Seagrass Trainer User's Manual

(ver 1.0)

Ministry of the Environment
Government of Japan

Revision records

Version	Uploaded date	Revised parts	Revision details and reasons
Ver1.0	2021/6/18		

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Introduction

Seagrass Trainer is a web tool to map marine ecosystems such as seagrass beds in coastal waters. Seagrass Trainer works with “Seagrass Mapper”, developed by using Google Earth Engine, a scientific analysis platform for cloud-based satellite imagery, and it can interactively map coastal ecosystems on the web. Both Seagrass Trainer and Seagrass Mapper work as part of the NOWPAP Marine Environmental Watch of the Ministry of Environment of Japan, which is operated by the Northwest Pacific Region Environmental Cooperation Center (NPEC).

In this manual, how to map seagrass beds (extracting seagrass beds and projecting them on a map) with Seagrass Trainer is explained while showing a step-by-step procedure and analysis results.

The basic flow of how to use Seagrass Trainer is shown in Figure 1 on the next page. The numbers in the figure correspond to section/sub-section numbers of the manual. From Section 2 (Preparation of data to be used for satellite analysis) to Section 3 (Examples of Analysis), a whole procedure, from detecting seagrass beds using satellite images with field survey data of sea-floor substrate as training data to evaluating obtained seagrass-mapping results, with analysis examples in Nanao Bay and Toyama Bay in Japan is explained.

Procedure	Note
■1. Access to Seagrass Trainer	Access to “Seagrass Trainer” tool on the website
1.1. Sign Up (user registration)	“User Registration” is necessary when signing up for the first time
1.2. Sign In/Sign Out	
■2./3.*.1. Preparation of data to be used for satellite analysis	
2.1./3.*.1 Satellite images - Selecting satellite images, or - Setting criteria for selecting satellite images	There are 3 ways of how to select satellite images: (1) searching satellite images from the GEE Public Data Catalogue (publicly available from GEE for free); (2) using matched images by setting searching criteria for the GEE Public Data Catalogue; or (3) preparing satellite images by user
2.2./3.*.1. Area of Interest (AOI) and training data (vector data) - Preparing data, or - Collecting information for drawing geometrical features	There are 2 ways of preparing data: (1) uploading self-prepared data (which can be edited in Seagrass Trainer) ; or (2) preparing data by drawing geometrical features in Seagrass Trainer, based on field survey information
2.3./3.*.1. Water Depth/Bathymetry data - Preparing water depth/bathymetry data	These data are used only when applying Water Colum Correction (BRI method), Water Depth Correction, and masking some parts by depth.
↓	
■1.2. Sign In	Access to Seagrass Trainer on the website and Sign-In
↓	
■3. Examples of Analysis	
3.*.2. Uploading data prepared in advance	In case user prepares data in advance
3.*.3. Drawing, editing and saving vector data	In case user draws Area of Interest (AOI) or training data (vector data) with Seagrass Trainer, or user edits uploaded data
3.1.4. Checking information in asset	
3.1.5. Searching satellite images	In case user searches satellite images in the GEE Public Data Catalogue and selects them.
↓	
■3.1.6./3.2.4. Setting parameters for analysis	
3.*.*.1. Satellite images	
3.*.*.2. Atmospheric Correction	
3.*.*.3. Water Depth/Bathymetry Correction	
3.*.*.4. Water Column Correction	

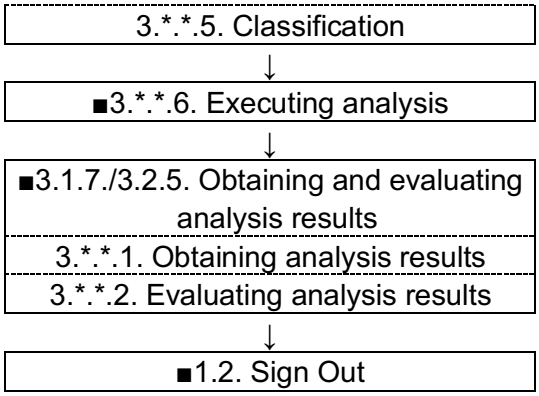


Figure 1 Basic procedure of using Seagrass Trainer.

* consecutive sub-chapter numbers are shown in asterisks (*).

1. Access to Seagrass Trainer

Access to the following URL.

https://seagrasstrainer.mapseagrass.org/

Before using “Seagrass Trainer” tool for the first time, User registration is required. See Section 1.1 for signing up.

For Sign in/Sign out after signing up, see Section 1.2.

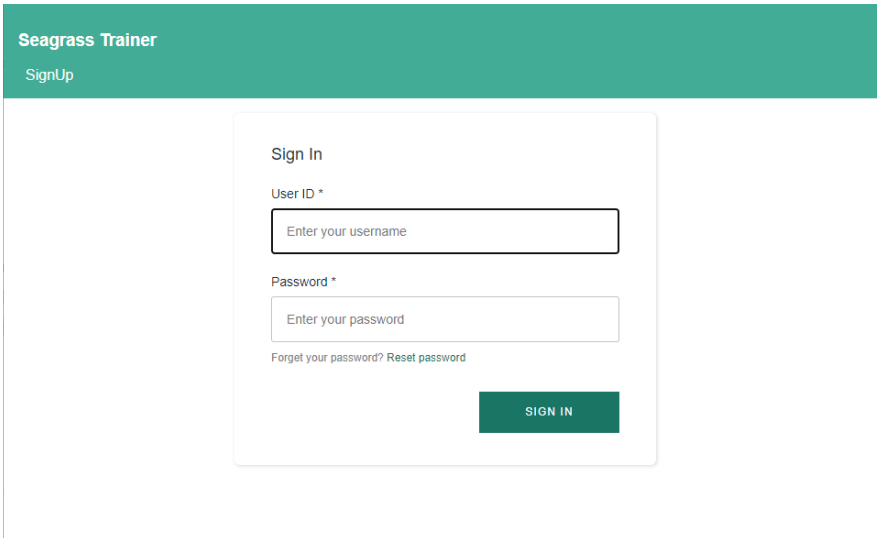


Figure 1-1 Sign In page which is shown when accessing to Seagrass Trainer.

1. 1 Sign Up (User registration)

When using Seagrass Trainer for the first time, user registration is required.

Send an application form to the administrator, Northwest Pacific Region Environmental Cooperation Center (NPEC). When an application is approved, NPEC sends an email to a new user to notify completion of user registration with a default password. User can re-set the password at the initial Sign-In.

*Please note that it may take one week at maximum to register a new user. So, it is strongly recommended to send an application form in advance.

(1) User registration

Click “Sign Up” on the top left corner of the Sign In page to display the page for user registration.

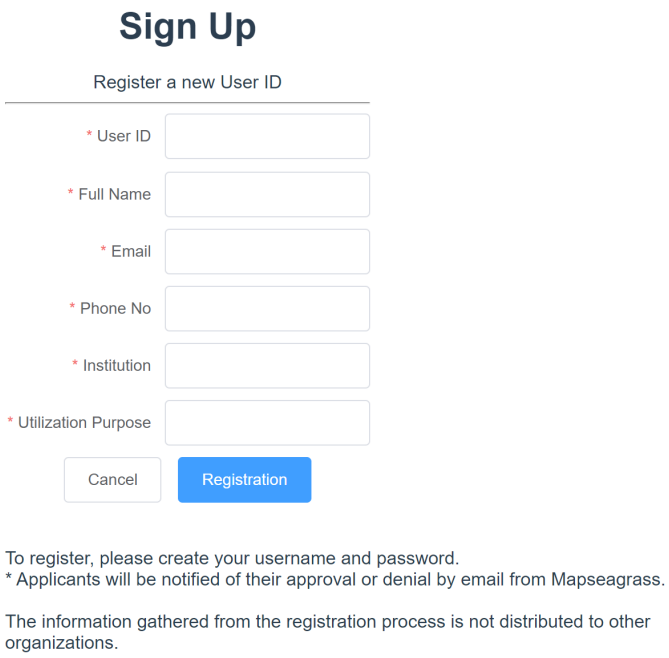


Figure 1-2 Sign Up page for user registration.

Enter the following personal information in each field on the Sign Up page.

*User ID: User ID (15 or less of lower case letters) *1

*FullName: full name (fist name first)

*Email: email address.

*Phone No: telephone number where user can be reached*2

*Institution: name of workplace (e.g. institution/organization) or school

*Utilization Purpose: purpose(s) of use of Seagrass Trainer

(User can re-set the default password after receiving an email from NPEC to notify completion of user registration.)

(* required fields)

*1 For User ID, make sure that:

- Must be no more than 15 characters;
- First letter must be alphabetic;
- All alphabetic must be lowercase; and
- Must not contain a period "." or a comma ",".

*2 For telephone numbers, make sure that:

- Type numbers only; and
- Include a country code
- Omit the first zero "0" number

Click "Cancel" to cancel signing up.

Make sure that all entered information is correct and click "Registration" to submit the form.

The administrator, NPEC, reviews a submitted registration form and decides whether to approve it or not. (*Since the review process is conducted manually, it may take some time.) After application is approved, an email is sent to a new user's registered email address to notify completion of user registration.

(2) Setting a Password

After receiving an email to notify completion of user registration, enter the user ID and the default password in each field on the Sign In page, and click the Enter key or "SIGN IN" to log in. (User ID and a default password are provided in the e-mail to notify completion of user registration.)

For setting a new password, click "SIGN IN".

Enter a new password in "New Password" and click "SUBMIT".

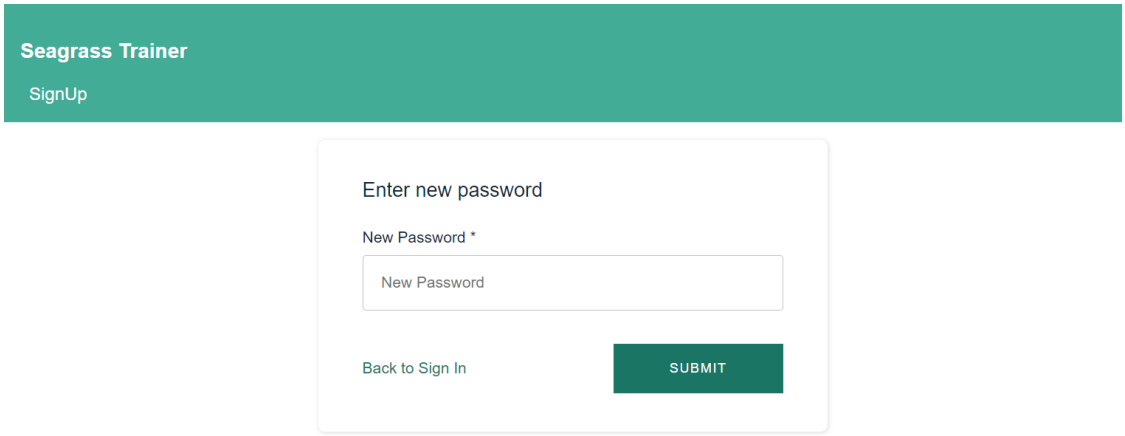


Figure 1-3 Webpage for setting a new password.

(3) Sign In

After setting a new password, click “Back to Sign In” to go back to the Sign In page. Then, enter User ID and the newly created password, and click the Enter key or “SIGN IN”.

1. 2 Sign In / Sign Out

After completing user registration, user can sign in to the Seagrass Trainer tool to use it. Enter User ID and the newly created password, and click the Enter key or “SIGN IN”.

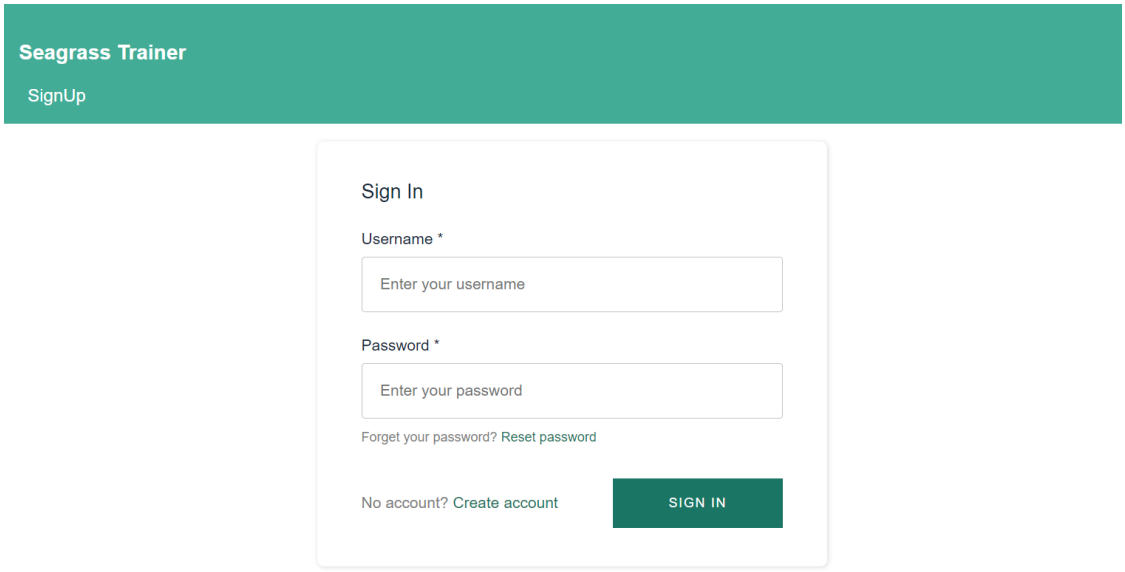


Figure 1-4 Sign In page.

When mapping seagrass beds, it is recommended to keep the web browser open (keep the sign-in status) until user retrieves the results (GeoTIFF file and CSV file). Once signing out, user cannot access to the folder for analysis results from Seagrass Trainer.

Figure 1-5 User interface.

2. Preparation of data to be used for satellite analysis

Table 2-1 shows a list of data to be used for mapping seagrass beds with Seagrass Trainer. These data are either prepared in advance and uploaded to Seagrass Trainer or prepared by using Seagrass Trainer to execute analysis. Please refer to Section 2.1: Satellite Images, Section 2.2: Area of Interest (AOI) and training data (vector data), and Section 2.3: Water Depth/Bathymetry data.

Table 2-1 Necessary data to be used for mapping seagrass beds with Seagrass Trainer.

Name in Seagrass Trainer	**Content**	**Data type**	**File format**	**Required or not**	**Can be prepared with Seagrass Trainer**
Satellite Image	satellite images	raster	tif[*1]	required	Yes[*2]
Satellite Metadata	metadata of satellite images	metadata file which comes with satellite image	xml, imd	required when uploading satellite images	Yes[*2]
AOI	data for area of interest (AOI)	vector (polygon)	shp, kml, kmz, csv, geojson	required	Yes
Training for ATC	training data for atmospheric correction (ATC)	vector (polygon)	shp, kml, kmz, csv, geojson	required for ATC, land masking, and/or dark pixel masking	Yes
Training for WCC	training data for water column correction (WCC)	vector (polygon)	shp, kml, kmz, csv, geojson	required for WCC.	Yes
Training for Classification	training data for supervised classification	vector (polygon or point)	shp, kml, kmz, csv, geojson (separate file for each class)	required for classification	Yes
Depth / Bathymetry	water depth / bathymetry	raster	tif	required for WCC (BRI method), water depth correction, and/or	

				masking by water depth	
-	Tidal level	text	csv	required for tidal level correction with user's own data[*3]	

[*1] one Tiff file with an image of all bands is stored (not multiple files by each band)

[*2] When using satellite images in the GEE Public Data Catalogue, user can prepare them by using Seagrass Trainer.

[*3] When applying tidal level correction (See 3.1.5.3), tidal level data are required. In Seagrass Trainer, tidal level data by the Japan Meteorological Agency (open source) are already installed. When user like to use other tidal level data, tidal level data need to be prepared on his/her own. For preparation of tidal level data, please refer to Appendix for details (Section 5 Tidal Correction with different data from JMA).

2. 1 Satellite Images

(1) Preparing satellite images

At first, decide how to prepare satellite images from 3 options below (Table 2.1-1). When selecting Option (i) or Option (ii), it is necessary to set image search criteria in advance. When selecting Option (iii), user needs to prepare both satellite images and their metadata*.

** Metadata is a text file which includes basic properties of satellite images (e.g. the date/time of an image taken, maximum/minimum latitude and longitude). A file format of metadata is configurated each satellite image.*

Table 2.1-1 How to prepare satellite images and three examples explained in this manual

Option	How to prepare satellite images	Examples in this manual
(i)	User searches for and selects satellite images in the GEE Public Data Catalogue.	Example A: Nanao Bay Satellite Image: June 1, 2015 taken by Landsat-8 (Data are available in the GEE Public Data Catalogue) User searches for this image in the GEE Public Data Catalogue. (See Section 3.1.5 Searching satellite images, and 3.1.6.1 Satellite images (i) when user searches for and selects satellite images in the GEE Public Data Catalogue)
(ii)	User only sets criteria for searching satellite images in the GEE Public Data Catalogues and uses matching satellite images (This option is useful when GEE image search doesn't work or user already knows search criteria for satellite images.	Example A: Nanao Bay Satellite Image: June 1, 2015 taken by Landsat-8 (Data are available in the GEE Public Data Catalogue) User sets criteria for image search, and GEE Public Data Catalogue automatically selects matching image. (See Section 3.1.6.1 (ii) when satellite images are automatically selected in the GEE Public Data Catalogue)
(iii)	User prepares satellite images on his/her own and uploads them to Seagrass Trainer. (For this option, metadata must be uploaded with satellite images.)	Example B: Toyama Bay Satellite Image: July 15, 2018 taken by WorldView-2 (The image is not available in the GEE Public Data Catalogue. User prepares the image on his/her own in advance and uploads it to Seagrass Trainer.)

(2) Types of Data which can be used in Seagrass Trainer

Types of data which can be used in Seagrass Trainer are as follows:

i. When using satellite images in the GEE Public Data Catalogue (Options (i) and (ii))

- Landsat 4 Tier1 TM TOA Reflectance
- Landsat 5 Tier1 TM TOA Reflectance
- Landsat 7 Tier1 ETM+ TOA Reflectance
- Landsat 8 Tier1 OLI TOA Reflectance
- Sentinel-2 MSI L1-C
- ALOS/AVNIR-2 ORI

ii. When using satellite images prepared and uploaded by user

- WorldView-2 WV110
- WorldView-3
- GeoEye-1
- Any (e.g. WorldView-4, SPOT, Planet)

*Please note that when using data in this category (ii), user also needs to prepare metadata of the satellite images, which are to be provided in extension files (.IMD for WorldView-2/3/4 and GeoEye-1, or .XML for SPOT and Planet).

2. 2 Area of Interest (AOI) and training data (vector data)

Data for Area of Interest (AOI), and training data for Atmospheric Correction (ATC), Water Column Correction (WCC) and supervised classification are used for analyzing satellite images, and user needs to prepare vector data of them as follows:

i. File types

Either shp, kml, kmz, csv, or geojson

ii. How to prepare data

(a) Case that user prepares data on his/her own and uploads them to Seagrass Trainer. In case of a shape file (shp), at least the four files among shape file components (*.shp, *.shx, *.dbf, and *.prj) must be zip-compressed.

(b) Case that user draws data and save them in Seagrass Trainer. In this case, user must decide geometrical features in advance to prepare training data and others.

(c) Case that user prepares data in advance and then edits and saves these self-prepared data in Seagrass Trainer. Please note that

although user can change the file name when saving them in Seagrass Trainer, only the files with the predefined names can be used for analysis.

The data prepared and uploaded by user (except for csv file) in advance are converted to a (zipped) shapefile and geojson format to be suitable for editing and analysis in Seagrass Trainer. (Csv files do not need to be converted and can be used for editing and analysis in Seagrass Trainer.)

The data drawn and/or edited in Seagrass Trainer are saved as shapefile and geojson format. When kml and/or kmz formats are included in uploaded files, they are also saved in kml format.

Be careful not to give the same file names to a zip-compressed shape file and a csv file. When same names are given to two different files, error message is given when executing analysis.

2. 3 Water Depth/Bathymetry data

Water depth/bathymetry data are raster data format and they are used for applying water column correction (WCC) and masking sea areas based on water depth information. So, for conducting these tasks, user needs to prepare water depth/bathymetry data and uploads them to Seagrass Trainer in advance. The file format should be GeoTIFF (.tif), and positive numbers shall be used to indicate the depth (greater numbers are deeper) .

3. Examples of Analysis

3. 1 Nanao Bay (Example A)

This section explains how to map seagrass beds in Nanao Bay, Japan by using a satellite image taken by Landsat-8, which is available in the GEE Public Data Catalogue. The list of data used for this analysis is shown in Table 3.1-1 below.

Table 3.1-1 Data to be used for mapping seagrass beds (Example A: Nanao Bay)

Name in Seagrass Trainer	**Content (data used in Example A)**	**Preparation**	**File Name**
Satellite Image	satellite image (taken on June 1, 2015 by Landsat-8)	Searching for an image in the GEE Public Data Catalogue in Seagrass Trainer (Case (i) user's own search, or Case (ii) setting searching criteria for image search)	―
Satellite Metadata	metadata of satellite image (no need to be uploaded)	―	―
AOI	AOI data (polygon shapefile in Option (i))	either Option (i): prepared in advance, or Option (ii): drawing and saving in Seagrass Trainer	AOI.zip (Case (i))*1
Training for ATC	training data for ATC (polygon shapefile)	prepared in advance	Train_ATC.zip *1
Training for WCC	training data for WCC (polygon shapefile)	prepared in advance	Train_WCC.zip *1
Training for Classification	training data for supervised classification (polygon shapefile)	prepared in advance	Train_CLS1.zip *1 Train_CLS2.zip *1 Train_CLS3.zip *1 Train_CLS4.zip *1
Depth / Bathymetry	water depth/bathymetry (satellite image which contains water depth value as pixel value, GeoTIFF)	prepared in advance	D.tif

*1 Zip-compressed shapefiles for uploading. The file name must not be changed. For training data for supervised classification, file numbers ("n" in "Train_CLSn.zip") should be consecutive. In addition to a shapefile, kml, kmz, csv, and geojson files can be used; however, the names (before "extension") should not be changed (e.g. "AOI.kml").

3. 1. 1 Preparation of data to be used for satellite analysis

Prepare the following necessary data in advance. In the following steps, AOI data and all training data (vector data) are shapefiles.

(1) Data for Area of Interest (AOI)

i. When user prepares data in advance

By using GIS software, draw polygon(s) for the area of interest (AOI) and save them as a Shapefile. Then, zip-compress all files of the created shapefile (at least four files: .shp, .shx, .dbf, and .prj) to make one file with a name, “AOI.zip”. In the case of Nanao Bay, AOI is set as shown in Figure 3.1-1. Polygon data for this AOI are created and saved as “AOI.zip”.

User can upload data prepared on his/her own in advance and edit them in Seagrass Trainer.

ii. When user draws polygon(s) and saves them in Seagrass Trainer

Decide the target area for analysis (AOI) in advance. In this example, AOI is set as shown in Figure 3.1-1.

See Section 3.1.3 Drawing, editing and saving vector data.

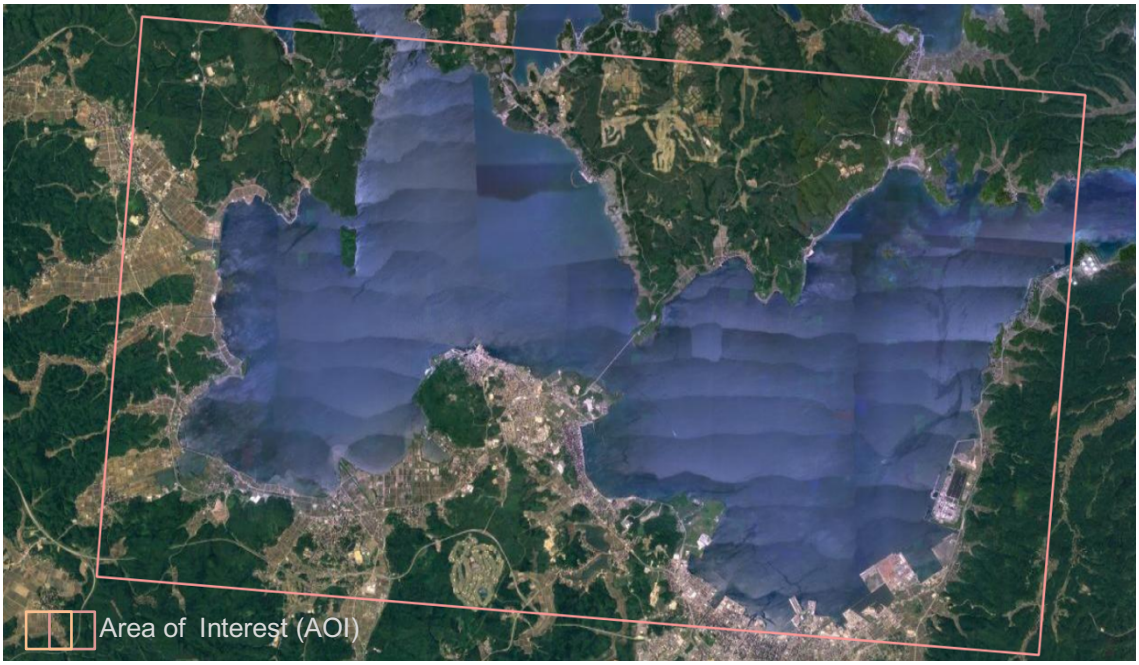


Figure 3.1-1 Are of Interest (AOI.zip) in Nanao Bay.

(2) Training data for Atmospheric Correction (ATC)

By using GIS software, draw polygon(s) of the referential area which is used for Atmospheric Correction (ATC). When using dark-pixel-profile (DPP) method, the reference area should be deep-sea areas where light-reflection from the sea floor is

negligible. When using near-infrared (NIR) method, user can include bright sea surface areas. The created polygons should be saved in a shapefile. Then, all files (at least four files: .shp, .shx, .dbf, and .prj) should be combined and zip-compressed as one file, “Train_ATC.zip”.

In the case of Nanao Bay, polygon data for ATC are created based on field survey and water depth/bathymetry information (Figure 3.1-2), and they are saved as “Train_ATC.zip”.

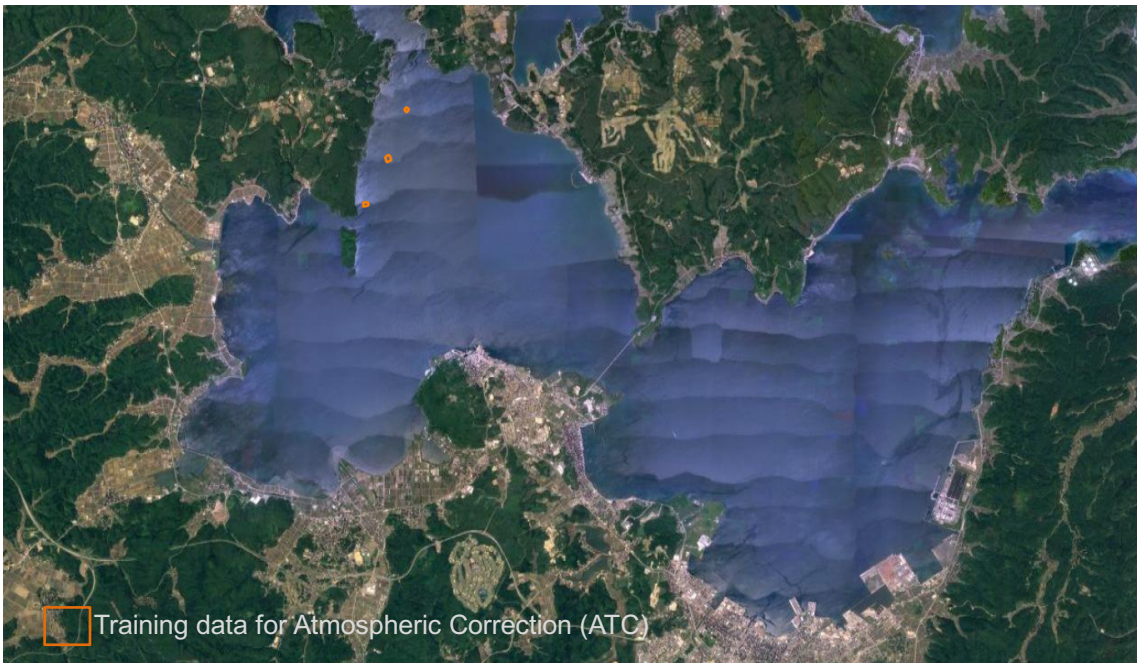


Figure 3.1-2 Training data for Atmospheric Correction (Train_ATC.zip) in Nanao Bay.

(3) Training data for Water Column Correction (WCC)

By using GIS software, draw polygon(s) for the reference area which is used for Water Colum Correction (WCC). The reference area should be selected based on the information of the field survey and other information, as presumed the area of sandy substrate with no seagrasses, which covers from a shallow water to deeper area. Multiple polygons can be selected. The drawn polygons must be saved as a Shapefile and zip-compressed as “Train_WCC.zip”, same as (2) above.

In this example, polygon data are created based on the information on the filed survey which is conducted using an underwater video camera (Figure 3.1-3) and saved as Train_WCC.zip.

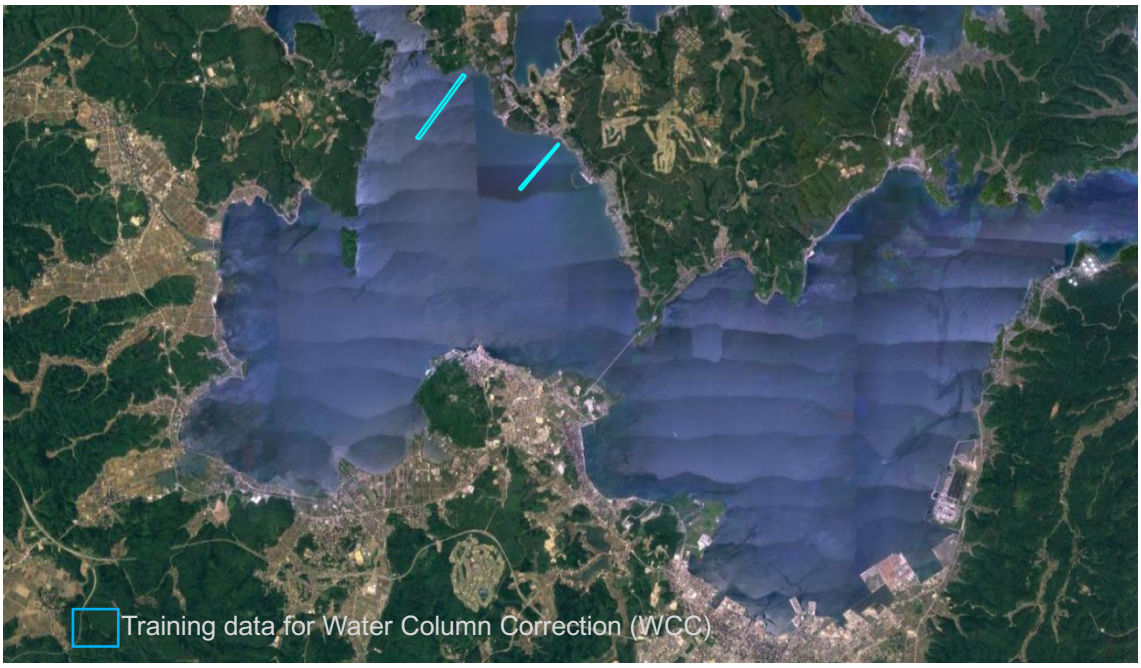


Figure 3.1-3 Training data for Water Column Correction (Train_WCC.zip) in Nanao Bay.

(4) Training data for Supervised Classification

By using GIS software, draw polygon(s) or point(s) of training data for satellite image analysis, which sets the reference area for classifying sea bottoms, based on the information obtained by field survey, existing database, research papers and/or scientific reports. The created polygon(s) or point(s) should be saved as a Shapefile by each class. They should be zip-compressed, same as (2) above. The file name is “Train_CLS*.zip”. (*= class number, using consecutive number starting from 1)

In the case of Nanao Bay, the following 4 training data are prepared based on the information on sea-floor substrate field survey which is conducted using an underwater video camera as well as the position information by GPS logger. (Figure 3.1-4)

Train_CLS1.zip (bottom: seagrass)

Train_CLS2.zip (bottom: sandy-muddy)

Train_CLS3.zip (bottom: seaweed)

Train_CLS4.zip (bottom: rocky reef)

These class numbers are recorded in the image of analysis results.

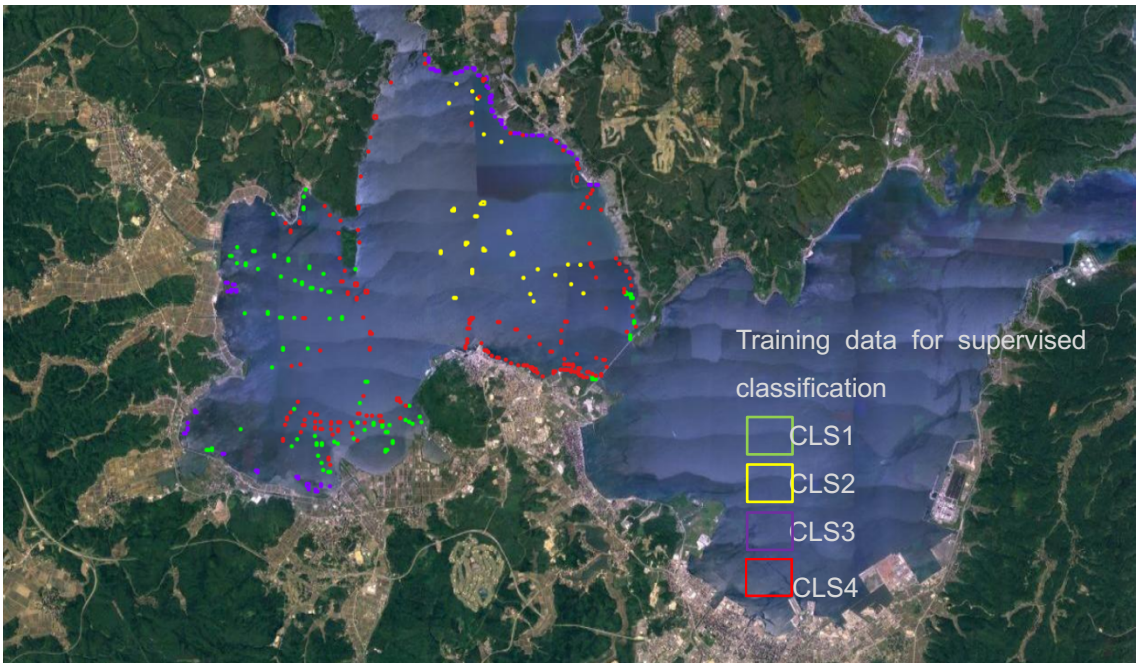


Figure 3.1-4 Training data for supervised classification (Train_CLS1~4.zip) in Nanao Bay.

(5) Water Depth/Bathymetry data

Prepare a raster image with pixel values which contains water depth information (unit: meter, positive number: deeper). This example uses 2-meter-meshgrid GeoTiff data of West Bay in Nanao Bay, Japan (covering northern latitude 37°03'58.26" ~ 37°08'12.33", and eastern longitude 136°51'09.73" ~ 136°56'56.84"), which is developed by Environment Simulation Laboratory Co, Ltd. (Figure 3.1-5). The file name is “D.tif”.

Water depth/bathymetry data are used for masking areas under a certain depth of water (for excluding these areas from analysis targets) or applying water column correction (WCC) by water depth, and/or water depth/bathymetry correction by tidal level. So, if these processing are not required, user doesn’t have to prepare water depth/bathymetry data.

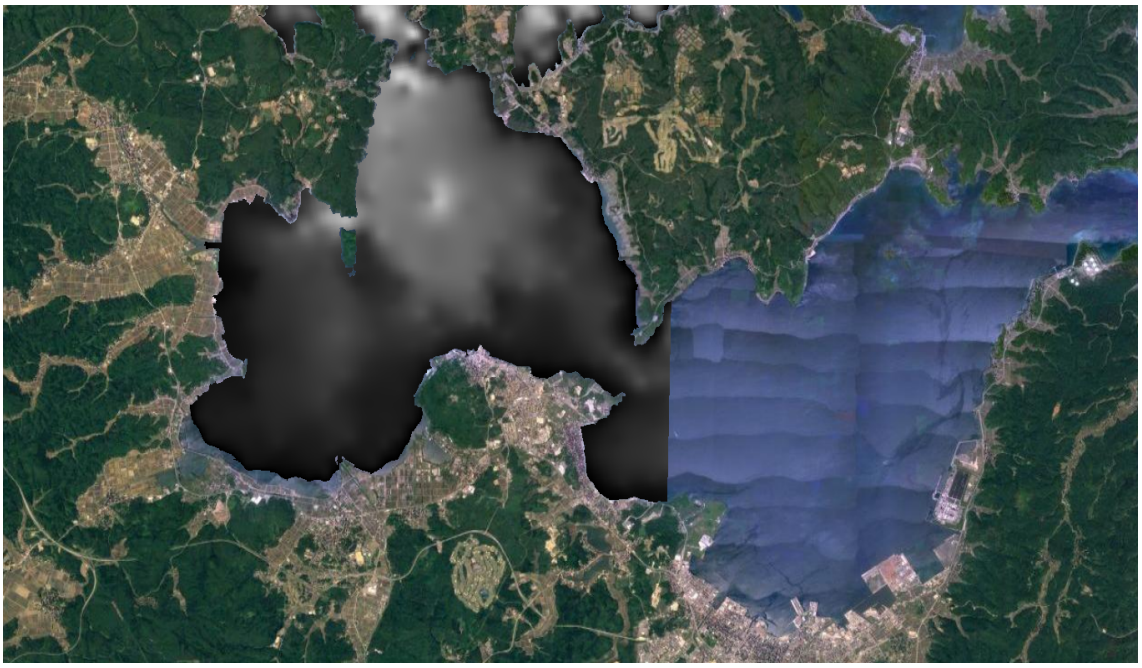


Figure 3.1-5 Water depth/bathymetry data (D.tif) in Nanao Bay.
Water depth is shown by colors: black (shallow) - white (deep).

3. 1. 2 Uploading data prepared in advance

After signing in to Seagrass Trainer (see Section 1.2), user uploads the data which are prepared in advance, and checks their contents, if necessary, by displaying them on the screen.

(1) Uploading data to Seagrass Trainer

Follow the next steps. The following figures show examples of a computer screen in each step.

i. Home screen> Dataset

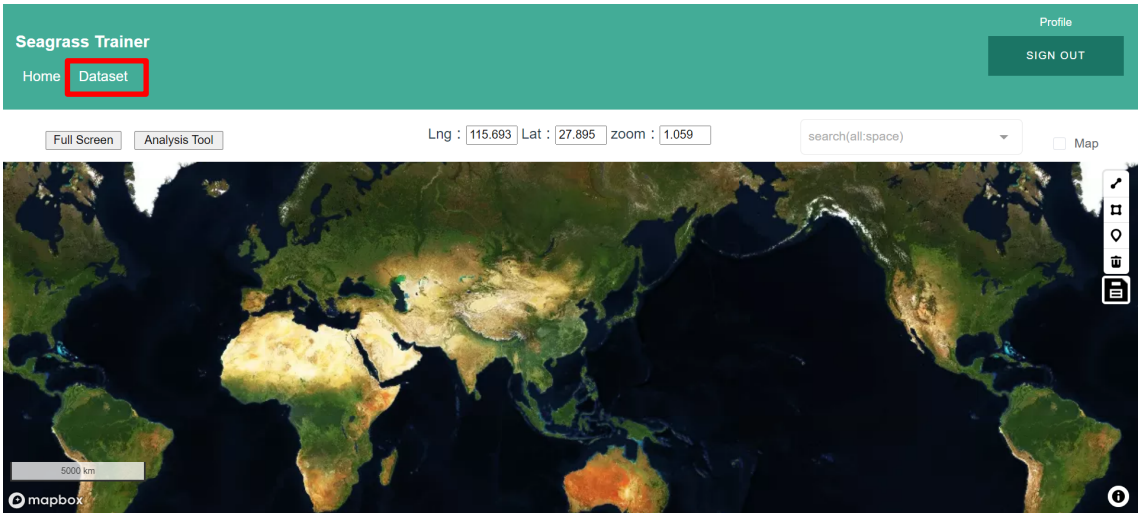


Figure 3.1-6(a)

ii. Dataset page > “Upload” > Input File Upload page is shown.

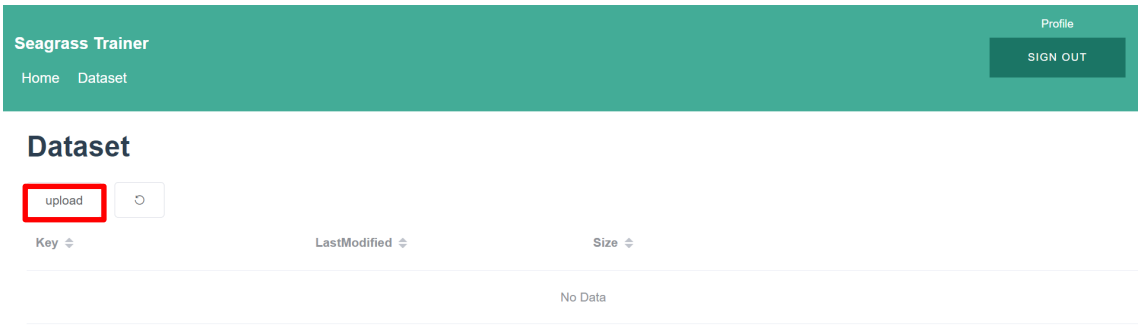


Figure 3.1-6(b)

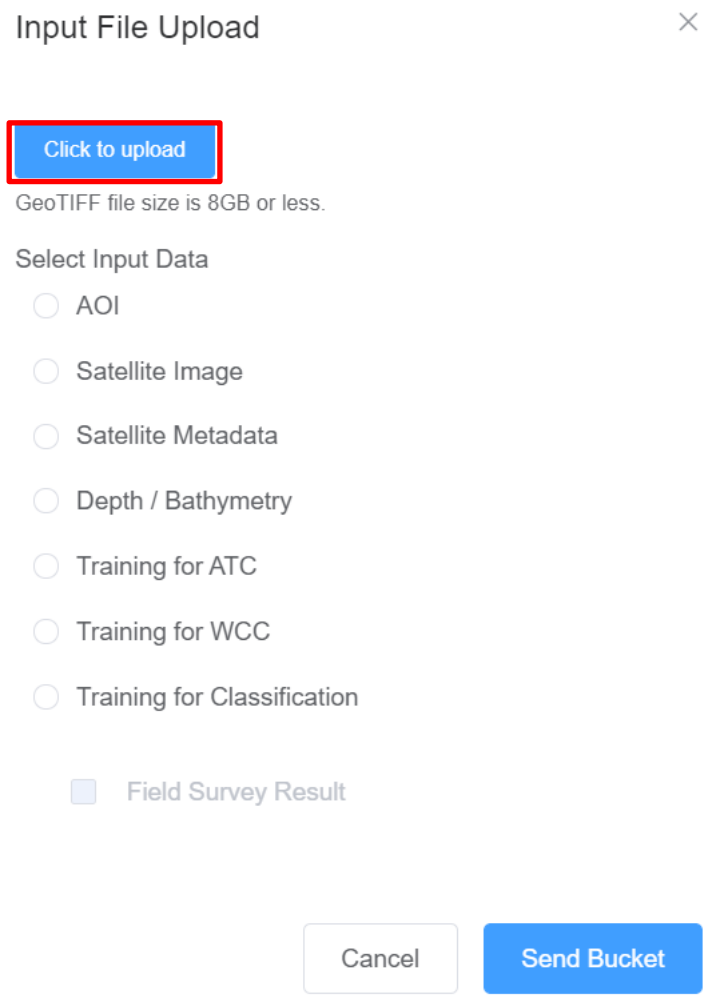


Figure 3.1-6(c)

iii. “Click to upload” > Select one file from the options and open it (In Figure 3.1-6(d), Select “AOI.zip”.)

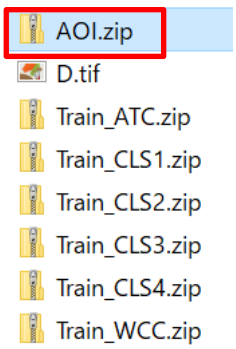


Figure 3.1-6(d).

iv. Select a data type which should be matched to the files in step (iii) above and click “Send Bucket”. (In Figure 3.1-6(e), select “AOI”)

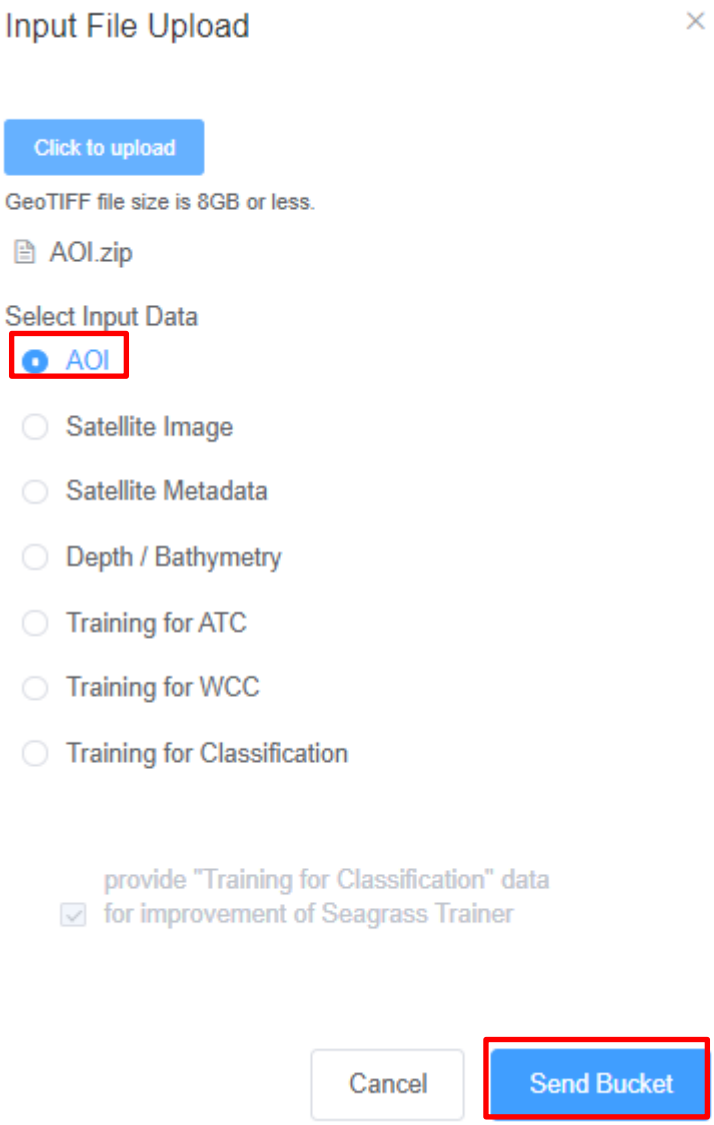


Figure 3.1-6(e)

If user can provide his/her “training data for supervised classification (Data type is “Training for Classification”)” to improve the quality of Seagrass Trainer, tick the box next to [provide “training for Classification” data for improvement of Seagrass Trainer]. When “Training for Classification” is selected, the box is automatically ticked. Then, the provided data will be used for improving the quality of Seagrass Trainer.

v. When the upload status bar disappears on the screen, uploading is completed. (When the data volume is large, it takes a while to complete uploading.)

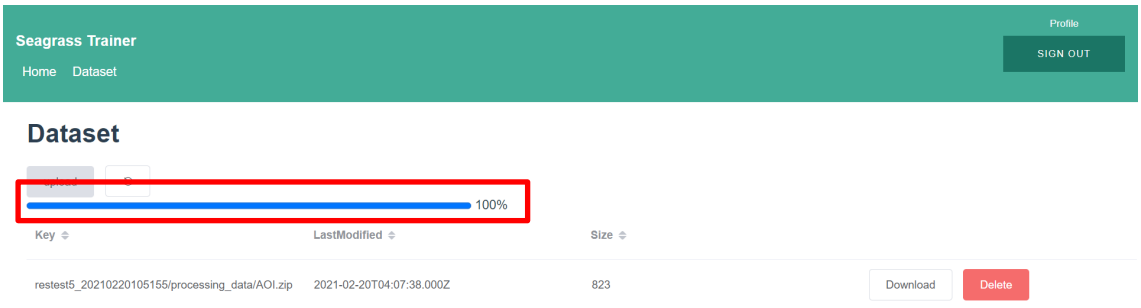


Figure 3.1-6(f)

While the status bar is on the screen, data uploading is on-going.

Figure 3.1-6(g)

Data uploading is completed when the status bar disappears on the screen.

vi. Repeat the same steps for each file to be uploaded.
*Please note that only ONE file can be uploaded by clicking “Send Bucket” one time. So, user should repeat the step (iii) – (v) above to upload all files. When repeating these steps, erase the file name before step (iii).

In case user wants to check, download or delete the uploaded files or drawn and saved files explained in Section 3.1.3, click the download or delete button with confirming the data type, the last updated date and time, and the data size

on the Dataset page.

(2) Checking uploaded data

If necessary, display uploaded data on the computer screen and check their contents. The following figures show examples of a computer screen in each step.

i. Home screen > Select target data in the pulldown menu in “Search” on the top right corner > Target data are shown

ii. When focusing on a specific area, place the cursor over the data and click the Enter key.

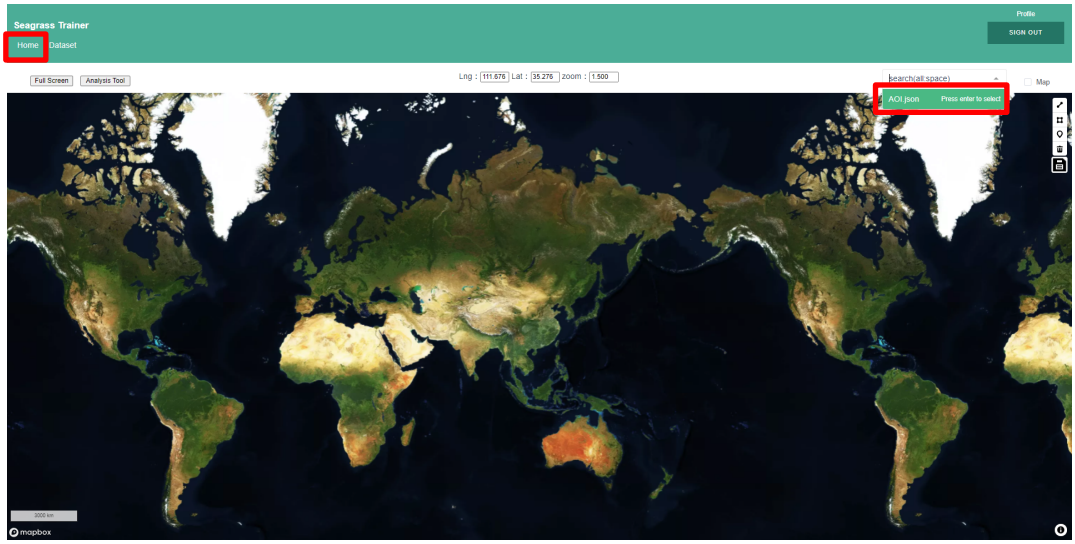


Figure 3.1-7(a) Selecting the target data.

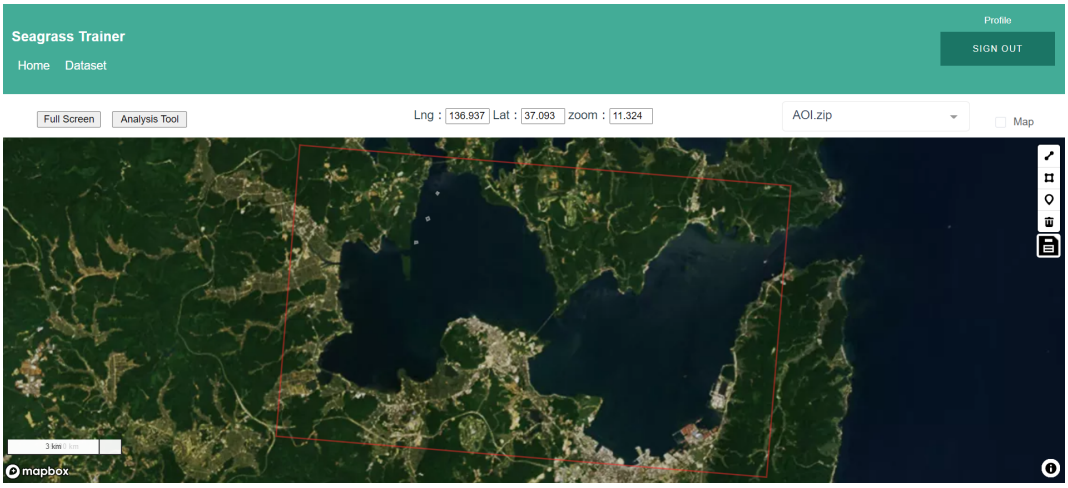


Figure 3.1-7(b) Target data are displayed.

iii. When ticking “Map” on the top right corner, the background is switched to a map. When unticking, the background is switched to a satellite image. (Please note that the background satellite image is NOT the uploaded one).

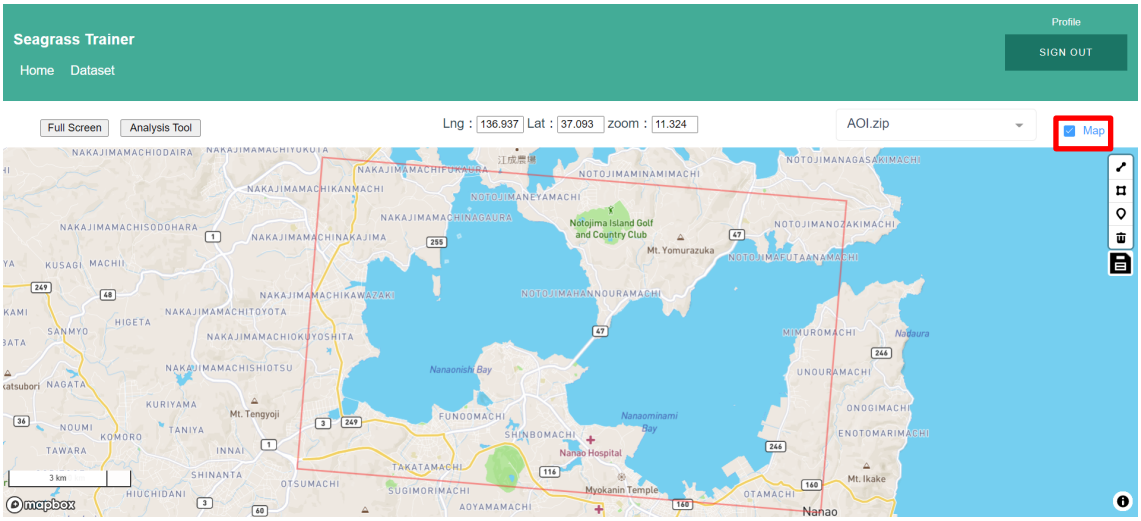


Figure 3.1-7(c)

3. 1. 3 Drawing, editing and saving vector data

This section explains how to draw, edit and save vector data, while using the data of Area of Interest (AOI) as example, with functions in Seagrass Trainer in order to use the saved data for analysis.

(1) Drawing and Saving vector data (when creating new vector data)

Follow the next steps for editing and saving data. Figures are examples of a computer screen in each step.

i. On the Home screen, enlarge the area around the target area. Then, click “Polygon tool” (second icon from the top) on the map to switch to the drawing mode.

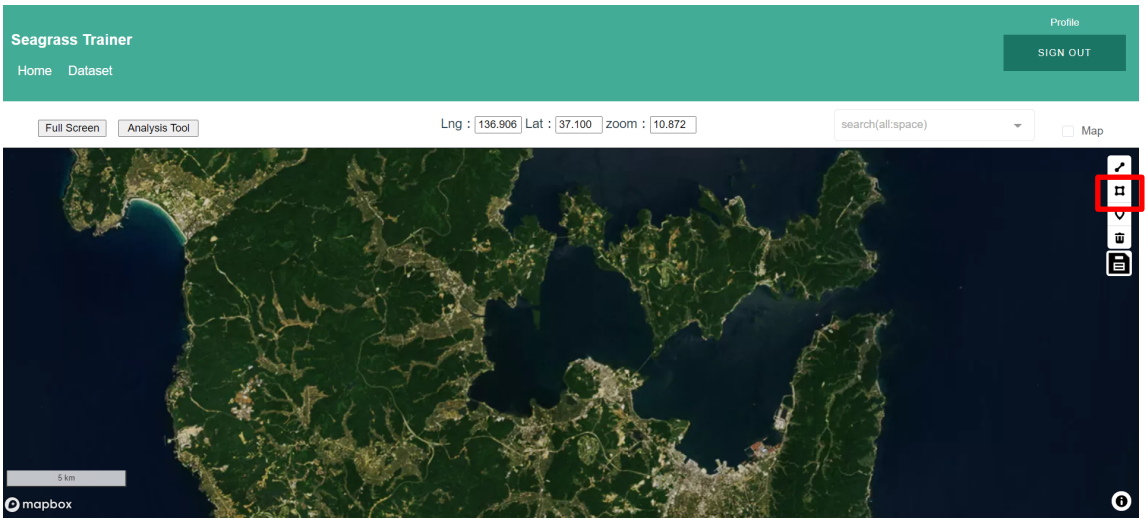


Figure 3.1-8(a) Selecting “Polygon tool”.

ii. Draw a polygon of AOI (Click each apex) on the map, then double click to finish drawing.

When moving the polygon: Drag the polygon

When editing the polygon: Click an apex of the polygon

When deleting the polygon: Select the polygon and click the “Delete” icon or the Delete key

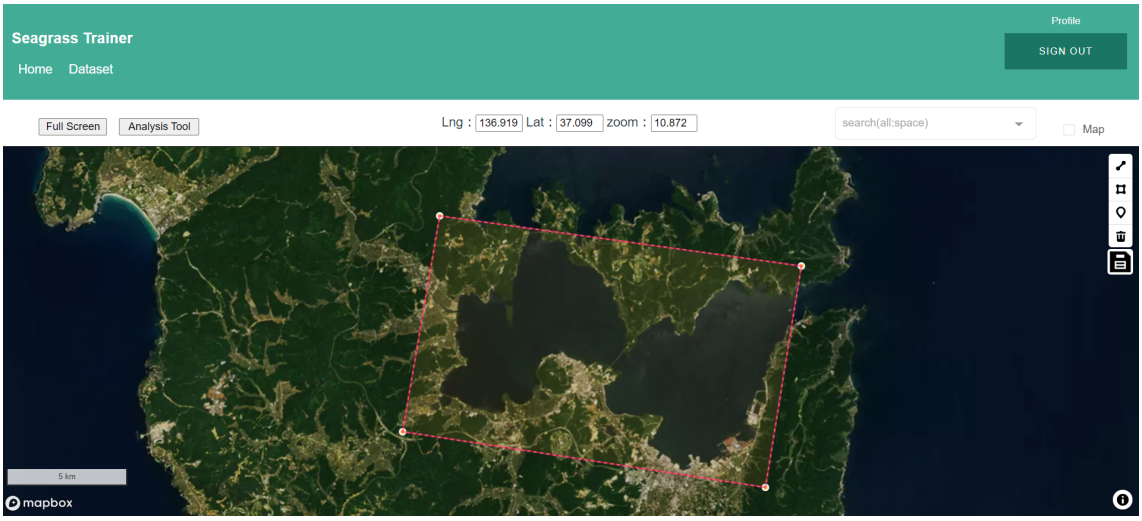


Figure 3.1-8(b) Drawing a polygon.

iii. After drawing the polygon, click the “Save” icon.

Select a data type (pull-down to find a matched type*[1]) and click “Save” to save it. (“AOI” is selected in this example.)

*1 Select data types from the below, which should match the purpose of using data

- AOI: AOI
- Training for ATC: Train_ATC
- Training for Classification: Train_CLS1…,Train_CLS10
(Decide the number of classes. Maximum number is 10)
- Training for WCC: Train_WCC

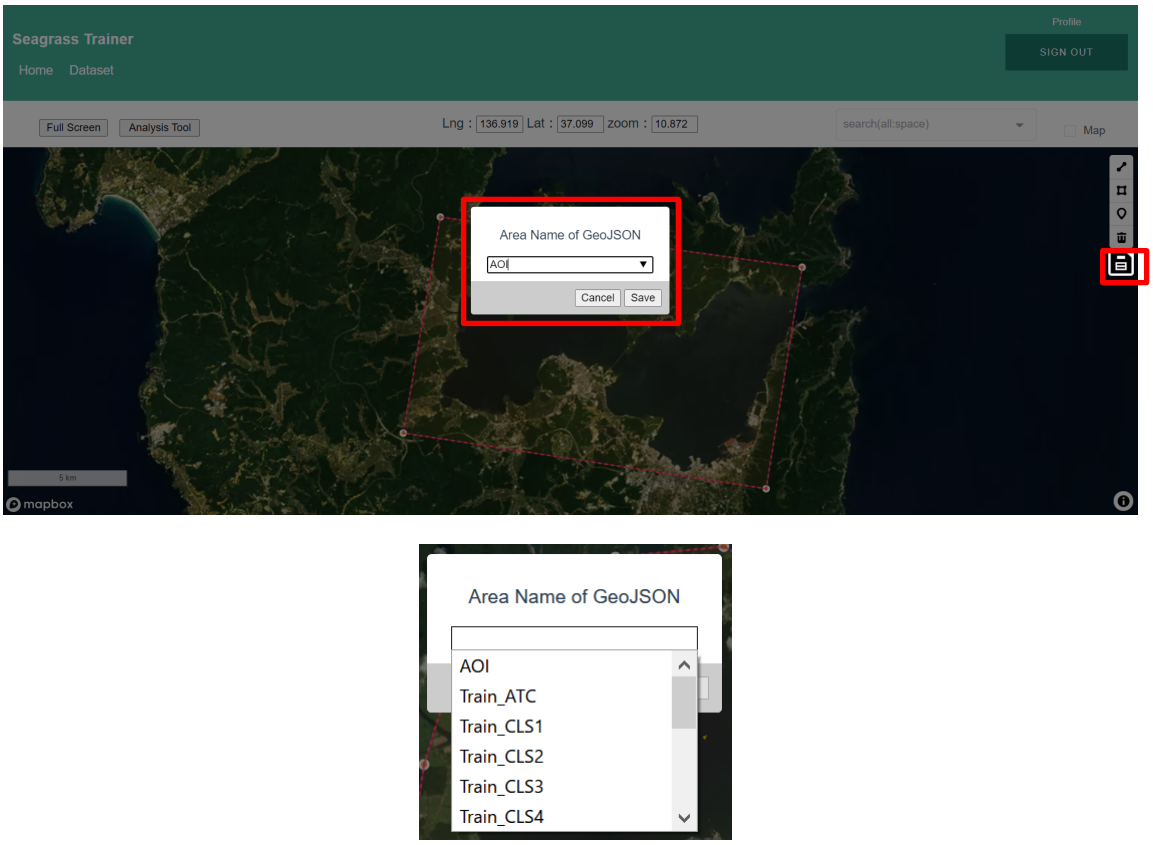


Figure 3.1-8(c)

Click the “Save” icon on the top right corner of the screen to save the file (top).
Example of the pulldown menu for selecting file names (bottom).

(2) Drawing and saving vector data (when editing uploaded data)

Follow the next steps for editing and saving vector data. Figures are examples of a computer screen in each step.

i. Display uploaded vector data on Home screen and enlarge the area around

AOI.

ii. Select the target polygon and click the inside of it to edit it.

- When moving the polygon: Click and drag the polygon

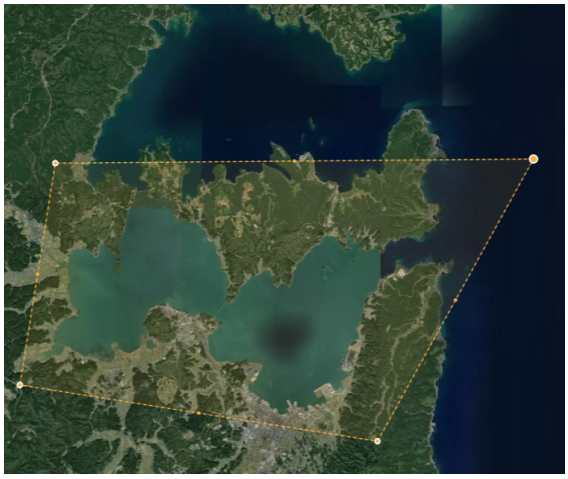
- When editing the apex of the polygon (changing the position of the apex or adding a new apex, etc.): Double click the target apex . Then,

For moving the apex: Drag the apex

For editing an apex: Click a side to display options.

Select one side and click it or drag it, and an apex is added.

Selecting a polygon
(After clicking once or twice)



Example of editing: Moving an apex
(dragging the right top apex)

Figure 3.1-8(d) Selecting the polygon for editing.

iii. After editing, click the “Save” icon.

Decide a file name for saving and click the “Save” icon. (The default name is the original file name.*1)

For changing the data type when saving it, delete the displayed file name and follow the step (1)-iii.

*1 User can change the file name in this step (for example, changing from “AOI.json” to “AOI2.json”), but please keep in mind that the file to be used for analysis is the one with the pre-defined name. (For AOI, “AOI.json” file is used.)

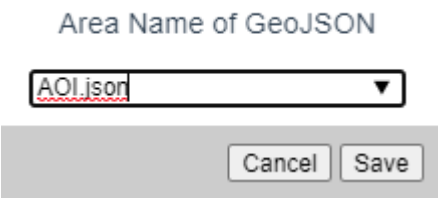


Figure 3.1-8(e) Deciding a filename.

3. 1. 4 Checking information in asset

After uploading prepared data (Section 3.1.2) and drawing and saving vector data (Section 3.1.3), user can execute satellite image analysis with Seagrass Trainer. All data are put into folders called “asset” and used for satellite image search and/or analysis with Seagrass Trainer. When checking asset information, press “Analysis tool” on the left top corner of the Home page to open “Satellite Image Analysis Parameters” tab. asset information is shown in the “Asset Folder Name” (Figure 3.1-8(d)). This asset folder name is automatically created as “User ID_YYMMDDHHMMSS” (indicating the year/month/day/hour/minute/second of signing in).

When creating multiple asset folders to manage information, it is necessary to sign out and sign in again every time when user creates a new asset folder. See Appendix (Section 6. Reuse of Training Data) for details.

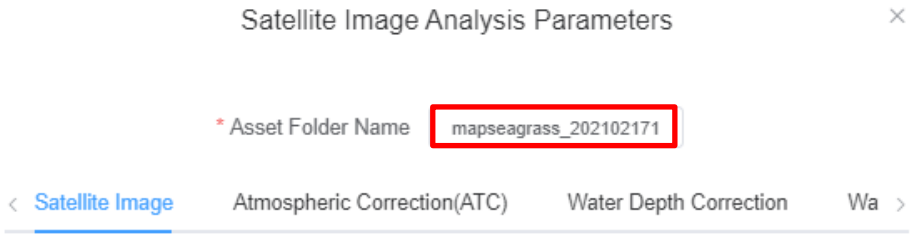


Figure 3.1-8(f)

It is recommended to copy and save the Asset Folder Name for checking its information. The name in the example is “mapseagrass_20210217114511”.

This “Asset Folder Name” can be loaded and used with another GEE tool, Seagrass Mapper, by entering the same asset folder name in the “Read Asset” field of Seagrass Mapper (https://mapseagrass.users.earthengine.app/view/seagrassmapper).

3. 1. 5 Searching satellite images

(1) Data for Area of Interest (AOI)

This section explains how to search for and select satellite images in the GEE Public Data Catalogue by using prepared data (Section 3.1.2), AOI data (AOI.zip/json) created in Section 3.1.3 and the “GEE Image Search” tool (Figure 3.1-9(c)). This step can be skipped if user sets only searching criteria for satellite images in the GEE Public Data Catalogue.

Before using the “GEE Image Search” tool, user should upload vector data of the target area (AOI.zip/json) to Seagrass Trainer, or draw such data with Seagrass Trainer and save them in advance.

Follow the next steps to select images by using the “GEE Image Search” tool. (In this example, Landsat 8 OLI image taken on June 1, 2015 is selected.) Images of a computer screen in each step are shown in figures.

i. Click “Analysis Tool” on the top left corner of the Home page.

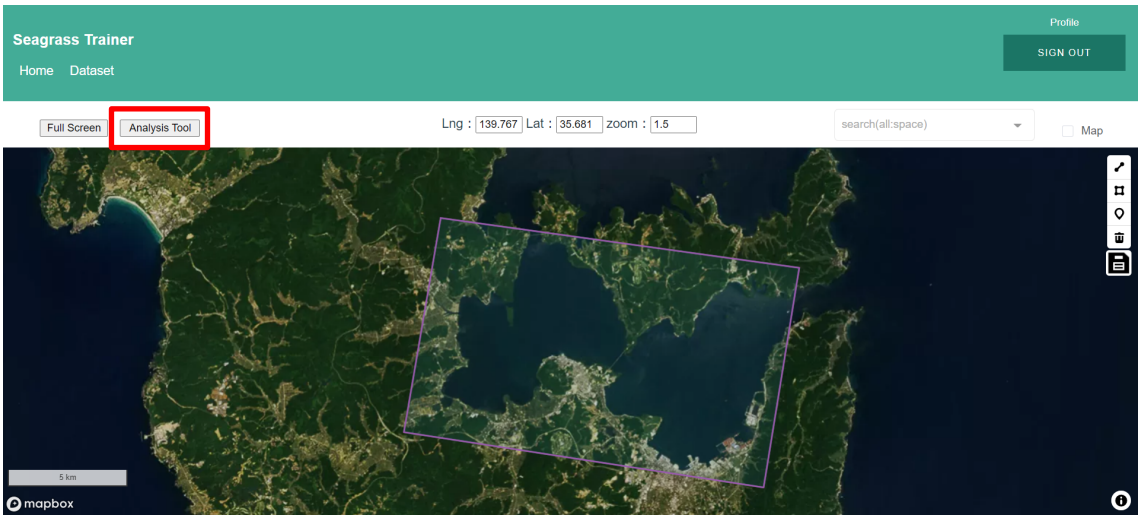


Figure 3.1-9(a)

ii. Click “Search Tool” on the “Satellite Image Analysis Parameters” tab > Then, another tab, ”GEE Image Search” is opened.

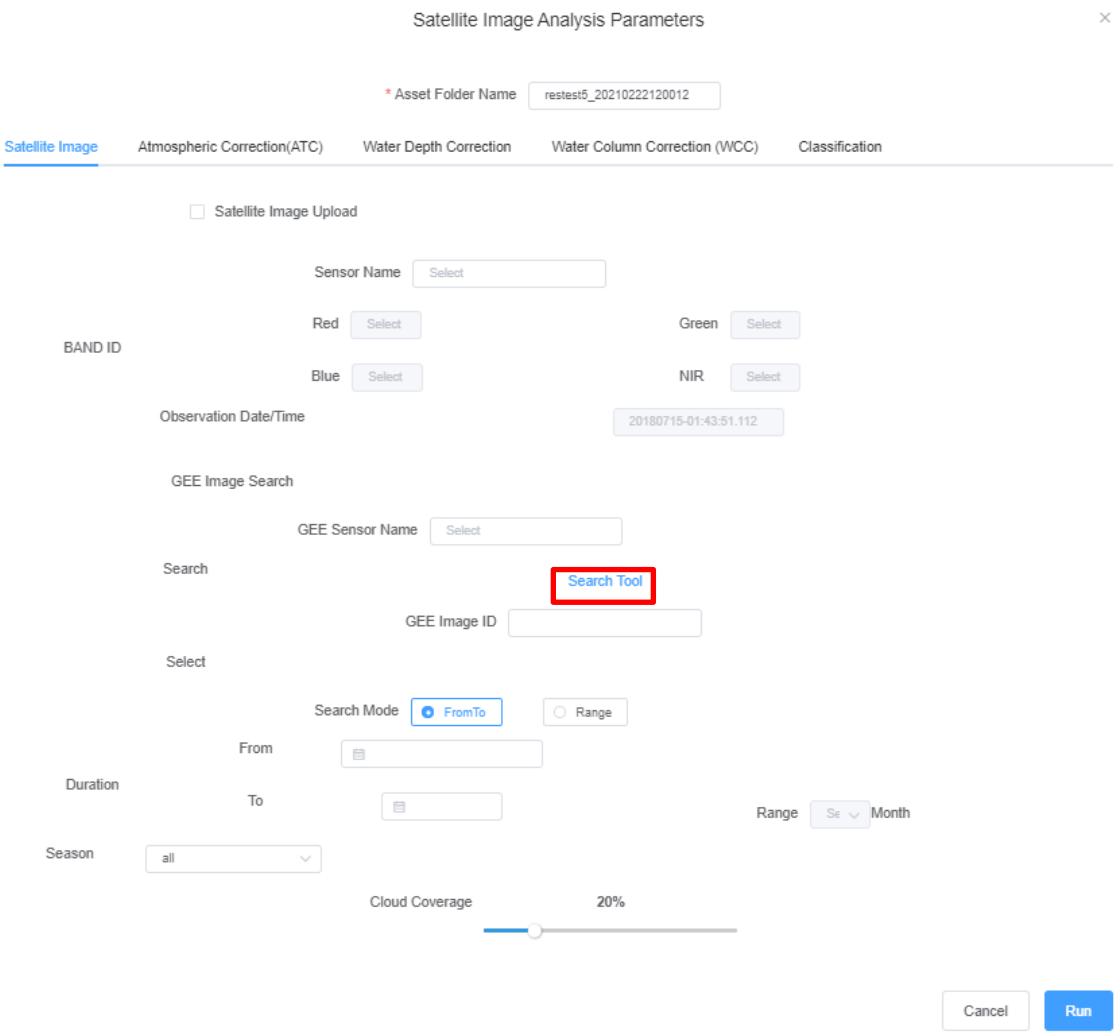

Satellite Image Analysis Parameters
* Asset Folder Name
restest5_20210222120012
Satellite Image
Atmospheric Correction(ATC)
Water Depth Correction
Water Column Correction (WCC)
Classification
Satellite Image Upload
Sensor Name
Select
BAND ID
Red
Green
Blue
NIR
Observation Date/Time
20180715-01:43:51.112
GEE Image Search
GEE Sensor Name
Search
Search Tool
GEE Image ID
Select
Search Mode
FromTo
Range
From
Duration
To
Range
Month
Season
all
Cloud Coverage
20%
Cancel
Run

Figure 3.1-9(b)

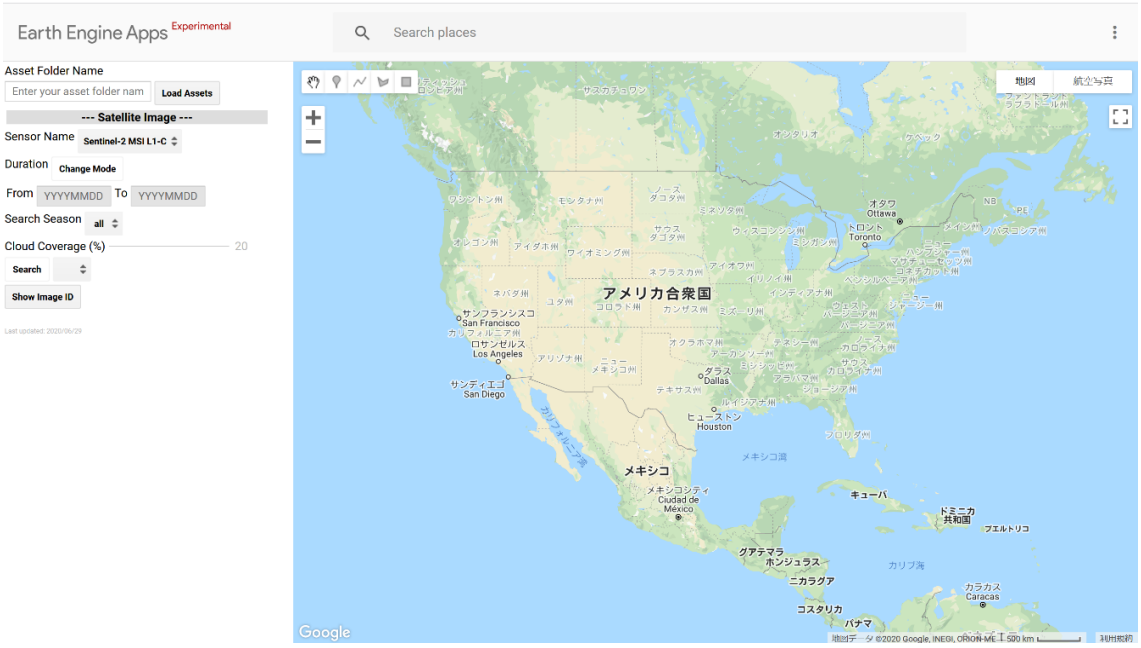


Figure 3.1-9(c) GEE Image Search page.

iii. Copy the “Asset Folder Name” on the “Satellite Image Analysis Parameters” tab and paste it in “Asset Folder Name” on “GEE Image Search” and click “Load Assets”. Now, satellite image options are narrowed down to the ones with the geographical area of AOI.zip.

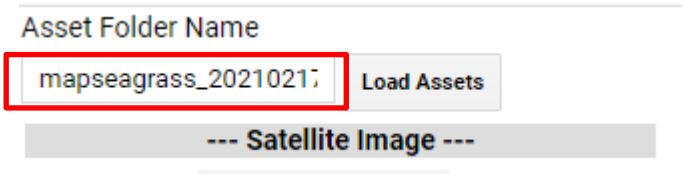


Figure 3.1-9(d) Pasting “Asset Folder Name” (GEE Image Search).

iv. Set search criteria: Sensor name, Duration of search (From/To or Search Season), and the percentage (%) of cloud cover on the “GEE Image Search”. In this example, search criteria are set as “satellite images taken from May 1 to June 30 in 2015 by Landsat 8OLI with 30% or less of cloud cover”.

v. Search > Start searching for matched satellite images

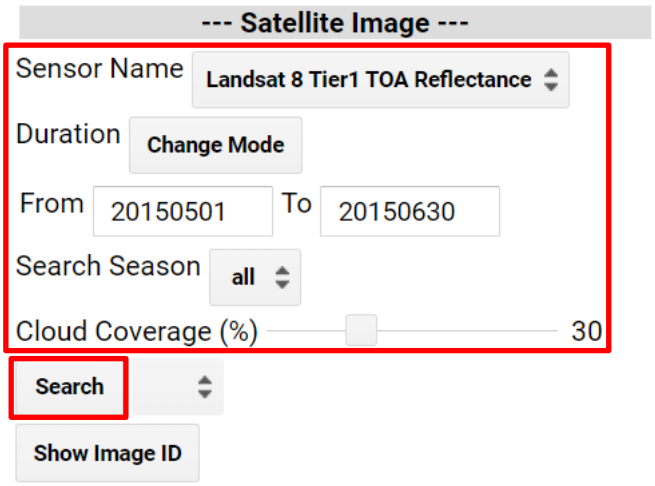


Figure 3.1-9(e)

vi. Satellite images which are matched to search criteria are displayed on the map.

vii. At the same time, Image IDs are shown in “Search”. From the pulldown menu, select a satellite image ID of June 1, 2015 by Landsat 8 OLI. Display this satellite image on the map to decide the data to be used for analysis.

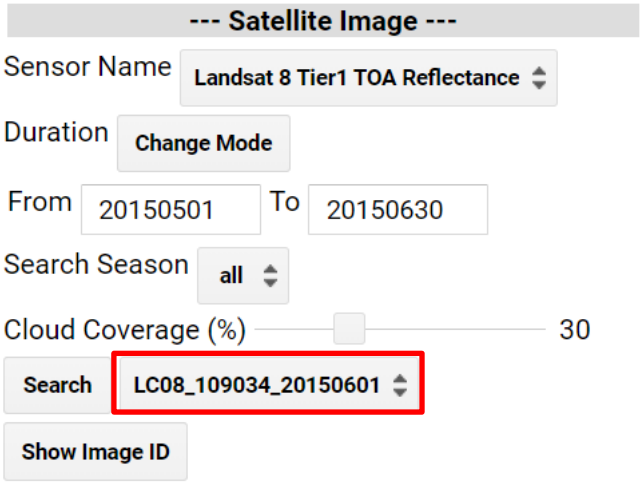


Figure 3.1-9(f) Switching displayed images.

viii. After selecting a satellite image taken on June 1, 2015 by Landsat 8 OLI from the pulldown options of Image IDs, click “Show Image ID” to display the text of the selected image ID (GEE Image ID) on the map. Copy the text and paste it

in the “GEE image ID” in the GEE Image Search of satellite Image Analysis Parameters tab. Then, select “Landsat-8” in GEE Sensor Name.

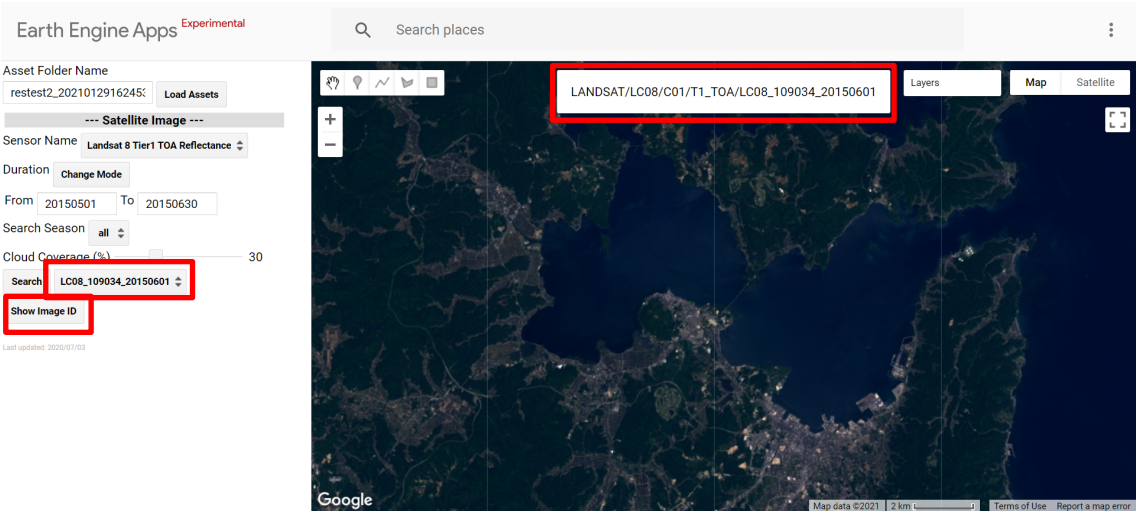


Figure 3.1-9(g) Copy the Image ID on top of the map.

Figure 3.1-9(h)

Paste the copied ID in GEE Image ID (bottom).

Select Landsat-8 in GEE Sensor Name (top).

After taking these steps, the selected satellite image is ready to be used for analysis.

3. 1. 6 Setting parameters for analysis

This section explains how to set analysis parameters (criteria for mapping seagrass beds).

In this example, user can use the “Satellite Image Analysis Parameters” tab used in Section 3.1.5 (Searching satellite images).

3. 1. 6. 1 Satellite images

i. When user searches for and selects satellite images in the GEE Public Data Catalogue

The example uses the image selected in Section 3.1.5 (Figure 3.1-10).

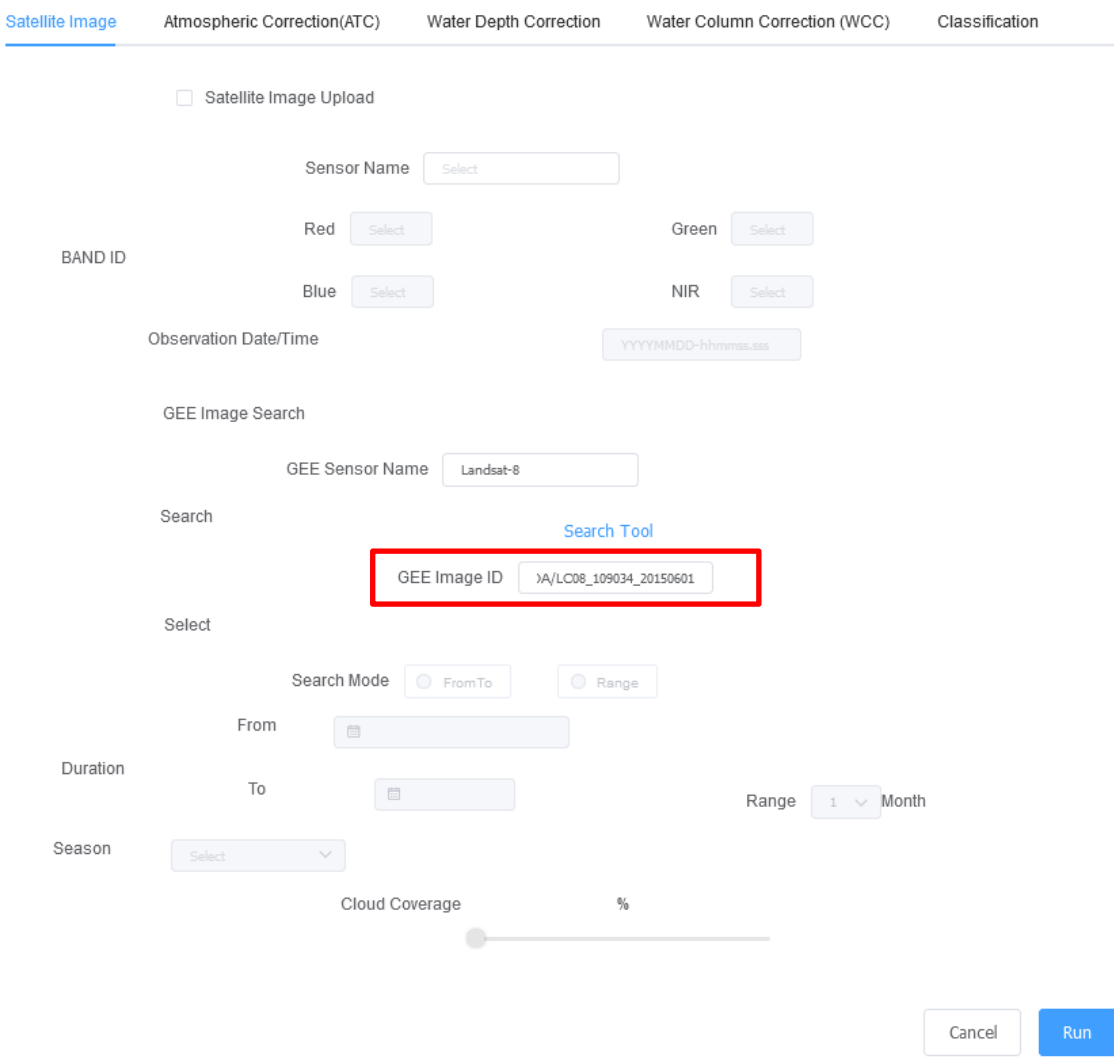


Figure 3.1-10 Setting parameters for selecting satellite images.

Make sure that the satellite image taken on June 1, 2015 by Landsat-8 is selected in the “GEE Image ID” field in the middle of the screen.

ii. When satellite images are automatically selected in the GEE Public Data Catalogue

In this example, search criteria are set as follows (Figure 3.1-11):

- GEE Sensor Name: Landsat-8 (when the field is blank, double click to open the pulldown menu.)
- Cloud Coverage: 20 (%)
- Search Mode: FromTo
- Duration From: 20150601
  To: 20150630
- Season: 6 (target month)

Now, satellite images matched to the criteria above are automatically selected in the GEE Public Data Catalogue and used for satellite image analysis.

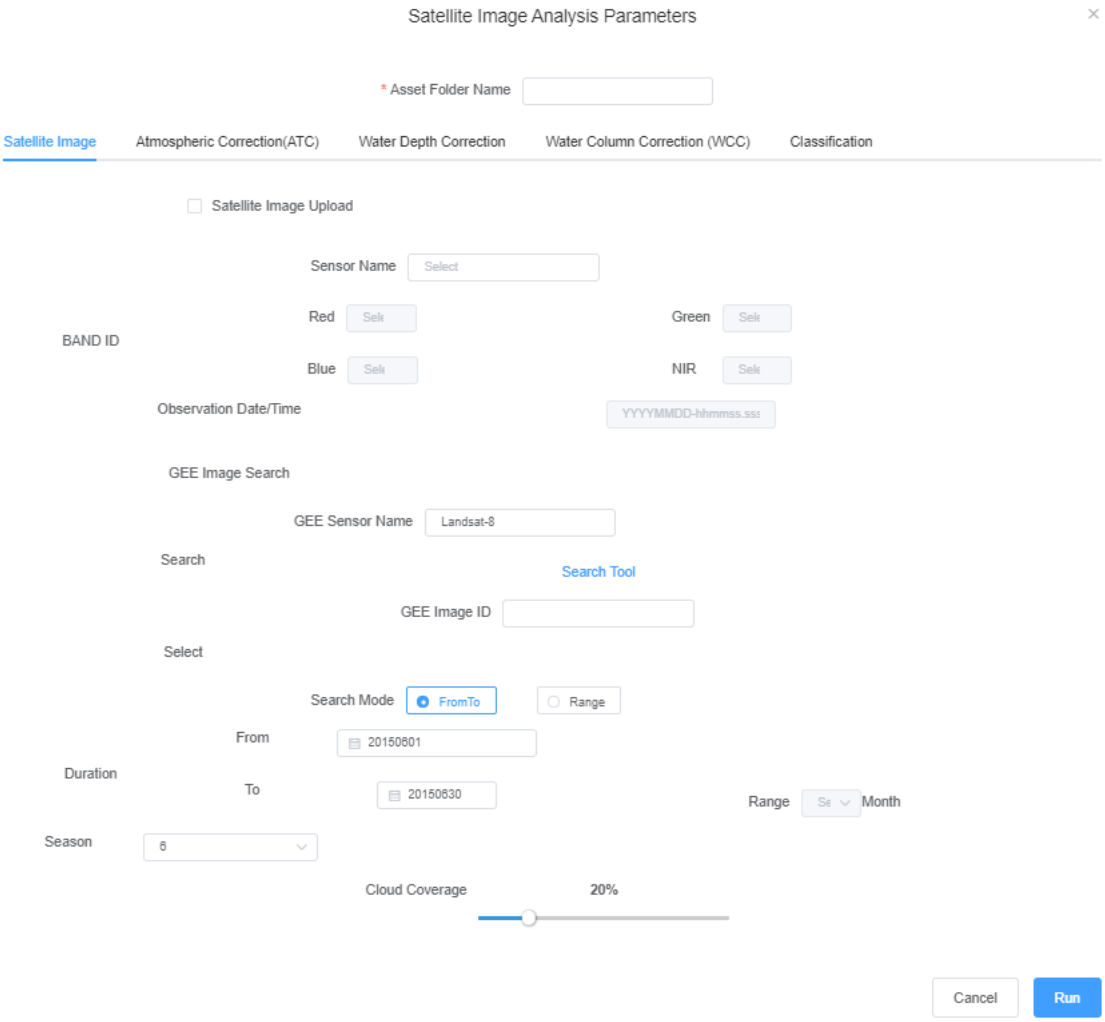


Figure 3.1-11 Setting parameters for selecting satellite images.

3. 1. 6. 2 Atmospheric Correction (ATC)

In this example, parameters for Atmospheric Correction (ATC) are set as follows (Ticked: applying, No ticked: not applying):

- Convert to TOA reflectance: No ticked[*1]

  The boxed is ticked if user likes to convert satellite image pixel data to TOA reflectance data.

- Mask for Land: No ticked

  The boxed is ticked if applying this function to mask land areas (Training ATC data are necessary.)[*2]

- Mask for Dark Pixel: Ticked

  The box is ticked for masking deep sea areas. It is useful to mask deep sea areas where light cannot reach the sea floor. (Training ATC data are necessary.)[*2]

- Execute ATC: Ticked

  The box is ticked as ATC correction is applied.

- ATC Method: Dark Pixel

  Select ATC method. In Seagrass Trainer, ATC algorithm of both dark pixel-profile (DPP) method and Near-infrared (NIR Model) method is embedded.

  DPP method removes atmospheric influences by excluding values of dark pixels (areas with no influence of reflection from sea floor). In NIR method, influences by the atmosphere and sun glint are removed based on the relationship between near-infrared (without water reflectance) and visible pixel value (with water reflectance).

  These methods have different suitable conditions: the DPP method for calm waters; and NIR method is good for rough waters with waves. However, it is recommended to select satellite images with no high waves as much as possible.

  When using the DPP method, the reference area should be taken from deep-sea areas where light-reflection from the sea floor is negligible. When using near-infrared (NIR) method, user should include bright sea surface areas to remove effect of sun glint.

- Average Filter Size: 1 (pixel)

  Setting the range for smoothing satellite images to which ATC is already applied. In this example, the filter size is set as “1” (pixel).

*1 This function is used for converting pixel value of satellite images to TOA reflectance. It is under construction in Seagrass Trainer. The same functions can be used in Seagrass Mapper. (Note that this function is not applied when satellite images are already provided in a data format of TOA reflectance. In this example, this option is not used, as satellite image used here is already converted to TOA reflectance data)

*2 When this function is applied, some parts of sea areas may be judged as land or dark pixel areas automatically. In such case it is recommended not to use this function.

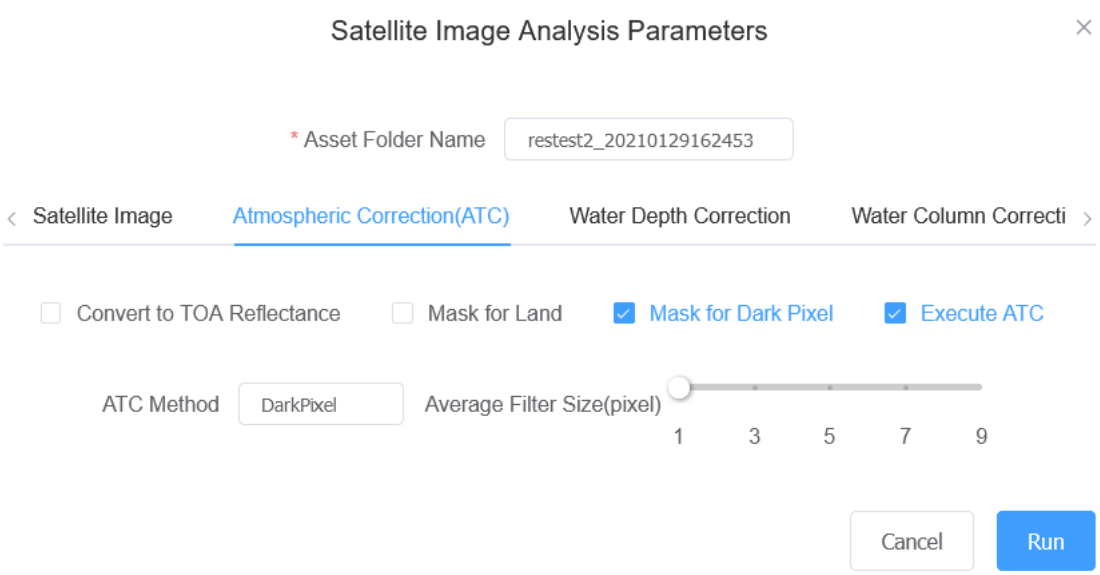


Figure 3.1-12 Setting parameters for Atmospheric Correction (ATC).

3．1．6．3 Water depth/Bathymetry Correction

In this example, parameters for water depth/bathymetry correction are set as follows (Ticked: applying, No ticked: not applying):

- Depth Data Upload: Ticked

  The box is ticked because water depth data are uploaded.

- Mask for Deep Area: Ticked

  The box is ticked because masking certain sea areas which are set based on the water depth/bathymetry data.

- Mask Depth: 10 (m)

  Nanao Bay is rather shallow at 25-meter-deep or less, and sea grasses are sparse at 10 meters or under. So the mask depth is set as 10 meters in this example.

- Execute Tidal Correction: No ticked [*1]

  (Nearby Station Code: not used)

[*1] Tidal Correction

Tidal Correction is useful for the area where the water depth changes greatly by the rise and fall of the tides.

In Seagrass Trainer, tidal correction is applied based on the sea level data by Japan Meteorological Agency. When using other sea level data, see Appendix (Section 5 Tidal Correction with different data from JMA).

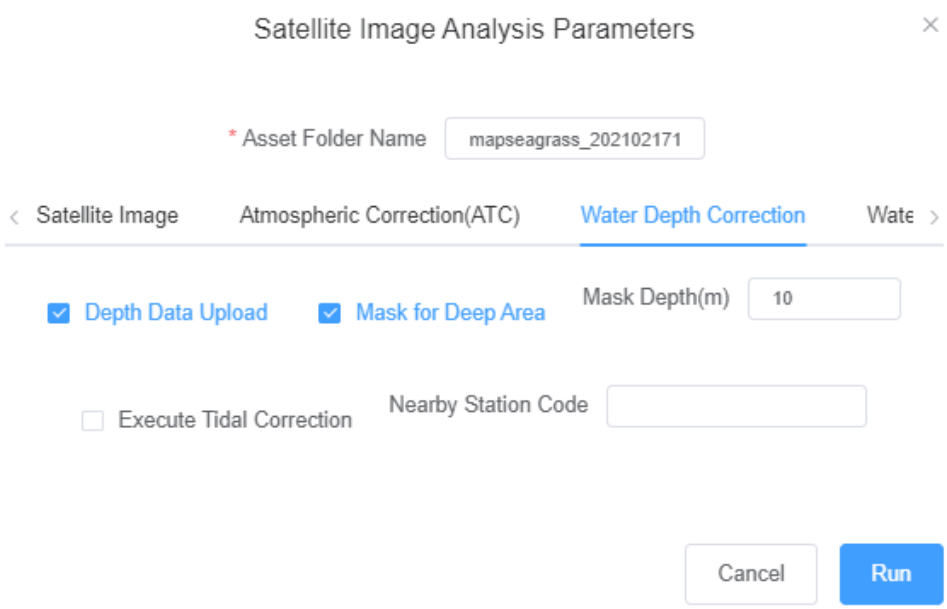


Figure 3.1-13 Setting Parameters for Water Depth Correction.

3. 1. 6. 4 Water Column Correction (WCC)

In this example, parameters for Water Column Correction (WCC) are set as follows (Ticked: applying, No ticked: not applying):

- Execute WCC: Ticked

The box is ticked because WCC is applied.

For shallow waters where seagrass is on the surface, WCC is not applied.

- WCC Method: DII

There are two methods of WCC embedded in Seagrass Trainer:

DII (depth in-variant index: Lyzenga, 1981); or

BRI (bottom reflectance index: Sagawa et al., 2010)

While the DII method only use satellite image data, the BRI method requires water depth data for applying WCC. There is no clear superiority between the two methods. If user has accurate/high-quality water depth data, selection of the BRI method is recommended. In case no accurate/high-quality water depth data are available, the DII method shall be used. In this example, DII method is selected.

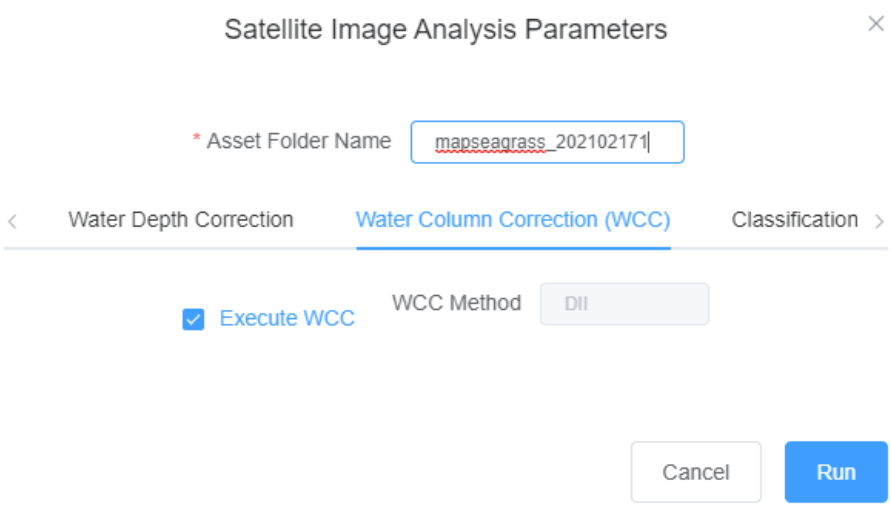


Figure 3.1-14 Setting parameters for Water Colum Correction (WCC).

3. 1. 6. 5 Classification

In this example, parameters for supervised classification of satellite images are set as follows(Ticked: applying, No ticked: not applying):

- Number of Classes: 4

Set the number of classes.

- Supervised Classification: Ticked

Tick the box is ticked because training data is used for supervised classification.

- Classification Method: Random Forest

Algorithm for image classification is selected here. In Seagrass Trainer, there are 5 options to classify sea floor (1 option of no supervised classification and 4 options with supervised classification).

-- No supervised classification --

<wekaKMeans>

When there is no training data for classification, select this method.

-- Supervised classification --

<Random Forest>

Random forests is an ensemble learning method for classification, regression and other tasks that operates by constructing a multitude of decision trees at training time and outputting the class that is the mode of the classes (Classification) or mean/average prediction (regression) of the individual trees.

<Decision Tree>
Decision tree learning is one of the predictive modelling approaches used in statistics.

<Support Vector Machines (SVMs)>
support-vector machines (SVMs, also support-vector networks) are supervised learning models with associated learning algorithms that analyze data for classification and regression analysis.

<MaxEnt (Maximum Entropy Modeling)>
Maxent is used to model species distribution probabilities using environmental data for locations of known presence and for a large number of 'background' locations.

- Sampling Scale: Original

  Setting the scale size for obtaining/sampling training information by overlapping satellite images with training data. Options are original, 10 meters, 5 meters or 1 meter. By default, “original” is selected. (The resolution of Landsat-8 is 30 meters, and in this example, “original” means 30 meters).

  When a polygon of training data is smaller than the size of the resolution of satellite image, all training data may not be used. In such a case, try to select a smaller sampling scale size.

- Training Rate: 70(%)

  Training data are divided into 2: one for image classification and the other is for accuracy evaluation. The percentage of the data used for supervised classification is set in “Training Rate”. (The rest is used for accuracy assessment.) For seagrass mapping, in general, 70-80 % of training data are used for image classification, and the other 20-30% are used for accuracy assessment.

- Training Data Split by Each Class: Ticked

  When the same rate is applied to training information of each class and taking a sampling of supervised data, the boxed is ticked.

- Majority Filter Size: 3 (pixel)

This is used for smoothing analysis results. The filter size should be adjusted by comparing the spatial resolution of satellite images to be used for analysis with output results. In this example, Majority Filter Size is set as 3 (pixel).

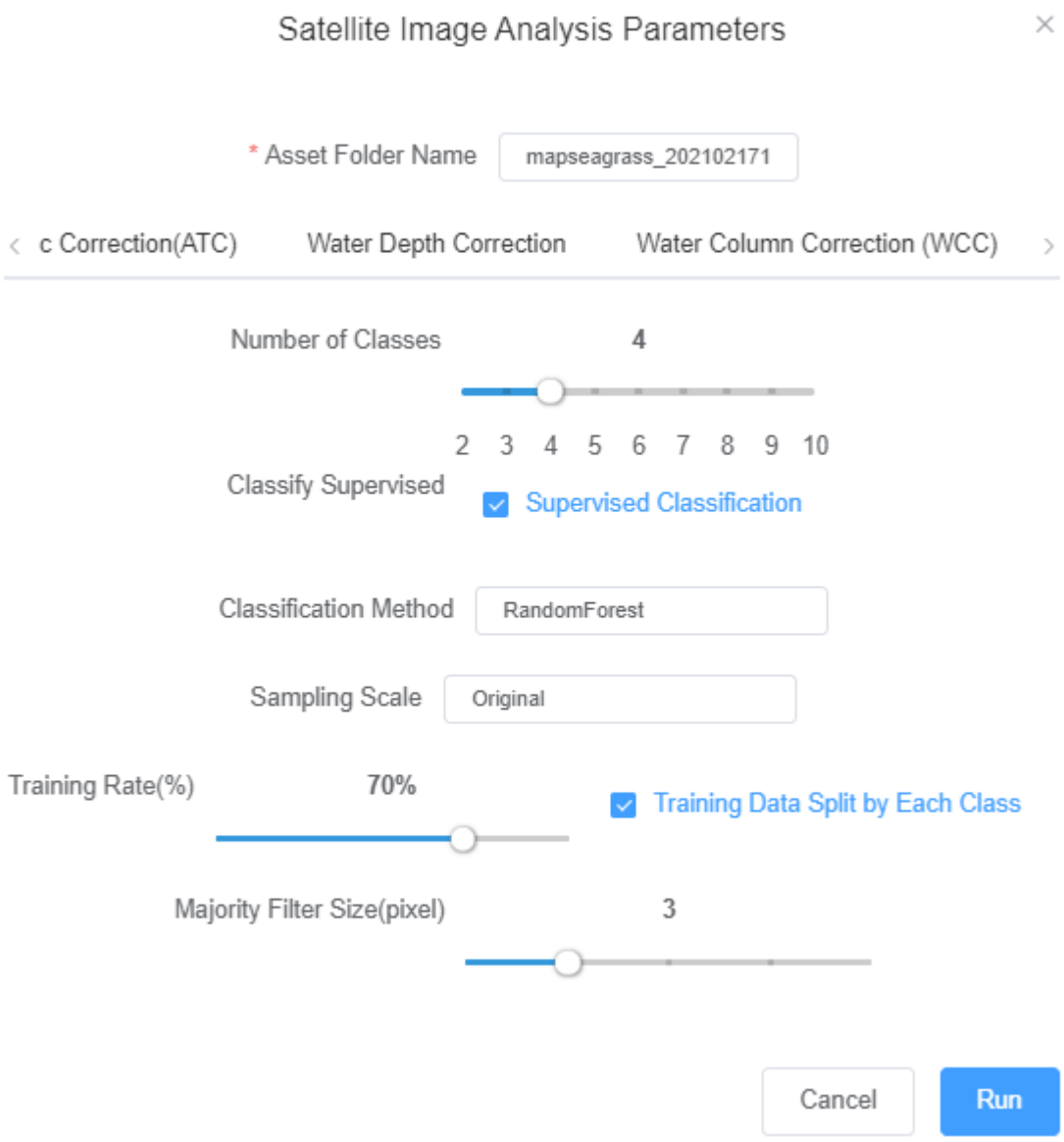


Figure 3.1-15 Setting parameters for supervised classification of satellite images

3. 1. 6. 6 Executing Analysis

After setting all parameters, click “Run” to execute analysis. Then, an email is sent to user to notify receipt of order.

After completing analysis, another email is sent to notify completion of the order.

* It is recommended to keep opening the browser (and not to sign out) until analysis results are obtained. After signing out, user cannot access to the analysis results folder from the Seagrass Trainer.

3. 1. 7 Obtaining and evaluating analysis results

3. 1. 7. 1 Obtaining analysis results

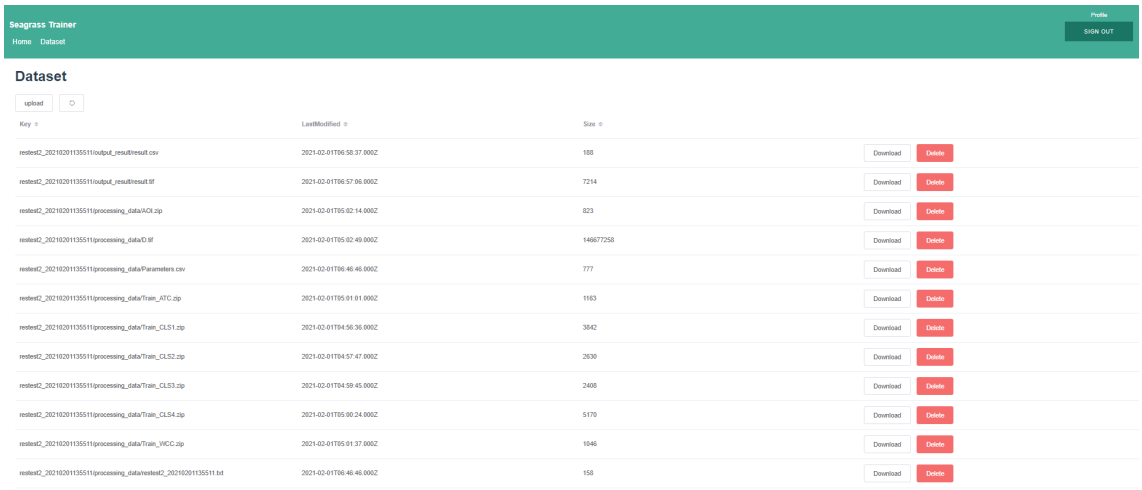
After receiving the email of notifying completion of the order, user can obtain analysis result files (GeoTIFF file for result images and CSV file for accuracy assessment results) from the Dataset page.

* It is recommended to keep opening the browser (and not to sign out) until completing download of result images.

The result files can be downloaded by clicking “Download”.

For deleting the result files, click “Delete” > “Confirm”.

*Analysis results are saved for about a month and then automatically deleted.



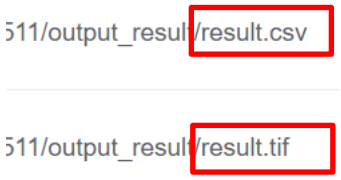


Figure 3.1-16 Dataset page after completing analysis (example)

3. 1. 7. 2 Evaluating analysis results

Display the downloaded analysis result image (result.tif) by using some image display software such as QGIS. The result image includes classification numbers, so it is possible to assign different colors to each number to show the distribution of each class on the map (Figure 3. 1-17).

The result of accuracy assessment (result.csv) can be opened with a text editor and/or spread sheet software (Figure 3. 1-18).

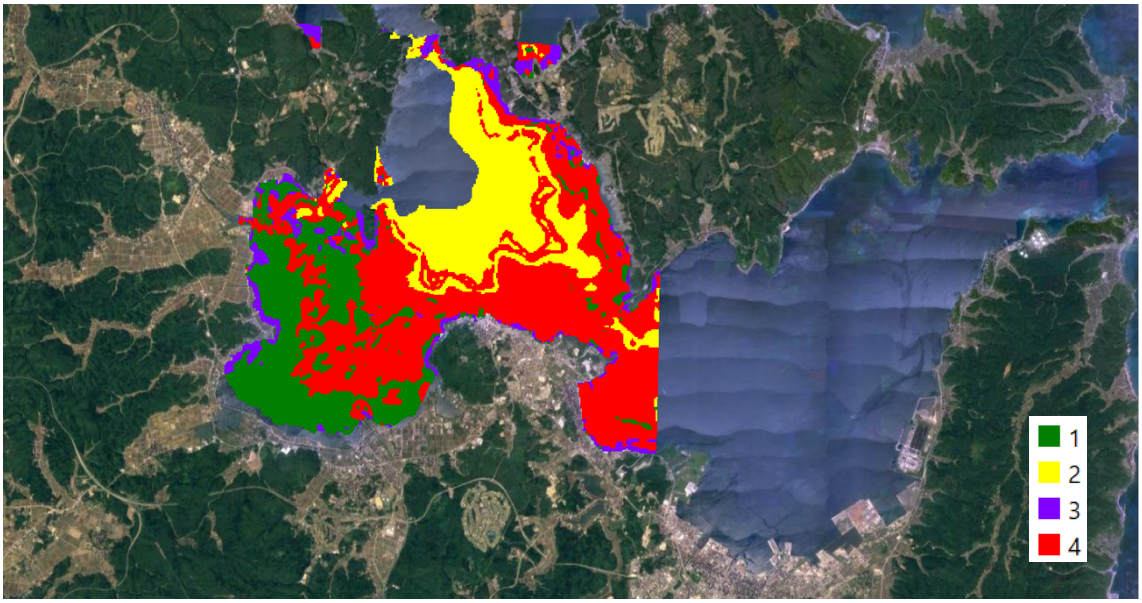


Figure 3.1-17 Result of satellite image analysis (example).
Assigning different colors on each class: Class 1 (seagrass) – green; Class 2 (sandy-muddy) – yellow; Class 3 (seaweed) – purple; and Class 4 (sandy-muddy or sparse seagrass) – red

total_accuracy	76.80%				
tau_coefficient	0.681934				
					users_accuracy
1	18	0	0	6	75.00%
2	0	11	0	0	100.00%
3	1	0	17	7	68.00%
4	10	1	4	50	76.92%
producers_accuracy	62.07%	91.67%	80.95%	79.37%	

Figure 3.1-18 Result of accuracy assessment (example)

In this example, the following result of accuracy assessment is obtained based on the training data for accuracy evaluation:

- Total number of points of training data for evaluation: (Class1) 29; (Class2) 12; (Class3) 21; (Class4) 63

  Among them, the number of points of correctly classified: (Class1) 18; (Class2) 11; (Class3) 17; (Class4) 50

  Producer's accuracy (the percentage of points of training data for evaluation which are matched with analysis results) is obtained by the following equation:

  18/29 x 100 = 62.07 %

  11/12 x 100 = 91.67 %

  17/21 x 100 = 80.95 %

  50/63 x 100 = 79.37 %

- Number of points of each class by analysis: (Class1) 24; (Class2) 11; (Class3) 25; (Class4) 65

  Among them, the number of points matched with training data for evaluation:

  (Class1) 18; (Class2) 11, (Class3) 17; (Class4) 50

  Producer's accuracy (the percentage of points of analysis results which are matched with training data for evaluation):

  18/24 x 100 = 75.00 %

  11/11 x 100 = 100.00 %

  17/25 x 100 = 68.00 %

  50/65 x 100 = 76.92 %

- Percentage of correctly classified points against all evaluation points (total accuracy): 76.80 %
- Reliability index against overall accuracy (tau coefficient): 0.681934

3. 2 Toyama Bay (Example B)

This section explains how to map seagrass beds in Toyama Bay, Japan by using a satellite image taken by WorldView-2, which user prepares in advance.

The list of data used for the analysis is shown in Table 3.2-1 below.

Table 3.2-1 Data to be used for mapping seagrass beds (Example B: Toyama Bay)

Name in Seagrass Trainer	**Content (data used in Example B)**	**Preparation**	**File Name**
Satellite Image	satellite image[*1] (taken on July 15, 2018 by WorldView-2, GeoTIFF)	prepared in advance	SatImage.tif
Satellite Metadata	metadata of satellite images (attached to WorldView-2, .IMD)	prepared in advance	Satimage.IMD
AOI	AOI data (polygon shapefile)	prepared in advance	AOI.zip[*2]
Training for ATC	training data for ATC (polygon shapefile)	prepared in advance	Train_ATC.zip [*2]
Training for WCC	training data for WCC (polygon shapefile)	prepared in advance	Train_WCC.zip [*2]
Training for Classification	training data for classification (polygon shapefile)	prepared in advance	Train_CLS1.zip [*2] Train_CLS2.zip [*2] Train_CLS3.zip [*2]
Depth / Bathymetry	water depth/bathymetry (satellite image which contains water depth value as pixel value, GeoTIFF)	prepared in advance	D.tif

[*1] One TIFF file with all band images, not separate files by band

[*2] Zip-compressed shapefiles for uploading. The file name must not be changed. For training data for supervised classification, file numbers ("*" in "Train_CLS*.zip") should be consecutive. In addition to a shapefile, kml, kmz, csv, and geojson files can be used; however, the names (before "extension") should not be changed (e.g. "AOI.kml").

3. 2. 1 Preparation of data to be used for satellite analysis

Prepare the following data in advance. Please refer to Section 3.1.1 for preparation of (1) – (5) below.

（1） Data for Area of Interest (AOI)

（2） Training data for Atmospheric Correction (ATC)

（3） Training data for Water Column Correction (WCC)

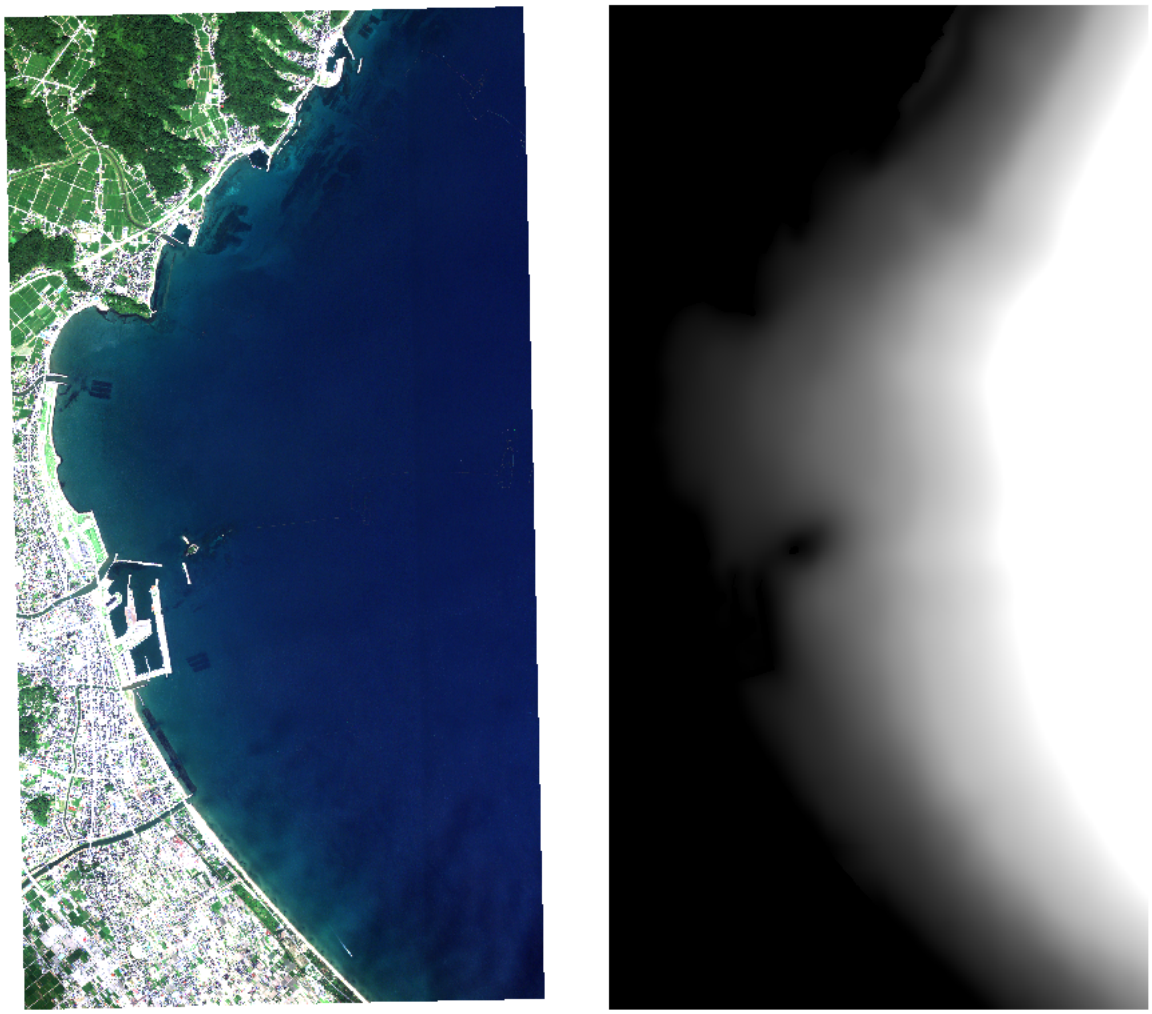
（4） Training data for Supervised Classification

（5） Water depth/Bathymetry data

（6） Satellite images and their metadata

Prepare satellite images (.tif) and their metadata (.IMD).

Make sure to change the filenames to be defined ones (SatImage.tif, SatImage.IMD).

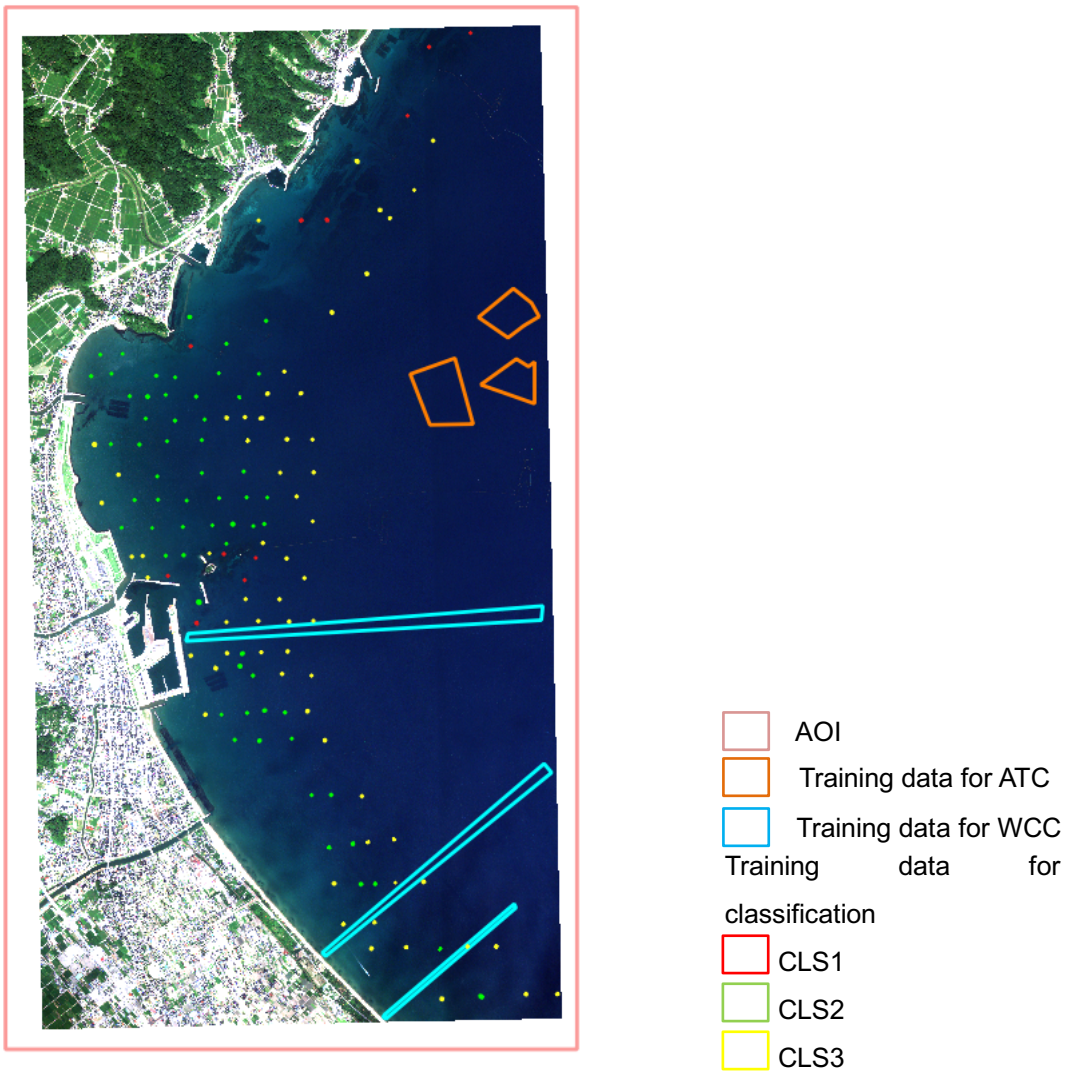


Satellite image

Water depth image

Water depth is shown by colors: black (shallow) – white (deep).

Figure 3.2-1 Data prepared in advance. (1/2)



Vector data (background: satellite image)

Figure 3.2-1 Data prepared in advance. (2/2)

3. 2. 2 Uploading data prepared in advance

After signing in Seagrass Trainer (see Section 1.2), user uploads the data which are prepared in advance and, if necessary, check their contents.

In this example, user also uploads both satellite images and their metadata which are prepared on his/her own in advance. See Section 3.1.2 (Uploading prepared data to Seagrass Trainer) for details.

3. 2. 3 Drawing, editing and saving vector data

In this example, there are no data to be drawn, edited or saved in Seagrass Trainer.

For drawing, editing and saving vector data, see Section 3.1.3 (Drawing, editing and saving vector data) for details.

3. 2. 4 Setting parameters for analysis

Set analysis parameters (criteria for mapping seagrass beds).

Click “Analysis tool” on the top left of the Home screen to open the Satellite Image Analysis Parameters tab. Copy the “Asset Folder Name” (“mapseagrass_20210221115847” in the example).

How to set each parameter is explained in the following sub-section.

3. 2. 4. 1 Satellite images

In this example, user already prepared satellite images and uploaded them to Seagrass Trainer. So, set the parameters for the satellite images to be used for analysis as follows:

Satellite Image Upload: Ticked (applying)

Sensor Name: WorldView-2

BAND ID: Enter the sensor name, then the band ID is automatically set.

Observation Date/Time (UTC): Automatically set by reading the metadata

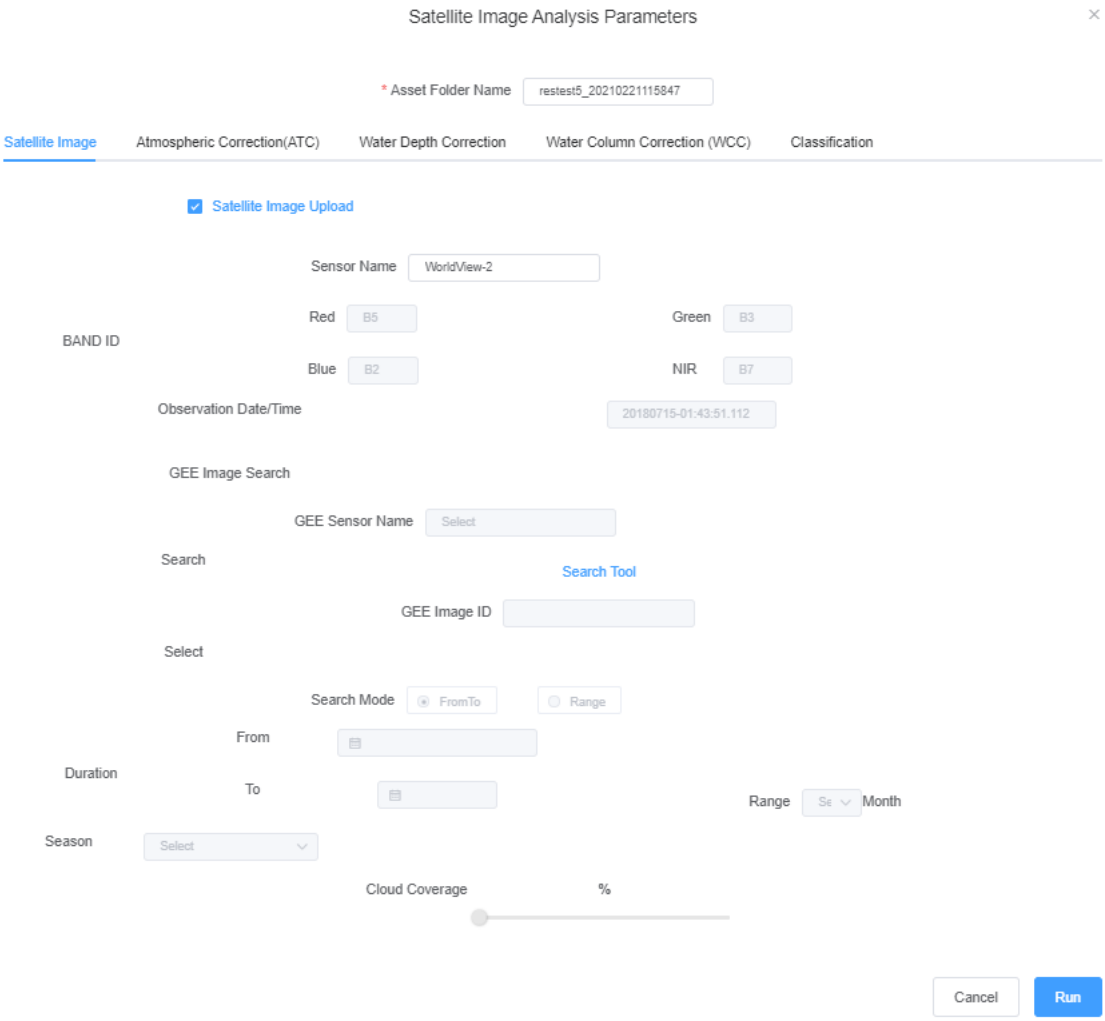


Figure 3.2-2 Setting parameters for satellite images.

3. 2. 4. 2 Atmospheric Correction (ATC)

In this example, parameters for Atmospheric Correction (ATC) are set as follows (Ticked: applying, No ticked: not applying):

- Convert to TOA Reflectance: No ticked
- Mask for Land: Ticked
- Mask for Dark Pixel: No ticked
- Execute ATC: Tick
- ATC Method: DarkPixel
- Average Filter Size: 1 (pixel)

See Section 3.1.6.2 (Atmospheric Correction) for details.

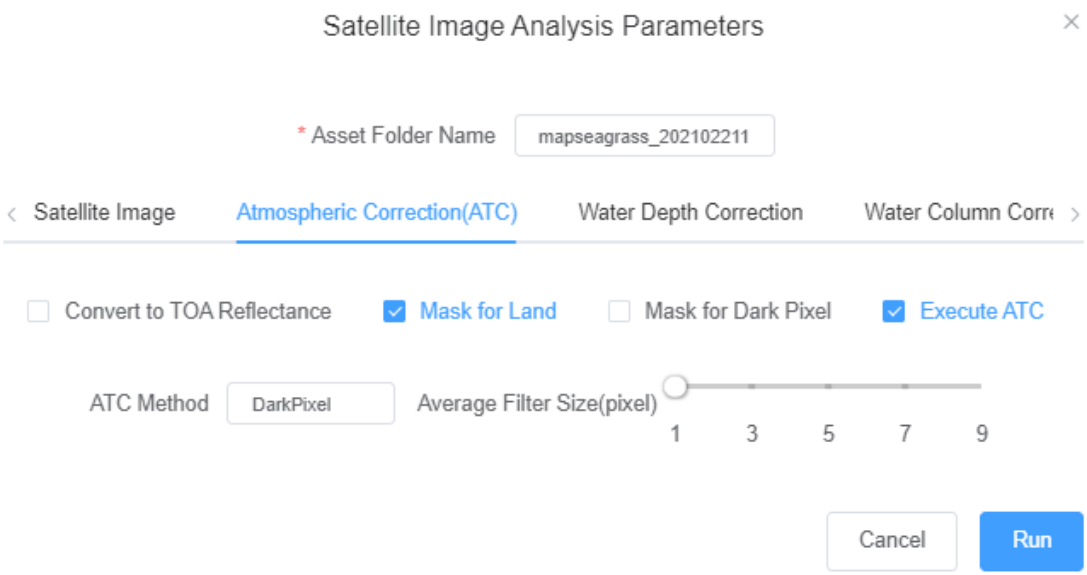


Figure 3.2-3 Setting parameters for Atmospheric Correction (ATC).

3. 2. 4. 3 Water Depth/Bathymetry Correction

In this example, parameters for water depth/bathymetry correction are set as follows (Ticked: applying, No ticked: not applying)

- Depth Data Upload: Ticked
- Mask for Deep Area: Ticked
- Mask Depth: 20 (m)
- Execute Tidal Correction: No ticked
- Nearby Station Code: not used

See Section 3.1.6.3 (Water Depth/Bathymetry Correction) for details.

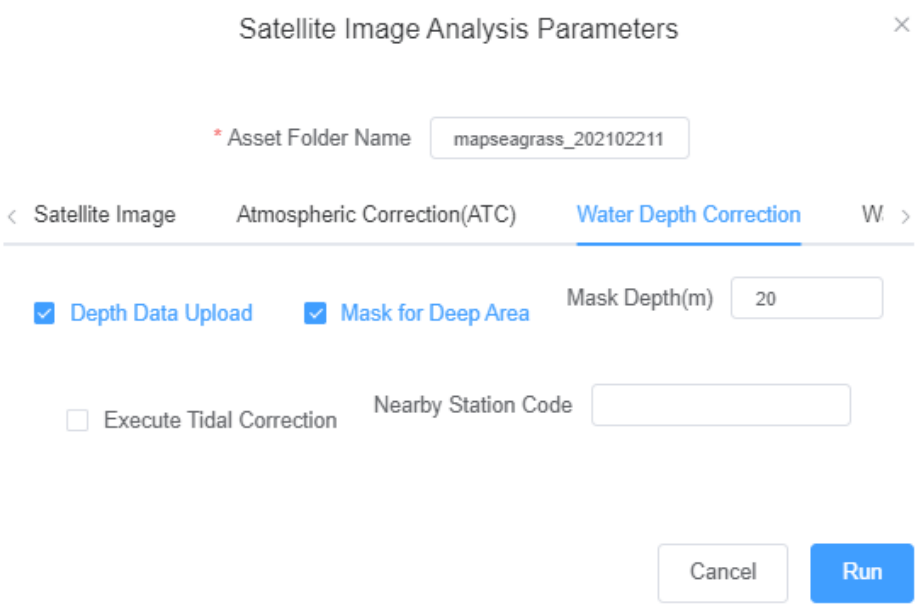


Figure 3.2-4 Setting parameters for Water Depth/Bathymetry Correction

3. 2. 4. 4 Water Column Correction (WCC)

In this example, parameters for Water Column Correction (WCC) are set as follows (Ticked: applying, No ticked: not applying):

- Execute WCC: Ticked
- WCC Method: DII

See Section 3.1.6.4 (Water Column Correction) for details.

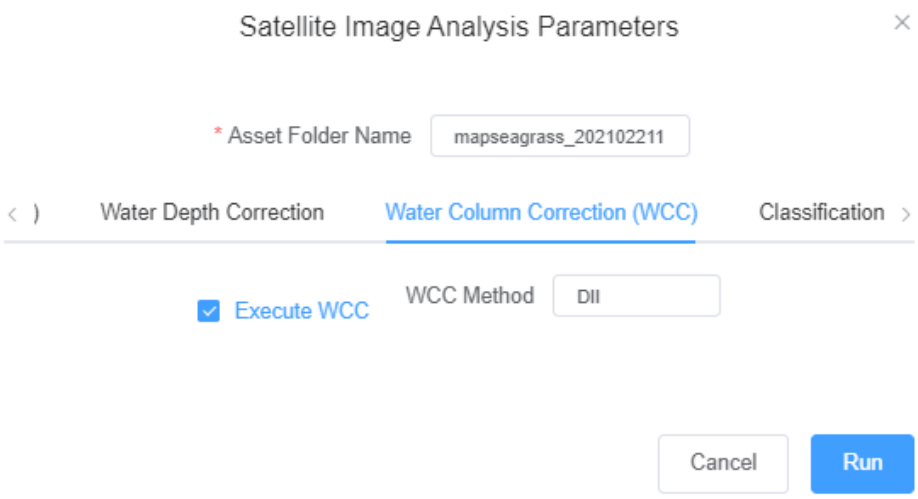


Figure 3.2-5 Setting parameters for Water Column Correction (WCC)

3. 2. 4. 5 Classification

In this example, parameters for supervised classification of satellite images are set as follows (Ticked: applying, No ticked: not applying):

- Number of Classes: 3
- Supervised Classification: Ticked
- Classification Method: RandomForest
- Sampling Scale: Original
- Training Rate: 70(%)
- Training Data Split by Each Class: Ticked
- Majority Filter Size: 3 (pixel)

See Section 3.1.6.5 (Classification) for details.

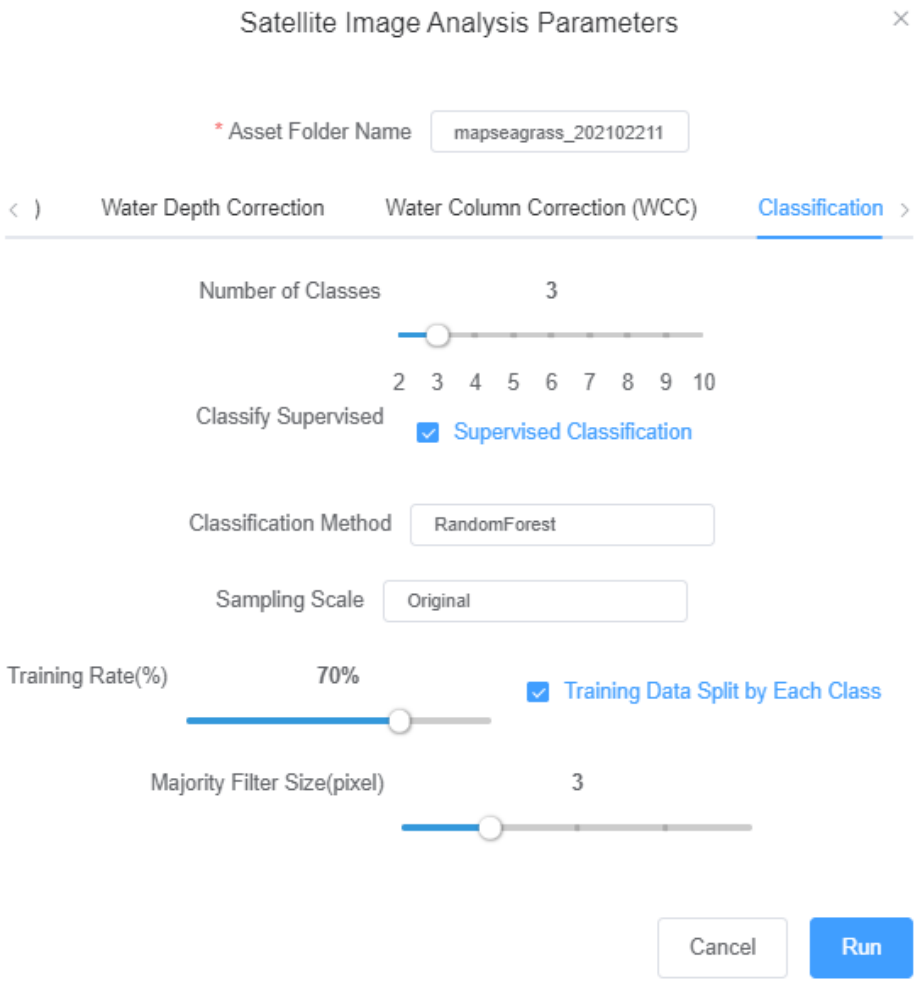


Figure 3.2-6 Setting parameters for supervised classification of satellite images.

3. 2. 4. 6 Executing analysis

After setting all parameters, click “Run” to execute analysis. Then, an email is sent to user to notify acceptance of analysis order.

After completing analysis, another email is sent to notify completion of the order.

* It is recommended to keep opening the browser (and not to sign out) until analysis results are obtained. After signing out, user cannot access to the analysis results folder from the Seagrass Trainer.

3. 2. 5 Obtaining and evaluating analysis results

3. 2. 5. 1 Obtaining analysis results

After receiving an email notifying completion of analysis, user can obtain analysis result files (GeoTIFF file for result images and CSV file for accuracy evaluation results) from the Dataset page. See Section 3.1.7.1 (Executing analysis) for details.

3. 2. 5. 2 Evaluating analysis results

Display the downloaded analysis result image (result.tif) by using the image display software such as QGIS. The result image includes classification numbers, so it is possible to assign different colors to each number to show the distribution of each class on the map (Figure 3. 2-7).

The result of accuracy evaluation (result.csv) can be opened with a text editor and/or spread sheet software (Figure 3. 2-8).

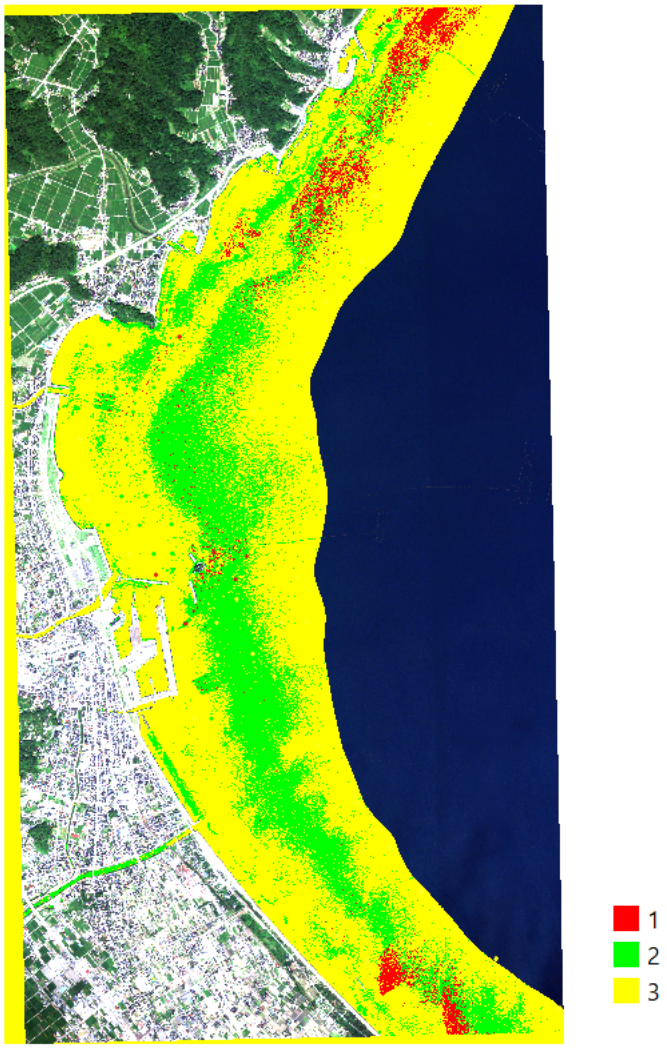


Figure 3.2.7 Result of satellite image analysis (example).
Assigning different colors on each class: Class 1 (seaweed) – red;
Class 2 (seagrass) – green; and Class 3 (sandy bottom) – yellow

total_accuracy	66.58%			
tau_coefficient	0.496395			
				users_accuracy
1	10	4	5	52.63%
2	9	78	48	57.78%
3	8	56	171	72.77%
producers_accuracy	37.04%	56.52%	76.34%	

Figure 3.2.8 Result of accuracy evaluation (example).

In this example, the following accuracy evaluation is obtained based on the training data for evaluation and the results of satellite image classification of the target area:

- Total number of points of training data for evaluation: (Class1) 27; (Class2) 138; (Class3) 224

  Among them, the number of points of correctly classified: (Class1) 10; (Class2) 78; (Class3) 171

  Producer's accuracy (the percentage of points of training data for evaluation which are matched with analysis results):

  10/27 x 100 = 37.04 %

  78/138 x 100 = 56.52 %

  171/224 x 100 = 76.34 %

- Number of points of each class by analysis: (Class1) 19; (Class2) 135; (Class3) 235

  Among them, the number of points matched with training data for evaluation: (Class1) 10; (Class2) 78, (Class3) 171

  Producer's accuracy (the percentage of points of analysis results which are matched with training data for evaluation):

  10/19 x 100 = 52.63 %

  78/135 x 100 = 57.78 %

  171/235 x 100 = 72.77 %

- Percentage of correctly classified against all evaluation points (total accuracy): 66.58 %
- Reliability index against overall accuracy (tau coefficient): 0.496395