

ESA-SARGASSUM

Sargassum Monitoring Service

Final Report

Reference: CLS-ENV-RP-19-0304
Nomenclature: CLS-ESASARGA-FR
Issue: 1. 0
Date: 2019, Sep. 05

CLS headquarters
11 rue Hermès
Parc technologique du Canal
31520 Ramonville Saint-Agne
FRANCE

Tel. +33 (0)5 61 39 47 00
Fax +33 (0)5 61 75 10 14
Mail: info@cls.fr
www.cls.fr

CLS Brest Le Ponant
Zone du technopôle de Brest Iroise
Avenue La Pérouse
29280 Plouzané
FRANCE

Tel. 33 (0)2.98.05.76.80
Fax 33 (0)2.98.05.76.90





Chronology Issues:

Issue:	Date:	Reason for change:	Author
1.0	5/09/2019	Final report	msutton

People involved in this issue:

Written by (*):	msutton, jpmarechal	Date + Initials:(visa or ref)
Checked by (*):	cdufau	Date + Initial:(visa ou ref) [Checker]
Approved by (*):		Date + Initial:(visa ou ref) [Approver]
Application authorized by (*):		Date + Initial:(visa ou ref)

**In the opposite box: Last and First name of the person + company if different from CLS*

Index Sheet:

Context:	
Keywords:	[Mots clés]
Hyperlink:	

Distribution:

Company	Means of distribution	Names
ESA	PDF via email	Olivier Arino



List of tables and figures

List of tables:

Aucune entrée de table d'illustration n'a été trouvée.

List of figures:

Figure 1: List of organisms having received credentials to test the web platform	3
Figure 2: Drift areas configured for the trial	4
Figure 3 : CLS operator dashboard	10
Figure 4 : Summary of published articles and number of views	21
Figure 5 : March 2019 - 6830 views on social networks and 35 interactions	21
Figure 6 : May 2019 - 5966 views on social networks and 93 interactions	21
Figure 7 : June 2019 - 2801 views on social networks - 50 interactions	22
Figure 8 : July 2019 - 1382 views on social networks and 17 interactions	22

List of items to be confirmed or to be defined

Lists of TBC:

Aucune entrée de table des matières n'a été trouvée.

Lists of TBD:

Aucune entrée de table des matières n'a été trouvée.

Applicable documents

AD 1 Plan d'assurance produit de CLS
CLS-ED-NT-03-394

Reference documents

RD 1 Operational Chain Specification CLS-ENV-RP-18-0163

RD 2 Service Trial Definition CLS-ENV-RP-18-0163



List of Contents

1. Project Overview	1
2. Purpose of the document	1
3. Service Trial Results	1
3.1. Service Trial Summary	1
3.1.1. End-users.....	2
3.1.2. Products delivered	4
3.1.2.1. Web platform.....	4
3.1.2.2. Situation bulletin and ed-user support	5
3.1.3. CLS operational monitoring results	9
3.2. End-users feedbacks (NBE)	11
3.2.1. Platform use	11
3.2.2. Sargassum drift forecast.....	12
3.2.3. Satellite Sargassum detection	13
3.2.4. Weather & Ocean data.....	14
3.3. Conclusions	15
4. Service exploitation and viability	16
4.1. Sustainability options	16
4.2. Commercial brochure.....	17
5. Communication statistics	19
6. APPENDIX I - End-user feedback questionnaire.....	23
7. APPENDIX II - Legal framework to use the platform	27



1. Project Overview

Unprecedented massive landings of Sargassum are regularly registered since 2011 along the shorelines of a huge area encompassing French Guyana, the Antilles and Caribbean Sea. The phenomenon affects widely the West Indies (Guadeloupe, Martinique, Barbados ...), Dominican Republic, Mexico, etc. and many sightings have been reported. Washing-ashore has tremendous negative impacts on local populations, coastal marine ecosystems and the economy sector, especially tourism and fisheries that are severely affected.

The objective of this project is to develop and implement an **innovative automated service based on Earth Observation (EO) data to monitor floating Sargassum algae** in the Caribbean area, estimate their drift and eventual landings on the coasts, and provide dedicated bulletins to the end-users. The service will provide a generic support to decision-making processes in all sectors impacted by the issue.

The solution developed consists in:

- (1) detecting sargassum algae on satellite images by computing a Normalized Floating Algae Index (NFAI) on a synergy of satellite sensors (MODIS/Aqua, Sentinel-3/OLCI, Sentinel-2/MSI),
- (2) running operationally a drift numerical model to estimate the Sargassum trajectories and their potential landings on the coasts using environmental data such as wind and sea surface currents from the Copernicus Marine Service and other data providers,
- (3) disseminating results on an operational secured web platform so that users can easily access the information
- (4) providing situation & forecast bulletins tailored to the end-user's specific needs

The project has been conducted according to three main phases over 12 months, during which end-users have played a key role. The first phase collected users' requirements that were included in the specifications of the service and the service trial definition. During the second phase, the service was developed according to the specifications. During the production phase, the end-users supporting the project could test the service and provide feedback according to their expectations. The project ended with an assessment phase, during which the viability and sustainability of the service was evaluated.

2. Purpose of the document

This document is the final report of the Sargassum Monitoring Service project. It presents the results of the Service Trial Phase, some inputs to the Service viability analysis and summarizes the communication actions undertaken during the one-year project.

The project final products are also described and presented as snapshots of the web platform and examples of the sargassum situation bulletin.

3. Service Trial Results

3.1. Service Trial Summary

The service trial was defined during the first phase of the project and described in the document CLS-ESASARGA-STD-18-0187.pdf. The service demonstration started on April 5th 2019 and ended on June 15th 2019.



3.1.1. End-users

Over 50 end-users were granted dedicated access to the platform. The end-users represented the Caribbean basin, from Mexico to Trinidad. The following table presents the list of entities, countries and economic sectors in which one or more end-users were provided with dedicated credentials.

Country	Organism	Economic sector
Aruba	Director Meteorological Department, Aruba National Commission for UNESCO	Meteorological institute
Aruba	Directorate of Nature and Environment of Aruba (DNM)	Environmental agency
Aruba	Aruba National Park	National park
Bonaire	STINAPA National Park Bonaire	National park
Bonaire	Dutch Caribbean Nature Alliance NGO basée Bonaire	National park
Bonaire	Gouvernement Bonaire (port authority)	Port authority
Curacao	CARMABI NGO basée à Curacao	National park
Curacao	Meteorological Dpt Curacao	Meteorological institute
Antigua & Barbuda	Europe	Europe
Barbados	Caribbean Tourism Organization	Tourism
Barbados	Barbados Coast Guard, Defence Force	Maritime Security
Barbados	CERMES	Science
Belize	National Meteorological Service of Belize	Meteorological institute
Dominican Republic	government agency Maritime Affairs Authority	Maritime Security
Dominican Republic	AlgaeNova	Valorisation
France	BRGM Guadeloupe	Environmental agency
France	ex-ESA	Science
France	Lycée Port Louis, Guadeloupe	Education
France	DEAL Martinique	Environmental agency
France	Caribbean Sea Clear	Collecte
France	ONF Guadeloupe - Mission PNA	National park
France	DEAL Guadeloupe	Environmental agency
France	UNESCO	Management



France	Agence territoriale de l'environnement de St Barthelemy	Environmental agency
France	CRPMEM	Fisheries
France	BRGM Guyane	Environmental agency
France	METEO France	Meteorological institute
France	CARTOPHYL	
Europe	Europa	
Jamaica	UWI Centre for Marine Sciences-Discovery Bay Marine Lab	Science
Jamaica	UWI Port Royal Marine Lab	Science
Mexico	Hotel Playa Sonrisa	Tourism
Mexico	CICESE	Science
Mexico	Hotel Xcalak Playa Sonrisa	Tourism
Mexico	MEXICO NAVY	Maritime Security
Mexico	CentroGeo (CDMX)	Environmental agency
Mexico	University of Quintana Roo	Science
Sint Maarten	National Park	National park
France	AGRNSM St Martin	Environmental agency
Sint Maarten	Head of Meteorological Department	Meteorological institute
Trinida & Tobago	University of trinidad & Tobago	Science

Figure 1: List of organisms having received credentials to test the web platform

To cover the needs of all the end-users interested in testing the web platform, 11 drift areas have been set up and configured, as seen in Figure 2.

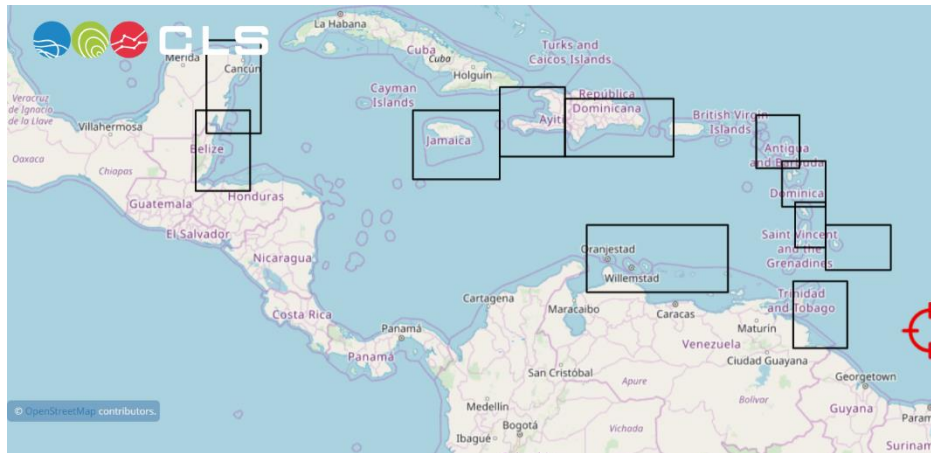


Figure 2: 11 Drift areas configured for the trial

The end users had a different level of involvement in the trial. While a few did never connect to the system, some end-users were active in providing valuable feedback on the system and on the quality of the products delivered. Section 3.2. presents results of the feedback analysis.

The end-users management and support was organized at CLS, with a dedicated support email address, and using CLS helpdesk tools. A legal framework was also defined and set up for the use of the platform and results during the test. End-users were asked to accept these terms and conditions before accessing the platform. Terms & conditions are presented in Appendix.

3.1.2. Products delivered

3.1.2.1. Web platform

The end-users had access to the web platform through a dedicated and secured web connection.

The end-users could access the results of the daily Sargassum detection on the satellite products of MODIS-Aqua, OLCI Sentinel-3A and Sentinel-3B on the whole Gulf of Mexico and Caribbean area. Results of the Sargassum detection on Sentinel-2, with a higher resolution, were also available for Guadeloupe, Martinique and Barbados areas.

The end-users could access and visualize different variables resulting from the computation of the Sargassum detection algorithm on the satellite data. Variables such as NFAI (Sargassum index) isolated, to display only the positive Sargassum detection, the associated cloud cover, and the raw NFAI, showing the Sargassum index value, with cloud cover and sea values included in the same layer were proposed for visualization. This allowed the user to test the different possibilities of visualizing the results of the satellite detection.

After the trial, the menu was re-organized and relabelled to make it more user-friendly and to ease the understanding and the navigation between the different variables. The representation of the Sargassum detection with the variable “NFAI isolated”, showing the “Sargassum mats only” was extended to all the satellite datasets.

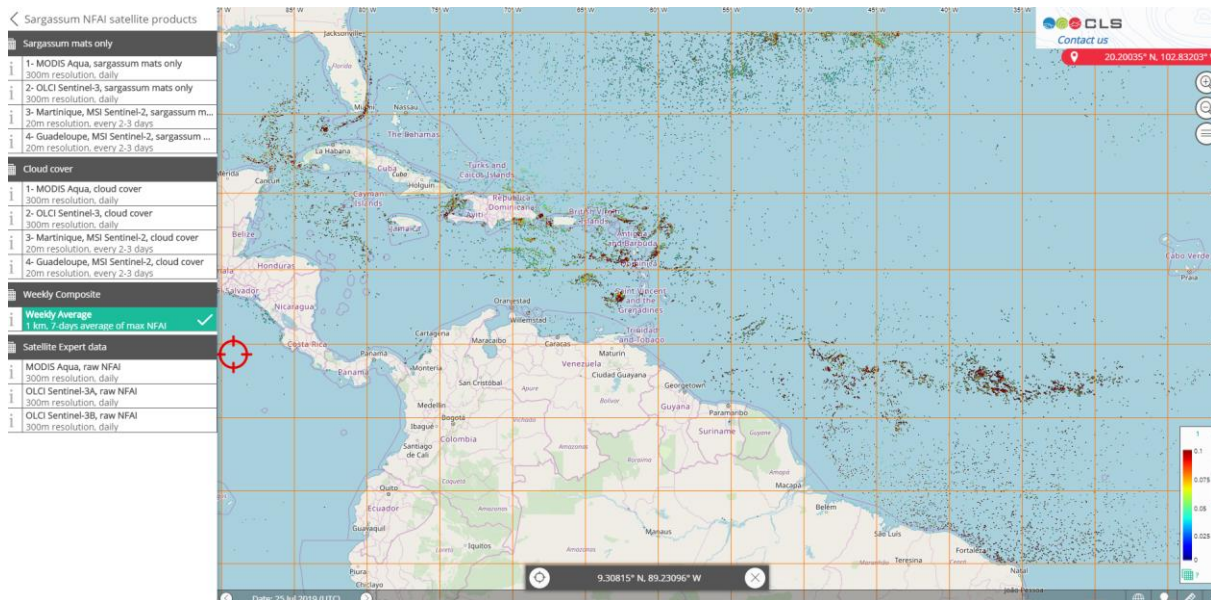


Figure 3 : Sargassum detection products “mats only” available on the web platform

The Sargassum detection data remained accessible on the web platform for one month and was also available for download from the CLS Datastore.

Further to the Sargassum satellite data, the end users had access to the drift model results for their specific area of interest only.

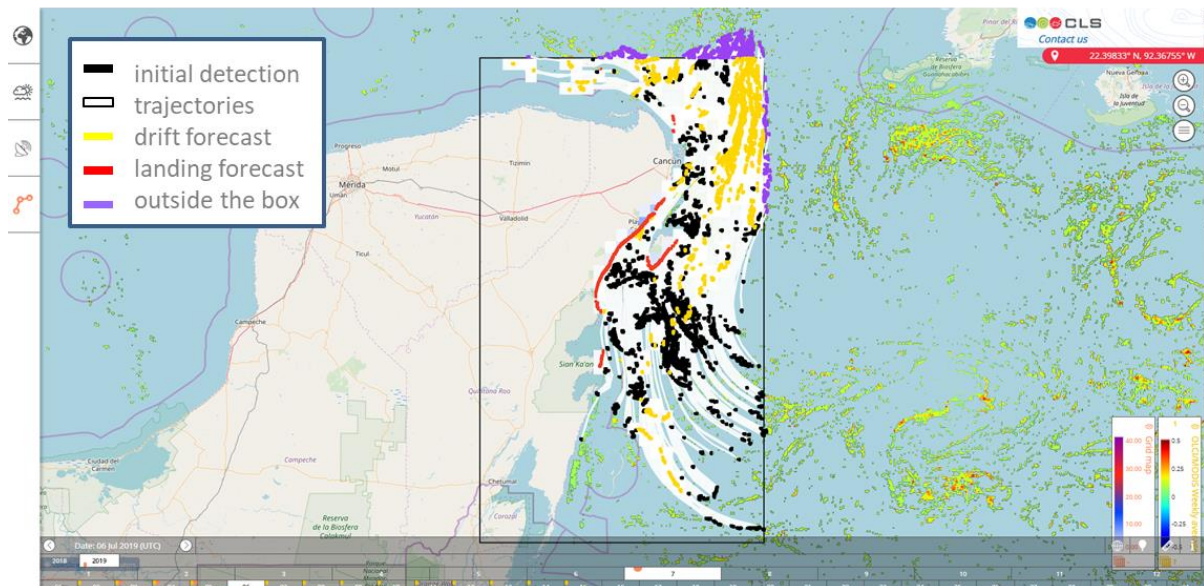


Figure 4 : Example of the sargassum forecast results for the Yucatan drift area

The results of the drift simulation remained available online for the whole duration of the trial.

3.1.2.2. Situation bulletin and end-user dedicated support

During the trial, several dedicated analyses were provided to the end-users in the form of situation bulletins.



These bulletins were provided in specific situations: when the Sargassum situation was critical and immediate landings foreseen, or to educate the end-users on the use of the platform and on the different products delivered.

Several bulletins were delivered to specific end-users, in particular for the users in Bonaire, Curaçao and Aruba, Belize, Dominican Republic, Mexico or Martinique.

This emphasis on the fact that situation bulletins are often needed by the end-users, especially for operational end-users who need to access the Sargassum situation quickly and include this in their daily routine operations.

The bulletins and analysis prepared during the trial are presented in the figures below.

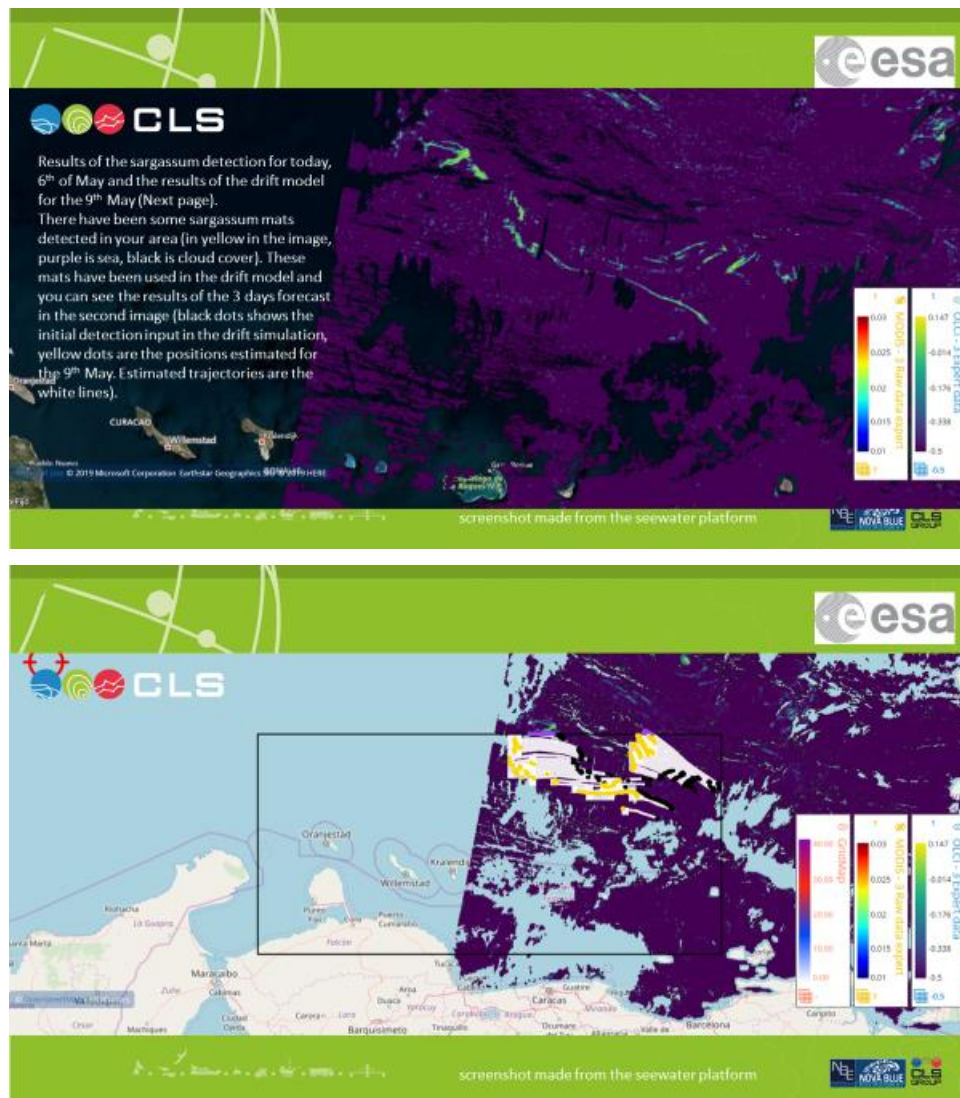


Figure 5 : Situation Bulletin prepared for DNM Aruba, 7th May 2019



Figure 6 : Situation Bulletin prepared for Dominican Republic, 15th May 2019

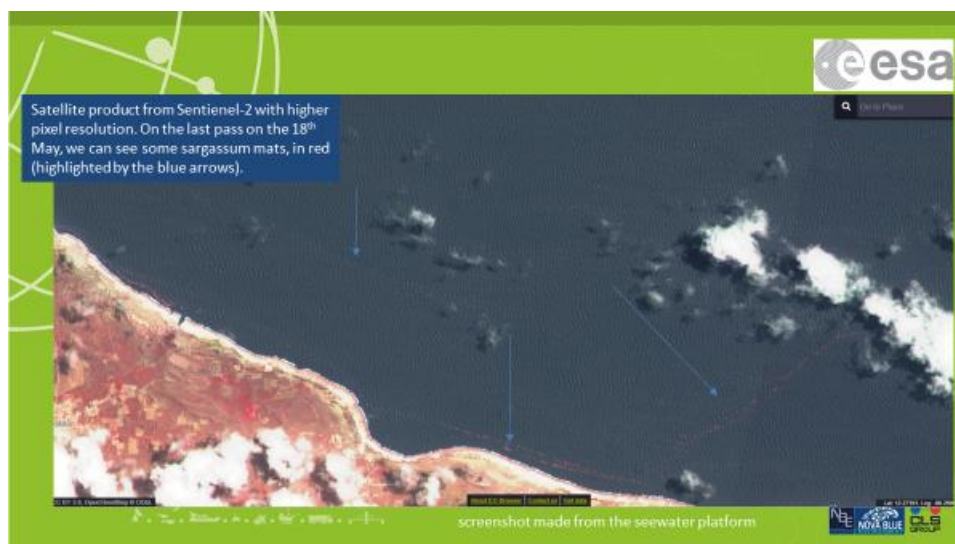


Figure 7 : Situation Bulletin prepared for the STINAPA park, Bonaire, 23th May 2019

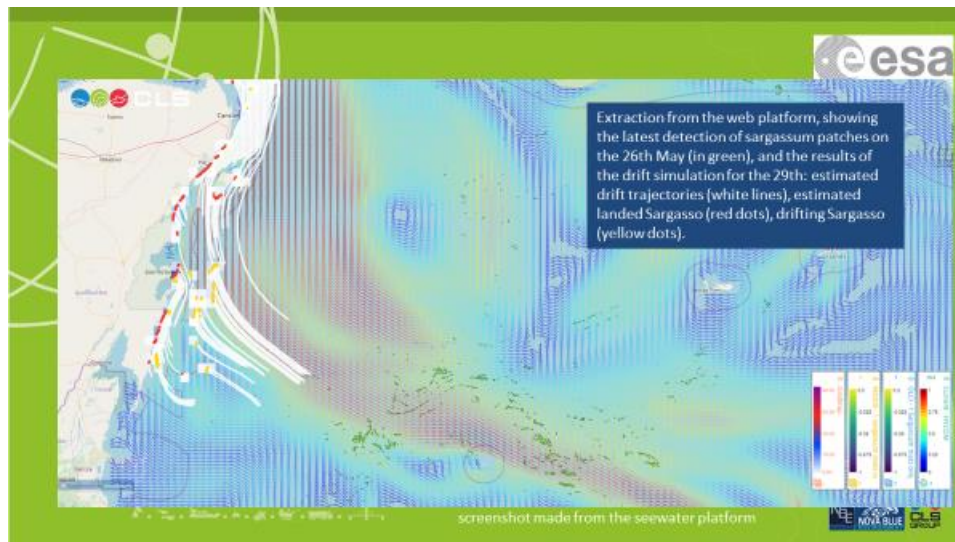


Figure 8 : Situation bulletin prepared for the Semar, Mexico, 27th May 2019

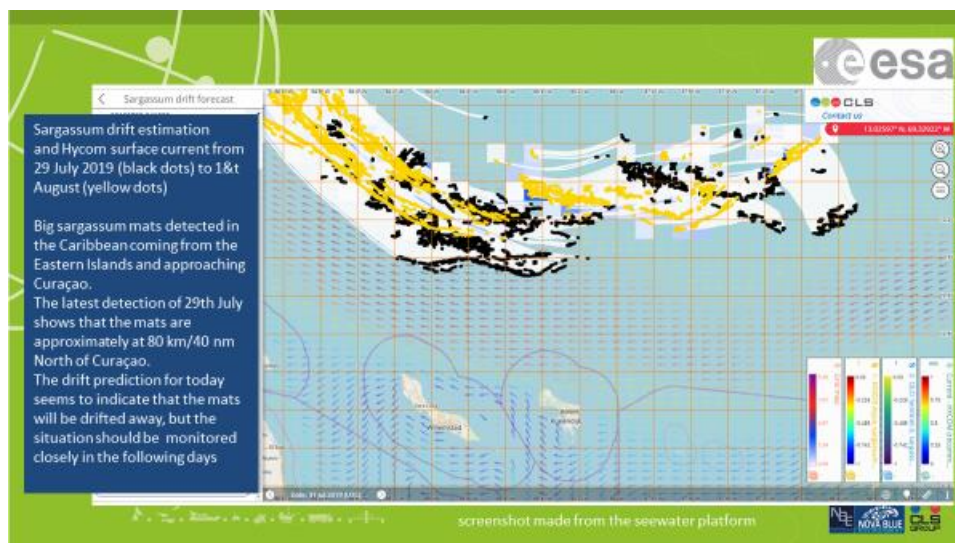


Figure 9 : Situation bulletin for Meteorological dept of Curaçao, 30th July

A template of a more general bulletin was also prepared during the trial phase and is presented in Figure 10.

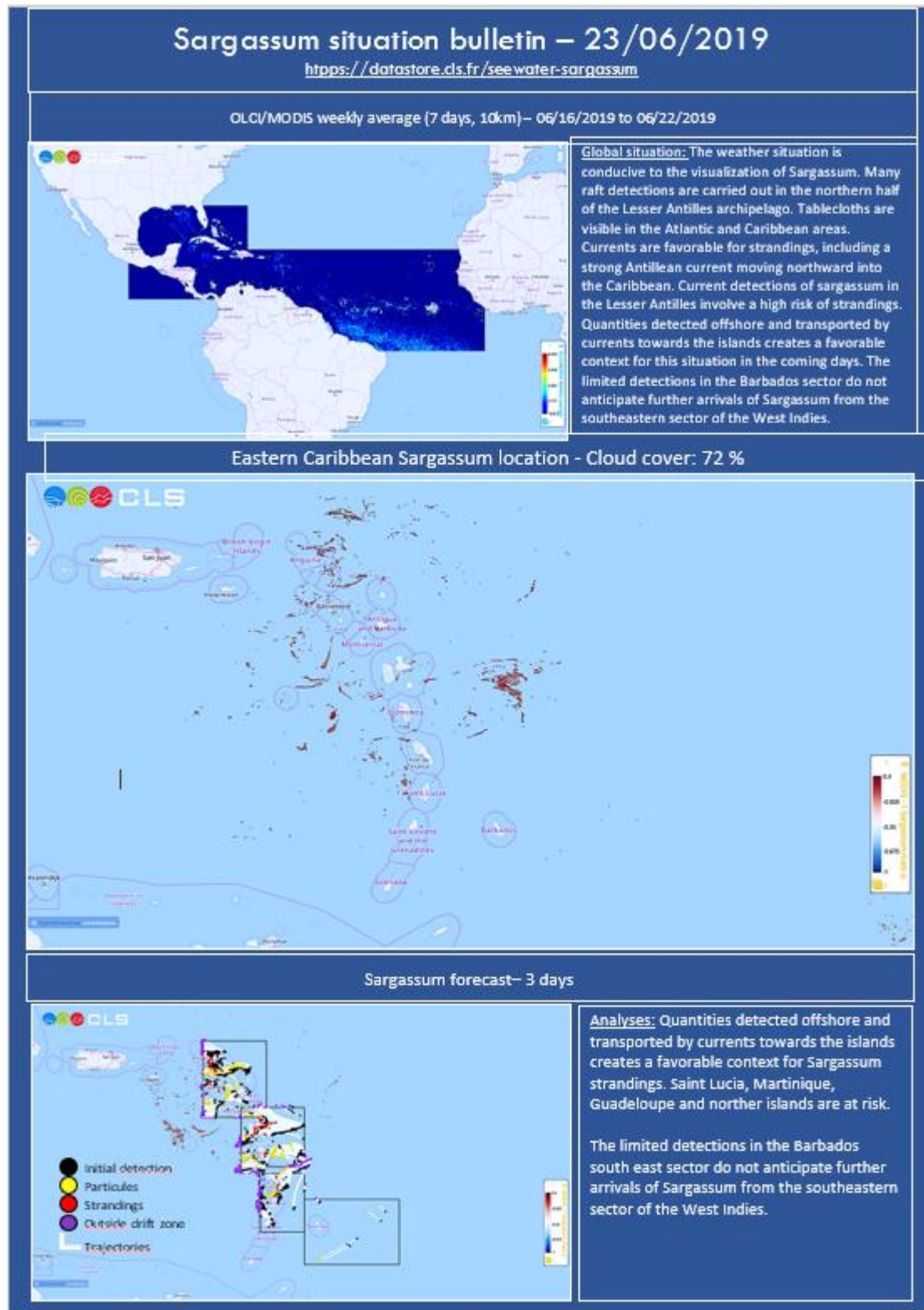


Figure 10: Template for a generic Sargassum situation bulletin

3.1.3. CLS operational monitoring results

The CLS operators monitored all the different tasks of the processing chain through a synthetic dashboard.

Proprietary information: no part of this document may be reproduced divulged or used in any form without prior permission from CLS.



This dashboard allows the CLS operators to quickly get an overview of all the tasks related to the Sargassum operational chain and to control their status. When a status is not OK, actions are automatically undertaken and the service referent is contacted. All the actions are traced in a log and JIRA tickets system.

The following figure shows the operator dashboard with all the tasks related to the Sargassum chain monitored.

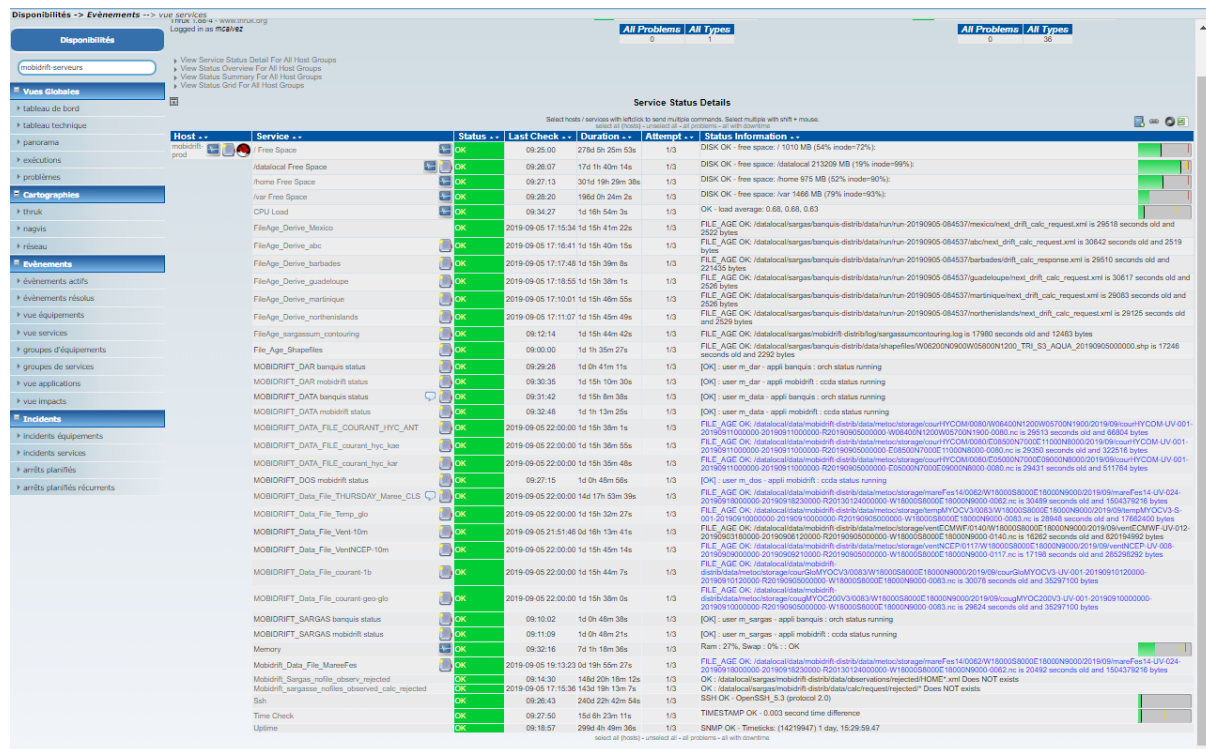


Figure 11 : CLS operator dashboard for the Sargassum service

The trial demonstration period lasted 71 days. 21 actions were recorded during this period.

11 actions were related to the production of the satellite detection products, from which 6 were because of errors in the production chain (delays in data download from the satellite agencies, errors in the computation), and 5 were related to the installation of new versions of the satellite production component.

These problems occurred in the first weeks of the trial.

After actions from the CLS operators, and after the set-up phase, no major delay was noted in production for the satellite detection. The Sargassum satellite data was always made available on time.

10 incidents occurred in the production of the drift results. Some were directly linked to the issues in the production of the satellite detection files described above. The other incidents were due to external factors, as the detection calculation resulted in a great number of Sargassum mats to input in the drift calculation. This problem occurred in the drift calculation for the Jamaica and Republic Dominican areas in particular but affected the calculation time in the others drift areas.

Overall, the service was not delivered on time not more than 3 days during the trial period. Corrective actions have been undertaken, and only one incident was recorded during the summer (the operational chain is still running after the end of the trial).

Communication towards the end-users were always done in due time.



3.2. End-users feedbacks (NBE)

In order to assess the Sargassum platform uses, a questionnaire was elaborated with 21 questions (see annex) covering the platform use, the drift forecast, the Sargassum satellite product visualisation and the complementary data on weather and ocean. The web platform had been designed according to the prior questionnaire “end-users’ requirements” (WP 2 100) that defined some of the guidelines for the tool content, based on Sargassum location, drifting, density, and trajectories across the Caribbean basin, with focuses on users’ region of interest.

The 50 users identified during the test phase were contacted to provide feedback and 13 questionnaires were received for evaluation.

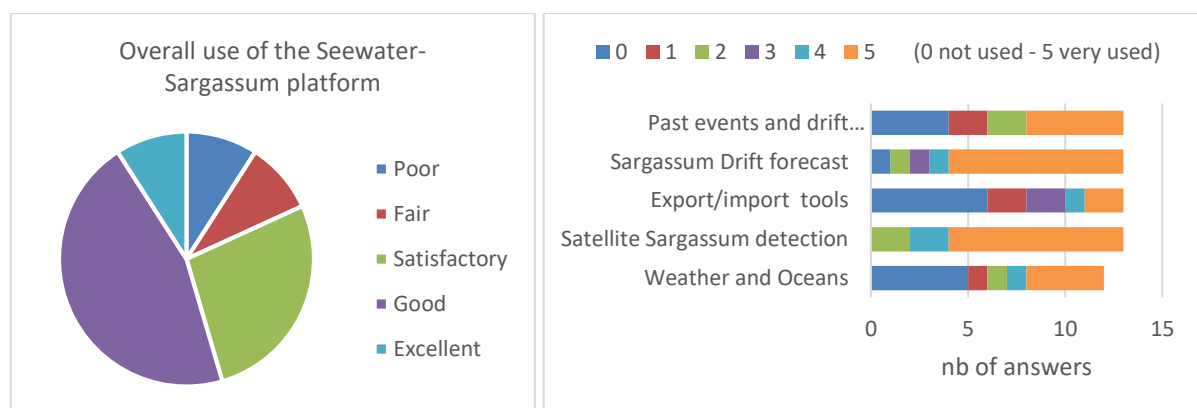
Users origin and Sargassum concerns

Users are from the French Antilles, Dutch Antilles, Barbados, Mexico and Belize, covering the Lesser Antilles archipelago and the western continental Caribbean. They are from different professional sectors: government administration, tourism sector, marine park, marine reserve, University, research institute, meteorological services.

3.2.1. Platform use

Users were invited to give their overview of the platform in terms of general usage. They rated this usage from poor to excellent, as well as the frequency of use of the different menu options (from 0 to 5).

- Overall use of the Seewater-Sargassum platform



82% of the users find the platform useful. The menu and visualisation tools are well rated, but the options are not used equally. Sargassum satellite detection and drift forecast are regularly used, while past events and ocean/weather data are not or poorly used. Users are mainly interested in visualisation tools of the current situation and potential risk at the regional level. 69 % of the users intend to continue using the platform.

Among the general difficulties identified, users respond in different ways, from Web interface compatibility issues to the ergonomics of menu options. Users with limited visit time require fewer effective options and information, while more experienced users want more details and more products.

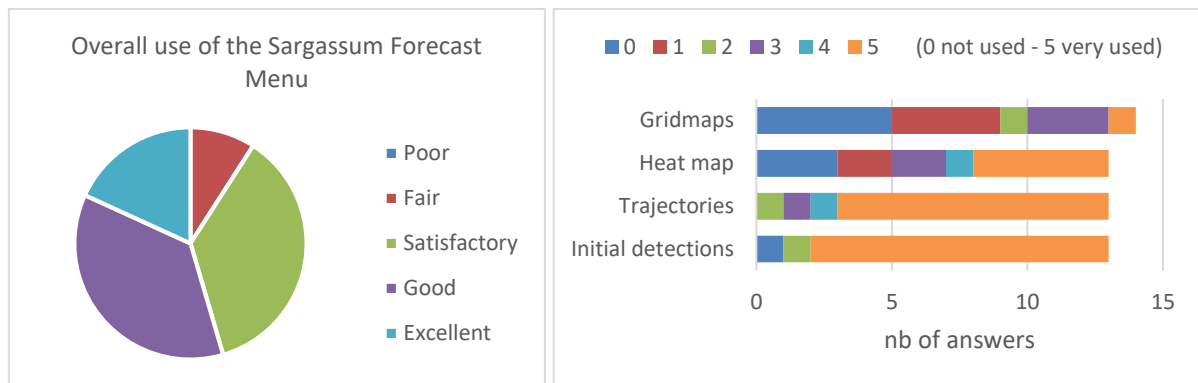
Some users suggest access to other products such as long-term trends and statistics at different scales and time periods, as well as more accurate data on Sargassum beaching locations along the coastline, using higher resolution products and more sources of marine surface currents. Some expert users would appreciate more export options, such as Geotiff and KMZ file formats, for use in other software.



3.2.2. Sargassum drift forecast

Sargassum forecast information was available to users. The web platform made it possible to visualize the initial detections of the Sargassum rafts as well as the trajectories over a period of 3 days. In addition, users could display information on the evaluation of the amount of Sargassum (heat maps) and a probability index on the presence of Sargassum in regions of interest.

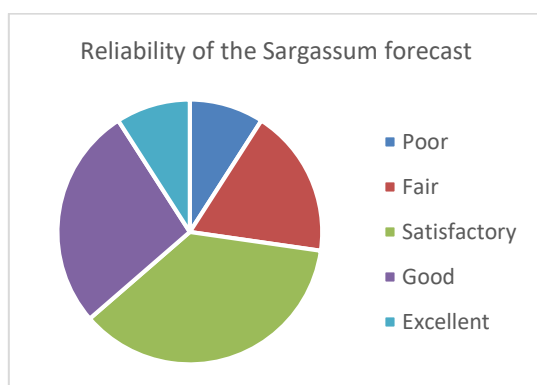
- Overall use of the Sargassum forecast menu



91% of the users find Sargassum forecast data useful, but primarily use initial detections data and trajectories, and 92% find it is easy to use and manipulate. Complementary heat maps (Sargassum quantity) and gridmaps (probability of presence of sargassum for the next 3 days) receive less attention.

The majority of users find the drift prediction reliable. However, they recommend a 5-day to 1-week forecast for better anticipation and risk assessment.

- Reliability of Sargassum forecast



82% of users find the forecast reliability fair to satisfactory and good. The 3-day forecast seems a good compromise, but it is suggested to increase to 5-day or 1-week. Several forecast windows would be useful.

While users had to log in to the platform to get access to the data, some users would appreciate to receive alerts when Sargassum appear in their region of interest to activate the Sargassum web platform access process.

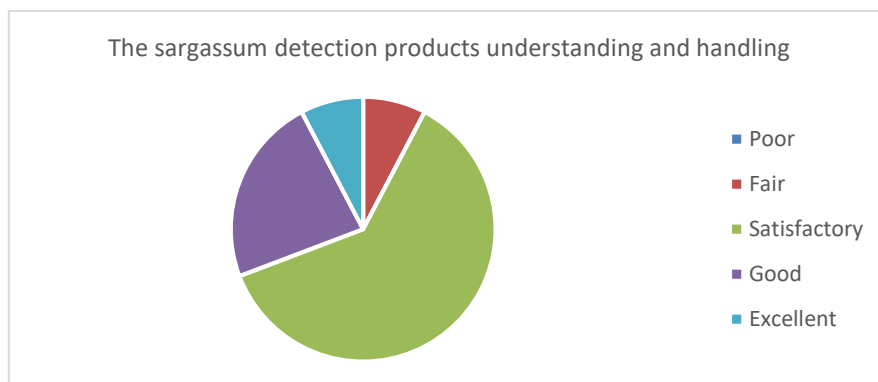
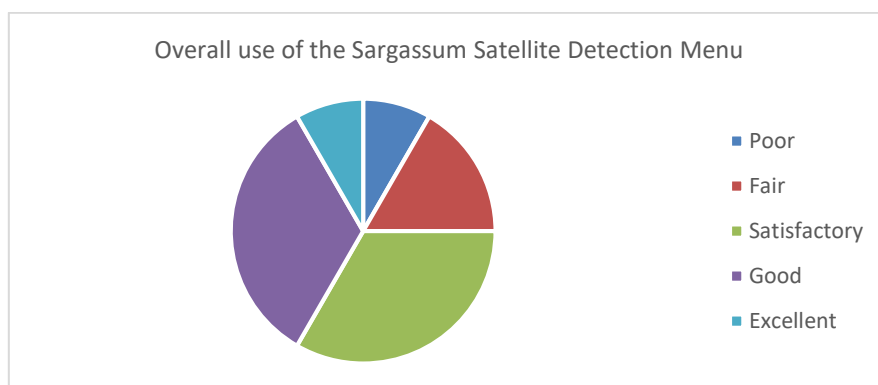


3.2.3. Satellite Sargassum detection

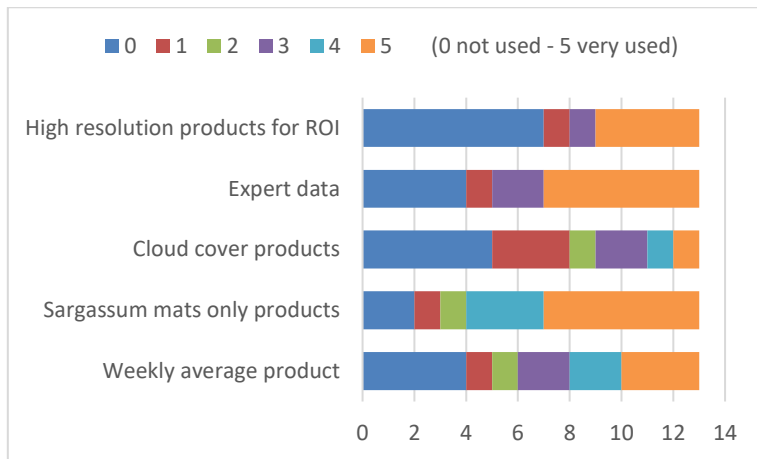
Several products were available to users to display the geographical location of Sargassum on regional maps. They could display Sargassum mats detection only, high-resolution regional products, very high-resolution local products, weekly composite and cloud cover from different satellite sources.

- Overall use of the Sargassum Satellite Detection Menu

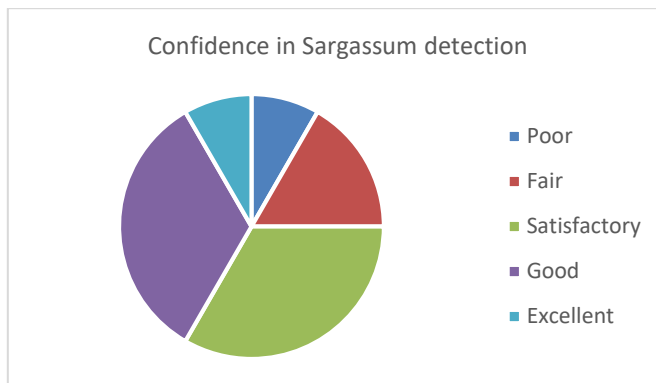
Overall use of the Sargassum satellite detection product is satisfactory and good for 66.6 % of users, and 92% find it overall easy to understand and handle. 91% of users understand the weekly average product. 90% are satisfied with the Sargassum mats only product, but some comments reveal the loss of information compared to raw products. High-resolution products (Expert data) have not been used by all users. Only 50% of the users who manipulated this data are satisfied with the understanding and manipulation of the product.



The high-resolution products for specific area have received attention of people in the region of interest and half of them find it satisfactory.



- Confidence in the Sargassum detection



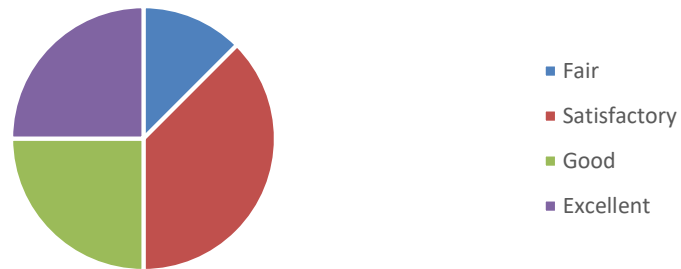
Most users trust the Sargassum detection product in terms of geographic location of Sargassum on the map. However, several users point out that the difference between “Sargassum mats only” and raw data in terms of location and quantity of algae detected by automated processes is less than that obtained from raw products.

3.2.4. Weather & Ocean data

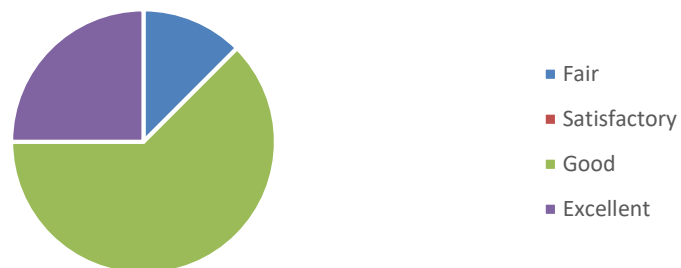
This menu gives users access to marine surface currents and winds. Several options display marine surface currents using three different models. This information can be used to hypothesize the drift of Sargassum rafts based on major surface currents in the region of interest. Only a few users have used these data sources (8 answers) and most find them easy to understand and manipulate, but not essential for Sargassum forecast, given other available products (drift and trajectories).



Overall use of the Weather & Oceans Menu



The Weather & oceans data understanding and handling



Weather & oceans data use for Sargassum forecast



3.3. Conclusions

The Sargassum web platform has been tested for 2 months. During that period, 50 users have had access to multiple options and assistance to help with the use of menus and tools. Only 13 users send feedback for our evaluation of the platform usage.

Two major categories of users arise. The first one is users that request simple and straight information in a visual format to advise local government, environmental agencies or tourism sectors about Sargassum beaching risk over a week period. The second group is composed of specialised operators who request more complex and detailed data, which might be beyond the mission of the Sargassum web platform.



The objective of the platform is to inform users about Sargassum location at regional and local scales (dynamic mapping) along with trajectory probabilities. The location maps and trajectories tools were the most used by operators and were rated well.

As analysis time is a constraint for many users, an alert system has been put forward as a mean to inform operators to connect to the platform to access Sargassum risk information. This alert would be launched as soon as Sargassum would enter a perimeter of interest within the operator's region.

Most of the users trust the Sargassum products and forecast, even if some highlighted differences in Sargassum location and quantities between products. However, there was not always a 100% match between Sargassum rafts identified on available products and Sargassum location used to run the drifting models, as complementary satellite sources were used besides those accessible on the platform.

Finally, the majority of the users are willing to continue using the platform, depending on costs of the service and available funding.

The platform has been very useful as a visualisation tool. For users to trust better the information available on the platform, the processes behind the delivery of the final products still need some adjustment in terms of total detection in automated processes, as there are sometimes significant differences between Sargassum signals visible on raw data images and Sargassum mats only product.

Users also have to bear in mind all the limitation of Sargassum satellite detection due to cloud cover and cloud shadows, sunglint, satellite cover, atmospheric conditions and resolution. All these parameters alter the Sargassum detection at the surface of the ocean which is often translated as absence of Sargassum while they might be present. The web platform is a synthetic visualisation tool of final products issued through complex automated processes. It will incorporate these changes as research progresses.

4. Service exploitation and viability

4.1. Sustainability options

After the end of the trial phase, several end-users have expressed their interest for continuing accessing the platform. Commercial proposals were sent to all the end-users asking for a quotation. The Sargassum Monitoring Tool (SAMTool) was proposed and included in more than 10 proposals. To date, one contract was successful with the French meteorological agency, Météo France, in the frame of their mandate to monitor the Sargassum situation for the French Antilles and Guyana.

The price of the service was established considering the cost of maintenance and operation of the system, cost of infrastructure, end-users management and support, in order to propose a service price as low as possible.

Different levels of services are proposed. The baseline service consists in accessing the web platform, and includes the access to the satellite detection products on all the optical sensors available using the automated detection algorithm on the medium and high resolution sensors, and the access to the drift model results for the area of interest, in an area of approximately 3°x3°.

A second level can be added to the baseline service, by including expert analysis on the satellite detection in situation bulletins. This second level is addressing the need for synthetic situation bulletins to capture the Sargassum situation at a glance.

A third level of service is also foreseen, to include an additional level of expertise in satellite detection. This third level addresses the need for a more accurate Sargassum detection on the satellite data thanks to a supervised detection by image analysts on the optical sensors, and on SAR (synthetic Aperture Radar) sensors (Sentinel-1 essentially) to complement the optical sensors when a strong cloud cover is affecting the Sargassum monitoring several days in a row in critical situations.

Two ways are foreseen to sustain the service. The first option considered for commercializing the SAM service is to address end-users individually or regionally (within the same area). Several end-users from different agencies within the same area can benefit from the same platform access, with



most of the operational & maintenance costs being shared. However, the first feedbacks received from the individual proposals is that 1) the price of the service is too expensive to be supported by one agency in most countries affected and 2) it is difficult for several agencies/entities to discuss and establish the contractual use of a shared service between them.

Considering these assumptions and the inter-regional dimension of the Sargassum issue, another way would be to look for international or inter-regional cooperative bodies to support the service for the whole area. Actions have been started in this way, by discussing with the UNESCO representatives in the Caribbean area, and by looking for collaboration with some other ESA initiative such as EO4SD Marine & Coastal project.

4.2. Commercial brochure

A brochure was designed to promote the service commercially. This brochure will be part of the commercial package and distributed to potential end-users and customers.





SAMtool: Sargassum Monitoring Service by CLS

Helping the Caribbean deal with sargassum

Since 2011, huge sargassum mass strandings have occurred in the wider Caribbean region affecting:

- Marine environment
- Human health
- Tourism
- Fishing & aquaculture

Since that date, CLS has been working on an operational service using radar and optical satellite sensors to detect sargassum and predict their drift trajectory. In 2018, with the backing of the European Space Agency, CLS and its partners worked with a group of 40+ local users to design and validate the service that is today known as SAMtool.

Key planning tool:

Today, SAMtool is a key operational tool to help:

- Monitor day by day the Sargassum situation all over the Caribbean area
- Raise awareness on the upcoming sargassum strandings
- Prepare the mitigation plan in advance to reduce the devastating effects of sargassum on local economies
- Prepare and support timely sargassum collection operations

Why choose SAMtool?

Key strengths:

- Daily production of sargassum Index
- Excellent combination of satellite data using optical and SAR sensors
- A proven operational drift model for landing prediction
- A user-friendly web platform to access the information

A scalable service:

- 24/7 analysts from the operational CLS center
- Region to basin scale
- Monitoring of sargassum spreading sites
- Close monitoring using drifting buoys

Daily sargassum detection

Drift forecast

User-friendly data

Scalable bulletins, early warning

servicedesk.cls_store@groupcls.com

<http://datastore.cls.fr/>





SAMTool is a scalable solution that is available through a secure web portal, without any local software installation. The screenshot on the left represents daily sargassum detections. On the right, yellow, black and red dots represent probable drift locations of Sargassum mats in two to three days time.

SAMTool




Satellite sensors

Daily sargassum NFAI detection based on a unique combination of Earth Observation ocean color satellite instruments (high resolution sensors for detection close to shore - 20m resolution). To complement detection at night and independent of the cloud coverage, CLS also offers high-resolution satellite radar expertise.



Drift model

Two to three day forecasts of sargassum drift are produced with our numerical drift model. Our Lagrangian advection model combines surface current and wind models with sargassum detections and uses a probabilistic approach to predict where landings are likely to occur.



Online access

An online interface provides access to the satellite detection products, drift results, as well as weather & oceanographic conditions. An export function makes it possible to create PDF Situation Bulletins.



Expert bulletins

Situation & forecast bulletins prepared by our expert analysts and tailored to the end-user's specific needs are available upon request.



SAMtool
Designed with local communities, SAMtool is a reliable, user-friendly sargassum detection and monitoring tool for mitigating the impact of sargassum in the Caribbean and Gulf of Mexico.

20
Experts mobilized to develop and operate CLS's sargassum service

24/7
operational service including team of on duty analysts

8
Satellite sensors - including radar and optical sensors - used for reliable sargassum detection in SAMtool

2-3 day
forecast capability with our state-of-the-art drift model

Since 2015, CLS, a subsidiary of the French Space Agency (CNES) and of the French Institute for the Exploitation of the Sea (IFREMER), has been developing Sargassum algae monitoring and forecasting expertise based on optical and radar satellite sensor technologies and ocean-surface drift modelling.

With solid expertise in Earth Observation, remote sensing, web development, database management, and an operational infrastructure for 24/7 processes, a pool of experts in ocean sciences and a permanent team of satellite image analysts on duty, CLS is able to provide a reliable and operational Sargassum Monitoring Service for the whole Caribbean and Gulf of Mexico regions.

SAMtool supports decision-making to governmental and non-governmental agencies involved in monitoring, evaluating, mitigating or tackling the recurrent Sargassum environmental issue: Meteorological Offices, Coast Guards, Navies, Port Authorities, Marine Park managers, scientists, NGOs, Touristic and Fisheries organizations.

Logos: esa, cnes, METEO FRANCE, CLS

Sarga-ops@groupcls.com website

Figure 12 : Commercial brochure

5. Communication statistics

Several actions were undertaken to promote the project and the Sargassum Service itself. CLS and NBE attended several conferences to present the project through oral presentation, posters or through informal discussions.

The following table summarizes the conferences attended during the time frame of the project.

Conference	Information	Date	Location	Action	Attending
GCFI 2018	https://www.gcfi.org/gcfi_71-conference/	5-9 November 2018	San Andres, Colombia	Presentation	CLS
SeaTech Week 2018	http://www.seatechweek.eu/	8-12 October 2018	Brest, France	Interview	CLS
OurOcean 2018	https://ourocean2018.org/	29-30 October 2018	Bali, Indonesia	Abstract submitted for oral presentation	CLS
XIVe Conférence de coopération régionale Antilles-Guyane	http://www.martinique.pref.gouv.fr/Politiques-publiques/Environnement-sante-publique/Sargasses/Conference-de-cooperation-regionale-Antilles-Guyane-Seminaire-Sargasses	3-5 October 2018	Martinique	-	NBE



4th IOCS	https://iocs.ioccg.org/	8-12 April 2019	Busan, Korea	Poster	CLS
IOCARIBE of IOC-UNESCO	http://iocaribe.ioc-unesco.org/component/djevents/details/2019-05-07/3-sc-iocaribe-xv	6-10 May 2019	Oranjestad, Aruba	Presentation & Report	CLS
ESA Living Week	https://lps19.esa.int/QuickEventWebsitePortal /living-planet-symposium-2019/website	13-17 May 2019	Milan, Italy	Poster & demonstration	CLS
OCEANS 2019	https://www.oceans19mtsieemarseille.org/	17-20 June 2019	Marseille, France	Poster & Presentation	CLS
CMEMS4 OR	http://marine.copernicus.eu/cmems4or/	6-7 June 2019	Horta city, Azores	Presentation & training	CLS
Sarg'Expo	https://www.sargexpo.fr/	24-26 October 2019	Baie-Mahault, Guadeloupe	booth & presentation	CLS, NBE

All the posters and presentations are provided in the Communication package folder attached to this deliverable.

Articles were published on CLS web pages, social media such as twitter were also fed with information related to the project.

All the articles and posts received a great number of views.

Page Title	URL	Publication Date	Number of views
CLS to develop an operational Sargassum service in the Caribbean	https://www.cls.fr/en/sargassum-service-caribbean/	14/09/2018	88
CLS wins contract with ESA to develop an operational Sargassum monitoring service in the Caribbean	https://datastore.cls.fr/cls-esa-sargassum-service/	13/09/2018	434
CLS Operational Sargassum Monitoring Service soon ready for end-users	https://www.cls.fr/en/cls-operational-sargassum-monitoring-service-ready-for-end-users/	06/03/2019	225
CLS Operational Sargassum Monitoring Service ready for end-users	https://datastore.cls.fr/cls-operational-sargassum-monitoring-service-ready-for-end-users/	26/02/2019	497
Monitoring a massive Sargassum mat in the Atlantic Ocean	https://www.cls.fr/en/cls-operational-sargassum-monitoring-service-ready-for-end-users/	27/05/2019	179
CLS drift model predicts Sargassum landing in Dominican Republic	https://datastore.cls.fr/cls-drift-model-predicts-sargassum-landing-in-santo-domingo/	27/05/2019	32
CLS will attend Oceans 2019 Marseille	http://www.cls-telemetry.com/oceans-2019/	17/06/2019	27
Validating Sargassum forecasts with Sentinel-2 data	https://datastore.cls.fr/sargassum-validation-sentinel-2-data/	11/06/2019	78
Météo France chooses CLS with its partners I-sea and NBE to provide Sargassum detection services in the French Antilles	https://datastore.cls.fr/meteo-france-chooses-cls/	04/07/2019	18
Page Products Sargassum	https://datastore.cls.fr/products/sargassum/		561



Figure 13 : Summary of published articles and number of views

 <p>CLS Group @CLS_Group · 12 mars</p> <p>En soutien aux autorités, le tourisme, et la pêche, CLS propose un service opérationnel pour les #sargasses avec des satellites @CopernicusEU dans le cadre d'un projet @ESA_EO. @SargaMonitoring ow.ly/4A6r30o0ERM</p> <p>Voir l'activité sur Twitter</p>	<p>2 580</p> <p>13</p> <p>0,5 %</p>
 <p>CLS Group @CLS_Group · 12 mars</p> <p>Hoping to help local authorities, tourism, fisheries, and other industries with operational #sargassum service using @copernicusEU satellites open to end-users in the Caribbean within @ESA_EO project. @SargaMonitoring #sargasses ow.ly/J9ez30o0EQx</p> <p>Voir l'activité sur Twitter</p>	<p>4 250</p> <p>22</p> <p>0,5 %</p>

Figure 14 : March 2019 - 6830 views on social networks and 35 interactions



 <p>CLS Group @CLS_Group · 27 mai</p> <p>A spectacular #sargassum mat in an ocean eddy. The new detection service by @CLS_Group with @ESA_EO #Sentinel-3 satellite data and @CMEMS_EU #oceancurrents has tracked this mat since May 8 and can forecast its landing. @EO_OPEN_SCIENCE ow.ly/xcY250uq6K9 pic.twitter.com/F7e0Q0qN45</p> <p>Voir l'activité sur Twitter</p>	<p>3 682</p> <p>67</p> <p>1,8 %</p>
 <p>CLS Group @CLS_Group · 24 mai</p> <p>Can #satellites help us cope with #sargassum problem? The ESA @EO_OPEN_SCIENCE #sargassum monitoring service from @CLS_Group includes detection, monitoring and a drift model to identify probable #sargasses landing sites. Learn more: ow.ly/O1O650uotSV</p> <p>Voir l'activité sur Twitter</p>	<p>2 284</p> <p>26</p> <p>1,1 %</p>

Figure 15 : May 2019 - 5966 views on social networks and 93 interactions



	CLS Group @CLS_Group · 3 juin Une vue dégagée sur des bancs de #sargasses au large de Costa Rica le 1 juin avec le service de surveillance des sargasses développé par @CLS_Group . Testez ce service gratuitement jusqu'au 15 juin, demandez un accès datastore.cls.fr/create-an-acco... pic.twitter.com/V9z9KPKXJ2 Voir l'activité sur Twitter	1 385	7	0,5 %
	CLS Group @CLS_Group · 3 juin Clear skies make it possible to see #Sargassum mats lurking off the coast of Costa Rica on June 1st with @CLS_Group detection and monitoring service. Request free access to this service until June 15th datastore.cls.fr/create-an-acco... pic.twitter.com/fgDjo1Zp5x Voir l'activité sur Twitter	1 416	43	3,0 %

Figure 16 : June 2019 - 2801 views on social networks - 50 interactions

	CLS Group @CLS_Group · 9 juil. CLS et ses partenaires NovaBlue Environment, Isea, sélectionnés par @meteoFrance pour contribuer aux bulletins de prévision des #sargasses aux Antilles. @JP_MARECHAL_NBE @iSeaNews twitter.com/Prefet971/stat... Voir l'activité sur Twitter	1 382	17	1,2 %

Figure 17 : July 2019 - 1382 views on social networks and 17 interactions



6. Conclusion

Massive landings of Sargassum started to affect the Caribbean area in 2011. When the project started in September 2018, the Caribbean had just encountered the worst Sargassum landing season since the beginning of the phenomena. The local and international authorities were only starting to consider the massive landings of Sargassum as a real and recurrent hazard. The number of meetings and conferences on the subject are growing in the region, but no real inter-regional collaboration has been set-up yet for the management of the Sargassum crisis. Collaboration exists mainly at the research level, and several initiatives have started to address the issue on the crisis management side, but with no real achievement to date.

The Sargassum Monitoring Service developed during the frame of this one-year project is therefore unique in its regional approach of the problem. End-users having tested the system have all been very positive about the tool and the products. The gain in resolution thanks to the Sentinel satellites is a real added value for Sargassum monitoring, allowing to refine the detection and the risk estimation of massive landings occurrence in the areas monitored. The tools provided through the web platform, the combination of satellite detection with drift modelling allows to provide support to operational teams on site, who need to access easily and quickly to synthetic information on the daily Sargassum situation.

All the end-users, from a diversity of economic sectors, answering the questionnaire stated that they were willing to continue accessing the service. This confirms the relevance of the Sargassum Monitoring Service in the management of this environmental and societal issue. This is confirmed by the success of the communication actions which have encountered a great interest. The next step will be to find the best approach to sustain the service at a regional scale in order to allow the end-users of all the Caribbean countries to benefit from this powerful and unique tool.



7. APPENDIX I - End-user feedback questionnaire

Name	
Institution	
Occupation	
Field of expertise (research, management, fisheries, tourism, ...) What interest do you have in a Sargassum Monitoring & Forecast Tool?	

Platform usability

		Poor	Fair	Satisfactory	Good	Excellent
1	Overall use of the Seewater-Sargassum platform (check the box)	.....	.....	.....	.....	.....
2	The platform is easily usable: (check the box) a- Menu navigation b- Visualization tools	..........	..........	..........	..........	..........
3	How do you use the features in the platform?	Weather and Oceans	Satellite Sargassum detection	Export/import tools	Sargassum Drift forecast	Past events and drift simulations
	From 0 (no use) to 5 (important use)					



4	What other inputs would you like to see in this platform (datasets, services, new functionalities)?	
5	Do you intend to continue using this platform?	
6	Other comments & suggestions List any difficulties you encountered during the test phase	

Sargassum Drift Forecast

		Poor	Fair	Satisfactory	Good	Excellent
7	Overall use of the Sargassum Forecast Menu (check the box)	.....	.....	.....	.....	.....
8	The sargassum forecast tool is easy to understand and manipulate (check the box)	.....	.....	.....	.....	.....
9	What feature do you use most?	Initial detection	Trajectories		Heat map	Gridmaps
	From 0 (no use) to 5 (important use)					
10	Reliability of the Sargassum forecast (check the box)	Poor	Fair	Satisfactory	Good	Excellent
11	3 days forecast is suitable for my need (check the box)	Poor	Fair	Satisfactory	Good	Excellent



	If 3-days not suitable, how long would you prefer the forecast to be extended? (check the box)	
12	Other comments & suggestions	

Satellite Sargassum detection

		Poor	Fair	Satisfactory	Good	Excellent
13	Overall use of the Sargassum Satellite Detection Menu (check the box)	.....	.....	.....	.....	.....
14	The sargassum detection products are easy to understand and manipulate (check the box)					
	Weekly average product					
	Sargassum mats only products					
	Cloud cover products					
	Expert data					
	High resolution products for Barbados, Martinique & Guadeloupe					
	Other comments & suggestions					
15	What information layer do you use the most?	Weekly average product	Sargassum mats only products	Cloud cover products	Expert data	High resolution products for Barbados, Martinique & Guadeloupe



	From 0 (no use) to 5 (important use)					
16	Confidence in the sargassum detection (check the box)	Poor	Fair	Satisfactory	Good	Excellent
17	Other comments & suggestions					

Weather & Oceans data

		Poor	Fair	Satisfactory	Good	Excellent
18	Overall use of the Weather & Oceans Menu (check the box)	.....	.....	.....	.....	.....
19	The Weather & oceans data are easy to understand and manipulate (check the box)					
20	The weather & oceans data are helpful to understand sargassum forecast (check the box)					
21	Other comments & suggestions					

8. APPENDIX II - Legal framework to use the platform

TERMS AND CONDITIONS:

Use of the Platform

The web platform "SeeWater Sargassum Monitoring Service", as described in the User Manual, consists of a set of IT components and services, servers, databases and software used to display and exploit data or other (hereinafter called "Platform" or "Services").

Proprietary information: no part of this document may be reproduced divulged or used in any form without prior permission from CLS.



The User acknowledges and accepts that the Platform is the property of and contain proprietary information and data of CLS and/or its partners. The authorized use of the Platform is limited to the User and its named employees, who are also required to comply with the present terms and conditions.

The Platform may not be used by any third party without the prior written consent of CLS.

The use of the Platform requires prior allocation of a login and of a password. This identification information is strictly personal and confidential and should not be disclosed to or shared with third parties. Under no circumstances shall CLS be liable for the loss of identification information by the User, who is solely responsible for such information, whether used by the User or its employees, or, if applicable, for any actions made through the use of such login/password, whether fraudulent or not. In addition, CLS does not have the means to verify the identity of persons accessing the Platform and cannot therefore be held liable in this matter. If the User has reason to believe that a person is using its identification details without having received the requisite authorisation, it must immediately inform CLS so that appropriate measures can be taken.

In any case the User shall be exclusively responsible and liable for, and shall indemnify and hold harmless CLS against all liabilities, costs (including legal costs on an indemnity basis), expenses, damages or losses resulting from any use or misuse of the Platform or any of its content by himself or any of its employees.

Scope

CLS grants the User a personal, non-exclusive, non-transferable right to use the Platform, its component parts, its content and the User Guide for its own internal needs, on its own infrastructure and limited to the following purposes:

- Identifying the Sargassum rafts positions;
- External communications about the Sargassum invasion situation;
- Use of the content of the Platform for analyses related to Sargassum arrivals.

In this framework, the User is entitled to publish screenshots of Sargassum rafts positions and drift forecast only.

Such rights are granted until 2019 June, 10th.

The User shall:

- Fill out a questionnaire aiming at assessing the Services adequation to its needs
- Provide regular feedback to CLS regarding any technical issue (connection, time-lag, data access, etc..)

The Platform and its content are confidential. The Client shall not disclose any of its content to any third party without prior written authorisation of CLS.

Unless otherwise authorised in written by CLS, in relation to the Platform (or one or more of its component parts) or any of its content, and by way of example only, the User is not authorised to:

- Publish, copy all or part, print, transfer to any third party, reproduce, modify, arrange or correct all or part of the components of the Platform or its content; or export and/or incorporate all or part of it into other computer programs;
- Sell, rent, sub-license, make available to third parties, market, lend or distribute in any way whatsoever;
- Use to provide any individual, company or entity with any services such as for instance data-collection and information-processing services
- Compile, decompile, disassemble, translate, reverse engineer or attempt to reverse engineer the software that is part of the Platform, except within the limits authorised by law.
- Use the Platform of any of its content for commercial purposes.

Suspension or Termination

At any time, CLS and/or its partners reserve the right to suspend access to and the use of the Platform:

1. For internal and/or technical reasons, in which case CLS and its partners shall seek to inform the User in advance before the scheduled date of such suspension of access;
2. Without notice, in the event of non-compliance with any obligations as provided for above or with the legal and regulatory provisions in force, or when CLS has reason to believe that the User has (i) used the Platform for any other purpose than the purposes listed above or, if applicable, to generate and transmit abnormal or excessive quantities of data/messages, spam messages or data that



represent a risk to the security or performance of the communication network used or to any other user, (ii) attempted to degrade, restrict, interfere with or disrupt the or bypass the network in question.

Copyright, trademarks and any other intellectual property rights

The User acknowledges that the Platform and all its components are the exclusive property of CLS.

The brands, logos, slogans, graphic elements, photographs, animations, videos, software, databases and other components are the exclusive property of CLS, and therefore cannot be reproduced, used or represented without express prior authorization, under penalty of legal prosecution.

In this light, the User is forbidden to use the name CLS without the prior written agreement of CLS;

Furthermore, without prior written authorisation of CLS, the User shall not:

- Extract by permanent or temporary transfer of all or a qualitatively or quantitatively substantial part of the content of the Platform, by any means and in any way whatsoever;
- Reuse, through making available to the public all or a qualitatively or quantitatively substantial part of the Platform, in any way whatsoever.

Personal Data

In the context of the use of the Platform, the User acknowledges and accepts that CLS has to process its personal data necessary for the operation of the Platform. Thus, in order to make it possible, the User entrusts CLS with the processing of its personal data, and notably collecting, drawing value from and making available various kinds of data (surname, first name, email, telephone numbers, registration number, Platform user-identification data, etc.). The purpose of these processing operations shall be strictly limited to the supply of access to the Platform and its contents. Moreover, CLS undertakes to only process personal data that is strictly necessary for the above-mentioned purposes.

As a general rule, CLS shall comply with the applicable legislation concerning the protection of personal data and notably the Regulation (EU) 2016/679 of 27 April 2016 ("GDPR"). As such, CLS undertakes to implement all appropriate technical and organizational measures to protect the User's personal data against any unauthorized or illegal processing and against the loss, accidental destruction and alteration of the personal data.

In accordance with the GDPR, the User has a right to access and rectify the personal data collected and processed by CLS. The User has also a right to oppose the processing of its personal data for legitimate reasons but acknowledges that following this request, access to the Platform and its content may no longer be supplied by CLS. The User can exercise its rights to access and rectify its information by logging in to its account. Otherwise, the User may exercise its rights by sending an email to: dpo@groupcls.com.

Disclaimer

CLS cannot under any circumstances guarantee the accuracy, merchantability or fitness of the content of the Platform for any particular purpose. Such content is made available only for the above-mentioned purposes and are provided without warranty of any kind. The use of the Platform or any of its components or contents and any information therein are the sole responsibility of Users.

CLS may not be held liable for any loss or damage incurred by the User or any third party deriving, directly or indirectly, from (i) the use of the Platform, (ii) from use or interpretation of any of its content/data, (iii) from any action or omission based on the above-mentioned content/data.

CLS cannot under any circumstances guarantee an uninterrupted access to the Platform or to its content.

Miscellaneous

These terms and conditions, and the access to the Platform are subject to French law, regardless of the location of the User. In the event of a dispute between CLS and the User, if necessary, after any attempt to find an amicable solution, the Court of Appeal of Toulouse (France) shall have exclusive jurisdiction, even in the event of an incidental claim, multiple parties, third-party notice and proceedings against a guarantor, including for summary or ex parte proceedings, protective measures and enforcement measures.