

# MONITORING OF JAPANESE FOREST BIOMASS USING STEREOSCOPIC ABILITY OF ASTER SENSOR

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**ABSTRACT:** Terra/ASTER sensor, which has nadir looking and backward looking functions, provides Digital Surface Model (DSM). The DSM consists of ground elevation above sea level and the heights of objects on ground such as building heights and tree heights. The tree heights, however, are not real heights of trees measuring top point, and they are the average heights of tree canopies. As forest grows, the average heights of tree canopies become higher. We suppose the average heights of the canopies have stronger relationship with biomass than with heights of trees. The changes of DSM at each range of periods show the quantity of growth or the disappearance of forest stands.

We get Terra/ASTER L1A product from 2001 to 2008 and generate DSM data using ASTER DEM/Ortho software SILCAST. In Broad-leaved deciduous forest, leaves are lost in winter and early spring. The DSM is the ground height and does not reflect the heights of trees at these seasons. The differences in DSM between summer season and winter season represent the biomass of broadleaf forest. In coniferous tree areas, DSM is not influenced by the changes of seasons.

There are a lot of errors in ASTER DSM and the influence of slope and elevations increase the errors. We detect the range of errors and improve the accuracy of DSM.

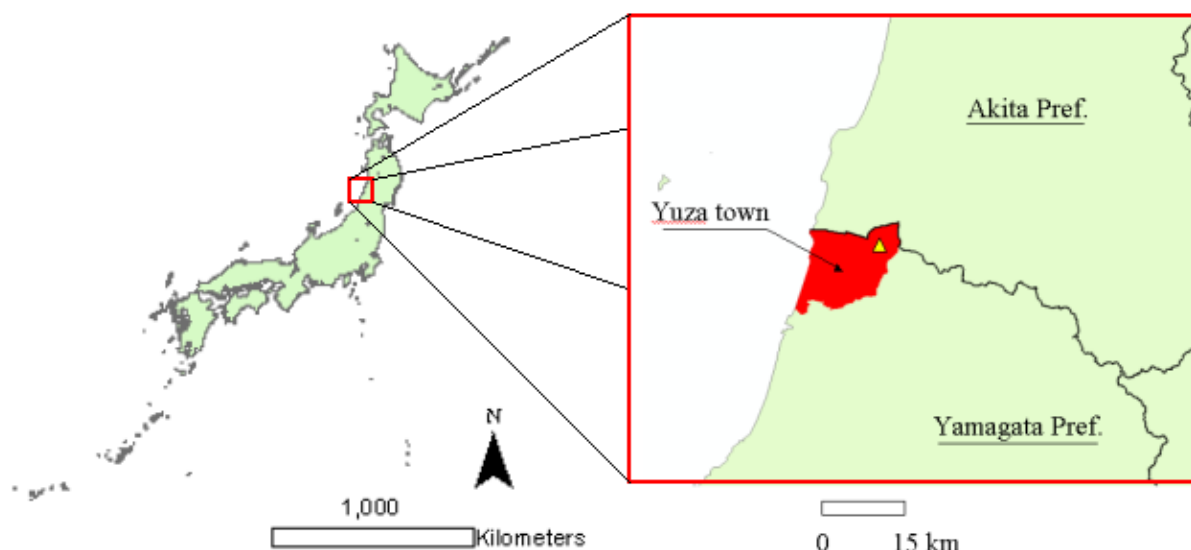
## 1. BACKGROUND

In Japan, two-thirds of the country, about 25 million ha, is covered by forest. The half of the forest is natural stands, and 30% of the forest is artificially managed. In the examination of the forest biomass, field survey is a major method. Comprehensive fieldwork by foresters is extremely time-consuming for large forest. Instead, aerial photograph interpretation and satellite image processing are an alternative solution for quick management of forest biomass. Likewise, stereoscopic tree surface monitoring has a great potential for continuous update of the forest biomass data.

## 2. DATA AND ANALYSIS PREPARATIONS

### 2.1 SURVEY AREA

Figure 1 illustrates the survey area of this study. Yuza town is located in the northern part of Yamagata prefecture in the northeast Japan, and includes the western side of Mt. Chokai. The elevation ranges from 0m to 1771m above sea level and the slopes range 0 degree to 58 degree. The plain is mainly used for agriculture and the mountainous area is covered with forest or grasses. The lower area is used for forestry and natural vegetation is remained in the higher area of mountainous area. In the Broadleaf tree area, fallen leaf trees such as *Fagus crenata*, *Quercus serrata*, and *Quercus. Mongolica var. grosseserrata* mainly stand.



**Figure 1. The position of yuza town in Japan.**

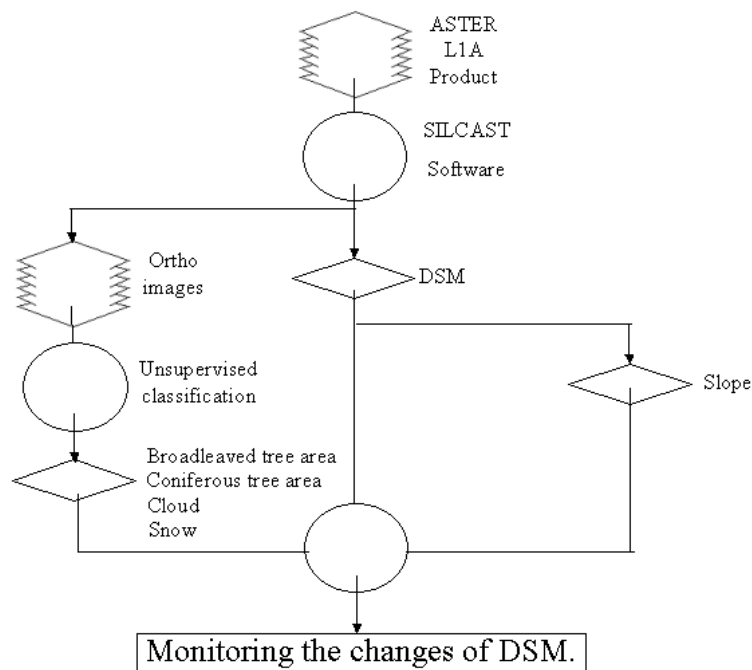
### 2.2 ASTER DATA AND ANALYSIS PREPARATIONS

We get Terra/ASTER L1A products from 2001 to 2008. There are 7 scenes shown in the Table.1. The datasets are processed according to the flow chart illustrated in Figure 2. Broadleaf tree area and coniferous tree area, illustrated in Figure 3, are detected by unsupervised classification using ASTER bands 1, 2, 3, 4, 5 and 6. The area covered by snow, cloud and cloud's shadow are also classified for each image.

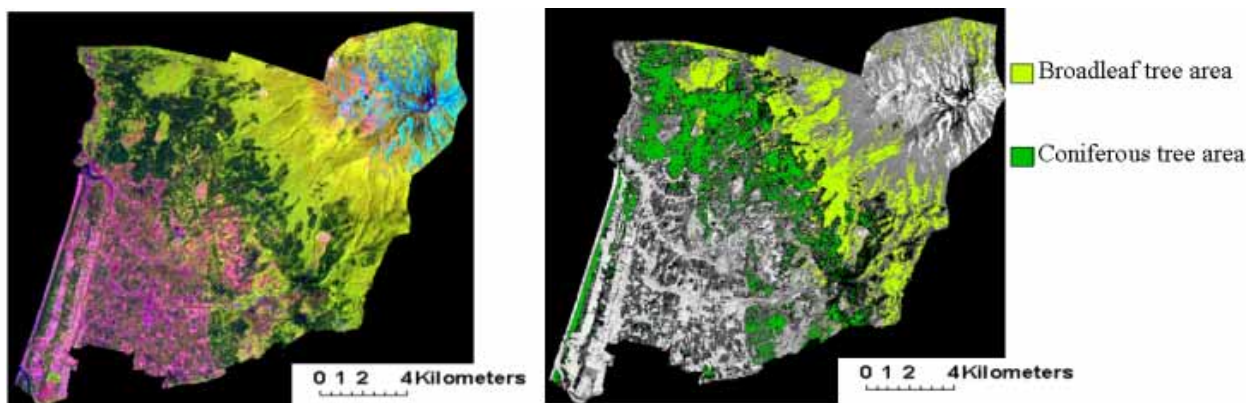
Calculated DSM and slope on 25th July, 2002 is illustrated in Figure 4.

**Table 1. ASTER data and their information**

Observation date	Cloud frequency	Snow cover (above sea level)	Leaves of tree
20th Apr. 2002	5%	600m <	lost
30th Jun. 2002	2-3%	a few	on
25th Jul. 2002	0%	a few	on
12th Apr. 2005	0%	400m <	lost
21st May. 2005	0%	850m <	half on
30th May. 2005	0%	1050m <	on
18th Oct. 2007	2-3%	a few	on



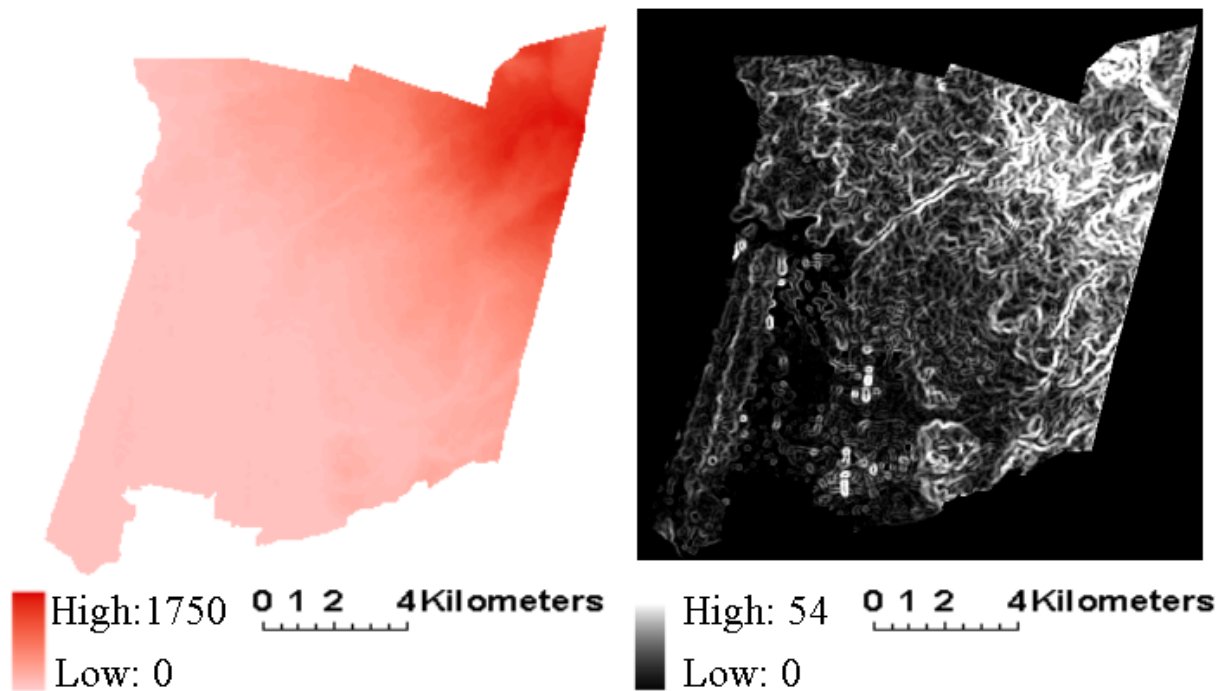
**Figure 2. Flow chart**



**Figure 3. ASTER image and result of classification.**

(R,G,B) = (4,3,2) in the left image.

The ASTER data used as background in the left are taken on 30th Jun. 2002



**Figure 4. DSM and slope**

### 2.3 PROPORTIONAL CONSTANT

We have discussed the proportional constant in the report of Sugihara T. et al. (2007).

$$\text{Average Forest Biomass (C ton/ha)} = \text{PC (proportional constant)} \\ \times \text{Average Height of DSE(m)}$$

$$\text{PC} = \text{Average Forest Biomass} / \text{Average Tree Height}$$

According to the result, the proportional constant is 8.7 in coniferous tree area and 10.6 in broadleaf tree area.

### 3. STRATEGY

When we compare the heights of DSM between two scenes, we must consider about the growth or loss in the biomass. In the scenes taken in simultaneous periods, however, the amount of biomass can be considered as almost same volumes. In other words, the heights of DSM in the scenes of near time will take almost same values. We compare DSM on 30th June, 2002 and 25th July, 2002, and considered them as same surface models. We investigated the difference between them and detected the errors in DSM.

The estimated biomass of broad-leaved tree area in 2002 is 43 C-t /ha in the previous report (2007) and the proportional constant is 8.7. We expect the average of difference of DSM at broad-leaved tree area between 25th July, 2002 and 20th April, 2002 to be 4.1m.

## 4. RESULTS

### 4.1 EFFECTS OF SLOPES AND ELEVATIONS

Figure 5 shows the gaps from average of the difference between the height of DSM at 30th June 2002 and 25th July 2002. We performed the heavy regression analysis of the absolute value of the gaps about the amount of slope and elevation. As the result, the amount of slope is related with the increase of the error. The height of elevation, however, has no relationship. We investigate the standard deviations at each amount of slope and the result is shown in Figure 6. The standard deviation at entire image of Figure 5 is 0.65. We can adopt the amount of DSM in the area where the amount of degree is under 7.

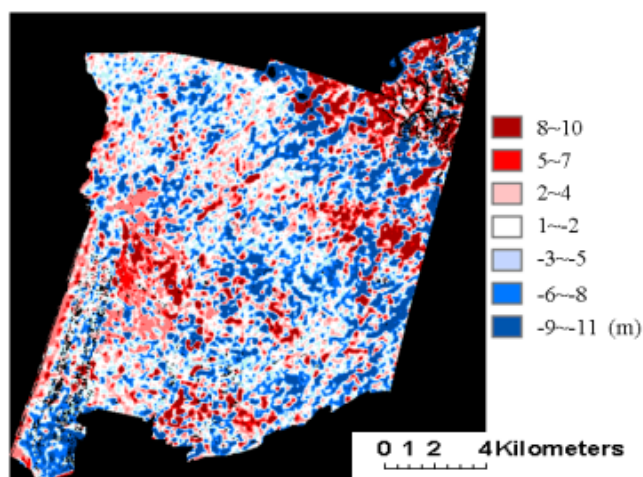


Figure 5. The gaps from average

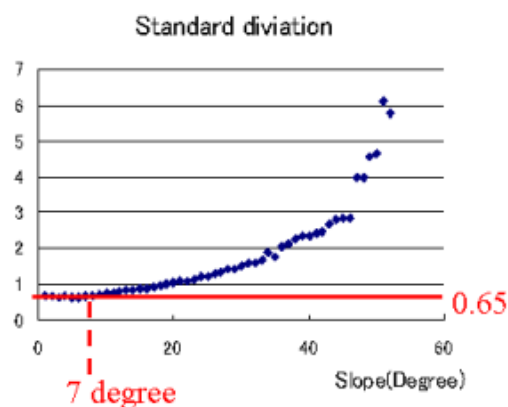


Figure 6. Standard deviations at each amount of slope

### 4.2 BROAD-LEAVED TREE AREA

Table 2 shows the result of monitoring a seasonal change at broad-leaved tree area.

Table 2. The result of monitoring a seasonal change at broad-leaved tree area

	Change of DSM (m)	STDV	Biomass change(C-t/ha)
20th Apr. 2002	7.2	1.3	74.88
25th Jul. 2002	0	0	0

## **5. DISCUSSION**

As the result of this study, the amount of STDV becomes higher than 0.65. We think it is because the procedure of excluding the area covered with snow or extracting the area of broad-leaved tree is increases the errors.

The procedure of correcting DSM data is another reason increasing the error. It is necessary to collect the DSM data calculated in SILCAST to match to elevation model above sea level (Sugihara T. et al. (2007)). The STDV of this procedure is 1.4 on 25th July, 2002 and 1.92 on 30th June, 2002. They also increase the error.

Each procedure improving the accuracy of DSM decreases the area to observe. Even now, the observable area is only 15 % of entire Broad-leaved area. ASTER data with light snow at the time of leaf fall is needed

## **6. REFERENCES**

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Sugihara, T., Saito, G., Forest Biomass Estimation Using Remote Sensing Data and GIS. Proceedings of the 28th Asian Conference on Remote Sensing (2007).