

# Global Land Cover Mapping

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# **Needs of global land cover information**

Land cover mapping

Land cover change mapping

- **For global change studies**
- **For regional land use planning and management**

# Needs of land cover information in environmental studies

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## academic field

## models

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Atmospheric  
circulation

BATS model (Dickinson et al., 1986)  
SiB model (Dorman and Sellers, 1989)  
SiB2 model (Sellers et al., 1996)

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Water circulation

global water budget (Oki, 1995)

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Biogeochemical  
circulation

CASA model (Potter et al., 1993)  
estimate of global nitrogen storage (Lin et al., 1999)

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Land degradation

estimate of soil loss (Nam et al., 2000)

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Land cover change

IMAGE2.0 model (Alcamo et al., 1994)

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# Three factors for successful global land cover mapping

Land cover classification system

Land cover ground truth

Information extraction from satellite images

# Land cover classification system

(present situation)

Project oriented

(challenge)

Harmonization

global-regional-local

users

# Land cover ground truth

(present situation)

Project oriented

(challenge)

Cooperative development  
for common use

# Information extraction from satellite images

(present situation)

Increasing information

multi-spectral,

SAR, polarization,

multi-temporal, time-series,

directional reflectance,

vegetation canopy lidar

(challenge)

combination of satellite information

# Comparison of MODIS, VEGETATION, and GLI

Land cover classification system

M: IGBP/DIS

V: Stibig's classification system based  
on LCCS (FAO)

G: Modified Stibig's classification system



# Comparison of MODIS, VEGETATION, and GLI

Land cover ground truth

M: Visual interpretation of Landsat TM

V: No concern

→ proposing the development of  
ground truth database

G: Ground truth database by GLI Land PI

# Comparison of MODIS, VEGETATION, and GLI

Information extraction from satellite images

M: ---

V: any method with written description  
of the methodology

G: decision tree method  
(decision criteria will be determined  
using ground truth data)

# For successful global land cover change mapping

(present situation)

comparison of pixel-wise classified results  
of different years

(challenge)

sub-pixel area % of a few basic land cover  
types

comparison of sub-pixel area % of different  
years

**Proposal of standard land  
cover classification system**

**&**

**Development of global land  
cover ground truth database**

# Existing classification systems

purpose	classification system (CS)
Land cover	Running CS (Running et al., 1994) IGBP-DIS CS (Belward ed., 1996) ***
LC/LU	IGU CS (van Valkenburg, 1950) LCCS (FAO, 2000) GLC2000 CS (Stibig, 2001) ***
Biogeochemical studies	Olson CS (Olson et al., 1983)
Vegetation ecology	C3 / C4 vegetation CS (Ito and Oikawa, 1999)
geobotany	Küchler CS (Küchler, 1949, 1983) Walter CS (Walter and Box, 1976) Schmithüsen CS (Schmithüsen, 1976)

# **Present situation of classification system(CS)**

**1) for global biophysical studies**

**IGBP-DIS CS is accepted**

**2) for social environmental (land use)  
studies**

**no proposal of land use CS from LUCC**

**3) for regional land management**

**no harmonized CS among nations**

**4) Duplicated information in LC and LU**

# **Strategy for the standard classification system**

- adoption Land Cover Classification System (LCCS) by FAO
- modification of GLC2000 CS (by Stibig)
- harmonization with IGBP-DIS CS
- inclusion of land use class

# **LCCS by FAO**

- hierarchical structure
- capability to choose various legend by the software
- inclusion of the classification of LC, LU, vegetation
- Scientific Steering Committee decided to examine the usefulness of LCCS (McConnell, 2001)



# **GLC2000 classification system by Stibig**

- GLC2000 project:

- JRC (Joint Research Center) of EU
  - global land cover mapping by  
SPOT/VEGETATION

- legend of 107 classes based on LCCS

# GLC2000 classification system (1)

## Vegetated Areas

### Terrestrial

Cultivated & Managed Terrestrial

Natural & Semi-natural Terrestrial

Woody (7- 2 m)

Trees (>30 - 3 m)

Shrubs (5 - 0.3 m)

Herbaceous (0.3 - 0.03 m)

Lichens / Mosses

### Aquatic or Regularly Flooded

Cultivated Aquatic or Regularly Flooded

Natural & Semi-natural Aquatic or Regularly Flooded

(ditto, without "Lichens / Mosses")

(sub-classes on Vegetation Structure, Leaf Type, and Leaf Longevity, and secondary layer of vegetation, and flooded duration are included)

# GLC2000 classification system(2)

## Non-vegetated Areas

### Terrestrial

#### Artificial Surfaces and Associated Bare

##### Consolidated

Bare Rock

Hardpan

##### Unconsolidated

Bare Soil

Loose & Shifting Sand

### Aquatic or Regularly Flooded

#### Artificial Water bodies, Snow & Ice

#### Natural Water bodies, Snow & Ice

Water

Snow

Ice

# **IGBP-DIS classification system**

## **17 classes**

Evergreen needleleaf forest  
Evergreen broadleaf forest  
Deciduous needleleaf forest  
Deciduous broadleaf forest  
Mixed forest  
Closed shrublands  
Open shrublands  
Woody savannas  
Savannas  
Grasslands  
Permanent wetlands  
Croplands  
Urban and built-up  
Cropland/Natural vegetation mosaic  
Snow and ice  
Barren or sparsely vegetated  
Water bodies

## **Inclusion of Crop list**

- include 65 crops with world area coverage of more than one million ha in 2000 by FAOSTAT**
- classification of crops can be used for food management or national land planning**
- easier ground truth collection for crops names than for leaf type or leaf longevity**
- leaf type or leaf longevity can be known from crop name**

# Proposed classification system (1)

## Vegetated Areas

### Terrestrial

#### Cultivated & Managed Terrestrial

##### Single crop/Multiple crop

Tree/Shrub/Herbaceous crop [#1 - 8]

( when crop name is identified, one of #101 –165  
is assigned )

#### Natural & Semi-natural Terrestrial

##### Closed/Closed to open/Open/Sparse

Trees (>30 - 3 m) [#9 – 21]

Shrubs (5 - 0.3 m) [#22 - 34]

##### Closed to open/Sparse

Herbaceous (0.3 - 0.03 m) [#35 - 38]

##### Closed to open

Lichens / Mosses [#39]

# Proposed classification system (2)

## Vegetated Areas

### Aquatic or Regularly Flooded

#### Cultivated Aquatic or Regularly Flooded

Rice [#40]

Other aquatic crops [#41]

#### Natural & Semi-natural Aquatic or Regularly Flooded

Flooded > 4 months

Tree, Shrub [#42, 43]

Flooded > 4 months and Waterlogged

Herbaceous [#44]

# Proposed classification system (3)

## Non-vegetated Areas

### Terrestrial

Artificial Surfaces and Associated Areas [#45]

Bare Areas [#46]

Consolidated [#47]

Unconsolidated [#48]

### Aquatic or Regularly Flooded

Artificial Water bodies, Snow & Ice [#49]

Natural Water bodies, Snow & Ice

Water [#50]

Snow & Ice [#51]

Snow [#52]

Ice [#53]



# **Features of the proposed classification system**

- **Applicable to global biophysical environmental studies**  
**convertible to IGBP-DIS CS**
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- 2) Applicable to a part of social environmental studies though agricultural information**
  - 3) Applicable to any map scale**

## **Further challenges of the proposed classification system**

- need to examine the feasibility of ground truth collection for each class
- still lack of a part of land use information

# Development of global land cover ground truth database (1)

Land cover ground truth

two layers of raster type data

1<sup>st</sup> layer: land cover code

2<sup>nd</sup> layer: ground truth site No.

with description of information  
source

(optional)

3<sup>rd</sup> layer: other information

# Development of global land cover ground truth database (2)

Reference coordinate system

ITRF94 coordinate system +GRS ellipsoid  
which is almost same as WGS 84

Grid in latitude/longitude

Multi resolution

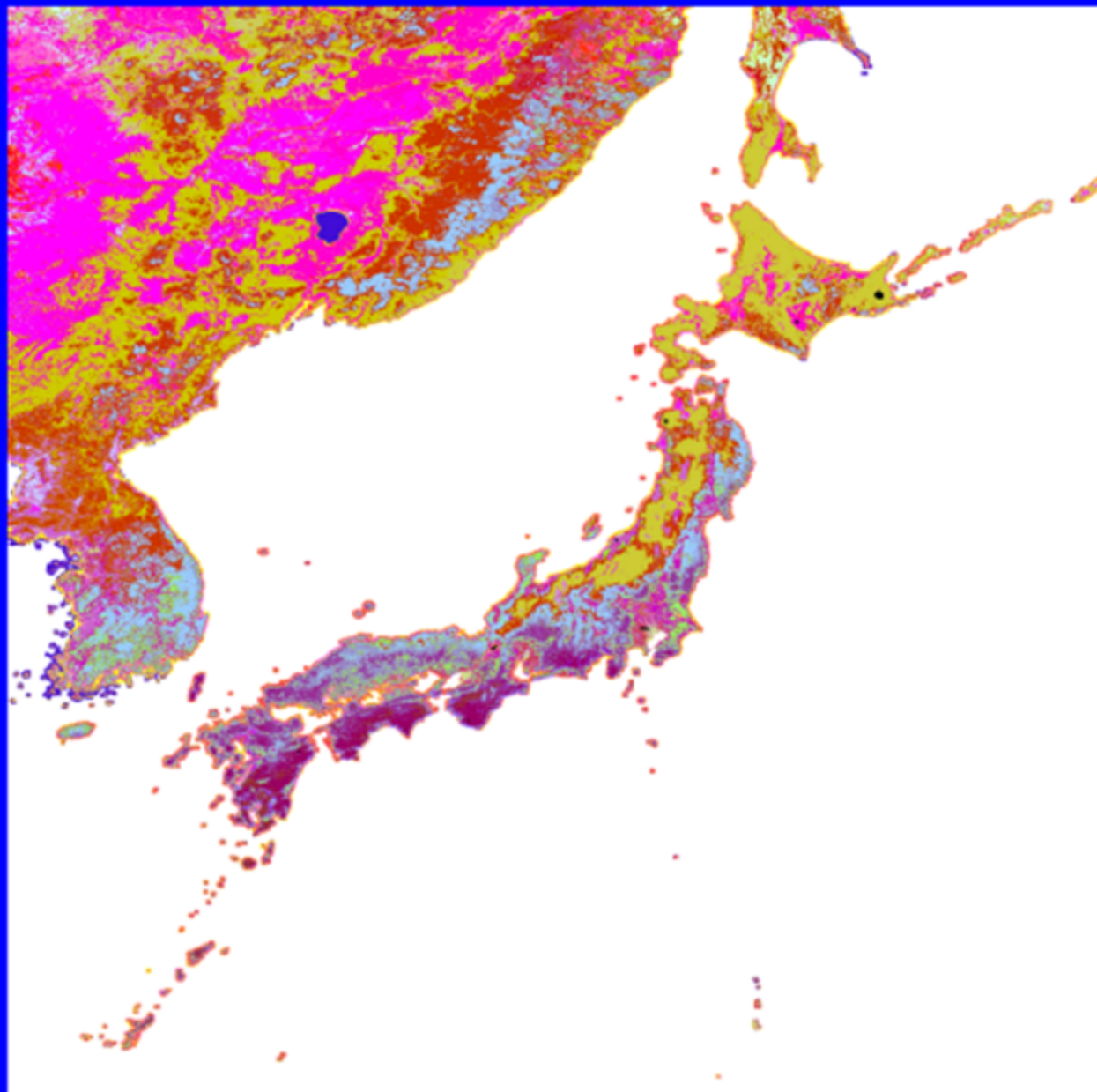
30, 15, 10, 6, 5, 3 arc second(others possible)

# Land cover ground truth

Two layers

-- Land cover code

--Site No.



# Land cover ground truth

Two layers

-- Land cover code

--Site No.



# Land Cover Ground Truth (Japan)

Site No.	Location (lat/long)	Land Cover Code	Land Cover	Information Source
1	N43d5' E144d22'	81	Wetland	Land use map 1:200,000, 1982 By Geographical Survey Institute, Japan + Knowledge (Tateishi)
2	N42d50' E143d5'	4	Agricultural land (Beet, potato, wheat)	Field survey (Hongo)
3	N40d30' E140d7'	7	Beech (Shirakami Mountain)	Land use map 1:200,000, 1982 By Geographical Survey Institute, Japan + Knowledge (Tateishi)
4	N43d18' E141d45'	1	Paddy(70%) and soybean(30%)	Land use map 1:200,000, 1982 By Geographical Survey Institute + Knowledge (Tateishi and Hongo)
5	N43d25' E145d	207	Pasture	Land use map 1:200,000, 1982 By Geographical Survey Institute, Japan + Knowledge (Hongo) + Landsat TM
6	N37d45' E138d55'	1	Paddy	Land use map 1:200,000, 1982 By Geographical Survey Institute, Japan + Knowledge (Tateishi)
7	N32d55' E131d40'	5	Evergreen Needleleaved forest	Land use map 1:200,000, 1982 By Geographical Survey Institute, Japan + Knowledge (Tateishi)
8	N33d35.51' E134d7'	7	Broadleaved deciduous forest	Landsat TM, May 31, 1989 + Land use map 1:200,000, 1982 By Geographical Survey Institute, Japan
9	N33d29' E134d8'	5	Evergreen Needleleaved forest	Land use map 1:200,000, 1982 By Geographical Survey Institute, Japan
10	N37d40' E139d6'	5	Evergreen Needleleaved forest	Landsat TM, June 16, 1985 + Land use map 1:200,000, 1982 By Geographical Survey Institute, Japan
11	N37d30' E139d15'	7	Broadleaved deciduous forest	Land use map 1:200,000, 1982 By Geographical Survey Institute, Japan