Proposal for development of a tool for mapping seagrass distribution in the NOWPAP region

1 Background

In recent years, seagrass and seaweed in coastal areas have been given special attention in terms of their potential for conservation of marine biodiversity and absorption of CO_2. CEARAC initiated its activities on mapping seagrass in the 2014-2015 biennium with development of a manual for seagrass and seaweed beds distribution mapping with satellite images and conducted case studies on mapping seagrass in the selected sea areas in the NOWPAP region for evaluation of the developed manual. In the 2016-2017 biennium, CEARAC has been working on feasibility study towards assessment of seagrass distribution in the NOWPAP region, in which CEARAC envisions estimating seagrass distribution in the entire coastal seas of the NOWPAP region in the future by using satellite images. Through the feasibility study, CEARAC identifies obstacles and required future actions towards assessment of seagrass distribution in the NOWPAP. By now, CEARAC with national experts has collected information to develop a database of seagrass distribution and threats to seagrass in the NOWPAP member states by reviewing literature in each NOWPAP member state.

To review the progress of the feasibility study and discuss future actions for mapping seagrass distribution in the NOWPAP region, the first international workshop on assessment of seagrass distribution in the NOWPAP region was organized in Himi, Toyama, Japan on August 3, 2017. During the workshop, consensus was formed towards assessment of seagrass in the whole NOWPAP region: use of freely available satellite images; involvement of the public to collect field survey information and map distribution of seagrass; and development of a tool using cloud computing technology. Following this consensus, CEARAC proposes to develop a tool for mapping distribution of seagrass in the NOWPAP region in the 2018-2019 biennium. This proposal is in line with two priority themes of draft NOWPAP Medium-Term Strategy (MTS) 2018-2023 being prepared by NOWPAP RCU; assessment of the status of the marine and coastal environment and conservation of marine and coastal biodiversity.

CEARAC will submit this proposal to be reviewed at the 15th CEARAC Focal Points Meeting (FPM) (Toyama, August 29-30, 2017) prior to the 22nd NOWPAP Intergovernmental Meeting (IGM).

2 Objective

Objective of this activity is to develop a tool for mapping and sharing information on distribution of seagrass in the NOWPAP region by using satellite images. The developed assessment tool will be shared among the NOWPAP member states to help mapping distribution of seagrass in each member state. Depending on availability of external funding, CEARAC will develop a website that

incorporates the developed tool in it, so that users can detect distribution of seagrass in their regions of interest by uploading their filed data.

3 Tasks

3.1 Detection of potential seagrass habitat and collection of water depth information

CEARAC will detect potential seagrass habitat in the NOWPAP region based on the result of literature review on seagrass distribution in the 2016-2017 biennium and information derived from satellite images. Information of water depth shallower than 20 m in the coastal areas of each NOWPAP member state will be collected by national experts nominated by CEARAC Focal Points, as it is helpful to correct effect of water column and mask deeper water. In case information of the water depth cannot be obtained, Bathymetry Mapper, a tool to estimate water depth from satellite images, will be used.

3.2 Development of a tool for mapping seagrass distribution with satellite images

When seagrass distribution is estimated based on satellite images, it usually takes a series of steps as shown in table 1: selecting and obtaining satellite images from spaces agencies, carrying out sea truth survey or collecting existing field data, preparing training data sets for classification, removing sun glint, correcting radiance by depth, classifying images and assessing accuracy of obtained classification results. This process indeed requires a person to have a profound knowledge on analysis of satellite images and it takes long time to map distribution of seagrass. In a case study in Nanao Bay, the steps and time in table 1 were taken to map distribution of seagrass with good quality, but it is quite unrealistic to take similar steps in the whole NOWPAP region.

Table 1 Steps and time taken for mapping distribution of seagarss in the case study of Nanao Bay

Steps	Action	Time
Selection and download of satellite images	Visual screening of satellite images in the database, “Earthexplorer” by United States Geological Survey (USGS) and downloading 417 GB of usable images which have less clouds and easier to recognize sea bottoms.	10 days
Preprocessing	Making RGB images, adjusting brightness and correcting water columns in ENVI software	5 days
Filed monitoring and preparation of	- Field monitoring with underwater video camera in Nanao Bay: 3 days	10 days

training dataset	- Preparing a training dataset in GIS: 7 days	
Image classification and accuracy assessment	Classifying images based on the developed training dataset and assessing accuracy of the classified images in ENVI software	10 days

Towards assessment of seagrass in the whole NOWPAP region, use of freely available satellite images, involvement of the public to collect field survey information and map distribution of seagrass, and development of a tool using cloud computing technology are expected. Thus, CEARAC proposes to develop a tool dedicated for mapping distribution of seagrass with freely available satellite images. The proposed tool will be a standalone software program that can carry out the following tasks:

a. Input user specified coordinates (row/path or latitude/longitude) for downloading Landsat 8 OLI and Sentinel 2 MSI satellite images from cloud server;
b. Apply radiance to reflectance calculation;
c. Use infrared data to identify land areas for masking;
d. Remove effect of sun glint;
e. Correct water column by Depth Invariant Index or Bottom Reflectance Index method;
f. Create true color images from Red, Green and Blue band;
g. Import training datasets in GIS format;
h. Test supervised and unsupervised machine learning methods to distinguish sea floor substrates; and
i. Assess accuracy of the classified image against training dataset

CEARAC will subcontract the development of the tool to a private company.

3.3 Development of a website for mapping seagrass distribution with satellite images

CEARAC will incorporate the tool developed in 3.2 in a website and provide services to users for mapping distribution of seagrass in their regions of interest using cloud computing technology. Similar services are already realized in mapping terrestrial biomass and water. ‘MapBiomass’ project enables visualization of changes in land use / land cover in Brazil and neighboring countries with time series of landsat data archive (Figure 1). This project involves the various organization and the public to collect filed data and assess obtained classification results. By using parallel data processing of cloud computing technology, user can map land use / land cover changes at high speed and low cost.

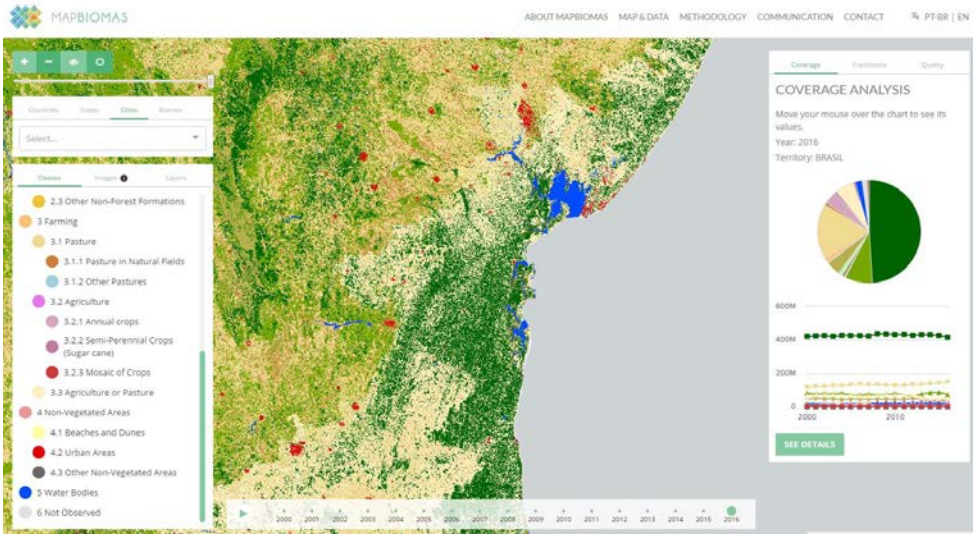

Figure 1 Website of MapBIomass project.

http://mapbiomas.org/

Another example is “Global Surface Water Explorer” of European Commission. In this website, changes in coastal areas can be visualized by identifying moisture of land surface using time series of landsat data archive (Figure 2).

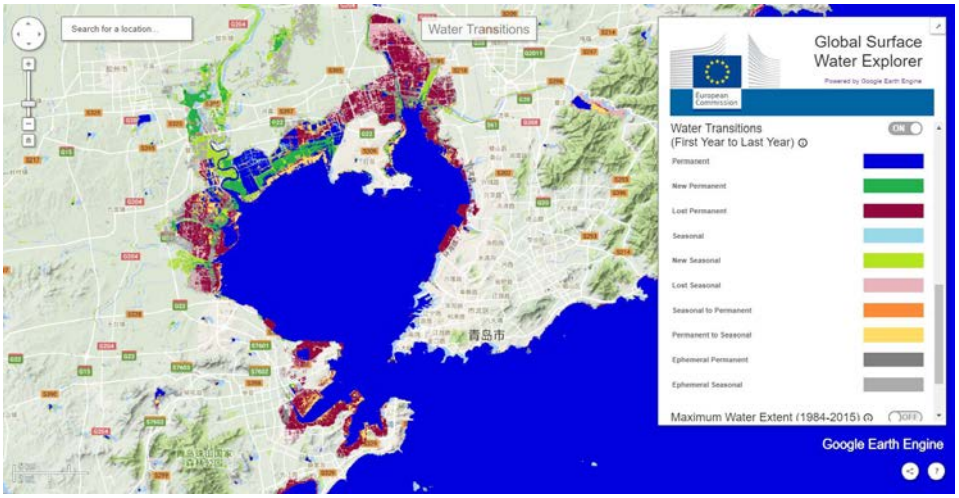

Figure 2. Temporal change of Land surface moisture around Jaouzohu Bay in Qingdao, China shown in Global Surface Water Explorer (https://global-surface-water.appspot.com/). Red areas are newly expanded lands created by landfills.

These websites are powered by Google Earth Engine, a planetary-scale for Earth science data and analysis. It combines a multi-petabyte catalog of satellite imagery and geospatial

datasets with analysis capabilities and makes it available for scientists, researchers, and developers to detect changes, map trends, and quantify differences on the Earth's surface. Similar cloud services are also available from Amazon. Amazon Web Services know as AWS, provides satellite data that can be used for mapping seagrass.

Since the development of the website using the cloud computing technology require additional funding, CEARAC will prepare a proposal for development of the website for obtaining funding from external sources. The task in 3.3. will be implemented if the funding is secured.

4 Expected outcomes

By the developed/released web-based information in the NOWPAP region, various stakeholders including governments, citizens, fisheries and/or politicians can share the same knowledge of distribution of seagrass which can help cooperate each other to plan policies to conserve and/or recover seagrass beds, and contribute to sustainable costal area management. When the total area of seagrass beds in coastal areas is identified, the information is also used to estimate the amounts of CO_2 absorbed in the sea, which is useful for relevant researchers and government officials in terms of mitigating global warming.

In addition, this activity can cooperate with a project of Ocean Remote Sensing in IOC/WESTPAC, and can be applied in the Southeast Asian countries as well.

5 Schedule

The timeline of this activity is shown below.

Time		Action	Main body
2017	August at CEARAC FPM15	Review of this proposal	FP
	December at NOWPAP IGM22	Review and approval of CEARAC workplan and budget for 2018-2019	IGM
2018	Q1 to Q3	Identification of potential seagrass habitat	Nominated national experts and CEARAC
	2018 Q4 to 2019 Q3	Development of a tool for mapping seagrass distribution with satellite images	CEARAC and consultant
2019			

	Q3 to Q4	Construction of web-based service for mapping seagrass distribution	CEARAC and consultant

6 Budget

Task	Time	Deliverables	To be completed	Main body	Budget (US$)
Detection of potential seagrass habitat	2018 Q1	-Map of potential sea seagrass habitat - Depth information on shallow waters (<20m) in the NOWPAP region	2018 Q3	Expert in China	5,000
				Consultant in Japan	5,000
				Expert in Korea	5,000
				Expert in Russia	5,000
Development of a tool for mapping seagrass distribution	2018 Q4	A tool for mapping seagrass distribution	2019 Q3	CEARAC	20,000
Construction of web-based service for mapping seagrass distribution	2019 Q3	Web-based service for mapping seagrass distribution	2019 Q4	CEARAC	External fund
Total					40,000