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JAPANESE SURVEY SYSTEMS AND FRAMEWORK DATASETS IN THE CONTEXT OF NATIONAL SDI

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Japanese Survey Systems and Framework Datasets in the Context of National SDI

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1. Introduction

This paper reports Japanese survey systems and framework datasets in the context of National SDI. Firstly Japanese survey systems including cadastral survey are introduced. Next present status of geospatial data framework development and related National SDI activities are described. Finally status and issues for data integration of large and middle scale datasets are discussed.

2. Acts related to surveys

In 1949, after World-War II, Survey Act, which provides a fundamental survey system in Japan, was enacted. Making reference to Survey Act, Act for Hydrographic Activities for hydrographic surveys was enacted in 1950 and National Land Survey Act for cadastral surveys was enacted in 1951. In addition, there is the Act concerning the Registration of Immovables that has a relation to cadastral surveys. Table 1 shows the acts and related information.

Table-1 Acts related to Surveys

Name of the Act	Scope	Objective entities	jurisdiction	Enacted year
Survey Act	Land Surveys	Central government Local government	Geographical Survey Institute, Ministry of Land, Infrastructure and Transport	1949
Act for Hydrographic Activities	Hydrographic Surveys	Central government Local government	Coastal Guard, Ministry of Land, Infrastructure and Transport	1950
National Land Survey Act	Cadastral Surveys	Central government Local government	Land and Water Bureau, Ministry of Land, Infrastructure and Transport	1951
Act concerning the Registration of Immovables	Land Register	Registry Office Private	Civil Affairs Bureau, Ministry of Justice	1899

3. Survey Act and NSDI

3.1 Overview of Survey Act in the context of NSDI

US Executive Order 12906, Coordinating Geographic Data Acquisition and Access: the

National Spatial Data Infrastructure (NSDI), published in 1994. The concept of NSDI was speared around the world. However, Japanese Survey Act realized mostly NSDI concept in 1949. Survey Act is one of the most important tools for establishing NSDI in Japan.

Main parts of Survey Act related to SDI are the followings.

(1) Purpose of the Act

"***Article 1.*** *The purpose of this Act is to effect coordination and standardization of surveying, where public funds or the use of public surveying data are in anyway involved, to avoid duplication, maintain accuracy, define necessary authority for execution and generally to effect improvement in surveying."*

(2) Scope of objective survey

Scope of Survey Act is not only Survey executed by Geographical Survey Institute (GSI), National Survey and Mapping Organization, but also surveys by public projects by other central governments, local governments and other public sectors.

*"**Article 4.** "Basic survey" within the meaning of this Act shall be basic fundamental surveys conducted by the Geographical Survey Institute, Ministry of Land, Infrastructure and Transport."*

*"**Article 5.** "Surveys for public projects" within the meaning of this Act shall be surveys for projects which will utilize public funds for all or part of their costs except minor surveys such as surveys for minor roads, buildings, etc., or surveys not requiring high accuracy as specified by Cabinet Order."*

(3) Avoidance of duplication works

*"**Article 32.** Surveys for public projects shall be based on the survey data of basic surveys or based on data of another survey for public projects which was based on basic survey datum."*

*"**Article 35.** In case the Minister of Land, Infrastructure and Transport deems it necessary for securing accuracy of survey or for avoiding duplication of surveys, he may give advice to the survey planning organs or he may require report of long term plans or yearly plans for surveys for public projects from survey planning organs."*

(4) Specifications

*"**Article 33.** All specifications prepared by survey planning organs for surveys for public projects shall include specifications as to kinds of instruments, methods of observations and methods of computations and the said specifications shall be submitted to the Minister of Land, Infrastructure and Transport for approval. The same shall apply in case of revisions of such plans.*

2. The surveys shall be executed based on the approved specifications stipulated in the preceding paragraph."

*"**Article 34.** The Minister Land, Infrastructure and Transport may prepare standard specifications for executing survey for public projects."*

(5) Submitting survey data of surveys for public projects to GSI and provision of reports of

surveys for public projects to the public

*"**Article 40.** When a survey planning organ obtains survey data in connection with survey for public projects, a copy of these data shall be sent without delay to the Chief of the Geographical Survey Institute."*

*"**Article 41.** Upon receipt of data under the provisions of Article 40, the Chief of the Geographical Survey Institute shall review the data, apply any checks, when deemed necessary, and shall notify the survey planning organ that submitted the data of the results of his findings.*

2. When, as results of review and checking of data provided for in the preceding paragraph, the Chief of the Geographical Survey Institute finds any data of sufficient accuracy and scope to be of public value, he shall publish the data concerned, giving kind of survey, time executed, location, name of survey planning organ and survey operations organ and opinions in respect to accuracy."

All survey data for public projects are collected to GSI, and GSI makes reports of overview (metadata) of surveys for public projects to avoid duplicated works. For example, when someone needs aerial photos, he can check who take aerial photos of the same area before taking new aerial photos.

(6) Use of survey data

*"**Article 30.** Persons planning to execute surveys based on data of basic surveys shall obtain the approval of the Chief of the Geographical Survey Institute prior to beginning such surveys. Approval required is for the purpose of assuring that survey data are appropriate for the survey concerned.*

2. Persons who executed surveys based on data of basic surveys in accordance with the provisions of the preceding paragraph shall clearly show the survey data of basic survey used for survey data of survey concerned with execution thereof.

3. Persons wishing to issue maps or other publications based directly or indirectly on survey data of basic surveys shall clearly show in such maps or publications to what extent he utilized basic survey data in preparation thereof."

This article is not to intend to make barriers to use of survey data but to use of survey data without any charge when someone make derived products from original survey data. Survey Act provides the similar rules for surveys for public projects.

3.2 Basic surveys and surveys for public projects

As mentioned in 3.1, public surveys consist of Basic survey and Surveys for public projects. Overview of each survey was showed as the followings.

(1) Basic Survey

GSI executes the Basic Survey. GSI has prepared 1:25000 scale topographic maps and maps less than 1:25000 scale for the whole country. GSI has also prepared large-scale topographic maps for areas of some big cities and active volcanoes.

GSI publishes these maps not only paper forms but also digital forms. If anyone compile new maps of 1:25000 scale or smaller, he/she uses GSI maps.

(2) Surveys for public projects

Surveys for public projects are done by public sectors including other central and local governments. The surveys consist of various kinds of surveys. While local government in Australia has a special organization for surveys, local government in Japan has no special organization. Surveys are executed in relation to specific projects.

The followings are typical ones.

— Urban Planning Map

Urban Planinng Act provides the preparation of Urban Planing Map by municipalities each five years. Base maps for urban planning is 1:2500 scale topographic maps which describe more than 150 kinds of geographic features including building footprints, pedestrian bridges, detail vegetation etc. Municipalities use the specification of "National Large Scale Map" prepared by GSI as the base map. This base maps cover urban and suburb area for about 1/3 of the whole country.

— Road Administraion and Manegement

Road Act provides the preparation of map for road administraion and management by road administrators such as central and local governments. The base map is 1:500 or 1:1000 scale topographic map. The maps are prepared only along roads and their surroundding.

These base maps (large scale topographic maps) are standardized as specifications for public surveys. All municipalities basically prepare the maps based on the same specification. Digital forms for the maps are also standardized since 1988. At first stage, geometric elements and topological elements were included in the specifications for use of GIS, but later many of topological elements were deleted because municipalities focus on production of paper maps and want to reduce the cost at that time.

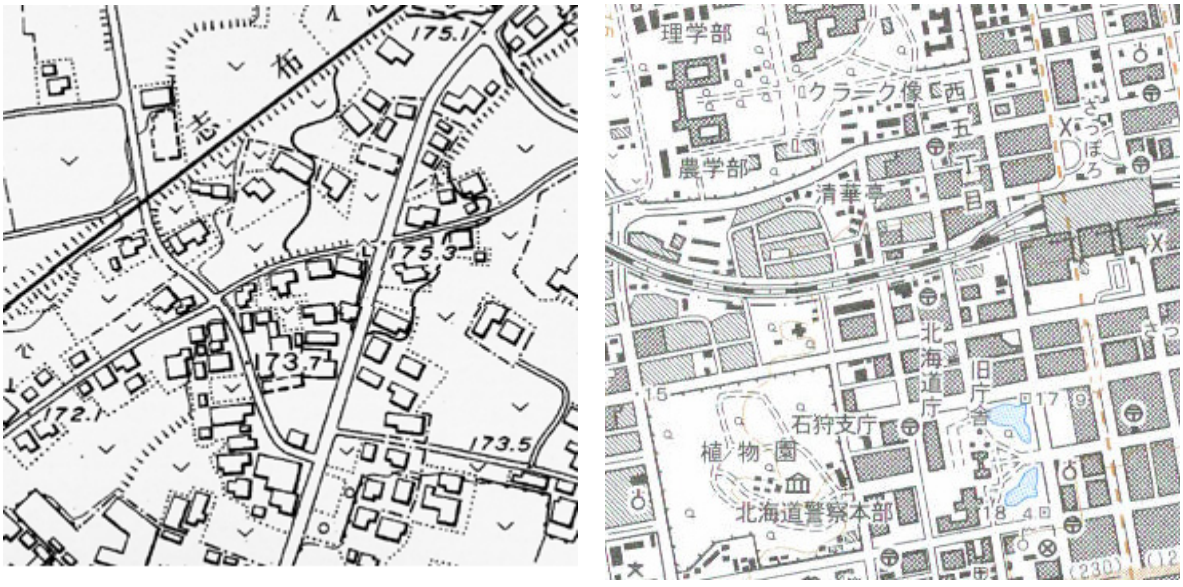

Figure-1 1:2500 National Large Scale Map (Left) and 1:25000 Topographic Map (Right)

3.3 Cadastral Survey

(1) Present status of cadastral survey

Modern cadastral survey started in 1951. Municipalities conduct cadastral survey to survey owner, parcel number, type of land, boundary and the dimension for every parcel of land, and GSI executes survey of control points for cadastral survey under the National Land Survey Act. The Act provides administrative procedures, subsidy rates from central government and technical specifications. The present progress since 1951 is less than 50% for the whole country and especially less than 20% for Densely Inhabited District. The main problems are too complex ownerships and too many parcels.

The most half of maps kept and utilized at registry office as record concerning land in Japan are still based on old map (recorded map) etc. made at the time of extensive revision of the land taxation system in the Meiji era (the end of 19th century). There are some cases that some recorded map is different from the real boundary and configurations etc., and the dimension of land listed on a registry book is inaccurate. The product of the cadastral survey is submitted to the registry office to update registry books and maps. After that, the updated registry books and maps are maintained by registry offices.

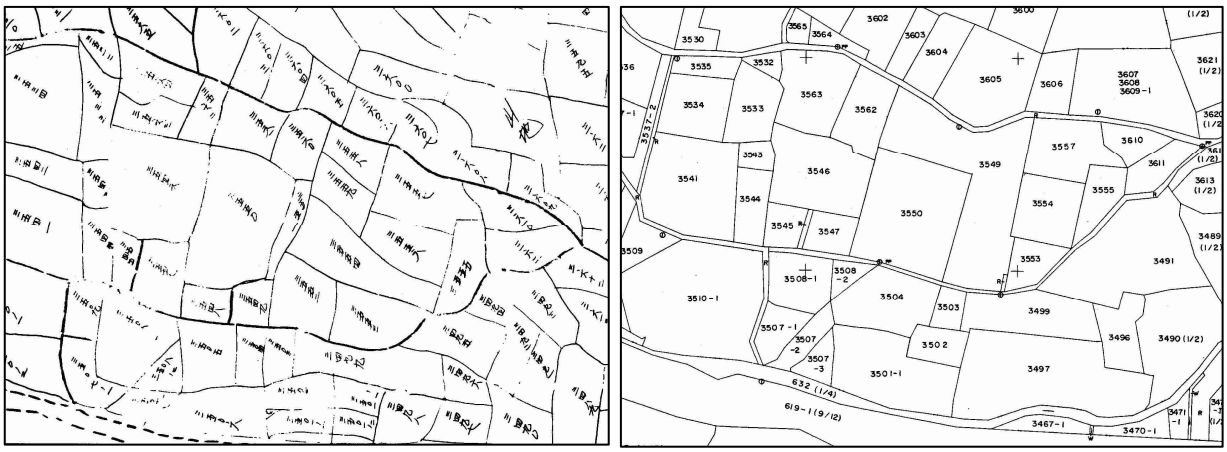

Figure-2 Old map (recorded map) (Left) and the corresponding cadastral map (Right)

(2) Cadastral map

The contents of cadastral map are address, boundary, parcel number, scale, control point and coordinates. Scales of cadastral map are defined in the Cabinet Order upon the Act.

- Residentail Area 1:500
- Farmlands 1:1000
- Forestry 1:2500 or 1:5000

Presently cadastral maps are prepared as digital forms, too.

(3) The relationship between Survey Act

The provisions of Survey Act shall apply to surveys conducted for the exception in cases where there are special provisions in National Land Survey Act.

(4) Utilization of cadastral map in the context of NSDI

The cadastral map is basically used for update of registry maps at registry offices. Some municipalities apply cadastral maps as basic maps to manage some information by GIS. The main problems against utilization of cadastral map are the followings.

- Progress of modern cadastral survey is not well especially in urban and suburb area, while maps based on old map are inaccurate.
- National Land Survey Act has no clear provision for dissemination of cadastral maps and the map is only open for public inspection; thus only municipalities may use it.
- Registration of Immovables by registry offices is run by the self-supporting system. Dissemination of cadastral map will affect this system.
- Cadastral map does not always describes the real world, because (a) land register is not mandatory for ownership but one of measures to claim ownership in the Japanese registry system and (b) a boundary of land as property is not always coincident with the boundary of parcel by public law.

The systems could be changed but the progress of cadastral survey would be still a serious problem. Japanese government has pushed forward the survey by Act on Special Measures concerning Promotion of National Land Survey since 1962.

4 Preparation and provision of framework dataset

4.1 Framework dataset prepared by GSI

GSI develops base geographic datasets and publishes them as Digital Map series. These Digital Map series, including Digital Map 2500 and 25000 (Geospatial Data Framework) are regularly updated to meet the diverse needs for GIS. The contents of Digital Map 2500 and 25000 are transportation network, drainage network, coastal line, administrative boundary, geodetic control point and geographic name. Digital Map 2500 also includes footprints of public buildings, parks, boundaries between road and residential area etc.

The followings are major products for NSDI program.

(1) Digital Map 25000 (1:25000 Level Framework dataset)

This digital map has been developed for the whole country with revision of paper topographic maps and distributed since 2000. The dataset of topographic maps is managed as one large database and revised immediately when main geographic feature changes. This digital map is produced by picking up related geographic features from the database and constructing topological elements.

(2) Digital Map 2500 (1:2500 Level Framework dataset)

This digital map has been developed by compiling National Large Scale Map prepared by municipalities since 1995. GSI produced this digital map by picking up related geographic features from National Large Scale Maps and constructing topological elements. The coverage is the same area of districts designated by Urban Planning Act.

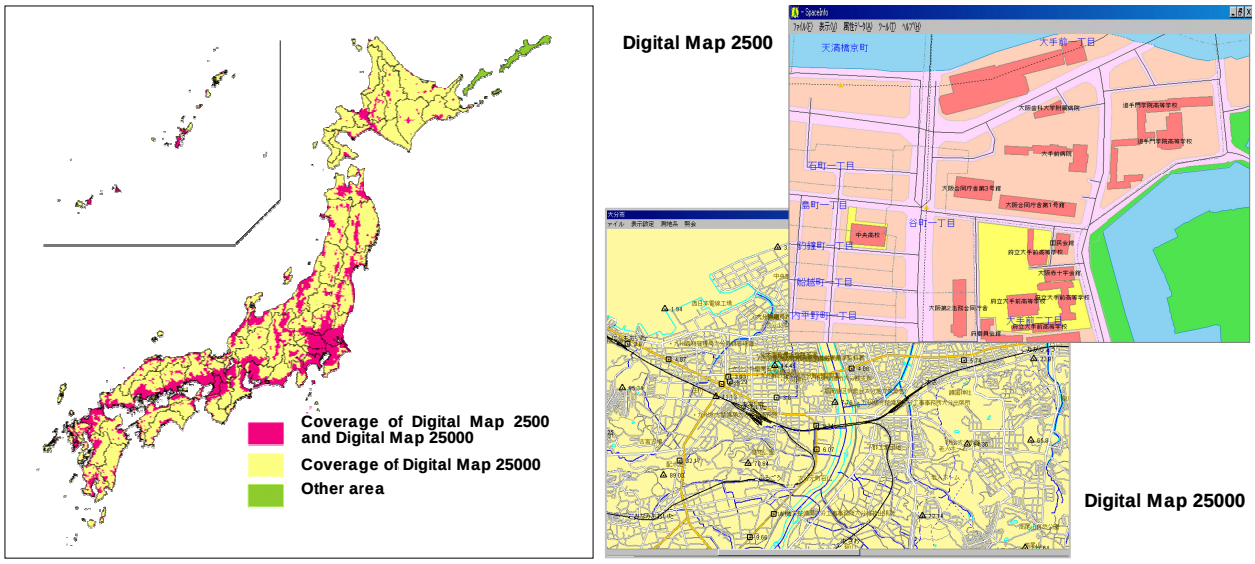

Figure-3 Coverage of Digital Map 2500 and 25000 and their examples

(3) DEM

Regarding DEM, the following kinds of series are published by GSI.

- Whole cuontry (50m grid DEM from 1:25000 scale maps)
- Active volcanos (10m grid DEM from large scale maps such as 1:2500, 1:5000 etc)
- Flatland (5m grid DEM from LIDAR surveys for mainly flood countermeasures)

Digital Map 2500 and Digital Map 25000 are designed by UML and encoded as XML files in accordance with ISO 19100 series standards. The dataset is distributed with UML design diagram (Application Schema). In addition to the above, GSI provides other digital products such as digital aerial photos, digital raster maps, place names and so on.

4.2 Dissemination of geographic datasets

(1) Digital datasets prepared by GSI

GSI publishes all digital maps products by CD-ROM and anyone can buy them. If someone wants to compile or modify the product in order to produce new products or provide services, no charge is required even for commercial uses. The only necessary procedure is an approval by GSI in accordance with the provision of Survey Act. However, any requests are approved except dead copy of the GSI product. Digital datasets are used for various products and services including the Internet ones in Japan.

(2) Web GIS services by GSI

GSI has launched a new information service on the Internet called *"Denshi Kokudo"* Web System, through which anyone can access to various geographic information. On the Internet, people can use the latest map information of GSI as a background map to their own geographic information and provide it at their web sites. GSI provides not dataset from Digital Map 25000 but all geographic features from topographic map database. Some local governments also provide all geographic features including building footprints from National Large Scale Map as background maps of this service.

As of July 31, 2006, 342 web sites are constructed using this system including central and local governments.

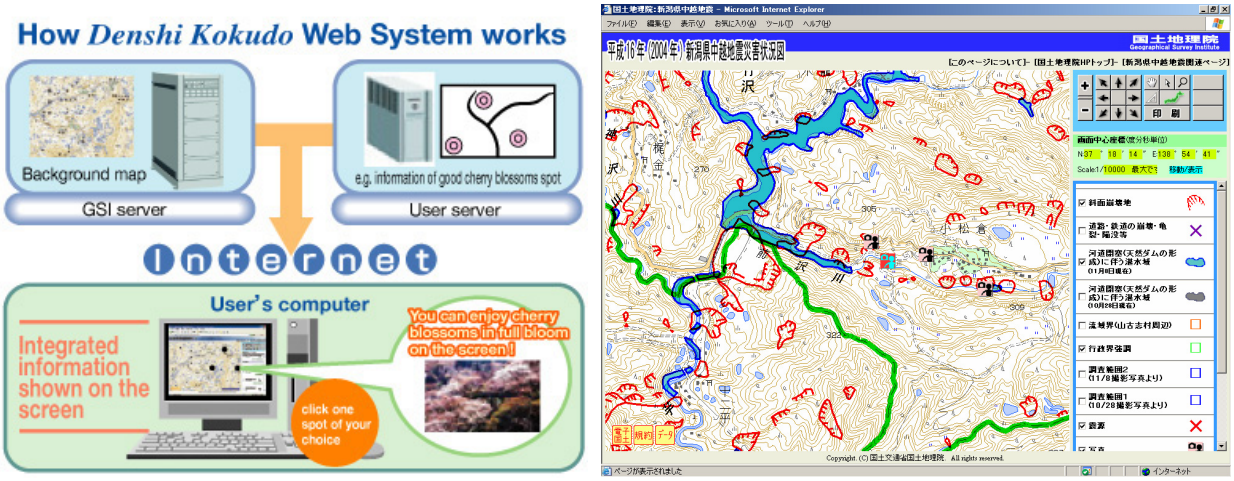

Figure-4 Web GIS services by GSI and an example

Left figure shows mechanism of this system. GSI sever provides vector form dataset of all features and user servers provide additional information to client system. Client system draws the maps with user information.
Right figure shows an example site for disaster management. Red features shows landslide area and deep blue ones shows dams by landslide caused by an earthquake.

5. NSDI activities and applications

5.1 NSDI activities

GIS Liaison Committee of Ministries and Agencies was established to promote NSDI in 1995. The Committee made long term plans and an action program. GSI participated in the Committee as the Secretariat. Several geospatial data frameworks are defined in the NSDI plan, and GSI realized the development of the framework datasets (as Digital Map 2500 and 25000). GSI also developed and operates Geospatial Data Clearinghouse.

The difference between Japanese SDI activities and other countries is that the targets of the program by the Committee include not only acquisition, access and standards of geospatial dataset but also developments of specific applications of geospatial dataset such as e-Government, disaster management and so on.

5.2 Applications of GIS by government

Cabinet Office has promoted establishment of e-Government for several years, GIS Action Program for 2002-2005 focused on the support of e-Government. The Program also focused on applications of environment and disaster management. Various GIS, especially Web GIS, are implemented by central government organizations for these application fields.

In case of local governments as of 2004, about 40% of municipalities are introduced GIS for their inside works. Recently introduction of map web site for communication with residents is rapidly becoming popular.

5.3 Application of GIS by private sectors

Traditional GIS has used for facility management in utility companies such as gas, electric power and so on. These are used inside the closed community.

In Japan, the most well-known application of GIS is vehicle navigation system. Now a vehicle navigation system, which has detailed map and information of point of interest, is installed in 20% of operating automobiles and 40% of new automobiles.

In 2003, a service of human navigation system using GPS mobile phone started. Tracking services of child and aged person for the family using GPS mobile phone are also becoming popular.

For the above services, private companies prepare and provide map dataset including building footprints. The main data source is National Large Scale Map prepared by local governments.

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Figure-5 Japanese map web site (Left) and vehicle navigation system (Right)

Building footprints are described in map. In case of Japan, address system is different from Western way. Most streets have no name and cadastral maps are not well prepared; thus a building footprint is one of the important key to make a relation between address and place. The use of building dataset is very common for vehicle navigation systems and Web services in Japan.

6. Discussion on integration of Built and Natural Environmental Datasets within a National SDI.

6.1 Utilization of cadastral map and National Large Scale Map

As mentioned 3.3, cadastral maps, especially for urban area, are less prepared, while National Large Scale Maps for urban and suburb area are well prepared. In practice, datasets derived from National Large Scale Map are used for general application services for urban and suburb area.

Base maps prepared by road administrators for road administration and management are used for facility management of underground geographic features. In large urban districts, road administrators (central and local governments), water supply organizations, subway organizations, gas companies, phone companies and electric power companies jointly developed database for facility management based on the maps. Cadastral map is not

used in this application field, either.

6.2 Issues of integration of large scale map and other scale map

(1) Data model, quality and contents

The data models between large scale, middle scale and small scale are different. The integration and conversion between the models is not easy. For example, road data is defined as lines with topology in middle and small scale dataset, while the same geographic feature may be defined polygon composed of boundaries between road and residential area.

Qualities of all geographic features presently depend on source map scale. Qualities of geographic features may be different in integrated database from various sources but the topologies between the related geographic features have to be kept. This work is not easy.

The contents of well-used features should depend on demands of users. What and how geographic feature should be included as framework dataset? For examples, buildings are well-used geographic feature in Japan. Pedestrian bridge may be an important geographic feature as topological network of pedestrians for human navigation. Cadastral map are important for dealing real estate.

These are common problems and not specific to Japan.

(2) Maintenance organization and update cycle

Dataset of 1:25000 scale topographic maps, which is source of Digital Map 25000, is managed as one large database and revised immediately by GSI, when main geographic feature changes. On the contrary, National Large Scale Map for Urban Planning, which is source of Digital Map 2500, updates each five years by municipalities.

This is one of the barriers to synchronize update of geographic feature between two Digital Map Series.

7. Conclusion

Survey Act enacted in 1949 is realized the concept of NSDI. In accordance with the Act, public survey projects are coordinated and standardized. GSI prepares middle scale map for the whole country. Large scale topographic maps for the whole urban and suburb area are prepared by municipalities as surveys for public projects, while progress of cadastral map preparation for urban and suburb area is not good, and dissemination of the map has some problems; therefore in practice, a little discussion on integration of cadastral map and other topographic map are made in Japan.

GSI prepares geospatial data framework from the above middle scale maps and large scale maps. In accordance with Survey Act, these datasets published, and anyone can use the datasets without charge except use of dead copy. One of the serious problems of real integration of two digital datasets is the difference of update cycle.