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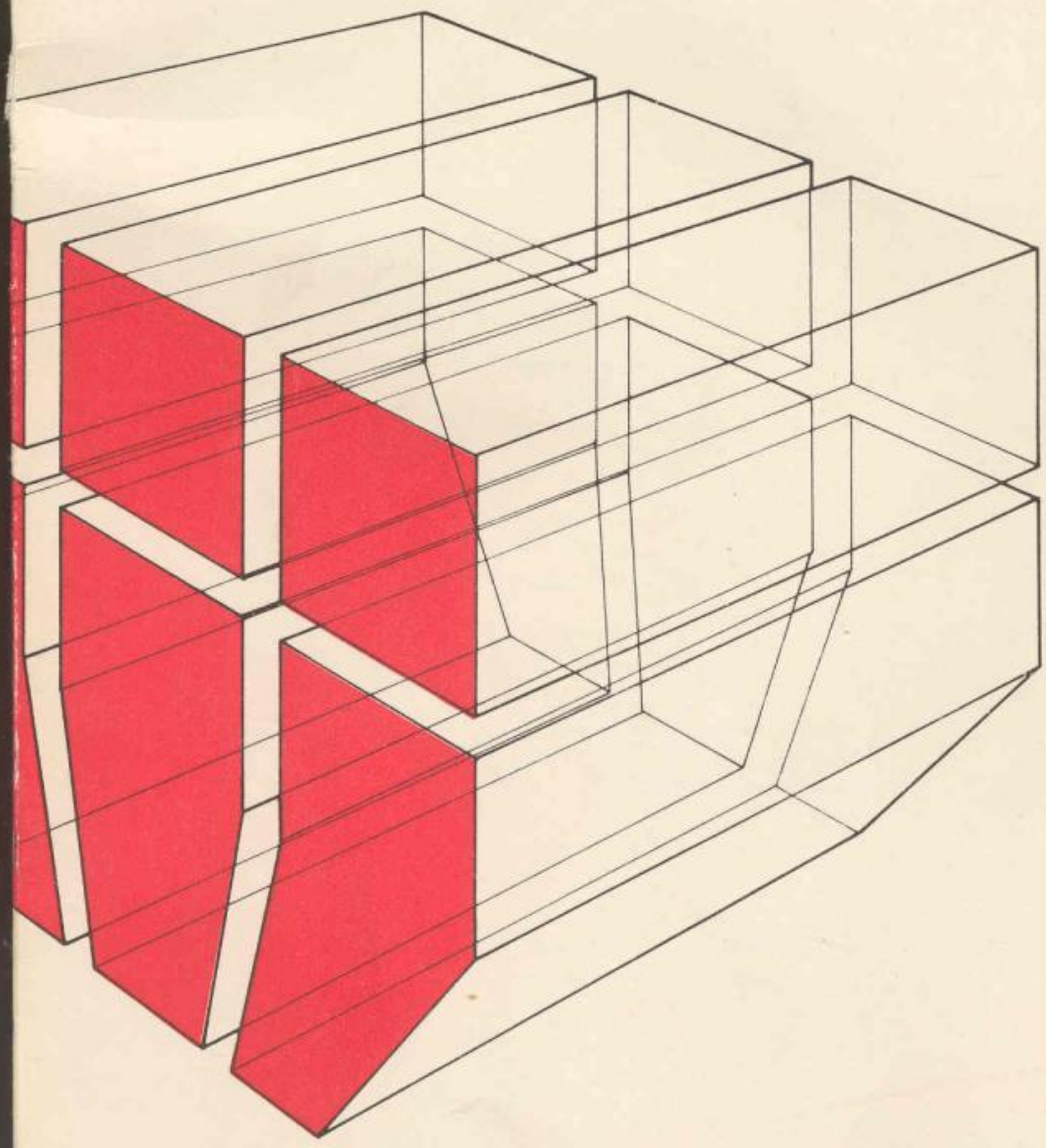
FORT HOOD GEOGRAPHIC INFORMATION SYSTEM: PILOT SYSTEM DEVELOPMENT AND USER INSTRUCTIONS



by
William D. Goran
William E. Dvorak
Lloyd Van Warren
Ronald D. Webster

CERL

FOREWORD

This research was conducted for the Fort Hood Environmental Programs Office, Fort Hood, TX, under Research Intra-Agency Order 330-80, dated 25 July 1980. The Fort Hood Technical Monitors were Mr. David Palmer, Mr. Raymond Leone, Ms. Karen Evans, and Mr. William Bodkin (all of AFZE-FE).

The work was performed by the Environmental Division (EN) of the U.S. Army Construction Engineering Research Laboratory (CERL). Dr. R. K. Jain is Chief of CERL-EN. Appreciation is expressed to Dr. F. Briuer (Fort Hood), Mr. James Westervelt of CERL, who helped design and develop this system, and to the following personnel of the University of Illinois: Dr. Thomas Frank, who worked with the LandSat data; Ms. Mary Catherine Jones, who prepared and digitized much of the data; and Mr. Daniel Goriesky, who developed the Information System.

COL Louis J. Circeo is Commander and Director of CERL, and Dr. L. R. Shaffer is Technical Director.

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3 SYSTEM OVERVIEW

Overall System Concept

The Fort Hood/ETIS pilot system offers an extremely fast and efficient way to combine the geographic attributes of the Fort Hood database. Conceptually, the database can be viewed as a stack of checkerboard-type grid cell maps. Each cell is associated with a 100- x 100-meter-square area. In this stack of "checkerboards," the top board represents a specific area type, such as vegetation. Each cell is assigned a code which corresponds to the dominant vegetation type within that 100-meter-square cell. The second board represents another specific area type, such as current land use. Each cell on this board represents exactly the same area as the cell directly above (or below) it on the other boards.

One way to visualize the database structure is to imagine standing directly above a set of stacked boards looking at the corner cell. If all of the boards were clear and marked with appropriate codes, it would be possible to see several of the corner cell's characteristics. Obviously, with a stack of more than a few such boards, the amount of information that could be seen when looking through the stack would be overwhelming, and lower boards would not be visible. The Fort Hood/ETIS pilot system allows the user to sort through all of these boards, select and combine whatever boards (or layers) are desired, and access these data using system-specific instructions.

A user can approach the system in two ways:

1. The user has a specific area of interest and wants to identify the location and extent of certain features, or combinations of features, within that area (see Appendix C).

2. The user has specific features, or combinations of features, required for a particular land use activity and wants to find them wherever they occur in the database (or within a specified area).

For either approach, the user's first system operation is to identify his* area of interest. If the user is primarily interested in locating specific features, rather than specific areas, he can either choose to search the entire database, or he can run the program more than once, searching smaller areas, or "windows," within the database. In general, the computer can search small windows more quickly and efficiently than large windows.

System Operation

After the user answers some initial questions, the basic design flow is as follows:

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* The male pronoun is used throughout this report to refer to both genders.

Step 1. The user defines his area of interest.

Step 2.

a. The user makes major category (primary) choice.

b. The user makes subcategory (secondary) choices.

Step 3. The system searches the database and creates a mask* for each subcategory choice and then prints the user table.

Step 4.

a. The user chooses one of five main options.

b. The user chooses suboptions from within the main option selected.

When a user first enters the system, he is asked three initial questions. These questions "set up" the system for that particular session. These questions are:

Noise protection on? (yes or no):**

Full prompting on? (yes or no):

Are you on a video terminal? (yes or no):

Noise Protection (yes or no):

The option of noise protection has been provided for users who experience interference, or noise, in telephone line transmission. This has been a particularly vexing problem at Fort Hood. If a user responds "yes" to this question, then transmission of maps cannot be interrupted -- either by noise or by the user. This allows processes which require relatively large time intervals to continue without interruption. However, this special protection is not provided during steps that require user input.

Full Prompting On? (yes or no):

The second question lets the user set the pace at which a session proceeds. With a "y" response, the user is prompted through each step in the session, and the data table is reprinted automatically after a new item is added. With an "n" response, choices are not displayed. The user is simply asked:

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* A "mask" is a map with all unit cells classified as either "zeroes" or "ones." Essentially, a "mask" identifies the area of interest with "ones," and "masks out" all other information with "zeroes."

**For all yes/no responses, a lower case "y" or "n" is sufficient.

7 VERSION II -- PILOT SYSTEM REDESIGN

As a pilot, the Fort Hood geographic information system was intended to be revised frequently. As the system was tested and various problems and limitations became apparent, changes were made to both the analysis capabilities and to the user interface. Numerous other changes have also been planned. However, these changes are no longer being implemented on the existing version of the system. Instead, a new version is now being developed which includes all the capabilities of Version I, as well as a number of new capabilities.

Several limitations have been identified in testing sessions with the current Version I. Among these are:

1. Operations within a session need to proceed in a set sequence -- define area of interest, select data, do overlay operations. This limits operations to preselected data.

2. Working areas can be defined only by rectangles, yet the area of interest may be a data element (e.g., training areas 41-45) or a non-rectangular area (e.g., everything within 500 meters of a particular stream or road).

3. Data can be selected only *one* subcategory at a time. Often, a user may want to group subcategories (e.g., watersheds 2, 3, and 4). This can be accomplished by using the *or* operation, but it is a tedious procedure to perform each operation, one at a time.

4. Operations can only be performed one at a time. It would be desirable to string together operations in a single command line.

5. Interdependencies within the program make simple program changes complex.

6. While there is a save function in Version I, it does not save the maps and/or tables constructed during a session *unless* the session is run again. It would be useful to have the capability to save tables/maps in separate files.

A number of other limitations in Version I relate to display and analysis capabilities that have not yet been developed (e.g., zoom capabilities for video displays, distance from operations, etc.) The above list of limitations relates to functional design of the system. Version II is now being developed to address these limitations, and it is being designed so that new display and analysis capabilities can be added easily.

In Version II, each of the procedures will "stand alone." The user will work from a main option page from the start of a session. As much as possible, the command capabilities of the UNIX operating system will be used.

These capabilities allow any number of commands to be strung together, each separated by some UNIX "piping"* command. A summary of differences between Version I and Version II is provided in Table 4.

Version II is presently only in the design phase. Thus, no output is now available. Also, though many features of the system have already been determined, some features are still likely to be changed. To the user, the system will be similar to Version I, but will offer greater flexibility. One major advantage of this new version will be the ease with which new subprograms and capabilities can be added. Eventually, numerous subprograms (such as Range Placement and ASIS) will be developed. A model of a system, with numerous potential subsystems, is given in Figure 13. In this type of scheme, users would transfer freely from the main GIS, which contains the geographic database and the display and overlay analysis capabilities to these various subsystems; the subsystems provide either unique types of analysis capabilities that use the main GIS database or data subsets with tabular output capabilities. Such a system could eventually serve the wide range of land-use activities that occur on military installations.

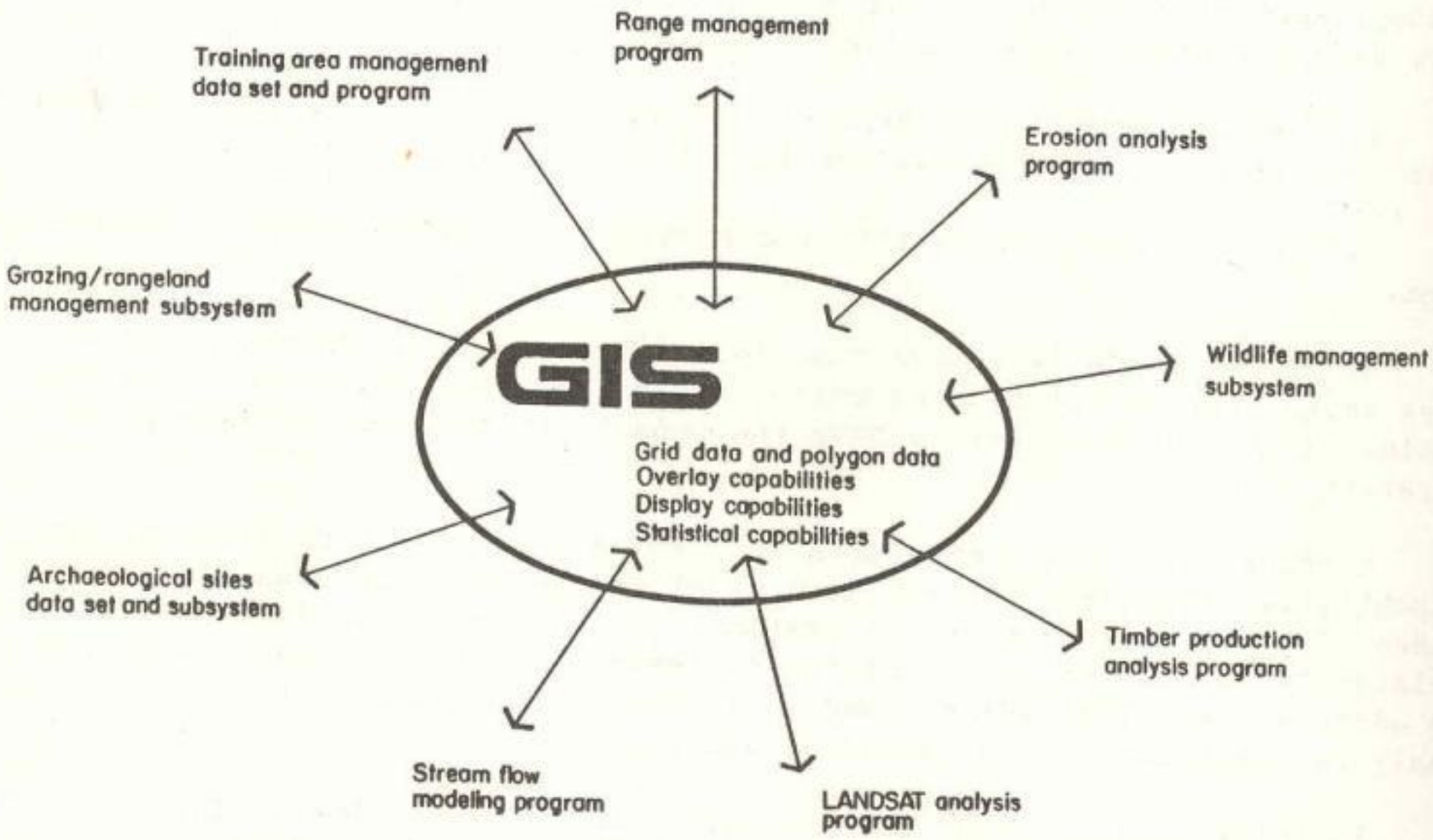

Figure 13. System and subsystem: potential programs.

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* Piping commands in UNIX are simply commands that allow operations to be fit together. Thus, a user can request a series of operations to occur in a particular sequence, all in a single command line.

Table 4

Summary of Differences: Version I Vs. Version II

CAPABILITY	VERSION I	VERSION II
Operations	Operations linked to various parts of the system	All operations stand alone.
	Operations must be executed one at a time.	Operations can be strung together.
	Order of operations in fixed steps, no loop back possible, and only preselected data available for subsequent operations in main option table.	Order of operations can vary; user can loop back whenever desired. User also functions from main option table.
	Only overlay operations available.	Overlay, distance calculations, and coincidence tabulations all available.
Data	Data accessed only at one time during session.	New data can be accessed for each new operation or sequence of operations.
	Data accessed only as one subcategory at a time.	Data subcategories can be accessed one at a time, in groups, or an entire primary category -- dump -- can be accessed.
	Data accessed only with binary mask where all cells have value of 1 or 0.	Data can be accessed either with binary masks or can retain unique subcategory values to each cell.*
	Data available only in grid files.	Data available in both grid and polygon files.

*This method of retaining subcategory values for each cell can result in very complex overlay maps, but does allow some very sophisticated analysis that is is not possible with only binary masks.

Table 4 (Cont'd)

CAPABILITY	VERSION I	VERSION II
Map Output	Device dependent files created for mapping.	Device independent graphic files created -- output through device specific files.
	Grid cell data only can can be mapped.	Some polygron mapping capabilities as well as grid cell capabilities.
Working Area	Six methods available to determine working areas -- but all must be rectangular.	Working area can be defined by any string of coordinate points, by data items (e.g., training areas 4-7) or by distance from operation around data item.*
Operations	Boulean overlay combinations range placement.	Boulean overlay combinations placement of any data item. Isoline map creation. Coincidence tabulations.
Modifications	Each modification requires substantial links between operations; several operations are affected by any change.	Since operations can stand alone, modifications are relatively simple. Only one operations is affected at one time.
	New capabilities may require restructuring of program sequence.	New capabilities can be added easily.
Save	Entire session can be saved in file which consists of a string of user inputs. Tables and graphics can only be reconstructed by re-running session. (No header information on saved files.)	Output from any operations, tables or graphics can be saved or deleted. Each operation creates new files, and these files also stand alone.

*While the working area in Version II can be defined by any polygon, the actual area defined by the system will be the smallest possible box. However, this box will not limit user capabilities, and statistical tables will be built using the user-selected polygron only.