Ocean Country Partnership Programme

Sri Lanka seagrass mapping training

Workshop report

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Ocean Country Partnership Programme:
The Ocean Country Partnership Programme (OCPP) is a bilateral technical assistance and capacity building programme that provides tailored support to countries to manage the marine environment more sustainably, including by strengthening marine science expertise, developing science-based policy and management tools and creating educational resources for coastal communities. The OCPP delivers work under three thematic areas: biodiversity, marine pollution, and sustainable seafood.

Contents

1. Introduction

A four-day training workshop on remote sensing and marine habitat mapping was delivered by Northumbria University and the Ocean Country Partnership Programme (OCPP) from Tuesday 17 to Friday 20 June 2025. This workshop was part of a wider two-year project to map the national extent and distribution of seagrass in Sri Lanka as well as build capacity in future seagrass habitat monitoring. The workshop was hosted at the Hilton Hotel in Colombo, Sri Lanka, and brought together 42 participants with an interest in marine habitat mapping and in particular seagrass habitat mapping from universities, government, and non-governmental organisations (NGOs). To address the different levels of experience among attendees, the workshop was structured into two streams:

Stream 1: Designed for environmental professionals without prior experience in Geographic Information Systems (GIS) or remote sensing, this stream provided a broad introduction to geospatial approaches for seagrass mapping. This training was designed for those who may work with habitat maps but would not generate the maps themselves. Participants attended two dedicated lectures on Tuesday morning, which aimed to improve general knowledge of GIS techniques and remote sensing applications for marine habitat monitoring.

Stream 2: Designed for participants with previous GIS and/or remote sensing experience, this stream ran throughout the remainder of the week and was targeted at participants who plan to generate habitat maps using remotely sensed data. It included a series of lectures in the mornings and hands-on practical sessions in the afternoons. Training covered a wide range of topics, including GIS theory and techniques; introduction to remote sensing methods and theory using satellite data; habitat classification concepts and workflows for marine habitat mapping; accuracy assessment approaches and best practice; and application of Google Earth Engine (GEE) for marine habitat mapping, coding in JavaScript, and future learning.

The main aims of the workshop were to:

- Build capacity in the use of GIS and remote sensing for seagrass mapping among environmental professionals in Sri Lanka.

- Provide tailored training for different levels of expertise, ensuring accessibility for beginners while offering advanced content for experienced practitioners.

- Support the long-term development of skills in satellite-based habitat mapping to improve monitoring, management, and conservation of Sri Lanka's marine ecosystems.

2. Agenda

Table 1 presents the agenda for the four-day workshop on remote sensing and habitat mapping.

Table 1: The four-day agenda for the workshop.

Tuesday 17 June 2025	
09:00–09:30	Registration and refreshments
09:30–10:30	Training Stream 1: Introduction to GIS and habitat mapping part 1
10:30–10:45	Tea break
10:45–12:00	Training Stream 1: Introduction to GIS and habitat mapping part 2
12:00–13:00	Lunch
13:00–14:45	Practical: Introduction to GIS software GEE
14:45–15:00	Tea break
15:00–16:45	Practical: Introduction to GIS software GEE
16:45–17:00	Closing summary and questions
14:45–15:00	Tea break
15:00–16:45	Practical: Habitat mapping in GEE
16:45–17:00	Closing summary and questions

Wednesday 18 June 2025	
09:00–09:30	Registration and refreshments
09:30–10:30	Training Stream 2: Intermediate GIS
10:30–10:45	Tea break
10:45–12:00	Training Stream 2: Remote Sensing
12:00–13:00	Lunch
13:00–14:45	Practical: Habitat mapping in GEE
14:45–15:00	Tea break
15:00–16:45	Practical: habitat mapping in GEE
16:45–17:00	Closing summary and questions

Thursday 19 June 2025	
09:00–09:30	Registration and refreshments
09:30–10:30	Training Stream 2: Remote Sensing
10:30–10:45	Tea break
10:45–12:00	Training Stream 2: Introduction to habitat classification using remote sensing data
12:00–13:00	Lunch
13:00–14:45	Practical: Habitat mapping in GEE
14:45–15:00	Tea break
15:00–16:45	Practical: Habitat mapping in GEE
16:45–17:00	Closing summary and questions

Friday 20th June 2025	
09:00–09:30	Registration and refreshments
09:30–10:30	Training Stream 2: Validation and training data principles
10:30–10:45	Tea break
10:45–11:15	Training Stream 2: Continued monitoring of marine habitats
11:15–12:00	Closing questions and informal discussion
12:00–13:00	Lunch and close

3. Training session summaries

3.1. Day 1

3.1.1. Morning lecture

The morning comprised the Stream 1 training workshop, which was delivered to all participants in both training Stream 1 and 2. Training Stream 1 was designed for participants that may work with habitat maps but may not need to generate the maps themselves as a part of their work. As such, the session had four key objectives, each of which were addressed through a combination of lecture content, and interactive discussion and activities. Each of these objectives will be outlined in turn.

Objective 1 was *to understand the marine and remote sensing context*. Content to address this objective included the importance of the marine environment and the rationale for undertaking habitat mapping work using remote sensing. Remote sensing as an approach was defined and examples of its broader applications were provided.

Objective 2 was *to be aware of the properties that underly a robust habitat map and, therefore, to develop your critical eye in appraising remote sensing data*. This objective was used as a way of introducing key concepts in remote sensing (e.g. the electromagnetic spectrum, bands, types of data resolution, image compositing) whilst applying those concepts in a practical way.

Objective 3 was *to learn about the choices, the imagery type, and the trade-offs involved*. As a part of this objective, participants undertook a group discussion activity on their tables and also considered the importance of defining the purpose of a habitat map before then selecting the imagery type and workflow to best suit that purpose.

Objective 4 was *to understand the key steps in a remote sensing habitat mapping workflow*. To demonstrate a typical workflow, the broad steps in the Sri Lankan seagrass mapping workflow were covered, including the rationale behind the type of imagery used, the role of GEE, ground truth data collection, and accuracy assessment. In addressing this objective, participants had the opportunity to contribute participatory mapping data on the distribution of Sri Lankan seagrass meadows by adding annotations to enlarged maps of Sri Lanka. This activity served dual purposes of (i) increasing participants' understanding of training data; and (ii) enabling us to incorporate valuable local ecological knowledge into the Sri Lankan seagrass maps.

3.1.2. Afternoon practical

The first practical of the workshop was for Stream 2 attendees only and aimed to provide a broad introduction to the GEE platform. The content was included in the practical handout and attendees were encouraged to work through the numbered sections, discussing with their peers as they went through.

The first practical was split into 3 parts (A, B, C). Part A provided a tour of the GEE platform and included tasks that allowed attendees to familiarize themselves with the different functionalities of the platform and how to navigate between them (Figure 1).

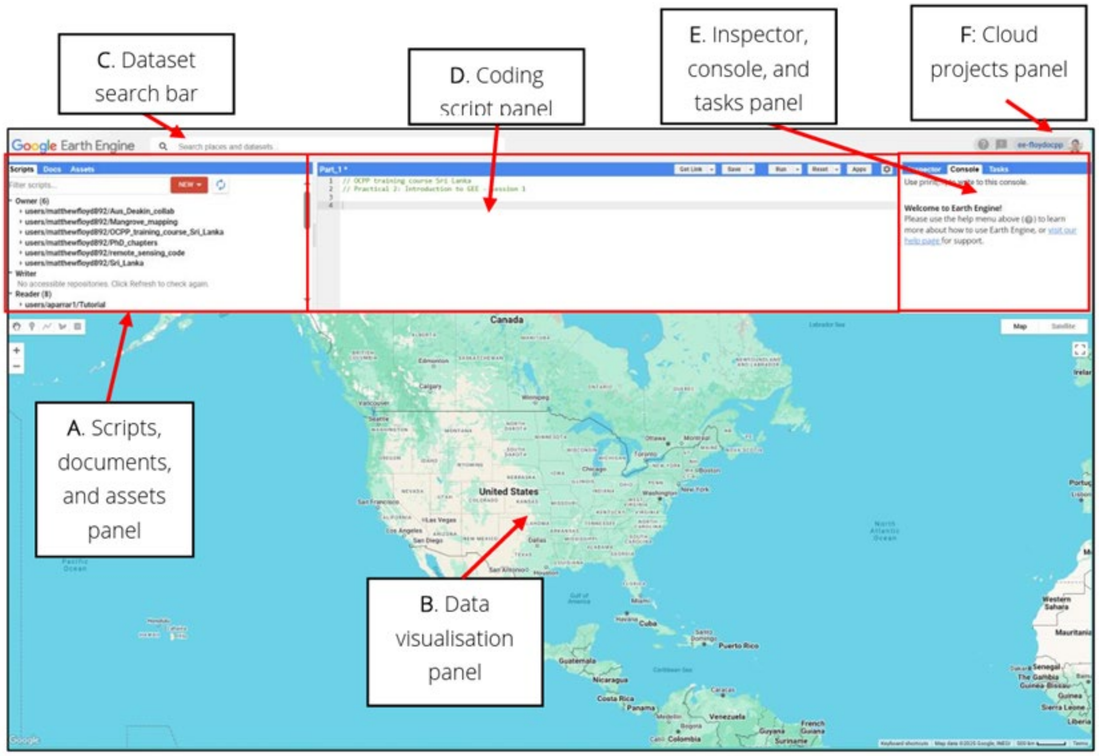

Figure 1. Google Earth Engine Application Programming Interface (API) layout.

In part A of the practical, participants were introduced to GEE and the handout document provided a guide to the different sections of the Application Programming Interface (API). The tasks in this part required participants to navigate the API and answer questions as they went through.

In part B of the opening practical, the handout worked through some basic coding skills and asked participants to run JavaScript code in GEE. For many participants, this was the first time they had used code on this platform.

In part C, participants were introduced to datasets available in the API. The handout guided participants through the process of importing Sentinel-2 data and some procedures for handling the data. In the final section, the participants exported the pre-processed data to their personal cloud assets.

3.2. Day 2

3.2.1. Morning lecture

The morning lecture content comprised an introductory lecture to GIS, followed by an introductory lecture to remote sensing. As on day one, each objective was addressed through a combination of lecture content, and interactive discussion and activities.

The objectives of the GIS introductory lecture were threefold.

Objective 1 was *to understand the importance of GIS and how it is linked to remote sensing*. This content explained GIS, its history, example applications, and that GIS can be used to visualise, analyse, interpret and store remotely sensed data. Examples of GIS software packages were discussed, including both commercial and freely available open-source options.

Objective 2 was *to be aware of the key properties of geospatial data*. Properties discussed included vector and raster data models, spatial resolution, and co-ordinate systems.

Objective 3 was *to know the key elements of a professional map output*. Such content was important to cover given that those generating habitat maps will be required to display and share them as map outputs. As part of this objective, examples of poor and good map design were discussed.

The remote sensing introductory lecture also had three objectives.

Objective 1 was *to understand the key principles of how remote sensing works*, which incorporated content on the electromagnetic spectrum and the portions that are of most use for marine applications of remote sensing.

Objective 2 was *to know the strengths and weaknesses of key satellites used for habitat mapping*. This content built on the material from the previous day, including a more detailed discussion of Landsat, Sentinel-2 and Planet satellite data.

Objective 3 was *to learn about spectral signatures and their importance for land cover mapping 1*. We explained the physics behind why objects appear different to our naked eye, and how spectral signatures can be used to underpin habitat mapping. Finally, we discussed the use of spectral signatures for calculating indices to characterise the Earth's surface.

3.2.2. Afternoon practical

The second practical was also divided into 3 parts (A, B, C).

Part A introduced participants to existing habitat maps and image pre-processing in GEE. This part began using the Allen Coral Atlas as a case study, attendees explored high-resolution reef and benthic maps for Sri Lanka, assessing their accuracy and discussing sources of potential error. They then worked through a series of coding tasks in GEE to revisit compositing and filtering imagery, calculate spectral indices such as Normalised Difference Vegetation Index (NDVI) and Modified Normalised Difference Water Index (MNDWI), and create a masked image stack for later classification. Following on from this, participants used the handout to guide them through importing Sentinel-2 data, applying filters, generating composite imagery, and masking land areas. The tasks reinforced concepts from the first practical while introducing additional processing steps, such as using water indices to generate Boolean masks.

In part B, participants applied an unsupervised classification to their prepared imagery. They used the K-means algorithm to group pixels into clusters based on their spectral properties, experimenting with both coarse (5-class) and finer (15-class) outputs. Participants then isolated individual clusters, such as those potentially representing seagrass, and displayed these as separate map layers.

In part C, the practical shifted to supervised classification. Participants created their own training datasets by adding labelled point geometries for three classes (water, vegetation, and bare land) and used these to train a classifier (Figure 2). The session concluded with exporting the resulting habitat classification to their cloud assets, ready for use in later accuracy assessments.

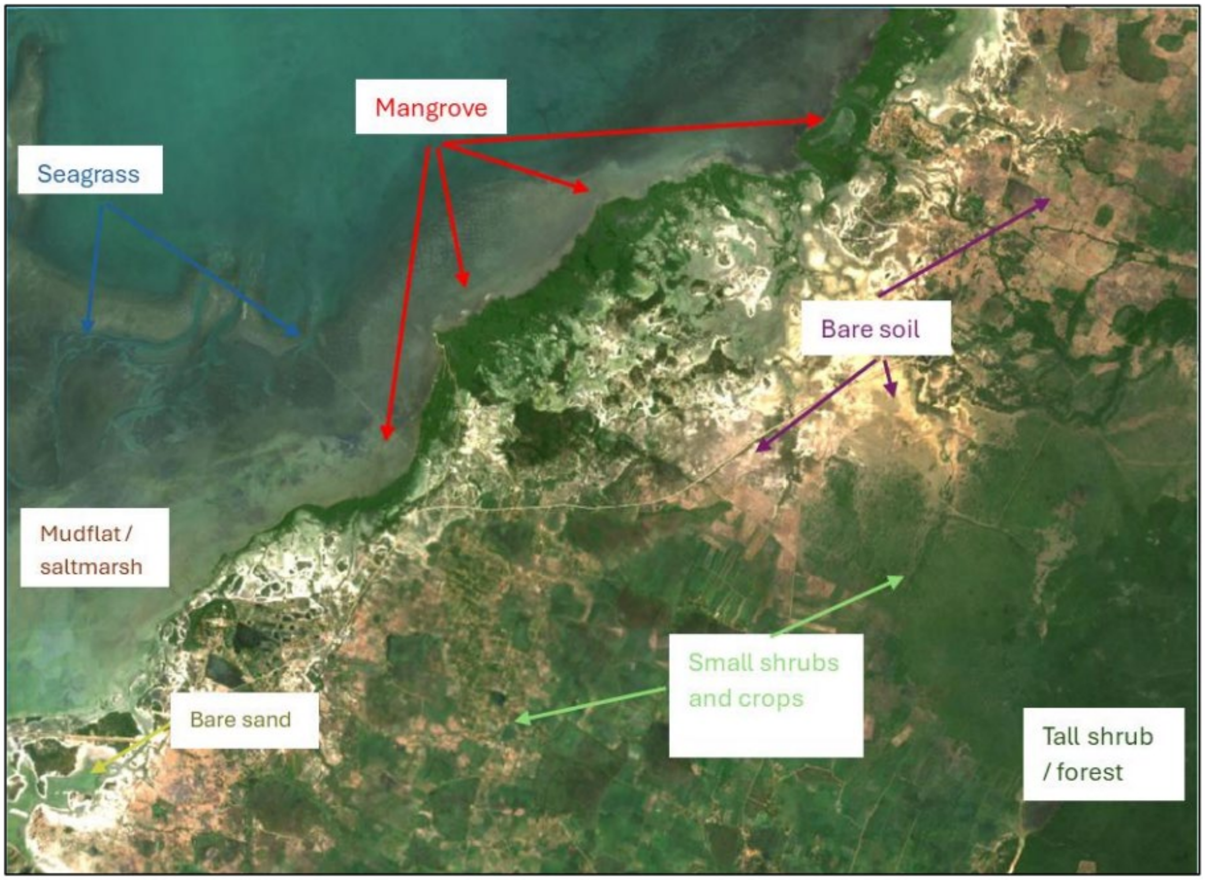

Figure 2. Area of interest for practical 2 with labelled land and benthic cover types.

3.3. Day 3

3.3.1. Morning lecture

The morning lectures included a second session on remote sensing and a session on habitat mapping using remote sensing data. As in previous days, the lecture objectives were achieved using a combination of lecture slides, discussion and quiz style questions, and videos.

The lecture on remote sensing had 5 objectives.

Objective 1 was *to identify sources of noise in satellite imagery and how they influence data quality*. Examples included turbidity, water depth, cloud cover, cloud shadow, adjacency effects, and sun glint, all of which can reduce the accuracy of benthic habitat mapping.

Objective 2 was *to understand steps that can be taken to reduce noise*. Participants learned about strategies such as filtering imagery to avoid turbid or cloudy periods, applying masks, and using indices like the MNDWI.

Objective 3 was *to understand the different levels of satellite data processing*. The lecture explained distinctions between Level-1C and Level-2A Sentinel products and the importance of choosing appropriate processing levels for habitat mapping.

Objective 4 was *to outline the steps taken in pre-processing*. A typical workflow was introduced, covering image selection and filtering, cloud and land masking, compositing, and optional corrections.

Objective 5 was *to understand how these pre-processing steps can be implemented in GEE*. Code demonstrations showed how filtering, masking, and compositing workflows are applied to prepare imagery for classification.

The lecture on habitat mapping using remote sensing data had 4 objectives.

Objective 1 was *to explain what habitat maps are and how they are used*. Content introduced habitat maps as spatial data layers describing the location, extent, or condition of habitats and assemblages. The lecture included how these layers can be used for species and habitat conservation, marine spatial planning, national inventories, and monitoring.

Objective 2 was *to be aware of current mapping products and projects*. Examples included the Allen Coral Atlas and Global Mangrove Watch, with discussion of their applications and limitations at different spatial scales.

Objective 3 was *to understand how remote sensing data are used in habitat mapping*. Participants learned how spatial, spectral, radiometric, and temporal resolution influence the ability of classification algorithms to distinguish habitats. Case studies demonstrated how reflectance values underpin classification.

Objective 4 was *to understand habitat classification methods*. Here, we covered unsupervised and supervised classification, with a focus on Support Vector Machines (SVM), Random Forests (RF), and Object-Based Image Analysis (OBIA). Participants considered the role of training data and spectral separability through group discussion.

3.3.2. Afternoon practical

As with the previous sessions, the practical was divided into 3 parts (A, B, C) and aimed to bring together many of the skills developed in the earlier sessions.

Part A introduced a case study mapping marine habitats around two islands in Laamu Atoll, Maldives. Participants followed the handout to identify key requirements of the case study, including habitat classes, time period, and spatial resolution. They then worked in GEE to select appropriate Sentinel-2 imagery, apply temporal and cloud filtering, generate composite images, and mask land areas. The participants then exported the pre-processed imagery to their cloud assets for later use.

In part B of the practical, participants carried out a supervised classification of the pre-processed imagery. They created training datasets for five habitat classes (deep water, coral reef, sand, sparse seagrass, and dense seagrass) by adding labelled point geometries to the map. The training geometries were then merged into a single dataset and used to train the classifier. Participants experimented with adding and refining training points to improve classification outputs, making use of both the high-resolution satellite basemap and the processed imagery for reference.

In part C, participants conducted an accuracy assessment of their supervised classification using a provided validation dataset. They uploaded the validation point shapefile into GEE, sampled the classified map at each validation point, and generated accuracy statistics including a confusion matrix, overall accuracy, and producer's and user's accuracy for each class. The practical concluded with exporting the final habitat classification to Google Drive.

3.4. Day 4

3.4.1. Morning lecture

The first morning lecture covered training and validation data principles and included 5 objectives.

Objective 1 was *to critically assess habitat maps*. Participants examined example outputs and discussed as groups to identify missing contextual information, such as legends, spatial resolution, and accuracy reporting, and discussed how to adopt a critical perspective when reviewing maps.

Objective 2 was *to understand the requirement for high-quality training and validation data*. Content explained the role of representative, well-distributed training data, the impacts of poor sampling strategies, and the importance of incorporating within class variability.

Objective 3 was *to decide which classes to include in a map*. Group case studies were used to demonstrate how class definitions must be context-specific, spectrally distinct, and aligned with project aims, highlighting the value of local knowledge in class design.

Objective 4 was *to understand the principles of map validation*. Guidance was provided on collecting validation data, including appropriate sampling strategies, avoiding mixed habitats, and ensuring compatibility with map specifications.

Objective 5 was *to understand the role of accuracy assessments*. The lecture introduced key accuracy metrics, including overall accuracy, producer's accuracy, and user's accuracy, emphasising their role in communicating confidence in data outputs.

The second lecture, and the final lecture of the workshop, introduced the principles of long-term habitat monitoring and also introduced attendees to available resources to further their learning.

Objective 1 was *to understand the principles of long-term monitoring*. Participants learned how consistent monitoring protocols allow for detecting trends, assessing ecosystem health, and providing early warning of stressors. Case studies from Tampa Bay (Florida, USA), the Maldives, and northern Europe illustrated the use of time series data to track seagrass recovery, expansion, and seasonal dynamics.

Objective 2 was *to understand the approach to time series sampling*. Content highlighted the importance of consistency in data sources, pre-processing, image selection, model training, and validation.

Objective 3 was *to access available resources for further learning in GEE*. Participants were introduced to online courses, developer forums, and standard operating procedures for seagrass mapping. Additional skills for managing code, troubleshooting errors, and extending workflows were discussed to support continued learning beyond the workshop.

3.5. Participatory mapping

As part of the wider OCPP project aims to generate national seagrass habitat maps for Sri Lanka from remote sensing data, the workshop included a participatory mapping exercise designed to capture local ecological knowledge. While robust ground-truth validation points have been collected in the field by collaborators at Blue Resources Trust, the presence of many national experts on seagrass distribution at the workshop provided an opportunity to further validate our satellite mapping outputs.

Large-scale (A0) printed maps of sites of interest were prepared using Sentinel-2 imagery (Figure 3). Participants familiar with these sites were invited to annotate the maps by placing green dots to indicate seagrass presence and adding written notes on extent and distribution. This exercise highlighted several key insights.

First, expert knowledge was found to be localised. Participants had detailed understanding of the specific areas in which they work, but overall there are still clear knowledge gaps across the national scale. This finding reinforced the need for the ongoing remote sensing work to provide a consistent, country-wide baseline.

Second, experts emphasised the patchiness and seasonal variability of seagrass cover. For example, a ranger from Puttalam Lagoon explained that seagrass can cover much of the lagoon at certain times of year and be almost absent at others. Such insights are important for interpreting remote sensing outputs and understanding temporal dynamics.

Finally, the participatory process itself proved most effective when carried out in a relaxed, informal manner. Allowing small groups of participants to approach the maps and discuss among themselves facilitated a useful discussion.

Overall, the exercise provided valuable contextual information to complement the remote sensing and validation datasets.

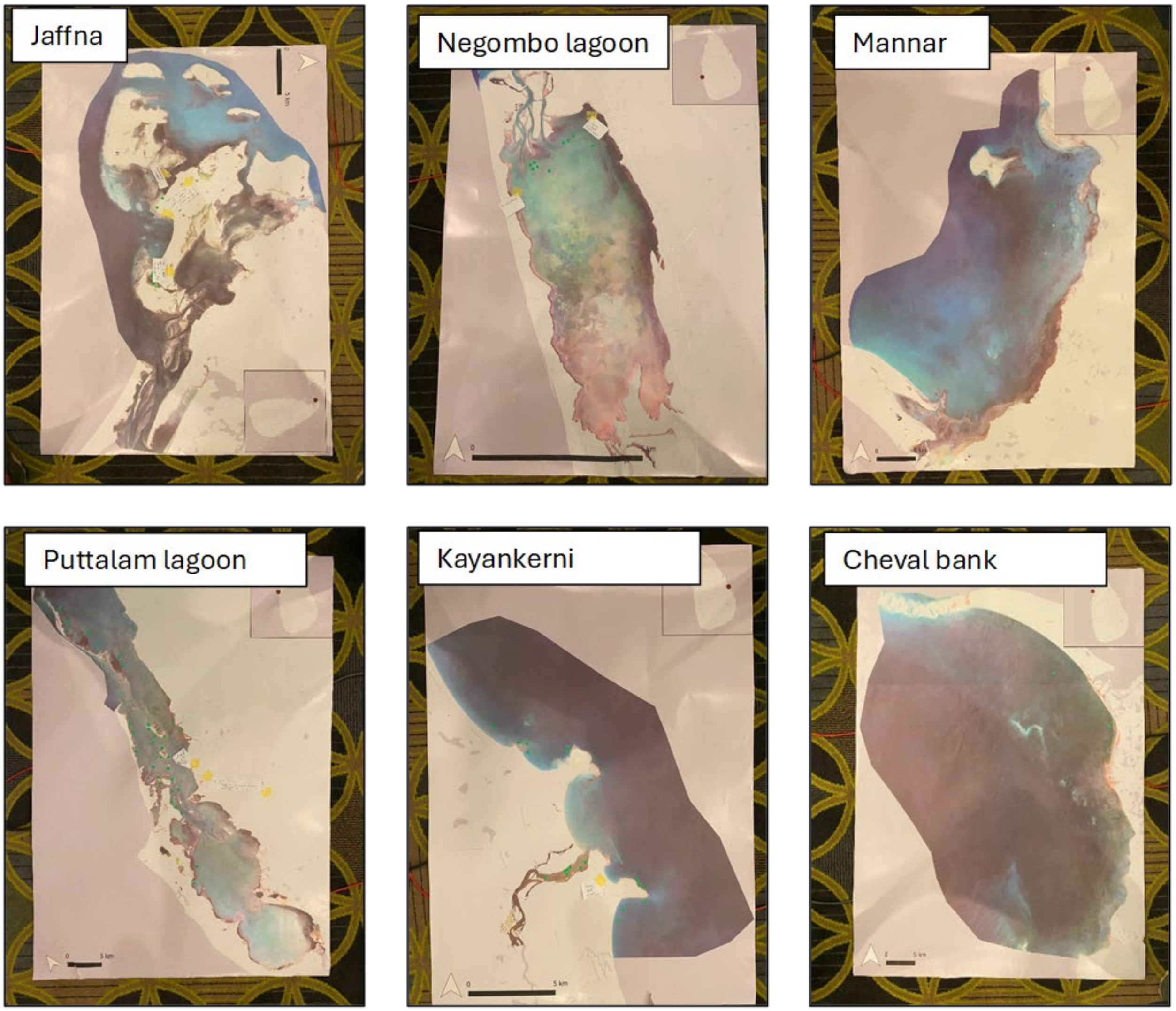

Figure 3. Satellite basemaps of 6 sites across Sri Lanka used in a participatory mapping exercise.

4. Workshop Monitoring, Evaluation & Learning

4.1. Workshop feedback surveys

Questionnaires were undertaken before and after workshop delivery to ascertain the impact of the training. The pre- and post-workshop questionnaires received 42 and 34 responses respectively.

Figure 4.1 compares pre- and post-workshop responses to the knowledge questions from the Stream 1 participants. There was a clear shift in knowledge ratings from the pre-workshop to the post-workshop assessments. Notably, there were 22 responses in the lowest two categories ("slightly knowledgeable" and "not at all knowledgeable") before the workshop, whereas there were no ratings in those categories after the workshop. Before the workshop, the most frequent responses were "moderately knowledgeable" (n = 21) and "slightly knowledgeable (n= 14). Following the workshop, the most frequent responses were "very knowledgeable" (n = 14) and "moderately knowledgeable" (n = 13).

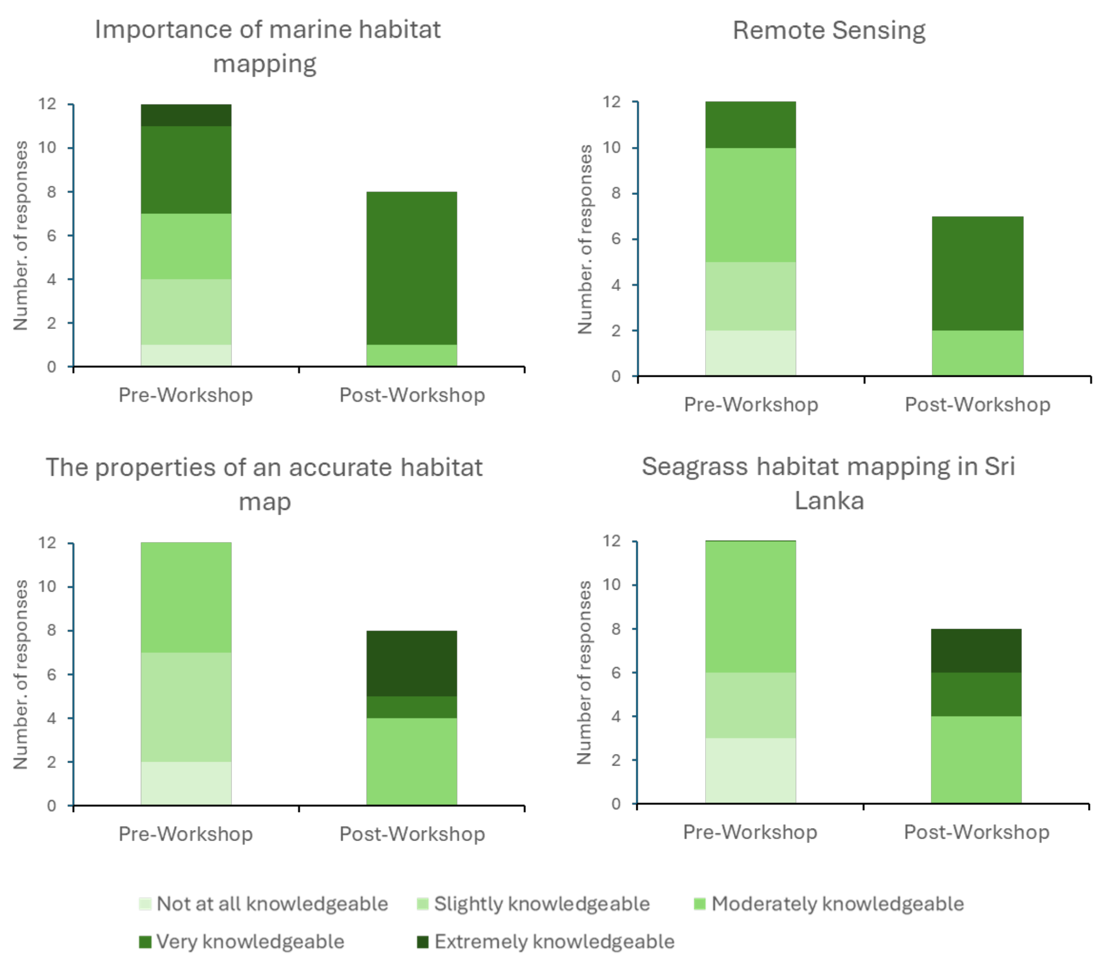

Figure 4.1. Pre- and post-workshop questionnaire responses from Stream 1 participants.

Figure 4.2 displays knowledge questionnaire responses from the Stream 2 workshop participants. Again, there was a clear shift in knowledge ratings from the pre-workshop to the post-workshop assessments. Before the workshop, the most frequent response was "moderately knowledgeable" (n = 46), whereas post-workshop, the most frequent response was ”very knowledgeable” (n = 54).

There was a notable increase in the number of participants rating themselves as "extremely knowledgeable" and "very knowledgeable" following the workshop. For example, the number of participants in these top two categories for "knowledge of remote sensing" rose from 8 pre-workshop to 15 post-workshop.

Similarly, for "knowledge of the properties of an accurate habitat map," the number of participants in the top two categories increased from 4 to 15. The data for the final question, "knowledge of using GEE to generate seagrass maps," also shows a marked change. The number of participants rating themselves as "very knowledgeable" or "extremely knowledgeable" for this topic increased from 0 to 13 between the pre- and post- workshop surveys.

The post-workshop responses to the questions on learning were strongly positive. In both cases 86% of responses were “strongly agree” to the statements “I have learnt more about the properties of an accurate habitat map” and “I have learnt more about marine habitat mapping and how remote sensing can be used to map seagrass”. Stream 2 participants also responded “strongly agree” in 89% of cases to the statement “This workshop provided me the opportunity to improve my knowledge and skills using technology including Google Earth Engine”.

Incorporating responses from both Stream 1 and 2 attendees, 74% of participants were involved in projects, programmes, or policy initiatives where they could apply the mapping techniques introduced in this workshop. 88% of respondents reported that they would use the knowledge gained from the workshop in the next 6-12 months.

Responses to questions on the quality of the workshop were also strongly positive. 97% of respondents said the content of the workshop was easy to understand. 100% found the supporting materials for the workshop useful.

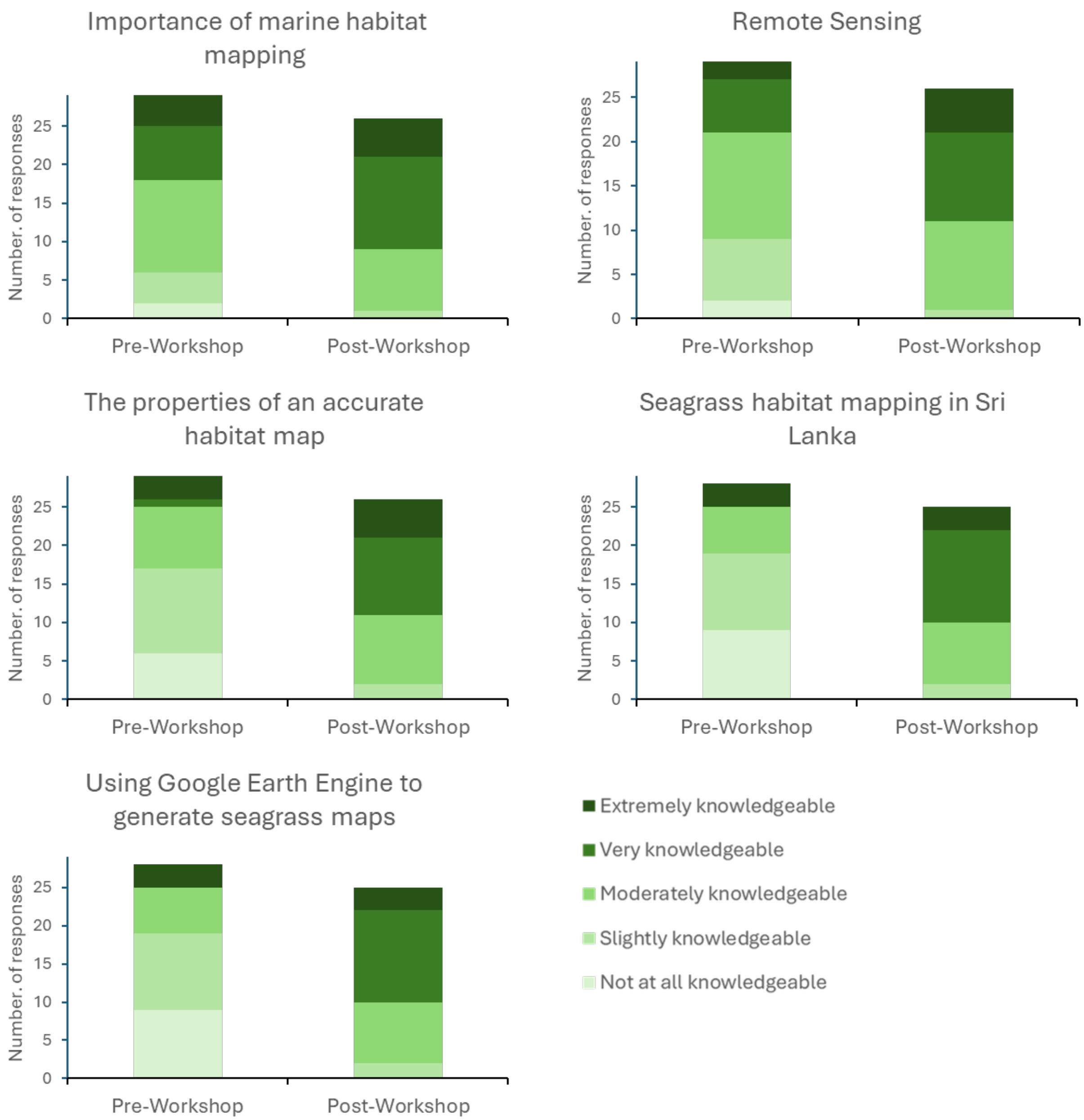

Figure 4.2. Pre- and post-workshop questionnaire responses from Stream 2 participants.

4.2. Lessons learned

The majority of comments on the feedback questionnaire included no suggestions for improvement (85%, n = 29). However, the following points were made which could inform the design of future workshops:

- One participant requested a certificate. We were able to action this request and send certificates to all participants after the workshop, but this could be planned from the outset

- There was one suggestion to create the SharePoint of resources in advance of the workshop.

- Three respondents said they would have liked more practical time. In order to accommodate this request whilst catering for all levels of prior experience, a longer workshop would likely be needed.

- One comment said that a field component would have been useful, though this would require additional budget.

- One response suggested that more applicants to the workshop ought to be given the opportunity to attend, but this would also require a corresponding increase in budget.

5. Next steps

The next stage of this project will focus on finalising and refining seagrass habitat maps derived from satellite remote sensing data. These outputs will be validated using ground-truth validation points already collected, as well as contextual knowledge gathered during the participatory mapping exercise.

All training materials used during the workshop have been shared with participants to support continued learning and recap of the workshop content. By providing both the lecture content and practical handouts, participants are able to revisit the material.

It is anticipated that the workshop has contributed to national capacity for seagrass habitat mapping in Sri Lanka. With over 40 participants trained in GIS, remote sensing, and the use of GEE, we hope the knowledge and skills developed during the week will support future monitoring, management, and conservation of marine ecosystems across the country.