Coral Reef Recreation and Tourism in the Eastern Caribbean

Dominica, Grenada, Saint Lucia, St. Kitts & Nevis, and St. Vincent & the Grenadines

Mapping Ocean Wealth (MOW) and Caribbean Regional Oceanscape Project (CROP)

OECS
Organisation of Eastern Caribbean States

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The Nature Conservancy

MAPPING OCEAN WEALTH

ABOUT THIS PROJECT

The Global Environment Facility (GEF) and the Organisation of Eastern Caribbean States (OECS) Commission, in partnership with the World Bank, is implementing the Caribbean Regional Oceanscape Project (CROP) to improve systems and put relevant structures in place in an effort to foster a Blue Economy and to promote greater consideration of the ecosystem functions and services which the ocean provides for member states. The project timeline was October 2017 - December 2021. Under this project, The Nature Conservancy used the Mapping Ocean Wealth approach to develop ecosystem service models and maps for the five CROP countries in the Eastern Caribbean.

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Introduction and Summary of Methodology

Overview

The Caribbean is highly dependent on coastal and marine tourism activities, many of them associated with coral reefs, either directly ("on-reef" e.g., SCUBA, snorkeling) or indirectly (e.g., beach-related activities, access to fresh seafood). While previous studies have quantified and mapped the value of coral reefs to tourism at the global scale, this project downscaled these analyses to the regional and local levels by integrating emerging artificial intelligence and machine learning (AI/ML) technologies, incorporating data from local sources, and engaging with stakeholders who suggested additional refinements to the methodologies.

Maps of seafood restaurants that feature fresh fish from local coral reef habitats also provide supplementary information about the influence of coastal habitats on tourism activities in the region.

This is the first time that these components of nature-based tourism associated with coral reefs have been so extensively mapped and analysed at these resolutions. We believe that the results are of considerable use for understanding the value of coral reefs and coastal ecosystems at local scales, applicable to management, that they will enable a broad range of users from the public to industry to government to better plan and manage both the tourism industry and any other active sectors within the blue economy.

Purpose of the Guide

We have developed this guide for individuals who are interested in downloading, analyzing, and applying the data for projects within the five countries covered by this project (Dominica, Grenada, Saint Lucia, St. Kitts and Nevis, and St. Vincent and the Grenadines). While these datasets were originally developed to complement the marine spatial planning processes undertaken under the Caribbean Regional Oceanscape Project (CROP), we describe a range of possible applications across multiple sectors, along with practical advice on the methodology, interpretation and caveats surrounding these datasets. More details about the model including links to technical reports can be found at Oceanwealth.org/project-areas/Caribbean/crop/coral-reef-recreation-and-tourism.

This is the first time that these components of nature-based tourism associated with coral reefs have been so extensively mapped and analysed at these resolutions.

This work furnishes stakeholders with detailed data and maps for two of the most important social and economic sectors in these countries.

Regional Policy Relevance

In 2013, the OECS Heads of Government endorsed the Eastern Caribbean Regional Ocean Policy (ECROP). In 2019, the ECROP was revised to align with the UN Agenda 2030 for Sustainable Development – SDG 2030. The CROP is designed in alignment with ECROP (2013) and has an overall objective to develop and implement integrated ocean governance policies to leverage sustainable public and private investment in the waters of OECS member states and other participating Caribbean countries. The first component of the CROP project is to strengthen ocean governance through the development of National Ocean Policies (NOPs) and Coastal and Marine Spatial Planning (MSP). The work described in this project falls under the subcomponent 2.1 of the CROP: Strengthening knowledge and capacity building.

The ecosystem service modelling work was undertaken in parallel with the development of the coastal and marine spatial plans under CROP, meaning that the ecosystem service model results were not available during their planning process. Nevertheless, this work furnishes stakeholders with detailed data and maps for two of the most important social and economic sectors in these countries – tourism and coastal fishing. Such data can now be incorporated into the MSP process and this should be a priority as part of the finalization of these, or indeed any future, plans.

At the simplest level these models and maps enable the discernment of critical areas of current use of natural resources and form a core background for stakeholder discussion and debate in the context of MSP. The same information can also be used in the projection of future use options, including the potential costs and benefits of different uses and activities in coastal and marine waters. A key element of MSP is that such planning needs to be cyclical and ongoing, rather than a static, one-off, process. This means that information can be continually added or updated to future planning cycles, along with knowledge of new opportunities or risks.

Methodological Summary

The multi-step approach to mapping the value of on-reef activities (diving and snorkeling) involved two broad tracks. The first was the development of a map showing the distribution of these activities using geo-located dive-sites and photos, with weighting of this distribution derived from overlapping locations, and metrics of diving intensity. The second track was to estimate a reasonable proportion of total tourism value that could be attributed to on-reef tourism activities. These two elements were combined to show a map of the value of on-reef activities, spread to the reefs themselves.

Input Datasets

A summary of datasets used in the analysis is provided below. Users are encouraged to reference the technical report for additional details on sources and geoprocessing steps.

Data input	Source(s)
PUDs (Underwater Photos)[1]	Flickr
PAMs (Underwater Photos)[2]	TripAdvisor
Dive Sites	Key sources: Diveboard, TNC, Saint Kitts and Nevis Department of Marine Resources/Ministry of Tourism, Saint Lucia Ministry of Fisheries, Marine Resource Management Unit. Checks and corrections utilized some 30 national sources and maps and cross-referencing to a further 5 global dive-site databases. See technical report for full list.
Dive Shops	Key sources: Diveboard, Diveary, Saint Lucia Ministry of Fisheries, Marine Resource Management Unit, Grenada Tourism Authority, TNC, Saint Kitts and Nevis Department of Marine Resources
Hotels	Global Accommodation Reference Database (GARD, Delta Check 2019), TripAdvisor, TNC, Grenada Hotel and Tourism Association, Saint Kitts and Nevis Ministry of Tourism, Saint Lucia Hotel and Tourism Association, Dominica Hotel and Tourism Association
Coral Reef Habitat	TNC (benthic habitat maps created under the ECMMAN Project)
Tourism Arrivals & Expenditures	Eastern Caribbean Central Bank (ECCB)[3]; Averaged values for the five years up to and including 2019.
Cruise Arrivals & Expenditures	Florida-Caribbean Cruise Association (FCCA) and Business Research and Economic Advisors (BREA); A Survey Based Analysis of the Impacts of Passengers, Crew and Cruise Line Spending. Volumes I & II. 2018[4]
Cruise Activities	Port guides and other web-based cruise guides
Seafood Restaurants	TripAdvisor

Unless otherwise noted, all data sources were accessed in 2019.

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1   Photo User Days (PUDS) are underwater photos were then standardized such that only one image per user per day can be counted across a 500m resolution grid spread across the region.

2   Photo by Attraction by Member (PAMs) are underwater photos from TripAdvisor standardized such that only one image per attraction per TripAdvisor member can be counted

3   ECCB. 2020. Real Sector Statistics - Selected Tourism Statistics. Eastern Caribbean Central Bank, Basseterre, St Kitts and Nevis.

4   FCCA, and BREA. 2018a. Economic Contribution of Cruise Tourism to the Destination Economies. A Survey-based Analysis of the Impacts of Passenger, Crew and Cruise Line Spending. Volume I: Aggregate Analysis. Florida-Caribbean Cruise Association (FCCA) and Business Research and Economic Advisors (BREA), Miami.
     FCCA, and BREA. 2018b. Economic Contribution of Cruise Tourism to the Destination Economies. A Survey-based Analysis of the Impacts of passenger, Crew and Cruise Line Spending. Volume II: Destination Reports. Florida-Caribbean Cruise Association (FCCA) and Business Research and Economic Advisors (BREA), Miami.

Over 300 dive sites were located from 40 sources for the five CROP countries

Definitions

Tourism, in this work, is focused on international visitors. We recognise that local tourism and recreation add significant additional value to on-reef tourism. We believe that our distribution model of use-intensity will largely include these local tourism and recreational components, however the values we have spread are limited to the international arrivals statistics.

Our work separates overnight tourism from cruise tourism as these represent very different patterns in terms of activities, spending, and spatial distribution.

Overnight tourism, in our models, includes both land-based stays and yacht-based stays, with the former making up the vast majority of all statistics. Overnight tourists spend an average of 8-13 days in a country, and will be spread to all places where there is accommodation, access, and attractions.

Cruise tourism also includes a small number of "excursionists." Cruise tourists, while representing very large numbers of visitors, typically only visit an island for a day, and do not use local accommodation. Their daily expenditure is extremely low, limited to single excursions (often planned by the cruise company), and geographically-constrained.

(Excursionists have most of the same characteristics as cruise passengers, while yacht visitors are closer to overnight visitors, remaining several days in a country and often renting their boats from local companies.)

On-reef tourism is a term we have developed to cover all activities which involve direct recreation on coral reefs. This is predominantly snorkeling and scuba-diving on coral reefs, although glass-bottomed boat tours would also be included. Our primary sources for assessing the intensity of on-reef tourism included user-uploaded photographs from the Flickr platform and a novel dataset of dive sites.

Geo-located photos were taken from Flickr. Underwater images were identified with image recognition software and these were counted in a 500m grid. To avoid the undue influence of multiple images from the same location by the same photographer on the same day we applied the Photo User Day (PUD) approach where only one image per person per upload day can be counted in any grid cell. Each grid cell then has a score of the total number of PUDs which provide not only location, but also a metric of use intensity (more photos implying great use)

Dive sites were initially taken from a global dive site dataset, but were then significantly enhanced through a search of other online sources, notably industry owned maps from the region for national or local areas. Exact locations were cross-checked and duplicates removed where discernible, sites known to be shipwrecks were annotated, and these were excluded if they were not adjacent to coral reefs.

Overnight visitors average stays of 8-13 nights for overnight visitors, while cruise passengers will only visit for one day. Thus, for the region as a whole cruise tourists represent 72% of arrivals, but 21% of visitor days.

Coral reefs are physical structures built by corals or with a significant presence of reef-building (stony) corals. Our maps of these ecosystems were modified from the high-resolution seabed habitat maps generated by The Nature Conservancy, with minor additions of reef areas informed by known reef-centered dive-sites – they thus represent a broad interpretation of habitat classes linked to coral-built structures or the presence of reef-building coral species.

Expenditure and arrivals – Expenditure and arrivals statistics are collated annually by the Eastern Caribbean Central Bank. The definition of expenditure includes all expenditure within the destination country, as well as travel fares for all international visitors. Arrivals, or visitors, include business, student, medical and family visitors. It was considered relevant to keep all of these under our model, not only because tourists dominate the statistics in all of the CROP countries, but further because all of these other classes may also be influenced in their destination choice by the possibility of undertaking tourism-related activities and their expenditure.

Expenditure – It is important to note that expenditure receipts do not all accrue to the CROP countries – this may be especially true for cruise passengers and those paying for accommodation to international or externally-based companies.

For this work we used averaged values for the five years up to and including 2019. EC Dollar values were converted to USD$ and using a currency deflator averaged to 2019 US Dollar equivalents.

Arrivals – These numbers represent individual visitors, without considering length of stay. Separate data suggests **overnight visitors average stays of 8-13 nights for overnight visitors**, while cruise passengers will only visit for one day. Thus, for the region as a whole **cruise tourists represent 72% of arrivals, but 21% of visitor days**.

Photo: ©Lily Haines

Coral Reef Tourism Modelling and Mapping Process

Mapped on-reef tourism expenditures in Saint Vincent and the Grenadines

TripAdvisor

Flickr

Text recognition

Image recognition

Manual data review and cleaning

Manual filter of images

On-reef Attractions

Underwater photo locations

Hotels

Dive shops

Ratio of dive shops to 1k hotel rooms

Ratio of coral reef reviews to total reviews

Ratio of underwater photos to total photos

Weights adjusted for nearby reef extent

Diveboard

Weighted dive site locations

Local Data Sourced

1km buffer applied and overlaid

Proportional on-reef values by country*

Use intensity map

Multiply by national statistics

Spread to map weighted by intensity values

Clip to coral reef extent

Total values of tourism expenditures and visitation

Overnight Stays

Cruise Ship Passengers

Visitors per Year

Annual Spending (US$)

Data

- Input data source
- Intermediate data product
- Calculated statistic
- Map product

Data Processing

- Geoprocessing Step
- Statistical Analysis
- AI/ML
- Data input
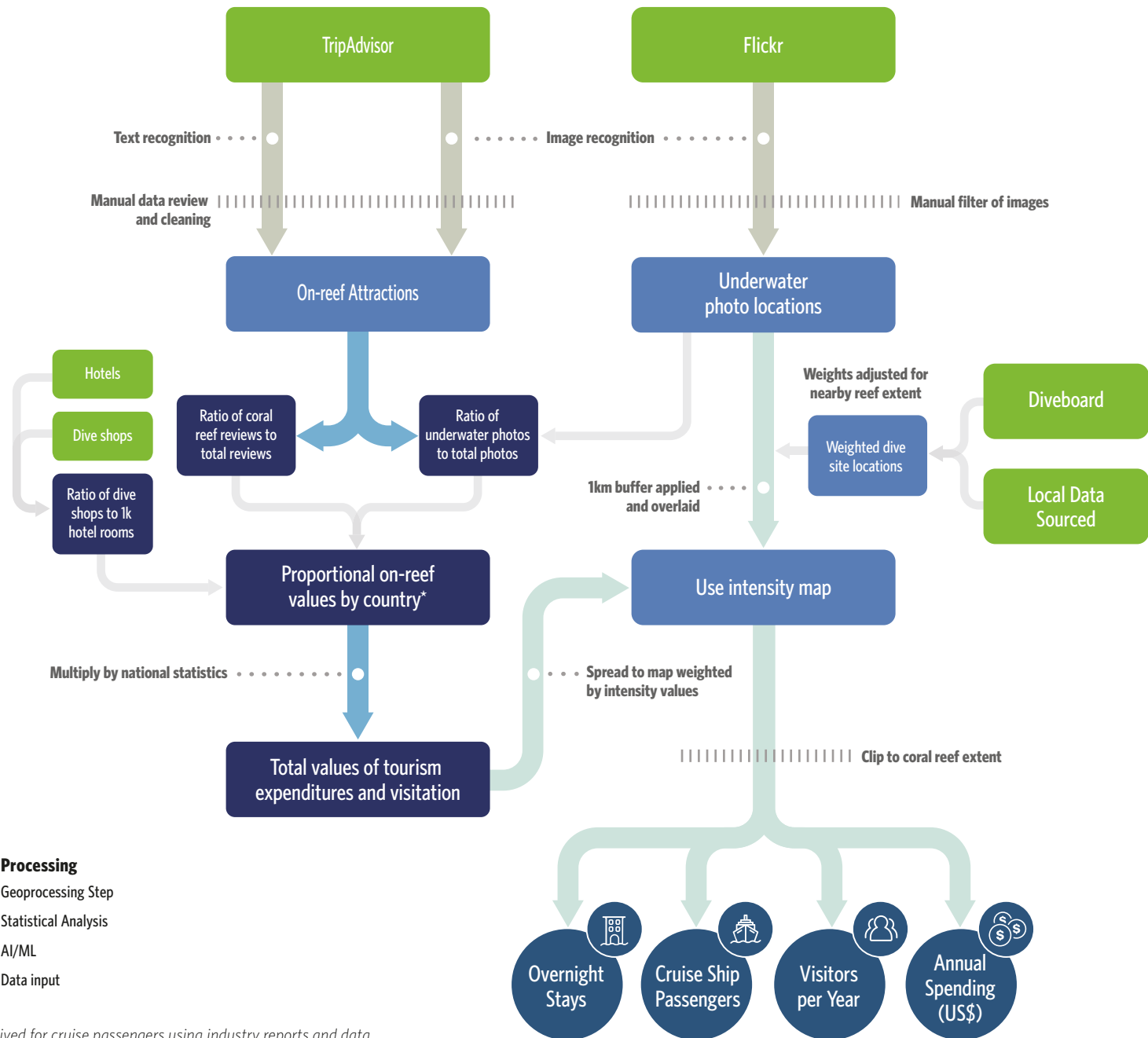
Separate proportions and extents derived for cruise passengers using industry reports and data.

Saint Vincent and the Grenadines

Findings

The map outputs, and associated statistics, reveal the very high overall value of on-reef activities, but also the very high variability of such values. Dollar values reported represent tourist expenditure that can be assigned to on-reef activities. They are estimated based on an assessment of both relative importance of on-reef activities and a wider information set on known expenditure from similar countries in the region. The numbers would include not only direct spending on these activities, but also the influence of on-reef activities in destination choice, with the assumption that, without the "draw" of on-reef activities, a small proportion of visitors would have chosen alternative destinations.

Exploring the data

Tourism expenditure directly linked to on-reef activities is estimated at US$118 million annually. This can also be expressed in terms of visitor numbers, with 83,000 overnight visitors and 60,000 cruise visitors choosing these islands for their on-reef activities. Such numbers, whether summed across the CROP countries or for each country individually, are very large, **representing over 4% of visitors and over 8% of all expenditure**. Such numbers give a sense of the overall current contribution of on-reef tourism to overall tourism, however it is important to note that declines in reefs would not precipitate the complete loss of these values. We have not attempted to calculate the likely reduction in such values that would arise from reef decline. It would likely be a significant loss, however we did not have sufficient data to inform such a calculation.

Over 97% of this expenditure is driven by the overnight visitors, with cruise tourism generating very limited levels of expenditure, and in more localised settings.

Zooming in

At least as important as these summary statistics are the statistics for individual coral reefs. The values here have been linked to individual reef cells of 1 hectare (100x100m). Some 65% of the region's reefs are inaccessible to on-reef activities, notably on the windward (eastern) shores of most islands. By contrast in areas where there are intensive activities, particularly where reefs are not extensive, individual reefs are generating very high expenditure values. **The top 10% of reefs are generating in excess of $60,000 per hectare per year.**

Seafood Restaurants

A subcomponent of this work included using text analysis of TripAdvisor reviews to generate locations of seafood restaurants serving fresh fish, with a focus on species that can be found on nearby coral reefs. The purpose of this analysis was to highlight additional benefits of coral reefs to tourism activities. 1,074 seafood restaurants were found across all CROP countries, with the highest concentration of activity located on the leeward coast of Saint Lucia. The second highest concentration of restaurants was found on the south coast of Grenada and the third highest in southern mainland St. Kitts and north western Nevis. While the data do not permit the quantification of monetary value for seafood activity, they give a valuable indication of the popularity of various seafood eateries specializing in options from reefs across the CROP countries. When compared alongside analyses done on reef fishing, they can provide additional information on the value of reefs for food provisioning and local livelihoods.

Data Access and Specifications

Outputs of this project included spatial datasets (File Geodatabase Raster Datasets) that can be imported, viewed, and analysed within Geographic Information Systems (GIS) such as Esri ArcMap, ArcPro, or QGIS. Data can be downloaded from the map viewer at maps.oceanwealth.org/oecs or at Oceanwealth.org/project-areas/Caribbean/crop/coral-reef-recreation-and-tourism. The downloaded file contains a geodatabase and a metadata document. Within the geodatabase, files starting with CRT describe coral reef tourism datasets (the other files, beginning with NDB describe nature-dependent beach tourism described within the same technical report). Data are broken out so that users can view data for all CROP countries or by individual countries, or with the data broken out into overnight tourists, cruise tourists, or combined tourism values. Expenditure and visitation data, described below, are also broken out into separate datasets.

Map viewer and output samples of the Mapping Ocean Wealth Platform

Applications

Maps and data such as these have an immediate and important role in drawing attention to a value that was perhaps already known by some, but which had never been clearly elucidated. Knowing that reefs are generating a very high proportion of tourist receipts, only from their on-reef value (and it seems likely that indirect values would be at least as much) highlights a significant socio-economic importance. **Raising public awareness of such value can help to foster support for reef conservation and rehabilitation.** Such knowledge needs to be factored in to planning and scenario-building.

By having a common currency, it is possible to place these values alongside others. In particular, high value reefs can be seen as key economic drivers at the national scale, to be protected against risks that might arise from such activities as pollution, coastal dredging, land reclamation and other coastal development. These values may become "opportunity costs" or the lost earnings that might be associated with otherwise apparently high value coastal developments. They can also be viewed as indicative values that may be achieved from other locations through a combination of improved management and sustainable development.

In using such values, whether in terms of visitor numbers or expenditure it is critical to be aware that **these are just a small proportion of total values coming from reefs.** Reefs are a critical component of nature dependency in beaches, and in supporting coastal fisheries (both of which are reviewed in separate documents), but also provide other benefits, not reviewed here, including the breaking of wave energy during storms.

Public interest

While coastal residents of the Eastern Caribbean are well-aware of the importance of reefs for livelihoods and economies, public perception of the monetary value of reefs can be low or vague. While it is not to be expected that individual public users will want or need direct access to the detailed results of our work, the work itself can be used to generate information of high public interest.

Community groups and NGOs should feel empowered to use this work, in support of their own campaigns or outreach. They may, for example, wish to make the case for coral reef restoration; or to argue against the expansion of ports or marinas; or to help steer the tourism sector to more sustainable approaches. Armed with maps and statistics their arguments will be both stronger and more balanced.

Business sector

One of the core businesses for on-reef tourism is of course the diving sector. While our maps and statistics may be of interest to anyone working in this sector to understand a static situation, it is perhaps more relevant to consider their value in the face of any projected change. By understanding the value of particular reefs, it is possible to frame stronger arguments for ensuring reef sustainability and management.

High value reefs can be seen as key economic drivers at the national scale, to be protected against risks that might arise from such activities as pollution, coastal dredging, land reclamation and other coastal development.

Reefs are also fishing grounds, coastal defenses, the producers of sand for the beaches and of many iconic views. They are part of the culture and well-being of the nations themselves.

Marine protected areas have often provided places of particularly high value for the dive industry and it may be that statistics on value can be used to argue for improved management. Likewise if there are conflicts between sectors, including urban planning, hotel and cruise sectors, or fishing, a better understanding of the value of on-reef tourism could play a key role in identifying key areas and presenting arguments against threats.

Reefs are also very much part of the wider "package" for many visitors to the CROP countries and yet it seems likely that some in the wider tourism sector are under-informed about their value. Such value, of course, needs to be combined with other elements of natural value (see separate reports). The risk to the industry may be that of destroying critical components of their own value. In parallel, of course is the risk that some in the industry could use the value maps to justify reef degradation, particularly in locations where reefs have lower value. For this reason it remains important to consider other values – reefs are also fishing grounds, coastal defenses, the producers of sand for the beaches and of many iconic views. They are part of the culture and well-being of the nations themselves.

Building data into planning

The CROP countries have made a commitment to develop their Blue Economy. Within this framework they are proposing to develop their coastal resources in a manner that is sustainable and that enhances natural value and human benefits.

Marine Spatial Planning is a key component of developing the Blue Economy. Central to MSP is the integration of all relevant sectors; inclusivity, with the engagement of all stakeholders, including minority groups; and the utilisation of all available information to inform planning processes.

In many settings, data on natural resource values for MSP is weak or lacking, however the current work provides a remarkable tool, available in only a very few countries. These data can be used alongside other data sources, ecosystem service values, and stakeholder opinions to guide decision-making and to inform equitable resolutions where there are differing interests. For example, these could be used during participatory mapping exercises, especially when used as a backdrop to structure conversations with stakeholders who bring their own knowledge regarding the values and impacts of on-reef tourism to the table.

Scale limitations

As described earlier, the data-inputs give us some ideas of the scope and limitations for these datasets. The coral reef base-maps have a high degree of accuracy. These were gridded to a 100m grid (one hectare cells). By contrast, the input data for locating on-reef activity is of variable, and often poorly defined, accuracy. To avoid risks of geographic errors generating false accuracy, both dive-sites and PUDs were buffered to a circle of 1km radius before being used to weight the reefs. Thus, although the reefs are mapped at 100m resolution, we recommend that the maps be used at an assumed resolution of no less than 1:25,000 and in generating statistics we advise not attempting to summarise information for any areas smaller than 4x4km.

Time-frames

All of the data used and presented represent tourism up to the end of 2019. The influence of Covid-19 on tourism has been enormous and we cannot assume that eventual recovery will include a return to the pre-pandemic patterns. As described earlier, tourism statistics have been averaged over a 5-year period up to and including 2019. Such an approach helps to remove annual fluctuations, however it may also mask trends or step changes that may arise (for example the building of a new cruise port or a rapid and large-scale expansion of overnight infrastructure). We recommend that users who are aware of such influences bear these in mind when examining our maps and make allowances for such change.

Stakeholders explore Mapping Ocean Wealth data at a 2019 workshop in Saint Lucia.

Other caveats and limitations

These are modelled data products based on a series of assumptions, including the motivations and activity patterns of tourists. Model assumptions have been vetted by experts, stakeholders, and data where possible. The model is also heavily based on crowd-sourced data points, which may be subject to bias. As such, interpretation of statistics, especially for very small areas, should be treated with caution. Estimates will be more robust when based on larger areas. Pixels with no values don't necessarily lack tourism values, as not all values will be captured in the modelling approach used.

Update and revise

A key advantage of our approach has been to build transparent models that are relatively simple to understand. Technical users are encouraged to explore the approaches we used – this may raise awareness of weakness or inspire questions which, at the simplest level, may enable those users to objectively comment on findings and suggest likely biases or even potential scenarios.

It is, of course, possible to re-run the models with different input layers or weightings. Detailed geoprocessing steps can be found in the technical report, and the project team can be contacted to share additional datasets and advise on how this might be done; however, it would of course require key technical and mapping skills to do this.

Post-Covid

The final outcome of the Covid pandemic remains hard to foresee. The grave social and economic impacts from the decline of tourism receipts will have had other consequences which remain poorly understood, but could include positive and negative environmental impacts (for example changes in fishing efforts, or agriculture, coastal development or pollution). The return of tourism may not follow pre-pandemic models. It seems likely that open-air, nature-centric tourism may recover faster than travel which places tourists in more crowded settings such as large-volume hotels and cruise ships.

There may be opportunities to use the pre-Covid models presented here to better understand the different components of tourism across the CROP countries and to begin to inform possible recovery scenarios.

Closing Words

FIND OUT MORE

For access to the high-quality maps and the full technical report, please visit the Mapping Ocean Wealth platform https://oceanwealth.org/project-areas/caribbean/crop/coral-reef-recreation-and-tourism/

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These maps tell a story that was already partly known – that diving and snorkeling on coral reefs is of considerable importance to the economy of Eastern Caribbean. But they go way beyond this, in enumerating that value and more importantly in mapping it at a resolution that has never previously been achieved. As countries move towards more ordered and holistic planning in the coastal and marine space such knowledge is critical, enabling demands on coastal space to be properly assessed and enabling informed consideration of both conflicts and synergies with other demands.

We encourage users to explore the data online, but also to consider its validity and utility in different contexts. Deeper engagement with the data will enable wider uses, including in some cases the opportunity to project and predict outcomes beyond the maps themselves. We hope that future users may also be able update and improve the maps, using similar approaches, and informed by the details we have provided underpinning our methods and our findings.

As countries move towards more ordered and holistic planning in the coastal and marine space such knowledge is critical, enabling demands on coastal space to be properly assessed and enabling informed consideration of both conflicts and synergies with other demands.

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