

1. *Development of the providing and management system for the national land survey information*

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Abstract: To support the better utilization of the information arranged through the national land surveys (e.g., termed the Land Classification Survey, the Water Survey, etc. as the public works), the providing and management system of those national land survey information has been developed, which is operated under the network environment. To design the data set structure, the following three divisions on the information are newly defined: 1) Prescribed information, 2) Common information, and 3) Related information. The Data Set Management System (termed DSMS), that contributes to manage the data sets in the web-site by linking the index-information in the database-site, is constructed so that we can operate and manage the data sets efficiently. The developed system in this study actualizes the unitary-management of the data sets with respect to the administrative district, as well as the easy operation to refer the information under the network environment.

Key Words: national land survey, data set, geographical information, data resource management

1. Introduction

National land survey projects based on the national land survey law have been implemented on a nationwide scale with the objective of surveying the status of the national land scientifically and comprehensively to contribute to the development, preservation and effective use of the national land¹⁾.

Typical projects include the land-classification basic survey, land-classification detail survey and water survey projects are cited as representative examples. These rank as two mainstays of the national land survey. For the land-classification basic survey and detail survey, the projects have been carried out within the framework of the land-classification survey.

For example, the land-classification basic survey specifies survey items such as land classification, geology, soil, land use, slope classification, drainage system, valley density, relief energy, disaster record and volcano observation facilities. The survey results have been used in many fields including various project plans and cross-disciplinary researches.

We have also digitized drawings for the results of land-classification basic surveys beginning with the year 1988 survey of the Ohshima district²⁾ and have studied about the method of making use of digital terrain information in the land-classification detail survey and water survey projects in addition to enhancing the efficiency of printing work of drawings through digital processing³⁾. The know-how accumulated through study by trial and error in the land-classification survey projects over twelve years constitutes the work rules for land-classification surveys in Greater Tokyo.

In national land survey projects, not only prescribed

information following the work rules but various kinds of information obtained in the process of surveys is information obtained in the process of surveys is accumulated as results. The prescribed information is managed by the department in charge of survey of the nation and municipality. However, since the information is not commercially available, it has been pointed out that general users cannot refer to and use it easily including whereabouts of the findings⁴⁾. Besides, some contents of the surveys implemented on a nationwide scale go back over several ten years in the time of survey. They are of value as past survey information, while new requirements have developed including an information update. To attain the original objective of national land surveys, it can be said that the time is coming to study as to in what forms survey information is managed and provided to permit addressing the needs of the times.

Based on these backgrounds, in this study, we revealed the problem when various kinds of information is accumulated, managed and provided for each classification of national land surveys. After that, we developed the providing and management system of those national land survey information, which is operated under the network environment to support the better utilization of the information arranged through the national land survey.

Information dealt with in this text is defined as information on national land surveys in a generic name for various kinds of information obtained from national land survey projects.

2. Purpose of the Research

The purpose of the research and development are as follows;

• After information items and information division dealt with are studied for each classification of national land surveys, fundamental requirements needed to manage and provide these pieces of information by making data sets are

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studied and marshaled.

- The data set structure are designed, the architecture of system function and the system to operate to have the results reflected in the detail design of the system.
- The system is actually operated under the network environment, and new requirements and problems developing in service of the system are absorbed to have the results reflected in the improvement and expansion of the system.

3. Significance of this research

3-1 Problems associated with the management and operation of national land survey information

Many people are paying attention to standardization problems in the so-called infrastructure preparation of spatial information including the information on the earth observation and various kinds of information in addition to satellite data. Most of them raise many problems required of the information providing and managing system from obtaining, processing and analyzing spatial information to structuring database and envisage ideal concepts attempting to incorporate them comprehensively.

In addition, some of the systems that people throughout the world can refer to metadata (data set specifications) under the network environment are already available to the public nowadays^{5),6)}. However, there are fundamental problems that it is difficult to establish the improvement structure of data sets continuously in the aspect of costs, labor and others required to improve the data sets in reality.

In order to improve as data sets spatial information varying in the quality and quantity of information as well as the national land survey information dealt with in the research, it is necessary to meet the following three requirements;

- To permit accumulating and managing information continuously.
- To permit responding to work developing newly in conjunction with providing information.
- To permit responding to requests for updating information.

It is because these requirements cannot be met that trouble occurs to the improvement of data sets after the completion of system development⁶⁾. This is also a problem that develops because developer's attention is grabbed by the design of element technology itself configuring the system. It becomes necessary to sort out information efficiently and to study about data structure capable of accumulation and the operational structure of the system carefully.

It can be pointed out that satisfactory discussions have not been made about the above problems in the research and development aimed at hitherto providing information and

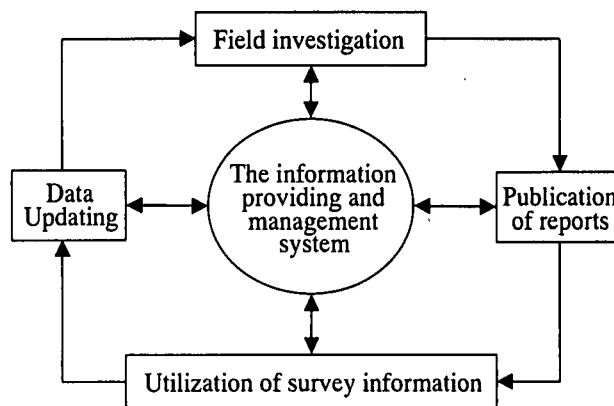


Fig.1 Project cycles of national land survey

supporting management.

3-2 Significance of the research and development

(1) National land survey projects

and ranking of the system

National land surveys are categorized into the classification of various surveys including land-classification basic surveys, land-classification detail surveys and water surveys as described. These details are omitted for want of space¹⁾⁻⁴⁾. In the 4th ten-year plan for national land survey projects (1990 through 1999), the utilization of land-classification survey results in the development and preservation of the national land had been advocated with the aim of structuring the national land of the multiple distributed type. In the 5th ten-year plan for national land survey projects from 2000 to 2009, targets such as ①the creation of multi-natural residential areas, ②the renovation of large cities and ③the expansion of regional cooperation are shown, and the importance of surveys at the level of cities, towns and villages, the implementation of the so-called land-classification detail survey is recommended. It should be noted in particular that the national land survey results are utilized to indicate the importance of implementing the infrastructure preparation of information on a nationwide scale aimed at supporting the making of national land use programs and regional disaster prevention programs.

Fig. 1 is a summary of such national land surveys as a chain of project cycles. It provides correlation of the nature of four works such as ①the implementation of surveys, ② the publication of findings, ③the utilization of survey information and ④the study of updated matters. It is needless to say that meeting the above three requirements is required of the information providing and managing system in the nature of each work. In national land survey projects, various kinds of information is gathered and accumulated from the past to the present and in the years to come. It

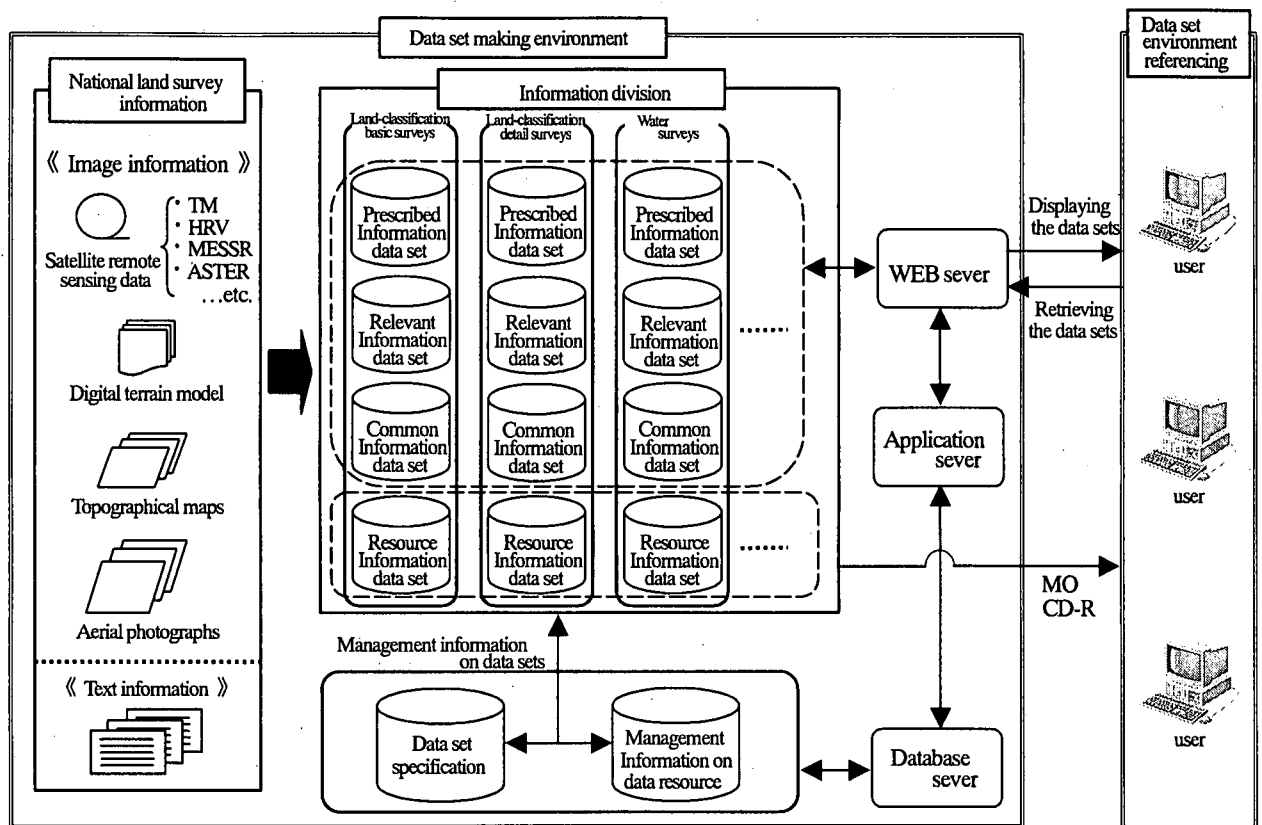


Fig.2 Operational environment of the developed system in this study

may be said that the priority of design and development cannot be established until defining the addressing relation between the nature of work and the function undertaken by the system as in Fig. 1 and also that the enhancement of life cycle efficiency can be accomplished in system development and operation. It is thought that the nature of the research implementing development with this matter in mind gives an important hint in the aspect of the design and development of the system dealing with spatial information.

(2) Information division and data set structure

National land survey information includes various kinds of information for each classification of surveys. The research deals with these pieces of information with them categorized into three information divisions such as ① prescribed information, ② relevant information and ③ common information. (See 5.1 (2).) It links these pieces of information with the design of data set structure in addition to categorizing and marshaling the information according to the information division for each classification of national land surveys. Much time and labor were spent for study in the stage of the establishment of information division associated with national land survey information and the allocation of information items involved in it (See Table 1 given later.). One of the features of the research is that the selection and sorting of troublesome information can be efficiently performed through the study.

(3) Making data sets

Research is becoming active on the structuring of clearing houses and others accumulating data catalogs, location information, etc. in combination with the reinforcement of the network environment. A principal objective is to study about information describing specifications including data set implementors and locations, the description of the so-called metadata (hereinafter referred to as "the data set specifications"). In general, it is seldom to design data set structure by linking the data set specifications with the existing data⁷⁾. Since various kinds of image information is dealt with including digital geography information and satellite remote sensing data in the research and development, it is required that these pieces of information can be easily referred to through the data set specifications. They are managed in a unified way by the data set specifications in addition to making information data sets on the basis of Tokyo, Hokkaido and all the other prefectures as well as cities, towns and villages.

It is designed to be able to refer to the relevant information through the data set specifications, and GUI excelling inoperability is structured in supporting this.

As described above, it has limitations in accumulating data sets continuously to establish a structure covering every information to improve it. Information can be efficiently gathered and accumulated by following the information division and data set structure presented in the research as required in order of precedence. Decision of the

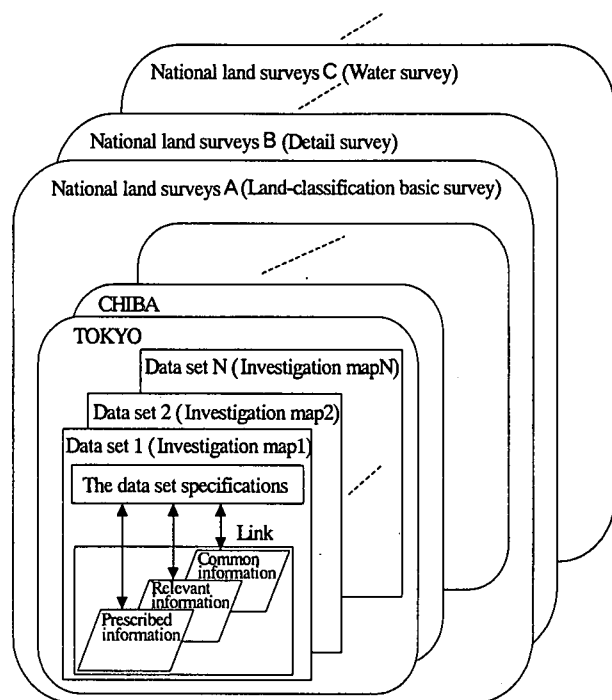


Fig.3 Data sets structure

precedence of information to accumulate is supported through the analysis function of the number of accesses to data set specifications, and also the efficiency enhancement and continuity of information accumulating work are accomplished by enhancing the quality of data sets themselves by this.

Another feature of the research is that the system aimed at managing information on an investigation area basis in the national land survey project, the so-called DSMS (Data Set Management System), is structured after data set structure capable of unified management is presented by linking the data set specifications with the existing data.

4. Whole system design

4-1 Requisite definition of the system

The basic requirements of information providing and managing systems developed in this study are as follows;

- ① After the information division is studied to permit sorting and managing information dealt with in national land survey projects efficiently, DSMS (Data Set Management System) capable of managing and operating information making data sets is structured according to it.
- ② Allowing for system configuration capable of meeting flexibly the nature of each work of the life cycle of the national land survey project shown in Fig. 1, continuous management and operation of data sets are accomplished.
- ③ The system must be one by which users can refer to the locations of information on national land surveys and the

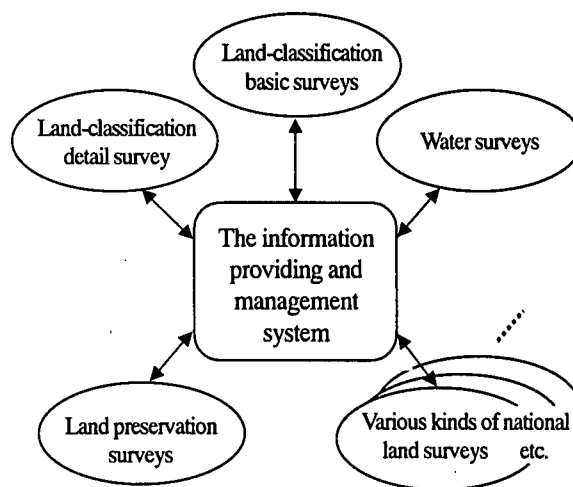


Fig.4 Contribution of the developed system

relevant information under the network environment without worrying about time and place restrictions.

4-2 Operation environment of the system

In designing systems undertaking the accumulation and management of various kinds of information on national land surveys. It is important to classify the operation environment of the system into “data set using environment” and “data set making environment” as shown in Fig. 2.

(1) Data set using environment

Data set using environment refers to environment in which outside users refer to and use data sets through the data set specifications under the network environment.

(2) Data set making environment

Data set making environment refers to work environment in which national land survey information is sorted out for making data sets before the information is uploaded to the WEB server. It corresponds to the work environment of the system management. Outside users can access only the WEB server.

5. System detail design

5-1 Study of data set structure

(1) Classification of national land surveys

The classification of national land surveys is an attribute to identify national land survey project names including land-classification basic surveys, detail surveys and water surveys. As described above, the research approaches three types of land-classification basic research survey, land-classification detail survey and water survey as the focus of study. It is designed to permit ease of expanding the information management of other survey projects alike by following the data set structure designed by the research.

(2) Composition division of the data sets

Table 1 Classification of the national land survey information

| | Prescribed Information | | Relevant Information | | Common Information | |
|---|--|--|--|---|--|--|
| | Image information | Numerical value and text information | Image information | Numerical value and text information | Image information | Numerical value and text information |
| Land-classification basic surveys | <ul style="list-style-type: none"> Land classification map Geology map Soil map Land use map Slope classification map Relief energy map Drainage system map Valley density map | <ul style="list-style-type: none"> Survey report Spot investigation record paper Statistic data Survey progress information | <ul style="list-style-type: none"> Result of land-classification detail survey Result of Water survey Land cover classification map Training sample Land condition map Legal regulation map Photograph etc. | <ul style="list-style-type: none"> Administrative data Literature, Study report Satellite remote sensing data etc. | | |
| Land-classification detail surveys | <ul style="list-style-type: none"> Land use aptitude evaluation map Slope stability evaluation map Land classification map Land use map Land preservation map Land production power repartition map Land condition repartition map etc. | <ul style="list-style-type: none"> Survey report Spot investigation record paper Statistic data Survey progress information | <ul style="list-style-type: none"> Result of land-classification basic survey Result of Water survey Land cover classification map Training sample Land condition map Legal regulation map Photograph etc. | <ul style="list-style-type: none"> Land use plan data Literature, Study report Satellite remote sensing data etc. | <ul style="list-style-type: none"> Base map for reference Topographical map Satellite remote sensing data Catalog of satellite remote sensing data Survey progress information Digital terrain model | <ul style="list-style-type: none"> Data specification Digital terrain model specification Link information (Related organization, contact place, etc.) Outline information about the National land survey Satellite remote sensing data specification information Observation year day Kind of the data PATH-ROW |
| Water surveys | <ul style="list-style-type: none"> Water use map Land use aptitude evaluation maps Drainage system map Valley density map Distribution map of underground water Distribution map at the deep well | <ul style="list-style-type: none"> Main water system investigation record paper Underground water data ledger Photograph Survey progress information | <ul style="list-style-type: none"> Result of land-classification basic survey Result of land-classification detail survey Land cover classification map Training sample Land condition map Legal regulation map Photograph etc. | <ul style="list-style-type: none"> Basin outline data Water relation data Profit water relation data Riparian work relation data etc. | | |

Table 2 Attributes for the data sets

| | |
|-------------------------------|--------------------------------|
| ①Name of national land survey | ⑥Data type |
| ②Name of Prefectures | Raster data, Vector data, etc. |
| ③Coverage of the map | ⑦Prescribed information |
| ④Scale | ⑧Relevant information |
| ⑤Date of survey | ⑨Common information |

by following the data set structure designed by the research.

Fig. 3 shows the composition concepts of the data sets dealt with by the system. Three information items described in Section 3.2 respond as a framework to marshal the information for each classification of national land surveys. In the research, the framework of the information is called the composition division of the data sets. The information is sorted out according to the composition division of the data sets for making data sets through the data set specifications. Table 1 shows the results of marshaling information dealt with for each classification of national land surveys. The following are the specific details of these three kinds of information and data set specifications.

a) Prescribed information

It refers to the information marshaled according to the work requirements for each classification of national land surveys. For example, land classification maps, geology maps and soil maps correspond to the information for land-classification basic surveys, and land use aptitude evaluation maps and various land condition maps correspond to it for land-classification detail surveys. For land-classification basic surveys and detail surveys, a principal objective is to study natural site conditions and land use aptitude. And for water surveys, it is to collect and analyze data associated with irrigation and flood control characteristics indispensable to the land use plan, water resource plan and flood control plan. To make effective use of these pieces of information for land use concept plans and area and zone plans in addition to implementing survey projects, it is required to share various kinds of national land survey information such as land-classification surveys and water surveys as shown in Fig. 4 and also to permit use of the information mutually.

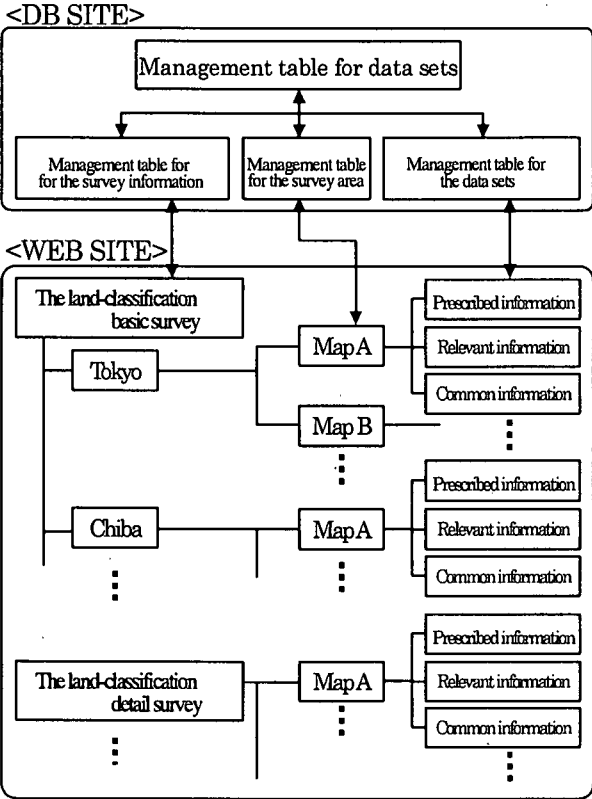


Fig.5 Data set structure

In practice, for the results of water surveys and land-classification surveys, survey information is scattered and lost because each survey is accumulated individually. Consequently, valuable project results have not been utilized effectively.

b) Relevant information

It refers to the information referred to and used in the process of preparing prescribed information. For example, when a land use status map is made in the land-classification basic survey, there is a limit to the implementation of a site survey over a wide area⁴⁾. Information on land cover classification maps generated from satellite remote sensing data is utilized for the state of distribution including urban areas, farmlands and paddy fields. Image information including such land cover classification maps and statistic information including classification accuracy are accumulated as relevant information data sets when necessary.

c) Common information

It refers to the information that does not belong to either of the above two data sets and that is referred to and used in common.

It includes topographical maps serving as a basis for retrieval and aerial photographs used in survey.

Table 3 Basic function of LAS-INFO

| Basic function | Main processing details |
|--|---|
| Data set making and managing function (For the system manager site) | ① Making Prescribed Information · Geometric correction of Image · Processing digital terrain model · Making digital terrain information · Processing satellite image etc. |
| | ② Making Relevant Information ③ Making Common Information ④ Registration and Changing data set ⑤ Management information on data set resource ⑥ Protecting data set |
| Data set retrieving and displaying function (For the user site) | ① Map retrieving and displaying of data set ② Character string retrieving and displaying of data set |

Topographical data when making slope classification maps, relief energy maps and drainage system and valley density maps, the so-called DTM(Digital Terrain Model) corresponds to it.

d) Data set specifications

Table 2 shows basic items described in the data set specifications.

It is designed to manage prescribed information, relevant information and common information and also to permit reference to these pieces of information. As shown in Fig 3. the data set specifications are prepared on an investigation map basis or an investigation area basis.

(3) Data set structure

Data set structure is designed according to the composition division of the data sets studied previously. It is classified into a WEB site and a database site (hereinafter referred to as "DB site") to provide data set structure as shown in Fig. 5.

On the WEB site, a folder accumulating information on an area basis is prepared to constitute a data set according to the link association of files having relative path relation. Specifically, a folder ranking the classification of national land surveys on the top is prepared, and a folder for the investigation area (Tokyo, Hokkaido and all the other prefectures as well as cities, towns and villages) and a folder for the investigation map are provided on the layer lower than that. Besides, folders for prescribed information, relevant information and common information are provided under the folder for the investigation map. It is designed to make all the data sets managed by area correspond with locations on the map to permit reference to the data sets from on the map.

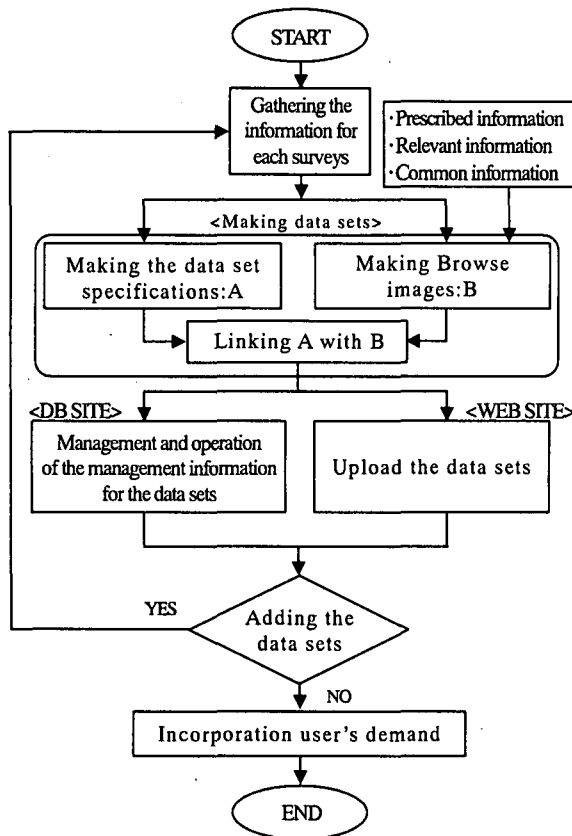


Fig.6 Procedure of data set production

And also it is designed to make data set structure on the side of the WEB site correspond with screen flow of the system to permit ease of responding to the design and development including the addition of the data set and system functions.

On the DB site, management information (data set specifications, belonging folders, file names, date of file creation, etc.) on data existing in the WEB site is converted to database form, and it is managed and operated by the system manager as "management information for data set resource." The management information is also used as index information when data sets are searched by any character string.

5-2 Making of data sets and study of operational functions

Basic functions to prepare data sets to manage and operate them are roughly classified into the following two. Table 3 shows the main processing details of each function.

(1) Data set making and managing function

① Data set making function:

It digitizes various kinds of information constituting data sets and undertakes processing before uploading them to the WEB site. Processing functions were improved to prepare various kinds of geographical information on the basis of geometric correction of images and digital terrain models.

② Data set managing function

Processing functions were improved to register and update data sets and to operate management information on data set resource on the side of the DB site shown in Fig. 5. Since these functions support information management on a data set basis, a subsystem composed of data set management function groups is called DSMS (Data Set Management System) in the research.

(2) Data set retrieving and displaying function:

Data set retrieval is provided with a map retrieving function and a character string retrieving function. Turnaround time before obtaining information is shortened by incorporating these functions. As the classification of national land survey and investigation area to be accumulated increases, the effect of incorporating these retrieval functions is gradually shown.

5-3 Procedure for improving data sets

Fig. 6 shows the procedure for improving data sets. Processing details can be classified as the following three stages;

- **Gathering and marshalling information:** Information constituting data sets is gathered and marshaled for each classification of surveys. Relevant information is gathered with priority given to information associated highly with prescribed information.
- **Making data sets:** Data set specifications and browse images are created. After the relation between the image quality to assure in display on the screen and the capacity of data is studied, a file format considered appropriate to numeric character information and image information is chosen as required.
- **Sending information:** Management information on data set resource is registered in the DB server in addition to uploading data sets to the WEB server. It responds to inquiries from users in system service.

The processing described above is carried out on the data manager's side. There are cases of the design and development of information providing systems of system users themselves registering their own information when

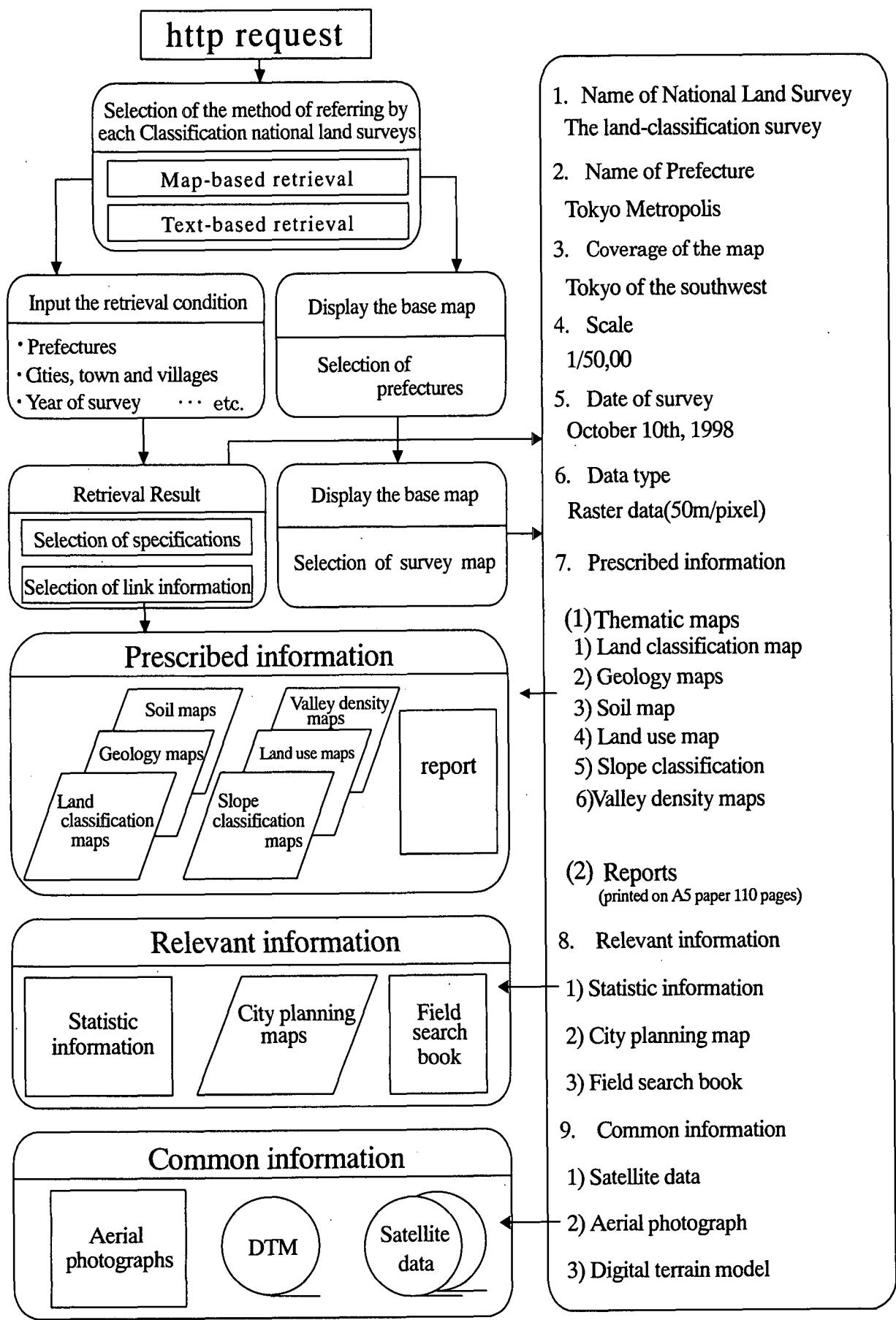


Fig.7 The flow of data set retrieval

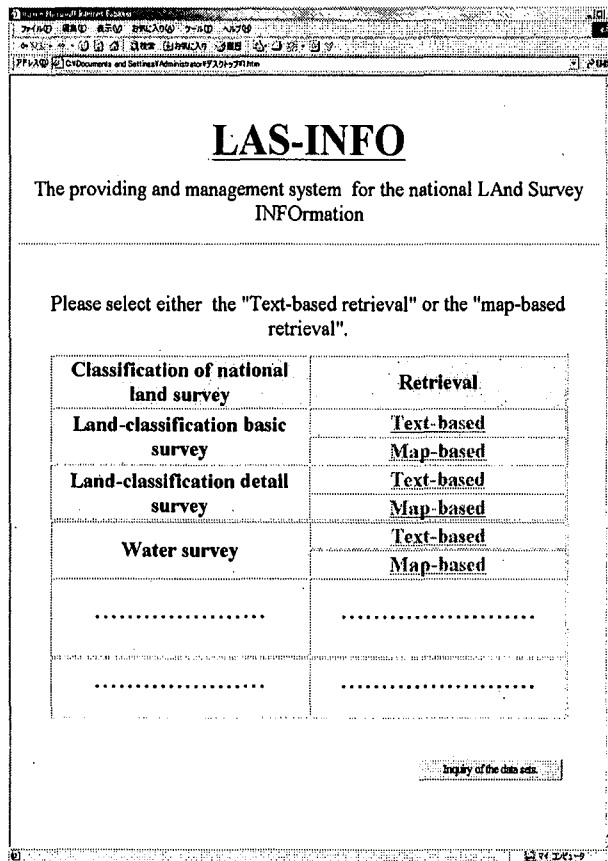


Fig.8 Example of retrieval procedures

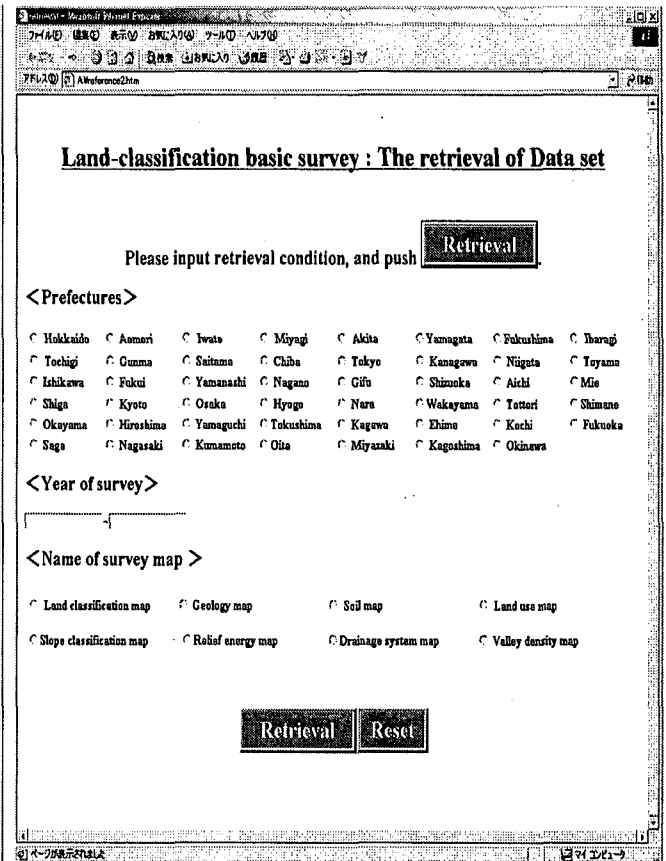


Fig.9 Example of the text-based retrieval

data sets are registered in the system⁵⁾. For this kind of system, the copyright management of data sets is entrusted to the registrant, and thus the workload for data set registration processing is lightened. That is, the manager has only to be involved in data set management only. However, since the copyright of information dealt with in the research belongs to the survey implementing organization, environment in which data sets are made and managed must be separated from environment in which data sets are referred to and used. Though the workload for data set making and management arises for the data set manager, it results in indispensable addressing to ensure the operation of the firewall system for the protection of data resources.

6. Cases of system applications

6-1 Procedure for retrieving data sets

Fig. 7 shows the correlation of information dealing with the total flow of data set retrieval. The system is operated to display the initial screen as shown in Fig. 8. Either of the

“map media retrieval” or the “condition specifying retrieval” is chosen with the mouse for each classification of national land surveys.

(1) Map media retrieval

The map retrieval procedure based is as follows;

- **Choice of Tokyo, Hokkaido and all the other prefectures:** The “MAP RETRIEVAL” button in the field “land-classification basic survey” on the initial screen in Fig. 8 is chosen with the mouse to display the base map giving the boundaries of Tokyo, Hokkaido and all the other prefecture. Tokyo, Hokkaido and all the other prefectures including the land-classification basic survey map to be obtained is specified with the mouse to cause a shift to the screen displaying the division of a 1/50,000 topographical map
- **Choice of survey map:** The intended division is clicked to display the list of data set specifications corresponding to this. Data set specifications to display the details is specified from the list.
- **Reference to link information:** The item to be referred to from among the prescribed information, relevant

information and common information on the data set specifications as shown in Fig.7 is specified with the mouse to display pertinent information.

(2) Condition specifying retrieval

In the research, improvements were made to the method of referring to data sets by specifying retrieval conditions in addition to the above map media retrieval. The "CONDITION RETRIEVAL" button shown in Fig. 8 is specified with the mouse to cause a shift to the screen shown in Fig. 9. Tokyo, Hokkaido and all the other prefectures as well as cities, towns and villages, and the year of survey are specified and entered on the screen. After the result of retrieval is displayed on the screen, it is designed to permit reference to data set specifications and link information shown in Fig. 7.

6-2 Expansion of data sets

Various kinds of information on national land surveys can be efficiently added by following the data set structure shown in Fig. 5. In future, it is necessary to add data set specifications alike about the classification of national land surveys not covered in the research.

7. Conclusion

The results of the research are summarized as follows;

- **Requisite definition of system development:** after pointing out the importance of unified management of information appropriate to the life cycle of national land survey projects (cf. Fig. 1), the scope of information dealt with in the research and requirements when accumulating and managing these pieces of information in a data set basis were defined.
- **Enhancement of data set management and operation efficiencies:** The idea of managing information on national land surveys as a data set was organized, and the information was classified into three information divisions (cf. Table 1) to design data set structure. A function to manage data sets on the WEB site through management information on the database site, the so-called DSMS (Data Set Management System) was structured to enhance data set management and operation efficiencies.
- **Making national land survey information data sets and unified management:** Information was managed in a unified way as a data set on an administrative district basis such as the basis of Tokyo, Hokkaido and all the

other prefectures or cities, towns and villages. Also the information providing and managing system was structured to permit ease of retrieving and referring to the location of data sets via the Internet.

Though image information and numeric character information became able to be released easily on the Internet, it is pointed out that discussions on the continuity of data marshaling and the expandability of information providing and managing systems are insufficient including the structure when technical information offering specialty is accumulated and managed. We think that one measures may have been able to be presented in this respect through the research and development.

We would be pleased if we could in any form contribute to the design and development of information providing and managing systems dealing with various kinds of relevant technical information on national land as well as information on national land survey projects intended in the research.

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