FRENCH SUGARCANE EXPERTISE

cirad
AGRICULTURAL RESEARCH
FOR DEVELOPMENT

enhance the value of sugarcane resources
eRcane

SPATIAL INFORMATION ANALYSIS FOR DECISION SUPPORT

LAND USE MAPPING

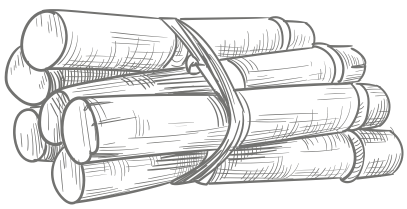
Access to Earth observation satellite images has increased in recent years: since 2013, NASA has been releasing images acquired by Landsat satellites free of charge, the French National Space Agency (CNES) provides access to very high spatial resolution images of Reunion Island, and the European Space Agency (ESA) launched the Sentinel-2 optical satellites into orbit in 2015 and 2017. The short revisit time of these satellites makes it possible to monitor crop growth, but also to partially overcome cloud cover in the tropics. Image processing software is also developing, and free remote sensing tools are constantly improving.
Cirad is working on developing land use mapping methods adapted to the specific conditions of southern countries: high within-field variability, small field size, presence of fallow land, associated crops, agroforest, etc. The Moringa processing chain was tested in the Reunion Island agricultural conditions, including both large fields (for major crops, such as sugarcane and grasslands) and small fields (for orchards and market gardening).

The relief of the island is also a key factor, since crops are arranged depending on the altitude, and mountains tend to retain clouds, masking part of the territory. Using data from the French National Institute of Geographic and Forest Information, a SPOT 6/7 or a Plëiades image, and Sentinel-2 or Landsat-8 images, land cover maps have been produced since 2016 to identify and map crops in Reunion. The Moringa chain is also being tested in Madagascar, Burkina Faso, Brazil, and Cambodia.

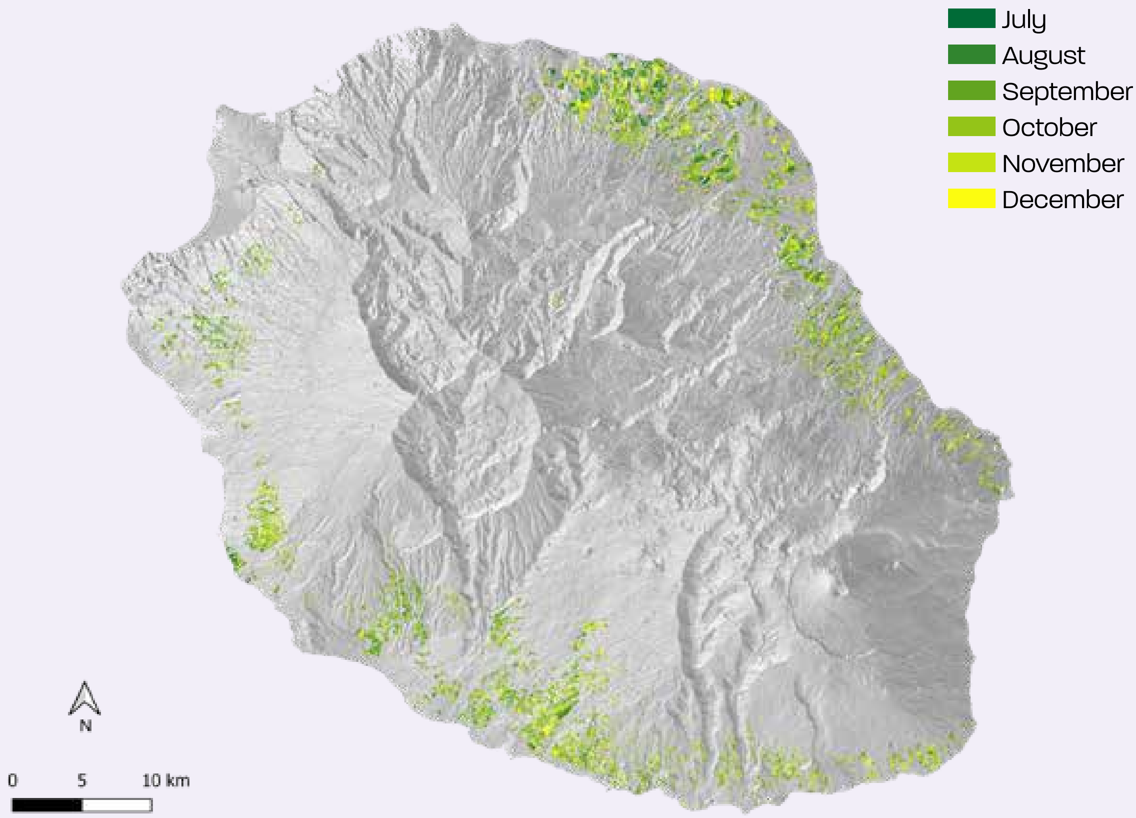
MASH: REAL TIME SUGARCANE HARVEST PROGRESS MAPS

In countries where sugarcane is grown by thousands of small farmers, i.e. in most producing countries, knowing the harvested sugarcane area and the unharvested area in near real time is an impossible task. However, this information is crucial for adjusting crop forecasts, and for the operation and the cash flow of sugar mills, human resources and harvesting logistics. A Cirad research team specializing in spatial information analysis developed a sugarcane harvest mapping method based on free images from European Sentinel satellites. With systematic acquisitions of the continental surface every 5 to 12 days, these allow near real-time detection of harvested areas and the production of synthetic harvest maps showing harvested fields and still standing cane fields throughout the 5 months of the campaign.

These maps are produced by an automated processing chain that downloads the relevant satellite images each day. It combines both the optical images of Sentinel-2 satellites and the radar images of Sentinel-1 satellites, which can see through clouds, even at night. The algorithm has been used in particular to monitor the harvesting of sugarcane areas in Thailand (400,000 ha) and South Africa (120,000 ha). It is currently used in La Réunion (24,000 ha), and is being deployed by the start-up GeoWatch Labs to implement it on a very large scale for its clients.

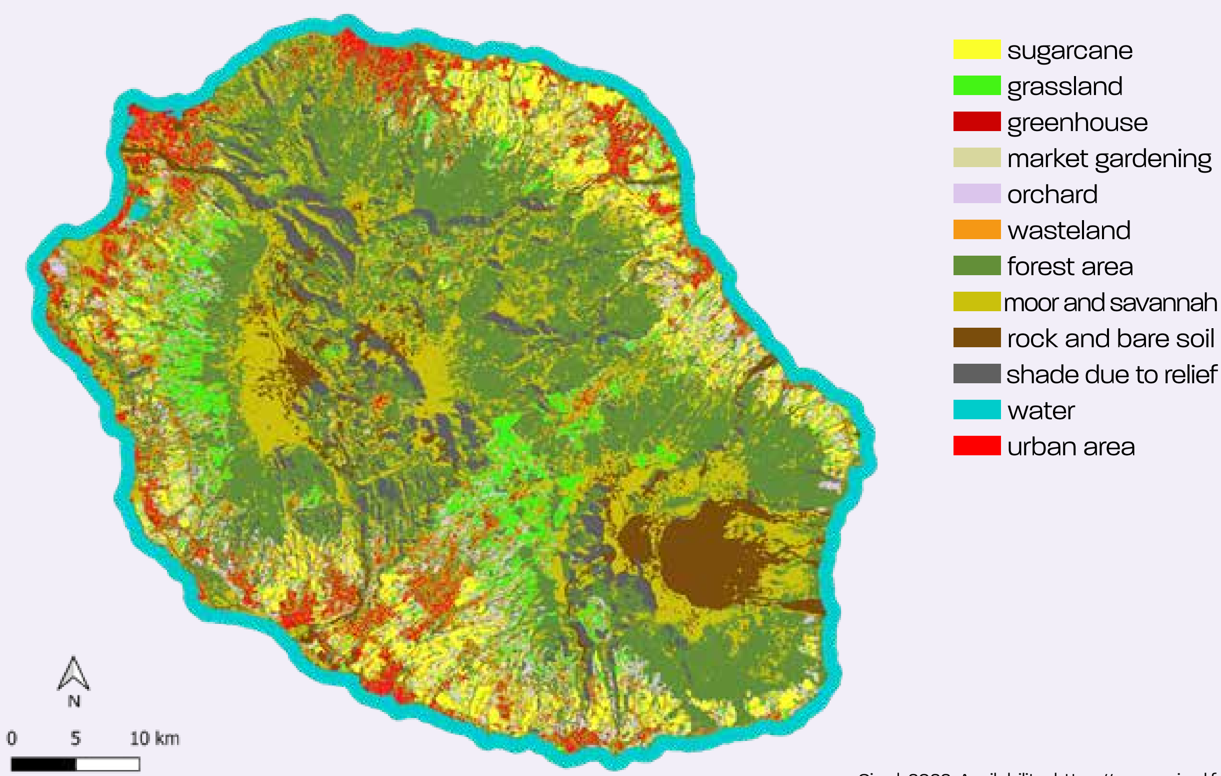


HARVEST DATE OF SUGARCANE FIELDS IN REUNION ISLAND DURING THE 2018 CAMPAIGN



Cirad 2019 Base map: BD Topo IGN 2019

2021 REUNION ISLAND LAND USE MAP



source: Cirad, 2022. Availability: https://aware.cirad.fr/

MODELING THE VARIABILITY OF SUGARCANE YIELD IN CURRENT AND FUTURE CLIMATES

Crop models can help understand and predict the effects of climate, soil, and management on crop growth and yield.

In particular, yield gap analysis based on differences between several types of yields - potential, water-limited or actual - provides a basis for identifying the main factors affecting crop yields.

This analysis provides information to guide the interventions of producers, researchers, and public bodies.

In Reunion Island, modeling studies are underway at Cirad and eRcane to understand and quantify the spatial and temporal variability of sugarcane yield gap differences.

Particular attention is paid to the influence of extreme events (cyclones, intense droughts) on sugarcane yields and how climate change will influence yields in the future.

These analyses make it possible to foresee the necessary adaptations for crop management to maintain production, particularly irrigation management.

PREDICTION OF SUGARCANE YIELD BY REMOTE SENSING

Yield forecasting is both crucial to optimize harvest conditions, and therefore producers' incomes, anticipate the risks of food shortages, develop import and marketing strategies, and difficult because there is no universal solution applicable to all scales, all crops and in all socio-economic contexts.

Predicting production by expertise at the level of each plot or farm is unreliable and often too expensive. Satellite imagery is a very accessible source of information today, and harvest forecasting one of the most widespread applications.

Cirad has developed a yield prediction method of sugarcane fields based on the normalized difference vegetation index (NDVI) estimated from Sentinel-2 free optical satellite images.

A calibration equation was established between the NDVI value measured 1 month before harvest by satellite images and the yield of the field at harvest. Calibrated from 120 reference plots, with different cane varieties and in different climates, it is nevertheless not very precise (error of about 20% at the scale of the field). This is why we use it to predict 1- the expected yield variation between the upcoming harvest and the previous harvest: this approach removes systematic errors from the equation, and 2- yield at more aggregated levels: the production basin, or the territory.
In Reunion Island, the errors found are 5% and 1.5% respectively.

SPATIAL GHG BALANCE OF LAND USES AND LAND USE CHANGES

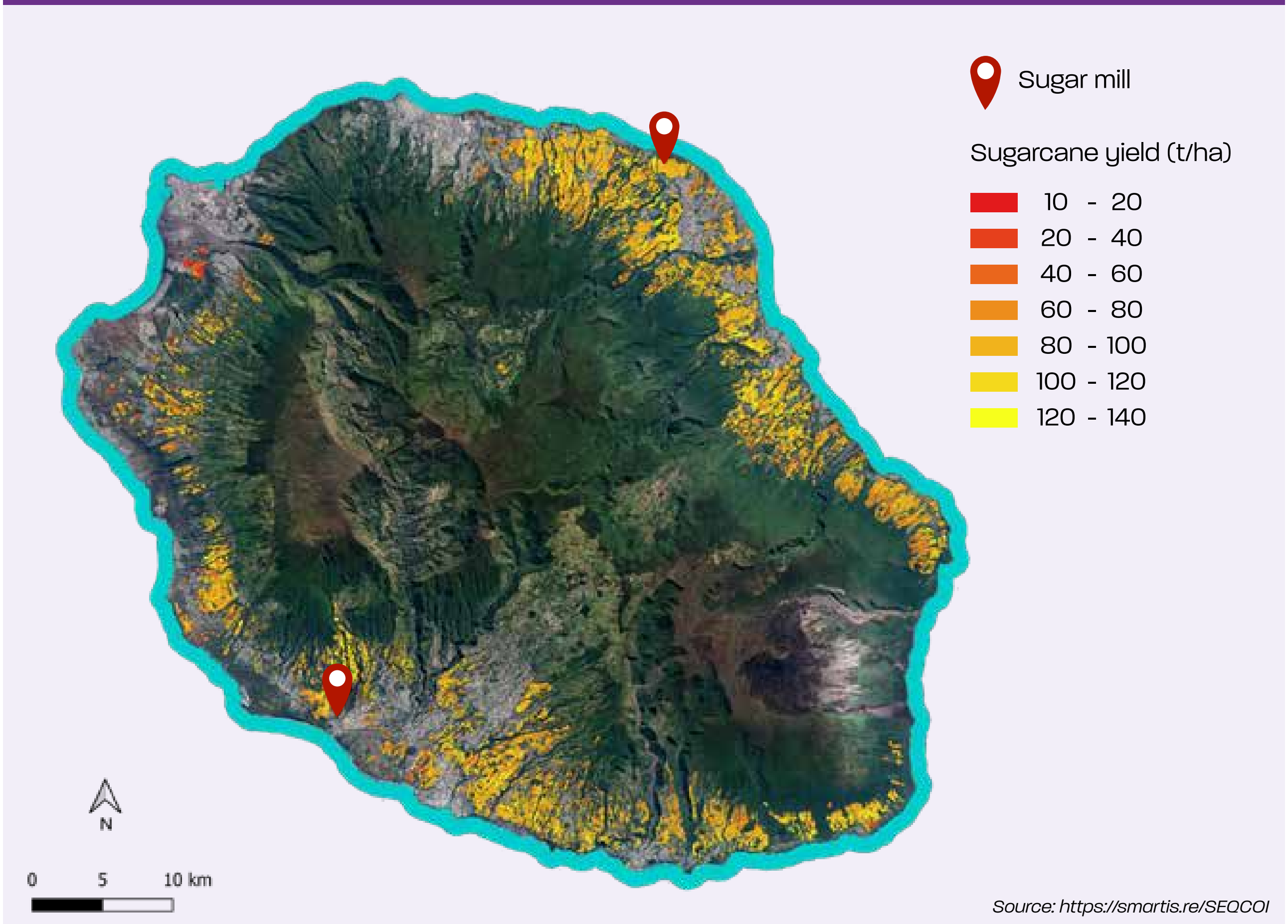
Globally, agriculture and land-use change produce 23% of total anthropogenic greenhouse gas (GHG) emissions. They are therefore major elements in the development of climate change mitigation strategies of countries that signed international agreements on climate change, and in particular in the calculation of Nationally Determined Contributions (NDCs).

To make the use of GHG balance calculators for uses or land use planning projects more accessible to decision-makers, while adapting them to tropical territories and their geographical heterogeneity, we developed a spatialized "turnkey" tool that implements IPCC guidelines to carry out a GHG balance in these territories with contrasting pedoclimatic conditions.

Based on FAO's EX-ACT calculator, our tool uses the current land use map of a territory, and a specific calibration of the model for that territory. To this end, we developed fast and inexpensive methods for estimating the values of the model's territory specific parameters (e.g. soil carbon stocks) using innovative measurement methods such as infrared spectroscopy, or spatial analysis.

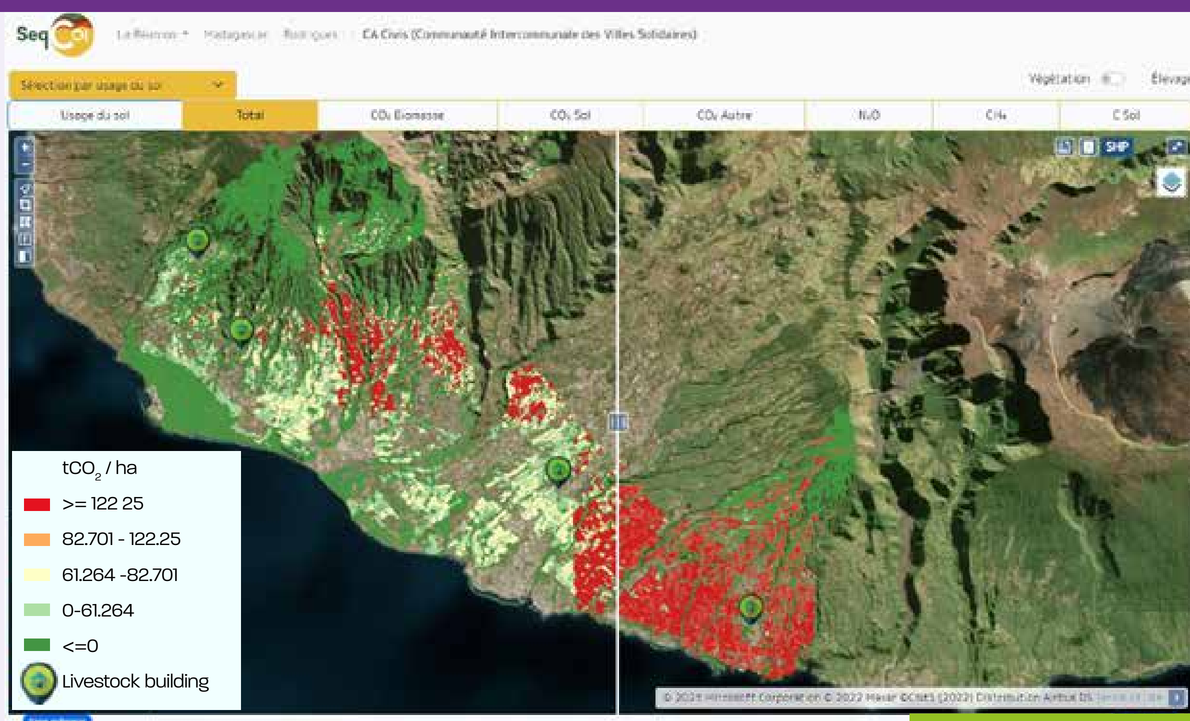
From the calculator's webmapping interface, the user can estimate the current GHG balance of the territory or of each of its land use geographical entity, in the different compartments of the balance, and by type of GHG. The user can actually easily define, with the mouse on the land use map, a scenario of land use changes, and evaluate with one click their impact on the GHG balance.

SUGARCANE PREDICTED YIELD FOR THE 2020 HARVEST



Source: *https://smartis.re/SEQCOI*

GHG BALANCE WEB APPLICATION



GHG balance web application interface, showing the GHG fluxes of land uses without (on the right) and with (on the left) a land use changes scenario, in the south of Reunion Island

Cirad:
Pierre TODOROFF
Agnes TENDERO
Lionel LE MEZO
Mickaël MEZINO
Mathias CHRISTINA