

## JAXA High Resolution Land-Use and Land-Cover Map

Masuo Takahashi<sup>\*1</sup>, Kenlo (Nishida) Nasahara<sup>2</sup>, Takeo Tadono<sup>1</sup>,  
Tomohiro Watanabe<sup>3</sup>, Masanori Dotsu<sup>3</sup>, Toshiro Sugimura<sup>3</sup> and Nobuhiro Tomiyama<sup>3</sup>

<sup>1</sup>Earth Observation Research Center, Japan Aerospace Exploration Agency  
2-1-1, Sengen, Tsukuba, Ibaraki 305-8505, Japan;  
Tel: +81(50) -3362-2129; Fax. +81(29) -868-2961  
E-mail: [takahashi.masuo@jaxa.jp](mailto:takahashi.masuo@jaxa.jp)

<sup>2</sup>Graduate School of Life and Environmental Sciences, University of Tsukuba  
1-1-1, Tennoudai, Tsukuba, Ibaraki 305-8572, Japan;  
Tel: +81(29) -853-4897; Fax. +81(29) -853-4897  
E-mail: [24dakenlo@gmail.com](mailto:24dakenlo@gmail.com)

<sup>3</sup>Remote Sensing Technology Center of Japan  
3-17-1, Toranomom, Minato-ku, Tokyo, 105-0001, Japan;  
Tel: +81(3) -6435-6700; Fax. +81(3) -5777-1580

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**Abstract:** Japan Aerospace Exploration Agency (JAXA) is creating the "JAXA High Resolution Land-Use and Land-Cover Map" using data from May 7, 2006, to April 17, 2011, acquired using the Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2), onboard the Advanced Land Observation Satellite ("Daichi"). The latest version of the map has been released on September 3, 2012. Ortho-rectification, atmospheric and slope correction are applied to the AVNIR-2 data. The classification categories are 1) water, 2) urban, 3) paddy, 4) crop, 5) grass, 6) deciduous forest, 7) evergreen forest, 8) bare land, and 9) snow and ice. The temporal classification accuracy was found to be 88.1%, which was calculated using the validated accuracy of the classification multiplied by the surface ratio in each category by the Ministry of International Affairs and Communication.

### 1. INTRODUCTION

Research on land-use and land-cover mapping using satellite imagery acquired by the earth observing satellites (EOS) and airborne sensors has had a long history. In addition to the capability of observing wide areas, EOS can also observe the same area repeatedly. Therefore, EOS data is very useful for the generation of land-use and land-cover maps that consider vegetation phenology.

The Earth Observation Research Center (EORC), Japan Aerospace Exploration Agency (JAXA) created a land-use and land-cover map of Japan, named the "JAXA High Resolution Land-Use and Land-Cover Map (JHR LULC Map)," using the data acquired by the Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2), which is onboard the Advanced Land Observation Satellite (ALOS, "Daichi"). In this study, we describe the data used, the method of classification, and the procedures for the validation of the JHR LULC Map (version 12.08 created on August and released on September, 2012). The version name was decided based on the digits of the year and month in which it was generated.

### 2. DATA USED IN GENERATING THE MAP

#### 2.1 ALOS Data

The input data from the ALOS for the JHR LULC Map version 12.08 used 2,143 scenes acquired for the entire area of Japan from May 7, 2006, to April 17, 2011, using the AVNIR-2, onboard the ALOS. For the regions affected by the Great East Japan Earthquake, the AVNIR-2 data used were those before the occurrence of the earthquake, i.e., before March 11, 2011. The images acquired using the AVNIR-2 were ortho-rectified to eliminate geographical distortions. In addition, atmospheric and slope corrections were applied in order to calculate the reflectance at ground level. Ortho-rectification was applied using a 50-m resolution digital elevation model (DEM) developed by the Geospatial Information Authority of Japan (GSI) and Geo Control Points (GCPs) that were acquired using the Panchromatic Remote-sensing Instrument for Stereo Mapping (PRISM) onboard ALOS and that are obtained by us during the field survey.

Atmospheric correction was applied using (1) the positions of the AVNIR-2 sensor and the sun when the ALOS was observed, (2) the amount of water vapor determined using objective analysis of the data of the National Centers for Environmental Prediction (NCEP) at the National Oceanic and Atmospheric Administration (NOAA) and Pstar2b, and (3) the atmospheric radiation transmission code developed and provided by the GOSAT OpenCLASTR project at the National Institute for Environmental Studies. Furthermore, as the observed radiance is different owing to the azimuth direction and the slope at ground level, slope correction was applied using the DEM and the solar position. The input data for this classification were the composite imageries acquired monthly as a degree tile, which are ortho-rectified and corrected for atmosphere and slope, such that the latitude and longitude are regardless of the year of the observation. A mosaic reflectance image of Japan, acquired using the AVNIR-2, and an enlarged reflectance image of Kanto district are shown in Figures 1 and 2, respectively. We are continually aiming to improve the geometric accuracy between each scene since version 12.02, released in March, 2012. The data used in version 12.08 decreased from 2,411 scenes used in the previous version, 12.02.

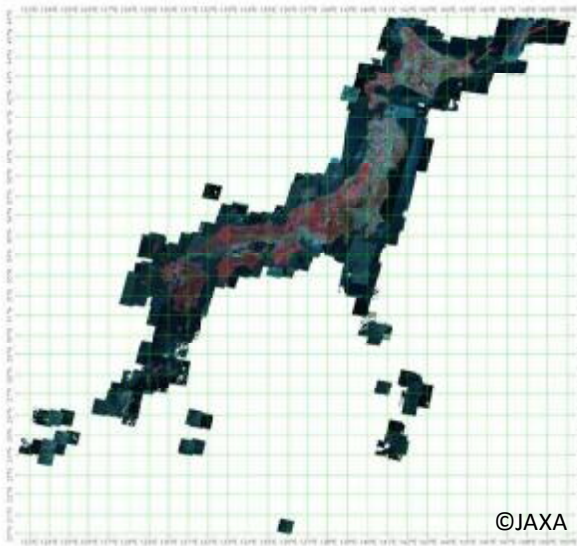


Figure 1 Mosaic reflectance image of Japan acquired using AVNIR-2 data

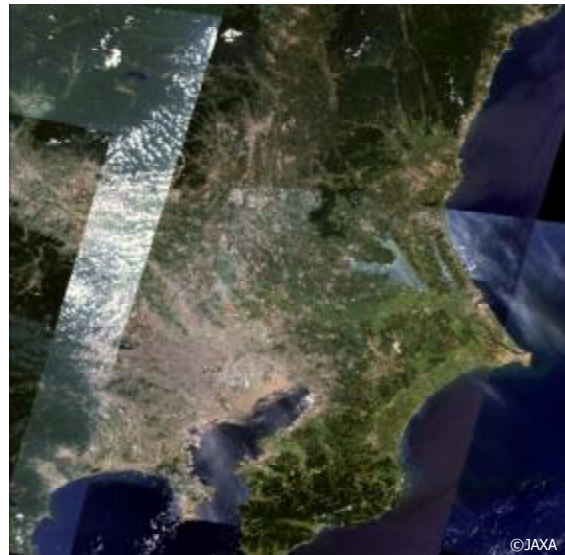


Figure 2 Enlarged reflectance image of Kanto district

## 2.2 Ancillary Data

The following ancillary data were used in the generation of the JHR LULC.

- Topographic information

50-m resolution DEM data developed by the GSI was used for ortho-rectification and slope correction. However, the data from the Shuttle Radar Topography Mission 3 (SRTM3) was used for the Northern Territories.

- ALOS/PALSAR Kyoto and Carbon Mosaic

Ortho-rectified and slope-corrected PALSAR mosaic images with a resolution of 10-m were used for water, paddy field, forest, and non-forest area classification.

- Terra/MODIS data

In order to compensate for the data of the areas that could not be acquired by the AVNIR-2 in summer, the normalized difference vegetation index (NDVI) with a resolution of 250-m, acquired by Moderate Resolution Imaging Spectroradiometer (MODIS) onboard the Terra was used. Furthermore, the vegetation phenology was discounted.

- Global Mapping in Japan (transportation network)

The transportation network data for the Global Mapping in Japan developed by the GSI were used as the reference data for road information.

## 3. CLASSIFICATION METHOD

For the classification, a decision tree method was used, which takes into account the vegetation phenology using monthly composite images of the AVNIR-2, topographic information, the PALSAR data, and the Global Mapping

(transportation network) data. Classification for Kushiro Marsh and for outlying islands such as Yakushima Island was performed by employing an ad-hoc method instead of the decision tree method owing to the scarcity of AVNIR-2 images for all seasons. Table 1 summarizes the classification categories. Pixel spacing is  $0.0004167^\circ$  and  $0.0005^\circ$  for the latitude and longitude, respectively, which corresponds to a spatial resolution of 50 m. Figures 4 and 5 illustrate the classification result for version 12.08 for the whole of Japan and an enlarged classification image of Kanto district, respectively.

Table 1 Classification category

Digital number	Classification categories
0	Unknown
1	Water
2	Urban
3	Paddy
4	Crop
5	Grass
6	Deciduous forest
8	Evergreen forest
10	Bare land
11	Snow and ice

#### 4. VALIDATION

The validation data are approximately 2,500 data points homogeneously distributed throughout all regions in Japan except in Okinawa; these data are acquired using AVNIR-2, independent of the monthly composite dataset used at classification, and from open-access information sources such as the Digital Japan Portal Web Site by the GSI and the natural environment conservation baseline survey by the Biodiversity Center of Japan of the Ministry of the Environment. Table 2 shows the accuracy evaluation of the JHR LULC Map version 12.08. The overall classification accuracy was calculated considering the surface ratio for land-use; the surface ratio data for each category as of 2009 was researched by the Ministry of International Affairs and Communication. As each category of the surface ratio classified by the Ministry of International Affairs and Communication is not the same as that of the JHR LULC Map, the categories were integrated and an overall evaluation of the classification accuracy was performed. Subsequently, the classification accuracy of JHR LULC Map version 12.08 was found to be 88.1%.

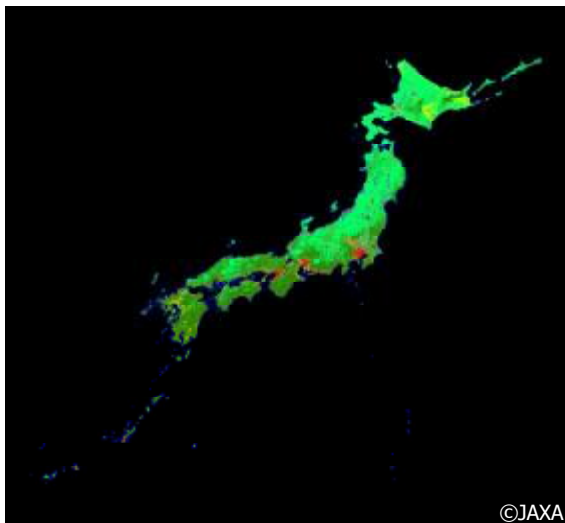


Figure 3 JAXA High Resolution Land-Use and Land-Cover Map of Japan

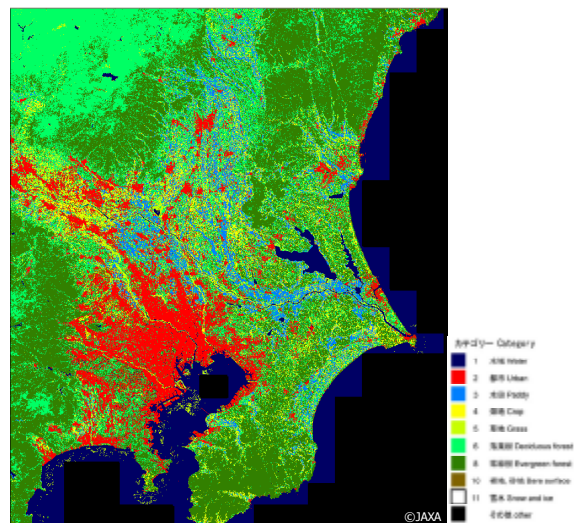


Figure 4 JAXA High Resolution Land-Use and Land-Cover Map of Kanto district

Table 2 Results of accuracy evaluation at validation points

	Water	Urban	Paddy	Crop	Grass	Deciduous Forest	Evergreen Forest	Bare	Snowice	Sum	Usr acc (%)
Water	264	9	1	0	0	0	0	13	2	289	91.35
Urban	5	320	0	9	0	1	0	72	0	407	78.62
Paddy	12	0	207	18	5	0	0	3	0	245	84.49
Crop	8	0	91	105	19	2	0	11	0	236	44.49
Grass	16	0	45	61	54	2	1	1	0	180	30.00
Deciduous Forest	17	23	28	55	49	76	41	47	0	336	22.62
Evergreen Forest	4	1	3	31	33	79	238	6	0	395	60.25
Bare	65	16	12	22	1	0	0	289	0	405	71.36
Snowice	0	0	0	0	0	0	0	0	0	0	0.00
Sum	391	369	387	301	161	160	280	442	2	2493	
Prod acc (%)	67.52	86.72	53.49	34.88	33.54	47.50	85.00	65.38	0.00		62.29

Table 3 Results of accuracy evaluation based on the surface ratio of Land-Use

Categories of JHR LULC Map	Categories in current state of surface ratio	Surface ratio (%)	Percentage of questions answered (Table 3, %)	Corresponding Accuracy of surface ratio (%)
Deciduous and Evergreen Forest	Forest	66.3	98.6	65.4
Paddy+Crop	Farmland	12.4	61.2	7.6
Urban	Building land+Road	8.6	61.2	7.5
Water	Water + River + Conduit	3.5	67.5	2.4
Grass + Bare	Other	9.2	57.2	5.3

## 5. CONCLUSIONS

In this study, we described the used data, the classification methodology, and the results of the validation in constructing JAXA High Resolution Land-Use and Land-Cover Map version 12.08. The extend of the map covers the whole of Japan, excluding outlying islands, and consists of 2,143 scenes acquired from May 7, 2006, to April 17, 2011, using the AVNIR-2 sensor onboard the ALOS platform. The overall classification accuracy for each category was 62.3%. The temporal classification accuracy was found to be 88.1%, which was calculated validated accuracy of classification multiplied current state of surface ratio in each category by the Ministry of International Affairs and Communication. Next, we plan to employ the training data and consider a supervised classification. Accordingly, we plan to perform accuracy improvement of the JHR LULC Map version 13.02. In addition, the JHR LULC Map is available for only non-commercial users of the JAXA EORC Web site without any cost.

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