

Development and Applications of the Global Map

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Abstract

The Geographical Survey Institute of Japan has been implementing the Global Mapping project not only as the participating organization from Japan, but also as the Secretariat of the International Steering Committee for Global Mapping. As the Secretariat, the Geographical Survey Institute of Japan has made efforts to develop and promote the Global Mapping project through international cooperation. Due to these efforts, the development of Global Map version 1 has dramatically progressed toward the goal of the completion of global coverage. As of February 18, 2008, 162 countries and 16 regions are participating in the Global Mapping project (ca 97 % of the whole land area), and 48 countries and 3 regions have released their Global Map version 1 data (ca 49% of the whole land area). The International Steering Committee for Global Mapping plans to release Global Map Version 1 of all land areas of the globe in 2008.

1. Introduction

The Global Map is basic geographical information to assist in achieving sustainable development and solving global environmental problems. Since the Ministry of Construction (the current Ministry of Land, Infrastructure, Transport and Tourism; MLIT) of Japan proposed the concept of the Global Mapping in 1992, the National Mapping Organization (NMO) of each country and the International Steering Committee for Global Mapping (ISCGM) have promoted the Global Mapping project. In 2002, this project was registered as a World Summit on Sustainable Development (WSSD also known as Johannesburg Summit) type 2 initiative with the goal of completion of global coverage by the year 2007. Recently, the Global Mapping project has made great progress in its data development toward the completion of the global coverage, thanks to the continuing efforts of participating NMOs and ISCGM of which the Geographical Survey Institute (GSI) serves as Secretariat. As of February 18, 2008, 178 countries and regions are participating in the project and 51 countries and regions have released their Global Map data (ca 49 % of the whole land area).

ISCGM is planning to release the Global Map of the whole land area in the middle of 2008, and continues to develop the data in cooperation with the participating NMOs.

This paper summarizes the current status and

progress of the Global Mapping project and the activities of GSI in developing the Global Map as the Secretariat of ISCGM as well as a participating NMO in the Global Mapping project. As many authors have written about the development of the Global Mapping project, such as Okatani et al. (2006), this paper will mainly summarize the activities in the latest two years.

2. Background and Historical Review of the Global Mapping project

Agenda 21, an action program for addressing global environmental challenges while continuing to support sustainable development, was adopted at the United Nation Conference on Environment and Development held in Rio de Janeiro in 1992. The need for geographical information for sustainable development was described in the chapter 40 of Agenda 21 ("Information for Decision Making"). To satisfy the need for geographic information, the Ministry of Construction of Japan firstly advocated the Global Mapping project in 1992.

In 1994, the first International Workshop on the Global Mapping was held in Izumo, Japan, and the establishment of a Steering Committee for Global Mapping was called for in its resolution. ISCGM, which would conduct the project, was established at the Second International Workshop held in Tsukuba, Japan in 1996 and started to implement the Global Mapping project. ISCGM

initially consisted of 14 members from 13 NMOs, and was chaired by Prof. J. E. Estes. Now, it consists of 20 members chaired by Prof. D. R. F. Taylor.

In 1998, ISCGM sent a letter to all NMOs in the world with recommendation of Mr. Habermann, the Director of the United Nations Statistic Division, to invite them to participate in the Global Mapping project. As a result, there was a big increase in the number of participating organization in the project, and the development of the Global Map was started.

The Global Map Specifications were developed and the Global Map data were first released from the web site of ISCGM in November 2000. Raster data of the whole land area converted from existing geographical information (GTOPO30 and GLCC) were released as Global Map version 0, and five countries, Laos, Nepal, Sri Lanka, Thailand and Japan, released their Global Map data as Global Map version 1. The development of Global Map version 1 is continuing and 51 countries and regions have released their data as of February 18, 2008.

At WSSD held in Johannesburg 2002, the importance of promoting development and wider use of earth observation technologies, including global mapping, were confirmed. The nations agreed to support the Global Mapping project by describing "Encourage initiatives and partnerships for global mapping" in the 132nd paragraph of the "Implementation Plan of WSSD". The Global Mapping project was also registered as a WSSD type 2 initiative, which is a voluntary partnership initiative, with the goal of completion of global coverage by the year 2007. Thereby the ISCGM and NMOs accelerated the development of the Global Map version 1 of each country.

Now, ISCGM continues to develop the data and plans to release Global Map version 1 with global coverage in the year 2008.

3. Current status of the Global Mapping project

3.1 Contents of the Global Map

The Global Map has the following three characteristics.

1) Digital geographic information at 1 km resolution

The data are stored in GIS (Geographic Information Systems), and features have coordinates in geographic system (longitude/latitude) with attributes. Its resolution

corresponds to 1 to 1,000,000 scale and 90% of the points will be within +/- 2 km for horizontal accuracy according to its specifications.

2) Covering the whole land area of the globe with consistent specifications

Global Map Specifications 1.1 were adopted at the 7th ISCGM Meeting in Cape Town 2000, and the Global Maps of many countries were developed based on the Specifications so that we can use them in the same manner. The specifications have undergone several revisions without changing bases, and we now have the Global Map Specifications 1.3.

3) Composed of 8 layers

The eight layers of Global Map are transportation, boundaries, drainage, population centers, elevation, vegetation, land cover and land use. The former 4 layers are in vector format (Vector Product Format, VPF), and the latter 4 are in raster format (Band Interleaved by Line, BIL). Each layer has several feature classes with necessary attributes. Detailed information can be found in the Global Map Data Dictionary in the Global Map Specifications.

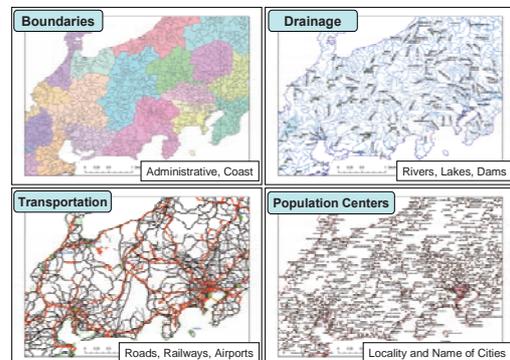


Fig. 1 Vector layers of the Global Map in central Japan

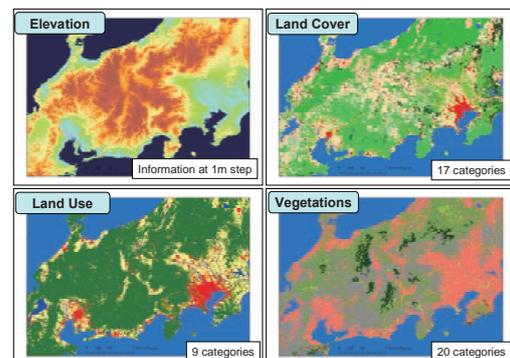


Fig. 2 Raster layers of the Global Map in central Japan
(Based on the Global Map Specifications 1.2.1)

To maintain the global coverage, the data are divided into Global Mapping tiles, which range from 5 degrees by 5 degrees (latitude by longitude) in lower latitude areas to 5 degrees by 90 degrees in high latitude areas. We can analyze many phenomena by selecting and overlaying the relevant layers of the Global Map. To monitor the changes of the environment, it is recommended that the Global Map should be updated every 5 years.

3.1.1 Global Map version 1

Global Map version 1 data are produced by the NMOs of respective countries and regions under their own responsibility. National and regional digital data created by NMOs are integrated into Global Map version 1 that covers the whole land area. Currently, developments of Global Map version 1 make progress country by country toward the goal of the completion of global coverage and the Global Map version 1 data are available country-wise.

3.1.2 Global Map version 0

Global Map version 0 was converted from existing geographical data sets (GTOPO30 and GLCC) and is available from the web site of ISCGM. This data set has 4 raster layers (elevation, land cover, land use and vegetation) of the whole world, although the data are not endorsed by any organization.

3.1.3 Global Land Cover by National Mapping Organizations and Global Percent Tree Cover

The Working Group 4 of ISCGM, which is responsible for planning and executing the data production for land cover, land use and vegetation, has discussed and developed a new land cover data set covering the whole land area using satellite imagery since the 11th ISCGM Meeting, 2004. In principle, the Global Map data should be developed by each NMO. However, considering the efficiency of workload and technical issues, it was decided to develop the global land cover data set at once with the cooperation of each NMO through data verification and by providing the ISCGM with the ground truth data. The Global Map Specifications were revised as version 1.3 in July 2007 to deal with the variation of raster layers.

As of February 2008, new raster layers have been

developed and are under verification, which are named Global Land Cover by National Mapping Organizations (GLCNMO, Fig. 3) for the land cover layer, and Global Percent Tree Cover (Fig. 4) for vegetation layer. GLCNMO is the land cover data with 20 classes, and Global Percent Tree Cover is an indicator of tree cover ranging from 0 % to 100 %. Classification based on a decision tree method was executed at the Center for Environmental Remote Sensing (CEReS) Chiba University and GSI to develop the GLCNMO data set. Both the GLCNMO and Global Percent Tree Cover data were derived from MODIS data obtained in 2003 (Terra satellite).

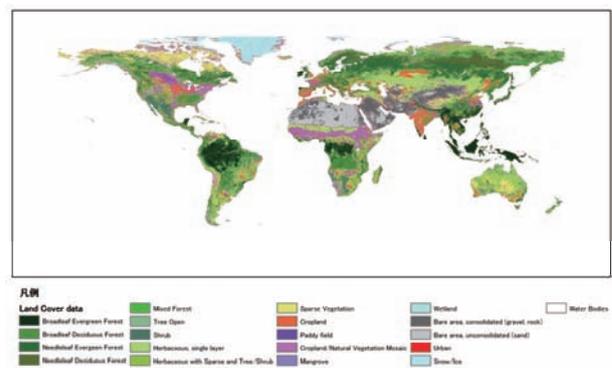


Fig. 3 GLCNMO (Tentative version)

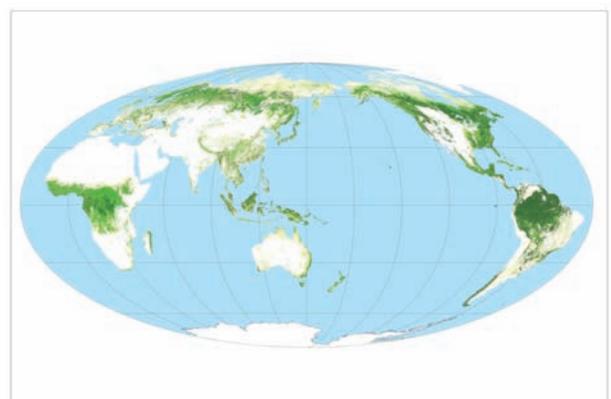


Fig. 4 Global Percent Tree Cover (Tentative version)

3.2 Progress of the Global Mapping project

In principle, participating NMOs develop their Global Maps and ISCGM releases their data country by country. Therefore, cooperation between ISCGM and NMOs is necessary to develop the Global Map, and each NMO contributes to the project according to its proper participating level from A to C (Fukushima, 2000).

As of February 18, 2008, 162 countries and 16 regions (ca 97% of the whole land area) participate in the Global Mapping project, and 48 countries and 3 regions (ca 49% of the whole land area) have released their Global Map version 1.0 data (Fig. 5, Table 1). In addition, 4 countries updated their data as Global Map version 1.1 after their first releasing of Global Map version 1.0.

Table 1 Progress of the Global Mapping project

Status	Progress	Number of Country / Region	Area	
Participating	Data available	48 / 3	48.6%	
	Data under verification	72 / 6	27.7%	
	Data developing	Not submitting data to the Secretariat	40 / 6	20.1%
		Submitting paper maps to the Secretariat	2 / 1	
Not Participating	Considering participating in the project	9 / 1	3.6%	
	Others	21 / n.a.		
Total		192 / n.a.	100%	

As of February 18, 2008

n.a. = Not Available

Progress of Global Mapping Project

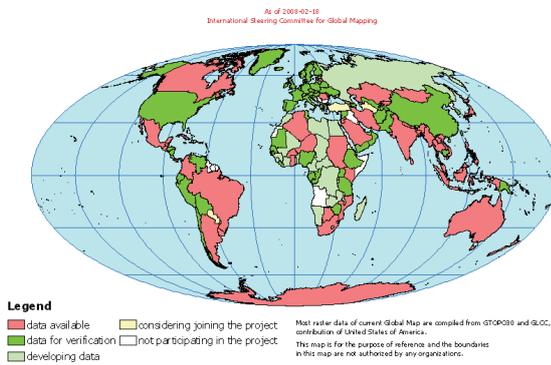


Fig. 5 Progress of Global Mapping project

To accelerate data release, ISCGM decided to release Global Map data even if they do not have all the layers so as to enhance data availability, at its 12th meeting in Cairo, in 2005. This is because it is hard to develop some layers, especially raster layers, in some countries. Now, 32 countries have released all the layers of their Global Map and other 16 countries and 3 regions have released mainly the vector layers of their Global Map and are developing the rest of their raster data.

Participating NMOs in the Global Mapping project through EuroGeographics collectively release their data as EuroGlobalMap. ISCGM classifies their data as under

verification and is currently consulting with EuroGeographics about the possibility of releasing their data from the web site of ISCGM. A few countries, such as Latvia, release their Global Map data both from the web site of EuroGeographics and ISCGM.

Figure 6 shows the progress of participation and data development. The number of participating organizations dramatically increased for a few years after ISCGM sent invitation letters with the recommendation of the United Nations in 1998, and has steadily increased until now. The number of organizations which released data has increased steadily since 2000, and dramatically increased for the recent two years.

21 countries (ca 13% of the whole land area) released their data for 5 years from 2000 to the end of 2005, 24 countries and 2 regions (ca 33% of the whole land area) released their data for 2 years from 2006 to 2007. ISCGM and NMOs accelerate the data development toward the completion of global coverage.

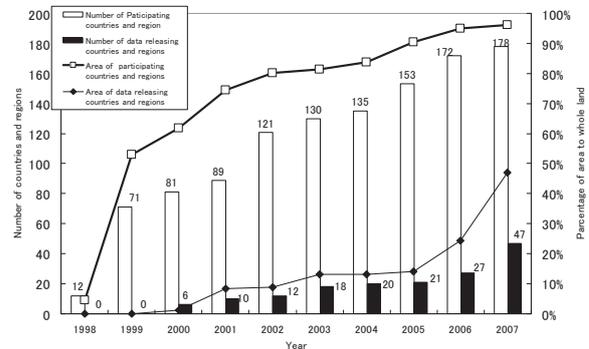


Fig. 6 Progress of participation and data development

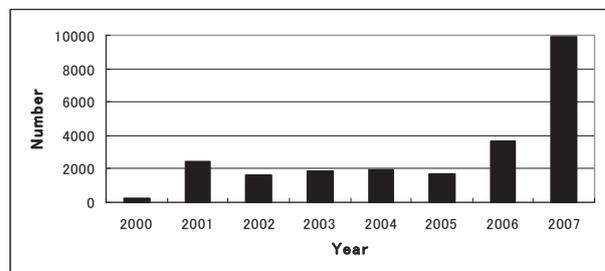


Fig. 7 Number of registered users (from November 2000)

Figure 7 shows the number of registered users of the Global Map download page from 2000 to 2007. The Secretariat reports this number every year at the annual

ISCGM meeting. The number of users is also dramatically increasing along with the development of the Global Map data in these two years.

4. Activities of GSI for the Global Mapping project

It is determined in the Rules of ISCGM (article 21 of Chapter 5) that the Secretariat shall be established at the Geographical Survey Institute (GSI) of Japan, and GSI plays a role not only as a participating NMO in the project, but also as the Secretariat of ISCGM. The activities of GSI are described respectively as follows.

4.1 Activities as the Secretariat of ISCGM

The duties of the Secretariat are conducting the general affairs of the Committee and managing the Committee smoothly (ISCGM rules, article 23 of Chapter 5). The main activities of GSI as the Secretariat of ISCGM are as follows.

Data verification

A NMO submits its Global Map to the Secretariat of ISCGM to release it from the web site of ISCGM. Before releasing, the Secretariat verifies the data, particularly its attributes, topologies and logical consistency. If some corrections are needed, the Secretariat communicates with the NMO asking for correction with technical advice. Since methods of developing Global Map data, including format and source of data, differ with each NMO, the submitted data also differ and are produced in various formats. Therefore, the Secretariat converts the data format into the Global Map format when the data are in other formats such as shape file format. Now, the data of 72 countries and 6 regions, which include participating organizations through EuroGlobalMap, are under verification, and the Secretariat and each NMO are making efforts to release the data. Usually, it takes several months to release the Global Map data after NMOs submit the data to the Secretariat, and additional months may be needed if communication is not in good condition.

Development of GLCNMO and Global Percent Tree Cover data

Working group 4 of ISCGM started to develop the

GLCNMO and Global Percent Tree Cover data in 2004. The data are mainly developed at CEReS, at Chiba University with the cooperation of each NMO. GSI assisted in their activity as the Secretariat of ISCGM. Tentative versions of the respective data are now available, and we plan to release the final product in mid 2008.

Invitation to participate in the Global Mapping project and requests for data submission

To advance the Global Mapping project, the Secretariat has been working to invite not-yet-participating NMOs to the project and encouraged data submission. In 2006 and 2007, the Secretariat sent invitation letters to some of the NMOs of not-yet-participating countries, and their embassies in Japan. Further the Secretariat visited a few embassies in Japan and some of their countries. The Secretariat also sent letters to the participating countries that had not submitted their data, requesting them to submit their data by June 2006. The number of data submitting countries and regions increased from 110 (ca 63% of whole land area) in December 2006 to 127 (ca 76% of whole land area) in December 2007.

The release of Global Map data and management of the web site of ISCGM

The Global Map is released from the web site of ISCGM, which is maintained by the Secretariat (<http://www.iscgm.org/>). In addition to releasing the data, we provide much information about the Global Mapping project through this web site, such as the progress of the project, application, history, latest news and so on. To download the Global Map data, registration is necessary and the Secretariat also maintains the download system.

ISCGM meeting

The Secretariat arranges the ISCGM meeting being held once a year basically. The 14th ISCGM Meeting was held in Cambridge, United Kingdom in July 2007, and the 13th meeting was held in Santiago, Chile in November 2006.

Global Mapping Newsletters

The Secretariat of ISCGM has published and sent the quarterly Global Mapping Newsletter to each NMO,

relevant organizations and subscribers since 1996. The Newsletter contains various articles such as activities of ISCGM, reports of related conferences, application of the Global Map, progress of the project. Most recently the 48th issue of the newsletter was published in December 2007.

Global Mapping Forum 2008

In June 2008, ISCGM will hold a Global Mapping forum in the United Nations University in Tokyo on the occasion of the release of Global Map Version 1 with the global coverage of all land areas, with the objective of exchanging ideas and information among data users and providers for the application of Global Map data to surveys and research concerning global environment and other relevant fields. The Secretariat is calling for participations and submissions of papers to the forum, and preparing for it.

4.2 Activities as a participating NMO

Updating the Global Map of Japan

The GSI and ISCGM released the Global Map of Japan version 1.0 in November 2000. This data was downloaded more than 15,000 times by many users and used as digital data for a small scale mapping. Since more than 5 years have passed since the release of the data, GSI decided to update the data as the Global Map of Japan version 1.1. Updated layers are transportation, boundary, drainage, population centers and elevation. Consolidated municipalities, new roads and railways and other features were updated as of December 31, 2005, using various materials such as 1:1,000,000 scale international maps (Abe, 2005).

Release of the Global Map data from the web site of GSI

The Global Map of Japan is available from the web site of ISCGM in VPF and BIL format. GSI also releases the Global Map of Japan in JPGIS format in addition to ISCGM format from the web site of GSI. JPGIS stands for "Japan Profile for Geographic Information Standards" and is the standard of geographical information in Japan based on ISO and JIS (Japanese Industrial Standard).

To browse the data easily, GSI also makes the Global Map of Japan available using the Cyberjapan system (Fig. 8). Cyberjapan is a kind of web map browsing system provided

by GSI, and we can easily overlay the features of the Global Map of Japan.

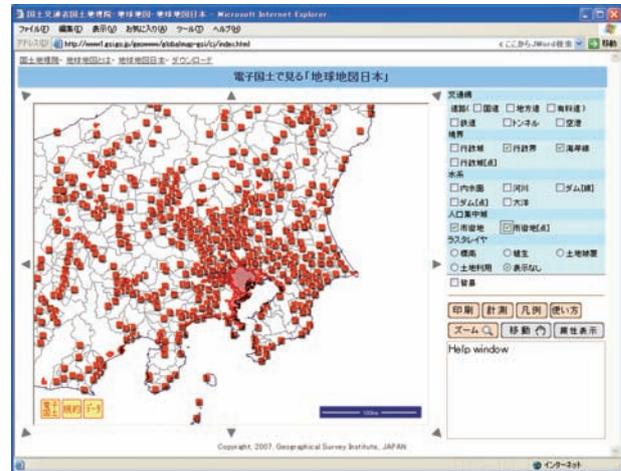


Fig. 8 Global Map Japan in the cyberjapan system

Support of the data development of other countries

Japan participates in the Global Map project at level A participation, which assumes to help other countries develop their Global Map. Therefore, GSI has produced data not only for Japan but also for other countries based on materials developed on their own and/or provided by ISCGM. GSI started to develop data for developing countries mainly in Asia and the Pacific region. To date, data for the following countries have been developed: Thailand, the Philippines, Vietnam and Kazakhstan in 1998; Mongolia, Kyrgyz and Bangladesh in 1999; Laos and Nepal in 2000; Myanmar and Sudan in 2001; Liberia in 2002; Swaziland in 2003; Senegal, Oman, Armenia, Tajikistan, Azerbaijan and Bolivia in 2005; and Cambodia, Republic of Congo, Mauritania and Niger in 2006, Namibia in 2007. Generally, Global Map data are developed from existing geographical information such as paper maps. Recently, GSI developed methods to develop Global Map data using satellite images, which include the products of Global Map of Senegal, Republic of Congo, Mauritania and Niger.

4.3 Other activities

Hosting the JICA training course

GSI recognizes the importance of technology transfer to developing countries for the development of the Global Map dataset. GSI has hosted the JICA (Japan International Cooperation Agency) group training course "Global

Mapping; Contribution to Global Map Development by GIS" every year since 1994. Now, this training course is in the 3rd phase and the term is for about 3 months. Through implementing the course GSI intends to develop a Global Map of training participants' countries by enhancing their skills and knowledge of GIS and remote sensing. Ninety participants from 54 countries and regions completed this training course from 1994 to 2007. Twenty seven of 54 (ca 50%) countries and regions which sent participants to training released their data, while 19 % of countries and regions released their data without participating in this training course. Therefore, this training course is considered very effective in transferring technology to developing countries and developing the data.

Global Mapping Seminar

To promote the development of the Global Map in Africa, a series of Global Mapping Seminar has been held once a year since 2002. MLIT of Japan has organized the seminar as a part of Global Mapping Partnership Program in cooperation with JICA and local NMOs. GSI also supports this seminar as the Secretariat of ISCGM. The latest Global Mapping Seminar was held at Direction des Travaux Geographiques et Cartographiques in Dakar, Senegal, January 2008. Nine participants from 6 countries joined the seminar. Two countries newly participated in the Global Map as the result through the seminar.

5. Relevant conferences and organizations

United Nations Regional Cartographic Conference for Asia & the Pacific (UNRCC-AP)

The 17th United Nations Regional Cartographic Conference for Asia & Pacific was held in Bangkok on 18-22 September 2006. The conference provided a regional forum to address the common need, problems and experience in the field of surveying and mapping. Prof. D. R. F. Taylor, chairperson of ISCGM, made a presentation and emphasized the importance of the GIS data, including the Global Map, for disasters. ISCGM also joined the panel discussion. The resolution of the conference welcomed the efforts of the Global Mapping project.

9th International Conference of the Global Spatial Data Infrastructure (GSDI9)

The 9th International Conference of the Global Spatial Data Infrastructure was held in Santiago, Chile on 3-10 November 2006. ISCGM joined this conference and organized 2 sessions relating to the Global Mapping project.

Group on Earth Observations (GEO)

ISCGM joined Group on Earth Observations (GEO) as a participating organization, and has cooperated with their activities as a member of Architecture and Data Committee and Working Group of Tsunami and is applying to be a member of Capacity Building and Science and Technology.

OneGeology

The 'OneGeology' project is an international initiative of the geological surveys of the world and a flagship project of the 'International Year of Planet Earth 2008'. The kick-off event was held in Brighton, England 12-16 March 2007. ISCGM supports this project with UNESCO and eight other international umbrella bodies.

6. Application of the Global Map

6.1 Disaster

Posting maps after big disasters

In December 2004, the Indian Ocean Earthquake occurred and triggered a series of Tsunamis along the coast in broad areas. GSI developed a wide area map using Global Map, VMAP (NGA), GTOPO30 (USGS) and ETOPO2 (NGDC) shown in Figure 9. The areas in height less than 10 meters are shown in pinkish color, which could be damaged by tsunami. This map helped to grasp the geographic features of the large tsunami-suffering area.

To describe geographic features of disaster-hit area, GSI develops elevation and land use maps of these areas using the Global Map data and release them from the web site of GSI. GSI created maps of the following regions; the Indian Ocean Earthquake-hit area in 2004, the Leyte landslide-hit area in February 2006, Area of Mt. Merapi in May 2006, the Java island earthquake-hit area in May 2006, the Java island earthquake-hit area in July 2006, area of Mt. Tongurahua in August 2006, the Solomon islands earthquake-hit area in April 2007, the Peru earthquake-hit

area in August 2007, the Sumatra island earthquake-hit area in September 2007 and the Bangladesh flooding area in November 2007.

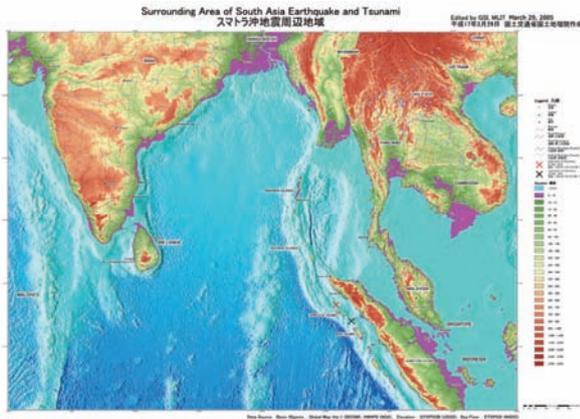


Fig. 9 Surrounding Area of South Asia Earthquake and Tsunami

GSI, as the Secretariat of ISCGM, has also posted maps to the ReliefWeb, a web site of United Nations Office for the Coordination of Humanitarian Affairs to provide information on humanitarian emergencies and disasters, since the Peru earthquake occurred in August 2007 (Fig. 10).

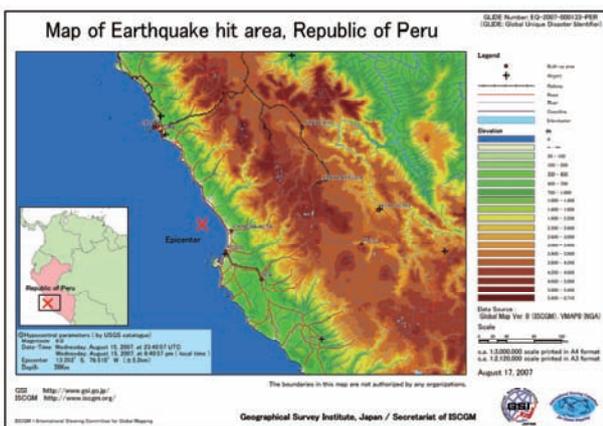


Fig. 10 Posted map to ReliefWeb of UNOCHA

6.2 Education

Global Map School

The first Global Map School, an international class using the Global Map, was held in September 2006. This was one of the model applications of Global Map proposed by the MLIT, Japan. The committee of the Global Map School chaired by Dr. Ota prepared for the class. GSI supported it as the Secretariat of ISCGM. Over 50 students

from Keio Futsubu School in Japan and Silliman high school in the Philippines joined the class using a videoconference system. During the class students from the two countries exchanged their views and ideas about geographical settings, major industry, and infrastructures of their own countries using the Global Maps. After the class, teachers and educators exchanged their ideas in an Internet symposium. The second Global Map School was held in March 2007 between-students from Japan and Thailand.

6.3 Promotion of the Global Map

Exhibition of Global Map/Percent Tree Cover (tentative version) by GSI

GSI exhibited a floor mat of Global Map (Percent Tree Cover data, tentative version) at the entrance hall of “The Science Museum of Map and Survey” of GSI from November 20, 2007 to the end of 2007. The floor map at the size of 5 meters by 10 meters attracted the interest of visitors (Photo 1). The Japanese media took up this exhibition news and the Science Links Japan (<http://sciencelinks.jp/>) picked it up on its website.



Photo 1 The floor map at the Science Museum of Map and Survey

Sending output maps to Foreign Embassies in Japan

GSI, as the Secretariat of ISCGM, introduced the Global Mapping project at a seminar on geomatics at the Canadian Embassy in Japan on June 19, 2007. Not only the data, but also the output maps of the Global Map of Canada had a good reception especially among non-specialists in GIS. Therefore, GSI started to send letters to the foreign Embassies in Japan with output maps in order to inform the

Global Map when the data of these countries was released (Fig. 11).

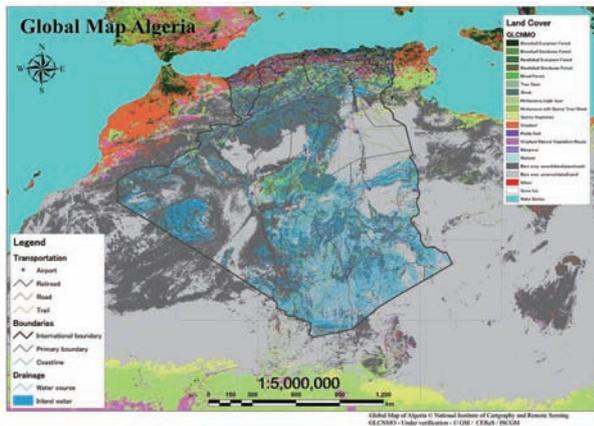


Fig. 11 Output map of the Global Map of Algeria, an example

Open Lecture at Universities

Staff members of GSI were involved in Open Lectures at Universities and promoted the Global Map. In August 2007, lectures about the Global Map were given to the public in an Open Lecture at Rissho University in Tokyo and Toyama University where the summary of the Global Mapping project and Global Map data were introduced.

7. Issues to be solved

7.1 Challenges on data development

Despite the remarkable progress in the development of Global Map version 1, NMOs of 42 countries and 7 regions are still developing their data in their countries and regions. Further, communication with NMOs after their data submission sometimes becomes difficult. Lack of efficient communication is one of the main obstacles for development. The Secretariat will have to communicate with NMOs one by one to advance the project.

7.2 Data Quality

The Global Map Specifications define data quality, such as consistency in topology or logical manner. The data of some countries may not fully meet the Specifications because of the several reasons, such as a lack of techniques. ISCGM and each NMO will improve the data quality while updating the data. In addition, Working Group 2 of ISCGM is discussing the revision of the Specifications and ISCGM

aims to provide more user-suitable data.

7.3 Challenges on using the data

The vector data of the Global Map are in Vector Product Format (VPF), and particular GIS software is necessary to use the data. The Global Map adopted the VPF format in 2000, and ISCGM has been considering the change of format to GML since the 9th Meeting of ISCGM in 2002.

In addition, ISCGM decided to release the Global Map in user-friendly formats in addition to the officially formatted Global Map at 14th Meeting of ISCGM in 2007. The Global Map will be available in easy formats to increase the use of data.

ISCGM and NMOs continue discussion about the data policy regarding commercial use, but have not reached a consensus yet. Therefore, the Global Map is freely used only for non-commercial purposes at the current state.

8. Conclusion

Recently, the development of Global Map version 1 has dramatically progressed toward the goal of the completion of global coverage with the international efforts of ISCGM and each NMO.

GSI has contributed to the project as not only a participating NMO in the project but also as the Secretariat of ISCGM.

ISCGM plans to release Global Map Version 1 with full global coverage of land area in 2008.

GSI continues to make efforts to develop the Global Map data and promote the use of the Global Map data with ISCGM and NMO of each country of the world.

Acknowledgement

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