Country Report on the status of Geospatial Information activity of Japan

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 (HOD), and various cartographic works are conducted by the GSI, the HOD, 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.

l 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.

1-1 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 (present 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, "Tokyo Datum").

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 Land Survey Department of Imperial Japanese Army based on the observations of the mean sea level at Reiganjima Island, Tokyo Bay from 1873 to 1879 by General Staff of the Imperial Army (present Chuo, 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 24.3900 meters due to the subsidence caused by 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 the mean sea level in Tokyo Bay and the surface which extends the mean Tokyo Bay onto the land is called "geoid." Thus, elevation is defined as the height from the geoid surface. Also, ellipsoidal height is the height from Earth ellipsoid (the spheroid, which has a shape best fit to the shape of the earth), and the geoid height is the height of the geoid surface from Earth ellipsoid.

In the GNSS surveys, only ellipsoidal heights can be measured. Thus, in order to determine elevation, it is necessary to subtract the geoid height from the ellipsoidal height. The geoid surface is irregularly undulated because of the heterogeneity of its interior mass distribution which is caused by geography and density. GSI conducted leveling, gravity and geoid surveys and developed geoid model which expresses the irregular distribution of the geoid heights. The new geoid model of Japan, "GSIGEO2011", has been established and released since April 1, 2014.

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

► Observation of geomagnetism

GSI has been conducting geomagnetic observation in Japan since 1970. The observation allows us to determine the time series variation of geomagnetic field in Japan and also its spatial distribution all over Japan. These data are used to establish magnetic charts of Japan and utilized for various navigation system and monitoring of volcanic activities. GSI is currently operating 3 observatories and 11 continuous observation stations for geomagnetic observation in order to monitor change in magnetic field.

► Observation of gravity

GSI has been conducting relative gravity observation in Japan since 1952. Absolute gravity observation has also been conducted since 1980. The observation covers all over Japan in order to determine spatial distribution of gravity in Japan and also monitor its change in time. The data is utilized for determination of the precise form of the Earth (geoid) as well as estimation of

its internal structure. The absolute observation has been conducted with FG5 absolute gravimeters since 1993 and is consistent with international calibration by the International Bureau of Weights and Measures (BIPM).

1-3 Providing an environment where anyone can survey

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

GSI has established about 1,300 (as of January 2014) 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.

► Elevation surveying by GNSS observation

GSI introduced the elevation surveying by GNSS observation for orthometric height determination of benchmarks on public surveys in April, 2013. The elevation surveying is a newly authorized survey method to determine elevation of third order public benchmarks using GCSs, which already have elevations determined by leveling survey, and a hybrid geoid model of Japan which accuracy is 2 cm in standard deviation. In the method, the elevation is determined by subtracting geoid height of the model from ellipsoidal height estimated by GNSS survey in which reference points are GCSs. The elevation surveying makes it easier and more efficient to install new benchmarks with a target accuracy of 3~5 cm even in the area away from existing leveling routes.

1-4 Providing reliable location information

► Providing reliable location information on unstable landform

● Semi-dynamic correction

Incessant crustal deformation due to the constant plate motions around Japan should be properly handled by “Semi-dynamic correction” for precise surveys with GCSs. In January 2010, “Semi-dynamic correction” was introduced for GSI’s control point surveys and public surveys which use only GCSs as reference points to remove the effects of strain caused by crustal deformations.

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 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

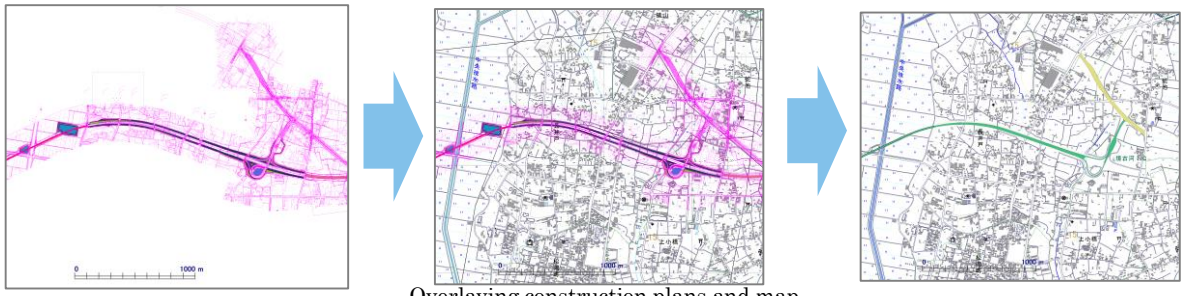
name information that can be used for various purposes. It serves as the base for displaying territories, managing national land and a location search key, making it absolutely essential information for promoting the use of geospatial information.

► 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

1-6 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 system), 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

Remote GNSS Monitoring System (REGMOS) has been set up to collect detailed data continuously in order to monitor crustal movements. GSI, mainly, set up REGMOS around volcanic regions to monitor volcanic activities. REGMOS works by not public electricity but solar power, and the communication method is adopted terrestrial mobile communication or satellite communication, so REGMOS enable to observe in no infrastructure regions. Furthermore, REGMOS works in harsh circumstances such as mountain, snowing, cold or wind regions.

► Management of the Coordinating Committee for Earthquake Prediction and the Earthquake Research Committee

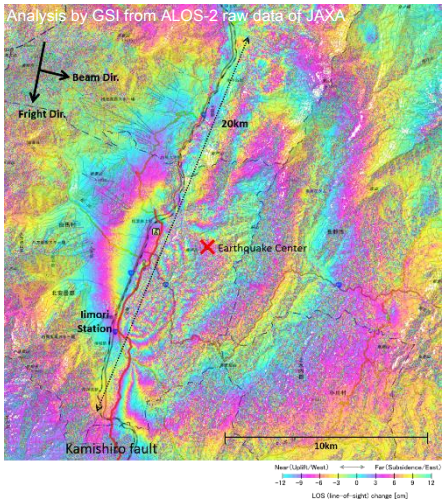
GSI is a secretariat of the Coordinating Committee for Earthquake Prediction that was established in April 1969 based on a Cabinet agreement and a proposal of the Geodesy Council.

GSI, together with the Ministry of Education, Culture, Sports, Science and Technology, and the Japan Meteorological Agency, is a member of the secretariat of the Earthquake Research

Committee of the Headquarters for Earthquake Research Promotion, which is a government organization for comprehensive evaluation of seismic activities.

►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.



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

1-7 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.

1-8 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 an 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.

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 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.

2-2 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.

2-3 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.

2-4 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.

2-5 Avoiding redundancy and assuring accuracy of Public Surveys in accordance with the Survey Act

Public Surveys is the survey implemented as large-scale construction work for infrastructure improvement by State and public organizations aiming to create maps for all kinds of project planning 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 creating an economic society.

► Ensuring accuracy and quality of Public Survey

As the only State organization responsible for survey administration on land surveys, GSI coordinates Public Survey, which account for more than 80% of surveys implemented in Japan. GSI promotes the Policy for ensuring the accuracy of Public Survey and the quality of survey results through utilization of proper survey techniques and appropriate use of survey results. In addition, GSI also promotes the Policy for avoiding redundancy of surveys and beneficial use of survey results which enabling effective and efficient implementation of Public Survey.

► Guidance and advice on Public Surveys

GSI confirms a survey plan submitted by a Survey Planning Organization of Public Survey, when they attempt to implement a Public Survey.

GSI gives technical advice and guidance regarding the Public Survey from these points of view; the Public Surveys will be conducted by survey techniques which can achieve the necessary accuracy, there is not overlap or duplication with other Public Survey, and the Survey will be more efficiently possible to implement by using other Public Survey results.

GSI also provides the state of implementation of Public Survey and make them available for public perusal on GSI Web site as promotes extensive utilization of the survey results of Public Surveys.

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.

3-1 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.

3-2 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.

► Hazard Map Portal Site

GSI manages a one-stop service portal site which allows users to search and browse various hazard maps prepared by local governments.

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.

4-1 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.

4-2 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.

4-3 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 Disaster Prevention Framework 2015-2030."

4-4 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.

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

Ishioka VLBI observation facility

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.

Ⅱ Hydrographic and Oceanographic Department of JCG (HOD)

The Hydrographic and Oceanographic Department of the Japan Coast Guard (HOD) has been conducting various activities from collecting to providing information essential to the safety of navigation and marine environment protection such as nautical charts, water depth and ocean condition, and also has been contributing to international cooperation to improve capacities on those activities in developing countries.

All the information treated by HOD is thought of as a fundamental or useful information for Geospatial Information Management (GIM). HOD has been providing various services to meet a variety of maritime demands in the field of GIM in recent years.

For example, HOD has established "Coastal Environmental Information Service" using the Internet and GIS technology to provide information on natural environment, disaster prevention equipment and facilities, coastal Environmental Sensitivity Index in the coastal area of all over Japan for preparation against oil spill accident.

Furthermore, HOD has established "Marine information Clearing House", which is an integrated database system that helps users search what sort of marine information owned by which of the party such as governmental institutions, universities, and local governments.

HOD also established a new service called as "Marine Cadaster" in 2013 to achieve "Integration of marine-related information". This service allows users to superimpose the information they need on the charts and display it using a web browser by visualization of its natural science information (seafloor topography, ocean currents etc).

Details of the other HOD activities on hydrographic work, geodetic work and international cooperation are explained below.

1 Hydrographic Work

1-1 Hydrographic Surveying and Charting

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

► Charts Compilation and Publication

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

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

► Electronic Navigational Charts

HOD 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. HOD 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 needed areas from the cells. When HOD receives 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.

1-2 Marine Survey

► Survey of Coastal Area

In order to cope with the delimitation of the Japan's Exclusive Economic Zone (EEZ) in accordance with the United Nations Convention on the Law of the Sea (UNCLOS), HOD has been carrying out detailed surveys of low-water lines, topography and geological structure of the sea-bed in coastal areas, particularly in those important areas around baseline defining the territorial sea and EEZ of Japan.

► Airborne Lidar Hydrography

HOD has been carrying out airborne lidar hydrographic operations since 2004 for mapping of very shallow waters.

► Survey of Continental Shelf Areas

HOD has been carrying out hydrographic surveys of Japan's continental shelf areas by using the large-type survey vessels "TAKUYO" and "SHOYO" equipped with sophisticated survey instruments such as multi-beam echo sounder in order to obtain basic data required for utilization and development of the continental shelf.

► AUV Surveys

HOD has been carrying out operation of the AUV "GONDOU" for bathymetric survey since 2013.

► Surveys for Earthquake Prediction Programme

HOD also conducts hydrographic surveys to contribute to the earthquake prediction programme. In order to obtain data necessary for the prediction of earthquake, HOD 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.

2 Geodetic Work

Fundamental geodetic works in Japan are principally executed by GSI and HOD. HOD is mainly responsible for hydrographic data whilst GSI is responsible for terrestrial ones.

2-1 Satellite Positioning

HOD, GSI and the Japan Aerospace Exploration Agency (JAXA) had carried 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 30 April, 2012, the information about EGS and other satellites observations is 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, HOD 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), HOD 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.

2-2 Gravity Survey

Gravity surveys are executed on land by GSI and at sea by HOD.

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

2-3 Geomagnetic Survey

HOD has been conducting the magnetic surveys for prediction of earthquake and volcanic eruptions.

2-4 Unmanned/manned Survey Launches

HOD has two unmanned/manned survey launches, "JINBEI" and nicknamed "MANBO II", to investigate submarine volcanoes. "JINBEI" was launched in 2002 whilst "MANBO II" was constructed as a survey launch of survey vessel "SHOYO" in 1998. They can be operated in unmanned remote-controlled mode or autonomous navigation mode at potentially dangerous sea areas.

2-5 The Earthquake Research Programme

HOD has been surveying for the earthquake research programme. In order to obtain data and information necessary to contribute to 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 the precise geoid.

HOD has been carrying out seafloor geodetic observations using the GPS/Acoustic combination technique since 2000. Twenty-four seafloor geodetic reference points had 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 centimetre order. The observation results 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 24 meter towards ESE and 3 meter upward was observed at the seafloor reference point located almost just above the hypocentre. 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.

3 International Activities

3-1 Intergovernmental Oceanographic Commission (IOC)

HOD also participates in activities IOC which is the subsidiary body of UNESCO. The international and regional projects that HOD related are showing as below.

- International Oceanographic Data and information Exchange (IODE)
- North East Asian Regional GOOS (NEAR-GOOS)
- Ocean Data and Information Network for the Western Pacific Region (ODIN-WESTPAC)

3-2 Contribution to International Capacity Building in Hydrography

HOD provides a 6-month training course "Hydrography for Charting and Disaster Management (Internationally Accredited Category B)" every year for hydrographers in developing countries 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. The training course consists of lectures, practical field training, observation, and study tours for various research institutions to fulfill the requirements of the International Standards of Competence for Hydrographic Surveyors including utilization of the GIS technology.

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

1 National Land Survey Survice

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.

1-1 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.

Land History Survey (1/25,000 to 1/50,000)

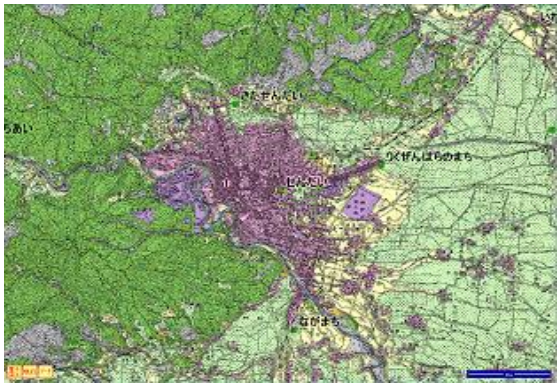
Artificial landform classification map (altered land)

Survey of land alteration (e.g. landfill, cut) status, comparing past and current data.

Natural landform classification map (initial landform)

Survey of altered land's original landforms (e.g. original river channels, before alteration).

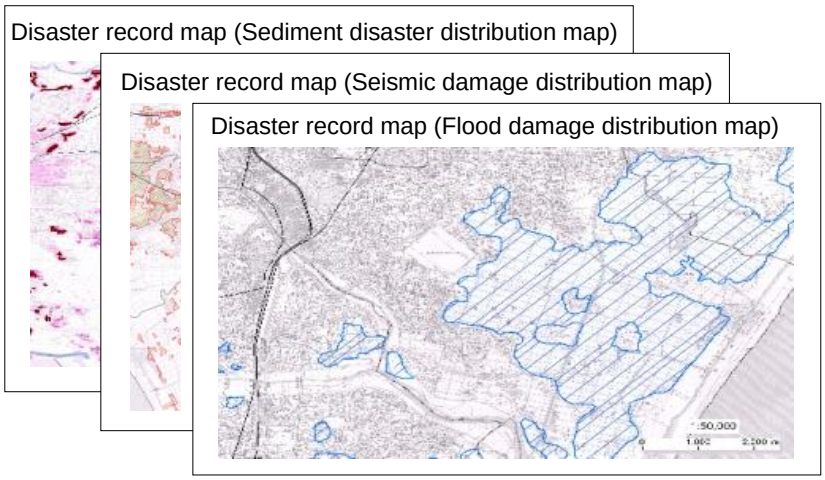
Land use history classification map (100/50 years ago)



Survey of land use status, generally looking at 2 times, 100 years ago and 50 years ago, using existing data, etc.

Disaster Record Information
（1/50,000）

Disaster history information held by the government agencies is widely aggregated and put together on disaster record map. The whereabouts of disaster chronology and disaster information are also researched.



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)

1-2 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)

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 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

2-1 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.

2-2 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.

2-3 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.

2-4 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

3-1 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.

3-2 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".

3-3 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.

3-4 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