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Iwao KANEYASU

1 Introduction

The Third National Comprehensive Development Plan was approved by the Japanese Cabinet in 1977 and the implementation of that plan is under way throughout the nation. The Plan not only aims at the countrywide regional development planning but also stresses the importance of the data gathering of the Japanese island to support the sound regional development plan. The research project to collect the land information throughout the country was started in 1974. The main purpose of the research project is to prepare the land information data systematically owing to the standard data format.

The grid data system was adopted and the X-Y coordinate data was also obtained to show the point, linear and spatial patterns such as historical assets, roads, and the specific city planning areas. The computer assisted system is needed to manage the large data base of National Land Information. Computer assistance in regional data bases requires systems which support:

(i) maintenance of large and increasing data;
(ii) combination of conversational and batch type data processing;
(iii) data operation, data analysis and display techniques;
(iv) changes of data item, data structure, application programs *etc.*

The joint project between National Land Agency and IBM Japan is developing an Advanced Land Information System (ALIS) as a tool for the data distribution, data analysis and data base management. The author joined the research project as a project leader, so the pilot system called ALIS is introduced and a case study is presented as an example of some applications.

2 Design of pilot system

2.1. Requirements

The pilot system plays a role of pioneering work toward the operational system in near future. ALIS tries to test large regional data with Mass Storage System (MSS), data base management system and its prototype of functions to investigate the feasibility of the operational system. It is hoped that the pilot system has a demonstration effect of National Land Information to the users in various fields as well as the potential users through demonstration, test run, case studies *etc.* The requirements for the design of pilot system are the management of

(i) large and different types of data, (ii) multiple applications, and (iii) problem solving in an interactive or batch mode.

2.2. Data

Areal data of Japanese islands is standardized as a grid data whose size is approximately 1 km by 1 km (The word 'mesh data' in stead of grid data is often used in Japan). The characteristics of the data are as follows:

(i) Uniformity: Both temporal and spatial comparison is possible through uniformity of data.

(ii) Compatibility: Standard grid system authorized by the Administrative Management Agency is accepted, therefore there is a compatibility with census data and other national data.

(iii) Relationships among data: The relationship between grid data and coordinate data is bridged through the 16 lattices in 1 km^2.

(iv) Data structure: Standard grid data can be reorganized. For instance, unit of height data is originally obtained by 250 m, and the unit of landuse data is 10 m. Rivers and roads are tree structure and network structure respectively.

The contents of National Land Information is shown in Table 1. The number of types of data and data element is about 130 and more than 1,300 respectively. Since there are about 300 MT (1600 BPI, 2400 ft), the data volume is estimated to be over 3,000 MB (Mega Bytes).

Table 1 Contents of National Land Information

Item	Data Volume	Item	Data Volume
Landform	5.9×10^6	Shorelines	
Height	1.6×10^4	Coordinates of shorelines	4.6×10^5
Height of mountain top	3.9×10^5	Length of shorelines	4.0×10^4
Average height	3.9×10^5	Administrative area	
Max. height	3.9×10^5	Coordinates of cities and towns	9.6×10^5
Min. height	3.9×10^5	Area of cities and towns	3.9×10^5
Relief energy	3.9×10^5	Regionalization	
Slope	3.9×10^5	Specified areas for development	5.3×10^4
Valley spacing	3.8×10^5	City planning areas	1.0×10^4
Surface geology		National conservation areas	8.7×10^4
Land surface	3.8×10^5	Cultural assets	4.9×10^5
Landform classification	3.8×10^5	Landuse	3.9×10^5
Soil	$3\ 8\times10^5$	Rivers	3.5×10^6
Subsidence		Disasters	1.5×10^5
Sea level	$3\ 0\times10^4$	Railways	2.0×10^6
Lakes		Roads	3.8×10^5
Coordinates of lakes	2.3×10^5		
Area of lake	2.4×10^4		

2.3. System software

The pilot system adopts the following design policy.

(i) The areal definition is specified by the 250 meter small grid system.
(ii) The design does not necessarily depends on the volume and types of areal category and areal attributes. Data addition is considered.
(iii) The system is an interactive online mode.
(iv) The functional commands can be easily added and modified through command definition language.

The basic software of ALIS is composed of Time Sharing Option (TSO), PL/I, and Virtual Storage Access Method (VSAM). The problem oriented language is given to the user. The user command input is translated and the command procedure statement and TSO command are carried out. Data extraction of National Land Information data base is processed by PL/I program through TSO-CALL command. Directory information of National Land Information and other data bases uses VSAM-KSDS (Key Sequenced Data Set). Input-output statement of PL/I program is translated by VSAM I/0 operation. Standard software provided by IBM helps the pilot system manage data handling efficiently.

2.4. Command functions

ALIS provides data base operation function and data analysis function. These functions can be operated by user's command inputs in combination with system's commands on TSO terminal.

The basic data extraction is composed of the following four commands: %SELECT, %COMPUTE, %DECISION, and %CONVERT. The % mark symbolizes the command functions. The user can select data element from data base through %SELECT command, compute by %COMPUTE, make a definition of values of new variables by %DECISION, convert attribute values of areal category by %CONVERT, and finally analyse data.

Outputs by the above four commands are filed on the temporary file (No. 1 to No. 5), and data on each file is used as an input, then the process continues. We can obtain the report of the results on a temporary file by %REPORT command and get the printed map by %MESHMAP command. Those temporary files can be saved on user's private file by %SAVE command and some basic data analysis such as cross table, basic statistics, contouring map, plotting birdeye view can be done. The $ mark in front of the user command is called the batch command. The batch command parameter is interpreted by conversational mode and the job is submitted to the background and then processed in a batch mode. The batch mode is useful for CPU bound jobs.

The general form of command statement is as follows and some output samples are seen in Fig. 2.

Command Name	Option	Keyword 1 (Value)	Keyword 2 (Value)....

Example:

Input: %SELECT MESH DATA ('POP, LANDUSE') OUT(1)
Message: WHERE ?
Input: 5359
Message: SEARCH PARAMETER ?
Input: POPULATION>5000×USECLASS=08

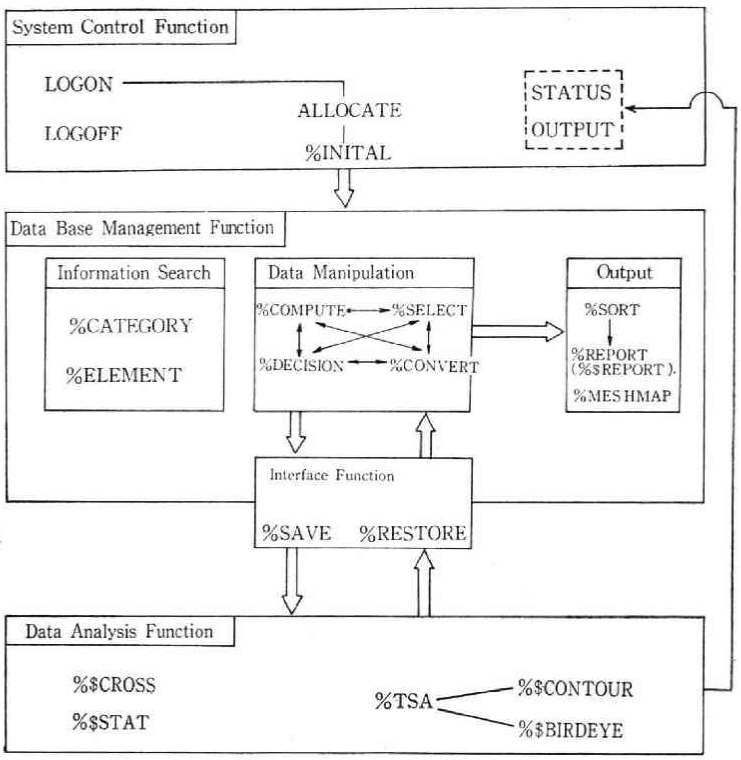

Fig. 1 Relationships among command functions

2.5. System hardware

The ALIS implementation is in PL/I, using IBM's standard application packages as well as TSO command procedure. The system runs on an IBM 370/168 under the OS/MVS operating system and TSO. The user terminal is an IBM 3767

Table 2 ALIS command list

Function	Command	Description
System Control	%INITIAL	System initialization
Data Base Management Search	%CATEGORY	Search for area category
	%ELEMENT	Search for detailed information
	%FILE	Search for temporary file
Transformation	%SELECT	Select the area data
	%$ SELECT	〃 (Batch)
	%SORT	Sort the area data
	%COMPUTE	Compute the area data
	%DECISION	Define the values of attributes
	%CONVERT	Conversion among different area category
	%$ CONVERT	〃 (Batch)
	%MATCH	Combine the attributes of temporary file
	%MERGE	Combine the different area data of temporary file
	%SAVE	Save the temporary file into user file
	%RESTORE	Restore the data from user file to temporary file
Output	%REPORT	Reporting
	%$ REPORT	〃 (Batch)
	%MESHMAP	Print map
	%$ MESHMAP	〃 (Batch)
	%SUMMARY	Summary report
Data Analysis	%TSA	Trend surface analysis
	%$ CROSS	Cross table (Batch)
	%$ STAT	Basic statistics (Batch)
	%$ CONTOUR	Contour map (Batch-Plotter)
	%$ BIRDEYE	Birdeye view (Batch-Plotter)
	%$ DISTRIB	Distribute MT to users

communication terminal or TSO terminal. The data base is stored on IBM 3850 Multi Storage System (MSS). IBM 3800 Printing Subsystem is used for the output in a batch mode.

3 Case study

3.1. Method

Case studies are being used to test the ALIS architecture, to identify significant and potential user, application, system hardware and software. The following example is a kind of demonstration to show the procedure of ALIS.

The study area is Tokyo Metropolitan Area and some 32,000 km^2 data is extracted from the source data file. This study area includes nine prefectures. The

number of administrative area is 414 cities or towns and equivalent to about 1/8 of 3,370 Japanese cities or towns. The extracted data is about 19,000 grid cells, that is about 1/20 of Japan (about 380,000 cells).

The extracted area category data is composed of grid data and administrative data. The grid data selected comprises landform, landuse and population, on the other hand administrative data includes 23 items such as city planning areas, natural conservation areas, national parks, and so on. Population data is collected by the Statistical Bureau of Japan. The data above mentioned is arranged and reorganized, then VSAM-KSDS data is created.

Symbolic code is attached to each data element and the data base structure is defined. Two area categories (Grid & Administrative) are registered on a Directory File. The structure of four area attribute files, 35 data group and 116 data elements is also defined.

3.2. Results

The purpose of the case study is to analyze landuse in Metropolitan Tokyo. The steps of the analysis are as follows.

Step	Command	Operation
1	%INITIAL	System initialization is started.
2	%SELECT	Population and landuse data are extracted from the data base. These data are moved to temporary file (No. 1).
3	%SAVE	The extracted data is saved from temporary file to user's private file.
4	%CROSS	Calculation of cross table between landuse and population is done. Output of cross table is available.
5		
6	%COMPUTE	Compute the ratio of natural landuse and the values are moved to temporary file (No. 2).
7	%DECISION	The ratio of natural landuse is divided into four categories, and moved to temporary file (No. 3).
8	%MESHMAP	The natural landuse pattern is printed out.
9	%SELECT	The data which ratio is over 50% is selected and moved from temporary file No. 2 to No. 4.
10	%SORT	The data is sorted by the distance from the center of Tokyo.
11	%REPORT	The output of distance, landuse, population *etc.* is obtained by grid ID.

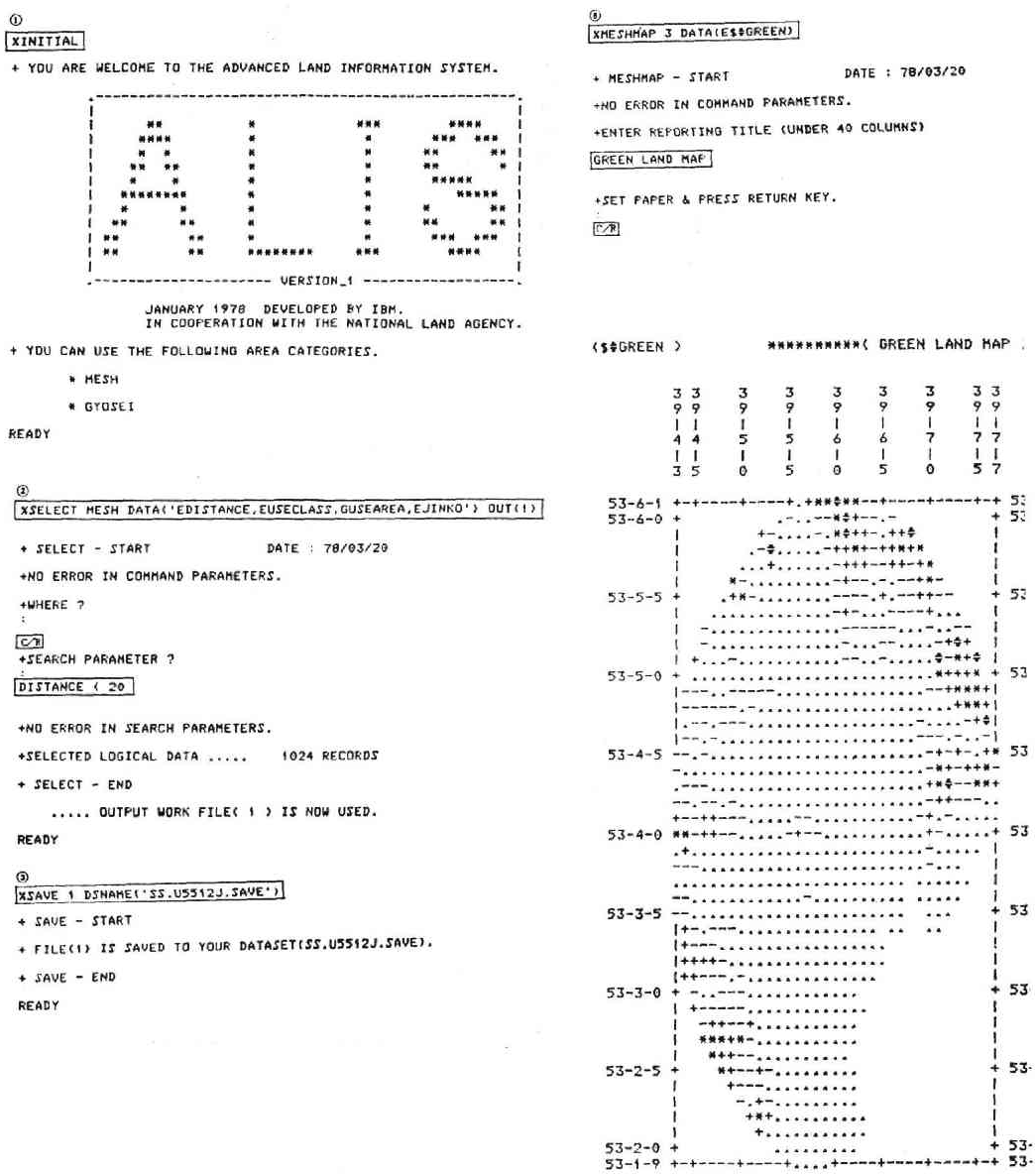

Fig. 2 Output sample of ALIS case study

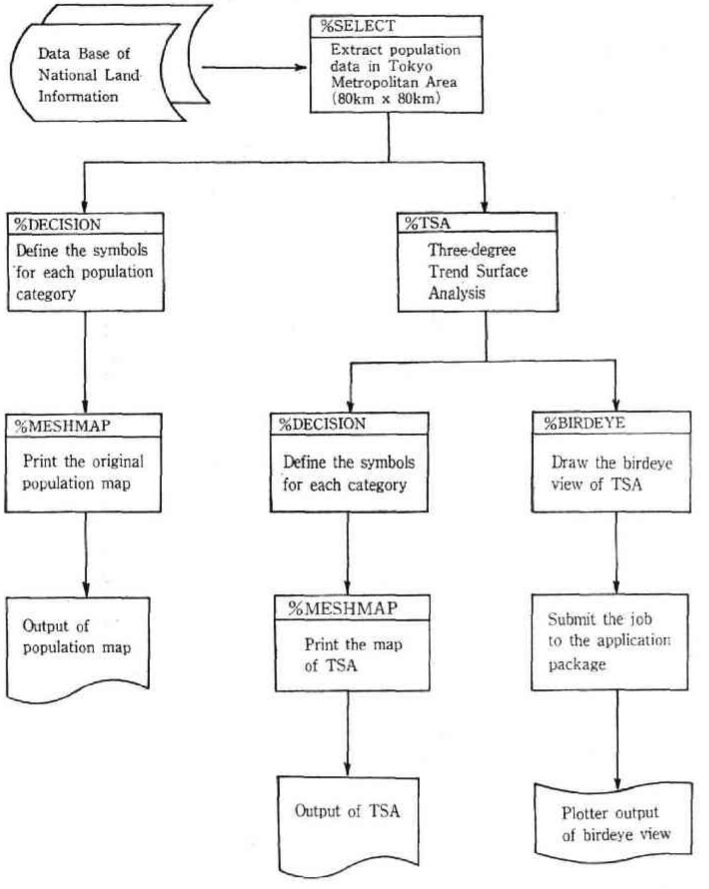

Fig. 3 Trend surface analysis of population in Tokyo

```
%TSA 1 DATA(EDINKO) OUT(2) ORDER(3)


        * T.S.A.   ----  START

        * INPUT  ORDER .......    3

        F = A1 + A2*X + A3*Y
          + A4*X*X + A5*X*Y + AC*Y*Y
          + A7*X*X*X + A8*X*X*Y + A9*X*Y*Y + A10*Y*Y*Y
        A1  =     7.5087E+04
        A2  =    -2.0570E+03
        A3  =    -1.3085E+03
        A4  =     2.2535E+01
        A5  =     3.0690E+01
        A6  =     7.0510E+00
        A7  =    -1.7440E-01
        A8  =     1.3260E-02
        A9  =    -1.2482E-01
        A10 =    -1.2580E-02

        * DATA COUNT ------------    5749

        * ZANSA (MEAN SQUARE) -----   2.0807E+07

        * T.S.A.  END

    ..... OUTPUT WORK FILE( 2 ) IS NOW USED.

READY
```

Fig. 4 Regression of TSA

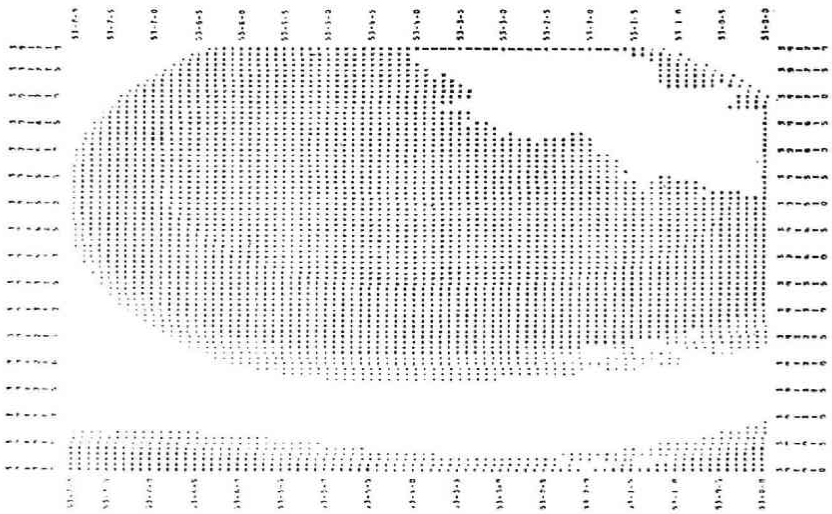

Fig. 6 Printed map of TSA

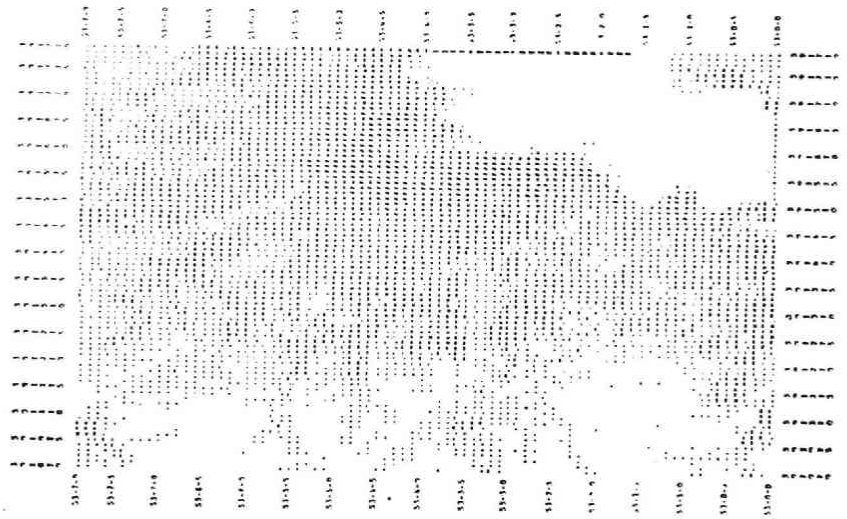

Fig. 5 Original map of population

User's command or input parameters are the statements surrounded by the square box on the printed output (Fig. 2). Each command works very well and the case study shows the feasibility of the pilot system. The application of Trend Surface Analysis is shown in Fig. 3 (Steps) and in Fig. 5 (Original Population Map) and Fig. 6 (Three-degree TSA).

4 Geographical implications

This pilot system implies geographers several meanings. National Land Information contains a lot of geographical data, however each data item is obtained in a different way. Therefore, when a geographer wants to use several data of National Land Information, it is very difficult to deal with data for a user with limited computer techniques. ALIS succeeded in making the management system of large geographical data base. In effects, a geographer has only to think about the geographical problems. What kind of data should be added ? What does a geographer try to analyze ? Only basic statistics or advanced application ? If he is good at programming, he can make his own problem-oriented program. If not, he asks a programmer to make an application program. Responding to data distribution and data base system with some applications, geographers should accumulate the analyses in applied areas.

As of today, data gathering of National Land Information is still under way. Data is not open to the public, but open to the limited people such as scholars and members of Government organizations.

5 Conclusions

ALIS uses the interactive functions of TSO as well as TSO command procedure as the command definition language. Therefore, it is not necessary to develop interactive functions and command definition functions. Data analysis function is included in the pilot system through the interface program by TSO command procedure statement. This shows the possibility of the system expansion and the flexibility of the system. When some application programs are wanted to be included in the system, about 50 step interface program is just needed.

It is without saying that further development is needed: enhancement of service functions, expansion of data, improvement of data manipulation, and development of application programs. The pilot system shows an approach to cope with such further development.

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