County Report on the status of Geospatial Information activity of Japan

Most of the Geospatial information in Japan is developed out under the Survey Act. Main objectives of the act are to coordinate various survey works efficiently, to standardize accuracy and to avoid duplicated work. Surveying and mapping projects managed by public organizations are mainly classified into two categories by the act. The first one is the Fundamental Survey executed nationwide by the Geospatial Information Authority (GSI), and the other is the Public Survey for local governmental projects or special projects which are carried out by other governmental or public organizations such as 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).

Preparation of various kinds of charts and nautical publications is carried out by the Hydrographic and Oceanographic Department (HOD) of the Japan Coast Guard.

I Geospatial Information Authority of 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 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 base map for depicting national land.

As a designated administrative organization pursuant to the Disaster Countermeasures Basic Act, GSI promotes disaster mitigation measures incorporating the latest technologies of surveying and mapping.

1-1 Controlling the reference framework of Japan

GSI defines the national reference framework as the reference represented by coordinates of latitude, longitude and elevation, based on geodetic and astronomical observations.

► Development of references for longitude and latitude

Origin of the Japanese Horizontal Control Network was established at the Tokyo Observatory (Minato, Tokyo) as a national reference framework in 1892. The Origin's coordinate was determined by astronomical survey and represented by latitude and longitude based on the independent Japanese geodetic system (the old Japan Geodetic System).

In April 2002, GSI adopted a world geodetic system as the national standard and abolished former Japan Geodetic System which was locally used in Japan. In this system, the coordinates of Origin of the Japanese Horizontal Control Network have been precisely determined through VLBI (Very Long Baseline Interferometry) observations conducted in accordance with the

international joint observations guidelines.

Due to the crustal deformation caused by the 2011 off the Pacific coast of Tohoku Earthquake, the longitude and the latitude of Origin of the Japanese Horizontal Network was updated to the accurate values by VLBI and GNSS observations.

► Development of references for elevation

● Reference of elevation for leveling surveys -Origin of the Japanese Vertical Control Network-

Origin of the Japanese Vertical Control Network as a national reference framework was established in 1891 in the premises of the observations of the mean sea level at Reiganjima Island, Tokyo Bay from 1873 to 1879 by General Staff of the Imperial Army (Chiyoda, Tokyo) . The elevation indicated by Origin of the Japanese Vertical Control Network was originally determined as 24.500 meters. However, this was revised as 24.4140 meters due to the crustal deformation induced by the Great Kanto Earthquake of 1923 and then revised again as 24.3900meters due to the subsidence of the 2011 off the Pacific coast of Tohoku Earthquake.
Today, GSI monitors height from the mean sea level through 25 nationwide tidal observation stations including Aburatsubo Tidal Station in Miura City, Kanagawa Prefecture and repeated leveling along the leveling route, which extends about 20,000 kilometers all over Japan, for maintaining the reference for elevation.

● Required elevation correction for GNSS surveys – geoid –

Elevation “zero” in Japan is defined as the extended mean sea level surface to land obtained from sea level in Tokyo Bay, which is called “geoid”. The geoid surface is irregular because of the heterogeneity of its interior mass distribution (geography and density). The geoid height is the height of the geoid surface from Earth ellipsoid (the spheroid, which has a shape very similar to the geoid surface).

In the GNSS surveys, only ellipsoidal height can be measured. Thus, in order to determine elevation, it is necessary to subtract (correction) the geoid height from ellipsoidal height. GSI conducts leveling surveys, gravity surveys and geoid surveys, and determines distribution of geoid heights in Japan.

1-2 Conducting observations that are necessary for controlling positional reference

► Observation of geomagnetism

The observation of geomagnetism allows us to determine the time series variation of geomagnetism and its spatial variation all over Japan. These data are used to monitor volcanic activity.

► Observation of gravity

The data obtained from gravity observations help us to determine the precise form of the Earth (geoid) as well as to estimate its internal constitution.

1-3 Providing an environment where anyone can survey

► GNSS-based Control Stations (Reference for GNSS surveys)

GSI has established 1,240 (as of January 2012) GNSS-based Control Stations (GCSs) throughout the country of Japan. , These national control points conduct GNSS continuous observation and provide the basis for various types of surveys. GCSs continuously receive

signals from GNSS satellites and transfer the observation data to GSI Headquarters in Tsukuba, Ibaraki Prefecture.

GNSS single-point positioning can only determine positions within an accuracy of 10 meters, but by referring GCSs, the accuracy can be improved to within centimeters and even to millimeters.

GCS observation data are utilized in various areas including surveying, and the monitoring of crustal movements. Moreover, the 130,000 national control points set up all over Japan (triangulation points, benchmarks and GCSs) are used as positioning references for mapping, cadastral investigations, land-use planning, or other purposes.

► Development of control points on remote islands

The Basic Act on Ocean Policy was implemented in July 2007. In order to specify Japanese territory and territorial waters precisely, as well as to manage and maintain remote islands, GSI establishes new triangulation points and resurveys existing triangulation points.

1-4 Providing reliable location information

► Providing reliable location information on unstable landform

● Semi-dynamic correction

In January 2010, "Semi-dynamic correction" was introduced for GSI's control point surveys to remove the effects of strain caused by crustal deformations due to the constant plate motions.

Public surveys which use only GCSs as reference points has been applied since 1st order control point surveys in January 2010. For the correction support, semi-dynamic correction software with the parameter files and its manuals are available on GSI website.

● GSI provides survey results on triangulation points and benchmarks as well as correction parameters

GSI has revised the survey results of triangulation points and benchmarks in October 2011 in the area where the large-scale crustal deformation occurred due to the 2011 off the Pacific coast of Tohoku Earthquake on March 11.

As for the revision of the public control points in such area, each survey planning organization can conduct the revision if necessary.

In order to make the survey results of public control points consistent with the revised results of triangulation points and GCSs, GSI prepared the software with parameter files for correcting coordinates/elevation for the quake-hit area. These materials are available on GSI website.

1-5 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 a larger scale 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 includes geographical information of land, orthophotos 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 reflected by delivering such information in digital form and advanced usage in requirements like land management, disaster prevention, 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 rapidly and efficiently in cooperation with managers/administrators of local public organizations and of the social infrastructure-related facilities.

● Geographical name information

The names of natural geographic features such as mountains, rivers and islands, and names of inhabited areas such as towns are converted into a database and then developed into 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.

● Ortho - image data

GSI improves ortho-image 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 ortho-image. This will enable the map symbol to link with each facility, and a user can exhaustively know the area.

► Fundamental geospatial data

Fundamental geospatial data are the common outline 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 2011. 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.

1-6 Steadily promote the maintenance and application of geospatial information focusing on Digital Japan Basic Map, in accordance with "Fresh Map 2011".

Fresh Map 2011 is an initiative to promote the use of facilities through application of Digital Japan Basic Map. Fresh Map 2011 periodically updates all acquired items (area-wide update) in Digital Japan Basic Map, quickly updates important facility items (quick update), and broadly provides Digital Japan Basic Map to citizens with the latest and easy-to-utilize information. It also encourages optimization through simple and easy tools which enables the use of Digital Japan Basic Map in various business settings.

Items that are important for disaster prevention such as administrative borders, coastline, roads, railroad, and buildings are covered by quick updates. Progress is being made in the construction of collaborative systems through collaboration with various people who manages public facilities and roads.

► Area-wide updates

Area-wide updates are steadily implemented to ensure that Digital Japan Basic Map is up-to-date.

► Quick updates

Quick updates are an initiative to provide notice of commencement of service at important facilities. The system helps to enhance facility maintenance and management through the application of Digital Japan Basic Map. Quick updates using construction drawings, etc., are developed with the collaboration with maintenance manager to reflect important changes to facility. This ensures facilities to possess accurate information.

► Promoting application of Digital Japan Basic Map

Following initiatives are implemented at administrative bodies in order to promote application of Digital Japan Basic Map.

[1] Provision of tools for effective utilization of Digital Japan Basic Map for optimization of administrative work.

A first initiative is to provide schemes and tools for application of Digital Japan Basic Map. One of the tools that is developed and provided enables visualization by linking maps with various information that are managed by forms, while placing Digital Japan Basic Map as a background map. This kind of tools enables more effective and efficient delivery of information management.

[2] Proposal of solutions to specific issues by application of Digital Japan Basic Map, etc.

Effective utilization and application of Digital Japan Basic Map helps to ascertain the extent of damage caused by earthquake, storms and floods to the facilities that are fundamental to social life. Such applications enable to propose solutions to meet the needs of people in charge of public facility maintenance and management.

Also, since the development, maintenance and application, etc. of all kinds of work systems at administrative bodies are outsources to private businesses, there will be concurrent progression of initiatives aimed at private businesses.

1-7 Monitoring crustal movements and analyzing disaster risks

► Continuous monitoring crustal movements through GNSS-based Control Stations

GNSS-based Control Stations, the fundamental observation network for crustal deformation monitoring known as GEONET(GNSS earth observation network), are being used to observe crustal movements throughout Japan. As 72-hour UPS has been installed to GCSs since FY 2011, stable operation is guaranteed even in times of disaster.

► Mobile observation

The remote GNSS monitoring system (REGMOS) has been set up to collect detailed data continuously in order to monitor crustal movements caused by volcanic activities etc. without any public electricity or phone line.

► Management of the Coordinating Committee for Earthquake Prediction and the

Earthquake Research Committee

The Coordinating Committee for Earthquake Prediction was founded in April 1969 following the agreement reached in the cabinet meeting and a proposition by the Council of Geodesy. GSI is in charge of its secretariat. Here researchers exchange academic opinions and information, and examine methods for predicting earthquakes in order to enable the practical use of earthquake prediction technology. Moreover GSI, together with the Japan Meteorological Agency and the Ministry of Education, Culture, Sports, Science and Technology, serves as the secretariat of the Earthquake Research Committee of the Headquarters for Earthquake Research Promotion. It is the official government body for evaluating earthquakes.

1-8 Preparing landform information for disaster mitigation

► Thematic maps for disaster mitigation

GSI helps people to live safer lives and to take measures to prevent potential damage from disasters by providing precise geospatial information on necessary landform.

● Land condition map

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

● Volcanic land condition map

The Volcanic Land Condition Map 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 carries out Airborne Laser Surveys and shows high-resolution elevation data on maps simply. 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 mitigation. The site offers a one-stop service that everyone can search and browse for necessary information.

1-9 Surveying the extent of disaster and providing the information

► Understanding state of disaster by “Kunikaze” survey aircraft

As an administrative organization designated by the government based on the Basic Act on Disaster Control Measures, GSI uses “Kunikaze” survey aircraft, which can be operated with year-round mobility, 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, airborne SAR and aerial laser scanners are rapidly provided to the relevant organizations to collect victim 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 are provided to the relevant organizations and publicized on Digital Japan portal 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 laser sensors 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 mitigation

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

The 2011 off the Pacific coast of Tohoku Earthquake

► 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.

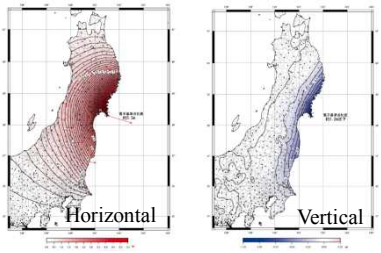
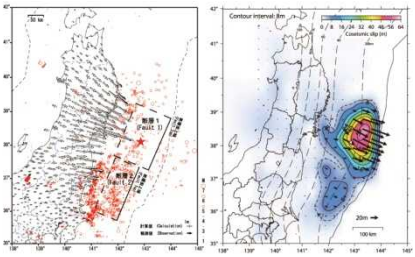


Diagram showing amount of change accompanying main shock (M90) on March 11



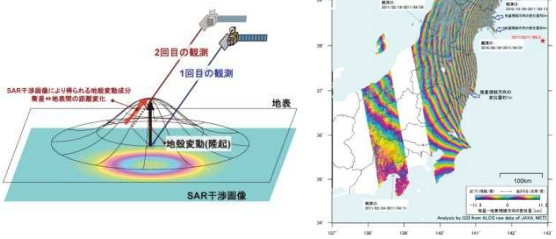
Earthquake source fault model

Slip distribution model (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.

Crustal deformations as shown through the analysis of InSAR are distance changes between satellites and grounds.



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

In the 2011 off the Pacific coast of Tohoku Earthquake, crustal deformation was observed over the whole area of the Tohoku region.

► 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

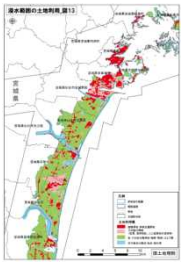
"Orthophotomap" compiling main items from Digital Japan Basic Map (map information) in ortho-image

► Maps displaying geospatial information (thematic maps)

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

1:25,000 map showing overview of scope of flooding

1:100,000 map showing overview of scope of flooding

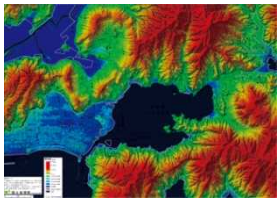


Land use in scope of flood

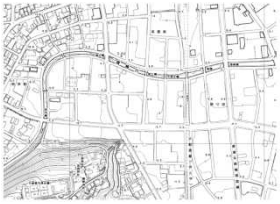
► Information useful for restoration and reconstruction

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.



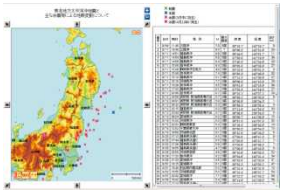
Digital Elevation Topographic Map for basic geospatial data based on laser surveys after earthquake disaster



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.



Main aftershocks

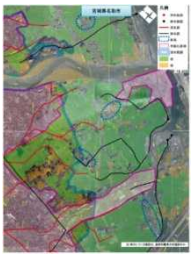
Road regulation information-intensive map

► 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)

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.

2-1 Providing technical support in disseminating geospatial information through the Digital Japan Web System

► Digital Japan Web System

GSI develops and supplies basic survey results such as fundamental geospatial data, Digital Japan Basic Map, and aerial photographs through Digital Japan Web System.

Digital Japan Web System can also be used as a tool to encourage State or local public organizations to create and share information, and also individuals and companies to disseminate information by overlaying various geospatial information on maps.

2-2 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, and has made them available to everyone.

► Browsing and transcripts

Anyone can browse the control 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, and are widely available to the public via the Science Museum of Map and Survey as well as GSI website.

2-3 Preparing a system to promote the utilization of geospatial information

► JapanProfile 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.

2-4 Avoiding redundancy and assuring accuracy of Public Surveys in accordance with the Survey Act

Public Surveys are implemented as large-scale construction work for improvement of social structure by State and public organizations aiming to create maps for all kinds of projects and management covering roads, rivers and cities, etc., and conclude surveys for land readjustment and improvement, and development of fundamental geospatial data, etc.The results of these surveys are extremely important for social life.

► Ensuring accuracy and quality of Public Surveys

As the only State organization bearing responsibility for survey administration relating to land surveys, GSI coordinates more than 80% of all the Public Surveys implemented in Japan. Policy is promoted through survey techniques to encourage appropriate use of survey results when implementing Public Surveys while ensuring the accuracy of Public Surveys and the quality of survey results. In addition, policy is implemented to avoid redundancy of surveys while enabling effective and efficient implementation by State and public organizations. These ensure beneficial use of survey results.

► Guidance and advice on Public Surveys

GSI confirms implementation schedules submitted by Survey Planning Organizations such as public and State organizations, etc. when they attempt to implement Public Surveys.

GSI gives technical advice and guidance regarding Public Surveys from points of view whether or not Public Surveys will be conducted by survey techniques can achieve the necessary accuracy, whether there is redundancy due to overlaps with other Public Surveys, and whether or not it will be possible to implement the Survey efficiently by using other Public Survey results. (See Article 36 of Survey Act)

GSI also promotes extensive utilization of the survey results of Public Surveys by posting them or by making them publicly accessible on GSI Web site.

3 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.

3-1 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 the Ministry of Land, Infrastructure, Transport and Tourism's National and Regional Planning Bureau, plays a key role within the government as the secretariat of the Conference for the Advancement, drafting plans to promote government-wide application, compiling policy promoted by relevant government agencies, and regulating 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 decided on 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 will be started to solve various issues based on the results to date and social changes.

GSI came to play a leading role in the government's decision on 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 June 2012.

► Regional cooperation between industry, academia, and government, etc.

In cooperation with people in industry, academia and government to share information and exchange opinions about geospatial information, GSI is taking measures for each region to promote the utilization of geospatial information. Each administrative organization utilizes geospatial information in different ways, so in order to promote optimization and enhancement of administration utilizing GIS and Digital Japan Basic Map, to identify the needs and the issues in each post, knowledge of development and benefit of using geospatial information need to be is distributed by sending guidelines to responsible persons at public organizations.

Specifically, inquiries from citizens can be dealt with quickly by looking at various overlapping administrative information, and if it becomes possible to understand circumstances with greater accuracy by matching information with collected address-attached maps, it will be possible to provide more appropriate support in dealing with various problems and taking precise measures to suit local circumstances.

Beneficial use of geospatial information enables knowledge to spread through establishment of an Investigative Commission for the preparation of GIS software operation manuals for

creating tsunami hazard maps.

3-2 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, 166 nations and 16 regions are participating in the project.

3-3 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 Surveying and Mapping Organizations (NMOs) 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 reduction in the Asia-Pacific region by developing the observation network that utilized the technology of space geodesy in cooperation with countries in the Asia-Pacific region. The system enables to understand the crustal deformation and the outbreak mechanism of earthquake.

► Antarctic observations

As a member of the Promoting Headquarters of the Japanese Antarctic Research Expedition, GSI created Antarctic photo maps and topographic maps. By making the results publicly available, GSI contributed to facilitating smooth and safe activities for the observation team.

Moreover, GSI provides detailed three-dimensional topographic data using the latest technology including satellite image analysis and ground lasers, and supplies fundamental data utilized in survey research on changes in the global environment.

II Hydrographic and Oceanographic Department of MLIT (HOD)

1 Geodetic Work

Fundamental geodetic works in Japan are principally executed by Geospatial Information Authority of Japan (GSI) and the Hydrographic and Oceanographic Department of Japan Coast Guard (JHOD).

1-1 Satellite Positioning

JHOD, JAXA and GSI have been carrying out observations of an experimental geodetic

satellite (EGS) named "AJISAI" since 1986 under the agreement for the operation of EGS. Since this agreement was dissolved in April 30, 2012, the information about EGS and other satellites observations are currently shared on the International Laser Ranging Services (ILRS) technical meeting.

In order to measure the precise position of the mainland and islands of Japan in the worldwide geodetic system, JHOD has been conducting Satellite Laser Ranging (SLR) observation of LAGEOS at the Shimosato Hydrographic Observatory since 1982, and has determined the positions of more than 70 off-lying islands using differential techniques of Navy Navigation Satellite System (NNSS) since 1974 and GPS since 1994.

Currently the Shimosato Hydrographic Observatory has been carrying out SLR observations under the ILRS technical liaison committee.

In order to watch the middle size crustal deformation (about 50km), JHOD continuously monitors the baselines in the Minami Kanto area, known as the nest of earthquakes, and volcanoes, by GPS geodetic survey in Izu Oshima, Manazuru, Yokosuka, Minami Izu, Kozu Shima, Miyake Shima and Hachijo Shima.

1-2 Gravity Survey

Gravity Surveys are executed on land by GSI and at sea by JHOD.

JHOD has been conducting the gravity surveys at sea area using survey vessels for prediction of earthquake and volcanic eruptions.

1-3 Geomagnetic Survey

JHOD is conducting the magnetic surveys for prediction of earthquake and volcanic eruptions.

1-4 Unmanned/manned Survey Launches

JHOD has two unmanned/manned survey launches, “JINBEI” and nicknamed “MANBO Ⅱ”, to investigate submarine volcanoes. “JINBEI” was launched in 2002. “MANBO Ⅱ” was constructed as a survey launch of survey vessel “SHOYO” in 1998. They can be operated in unmanned remote-controlled mode in the dangerous area.

1-5 The Earthquake Research Program

JHOD has been surveying for the earthquake research program. In order to obtain data and information necessary for the prediction of earthquakes, magnetic and gravity surveys have been conducted in specific areas, such as plate boundaries. Total intensity magnetic anomaly and free-air gravity anomaly maps are made for elucidation of sea-bottom structure. Additionally, Free-air gravity anomaly is necessary to calculate precise geoid.

JHOD has been carrying out seafloor geodetic observations using the GPS/Acoustic combination technique since 2000. Twenty four seafloor geodetic reference points have been deployed by 2012 mainly on the land-ward slope of the major trenches, such as the Japan Trench and the Nankai Trough. The primary purpose is to detect and monitor the seafloor crustal movement affected by the subduction of the oceanic plates.

The precision of the observation is centimeter order. The observation result of off Miyagi

prefecture during 2006-2010 showed the intraplate crustal movement at the rate of 5.5 cm/year towards WNW. After the 2011 off the Pacific coast of Tohoku Earthquake (M9.0), displacement of about 24 meter towards ESE and 3 meter upward was observed at the seafloor reference point located almost just above the hypocenter. The other reference points above the source area also moved 5-23 meters towards ESE. The displacements detected in the sea region above the source area were very useful for understanding of this earthquake.

2 Hydrographic Work

2-1 Hydrographic Surveying and Charting

JHOD provides the information on sailing routes and methods that are necessary for safe navigation with hydrographic information such as water depths, tidal currents, and tides through nautical charts and publications.

► Charts Compilation and Publication

JHOD compiles navigational safety information and hydrographic data including coastline, geographical features and navigational marks. Then accurate and user friendly charts are completed choosing appropriate scales and divisions.

JHOD also publishes English nautical charts for foreign vessels. English nautical charts have the same contents as Japanese charts.

► Electronic Navigational Charts

JHOD publishes Electronic Navigational Charts (ENCs) for safe and efficient navigation at sea. Small scale ENCs (smaller than 1/80,000) cover the entire sea areas around Japan. JHOD also publishes large scale ENCs for major ports and sailing routes in the coastal sea areas. Each ENC covers rectangular unitary sea area (cell) divided by longitudinal and latitudinal lines. Users can select and purchase the area they need from the cells. When JHOD has got the information on changes of coastlines or depths, it provides the “Electronic Notices to Mariners” through the Internet to update the contents of ENCs and promotes the collaboration with the East Asian countries to improve the contents of ENCs.

2-2 Marine Survey

● Survey of coastal Area

In order to cope with the establishment of Japan’s exclusive economic zone (EEZ) in accordance with the United Nations Convention on the Law of the Sea (UNCLOS), JHOD has been carrying out detailed surveys of low-water lines, topography and geological structure of the sea-bed in coastal area, particularly in those important areas around baseline defining the territorial sea and EEZ of Japan.

● Airborne Laser Hydrography

JHOD has been carrying out airborne laser hydrography operations since 2004 for the mapping of very shallow waters.

● Survey of Continental Shelf Areas

JHOD has been carrying out hydrographic surveys of Japan’s continental shelf areas by using the large-type survey vessels “TAKUYO” and “SHOYO” equipped with modern survey instruments such as multi-beam echo sounder in order to obtain basic data required for

utilization and development of the continental shelf.

● Surveys for Earthquake Prediction Program

JHOD surveys for the earthquake prediction program. In order to obtain data information necessary for the prediction of earthquake, JHOD has been carrying out surveys and investigations for submarine topography and/or active sea-bottom structures at specific areas off Miyagi and near Nankai trough.

3 International Activities

3-1 Intergovernmental Oceanographic Commission (IOC)

JHOD has also been working as a member of IOC which is the subsidiary body of UNESCO and has been participating in the following international joint projects:

- International Oceanographic Data and information Exchange (IODE) National Coordinator
- International Bathymetric Chart of Western Pacific (IBCWP)
- North East Asian Regional GOOS (Global Ocean Observing System)/Coordinating Committee (NEAR-GOOS)
- IOC Sub-Commission for the Western Pacific Region (WESTPAC)
- Ocean Data & Information Network for the Western Pacific Region (ODIN-WESTPAC)

3-2 Contribution to International Capacity Building in Hydrography

JHOD provides a 6-month training course “Hydrography for Charting, Disaster Prevention and Environment Protection (Internationally Accredited Category B for Hydrographic Survey)” every year for hydrographers in developing countries in Asia and Africa in cooperation with Japan International Cooperation Agency (JICA), which is an independent governmental agency. The participants have been assuming important positions in hydrographic activities in their home countries.

III Ministry of Land, Infrastructure, Transport and Tourism (MLIT)

1 National Land Survey

The National Land Survey in Japan has been implemented with the directions and guidance by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT). The objective of the survey is to contribute to developing and conserving the national land, and to utilizing it more effectively. The government enacted the National Land Survey Act in 1951 aiming to promote the surveys. In 1962 in order to bring forward the survey in terms of financial assistance, the government enacted the Act on Special Measures for Promotion of the National Land Survey.

The National Land Survey consists of three key surveys that are prescribed in the National Land Survey Act; the Land Classification Survey, the Water Use Survey and the Cadastral Survey.

1-1 Land classification Survey and Water Use Survey

A land classification survey is the survey of the topographical and geological features, soil, and present land use. A water use survey aims at investigating the basic statistics of a river, such as annual rainfall, discharge, present water utilization for farming or drinking and groundwater.
The above mentioned surveys are compiled into the following maps and books:

- Land classification maps (Topographical classification map, Surface geology map, Soil map, Present land use map, Land use capability classification map, and Disaster record map) and an Explanatory data book.
- Geological cross section map in urban area.
- Water use and facilities (rainfall observation facilities, sluice gates, hydroelectric power station, etc.) map and information on major river system.
- Groundwater map and ledger of well.

1-2 Cadastral Survey

The cadastral survey in Japan aims to clarify the location, boundaries, ownership, lot number, the lot area 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 the area 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 confirmed by landowners in attendance. Then, boundary monuments are set on the each point of the boundary corners. Then the 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 land use of survey areas. 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 update necessary registration information based on the results.

The progress status of the cadastral surveys at the end of FY2011 is as follows:

- Progress Ratio : 50%
- Total Area of the Cadastral Survey Completed : 142,264 km^2 (sixty year period from FY1951 to FY 2011)

Ⅳ 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.

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

1 Geological Maps

GSJ has been publishing most of geological maps in Japan. A series of basic geological maps from GSJ is prepared on the scale of 1:50,000 (1:75,000 before 1952) and 1:200,000. The coverage has become 74% at the scale of 1:50,000 (including covering areas of 1:75000) and 100% at the scale of 1:200,000 as of May of 2012.

GSJ has also been engaged in marine geological and geophysical surveys around Japan. The results of surveys have been published as “Marine Geological Map” series since 1975, which include geological maps and sedimentological maps. From 2002, these series have been published on CD-ROM.

Table: Numbers of Geological Maps

Map Series	scale	–2008	2009–
Geological Map	1:200,000	111	13
	1:75,000	83	-
	1:50,000	730	16
	< 1:500,000	20	-
Marine Geological Map	Geological 1:200,000	31	1
	Sedimentological	25	5

	1:200,000		
	< 1:1,000,000	9	-

2 Geophysical Maps

GSJ has been conducting gravity and high-resolution aeromagnetic surveys at the onshore and offshore areas of Japan. The results have been published as the “Gravity Map Series” and the “Aeromagnetic Map Series” since 1972. The offshore gravity data have been published as the appendices of “Marine Geology Map”. Recent target areas of high-resolution aeromagnetic survey are mostly related to the elucidation of onshore active volcanoes or active fault system. The high-resolution aeromagnetic map of "Iwate Volcano (1:25,000)" is the recent publication in the aeromagnetic map series.

Table: Numbers of Gravity Maps and Geomagnetic Maps

Map Series	scale	–2008	2009–
Gravity Map (Bouguer Anomalies)	1:200,000	26	2
	others	6	1
Aeromagnetic Map	1:200,000	33	-
	> 1:100,000	9	1
	< 1:500,000	2	-

3 Other Maps

Many thematic geological map series and digital geoscience maps (CD-ROM) are also published from GSJ.

Table: Numbers of thematic geological maps and digital geoscience maps

Map Series	–2008	2009–
Geological Map of Volcano	14	2
Strip Map of Active Faults and Neotectonic Map	30	-
Water Environment Map (inc. Hydrogeology Map)	47	1
Mineral Resources Map (1:500,000)	7	-
Geological Map of Coal Fields and Oil & Gas Fields	29	-
Oversea Geoscience Map	9	1
Miscellaneous Map	65	1
Digital Geoscience Map	35	11

GSJ Homepage: http://www.gsj.jp/HomePage.html
Contact e-mail address: intl@gsj.jp

4 AIST Map system data bank (Research Information Database for AIST map data)

Various types of data are developed and distributed through AIST's database. Many of them contain coordinate information. For the maximum utilization of the database, AIST employed OGC standard to distribute the data, which enables to federate with other agency's data with ease. OneGeology, which is an international initiative of the geological surveys of the world including GSJ, also employs this OGC standard to share and provide geological data to the user community as one stop service.