Satellite Imagery Solutions for Monitoring of Forest and Ecosystems

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OVERVIEW: Forest conservation activities aimed at curbing global climate change and ecosystem conservation activities aimed at preventing loss of biodiversity have been carried out on a global level in recent years. Monitoring based on the analysis of satellite imagery for which time-series data exists from the past is an effective way of quantitatively evaluating these conservation activities. Hitachi provides satellite imagery analysis solutions and monitoring systems that coherently offer everything from image collection through processing and analysis for use in forest and ecosystem conservation.

INTRODUCTION

DEBATES are being held and countermeasures are being taken to combat global climate change and the biodiversity crisis, centered on the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity. Hitachi is working on satellite imagery solutions to monitor forest and ecosystem conservation(1), and is promoting the provision of satellite imagery analysis solutions (the sales of satellite imagery data and data analysis services) and monitoring systems.

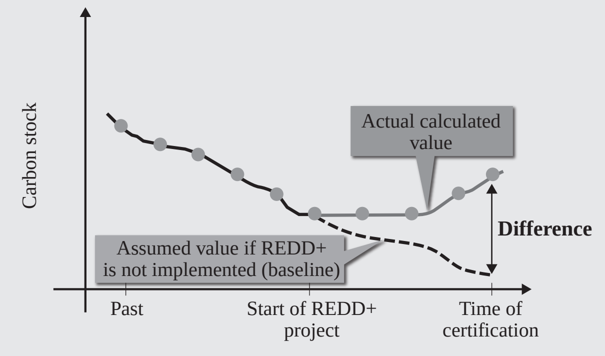
This article discusses the satellite imagery solutions Hitachi is working on for evaluating forest and ecosystem conservation activities.

SATELLITE IMAGERY SOLUTION FOR EVALUATING FOREST CONSERVATION

REDD+ Procedures

As a forest conservation activity that developing economies are participating in to combat climate change, the Reducing Emissions from Deforestation and Forest Degradation in Developing Countries Plus program (REDD+: a program that seeks to reduce the emissions caused by deforestation and forest degradation in developing countries while conserving forest carbon stock and managing forests in a sustainable manner so as to improve forest carbon stock) is starting to incorporate a concept whereby increases in carbon stock stemming from forest conservation are rewarded with credits. REDD+ includes both the efforts of the UNFCCC as well as voluntary efforts running in parallel. At present, voluntary REDD+ efforts are leading the way, including the independent Verified Carbon Standard (VCS), which is influencing discussions of REDD+ methods at the United Nations. The procedures of REDD+ based on VCS are described briefly below.

First, the carbon stock is estimated based on the state of the forest, starting in the past. This information is extrapolated to draw up a baseline (the assumed amount of carbon stock if the REDD+ project were not implemented). When a REDD+ project is started, the amount of carbon dioxide (CO_2) emitted from the forest is reduced by measures such as curbing deforestation and forest degradation, thereby causing the carbon stock of the entire forest to increase (see Fig. 1). The difference between the actual calculated value of the carbon stock and the assumed baseline value is certified by the VCS certificate authority, and carbon credits are issued.



REDD+: Reducing Emissions from Deforestation and Forest Degradation in Developing Countries Plus

Fig. 1—Increasing Carbon Stock.
By implementing REDD+, carbon stock increases over the baseline predicted value. Credits are issued once the difference is calculated and certified.

The business operator involved in the REDD+ project can then earn revenue by trading credits on the market, and then use this money as funding to manage the forest for the project, or to contribute to the costs involved in certification or monitoring.

Use of Satellite Imagery for REDD+

At the COP15 conference held in 2009, it was made clear that an effective means of REDD+ monitoring is to combine remote sensing with field surveys(2). Remote sensing and field surveys are being combined just as in the case of VCS REDD+ monitoring. Examples of these monitoring procedures are shown in Fig. 2. VCS REDD+ monitoring uses satellite imagery for the two purposes of formulating a baseline and evaluating the amount of carbon stock increase due to a REDD+ project, based on the methodology.

Baseline formulation

With the VCS REDD+ methodology, the use of remote sensing data is stipulated for formulating baselines, and there are exacting regulations for items such as satellite imagery, spatial resolution, and observational frequency(3). Fig. 2 (a) shows one example of a baseline formulation procedure.

Evaluating amounts of increase in carbon stock

After the REDD+ project starts, increases in carbon stock due to the implementation of forest conservation are evaluated on a regular basis [see Fig. 2 (b)]. As with the baseline formulation procedure, the total amount of biomass in the project region is calculated using a combination of satellite imagery and field surveys, and the change in carbon stock is derived.

Fig. 3 shows the satellite imagery analysis solutions for forest conservation monitoring conceived of by Hitachi based on the VCS REDD+ monitoring methods, guidelines by the Intergovernmental Panel on Climate Change (IPCC)(4), and other considerations.

(1) Satellite imagery acquisition plan

Investigate whether or not satellite imagery (especially medium-resolution satellite imagery) archives exist for the REDD+ project target region

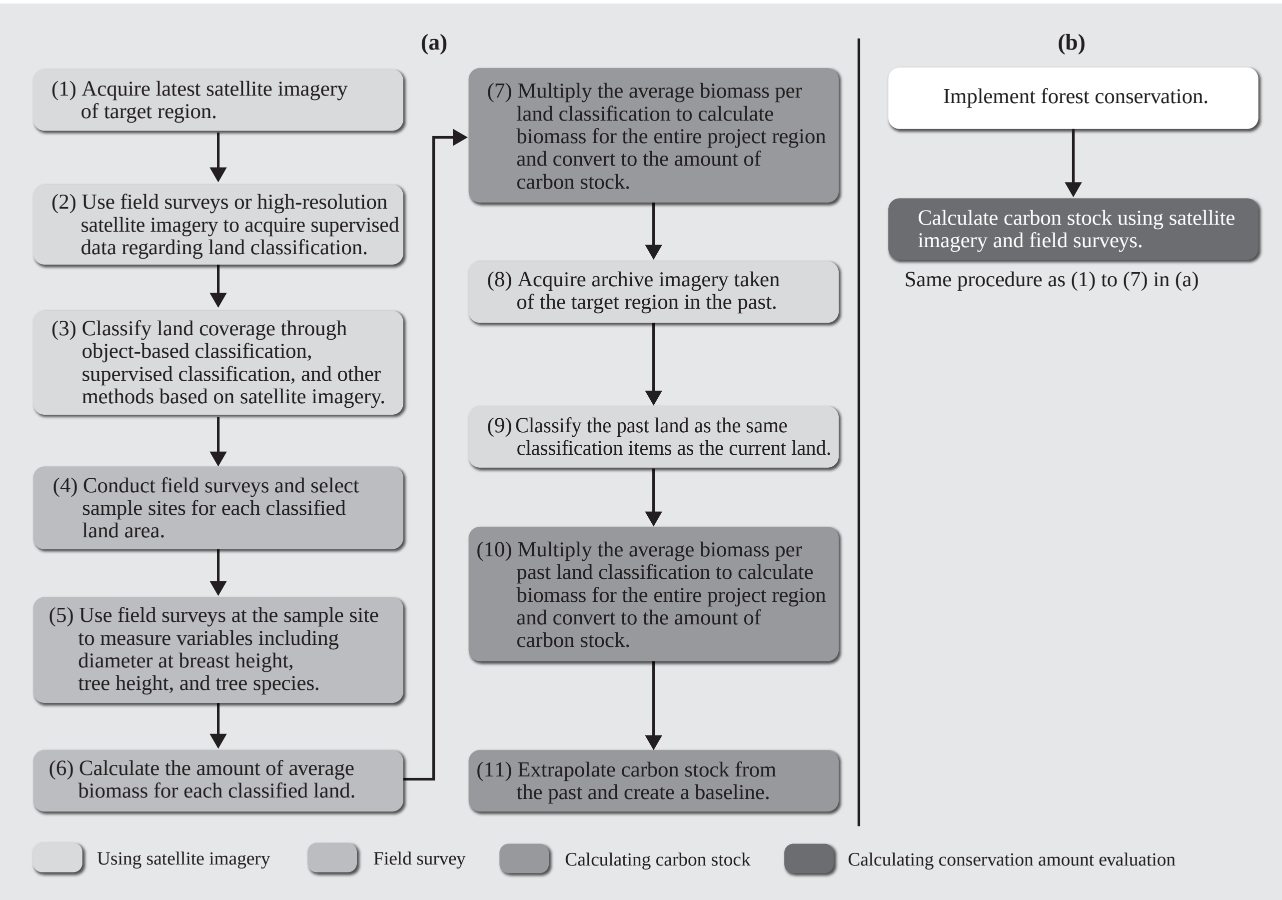


Fig. 2—Example of REDD+ Monitoring Procedures.
The monitoring procedure for formulating a baseline is shown in (a), and the monitoring procedure for evaluating increases in amounts of carbon stock is shown in (b).

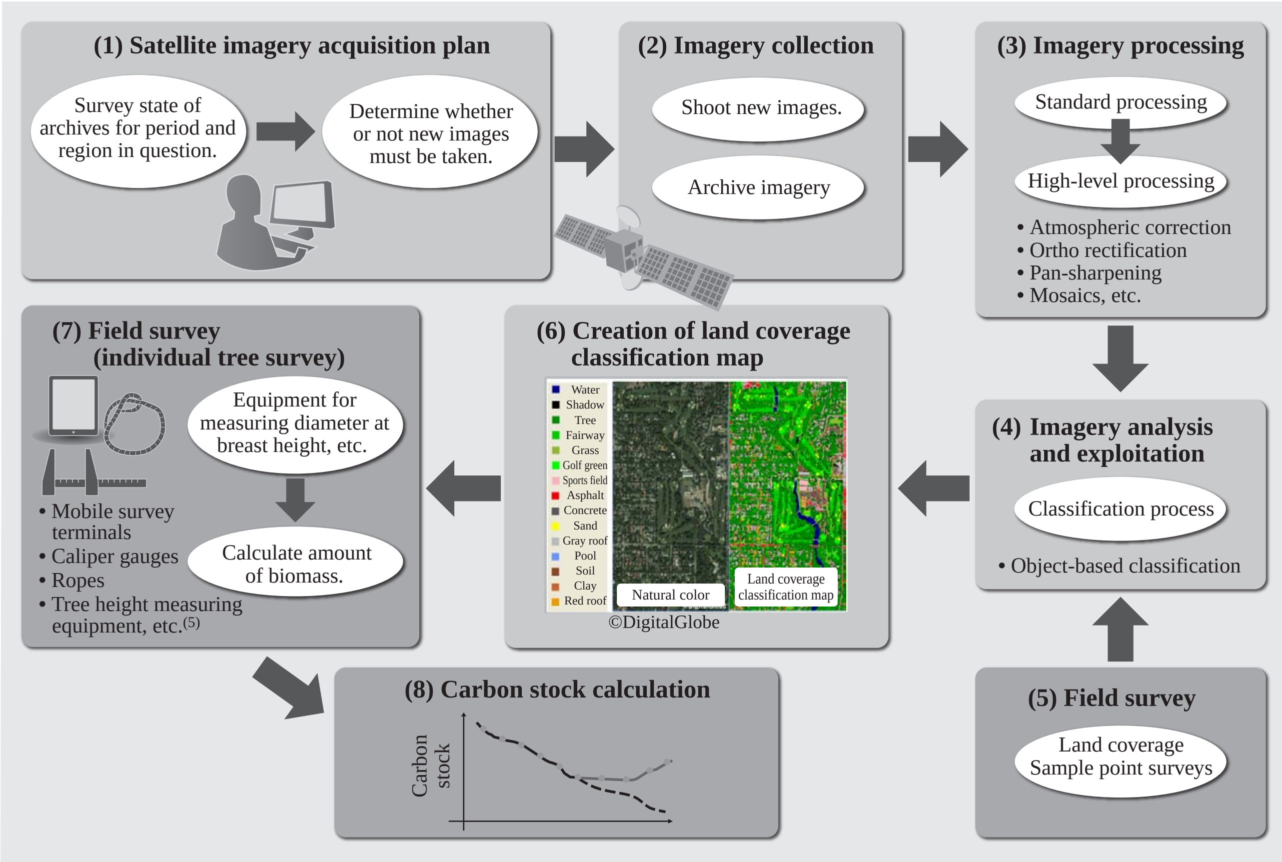


Fig. 3—Satellite Imagery Analysis Solution for Monitoring Forest Conservation.
Changes in carbon stock are calculated by combining satellite imagery [(1)—(4), (6)] and field surveys [(5), (7), (8)]. Hitachi takes advantage of a wealth of knowledge in satellite imagery systems in order to contribute to the monitoring of forest conservation.

during the timeframe used as the baseline, and determine whether or not new images must be taken based on whether or not there is recent satellite imagery.

(2) Imagery collection

Acquire archives or newly taken imagery.

(3) Imagery processing

The imagery acquired in (2) is processed in order to adjust for deformations specific to the sensors, and to apply atmospheric correction, orthogonal (ortho) rectification, and other corrections. Positions are aligned with past images in order to investigate changes in the forest over time.

(4) Imagery analysis and exploitation

Object-based and supervised classification are applied to the imagery along with other forms in order to classify land coverage.

(5) Field survey

Accuracy verification and correction are applied on-location to check land coverage classification as necessary.

(6) Creation of land coverage classification map

The results of (4) and (5) are combined in order to create a land coverage classification map for the target region.

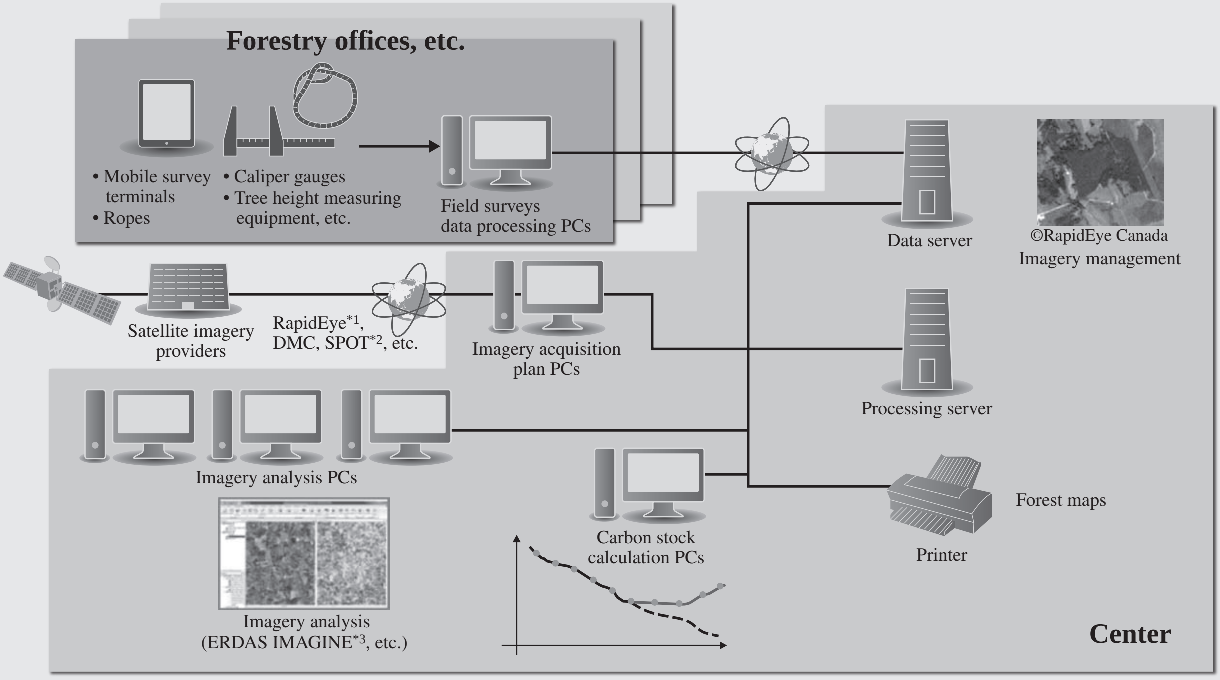
(7) Field survey (individual tree survey)

Sample points are surveyed on location to acquire data such as tree height and diameter at breast height.

(8) Carbon stock calculation

The results of (6) and (7) are combined to find the amount of biomass stored in the trees and calculate the carbon stock.

Fig. 4 shows an overview of the system of satellite imagery solutions described above. Field survey information owned by national forestry offices and other organizations is stored in a central data server, is combined with satellite imagery obtained from satellite imagery providers (mainly medium resolution satellite imagery including RapidEye, DMC, SPOT, and others), and is used for tasks such as the creation of forest maps and the calculation of carbon stock. By applying its track record and the knowledge it has cultivated in satellite imagery utilization systems, Hitachi supports the evaluation of forest conservation projects in developing countries through the construction of the types of forest monitoring systems shown in this figure.



PC: personal computer
*1 RapidEye is a registered trademark of RapidEye Canada Ltd.
*2 SPOT is a trademark or registered trademark of Spot Image in France and other countries.
*3 ERDAS IMAGINE is a trademark or registered trademark of ERDAS, Inc.

Fig. 4—Overview of Forest Monitoring System Using Satellite Imagery.
This system is used to analyze and manage the satellite imagery obtained from satellite imagery providers, as well as to calculate carbon stock.

SATELLITE IMAGERY SOLUTION FOR EVALUATING ECOSYSTEM CONSERVATION

Debates and discussions have been held at the Convention on Biological Diversity's COP conferences, and ecosystem conservation efforts are being carried out around the world to protect biodiversity. In addition to forests, which are ecosystems that are important for biodiversity, coral reefs, seaweed beds, and other marine ecosystems are also important ecosystems in which large numbers of organisms live. The use of remote sensing data including satellite imagery is also effective for monitoring these types of ecosystems as well[(6)], and is contributing to the evaluation of biodiversity.

The use of satellite imagery solutions to monitor ecosystem conservation is envisioned to work the same way as in the monitoring of forest conservation, and satellite imagery can be effectively utilized for ecosystem conservation as well. WorldView-2, which is owned by the American company DigitalGlobe* and for which Hitachi has data distribution rights in the Asian region, has a high resolution of 2 m in multispectral ranges, and includes a highly water-permeable coastal band (observation wavelength band between 400 and 450 nm). By combining the

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Fig. 5—Coral Reef Imagery from WorldView-2.
The imagery of WorldView-2 with its highly water-permeable coastal band can be utilized in the monitoring of coral reefs and other coastal region ecosystems.

WorldView-2 coastal, blue, and green bands and measuring relative absorption amounts, it is potentially possible to measure down to a water depth of between 20 and 30 m[7], which makes this an effective means of monitoring coral reefs and other ecosystems in coastal regions (see Fig. 5).

CONCLUSIONS

This article discussed the satellite imagery solutions Hitachi is working on for use in evaluating forest and ecosystem conservation activities.

It is expected that forest and ecosystem conservation efforts will increase around the world in the coming years, and Hitachi will continue working to ensure that the satellite imagery solutions it offers for use in evaluating these conservation activities will contribute even further.

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