TREES DO GROW ON MONEY

SHIFTS IN FUNDING FOR FOREST GOVERNANCE MEAN DONORS WANT TO SEE THEY'RE ACHIEVING RESULTS. RICHARD TIPPER AND KARIN VIERGEVER LOOK AT THE PROS AND CONS OF THE DIFFERENT EARTH OBSERVATION DATA AVAILABLE FOR MEASURING FOREST AREAS

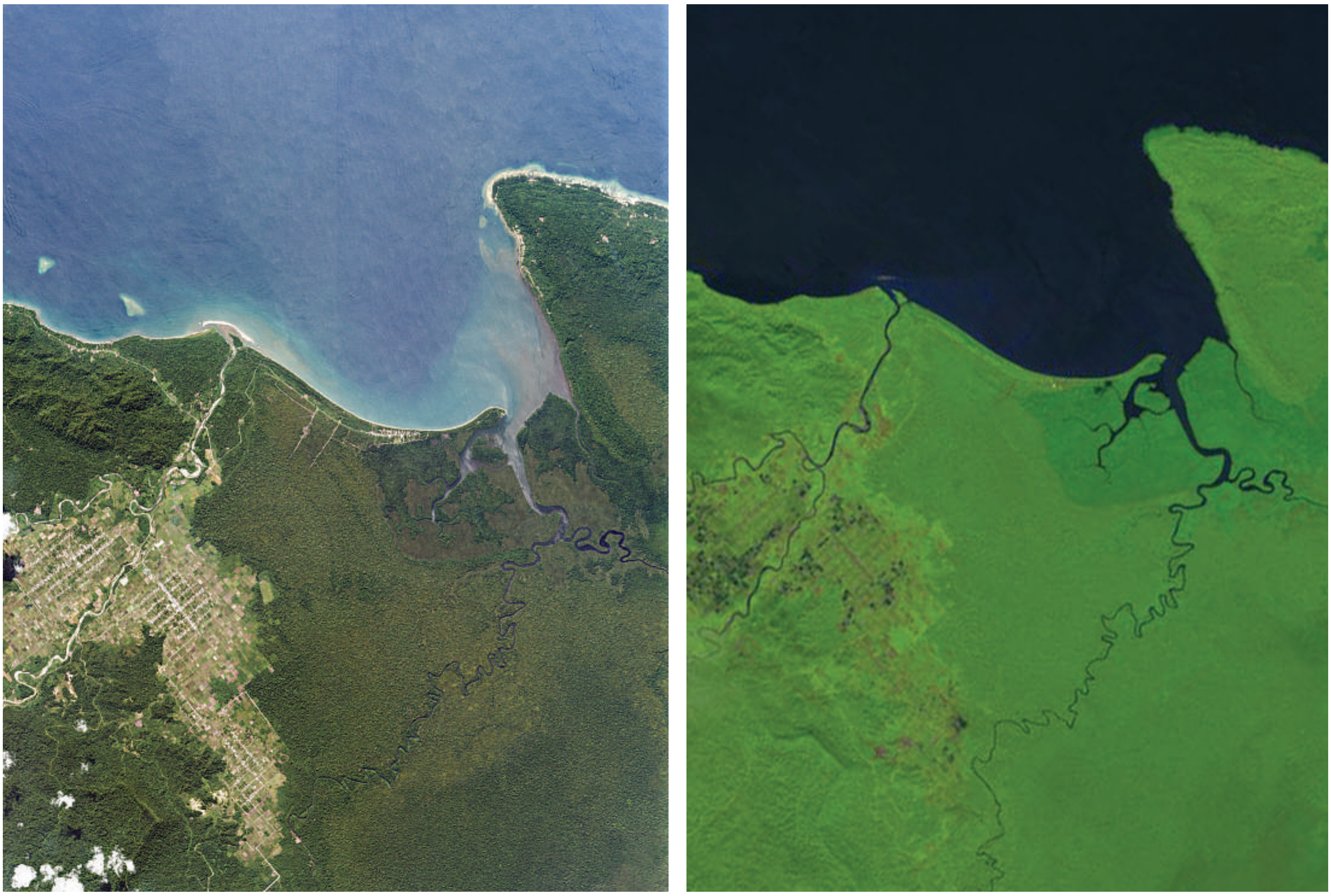
The importance of forests in mitigating climate change was reaffirmed at the historic UN agreement in Paris in December, and a notable shift in financing models towards results-based systems makes accurate measurement from earth observation satellites more important than ever.

In Article 5 of the Paris Accord, parties to the convention are encouraged to support reductions in emissions from deforestation and forest degradation, as well as backing forest conservation, restoration and improved management measures in developing countries. These measures are known as REDD+.

While aid funding for improved forest governance has traditionally been applied on a needs basis, there is increasing interest in financing projects on the basis of results: the avoided loss of forest and resulting carbon emissions. Norway has taken the lead in the move towards results-based finance and while other donors have viewed it with some wariness, there is an increasing acceptance from both the results-based and the needs-based financing perspectives that results or outcomes from forestry programmes need to be measured. At the very least, it allows donors to understand whether they are achieving their objectives and delivering value for money. Earth observation (EO) by satellites is widely recognised as the only practical way to monitor forest changes at national or regional scales. Good practices in the application of EO to REDD+ are emerging through the efforts of the Global Forest Observations Initiative (GFOI), and through various UN, World Bank and donor-led schemes, developing countries are being encouraged and supported to develop systems for mapping forest resources and quantifying changes in forest cover and conditions.

The main observation tasks required by REDD+ can be split into 'resource mapping' (the mapping of forests and related vegetation classes and their condition) and 'change mapping' (the mapping and quantification of change from one year to the next) – for reasons of error propagation, change is rarely quantified by comparing two resource or forest cover maps.

Which earth observation assets are chosen for these tasks will depend on details such as cloud cover levels, forest complexity, technical capabilities and affordability. For any country with complex forest estates and change dynamics, or with ambitions for forest monitoring that go beyond the most basic REDD+ monitoring requirements, it is likely that multiple sensors will be needed to achieve its aims.



30m Landsat image acquired in June 2014 and a 5m Planet Labs image taken in August last year. These images were taken along the northern Papuan Coast of New Guinea, showing a growing network of agricultural villages along small rivers in the Papuan jungle that empty into Cenderawasih Bay (Planet Labs image © Planet Labs).

Choices

For forest change detection, response times and accuracy are key considerations. While national reporting may require only annual observations of change, enforcement and response agencies are looking for faster and subtler methods of detecting change that can pick up activities such as illegal logging or the clearance of small patches for subsistence agriculture or small-scale mining.

In general, there is a shift from relatively coarse scale forest resource mapping, such as the 250m MODIS, to medium resolution products based on the likes of Landsat, DMC, CBERS, SPOT and Sentinel-2. While MODIS has the attraction of high frequency revisits, consistent and easy-to-handle data products and a historic archive going back to 2000, its relatively coarse resolution makes precise boundaries between agriculture and forest difficult to determine. There is also far less capability to distinguish forest types within a landscape.

In some cases, this data is being supplemented by airborne LIDAR missions, particularly for areas of high carbon stocks or important biodiversity, while radar methods have proven to be particularly useful in the mapping of fragmented dryland forests. There are also a number of exciting new developments on the way in terms of satellite deployment and equipment. These new EO constellations are likely to have an impact on both forest resource assessment and change detection.

In the case of optical sensors, the increasing availability of very high resolution images and falling costs is likely to continue with new constellations, such as Urthecast, Planet Labs and DMC3. But despite increasing availability and lower prices, these products are unlikely to become the mainstays of national EO applications. Instead, they will most likely be used for calibration, validation tasks and discrete operations, such as prosecutions or monitoring activities in highly sensitive areas.

New radar sensors are also becoming higher resolution. For example, TerraSAR, CosmoSkyMed, ALOS-2/PALSAR-2, and India's RISAT are offering spatial resolutions at less than 5m, allowing for better mapping of finer scale degradation patterns such as logging tracks. The European Space Agency's upcoming BIOMASS mission, scheduled for 2020, will be the first space-borne P-band radar, which saturates at higher levels of forest biomass. Outputs of the mission will include maps of forest biomass and forest height at a resolution of 200m. An experimental 'tomographic' phase will aim to provide 3D views of forest areas.

New technologies and further development of existing methods may provide data and information where persistent cloud cover limits optical satellite data, and in areas of the tropics where radar sensors experience reduced sensitivity at high levels of biomass.

LiDAR provides near-3D information on canopy structure and ground topography, so can be used to derive accurate estimates of forest canopy heights. It has been found to be more accurate than even field-based height measurements. It is an established method for forest mapping and monitoring, but still an emerging technology in terms of national-scale mapping.

The detailed vertical and horizontal resolution of airborne LIDAR enables field measurement-like data over larger areas. However, compared to many other EO data sources, LiDAR from airborne platforms is expensive, although the high data acquisition costs can compare favourably overall, given that more data is often needed using other methods. LiDAR from satellite platforms is currently less common: NASA's Geoscience Laser Altimeter System (GLAS) on the ICESat satellite was originally intended for monitoring ice sheet topography and atmospheric properties, but the coarse horizontal spatial resolution data has been used to contribute to global forest canopy height models and large-scale tropical biomass maps.

Maps of forest characteristics at such large scales are not generally used for REDD+. However, NASA's Global Ecosystem Dynamics

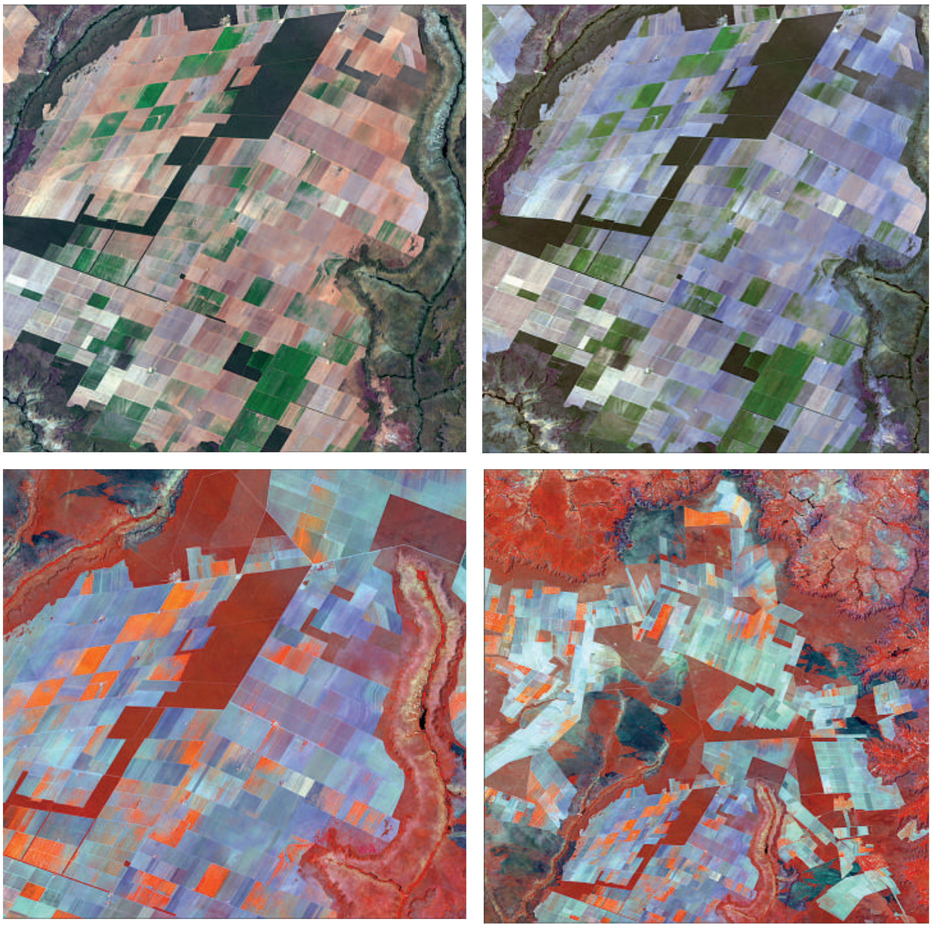
Investigation LiDAR (GEDI) mission will operate for one year from the International Space Station, from 2018. It was designed specifically for mapping and monitoring forest structure, biomass and change, and will offer higher resolution spaceborne LiDAR data.

Another option is interferometric X-band, such as TerraSAR-X, which can be used to estimate forest canopy height. A drastic reduction in canopy height indicates deforestation, while a smaller reduction could indicate degradation. This method is less accurate than LIDAR, but there is more historical data available and it can be significantly cheaper.

EO applications in forests are using an increasingly broad range of sensors for different tasks, from coarse resolution resource mapping to high frequency change detection and characterisation. With interoperability of data from different satellite sensors and data model integration identified as areas of priority, that is likely to continue as more EO assets and techniques become available.

EO APPLICATIONS IN FORESTS ARE USING AN INCREASINGLY BROAD RANGE OF SENSORS

Richard Tipper is executive chairman and Karin Viergever is head of earth observation at Ecometrica (www.ecometrica.com)



30m Landsat imagery (displayed as a false colour composite) for the north of Formosa do Rio Preto municipality in Bahia, Brazil with considerable deforestation and expanding agricultural activity. Comparisons with 5m SPOT and RapidEye imagery enable better detection of smaller scale deforestation and degradation activity in sparse savanna landscapes