Progress of Global Mapping Project since Johannesburg Summit in 2002

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Abstract

The Global Mapping Project aims to develop and update geographic information on global land under the cooperative efforts of the International Steering Committee for Global Mapping (ISCGM) and the national mapping organizations (NMOs) of the entire world. With regard to activities for the promotion of the project, the World Summit on Sustainable Development (WSSD; Johannesburg Summit) in 2002 was the most important milestone in gaining the world's awareness of the project regarding its importance for sustainable development. This paper reviews the outline of the project, summarizes activities mainly implemented after WSSD, and introduces problems the project currently faces and tasks being implemented. Finally, the paper concludes that continuous promotional efforts of the project, hand in hand with NMOs, in the areas of sustainable development, Earth observation and geographic information community, are indispensable for the completion of the Global Map by 2007, the goal set out at WSSD.

1. Introduction

The Global Mapping Project aims to develop and update global digital framework geographic information under the cooperation of national mapping organizations (NMOs) of the world. The project seeks to develop global geographic framework data for decision making through international coordination and consensus. In this paper, Chapter 2 reviews the historical overview of the Global Mapping Project, Chapter 3 shows the current status of the Global Mapping Project, Chapter 4 reviews activities relating to the Global Mapping Project after WSSD, Chapter 5 mentions current problems and possible solutions of the Global Mapping Project, and finally Chapter 6 concludes the progress of Global Mapping Project since the Johannesburg Summit in 2002.

2. Historical overview of the Global Mapping Project

The United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, 1992, adopted Agenda 21 as a programme for addressing global environmental challenges and setting out measures to be implemented. Agenda 21 states that the availability of geographical information is critical for environmental decision making (Agenda 21. 40. 9.).

In line with the vision stated in Agenda21, the concept of the Global Mapping Project was first advocated in 1992 by the Ministry of Construction (now reorganized as the Ministry of Land, Infrastructure and Transport: MLIT) and the Geographical Survey Institute (GSI) of Japan, in response to growing concern about the global environment as a contribution from the mapping and surveying sector.

The primary objective of the Global Mapping Project is to contribute to solving global environmental problems and realization of sustainable development through the provision of a base framework geographic dataset. The Global Map data are developed by NMOs in accordance with common data specifications. In order to promote and implement the Global Mapping Project, the International Steering Committee for Global Mapping (ISCGM) was set up in 1996 and the GSI has been working as its secretariat since its inception.

The development of the Global Mapping Project has been written by many authors, including Maruyama (1998), Estes and Kline (2000), Fukushima (2000), Une (2001a), Une (2001b), Masaharu and Akiyama (2003), Hoshino et al. (2004) and Nakajima (2004). Important project-related events are shown in Table 1.

Table 1 Important events of the Global Mapping Project

Year	Venue	Name of event
1994	Izumo, Japan	1st International Workshop on Global Mapping
1996	Tsukuba, Japan	2nd International Workshop on Global Mapping
1996	Tsukuba, Japan	1st Meeting of ISCGM
1996	Santa Barbara, USA	2nd Meeting of ISCGM
1997	Gifu, Japan	1st Global Mapping Forum
1997	Gifu, Japan	3rd Meeting of ISCGM
1998	Sioux Falls, USA	Global Mapping Forum '98
1998	Sioux Falls, USA	4th Meeting of ISCGM
1998	Canberra, Australia	5th Meeting of ISCGM
1999	Cambridge, UK	6th Meeting of ISCGM
2000	Cape Town, South Africa	7th Meeting of ISCGM
2000	Hiroshima, Japan	Global Mapping Forum 2000
2001	Cartagena, Colombia	8th Meeting of ISCGM
2002	Budapest, Hungary	9th Meeting of ISCGM
2003	Ginowan, Japan	10th Meeting of ISCGM
2003	Ginowan, Japan	Global Mapping Forum 2003
2004	Bangalore, India	11th Meeting of ISCGM
2005	Cairo, Egypt	12th Meeting of ISCGM

In addition to these events directly related to the Global Mapping Project, there have been several events that highlight and encourage promotion of the Project, as follows;

1998: Invitation from ISCGM with a UN recommendatory letter to all the NMOs in the world to participate in the Global Mapping Project was made and development of the Global Map data was started.

2000: Provision of Global Map data was started

2002: Global Mapping was referred to in "the Plan of Implementation" document of the World Summit on Sustainable Development (WSSD; Johannesburg Summit).

Because of the invitation, the number of participating countries/regions grew dramatically from 12 (1998) to 71 (1999). This was an important event for Global Mapping Project as it became truly global.

For the Global Map data development, specifications for the Global Map data (to be mentioned later) were decided, and the data of Laos, Nepal, Sri Lanka, Thailand and Japan as top runners have been completed and officially released on ISCGM's Web site (http://www.iscgm.org/) on 28 November 2000. From that time, the number of countries whose data are available has been continuously increasing.

At the WSSD, a watershed event of global importance, ISCGM actively participated in the summit and its preparatory processes. As a result, the adopted "Plan of Implementation of WSSD" emphasizes the necessity of promoting development and wider use of earth observation technologies, including global mapping and calls for encouraging initiatives and partnerships for global mapping.

The description of Global Mapping initiatives and promotion of partnerships at the "Implementation Plan of WSSD" (http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/WSSD_PlanImpl. pdf) are as follows;

132. Promote the development and wider use of earth observation technologies, including satellite remote sensing, global mapping and geographic information systems, to collect quality data on environmental impacts, land use and land-use changes, including through urgent actions at all levels to:

(a) Strengthen cooperation and coordination among global observing systems and research programmes for integrated global observations, taking into account the need to build capacity and sharing of data from ground-based observations, satellite remote sensing and other sources among all countries;

(b) Develop information systems that make the sharing of valuable data possible, including the active exchange

of Earth observation data;

(c) Encourage initiatives and partnerships for global mapping.

133. Support countries, particularly developing countries, in their national efforts to:

(a) Collect data that are accurate, long-term, consistent and reliable;

(b) Use satellite and remote-sensing technologies for data collection and further improvement of ground-based observations;

(c) Access, explore and use geographic information by utilizing the technologies of satellite remote sensing, satellite global positioning, mapping and geographic information systems.

Global Mapping also became a registered WSSD Type 2 partnership/initiative under the name of ISCGM. A document for this registered WSSD Type 2 partnership/initiative is shown at:
http://webapps01.un.org/dsd/partnerships/public/partnerships/226.html.

In the document, it is targeted that:
"all the participating NMOs complete their development of the Global Map, a concrete framework for partnership, and regular update system at an interval of five years to be established before 2007."

Following these events, many activities have been done for further promotion of the Global Mapping Project since WSSD, such as activities in the Group on Earth Observation (GEO).

The current status of these activities is mentioned in the following part of this document.

3. Current status of the Global Mapping Project

As of March 2006, 160 countries and regions are participating in the project, which covers more than 90% of the land area of the Earth. Of these, 22 countries' data have been completed and are freely downloadable for non-commercial use through the Internet from the ISCGM website at http://www.iscgm.org/ (Fig.1).

ISCGM, a promoting body of the Global Mapping Project, consists of twenty members. Except for the chair of ISCGM, they represent national mapping organizations and regional geographic information organizations; namely, Antarctica (SCAR), Australia, Bangladesh, Canada, China, Europe (EuroGeographics), France, India, Iran, Japan, Kenya, the Republic of Korea, Malaysia, Mexico, New Zealand, Niger, South Africa, the United Kingdom and the United States of America (in alphabetical order). The committee is currently chaired by Professor D. R. F. Taylor of Carlton University, Canada.

Fig. 1 Progress of Global Mapping Project

ISCGM has held its meetings nearly once a year at places all around the world. ISCGM has 4 working groups. Among them, Working Group 2 and Working Group 4 deal with the technical aspects of the project. Working Group 2 deals with the specifications of Global Map and Working Group 4 deals with global raster data development.

The Global Map is a global digital framework for geographic information on land with the following characteristics.

1) Digital geographic information at 1 km resolution (at 1:1,000,000 scale)
2) Covering the whole land area of the globe with consistent specifications
3) Composed of 8 layers

More precisely, the specifications define the accuracy of Global Map data as follows;

"For horizontal accuracy, 90% of points will be within ±2 km of their actual location. In the case of data obtained from satellite images, the maximum error is less than or equal to 0.5 km. Vertical accuracy is notionally ±150 metres for 90% of points. This figure

may need to be reviewed once the data are available, as sources to this accuracy may not be available in areas of high relief."

The eight layers of Global Map data are as follows; Transportation, Boundary, Drainage, Population Centers, Elevation, Vegetation, Land Cover and Land Use. The former 4 layers are vector data and the latter 4 layers are in raster format. The current data format for the vector layers is VPF (Vector Product Format) (Figs. 2 and 3).

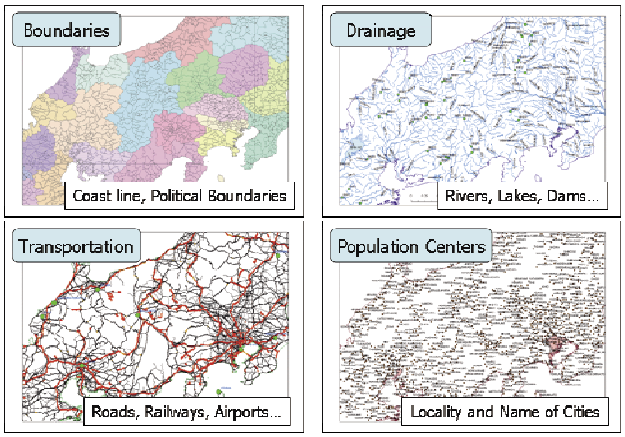

Fig. 2 Contents of Global Map data (vector l ayers)

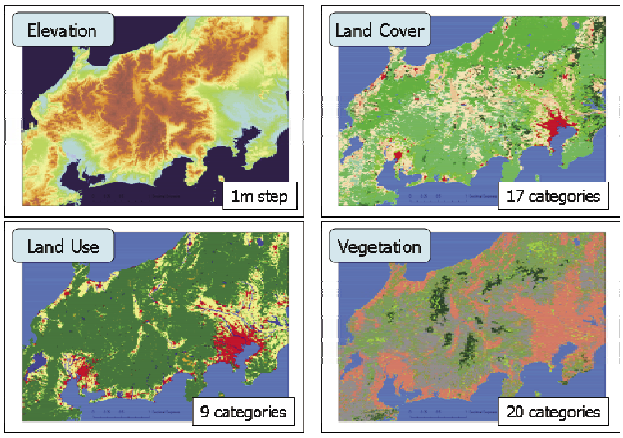

Fig. 3 Contents of Global Map data (raster layers)

Detailed features and attributes of the Global Map can be found in the specification document available on the Global Map website (http://www.iscgm.org/).

The Secretariat of ISCGM has been facing difficulties in releasing Global Map data for reasons mentioned later.

4. Activities relating to the Global Mapping Project after WSSD

In addition to making efforts to increase the number of participating countries and the data release, ISCGM and related bodies have been continuously and actively promoting the project by holding meetings and seminars relating to Global Mapping and participating in related meetings and conferences including those in capacity building programs such as the JICA (Japan International Cooperation Agency) Group Training "Global Mapping Course".

For example, ISCGM held lecture meetings to raise awareness of the Global Mapping project, to make wider use of the Global Map and to examine ways of contribution of digital geographic datasets for all land areas of the globe to earth observation projects. Also, Global Mapping Seminars, which aim at further enlightening the Global Mapping Project and improving technology for the Global Mapping in African regions through lectures related to policy and technological perspectives on the use of Global Map data were organized by ISCGM, the Ministry of Land, Infrastructure and Transport (MLIT) of Japan, the Regional Center for Mapping of Resources for Development (RCMRD) with support from Survey of Kenya (SOK), Kenya Institute of Surveying and Mapping (KISM), JICA in Nairobi, Kenya in 2002-2004, and in Dakar, Senegal in 2005 by ISCGM, MLIT, Direction des Travaux Géographiques et Cartographiques (DTGC) with support from JICA.

Regarding participations in related meetings and conferences, ISCGM in particular participated in the mechanism of Group on Earth Observations (GEO) in addition to attending meetings of liaison organizations such as GSDI, ISDE (International Symposium on Digital Earth) and PCGIAP.

In the following part, activities on GEO and meetings organized by ISCGM are explained as examples of the important activities.

4.1 Activities of ISCGM in Group on Earth Observations (GEO)

The 10-Year Implementation Plan for the Global Earth Observation System of Systems (GEOSS) was endorsed at the Third Earth Observation Summit (EOS-III) held in Brussels, Belgium on 16 February 2005. As Global Map should be well featured in GEOSS, ISCGM has been actively involved in the discussion of planning of GEOSS. Implementation of GEOSS is crucial for the Global Map as well. Therefore, this section reviews the past activities of ISCGM in GEO to serve as a basis for considering future activities of ISCGM.

At the 2003 G-8 Summit in Evian, France, the importance of Science and Technology for Sustainable Development, especially that of global earth observation, was stressed. It was agreed to strengthen international cooperation on global observation. As a result, the First Earth Observation Summit (EOS-I) was held in July 2003 in Washington DC, USA. It was agreed in the EOS-I to establish an ad hoc Group on Earth Observations (GEO) to prepare a 10-year implementation plan for a coordinated, comprehensive, and sustained Earth observation system of systems. The first meeting of GEO (GEO-1) was held for two days after EOS-I.

After EOS-I and GEO-1, two summits and five ad hoc GEOs were held with substantial results as shown in Table 2. By the time of GEO-4, the expression "a coordinated, comprehensive, and sustained Earth observation system or systems" was fixed as "the Global Earth Observation System of Systems (GEOSS)". At GEO-4, held in Tokyo in April 2004, ISCGM joined GEO as a participating organization. Taking full advantage of the GEO-4 meeting, ISCGM held a seminar "Contribution of Global Map to Earth Observation" on 24 April as a side event. This event is described in detail later in this paper. In EOS-II, a framework document of a 10-year plan was adopted. Based on the framework document, a draft 10-year plan was made together with its draft reference document. These documents were circulated to member countries and participating organizations. In GEO-5, a 10-year plan was intensively discussed. Finally, in EOS-III, a 10-year plan was endorsed, and its reference document was recognized as a living document with possible future revisions. It should be noted that GEO has become permanent from an ad-hoc entity. These documents are referred to at http://earthobservations.org/. ISCGM has attended all the meetings since it became a participating organization. Information on ISCGM activities on EOS and GEO meetings which developed "The 10-Year Implementation Plan" is shown in Table 2.

As results of activities by ISCGM, descriptions related to the Global Map and other geo-information were included in the 10-year plan and its reference document.

The current role of GEO is to take necessary steps to implement GEOSS in accordance with its implementation plan. The first permanent GEO (Group on Earth Observations, differs from the former GEO) meeting (GEO-I) was held in Geneva, Switzerland in May 2005 and GEO-II was also held in Geneva in December 2005. ISCGM needs to be involved in GEO activities in order to make full use of the Global Map in the Earth observation field and to make it possible to maintain smooth maintenance of Global Map using remote sensing technology.

Table 2 Activities of ISCGM on EOS and GEO meetings

Meeting	Venue	Date	Main results and ISCGM activities
EOS-I	Washington DC, USA	31 Jul. 2003	* establishment of ad-hoc GEO * decision to pre- pare 10-year plan
(Ad hoc) GEO-1	Washington DC, USA	1-2 Aug. 2003	* structure and schedule of GEO
(Ad hoc) GEO-2	Baveno, Italy	28-29 Nov. 2003	
(Ad hoc) GEO-3	Cape Town, South Africa	25-27 Feb. 2004	
(Ad hoc) GEO-4	Tokyo, Japan	22-23 Apr. 2004	* ISCGM joined GEO as a partici- pating organization * Sec. General of ISCGM attended * ISCGM held a seminar as a side event
EOS-II	Tokyo, Japan	25 Apr. 2004	* Framework docu- ment adopted * Sec. General of ISCGM attended
(Ad hoc) GEO-5	Ottawa, Canada	29-30 Nov. 2004	* discussion on draft 10-year plan * Chair of ISCGM attended
(Ad hoc) GEO-6	Brussels, Belgium	14-15 Feb. 2005	* finalization of 10-year plan * Sec. General of ISCGM attended
EOS-III	Brussels, Belgium	16 Feb. 2005	* endorsement of 10-year plan * establishment of permanent GEO * Sec. General of ISCGM attended
GEO-I	Geneva, Switzerland	3-4 May 2005	* Representative of ISCGM attended
GEO-II	Geneva, Switzerland	14-15 Dec. 2005	* Sec. General of ISCGM attended

4.2 Lecture meetings organized by ISCGM

Several meetings were held by ISCGM aiming to raise people's awareness of the Global Mapping Project and other purposes. Two meetings, one held at the United Nations University (UNU) in Tokyo on February 2005, and the other held at the National Museum of Emerging Science and Innovation in Tokyo on April 2005, are introduced here.

As for the meeting in February 2005, ISCGM gave "Global Mapping Lecture Meeting" at the Elizabeth Rose Conference Hall of UNU on 12 February jointly hosted by GSI.

The objective of this meeting was to make wider use of the Global Map in addition to raising people's awareness of the Global Mapping project.

The meeting assembled about 100 participants to hear three presentations, "Overview of Global Mapping and Status of the Development," by Mr. Hiromichi Maruyama, Director of Geographic Department, GSI; "Application of Global Map" by Dr. Srikantha Herath, Senior Academic Programme Officer Environment and Sustainable Development of UNU; and "My Actions for the Global Environment" by Atty. Kazuya Maruyama, Representative of Maruyama International Law, Patent Office.

It was recognized through comments of the participants that many of them could understand the significance of the Global Mapping Project and even seemed to encourage ISCGM for further implementation of the project.

About the meeting on April 2005, ISCGM hosted a lecture meeting jointly with GSI titled "Contributions of Global Map to Earth Observation" on April 24 at the National Museum of Emerging Science and Innovation in Tokyo.

This meeting was held as a side event of the Fourth Plenary Meeting of the Group on Earth Observations (GEO4) which preceded Earth Observation Summit II. The theme of the meeting was how the Global Map can contribute to earth observation projects.

Two overseas lecturers, Dr. Ashbindu Singh, UNEP, and Dr. Dietrich E. Leihner, FAO, as well as Dr. Ryutaro Tateishi, Associate Professor of Chiba University, and Dr.

Takeo Tadono, JAXA-Japan Aerospace Exploration Agency, gave presentations. In addition, Mr. Akira Yaguchi, Deputy Director General of GSI and Hiromichi Maruyama (ISCGM) gave lectures. The topics of the lectures ranged widely from the activities of international organizations to technical issues such as development of a land cover dataset.

In spite of being held on Saturday morning, the meeting was well attended by about fifty people including foreign participants in the GEO4 and heated discussions took place after the lecture meeting (a picture of the meeting is shown in Photo 1).

Photo 1 Picture of the meeting "Contribution of Global Map to Earth Observation"

5. Issues around the Global Mapping Project

As mentioned above, the completion of data development of land area of Global Map Version 1 is targeted for 2007. While the number of participating countries /regions has been greatly increasing, the development of Global Map data is still underway.

The Secretariat of ISCGM is deeply aware of the fact that there are problems which need to be solved in data development, such as difficulties of data development in the current data format, insufficiency of capacities for developing the data at each participating organization, and lack of examples of Global Map data applications to encourage participating countries to promote data development.

Of these, we are going to explain the following two problems. One is the difficulties of developing Global Map vector data under the current data format VPF, and the other is the issues related to developing new Global Map raster data relating to the fact that many countries have difficulties in developing such data.

5.1 Problems relating to the current vector data format

Although the current vector data format is VPF, and this was adopted because of its harmonization to the principle that the developed data should be open to the public at marginal cost, the VPF format is a serious obstacle, as it has become obsolete. No common GIS software can edit the data in VPF directly, and special software is required to export data in VPF, which creates problems for both producers and users. As a result, most of the participating organizations have submitted their draft Global Map to the Secretariat in different formats like Shape Files, and format transformation has become a heavy burden for the Secretariat. Because of this heavy burden, a lot of time has been spent for data transformation, which accordingly impedes the data release.

Another problem of the VPF format is the complexity that the same information is kept in different classes (files). A typical example is that an edge of a polygon feature is also another independent line feature. This kind of redundancy might be accepted in terms of avoiding errors. However, it sometimes causes logical contradictions.

ISCGM has started to solve the problems with the specifications described above, through the activities of Working Groups and the Secretariat.

Reactivation of Working Group 2, which deals with specifications, was resolved at ISCGM9 held in Budapest, Hungary in 2002.

At this stage, the Secretariat thought that the specifications for vector layers should be revised based on the following principles:

1) Simplicity

Specifications should be as simple as possible so that participating countries can understand them easily without trouble.

2) Interoperability

The Global Map must be used by a wide range of people in order to attain its objective. For this purpose, the Global Map should be used in various GIS environments and its specifications should be compatible with the modern geo-information standards which are expected to be common in the near future, and maintained with the least change in advancing technology.

3) Uniqueness

Global Map specifications should be defined without ambiguity from the production point of view, and designed to minimize the redundancy included in Global Map data in order to avoid contradictions from the maintenance point of view.

4) Extensibility

Some needs might come up to add some contents to the current Global Map due to some environmental and social changes. The specifications should allow such extension with slight modification.

The Secretariat is looking at the outcome of ISO/TC211 activities carefully, noting that items 2) and 4) may be solved easily if we apply specifications compliant with ISO/TC211 standards. The following areas are among the major concerns of the Secretariat.

Encoding: Conformance with web mapping is considered as well as adoption of ISO/TC211 standards.

Data model: The data model is revised noting 1) and 3) mentioned above. Efforts to minimize ambiguities are also necessary. An object-oriented model is another important aspect. In this regard, abolition of FACC code is under consideration.

Metadata: A best practice standard is being sought among existing standards compliant with ISO/TC211 standards.

As a result, the adoption of GML as Global Map format has come under review at ISCGM (Figs. 4 and 5) and revision of encoding is under discussion as follows:

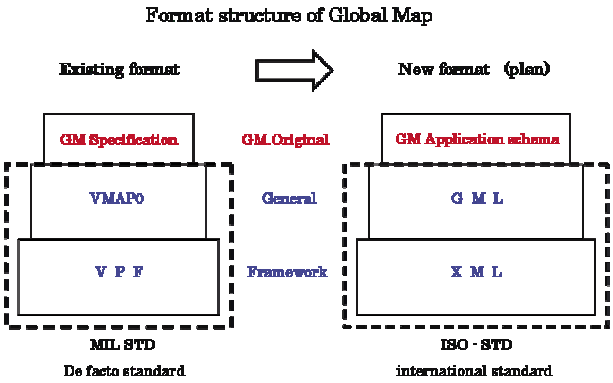

Fig. 4 Format structure of Global Map

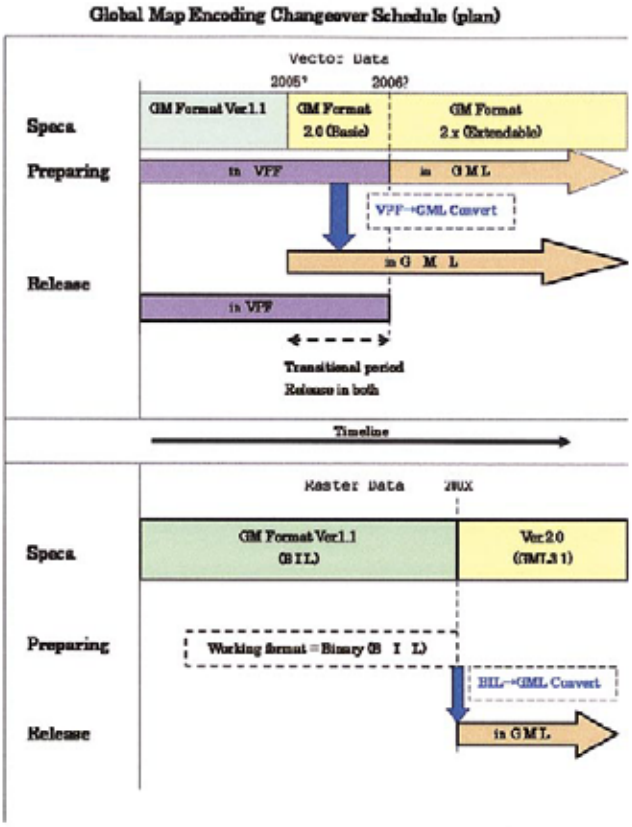

Fig. 5 Global Map Encoding Changeover Schedule (plan)

1) Basic encoding specification:

For Vector Layers: GML 2.12 (Lower compatibility with GML3)

For Raster Layers: GML 3.10 (includes Grid Coverage, ISO GML candidate)

2) Tiling: Disuse = A seamless file for each country (Must prepare for some exceptions)

3) Application Schema: Initial schema is equivalent to current format.

4) Resolution of coordinate values: At least 3 digits below the decimal point (about 100m at the equator)
5) Meta-data: ISO19115 + ISO19139
6) Quality Control Methods: Indicate result of selected test in Meta-data. List of tests should be defined.
7) File format submission to the secretariat:
   GML (completed)
   ArcInfo Coverage (condition: restricted)
   ArcGIS Shape (condition: restricted)
8) Transfer support:
   Newly revised data development manual.
   Preparation of format conversion software.
   (SHP-GML, VPF-GML, Coverage-GML)
   GML conversion is available at the Secretariat.
   Dataset should be available in both formats in the transition period.
   Development of a GML-VPF converter might be considered.

Though revised Global Map Specifications should be similar to the existing Specifications, some standard specifications are not fixed yet. Therefore related parts of the revised Global Map Specifications are tentative, e.g. Meta-data for "Grid Coverage." Participating countries could extend feature sets, but the way of extension should be ordered and limited within "GM profile" or similar mechanism. Multi-lingualization is to be achieved through a standard XML mechanism.

5.2 Issues around new raster data development

For raster data, the format is BIL (Band Interleaved by Line). The creation method of global vegetation, land cover and land use data is different from that of vector data in the following points;

1) Especially for land cover data, data acquisition from satellite images can be done much effectively and efficiently than collecting these data from each country.
2) For land cover, land use and vegetation data, most of the participating NMOs have little experience in developing their data for technical reasons.
3) We cannot understand the name of a road through a satellite image, but can distinguish cropland from an urban area through a satellite image.

In other words, raster data development may be more feasible if we prepare global raster data by analyzing satellite data all at once and ask each participating organization to help to validate the developed data rather than waiting for data submission from them.

Based on these facts, WG4 of ISCGM had started to investigate the methods and strategy for the development of a new land cover dataset on a global scale in a more realistic way. Developing a land cover dataset of the whole world at once might be more effective than developing it one by one, like vector data, and it is considered that the network of countries participating in Global Mapping could be effectively used for developing especially ground truth data. This working group also suggests developing a new layer of percent tree cover instead of a vegetation layer, while suspending a land use layer, because vegetation, land use and land cover are very similar.

However, this does not mean exclusion of NMOs from raster data development. NMOs play essential roles in data development, such as collection of ground truth data and validation of classification results. They are expected to improve the quality of the developed raster data (Fig. 6). These are important for steady updating of raster layers as well. Therefore, ISCGM named this new scheme of raster data development GLCNMO.

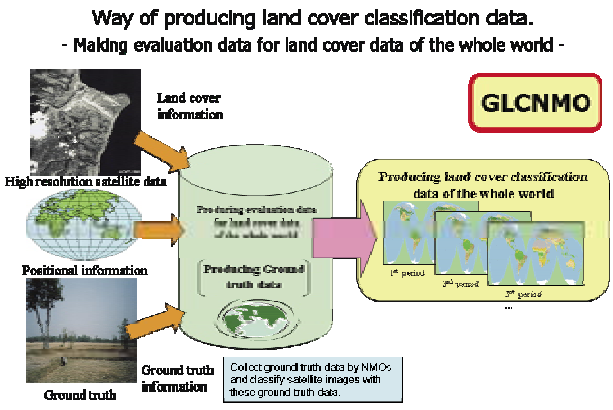

Fig. 6 Way of producing land cover classification data (GLCNMO)

Naturally, participating organizations with enough experience of land cover data development or with a will to develop their own land cover data can create original data besides that developed through the method mentioned above.

6. Conclusion

Since WSSD, ISCGM and related organizations have been making efforts to promote the project, taking advantage of the watershed events for obtaining international recognition of the importance of the Global Mapping Project.

Of these efforts, ISCGM has actively participated in the Group on Earth Observations (GEO) especially as the Global Map should be well featured in"the Global Earth Observation System of Systems (GEOSS)."

Properly, activities for increasing the number of countries participating in the project and countries that release Global Map data are also important, and thus ISCGM has been making the largest efforts in these areas.

We found some problems that prevent us from going further, but we have considered and discussed plans to overcome this situation.

The Global Map is targeted to be released for the whole globe by 2007, and we are eager to realize it in cooperation with the NMOs of the whole world.

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