

What's the catch?

David Blamire-Brown reports on how Britain's Marine Management Organisation is using low cost satellite data to monitor far-flung Protected Marine Areas

Monitoring four million square kilometres of ocean is a challenge no matter what resources are available. It's especially difficult for the UK Overseas Territories with their small populations, limited resources and variable environmental conditions. But satellite-derived earth observation data and advanced spatial analytics offer the prospect of low-cost, sustainable solutions.

The Marine Management Organisation (part of the Defra group) and SCISYS UK Ltd have teamed to develop a prototype tool that can support the monitoring and detection of illegal, unregulated and unreported (IUU) fishing.

Blue Belt Programme

In 2016, the UK government committed £20m to protect more than four million sq. km. of precious marine habits surrounding UK Overseas Territories. These waters are home to globally significant biodiversity, e.g., containing 85% of the Critically Endangered Species for which the UK Government is responsible.

The Blue Belt Programme is initially focused on seven islands and archipelagos: British Indian Ocean Territory, South Georgia and the South Sandwich Islands, British Antarctic Territory, Pitcairn, St Helena, Ascension Island and Tristan da Cunha.

The Programme is being delivered as a partnership by the Centre for

Environment, Fisheries and Aquaculture Science (Cefas) and the Marine Management Organisation (MMO). These are working with the UK Overseas Territories to:

- Improve scientific understanding of the marine environment,
- Develop and implement evidence-based, tailored marine management strategies including surveillance and enforcement, and
- Ensure management is sustainable and long term.

A key aim of the Blue Belt Programme is to deliver a legacy of cost-effective solutions to the issues faced by the UK Overseas Territories. One critical issue – IUU – is estimated to cost \$20bn a year, and for the UK Overseas Territories it:

- Increases the risks to sensitive marine environments and populations,
- Undermines local economic activities, and
- Threatens the stability of coastal communities.

The Blue Belt Programme has established new capabilities to identify illegal maritime activities. These capabilities include feasibility trials and operational surveillance and analysis using satellite earth observation data from a combination of commercial and open data sources.

The work has demonstrated that centralised surveillance and monitoring is valuable. But the approaches are expensive, requiring extensive manual intervention and the



The Blue Belt Programme protects four million km2 of precious marine habitats

acquisition of commercial satellite data. The MMO decided to explore the viability of free and low-cost satellite data sources and create a low-maintenance tool that could be operated by the UK Overseas Territories themselves.

A critical factor for viability is detecting potential IUU activity by vessels between 40m and 100m in length from satellite data with a resolution of 10m.

Tool design

The MMO partnered with SCISYS to build a prototype surveillance tool that would use free satellite data from the ESA's Copernicus mission Sentinel satellites. This ensures that the tool is low-maintenance and affordable as an ongoing service.

SCISYS's solution drew on its experience of working with earth observation and remote sensing geospatial data and took advantage of two SCISYS technology solutions that addressed many of the design challenges:

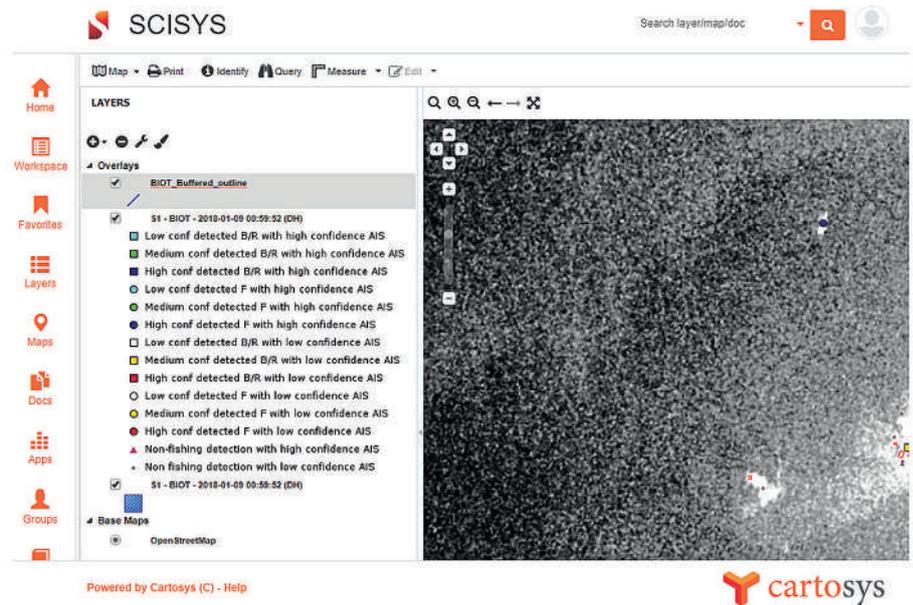
- Rapid Vessel Detection (RVD) tool - an established vessel detection algorithm that has been proven to successfully classify even small vessels, separating them from icebergs and other potentially misclassified objects using Sentinel data in challenging environments such as the British Virgin Islands. The tool builds on previous marine pattern-of-life and maritime domain awareness research, automatically exploiting bulk optical and Synthetic Aperture Radar (SAR) data, highly efficiently and flexibly.
- Cartosys - a web-based geo-portal framework, proven in operational use with clients including the Forestry Commission, UK Power Networks and Angel Trains. Cartosys has an open architecture and supports Open Geospatial Consortium (OGC) standards. As well as reducing future licence costs, it can also link into other developments within the wider Defra group to build earth observation data-sharing platforms via OGC web services.

Data processing and analysis is automated to avoid the need for specialist manual intervention.

The tool includes user-friendly, self-service, web-based functionality that allows users to create and share their own analysis and reporting products.

The solution is based on standard technology, making it easy to manage and configure without needing specialist technical support. It also has the flexibility to evolve and enhance to exploit future developments in satellite earth observation technologies. And by using open standards and an open architecture, the tool makes it easier to share data with other systems and partner organisations and to integrate with other systems.

The solution is deployed on modern cloud infrastructure whose efficient



Example of the user portal showing a subset of detections

technical design enables the rapid processing of large data volumes without incurring large operating costs. Cloud computing helps keep the tool cost-effective by ensuring that computing power is only paid for when it is used. The prototype uses Amazon Web Services (AWS), including the serverless computing service AWS Lambda. Serverless technology lets you run code without provisioning or managing servers. You pay only for the compute time you consume - there is no charge when your code is not running.

The tool is also being designed to be sensitive to the realities of conditions in UK Overseas Territories' offices, e.g. limited, unreliable internet connectivity.

The tool is being developed using Agile techniques to quickly develop functionality and gather feedback. This not only reduces the burden on the Blue Belt Programme team, but also ensures that user needs are always kept in focus.

Progress report

The first phase of the project has used a six-month historical archive of Sentinel and AIS (Automatic Identification Systems) data. This means that detections can be compared to known observations.

The initial version of the prototype tool demonstrated the feasibility of detecting potential fishing vessels, particularly those between 40m and 100m in length (important for remote territories such as Ascension Islands and Tristan da Cunha). Detections can be cross-referenced with AIS data to validate and calibrate confidence levels for detections. Following calibration, detections can be compared to AIS data to identify vessels without AIS locations. These "dark vessel" detections are a high priority for further investigation.

The next step is to collect data over longer time periods. This allows users of the tool to identify patterns of behaviour, thereby supporting more effective planning of intelligence gathering and enforcement activities.

Initial findings from the work have identified several challenges to be addressed in future phases, including:

- Unique environmental conditions in each UK Overseas Territory, e.g. sea state or weather. These require specific tuning of the detection algorithm to reduce false positives.
- Variations in the data collected by the Sentinel satellites. For example, different polarizations and modes of SAR data collected by Sentinel-1 in different territories.
- Limited coverage from Copernicus, e.g. there was no Sentinel-1 SAR coverage for the Pitcairn Islands for the period being evaluated. Typically, satellite collection focuses on land areas, with less coverage in the wider marine zones required for the Blue Belt Programme.

Where next?

The MMO and SCISYS are currently fine tuning the detection algorithms and adding features to the user front-end to explore how the tool could work in low-bandwidth environments.

Future ideas include adding additional data sources and exploring different ways of delivering the tool on behalf of UK Overseas Territories. This includes exploring the potential of re-using other geospatial infrastructure being developed by the Defra group, such as an earth observation data sharing portal.

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