CARTOGRAPHY IN JAPAN
2011-2015

NATIONAL REPORT TO THE 16th GENERAL ASSEMBLY OF
THE INTERNATIONAL CARTOGRAPHIC ASSOCIATION

Rio de Janeiro 2015

THE NATIONAL COMMITTEE FOR CARTOGRAPHY, SCIENCE COUNCIL OF JAPAN

THE JAPAN CARTOGRAPHERS ASSOCIATION

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PREFACE

This is the National Report of Japan to the 16th General Assembly of ICA and the 27th International Cartographic Conference in Rio de Janeiro, Brazil, 2015.

The purpose of this report is to introduce the cartographic activities that have taken place in Japan from 2011 to 2015. The contents describe the following:

1. Activities of the National Committee for Cartography and related academic associations
2. Activities of national mapping organizations
3. Activities of local government
4. Activities of public corporations, foundations, museums and libraries
5. Activities of the private sector

The cartographic works carried out in Japan over the past four years have been rather remarkable. Not only have various kinds of digital maps and GISs been published or built, but also mobile or ubiquitous map information systems including digital map signage installed on site have been developed.

We hope that the many cartographers among the ICA members will be able to better understand the cartographic activities of Japan through this report.

Takashi MORITA
Chairman, The National Committee for Cartography, Science Council of Japan
President, The Japan Cartographers Association

I. ACTIVITIES OF THE NATIONAL COMMITTEE FOR CARTOGRAPHY AND RELATED ACADEMIC ASSOCIATIONS

1. Activities of the National Committee for Cartography (NCC)

The NCC is a branch of the Science Council of Japan (SCJ). The SCJ which is a governmental organization established in 1946 and reformed in 2006, directs Japanese academic research (http://www.scj.go.jp/en/index.html). The SCJ is therefore a member of the International Cartographic Association (ICA), and NCC is a national committee for the ICA.
The members of the NCC are nominated by the SCJ on the basis of co-optation by the members and associate members of the SCJ. The committee currently has nine members. The chairman for the current term is Prof. Takashi MORITA, whose term runs from 2011 to 2017.

1) Activities for the 15th General Assembly of the ICA, and the 25th International Cartographic Conference in Paris, France, in 2011

A Japanese delegation of 21 members headed by Prof. Takashi MORITA attended the conference. Twenty papers were presented and five maps were exhibited at the Children's World Map Exhibition, and around fourteen maps were shown at the International Map Exhibition. Continuation of the Commission on Ubiquitous Mapping proposed by Japan was agreed by the general assembly, and Prof. Masatoshi ARIKAWA was nominated as the chairman of the commission.

2) Activities for the 26th International Cartographic Conference in Dresden, Germany, 2013

A Japanese delegation of 9 members headed by Prof. Takashi MORITA attended the conference. Seven papers were presented. Seventeen maps were shown at the International Map Exhibition and six maps were exhibited at the Children's World Map Exhibition.

3) Activities of Japanese members in the ICA Commissions (2011-2015)

(1) ICA Workshop on Ubiquitous Mapping in Tokyo and Kesennuma, Japan from July 28 to 31, 2012

The workshop was composed of two parts. The first part was held on one day, that is, July 28, 2012 at the University of Tokyo, Kashiwa Campus. The part focused on exchanging ideas through aural presentations of research and planning for activity of ICA Commission of Ubiquitous Mapping. The number of the participants of the first day is about thirty. The second part was held on three days from July 29 to 31 in Kesennuma City where is famous as beautiful ria (deeply-indented) coast and was destroyed in part by Tsunami on March 11th, 2011. The workshop has provided participants with several mobile applications on iPhone which were developed by our local organizing group to efficiently understand on site what happened in the areas damaged by Tsunami on March 11th, 2011 using past aerial photos and the borders Tsunami arrived overlaid on aerial photos and residential maps with GPS positioning. Also, participants had chances to meet and communicate with some officers of local governments suffered by Tsunami to discuss map use for decreasing the damage of Tsunami disaster in the future.

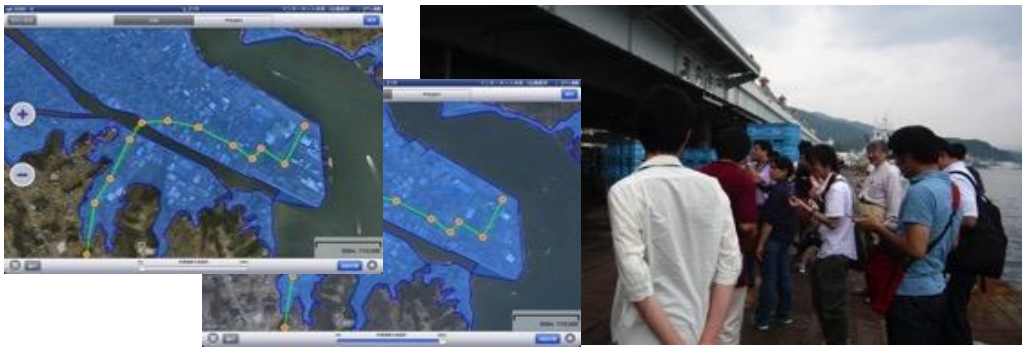


Fig.1 Participants with iPad/iPhone with original location-based applications showing *their current positions* and *trajectories* on aerial photos *before* and *after* tsunami with the borders of suffered areas.

(2) Open Panel Discussion on Maps Designed for Females to Enrich Daily Life and Travel on Nov. 16, 2013 in Tokyo, Japan.

The commission of ubiquitous mapping organized an open panel discussion on Maps Designed for Females to Enrich Daily Life and Travel with conjunction of Geospatial EXPO 2013 (http://www.g-expo.jp/) held at National Museum of Emerging Science and Innovation in Tokyo on Nov. 16, 2013. The panelists are (a) KIKI who is a cover girl of the most popular female travel monthly magazine "OZ Magazine" including female maps. She is also a fashion model, an actress and a graphic designer, (b) Ms. Yuka KIKUCHI who is a chief female editor of the most popular travel guide book series "Co-Trip" publish by Shobunsha Publishing Inc. as one of the biggest map companies in Japan. Co-Trip is the first female travel magazine in the world, started from 2008, and are sold more than eight million in Japan, (c) Ms. Megumi YOKOI is a producer of free city walking guide leaflets designed for females provided by Tokyo Express Railway Corporation, and (d) Prof. Masatoshi ARIKAWA as a researcher on maps designed for females. The master of the open panel discussion is DJ TARO who is a famous male disk jockey at FM Radio "J-WAVE" in Tokyo. He came from Brazil and is known as a person to use new IT frameworks and hot gadgets actively. The open panel discussion was broadcasted through Ustream.

(3) International Symposium on Cartography in Internet and Ubiquitous Environments (CIU2015) in Tokyo, Japan from March 17 to 20, 2015.

The three commissions, which are Maps and the Internet, Theoretical Cartography, and Ubiquitous Mapping, organized a joint International Symposium on Cartography in Internet and Ubiquitous Environments (CIU2015) in Tokyo, Japan from March 17th to 20th, 2015. It was also sponsored by Center for Spatial Information Science (CSIS) of the University of Tokyo. The first and fourth days were spent for technical tours of visiting Roppongi Hills (one of the largest integrated property development in Japan), Tokyo Traffic Control Center, the Geospatial Information Authority of Japan (GSI), Geological Museum and so on. The participants experienced various kinds of maps and the culture behind them in Japan. The conference was held on the second and third days at Sanjo Conference Hall in Hongo Campus of the University of Tokyo. The number of the participants was about seventy, and they came from Japan, China, USA, Taiwan, Philippines, Vietnam, Indonesia, Australia, India, Bangladesh, Iran, Kuwait, Egypt and Germany. The President Georg GARTNER and the Secretary-General László ZENTAI gave great video messages in the opening session and made clear the significance of the symposium. Prof. Takashi MORITA, vice-president of ICA from 1999 to 2003, gave a keynote talk on "Evolution of Cartography in Internet and Ubiquitous Environments". There were 26 oral presentations and 6 poster presentations in eight sessions. The following are the titles of the sessions.

(A) Mapping in Social Media and Big Data
(B) Use of Maps and Mapping
(C) 3D and Real-Time Sensing
(D) Web Mapping and its Applications
(E) Theoretical Cartography for Geospatial IT Society
(F) Mapping and Knowledge Management
(G) Remote Sensing and Modeling
(H) Map Visualization

Papers and abstracts of the presentations and the keynote talk are available on the web site.
http://ubimap.csis.u-tokyo.ac.jp/ciu2015/

In the closing session, we discussed the meaning and necessity of Cartography for maps and mapping in the modern environments. Emergence of web and mobile mapping is leading us to less diverse world of Cartography, but they are not dominant and there remains the diversity in maps and mapping if we take into account a wide variety of modern environments, as which the participants have experienced during the technical tours in Japan. We concluded the urgency of developing a new theory of Cartography to involve new various environments as a collaboration among the three commissions. Particularly, the meaning of maps for blind people and non-visual maps for conveying spatial information to human's brain must be a key concept to develop the new theory of Cartography for new IT environments.

Fig.2 Group Photo in front of Sanjo Conference Hall in Hongo Campus, the University of Tokyo (CIU2015, Tokyo, March 18)

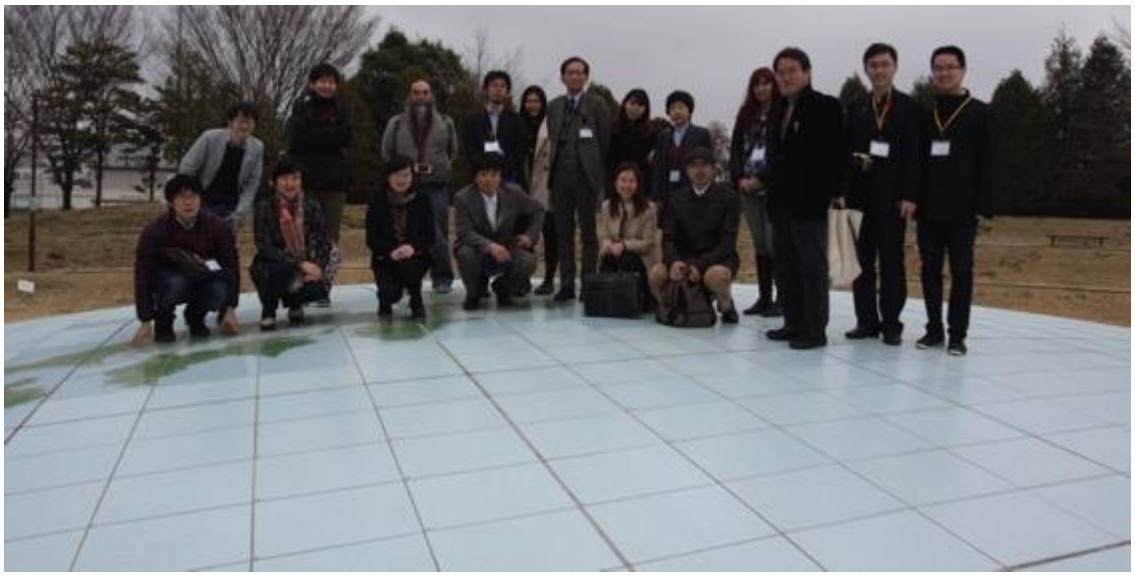


Fig.3 On the big ceramic globe with 1:200,000 in Geospatial Information Authority of Japan (CIU2015, Tokyo, March 20)

(ARIKAWA Masatoshi, MORITA Takashi)

2. Activities of the Japan Cartographers Association

The Japan Cartographers Association (JCA) is the only Japanese scientific association whose aims are for advancement of cartography in Japan. JCA is one of the cooperative academic societies of the Science Council of Japan (SCJ) and has close partnership with the National Committee for Cartography of the SCJ.

JCA was established in November 1962 at the time of the First International Cartographic Conference in 1962 in Frankfurt am Main. In 2013, JCA held a ceremony to celebrate the 50th anniversary. There are currently about 900 members and the secretariat's office is located in the Japan Map Center Building in Tokyo. The president is Prof. Takashi MORITA of Hosei University.

The activity plan and budget of JCA are decided annually at the general assembly, which is usually held in late February. Concrete actions are operated by the standing committee, which is consisting of 18 members and chaired by Prof. Masatoshi ARIKAWA of the University of Tokyo.

The regular activities of JCA are as follows:

(1) Annual Scientific Conference

A two- or three-day conference including a special lecture is held annually in summer or autumn in Tokyo and local city alternately, with about 200 attendees. The mean number of presentations in aural session, poster session and symposia of 2011-2015 conferences is about 40. Proceedings are distributed to participants of the conference. Maps, geographic information systems and cartographic materials are exhibited at the conference. Exhibitors are the Geospatial Information Authority of Japan (GSI), the Hydrographic and Oceanographic Department of the Japan Coast Guard and other government organizations as well as commercial sectors.

(2) Regional Conference and JCA Workshops

The regional conference is held once a year, usually in autumn, in a city excluding Tokyo. The number of attendees of a conference is 40-60. JCA Workshops, mostly a half-day program, are also held three to four times a year.

(3) Excursions

A one-day or two-day excursion is held in conjunction with the annual scientific conference and the regional conference. The workshops occasionally include an excursion or a technical tour.

(4) Commissions

JCA has nine commissions (see below), some of which correspond to ICA commissions. Each commission has its own activities directed by the leadership of chairperson. They sometimes plan symposia of the annual scientific conference or the regional conference, excursions and JCA workshops as well as the commission workshops. The JCA Commission on Ubiquitous Mapping managed The International Symposium on Cartography in Internet and Ubiquitous Environments 2015 (CIU2015), which was held in March, 2015 at The University of Tokyo by the ICA Commissions on Ubiquitous Mapping, on Maps and the Internet and on Theoretical Cartography.

- Commission on History of Cartography
- Commission on Cartographic Terminology
- Commission on Professional Education and Training
- Commission on Marine Cartography
- Commission on Map Use & Sub-Cartography
- Commission on Ubiquitous Mapping
- Commission on School GIS Education
- Commission on Chinese Maps
- Commission on Maps and Toponymy

(5) Publications

JCA publishes a quarterly journal “Chizu -- Kukan Hyogen no Kagaku (Map, Sciences of Spatial Representation)”. It is composed of scientific papers, various reports, book reviews and news. Each issue has a paper map (occasionally a CD) as an appendage. Since the appendages are selected from unique and not-easy-to-get materials, JCA members get many interesting maps in this way.

(6) Website and Mailing List

JCA makes its activities public through website (http://www.jmc.or.jp/gakkai/). JCA also operates a mailing list, which is useful for exchange of information.

(7) Collection of Maps and Relating Materials

Maps and various materials relating to maps are collected principally by way of donation or exchange including those from foreign institutions.

(8) Commendation

JCA made a regulation of commendation 'JCA Award' in 2006. The first commendation ceremony was held in the general assembly of 2007 and two JCA members whose scientific papers in Chizu are excellent, a map-publishing company, a high school teacher, and 56 JCA members who contributed specifically to the promotion of JCA are awarded.

(9) Cooperation with Other Scientific Organizations

JCA is a member of the Japan Geoscience Union (URL: http://www.jpgu.org/) which is composed of 48 scientific societies in Japan covering geophysics, geology, geography and relating sciences. JCA conducts "Mapping and spatial representation in geoscience" session as one of the regular sessions of the annual meeting of the Japan Geoscience Union. JCA also a member of both the Japanese Geographical Union (URL: http://www.ajg.or.jp/JOGS/) and the Committee on the Cooperation of Societies of Human and Economic Geography and Geography Education (URL: http://hgsj.org/renkei/kyougikai/). JCA takes actions for the promotion of cartography and its education through these unions. JCA supports many events of map exhibition, map contest, workshop, training course, etc. organized by GSI, Japan Map Center, scientific societies, local organizations, etc.

(WAKABAYASHI Yoshiki)

3. Certification of GIS engineer organized by the GIS Association of Japan (GISA)

GIS Association of Japan (GISA) established GIS Certification Association (GISCA) under the corporation of related academic societies including JCA in October 2006. The roles of GISCA are the certification of "GIS Expert" and "GIS Expert Emeritus" to the professional individuals and the certification of GIS education to the academic and social education organizations. More than about 400 people were certified as GIS Expert since the certification has started. GISCA draws upon the method of GISCI in US and modifies it for Japan to evaluate GIS professionals.

The title "GIS Expert Emeritus" is presented to the people who have been taking leadership to the field of GIS more than 25 years, if the certification committee decides the certification by the nomination from GIS related organizations. 19 people shown under have been celebrated since 2010.

2010:

Toshiro Edamura (Professor Emeritus, Kobe University)
Masao Iri (Professor Emeritus, The University of Tokyo)
Michio Nogami (Professor Emeritus, Tokyo Metropolitan University)
Atsuyuki Okabe (Professor Emeritus, The University of Tokyo)
Hiroyuki Kohsaka (Professor, Nihon University)
Teruko Usui (Professior, Nara University)
Etsuo Yamamura (Professor Emeritus, Hokkaido University)
Yuji Murayama (Professor, University of Tsukuba)

2011:

Kenji Ohmasa (Professor, The University of Tokyo)
Yosihisa Hoshino (Former Director-general of the Geospatial Information Authority of Japan (GSI))
Kazuhiko Ohtake (Former Director-general of the Geospatial Information Authority of Japan (GSI))
Takashi Morita (Professor, Hosei University)
Ryosuke Shibasaki (Professor, The University of Tokyo)

2013:

Shin Yoshikawa (Professor, Osaka Institute of Technology)
Sachio Kubo (Professor, Soka University)

2015:

Kunio Nonomura (Former Director-general of Geospatial Information Authority of Japan (GSI))
Ryutaro Tateishi (Professor, Chiba University)
Yasushi Asami (Professor, The University of Tokyo)
Morishige Ota (Fellow, Kokusai Kogyo Co., Ltd.)

GISCA also certifies GIS educations provided by academic and industrial organizations. More than 30 education programs have certified by June 2015. (http://www.gisa-japan.org/eng/index.html)

(OTA Morishige)

II. ACTIVITIES OF NATIONAL MAPPING ORGANIZATIONS

In the Japanese government, several organizations are responsible for fundamental surveying, mapping and charting projects. Basic geodetic surveys are carried out mainly by the Geospatial Information Authority of Japan (GSI) and the Hydrographic and Oceanographic Department (JHOD), and various cartographic works are conducted by the GSI, the JHOD, the Forestry Agency, the Geological Survey of Japan of the National Institute of Advanced Industrial Science and Technology (GSJ, AIST), and the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and other organizations.

1. Geospatial Information Authority of Japan, the Ministry of Land, Infrastructure, Transport and Tourism (GSI/MLIT)

1) Developing, updating, and providing geospatial information as the infrastructure in a responsible manner

GSI establishes the geodetic reference framework of Japan and uses it to develop geospatial information such as topography and position of buildings. This essential information is provided to the public for administrative, social and economic activities.
In order to conduct accurate surveys, GSI manages the coordinate system by providing a proper positional standard while developing the fundamental geospatial information. Also, GSI develops, updates, and provides Digital Japan Basic Map as a basic map for depicting national land.
As a designated administrative organization pursuant to the Basic Act on Disaster Control Measures, GSI promotes disaster management measures incorporating the latest technologies of surveying and mapping.

(1) Developing and updating Digital Japan Basic map which depicts whole land of Japan.

Maps that accurately represent current land conditions are indispensable for land administration and various socioeconomic activities. Also, the use of ICT (Information and Communication Technology)-based maps is growing and demand for digital maps of larger scales is increasing. With the enactment of the Basic Act on the Advancement of Utilizing Geospatial Information in May 2007, GSI is steadily developing and providing the Fundamental Geospatial Data as positioning reference of digital maps, as well as Digital Japan Basic Map which includes this digital information and depicts whole land of Japan.

>> Digital Japan Basic Map

Digital Japan Basic Map is basic geospatial information of Japan which is composed of map information which is general geographical information of national land, orthoimage and Geographical Name Information which will be used as a keyword to search the name of resident place and natural place-name. Various users' needs can be fulfilled by releasing through GSI Maps, as well as in digital formats such as Digital Map (Basic Geospatial Information) in vector format, Digital Topographic Map 25000 in raster format, and orthoimage data. Advanced usage responding to the requirements such as land management, disaster risk reduction, etc. can also become feasible.

- Map information

New national land map data include various information necessary for land management, such as topography and structure as well as the Fundamental Geospatial Data such as roads and buildings. The data will be updated quickly and efficiently in cooperation with managers/administrators of local public organizations and of the social infrastructure-related facilities.

- Orthoimage

GSI improves orthoimage data using digital aerial photographs in the city planning area and its environs while taking into consideration of the needs of local public organizations. Map information can be overlaid onto orthoimage. This will enable the map symbol to link with each facility, and a user can exhaustively know the area.

- Geographical name information

The names of natural geographic features such as mountains, rivers and islands, and names of inhabited areas such as towns are stored into a database and then published as geographical name information that can be used for various purposes. It serves as the base for displaying territories, managing national land and a location search key, making it absolutely essential information for promoting the use of geospatial information.

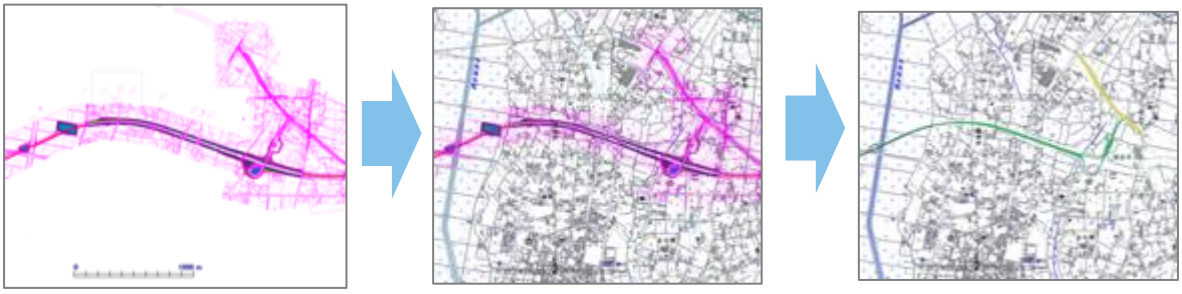
>> Fundamental Geospatial Data

Fundamental Geospatial Data are the common fundamental map data that anyone can use without any restrictions via

the Geographic Information System (GIS). GSI is providing the data by seamlessly integrating large-scale map data in cooperation with other related organizations. The Fundamental Geospatial Data are the part of Digital Japan Basic Map which covers entire land in 2014. From 2012, GSI is working on updating the data on a full scale cooperatively with Digital Japan Basic Map.

>> Collaborative and cooperative relationships for improving, updating and utilizing

GSI is trying to establish the collaborative and cooperative relationships with related organizations within the community by organizing meetings among industry, government and academia in order to develop, update and utilize the Fundamental Geospatial Data and Digital Japan Basic Map promptly.



Information from facility administrators

Overlaying construction plans and map information

Updated map information

Fig.1 Method for Updating Road Information in Cooperation with Road Administrators

(2) Preparing landform information for disaster risk reduction

>> Geographic information for disaster risk reduction

GSI provides geospatial information regarding landforms that is required for citizens to live in a safe place, to predict damages caused by natural disasters accurately and to take measures against natural disasters.

- Land condition data

The Land condition data are created mainly for plain areas where cities are located. On these data, landforms are categorized by reflecting a feature of land and history of land formation.

- Volcanic land condition data

The Volcanic Land Condition Data categorizes land forms associated with volcanic activities such as lava flows.

- Urban area active fault map

Urban area active fault map shows the distribution of landforms and the detailed positions of faults in major active fault zones around urban areas (areas where earthquake damage may be extensive) throughout Japan.

- Digital Elevation Topographic Map for basic geospatial data

GSI provides high-resolution elevation data. The data are used as basic materials for compiling hazard maps that identify areas that are vulnerable to floods and storm surges.

>> Hazard map portal site

On a portal site, GSI and other departments of the Ministry of Land, Infrastructure, Transport and Tourism released hazard maps prepared by local governments and geographic information for disaster risk reduction. The site offers a one-stop service that everyone can search and browse for necessary information.

(3) Surveying the area of disaster and providing the information

>> Grasping disaster situation by “Kunikaze III” survey aircraft

As an administrative organization designated by the government based on the Basic Act on Disaster Control Measures, GSI uses “Kunikaze III” survey aircraft to response rapidly to unpredictable natural disasters. When large-scale disasters occur, such as earthquakes, volcanic eruptions and floods, observations are carried out by taking emergency aerial photographs. In addition, data of airborne SAR and aerial laser scanners are rapidly provided to the relevant organizations to collect damage information.

- Emergency aerial photogrammetry

Aerial photographs provide crucial data for accurate and comprehensive damage assessments after a large-scale disaster such as a major earthquake.

Aerial photographs taken in emergency situations and orthoimages generated from them are provided to the relevant organizations and publicized on GSI Maps website.

- Airborne SAR observations

Since it is impossible to take aerial photographs when smoke is rising from craters during volcanic activity, the aircraft equipped with synthetic aperture radar (SAR) sensor that can collect imagery through such smoke and cloud conducts surveys.

- Aerial laser scanner observations

Observation of changes in height is used as basic information for flood control measures during heavy rain and typhoons, etc.

Changes in the height caused by major earthquakes, etc. are flexibly monitored to support restoration and recovery measures.

>> Providing maps to the related organizations for disaster risk reduction

When disasters such as earthquakes strike, all kinds of maps are provided immediately after in order to support the gathering of damage information, emergency measures, and recovery and restoration.

>> Arial Photographing by an Unmanned Aerial Vehicle

In November 2013, a submarine volcano off Nishinoshima Island, which is a remote island located approximately 1,000km south of Tokyo, erupted, forming a new land as a result of a large amount of lava flow. In response to this event, the GSI took aerial photographs around Nishinoshima Island on December 4th and 17th 2013, and February 16th and December 4th of last year, utilizing conventional aerial vehicle. However, since the island is located in the far distance from the main islands of Japan, it is very difficult to access there frequently. Then the GSI tried to dispatch an unmanned aerial vehicle last March, and succeeded to take aerial photographs automatically, for the first time in Japan for surveying. Also the GSI conducted subsequent observation and succeeded to obtain the latest quantitative data concerned with the island in last July and this March.

>> Ground surface deformation monitoring all over Japan by InSAR using ALOS-2 data

Advanced Land Observation Satellite (ALOS-2), Japanese dedicated satellite for synthetic aperture radar (SAR) as a successor of ALOS, was launched on 24 May, 2014. ALOS-2 has started the basic observation since 4th August 2014. GSI has started to make a full use of ALOS-2 data for ground surface deformation monitoring by Interferometric SAR (InSAR). The monitoring covers not only the areas designated by previous ALOS policy but also the whole country in regular basis. In addition to the InSAR analysis in regular basis, GSI conducts emergency analysis after hazardous events such as earthquakes and volcanic eruptions. Information on crustal deformation caused by the events can be provided by GSI and becomes available for disaster responses no later than 72 hours after the events.

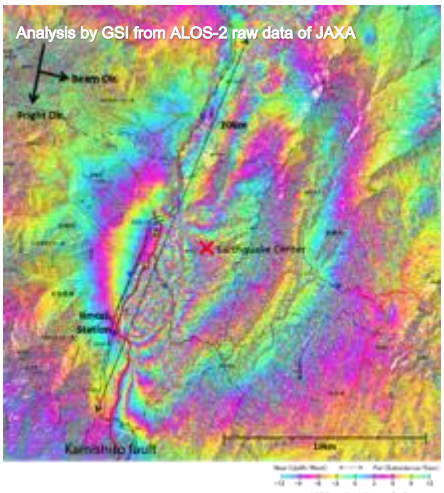


Fig.2 Crustal movement from the 2014 northern Nagano Prefecture earthquake captured by Interferometric SAR

2) Creating an environment where a diversity of geospatial information is developed effectively and readily available and utilizable by anyone

GSI is developing a framework to encourage distribution and the use of geospatial information for efficient developments and wide applications of geospatial information. It also establishes rules and standards for the development, distribution and use of geospatial information.

(1) The Geospatial Information Library

The Geospatial Information Library is a clearing house for geospatial information. Through the Internet, anyone can search, browse, and acquire basic survey results by GSI, such as maps, aerial photographs, and geodetic control points, as well as public survey results such as maps created by national and local public organizations.

(2) Providing national geospatial data onto the Web as an essential part of NSDI

>> GSI Maps

As a fundamental part of the Geospatial Information Library, GSI provides a web map entitled “GSI Maps,” (http://maps.gsi.go.jp/) where more than 1,000 layers of national authoritative geospatial information are available.

>> GSI Tiles

GSI provides open access to map tile data for GSI Maps. Branded as GSI Tiles, these data are used in various web map sites of the nation, and also are used in various computing environment such as mobile device and desktop GIS.

>> GSI Maps Partner Network

GSI runs a community of more than 100 GSI Tiles developers to promote various application of GSI Tiles.

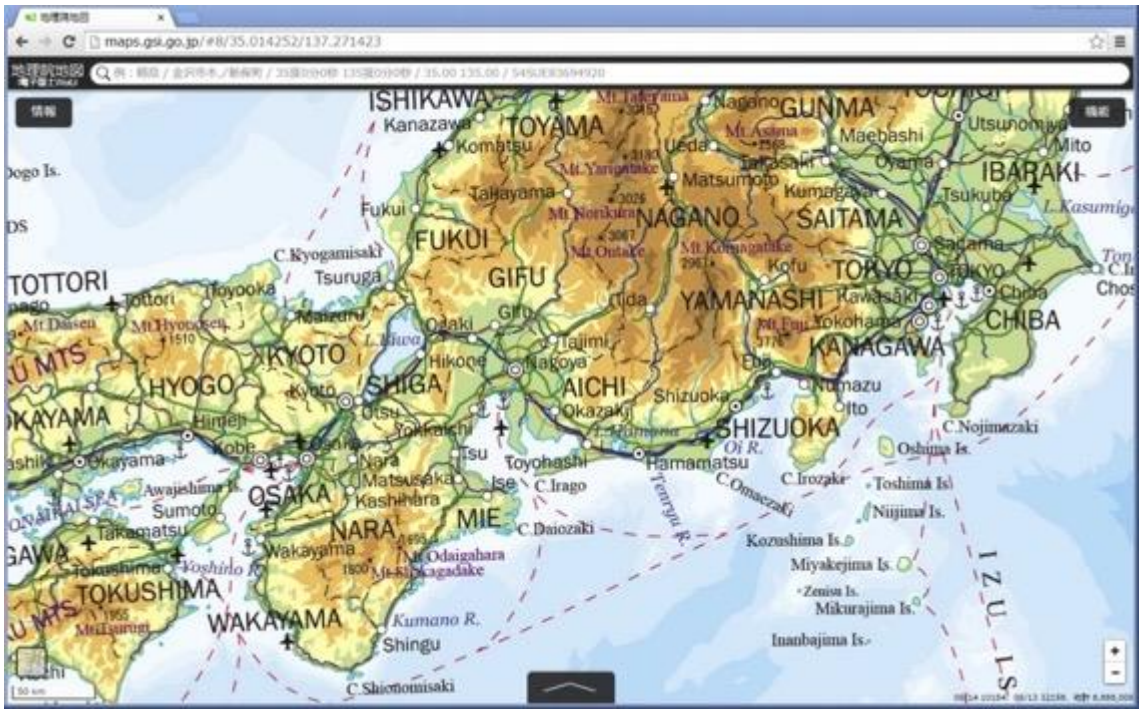


Fig.3 GSI Maps (http://maps.gsi.go.jp/)

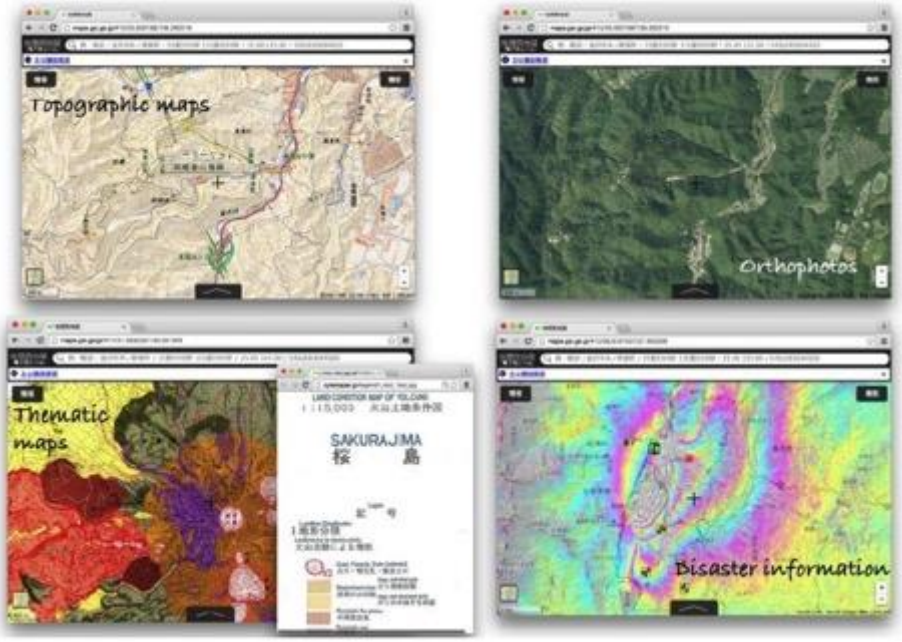


Fig.4 Various Layers from GSI Maps

(3) Managing and providing the map archives of invaluable national land records

Aerial photographs and maps are irreplaceable precise records of land features at different times. GSI has digitalized the massive amount of existing geospatial information in our archives. Anyone can browse these digitalized maps and aerial photographs on the internet.

>> Browsing and transcripts

Anyone can browse the control point data list (coordinates of control points) and past/present maps and Aerial photographs, and/or receive transcripts of such documents from GSI.

>> Exhibition of antique maps

GSI archives an array of antique maps including Inoh-zu for historical and cultural purposes and for academic research. The maps are safely stored and maintained as a cultural resource for future generations. The antique maps can be browsed on the internet.

(4) Preparing a system to promote the utilization of geospatial information

>> Japan Profile for Geographic Information Standards（JPGIS）

The Japan Profile for Geographic Information Standards (JPGIS) is a subset of geographic information standards which provides the minimum rules on production and use of geographic data. The cost and efficiency related to geographic information can be improved by making and using spatial data and systems based on JPGIS. Therefore, it facilitates the formation of information society and safe and secure society.

>> Formulating guidelines for geospatial information

In order to promote the utilization of geospatial information, it is necessary to have a clear set of rules. In relation to this, the government formulated "Guidelines for handling of personal information in geospatial information and promotion of secondary use" in 2010. GSI fulfilled an independent role in deciding on these guidelines.

As a way to facilitate the provision and dissemination of geospatial information from the viewpoint of national security, GSI actively participates and contributes to environmental improvement while promoting its use.

3) Developing and Providing Information for Disaster Management

As a designated administrative organization under the Basic Act on Disaster Control Measures, GSI, in order to contribute to the disaster management activities by government ministries, local public organizations, etc., collects various types of appropriate and timely geospatial information and provides it promptly to relevant organizations and publicly releases it on its web site.

(1) Developing and Updating of Basic Information for Disaster Risk Reduction

>> Clarifying Disaster Risks by Monitoring Crustal Deformation

Japan is located on a complex plate boundary zone and therefore is subjected to active crustal movements. GSI continuously monitors and examines movements caused by earthquakes and volcanic activities by using data of GEONET, VLBI, InSAR in order to understand mechanisms of these phenomena in detail. In addition, GSI contributes to evaluation of the disaster risks, reduction or mitigation of disasters by providing information of the land movements to various government committees, organizations, local governments, and so on.

>> Developing Topographic Information

To make people's lives safer, GSI supports disaster management by providing precise geospatial information about the natural characteristics of land such as Land Condition Data, Volcanic Land Condition Data and Urban Area Active Fault Maps, etc. that is needed to make more accurate evaluations of disaster risks. By field surveys and aerial photo-interpretations about main plains and surrounding areas, active volcanoes, and major faults in Japan, GSI develops and provides information about such things as history of land formation, vulnerable areas for ground shaking or liquefaction, landforms that have been formed by volcanic activity, and the locations of active faults.

(2) Providing Information for Disaster Response and Recovery

>> Disaster response using the Digital Disaster Response Information System

The Digital Disaster Response Information System is a system which combines basic information such as 3D detailed elevation data created from existing map information, airborne laser surveys, etc., with moment-by-moment real-time information on situations that occur immediately after a disaster. This information is overlaid on one digital map to analyze and provide information on various types and scales of disasters.

(3) Activities of GSI in Response to the 2011 off the Pacific coast of Tohoku Earthquake

The 2011 off the Pacific coast of Tohoku Earthquake took place at 14:46 local time on 11 March 2011. The epicenter was located about 130 km ESE off the Tohoku coast. Its magnitude, 9.0, was the largest observed in Japanese history and was the fourth largest in the world since 1900. In addition to a terrible shaking, the main shock brought a gigantic tsunami wave more than ten meters high with a maximum run-up height of 40m over a wide range of the Pacific coast

in the Tohoku region.
Just after the occurrence of the 3.11 earthquake, GSI went into emergency status and immediately set up an emergency headquarters (EHQs) to serve as the decision making body for disaster operations. In accordance with the decisions of EHQs, GSI took various actions to support the victims and damaged regions by surveying and providing geospatial information, such as distributing maps and aerial photos, observing crustal movement and mapping inundation areas, under the full collaboration with private surveying companies and related organizations.

>> Crustal movement observed by GNSS-based Control Stations

Crustal movement can be observed from analysis of GNSS continuous measurement by means of GNSS-based Control Stations. Also, detailed models (earthquake source fault/slip distribution) can be estimated from analysis of observed data of crustal movement.

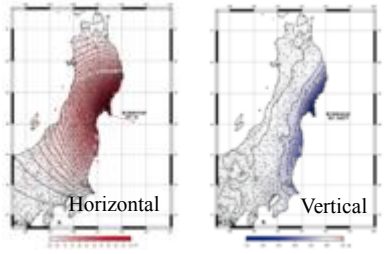


Fig.5 Diagram showing amount of change accompanying main shock (M90) on March 11

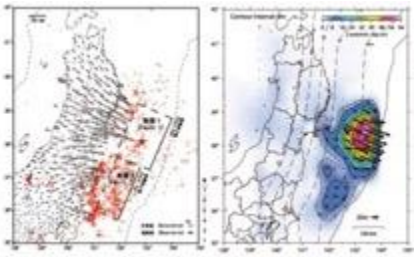


Fig.6 Earthquake source fault model (left) and Slip distribution model (right) (after GSI and Japan Coast Guard)

>> Crustal deformation observed by Interferometric SAR (Synthetic Aperture Radar)

Interferometric SAR (InSAR) is a technology that monitors deformations of the Earth's surface by transmitting and receiving a radio wave from satellites. In the InSAR process, SAR observations are carried out at two different times in the same ground surface location. Information acquired in the first and second observations is analyzed, and ground surface displacement can be visualized by expressing the calculated phase contrast with colors.
In the 2011 off the Pacific coast of Tohoku Earthquake, crustal deformation was observed over the whole area of the Tohoku region.

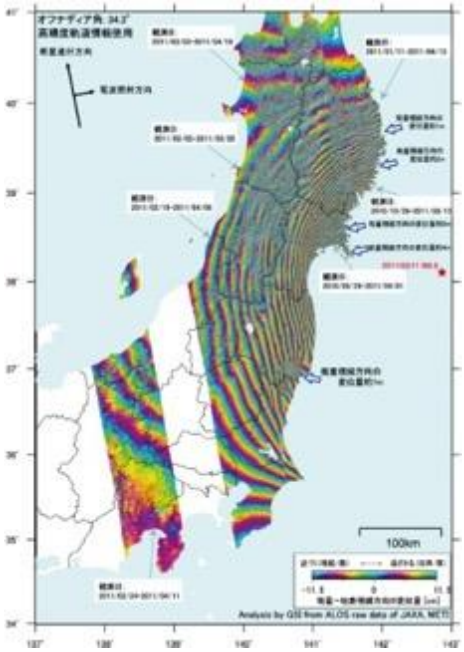


Fig.7 Resolving crustal deformation by joint analysis of SAR interferometry and GNSS-based Control Stations

>> State of disaster as observed from air

Aerial photographs and ortho-image are important materials for accurate and comprehensive understanding of what is happening where in times of wide area disasters such as great disasters, etc. When disasters occur, GSI takes aerial photographs from aircraft and provides these to the relevant organizations. A system is adopted to enable mobile operations for quicker provision of information on the state of disasters.

Before earthquake disaster (image taken in 2008)

After earthquake disaster (image taken on March 19, 2011)

Ortho-image

"Orthophotomap" compiling main items from Digital Japan Basic Map (map information) in ortho-image

Fig.8 Aerial Photos and Ortho-images Showing Tsunami Disaster

>> Maps displaying geospatial information (thematic maps)

Thematic maps are created based on aerial photographs to show the state of disasters, etc.

Fig.9 1:25,000 map showing overview of scope of flooding

Fig.10 1:100,000 map showing overview of scope of flooding

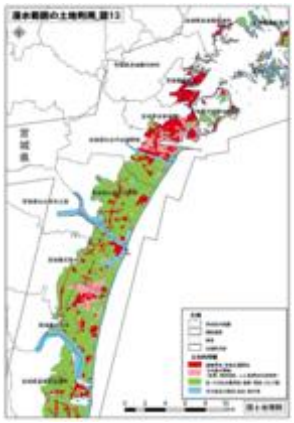


Fig.11 Land use in scope of flood

>> Information useful for restoration and reconstruction

Airborne Laser Surveys are used to measure elevation and create Digital Elevation Topographic Map for basic geospatial data. In addition, base maps are maintained for disaster reconstruction projects. They are provided to State and local public organizations.

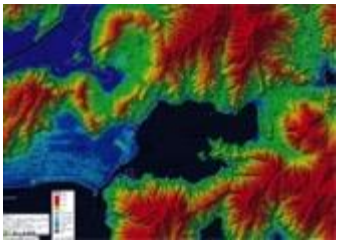


Fig.12 Digital Elevation Topographic Map for basic geospatial data based on laser surveys after earthquake disaster

Fig.13 Base map for disaster reconstruction plans

>> Information provided through Digital Japan Web System

When a disaster occurs, Digital Japan Web System is used to provide surveyed and compiled damage-related information as well as information that supports emergency measures, restoration and reconstruction.

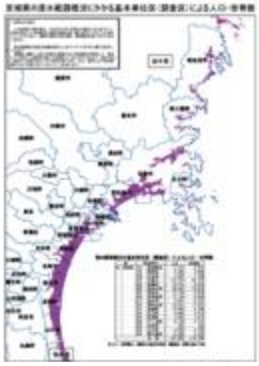
Distribution of Main aftershocks

Road regulation information-intensive map

Fig.14 Examples of Information Provision through Web

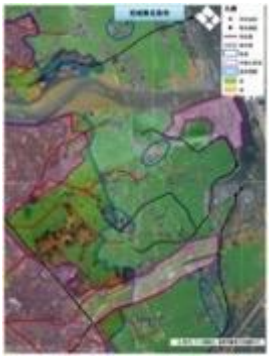
>> Example of application of geospatial information

The various useful geospatial information is provided in application for understanding and analysis of the state of disaster, etc. by all kinds of organizations.



Rough estimation of population and households in area affected by tsunami flooding (Ministry of Internal Affairs and Communications)

Map showing outlook of suffering (Miyagi Prefecture)



Use in understanding positions of disaster-affected areas and agricultural land, agricultural facilities, and settlements (Ministry of Agriculture, Forestry and Fisheries)

Fig.15 Examples of Application of Geospatial Information

4) Promoting the use of geospatial information through a wide range of domestic and international collaborations

As the administrative agency in charge of surveying and mapping, GSI is promoting policies to support the development of the nation's life in cooperation with the relevant organizations in industry, academia and government.
GSI plays an international role as the only administrative organization of the Japanese government involved with the survey of national land.

(1) Taking the lead in developing measures for the Advancement of Utilization of Geospatial Information

>> Planning and formulation of government policies on geospatial information

The Basic Act on the Advancement of Utilizing Geospatial Information was enacted in 2007, and the government's Conference for the Advancement of Utilizing Geospatial Information is proceeding with initiatives aimed at promoting the application of geospatial information.
GSI, together with the Cabinet Secretariat and National and Regional Planning Bureau of the Ministry of Land, Infrastructure, Transport and Tourism, plays a key role within the government as the secretariat of the Conference for the Advancement, in drafting plans to promote government-wide application, compiling policies promoted by relevant

government agencies, and facilitating cooperation between industry, academia and, government.

>> Basic Plan for the Advancement of Utilizing Geospatial Information

The government's "Basic Plan for the Advancement of Utilizing Geospatial Information," which was established by the Cabinet in 2008 as a basic plan for the advancement of utilizing geospatial information, has aimed to conduct development of Fundamental Geospatial Data and space-based PNT bases, creation of rules for beneficial use, and various initiatives for cooperation between industry, academia, and government by the end of FY 2011. From FY 2012, a new plan has started, which is designed to reflect the result of the Basic Plan established in 2008 and address the various issues associated with changes in social conditions.

GSI came to play a leading role in the government's establishment of this new plan by compiling the future direction of the Advancement of Utilizing Geospatial Information based on the various views of each government agency and industry, academia and government. GSI will continue to lead the way with initiatives in promoting application in society so as to steadily advance the new plan and thereby realize a society that uses geospatial information.

>> National alliances of industry, academia, and government

"The Committee on Industry-Academia-Government Alliance on Geospatial Information" was established with the purpose of promoting the effective utilization of geospatial information and for the sharing of issues related to geospatial information among Industry-Academia-Government. In the committee three working groups have been established for each theme. As a member of the secretariat of the Committee on Industry-Academia-Government Alliance, GSI is liaising and coordinating with the academic and industrial worlds to smoothly promote initiatives for cooperation among industry, academia, and government such as the G-space EXPO in November 2015.

>> Establishment of industry-academia-government partner systems to meet local needs

GSI is working to establish linkages and collaborative relationships with relevant organizations by, for example, setting up meetings related to partnerships among industries, academic institutes and local governments. GSI is also working in stages to develop a system for partnership and collaboration with local public organizations.

(2) Improving "Global Map" as the world's fundamental geospatial information

>> Global Map

The Global Map is digital geospatial information of whole land area of the globe with consistent specifications that has been developed in collaboration with national mapping organizations around the world in order to deal with global-scale issues such as global environmental problems, etc.

The project to develop the Global Map was proposed by the Ministry of Construction (the present MLIT) in 1992. GSI served as the organization's secretariat since the establishment of ISCGM (International Steering Committee for Global Mapping) in 1996 to propel the project, and is playing a leading role in the promotion. Today, 167 nations and 16 regions are participating in the project.

(3) International Cooperation for the Use of Geospatial Information

>> The United Nations World Conference on Disaster Risk Reduction

The 3rd United Nations World Conference on Disaster Risk Reduction was held in Sendai in March 2015, where the importance of maintaining, updating and providing disaster risk information like hazard maps through the use of geospatial information was written in the "Sendai Framework for Disaster Risk Reduction 2015-2030."

(4) Taking a leading role in developing geospatial information technologies in cooperation with other countries

>> Technical cooperation for developing countries

GSI is providing technical support for National Geospatial Information Authorities (NGIAs) through JICA (Japan International Cooperation Agency) with the aim of developing maps and improving survey skills in developing countries.

>> Monitoring crustal deformation in the Asia-Pacific region

GSI contributes to the disaster risk reduction and management in the Asia-Pacific region by participating continuous and campaign GNSS observation network conducted by UN-GGIM-AP. A part of the data is routinely analyzed and the solution is opened through GSI website (http://vldb.gsi.go.jp/sokuchi/pasia/top.HTML) together with the observation data. GSI also conducts InSAR analysis of ALOS-2 in case of huge earthquakes in the region. After the Nepal earthquake struck on 25th April 2015, InSAR-derived crustal deformation data using ALOS2 data and Global Map data for elevation and land cover of central Nepal were shared through UN-GGIM-AP proto-type geoportal.

>> Establishing of the geodetic infrastructure for monitoring the Earth system

The International Association of Geodesy (IAG) has been promoting globally coordinated collaborative geodetic observation realized by the Global Geodetic Observing System (GGOS). GGOS aims to monitor a global picture of the

surface kinematics of the Earth by integrating different geodetic techniques. In order to contribute to GGOS, GSI has been participating the International GNSS service (IGS) and the International VLBI service for Geodesy and Astrometry (IVS) those are two of main segments of GGOS. GSI is also contributing to GGOS by constricting geodetic observation station in Ishioka, Ibaraki Prefecture. The station has several space geodetic facilities including GNSS, VLBI and an absolute gravimeter. The biggest challenge in the station is introduction of the next generation VLBI system called VGOS. VGOS has been developed by IVS in order to meet the requirement from GGOS. The target of VGOS is 1-mm position accuracy, 24-hours continuous observation, and immediate analysis.

Fig.16 Ishioka VGOS Station

GSI is constructing VGOS station at Ishioka. The VGOS antenna was completed in March 2014 and has joined international observations of IVS since March 2015.
GSI also contributes to international observations of VLBI in Asia and the Pacific region. The region is one of the less dense areas for VLBI observation. GSI has lunched collaborative observation in the region and established the Asia Oceania VLBI group (AOV). GSI is serving as the Secretariat of AOV and coordinating the international observations.

>> Antarctic observations

As a member of the Promoting Headquarters of the Japanese Antarctic Research Expedition (JARE), GSI has conducted geodetic observations and developed Antarctic topographic maps since the first JARE of 1956. Moreover, GSI develops detailed three-dimensional topographic data using the latest technology including satellite image analysis and ground lasers. From March 2014, GSI started to provide topographic maps, aerial photographs, satellite image maps, DEM, and results of control point survey, etc. from its Website "Antarctic Geospatial Data" below.

http://antarctic.gsi.go.jp/index-e.html

By making these survey results publicly available, GSI contributes to smooth and safe operation of the JARE observation team.
GSI has also conducted GNSS continuous observation in Antarctica since 1995. The site is one of IGS core tracking stations and utilized for orbit determination of GNSS satellites and realization of global geodetic reference frame such as International Terrestrial Reference Frame (ITRF). The site also has observation facilities for other GGOS techniques, VLBI and DORIS. VLBI is operated by the National Institute of Polar Research and DORIS is operated by the National Institute of Geographic and Forest Information (IGN), France. These facilities were collocated by GSI in 2013 and contributes to collaborative global geodetic observation.

2. Hydrographic and Oceanographic Department, Japan Coast Guard (JHOD), Ministry of Land, Infrastructure, Transport and Tourism

(1) Publication of nautical charts and aeronautical charts

Revisions and corrections of nautical charts are based on the results of hydrographic surveys. The publication from 2011 to 2014 is as follows.

Table 1 Number of Nautical Charts and Other Charts

		2011	2012	2013	2014
Nautical Chart	New Chart	11	8	6	6
	New Edition	56	63	69	79
Aeronautical Chart	New Chart	1	0	0	0
	New Edition	4	5	4	3
Electronic Navigational Chart	New Chart	17	14	13	13
	New Edition	86	163	158	317

1) Nautical charts

Middle and larger scale charts are published, mainly for ships under international trades to access to harbours.

2) Aeronautical charts

1/1,000,000 series of international aeronautical charts and 1/1,000,000 series of aeronautical route charts are published according to the standard of International Civil Aviation Organization.

3) Electronic navigational charts

To cater for the phased mandatory carriage requirement of ECDIS to the ships under international navigation in and after 2012, the existing ENCs has been supplemented with the data that improves convenience and reliability. Electronic Notices to Mariners are edited to update such ENCs.

(2) Hydrographic surveys

Hydrographic surveys by JHOD from FY2011 to FY2014 for chart publication are as follows.

Table 2 Number of Hydrographic Surveys

	FY2011	FY2012	FY2013	FY2014
Coastal Survey	6	8	6	2
Harbour Survey	1	1	3	1
Correction Survey	180	175	171	164

1) Coastal surveys

Coastal surveys aim to obtain data for new publication or new edition of coastal charts.

2) Harbour surveys

Harbour surveys aim to research progress of harbour improvement and to obtain data for new publication or new edition of harbour charts.

3) Correction surveys

Correction surveys aim to obtain data for chart updates such as local depths, low tidal lines or cancellation of report soundings.

4) Airborne laser surveys

Airborne laser surveys aim to obtain data to develop coastal zone infrastructural information.

(3) Disaster Measures

1) The Great East Japan Earthquake

The Great East Japan Earthquake on 11 March 2011 ensuing huge tsunamis ravaged many cities, ports and harbours along the Pacific coast of north-eastern Japan. After the earthquake and tsunamis, the JHOD immediately dispatched all 5 survey vessels belonging to the JHOD headquarter, and undertook hydrographic surveys at tsunami-affected ports. These surveys helped clear the passage in ports filled with sunken debris, and enabled vessels to reach a quay with full of awaited disaster relief supplies on board. The JHOD carried out hydrographic surveys and revision of charts for available quays and shipping routes of affected ports for about one year, and after that, conducted hydrographic survey for all the chart area, followed by chart revision, which will be completed in 2015.

2) Eruption of Nishino-shima Island

On November 2013 an aircraft of the Japan Coast Guard found a new, small island exploding volcanic ash and bombs near Nishino-shima Island, which is one of the volcanos on the Izu-Mariana Arc (Fig.17 and 18). This newly-formed island took the old island into its part and still continues growing with very active eruption. As of 25 March 2015 the Island had grown to about 2.46km^2, which is 10 times bigger than before the eruption (Fig.19). JHOD regularly monitors the volcanic activity to which JHOD has kept alerting mariners by issuing Navigational Warnings. After the volcanic activity settles down, JHOD will conduct hydrographic survey and determine the low-water line associated with Nishino-shima Island for revising nautical charts.

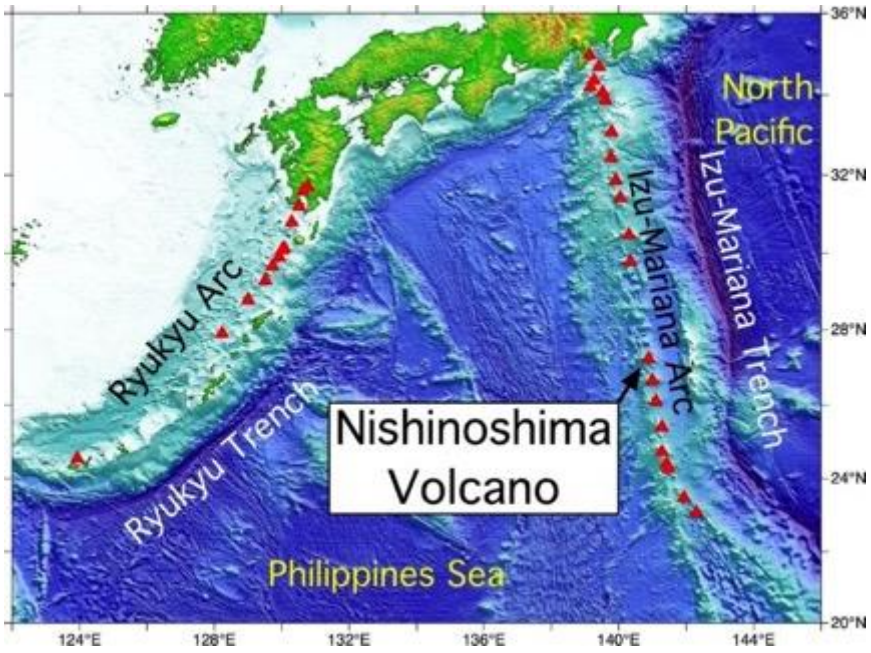


Fig.17 Location of Nishino-shima Island

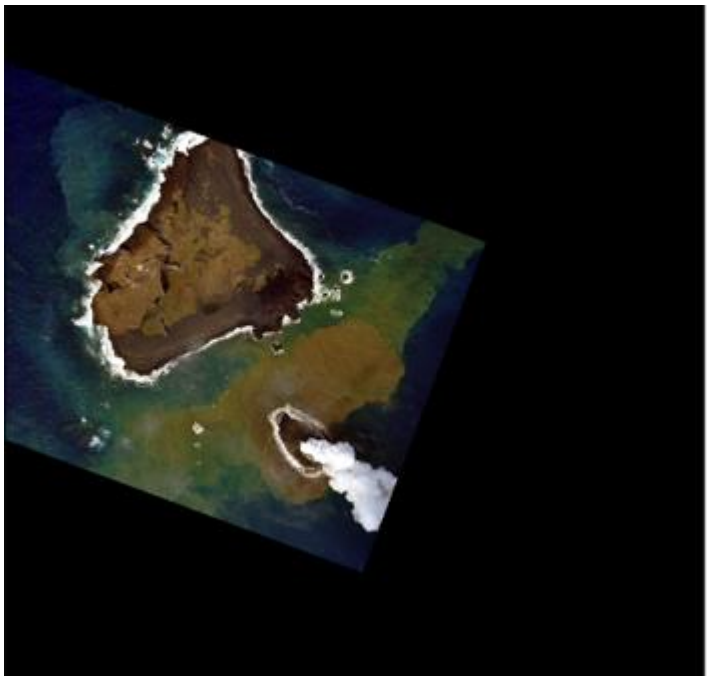


Fig. 18 Aerial photograph on 21 November 2013

Fig. 19 Aerial photograph on 25 March 2015. A dotted white line indicates the outline of the pre-existing island.

(4) International technical co-operation

1) JICA Group Training Course

The JHOD has been annually implementing 6-month training course on the "Hydrography for Charting and Disaster Management (Internationally Accredited Category B)". It is implemented as a part of the technical cooperation projects by the Japanese Government for developing countries and provided by the JHOD and JICA (Japan International Cooperation Agency). Its credential of Category B for Hydrography was renewed in 2014 for 6 years at the 37th meeting of FIG/IHO/ICA International Board on Standards of Competence for Hydrographic Surveyors and Nautical Cartographers (IBSC37). This course is aiming at improvement of the knowledge of modern theory and technique of hydrographic surveys, and totally 404 trainees from 42 countries have been accepted since its establishment in 1971 until 2014.

Fig.20 Photos of JICA Group Training Course

2) IHO-NF CHART Project

International Hydrographic Organization (IHO) has organized a 15 weeks training course titled "Japan Capacity Building Project" to train cartographers of its member states at United Kingdom Hydrographic Office (UKHO) every year since 2009 in financially supported by the Nippon Foundation (NF).
In 2014, it had a change of the project operation and the project title to "IHO-NF CHART Project". The JHOD has participated in management of the project since its establishment, and 37 cartographers from 27 countries finished the training until 2014.

(5). Others

1) Visual information of Navigational Warnings

For safety of navigation, JHOD provides information on newly installed Aids to Navigation, and scheduled training exercises at sea in the Notices to Mariners through the Internet. JHOD broadcasts emergency information in Navigational Warnings. Notices to Mariners and Navigational Warnings have been provided with a character. From 18th June 2014, the visual information of character information which showed on the map is also offered. The URL is as follows;

http://www1.kaiho.mlit.go.jp/TUHO/vpage/visualpage_en.html.

Fig. 21　Display of visual information of Navigational Warnings

3. Ministry of Land, Infrastructure, Transport and Tourism (MLIT)

(1) National Land Survey Service

The National Land Survey in Japan has been implemented by the national and local governments. The objective of the survey is to contribute to developing and conserving the national land, and to advancing its use. Also the survey on the actual condition of the national land is conducted scientifically and comprehensively in order to clarify the cadastral data. The survey has been implemented from 1953 based on the National Land Survey Act(1951) and the Act on Special Measures for Promotion of the National Land Survey(1962). Initially, the main purpose of the survey was increase in food production but it has been varied across the ages, such as access to industrial water and daily life water, environment preservation, and safety and security of people's life.

The National Land Survey consists of three key surveys; the Land Classification Survey, the Water Use Survey and the Cadastral Survey. The national government implements basic surveys for each survey conducted by the local governments with an aim to facilitate them. The survey is characterized by making results into basic maps, explanations and ledgers.

1) Land classification Survey and Water Use Survey

A land classification survey is the survey of the status of utilization of the land, soil texture, physical and chemical properties of soil texture, the status of erosion and other natural factors, and the productivity for the purpose of classifying the land by the possibility of its use. In recent years the land background survey, which illustrates the records of past disasters and potential risk, is promoted intensively in order for disaster prevention.

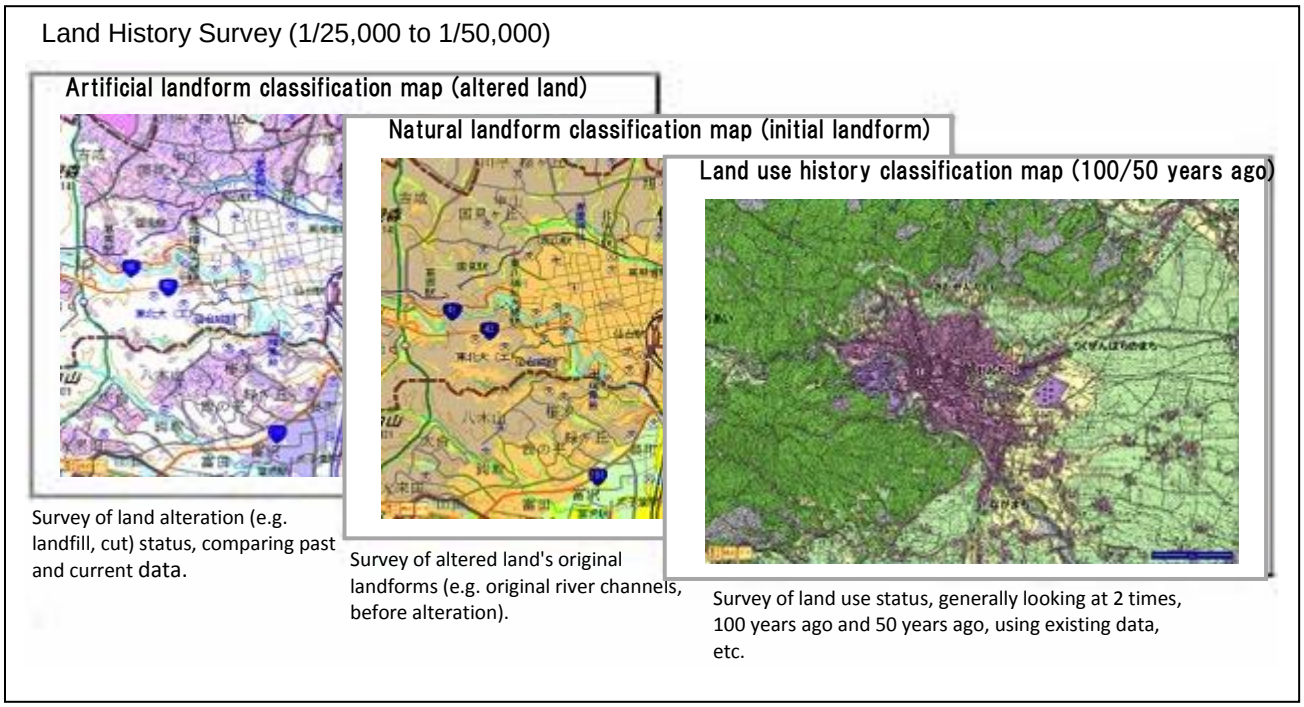


Fig.22 Land History Survey

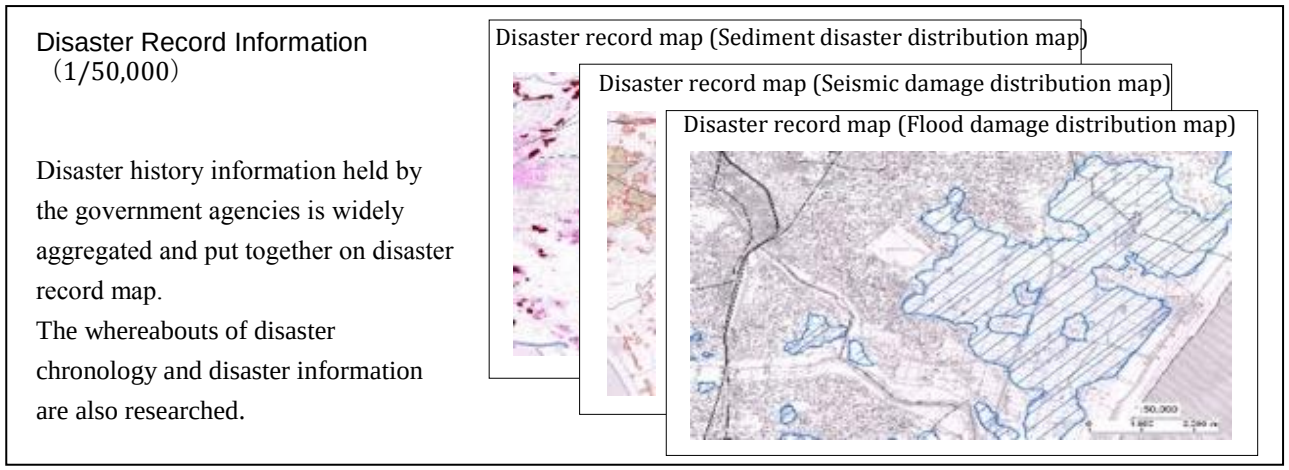


Fig.23 Disaster Record Map

A water use survey is the survey of meteorological phenomenon, flow volume of the land water, water quality, the status of running sand, quantity of water intake, capacity of pump, drainage volume and custom of water use for the purpose of contributing to water control and water utilization. Regarding the surface water, the surveys on the major water systems are almost completed, the surveys on deep well in terms of groundwater that is difficult to be visualized and its mapping are now studied.
The above mentioned surveys are compiled into the following products (maps and books):

a) Land classification survey (Topographical classification map, Surface geology map, Soil map, Present land use map, Nature environment condition map, Disaster record map, Land use trend map, Explanatory book and Survey book)
b) Water use survey (Present water use map,(First-class water system and Second-class water system),Major water system survey report, Prefectural water survey report, National groundwater information ledger, Groundwater map, Groundwater information map and Description)

2) Cadastral Survey

The cadastral survey in Japan aims to clarify locations, boundaries, ownership, each lot number, lot areas and status of land use of each parcel. Almost all the cadastral surveys are implemented by local municipalities.
In order to facilitate local municipality's cadastral surveys, MLIT provides 50% subsidy to the total operational cost, based on the ten-year period National Survey Plan. MLIT also gives standard operating instructions and guidelines to local municipalities and others concerned.
In general, cadastral surveys contain the following key operations: drawing up operational planning, detailed surveys on-the-spot, measuring areas of each parcel, making cadastral maps and compiling cadastral information. In addition, necessary control point surveys (making up forth-order triangulations) for smooth implementation of cadastral surveys are carried out by GSI prior to operations of the cadastral surveys. At the stage of the detailed survey on-the-spot, all the boundaries are basically confirmed by landowners in attendance. After that, boundary monuments are set on the each point of the boundary corners. Then, area of each parcel is calculated from the each corner point.
The scale of cadastral maps and its required accuracy of measurements are decided according to current land use of survey areas. For instance, the scale of 1:250 and 1:500 are usually used in urban areas.
The results of the cadastral surveys will be sent to registry offices with Ministry of Justice after MLIT approved them. Registry offices modify registration information based on the results.
The progress status of the cadastral surveys at the end of FY2014 is as follows:

- Progress Ratio : 51%
- Total Area of the Cadastral Survey Completed : 145,731 km^2 (sixty year period from FY1951 to FY 2014)

4. Ministry of Agriculture, Forestry and Fisheries (MAFF)

(1) Large Scale Topographic Maps

The Forestry Agency began a nationwide project in mountainous areas for the purpose of elaborating Basic Forest Maps (BFMs) as the basis for forest planning in accordance with the Forest Act in 1939. The project covering mountainous areas was completed in 1980. Currently the Forestry Agency and the Prefectural Governments are carrying out revision work of the existing Basic Forest Maps.

Forest Planning Maps, with forest inventory information attached on BFMs, are updated almost every five years. The Forestry Agency is responsible for Forest GIS , in which digitized Forest Planning Maps are incorporated , of national forest and respective local governments are responsible for the ones of private forest. Both Forest GIS provide a tool for forest owners to make a better forest management plan.

(2) Soil Maps

Soil maps in Japan are roughly divided into two categories; for cultivated lands and for forest lands. They are prepared by the Ministry of Agriculture, Forestry and Fisheries.

A 1:50,000 scale map series of soil types and productivity of cultivated lands has been prepared by the Agricultural Production Bureau since 1959, and the entire area of cultivated land, 51,000 km^2 in all, is covered.

A 1:20,000 or a 1:50,000 scale map series of soil types in national forests has been prepared by the Forestry Agency since 1947. Most of national forests have been covered by this series. A 1:50,000 scale map series of soil types for many private forests has been elaborated as well.

5. Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology (GSJ, AIST)

(1) Introduction

The Geological Survey of Japan (GSJ) conducts geological surveys on land and sea as a part of development of intellectual infrastructure and promotes continuous and systematic improvement of various geoinformation. GSJ has been publishing many kinds of geological maps of Japan. Based on these results, GSJ carries out scientific researches for realizing safe and sustainable society: studies concerning natural hazards to the land and people such as earthquakes and volcanic eruptions, geological disposal of radioactive wastes, environmental preservation and stable supply of energy and mineral resources.

GSJ also promotes international scientific cooperation including geological surveys with overseas geological surveys and geoscience research institutions. In cooperation with NASA and USGS, ASTER satellite imageries are archived and used in GSJ's researches and surveys for volcanic activities, urban mapping, vegetation change, and so on. GSJ is also responsible for the distribution of the LANDSAT 8 data in near real-time as a receiving center in the region.

(2) Geological maps

1) Basic geological map series

Series of basic geological maps are prepared on the scale of 1:50,000 (1:75,000 before 1952) and 1:200,000. The 1:50,000 scale geological maps are drawn based on detailed field surveys and the latest research techniques. The 1:200,000 scale geological maps are compiled from the published geological maps with additional supplementary geological surveys.

Nationwide geological maps were published only in small-scale such as 1:1,000,000 or 1:2,000,000 until the end of the last century. The first version of the 1:200,000 scale seamless digital geological map of Japan was completed and released on the website in 2005. The latest 1:200,000 scale seamless digital geological map is provided both in basic (195 geological units) and detailed (387 geological units) versions.

GSJ has also been engaged in marine geological and geophysical surveys around Japan. The results have been published as the "Marine Geological Map" series since 1975, which include geological maps and sedimentological maps. Since 2002, they have been published as CD-ROMs.

Aiming to mitigate geological disasters in coastal urban areas, surveys have been carried out in an integrated way, covering the sea, coastal, and land areas since 2008. These outcomes are compiled as seamless land and sea geological maps and are published as CD-ROMs since 2010.

2) Geophysical map series

GSJ has been conducting gravity and high-resolution aeromagnetic surveys onshore and offshore all around Japan. The results have been published as the "Gravity Map" series and "Aeromagnetic Map" series since 1972. The offshore gravity data have been published in the appendices of the "Marine Geology Map" series. Recently, high-resolution aeromagnetic survey are mainly undertaken to elucidate the activities of onshore volcanoes or fault systems.

3) Geological map of volcanoes

To improve the accuracy in predicting volcanic eruptions, GSJ conducts researches on active volcanoes in Japan. The research outcomes are published as the Geological Maps of Volcanoes.

4) Other map series

Other thematic geological map series and digital geoscience maps (CD-ROM) are published by GSJ. Several of them have come to an end of new publication, but they have been turned to web services such as databases and on-demand viewing systems.

(3) Providing geological data on the Web

1) Data policy and license

In line with the national open data policy, GSJ has adopted the Creative Commons Licenses since October 2013. GSJ adopts the Creative Commons Attribution 2.1 Japan license (CC BY 2.1 JP) or the Creative Commons Attribution-NoDerivatives 2.1 Japan license (CC BY-ND 2.1 JP) for the terms of use of its geological information. The CC BY-ND license prohibits derivative works to the original. However, GSJ allows users to make minor changes without submitting an application for permission in two cases stated below.

- Changing format (including translation) and extracting parts for use
- In a case that parts of derivative works are clearly separated from the original

Generally, the geological information on the GSJ's website can be used by indicating the credit of GSJ, without obtaining the permission beforehand.

2) Data services

Most of the published (paper) geological maps have been openly available as raster data on the GSJ's website. GeomapNavi, a viewer application, provides users with easy handling of the maps: zooming in, zooming out, overlaying, changing the transparency, etc. It assists them in searching literature about geology and earth science around the shown location. Moreover, users can overlay data provided by other institutes, for example, the Landslide Distribution Maps by the National Research Institute for Earth Science and Disaster Prevention (NIED) and the Historical Agro-Environment Web Map Service by the National Agriculture and Food Research Organization (NARO), and examine how such data relate with geology.

The 1:200,000 scale seamless digital geological map of Japan has its own viewer application which enables smooth and speedy browsing in 2D or 3D.

The OGC (Open Geospatial Consortium) web map services are available from the GSJ website in WMS (Web Map Service) or WMTS (Web Map Tile Service) in every service such as nation-wide geological maps, Bouguer gravity anomaly maps, geochemical maps, and a geological map of East and Southeast Asia. The web map service for 1:50,000 scale geological maps around the Tokyo and Osaka areas is available as of July 2015. In addition to the geological map contents, software ("EasyWMSView") has been developed to preview all map services. The viewer software can be used as an open-source application and downloadable from our website.

Map data download services have been arranged for the quadrangle series of the 1:50,000 scale geological maps with all the published areas as raster data (GeoTIFF and Jpeg). Vector data processing of 1:50,000 scale geological maps is ongoing, and download service of vector data (shape file and kml) is presently available for several areas.

GSJ provides a 1:1,000,000 scale geological map of Japan and a geological map in East and Southeast Asia to the activity of worldwide geological map project "OneGeology".

3) Databases

In addition to the geological maps, various types of geological data are available online, for example, information about active faults, volcanoes, tsunami deposits, submarine seismic profiles, physical properties of rock samples, etc.

4) Other activities

GSJ has exchanged publications and journals including geospatial information with other geological survey organizations abroad, and provided them as useful reference materials to researchers, stakeholders and the public. Metadata of these literatures are available from the database of GEOLIS (Geological Literature Search System).

GSJ maintains the standards for geological map codes defined by the Japan Industrial Standard (JIS) and is responsible to renew the term of validity.

Geological information, unlike other geospatial information, is fairly difficult for those who are not familiar with geology to understand, due to the age data and technical terms to describe complicated characteristics of the earth. GSJ has published an online visual dictionary for such users, where many technical terms are explained with photos and/or illustrations.

URL: GSJ official website: https://www.gsj.jp/en/

Contact e-mail address: intl@gsj.jp

(Editors: UNE Hiroshi, ISHIHARA Kenichiro)

III. ACTIVITIES OF LOCAL GOVERNMENT

Since the Great East Japan Earthquake in March 2011, various municipalities, not only within Tohoku area but also from all over Japan, have been practicing the earthquake disaster recovery in cooperation with civic associations, universities, companies and the central government. Cartographic data and GIS, which were extremely useful in the aftermath, also contribute to the reconstruction project greatly. For example, it is necessary to have the large-scale cartographic data for land readjustment and land-use planning, as well as the middle- and large-scale data for inspection and design of roads, bridges and harbors. New projects such as liquefaction countermeasure and radioactive decontamination often require the specific cartographic data and GIS.
Nowadays, public finance and workforce are diminishing due to low birthrates and aging population. People even predict that some of the existing municipalities may disappear in the future. Under such a condition, the method of Open Innovation rivets our attention in expectation. In addition to municipalities, stakeholders such as residents, NPOs and private companies now attempt to tackle local issues by utilizing the properties and the data owned by local governments. Particularly, there is a new trend where people strongly request to disclose cartographic data and location information as open data.

1. Disaster Recovery

Four years after the earthquake made shift the capital improvement plan: the focus from recovery to reconstruction, and the target from large to local areas. In this situation, new projects have launched in the disaster areas in addition to the city planning. These projects include a study on how to apply the experiences, knowledge and technology acquired through the recovery plan to other areas and an event to impart such information to the world.

(1) Eco Model Town

Sendai city has built Eco Model Town with IT technology in Tagonishi area after undertaking land adjustment. This project was implemented in collaboration with Tohoku University and private companies. It aims to establish the residents' comfortable lifestyle while controlling energy consumption. The town takes advantage of using 3D cartographic data and GIS for solar simulation of photovoltaics (PV) and energy management (see Fig. 1).

Fig.1 The Eco Model Town "TAGONISHI"

(2) G-Spatial City Project

G-Spatial City Projects are research projects on disaster prevention by utilizing geospatial information. In FY2014, more than 30 municipalities conducted experiments. Many of the projects have developed applications and services based on the digital maps and digital elevation data organized by the Geospatial Information Authority of Japan, as well as the hazard maps and statistical data owned by local governments. These applications and services were investigated whether they are useful in the case of earthquakes, tsunamis and floods. For example, an information delivery system was created to send messages about disaster prevention in Shonan area (incl. Fujisawa city, Chigasaki city and

Samukawa-town). It is based upon the simulations of tsunami after a large-scale earthquake and of people's behaviors in the aftermath. Figure 2 is a map to show the areas where the wireless communication system for disaster prevention is activated. Other examples are Osaka and Nagoya cities, both of which have enormous underground networks. They simulated flood and fire disasters occurred inside the subterranean spaces (large underground mall adjacent to the station) and emergency evacuation support by using indoor map/positioning.

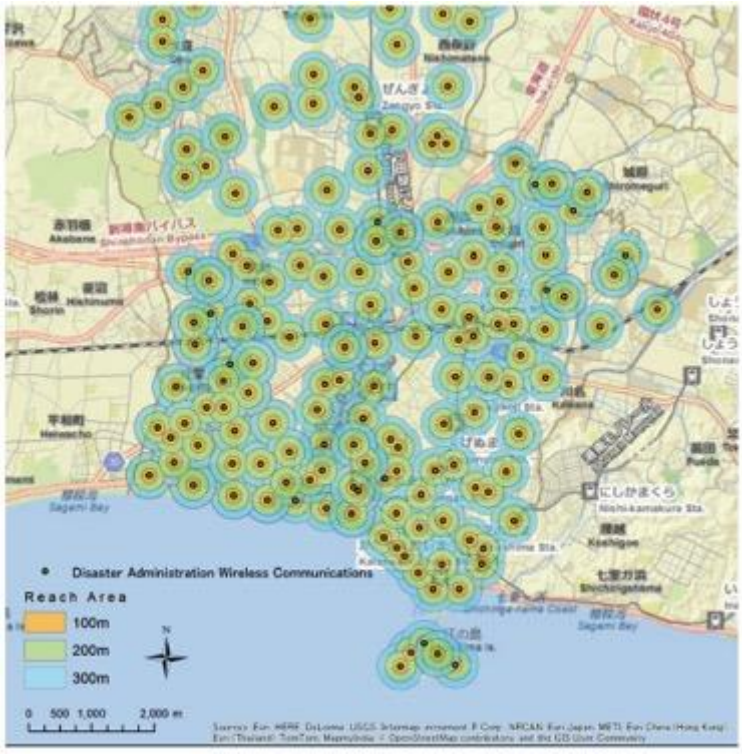


Fig.2 The Areas of Wireless Communication Service for Disaster Prevention in Shonan Region

(3) The Third UN World Conference on Disaster Risk Reduction

The UN World Conference on Disaster Risk Reduction was taken place in Sendai in March 2015. The total number of participants was more than 150,000, including over 6,500 people from 187 countries and the related organizations, to discuss the international strategy for disaster reduction. Sendai city, local municipalities, universities, NPOs and volunteers cooperated with each other to organize a reception and a study tour (see Fig. 3).

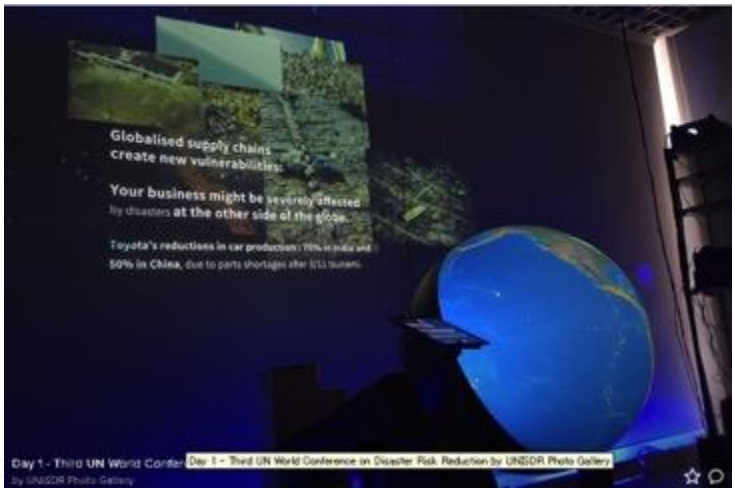


Fig.3 The Third UN World Conference on Disaster Risk Reduction

2. Open Innovation

Since the proposal of Government 2.0 by Tim O'Reilly in 2013, local governments attempt to establish the problem-solving systems not by themselves but in collaboration and co-creation with NPOs, private companies and universities. One of the illustrations is *Chibarepo*, a system launched by Chiba city in 2014. In this system, citizens report local problems they face by using ICT to the local administration and share them with others (see Fig. 4). Finding some issues such as illegal dumping, graffiti, road subsidence and streetlight outages, they report them to the city council with the photos through an application. The council categorizes them into either "Issues to be solved by the citizens" or "Issues to be solved only by the council" and disclose the results on the website map.

Fig.4 Snapshot of *Chibarepo*

(1) Open Data

Open data has a strong familiarity with maps and geospatial information. To set up the disaster prevention service, for example, hazard maps and weather information are prerequisite. The development of a bus operation program requires the location information of bus stops and information about the timetable. Recently, the growing number of local governments tends to disclose their cartographic data. For instance, Muroran city releases an urban planning map and aerial photographs. Urayasu city, on the other hand, discloses about 30 thematic maps and 50 layers on the website, which are utilized as the basemap of OpenStreetMap (see Fig. 5).

Fig.5 OpenStreetMap in Urayasu

(2) Hackathon

Currently, many events are taken place by using open data, including maps and geospatial information, in order to tackle local problems. One illustrative event is called hackathon: a coinage to signify an event to develop and provide an application and service for problem solving by various stakeholders, particularly computer programmers and engineers. For example, there were hackathons in 2014 in Aizu Wakamatsu (entitled "Open Data Contest") and Kawasaki ("G-Spatial Future Design Project", or GFD) cities. In the latter event, GFD, about 500 people participated to create 9 application services, all of which applied cartographic data and digital elevation data, as well as the open data concerning bus stops and public parks (see Table 1).

Table 1 Result of Hackathon "GFD"

	Application services name	Substance
1	Miyamae Culture Club	A local SNS installing the geofencing function
2	*Jiji-Baba* Watch	A game application to encourage communication between children and elderlies
3	Miyamae Ward *Suteki Hakken!*	An application to enjoy quizzes and *karuta* card games making with children
4	Sightseeing Recipe	A platform to automatically create a travel guide application with the data made by MS-Excel
5	*Gurutto* Miyamae Voice APL	A town guide application to introduce attractions of Miyamae by the residents' voices
6	*Omoide-saka no* Bingo	An application to collect *saka* (slope) cards for bingo. When a person goes to a slope in Miyamae, it connects to the location information to provide a card.
7	*Gurutto* Miyama Bus	One Stop Service to support using a bus transport
8	Kouen he ikou	An application to provide information about public parks in Miyamae
9	*SAKABU*	A fitness application by using slopes

Reference URL:

Eco model town TAGONISHI: http://www.kkc.co.jp/english/pick_up/greencommunity_01.html
The Third UN World Conference on Disaster Risk Reduction: http://www.bosai-sendai.jp/en/
G-Spatial City Project: https://www.youtube.com/watch?v=26PpgPXwxIY
Chibarepo: http://chibarepo.force.com/ (in Japanese)
Muroran City: http://www.city.muroran.lg.jp/main/org2260/odlib.php (in Japanese)
Urayasu City: http://www.city.urayasu.lg.jp/shisei/keikaku/joho/1007718.html (in Japanese)
Aizuwakamatsu Open Data: http://www.city.aizuwakamatsu.fukushima.jp/docs/2009122400048/ (in Japanese)
G-Spatial Future Design Project: http://gfuturedesign.org/ (in Japanese)

(NAKAJIMA Madoka)

IV. ACTIVITIES OF PUBLIC CORPORATIONS, FOUNDATIONS, MUSEUMS AND LIBRARIES

1. Public Corporations and Foundations

(1) Japan Map Center (JMC)* *: Special Member of the Japan Cartographers Association

Main responsibilities of JMC are to distribute Japanese official maps and geo-spatial information produced by the Geospatial Information Authority of Japan (GSI), to provide information service and books on geo-spatial data, to hold and promote exhibition and training programs, and to conduct research and development on cartography and GIS. JMC and Japan Geographic Data Center jointly hold Proficiency Test on Cartography and Geography.

(2) Japan Hydrographic Association (JHA)*

JHA supplies services such as reproduction and distribution of the Japanese official nautical charts, aeronautical charts, electronic navigational charts and other hydrographic publications issued by the Hydrographic and Oceanographic Department of Japan Coast Guard (JHOD/JCG). It also promotes marine information services and conducts research and development on oceanography.

(3) Map Association*

The members of Map Association are wholesalers and retailers of the Japanese official maps that are produced by the Geospatial Information Authority of Japan. Cooperating with the Japan Map Center, it plays an important role in smooth and rapid distribution of the maps as well as promoting better utilization of maps.

(4) Mapping Technology Association*

Mapping Technology Association was established by mapping companies for the purpose of promoting sound development of mapping industry. It runs a web museum, "Mapping Museum", which displays the maps collected by the member companies.

(5) Japan Digital Road Map Association (DRM)*

DRM produces and provides digital road map database for administrative use and for car navigation.

Digital road map database is vital for the basis for intelligent transport systems (ITS) as well as various systems for road management.

(6) Japan Association of Surveyors (JAS)*

JAS is an organization for survey technicians active in the Government, Academia and Industrial Corporations.

The main purposes are contribution to, dissemination and advancement of surveying technology. It holds an annual exhibition on Geo-spatial Information.

(7) Association of Precise Survey and Applied Technologies (APA)*

APA carries out research and experiment of advanced survey and mapping technology, commits to deliberation for international standardization of digital geographic information, and examination of survey results. It is also entrusted with technical development projects from national organization in the field of survey and mapping.

(8) Japan Geographic Data Center*

Japan Geographic Data Center collects information about geographic names and population data around Japan and provides them in the form of database and booklets. It also holds Proficiency Test on Cartography and Geography with Japan Map Center.

(9) Japan Construction Information Center (JACIC)

JACIC carries out surveys and research on information systems, including GIS, in the construction field and provides construction information service.

(10) Infrastructure Development Institute -Japan (IDI)

IDI promotes international assistance in the infrastructure development of developing countries including geospatial information development, which are essential to the nations' economic development as well as to the safety and comfort of their citizens.

(AKIYAMA Minoru)

2. Museums and Libraries

(1) GSI / Science Museum of Map and Survey

Science Museum of Map and Survey was established in 1996. It is the adjunct facilities of the Geospatial Information Authority of Japan. It has three main facilities; Exhibition Hall, Information Service hall, and Earth Plaza. The Exhibition Hall consists of exhibition rooms, map gallery and orientation

room. The Information Service Hall offers perusal and delivery service of the survey results and documents produced by the GSI. At Earth Plaza, a spherical model of the Japanese archipelago is on display to give visitors an idea of the roundness of the Earth. A retired survey aircraft is also displayed.

(2) Gifu Prefectural Library / World Distribution Map Center

The library collects, exhibits and provides the maps, distribution maps in particular, that were collected from all over the world. A special exhibitions and lectures for school children are carried out periodically.

(3) ZENRIN Map Gallery

ZENRIN Map Gallery is operated by ZENRIN co., Ltd., a leading mapping company in Japan. Its collections include antique maps collected from across the world and historic schoolbook atlas.

(4) Museum of Yokohama Urban History

Museum of Yokohama Urban History exhibits antique maps and documents to show the development and expansion of Yokohama-city.

(5) Yamanote Museum

Yamanote Museum exhibits mineral of Hokkaido and the world. On the wall, in addition to the world geological maps, the reprint of "Ino map" are on display. There is also a corner to showcase the legacy of surveying equipment.

(ENDO Hiroyuki)

V. ACTIVITIES OF PRIVATE SECTOR

1. Digital Services

There are many kinds of companies contributing in the fields of GIS and Mapping services in Japan.
A large part of building GIS data and Mapping services are done as the trustee business from national or the local government as a part of the infrastructure maintenance of the country. Main players of GIS and Mapping services in Japan are, a surveying company, a map preparation company, and a map publishing company.
The maintask of surveying company is the engineering survey, geographic data entry and maintenance, and cadastral survey under public organizations. Moreover, quite a few private companies have capability to consult, design and construct GIS for their clients such as national and local governments. Biggest companies such as Kokusai and Pasco contribute for the fields of GIS, photogrammetry, geological survey, civil engineering, overseas assistance, oceanographic survey, marketing, and so on. They keep more than 1000 employees and their annual incomes are more than 300 million US$.
In case of a map preparation company, it is said that business environment has been getting harder in these years. The main cause are, increase of the number of competitors in mapping business, such as IT companies and office supplies companies, and decrease of budget cut of a country and the local government. Yet, not a few companies have been keeping solid business with on-going evolution.
The map publishing companies in Japan traditionally play an important roll to supply maps for transportations, sightseeing, shopping and for public organizations. Nowadays, their business expands to the field of car and human navigations. Biggest companies in this field are, for example, ZENRIN, Shobunsha, and Incrementp. Recently, human navigation service provided by, for example, Navi-time Japan and NTT Docomo are growing rapidly. Such companies serve the direction to the destination and provide the information around the destination through smartphones and the internet.

Table 1 Company and URL

Companies	URLs
Kokusai Kogyo	http://www.kkc.co.jp/english/index.html
Pasco	http://www.pasco.co.jp/global/english/
ZENRIN	http://www.zenrin.co.jp/english/
Shobunsha	http://www.mapple.co.jp/english/
Incrementp	http://www.incrementp.co.jp/english/
Navi-Time Japan	http://corporate.navitime.co.jp/en/profile/index.html
NTT docomo	http://www.nttdocomo.co.jp/english/

Fig. 1 The Image of the use of map data by Zenrin

(TSUKADA Nonoko)

(1) Car Navigation

The total amount of Car Navigation Systems shipped in Japan until December 2013 is over 59million.
The role of the car navigation is changing while ITS advances. In late years, about the guidance function to the conventional destination, smartphone application is taking a role away in substitution for relatively cheap PND which occupied the market for some period. As for the vehicle installation type car navigation, is expected a tool for driving support, and the maintenance of highly precise map data of that purpose begins.

Table 2　Car Navigation System and URL

Toyota	http://www.toyota.co.jp/en/tech/its/vision/index.html
Nissan	http://www.nissan.co.jp/en/navi.html
Honda	http://www.honda.co.jp/navi/
Panasonic	http://panasonic.jp/car/
Mapfan	http://www.mapfan.com/
Zenrin	http://www.zenrin.co.jp/product/carnavi/inquiry/index.html

Fig.2　Navigation map data on smartphone by Mapfan
(ENDO Hiroyuki)

(2) LBS Game and AR

The game using the LBS (Location-Based Services) on cell phones is called "Ichi-ge", and has been very popular. Colopl, a game using geospatial information, has virtual money system called "Pl". You can gain “P1” by the distance you work or move to create your own virtual city called "Colony". Its users are over 1,500,000. AR (Augmented Reality) application using LBS started beginning "Sekai Camera" in 2009. In March, 2011, ZENRIN DataCom and NTT DOCOMO started providing for AR application "chokkan-navi" to the Android market.

Table 3　URL list

Colopl	http://colopl.co.jp/
Keitai Kunitori Gassen	http://kntr.jp/
Sekai Camera	http://sekaicamera.com/
Chokkan-navi	http://www.zenrin-datacom.net/android/chokkan/

(OTA Morishige)

2. Trends in Map Publication

According to the map use fact-finding of 2015 by ZENRIN CO., LTD which is a private map company carried it out, the person who used a map for the past less than one year spans that to 90% of the whole, shows us that many people use a map in one way or another.
As we see the breakdown, 68% and the Web map for most, mobile come with 46%, we can find that and a person using a Web map for PCs are greatly affected by the ICT such as a digital device and the Internet. On the contrary, the person using a paper map is decreasing year by year with 26%.

(1) Web map service

The Web map service which many people use becomes the competition domain, and various companies enter it. They are handy maps because of their availability by accessing the Internet at no cost. But, it brings a new problem as lots of reuse ignoring copyright increase. On the other hand, the use of an open map increases in voluntary such as Open Street Map

(2) Smartphone apps

Map application for a smartphone and tablets are to occupy the market in place of a map of the paper. The application of various themes is used using the positional information of the GPS and a communication base station.
Other than the general map application, there are various type of map application, such as the one to appeal to the sensitivity of a young woman or the application that can watch the ancient map of the spot now or the application to show only a direction without showing a map, and to guide to the destination, a good point-like. In addition, the application of the car navigation increases recently, too.

Fig. 3 Interface designs of map apps for smartphone and tablet

(3) Map-themed publications

The circulation of the map itself of the paper is dull, but the publication which featured the theme of a map gets popularity. For example, the book that explains the detailed topography of the city while showing a relief map. Another one is the walking map which follows some old river traces and underdrains. And other one is the books that explains the land condition and the disaster risk of the city, for disaster management. Various maps are used in these publications, and there are some maps by the new technology as “Red Relief Image Map”

Fig. 4　Map-themed publications

(4) Bird's-Eye View

Publication of traditional manually drawn bird's-eye views has sharply dropped. However, the bird's-eye view by the automatic processing with the computer came to be made from DEM easily. In late years it is not unusual for these bird's-eye view to be sold as a souvenir at mountains resorts.

(5) Atlas

In private sectors, the mainstream products are revised editions of school atlas and their arrangement of compact atlases of B5 and A4 sizes. Road maps and urban maps formerly published in the form of single sheet are now published in a book-format and a style of city atlas by Prefecture.

While younger people are said to be reading books not much, middle-aged people are getting older in the Japanese society. Maybe reflecting these changes, "Maps Using Larger Character", an atlas with larger type sizes, and binder-type atlases in ring-file format are published in a series fashion.

In the atlas produced by private sector, an information map of the world that explains economy, culture, people and history of the world and an information map of Japan that introduce economy, culture and history by region are published annually from publishers specialized in practical articles and drawing wide interests.

These types of atlases are published from a few companies and some of them are selling over 30 thousand copies annually.

(6) Residential Map

In a residential map, the ground plan of individual housing and building can be identified and each building is provided with such information as occupants' name and name and address of the building. In addition to such information as names of the building and tenants, road traffic information such as locations and names of bus stop, traffic signals, crossings, street names and one-way traffics are also indicated.

The scale of those maps is usually large as ranging from 1:1,000 to 1:5,000. Residential maps cover about 95% of more than total 2,800 local municipalities throughout Japan. They are drawn up and sold by several private firms and usually made into a bound book edited for each city, town or village.

All basic data for those maps are solely collected by a private field survey. Data update by a field survey is usually done annually for cities where changes are frequent, and once every 2 to 5 years for the rest of areas.

As the information update is done regularly, those maps are used in wide applications such as delivery service and moving industry, ambulance, police, and security service works and marketing researches.

Fig.5　Residential Map and smaller scale Data by ZENRIN Co., Ltd.

(ENDO Hiroyuki)