the geoarea records from the archival data storage are obtained. These records usually contain much more information than is desired for a study. Study variables are selected from the geoarea records and an inverted file created, i.e., a record now contains all geoarea values for one variable instead of all variables for one geoarea. This makes retrieval for mapping very efficient.

CONCLUSION

The value of dictionaries, interactive graphic techniques and a data management interface have been discussed. The degree to which interactive mapping will help solve urban problems is unclear, but it is apparent that the development of an interactive thematic mapping module is an asset to a geographic information system.

Appendix - SEEDIS

CARTE is a display module of SEEDIS [1], the information system at Lawrence Berkeley Laboratory. This includes analysis and retrieval, and display programs for data bases which include selected enrgy-related variables for counties, and most of the 1970 Census of Population and geographic base files for the census tracts, counties, SMSAs, and states of the United States.

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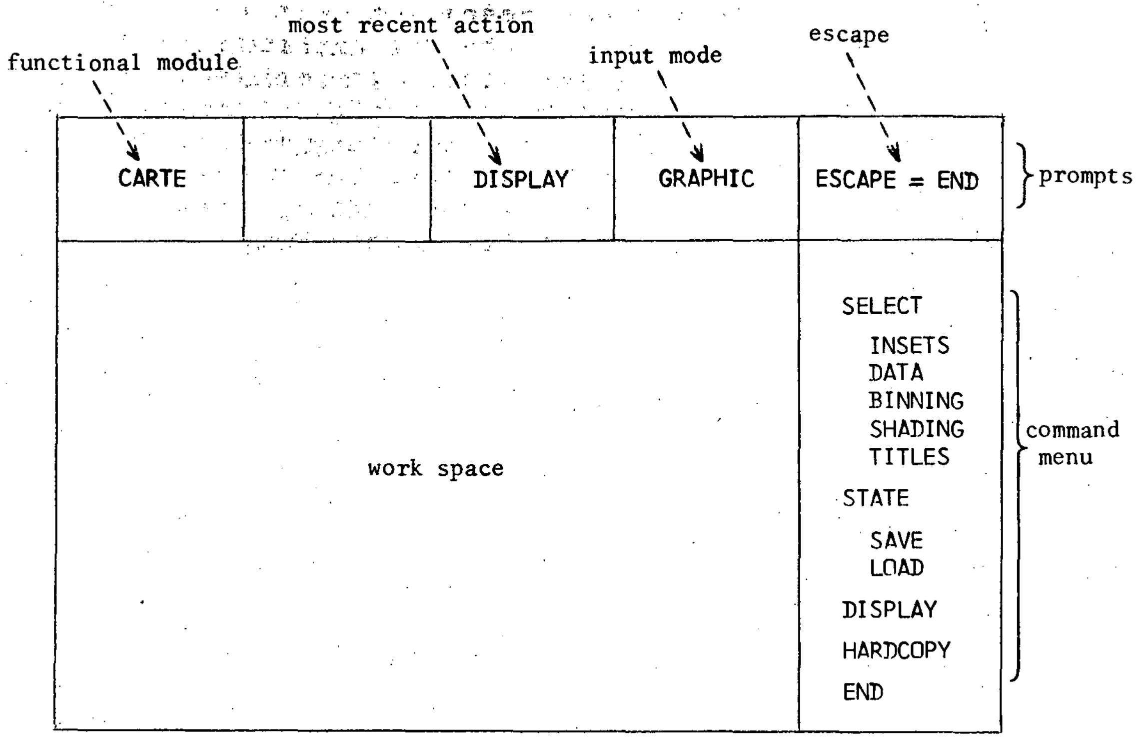
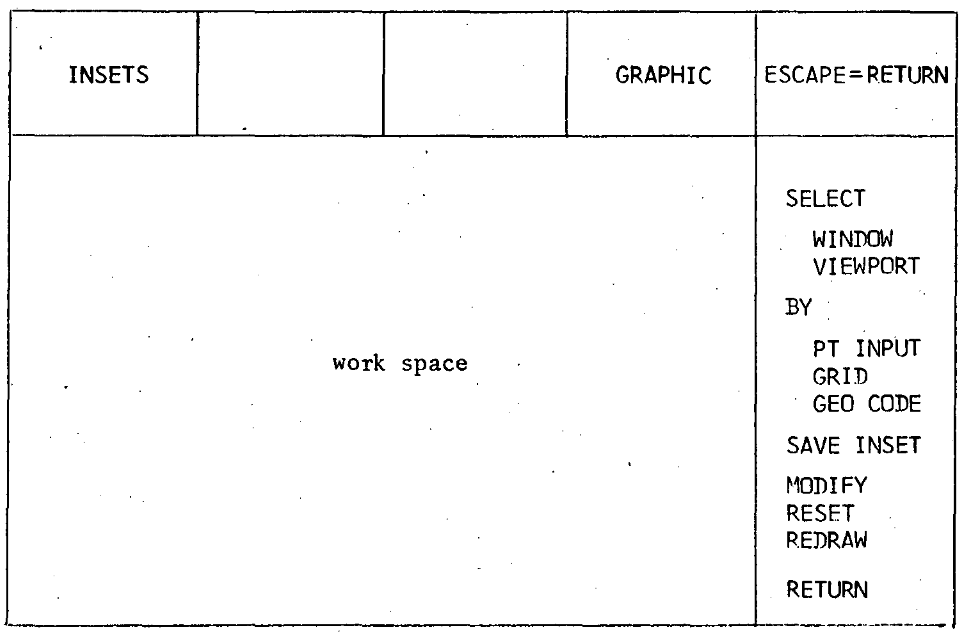
Acknowledgements

The software development which this report describes has been greatly enhanced by the contribution of ideas and techniques from many individuals, particularly the members of the Graphics Research Group at LBL. Preparation of the report has been ably assisted by Bruce Burkhart, Rita McLaughlin, and Virgina Sventek. The work was done with support from the US Department of Labor and the US Energy Research and Development Administration.



Zero Level Commands



First Level Commands

Figure 1

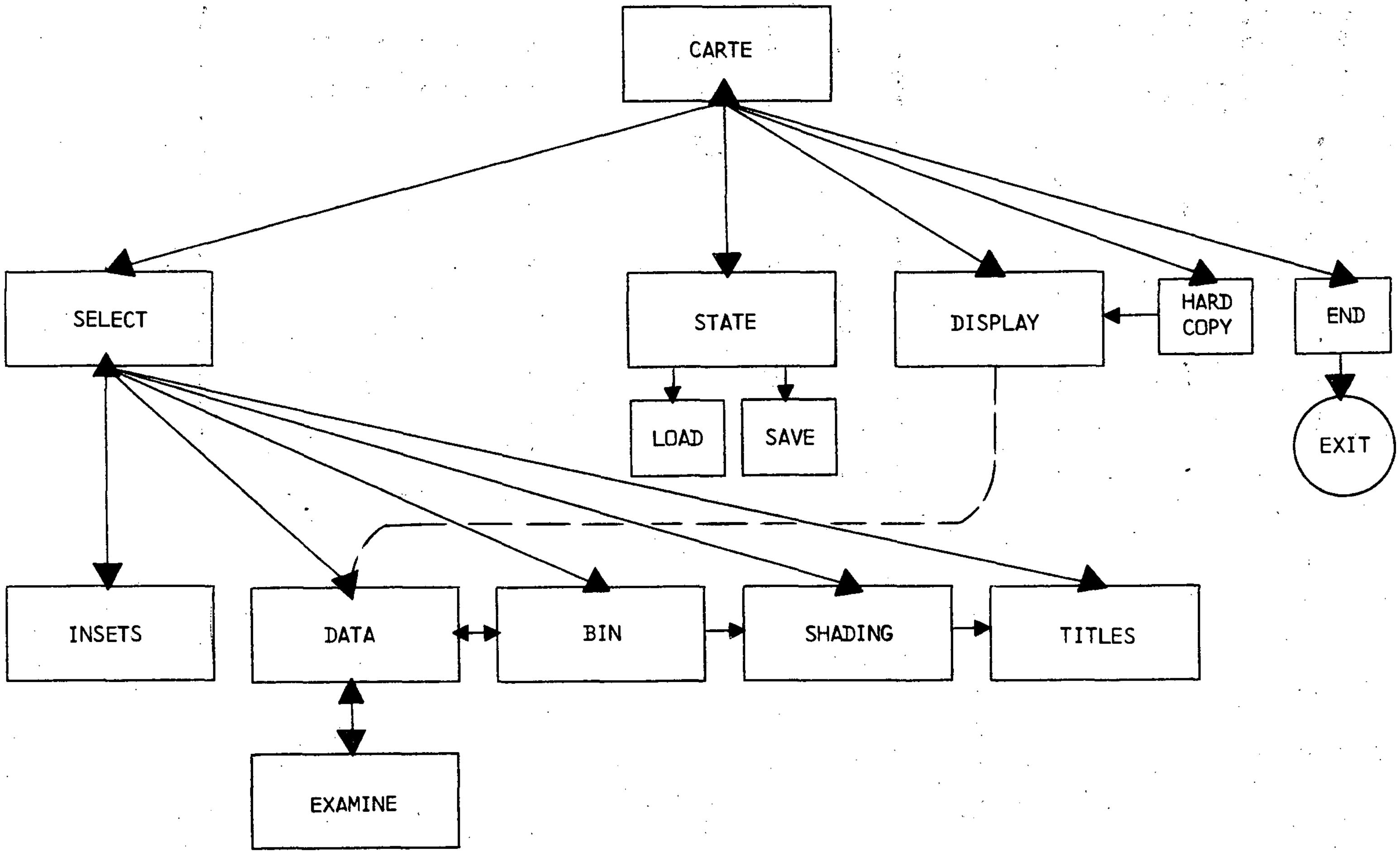

CARTE
SELECT
STATE
DISPLAY
HARD COPY
END
LOAD
SAVE
EXIT
INSETS
DATA
BIN
SHADING
TITLES
EXAMINE

Figure 2

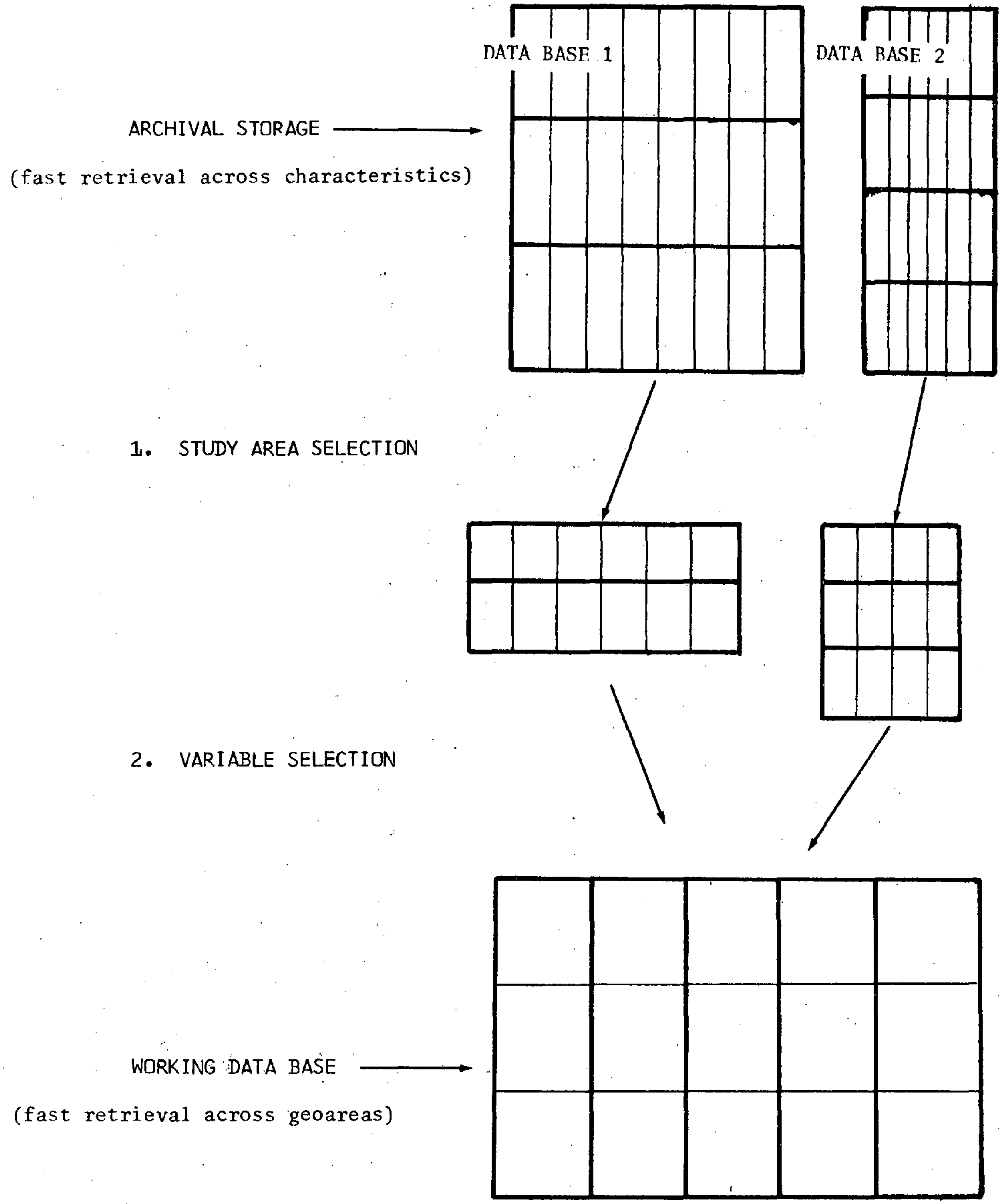

DATA BASE 1
DATA BASE 2
ARCHIVAL STORAGE
(fast retrieval across characteristics)
1. STUDY AREA SELECTION
2. VARIABLE SELECTION
WORKING DATA BASE
(fast retrieval across geoareas)

Figure 3

0 0 J 0 4 6 0 1 3 0 0

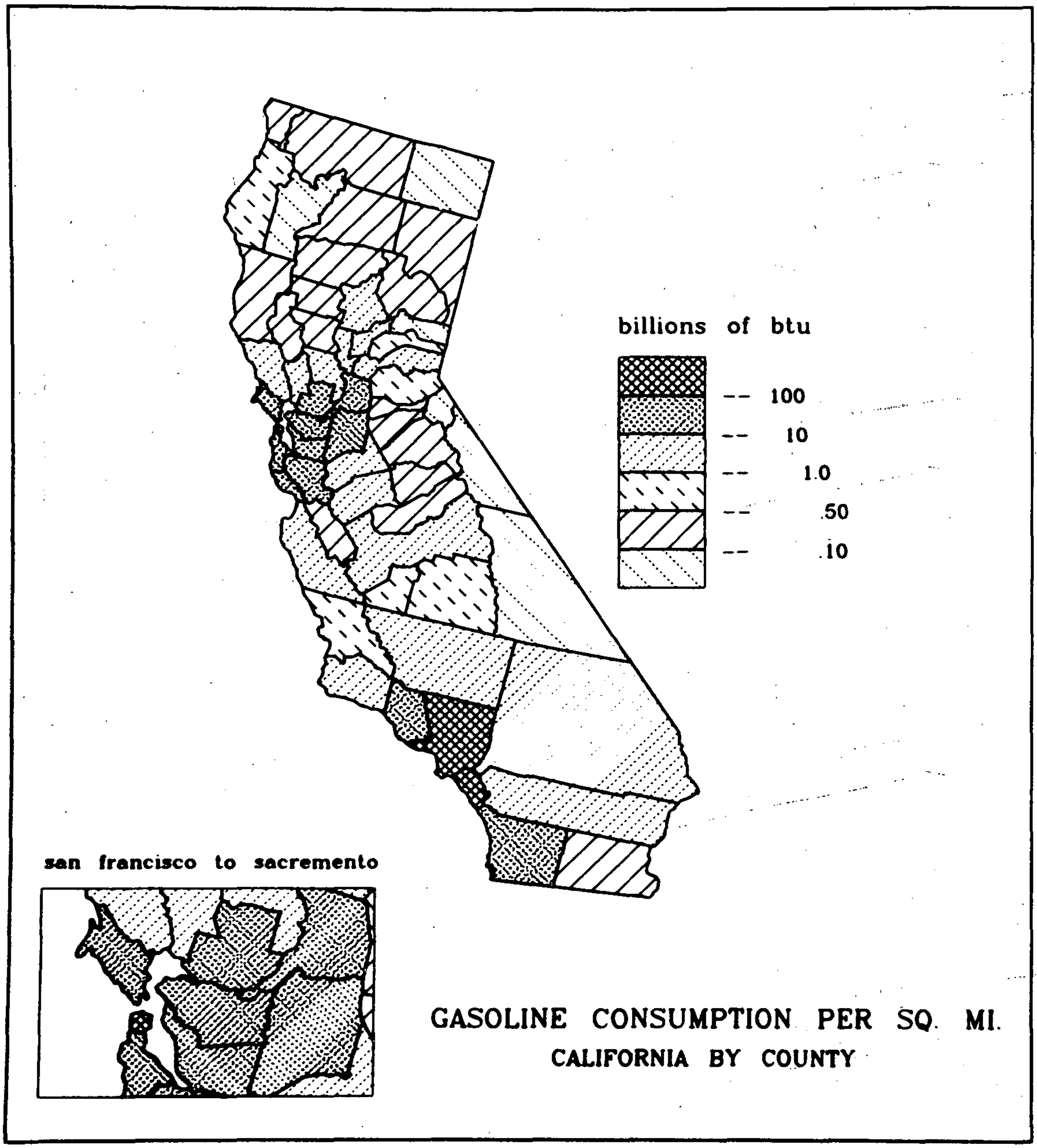


Figure 4