Application of the Global Map Data for Global Issues

N. Kishimoto, Y. Fukushima, K. Otoi, T. Nakamura, H. Takahashi, S. Oomiya, S. Kojima, and M. Yoshikawa,

Geospatial Information Authority of Japan, 1 Kitasato Tsukuba Ibaraki 305-0811 Japan, n-kishimoto@gsi.go.jp

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ABSTRACT:
The Global Map version 1, which includes the data of Global Land Cover and Vegetation (Percent Tree Cover) developed using MODIS data of 1km resolution in 2003 as primary source data, was released in 2008. Since then, application cases of Global Map (GM) data as follows have been increasing.
a) Use for GHG Inventory: Land Cover data of GM can be used for the estimation of emissions and removals of Greenhouse Gases (GHGs) and its cross check in developing countries, in reporting GHG inventory for Land Use, Land-Use Change and Forestry (LULUCF) sector to UNFCCC. b) Use for Flood Analysis: Land Cover and Elevation data of GM are used for runoff analysis in Integrated Flood Analysis System (IFAS). c) Use for relationship analysis between population, water and tree: Vegetation data of GM is used to analyze these relationships with the combination of Gridded Population density and rainfall data. d) Use for forest change: Vegetation data of GM is used to grasp the forest distribution and its area in the world. e) Use for disaster mitigation: GM data is used as maps, which show geographic features of disaster hit-area in the event of natural disaster to avoid second disaster and aid victims.

1. Introduction

The Global Mapping Project is an effort in which National Mapping Organizations (NMOs) from 180 countries and regions of the world develop Global Map (GM) through international cooperation. The objectives of the project are to contribute to solving global environmental problems and achieving sustainable development. GM is digital geographic dataset of the whole globe which consists of eight thematic layers: boundaries, drainage, population centers, transportation, elevation, land use, land cover and vegetation, and to be updated every five years.

The GM version 1, which includes the data of Global Land Cover and Vegetation (Percent Tree Cover) was released in 2008. Global Land Cover and Vegetation data are developed with the cooperation of Geospatial Information Authority of Japan, Chiba University and collaborating NMOs which provide ground truth data and verified data. The GM data developed in consistent specifications enables us to compare the status of the environment globally and chronologically.

Since the release of Global Land Cover and Vegetation data, application cases of GM data have been increasing. This paper introduces main application cases of GM especially Global Land Cover and Vegetation data at the present stage.
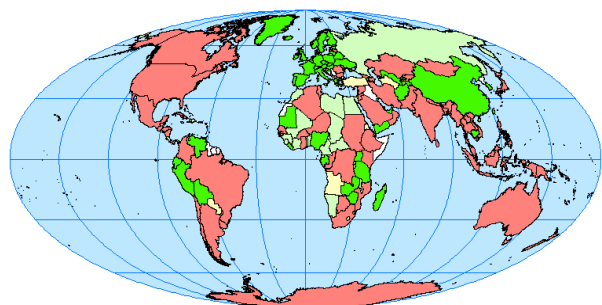
Legend
- data available
- data for verification
- developing data
- considering joining the project
- not participating in the project

	Countries and Regions	Area ratio (%)	Population ratio (%)
Available	75	59.9	52.5
Verification	62	19.1	38.2
Developing	43	17.6	6.5
Total	180	96.6	97.2

Figure 1, Status of Participating countries

2. GM Land Cover Data

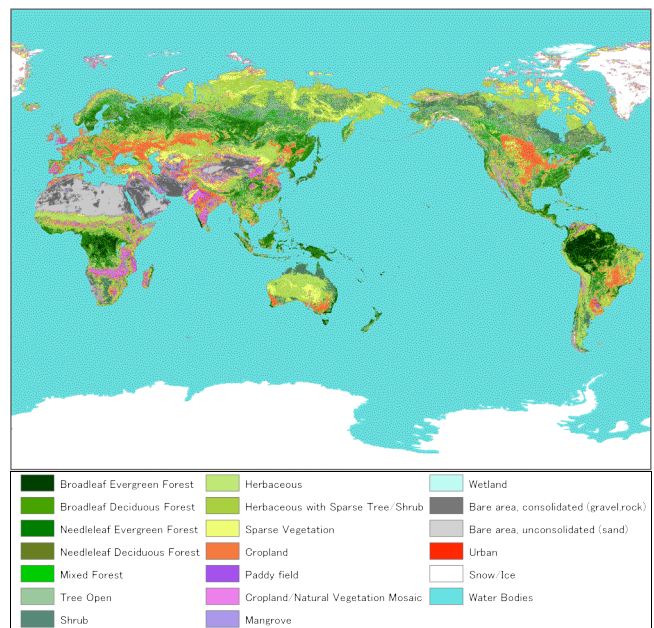| Broadleaf Evergreen Forest	Herbaceous	Wetland
Broadleaf Deciduous Forest	Herbaceous with Sparse Tree/Shrub	Bare area, consolidated (gravel.rock)
Needleleaf Evergreen Forest	Sparse Vegetation	Bare area, unconsolidated (sand)
Needleleaf Deciduous Forest	Cropland	Urban
Mixed Forest	Paddy field	Snow/Ice
Tree Open	Cropland/Natural Vegetation Mosaic	Water Bodies
Shrub	Mangrove	

Figure 2, Global Land Cover Data of Global Map

Data Design of GM Land Cover Data is in accordance with Global Map Specifications and its main points are as follows,
- Grid cells are arrayed on a horizontal coordinate system in degrees of latitude and longitude referenced to ITRF94 and GRS80
- Cell size is 30 arc-seconds by 30 arc-seconds
- 20 classes are defined as shown in figure 2, using Land Cover Classification System (LCCS) developed by Food and Agriculture Organization (FAO)

Data sources are as follows,
- MODIS data in 2003, which is 7-band, 1-km resolution and eight periods of 16-day composite is used as primary source data
- Training Data of 1607 polygons for supervised classifications are collected from Landsat images, MODIS NDVI seasonal change patterns, NMO's comments on the reference of satellite images and regional maps

Classification method is as follows,
- 14 out of 20 categories are developed using Supervised classification
- 6 categories which are urban, tree open, mangrove, wetland, snow/ice and water bodies are classified independently

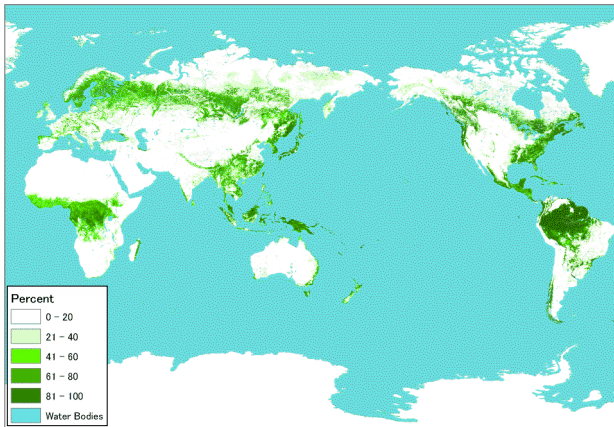## 3. GM Vegetation (Percent Tree Cover) Data

Figure 3, Global Vegetation Data of Global Map

Data design of GM Vegetation data in accordance with GM Specifications is as follows
- Coordinate system and cell size are same as Land Cover data.
- Value range is from 0% to 100% with interval of 1 %
- The data shows the ratio of the area covered with branches and leaves of trees (tree canopy) to the ground surface seen from the above (vertical direction).

Data Sources are as follows
- 16-day composite MODIS data in 2003 is used
- Training data from 221 satellite images are used

Classification method is as follows
- Regression decision tree method is used
- Tree is defined as a woody perennial with a single main stem or in the case of coppice with several stems, having more or less a definite crown
- Height threshold value of tree is approximate 3-5 meters at minimum
- Bamboos and palms are included in the definition of tree and shrub and grasses are not included

4. Application Cases

4.1 Use for GHG Inventory

4.1.1 GHG Inventory in UNFCCC and LULUCF sector
GM has features such as Global Coverage, consistent Specifications and five-year update. The GM data with these features encourage us to make a comparison of the status of the environment globally and chronologically. In addition to this comparability, usability derived from open data policy of GM and reliability of GM authorized by each government make GM data easy to use for environmental issues.

In particular GM might be able to contribute to policy making processes in climate change field, because forest and land management through GIS and remote sensing are becoming

important to keep terrestrial carbon accounting in both developed and developing countries in United Nations Framework Convention on Climate Change (UNFCCC) processes.

Based on UNFCCC and Kyoto Protocol to the UNFCCC, contracting parties have obligation to submit their national inventories concerning emissions and removals of GHGs to Conference of the Parties (COP) to the UNFCCC through UNFCCC Secretariat. For Annex I countries, it is required to submit their GHG inventories every year, and for non-Annex I countries it is required once every four or five years.

In GHG inventories, calculation of emissions and removals of GHGs from Land use, Land-use Change and Forestry (LULUCF) sector is required based on areas of 6 land use categories. GM Land Cover data is expected to use for this area calculation.

GM Land Cover data is described as an example of international land use dataset in the "Intergovernmental Panel on Climate Change (IPCC) Good Practice Guidance for LULUCF" and "2006 IPCC Guidelines for National Greenhouse Gas Inventories" for National GHG Inventory.

4.1.2 GM Application Example into LULUCF sector
Developed countries can calculate emissions and removals of GHGs by themselves. However developing countries, which do not have sufficient statistical data and detailed geographic information on land use and land cover, are not able to improve their GHGs inventories.

In these cases, GM Land Cover data can be used for area calculation to estimate emissions and removals of GHGs and its cross check. Following is the procedure using GM Land Cover data.
1. Calculate each area of 20 categories of GM Land Cover
2. Estimate emissions and removals of GHGs for 20 categories of GM Land Cover
3. Integrate the amount of GHGs into LULUCF 6 categories

Global Map Land Cover 20 categories	→	LULUCF 6 land use categories
Broadleaf Evergreen Forest	----	Forest Land
Broadleaf Deciduous Forest	----	
Needleleaf Evergreen Forest	----	
Needleleaf Deciduous Forest	----	
Mixed Forest	----	
Tree Open	----	
Mangrove	----	
Shrub	----	
Herbaceous	----	Grass Land
Herbaceous with Sparse Tree / Shrub	----	
Sparse Vegetation	----	
Cropland	----	Cropland
Paddy field	----	
Cropland/Other Vegetation Mosaic	----	
Wetland		Wetlands
Urban		Settlements
Bare area, consolidated (gravel, rock)	----	Other Land
Bare area, unconsolidated (sand)	----	
Snow/Ice		
Water Bodies		

Table 1, Examples of integration of 20 categories of GM Land Cover data into 6 land use categories of LULUCF

4.2. Use for Flood Analysis

GM data is used in Integrated Flood Analysis System (IFAS) developed by International Center for Water Hazard and Risk Management (ICHARM), Public Works Research Institute (PWRI). Main objective of IFAS is to reduce flood damages in developing countries which are lacking hydrological information.

In addition to satellite-based and ground-based rainfall data, GM data is used for runoff analysis as follows,
➤ Land Cover data of GM is used for setting parameters such as roughness, surface permeability, soil permeability, soil thickness and rock permeability in combination with other data such as soil and geological data.
➤ Elevation data of GM is used for developing channel network and basin shape.
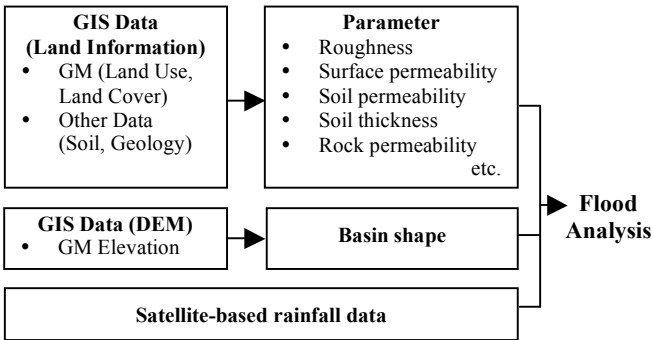
Table 2, Flow of Flood Analysis in IFAS

4.3. Use for relationship analysis between population, water and tree

Figure 4 is a composite map using GM Vegetation data, Gridded Population of the World and Annual precipitation data. The map represents the relationship between tree cover, population density and rainfall. Population density is assigned with red strength, tree cover is assigned with green strength, yearly precipitation is assigned with blue strength and then these RGB colors are combined.

The reddish area has a large population; the greenish area has high tree cover rate; and the bluish area has a lot of rainfall. For example, cyan or light blue areas have a lot of annual precipitation and high percent tree cover, but low population density. These areas predominate around the equator.
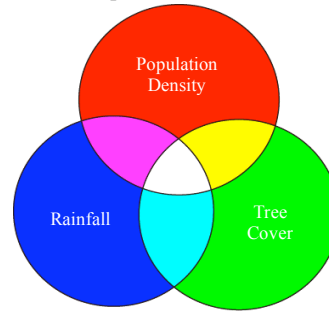
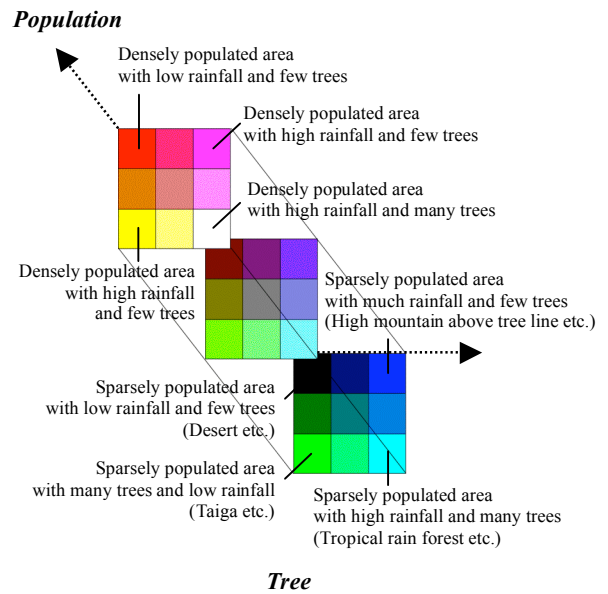Figure 5, Conceptual Diagram of RGB Composite

Figure 6, Color sample of RGB Composite Map of GM Vegetation, gridded population and annual precipitation
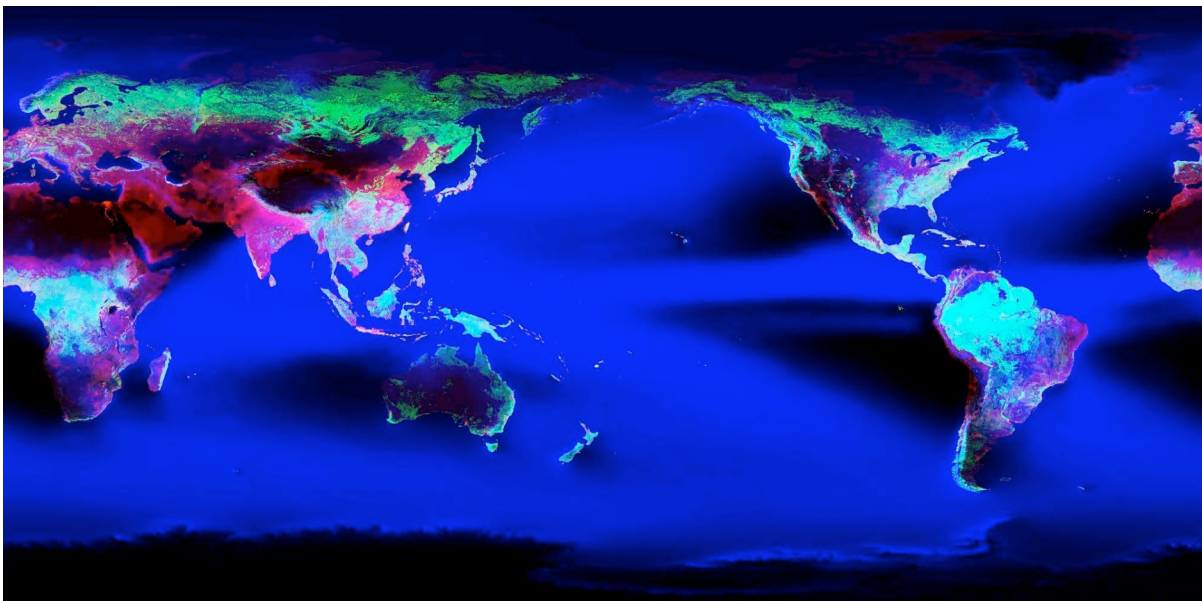
Figure 4, RGB Composite Map of GM Vegetation, gridded population and annual precipitation

4.4. Use for Forest Change

Figure 7 shows Annual Change Rate of Forest area from 2000 to 2005. This is developed with the combination of Percent Tree Cover of GM and FAO statistics: Change in extent of forest and other wooded land 1990-2005.

➢ In the reddish area, forest area decreased by more than 0.5% annually.
➢ In the bluish area, it increased by more than 0.5%.
➢ In the greenish area, the change rate is less than 0.5%.

For each color, the denser the color is, the higher the Percent Tree Cover is.

Nowadays in the field of climate change, Reducing Emissions from Deforestation and Forest Degradation in Developing countries (REDD) has become one of the most important issue. This figure can be used to identify the areas which are needed to be preferentially-taken countermeasures by combining with other statistical data. Also, it helps people who are not experts in the environmental field understand and think of the global environment.

This map appeared in "Annual report on the Environment in Japan" as well as in the report for elementary or junior-high school students.

4.5. Use for Disaster Mitigation

To avoid secondary disaster and aid victims efficiently in the event of a natural disaster, Geospatial Information Authority of Japan (GSI) develops maps using GM data which show geographic features of disaster hit area.

These maps are distributed to all over the world through the internet such as the Relief Web (www.reliefweb.int) of United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA). It is posted on the GSI and ISCGM website, too.
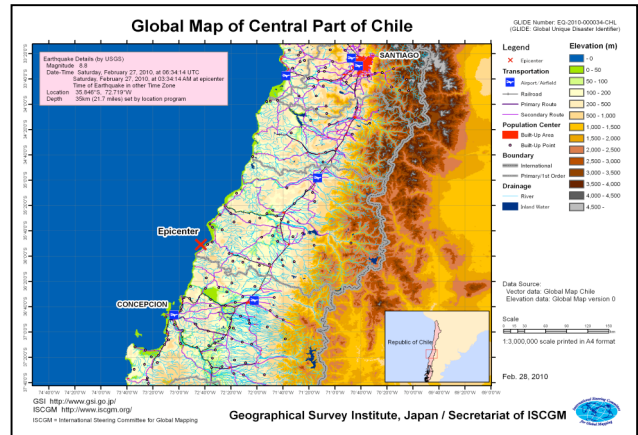

Figure 8, Map developed in Chili Earthquake, February

5. Future Prospects

Global Land Cover and Vegetation data of GM Version 2 are being developed using satellite images of MODIS in 2008 and it will they released around 2013. Further uses of GM data into various fields including climate change and natural disaster are expected in the future.

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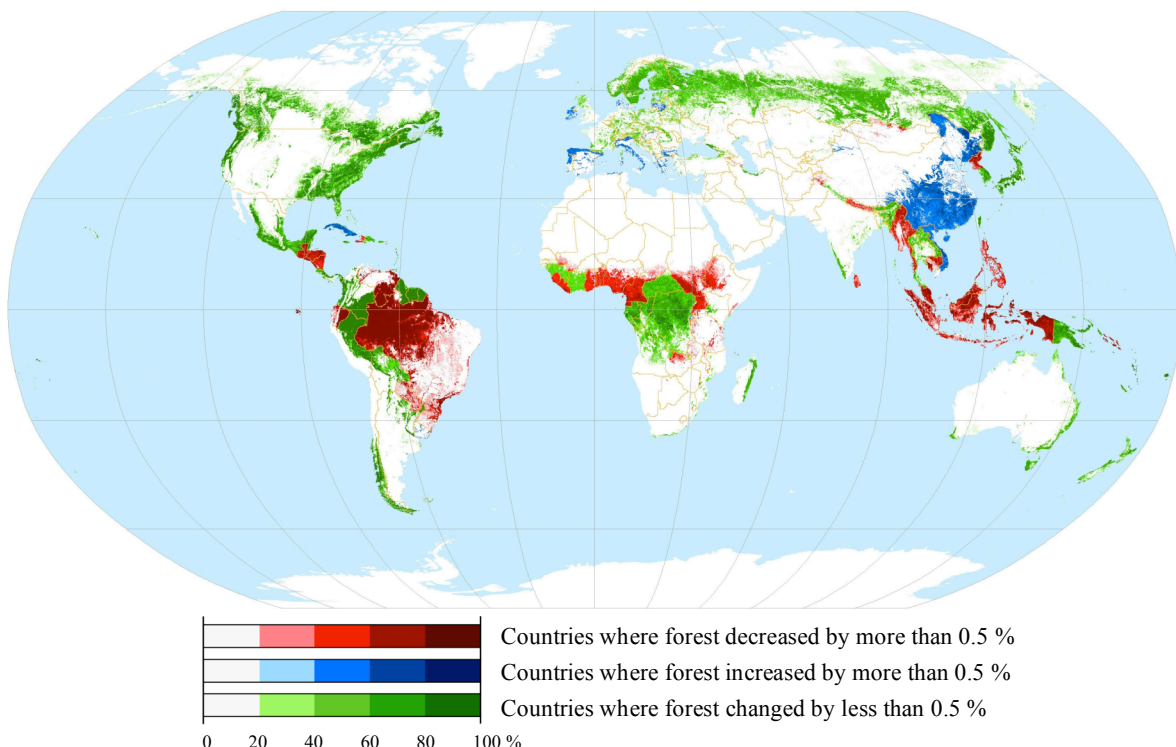

Figure 7, Annual Change Rate of Forest Area (2000-2005)

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(All website above are accessed 31 May 2010)