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Global mapping and spatial data infrastructure: development and challenges for dissemination of Geospatial data**

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GLOBAL MAPPING AND SPATIAL DATA INFRASTRUCTURE
- Developments and Challenges for Dissemination of Geospatial Data -

D.R. FRASER TAYLOR, Carleton University, CANADA
HIROMICHI MARUYAMA, HISAKAZU SASAKI, TAKAKI OKATANI, Geographical Survey Institute
Kitazato-1, Tsukuba, Ibaraki, JAPAN 305

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SUMMARY:

The Global Map Project is a project to prepare Global Map, a basic digital map at the scale of 1:1 million covering the whole land area of the globe with consistent specifications, in international cooperation with the national mapping organizations of the world. As Global Map can be regarded as an initial form of framework data for an NSDI and a RSDI, the development of Global Map can be a first step in establishing an NSDI and RSDI. The Global Map Project has already triggered several initiatives to prepare regional framework data such as the Americas Global Map. The future sustainability of Global Map relies heavily on the NSDI and RSDI of respective countries and regions many of which are under development. The interaction between Global Map and both NSDIs and RSDIs is both mutually beneficial and required for the sound development of a Spatial Data Infrastructure at any scale.

ACRONYMS:

GEO: ad-hoc Group on Earth Observation
GEOSS: Global Earth Observation System of Systems
GIS: Geographic Information System
GLCC: Global Land Cover Characterization
GMPP: Global Mapping Partnership Program
GSDI: Global Spatial Data Infrastructure
GSI: Geographical Survey Institute of Japan
GTOPO30: Global 30 Arc Second Elevation Data
ICA: International Cartographic Association
ISCGM: International Steering Committee for Global Mapping
ISO: International Organization for Standardization
ISPRS: International Society for Photogrammetry and Remote Sensing
JICA: Japan International Cooperation Agency
MLIT: Ministry of Land, Infrastructure and Transport
NMO: National Mapping Organization
NSDI: National Spatial Data Infrastructure
OGC: Open Geospatial Consortium
PCGIAP: Permanent Committee on GIS Infrastructure for Asia and the Pacific
RSDI: Regional Spatial Data Infrastructure
SDI: Spatial Data Infrastructure
SCAR: Scientific Committee on Antarctic Research
WSSD: World Summit on Sustainable Development

1. INTRODUCTION

In the late 20th century maps were increasingly produced in digital form as a result of the rapid development of computer technology. Digital maps are far more flexible and useful than paper maps if and only if appropriate circumstances allow them to be used. Infrastructure creates such circumstance and can be characterized as Spatial Data Infrastructure (SDI). This consists of various components such as framework data, standardization, human resources and regulations. We can think of SDI at various levels; NSDI (national level), RSDI (Regional level) and GSDI (global level). There is no doubt that in the 21st century SDIs take over the role of conventional maps as a basis of development for each country, and currently are a basis to address issues such as the conservation of the environment and the realization of sustainable development at a national, a regional and international level.

Global Map is a basic digital map at the scale of 1:1 million covering the whole land area of the globe with consistent specifications. Global Map at the national scale is a small scale base map of the country and an initial framework dataset for an NSDI. Therefore, the development of Global Map can be a first step in establishing an NSDI at the national level. This is also true for a RSDI. On the contrary, Global Map can be properly maintained based on well established NSDIs and RSDIs.

This paper gives a general description of the Global Mapping Project, analyses of mutual dependency relationships between Global Map and SDIs, and finally argues that enhancing this relationship is indispensable for sound development of both Global Map and SDIs.

2. GLOBAL MAP

Global Map consists of eight layers of geographical data, such as transportation, boundaries, drainage, population centers, elevation, vegetation, land cover and land use. Technical Details of Global Map are described in the specification document which is open and available through the Internet (http://www.iscgm.org).

2.1 The Global Mapping Project

The Global Mapping Project is a project to produce Global Map in cooperation with the National Mapping Organizations (NMOs) of the world. The development of the project is described below.

2.1.1 Background

At the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992, Agenda 21, an action program for addressing global environment challenges while continuing to support sustainable economic development, was adopted. Agenda 21 clearly mentions that there is need for improved coordination among environmental data and information, and it emphasized the transformation of existing information into forms more useful for decision-making. In particular, geographically specific spatial information is critical. Spatial information enables us to enhance our understanding of global and regional relationships inherent in the present status and processes leading to changes in key components of the global environment. To this end, in 1992, the Ministry of Construction (presently Ministry of Land, Infrastructure and Transport, MLIT) of Japan advocated the Global Map concept.

2.1.2 Formation of the project

Since the Global Map concept was introduced, the Ministry of Construction made various efforts to get support for this concept from many countries in the world taking full advantage of various international conferences on surveying, mapping and related fields such as the UN Regional Cartographic Conferences

and congresses of the ISPRS and ICA. At the same time a detailed plan to develop Global Map, including contents of Global Map and a strategy to implement the plan, were developed. As a result, the Global Map concept turned into Global Mapping Project. As a first step in the implementation of the project, the International Steering Committee for Global Mapping (ISCGM) was established in February 1996 to realize and enhance the Global Mapping Project. Currently ISCGM has 20 members, 2 advisors and 11 representatives of liaison organizations. ISCGM is chaired by one of the authors of this paper, Professor D. R. F. Taylor, Carleton University, Canada. Other Members are the heads of NMOs of Australia, Bangladesh, Canada, China, France, India, Iran, Japan, Kenya, the Republic of Korea, Malaysia, Mexico, New Zealand, Niger, South Africa, the United Kingdom, the U.S.A., and representatives from the Scientific Committee on Antarctic Research (SCAR) and EuroGeographics. Liaison organizations include very influential international organizations and academic institutions in the field of surveying and mapping. The Geographical Survey Institute of Japan (GSI) has taken the secretarial role for ISCGM since its establishment.

The Global Mapping Project is a voluntary based international collaborative activity, and complete coverage of the Global Map can only be realized with the participation of all the NMOs of the world. Therefore, in November 1998, the UN sent the heads of NMOs of respective countries and regions a letter from Professor John Estes, Chair of ISCGM at that time, with a letter of recommendation from the UN Statistics Division inviting them to participate in the Global Mapping Project. In addition, ISCGM prepared the specifications for Global Map.

2.1.3 Implementation of the project

In principle, participating countries are to prepare Global Map coverage for their own countries. Some countries, however, may have difficulty in developing digital geographic data by themselves. Therefore, Global Mapping involves three levels of participation from which individual MNOs may choose. Level A countries not only provide their own data but also help the development of Global Map data for Level C countries from source materials (such as paper maps) provided by those countries. Level B countries create their own national coverage.

Participation in Global Mapping is achieved by submitting the application form to the Chair of ISCGM. Participating NMOs must agree to develop Global Map coverage for their countries depending upon the level of participation chosen and to make the data freely available for non-commercial purposes. The ISCGM secretariat prepares the data and the server for downloading Global Map data through the Internet.

The benefits of participation in Global Mapping for NMOs include: (1) Joining the world community of surveying and mapping organizations will facilitate the acquisition of the latest information and knowledge of digital geographic data development and service; it would also facilitate helping to raise the status of the organization by active participation in international activities and the contribution to sustainable development, which is the final goal of the Global Mapping Project; (2) It increases the possibilities for capacity building through activities such as the Global Mapping training course and the Global Mapping Seminar; (3) Two major GIS software vendors fund grant programs. The recipient must be NMOs that are participating in the Global Mapping Project.

When ISCGM was created in 1996, it was decided to develop Global Map by the year 2000 using existing global datasets such as GTOPO30 (elevation), GLCC (land cover) and VMap0. This initial target was attained. At the World Summit on Sustainable Development (WSSD) held in 2002 in South Africa, Global Mapping was registered as a Type 2 initiative with the goal of completion of global coverage by the year

2007. Although the target is to complete global coverage by 2007, revision of Global Map is an ongoing continuing process.

2.2 Use of Global Map

It is anticipated that Global Map will be used in various fields to help to attain sustainable development. For example, sustainable natural resource control and water resource control are fields where Global Map can be used effectively in combination with other socio-economic data. In these fields, several layers of Global Map such as transportation, rivers, elevation and land cover play a key role for modeling or simulating phenomena or processes. Modeling of the destruction of mangrove forests and the prediction of river flows of international rivers are themes which have already been studied using Global Map (Chang et al., 2001).

Global Map, which should be maintained regularly, can also be used effectively to monitor environmental changes of the land surface such as deforestation and desertification by comparing data from different years.

2.3 The Present Status of Global Mapping

2.3.1 Participation and data development

Currently (May 2005) 143 countries and regions that correspond to 87% of land area of the Earth are participating in the project (Figure 1). Global Map coverage of 20 countries has been completed and is downloadable from the ISCGM website at http://www.iscgm.org/. This corresponds to 13 % of the World's land surface. This figure may seem small considering that 2007 is the target year for completion of the entire dataset. The Secretariat of ISCGM, however, has already received Global Map data from more than 68 countries and regions and these are under verification at the secretariat. If these data are added, Global Map coverage has been achieved for more than 50 % of World's land surface.

2.3.2 Coordination of the project

ISCGM meeting has met 12 times since its establishment in order to coordinate various issues arising from the actual implementation of the project and to refine the project in response to social, economical and technological changes in international society. ISCGM has four working groups to deal with specific issues such as long term strategic planning, data policy, and the updating technical specifications. A Major item being dealt by the technical specifications working group is to modernize the present format of Global Map to meet requirements of Web based map services.

A recent typical example of ISCGM's activity to refine the project in the light of international changes is found in the area of global earth observation. The importance of coordinated global earth observations has been widely recognized since Evian Summit held in 2003. After the Evian Summit, the Earth Observation Summit was held in 31st July 2003 and an ad-hoc Group on Earth Observation (GEO) was organized as its working group. The ten year implementation plan of GEOSS (Global Earth Observation System of Systems) was adopted after two years intensive discussion among more than 50 countries and 40 international organizations. Recognizing the importance of global geographic framework data in earth observations as a basis of integrating various earth observation data with other socio-economic data, ISCGM has been involved in GEO activities as a participating organization since April 2004 and the Global Mapping Project was identified as an important initiative in the reference document of the 10-year implementation plan.

2.3.3 Capacity Building on Global Map data development

Several capacity building programs have been conducted as part of the project.

2.3.3.1 The Group Training Course on Global Mapping

GSI has been conducting JICA group training courses on Global Mapping for technology transfer to developing countries. The lecturers for the course are specialists from the environmental, cartographic and surveying fields. The curriculum of the course includes the significance of Global Mapping, the structure and production methods for Global Map data, and both basic and advanced knowledge of related fields. The course is composed of lectures, fieldtrips and practice. It is about two and half months long, and 5 - 8 participants attend this course every year. The Global Mapping course has accepted 67 participants from 36 countries in the nine years from 1994 to 2004.

The practical objective is to develop the prototype of a country's Global Map using source data brought by participants from each nation As this exercise is conducted by the technical contact person in the Secretariat of ISCGM, this helps to strengthen mutual communication, and, of course, develops practical knowledge.

2.3.3.2 The Global Mapping Partnership Program (GMPP)

The Ministry of Land, Infrastructure and Transport (MLIT), Government of Japan established the "Global Mapping Partnership Program (GMPP)" to further strengthen partnerships, especially with developing countries, and to promote Global Mapping activities. The Global Mapping Seminars are the most visible example of activities of the GMPP in terms of capacity building, as they provide a technical transfer opportunity for Global Mapping. So far, the seminar has been jointly organized by MLIT, ISCGM, the Japan International Cooperation Agency (JICA) and local mapping-related organizations and has been held three times in 2002, 2003 and 2004.

Figure 2. Group Training Course in GSI (left) and Second Global Mapping Seminar in Nairobi (right)

2.3.3.3 The grant programs on Global Mapping by GIS vendors
ESRI offers a grant program for NMOs participating in the Global Mapping Project in which they receive one set of ArcGIS software and training. This grant is very helpful in the implementation of the project because it provides participating countries with a tool for developing their Global Map. A similar grant program from Intergraph is currently being implemented.

2.3.4 Data provision system
At present, based on the agreement for the data release, anyone, after registration, can download Global Map data of 20 countries freely through the Internet and use them for non-commercial purposes. The download site is currently operated in a style of transferring archived data files. Therefore, users cannot see the data contents before they download the data, extract data files from the archived file, and start the data viewer software or their own GIS software that can handle VPF format on which Global Map is based. Data provision in this style is not user friendly when web mapping technology is widely available. The tenth ISCGM meeting agreed to make the Global Map data available by Web mapping technology in order to enhance the accessibility and usability of Global Map data. The secretariat is now creating a Web portal for Global Map which is expected to be available soon.

3. ROLE OF GLOBAL MAP IN ESTABLISHING SDIs

3.1 Establishing an NSDI
Through participation and data development in the Global Mapping Project, a participating organization can build some of the components required for establishing an NSDI. First of all, an NMO can create small-scale framework data (Global Map of the country concerned). Secondly, human resources to deal with geo-information are produced through the development of Global Map and the various kinds of training conducted during the Global Map development. They become familiar with standardization issues in geo-information as Global Map utilizes the results of standardization efforts by ISO/TC211 and OGC in developing its specifications wherever possible. Thirdly, although this might be an issue in future, through the use of Global Map, participating organizations can gain experience in the legal and policy aspects of geo-information. Finally, each of these components are sustainable as by joining the Global Mapping project organizations become part a network of NMOs.

In developing an NSDI more complex issues than those in the development of Global Map emerge. However, the necessary components are there for the participating organization. In order to create an NSDI through the experience of developing Global Map, NMOs must address the following issues in cooperation with various organizations in the country concerned with geo-information in the country.

- The preparation of framework data at larger scale than 1:1,000,000
- The coordination of organizations in the country dealing with geo-information through efforts to enhance the use of Global Map for sustainable development in that country
- The continuous participation in international projects or activities in order to keep up with technological progress in this field

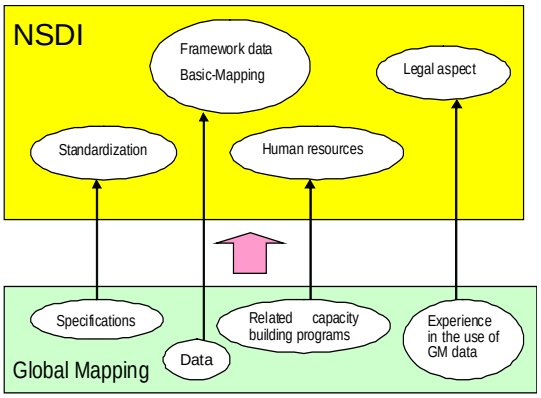

Figure 3. From Global Mapping to establishment of NSDI

3.2 Establishing RSDIs

Experience in Global Mapping helps regions to establish their RSDIs. In the Latin America region, there is a movement to develop seamless framework data covering the continent based on the Global Map of the region. A similar effort is underway in the Asia and the Pacific region under PCGIAP.

ISCGM, since its establishment, has tried to disseminate information on the importance of Global Map using various meetings of intergovernmental, UN related, and academic fora with no specific intention to help establishing NSDIs and RSDIs. However, ISCGM's activities seem to have contributed to increasing the understanding of the importance of SDIs at various scales among the world community of NMOs and to present an actual implementation model of a SDI at the global scale.

4. THE FUTURE OF SDIS AND GLOBAL MAP

In the previous section, NSDIs and RSDIs were considered from a Global Map point of view. These are also indispensable for Global Map. For example, there has been an effort to prepare regional framework data of Europe, first as MapBSR Project dealing with only the Baltic Sea Region which was completely independent of Global Map. Later this became EuroGlobalMap, which is indispensable for Global Map as the European contribution to the Global Mapping Project.

This kind of interrelationship should be for the following reasons:

- Improvement of sustainability in geo-information field
  The target for the completion of Global Map is the year 2007. After completion, it should be updated regularly so that global environment change can be properly monitored. Proper maintenance of SDIs is necessary to meet their original purposes as well. This interrelationship can help the maintenance of both SDIs and Global Map as the requirements are similar.
- Visible contribution to environment issues and sustainable development
  The original purpose of Global Map is to contribute the solution of global environmental issues and attaining sustainable development. However, the scale of Global Map is too small when looking at national environmental issues rather than regional and global ones. By combining framework data of NSDIs and RSDIs, Global Map can be used for many more purposes than originally anticipated. Global Map can also be useful for comparison with other areas and understanding national or regional issues in a global perspective.

- Improvement of visibility of geo-information in other fields
  Geo-information continues to be very important for the future of society. However, geo-information is often invisible and under appreciated to people in other fields. In order to solve such a situation, geo-information should be highlighted in other fields, especially those which will have great influence on society such as IT and global earth observation. Global Map and SDIs will both be useful for this purpose

5. CONCLUSION

Present status of Global Mapping Project is described. Its contribution to establishing NSDIs and RSDIs has also been analyzed. It is also described that Global Map requires established SDIs for its sustainability. This kind of interrelationship is indispensable both for the future of Global Map and SDIs and for the field of geo-information in general.

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