

FROM GROUND TO ORBIT:

COMBINING IN-SITU AND SATELLITE MONITORING OF WATER AND FOREST
RESOURCES FOR ADAPTATION TO CLIMATE CHANGE”

10TH NOVEMBER 2025

ERIC BREL

Espace pour la Guyane
Centre Spatial Guyanais

CNES – Agence française de l'Espace / Expertise technique française

L'ÉCOSYSTÈME SPATIAL FRANÇAIS EN CHIFFRES

3 milliards €

Le budget spatial institutionnel français en 2024, ce qui représente :



45 €

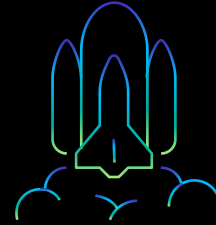
par an et par
habitant

5^e

pays, après USA,
Chine, Japon et la
Russie

1^{er}

budget national
en Europe



1 000

entreprises françaises dans la
filière spatiale, qui représentent

1 500 établissements

90 % de PME et ETI (entreprises
de taille intermédiaire)

Plus de

80

formations académiques
spécialisées dans le spatial



Plus de

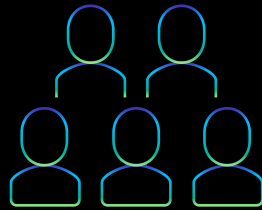
15

Centres Spatiaux Universitaires
collaborant avec le CNES

70 000

personnes

travaillent dans la filière spatiale en France, dans
l'industrie manufacturière et de services et le
secteur académique.



1^{er}



pays européen en terme
**d'investissements
privés** dans le spatial

OUR 4 STRATEGIC PRIORITIES



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Vidéo CSG/S Martin, 2023

STRENGTHEN

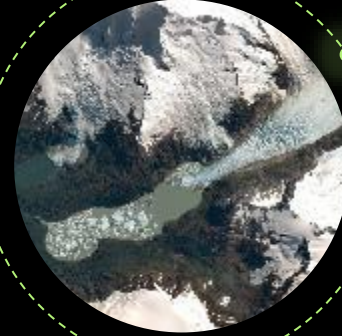
our strategic autonomy



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SUPPORTING

the competitiveness of
the space ecosystem



© CNES/Distribution Airbus DS,
2020

COMMIT

to a sustainable world

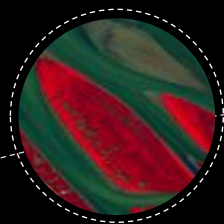


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SHOWCASE

our scientific excellence

CONTRIBUTE TO
TERRITORIES
RESILIENCE



IMPLEMENTING
AN AMBITIOUS
CSR POLICY



BEST UNDERSTAND OF
CLIMATE CHANGE



© Copernicus Sentinel Data, 2022

PROMOTE
A **SUSTAINABLE**
USE OF SPACE



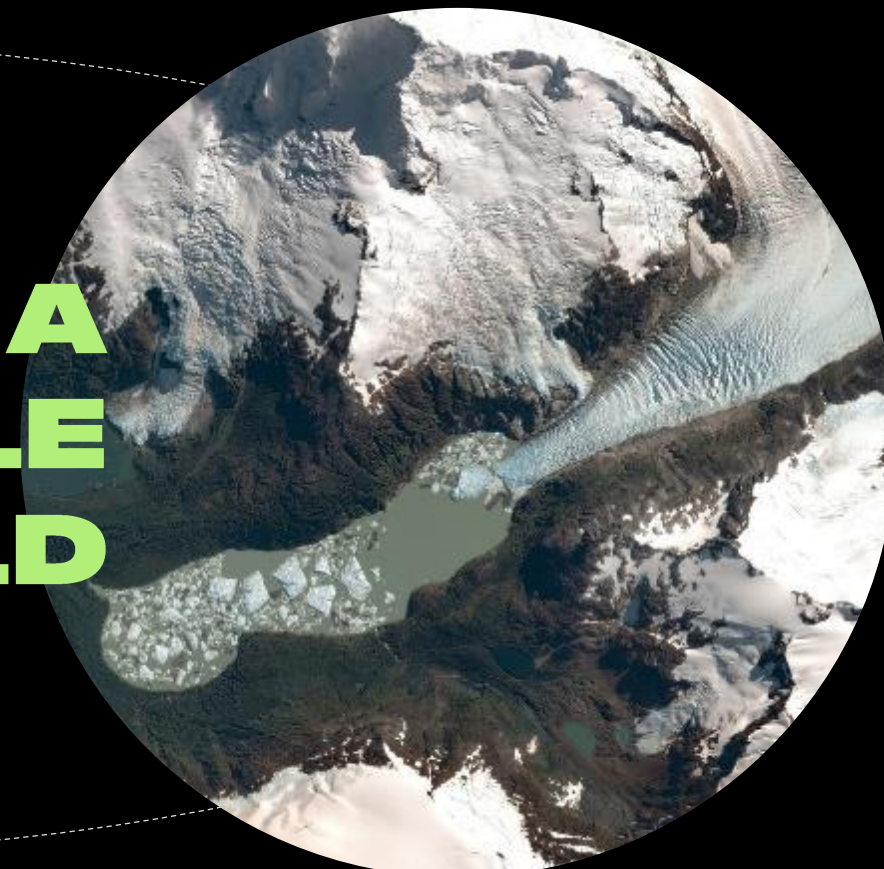
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DECARBONER
THE SPACE SECTOR



© CNES/DUCROS David, 2016

COMMIT TO A SUSTAINABLE WORLD



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2020

SERVICES FOR EVERYONE

Lunar economy

Space logistics

Constellations

In orbit services

EXPERTISE, TECHNICAL RESOURCES,

Meet our experts for personalized support, get in touch with our laboratories, their technical resources and space data, our industrial patents

FOR PRIORITY SECTORS

Télécom.

Mobility

Health

Insurances

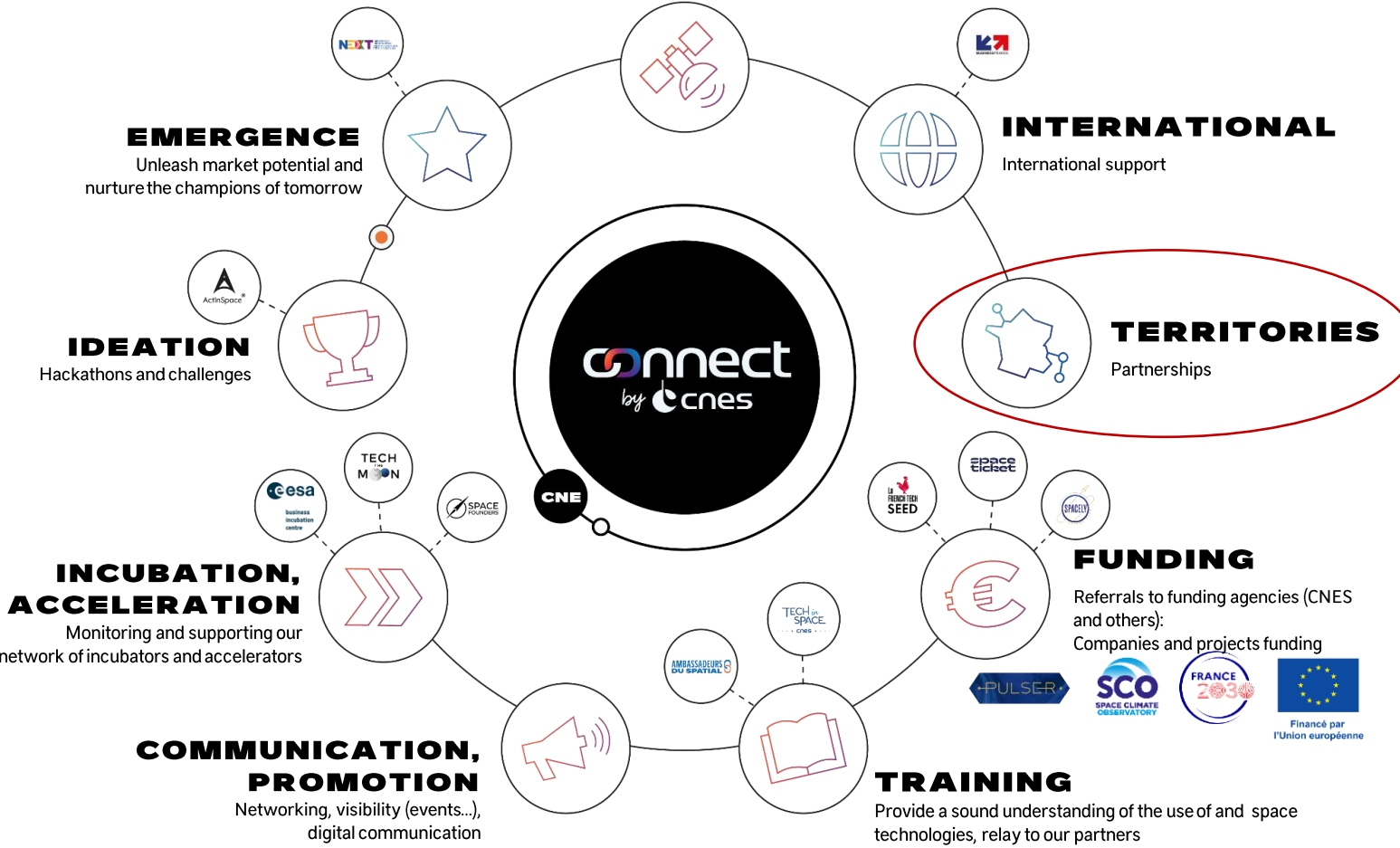
Forests

Agriculture

Energy

Territories management

Maritime



A stylized map of France is centered on the page, outlined in black. Overlaid on the map and the background is a network of nodes and lines. The nodes are small circles in teal, light blue, and purple. Some nodes are connected by thin grey lines, forming a network structure. The background also features faint, concentric dashed circles.

02

**APPLICATIONS
IN ALL
SOCIO-ECONOMIC FIELDS**

rayon de 2500 km autour de sa position







03

SPACE MISSIONS

TRISHNA



Bilateral programs devoted to water

Land, Coastal, Ocean
Water

Satellite precursors
LSTM, S3-NG TOPO
Downstream Programs

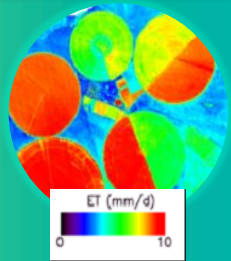
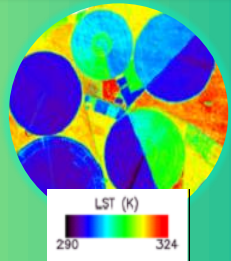


DATA
TERRA

Theia

hydroweb.next

Ground surface temperature
and daily evapotranspiration

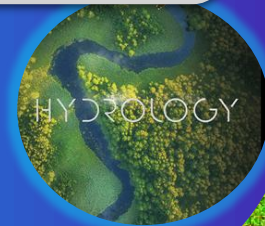


Launch scheduled in 2026-27

SWOT



First global survey of
Earth's surface waters



Launched Dec 16, 2022



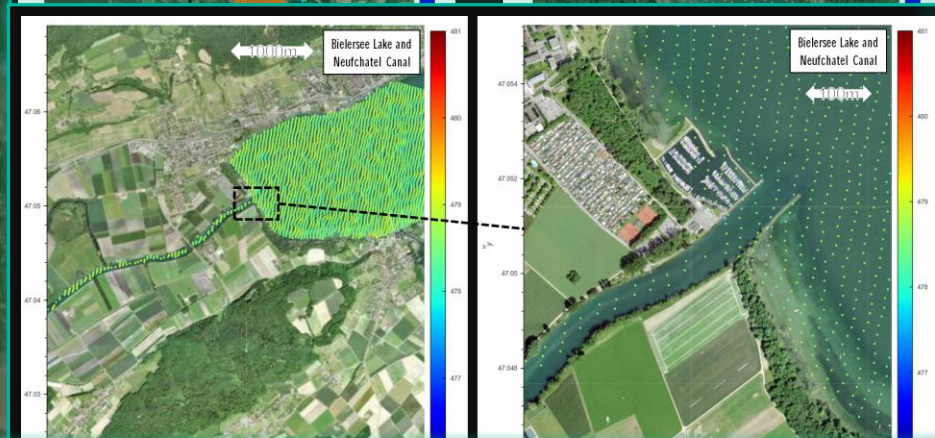
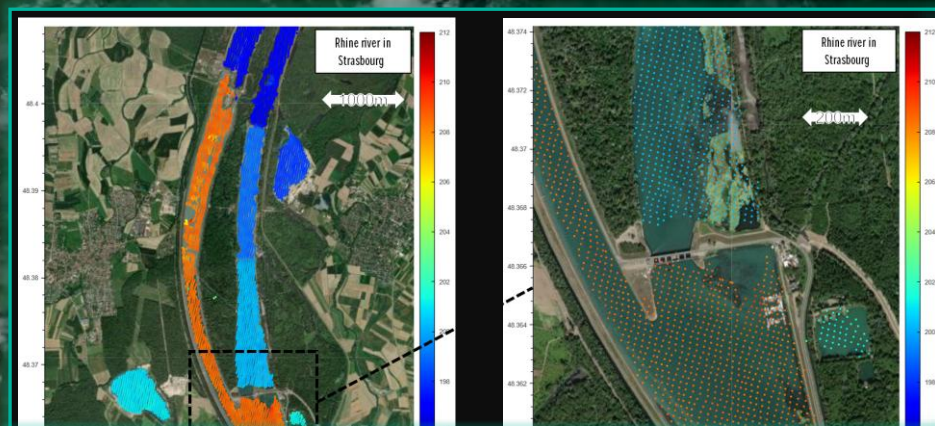
- **SWOT** works extremely well on large lakes & rivers
 - 100 m rivers & $(250\text{ m})^2$ lakes
 - Mission requirements
 - Global inventory of surface water (21-day cycle)



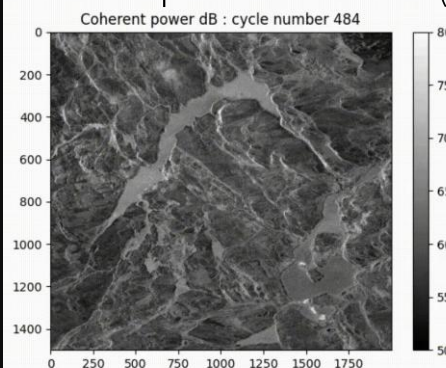
- **SWOT** outperforms its optional goals
 - 50 m rivers & $(100\text{ m})^2$ lakes
 - Better monitoring of water cycle
 - 6 million lakes are monitored



- **SWOT** delivers on frozen lakes & rivers
 - Ice is bright enough for heights
 - Frozen/Liquid state from σ_0
 - 1-day phase captured thaws



SWOT captures the lake thaw (left)



Confirmed with local webcam (right)

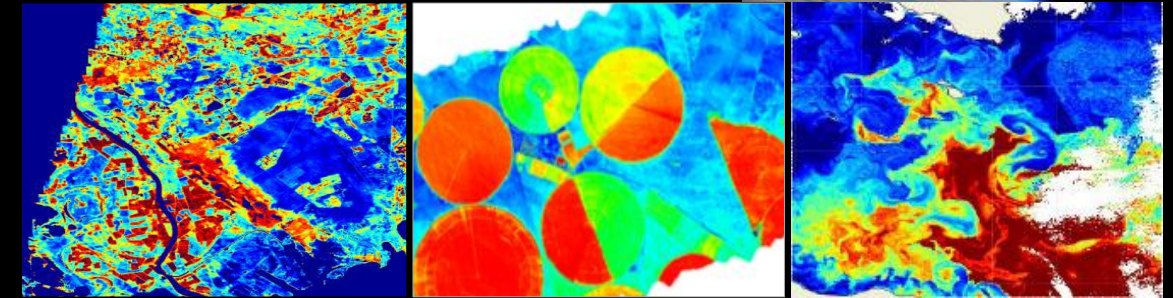
MEASURE THE SURFACE TEMPERATURE

The Franco-Indian TRISHNA mission and its frequent high-resolution measurements address major scientific, economic, and societal challenges through the five main themes which the mission addresses from research perspective and application development. These five main themes are:

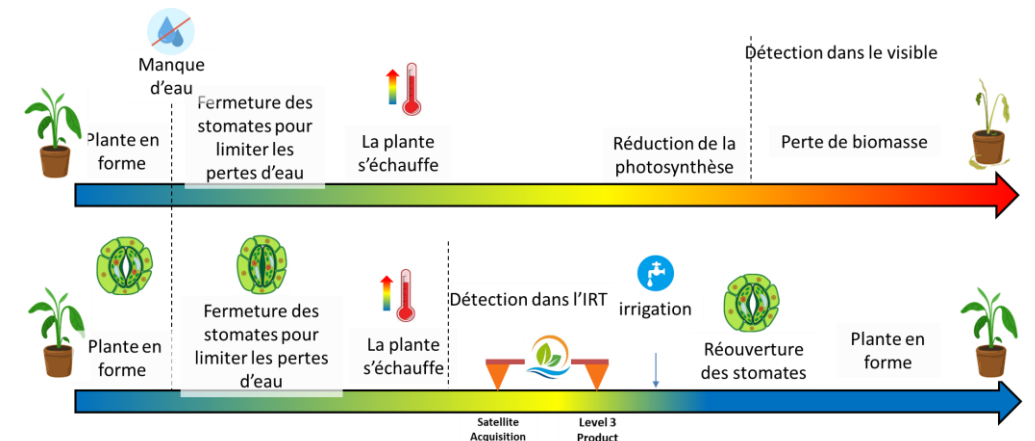
- ECOSYSTEM MANAGEMENT AND WATER STRESS DETECTION (ADJUSTING IRRIGATION NEEDS AS BEST AND AS EARLY AS POSSIBLE)
- MONITORING OF COASTAL AND INLANDS WATERS
- URBANIZATION AND URBAN HEAT ISLANDS
- ATMOSPHERE (AEROSOLS, WATER VAPOR, CLOUDS)
- CRYOSPHERE (SNOWMELT RUNOFF)

Mission characteristics:

- Lifetime 5 years
- Global land and coastal coverage
- 3-day revisit, 60 m resolution
- Equator crossing: 12:30 PM & AM
- Variable viewing angles up to 38 degrees
- VNIR-SWIR (7 bands) – TIR (4 bands)
- NeDT 0.2K instrument output, 0.5°K at 1C level
- Linked with ESA mission: LSTM to be launch in 2029 – A and 2030 – B
- Free and open data:
 - Level 2: surface reflectance, **surface temperature**, emissivity, plant-related variables, evapotranspiration flux
 - Level 3: **'Daily evapotranspiration product by interpolation**



Focus on the contributions of TRISHNA in agriculture



(Philippe Gamet, CESBIO/CNES)

TROPICAL FOREST

Beyond Carbon : Changes in forest affect the benefits we gain from forests.

Changes in forest have major effects on the socio-economics, material, energy, protective, biodiversity & cultural benefits offered by forests.

Through the BIOMASS mission, ESA and CNES will have a better understanding of tropical forest structure:

- Thanks to its P-BAND radar instrument, and by measuring forest biomass (AGB) and height, BIOMASS will be able to produce a **precise status of tropical forest throughout the world** (on covered area), and to quantify the role of tropical forests in carbon sequestration.
- Moreover, the P-BAND radar capability will enable **to map the area under the trees**, to give precious insight about topographic elements and water flux under the canopy.

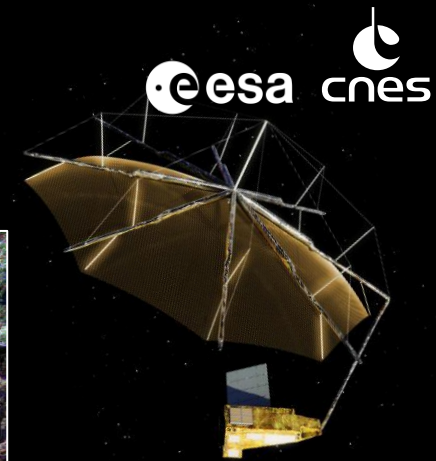
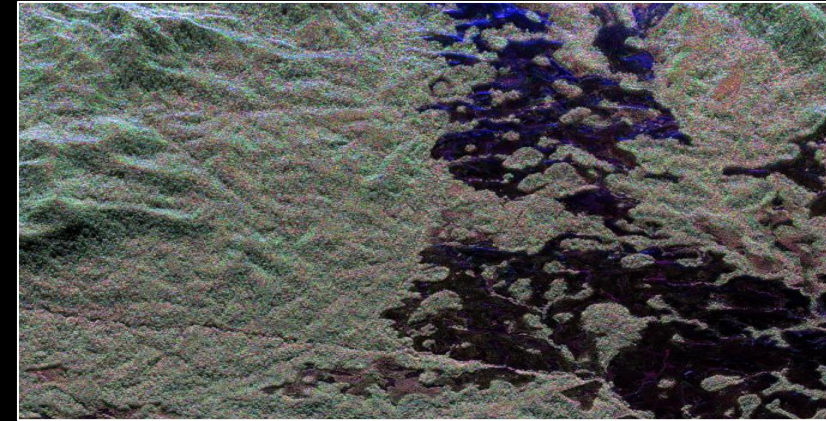
Partial coverage of the globe:

- Red : priority
- Yellow : best effort



7th Mission of ESA's Earth Explorer programme

- Launch on April 29, 2025 from Kourou on VEGA-C



BIOMASS Products



200 m resolution
(10 t/h for low biomass)



200 m resolution



50 m resolution



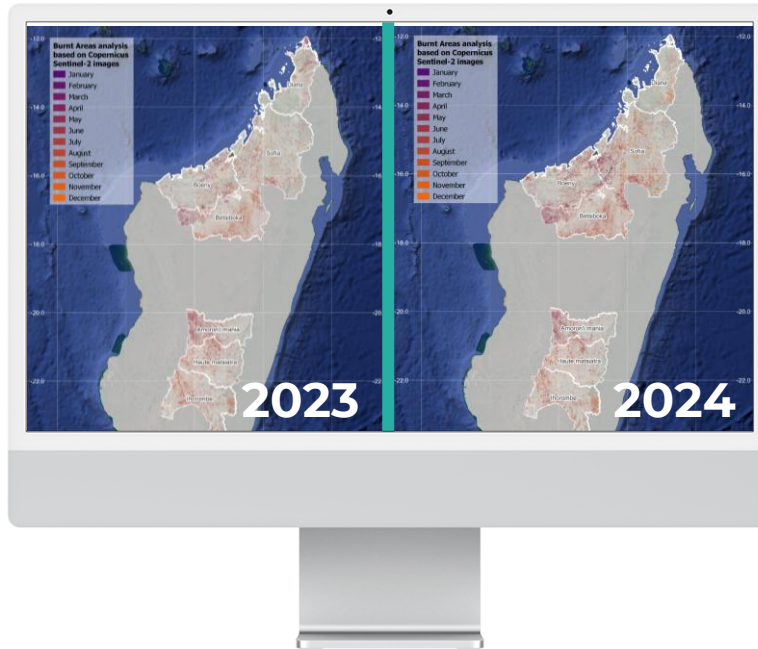
04

APPLICATIONS

USING SENTINEL 2, EXAMPLE :

This project GDA Madagascar project combined three complementary EO services:

Fire Detection



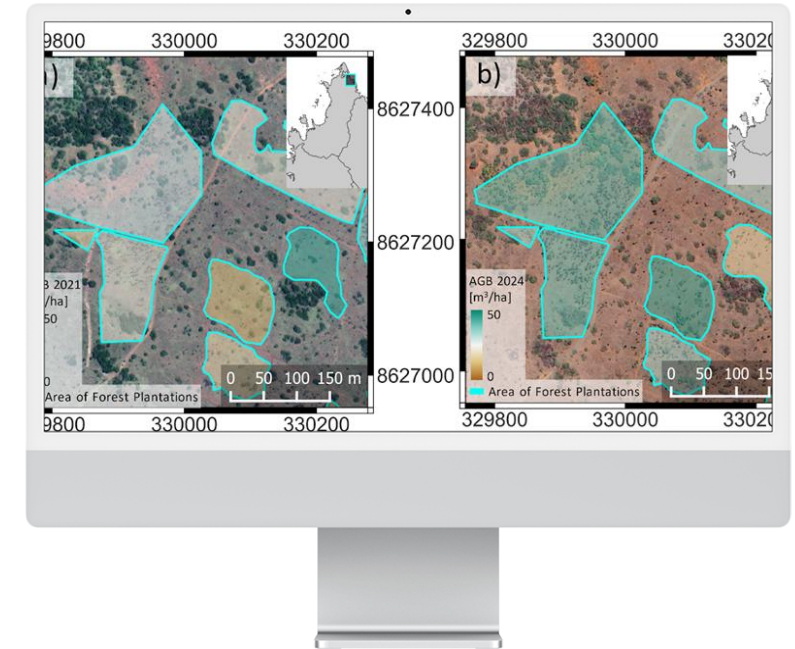
- Using Sentinel-2 imagery and the Normalized Burn Ratio (NBR) index, analysts mapped over 25,000 km² of burnt areas in 2023 and 30,000 km² in 2024.
- Temporal trends revealed seasonal peaks between May and November, aligning with Madagascar's dry season.

Reforestation Monitoring



- Using NDVI time-series from Sentinel-2, the team monitored the growth and health of 587 reforested plots across the country.
- This approach quantified tree survival, growth rates, and disturbance events, enabling regional comparisons and adaptive management.

Biomass Estimation



- Advanced modeling combined very-high-resolution imagery (WorldView, PlanetScope) with GEDI LiDAR to estimate aboveground biomass per hectare.
- This data supports carbon accounting and identifies regions where reforestation efforts are thriving or need reinforcement.

OTHER APPLICATIONS



With France2030 investment plan, demonstration of hydrologic services for public water policies, 4 work packages:

- Surfaces and volumes of water bodies
- Surface water quality
- Irrigated plots and vegetation cover
- Single portal for visualization, exploitation and analysis



<https://hydroscopia.fr/>

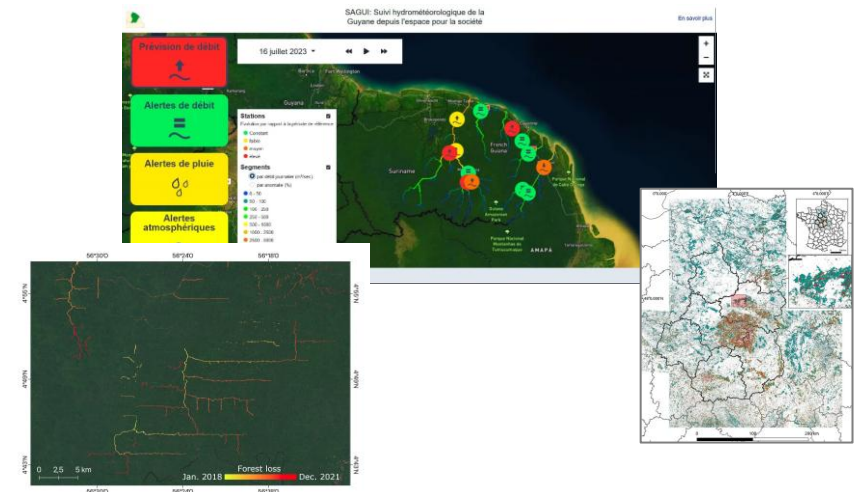


A project to support decentralized state services in managing drought orders



ISCO is an international initiative to enhance the use of satellite data for climate action:

- IRRISAT-MOROCCO – irrigation water optimization support system using satellite data
- OpHySE – Operational Hydrology from Space and models in French Guiana
- TropiSCO – Map of deforested areas in near real-time
- SCOp – Annual maps of temperate forest dieback



- Proposal for a topographic and water flow model under the canopy by combining BioMass, SWOT and other space missions with calibrated airborne lidar measurements



THANKS!