Sustainable Sargassum Management
in the Overseas Territories

Drone Mapping & Monitoring Training Report

Anguilla, Montserrat & Tortola, BVI

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For CANARI

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Rationale

Basemaps and elevation models are fundamental for surveying, modelling, managing and ultimately the conservation of natural resources. Remote sensing data acquired from satellites and piloted aircraft has traditionally been a useful tool for mapping and quantifying the abundance and distribution of habitats and resources and thereby monitoring environmental change over. In many cases, data from these platforms provide the only way to measure features or processes on the Earth's surface and in the atmosphere, and evaluate how these parameters are changing. In recent years the utility of colleting remote sensing data acquired from piloted aircraft and more recently satellite technologies, together with a geographical information system (GIS) has allowed for the production of basemaps over larger geographical areas with better accuracy, resolution and lower budgets than previously possible with conventional field surveys. Despite these advances, the use of conventional airborne and satellite remote sensing platforms for many environmental applications still pose a number of challenges, due largely to the cost, technical expertise, lack of operational flexibility, and limitations in terms of spatial and temporal resolution traditionally associated with production of these maps, requiring extensive airborne field surveys and *in situ* measurements.

To address this growing demand for spatial data on the state of the environment, the science of remote sensing, including the availability of small airframes, payload sensors and semi-automated mapping software to provide detailed three-dimensional (3D) representations of Earth surface features and topography, has rapidly progressed. Over the last decade, advances in remote sensing technologies have seen the development and application in the use of small Unmanned Aircraft Systems (UAS) as a valuable tool for environmental management. The utility of UAS for conservation and environmental management scenarios include: habitat and resource base mapping; elevation and flood modelling; feature detection such as animal enumeration, reflectance and Normalized Difference Vegetation Index (NDVI) for vegetative health analysis; search and rescue, disaster management and impact assessment; monitoring and surveillance activities; and a number of 3D volumetric measurements. Core functionality is derived from the georeferenced, high resolution color images UAS systems can capture and the speed in which a number of additional output products can be easily generated.

With rapid deployment and decreased flight costs, UAS allows researchers to survey specific areas at regular intervals to establish baseline conditions and monitor environmental changes. UAS are filling an important niche for researchers as they are particularly well-suited for mapping at an intermediate spatial scale (i.e. 1-10 km^2) at a fraction of the cost, training and time required to both conduct and process conventional aerial survey data. Furthermore low flight ceilings can allow for the collection

of data with high spatial resolution (< 5 cm), which is not vulnerable to cloud cover and other weather conditions typical in tropical areas, thereby providing a cost-effective means of acquiring highly accurate and timely spatial data.

An UAS entails a whole system, composed by a lightweight Unmanned Aerial Vehicle (UAV) or remotely piloted aircraft, its imaging payload, a Ground Control Station (GCS) and the ground-based pilot and UAS crew. These small and flexible remote sensing platforms are emerging with a wide array of payload sensor systems that can be tailored to specific management needs. Correspondingly several semi-automated image processing software provides the ability to quickly capture georeferenced pictures and videos as well as create high resolution photogrammetric products (e.g. orthophoto mosaics and elevation surface 3D models) derived from UAS-based aerial imagery. This data can be easily brought into a GIS or Google Earth for visualization, data extraction and further analysis. UAS remote sensing technology has become highly accurate and relatively affordable and tremendous growth in the sector is anticipated to continue over the next decade.

Drone Training Objectives

A central pillar to effective environmental management is accurate, reliable, and up-to-date information for decision-making. The procurement of UAS for use in the Overseas Territories (OTs) sets a new standard in both conservation and the effective management of sargassum and several other environmental resources managed by the OTs (i.e. critical habitats, agriculture, disaster management, surveillance, enforcement efforts). To demonstrate UAS best practices and enhance the safe and efficient use of drones in the collection and management of spatial data and information, the MarSIS Commercial UAS Policy and Operations Protocol was applied to promote the safe, efficient and lawful operation of UAS technology in the OTs. The UAS Operations Manual can be used to guide CANARI's intended applications for sargassum management using UAS technology and will include, *inter alia*, references to the policies pertinent to the local jurisdictions, UAS safe operating procedures, UAS operations flight checklists, pilot and maintenance logs as well as spatial data management guidelines.

Accordingly a custom five-day classroom and practical hands on flying training course was developed based on global commercial UAS policy and operating procedures, the operation and safe flying of UAS technologies, as well as instruction on aerial mapping techniques was undertaken to promote the safe, efficient and lawful operation of drones in the OTs to ensure compliance with all relevant regional and national UAS policies and stakeholders (e.g. Civil Aviation Authorities – Air Safety Support International (ASSI) SUA Guidelines in the Overseas Territories) to inform stakeholders of

the upcoming training and share the application of safe and socially-acceptable UAS operating procedures as well as promote the development of aerial drone mapping to support environmental planning and sargassum management initiatives using drones in OTs

The objective of CANARI's - SSM OT UAS Drone Training Course was to provide practical training for seven persons in each of the three OTs (Anguilla, Montserrat & Tortola, BVI) in the use of Unmanned Aerial Systems (UAS) and introduce a variety of aerial spatial mapping and monitoring techniques. This five-day intensive training course (Appendix I) highlighted several UAS applications to support environmental monitoring and sargassum management, in part through the collection and processing of aerial imagery at beach monitoring demonstration sites (e.g. terrestrial, coastal, municipal infrastructure) in each country.

UAS Training Package also included guidance on the procurement of UAS equipment and software needs based on potential applications of UAS technologies by CANARI (Appendix II). In addition, efforts were made to share training objectives and results with local and regional media (press releases) as well as via other public outreach information and communication mechanisms (e.g. Instagram, Facebook & Linked In posts) alongside the training initiative to widely share the objectives of the Drone training exercise and support public sensitization of the role of drone technology as a tool for environmental monitoring in each of the OTs.

Classroom session providing an overview of the various UAS and mapping components and accessories.

UAS Training Course Agenda

DAY ONE – Monday	
Activity	**Location**
Welcome & intros	Classroom
UAS applications, mapping technologies & training objectives Global & National UAS Policy and Regulations UAS Policy, Operations Protocol & Data Management	PPT
BREAK	
UAS Set up & Operation, Flight Safety Procedures	Classroom
Flight Control - Introduction to DJI Go	DEMO
LUNCH	
Best Practices, Pre-flight checks*	Video
Manual Flight Practice 1	Training Field
Post-flight procedures	
End of Day 1	
DAY TWO – TUESDAY	
Activity	
Review Day 1, UAS, Top Pilot Errors & Flight Modes UAS Team Roles, Flight Checks & Operating Procedures	Video
Manual Flight Practice 2	Training Field
Autonomous Flight (Demo) & Operating Procedures Post-flight Checks	MME
LUNCH	
Mapping software, survey methods, results & outputs Data Management & Post-processing	Classroom
Review Autonomous Flight (Demo) survey results / outputs	
Flight Planning Applications (Video & Demo) Flight planning (DD) Flight 1 on Day 3 (Training field)	
End of Day 2	

Activity	**Location**
Review Day 2: flights, emergency & safety procedures	Classroom
Review MME Dashboard & Training Survey Results UAS Set-up & Pre-flight Checks	
BREAK	
Conduct Autonomous Flight 1 (Surveys)	Training Field
LUNCH	
Post-flight & data management procedures Post-processing (MME) of Flight 1 (Training Field) survey data Site selection considerations for Mission 1 & Review POA / FSA	
End of Day 3	
DAY FOUR – THURSDAY	
Activity	
Review mapping methods, lessons learned & Q/A session Review Mission 1 results, outputs & data export/sharing (MME) Mission 1: POA, FSA, Flight planning, UAS Set up & Pre-flight checks	
BREAK	
Fly Survey Mission 1: Terrestrial mapping - Mangrove	TBD
LUNCH	
Post-flight procedures & data management Post-processing - Mission 1	Classroom
Results: Data review, reporting & sharing	DD
Site planning considerations for Mission 2 & Review POA / FSA	
End of Day 4	
DAY 5 – FRIDAY	
Activity	
Review Lessons, Mapping Methods & Outputs, Q&A Review - Mission 1 Results & Products UAS Data; Conducting Measurements & Annotations Flight planning & pre-flight checks - Mission 2	Classroom
TRAVEL TO SURVEY SITE	TBD
Fly Mission 2: Coastal mapping – Marine	
Post-flight procedures & data management	
LUNCH	
Post-processing - Mission 3 Intro to data analysis: mapping of features & reporting UAS final review & UAS tips/resources	Classroom
Course evaluations	
Closing, Next Steps & Presentation of certificates	

Course Participants

Twenty-one (21) persons were trained and successfully completed the 5-day UAS training course in the three Overseas Territories (OTs) of Anguilla, Montserrat, and Tortola. Course evaluations indicated that trainees found the course to be executed successfully with positive reviews.

Anguilla Drone Team

Name	Surname	Position	Organisation	Sector	Sex	Email
Carencia	Rouse	Director-Environment	Department of Natural Resources	Government	Female	Carencia.rouse@gov.ai
Rhon	Connor	Principal Associate	Department of Natural Resources	Government	Male	Rhon.connor@gov.ai
Randal	Richardson	Fisheries Officer	Department of Natural Resources	Government	Male	Randall.richardson@gov.ai
Ronsford	Connor	Surveyor	Department of Lands and Surveys	Government	Male	Ronsford.connor@gov.ai
Devon	Carter	Research Officer	Anguilla National Trust	CSO	Male	dc.axatrust@gmail.com
Julian	Hughes	Senior GIS Officer	Department of Physical Planning	Government	Male	Julian.hughes@gov.ai
Kareem	Minette	Assistant Surveyor	Department of Lands and Surveys	Government	Male	kareem.minette@gov.ai

Montserrat Drone Team

Name	Surname	Position	Organisation	Sector	Sex	Email
Theodore	Phillip	Senior Clerical Officer	Disaster Management Coordination Agency	Government	Male	phillipt@gov.ms
Stephon	Hixon	Environment Officer	Department of Environment	Government	Male	stephon12ah@gmail.com
Ajhermae	White	Environment Officer	Department of Environment	Government	Female	whitea@gov.ms
Chase	Buffonge	Data collector	Department of Agriculture (Fisheries Unit)	Government	Male	buffongecl@gov.ms
Antoine	SinClair	Student Intern	Montserrat National Trust	CSO	Male	Jeremiahsinclair68@gmail.com
Alicia	Allison	Student Intern	Montserrat National Trust	CSO	Female	Chinallison656@gmail.com
Lavern	Rogers Ryan	GIS Systems Manager	Physical Planning Unit (GIS Division)	Government	Female	Rogersl@gov.ms

Tortola, BVI Drone Team

First Name	Last	Position	Dept	Sector	Gender	Email
Troy	Dawson	Geographic Information Systems Officer	GIS Planning Department	Government	Male	tdawson@gov.vg
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Abbi	Christopher	Assistant Fisheries Officer /	Department of Agriculture and Fisheries	Government	Female	aechristopher@gov.vg /
Janelle	Hodge	Research and Development Officer	Department of Agriculture and Fisheries	Government	Female	JLHodge@gov.vg
Rondel	Smith	Terrestrial Warden	National Parks Trust of Virgin Islands	CSO	Male	rondelharveysmith@hotmail.com
Shannon	Gore	Principal Consultant	Coastal Management Consulting	CSO	Female	Sd_gore@yahoo.com

Select pictures from the CANARI SSM OTs - UAS mapping & monitoring training course Sept 2021

CLICK LINK TO VIEW MORE TRAINING PICTURES -> https://gopro.com/v/62Kn5z41b7aGv

Montserrat Team

CLICK LINK TO VIEW MORE TRAINING PICTURES -> https://gopro.com/v/QnERP8J81yE4Q

BVI Team

CLICK LINK TO VIEW MORE TRAINING PICTURES -> https://gopro.com/v/Jb9MBoyqOQr89

Monitoring Beach Sites - Preliminary Results

Two sargassum monitoring site beaches drone mapping surveys were successfully set up in each OT. Participants developed aerial flight plans, conducted, and processed data using DroneDeploy photogrammetry and spatial analysis software together with DJI Air2S drones. Hundreds of aerial images were collected during each training week in which mapping missions and UAS flight surveys were uploaded and post-processed by trainees to create orthomosaic maps (.jpeg, .geotiff, .kml), elevation models as Digital Surface and Terrain Models (DTM and DSM) (.jpeg, .geotiff) 3D models as point clouds (.las, .txt). Moreover drone teams learned how to collect supplementary drone survey data including: 360 site panoramas, video flight survey and photo plans at each monitoring site. All drone mapping survey results can be viewed via the DroneDeploy web-mapping dashboard portal URLs.

The following web-mapping URLs can be clicked to view results of the training exercises.

ANGUILLA

Savannah Bay & Cove Bay

Web-mapping results: Click URLs below

MONTSERRAT

Web-mapping results: Click URLs below

Marguerita Beach & Little Bay

TORTOLA, BVI

Web-mapping results: Click URLs below

Road Town Harbour & Cane Garden Bay

Next Steps

Moving forward, each OT drone team will first need to determine the UAS Team roles and responsibilities of their Drone Unit (i.e. Team Coordinator, Data Manager, Lead Pilots, Engineer, Crew Members) as well as the operational procedures for drone flight requests and the storage of

equipment. It is also recommended that each team develop a UAS Team Flight Survey calendar to schedule days and times for the OT UAS teams' to conduct flight practice over the next month.

Team have now set up their sargassum baseline monitoring site mapping surveys as well as supplementary drone survey data including: 360 site panoramas, video flight survey and photo plans at each monitoring site which can be used for the upcoming participatory mapping aspects of the Project (see URLs on previous page). In late October, all OT UAS Teams will be enrolled in the ***Sargassum Monitoring Protocol using Drones Course*** via an online Training Academy (www.drkimbaldwin.com). This 4-week virtual course comprises of self-paced lessons together with four Zoom classes in which the teams will be guided in the conduction of the CERMES Sargassum Monitoring Protocol to learn how to quantified the abundance of beached sargassum at their monitoring sites. Next the OT Drone teams will be taught how to undertake participatory mapping exercises and will be provided with monthly technical support calls until the end of the contract (March 2023).

Deliverables

Based on the goals of the SSM Project the following deliverables were produced.

- Delivered three (3) 5-day UAS training courses on the flying and the safe operation (drone licensing and regulations, UAS components, safety and emergency policy, site evaluation, weather conditions, flight checklists, standard operating procedures, data management); including mapping techniques – flight checks, planning, aerial surveys and post-processing.
- In collaboration with trainees, determined, planned and undertook UAS aerial mapping surveys to set up three (3) drone mapping sites (i.e., sargassum monitoring beaches) in including the post-processing of aerial data and the development of mapping products and baseline site analysis.
- Provided electronically all course material relevant to the training including agenda/schedule, attendance register, presentation slides, handouts and UAS mapping resources.
- Produced drone training workshop report including information shared (i.e. PowerPoint presentation slides, handouts, references), results of demonstration site surveys conducted and photographs/videos captured during the training and a needs assessment.
- Took pictures of the training and produced several social media posts during each training (Linked In, Instagram and Facebook) as well as conducted short video feedback interviews.
- Conducted an evaluation using a questionnaire form with the participants.

Appendices

Appendix I. Intro to UAS Mapping & Monitoring Course Outline

St. James, Barbados | 246.241.8940 San Diego California | 858.472.7254 marsis.solutions@gmail.com | www.marsis.us

Introduction to UAS Flying and Mapping Course Outline

This five day course provides an overview of commercial drone policies, safe flying procedures and drone survey mapping methods using FAA commercial standard operating procedures (e.g. team roles, flight procedures, data management and reporting).

Overview of UAS Applications

- Overview of remote sensing, mapping and spatial analysis
- Drone 'UAS' applications (global, regional, national)
- Mapping methods, drone surveys and outputs
- Data conversion, spatial analysis and sharing information

UAS Policy/Procedures

- UAS Policy and Operations Protocol (as well as DJI Drone & Mapping Software User Manuals)
- Safety and risk management strategies
- Specific national drone operating procedures: including UAS regulations and flight requirements
- Flight Feasibility and Safety Assessment (FSA)
- Crew co-ordination and support crew duties
- Maintenance procedures

UAS - Ground / Theory (in-classroom)

- Description of UAS and system components
- Handling of UAS, check-out and transportation
- Assembly/disassembly of the UAS and system components including camera
- Handling and charging of UAS system & component batteries
- Detailed explanation on the use of the transmitter, operating frequencies, limitations
- Flight controls, sound & light signals
- Manual and auto-pilot modes, range/signal check
- Crew management and responsibilities
- Pre-flight inspections and checks
- Mission planning and conduction of flight surveys
- Pre- and post-flight procedures
- Problem solving, fault analysis

UAS - Practical / Flight Exercises (via DJI Go)

- Range/signal check
- Take-off and landing procedures and skills
- Practical flight exercises (normal automatic control)
- Practical automated flight exercises (and backup manual control)
- Automatic safety features
- Camera operation and options
- Non-normal procedures, threat and error reporting
- Safety considerations and flight operations

Post-Processing Outputs (via Maps Made Easy / Drone Deploy)

- UAS Data Storage & File Management
- Post-Processing and Outputs (Orthomosaics, Elevation Point Cloud, DSM, DTM)
- Additional Functionality (3D measurements, annotation and analytic dashboard tools)
- Reporting (Flight Parameters, Accuracy and Annotations Summary)
- Data Conversion (GIS, KMZ, URLs, PDF, contours) & Exporting
- Web-based Mapping & Data Sharing / IT Platform Tools

Appendix II. UAS hardware & software for sargassum monitoring in OTs (July 2022)

Recommended Drone Equipment, Hardware & Software for Sargassum

Item	Description	Quantity
Quadcopter Drone	Equipped with standard (RGB) camera payload (1-inch 20-megapixel sensor with 4K/60fps video) and a GPS-capable for mapping. ***e.g.* DJI© Phantom4 Pro, Mavic2 Pro/Zoom, Mavic Pro, Mavic Air or Air2 + Air2S***	**1**
Drone Batteries	Intelligent Flight Battery (LiPo 15.2V)	**3**
Propellers	Low-noise quick-release (2-pack)	**2**
Memory Card	MicroSD (64 GB) high-speed (Class U3)	**2**
Carrying Case / Backpack	For transportation of the drone and accessories	**1**
iOS Mobile Device / Tablet	A minimum of ***iPad 2019+ (25 cm) or iPad Mini 5* (2019) 64 GB (either Wi-Fi enabled or cellular*)***	**1**
Landing Pad	Lightweight portable drone landing pad	**1**
Polarizer Lens	Circular Polarizer / Linear (CPL) filter to reduce glare from beach and off of the sea	**1**
Quadrat, PVC, Flags Clipboard, Slate & Datasheets	Equipment for beach monitoring field surveys Recording of flight parameters and field notes	**1**
Desktop or Laptop Computer	Windows (64 bit) with minimum of 8 GB RAM	**1**
External Drive	Portable hard drive (minimum of 2 TB)	**1**
Cloud Storage (FOR PROJECT)	Central storage allowing remote access and sharing of data collected by OT Partners (minimum of 2TB) ***e.g. Google Drive, DropBox***	**1 Year**
Drone Mapping & Analysis Software	For collecting, processing, analyzing, displaying and sharing drone media and geospatial data ***e.g. DroneDeploy - Individual (Annual) Plan***	**1 Year**

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K. Baldwin | 7.2022

Appendix III. Drone Training Course Slides

CLICK TO VIEW → Intro UAS Training OTs Sept 2022