

MONITORING MANGROVES WITH EARTH OBSERVATION DATA: MANGMAP, A USER-DRIVEN AND INTERACTIVE MAPPING PLATFORM

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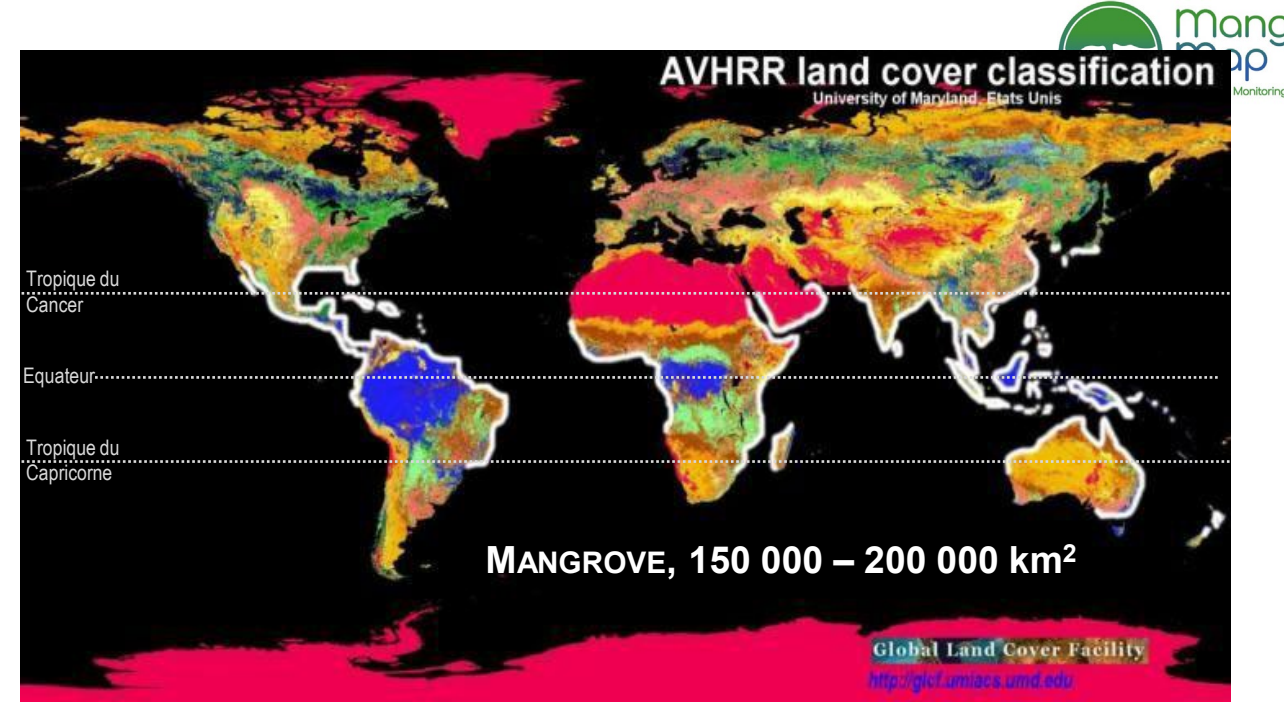
¹IRD / UMR Espace-dev, ²La TeleScop

Mangrove forest

➤ $\frac{3}{4}$ of all coastal intertropical areas

➤ Intertidal forest ecotone

➤ Root systems adapted to marine immersion and extreme salinity

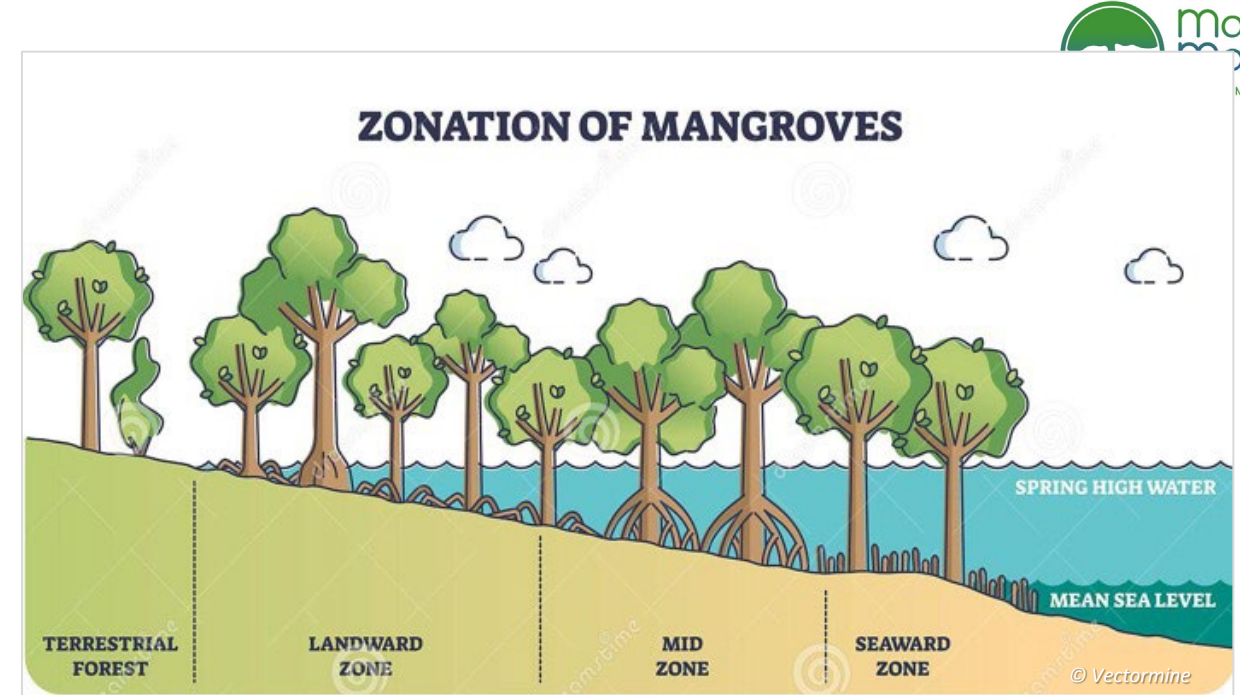


Mangrove ecosystems

➤ $\frac{3}{4}$ of all coastal intertropical areas

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➤ Root systems adapted to marine immersion and extreme salinity



Mangrove ecosystems

- $\frac{3}{4}$ of all coastal intertropical areas
- Intertidal forest ecotone
- Root systems adapted to marine immersion and extreme salinity

Specy: *Rhizophora*



Specy: *Avicennia*



Importance of mangroves

➔ Numerous ecosystem services



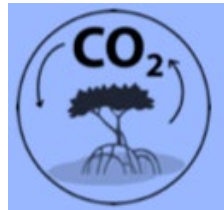
Coastal
protection



Biodiversity



Natural
resources



Carbon
sequestration
"Blue Carbon"

➔ Well-being and livelihoods of populations increasingly concentrated along the coasts



Threats to mangroves

Mangroves have decreased by **30-50%** over the last 50 years (*Duke et al. 2007 ; Polidoro et al. 2010*)

➤ Human pressure & destruction



Basse-Casamance, extensive rice cultivation in mangroves

➤ Natural / climate change impacts



French Guyana, coastal erosion impacts on mangrove

Monitoring mangroves with MangMap: context

- Designed as an open science tool in support to southern partners, not a research project of EO R&D

Downstream application - EO for Society



1. Scientific Research

Multidisciplinary research projects including EO data, methods and applications

→ SOS Mambo (CNES/TOSCA) Poster Session

2. Science as vector of development

Capacity building & empowerment, open data dissemination, open science programs, Education...



Adapting research output, seeking to meet transverse needs of local Partners

Monitoring mangroves with MangMap: context

- Designed as an open science tool in support to southern partners, not a research project of EO R&D
- Original needs: Partners in Madagascar, extended to an international framework

Bottom-up approach

- **Upstream collaborative Partners:** invited to share reference data, and to relay MangMap actions in favor of End-users awareness and empowerment
 - **Dowstream End-users:** consulted to collect feedbacks, needs & recommendations to set and scale future orientations
- The network under construction is MangMap's **priority for 2025**

Target end-user profile

*Scientists, academic students, PhDs,
post-docs...
GIS analysts, officers in
environmental agencies, Parks,
protected areas, technical services at
all territorial levels...*

*Prerequisites: notions in remote
sensing*

Monitoring mangroves with MangMap: proposal

Provide an **interactive dashboard** dedicated to **satellite driven mangrove monitoring**

based on **tools & services complementary** to existing platforms, **in full open access**, focused on **local scales and infra annual timelines**,

allowing consultation, retrieval or on-line production of new information, inside specific **End-user areas of interest & time range of interest within the time series**

in order to assist End-users in identifying & documenting in time and space mangrove distribution and status

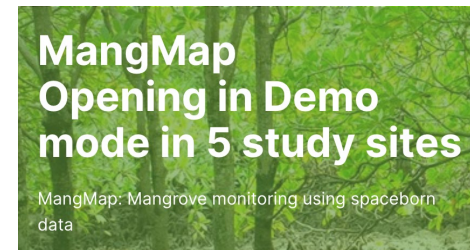
On-the-shelf pre-processed products of coastal areas with mangroves

- Reflectance & Spectral indexes
- Temporal composites of indexes
- Mangrove extent (quarterly)



On-demand Services to support product analysis

- Statistics reports on Index evolutions
- Differences in raster indexes
- Assessment of spatial evolutions



Opened in july 2024

- Bombetoka Bay, **Madagascar**
- Obock Region, **Djibouti**
- South Coast, **Senegal**
- North Province, **New Caledonia**
- Central Coast, **French Guiana**

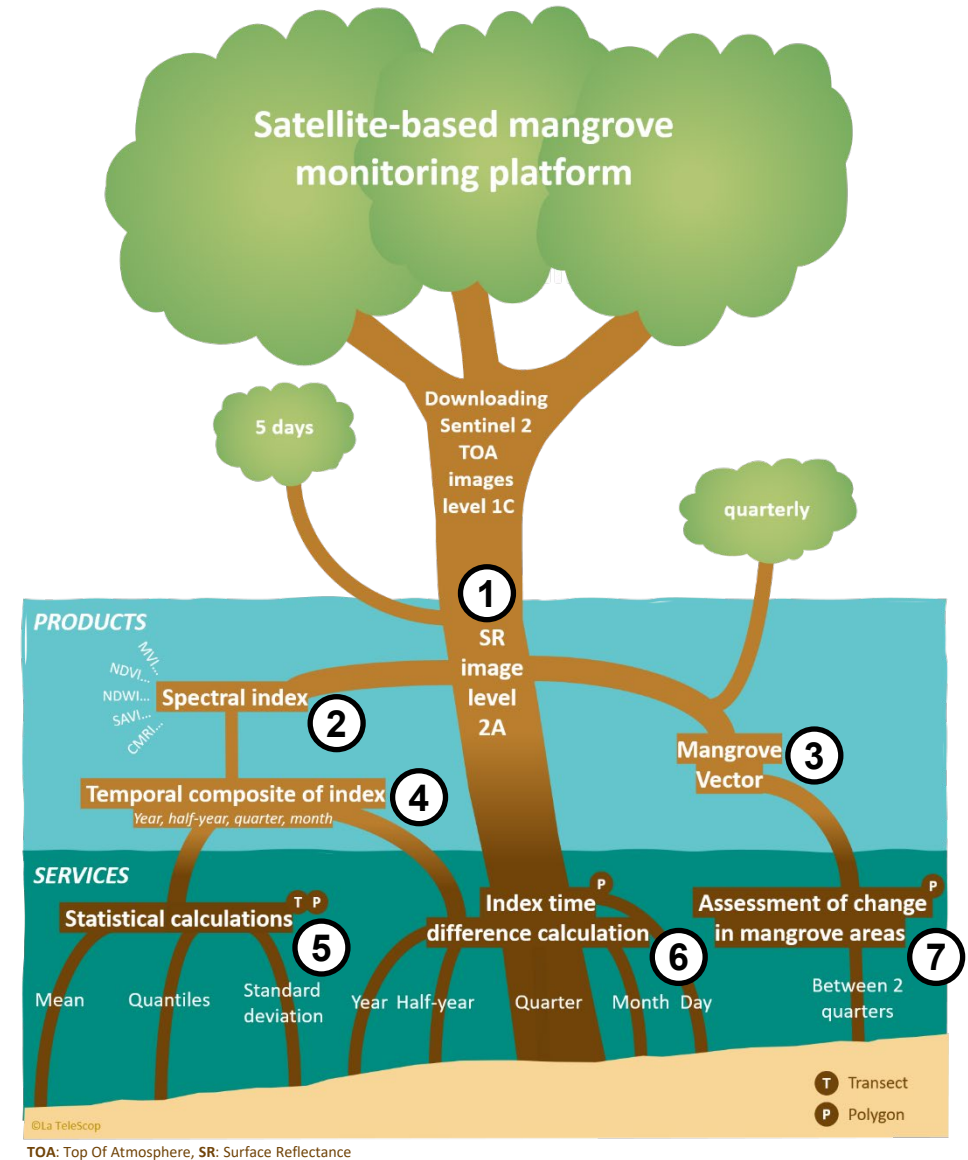
Monitoring mangroves with MangMap: products and services

Data, image processing, products in coastal areas

- ① Sentinel 2 reflectance data (level 2A) every 5 days (3 different color composites)
- ② 11 spectral indexes informing on mangrove: NDVI, NDWI, NDWI2, MNDWI, MNDWI2, NDRE, BIGR, CMRI, IRECI, MVI, SAVI, every 5 days (raster outputs)
- ③ Mangrove extent quarterly (vectors outputs)
- ④ Temporal composites (all indexes): month, quarter, half-year, year (raster outputs)

On-demand Services

- ⑤ Statistics reports: evolutions in temporal composites values within end-user polygons, along transects, on plot (graphs, table outputs)
- ⑥ Date to date raster differences in temporal composites values: within end-user polygons (raster outputs)
- ⑦ Assessment of mangrove spatial evolution: within end-user polygon (raster, table outputs)



Monitoring mangroves with MangMap: products and services

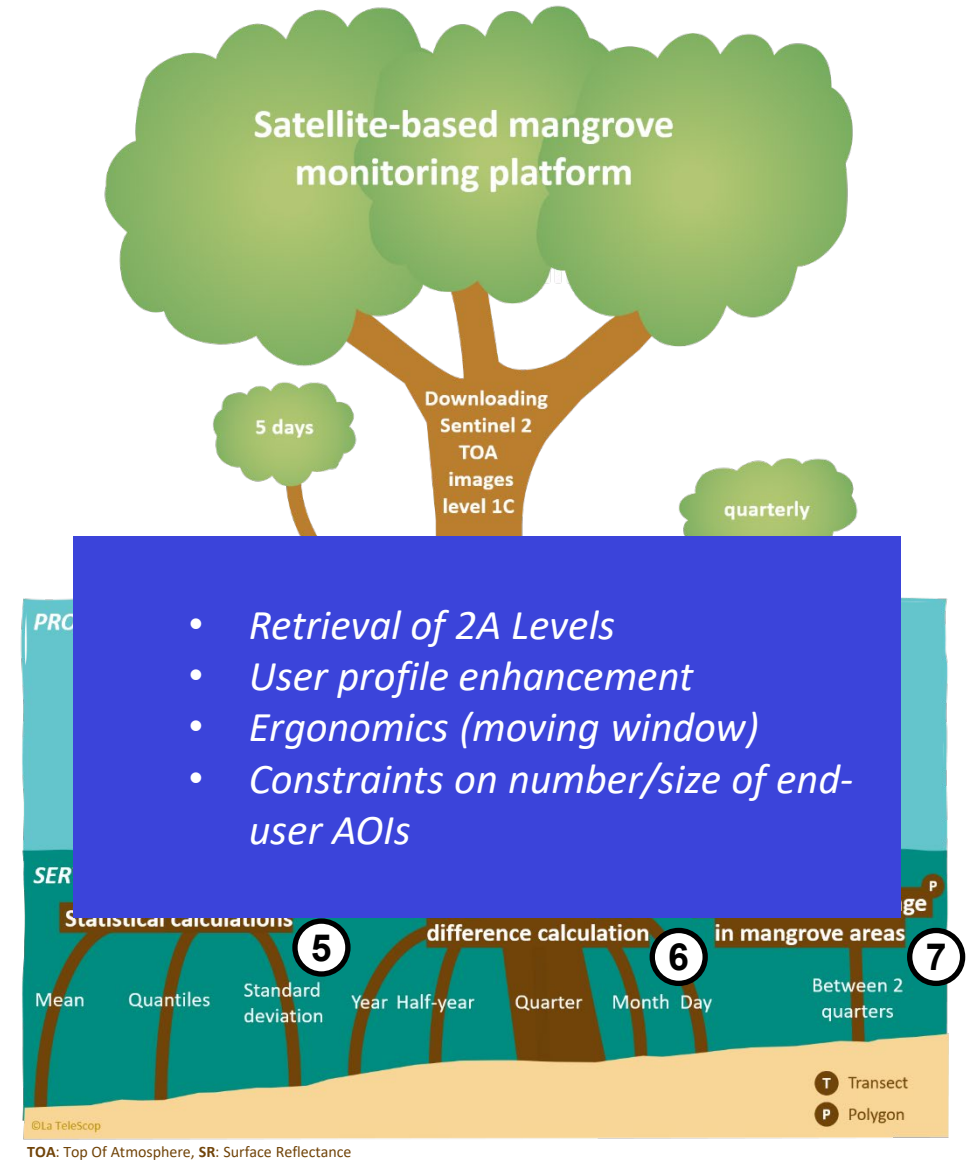
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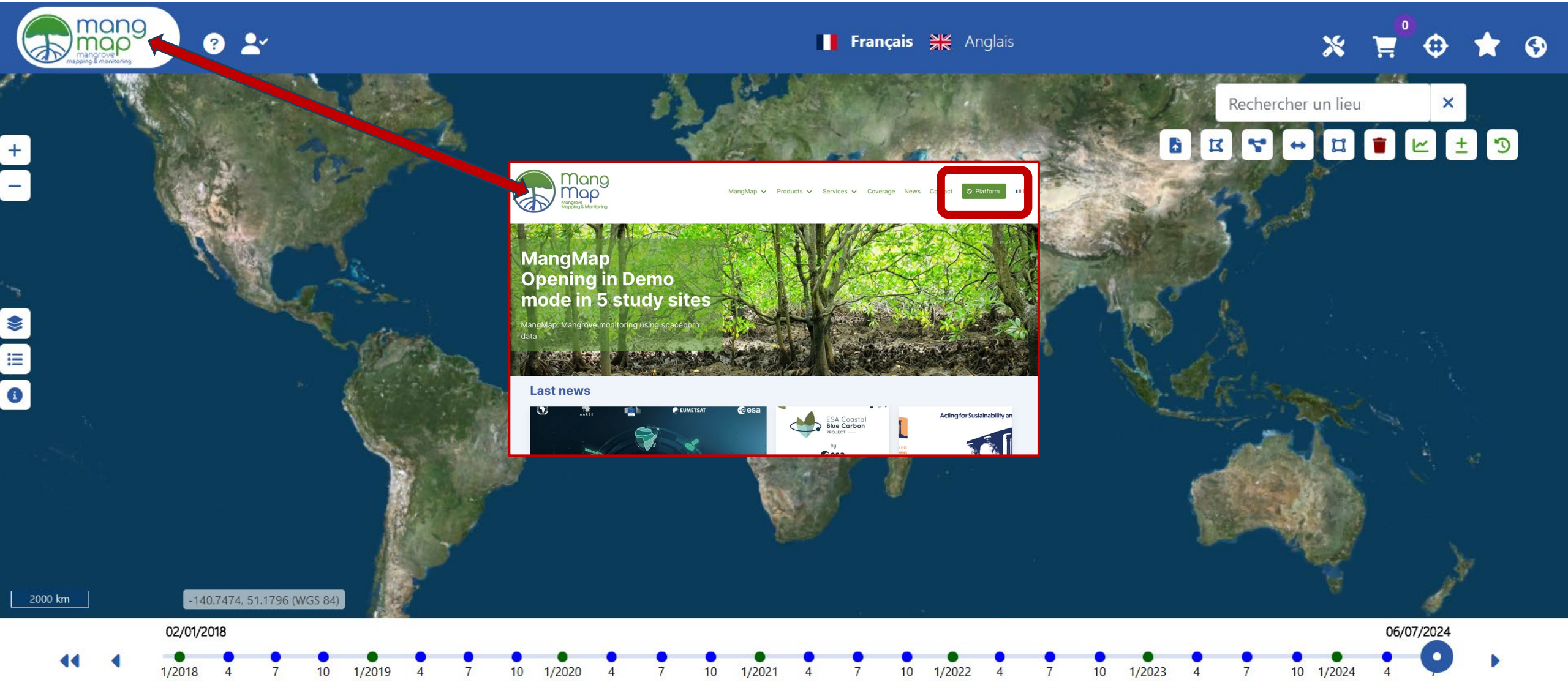
On-demand Services

- ⑤ Statistics reports: evaluation in temporal composites values within end-user polygons, along transects, on plot (graphs, table outputs)
- ⑥ Date to date raster differences in temporal composites values: within end-user polygons (raster outputs)
- ⑦ Assessment of mangrove spatial evolution: within end-user polygon (raster, table outputs)

Demo mode: upgrades in progress

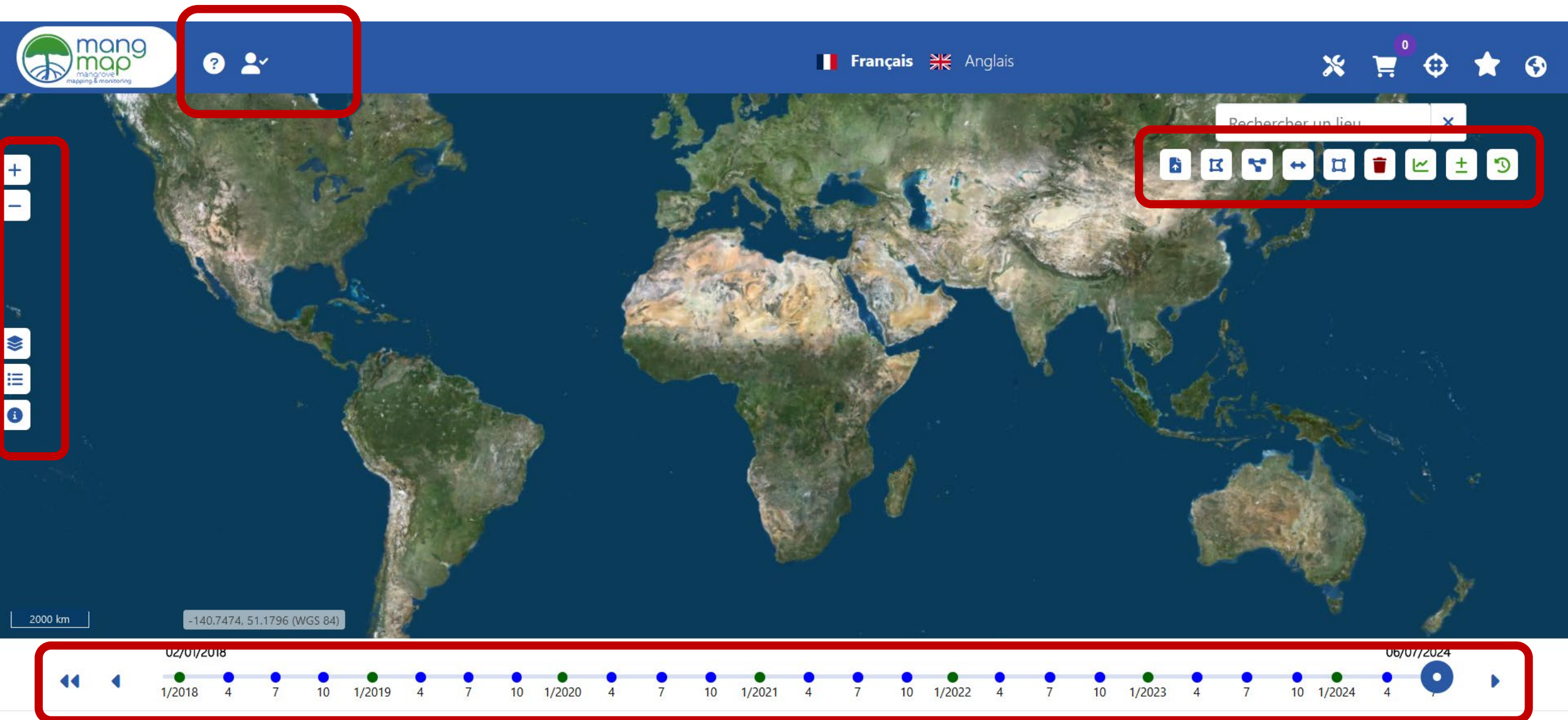


User interface: access from website



The screenshot displays the MangMap website interface. At the top left is the MangMap logo with a red arrow pointing to it. The top navigation bar includes language options for Français and Anglais, and utility icons for search, shopping cart, location, star, and globe. A search bar on the right contains the text "Rechercher un lieu". The main content area features a satellite map of the Pacific region. A red-bordered overlay window is positioned over the map, containing the MangMap logo, a navigation menu with a "Platform" button highlighted in a red box, and a news section titled "MangMap Opening in Demo mode in 5 study sites". Below the news section is a "Last news" area with three article thumbnails. At the bottom, a timeline slider shows dates from 02/01/2018 to 06/07/2024, with a 2000 km scale bar and coordinates (-140.7474, 51.1796 (WGS 84)).

User interface: access from website



The screenshot displays the MangroVe website's user interface, featuring a world map as the central element. Several key components are highlighted with red boxes:

- Top Left:** The MangroVe logo and a navigation menu containing a question mark icon and a user profile icon.
- Top Center:** Language selection options for "Français" (French) and "Anglais" (English).
- Top Right:** Utility icons including a shopping cart with a "0" notification, a search icon, a star, and a globe.
- Search Bar:** A search input field with the placeholder text "Rechercher un lieu" and a close button.
- Map Interaction:** A toolbar on the right side of the map with icons for home, full screen, share, pan, zoom in, zoom out, and refresh.
- Map Controls:** A vertical toolbar on the left side of the map with icons for zoom in, zoom out, layers, list, and info.
- Map Data:** A scale bar showing "2000 km" and a coordinate display showing "-140.7474, 51.1796 (WGS 84)".
- Timeline:** A horizontal timeline at the bottom of the map, spanning from "02/01/2018" to "06/07/2024". The timeline features a series of colored dots (green and blue) representing data points, with dates marked at intervals (e.g., 1/2018, 4, 7, 10, 1/2019, 4, 7, 10, 1/2020, 4, 7, 10, 1/2021, 4, 7, 10, 1/2022, 4, 7, 10, 1/2023, 4, 7, 10, 1/2024, 4). Navigation arrows and a play button are also present.

User interface: access from website

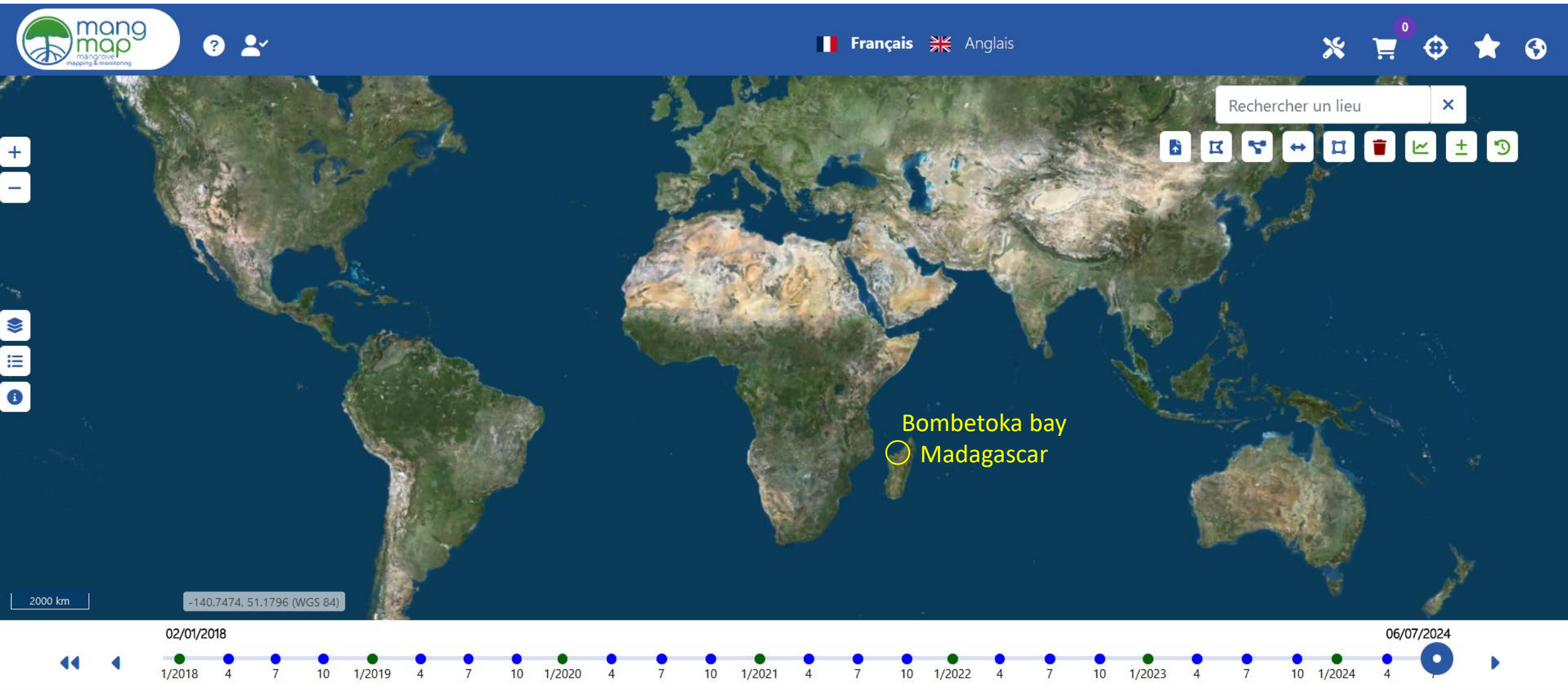
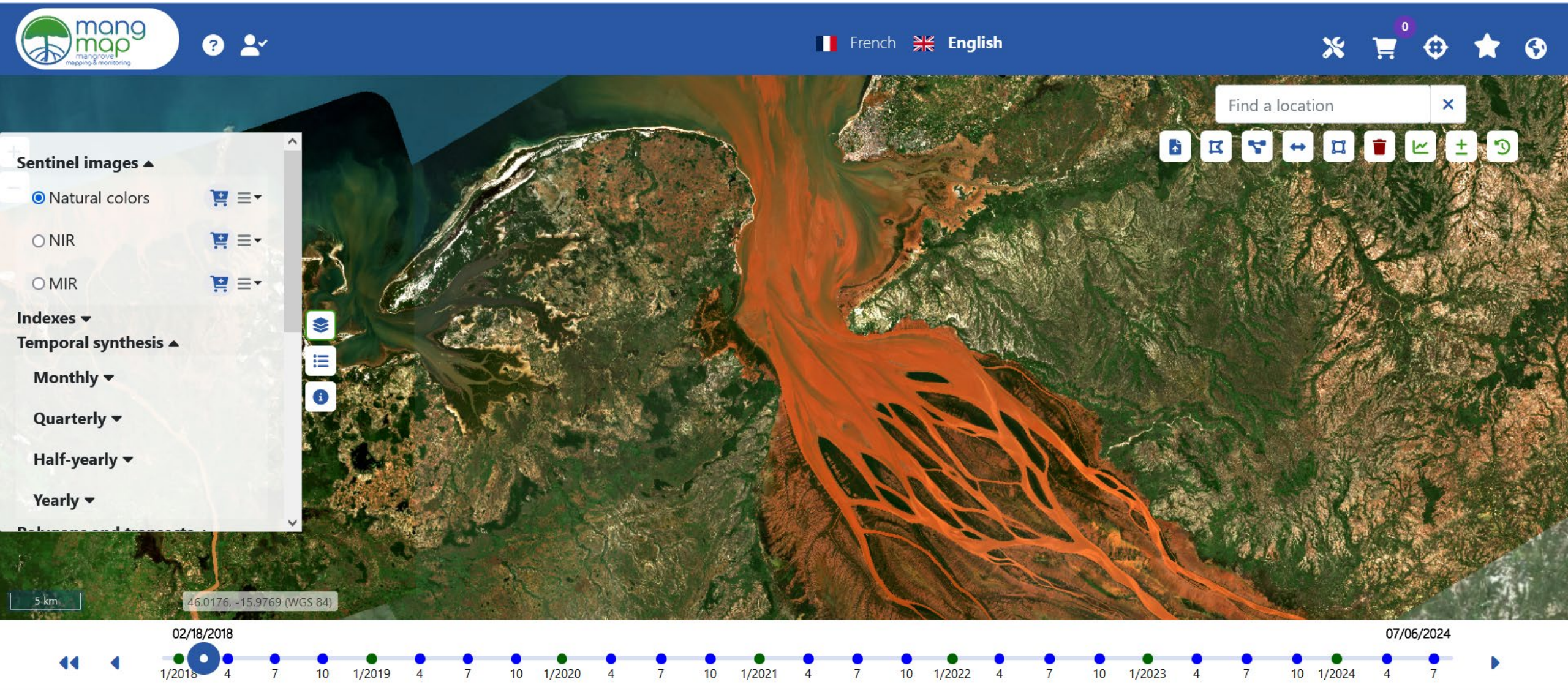


Image browsing: full temporal series (every 5 days)



The screenshot displays the Mangrove Mapping & Monitoring web application interface. The main view is a satellite image of a mangrove delta system, showing a large, branching network of channels and islands. The water in the channels is a reddish-brown color, likely due to sediment. The land is a mix of green and brown, indicating different vegetation and soil types.

The interface includes a top navigation bar with the Mangrove Mapping & Monitoring logo, a search bar, and language options (French and English). A sidebar on the left provides options for image styles (Natural colors, NIR, MIR) and temporal synthesis (Monthly, Quarterly, Half-yearly, Yearly). A bottom timeline shows the full temporal series from 02/18/2018 to 07/06/2024, with markers every 5 days. A 5 km scale bar and coordinates (46.0176, -15.9769 WGS 84) are also visible.

Sentinel images

- Natural colors
- NIR
- MIR

Indexes

Temporal synthesis

- Monthly**
- Quarterly**
- Half-yearly**
- Yearly**

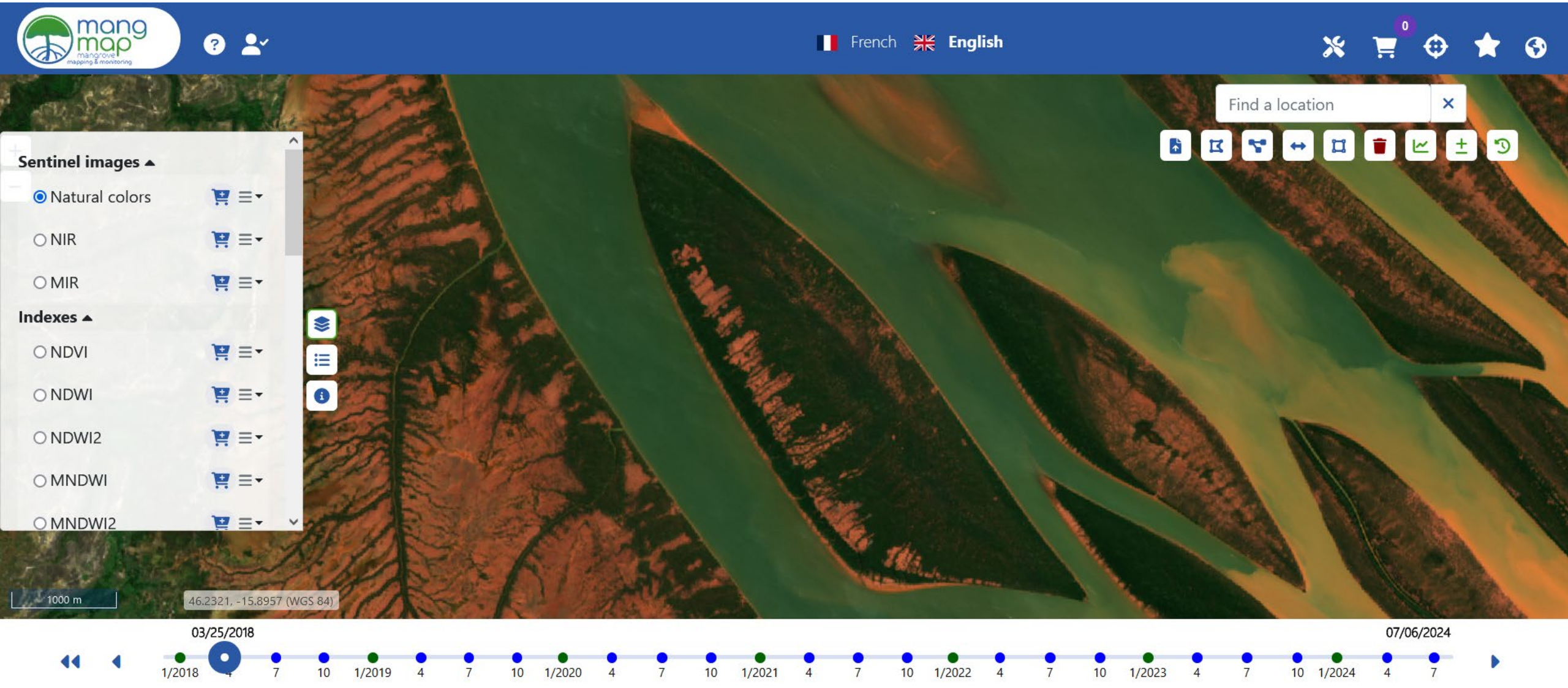
5 km

46.0176, -15.9769 (WGS 84)

02/18/2018 07/06/2024

1/2018 4 7 10 1/2019 4 7 10 1/2020 4 7 10 1/2021 4 7 10 1/2022 4 7 10 1/2023 4 7 10 1/2024 4 7

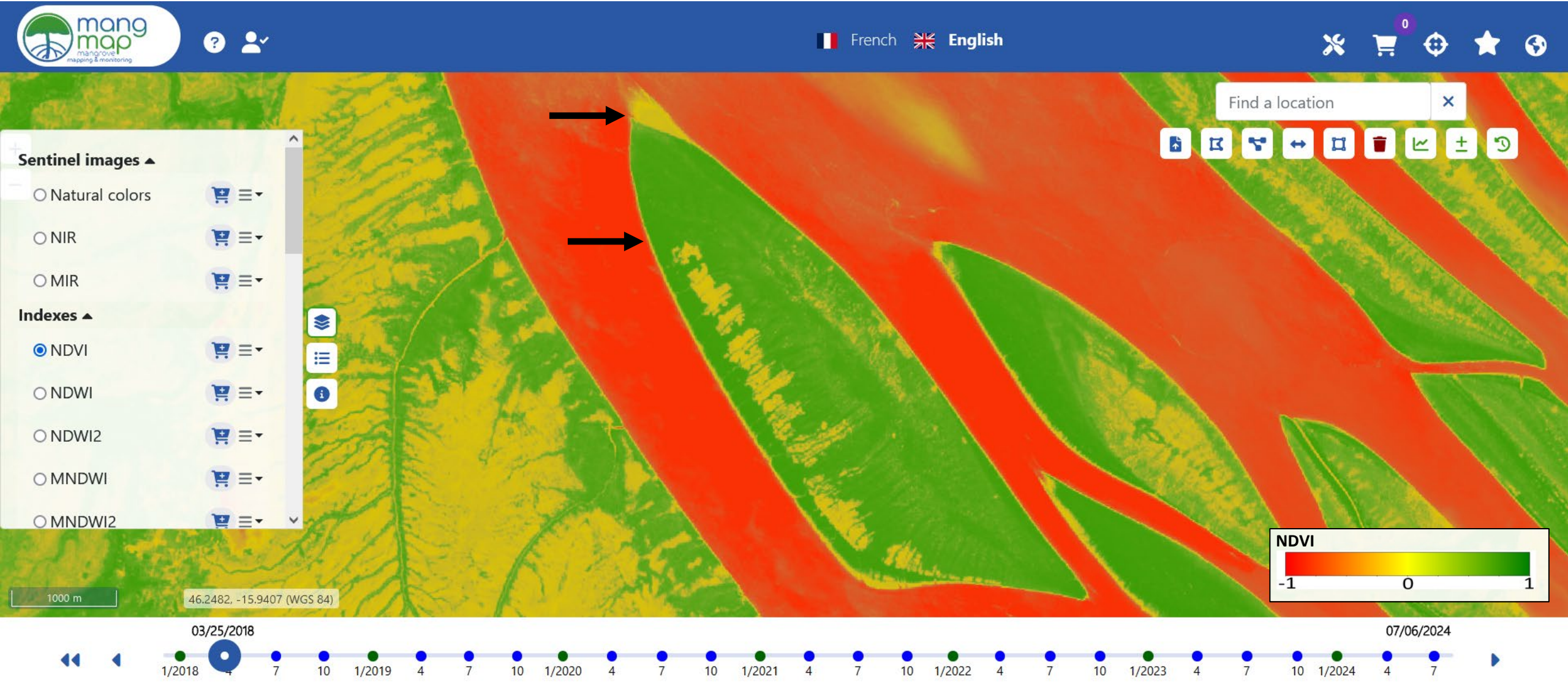
Image browsing: full temporal series (every 5 days)



The screenshot displays the Mangrove Map web application interface. At the top, there is a blue navigation bar with the Mangrove Map logo, a search bar, and language options for French and English. The main area shows a satellite image of a mangrove wetland with a complex network of water channels. On the left, a sidebar menu allows users to select different image types (Natural colors, NIR, MIR) and indices (NDVI, NDWI, NDWI2, MNDWI, MNDWI2). On the right, there are various map controls including a search bar, a 'Find a location' input, and a toolbar with icons for home, full screen, share, pan, zoom, and refresh. At the bottom, a timeline slider shows the temporal series of images from 03/25/2018 to 07/06/2024, with a current date indicator and navigation arrows. A scale bar indicates 1000 meters and the coordinates are 46.2321, -15.8957 (WGS 84).

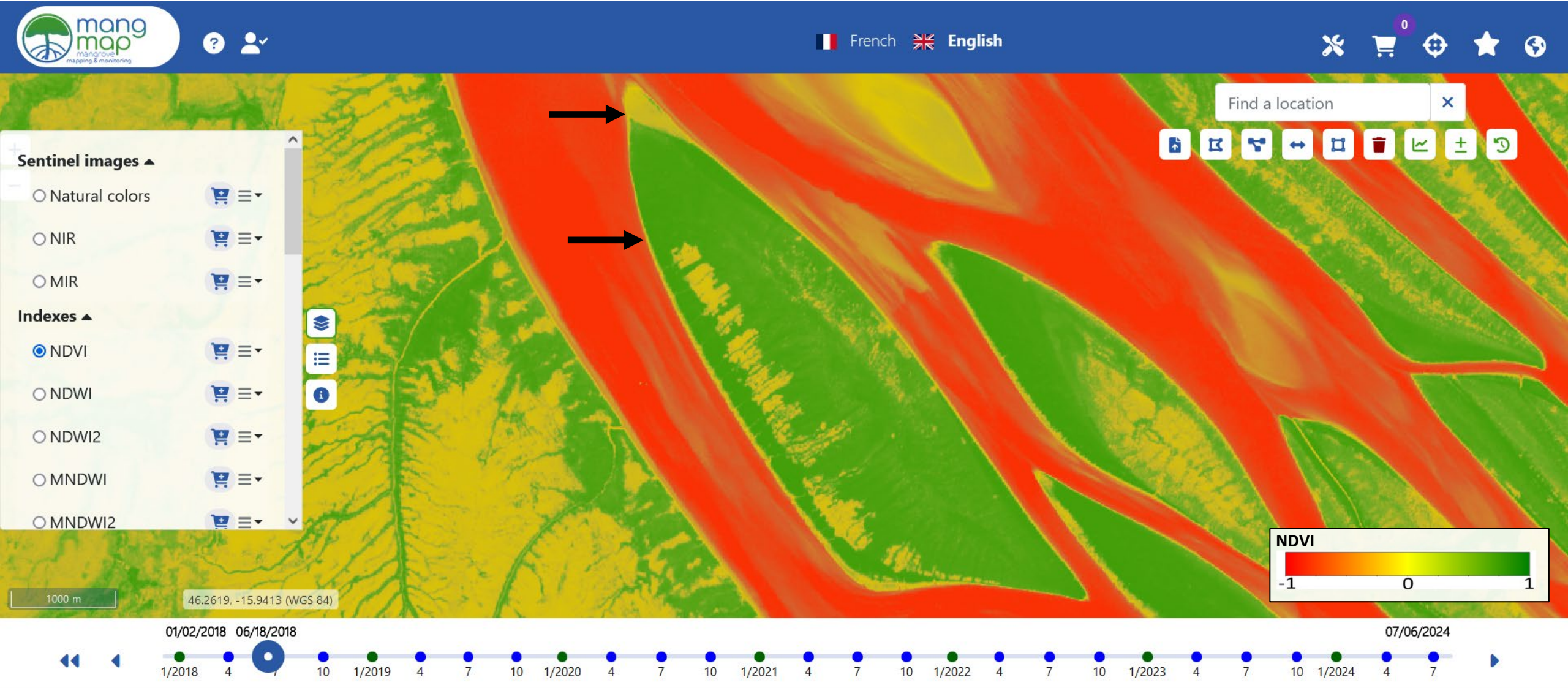
Indexes: every 5 days (11 indexes)

Temporal composites : monthly/quarterly/half-yearly/yearly



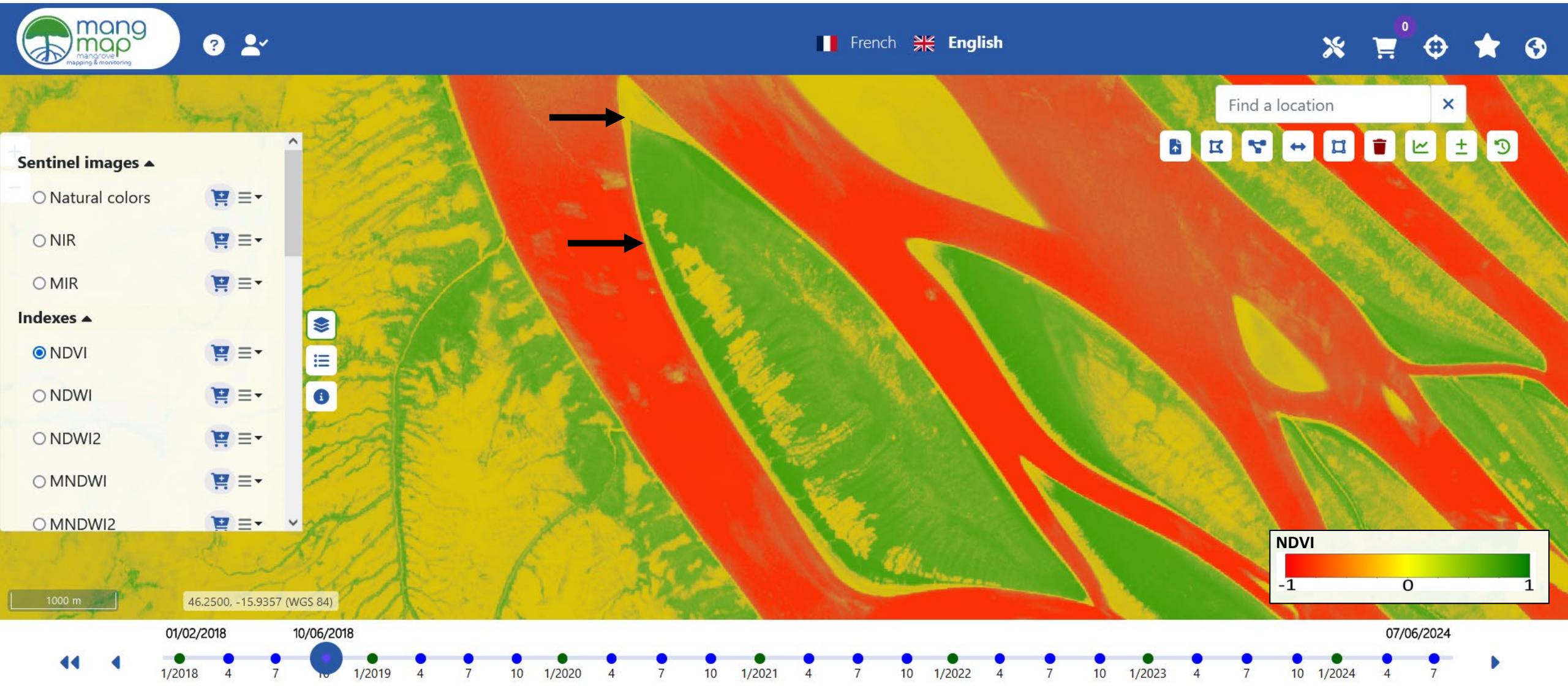
Indexes: every 5 days (11 indexes)

Temporal composites : monthly/quarterly/half-yearly/yearly



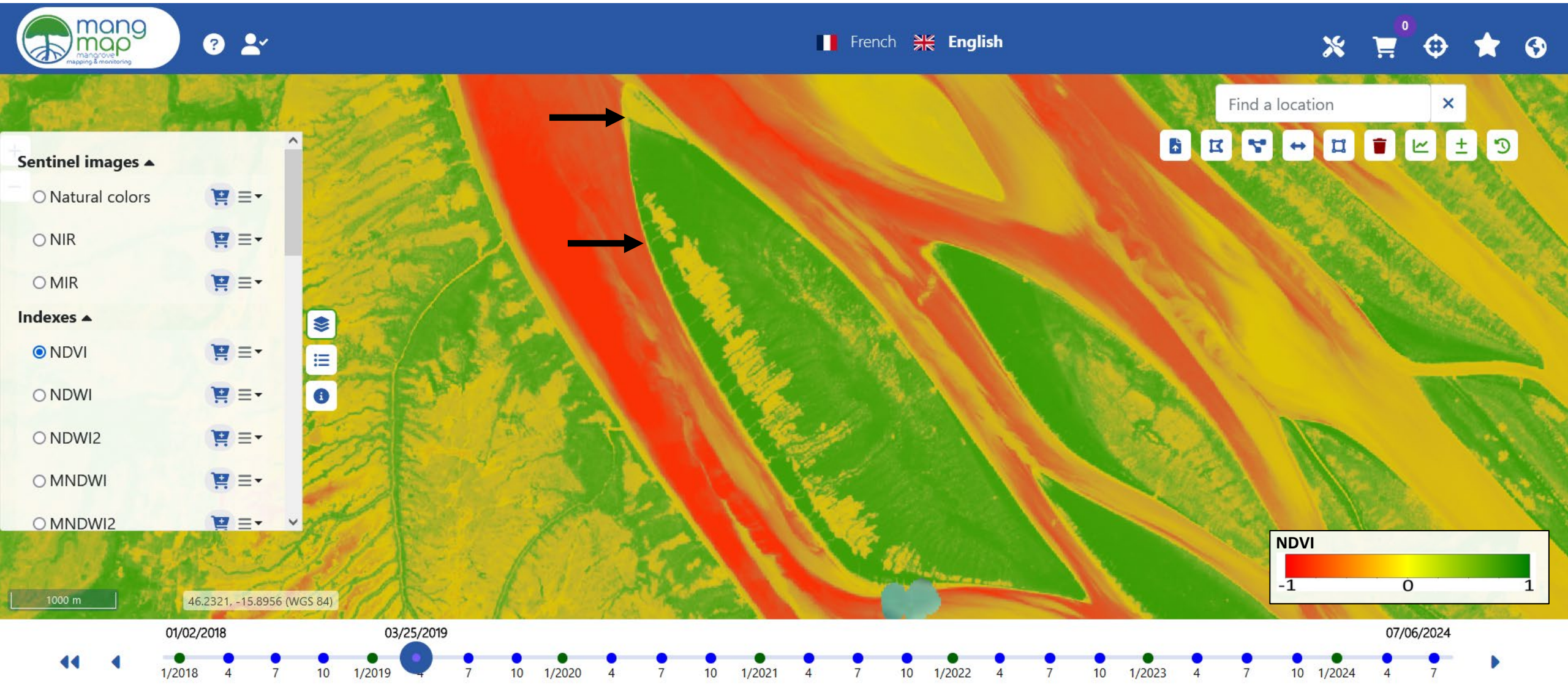
Indexes: every 5 days (11 indexes)

Temporal composites : monthly/quarterly/half-yearly/yearly



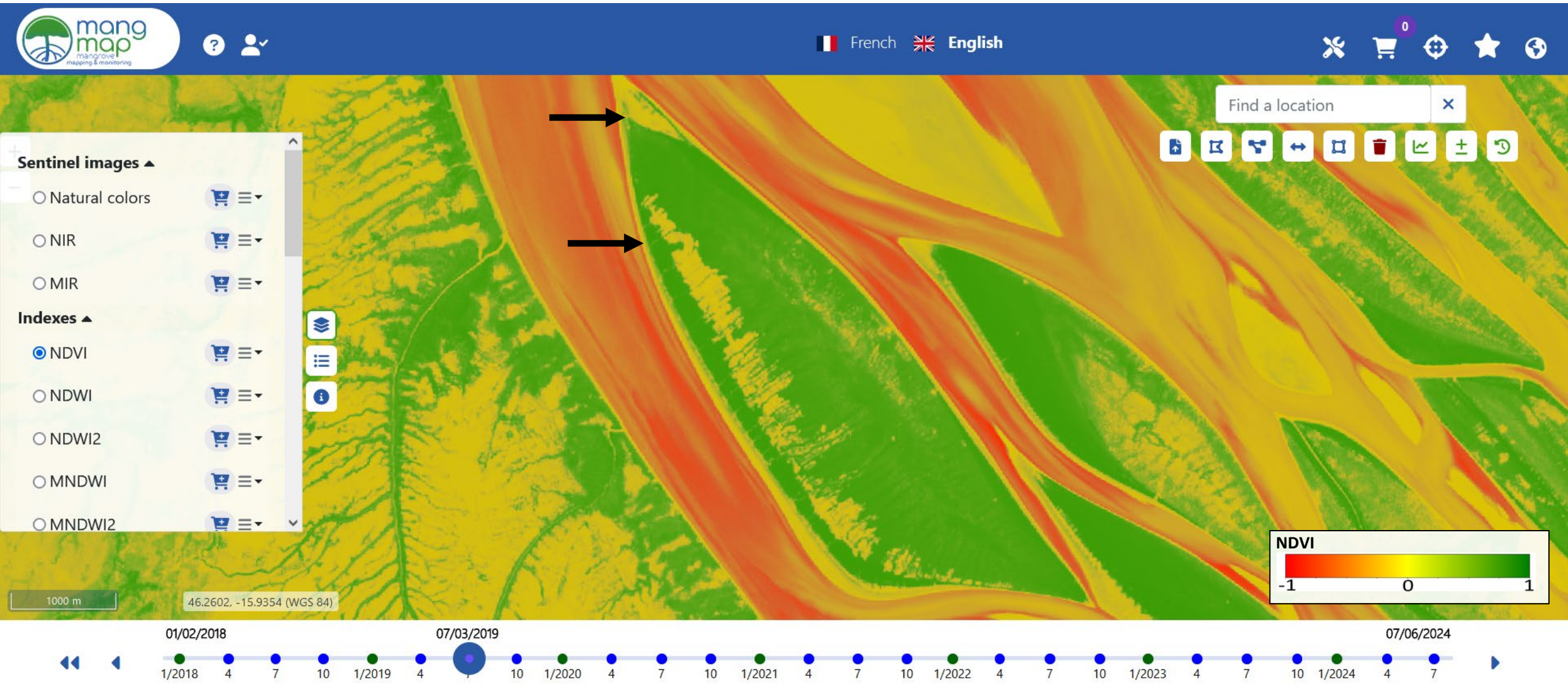
Indexes: every 5 days (11 indexes)

Temporal composites : monthly/quarterly/half-yearly/yearly



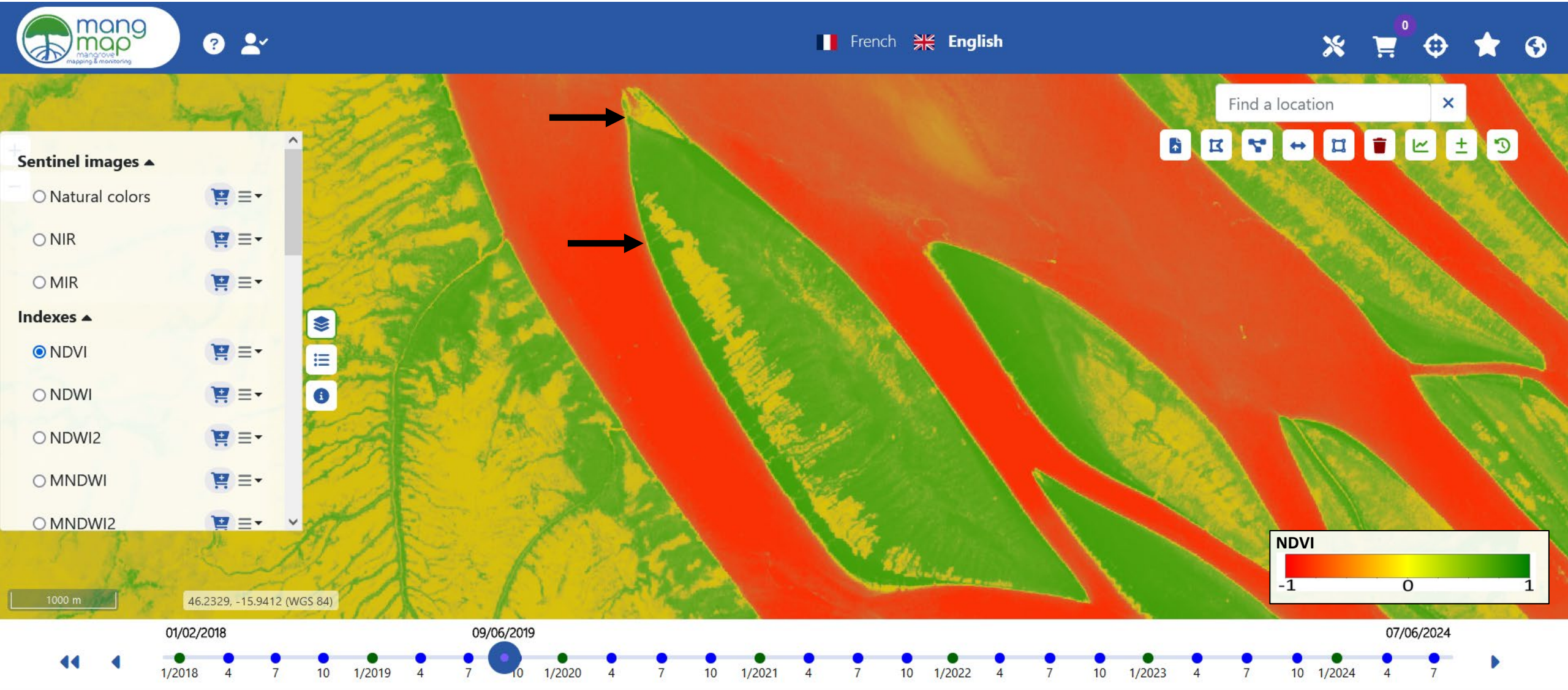
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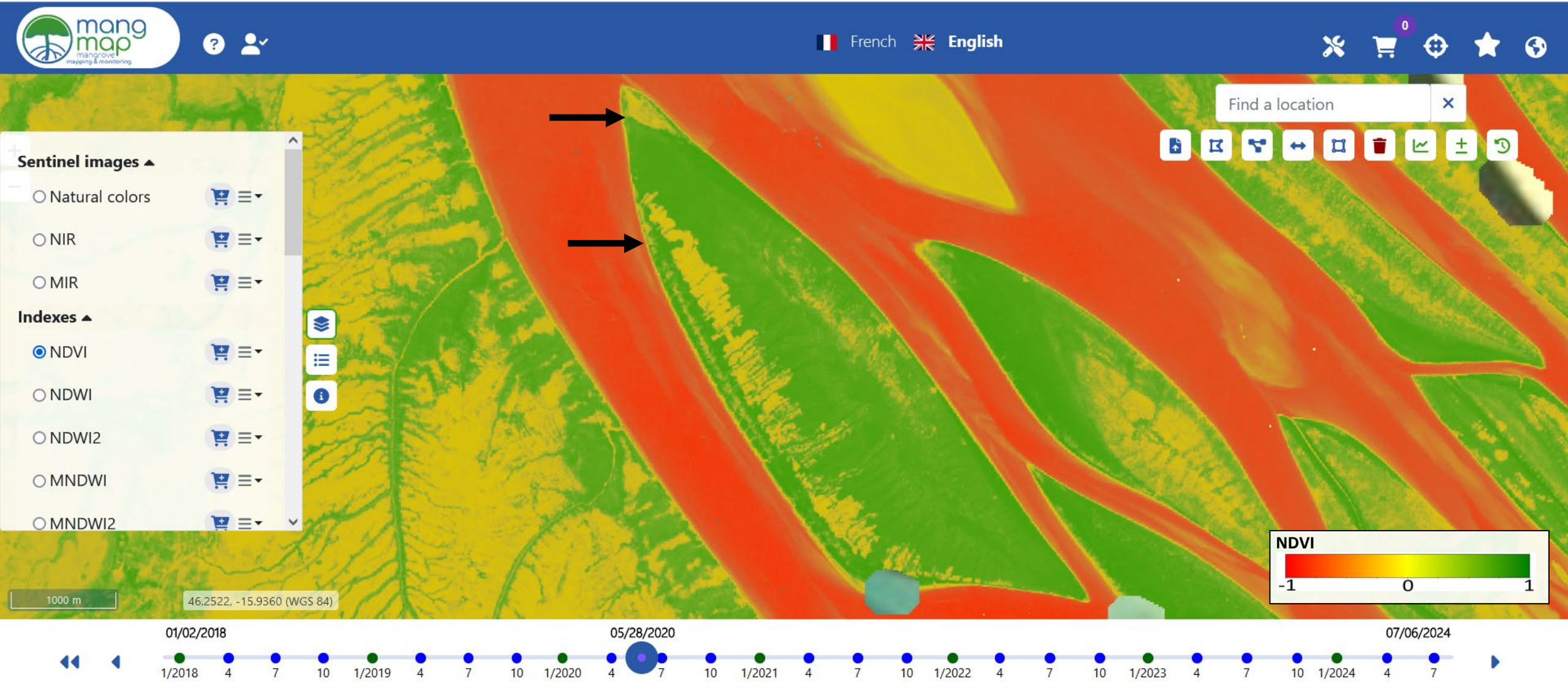
Indexes: every 5 days (11 indexes)

Temporal composites : monthly/quarterly/half-yearly/yearly



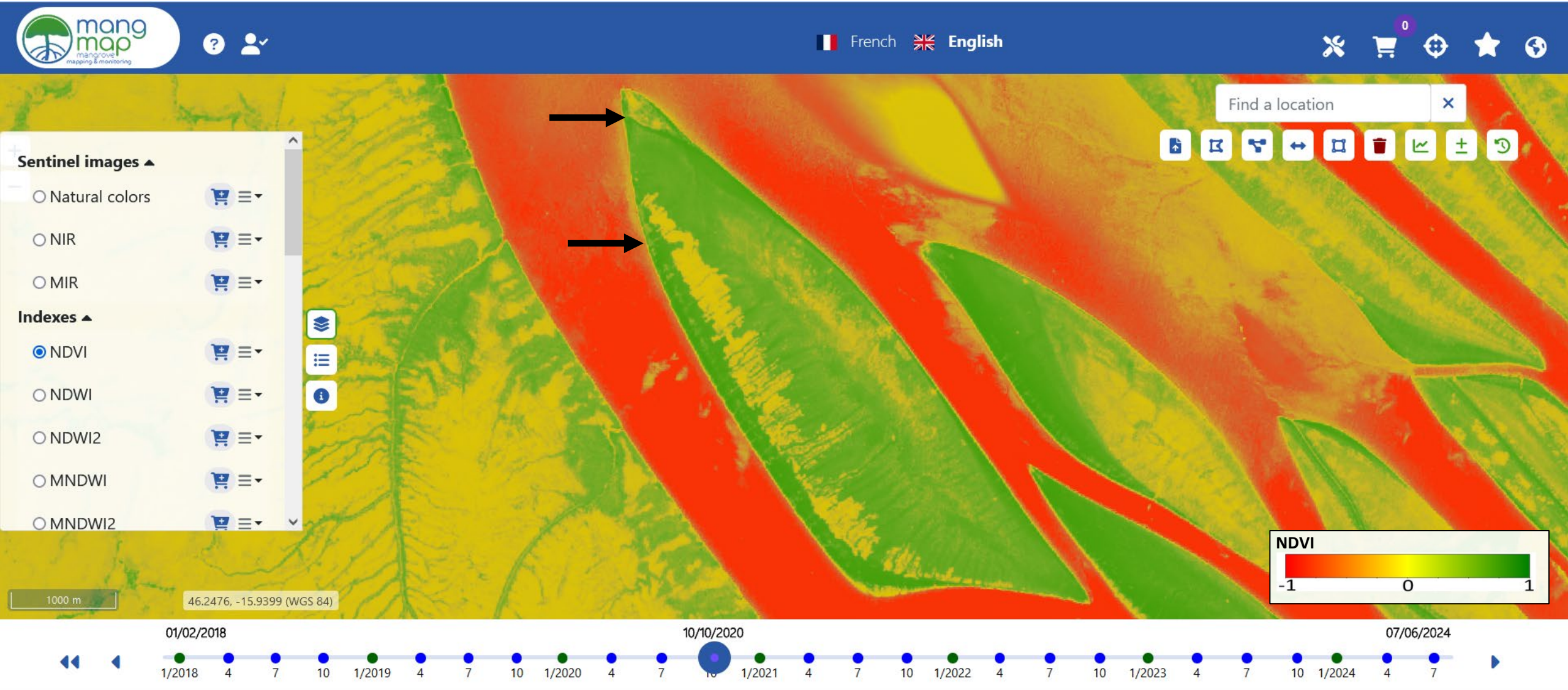
Indexes: every 5 days (11 indexes)

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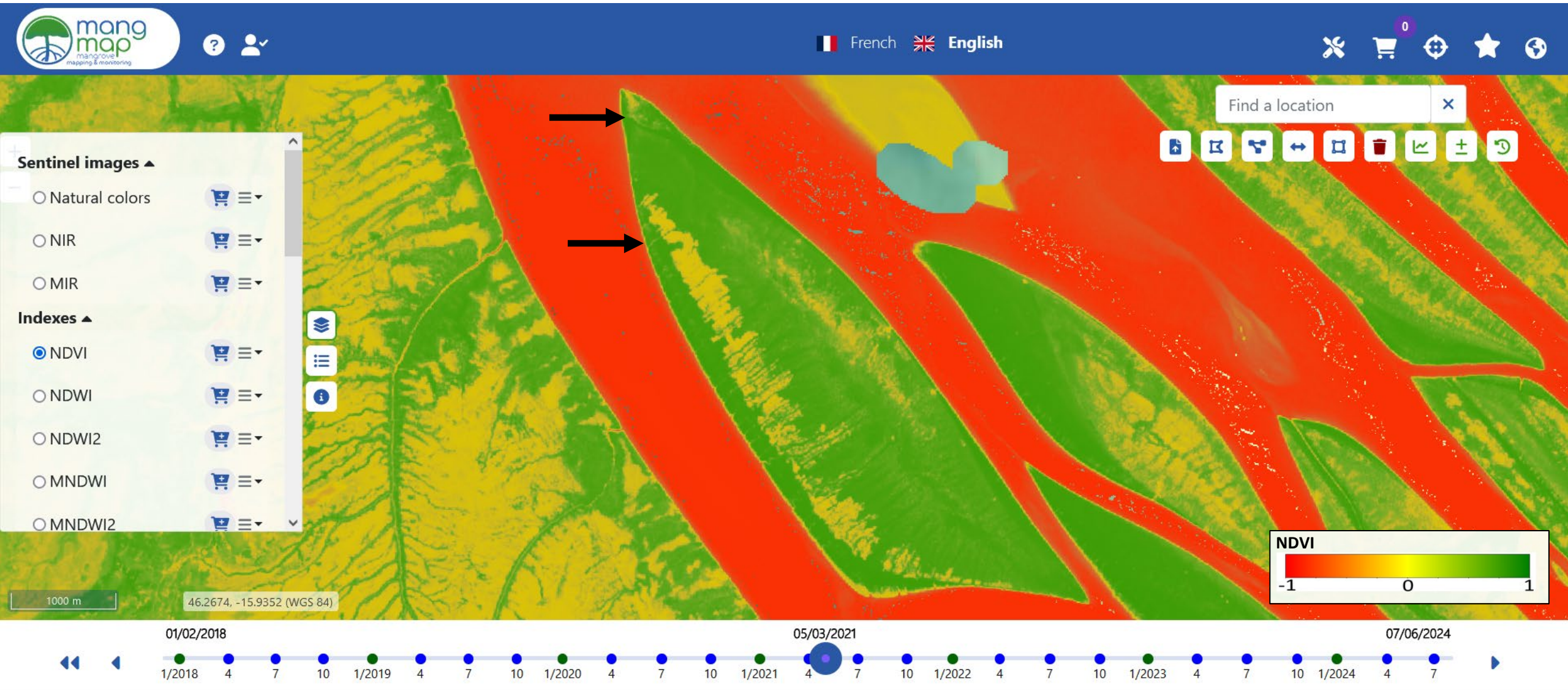
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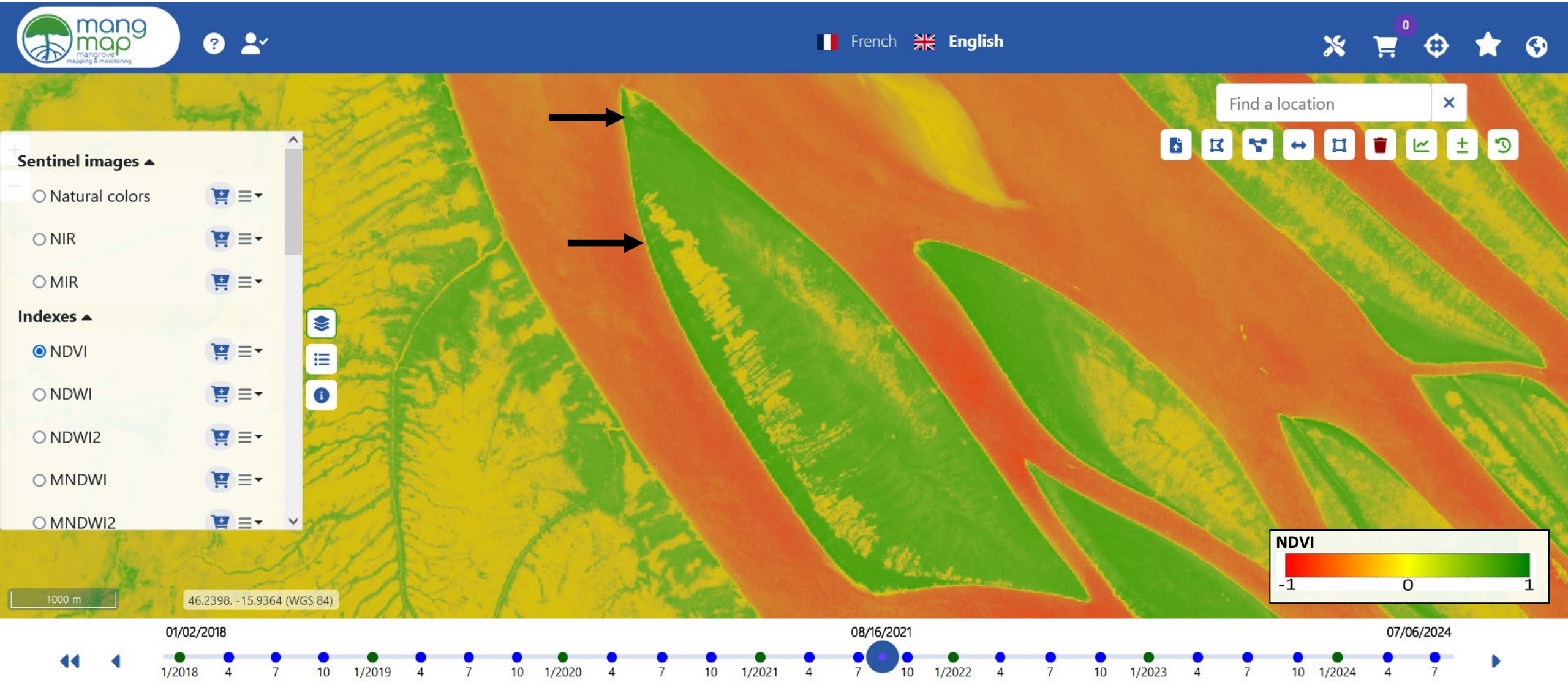
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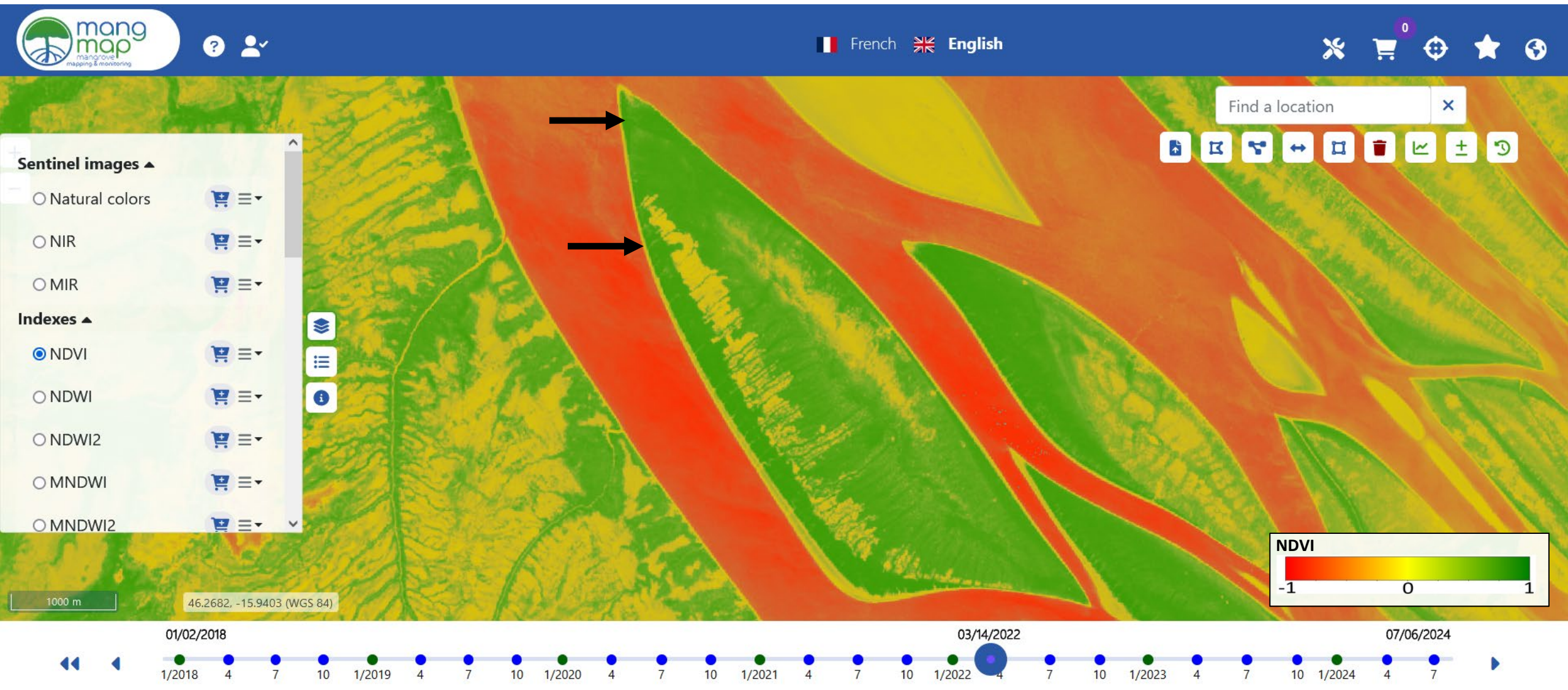
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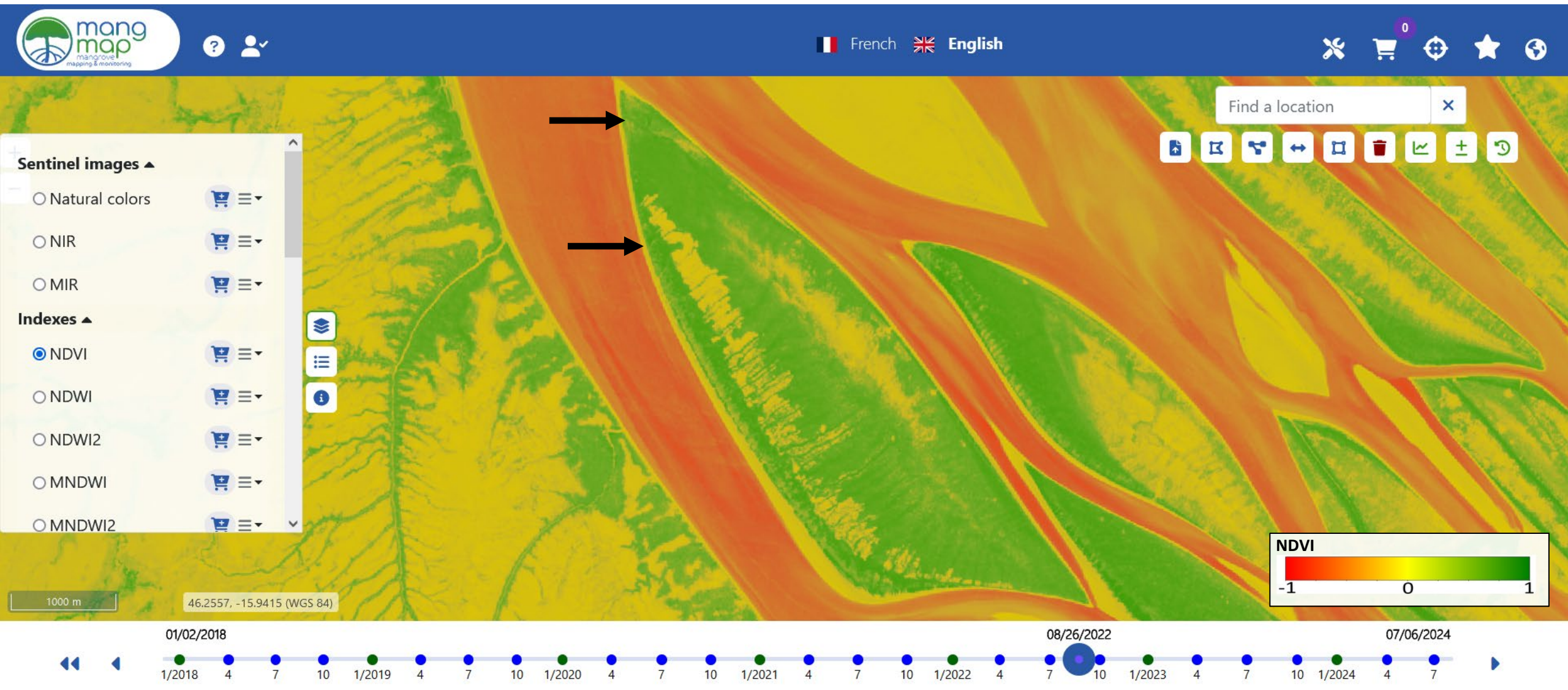
Indexes: every 5 days (11 indexes)

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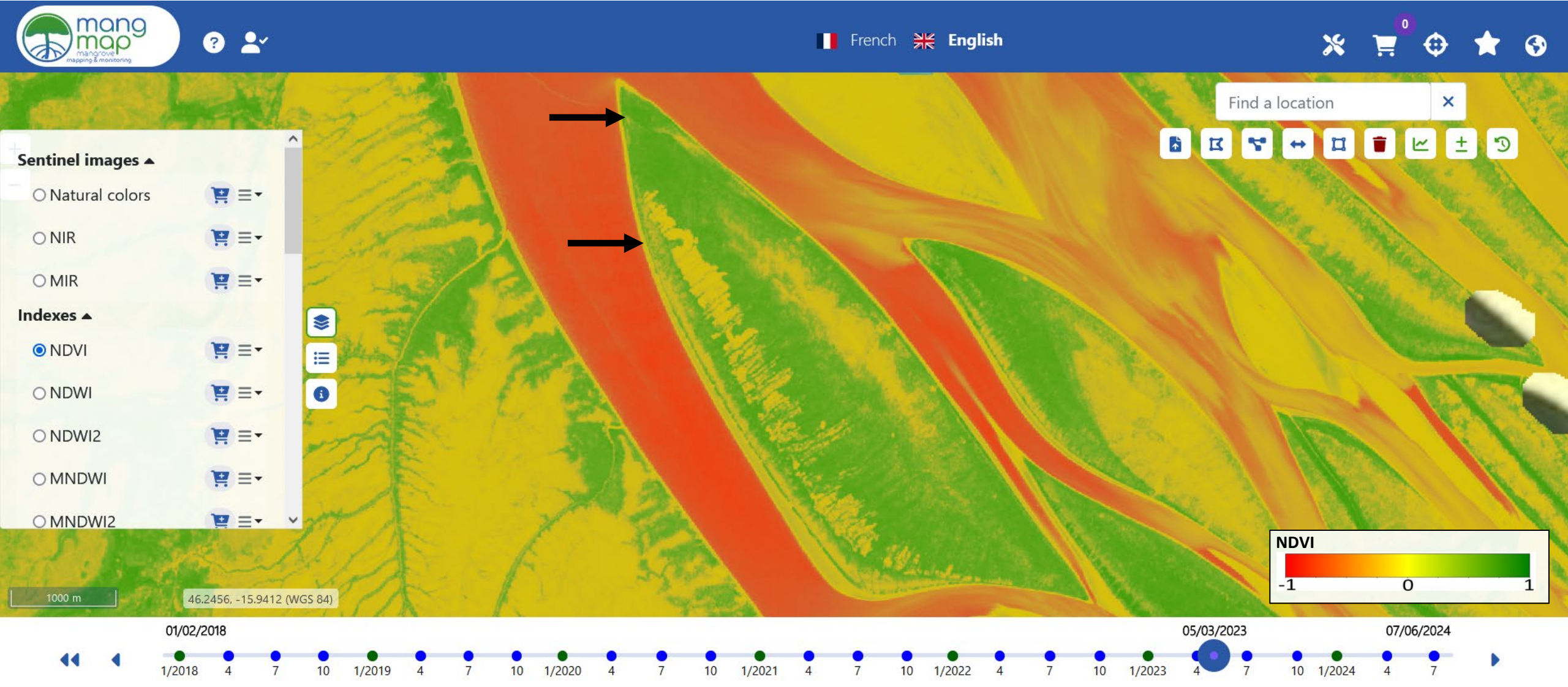
Indexes: every 5 days (11 indexes)

Temporal composites : monthly/quarterly/half-yearly/yearly



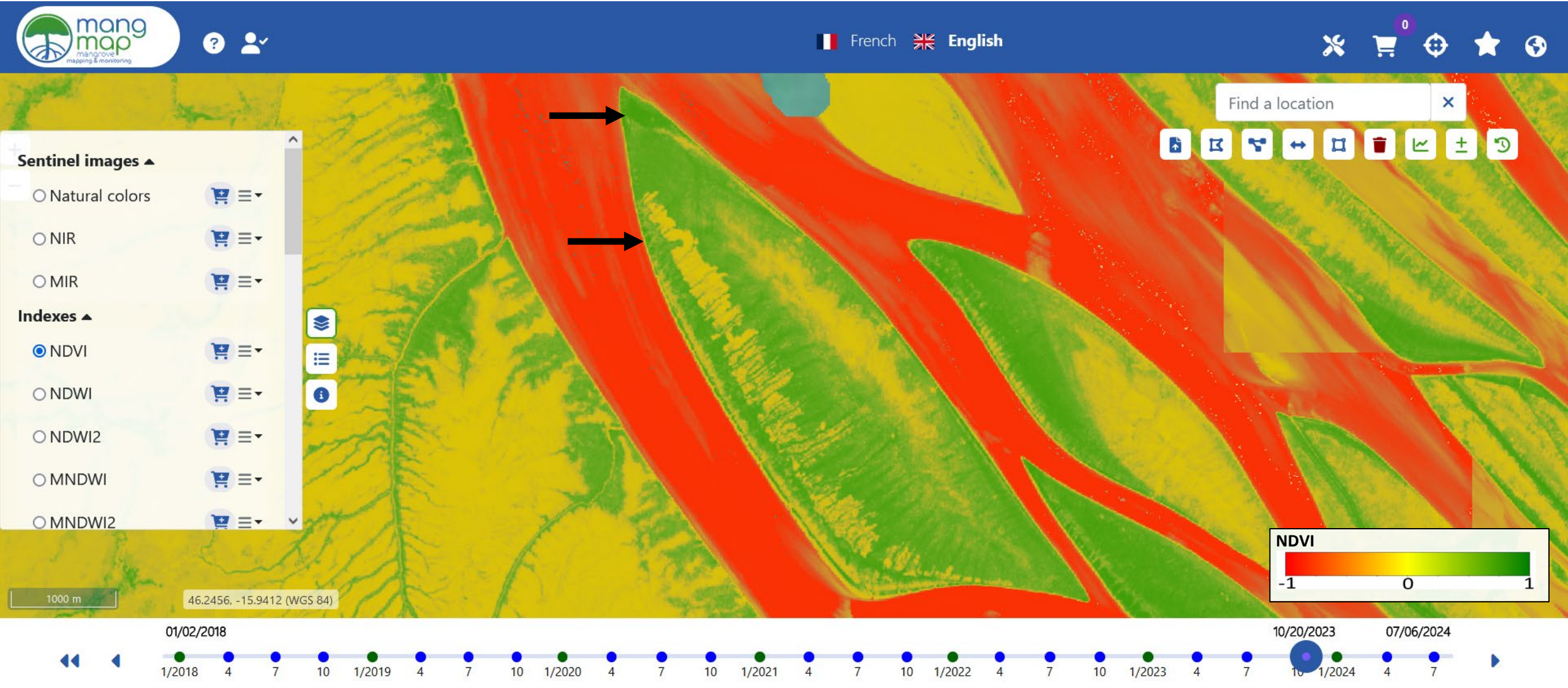
Indexes: every 5 days (11 indexes)

Temporal composites : monthly/quarterly/half-yearly/yearly



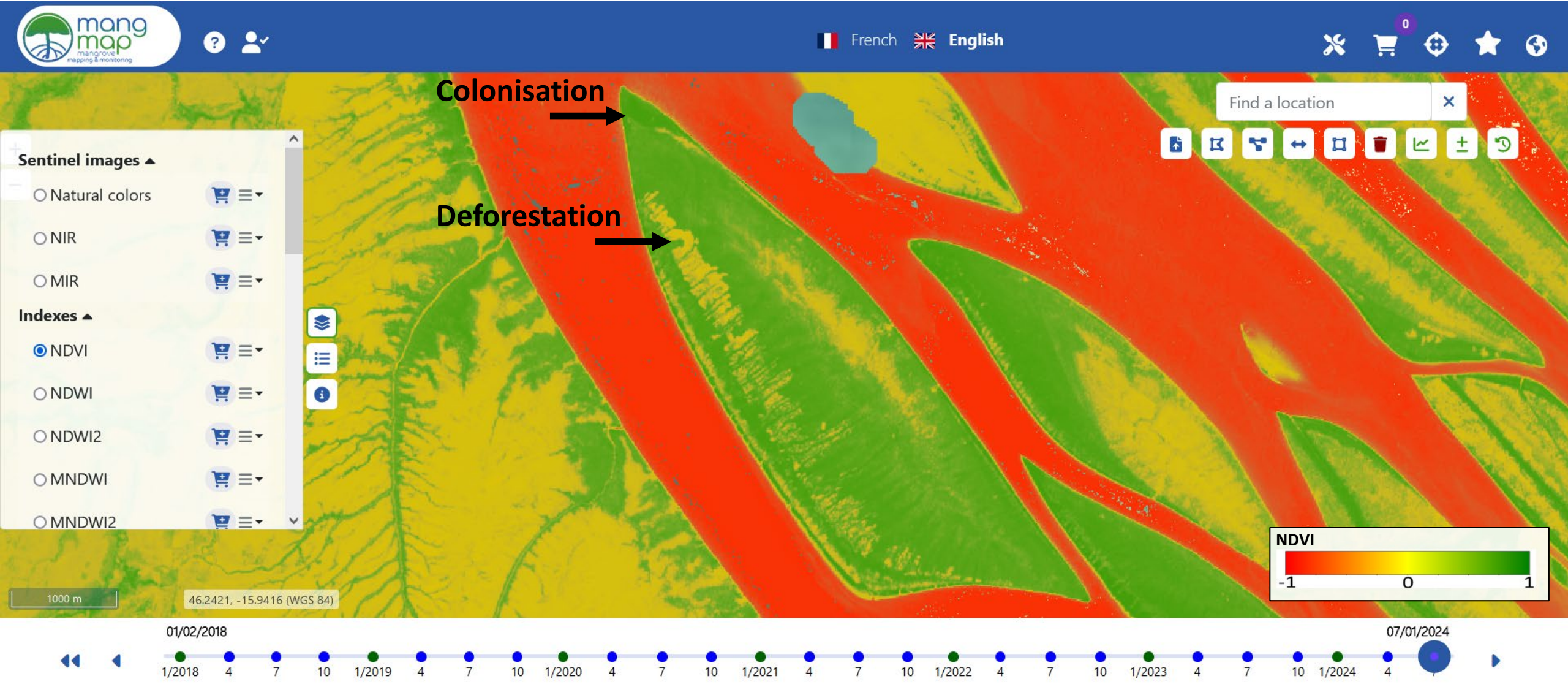
Indexes: every 5 days (11 indexes)

Temporal composites : monthly/quarterly/half-yearly/yearly



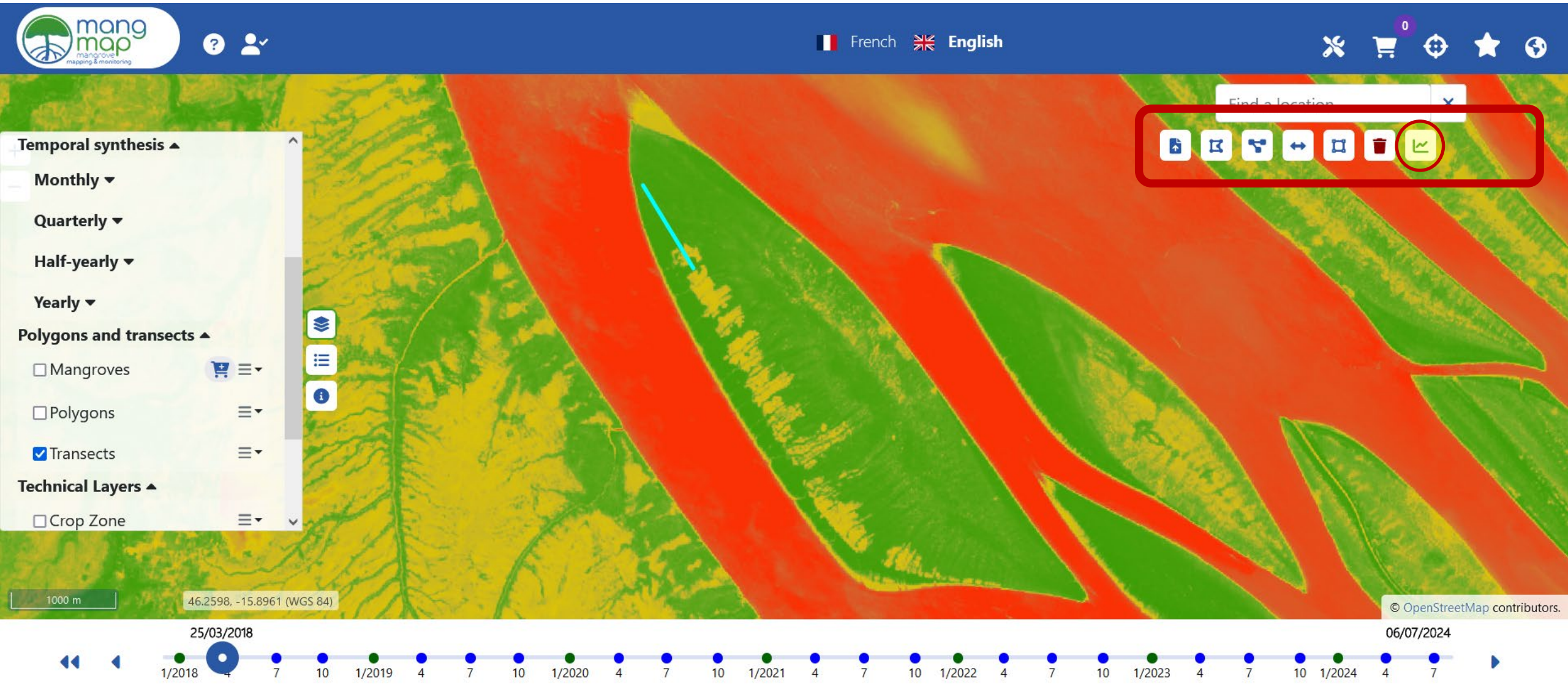
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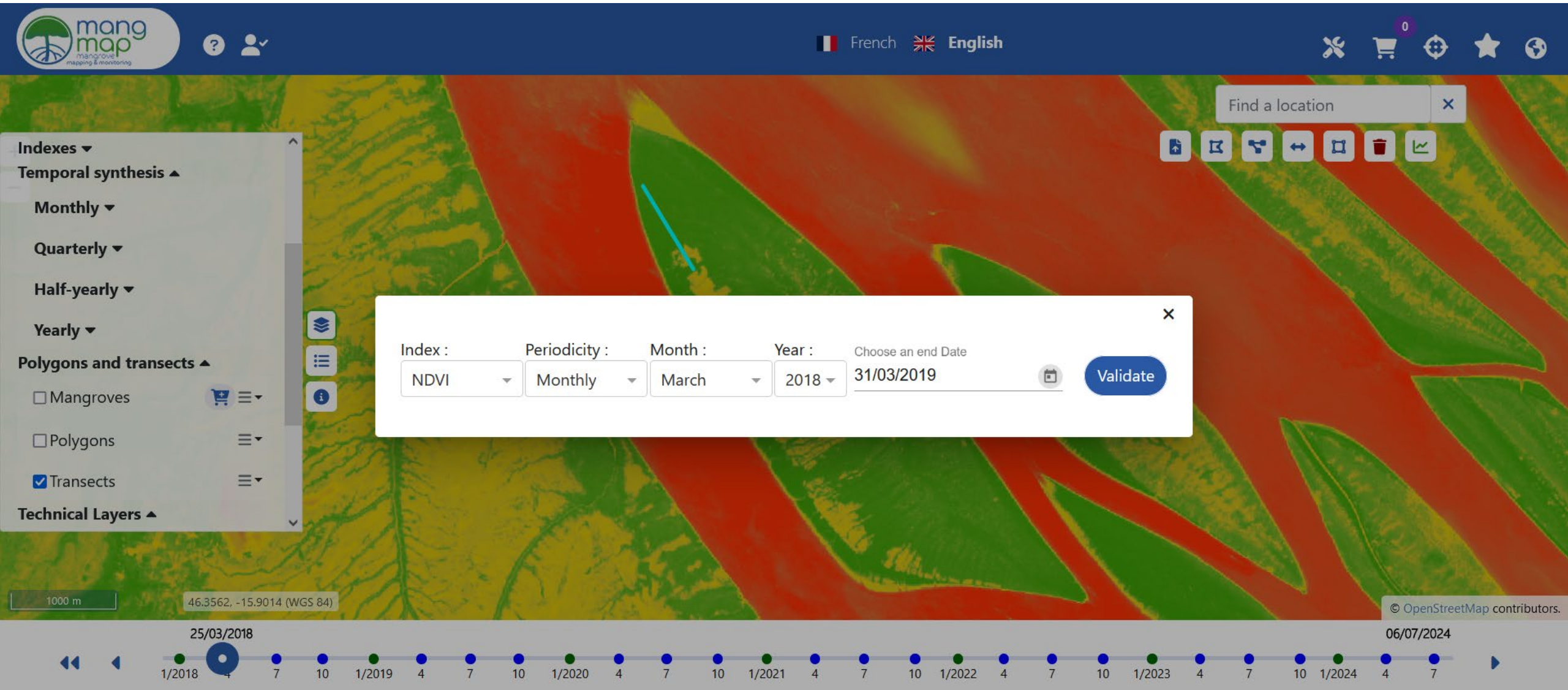
On-demand Services

Statistics report along enduser transect



On-demand Services

Statistics report along enduser transect



The screenshot displays the Mangrove Mapping & Monitoring web application interface. The main map area shows a satellite-style view of a mangrove area with a blue transect line. A configuration dialog box is open, allowing users to select the index (NDVI), periodicity (Monthly), month (March), and year (2018). The end date is set to 31/03/2019. The interface includes a sidebar with navigation options like 'Indexes', 'Temporal synthesis', and 'Polygons and transects'. The top navigation bar shows language options (French, English) and user account information. The bottom of the screen features a timeline slider for temporal synthesis, currently set to 25/03/2018, and a scale bar indicating 1000 m.

On-demand Services

Statistics report along enduser transect

Indexes ▾

Temporal synthesis ▲

- Monthly ▾
- Quarterly ▾
- Half-yearly ▾
- Yearly ▾

Polygons and transects

- Mangroves
- Polygons
- Transects

Technical Layers ▲

1000 m

1/2018



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06/07/2024

4 7


On-demand Services

Statistics report along enduser transect



On-demand Services

Statistics report along enduser transect



Indexes ▾
Temporal synthesis ▲
Monthly ▾
Quarterly ▾
Half-yearly ▾
Yearly ▾
Polygons and transects
 Mangroves
 Polygons
 Transects
Technical Layers ▲

1000 m

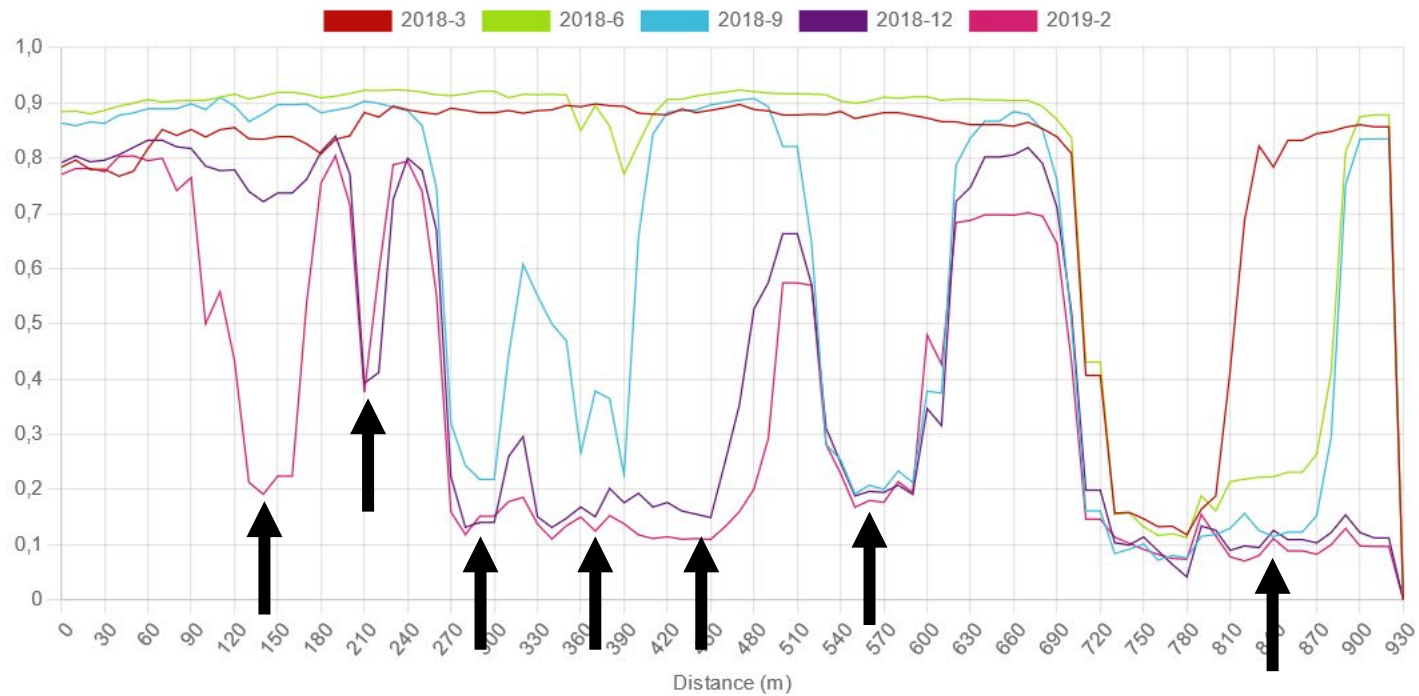
1/2018

Index : NDVI ▾ Periodicity : Monthly ▾ Month : March ▾ Year : 2018 ▾ Choose an end Date : 31/03/2019 📅 **Validate**

- Mean Maximum Minimum Quartile 1 Quartile 2 Quartile 3 Standard deviation

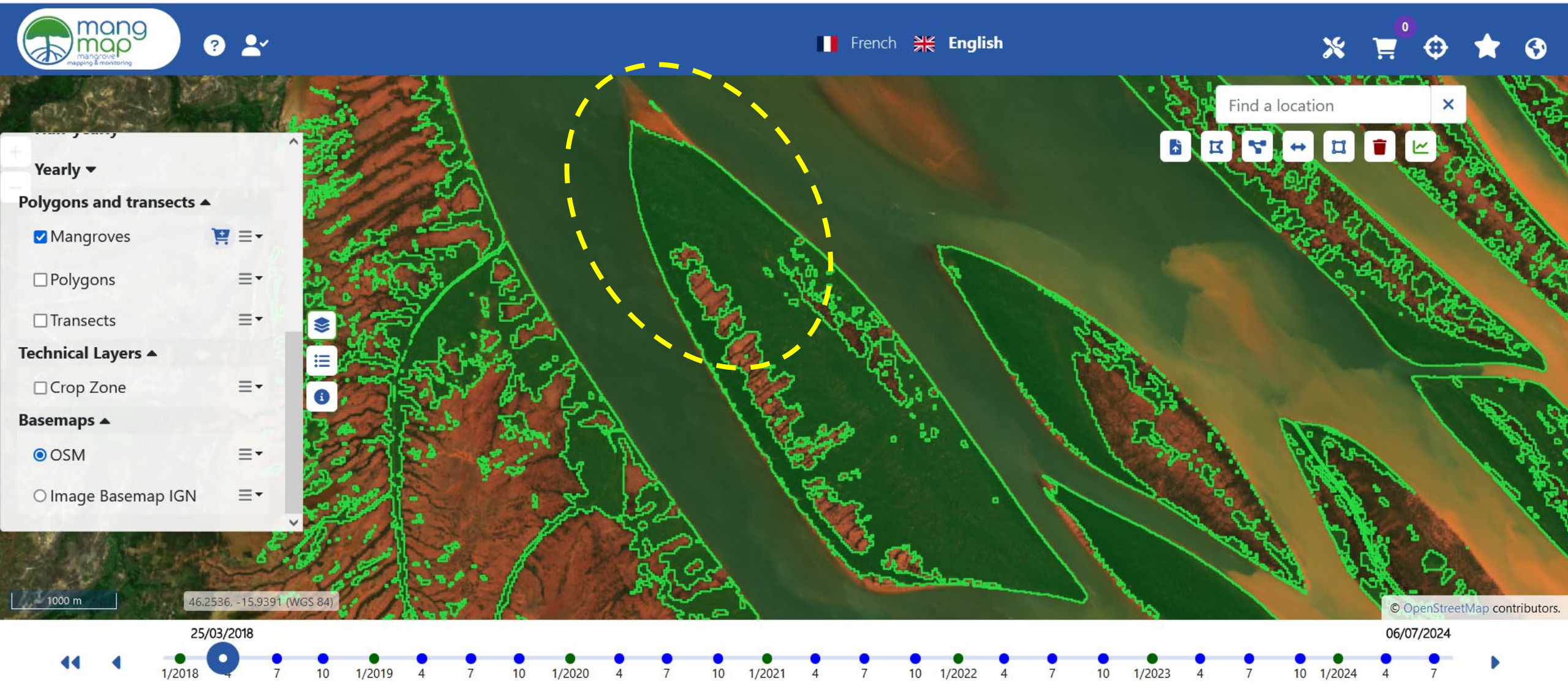
- × 2018-3 × 2018-6
- × 2018-9
- × 2018-12
- × 2019-2

Only 5 dates are available, to see more, please click on this button : 🗑️

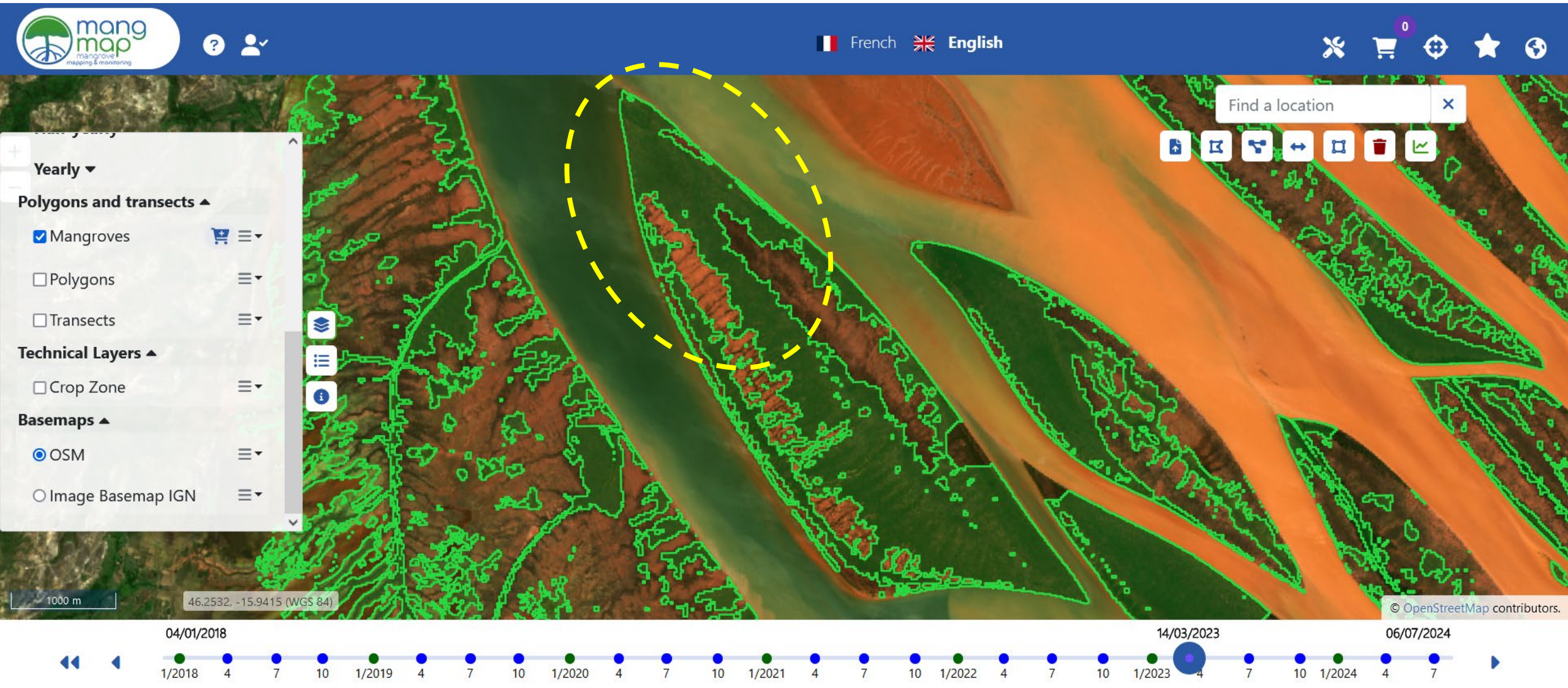


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06/07/2024

Quarterly Mangrove extent – 25/03/2018

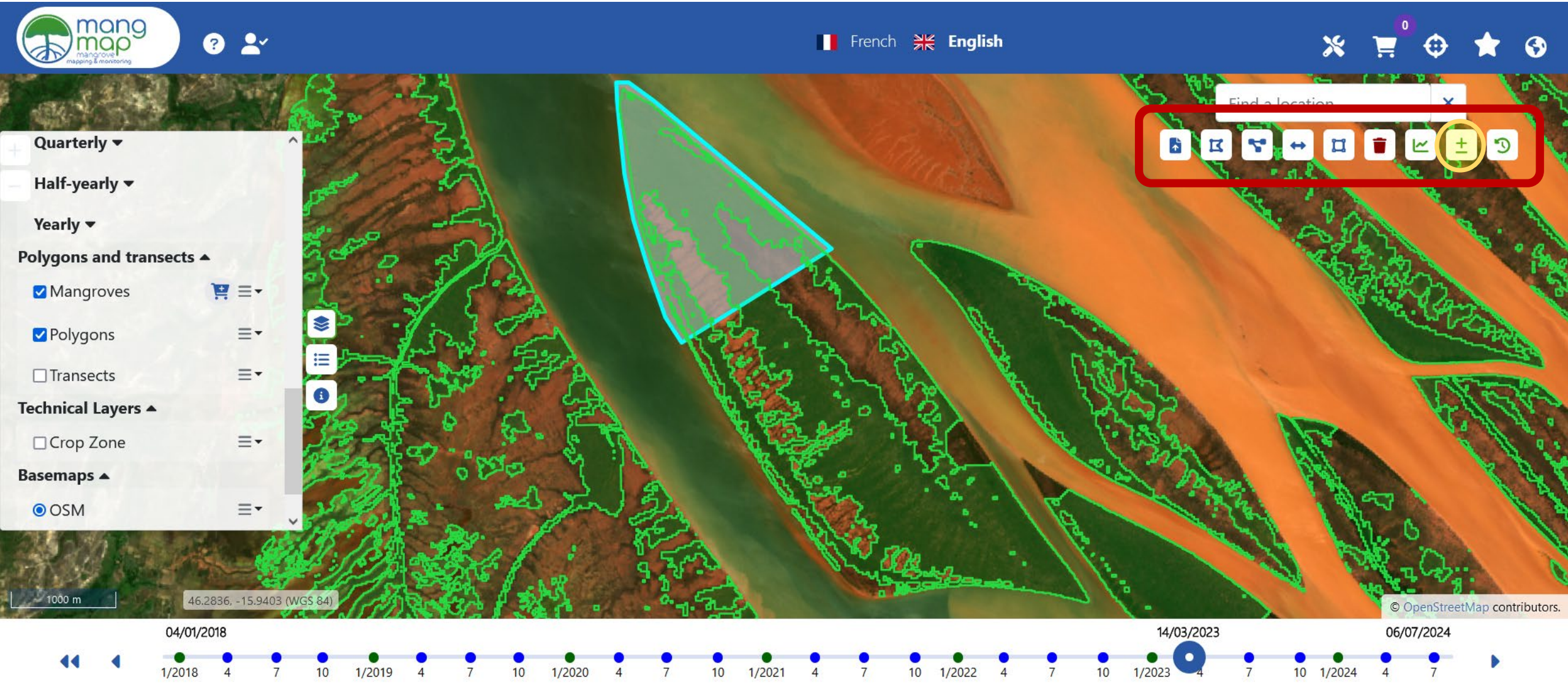


Quarterly Mangrove extent – 14/03/2023



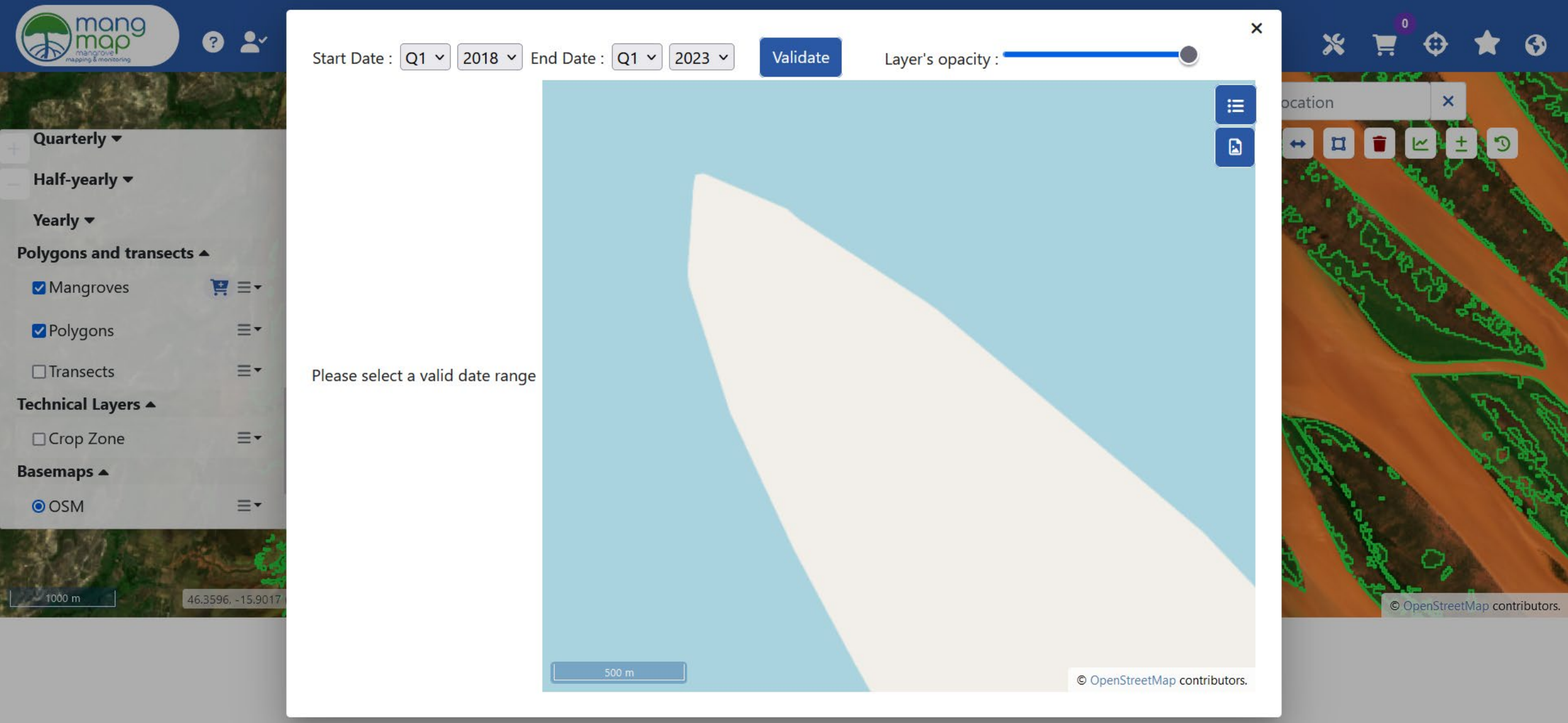
On-demand services

Mangrove spatial evolution within enduser poygon



On-demand services

Mangrove spatial evolution within enduser polygon



The screenshot displays the mangrove mapping application interface. A modal dialog box is open, prompting the user to select a valid date range. The dialog includes the following elements:

- Start Date:** Q1 2018
- End Date:** Q1 2023
- Validate** button
- Layer's opacity:** A slider control.
- Message:** "Please select a valid date range"
- Scale bar:** 500 m
- Copyright:** © OpenStreetMap contributors.

The background interface shows a map with mangrove polygons highlighted in green. The left sidebar contains the following menu items:

- Quarterly
- Half-yearly
- Yearly
- Polygons and transects
 - Mangroves
 - Polygons
 - Transects
- Technical Layers
 - Crop Zone
- Basemaps
 - OSM

The bottom of the interface shows a scale bar of 1000 m and coordinates: 46.3596, -15.9017.

On-demand services

Mangrove spatial evolution within enduser poygon



Yearly ▾

Polygons and transects

- Mangroves
- Polygons
- Transects

Technical Layers ▲

- Crop Zone

Basemaps ▲

- OSM
- Image Basemap IGN

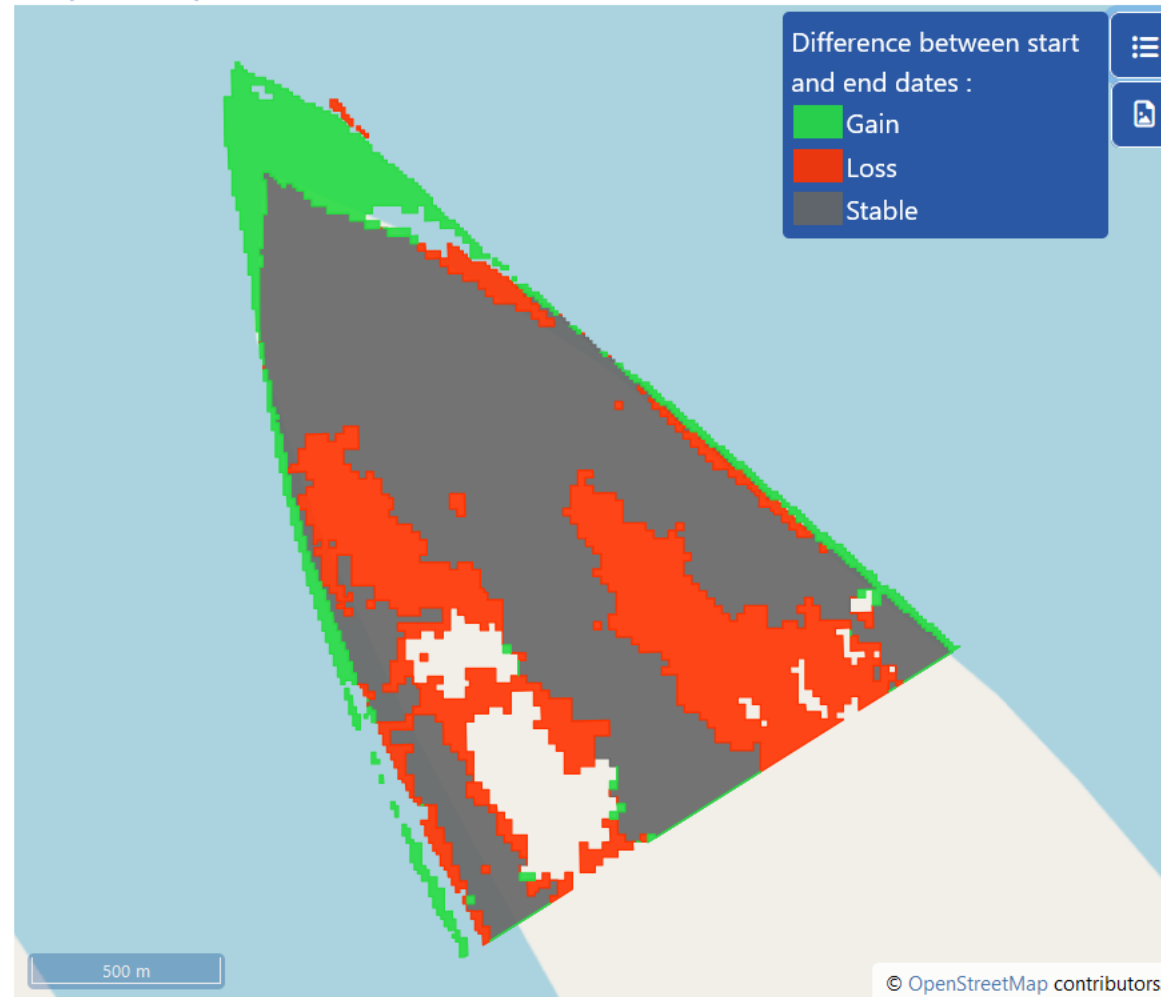
1000 m

Start Date : Q1 ▾ 2018 ▾ End Date : Q1 ▾ 2023 ▾

Validate

Layer's opacity :

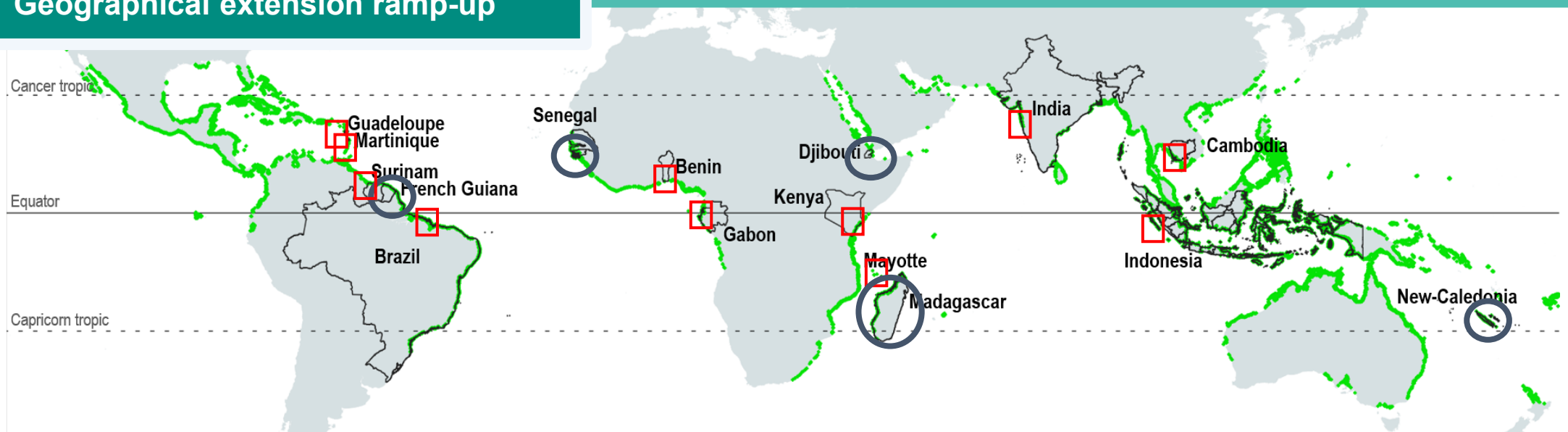
| Surface | 2018 Q1 | 2023 Q1 |
|---------------|-----------|-----------|
| Total | 183.65 ha | 150.63 ha |
| Stable | 183.65 ha | 129.69 ha |
| Gain | | 20.94 ha |
| Loss | | 53.96 ha |



Conclusion – next steps

- Extension to 11 new sites + new Madagascar sites : ramp-up October 2024 – May 2025

Geographical extension ramp-up



Conclusion – next steps

- Extension to 11 new sites + new Madagascar sites : ramp-up October 2024 – May 2025
- Further upgrades planned starting Q2 of 2025

Next developments on the platform

- Quality assurance plan under construction
- Improvements of end-user experience after collecting first feedbacks
- New products and services based on S2 Time series, on radar time series, on Very High Spatial Resolution imagery in specific sites

Examples: Motion window in Enduser AOI; Enduser configuration of surveillance/alerts of local degradation / deforestation / restauration...

Prospects 2025/26

Migration in a scalable scientific cloud infrastructure, under construction in Montpellier (kubernetes, STAC...)

Conclusion – next steps

- Extension to 11 new sites + Extension of Madagascar sites : October 2024 – May 2025
- Further upgrades planned starting Q2 of 2025
- Networking with Focal Partners: Workshops and Training sessions in prep for 2025

Capacity building & empowerment

- Raising awareness: Webinars in all sites
- On-site Training to MangMap Services: key sites
- Webinar Training to MangMap Services: all Sites
- News on website, Posts on social media

WE ARE OPENED TO COLLABORATIONS !



Showcased during field work



Majunga University, Madagascar, 03/2024

Showcased in Thematic Training Session



Thank you for your attention

To follow us

<https://mangmap.org>



Contact us

contact@mangmap.org

Algorithm of the mangrove detection methodology

Qualification on very stable mangrove (Guadeloupe) :
 Accuracy = 0,98
 Kappa = 0,90
 Sensitivity = 0,97

Good match with Global Mangrove Watch in our study sites
 Same difficulties due to S2 resolution with omissions in
 - very fragmented mangroves
 - very low density mangroves
 - very young mangrove

Focal Relay Points : On-sight IRD scientists + local Partners

Madagascar
 Centre National de Recherche sur l'Environnement

Sénégal
 Ecole Polytechnique de Thiès (LASTEE)

Djibouti
 Centre d'Etudes et de Recherche de Djibouti

