AI for Earth Grantee Profile
The Nature Conservancy | Mapping Ocean Wealth
Quantifying the value of coral reefs on tourism

Summary

The Nature Conservancy's Mapping Ocean Wealth initiative is focused on calculating and describing the benefits the ocean provides to people, in part by using photo repositories as a data source. In collaboration with Microsoft AI for Earth and Esri, the team developed an AI-powered web application to illustrate the value of coral reefs globally and by country. The initial model relied upon user-input data tied to images posted on Flickr, which resulted in many photos being missed. By integrating AI and machine learning capabilities, image recognition attains a greater level of specificity and accuracy.

The Mapping Ocean Wealth application allows users to explore the tourism value in specific places to support sustainable management goals. Mapping Ocean Wealth helps move from global analysis of coast and ocean ecosystem service to looking at specific technology around recreation and tourism in calculating the economic value of coral reef ecosystems.

Saving the oceans through tourism and AI

Coastal habitat loss is a significant threat to ocean biodiversity and coastal ecosystem health. Coral reefs are an important piece of coastal storm defense, and their destruction from dredging, bombing, warming seas, and other hazards poses a threat to this ecosystem around the world.

Sustainable reef management is influenced to some degree by how tourism affects the local economy. The global value of coral reefs (US $36 billion annually) demonstrates how tourism does and will continue to rely on the health of coral reef systems. The Nature Conservancy (TNC) created its Mapping Ocean Wealth initiative to calculate and describe the benefits the oceans and coasts provide to people. By identifying and mapping the quantifiable impact of coral reefs on local economies, the Mapping Ocean Wealth project aims to encourage protection of ocean ecosystems as an economic asset.

The Caribbean is more dependent on the travel and tourism sector than any other region worldwide, accounting for over 10 percent of GDP, and 15.2 percent of jobs in the region. Coral reefs make a critical contribution to tourism, either directly (such as SCUBA and snorkeling) or indirectly (such as beach-related

activities and access to fresh seafood). TNC is using its Mapping Ocean Wealth approach to develop ecosystem service models and maps at the scale of the Eastern Caribbean (specifically, Dominica, Grenada, Saint Lucia, St. Kitts & Nevis, and St. Vincent & the Grenadines). This work is in support of the Caribbean Regional Oceanscape Project (CROP), an effort to foster this region's blue economy and to promote greater consideration of the region's ecosystem functions and services.

Building a better tool for finding ocean photos

Mapping Ocean Wealth initially relied on images posted to the photo sharing site Flickr, tagged by users with keywords such as "reef" or "scuba", to identify photographs of ocean reefs. However, tags aren't consistently or reliably applied to all the relevant photos, which means many could be overlooked. To scale the identification of relevant images, TNC relies upon Microsoft technology and Esri GIS platforms. The goal is to use AI to create more robust collaboration and accelerate conservation planning on the ground by more easily and reliably identifying reef or reef-adjacent images (such as beaches and ocean views), and thereby better report the value of tourism.

After the team built the software and trained the algorithm on a smaller dataset of photos with assistance from Microsoft AI Specialist [Paige Bailey](#), they scaled the application to analyze geo-located underwater images posted to Flickr, and later added TripAdvisor as an additional source. Bailey was instrumental in letting TNC know which products and capabilities are available, demoing how these technologies work, and determining a methodology for model training. Through machine learning, the app can distinguish between a photo of scuba diving and one in a pool, for instance. By matching the frequency and number of coral reef-related photos to other data (such as spending on nearby hotels and licenses for tour operators), data scientists can more accurately quantify the impact of coral reef tourism, kilometer by kilometer.

"Now we can push a button, and in a matter of hours we get millions of images processed."—Dr. Mark Spalding, Global Science Lead, TNC

The Microsoft AI for Earth grant has allowed for greater collaboration between TNC, Esri, and Microsoft. Microsoft Azure and the cognitive services API not only provides a powerful and flexible platform to store and crunch data; it also provides tools like machine learning and data scraping that can be used to process images to better understand the state of the world's ocean resources—and how they can better protect the planet. The team used Microsoft Azure Cognitive Services, a custom vision service, to classify the remainder of the photos from Flickr and TripAdvisor, iteratively refining the training layers until high levels of accuracy were obtained.

To analyze text, an expert team from Microsoft then applied a random-forest regression model to automatically classify the remainder of the reviews and return a list of reviews that matched each set of criteria. The models were evaluated based on metrics of precision and recall, as frequently found in the machine learning literature. Data output could then be plotted on a map using either known locations of TripAdvisor locations to which photos and reviews were associated, or, in the case of Flickr, using the coordinates embedded in photo metadata. These points were then combined with other data inputs, including names and locations of dive sites, dive shops, hotels, and other attractions, as well as statistics and reports on tourism arrivals, expenditures, and reef-related activities. For on-reef activities and nature-dependent beaches, data were considered sufficiently reliable to build a direct model of value.

This kind of analysis and visualization would be impossible at a worldwide scale were it not for AI and the Azure-powered web app, says Dr. Mark Spalding, TNC's Senior Scientist and Global Science Lead. "Now we can push a button, and in a matter of hours we get millions of images processed," Spalding says.

Showing the value of the oceans for conservation

The results from this initial work showed that coral reefs contribute to $36 billion dollars of tourism spending annually, and drive almost 70 million visits per year, worldwide. Closer examination revealed the particularly heavy dependence of many developing economies, including Small Island Developing States (SIDS), on coral reefs. This information can accelerate real-time conservation planning with AI and machine learning. "We can look at trends, then investigate the causes of those trends," Spalding says. "If we can link changes to mismanagement, the tool becomes even more powerful because we can step in quickly and save the reef. This also helps ensure the tourism industry meets their bottom line—to preserve the condition of coral reefs as valuable tourist destinations."

> "Seeing that hard data helps localities plan and realize their natural resources truly are precious."—Dr. Spalding

That insight can change the general approach to conservation planning and translate into a stronger commitment to protecting the environment. For example, when The Nature Conservancy showed the Mapping Ocean Wealth map of the Florida Keys coral reefs to local officials, they realized just how much money pristine coastal and marine environments funnel into the local economy. In stretches of tourism-centric areas in the Keys, each square kilometer of reef accounts for up to more than $1 million every year. Florida leaders said that easy-to-understand visualization would help them better preserve a critical natural (and economic) resource. "People are starting to have 'aha' moments," Spalding says. "Seeing that hard data helps localities plan and realize their natural resources truly are precious."

Going forward

The hope is that the Mapping Ocean Wealth project continues to open the door to partnerships within the tourism industry, such as with the World Travel and Tourism Council and JetBlue, helping to provide a more dynamic view of the value of coral reefs globally and locally. Advanced cognitive services will depict the relationship between coral reef health and tourism itself. By using best practices learned from the Mapping Ocean Wealth initiative, similar AI and machine learning capabilities can scale to other conservation projects with image recognition needs.

TNC found that these advanced methods yield robust datasets that can be used as data inputs into the ecosystem service models, offering an improvement over traditional keyword searches used in previous studies. This has enabled the mapping of distinct sub-components of reef-related tourism, such as:

- On-reef tourism—map of use-intensity and values of activities that take place on or near a reef, specifically SCUBA and snorkeling.

- Nature-dependent beaches—map of use-intensity and values of beaches that are perceived by tourists as having a high level of naturalness or pristineness. This may be due to clear and calm turquoise water, white sands, or nearby foliage. Some of these characteristics can be influenced by the presence of nearby reefs.

- Paddle sports—heatmap of non-motorized watersports activities (such as kayaking and paddle boarding). These activities are often reef-associated and clearly depend on healthy natural coastal waters.

- Seafood restaurants—heatmap of seafood restaurants in the region. These are often largely dependent on the ability to serve fresh fish that were caught on or adjacent to reef habitats.

TNC will engage in ongoing and future marine spatial planning through the direct provision of spatially explicit information on their ecosystem service values, particularly relating to fisheries and nature-based tourism. By refining and expanding the approach to analyzing large datasets through image recognition and textual analysis tools, TNC will refine existing models while generating novel methodologies and insights.

About the Nature Conservancy

The Nature Conservancy (TNC), founded in 1951, is a charitable environmental organization focused on global conservation of lands, water, and climate. With a staff of more than 600 scientists, TNC is dedicated to conservation efforts and nature protection in 72 countries. The work of TNC has protected more than 119 million acres of land and 5,000 miles of rivers globally.

Resources

Websites

Mapping Ocean Wealth

Press

Cloud computing and AI help The Nature Conservancy dive deeper into conservation