NLA INTERNATIONAL

Blue Economy Knowledge System (BEKS)
Intel Sitrep

Project	Sargasso Sea Commission: Governance of high-seas ecosystems and the use of Big Data/AI
Search themes	Big data and AI in ocean governance references - **GLOBAL**
Search period	Up to 9/11/2021
Date of report	9/11/2021
Produced by	OSJ
Recipients	NLAI team

- This document presents collated news links related to the Sargasso Sea Commission Project, drawn from NLAI's Blue Economy Knowledge System (BEKS).
- The systems that curate this content are customisable, and can be adapted to track specific terms, people, policies, and organisations. Partners who wish to start tracking new terms should make these known to their NLAI Point of Contact and they will be added to the system.
- These articles are open source, so can be shared with colleagues and across relevant stakeholder groups.
- This initial report is for an extended search period. Future reports will be a collation of information and articles over a weekly period.
- To move around the document easily, you may:
    - Click on any of the headings or articles listed on the contents page to be taken to that section of the document.
    - Click on the 'RETURN TO CONTENTS PAGE' link at the foot of each page to jump back to the main navigation area

TABLE OF CONTENTS

RETURN TO CONTENTS PAGE

RETURN TO CONTENTS PAGE

1 Marine monitoring and surveillance

1.1 SPACEWHALE: Space Tech, AI Meet To Monitor Whales From (August 2021)

Modern space technology and artificial intelligence have combined to enhance the conservation of marine animals: the new service, “SPACEWHALE”, developed by a team of creative scientists in Germany and the UK, detects whales from space.

Supported by funding from the European Space Agency (ESA) Space Solutions program, this research enables whales and other large marine megafauna to be surveyed at an unprecedented scale. Earth Observation from satellites is developing fast and within a few years, space technology companies aim to provide daily high-resolution images of the whole globe. SPACEWHALE aims to makes use of this to boost marine research and conservation.

In contrast to previous whale monitoring by ship or aircraft, satellite images cover the global ocean surface. SPACEWHALE does not only detect whales but also other large marine animals. Many questions that previously required individual biological studies can now be answered with just a few clicks. Which areas are especially used by marine mammals? When do whales pass through a certain region during their migration? With the answers to these and other questions, solutions can be found that combine species protection on the one hand and human use of the seas on the other. For example, periods can be determined in which oil and gas or offshore wind farm activities cause the least disturbance to wildlife.

“Earth Observation by satellites is currently developing rapidly. It will only take a few more years for space companies to provide high-resolution images of the entire globe on a daily basis," said project manager Caroline Höschle from BioConsult SH. "That makes SPACEWHALE a forward-looking tool, but it already performs fantastically well with the imagery we have today. Over 70 % of the Earth’s surface is covered by water and thus large areas are still unexplored. The intelligent use of satellite imagery now brings us a lot of previously inaccessible data. SPACEWHALE is part of this revolution," Höschle said. “SPACEWHALE is a fast and efficient means of surveying whales - at a comparable cost to traditional methods for only a small area of the oceans.

SPACEWHALE uses satellite imagery with a resolution of 31 cm per pixel across the ground, meaning that a 23 m fin whale has a length of around 77 pixels when it fully surfaces. “This is currently the highest commercially available resolution and though the images appear rather coarse, the resolution is just perfect to detect large whales,” says data scientist Dr. Grant Humphries from HiDef Aerial Surveying Ltd.

Automatic image recognition is now widely used for many applications in our daily life but to be successful, it needs to be based on a large set of training images. So far, there are hardly any satellite images of large whales that could be used as training images. The staff of BioConsult SH and HiDef Aerial Surveying Ltd. found a solution to this problem: they used digital aerial images of the smallest baleen whales, namely the 7 to 10-metre-long minke whales, which came from monthly whale monitoring flights of offshore wind farms. The researchers were able to show that the algorithm trained in this way could subsequently recognise 23-metre-long fin whales and other whale species on satellite images.

Initial trials of SPACEWHALE proved successful: in the Mediterranean Sea, the algorithm detected almost twice as many fin whales as a previous manual investigation. In the Bay of Biscay, the algorithm detected fin whales and three other whale species. SPACEWHALE successfully counted humpback whales off the Hawaiian and Southern Right Whales off the Argentinian coasts.

“SPACEWHALE makes a significant contribution to marine conservation; artificial intelligence combined with satellite images offers completely new opportunities,” said Höschle. The application of SPACEWHALE can help identify critical habitats of whales and inform marine spatial planning and impact assessments of offshore developments. Accelerating climate change is also expected to cause profound changes, especially in Arctic waters, with associated declining ice cover and expanding human activities in whale habitat. Historical ranges of whales are changing. "With SPACEWHALE, we want to contribute to the targeted implementation of protection measures for great whales, even in the most remote areas," says Höschle.

1.2 TEKEVER Signs Maritime Surveillance Contract with EMSA - Naval News (Oct 2021)

The European Maritime Safety Agency (EMSA) has awarded a new contract to CLS, a French Space Agency subsidiary, and TEKEVER, a European drone manufacturer, for remotely piloted aircraft surveillance of European waters.

Through a four-year contract with maximum budget of €30M, EMSA is replacing a previous contract signed in 2018 for flights beyond visual line of sight by adding a new rescue capability: CLS and TEKEVER have added a new device to the maritime patrol version of their remotely piloted aircraft, able to deploy rescue boats for up to 8 people. The device also features Artificial Intelligence that calculates the best time to release the lifeboat to get as close as possible to the ship or person in distress.

EMSA is facilitating increased collaboration between European countries by enabling the deployment of regional operations and in doing so enhancing the effectiveness of surveillance over European waters.

The collaboration between CLS-TEKEVER consortium (named REACT) and EMSA is already rooted in a strong history through several drone operations since 2018. Totalling no less than 1200 flight hours on the counter and nearly 250 missions over 4 years.

These flights have established the strong utility of remotely piloted aircraft for maritime surveillance and safety in European waters, environmental protection (detection of oil pollution, potential identification of polluters, and support for the fight against illegal dumping), fisheries control, the fight against illegal fishing and general maritime law enforcement.

A new rescue capability.

Deploying a boat of this size by remotely piloted aircraft is a real first in Europe. This new capability has been fully demonstrated during search and rescue exercises. The aircraft's onboard sensors allow the detection of survivors, which is the starting point for calculating the best drop point without any human intervention. The onboard AI allows the deployment of the life raft at a distance close enough, but certain enough to optimize the chances of rescue.

1.3 Remote Sensing Applications in Monitoring of Protected Areas (2020)

[Abstract]

Protected areas (PAs) have been established worldwide for achieving long-term goals in the conservation of nature with the associated ecosystem services and cultural values. Globally, 15% of the world's terrestrial lands and inland waters, excluding Antarctica, are designated as PAs.

About 4.12% of the global ocean and 10.2% of coastal and marine areas under national jurisdiction are set as marine protected areas (MPAs). Protected lands and waters serve as the fundamental building blocks of virtually all national and international conservation strategies, supported by governments and international institutions. Some of the PAs are the only places that contain undisturbed landscape, seascape and ecosystems on the planet Earth.

With intensified impacts from climate and environmental change, PAs have become more important to serve as indicators of ecosystem status and functions. Earth's remaining wilderness areas are becoming increasingly important buffers against changing conditions. The development of remote sensing platforms and sensors and the improvement in science and technology provide crucial support for the monitoring and management of PAs across the world.

In this editorial paper, we reviewed research developments using state-of-the-art remote sensing technologies, discussed the challenges of remote sensing applications in the inventory, monitoring, management and governance of PAs and summarized the highlights of the articles published in this Special Issue.

RETURN TO CONTENTS PAGE

1.4 Artificial intelligence for marine monitoring: part I | CMEMS (June 2021)

Artificial intelligence (AI) is all around us. From search engines, spam filtering and gaming, to crime fighting, medical diagnoses and Amazon Alexa, we interact with it many times a day. But AI can also be useful for exploring environmental data. Mercator Ocean international in the frame of the Copernicus Marine Service (CMEMS*) is doing just this.

Huge quantities of data are collected about the marine environment every day by instruments at sea, in the air and in space. Such a large bank of data and real-time forecasts have the potential to help researchers better understand how the environment is changing, but it is essential to find ways to pull out useful information from the plethora of raw data.

This is where AI comes in. In a series of three articles, we are presenting examples of how artificial intelligence is used by the Copernicus Marine Service to add value to environmental data. This first article looks at the use of AI in a 'digital twin' of the ocean, as well as a project that uses machine learning to fill gaps in the data we have available to us.

Digital Twin of the Ocean

The European Commission is developing plans for a digital model of the Earth (a 'digital twin') to monitor and predict environmental change and human impact. The initiative is called Destination Earth (DestinE) and these twins will make it possible to interactively explore various natural processes and human activities. As part of this ambition, the Copernicus Marine Service and Mercator Ocean International are working on plans for a Digital Twin of the Ocean.

The work kicked off with a collaboration with several other organisations on a European Space Agency project. In November 2019, a European Commission workshop on convergent use of High Performance Computing (HPC), cloud, data and artificial intelligence resources took place. The aim was to investigate what would be available and what would be needed in relation to building a future digital infrastructure related to advanced Earth system modelling for EU policy support.

During this event Mercator Ocean presented the capabilities and initiatives with the use of Copernicus Marine data, technology, methodologies and infrastructures to be applied to a digital twin of the ocean. MOi, harnessing the Copernicus Marine infrastructure, currently participates in the ESA Digital Twin Ocean Precursor (DTOP) (watch video at 44:00 for more information) led by IFREMER and including a consortium of European partners. The extension of such work and full digital twin of the ocean will be launched in the next several years.

Our next aim is to use machine learning to better understand marine heatwaves," explains Yann Drillet, Head of the Copernicus Marine Global Production Centre and of Operational Oceanography at Mercator Ocean international. "We will train a neural network with our long-term datasets based on observations and modelling so that it can improve our detection and forecasting of these events."

"Later, we have plans to use machine learning for several other applications – to emulate and/or to downscale specific ocean variables based learning approach using observation and simulation, to reconstruct ocean currents and trajectories, to classify and identify objects (microplastic patches floating at the ocean surface, for example) based on satellite observations, and to provide better information on uncertainty for our datasets," continues Yann.

Using classical (non-AI) approaches to process data uses an enormous amount of computing power. Computers put input data into physical equations, and are obliged to solve the whole equation, so to speak. AI, on the other hand, is based on a statistical approach – everything happens inside a 'black box' and it can focus on only dedicated variables. This reduces the power and time needed to make computations. AI is also better for combining input data with different resolutions and outputting data with a higher resolution.

"AI and classical approaches are complementary, and we will combine them to answer big questions," says Yann. "Using our existing database of information together with trained neural networks, we will be able to

RETURN TO CONTENTS PAGE

better understand things like the dynamic of the ocean, the ocean environment (including human activities and pollution) and climate change."

Machine learning to fill gaps

One place that the Copernicus Marine Service has already used machine learning to improve our understanding of the ocean is in a novel R&D project called 3DA. Many of our observations of the ocean come from satellites, which take measurements along specific tracks as they pass overhead. Between these tracks, there are gaps. 3DA looked into a new way of filling these gaps.

Copernicus Marine fills the gaps using a statistical method called interpolation, a process that uses values at known points to estimate values at unknown points. To get information about how the unknown and known values evolve together, a tool called a 'covariance structure' is needed.

Traditional covariance structures are static; this means that they do not evolve over time, for example with the changing seasons. But 3DA used machine learning to sift through past data and develop evolvable covariance structures that are much more realistic. The 3DA method also provides an estimate of uncertainty that is flow dependent, meaning that users can better see where they should have confidence in the interpolation and where it is less reliable.

1.5 Artificial intelligence for marine monitoring: part II | CMEMS (June 2021)

The second in our series of articles about how artificial intelligence (AI) is used by the Copernicus Marine Service (CMEMS*) to add value to environmental data focuses on a type of AI known as artificial neural networks. Inspired by the neural networks in our own brains, these consist of a series of algorithms that seeks to recognise underlying relationships in a set of data.

At the Copernicus Marine Service, neural networks are generally used to infer certain variables from others and to fill in geographic or temporal gaps. One place in which they feature is our MOB TAC – the Multi Observations Thematic Assembly Center. MOB TAC combines data from two or more sensors, either on board satellites or in situ, with state-of-the-art data fusion techniques to provide information on ocean variables.

1.6 Artificial intelligence for marine monitoring: part III | CMEMS (June 2021)

Part three in our series about how the Copernicus Marine Service (CMEMS*) uses artificial intelligence to add value to environmental data continues our look at artificial neural networks. Our previous article explored how they are used in the Copernicus Marine Multi Observations Thematic Assembly Center (MOB TAC); this article will move on to our Ocean Colour Thematic Assembly Center (OC TAC).

Based on satellite data of the colour of the ocean, OC TAC delivers two sets of products for all regions of the ocean – the phytoplankton chlorophyll concentration and the OPTICS. The OPTICS covers all other variables that can be retrieved from ocean colour sensors, including the absorption and scattering of light, the transparency of the water, the dissolved organic matter and the suspended particulate matter.

OC TAC supports scientists to carry out ocean research and policymakers to apply and monitor environmental policies. The data also supports the daily lives of specific communities; for example, the chlorophyll product is useful for the fishing industry to decide where to send their fleets – where there is more chlorophyll, there are usually more fish – and for the aquaculture industry to strategically position their aquaculture infrastructure in coastal and shelf waters.

Like MOB TAC, OC TAC uses neural networks in three of its products – one for the Black Sea and two for the Baltic Sea. The networks are trained with in situ data and applied to retrieve chlorophyll and other optical properties.

"With OC TAC, we are trying to provide the most accurate ocean variables for the European Seas," explains Vittorio Brando from the National Research Council of Italy (CNR), which leads the development of OC TAC. "We are achieving this aim by applying specific algorithms that respond to the peculiarities of each region –

RETURN TO CONTENTS PAGE

for example, the Mediterranean Sea is blue but a different blue to the Atlantic Ocean due to the differing amounts of solid and dissolved particulate matter."

On top of this, coastal areas are usually browner because of, for example, solid material being deposited into the water by rivers. Further from the coast, the water tends to be bluer. OC TAC uses a blending approach that uses at least two algorithms for each sea, changing the contribution of each algorithm as we move further from the coast.

As the Black Sea and the Baltic Sea are quite complex parts of the global ocean, neural network functions work well as retrieval algorithms.

For surface chlorophyll concentration in the Black Sea, we use a neural network closer to the coast and an analytical algorithm in the open ocean. Moving further from the coast, the neural network gets further from its comfort range and the analytical algorithm becomes more useful.

For the Baltic Sea, the Copernicus Marine Service uses neural networks to retrieve information about chlorophyll and OPTICS. For each product, two complementary neural networks are applied. Among other applications, the resulting information has been used to monitor harmful algal blooms in the Baltic Sea.

"Neural networks are great, but they are just one of the tools of the trade when it comes to analysing the optical properties of the ocean," explains Vittorio. "For analytical solutions, we understand how and why they work but neural networks are often considered a bit of a black box – this is part of their beauty but it also makes them more difficult to interpret!"

1.7 Smart Oceans: Artificial Intelligence and Marine Biodiversity Governance - OWN (May 2021)

This lecture by Dr. Karen Bakker will discuss a new type of environmental governance that holds significant promise for marine biodiversity conservation: AI-powered mobile marine protected areas (MMPAs). MMPAs have spatio-temporally mobile boundaries that change position as endangered fish migrate through the ocean. In order for MMPAs to responsively adapt to environmental variability, species mobility, and disturbance dynamics, a sophisticated AI-powered computational apparatus "Smart Oceans" is required, including machine learning algorithms, computer vision, and ecological informatics techniques used to analyze data from various sources (e.g. nano-satellites, drones, environmental sensor networks, digital bioacoustics, marine tags, deep sea UAVs). This talk will cover Smart Ocean's digital tools and governance frameworks as well as recent applications with endangered bluefin tuna and endangered turtles. Do MMPAs achieve better biodiversity conservation outcomes than traditional static protected areas? Come to this session to find out!

1.8 AI is a promising new tool for monitoring marine biodiversity | Oceans of Biodiversity (June 2020)

Artificial Intelligence (AI, using machine learning and neural networks) has made amazing strides, notably in recognising human faces. It is also being used to identify patterns on photographs of individual patterns on whale fins and flukes, and whale shark markings. It is revolutionary in helping citizens learn how to identify species (such as in iNaturalist) and is poised to enable automation of biodiversity monitoring through analysis of videos and photographs. The use of images has the added benefit of having minimal disturbance to biodiversity (nothing being killed) and images can be archived for future research. Here are some examples I compiled recently. Please add more to the comments box below.

- iNaturalist uses AI to put a taxonomic name (species or higher level) against one species per image. Volunteer experts help confirm identifications and images with >100 confirmed identifications are used to train the AI. Images are archived. Data is automatically published to GBIF.
- MerlinID uses AI on images and observation context to help identify birds.

RETURN TO CONTENTS PAGE

- Ecotaxa is a system for Identification Plankton images using AI.
- www PIC is a plankton image archive with applications for AI training.
- Linne Lens identifies multiple animals (especially fish) in real-time on videos from a smart-phone app. It can count and name fish and other species in videos and photographs.
- CoralNet AI (deep neural networks) to annotate benthic images. It is in use for semi-automated annotation of benthic images of coral and rocky reefs.
- FathomNet MBARI system for training AI using expert knowledge to detect marine species (even detecting a species is present can be useful to save time watching many hours of video).
- Squidle+ New Australian platform for marine image storage, mapping and annotation supported by Schmidt Ocean Foundation and Australian Integrated Marine Observing System has potential for community image storage, expert annotation and AI training.
- VIAME is NOAA's AI for video analysis, detects fish in images and videos. Fish are detected in videos which are then expert annotated.
- Bisque (Bio-Image Semantic Query User Environment) stores, visualizes, organizes and analyze images in the cloud.
- biome.com is a specialist in environmental image analysis including having an app for species identification in Japan.

1.9 To share or not to share in the emerging era of big data: perspectives from fish telemetry researchers on data sharing

The potential for telemetry data to answer complex questions about aquatic animals and their interactions with the environment is limited by the capacity to store, manage, and access data across the research community. Large telemetry networks and databases exist but are limited by the actions of researchers to share their telemetry data. Promoting data sharing and understanding researchers' views on open practices is a major step toward enhancing the role of big data in ecology and resources management. We surveyed 307 fish telemetry researchers to understand their perspectives and experiences on data sharing. A logistic regression revealed that data sharing was positively related to researchers with collaborative tendencies, who belong to a telemetry network, who are prolific publishers, and who express altruistic motives for their research.

Researchers were less likely to have shared telemetry data if they engage in radio and (or) acoustic telemetry, work for regional government, and value the time it takes to complete a research project. We identify and provide examples of both benefits and concerns that respondents have about sharing telemetry data.

1.10 Satellites and big data to monitor Marine Protected Areas and the Ocean | CoastObs

This year, the Global Ocean Action's goal is to take action and protect 30% of our blue planet by 2030. How can remote sensing help monitor Marine Protected Areas?

Our Ocean provides countless benefits to our planet and to all the creatures that live there. It produces about 50% of the world's oxygen[i] and it absorbs 1/3 of global CO2 emissions[ii]. It is also the core regulator of our climate and weather phenomena, as well as the world's largest source of protein[iii]. Let's not forget that many medicinal products come from the Ocean that help fighting different types of cancer, heart diseases, Alzaimer, among others.[1], and the interest for Earth's seas just keeps increasing as medical researchers believe that they might harbor novel disease-fighting chemistry[iv].

Knowing all these benefits and valuable contributions to our life and health, it is key to understand the importance of protecting our ocean and its ecosystems. This year, the Global Ocean Action's goal is to raise awareness and invite all leaders and decision makers to join this worldwide movement by drawing their attention on our ocean and ask them to take action and protect 30% of our blue planet by 2030. So, 30x30 is

RETURN TO CONTENTS PAGE

the TARGET! By safeguarding at least 30% of our ocean through a network of highly protected areas we can help ensure a healthy home for all!

The European Union's response to this global challenge

Recognising the need for a fast and collective response on pan-european level, the European Commission adopted the new EU Biodiversity Strategy with the horizon towards 2030. This strategy will work as a compass in the post COVID-19 time to build stronger and more resilient communities enabling them to fight global threats such as disease outbreaks and natural disasters and understanding the importance of nature and its wildlife.

Overall, the EU Biodiversity Strategy 2030:

- protects sensitive marine species and fish stock recovery areas (more Natura 2000 protected areas)
- eliminates destructive fishing activities
- builds a consistent EU Nature Restoration Plan
- leads to a global biodiversity framework including biding ocean restoration targets
- is the core part of EU Green Deal

How can the satellites protect our MPAs?

Our satellites are the Earth Observers or our planet's heroes which can "see the sea" in ways that are otherwise impossible. Do you remember the super hero in the movie „Toy Story"?

Satellites are amazing tools for observing the Earth and the big blue ocean that covers more than 70 percent of our planet. By remotely sensing from their orbits high above the Earth, satellites provide us much more information than would be possible to obtain solely from the surface.

Our Marine Protected Areas (MPAs) need to be monitored as they play a vital role in protecting and preserving our global ocean ecosystems. 10% of the world's oceans could be marine reserves by 2020 if UN goals are met. However, those targets remain on paper without a practical implementation.

Which can be the solutions?

A vital solution lies in the use of satellite-interfacing sensors and data processing tools that are beginning to allow us to watch how ships use the oceans as easily as we track Uber taxis cruising around a city. More and more ships now carry sensors that publicly transmit their position to the satellites, to have a map of the traffic and avoid crashing into each other. We can make use of these same streams of safety data to detect where industrial fishing is concentrated. Smart new algorithms can help pick out specific kinds of vessel behaviour using big data and tracking their fingerprints.

Another important piece in the ocean-observation puzzle are the high-resolution pictures from Earth that allow marine scientists to observe the Ocean and inform about , marine habitat mapping and monitoring, track anthropogenic activities and assess its impacts on biodiversity in MPAs[i].

Applications of remote sensing on Ocean observation

Monitoring Phytoplankton via satellites

The tiny phytoplankton found in the world's ocean is tremendously productive, as it creates half the oxygen we need to breathe, produce carbohydrate which is used as an energy source and are an essential food source for small crustaceans, fish and mussel larvae, which are themselves food for larger fish. If phytoplankton is in shortage, the whole food chain is jeopardised. There are various groups of phytoplankton around the globe with different functions in marine ecosystems. Until recently, it was impossible to track those phytoplankton groups. Even satellite data were unable to predict phytoplankton concentrations and algal growth in specific regions.

RETURN TO CONTENTS PAGE

But technology progress and new opportunities are popping up. CoastObs is developing a service to be able to monitor phytoplankton size classes and primary production.

This new algorithm is important to help us preserve our marine areas but it will also help us identify toxic "harmful algal blooms" (HABs) and maintain good water quality. CoastObs is already providing a weekly bloom monitoring service to the Netherlands, but once CoastObs platform is released, this product can be asked for any other region in Europe.

The platform will also help monitor seagrass and macro-algae cover, which will be extremely helpful to monitor the Marine Protected Areas that have these ecosystems.

Remote sensing for Ocean monitoring shows great promise to support wildlife managers in their efforts to protect marine biodiversity around the world, and the great news is that innovative products for water monitoring keep developing!

Let's use the modern technology and satellites capacities to save our seas and their rich aquatic ecosystems. Our ocean is our home and this is the main message of this year's global campaign.

1.11 Emerging Marine Monitoring Technologies Enable More Effective Management of Protected Areas | The Pew Charitable Trusts (September 2021)

Creating large-scale marine protected areas (MPAs) can be a powerful way for governments to safeguard entire ecosystems. But the success of those MPAs in delivering conservation benefits depends on effective management. That includes monitoring—collecting and analyzing data—which is fundamental to understanding ongoing changes in ocean conditions and biodiversity, measuring the success of conservation strategies, and identifying paths to improve the management of protected areas.

For example, if a goal of an MPA is to increase the local population of apex predators by diminishing illegal, unreported, and unregulated (IUU) fishing, then an evaluation of whether protections are successful over time will require data on shark population dynamics, combined with information on how much illicit fishing is occurring in the MPA.

Governments and other ocean stakeholders can also share the information gained through monitoring—for example, by making fishing activity records publicly available, or through sharing animal tracking data—to help increase transparency and accountability in overall management and governance.

Fortunately, monitoring of oceanographic conditions, marine biology, and the presence and impact of human uses on the marine environment has progressed over the past three decades. In the 1990s, experts began using satellite remote sensing technologies to track changes in global oceanography—including sea surface temperature and productivity—in real time. Advancements in electronic tagging in the 2000s enabled scientists to track the distribution of marine animals, such as sharks and whales. Since the 2010s, scientists have also developed the technology to track and quantify fishing and other human activity across the global ocean, which has emerged as a major way to help detect IUU fishing.

Now, marine managers around the world can access and integrate these data streams to support informed and dynamic ocean management. At the cutting edge of this marine data revolution is the Global Fishing Watch Marine Manager, a new portal founded by Dona Bertarelli, special adviser for the blue economy for the United Nations Conference on Trade and Development and co-chair of the Bertarelli Foundation, and developed by the non-profit Global Fishing Watch.

The technology leverages machine learning and harnesses near-real-time, open-source, dynamic and interactive data to evaluate ocean conditions, marine biology, and human activity, such as fishing. In doing so, it allows marine managers and researchers to combine numerous datasets to make informed decisions to better manage the ocean

The portal, which is provided without cost to governments and marine management bodies, is being piloted in Guyana, the Mediterranean, the Black Sea, and several Pew Bertarelli Ocean Legacy sites such as Ascension

RETURN TO CONTENTS PAGE

Island, the Galápagos Islands, and Tristan da Cunha. The platform includes both a public-facing dashboard and private channels for marine reserve managers and stakeholders to share and analyze data.

Marine Manager complements a suite of other tools that can be used for monitoring and analyzing vessel activity within marine protected areas. Using satellites, remote sensors, and artificial intelligence, Ocean Mind, a U.K.-based non-profit, successfully supported efforts to identify potential IUU fishing risk within the Pitcairn Island Marine Reserve over a five-year period. That project demonstrated how large, isolated, fully protected areas can be monitored remotely, in near real time, from space. Such work has led to the advancement of several other platforms working to combat IUU fishing, such as Vulcan Skylight and Vesseltracker.

Marine managers are also leveraging significant breakthroughs in monitoring of biodiversity and ocean life to improve stewardship of the seas. One example is the analysis of environmental DNA (eDNA), which offers an exciting new alternative to traditional wildlife survey methods by collecting and testing ocean water samples for DNA traces of organisms present in the area. That allows biologists to learn what species are there without having to locate and assess them individually. eDNA is the most efficient way to determine the presence of a wide array of marine life—including rare or difficult-to-find species—and can be used to broadly assess biodiversity in a rapid, repeatable, and relatively affordable manner.

With the support of the Pew Bertarelli Ocean Legacy Project, the managers of the Ascension Island Marine Protected Area are establishing an eDNA laboratory on the island to monitor the status of key species and the presence of dangerous invasive species that threaten biodiversity. If successful, Ascension Island's pilot eDNA program may serve as a case study in effective, low-cost monitoring that can be replicated in other remote MPAs.

These are just a few of the many new approaches and tools that are increasing the visibility of human activities on the water, and the movement of species below, in order to rapidly enhance the ability to understand and manage marine ecosystems. These and other technologies offer accessible, efficient, and effective opportunities to improve oversight of human activities—and help people better steward the global ocean.

1.12 Innovations and technology to protect our Overseas Territories - Marine developments

Marine protected areas (MPAs) currently cover over 5% of the world's ocean

and are designed to protect and preserve various resources within their boundaries. This goes some way to meeting internationally agreed goals of 10% ocean protection by 2020, and 30% by 2030.

Well-designed marine protected areas can vastly improve the health and biodiversity of ocean ecosystems. They provide a refuge for endangered and commercial species to recover, where fish are able to reproduce, spawn and grow into adults. Critical habitats become protected from damaging human activities such as destructive fishing techniques and can increase their resilience against external impacts such as climate change.

Each individual MPA should be designated to protect marine ecosystems, processes, habitats, and species, and has its own management regime determined by its sovereignty. Where an MPA is well managed it contributes to the restoration and replenishment of resources for social, economic and cultural development. Cost-effective monitoring and surveillance of these marine protected areas is therefore critical to their success.

The Blue Belt programme is working with a number of technology partners to help deliver this goal.

For example, in partnership with the Satellite Applications Catapult and OceanMind, we are able to access innovative satellite technologies to help establish, monitor and enforce large-scale MPAs across the British Indian Ocean Territory, Pitcairn Islands, Ascension, Tristan da Cunha, Saint Helena, British Antarctic Territory and South Georgia and the South Sandwich Islands.

RETURN TO CONTENTS PAGE

How is technology used to protect British Overseas Territories and MPAs?

Thanks to significant growth in technological capabilities, machine learning is helping to revolutionise the how we detect illegal fishing activity. We can now identify and corroborate many different types of fishing activity automatically from satellite information. By using highly sophisticated systems that perform in-depth computational analysis, we are able to automate maritime information analysis from a wide variety of sources, which in turn empowers expert analysts to work more effectively.

Using the technologies provided by OceanMind and the Satellite Applications Catapult, we are now able to work with the Overseas Territories to ensure that we are able to focus on indicators of possible Illegal, Unreported and Unregulated (IUU) fishing that might otherwise go unnoticed.

These improved technology enhancements are used in the monitoring and surveillance of both UK marine protected areas and Overseas Territories.

Satellite information from Automatic Identification System (AIS), Synthetic Aperture Radar (SAR) and Electro-Optical (EO) satellite data along with Vessel Monitoring System (VMS) data have been consolidated and cross referenced against external information such as fishing licence and vessel registry databases, regional fisheries management organisations, fisheries rules and regulations and vessel tracking identity telemetry, to identify and distinguish between the various vessels located within areas of interest.

By using satellite data and satellite imagery together with a wide variety of data sources, including oceanographic data, our goal is to be able to work with the Overseas Territories to track and monitor vessel behaviour in and around these new, large-scale, remote MPAs, and ensure that the risk to these reserves is significantly reduced.

New Innovations for monitoring and surveillance

Further innovations are also being used to assist in the effective deployment of manned or unmanned maritime and aerial patrol assets. Patrol support activities also allow for the possibility of satellite technology being used to support near-real time monitoring and surveillance that identifies possible illegal fishing activities and helps streamline patrol planning exercises.

Another technological innovation involves the use of Unmanned Surface Vehicles (USVs), which may facilitate the patrolling of MPA borders. It also allows enforcement vessels to respond to any boats identified as undertaking suspected illegal fishing activities. These vessels are sent to specific co-ordinates to gather evidence that will assist the authorities with ongoing enforcement.

In addition to the state of the art monitoring systems now available, USVs may be used alongside expert fisheries analysts to provide a higher success rate for enforcement.

In the Pitcairn Islands, we have worked with OceanMind to review the ability of technology-aided analysis and remote sensing capabilities to provide insights into what is happening in remote areas of UK sovereign waters. This monitoring also has a deterrence effect, with fishing vessels expending valuable time and fuel to avoid the perception of violation of the marine reserve.

Regular fisheries compliance analysis of traffic around Pitcairn Islands is regularly undertaken and correlated with satellite imagery to look for ‘dark’ or non-transmitting vessels that may continue to operate in the area.

As a consequence, new technologies are providing a valuable potential solution to the challenge of monitoring and enforcing these new and geographically remote Marine Protected Areas.

1.13 Genetic tool could improve monitoring of marine protected areas | UCLA

Researchers used to need to scuba dive to find out which fish live in any given area of the ocean. Now, a new UCLA study has found that environmental DNA, or eDNA, can be used to identify marine organisms living in a certain space.

RETURN TO CONTENTS PAGE

Environmental DNA is the term for the DNA from cells that are constantly released by organisms into their environments — much like the hair and skin people normally shed in the shower. In the past decade eDNA technology has advanced rapidly, making it a competitive tool for assessing ecosystem biodiversity.

The findings, which were published in PLOS One, could have major implications for monitoring of marine protected areas, sections of ocean where fishing and other activities are prohibited to conserve marine life and habitat.

In 2012, California established 124 marine protected areas covering about 16% of state waters. Regular monitoring of those areas is critical for understanding if marine life is being protected successfully, said UCLA ecologist Paul Barber, the study's senior author. Before eDNA, the only way to tell if marine protected areas were working was for scuba divers to count and identify every fish they saw, a method known as visual surveying.

"These surveys typically require experienced divers with specific training to spend hours and hours underwater," said Barber, a member of the UCLA Institute of the Environment and Sustainability. "Now we can simply lower a bottle into the ocean from the side of a boat."

The researchers compared which species were detected using eDNA and which were counted using visual surveying during summer 2017 at three sites inside and outside of the State Marine Reserve near Santa Cruz Island. Using eDNA, they identified nearly all of the same species as the visual surveys.

The only fish that did not show up using the technique were five species of rockfish — an issue the researchers said could be easily fixed by tweaking the genetic test to recognize that specific DNA when it appears in water samples.

The eDNA also revealed an additional 30 species that had been seen in the same areas in previous years but that were not spotted during the 2017 visual surveys.

"We demonstrated that that we can use eDNA as a tool to monitor these ecosystems," said Zachary Gold, the study's lead author, a former UCLA doctoral student who is now a researcher at the University of Washington and National Oceanic and Atmospheric Administration. "This is an opportunity going forward to expand the scope and scale of monitoring marine protected areas."

Wider use of eDNA could help scientists overcome some of the challenges of visual surveying as a technique for monitoring marine species. For one, the new method could be far less expensive than the current one: Each eDNA sample costs around $50, while the National Park Service spends hundreds of thousands of dollars per year to survey 33 sites in the Channel Islands.

And in part because of those costs, visual surveys are conducted only once a year, which means seasonal variations in fish species have rarely been studied.

Another current challenge is that visual surveying is only performed in waters up to 10 meters (about 33 feet) deep, which means the technique cannot be used in more than 99% of California's marine protected areas.

To analyze eDNA, researchers run the water they collect through a filter that captures the cells and DNA of marine organisms. Those filters are frozen on the boat and taken to a lab, where researchers extract DNA from the cells, sequence it and identify which species the DNA belongs to using a reference database.

For the PLOS One study, Gold used a reference database called the Anacapa Toolkit, which was developed previously by UCLA scientists.

The authors acknowledge that eDNA surveys won't completely replace visual surveys, because the newer method can't reveal the sex, size, abundance or behavior of the fish being studied — all of which are important elements of a complete assessment. "There will always be value to having eyes in the water," Barber said.

But the simplicity of eDNA could create opportunities for community science — research in which non-scientist members of the public can participate. For example, Gold set up a program with the Los Angeles-

RETURN TO CONTENTS PAGE

based non-profit Heal the Bay that teaches volunteers how to collect water samples. The combination of eDNA tools and a wider network of people collecting samples could dramatically improve the monitoring of marine ecosystems.

1.14 Application of machine learning to predict visitors' green behavior in marine protected areas: evidence from Cyprus (March 2021)

[Abstract]

Interpretive marine turtle tours in Cyprus yields an alluring ground to unfold the complex nature of pro-environmental behavior among travellers in nature-based destinations. Framing on Collins (2004) interaction ritual concept and the complexity theory, the current study proposes a configurational model and probes the interactional effect of visitors' memorable experiences with environmental passion and their demographics to identify the causal recipes leading to travellers' sustainable behaviors. Data was collected from tourists in the marine protected areas located in Cyprus. Such destinations are highly valuable not only for their function as an economic source for locals but also as a significant habitat for biodiversity preservation. Using fuzzy-set Qualitative Comparative Analysis (fsQCA), this empirical study revealed that three recipes predict the high score level of visitors' environmentally friendly behavior. Additionally, an adaptive neuro-fuzzy inference system (ANFIS) method was applied to train and test the patterns of visitors' pro-environmental behavior in a machine learning environment to come up with a model which can best predict the outcome variable. The unprecedented implications on the use of technology to simulate and encourage pro-environmental behaviors in sensitive protected areas are discussed accordingly.

1.15 Autonomous Marine Robot Based on AI Recognition for Permanent Surveillance in Marine Protected Areas - PubMed (April 2021)

The world's oceans are one of the most valuable sources of biodiversity and resources on the planet, although there are areas where the marine ecosystem is threatened by human activities. Marine protected areas (MPAs) are distinctive spaces protected by law due to their unique characteristics, such as being the habitat of endangered marine species. Even with this protection, there are still illegal activities such as poaching or anchoring that threaten the survival of different marine species.

In this context, we propose an autonomous surface vehicle (ASV) model system for the surveillance of marine areas by detecting and recognizing vessels through artificial intelligence (AI)-based image recognition services, in search of those carrying out illegal activities. Cloud and edge AI computing technologies were used for computer vision. These technologies have proven to be accurate and reliable in detecting shapes and objects for which they have been trained. Azure edge and cloud vision services offer the best option in terms of accuracy for this task.

Due to the lack of 4G and 5G coverage in offshore marine environments, it is necessary to use radio links with a coastal base station to ensure communications, which may result in a high response time due to the high latency involved. The analysis of on-board images may not be sufficiently accurate; therefore, we proposed a smart algorithm for autonomy optimization by selecting the proper AI technology according to the current scenario (SAAO) capable of selecting the best AI source for the current scenario in real time, according to the required recognition accuracy or low latency.

The SAAO optimizes the execution, efficiency, risk reduction, and results of each stage of the surveillance mission, taking appropriate decisions by selecting either cloud or edge vision models without human intervention.

1.16 Remote Sensing Applications in Monitoring of Protected Areas：A Bibliometric Analysis (Feb 2020)

The development of remote sensing platforms and sensors and improvement in science and technology provide crucial support for the monitoring and management of protected areas. This paper presents an

RETURN TO CONTENTS PAGE

analysis of research publications, from a bibliometric perspective, on the remote sensing of protected areas. This analysis is focused on the period from 1991 to 2018.

For data, a total of 4546 academic publications were retrieved from the Web of Science database. The VOSviewer software was adopted to evaluate the co-authorships among countries and institutions, as well as the co-occurrences of author keywords. The results indicate an increasing trend of annual publications in the remote sensing of protected areas.

This analysis reveals the major topical subjects, leading countries, and most influential institutions around the world that have conducted relevant research in scientific publications; this study also reveals the journals that include the most publications, and the collaborative patterns related to the remote sensing of protected areas. Landsat, MODIS, and LiDAR are among the most commonly used satellites and sensors.

Research topics related to protected area monitoring are mainly concentrated on change detection, biodiversity conservation, and climate change impact. This analysis can help researchers and scholars better understand the intellectual structure of the field and identify the future research directions.

1.17 The application of remote sensing for marine protected area management | Request PDF (January 2014)

Marine protected areas (MPAs) are important tools for the conservation of marine biodiversity but their designation and effective monitoring require frequent, comprehensive, reliable data. We aim to show that remote sensing (RS), as demonstrated for terrestrial protected areas, has the potential to provide key information to support MPA management. We review existing literature on the use of RS to monitor biodiversity surrogates, e.g. ecological (e.g., primary productivity) and oceanographic (e.g., Sea Surface Temperature) parameters that have been shown to structure marine biodiversity.

We then highlight the potential for RS to inform marine habitat mapping and monitoring, and discuss how RS can be used to track anthropogenic activities and its impacts on biodiversity in MPAs. Reasons for low integration of RS in MPA management and current limitations are also presented.

This work concludes that RS shows great promise to support wildlife managers in their efforts to protect marine biodiversity around the world, in particular when such information is used in conjunction with data from field surveys.

2 Environment and Climate Change

2.1 Artificial Intelligence: How High-Tech Tools Are Helping Combat Climate Change - DER SPIEGEL (Sep 2021)

New technologies can also help in detecting problems under water more quickly. The oceans are important in the fight against global warming in that they absorb carbon dioxide and produce oxygen. But the climate crisis is causing water to acidify and ocean temperatures to rise, leading to hurricanes and rainfall and causing important ecosystems like coral reefs to die.

Algorithms are used to comb through aerial photographs to map coral reefs, identify species diversity and monitor reef health. Scientists at the German Research Center for Artificial Intelligence (DFKI) have developed an algorithm that classifies plastic waste floating in the oceans based on aerial photographs. The tool is intended to support governments in Southeast Asia, including that of Cambodia, in the fight against waste – and to make it possible to determine where it originates.

Meanwhile, the French software company Sinay is also using maritime data for environmental protection. It harnesses AI to calculate routes to help ships consume less fuel. Sound detectors also eavesdrop on marine animals to identity which species and how many animals are in a given area. Sinay has assembled its own underwater sound archive, which it continues to grow.

RETURN TO CONTENTS PAGE

"For example, the algorithm analyzes whether there are protected species in an area before the installation of wind farms and whether the designers need to change their plans," says Léa Manneheut, a data scientist at Sinay. If there are a lot of animals at planned construction sites, the noise pollution during the work can at least be reduced with certain insulation measures.

Manneheut and her colleagues at Sinay have observed that companies are also paying increasing attention to environmental and climate aspects for image reasons. "There is growing pressure from the public," she says.

Researcher Lynn Kaack of the Hertie School says there is a still a lot of catching up to do in terms of interdisciplinary experts working together. Often, people who are interested in doing work don't even know who to turn to for executing ideas. In response, Kaack co-founded the Climate Change AI initiative, a community that is aiming to better connect climate and AI experts.

"Scientists need more money for interdisciplinary research," she says. "But ultimately, the most important thing is that projects are actually implemented – and that's where things are falling short." More support also needs to be given to start-ups. But she says it is also important to initiate KI projects at companies and organizations that already exist – with, for example, funding programs that enable AI experts to work at NGOs or companies so that they can implement concrete projects.

"Not everyone wants a tech career at Google – many would like to use their skills for climate protection," she says.

3 Marine Science

3.1 The Emergence of AI in Hydrography | Hydro International (February 2021)

With the ever-increasing and affordable availability of capacity and computing power to process and store data, the emergence of artificial intelligence (AI) in marine geomatics, ocean sciences and hydrography is palpable.

Mathematical models are very powerful, but their reliability must be validated and demonstrated using calibration points. It's the same for AI. It cannot emulate and learn properly if it cannot rely on observations that represent reality. In the commercial shipping world, AI-based technologies are about to be tested, resulting in additional bathymetry and hydrography needs that will quickly become necessary and critical.

Commercial Marine Autonomous Surface Ships (MASS) such as the 'Rolls Royce-Kongsberg' are prototypes in development and will eventually be tested in Europe – Norway is a leader in the field. Many see these commercial MASS as providing for economies in terms of fuel consumption, optimization of transportation routes, reduction of greenhouse gas emissions and reduced risks to navigation by respecting many rigid and strict rules of navigation in the world.

How can commercial MASS learn, if indeed they can learn, from the charted and uncharted seabed where hydrographic data is insufficient or even absent? I suggest that the success of AI in hydrography is fundamentally dependent on the quantity and quality of all available bathymetric and hydrographic data, whether static, predictive, near real-time or real-time (dynamic).

Lack of Basic Data

In the world of ocean sciences (bathymetry and hydrography), there is a lack of basic data that meets modern technological standards. However, the data acquired with multibeam echo sounders (MBES) has for some decades been localized and is increasingly dense and voluminous. Also, the additional data coming from MBES and specifically its multiplier effect of backscatter data signal, and the Lidar and Satellite-Derived Bathymetry (SDB) multiplier effect of reflectance data signal, amplifies this further.

I emphasize that there is also a lot of unknown, unavailable data, and when it is known and made available, it is often non-standard and low precision. For this reason, it tends to be unused or rejected. Since AI is based

RETURN TO CONTENTS PAGE

on computing ability and the power of mathematics and statistics, the availability of all data, especially big data, plays a key role in computer learning, machine learning and deep learning.

Respecting Established Standards

AI in hydrography will be stimulated and catalysed by MASS. The key to success will be based on the same fundamental issue known in hydrography for a long time (i.e. associated bathymetric and hydrographic data of known quality and respecting established standards). This represents a major challenge considering that the vast majority of the world's oceans and coastal areas have little or no modern hydrographic data of sufficient quantity and quality. However, there are several opportunities with the current technological wave that we are encountering.

To prepare for hydrographic AI, it is better to have the maximum quantity of data where the quality is known, even if it does not always meet the standards, than not having the data, or having just a little data. This is especially true in remote areas where new needs emerge.

Alternative Data Sources

In this context, promoting and adopting Crowdsourced Bathymetry (CSB) and the unreserved use of alternative data sources such as SDB, airborne hydrographic Lidar and autonomous data acquisition vehicles (airborne, surface and submarine) is a must and will even be forced and accelerated more than ever.

For hydrographic data, ideally, the most accurate and exact data is needed. On the other hand, in the context of AI in hydrography, I suggest that all data, even if inaccurate or imprecise, is of interest. Rather than being obsessed with precision and accuracy, we must accept data for which the accuracy and precision would not be sufficient for traditional standard purposes. By knowing or even ‘qualifying’ the precision and accuracy, this data will allow the machine and deep learning algorithms to identify areas of risk to avoid for some current and future MASS.

Challenges and Opportunities

What currently appears to be incomplete and imprecise could, in the context of AI, enable a paradigm shift in which hydrographic data reaches unexpected maturity through repetition and mathematical/statistical correlation in the future.

The emergence of AI in hydrography is full of challenges and, more importantly, opportunities. This is an exciting and important developing field to follow everywhere in the world and especially in the hydrographic community. With three oceans and the longest coastline in the world, Canada should clearly have an interest in playing a pivotal role in the issue of ‘How to prepare for Hydrographic Artificial Intelligence Networks and Systems’.

3.2 Developing Machine-Learning Methods to Quickly Classify Underwater Soundscapes - SECOORA

Underwater soundscape data analysis will soon be more efficient. Dr. James Locascio, Mote Marine Laboratory, was awarded funding from SECOORA to use previously collected marine acoustic data to develop machine-learning algorithms that identify biological, geophysical, and anthropogenic sounds.

The marine acoustic data being analyzed were recorded with hydrophones in marine protected areas and other marine habitats. A hydrophone is an underwater technology that detects, and records ocean sounds from all directions. Underwater sounds are made by fish, marine mammals, hurricanes, and people (such as engines from small boats to transoceanic ships) all make noise. The soundscapes created by this diverse array of sources are rich in information about species presence and behavior, habitat quality and habitat use patterns, anthropogenic activity, and environmental conditions.

With SECOORA’s support over the next two years, hundreds of thousands of archived acoustic files that were collected from different habitat types will be analyzed by Locascio and his team, which includes staff from Mote and Loggerhead Instruments. The team will develop machine-learning algorithms that can be trained

RETURN TO CONTENTS PAGE

to automatically identify species-specific sounds. These algorithms will be able to classify and label sounds such as marine mammals, fish, invertebrates, and anthropogenic noise such as boat engines. Unknown sources will also be classified, distinguishing them as either biological or anthropogenic in origin.

Gliders and autonomous underwater vehicles (AUVs) will be used to conduct mobile surveys to collect new data as well. This work intersects with Mote's Harmful Algal Bloom (HAB) research efforts. As the Locascio's group and the HABs team plan to collect acoustic data in areas where blooms occur, Locascio's team will add sensors to the gliders and AUVs to compare soundscapes of affected and unaffected areas and track animals carrying acoustic tags.

The advances Locascio and his team make in machine learning for processing acoustic files will be shared with SECOORA and the IOOS Data Management and Communications community.

The team will also make existing data and results accessible and useful to stakeholders, and work with the South Atlantic Fisheries Management Council and Gulf of Mexico Fisheries Management Council to determine the best way that their results can be applied to help inform management decisions for the region.

3.3 Big Data in Marine Science — The University of Aberdeen Research Portal (April 2020)

This document explores the potential of big data, i.e. large volumes of high variety data collected at high velocity, to advance marine science. Marine science is rapidly entering the digital age, as introduced in Chapter 1.

Expansions in the scope and scale of ocean observations, as well as automated sampling and 'smart sensors', are leading to a continuous flood of data. This provides opportunities to transform the way we study and understand the ocean through more complex and interdisciplinary analyses, and offers novel approaches for the management of marine resources. However, more data do not necessarily mean that we have the right data to answer many critical scientific questions and to make well-informed, data-driven management decisions on the sustainable use of ocean resources.

To increase the value of the wealth of marine big data, it must be openly shared, interoperable and integrated into complex and disciplinary analyses, which can be based on artificial intelligence. The marine science community has not yet reached the big data revolution and the 'data deluge' introduces a unique set of challenges that are new to many marine scientists. This document identifies bottlenecks and opportunities related to data acquisition, data handling and management, computing infrastructures and interoperability, data sharing, big data analytics, data validation, and training and collaboration.

Specific challenges should be overcome to ensure themaximum value of marine big data can be reaped. We present topics and case studies of some recent advances in the application of big data to support marine science that demonstrate these challenges and recommendations. Chapter 2 covers climate science and marine biogeochemistry, with particular focus on European and global initiatives to integrate carbon and other biogeochemical data that are used to inform global climate negotiations. Chapter 3 discusses how big data could be used to create high-resolution, multidisciplinary habitat maps for planning new marine protected areas. Chapter 4 looks at marine biological observations including genetic sequences, imagery and hydro-acoustic data and calls for a globally connected network of long-term biological observations for more complex interdisciplinary analyses using big data. Chapter 5 addresses food provision from the ocean and seas with a focus on aquaculture and the management of sea-lice outbreaks and escaped, farmed salmon using artificial intelligence.

RETURN TO CONTENTS PAGE

4 Ocean governance

4.1 Riviera - News Content Hub - How Sweden is using AI in coastal emergency response (July 2021)

Sweden's sea and air rescue leaders have started testing AI to monitor emergency calls in the Baltic Sea and around the Swedish coast. Tenfifty's technology assists the rescue leader in identifying emergency calls. It assists in intercepting and interpreting incoming emergency calls by presenting them in an operator-friendly interface.

Swedish Maritime Administration's sea traffic control centre, JRCC in Gothenburg, Sweden, works around the clock throughout the year to assist those in distress and leads rescue efforts.

Interception of emergency calls depends on the operator's ability to perceive the individual call that is often made via a radio transmission with low audibility. If AI detects an emergency call, this is noted in the operator's interface.

This is part of the Heimdall Innovation Project, which aims to develop functional AI technology to gain assistance with emergencies.

The Heimdall system is being tested on emergency calls that the rescue leaders observe through interception designed to calibrate and further improve reception.

Maranics is responsible for building user interfaces within the project. It is creating the data capture that goes beyond speech-to-text. This includes data on weather, ship information and position. The solution is based on pilots the company has implemented and tested together with classification society DNV.

Swedish Maritime Administration rescue leader Tobias Nicander said this technology reduces work-induced stress by providing better technical support to the operators.

"It feels tremendously satisfying that we can now conduct live tests using real emergency calls," he said.

"I see great potential for the application. In sea and air rescue, it is a major advantage to gain technical support as a complement to the human ear."

Tenfifty chief technology officer David Fendrich said this was an example of how to create a reliable AI service where man and machine work together.

"Technology designed to convert speech to text using neural networks has made immense strides in recent years and it is extremely pleasing to be able to use technology for social benefit," Mr Fendrich said.

Maranics chief information officer Mattias Larsson explained how the company supports operations in the Heimdall project.

"With the help of filtered, structured and easily accessible digital information, we hope to create a safer work situation for the operator," he said.

4.2 Can AI Save Our Oceans? Let's Start With The Data (September 2019)

The ocean is in a dire crisis that puts the entirety of humanity at risk. The gravity of its issues range from climate change to plastics pollution to overfishing, all of which are overwhelming issues to tackle individually, and seemingly insurmountable when looked at together.

Scientists have noted that even if we were to halt all of our fossil fuel activity today, we are still on track to lose 90% of the ocean's corals by 2050. Coral is the ocean's life system and without it, we will soon also have an ocean without life.

In spite of the terrible news, there are some glimmers of light and hope spots that we can point to, especially in the areas of AI for the benefit of the ocean. This will be the first in a series of articles that puts a spotlight

RETURN TO CONTENTS PAGE

on the top innovators and innovations that are using the power of technology, and specifically AI to restore and regenerate our precious oceans.

Ultimately, AI is about leveraging data in the most efficient and unique ways to uncover new insights, innovations, and ways to work. When it comes to ocean data, the information is often overwhelming, unavailable and almost always fragmented. Making sense of data is the key to creating solutions for our oceans and acting on them.

Limited Knowledge is Hindering Us

Many of the issues facing our ocean today originate with us not knowing that much about it, in spite of it making up over three-quarters of our planet. It's interesting to note that we know much more about the topography of Mars and the Moon than our own ocean. Because life underwater isn't always visible, it has largely stayed out of sight and out of our cultural mindshare. Only very recently has public awareness bubbled up about the precarious state of our oceans. It's also recent that the acceleration of its degradation has become so visible that it is impossible to ignore. But what can be done about the precarious state of our oceans?

I spoke with several AI start-ups that are doing their part to enable solutions for the oceans. Sinay is aggregating ocean data and applying machine learning to empower positive ocean action, Data 360 is using data to identify cultural knowledge gaps and opportunities and Hadal is mapping the ocean floor to expand our knowledge of ocean topography (Bathymetry).

Bridging the Gap in Maritime Expertise and Data

There are many initiatives to gather data about the oceans, however, certain datasets are difficult to gain access to, and the sheer volume of information is massive. Making sense of this data requires access to computational resources and expertise in the fields of oceanography, and physics; when you add machine learning to the equation, it adds up to a rare combination of skill sets in not necessarily available in today's corporate maritime landscape.

Sinay is looking to bridge the gap in maritime expertise and data. Their platform aggregates data from over 6,000 sources ranging from IoT sensor data that measure water quality, wave and weather data, shipping vessel locations, and ocean acoustic. They then apply machine learning algorithms to correlate information for real-time decision making, insight into operational efficiencies, and reductions in cost as well as environmental harm.

SINAY

Sinay is applying its technology to a variety of use cases, one example is "acoustic pollution", an area that hardly receives any attention today. We don't think about it, but additional noise in the form of higher sound pressure levels has a huge impact on underwater ecosystems; underwater, sound can travel hundreds of miles at speeds five times faster than in air. The additional sound energy introduced in the ocean during new port construction, additional vessels in shipping lanes, and open water construction such as offshore wind farms can harm marine life. Cetaceans (dolphins, whales) are sensitive to high sound pressure levels and therefore are at risk for injury, which sometimes takes the form of large scale beaching events. Additional noise in the form of acoustic pollution disrupts all types of fish, as well as their larvae, risking the entire ocean ecosystem.

Sinay can take data from various buoys deployed in an area of interest and apply machine learning techniques to detect marine mammal proximity in real-time, enabling decisions regarding construction projects, shipping routes or port expansion to be made with wildlife protection as a priority.

Shifting Cultural Tides with AI

Disseminating knowledge about the oceans at scale is one of the most important things we can do to help society understand the damage we are doing and course-correct before it's too late. AI can help us shift the

RETURN TO CONTENTS PAGE

discourse, by understanding our knowledge gaps, creating awareness and expanding the dialogue in the areas most needed.

Using AI to analyze scientific research

Ocean Health, a leading scientific journal for the oceans shows the disconnect between what people who are knowledgeable about ocean health (i.e. the researchers) are writing about and what the general public wants to read.

In a recent analysis of topics, Data 360, a leading big data and analytics company found that researchers have focused narrowly on a small number of topics vs the expanded interests that general public advocates are addressing.

Big data and AI and machine learning can for the first time connect people to the issues and solution focused areas that are happening near them. AI can also help content creators identify influencers by city, by topic or interest level, understand how to model public cognition around issues, identify barriers to solutions with the public and develop an in-depth analysis of public sentiment, as well as predictive modeling for how to solve the public engagement problem.

Data 360 is bridging the gap between the knowledge that is shared online and what consumers are actually craving in terms of information.

Measuring the Ocean

Measuring the ocean and its various properties can take on many forms, from using drones to probe sea surface temperature, to mapping vehicles that characterize the seabed with sidescan sonar. With an average depth of 4000 meters, the seabed of the world's oceans remain out of reach and therefore out of mind. Less than 10% of the seafloor is currently mapped to high resolution, meaning we have a long road ahead of us.

“The seabed is the interface between the ocean and the earth’s crust.” says Rob Damus, COO of Hadal, a manufacturer of unmanned subs that is mapping the ocean floor. “It was once considered a barren landscape, but exploration and mapping efforts have proven the seafloor to be a dynamic environment, teeming with pockets of chemosynthetic life and geologic activity. Mapping the entire seabed would enable a deeper understanding of generally accepted models on ocean circulation, seabed geomorphology, and benthic processes that define this landscape, all of which contribute to and substantially influence our terrestrial lifestyle.”

The ocean plays a pivotal role in regulating the climate of the Earth, therefore we continue to need a better understanding of modelling efforts; without remote sensing data measurements from the oceans, we are simply guessing at how this massive heat sink behaves.

Data Leading to Action

The full potential of AI to be realized for the benefit of the ocean starts with data because you can’t change or act upon what you can’t measure. For the ocean, it can serve as a baseline that helps scientists measure pH changes, identify species, search for patterns and more. Data is helping ports understand water quality and enable real-time decision making for outlier incidents. It’s helping shipping companies create more efficient shipping routes, consume less fossil fuels and avoid collisions with whales and other marine life.

This is just the beginning, just as satellites orbiting our atmosphere enabled new technologies that are commonplace today such as GPS, and real-time traffic and routing, data that maps the entire ocean surface and floor can provide insights into weather patterns, quantity of fish stocks, water temperature, salinity and more.

Data is a baseline but AI is being applied in many ways to help save our oceans, I’ll be diving into more of those exciting technologies in future posts.

RETURN TO CONTENTS PAGE

5 Marine Mapping

5.1 Coral Reef Mapping with Remote Sensing and Machine (July 2021)

Mapping habitats is essential to assist strategic decisions regarding the use and protection of coral reefs. Coupled with machine learning (ML) algorithms, remote sensing has allowed detailed mapping of reefs at meaningful scales. Here we integrated WorldView-3 and Landsat-8 imagery and ML techniques to produce a map of suitable habitats for the occurrence of a model species, the hydrocoral Millepora alcicornis, in coral reefs located inside marine protected areas in Northeast Brazil. Conservation and management efforts in the region were also analyzed, integrating human use layers to the ecological seascape.

Three ML techniques were applied: two to derive base layers, namely geographically weighted regressions for bathymetry and support vector machine classifier (SVM) for habitat mapping, and one to build the species distribution model (MaxEnt) for Millepora alcicornis, a conspicuous and important reef-building species in the area. Additionally, human use was mapped based on the presence of tourists and fishers. SVM yielded 15 benthic classes (e.g., seagrass, sand, coral), with an overall accuracy of 79%.

xBathymetry and its derivative layers depicted the topographical complexity of the area. The Millepora alcicornis distribution model identified distance from the shore and depth as topographical factors limiting the settling and growth of coral colonies. The most important variables were ecological, showing the importance of maintaining high biodiversity in the ecosystem. The comparison of the habitat suitability model with species absence and human use maps indicated the impact of direct human activities as potential inhibitors of coral development. Results reinforce the importance of the establishment of no-take zones and other protective measures for maintaining local biodiversity.

6 Marine pollution

6.1 Bringing AI onboard to support shipping's decarbonisation journey

The shipping industry has started retrofitting vessels, exploring new fuel types and rethinking vessel design to help achieve ambitious environmental goals. Could artificial intelligence be the latest weapon in the fight against climate change?

The Covid-19 pandemic sent shipping sailing into uncertain waters from container shortages, port restrictions and problems surrounding crew changes. Now the industry is facing a new challenge: decarbonisation.

The industry produces 940 million tonnes of CO2 annually and generates around 2.5% of global greenhouses gasses (sourced from Europa.eu). Shipping authorities including the International Maritime Organisation and governments have set out decarbonisation goals and strategies.

Predictive maritime intelligence company Windward is using artificial intelligence to offer the industry collaborative fuel and emissions monitoring to help drive data-driven business models to benefit carbon management.

We speak to Ami Daniel, co-founder, and CEO of Windward, to find out more about the AI technology assisting the industry on its decarbonisation journey.

Frankie Youd: Could you provide me with some background on the company and the solutions that it offers to the industry?

Ami Daniel: We are a B2B software-as-a-service company fusing expertise, data science and AI. We provide one AI decision support platform across different elements of risk to both businesses and governments from cargo owners, freight forwarders, banks, insurance companies, commodity traders, energy and oil, shipping companies to governance – so it's quite a broad range.

RETURN TO CONTENTS PAGE

We take data from all kinds of sources – we source and buy and proprietary data as well – and transform that into insights. I think that's our unique space; they are shipping experts, we are AI experts.

We have one platform for recommendations on vessels, cargoes, and countries; we provide recommendations for security, safety, compliance, ocean, freight, and carbon. Every time BP and Shell charter vessels to move their cargo, they use our trade compliance software for a go/no go recommendation on the ship.

How does this AI solution assist the industry with its decarbonisation journey?

We use different versions of AI and deep learning; machine learning with whatever is appropriate to build very accurate solutions. As this ecosystem evolves and becomes more digitalised people expect a higher level of accuracy.

We've been building a product for carbon emissions; the reason for this is there are a lot more carbon regulations. Shipping is accountable for about 2.5% of the world's carbon emissions, but it's growing 10% year over year. It's not reducing and everybody's trying to understand what to do. People can shift to greener fuel, build new vessels, or just optimise the course decisions operations.

There's an emissions trading scheme that is going to be mandatory as of 1 January 2023. We believe we need to get to 97%, 99% accuracy for the technology otherwise we won't be usable. The way we're doing it is with AI, instead of just plugging in some numbers we're training an AI model, which is also called deep learning.

If you talk about AI, trust is important. So how do you know this works? The answer is you backtest. You have a fleet of 20 to 30 vessels, but we don't. We could start by showing you a model that predicts that 90%, or 95%, for 2019 or 2020. We'll do a double-blind test, it's very easy to test because you own the assets.

For example, if you have a car and you drive your car to London and back, you would know how much fuel you pay for it. If you were with us, you can take that to the website and compile that. You could do a blind test and say: "How much fuel did I put into my car in the last year?" We could send you a number, and you can know in a minute if that number is close to reality or not.

What does the AI do with the data that is collected on the vessel?

As opposed to some people who say "let's assume the vessel sails 15 hours", we take actual data on how the vessel is operated. We launched the 'Data For Decarbonisation' programme a couple of weeks ago. As opposed to oil trading, which is a zero-sum game, carbon emissions are not a zero-sum game.

Everybody needs to do this; we need everybody to get there and it's not competitive. We launched the data from our decarbonisation programme, which leverages the behavioural data we have had investments in for the last 10 years which is best in class. But on the other hand, it allows companies to contribute their data to allow for the most accurate models in the world. In return, they get the benefit of getting models on everyone's data. It's a network effect.

The more people join, the better the data becomes. I think this is a different approach to this space than I think other people are taking. Initial results show 97% accuracy, approximately, for the models on a voyage by point basis. I think this is going to be useful material for carbon trading, carbon-efficient chartering, auditing, and benchmarking.

How important do you think collaboration is when it comes to this element of the industry?

We know that by optimising the choice of which vessel you choose for the voyage you can reduce the carbon footprint by about 5%, which is great, but you can get to 20% if you plan the estimated time of arrival and the speed. Nobody can do that alone; you need to go back to the charter party and amend it.

I think this kind of collaboration accelerates and enables that. This opens up the industry for collaboration and accelerated digitalisation. We're having a lot of interest since we launched from all parts of the ecosystem, from shipowners, from charters, from banks. Everybody understands the need to move, but

RETURN TO CONTENTS PAGE

everybody isn't sure how to. This is not just about data, it's about working together and accelerating the path.

Is the technology fitted into the existing vessels or is additional technology needed?

What should be emphasised is that there are great companies in the space that require you to install your internet of things (IoT), we don't do that. Whatever you have we can work with; it takes one or two hours. I think it's really important because oftentimes, shippers will have around 15 new vessels and 15 old vessels. The new vessels will be OK with IoT but the oldest won't.

The retrofitting cost is huge, and it also requires you to have the vessels in a layup or dry dock or something like that. Because this is based on our behavioural data, we don't need anything. Customers give us one dump of their fuel consumption data and join the programme, so people can join the programme in a day.

Do you think this could be the future of the industry?

Yes, for sure. The problem is the public won't have the patience required to retrofit all the vessels and all the fuels – it would take too much time. Capital industry will die, the industry needs to start making progress now, you can't wait 10 years.

The message is move now. You lean in, you use AI, and you improve your results by 5%, 10%, 50% –you don't just wait for new builds.

6.2 MARLIT, artificial intelligence against marine litter: Litter that floats and pollutes the ocean -- ScienceDaily (Feb 2021)

Floating sea macro-litter is a threat to the conservation of marine ecosystems worldwide. The largest density of floating litter is in the great ocean gyres -- systems of circular currents that spin and catch litter -- but the polluting waste is abundant in coastal waters and semi closed seas such as the Mediterranean.

MARLIT, an open access web app based on an algorithm designed with deep learning techniques, will enable the detection and quantification of floating plastics in the sea with a reliability over 80%, according to a study published in the journal Environmental Pollution and carried out by experts of the Faculty of Biology and the Biodiversity Research Institute of the University of Barcelona (IRBio).

This methodology results from the analysis through artificial intelligence techniques of more than 3,800 aerial images of the Mediterranean coast in Catalonia, and it will allow researchers to make progress in the assessment of the presence, density and distribution of the plastic pollutants in the seas and oceans worldwide. Among the participants in the study, published in the journal Environmental Pollution, are the experts of the Consolidated Research Group on Large Marine Vertebrates of the UB and IRBio, and the Research Group on Biostatistics and Bioinformatics (GRBIO) of the UB, integrated in the Bioinformatics Barcelona platform (BIB).

Litter that floats and pollutes the ocean

Historically, direct observations (boats, planes, etc.) are the base for the common methodology to assess the impact of floating marine macro-litter (FMML). However, the great ocean area and the volume of data make it hard for the researchers to advance with the monitoring studies.

"Automatic aerial photography techniques combined with analytical algorithms are more efficient protocols for the control and study of this kind of pollutants," notes Odei Garcia-Garin, first author of the article and member of the CRG on Large Marine Mammals, led by Professor Àlex Aguilar.

"However," he continues, "automated remote sensing of these materials is at an early stage. There are several factors in the ocean (waves, wind, clouds, etc.) that harden the detection of floating litter automatically with the aerial images of the marine surface. This is why there are only a few studies that made the effort to work on algorithms to apply to this new research context."

RETURN TO CONTENTS PAGE

The experts designed a new algorithm to automate the quantification of floating plastics in the sea through aerial photographs by applying the deep learning techniques, automatic learning methodology with artificial neuronal networks able to learn and take the learning to higher levels.

"The great amount of images of the marine surface obtained by drones and planes in monitoring campaigns on marine litter -also in experimental studies with known floating objects- enabled us to develop and test a new algorithm that reaches a 80% of precision in the remote sensing of floating marine macro-litter," notes Garcia-Garin, member of the Department of Evolutionary Biology, Ecology and Environmental Sciences of the UB and IRBio.

Preservation of the oceans with deep learning techniques

The new algorithm has been implemented to MARLIT, an open access web app described in the article and which is available to all managers and professionals in the study of the detection and quantification of floating marine macro-litter with aerial images. In particular, this is a proof of concept based on an R Shiny package, a methodological innovation with great interest to speed up the monitoring procedures of floating marine macro-litter.

MARLIT enables the analysis of images individually, as well as to divide them into several segments, according to the user's guidelines, identify the presence of floating litter in each certain area and estimate their density with the image metadata (height, resolution). In the future, it is expected to adapt the app to a remote sensor (for instance, a drone) to automate the remote sensing process.

At a European level, the EU Marine Strategy Framework Directive indicates the application of FMML monitoring techniques to fulfill the continuous assessment of the environmental state of the marine environment. "Therefore, the automatization of monitoring processes and the use of apps such as MARLIT would ease the member states' fulfilment of the directive," conclude the authors of the study.

6.3 Artificial intelligence protects the oceans by identifying ships sinking bilge water

While cases of ships unloading and bilge water pouring off the coast are reported regularly, a startup has decided to use satellite imagery to condemn polluters. Their best ally is artificial intelligence, which was developed with the help of Amazon.

This nonprofit organization, called SkyTruth, tracks boats, whether tankers or boaters, who drop their sewage. These can actually disturb marine flora and fauna when they are tossed off the coast. A prohibited method, too, explains the International Maritime Organization, the International Maritime Organization, which is dependent on the United Nations.

Since it is almost impossible to monitor a ship’s activity relying on the collaborative work of volunteers alone, SkyTruth with the help of Amazon Web Services has developed artificial intelligence capable of interpreting satellite data and indicating the date and time of the boat’s discharge of sewage. The algorithm is based on radar data from Copernicus Sentinel-1, the observation satellites that the European Space Agency (ESA) has put into orbit. Imaging makes it possible to see the long traces of bilge water on the surface with the naked eye. Using a deep learning method, SkyTruth then trained an AI to identify the source of this marine pollution.

Ship owners and owners can be denounced and held responsible for this pollution. The idea is basically to put the sword of Damocles over the heads of the polluters by indicating what ships leave in their wake

This is not the first time Amazon Web Services has used IT infrastructures to combat human impact on the environment or to advance science. With Capgemini and researchers, AWS has developed artificial intelligence capable of recognizing sperm whales in order to better understand their migration flow and encourage ships to reroute their sea paths. Along with the World Wide Fund for Nature, Amazon has also created an orangutan identification system to identify its population.

RETURN TO CONTENTS PAGE

7 Marine biodiversity

7.1 Citizen scientists train artificial intelligence for healthy oceans (May 2021)

Spyfish Aotearoa is a newly launched collaboration between DOC and Wildlife.AI, a charitable organisation applying artificial intelligence to conservation.

Within the Spyfish website, volunteers watch 10-second video clips to identify and count the species they see. They are brought through the process step-by-step, and there is a chat function to connect with experts if the identification is unclear.

The underwater footage on Spyfish Aotearoa is from monitoring surveys that DOC conducts in marine reserves each year.

“The surveys provide hours of footage of the species investigating the baited cameras. They let us estimate how abundant some types of fish are in our reserves, such as blue cod, snapper, some species of sharks, and many more,” says DOC Technical Advisor Monique Ladds. “It’s a way to tell how well our marine reserves are doing at protecting these species.

“However, identifying and counting species in the videos is time-consuming, especially for a single person.”

The amount of footage to analyse is only set to increase in coming years, as DOC works to increase monitoring at marine reserves around the country.

DOC Intern Hiromi Beran and Wildlife.AI General Manager Victor Anton built Spyfish Aotearoa over the summer and finalised it in the first half of 2021.

“It’s been fantastic seeing the project come together,” says Hiromi Beran. “People really get into it. It’s essentially a fun, extremely helpful game.”

Spyfish Aotearoa is also being used to train artificial intelligence software. In the future, these models will be able to automatically identify and count the species.

“Using machine learning will save a huge amount of time and resources, and produce data that can be used almost immediately,” says Anton. “Making the most of the opportunities provided by artificial intelligence will greatly improve marine conservation outcomes for the future and bring us further along in the path towards thriving oceans.”

“And along the way people in Aotearoa and overseas will be able to see and learn more about the species in our marine reserves, while contributing directly to marine conservation,” says Beran.

7.2 Scientists Create First Map of World’s Corals

Researchers have created the first complete map of the world’s coral reefs.

Development of the map was led by scientists at Arizona State University. They partnered with coral reef scientists, universities, non-profit organizations and private groups across the world.

The online map is designed to be a coral conservation tool that can also support ocean planning and coral science activities.

Called the Allen Coral Atlas, the map was named after Microsoft’s late co-founder, Paul Allen. Allen’s private company, Vulcan Inc., started providing financial support to the project in 2017. The idea came out of an effort by researcher Ruth Gates of Hawaii to create “super coral” to help save reefs.

When announcing the launch of the map recently, the creators said it is the first worldwide, detailed map of its kind. It gives users the ability to see detailed information about local reefs, including different kinds of undersea structures like sand, rocks, seagrass and coral.

RETURN TO CONTENTS PAGE

The maps include areas up to 15 meters deep. They are meant to inform policymakers facing decisions about protected ocean areas, plans for structures and seawalls and coral renewal projects.

Greg Asner led the effort to create the atlas. He is the director of Arizona State University's Center for Global Discovery and Conservation. He told The Associated Press that for the first time, the project had created “a uniform mapping of the entire coral reef” system.

Asner said the researchers depended on a network of hundreds of field volunteers who provided local information about reefs. This enabled the team to program the satellites and software to study the right areas.

The map includes a coral bleaching tool to identify corals that are struggling because of climate change and other problems.

Asner said about 75 percent of the world's reefs had not been mapped in such a complete way before. He noted that many had not been mapped at all.

The University of Queensland in Australia used artificial intelligence (AI) technology and local data to help build the atlas. Anyone can look at the maps for free online.

Both Allen and researcher Ruth Gates died in 2018, leaving Asner and others to carry on their work. Asner said Gates "would be so pleased…that this is really happening.”

Asner said many of the calls he is receiving are from researchers who hope to use the maps to “be sure that their planning and their reef restoration work is going to have its max efficacy.”

8 Ports and Shipping

8.1 Microsoft consultants to deliver AI-solution at Khalifa Port (July 2021)

Opened up in 2012, Khalifa Port is the main gateway for cargo to Abu Dhabi and the rest of the UAE. The port can currently manage 12 million tonnes of general cargo, and its management company – Abu Dhabi Terminals – hopes to bring this up to 35 million tonnes by 2030.

The company has now taken a next step in realising this objective, adopting the potential of AI to shore up and optimise the vast traffic flowing through Khalifa Port. A new smart solution – built on Microsoft Azure cloud platform – paves the way for accurate container tracking in real-time, with a promise of 100% traceability.

The solution will also lay the foundation for a possible autonomous shuttle system at Khalifa Port in the future – cutting the manpower, energy and logistical prowess required to manage the sizeable port. Abu Dhabi Terminals has roped in experts from Microsoft Consulting Services to help implement the solution.

CEO at Abu Dhabi Terminals Ahmed Al Mutawa explained the far-reaching benefits of the move. “By driving innovation through the implementation of artificial intelligence and automation, Abu Dhabi Terminals is committed to modernising our port environment, while also dramatically reducing our carbon footprint, and costs, as well as turnaround times for those accessing Khalifa Port.”

“The support of the UAE Ministry of AI and our partnerships with world-leading technology providers such as Microsoft, not only future proofs our nation’s maritime assets and infrastructure, but enables Abu Dhabi Terminals and our shareholders at Abu Dhabi Ports to reap tremendous long-term benefits as we continue this exciting digital transformation journey.”

Digital is key

The company is setting the tone for a much-needed transformation in ports – in the UAE and across the Middle East. Already in 2018, a Boston Consulting Group report explained how the Middle East – despite having one of the fastest growing ports sectors in the world – is struggling with utilisation and handling rates.

RETURN TO CONTENTS PAGE

The Covid-19 crisis has only intensified this struggle – and many position technology as the answer. As explained by Abu Dhabi Terminals' chief automation office Arturo Garcia, the use of AI to solve this problem is a groundbreaking step.

"AI and automation technology are not widely used in the port industry, but we firmly believe in its potential and are convinced that our approach will not only benefit Abu Dhabi Terminals and the UAE, but will extend to the entire shipping industry, transforming the way business is done."

9 Fisheries and aquaculture

9.1 Digital fishing challenge casts wide net | Mirage News (March 2021)

Scientists protecting Kakadu National Park are calling on citizen scientists to take part in a digital fishing challenge to help generate the largest dataset of fish species in the world.

In partnership with Microsoft, the Australian Government's Supervising Scientist Branch has developed an AI-based solution to track underwater species, which will help researchers and Indigenous rangers safely monitor billabongs without fear of croc attacks.

Minister for the Environment Sussan Ley said scientists looking after river health need the public's help to label more than 500,000 images of fish.

"This dataset will make it far easier to train artificial intelligence to identify different fish species, creating a tool which will support the protection of the dual-world heritage listed Kakadu National Park," Minister Ley said.

"We are asking members of the public to simply log on and annotate the images. Some of the species you may encounter include the barramundi, the chequered rainbowfish and the penny fish.

"This is a great way to have a positive environmental and scientific impact from your sofa."

Supervising Scientist Keith Tayler said with the help of the public it is hoped the tool will eventually be used by Indigenous ranger groups to safely undertake long-term environmental monitoring at Kakadu.

"Fish monitoring was previously tackled by teams of up to 15 people working in the field for weeks at a time, who had to use nets to sample fish or count them through see-through panes in a bubble boat," Mr Tayler said.

"However increased crocodile activity in the area has made that a perilous proposition.

"This technology will mean ecologists and rangers no longer need to manually process videos of fish which frees up time for other research to help protect and rehabilitate ecosystems."

Microsoft Chief Technology Officer Lee Hickin said using cloud computing and artificial intelligence to automate fish stocks would help scientists around the globe.

"Our collaboration builds on a similar AI-based solution developed in 2018 to identify fish in Darwin Harbour that was the result of a partnership between Microsoft and the NT Department of Primary Industry and Resources fisheries team.

"The framework developed for Kakadu can be re-deployed anywhere, from Antarctica to the Great Barrier Reef. The dataset, called BRUVNet, will be made publicly available to fisheries scientists around the world.

"By using AI and Deep Learning to automate the data processing and analyses in the back end, we will have a highly complex, easily deployable and scientifically rigorous environmental monitoring tool."

The Supervising Scientist Branch within the Department of Agriculture, Water and the Environment carries out environmental research and monitoring to protect Kakadu National Park from the effects of past uranium mining.

RETURN TO CONTENTS PAGE

9.2 South Korea to use drone to combat China's illegal fishing (May 2021)

A senior South Korean Minister has pledged to use surveillance systems to combat China's illegal fishing.

The Minister of Oceans and Fisheries, Moon Seong-hyeok said illegal fishing must be "completely eradicated". He also said it creates increased security threats across the region.

South Korea has long campaigned for an end to illegal fishing in the Yellow Sea. But Seoul has since taken matters into their own hands. From next year, the nation will increase its maritime surveillance systems, including the use of drones and artificial intelligence.

Local media reports suggest around 180 Chinese vessels were found near the maritime border with North Korea each day. In 2011, a Chinese illegal fishing captain stabbed a South Korean coast guard to death in the Yellow Sea. The 43-year-old was sentenced to 30 years in jail.

China is South Korea's biggest trading partner. However, Seoul's key military partner is the United States. There are growing tensions between China and the wider region, including diplomatic strains with the United States and Australia.

Although Beijing denies the allegations, a UN Security Council report found North Korea sells up to 1,000 fishing permits each year to countries like China.

9.3 Costa Rica Joins Efforts with NGO "Oceanmind" Against Illegal Fishing (August 2021)

Costa Rica signed a cooperation agreement with the NGO OceanMind to facilitate the application of maritime regulation thanks to the experience of this organization in the analysis of satellite information and ship tracking.

The alliance, signed through the Institute of Fisheries and Aquaculture (Incopesca), strengthens the actions of our country in terms of protection of the fishing fleet and marine resources, reinforcing the commitment to safety for fishermen, conservation and fight against illegal fishing.

Continuing to strengthen efforts against illegal, unreported and unregulated fishing

"As a country we must continue to strengthen efforts against illegal, unreported and unregulated fishing in our marine territory, as we still have significant challenges […]", declared Daniel Carrasco, executive president of Incopesca. OceanMind will support the Government with ongoing analysis, training to empower the nation's future capabilities, and advanced technology such as machine learning.

"Costa Rica is taking great steps in the use of intelligence in the application of marine regulations, we are proud to be able to support the government to increase its own capacity together with other countries in the region," said Pablo Trueba, senior analyst at OceanMind Fisheries.

In addition, this agreement and the use of state-of-the-art technological tools and artificial intelligence will facilitate the protection and safety of fishermen when they are in the open sea, will provide faster and more efficient entry and disembarkation in ports, and will open opportunities to implement incentives. regulatory and marketplace to reward them.

9.4 Singapore shrimp aquaculture start-up receives funding from Bosch

Global technology conglomerate Bosch has invested in shrimp aquaculture innovator AquaEasy in Singapore, following the launch of an initiative to develop start-ups in the region.

AquaEasy uses sensors, software, and services to provide data analysis supported by artificial intelligence to the shrimp sector. With its support, shrimp farmers in Indonesia, Vietnam, and Singapore have been able to "increase yield, predictability, and implement sustainable aquaculture practices, while reducing risks and costs," the company said in a press release.

Bosch has engaged with the start-up since 2018, providing support for it in various areas including market development, business strategies, recruitment, networks, and partnerships.

RETURN TO CONTENTS PAGE

"Through corporate venturing, Bosch has been able to expand into new domains such as aquaculture in an agile way. Our joint investment into AquaEasy reflects the strong market potential in Asia where the majority of global shrimp production takes place. As a corporate venture, AquaEasy leverages Bosch's deep sensor and AI expertise for its competitive edge, and is well-positioned to tap into this market from Singapore," EDB New Ventures and Innovation Vice President Choo Heng Tong said.

AquaEasy is the first start-up that has received funding from Bosch and EDB New Ventures, an in-house innovation operated by Singapore's Economic Development Board, a government agency under Singapore's Ministry of Trade and Industry.

On 28 July, EDB New Ventures launched a start-up incubation network called grow Singapore. The incubator hub aims to leverage Singapore's position as an innovation center in the region.

"With grow Singapore, Bosch now has a 'venture engine' here to create high-growth new businesses and we are excited that AquaEasy is the first of many ventures to come," Tong said.

EDB New Ventures hopes to launch least five new businesses in Singapore by 2023 in order to create new growth opportunities for Bosch in Asia.

9.5 Artificial intelligence helping anglers track health of Rockhampto | Mirage News (Aug 2021)

Local businesses need to adapt and innovate to keep up with the constantly changing world and build resilience into their business. Advance Rockhampton is teaming up with key players in the business innovation and AI industries to show how emerging technologies can help Rockhampton businesses thrive.

InfoFish Australia, a family business created in Rockhampton, have a long involvement in fisheries research using Artificial Intelligence (AI) and is dedicated to creating better fisheries through citizen science.

InfoFish Australia co-owner Stefan Sawynok said this month they are focusing on scanning the Fitzroy River using biometrics AI technology.

"Our intention is to develop a full picture of what is happening above and below the water by completing a three part survey," Mr Sawynok said.

"The traditional method of assessing and classifying the fish signals generated by a survey is by manual inspection, which limits most sampling to a small slice of river.

"Using AI technology we can assess a lot more signals which allows us to sample the whole body of water, using a survey technique we developed specifically for this purpose.

"Thus the power of AI is that we have gone from doing say a 1km x 1km square (250 acres) in a dam as a sample to this year doing over 150, 000 acres of surveying in total."

Rockhampton Region Mayor Tony Williams said this is a fabulous example of the benefits artificial intelligence can bring to our region.

"The work that InfoFish do to assist in identifying fish population is extremely valuable to the Rockhampton region," Mayor Williams said.

"The mapping of the Fitzroy River for biomass of barramundi and king threadfin will greatly assist us in understanding the health of these fish stocks."

Advance Rockhampton Executive Manager Greg Bowden said Council's Economic Development team are excited and ready to support local businesses in their innovation journey.

"Whilst change can be challenging, it also presents an opportunity for local businesses to find new and better ways to grow. Implementing digital technologies and business innovation will assist with change," Mr Bowden said.

RETURN TO CONTENTS PAGE

10 Ocean Navigation/Exploration

10.1 ARTIFICIAL INTELLIGENCE AND OTHER INNOVATIONS ARE FOREVER CHANGING LARGE VESSELS - Global Trade Magazine (June 2021)

Throughout the course of human history, civilizations have relied on transit across water to travel, trade and invade. Archaeologists can trace the use of boats back many thousands of years, with circumstantial evidence pointing toward their use as early as 9,500 BC, well before the Pesse canoe, commonly thought to represent the world's oldest known boat.

Navigational knowledge and boatbuilding techniques have advanced steadily over time; the enormous ships we see transporting people and goods today are extraordinary evolutions of their ancestors.

In the container ship realm, it was not until the 1950s that the first commercially successful vessel completed its maiden voyage. Named *Ideal X*, it was a T2 tanker owned by Malcom McClean that carried 58 containers between Newark, New Jersey, and Houston. By contrast, today's largest container ship, the *HMM Algeciras*, can carry up to 24,000 TEUs.

Shipping is, quite literally, big business. In monetary terms, the $900 billion shipping logistics industry is expected to be valued at more than $2 trillion by 2023, growth underpinned by increasingly efficient vessels that make use of cutting-edge innovations.

For instance, by 2025 the global market for electric-powered shipping vessels is set to be worth $8.4 billion, rising to $15.6 billion come the end of the decade.

Meanwhile, the demand for maritime data analytics is set to increase from $895 million in 2019 to more than $1.8 billion by 2027. Wherever you look, technology is steering the value of big ships upwards.

Artificial intelligence – an unstoppable tide?

One strand of technological innovation in ships that is making waves is artificial intelligence (AI).

Defined as the ability of a machine or a robot controlled by a computer to do tasks that are usually done by humans because they require human intelligence and discernment, AI is taking on an increasing number of use cases aboard large vessels.

Fuel is one of the largest costs for shipping companies. For Swedish shipping giant Stena Line, it constitutes a massive 20 percent of all running costs. Innovation to help cut fuel consumption has therefore become a major priority.

Stena, which is also one of the world's largest ferry operators, has been experimenting with the use of AI technology on one of its vessels as it travels overnight from Gothenburg to the German Port of Kiel.

Working in collaboration with Hitachi, the Stena Fuel Pilot can predict the most fuel-efficient way to operate a vessel and assist the onboard captain and crew to lower the fuel consumption. The results from *Stena Scandinavica* show a reduced fuel consumption of 2-3 percent per trip, results which have prompted Stena to deploy the AI assistant across its entire fleet of 37 ships.

Niklas Kapare, captain on *M/S Skåne*, has used the technology first-hand. He commented: "We can see that it is working, even though we need to continue to adjust it to improve the results. As a captain, I get a good overview of several factors such as wind, currents and squat, and assistance to use the right power and number of engines to lower the fuel consumption."

Another important use case for AI aboard vessels is navigation. Using sophisticated tracking software in tandem with IoT connectivity, these systems can be leveraged to analyze multiple navigational scenarios.

Stena is, once again, leading the way in this regard through its AI Captain solution. It is capable of recalculating routes during voyages when it receives information to suggest that problems may lie ahead. Such problems

RETURN TO CONTENTS PAGE

could be in the immediate distance, and it is here that AI-powered image recognition technology has a role to play.

An example of this in action is a collaboration between Chinese tech firm SenseTime and Japanese shipping company Mitsui OSK Lines. SenseTime's system leverages ultra-high-resolution cameras and a graphic processing unit to automatically identify vessels in a ship's surrounding area, designed to prevent large vessels such as container ships and cruise liners from colliding with smaller ones. The solution can also alert crew to other hazards when visibility is poor.

It is not just aboard ships that AI can have an impact, however. The industry could also benefit from slicker terminal operations, with AI being trialed in a number of areas such as container handling, decking systems, gate volume predictions and vessel stowage.

According to a study from Navis toward the end of 2019, 88 percent of respondents indicated that automated decision-making will be very, if not extremely, important for the future of innovation at terminals.

Andy Barrons, chief strategy officer at Navis, said at the time: "Just a few short years ago, only a handful of our customers were even open to the idea of automation or other disruptive technologies designed to make the container terminal smarter, safer and more sustainable.

"The survey demonstrates just how far the industry has come–and will continue to go–in harnessing technology in the right ways to automate decision making within terminals. We firmly believe that automation and the use of AI is our future, and will continue to support our current and future customers as they embark down this critical path."

A fully autonomous future?

But just how far will AI technology embed itself into the workings of ships and the wider industry?

It is a mightily difficult question to answer, but there are signs that we are only just at the beginning of AI's shipping industry voyage.

Yara Birkeland is an emission-free and fully autonomous 120 TEU container ship that is under construction and due to be launched imminently. At the end of November 2020, the ship was handed over to Yara from the Norwegian shipyard Vard Brattvåg, where it is undergoing testing for container loading and stability before being sailed to a port and test area in Horten for further preparations.

Elsewhere, the European Union through its Horizon 2020 Research and Innovation program is funding a three-year project aimed at creating trade lanes linked by automated port services and used by autonomous ships.

The Advanced, Efficient and Green Intermodal Systems (AEGIS) initiative is expected to complete in May 2023 and is in line with the EU's plans to accelerate efforts to shift road transport volumes to rail and waterborne transport. Although the project is targeting smaller ships and short-sea operations, the wider implications could be momentous if it is deemed a successful endeavor.

However, one of the stumbling blocks in relation to automated ships is cost.

The enormity of the technology required (at least at present) means that many ship operators, especially those with large vessels, will not be entertaining the prospect of full-scale fleet conversion anytime soon. The *Yara Birkeland*, for example, is estimated to cost around $25 million–three times more than a conventional container vessel of the same size.

While AI has proven to yield considerable financial savings, operational efficiencies and safety benefits across a range of use cases, it may be some time before we see unmanned giants roaming our seas.

RETURN TO CONTENTS PAGE

10.2 Can Artificial Intelligence Detect Sea-Ice And Enhance Safety? (July 2021)

Often, we all wonder if the Unsinkable Ship 'The Titanic' could have been saved from the iceberg. Well, the answer lies with technology; if the world was capable enough to identify the turmoils and barriers in the deep sea, so many accidents, not only Titanic, wouldn't have happened.

Today, our marine and navigation system has evolved. Adverse climatic conditions and all those affecting the movements in deep-sea can be identified and prevented too. But one such factor, which requires much attention, is the ice and small glaciers. Often captains and marine experts have mentioned different kinds of ice that pose a significant threat to the ships.

What does the latest research say?

Ice has different patterns in terms of size, and it sometimes becomes challenging to recognize its size and location as it may be under the deep sea in most cases. Another important thing is that AI implementation is still developing in the Arctic Region (Large Quantity of Ice found) and needs instant deployment.

The need for such technologies also rose because of the rapid transition in the climate that tends to alter sea ice with the change in temperature of the ocean. Unfortunately, with such updated satellite technology, it becomes tough to identify the threat and take the necessary steps.

As a result, Ekaterina Kim, Associate professor, Dept. of Marine Technology, Norwegian University, and her colleagues Ole-Magnus Pedersen, a Ph.D. candidate, and Nabil Panchi from IIT Kharagpur have decided to develop an application that uses Artificial Intelligence to detect sea ice in the Arctic.

The Arctic is a region with some unique and extreme challenges; therefore, an AI application is essential in so many ways. Proper data analysis shared through human activities in remote arctic locations helps the process.

Sea ice detection isn't a new concept, and research and studies about the same are still happening. Below are some of the popular areas of research conducted to date:

Polar Sea Ice: Detection, Monitoring, and Modelling

Sea Ice Remote Sensing and Analysis

Automatic sea ice detection in satellite pictures

Sea ice detection based on improved similarity measurement method using hyperspectral data

Sea ice detection using GNSS-R data from UK TDS-1

How does the AI-based App "Ask Knut" help?

Ask Knut, an AI-based app and a project lead by Ekaterina Kim, is a blend of machine learning and artificial intelligence developed using a wide range of photos of ice formations, sea ice, and icebergs. It can analyze the image and tell all its details that would help the present situation.

The team plans to install a user-friendly system on the ship's bridge, which can constantly scan and film the surface. This lets people on the ship determine the threat and do the needful. The app also can recognize different photographs of ice shots by ordinary users.

The Ask Knut App has been developed using thousands of different kinds of ice photographs. The image shows what the app sees compared to what humans see. Credit: Sveinung Løset/NTNU

To build recognition, the research team developed the algorithm with photos. The teaching to the system includes factors like the ice formation, making the machine capable of analyzing the differences. Another critical factor to consider from a research perspective is monitoring glaciers and icebergs. Constant monitoring helps analyze melting and freshwater quality.

The researchers also expect to distinguish the kinds of ice, white and blue objects, underwater ice, etc., through the mobile application. Considering the navigation point of view, ice can be tough to spot, especially

RETURN TO CONTENTS PAGE

from the ship level. It also becomes challenging to identify and differentiate between the strong ice, multiyear ice, etc. The team is also very keen on the addition of new data and analysis to the AI system. It also needs exposure to a lot of information for better understanding.

The team led by Kim envisions that the future can be much more optimistic when the pandemic slows down, and there would be again ships cruising to the arctic region. She also emphasizes the need for a collective effort from everyone to collect pictures and thereby helping to develop the system.

Artificial intelligence is like something which performs better with inheriting a consistent amount of data at regular intervals. As a result, it enables computers to detect patterns and solve problems.

10.3 Riviera - News Content Hub - How AI is optimising ship navigation

Artificial intelligence (AI) enjoys a relatively robust degree of trust within the maritime industry for vessel and voyage optimisation, but many poll respondents still won't hand the ship master's controls over to a computer

A majority of the attendees at Riviera Maritime Media's webinar How AI is optimising navigation felt so comfortable with AI technology that would be willing to pay for it.

When asked a series of poll questions during the webinar, 76% of attendees said they trusted AI, while 24% did not. In another poll, 62% of respondents said they feel ready for an impending AI revolution in ship navigation.

Explaining some of the latest developments in voyage optimisation technology, University of Southampton associate professor of AI for marine applications Dr Adam Sobey, Sinay product experience manager Marie Besson-Leaud and data scientist Léa Manneheut said they believe the shipping industry is ready to fully embrace AI-powered navigational systems.

With an ever-increasing number of AI tools being developed and tested, the panel also agreed that shipping companies will benefit by enabling algorithms to calculate the optimum route for reducing fuel consumption and emissions.

During a debate on the use of AI for better weather routeing, collision avoidance and saving owners money, Dr Sobey said AI will allow owners to optimise draught and trim on their vessels in order to lower emissions and bunker expenditures.

Proof to back up the assertion came from a vessel owner Dr Sobey is working with, using an AI-based program that he has been involved in developing. Dr Sobey, who is also group lead for marine and maritime at the Alan Turing Institute and a non-executive director at Theyr, has assisted Theyr with development of the voyage optimisation software, T-VOS. He said the software uses an algorithm to calculate shipping routes to avoid bad weather, utilise ocean currents, optimise vessel speed and ensure a safe voyage.

"Results so far ... are a 5% reduction in fuel, 10% reduction in time and 7% increase in time-charter equivalence, or profits," said Dr Sobey.

"[The unnamed vessel owner] saved 250,000 tonnes of CO_2 in the first year of operation," said Dr Sobey, "and expect to save US$90M over the next decade."

Asked to define route optimisation and its primary goal, 40% of webinar attendees said route optimisation should be focused on the safest navigation for the weather conditions, while an equal percentage said the focus should be on fuel consumption. Another 12% believed route optimisation should achieve the most secure route, avoiding areas of the world known to be prone to piracy and GPS spoofing or jamming. The remaining 8% said route optimisation boils down to vessels taking the fastest route.

Sinay's Ms Besson-Leaud said the focus of her company's route optimisation unit is to "get the best route depending on following criteria: time, shipping company needs, fast arrival or reduced fuel cost, route safety and security."

RETURN TO CONTENTS PAGE

French group Sinay is developing software modules for route planning and optimisation, consumption predictions and predicted time of arrival. The product uses historic and real-time automatic identification system (AIS), weather and oceanographic information, engineroom data and fuel monitoring as data points.

Ms Besson-Leaud described the potential benefits of Sinay's predicted time of arrival module, which is being tested by some major French ports, as giving owners and operators an ability to "anticipate and adjust speed and journey [variables] to reduce CO2 emissions".

Other opportunities for this solution are for better stopover management and operations, to improve voyage frequency and improve port traffic safety, she said.

10.4 Ocean SuperCluster to Provide $2 Million for GeoScan Wide Area Acoustic Corer | Financial Post (August 2021)

ST. JOHN'S, Newfoundland, Aug. 11, 2021 (GLOBE NEWSWIRE) — Kraken Robotics Inc. ("Kraken" or the "Company") (TSX-V: PNG, OTCQB: KRKNF), Canada's Ocean Company™, is pleased to announce that its wholly owned subsidiary, PanGeo Subsea Inc. has secured $2 million in funding from Canada's Ocean Supercluster for the development of wider scanning capability and increased efficiency called GeoScan.

GeoScan Project Details

Under this new $3.4 million project, PanGeo will work with Cellula Robotics of British Columbia and the Marine Institute of Memorial University of Newfoundland to reconfigure the Acoustic Corer™ 3D technology to allow for a wider area scan and the ability to image geohazards to depths greater than 30 meters sub-seabed. In addition to providing wider area scans, PanGeo will incorporate new Artificial Intelligence (AI) processing technology to improve data acquisition and accelerate data processing. Ultimately this technology will lead to a reduction of personnel offshore and improved vessel efficiencies in support of Canada's net zero reduction targets for 2050. This project will run through to March 2023.

PanGeo's 3 D Advanced Acoustic Technology De-Risks Offshore Installations

PanGeo's wide-area GeoScan (see Figure 1) will interrogate for sub-seabed hazards and support efforts in de-risking offshore wind, oil and gas, and other offshore installations. As the offshore wind farm sector grows and matures, foundations are getting bigger with more power generation per turbine. Turbine capacity has increased from 1.5 GW to now 14 GW which has driven the size of monopile foundations from 5 meters to 10 to 12-meter diameters, thereby creating the market pull for wider area scanning requirement. Solutions provided by the GeoScan will contribute to de-risking foundation installations by imaging and identifying geohazards allowing prime contractors to microsite pile locations and reduce costly pile refusals.

10.5 AI Is Pivotal For The Future Of The Autonomous (August 2021)

The shipping industry is responsible for around 90% of the world's trade distribution, carrying the likes of machinery, motors, food and vehicles around the globe. However, despite being around for nearly 5,000 years, the industry has been incredibly slow to innovate. All you have to do is look at how the automotive industry has gone from the original car through to self-driving vehicles in less than 200 years to fully appreciate how behind the curve the maritime world is.

There are many parts of the shipping industry that need to be reimagined to continue to keep up with the growing demand of delivery and technology is at the heart of this, factoring into nearly every element of the shipping process.

Health and safety on board ships is the highest priority for operators, customers and crews, and technology can play a big role in reducing the rising number of collisions. Some 90% of maritime collisions occur in congested waterways, as crews struggle to navigate vessels, but this number can be drastically reduced by introducing the right data artificial intelligence (AI) model.

RETURN TO CONTENTS PAGE

AI technology provides captains and crews with additional support to deal with the complex scenarios crew face on a daily basis, including low visibility. The connected technology also ensures that data is shared in real time between crew that are on and off shore, allowing the captain to make more informed decisions and introduce new processes to make everyone's lives easier while keeping up with demand.

Introducing these new technologies allows the navigational officers on board to priorities their duties and save time on tasks, like simultaneously shifting between different sides of the ship, watching the navigational tools and calculating risks the crews face on a daily basis. It's an impossible task that requires an immense level of concentration through their duration at sea. The development models also help the captains and senior shipmates make better decisions based on the data gathered by the tech such as Orca AI. With AI developments, the level of responsibility and pressure on roles such as this will be aided greatly for the better.

Steps have already been taken to improve safety on ships, with the installation of motion sensors, but even this can be taken one step further by creating a complete hive network of sensors and readers to assist in measuring every part of the ship. This enables onboard crew to detect faults in hardware and software, harsh weather conditions, traffic updates and feed all the data back to shore where operators are able to update clients, tracking systems and even schedule future repairs or changes. The tech advancements offer crews more autonomy in their roles and get a good hand on sustainability by preventing errors and learning from previous mishaps.

In the future, AI technology will also enable stakeholders and senior leaders in the shipping industry to look at the social and economic levels of struggling regions and create new channels, production lines and ports.

Shipping companies must assume a larger responsibility for workers within their networks and focus on those from areas and environments where protection of human rights is poor. The industry should look to become a safe space for crews to operate and navigate while protecting and respecting the people, natural resources and habits.

The basic understanding of establishing AI to alleviate risk and unnecessary stress on crews and operating staff will unlock the added business potential to explore new avenues of growth. The benefits for businesses looking at this will likely show customers to take more responsibility and an alternative approach to the social responsibility of shipping as a means of delivery and operational performance. Off the back of this, the door will open for unlikely partnerships that can boost mutual benefits, profits and create a wider society throughout the industry.

Sustainability is at the forefront of the global mind and the base of sustainability is human wellbeing. Introduction of new AI technologies will give businesses better outlooks on future operations with crew changes, emissions tracking and reduction of stress.

The industry is heading in a direction where crews and senior management will be able to make instant decisions backed by hard data and take health and safety into account at all points. Intelligent ships will allow faster operations, a happier workforce and a better understanding of where we need to take the industry. For the time being, AI needs to be welcomed into the industry as a means of growth and development instead of a replacement for people. We need to look to enhance the day-to-day of onboard operators which will in-hand benefit the lines, production, levels of risk and impact on environment.

10.6 Solving the Sky-High Costs of Ocean Exploration with A.I. — Oceans Deeply

Research ships are vital for advancing marine science but are costly to operate. Oscar Pizarro, a scientist at the University of Sydney's Australian Centre for Field Robotics and the Schmidt Ocean Institute, thinks automated expeditions are the future of ocean science.

A MAJOR CHALLENGE in studying the ocean is simply the cost. According to a report published by UNESCO last year, ocean research vessels rack up charges ranging from $10,000 to more than $40,000 a day to operate. Increasing costs "will almost certainly" constrain the future use of such ships, researchers found.

RETURN TO CONTENTS PAGE

One of the biggest expenses? The crew itself. That's why Oscar Pizarro, a principal research fellow at the University of Sydney's Australian Centre for Field Robotics and chief scientist at the Schmidt Ocean Institute, thinks taking humans out of the mix is an answer. He recently led a research cruise testing automated research drones that he hopes could, eventually, undertake an expedition on their own from an autonomous ship.

The 20-day expedition on board the research vessel Falkor returned this week after deploying a fleet of drones to map the seafloor off the coast of Hawaii. Teams from several research institutions and universities used a variety of drones, aiming to improve each automated system and the team's ability to keep track of multiple drones at once. It's an idea that Pizarro thinks will one day lead to cheaper, automated expeditions, leaving human researchers on land.

Oceans Deeply spoke with Pizarro about the expedition while he was aboard the Falkor, traveling from the coast of Maui to the Big Island.

> Oceans Deeply: Why is it important to be mapping the coral reefs and the seafloor with automated technology?

Oscar Pizarro: We really depend, as a global civilization, on the ocean. We really need it to be healthy for us to also stay alive and healthy; and in order to make informed decisions and trade-offs between how we exploit it and how we look after the ocean, we need to have good science, and science ultimately relies on having good observations.

If observations are expensive, you will have fewer of them, and you will have to rely more on your assumptions and models. But if you have observations that are good quality, you can have better predictions that can inform decision-making, policymaking and hopefully that will help look after the oceans and keep them healthy for everybody on this planet.

> Oceans Deeply: What are the challenges in designing these autonomous vehicles to map the seafloor?

Pizarro: There are plenty of them – just ironing out glitches in software for everything from the logging instruments to making control decisions, to executing missions where you're trying particular behaviors.

There's a lot of logic built into it, in terms of how to behave when something goes wrong – what to do at the end of a mission when you haven't heard from your human overlords. There's a lot of smarts built into these systems. Some of that may not be fully tested, and so there's a bit of iteration just getting all that stuff glued together and talking end-to-end. Sometimes, when you add a new instrument or a new capability, that may break or may need to be updated, or sometimes one of your instruments has an internal upgrade, and that produces other problems.

Then, hardware-wise, if it's a new system, some of the things may not have spent enough time being run through the paces and confronted with the range of demands you may expect in terms of currents, or depth, or simultaneous load of thrusters going on while using high-power sampling interference.

Then there's just operating in a new environment. You tend to find that when things are operating, the situation may change faster than you realize, and then these autonomous systems have to make these decisions on their own. Often they're doing the right thing, but sometimes they're not and that's where you have to go in and iterate again. So, the challenges are also in learning from using these things in real-world situations.

> Oceans Deeply: What are the benefits of having multiple drones that are doing the same thing?

Pizarro: The point of having multiple platforms is that you should be able to perform a survey more quickly, or collect more data for the same amount of time you're spending at sea.

One of the greatest limiting factors is ship time, so it's more about how do you run in parallel this type of work so that you're multiplying the capabilities of a ship like Falkor.

RETURN TO CONTENTS PAGE

And the challenges there are in this planning. "Oh, we're supposed to be here at 10 a.m., and also 2km (1.2 miles) to the west at 10 a.m." Can't do both, right? So what are we going to do? The tools that help us deal with having many things in the air at the same time is one of the aspects that we're also trying to develop further on this trip.

What we're trying to get here is showing multiple vehicles operating together in a way that's sensible in that we're getting high-quality scientific data out of them without swamping the human operators and without requiring too much of an army of specialists to do so.

> Oceans Deeply: What does your work on this expedition tell you about the future of drones and humans in oceanographic research?

Pizarro: I'd like to think that the future is bright. These platforms and their capabilities are only going to get better. I think what really motivates me in the long term is how to make them more cost-effective and scaleable. So how do we deploy a large number of autonomous systems and sample the ocean at a much broader and intensive scale than we do today, without it costing hundreds or thousands of times more? We're not going to spend much more money than we do on this. How do we get more out of the money we're spending on it?

It seems that autonomous systems that ultimately don't rely on having people in the field is the way to go. These demonstrations, these tools that we're slowly putting together, will likely play a role in that type of scenario – where you have an autonomous surface vessel that deploys unmanned underwater vehicles away from civilization with light oversight from people, doing fairly complex operations, like imaging the sea floor. And it's not costing you tens of thousands of dollars to just be there.

10.7 Maersk Invests in AI Innovation (Oct 2018)

Maersk has invested in New York-based freight-booking artificial intelligence (AI) start-upLoadsmart as it looks to diversify its operations away from purely maritime transportation.

The world's largest container shipping line is leading a $21.6 million Series A funding for Loadsmart through its Maersk Growth arm, a department it uses to research new technologies and find new investment opportunities.

It is joined by investment firm Connor Capital SB and asset management firm Chromo Invest in backing Loadsmart.

PTI Insight: Blockchain – The Missing Links

The new investment raises the total amount raised by Loadsmart to $34.7 million. It will use the capital, initially, to accelerate its product and engineering operations.

Loadsmart leverages AI to automate the truckload booking flow in the US and provides instant prices to shippers with capacity guaranteed on all US lanes.

Find out more about how smart technologies can change the shipping industry with a Port Technology technical paper

Through its automated platform, shippers can book a truck in seconds, as well as reduce their spot exposure by 50% and procurement execution by 90%.

Speaking about the investment, Sune Stilling head of Maersk Growth, said: "We see huge potential with Loadsmart.

"Forward integrations between ocean shipping and over-the-road services can create incredible synergies and eventually provide a full service to shippers."

World Economic Forum: Blockchain Worth $1 Trillion to the Global Economy

RETURN TO CONTENTS PAGE

Richard Salgado, co-founder and CEO, Loadsmart, also commented: "Our strategy has been to focus exclusively on product development and technology.

"Now we are ready to grow. This round of investment will enable us to increase the business exponentially while maintaining high-service levels. It will also enable us to scale without losing the edge on innovation and technology."

PTI asked Maersk how much it invested, but it declined to disclose the amount.

10.8 7 Startups Using AI, Satellites, And Data Science To Transform The Maritime Logistics Industry (Nov 2017)

Trade continues to grow and the world's ports need to handle greater numbers of goods each year to cope with demand – this means security is more important than ever before and real time data gathering is essential.

In August 2020 the Maritime Port Authority of Singapore (MPA) announced a deal with Lita Ocean, a Singaporean shipbuilding and repair company, for a fleet of six next-generation patrol vessels which have predictive capabilities.

It is the latest in a series of deals Lita Ocean has made to provide some of the busiest and fastest growing ports in the world.

The company has also provided Saudi Ports Authority (Mawani) eight new patrol vessels.

Saudi Arabia receives some of the biggest vessels on the sea and is a key hub for goods and cargo.

This requires substantial security procedures and insight into how the environment can be kept clean and safe, matters which are important ports across the world.

In the case of MPA the vessels, 17m in length, were bought to enhance front-line capabilities and, like Saudi Arabia, better protect operations and the marine environment.

Equipped with an Intelligent Port Marine System, the new fleet would help MPA enforce security measures and better respond to marine emergencies.

The vessels will make the Port's overall operations more efficient, with their predictive capabilities using real-time and historical data enabling them to carry out targeted enforcement and response mitigation.

This is critical as ports are quickly becoming ecosystems of data. The more data they produce, the greater the need for further investment to analyse it.

Next-generation technology, such as that which Lita Ocean builds and provides, is going to become more important in the near and medium term.

10.9 MPA and Mawani use Lita Ocean for data-led patrols - Port Technology International

Trade continues to grow and the world's ports need to handle greater numbers of goods each year to cope with demand – this means security is more important than ever before and real time data gathering is essential.

In August 2020 the Maritime Port Authority of Singapore (MPA) announced a deal with Lita Ocean, a Singaporean shipbuilding and repair company, for a fleet of six next-generation patrol vessels which have predictive capabilities.

It is the latest in a series of deals Lita Ocean has made to provide some of the busiest and fastest growing ports in the world.

The company has also provided Saudi Ports Authority (Mawani) eight new patrol vessels.

RETURN TO CONTENTS PAGE

Saudi Arabia receives some of the biggest vessels on the sea and is a key hub for goods and cargo.

This requires substantial security procedures and insight into how the environment can be kept clean and safe, matters which are important ports across the world.

In the case of MPA the vessels, 17m in length, were bought to enhance front-line capabilities and, like Saudi Arabia, better protect operations and the marine environment.

Equipped with an Intelligent Port Marine System, the new fleet would help MPA enforce security measures and better respond to marine emergencies.

The vessels will make the Port's overall operations more efficient, with their predictive capabilities using real-time and historical data enabling them to carry out targeted enforcement and response mitigation.

This is critical as ports are quickly becoming ecosystems of data. The more data they produce, the greater the need for further investment to analyse it.

Next-generation technology, such as that which Lita Ocean builds and provides, is going to become more important in the near and medium term.

10.10 Five Reasons Why It Is Important to Map the Ocean Floor | Hydro International

The health of our oceans and the health of our planet are one and the same. Yet the link between how much we know about this environment and how we protect it is not always clear.

In this article, I outline 5 reasons why better mapping could help us to understand the basics of our ocean ecosystem and help us protect it – and one reason why mapping could compromise our environment.

The 5 reasons why:

Our future

Our future is tied to the health of the world's oceans. They capture carbon, regulate the earth's temperature and are a source of food for billions of people. To protect our oceans and future generations, we need to build a better understanding of our changing climate and the effect it has on the marine environment.

Unfortunately current models use data that is up to 80% incomplete, with calculations that are based on misleading averages. For example, we know that on average the sea is 3km deep, but this doesn't account for outliers like the Mariana Trench which stretches to depths of 11km.

So, if we don't know its exact volume, how can we understand the ocean to its full extent? And, more critically, how can begin to understand the full extent of how humans are impacting the marine environment?

Organisations and partnerships around the world are trying to change this, including The Nippon Foundation-GEBCO Seabed 2030 project – which aims to create a global map of the ocean by the end of the decade. By collecting and sharing more data that depicts the actual depths of the seafloor, we can build a better understanding of our marine environment and how to protect it

Possibility

We know so little about the ocean's potential to support life on earth. In fact, it's a well-known fact that we know more about the surface of the moon than we do about the seafloor.

But recent years have seen increased ocean exploration, which has led to the discovery of previously untapped resources: new medicines, genomes, food and energy resources, and even aspects of our own cultural heritage. But if there is a wealth of natural resources that can be sourced from our oceans, how do we manage their use fairly and sustainably?

Habitat mapping, analysis of seabed samples, and a host of other marine geospatial data sets can support this aim, by building a full itinerary of our ocean resources and a means of monitoring their use. Without this data, we risk depleting vital resources and causing irreversible damage to critical marine habitats.

RETURN TO CONTENTS PAGE

Protection

Communities around the world depend upon the existence of many vital marine environments, and both human and animal populations alike are threatened by their overexploitation. The 30x30 project aims to safeguard these environments by designating 30% of the world's oceans as marine protected areas by 2030. But to do so, there are formidable hurdles.

Likewise, as offshore renewable energy becomes increasingly important, access and rights to parts of the ocean become fundamental to both conservation and economic efforts.

For both of these initiatives to work, ocean territories and areas of responsibility need to be well-defined. But this is easier said than done, as the coastline is ever-changing.

To be able to define clear, mutually agreed boundaries, good survey data and tidal observations are essential – as well as expertise in Law of the Sea. If you can't define your coastline you can't fully protect your seas

Resilience

Coastal inundation poses a significant threat to millions of people around the world. Caused by storm and tidal surges, it can completely submerge surrounding areas in sea water – causing substantial damage to infrastructure and harm to vulnerable communities. With rising sea levels, it is estimated that this issue could affect up to 4.6% of the global population annually by 2100.

A good understanding of the shape of the seabed and the nature of the coastline can help authorities to develop models that predict the impact of coastal inundation on low-lying areas. By identifying areas at risk, they can then take measures to protect communities. For example, the planting of mangroves can reduce the impact of strong wave action.

Access to disaster insurance products is also a key driver of national resilience in Small Island Developing States – so quantifying the effects of coastal morphology and composition are increasingly essential to allow access to this.

Safety

Last, and by no means least: safety is dependent on an understanding of ocean depths, obstructions and tidal currents – not only the safety of individuals, but for the ecosystem as a whole.

Untold damage to environmentally sensitive areas can occur just from the release of fuel reserves from a stricken vessel. When it comes to the effect from a bulk carrier or oil tanker, the damage can be multiplied by an order of magnitude.

Even now with ubiquitous remote sensing technology, many navigational products rely on 19th century data collected in rowing boats with lines and lead weights. Therefore it's imperative that we collect more accurate data to support the safe and efficient navigation of shipping around the world.

And 1 reason why not.

Pollutants

To adequately map the oceans to a reasonable standard by 2030 would require every known ocean research vessel to work every day for the next 10 years. Notwithstanding, most of these vessels are not configured for ocean survey specifically, and certainly not for deep water mapping. Therefore the failure rate from working on this continuously would make it untenable – as would the other research lost if all these ships were only focused on survey.

Even more problematic is the consumption of fuel and the production of undersea noise which would have environmental consequences in their own right. So, what we don't need is just more of the same.

Environmentally friendly propulsion would be a step in the right direction and in nearshore, clear waters, remote sensing can provide part of the solution. However, ocean survey requires a game-changing technological leap.

RETURN TO CONTENTS PAGE

The most likely direction for this is in autonomous vessels – small, uncrewed vessels that can operate semi-independently, either through programming or remote control – which don't operate using fossil fuels. Even so, such technology on its own is not yet at the stage where it will singlehandedly change the amount of data collected.

Another hopeful avenue is through building local capability for survey. By putting the skills to undertake surveys into the hands of local practitioners, the amount of data collected will increase at a lower environmental cost. This requires training; not only in survey and survey processing, but in data management and dissemination.

Gaining a better understanding of our ocean is a fundamental objective in protecting it. It is a big job though one which I am optimistic about.

Developments in technology and collaborations in data gathering suggest we are on the brink of knowing much more about size and shape of the ocean. As we look ahead to COP26, and beyond that to the UN Decade of Ocean Science for Sustainable Development, the UK Hydrographic Office will continue to share data with our partners that supports safe, secure and thriving oceans.

10.11 GSTS Awarded Contract for Vessel Risk Detection Using Artificial Intelligence Algorithms

HALIFAX, NS, June 1, 2021 /CNW/ - Global Spatial Technology Solutions ("GSTS" or "the Company") an Artificial Intelligence (AI) and Maritime Analytics company, announced today that it has been selected by Defence Research and Development Canada (DRDC) to provide advanced Maritime Risk Detection and Assessment capabilities in support of maritime border security and surveillance. The solution will identify ships in an area of interest and using the cutting-edge techniques of artificial intelligence and machine learning, consolidate a ship's identity, movement history, and risk status with information collected from multiple sensors. Fusing the intelligence into a single operating picture, GSTS's solution enables users to improve Maritime Domain Awareness. The total contract is funded under the Canadian Safety and Security Program.

This powerful solution will leverage OCIANA™, an AI-based platform developed by GSTS that rapidly processes data from multiple sensor sources to provide intelligence in near real-time. Using various satellite data sets, coupled with machine learning algorithms for object analysis, OCIANA™ enables customers to detect, assess and respond to maritime threats rapidly and effectively.

"This contract will enable GSTS to demonstrate the capability to satisfy many of the world's most challenging maritime risk and threat detection issues pertaining to security, environmental and commercial risks. It will provide next-generation capabilities to satisfy the requirements of security, customs and immigration, defence, coast guard and environmental agencies on a global scale," said Richard Kolacz, CEO of GSTS. "It is another example of the versatility of the maritime AI solutions developed by GSTS, and of the continually increasing revenue stream enabled by the OCIANA™ roll out.

The project is unique in that it will demonstrate the ability to use the proprietary AI algorithms developed by GSTS, with a country's own surveillance data sets to provide enhanced Activity Based Intelligence. This enables nation states to use the GSTS solution within their existing maritime surveillance systems, to extract additional intelligence, or combine them with the OCIANA™ platform capabilities to provide enhanced Maritime Domain Awareness.

OCIANA™ is an AI-based platform developed by GSTS that rapidly processes satellite data with other data sets harvested from ocean, weather, and port activity to provide decision-making information in near real-time. OCIANA™ will provide enhanced situational awareness, decision-making and inter-agency communications capability to enable governments and agencies to respond to any maritime threat or incident.

RETURN TO CONTENTS PAGE

About GSTS

GSTS is a leader in Artificial Intelligence solutions for the maritime domain. Our solutions are designed to save lives, energy, and the environment on a global scale through the use of innovative applications based on emerging data sets and analytics. Our solutions enable enhanced decision-based operations for civil, commercial and defence and security agencies and industries. For more information, visit www.gsts.ca.

11 Marine Renewables and Sustainability

11.1 ELEMENT set to start onshore testing programme for Nova Innovation's tidal energy turbine - Offshore Energy (October 2021)

EU-backed ELEMENT project, whose aim is to slash the cost of tidal energy by 17% using artificial intelligence, is well underway with preparations to start with the onshore testing programme at ORE Catapult’s Blyth facility.

The onshore testing will see the Nova Innovation’s RE50 tidal turbine installed on ORE Catapult’s 1MW powertrain test facility as part of the first in a series of test campaigns to verify the ELEMENT control system performance.

On the expected successful completion of the onshore testing, the turbine will undergo tow trials before being transported to the Étel estuary test site in Brittany.

The optimised and validated ELEMENT control system will then be installed on an existing Nova M100 tidal turbine in the Shetland Tidal Array as well.

Funded by the European Union’s Horizon 2020 research and innovation programme, the ELEMENT project is developing a control system that will show how artificial intelligence can slash the cost of tidal energy by an estimated 17%, bolstering the case for tidal energy as an important part of the world’s future energy mix.

From mid-2019 to mid-2022, eleven academic and commercial partners are working together to develop and demonstrate the ELEMENT control system for Nova Innovation’s turbines.

The test set up allows the performance of the ELEMENT control system to be demonstrated for representative tidal flow conditions. The onshore testing provides a controlled test environment where test conditions are defined by the operator – not the prevalent tidal or sea conditions, according to ELEMENT.

Not only does this provide a unique opportunity for tuning and optimisation of the control system under controlled conditions, but also improves confidence of the ELEMENT control system performance by minimising the risk of early complications and unplanned maintenance – significantly easier to address in the test hall compared to an offshore deployment.

The data gathered will verify the ELEMENT control system performance, across a range of tidal conditions, and provide the opportunity to complete initial optimisation of the control system prior to the offshore testing programme – key elements of successfully delivering the ELEMENT project.

Ultimately, the onshore testing provides independently verified results that will help developers across the sector assess the benefits of introducing intelligent control systems to maximise energy capture and reduce operational overheads.

11.2 Riviera - Opinion - AI, machine learning and maritime sustainability (2018)

Enabled by global connectivity and internet of things technology, the stream of numbers covering fuel consumption, performance, weather and hundreds of other variables has never been greater

The ability to gather masses of high-frequency data is nothing new in maritime. Enabled by global connectivity and internet of things technology, the stream of numbers covering fuel consumption, performance, weather and hundreds of other variables has never been greater

RETURN TO CONTENTS PAGE

The question is how to make sense of all of that information; a challenge well beyond manual analysis that requires sophisticated analytics tools capable of comprehending information at scale and across timelines.

Which is, of course, where artificial intelligence (AI) comes in. More specifically, machine learning (ML) systems and their algorithms that are capable of churning through disparate data points throughout the history of operations to bring to light insights among the noise: key relationships between variables that can be used to predict future outcomes.

Voyage optimisation

There are plenty of ways this kind of capability can be put to work. Predictive vessel management and maintenance is one, spotting the signs in the build-up to a preventable event and stepping in before it disrupts operations. Another is the ability to optimise voyages in real-time, a technique that promises to substantially improve operators' returns.

Understandably, much of the hype around digitalisation and the advent of AI in maritime is focused on boosting those bottom lines. More often than not this is viewed in terms of fuel consumption. And rightly so, particularly given the 2020 sulphur cap and the US$15Bn fuel cost hike expected to hit the global shipping container industry.

Sustainability

But sustainability is now an issue in and of itself. The latest report from the UN's Intergovernmental Panel on Climate Change laid out a bleak prognosis for the future of the planet, including the fact that we may have just 12 years to take meaningful action on climate change. The report outlined the need to cut global emissions by a whopping 45%.

The maritime industry has a moral responsibility – and in some cases, a legal requirement – to improve on sustainability. And although it is not going to be easy, the promise of AI and ML is real.

The initial challenges, however, are pretty fundamental, as co-founder of data-driven shipping sustainability platform We4Sea, Dan Veen explains.

"There are many companies with different and even conflicting interests who control part of the supply chain: shipowners, managers, charterers, agents, suppliers and equipment manufacturers," he said.

"They all play a role in getting, distributing or analysing data. Transparency in the supply chain, enabled by AI and big data, is not [necessarily] in the interest of all of those parties."

It is also about the technical limitations of those taking decisions relating to sustainability. "The knowledge on IT-related issues is limited," he said. "Many managers are former captains – very experienced in those kinds of matters – but without training in the fields of AI and ML."

Those technical deficiencies form something of a snowball effect when paired with issues of methodology and mentality. "A lot of shipping companies are managing the company like a ship: just like a captain, you are trained to solve all issues yourself."

The solution is easy to see but not necessarily one that shipowners are taking. "With the speed of development in IT, there is no other choice than to partner with external companies that can help you to learn and develop faster," said Mr Veen.

For example, he points to the huge majority of vessels still using noon reports as their primary source of fuel efficiency data.

"That means that all data is relying on a manual, error-prone report sent once every 24 hours. Knowing that data on vessel speed, weather data, heading and draft is available every 2-3 minutes, it's surprising that many shipping companies do not use the abundant flow of data... to monitor vessels in near real-time, or even to predict things that may happen."

"The data is there on our doorstep, we just have to learn how to use it," he concluded.

RETURN TO CONTENTS PAGE

ML-driven data science

Maritime tech company Nautilus Labs is another offering ML-driven data science to ship operators, despite admitting that the potential of the technology has not yet been fully realised.

Nautilus Labs chief executive Matt Heider outlined reasons for the gap between the hype and the current state of affairs. The first of which is that “many maritime businesses still trust manually collected and reported data more than high-frequency data,” he said.

“This leads to a dependency on this type of data – even though it is limited and error-prone. That reliance on old methods is hard to change.”

There is also the fact that, for machine learning in maritime to reap the rewards it has promised, AI needs access not only to huge swathes of accurate, high-frequency vessel data, but also other data sets about the environment the vessel operates in.

“Tying those two points together, if a business does not have or trust the elemental dataset, then it is impossible to create actionable insights with ML,” he said.

But there is hope that AI can drive improved sustainability. “We see ML and the artificial intelligence it will create in the future as the bedrock of a slew of innovations that will bend the emissions curve of the industry and bring it to a more sustainable place,” continued Mr Heider.

“All across the value chain, there are small ways that different components of the market can be made more efficient with advanced software – and those small efficiencies aggregate to massive savings over time. For our clients in shipping, ML-based fleet optimisation – once fully embraced and developed – has the ability to reduce total fuel usage by up to 30%.”

In the case of We4Sea, using the data on the doorstep involves developing digital twins of ships to see where performance can be improved through benchmark comparisons, data analysis and simulations.

Nautilus Labs combine proprietary algorithms with KPI’s, weather data, route plans and more to construct a voyage optimisation calculator that clients can leverage on a daily basis.

Supply chain visibility

But sustainability is not all about voyage optimisation. AI and ML can also help to eliminate unnecessary voyages in the first instance. San Francisco-based ClearMetal provides predictive supply chain visibility software for shipping companies and other logistics carriers.

“The reality is that AI and ML are only as good as the data you feed them,” ClearMetal’s director of marketing Tyler Holmes explained. “The supply chain is one of the most complicated things for shippers around the world to get a complete picture of. The end-to-end supply chain is massive, spread across an enormous amount of data formats, systems, direct partners, and third parties. Add to this challenge that often the data shippers have access to is late, incomplete, inaccurate or never arrives at all.”

The silver lining of that scale and complexity is that even the smallest of changes can have a big impact. “AI and ML are the only way for those changes in efficiency to be made at scale because there is just no way for a human to crunch the amount of data involved,” he said.

“It is imperative to leverage these technologies to make changes in an iterative fashion because even small changes that a human might not pick up on translate to enormous gains at scale.”

Mr Holmes’ advice is applicable to maritime leaders whether they are looking to optimise voyages or harness the power of improved supply chain visibility. “What we recommend to our customers is ‘start where you can make an impact’,” he said.

“As fast as technology evolves, those traditional long-term projects run the risk of being obsolete by the time they are complete. The opportunity cost of not taking an iterative approach to optimisation is scary when we are talking about trillions of dollars in the global economy.”

RETURN TO CONTENTS PAGE

Which brings us back full circle to the cold hard facts of maritime sustainability. Despite the pressing need to take action on climate change, decisions will ultimately be driven by dollars.

“Left unchecked, the maritime industry could account for a fifth of global greenhouse gas emissions by 2050,” said Mr Heider.

Voyage economics

But AI solutions could provide “a meaningful step towards not only improving sustainability efforts but also improving voyage economics, and ultimately the two have to be linked,” he said.

“The industry has no compelling reason to act if it is not driven by economic motivations, and we see ML and AI as the technological bridge that connects improved efficiency with both better financial and environmental outcomes.”

Fortunately for the planet, the numbers bear that out. Mr Veen described a successful project in which the company’s ML platform was used to analyse two sister ships of a Dutch shipowner burning 30 tonnes of fuel per day at sea.

By comparing data collected with the company’s digital twin technology, it became clear that both vessels were not sailing according to their design specifications. “Most noticeable was the relatively low speed of sailing, he explained. “That had an impact on the average engine load, which was often below 40% of its maximum rating.”

“As the shipowner had no torque meter data, this remained unnoticed for 15 years. So we simulated a different scenario where the engine was de-rated to be closer to the actual use of the engine and showed a possible saving of 5-6% on fuel consumption.”

Nautilus Labs also shared some bold predictions about how AI and ML could make small differences on a huge scale in maritime’s battle to become more sustainable.

“These numbers really add up,” said Mr Heider. “Even if we conservatively estimate an average reduction of 0.5M tonnes of fuel waste per day due to improved monitoring, transparency and accountability, that equates to many millions of tonnes of reduced consumption per year globally across the world’s fleet.”

And that could be just the beginning. “The follow-on impact for the environment is massive, and that is just by eliminating the most basic forms of fuel waste. As we continue to get into more advanced forms of the decision support for both the crew and the shoreside teams, the fuel savings increase dramatically, as does the benefit to the environment and our clients’ bottom line,” he said.

No doubt Nautilus Labs, We4Sea, ClearMetal and others in the maritime efficiency space will hope impending climate disaster will be the catalyst for maritime leaders to embrace AI, ML and data science in a bid to reduce fuel consumption and emissions. But you don’t need an algorithm to conclude that it will not quite be that straightforward.

11.3 How Artificial Intelligence impacts renewables industry - SAFETY4SEA (November 2017)

In the position paper “Making Renewables Smarter: The benefits, risks, and future of artificial intelligence in solar and wind”, DNV GL explores where artificial intelligence (AI) will have an impact to increase efficiencies in the renewables industry.

AI is expected to automate operation over the course of the following years in the solar and wind industries and boost efficiencies, as well, across the renewable energy sector, DNV GL mentions.

Wind and solar generation plants have benefited from the recent development of these technologies and have had sensor technology installed from the beginning.

As a result, most of the advances supported by artificial intelligence have been in resource forecasting, control and predictive maintenance.

RETURN TO CONTENTS PAGE

Solar and wind industry stakeholders will see artificial intelligence benefits in a number of areas, including:

- Robotics growing in prevalence for remote inspection, with new benefits in maintenance and troubleshooting.
- Crawling robots that can get close to a structure's surface enabling a new set of technologies.
- Supply chain optimizations by autonomous driving robots, which can in future build entire onshore wind or solar farms.
- Autonomous drones with real-time artificial intelligence-supported analysis will become the primary tool for carrying out effective and efficient inspections of wind turbines and solar panels.
- AI applications accelerating due diligence, reducing the time investment of planning and analysis that today requires many human hours.
- Artificial intelligence will also automate decision making, driving costs out of energy development, production, and delivery in the solar and wind industries.

For most operators in the renewables industry, building artificial intelligence systems that are stable, progressive and reliable requires sets of knowledge and data from across many different projects. To achieve that, a deep knowledge of the domain of industry experience is key.

Fortunately, there is a large amount of historical data in the market, DNV GL concludes.

11.4 Q&A: Making the case for mobile marine protected areas (Jan 2020)

In 2000, Stanford marine ecologist Larry Crowder read an intriguing scientific paper that introduced the concept of mobile marine protected areas, or mMPAs – ocean sanctuaries whose boundaries can shift in space and time to protect animals that follow changing ocean features like the Gulf Stream. When the features moved, the protections moved with them.

"I remember thinking, 'It's a cool idea, but we can't do it,'" said Crowder, the Edward Ricketts Provostial Professor in Stanford's School of Humanities and Sciences and a senior fellow at the Stanford Woods Institute for the Environment.

Fast forward twenty years. The technological hurdles that once gave Crowder pause about the feasibility of mMPAs have largely been overcome. Remote sensing satellites can now track boats and fishing vessels anywhere on Earth in real time. GPS allows fishers to know instantly whether they've strayed into a protected area, even if the boundaries have changed. And scientists can remotely follow the movements of sharks, turtles, whales and other creatures and then use computer models to predict their future movements.

But even though mMPAs are now technologically possible, the legal and policy frameworks necessary to make them a reality are still lacking. "It's time to get the policymakers involved in thinking through how they might use this new tool," Crowder said.

To this end, Crowder and his colleagues have published a commentary in the journal Science proposing that mMPAs and other "dynamic area-based management tools" be discussed at the June 2–6 meeting of the United Nations Convention on the Law of the Sea (UNCLOS) in Lisbon. The convention, a treaty which has been in effect since 1982, defines the rights and responsibilities of nations with respect to their use of the world's oceans and establishes guidelines for the management of marine natural resources.

The Center for Ocean Solutions spoke with Crowder about how mMPAs can reduce conflicts between humans and marine life and help protect species and habitats under climate change. The following interview has been edited for clarity.

RETURN TO CONTENTS PAGE

First, what is a mobile marine protected area?

Marine protected areas evolved out of the use of terrestrial protected areas to protect locations with high amounts of biological diversity, unique habitats or cultural sites. On land, static designations make sense, since terrestrial habitats don't move around in ecological time.

In the sea, however, there are some habitats that sit still for the most part – like coral reefs, kelp forests and seamounts – but there are other habitats that move around, including the positions of ocean fronts and currents.

It seems like an abstract idea, but we do it all the time already. Think about air traffic control. Here in the Bay Area, we have three major international airports. Planes can land from the north or from the south. When it gets foggy, air traffic controllers space out the airplanes, and when the wind direction changes they might have planes land from the north rather than from the south. All of those conditions are thought through based on changing environmental conditions. There's a protocol that says when the visibility drops below some level, you space out the airplanes. There's no public meeting or discussion. It just happens because the rules have already been worked out in advance.

What is an example of an ocean feature that moves around?

The North Pacific Transition Zone is a ribbon of water that's defined by certain bands of water temperature and density. It shifts 1,000 kilometers (about 621 miles) north to south with summer and winter. It's like a buffet line that many animals flock to in the North Pacific because most of the ocean doesn't have high densities of food, but this convergence zone does. It's also where conflicts between humans and marine life are likely to occur. The question is, by using a dynamic approach, can we reduce the conflicts by just shifting where humans operate a bit from where they operate now?

If I say, "Draw a rectangle around the entire North Pacific Transition Zone in its summer and winter locations," you end up with a big box because it's 1,000 kilometers north to south. But another option is to draw a smaller polygon that covers it as it moves from summer to winter. If you use mobile marine protected areas rather than static areas, you can potentially protect a much smaller box.

What kinds of marine animals would mMPAs protect?

Any organism that you think of as being an open ocean organism that doesn't swim willy nilly across the ocean. There are places in the ocean that they go to. To give one example, endangered loggerhead sea turtles nest in Japan but they range across the entire Pacific Ocean. The juveniles feed in Baja California, Mexico, and then they return to Japan some 20 to 30 years later when they are ready to breed. The turtles don't move haphazardly. They move in response to these oceanographic features. There's a predictable habitat where they end up in the North Pacific Transition Zone. That habitat moves seasonally and will shift farther with climate change. Other examples include albatrosses, whales, sharks, tunas and so on.

What would an mMPA that protects sea turtles look like?

In fact, there's already a program in place that NOAA (National Oceanic and Atmospheric Administration) put together that's called Turtle Watch. By putting satellite tags on loggerhead and leatherback sea turtles in the North Pacific, NOAA scientists have developed statistical models that allow them to determine habitat associations of those turtles over time. They update their forecast once a week.

It turns out temperature is a really strong predictor of where the turtles will be. So they can create models that basically say, "If you fish at this particular temperature, that's likely to be where the sea turtles are. So fish north of there, or fish south of there, but don't fish in this band."

Right now, Turtle Watch is only enforced in the United States. But you could imagine something like it serving as an advisory to the international fleet as well, to tell them, "Go catch tunas, go catch swordfish, but catch them in a place where your turtle bycatch is likely to be low."

RETURN TO CONTENTS PAGE

Can you summarize your proposal about mMPAs to the United Nations?

We're not proposing that UNCLOS be changed. We're recommending a follow on treaty which would allow new, more modern approaches to area based ocean management. What we argue in our paper is that we're now in a position scientifically to consider marine protected areas whose boundaries can shift. It ought to at least be on the table.

The proposals are for the delegates who are negotiating this potential new treaty to just add the idea of mobile protected areas to their venue, or at least not exclude it. It hasn't been on their radar because it's a relatively new thing. Whether they actually use it and when and where is totally up to the people who are working these cases.

How do mMPAs tie in or overlap with your own research?

I've been working on bycatch in fisheries for 30 years. I study how to keep turtles out of fishing nets and sea birds out of longlines. In the past, scientists have focused on "gear fixes." They might, for instance, try to change the longline hook or use different baits or experiment with putting a different-colored light stick on the longlines. I worked on turtle-exclusion devices that allowed turtles that get into a trawl to get kicked out before they drown.

Dynamic management offers another way to reduce risk to marine animals by separating in space and time the critters that you're trying to protect from the human activities.

Any environmental management that you implement has to work for the people and the planet. We want to come up with solutions that achieve protection for the sea birds and sea turtles but also allow fishermen to continue to do business. We want to sufficiently protect whales but also allow global shipping to continue.

12 Ocean Conservation

12.1 Using Artificial Intelligence to Save Coral Reefs | Nasdaq

Coral reefs are some of the most diverse ecosystems in the world, sometimes called the "rainforests of the sea." Coral reefs are a vital part of marine life, act as guards against forces of nature and are a key source of livelihood for millions. Unfortunately, these diverse habitats are rapidly degrading. Here's how advanced technologies such as Artificial Intelligence (AI) are being used to save coral reefs.

Coral reefs: Rainforests of the sea

Coral reefs are natural protectors for coastlines against storms and erosion. Healthy coral can help prevent loss of life and property from waves, floods and storms by absorbing 97% of the energy. Tropical coral reefs cover a mere 0.1% of the ocean, but an estimated 25% of marine life depends on these diverse ecosystems.

According to the Economics of Ecosystems and Biodiversity (TEEB) study, "approximately 850 million people live within 100 km of and derive some benefits from coral reefs, with at least 275 million depending directly on reefs for livelihoods and sustenance." In the U.S., the total economic value of coral reef services including fisheries, tourism, and coastal protection—is over $3.4 billion each year.

Coral reefs are endangered. According to the United Nations Environment Programme, between 25 and 50% of the world's live coral has been lost in the last 30 years. Coral reefs face many threats—natural (such as diseases, predators, and storms) as well as from human activities. Some of them involve physical damage from coastal development, dredging, quarrying, and boat anchors. Additionally, there is a cascading effect due to activities such as overfishing and coral harvesting which alter the structures of marine life. The United States Environmental Protection Agency lists the "increased ocean temperatures and changing ocean chemistry (ocean acidification)" as global threats to coral reef ecosystems. The aggregate effect of these factors together is placing pressure on 75% of coral reefs globally.

This calls for timely measures to adequately protect coral reefs from further damage.

RETURN TO CONTENTS PAGE

AI to the rescue?

A crucial part of the effort towards protecting coral reefs include mapping, monitoring, analyzing, and restoring them. The process of collecting data for reef monitoring has traditionally been done by divers by capturing video footage and pictures. However, many times, divers have to interfere with their surroundings and it unintentionally affects the results of the survey. In addition, there are practical restrictions such as time spent under water. Overall, there are many gaps which exist in these approaches, be it in terms of in mapping coral reefs or real-time monitoring. Some of these gaps can be plugged in by deploying AI and machine learning.

An AI-powered solution by Accenture, Intel (INTC), and the Sulubaaï Environmental Foundation—to monitor, characterize, and analyze coral reef resiliency dubbed as project CORaiL, was announced in April 2020. The teams from Accenture, Intel, and Sulubaaï implemented an artificial concrete reef—called a Sulu-Reef Prosthesis (SRP)—to provide support for unstable coral fragments underwater. In addition to the fragments of living coral which were planted on the SRP, intelligent underwater video cameras, equipped with the Accenture Applied Intelligence Video Analytics Services Platform (VASP), were planted to detect and photograph fish in the reef surrounding the Pangatalan Island in the Philippines.

VASP uses AI, powered by Intel Xeon, Intel FPGA Programmable Acceleration Cards, and Intel Movidius VPU to count and classify the marine life. The data collected is structured using analytics enabling researchers to make data-driven decisions that will help the reef progress. The teams are now working on infrared cameras, which enable night-time video capture to create a complete picture of the coral ecosystem.

In October 2020, the researchers from the Arizona State University Center for Global Discovery and Conservation Science have generated a global coral reef extent map using a single methodology capable of predicting the location of shallow coral reefs with nearly 90% accuracy. The researchers at ASU have further developed a new airborne mapping approach. “By combining laser-guided imaging spectroscopy and artificial intelligence, the new approach reveals unprecedented views of coral reefs below the ocean surface. The maps show where live corals persist as well as areas of degraded reef,” according to the study.

Overall, many research papers see AI and machine learning applications as a promising approach to eliminating the bottleneck in data processing for coral reef monitoring. The use of these technologies can enhance the speed of processes at a much-reduced form, and dramatically improve how coral reefs are measured and monitored worldwide.

12.2 Global Fishing Watch launches new technology to enhance ocean management - Global Fishing Watch

Washington, D.C. — Global Fishing Watch has launched an innovative technology portal to help strengthen management of marine protected areas (MPAs) and other effective area-based conservation measures (OECMs). The portal hosts diverse datasets and analysis tools to support marine spatial planning and ocean stewardship. Founded by philanthropist and ocean advocate, Dona Bertarelli, the technology aims to revolutionize our ability to dynamically monitor and conserve marine ecosystems.

The United Nations set a target of protecting 10 percent of the world’s ocean by 2020. Today, less than 8 percent of the ocean is safeguarded through MPAs or OECMs, with less than 3 percent covered by fully or highly-protected areas. Despite progress in recent years, a lack of open, timely and user-friendly data has impeded the design and management of MPAs. Global Fishing Watch Marine Manager aims to help solve this problem by combining and visualizing near real-time, dynamic data on ocean conditions and human activities and their impacts.

“Marine protected areas are increasingly being recognized as a tool to restore ocean health, combat climate change and support a sustainable and regenerative blue economic recovery,” said Dona Bertarelli, United Nations Conference on Trade and Development Special Adviser for the Blue Economy and co-chair of the Bertarelli Foundation. “Realizing their potential requires urgent action to achieve the goal of protecting at least 30 percent of the ocean by 2030, through the creation of marine protected areas and effective

RETURN TO CONTENTS PAGE

management on the water. Global Fishing Watch Marine Manager is part of the solution to improve ocean protection and achieve international conservation goals."

Global Fishing Watch Marine Manager has launched ahead of the opening conference for the Decade of Ocean Science, a United Nations initiative to bolster scientific research and innovative technologies to support the sustainable development of our ocean.

"Global Fishing Watch is tapping the technology revolution to empower sustainable management of marine ecosystems. Our marine manager portal puts scientific information at the fingertips of managers and researchers, with the tools necessary to rapidly analyze data and monitor vast ocean areas," said Tony Long, CEO of Global Fishing Watch.

MPAs and OECMs are essential tools for building resilience to rising sea surface temperatures and ocean acidification, and they help create safe havens for biodiversity and fish stocks to replenish. But robust and science-based management is needed to fully realize their vital contribution.

The portal allows marine managers and researchers to monitor vessels involved in commercial fishing and other activities, such as vessels involved in tourism, oil drilling and shipping. Vessel information can be overlaid with environmental datasets such as salinity and sea surface temperature to understand climate change impacts over time.

"Protecting our oceans is a global task that requires global action. As a leader in marine conservation, Canada is proud to support the Global Fishing Watch's marine manager portal. Their world-class technology will monitor marine protected areas and advance scientific research, contributing to the overall health of our oceans and helping us to protect 30 percent of the ocean by 2030," said The Honourable Bernadette Jordan, Minister of Fisheries, Oceans and the Canadian Coast Guard.

Inaugural partners using the portal include management authorities responsible for the iconic Galápagos Islands—one of the most biologically diverse MPAs in the world—and the globally-significant Ascension Island MPA—a protected area that has never had considerable fishing activity. Important marine areas for Guyana and the islands of Tristan da Cunha—located in the south Atlantic Ocean—and Niue—in the South Pacific—are also included in the launch of the portal. More locations are set to join as the portal's development continues.

12.3 Artificial Intelligence in the Ocean: What it is and how it facilitates ocean conservation - AltaSea (May 2021)

Earth is 70 percent ocean, yet many aspects of it remain a mystery. We have better maps of the surface of Mars than we do of our own planet's ocean floor, and an estimated 91 percent of ocean species have not been classified. Faced with the need to increase understanding of the ocean in order to better protect it, scientists are increasingly turning to artificial intelligence (AI) to speed up knowledge-gathering and improve data collection.

Artificial intelligence is an umbrella term for software systems capable of making decisions that traditionally would require a human brain. The algorithms behind AI analyze real-time data—from various sources such as sensors, digital data, and remote inputs—and then act based on the insights gained from the data. Through this process of machine learning, algorithms are able to find patterns in collected data in order to make educated predictions about future events.

The ability for machine learning to process massive amounts of data, extract useful information, and identify trends is invaluable when it comes to learning about the ocean. The enormity of the ocean and the challenges of exploring the underwater environment meant humans were discovering the ocean at a snail's pace prior to the rise of technology. Formal oceanography started with the expedition of the H.M.S. Challenger in the 1870's, and underwater vehicles were not created until the late 1950's. That means we have only been able to investigate the oceans' 3.8 billion years of history, 332 million cubic miles of water, and myriad species from below the surface for less than a century.

RETURN TO CONTENTS PAGE

Now artificial intelligence has enabled scientists to complete monumental tasks, like identifying and locating humpback whale songs in 180,000 hours of underwater recordings, with a relative speed that means we are gaining more ocean knowledge more quickly than ever before.

As the New York Times explains, machine learning is even more valuable in the age of climate change because, “animals move their habitats [as] temperatures rise and currents shift.” As the makeup of the ocean changes, data quickly becomes obsolete and the need to collect and understand updated metrics becomes critical to managing threatened marine populations.

Along with facilitating a better understanding of the impacts of climate change, AI enables natural ocean processes to be harnessed for climate change mitigation. For example, the company Hypergiant has created a bio-reactor that uses AI to optimize the growth of carbon-sequestering algae. The system uses AI to monitor its algae tank and adjust factors such as light, pH, and temperature to maximize the growth of CO2-eating algae. According to Forbes, “the system is 400 times more effective at absorbing CO2 than trees.”

Researchers have also used artificial intelligence to improve performance and increase revenues of offshore wind farms. Such developments help bolster the renewable energy industry and fight climate change by maximizing the ability to harvest clean energy. As the world rapidly shifts away from fossil fuels, ensuring the reliability and efficacy of new energy technology is a vital component of an emissions-free future.

When it comes to threats facing the ocean, AI is used to confront issues as disparate as plastic pollution and illegal fishing. Currently, an estimated 20 percent to 32 percent of wild-caught fish imported to the United States are illegally caught. To address this, OceanMind uses satellite data and AI to trace ships’ movements and fishing methods, improving the transparency of the seafood supply chain. The Google-affiliated Global Fishing Watch also harnesses AI to identify and address illegal fishing. Illegal and unsustainable fishing practices that were historically hard to monitor on the high seas can now be tracked and eradicated thanks to AI technology.

Jenny Krusoe, the Founding Executive Director of AltaSea, says that artificial intelligence is integral to addressing anthropogenic threats to the environment and reducing the impact of the shipping industry.

“Data is the key to moving forward quickly and solving these problems for our planet,” she said during a panel discussion with AI LA about the role of artificial intelligence in ocean health.

From exploring ecosystems, to understanding wildlife behavior, to facilitating a responsible human-ocean relationship, artificial intelligence has become a crucial component of ocean science and conservation.

12.4 The Amazing Ways We Can Use AI for Healthy Oceans | AIWS (Feb 2021)

71% of our planet is the ocean. Humanity’s future is in the oceans. Oceans drive key planetary systems that affect us on land. Artificial intelligence empowers marine conservationists to dive deep into a new chapter of marine exploration. AI is assisting scientists to address several problems ranging from climate change to overfishing to plastics dumping. Scientists are leveraging AI to collect enormous ocean data and discovering new insights to create solutions.

We enjoy many benefits from oceans, such as getting oil and gas. AI potentials can be utilized to efficiently extract energy resources, discovering new medicines, apprehending climate change, and finding endangered species.

Following are some advantages of AI in the conservation of oceans and marine life:

1-AI to explore ocean:

Around 95% of the oceans are unexplored. Researchers are using AI to investigate and understand those areas of oceans that cannot be reached by us. Researchers use AI algorithms to record data from marine vehicles or camera systems for evaluation. AI helps in identifying new marine animal and plant species living deep under the sea.

RETURN TO CONTENTS PAGE

- Kaiko is a remotely operated underwater vehicle developed by Japan Agency for Marine-Earth Science and Technology for sea exploration of up to 11000m depth. AI technology helped in uncovering and collecting many biological species that could prove beneficial in medical and industrial applications.
- Crabster is an underwater AI-based robot, developed by the Korea Institute of Ocean Science and Technology, used to rectify faults underwater structures, such as oil or gas pipelines.

2-Collect large computational data and identify marine species:

Researchers are using AI technologies to gather a vast amount of data about the ocean environment, recording temperature, marine life, earthquakes, tsunamis, and many more. Data that cover the entire sea can prove to be very useful for insights into pH changes, identify marine species and patterns, fish stocks information, and more.

- Researchers at North Carolina State University have designed an AI algorithm that can recognize marine species or microscopic organisms.

3-AI helping reduce plastic pollution**:**

Marine life and oceans are encountering serious damage from plastic pollution. According to researchers, around 1 million seabirds and 100,000 marine animals die due to plastic dumping every year. With the support of machine learning models, scientists could collect more data and analytics to get more meaningful insights. Artificial intelligence is utilized for building more informed strategies to reduce plastic pollution of oceans.

- Ocean Cleanup, a non-profit organization, uses AI tools to help clean oceans by extracting plastic pollution.
- Sustainable coastline, a New Zealand based NPO, is working in collaboration with Microsoft to restore coastal environments. They are using AI to find out the sources, causes, and solutions to coastal pollution.

4-AI to Save Marine Life:

Climate change is not only affecting animal and plant species on land but it has an adverse impact on marine life also. Many marine species are on the verge of extinction. Scientists are applying AI techniques to monitor marine life and mammals to protect them. AI technology could be used to minimize illegal poacher activities.

- Flukebook.org is an online AI-powered research platform that supports the conservationists to study and protect whales and dolphins by providing a common data portal and automatic identification of species.
- OOICloud, a collaborative project by Columbia University and Queens College, provides an AI-powered platform that gives scientists, oceanographers, and conservationists access to a massive amount of data for ocean study and management.

5-Saving coral reefs:

Coral reefs are a diverse ecosystem that provides habitat to over 25% of marine life and are also beneficial to humans in many ways. Due to pollution and other human activities, the health of coral reefs is degrading continuously. Researchers are utilizing artificial intelligence technology to monitor and reinstate coral reefs.

- Accenture, Intel, and Sulubaai Environmental Foundation have collaborated on project CORail, an AI-based solution to watch, classify, and analyze the health of coral reefs. This project collects data from underwater cameras equipped with Video Analytics Services Platform (VASP). Researchers are using AI to detect, count, and classify marine life.

RETURN TO CONTENTS PAGE

6- Sustainable Fishing:

The world's fish stocks are decreasing and illegal seafood trade is rising at a rapid rate. To resolve this problem, researchers are taking the help of artificial intelligence to ensure efficient aquaculture and fisheries management.

12.5 Machine Learning and Ocean Conservation — CSResearch (2017)

Reversing the rapid decline in ocean health is critical to addressing climate change. It is a global challenge requiring a global solution. Our oceans cover 70% of the world's surface, generate over 50% of the world's oxygen, absorb half the carbon produced and account for 80% of the planet's biodiversity. Ocean Health is critical for economic and food security reasons, with over 100 million households livelihoods dependent on the fisheries industry and 3 billion dependent on seafood as their primary protein (Source: WEF).

In many countries around the world, the seafood sector is growing at twice the rate of GDP growth. It is a significant employer and contributor to government revenues. However globally, illegal, unreported and unregulated (IUU) fishing represents a theft of around 26 million tonnes, or close to $24 billion value of seafood a year. In certain cases, such as tuna, stocks have declined over 90%, and some species could soon be classed as 'at risk'. The decline of such stocks impacts economic development, jobs, livelihoods of coastal communities that are already under stress, as well as having serious environmental consequences. Illegal, unregulated and unreported fishing has exacerbated the situation, taking more fish out of our seas than scientists recommend.

In addition, the seafood sector is a particularly challenging sector for the 100 million who work across the seafood value chain. Poor labour conditions and human rights abuses, both on fishing vessels and in processing plants, are notorious and well documented. As vessels travel in and out of national jurisdictions, monitoring such poor and hazardous labour conditions require new approaches.

New technologies around traceability in the seafood supply chain could offer powerful new techniques to address illegal fishing and ensure growth can be sustainable. Technologies such as lower cost satellite tracking, unmanned drones that can fly for months on end, unmanned vessels, lower cost sensors, big data, blockchain, can help automate and remotely monitor fisheries, making it easier to regulate against illegal fishing activities.

Sustainable innovation will require industry to take greater responsibility along the supply chain. By requiring that all seafood is fully traceable to the vessel or aquaculture farm, retailers and harvesters can ensure all seafood entering the supply chain is safe and legally sourced. This requires strong public-private collaboration.

We announced our commitment to the UN Oceans Conference 2017 and the launch of a project dedicated to developing talent and skills on machine learning and AI for addressing Oceans challenges.

Data analytics and machine learning can provide a range of new or deeper insights/foresights for understanding, sizing and managing ocean resource exploitation and illegal fishing, among many other challenges.

There are many diverse ways to nurture talent, but in all cases an essential element is practical tangible experience. This si the format of Data Science for Social, an initiative dedicated to the exploration of data science to problems that matter. The format is challenge driven, whereby a group of data scientists (with skills on machine learning, image detection, statistics, visualization and geospatial analysis) work on a specific problem. In one of the first projects, the goal is to demonstrate how Machine Learning applied to a combination of AIS data, high resolution satellite images and other ocean data sources can provide meaningful progress towards addressing the challenge od detecting and ending illegal fishing.

RETURN TO CONTENTS PAGE

12.6 AI for Coral Reef Conservation: Data Collection for Computer Vision in the Vamizi Island | Knowledge 4 All Foundation Ltd.

Description

The goal of this project is to develop a computer-vision based non-intrusive automatic data collection mechanism to collect images and give insights about ecological succession on coral reefs in the Vamizi Island, allowing biologists to analyze data in real-time and infer on animals life story, behavior and population in Mozambican waters.

Rationale

Coral reefs are among the world's most diverse ecosystems, with more than 800 species of corals providing habitat and shelter for approximately 25% of global marine life, although they cover less than 0.1% of the ocean floor. Coral reefs are also extremely valuable ecosystems providing livelihood for 1 billion people, and generate 2.7 trillion US Dollars from fisheries, coastal protection, tourism and recreation each year worldwide.

Nevertheless, coral reefs are rapidly declining due to various global and local factors such as overfishing, climate change, ocean acidification, pollution and unsustainable coastal development.

In this context, technological resources have been used for monitoring and analysing the state of coral reefs, and to allow biologists to obtain data in real-time to know about animals' life story, behaviour, population, and survivorship, collecting valuable data that informs sound decision-making and management/conservation efforts.

Different studies show various approaches for collecting data for marine biodiversity conservation purposes, such as using Remotely Operated Vehicles, Autonomous Underwater Vehicles, and fixed underwater video cameras equipped with Video Analytics Services Platforms.

Most of these studies developed deep learning tools for rapid and large-scale automatic collection and annotation of marine data. However, these studies suggested that to improve current solutions, convolutional neural networks have to be optimised and backup power supplies must be improved.

Moreover, some studies also consider applying infrared cameras, which would enable night-time video capture to create a complete picture of the coral ecosystem. In Africa, however, little or no research has focused on these approaches to apply advanced technology to research marine ecology conservation.

Outcomes

In the long-term, resolving this question will help gain insight on the ecological processes around artificial reefs (particularly important in the context of the oil and gas developments occurring in Mozambique and which will warrant the implementation of reef restoration measures).

Further, this system will be helpful to develop many other research projects which require long periods of observation in remote reefs where permanent and nighttime access is limited. Additionally, this project will create capacity in the young mozambican research community regarding the application of Artificial Intelligence technologies to tackle marine conservation issues.

Vision

This project is an opportunity to pioneer the development of new technologies that will ultimately support conservation effort through enhanced data collection and processing.

The vision is to improve data collection capacity by building on top of already existing systems, namely by developing a different mechanism to provide power supply capable of maintaining such systems in coral reefs located more than a few kilometres from shore by using floating solar panels instead.

In the long-run, the project will be replicated for different coral reefs to allow biologists to obtain data in real-time and learn about animals' life story, behaviour, and population dynamics. In addition, multiple units

RETURN TO CONTENTS PAGE

would be deployed at several locations to allow for more comprehensive research or monitoring reefs from various angles.

12.7 Harnessing big data to support the conservation and rehabilitation of mangrove forests globally | Mapping Ocean Wealth

Mangroves are a key habitat for our Mapping Ocean Wealth work, and it's easy to see why. These coastal forests protect shorelines, store and sequester vast amounts of carbon, enhance fisheries, and even provide opportunities for recreation and tourism.

These types of ecosystem service analysis, as well as conservation and marine planning initiatives rely on the best available science and data; but identifying and accessing the most reliable source of data can be a challenge. This is especially true for data on mangrove forests, where advances in satellite data and spatial data processing have led to an abundance of mangrove data at multiple scales, while coordination among mangrove data providers has lagged behind.

A potential solution has been proposed in a recent paper, "Harnessing Big Data to Support the Conservation and Rehabilitation of Mangrove Forests Globally". Led by Dr. Tom Worthington (Cambridge University), alongside colleagues at The Nature Conservancy and the Global Mangrove Alliance, this paper makes the case for an integrated data platform, currently in development, which will provide centralized access to a wide variety of mangrove datasets, including baseline datasets (e.g., extent, condition, structure), secondary datasets (e.g., derived products such as restoration potential), and analytical dataset (e.g., ecosystem service valuations).

The paper also provides an overview of existing and upcoming datasets, the challenges of using this data for on-the-ground management, as well as guidance as to how global datasets can support existing policy mechanisms needed to fulfil global commitments such as Sustainable Development Goals and Aichi Targets.

The paper provides a path forward for integrating and aligning the vast amount of of mangrove data in a way that is useful to a wide range of stakeholders and conservation practitioners. In the first phases of development, the platform will feature data and interactive statistics on global patterns of change on a multi-year scale, as well as change alerts and data on blue carbon. As the platform is further developed, options for more sophisticated data queries will be available, as will national and local-scale.

Improving access to mangrove data will promote advancement in conservation and restoration of these important habitats.

13 Technology: Sat-based solutions, remote sensing and earth observation

13.1 Frontiers | Satellite Remote Sensing in Shark and Ray Ecology, Conservation and Management | Marine Science

Global elasmobranch populations have declined dramatically over the past 50 years, and continued research into the drivers of their habitats and distributions is vital for improved conservation and management. How environmental factors influence elasmobranch behavior, habitat use, and movement patterns is still relatively poorly understood, in part because of the scale over which many of these animals roam and the remote nature of the marine ecosystems they inhabit.

In the last decade there has been an explosion of satellite remote sensing (SRS) technologies that can cover these vast spatial scales for the marine environment. Consequentially, SRS presents an opportunity to analyze important environmental drivers in elasmobranch ecology and to aid management decisions for the conservation of declining populations.

RETURN TO CONTENTS PAGE

A systematic literature review was undertaken to synthesize the current use of SRS environmental data in elasmobranch research. In addition, to facilitate the use of SRS in this field moving forward, we have compiled a list of popular SRS data sources and sensors for common environmental variables in marine science. Our review of 71 papers (55 published in the last 10 years) identified ten SRS-derived environmental variables that have been used in elasmobranch studies, from a range of satellite sensors and data sources. Sea surface temperature and ocean productivity were the most frequently used variables. Articles primarily analyzed variables individually or in pairs, with few studies looking at a suite of interacting variables.

Here, we present a summary of the current state of knowledge on the application of SRS, current gaps and limitations, and discuss some of the potential future directions in which we envisage this field developing. Threatened elasmobranch populations inhabit some of the world's most remote marine ecosystems. With often global coverage, SRS presents an opportunity to analyze the important environmental drivers of elasmobranch ecology to aid management decisions for the conservation of declining and threatened populations.

13.2 How satellites and big data can help to save the oceans (May 2016)

Over the past century, rampant overfishing, severe pollution, and runaway coastal development have taken a huge toll on the world's oceans. Now, however, two major advances in global ocean governance are quietly unfolding, offering hope that the early decades of the 21st century will mark a turning point in which humanity can begin to repair the global seas.

Yet a key question remains: Will the new availability of sophisticated, satellite-based technologies, coupled with the democratisation of online data about the health of our environment, help ensure that these positive advancements live up to their potential to protect the oceans?

The first encouraging policy development is the explosive movement by countries around the world to set up massive marine protected areas of unprecedented size. The biggest of these newly proposed mega-marine protected areas, the Pitcairn Islands Marine Reserve, is three-and-a-half times larger than the UK, and more than 100,000 times larger than the historical median size for an ocean protected area.

The 19 mega-marine protected areas created or announced in the last six years would comprise an area larger than all the protected ocean areas created previously. Several huge marine reserves currently being considered would add an additional 775,000 square miles (1.8 million square kilometres) of ocean protection.

The second key development is that the UN is now drawing up a treaty that would, for the first time, manage biodiversity across the high seas — the region outside the 200-mile exclusive economic zones of individual nations.

The forthcoming UN high seas treaty would be setting new rules for a swath of the ocean 22 times larger than the US. These new regulations are focused on preserving marine biodiversity, establishing international ocean reserves, evaluating processes for sharing marine genetic resources, and effectively carrying out environmental impact assessments.

In the absence of systems to monitor boundaries, large marine protected areas will be nothing more than huge paper parks.

These bold new policies suggest that decision-makers are finally committed to taking the kind of aggressive actions needed to stay a step ahead of industrialisation in the oceans — something we failed to do when industrialisation occurred on land.

This issue extends well beyond industrial-scale fishing. Recent innovation and technological development have now made it possible to take the industries of farming, mining, power generation, and even data centre management underwater.

The scope and significance of this mass acceleration of new uses of the ocean cannot be overstated. In 2014, for example, the world began eating more fish from farms than from the wild — a marine reprise of our

RETURN TO CONTENTS PAGE

historic shift on land from hunting wild food to farming. Mining claims have already been staked to roughly 400,000 square miles of deep-sea ecosystems.

The campaigns to vastly expand marine protected areas and significantly improve international governance of the oceans are extremely exciting. But both of these important policy movements have an Achilles heel: Laws only matter if you can ensure that people actually follow them.

These new policies cover such vast areas that they render boat, plane, and other traditional forms of ocean observation as obsolete as sextants. In the absence of systems to watch their boundaries, large marine protected areas will be nothing more than huge paper parks. Likewise, our efforts to control the exploitation of high-seas biodiversity via the new UN treaty will only be effective if we aren't blind to what is happening in this large and distant part of the ocean.

But just as technological innovation is fueling a rapid acceleration of development in the ocean, high-tech solutions may also hold the key to ensuring that a marine industrial revolution advances responsibly and intelligently. These advances, when put in the hands not just of governments but also of researchers, citizen-scientists and environmental groups, promise a new era in which we can actively observe and responsibly plan out what's going on in the world's seas.

A vital solution lies in the use of satellite-interfacing sensors and data processing tools that are beginning to allow us to watch how ships use the oceans as easily as we track Uber taxis cruising around a city. Like airplanes, more and more ships now carry sensors that publicly transmit their position so they don't crash into each other. We can make use of these same streams of safety data to detect where industrial fishing is concentrated, to watch as seabed mining exploration begins, and to observe how cargo ships overlap with whale migration pathways.

Instead of the oceans being a black hole of data, our new challenge is figuring out ways to intelligently and efficiently sift through the billions of data points now pouring in. Fortunately, smart new algorithms can help pick out specific kinds of vessel behaviour from this sea of big data. Ships leave unique behaviour fingerprints. For example, purse seine fishing boats make circles around fish schools when setting their nets, while long-line fishing boats travel linearly up and back along the gear they set.

In a recent report in the journal Science, colleagues at the non-profit Global Fishing Watch and I monitored progress as the nation of Kiribati closed a section of its ocean the size of California to fishing. After six months of observation, we happily saw that all vessels, save one, left to fish elsewhere. Our group also mapped out the activity of purse seine (a type of net) fishing boats on the high seas of the Pacific — generating the first publicly accessible view of where fishing activity occurs in the very region that the UN high seas convention may consider setting up international protected areas.

A key question ahead is whether governments will realise the value of this new data and act on calls from the scientific community to require that more vessels carry these observation sensors and use them properly.

We estimate that approximately 70% of all large fishing vessels worldwide are already equipped with these publicly accessible tracking systems. Some captains, unfortunately, misuse the tool by turning it off after leaving port or failing to enter proper vessel identification information into the system. All such noncompliance issues are readily detectable by big data processing.

Imaging satellites can function like space-based red light cameras that snap pictures of law-breakers at sea.

If political will can be mustered to close these loopholes, these observation technologies could shed an immense amount of light on our now-dark oceans.

Orbiting in space alongside these ship-tracking satellites is another rapidly growing fleet of nanosatellites that constantly take high-resolution pictures of the earth. This technology promises to be an important additional piece in the ocean-observation puzzle.

RETURN TO CONTENTS PAGE

Tracking

The goal of the groups tending to these flocks of tiny electronic eyes is to be able to take a high-resolution snapshot of the entire earth, every day. These new imaging satellites may soon allow marine ecologists, ocean conservation groups, and marine park managers to begin to search in near real-time for ships in protected areas, to monitor weekly (even daily) losses of coastal mangrove forests, and to document abuses to coral reefs, such as dredging.

With foresight, the intelligence derived from the vessel tracking systems may eventually be interlinked with these imaging satellites to enable them to function like space-based red light cameras that snap pictures of law breaking at sea as it happens.

Not all next-generation ocean observation has to be based in outer space. An exciting array of new marine-monitoring technologies is increasingly available that also could be useful. Aerial drones are beginning to be used to patrol coastal waters. Fleets of drone ships may follow suit and could help monitor both the health of ocean resources, as well as the behaviour of those that harvest them. Shore- and aircraft-based radar and acoustic recorders that listen for boat noise could also be deployed.

High stakes

Now, anyone can keep tabs on the most remote parts of the ocean on their phones. Global Fishing Watch, for example, is releasing a product this year that will let anyone view and interact with data on fishing from across the global oceans for free. Planet Labs, a startup that manages the largest constellation of earth-observing nanosatellites, recently released a constantly updated, free library of imagery for all of California – including its estuaries, bays, kelp forests, and nearshore waters.

The challenge ahead, as we enter this new era of improved ocean stewardship and attempt to govern increasingly bigger regions of the ocean, is to ensure that our new policies are actually enforced. The stakes here are high. We have to make these emerging protected areas and treaties work, and we must do it soon, if we intend to help the oceans continue to dish out large helpings of food, energy, and wonder.

13.3 EU4OceanObs Kicks-off - Strengthening the EU's Involvement in International Ocean Governance - Mercator Ocean (November 2020)

The EU4OceanObs project has officially been launched with a virtual kick-off meeting held on the 24th of November 2020. Entrusted by the European Commission (EC) to Mercator Ocean International (MOi), the project will implement the EC's Foreign Policy Instrument Action on International Governance: EU component to global ocean observations as part of the EC's long-term strategy on global in situ ocean observation.

EU4OceanObs' main objective is to increase the EU's visibility as a leading global actor, and increase its influence in international decision-making bodies related to the collection and use of global ocean observations. To this end, the project will jointly strengthen EU contributions and achievements in two overarching international programmes: Global Earth Observation (GEO) through its ocean component GEO Blue Planet, and the Global Ocean Observing System (GOOS) through its G7 coordination centre. The project will also play a catalytic role towards the development of sustainable practices for marine and maritime applications, adding value to the Copernicus Marine Service and contributing to the United Nation's Sustainable Development Goals and international ocean governance.

A new team has been set up, fully integrated at MOi, to pilot the EU4OceanObs project and over the next two years work side by side with the European Commission, the G7 Coordination Centre and the GEO Blue Planet Secretary. The project taskforce, headed by the MOi Scientific Director, Pierre Yves Le Traon, includes a new GEO Blue Planet European Office and a G7/GOOS European Office. The GEO Blue Planet Office will contribute to international initiatives for sustained oceans and on behalf of the European Commission, further integrate and promote European activities in this domain. The G7/GOOS European Office will foster synergies between these two bodies and on behalf of the European Commission support the G7/GOOS

RETURN TO CONTENTS PAGE

coordination centre and notably advance its actions related to the Future of the Seas and Oceans initiative and other international developments on global ocean governance

Mercator Ocean International is a non-profit company created in 2010, providing ocean science-based services of general interest focused on the conservation and the sustainable use of the oceans, seas and marine resources (UN SDG14). The organisation has developed complex ocean simulation systems (numerical models) based on ocean observation data (satellite and in situ) that are able to describe, analyse and forecast the physical and biogeochemical state of the ocean at any given time, at the surface or at depth, on a global scale or for a specific zone, in real-time or delayed mode.

Since November 2014, the organisation has been conceiving, implementing and operating the Copernicus Marine Service on behalf of the European Commission, in order to meet the needs of national, European and international stakeholders dealing with environmental policies, maritime safety, and defence, the stewardship of marine resources, biodiversity conservation and climate studies. MOi was also selected along with ECMWF, EUMETSAT, and the EEA to implement the WEkEO DIAS cloud computing platform. MOi will now enter and bring its expertise in a new frontier of international ocean governance by coordinating the EU4OceanObs project.

In the next weeks, a new dedicated website will be launched with information on the project's activities and upcoming events.

13.4 Ocean Remote Sensing from Space: A Tale of Three Commons in: The Future of Ocean Governance and Capacity Development (2018)

Introduction

The uniqueness of the ocean lies in Its vastness, its constant movement, flow, and circulation. This seems to elude graphic illustration on a static map with point markings and line drawings, or image capture of the watery element, particularly when it takes the form of currents, waves, fog or clouds, or when it is precipitating, melting or blowing. Geometric representations and instant snapshots of the ocean are ephemeral and fleeting, subject to interpolation and interpretation. Exploring, representing and articulating the dynamics of ocean space is a challenging endeavor that can be enriched by the view from above—high above—from outer space, via the pathways of cyberspace.1 The View from Above Viewing the ocean from outer space is an unusual, formidable perspective. It differs profoundly from that of the traditional lookout in the mast of a sailing vessel or present-day, ship-based radar instruments, horizontally scanning their immediate surroundings and committing important observations and positions to a log. By contrast, modern satellite-based sensors are pointed downward. The vertical perspective permits map-like arrangements of data collections. These are scalable and in effect comparable with other geospatial information as it relates to marine surveillance, mapping, and synoptic views of environmental conditions. Moreover, while confined by Kepler's Laws to orbital motion several hundred kilometers high above the rotating Earth, optical and radar remote sensing systems can effortlessly repeat their measurement

Ocean Sciences cycle, covering vast swaths of ocean surface and eventually the entire globe on a regular basis. In a typical scenario, satellite-based sensors transform the radiation or backscatter response to a stream of electrons. Data streams are rapidly transmitted to a ground-based facility and processed by algorithms that record them as ocean color, temperature, sea surface elevation, or sea ice, as the case may be. Over the past decades, scientists and mariners have learned to utilize and interpret wide-area coverage of ocean remote sensing data, often in conjunction with in situ validation data from a buoy or Argo float network. They study spatial and temporal dimensions of biophysical and chemical processes, measure trends of global sea level rise, and monitor oscillations, such as El Niño and La Niña events. They routinely assess the risk of operating in remote and harsh marine environments by integrating up-to-date satellite data into mapping, 62modelling, and forecasting activities.2

Advanced satellite technologies and constellations of high-precision sensor systems are revolutionizing the way we can observe the ocean surface on a daily basis at spatial resolutions that range from a few hundred

RETURN TO CONTENTS PAGE

meters to several kilometers. Microwave scatterometers provide detailed global data on near-surface wind fields and on sea ice distribution. Altimeters observe ocean circulation patterns, measure significant wave height, and monitor sea levels at centimeter accuracy. Synthetic aperture radars are similar 'weatherindependent' instruments generating detailed imagery of coastal wind fields, waves, frontal currents, surface oil pollution, and sea ice. Along-track scanning radiometers provide accurate sea surface temperature maps. Ocean color radiometry is essential in coastal regions for measuring parameters such as chlorophyll-a concentration, primary productivity, and suspended matter. Many of these 'surficial' data sets and time series are used for validating multidimensional marine ecosystem models of ocean space.3 Over the coming years, public and private sector investments in Earth observation technology and geospatial infrastructure will amount to billions of dollars, supporting the scenarios and applications mentioned above. They hold promise for more capable sensors, more frequent and detailed observations, and more timely delivery of related products and services originating from the increasingly crowded precinct of low Earth orbits. Going beyond the view from above and rapid development of space technology, how will policy-makers, managers, and the public-at-large receive and react to scientific evidence of ocean change? What societal benefits might be gained, given the coveted view from above?4 And, conversely, can Earth observation technologies help to sustain the health of the ocean, given open and reliable access to online data streams and scientific research into essential ocean variables?5 Digital Pathways across the Global Commons One might address the concerns related to ocean science policy, societal benefits, and ocean health from a global commons point-of-view by following the pathways of digital data and image representations of ocean space, as they accumulate from sensors based in outer space and enter a third domain of the global commons, namely, cyberspace. Cyberspace has rapidly emerged as the main vector for transmitting electronic signals, processing data, and accessing information.

Satellite oceanography worldwide is thriving in this man-made domain; scientists and fast-growing users groups by and large depend on open access to it. One of the essential infrastructure elements of cyberspace is the intercontinental fiber-optic cable network. It shuttles more than 90 percent of the worldwide Internet traffic across the ocean floor; the remaining traffic is handled by high-speed data links via communication satellites.6 Once more, the cybernetic pathways of Earth observation data—this time processed data to end users—transects the global commons of ocean space and outer space. While both of these domains are governed by international treaties, cyberspace is not, at least not yet. A significant challenge to the viability of the emerging cyber-common is inadequate security, insufficient norms and regulations, and ineffective mechanisms of enforcement.7 Restriction or outright disruption of access to Earth observation data would significantly blindside our ability to monitor vast areas of ocean space. Meanwhile, satellite remote sensing is accumulating enormous data sets, filling archival storage vaults by the petabyte; many of them are openly available online.8 Data volumes have already reached a critical mass to be used in interoperable ways for large-scale syntheses and big data analytics. Assimilation with a host of other geospatial records is an exciting and demanding element of future interdisciplinary scientific research and operational oceanography. It relies on improved connections between data repositories and automated, custom-made queries so as to extract, reveal, and quantify relationships. Approaching the topic from a social justice perspective, Elisabeth Mann Borgese recognized the value of, and the all-important access to, Earth observation data at a very early stage of its development.

Two years after the launch by the United States of their first civilian Earth Resource Technology Satellite (ERTS-1, later re-named LANDSAT-1), and four years before their pioneering seasat radar satellite returned a bounty of ocean measurements, she asserted, "only when satellite detection of natural resources is governed by international law will it benefit mankind."9 Her 1987 proposal for the establishment of a World Space Organization (wso) under the auspices of the United Nations was informed by experience gained during the negotiations leading up to the United Nations Convention on the Law of the Sea. Mann Borgese's overarching and principled wso framework did not find support then. Instead, smaller and voluntary non-binding international and intergovernmental arrangements started to emerge at the time, as the initial scope of satellite observation and resource mapping was broadening to include environmental assessment and monitoring activities. During the 1980s, the Group of Seven (G7) countries established partnerships in the international arena to "coordinate comprehensive and sustained Earth observations for the benefit of

RETURN TO CONTENTS PAGE

humankind."10 The G7 Committee on Earth Observation Satellites (ceos) was initially formed in 1984 as a mechanism for national space agencies to collaborate on missions and data systems. Under the United Nations umbrella, the Global Ocean Observing System (goos) informs environmental management policies and agreements and co-ordinates observations for climate, ocean health, and real-time services. The Group on Earth Observations (geo) is a voluntary intergovernmental partnership of more than 100 nations pursuing the creation of an ambitious Global Earth Observation System of Systems, connecting Earth observation resources with a wide range of designated societal benefit areas. More often than not, these exemplary efforts of governance, collaboration and regulatory capacity-building are struggling to keep up with the relentless pace of ocean related activities and technology development

Not unlike ocean circulation, the oceanic circle of satellite remote sensing data is also a continuous system: from surface to sensor to user, driven by the quest for a constant supply of reliable data and image products. Uninterrupted flow is the key to its function, and open access is essential for widespread applications in the near future. Scientists, researchers, and operational managers will continue to be leaders in marine monitoring activities and forecasting services. Citizen science is likely to join in these efforts, taking advantage of data democratization and data access opportunities. Emergency responders will focus on near real-time analysis for natural and human-made disasters, such as major storms, oil spill pollution, harmful algal blooms, or oxygen-depleted dead zones. At the institutional level, satellite data are increasingly used in conjunction with other geospatial tools to assess regulatory regime performance and to enforce rules concerning large marine protected areas or illegal, unreported and unregulated fishing. The growing body of spatial-temporal information derived from ocean observing satellite sensors will continue to challenge conventional assumptions of movement and circulation patterns.

Many efforts are bound to move beyond co-ordinating the activities of Earth observation producers.11 Examples include Copernicus, The European Earth Observation Programme12 and its Marine Environment Monitoring Service,13 and the Global Fishing Watch.14 They will involve a complex combination of actors, mandates and authorities. As a case in point, one might consider a private company launching a satellite sensor into space on an Indian or Russian rocket, providing environmental monitoring services and geospatial products via Internet to government or non-governmental organizations concerned with the implementation, enforcement, or monitoring of international regimes. The role of satellite observations in addressing marine surveillance and environmental issues at local, regional, and global scales could be viewed as being largely instrumental, or technical, complemented by advanced methodological approaches first to identify, then classify, and eventually model the magnitude, characteristics, and extent of ocean features. As such, the observations from outer space cannot solve problems of climate change, marine habitat loss, ocean acidification, or overfishing. Yet, reliable satellite data and time series of ocean space will frequently form the geospatial backbone when it comes to addressing, alleviating, and solving these problems. How beneficial the view from above and how useful the digital manifestations of the oceanic satellite data circle can be for humankind will in no small part rely on open access and emerging governance regimes of the cyberspace common.

13.5 How Satellites and Big Data Can Help to Save the Oceans - Yale E360 (April 2016)

Over the past century, rampant overfishing, severe pollution, and runaway coastal development have taken a huge toll on the world's oceans. Now, however, two major advances in global ocean governance are quietly unfolding, offering hope that the early decades of the 21st century will mark a turning point in which humanity can begin to repair the global seas.

Yet a key question remains: Will the new availability of sophisticated, satellite-based technologies, coupled with the democratization of online data about the health of our environment, help ensure that these positive advancements live up to their potential to protect the oceans?

The first encouraging policy development is the explosive movement by countries around the world to set up massive marine protected areas of unprecedented size. The biggest of these newly proposed mega-marine protected areas, the Pitcairn Islands Marine Reserve, is three-and-a-half times larger than the United

RETURN TO CONTENTS PAGE

Kingdom, and more than 100,000 times larger than the historical median size for an ocean protected area. The 19 mega-marine protected areas created or announced in the last six years would comprise an area larger than all the protected ocean areas created previously. Several huge marine reserves currently being considered would add an additional 775,000 square miles of ocean protection.

The second key development is that the United Nations is now drawing up a treaty that would, for the first time, manage biodiversity across the high seas — the region outside the 200-mile exclusive economic zones of individual nations. The forthcoming United Nations high seas treaty would be setting new rules for a swath of the ocean 22 times larger than the United States. These new regulations are focused on preserving marine biodiversity, establishing international ocean reserves, evaluating processes for sharing marine genetic resources, and effectively carrying out environmental impact assessments.

In the absence of systems to monitor boundaries, large marine protected areas will be nothing more than huge paper parks.

These bold new policies suggest that decision-makers are finally committed to taking the kind of aggressive actions needed to stay a step ahead of industrialization in the oceans — something we failed to do when industrialization occurred on land. This issue extends well beyond industrial-scale fishing. Recent innovation and technological development have now made it possible to take the industries of farming, mining, power generation, and even data center management underwater. The scope and significance of this mass acceleration of new uses of the ocean cannot be overstated. In 2014, for example, the world began eating more fish from farms than from the wild — a marine reprise of our historic shift on land from hunting wild food to farming. Mining claims have already been staked to roughly 400,000 square miles of deep-sea ecosystems.

The campaigns to vastly expand marine protected areas and significantly improve international governance of the oceans are extremely exciting. But both of these important policy movements have an Achilles heel: Laws only matter if you can ensure that people actually follow them. These new policies cover such vast areas that they render boat, plane, and other traditional forms of ocean observation as obsolete as sextants. In the absence of systems to watch their boundaries, large marine protected areas will be nothing more than huge paper parks. Likewise, our efforts to control the exploitation of high-seas biodiversity via the new U.N. treaty will only be effective if we aren't blind to what is happening in this large and distant part of the ocean.

But just as technological innovation is fueling a rapid acceleration of development in the ocean, high-tech solutions may also hold the key to ensuring that a marine industrial revolution advances responsibly and intelligently. These advances, when put in the hands not just of governments but also of researchers, citizen-scientists and environmental groups, promise a new era in which we can actively observe and responsibly plan out what's going on in the world's seas.

A vital solution lies in the use of satellite-interfacing sensors and data processing tools that are beginning to allow us to watch how ships use the oceans as easily as we track Uber taxis cruising around a city. Like airplanes, more and more ships now carry sensors that publicly transmit their position so they don't crash into each other. We can make use of these same streams of safety data to detect where industrial fishing is concentrated, to watch as seabed mining exploration begins, and to observe how cargo ships overlap with whale migration pathways.

Instead of the oceans being a black hole of data, our new challenge is figuring out ways to intelligently and efficiently sift through the billions of data points now pouring in. Fortunately, smart new algorithms can help pick out specific kinds of vessel behavior from this sea of big data. Ships leave unique behavioral fingerprints. For example, purse seine fishing boats make circles around fish schools when setting their nets, while long-line fishing boats travel linearly up and back along the gear they set.

In a recent report in the journal Science, colleagues at the non-profit Global Fishing Watch and I monitored progress as the nation of Kiribati closed a section of its ocean the size of California to fishing. After six months of observation, we happily saw that all vessels, save one, left to fish elsewhere. Our group also mapped out the activity of purse seine fishing boats on the high seas of the Pacific — generating the first publicly

RETURN TO CONTENTS PAGE

accessible view of where fishing activity occurs in the very region that the UN high seas convention may consider setting up international protected areas.

A key question ahead is whether governments will realize the value of this new data and act on calls from the scientific community to require that more vessels carry these observation sensors and use them properly. We estimate that approximately 70 percent of all large fishing vessels worldwide are already equipped with these publicly accessible tracking systems. Some captains, unfortunately, misuse the tool by turning it off after leaving port or failing to enter proper vessel identification information into the system. All such noncompliance issues are readily detectable by big data processing.

Imaging satellites can function like space-based red light cameras that snap pictures of law-breakers at sea.

If political will can be mustered to close these loopholes, these observation technologies could shed an immense amount of light on our now-dark oceans.

Orbiting in space alongside these ship-tracking satellites is another rapidly growing fleet of nanosatellites that constantly take high-resolution pictures of the earth. This technology promises to be an important additional piece in the ocean-observation puzzle. The goal of the groups tending to these flocks of tiny electronic eyes is to be able to take a high-resolution snapshot of the entire earth, every day. These new imaging satellites may soon allow marine ecologists, ocean conservation groups, and marine park managers to begin to search in near real-time for ships in protected areas, to monitor weekly (even daily) losses of coastal mangrove forests, and to document abuses to coral reefs, such as dredging. With foresight, the intelligence derived from the vessel tracking systems may eventually be interlinked with these imaging satellites to enable them to function like space-based red light cameras that snap pictures of law breaking at sea as it happens.

Not all next-generation ocean observation has to be based in outer space. An exciting array of new marine-monitoring technologies is increasingly available that also could be useful. Aerial drones are beginning to be used to patrol coastal waters. Fleets of drone ships may follow suit and could help monitor both the health of ocean resources, as well as the behavior of those that harvest them. Shore- and aircraft-based radar and acoustic recorders that listen for boat noise could also be deployed.

Essential to effectively monitoring and controlling the industrialization of the oceans is democratization of this new ocean-observation data. Good intelligence on what was happening at sea used to only be the purview of vessel captains.

The good news is the world's oceans have not experienced the extinctions that have occurred on land. But as ecologist Douglas McCauley explains in a Yale Environment 360 interview, marine life now face numerous threats even more serious than overfishing.

Now, anyone can keep tabs on the most remote parts of the ocean on their phones. Global Fishing Watch, for example, is releasing a product this year that will let anyone view and interact with data on fishing from across the global oceans for free. Planet Labs, a startup that manages the largest constellation of earth-observing nanosatellites, recently released a constantly updated, free library— including its estuaries, bays, kelp forests, and nearshore waters.

The challenge ahead, as we enter this new era of improved ocean stewardship and attempt to govern increasingly bigger regions of the ocean, is to ensure that our new policies are actually enforced. The stakes here are high. We have to make these emerging protected areas and treaties work, and we must do it soon, if we intend to help the oceans continue to dish out large helpings of food, energy, and wonder.

RETURN TO CONTENTS PAGE

14 Technology: Geospatial Data

14.1 Geospatial Data Infrastructures and Ocean Governance in: The Future of Ocean Governance and Capacity Development (2018)

As trite as it may sound, everything has a location. The issue with geospatial information and technologies is that more locations and applications relate to the Earth's brown and green surfaces, and built environments, rather than to the blue ocean. This fundamental issue of disproportionate data collection, analysis, and use is at the heart of a tremendous growth in new applications and data created within the ocean domain. From a marine spatial planning perspective, it also forms the need for ocean governance through data sharing and scientific communication.

The driving forces of the new era of ocean geospatial development are climate change, resource use/depletion, and geopolitical conflicts. The greatest benefit of geospatial technology and analysis is that these forces can be viewed as they occur in reality, as interconnected and overlapping problems that have spatial extents, as well as spatial causes and solutions. Ocean governance happens somewhere, within situations having locations, movements, and interactions. Whether it be political, technical or natural, location is central, and so location-based technologies and geospatial data must be at the core of any analysis or policy associated with governance.1

Geospatial data infrastructures are expressions of policies and products. Data management is the essential, but not sole, product component. Within this are related issues of connectivity (bandwidth), security, metadata, software, storage, preservation, open access, privacy, and cloud computing, to name a few. Processes of collecting, sharing, and communicating geospatial data are changing radically, thereby forcing a reflection on the policies and products. This will continue to have an enormous impact on ocean governance as it gets to the core of management issues preceding decision-making.

The entire system of geospatial data and technology has for some time been defined as spatial data infrastructures (SDI). From data collection to metadata, format integration, distributed computer interaction, software, storage, archiving, processing, analysis and communication (mapping display), the entire system has been viewed as something that should work harmoniously as one positive feedback system. For over three decades now, the SDIideal has been held up as a goal.2

A focus on bathymetric data at one kilometer resolution was perhaps the first example of geospatial infrastructure that could express spatial dimensions of ocean features, as well as allowing for integration of data into other products and visualization tools. This has given way to new products at finer resolution in tens of meters or better. While these tend to be spatially limited (small areas), the technology has achieved a maturity where the only barrier to mapping the entire seafloor at such fine resolution is cost.

One should also note that disasters still drive data collection and mapping, exemplified by the Deep Water Horizon oil spill in the Gulf of Mexico, the MH370 air crash in the Indian Ocean, and recent Atlantic Basin hurricanes. Moreover, significant efforts have been undertaken to align/combine data types and sources for a more fulsome view of an active ocean in all its dimensions, and not simply features derived from bathymetry.3

Data fuels geospatial infrastructures and this has created a shift to 'open data', with better standards and formats that are interchangeable between proprietary systems. Data policies in the past (i.e., cost recovery, security/privacy concerns) created barriers to access and use of ocean-based geospatial data. Ocean data managers and funding agencies are looking toward open data as a solution to their needs for innovation, data sharing, and the development of better tools and shared analysis.4

Open ocean data holds the promise of more knowledge translation and refined data for decision-making, rather than merely enormous quantities of data stored on massive servers that never see the light of day. Models and analytical techniques that are too complex and take too long when data is sequestered by only

RETURN TO CONTENTS PAGE

one organization can now be shared and improved upon quickly. Actual costs are lowered when data is made available to the community.

The exponential growth in the collection of ocean-based geospatial data is changing the level of detail with which we can visualize the ocean. Wave gliders, autonomous vehicles on or below the surface, remotely controlled submersibles, drones, telemetry tracking of fish and mammals, buoy arrays, satellite platforms with better sensors and more data collection, and more platforms, are collecting data at finer resolutions, with more accuracy, and in near real-time. Access to better sensors and data collection in the atmosphere and on land means a greater ability to develop integrative models of the Earth.5 There should be no end in sight for more and better data collection.

If we have so much data, then surely we must be able to address geospatial ocean issues more adequately. Herein is the opposing side of the geospatial infrastructure. More data does not necessarily translate into more information and knowledge or better decision-making. Research and development in the areas of artificial intelligence and machine learning, combined with cloud computing and big data, will be needed more than ever.

And yet, with the advent of these new tools to deal with vast quantities of data, we are creating new governance problems that we must attend to in the ocean geospatial community, especially as it relates to the complexities of a three/four-dimensional ocean. What this has led to is a greater need for computational models, algorithms, geospatial statistics, and other computer science approaches to deal with ever larger quantities of spatially referenced big data.6

An interesting set of solutions to these problems is coming from advances in augmented and virtual reality systems that provide the opportunity to visualize data about the ocean in multiple dimensions and temporal scales (past, present and future). In some ways, this is creating a situation where we can visualize spatial representations akin to movies. Computer graphics turn the unreal or imagined into near realistic explorations of the environment. Finding Nemo is no longer a cartoon, but the future of how we will see our data.

The software we use is about comfort and exposure; what one learns is usually what one uses. In the past, such software was strictly in the domain of the expert, as well as expensive and heavily reliant upon more powerful computers and mass data storage devices. Analytical programs and data visualization tools that have built-in spatial tools for experts and non-experts are becoming the norm. The days of exclusive geospatial technologies are fast coming to an end, which will open geospatial data visualization into new ocean applications from non-ocean communities.7

When the geographic information system (GIS) was invented in the late 1960s by Roger Tomlinson, the size and power of computers were such that the memory and capacity to process data was very low. Hardware is now so fast, small, and inexpensive that we are almost at a point where it is disposable. A server with 10 terabytes of storage and multiple core processors is within reach of almost any laboratory or ocean scientist. Storage, processors, and Internet connectivity, while still an issue for remote areas, have become fast enough to stream massive quantities of video, data, and imagery. It would have been unthinkable to be able to live-stream video from an underwater submersible a few years ago. Now we expect it. The days of the expensive mainframes to do GIS and spatial analysis of mass quantities of data are either over, or close to it.

While numerous developments have taken place with respect to geospatial technologies and data, ever-more changes in the technology landscape are lining up to radically alter how we analyze, model, explain, and communicate ocean complexities and our uses of that precious resource. Mobile computing has matured to a stage where devices such as smartphones, GPSunits, laptops, and data collection platforms like drones have created expectations that data collection and access is a given. We are now used to the idea that our mobile devices can pinpoint our location within meters. This cannot be overstated in terms of implications for ocean geospatial technology and governance. We now see projects around the world where fishers and citizens alike collect and provide access to real-time data within a mobile computing environment.8

RETURN TO CONTENTS PAGE

The final, perhaps most exciting, aspect of geospatial technologies impacting our ocean sciences and governance are the systems allowing us to collect data remotely, via satellites and/or tracking systems that mix fixed assets, that allow for accurate positioning, along with sensors gathering data from moving through the ocean or above through new and much more accurate space-based platforms. This necessitates a return to some of the most essential and oldest elements of geospatial data infrastructures. Making certain that our descriptions of the data and collection methods used (metadata and ontologies) are robustly utilized ensures data sharing is both efficient and correct. These core, pre-use, data challenges test (perhaps exceed) our ability to collect and visualize the data we need.9

Communicating spatial relationships always comes back to the map. Maps have been central to our understanding and use of the ocean for centuries. In terms of ocean governance, marine spatial planning is about communicating science and policy through maps. The creation of stable and easy to use web-based mapping tools, accessible anywhere, and with the ability to do live updates, is an exciting development.10 Ocean governance may not, therefore, be hampered by a lack of much-needed data. The future is one where creativity in how we visually communicate will change the nature of the governance issue.

Among numerous gifts, Elisabeth Mann Borgese instilled in us a belief that the ocean should be open to all, while protected for today and the future. Directions within the geospatial community reinforce these ideals through the sharing of geospatial data in an open environment, protected for the future, and from more advanced and numerous data sources. It allows us to communicate how we see the ocean, its use, the issues it faces, and the future we wish to create for the protection of the blue planet.

The current and future of how we map the ocean and communicate its nature in geospatial forms differs from the past. Even so, it is still the same as before because we are expressing geospatial ‘reality’ as best we can to communicate both issues and solutions. The driving forces facing our efforts in ocean governance—climate, resources, and conflict—require the best we can offer. Integrated technologies and geospatial data within an infrastructure should allow for the notion of ‘geo-spatial’ to become more inclusive as ‘mare-spatial’.

15 Additional Sources

15.1 What Works in Water and Ocean Governance | United Nations Development Programme

Governance reform is about instituting and practicing new ways of operation and interaction. It is no linear process but rather a whole-of-society transition that negotiates among varied interests and challenges towards changing entrenched practices.

Embarking on the present review, and in the interest of harvesting practical lessons from UNDP’s Water & Ocean Governance (WOGP) portfolio, the exploration was focused on “What works in water/ocean governance?” The report aims to unveil the most critical steps or factors that made these generally successful water and/or ocean governance projects reach their objectives.

The report therefore puts a selected set of projects of the WOGP under the spotlight. Whereas the achievements are often of a very different nature, they all tackle complex, cross-sectoral water or ocean issues that none of the actors involved could have managed on their own. This illustrates the important difference between management – addressing matters that are principally tackled by one actor, often within the purview of one organization – and governance, which relates to the broader relations and rules that regulate the way a whole sector or society acts jointly.

RETURN TO CONTENTS PAGE

15.2 Frontiers | 100 Opportunities for More Inclusive Ocean Research: Cross-Disciplinary Research Questions for Sustainable Ocean Governance and Management | Marine Science

In order to inform decision making and policy, research to address sustainability challenges requires cross-disciplinary approaches that are co-created with a wide and inclusive diversity of disciplines and stakeholders. As the UN Decade of Ocean Science for Sustainable Development approaches, it is therefore timely to take stock of the global range of cross-disciplinary questions to inform the development of policies to restore and sustain ocean health.

We synthesized questions from major science and policy horizon scanning exercises, identifying 89 questions with relevance for ocean policy and governance. We then scanned the broad ocean science literature to examine issues potentially missed in the horizon scans and supplemented the horizon scan outcome with 11 additional questions. This resulted in an unprioritized list of 100 general questions that would require a cross-disciplinary approach to inform policy.

The questions fell into broad categories including: coastal and marine environmental change, managing ocean activities, governance for sustainable oceans, ocean value, and technological and socio-economic innovation. Each question can be customized by ecosystem, region, scale, and socio-political context, and is intended to inspire discussions of salient cross-disciplinary research directions to direct scientific research that will inform policies. Governance and management responses to these questions will best be informed by drawing upon a diversity of natural and social sciences, local and traditional knowledge, and engagement of different sectors and stakeholders.

15.3 Ten use cases of innovative data - driven approaches for policymaking at EU level - URENIO Watch

[EXTRACT]

Illegal fishing and overfishing are serious global challenges from an environmental and economic point of view. Experts estimate that about 20-40% of the fish caught in the wild enters the market as a result of illegal fishing activities, accounting for more than $20b each year. Also, global overfishing can permanently destroy ocean ecosystems, jeopardising global food security. According to the UN, "about a third of marine fish stocks worldwide have been overfished, and over 90% of the world's fisheries are fully exploited or over-fished".

Monitoring and enforcing protected marine reserves, fishing quotas and legislation in remote parts of the world is a challenge that is currently not sufficiently addressed. This 'policy failure' results in the presence of industrial-scale pirate fishers having a sense of impunity. There is a need better to protect the oceans from illegal activity, so that environments can be protected and depleted fishing stocks can be safely preserved and rebuilt. This use case illustrates the opportunity that exploitation of vessel positioning data, linked to other data sets, represents for an improved conservation of marine resources and global ocean governance. From a design perspective, this use case has reached stage 4 in the process (Figure 6): in the case of illegal fishing, the scale of the problem is well known (although it may be understated), and there is a specific policy question that needs to be addressed ('how can we effectively identify suspicious or illegal fishing activities?'). This policy question has been translated into data needs and most of the data to effectively tackle this question exists and has been identified as being available either from commercial providers or the different governments and institutions.

The EC has the task to monitor illegal fishing activities as part of enforcing the European Union's Common Fisheries Policy (CFP). The Commission's ambition is to fully implement the concrete commitments of the reformed Common Fisheries Policy during the 2015-2020 period. However, to accomplish this, an improved ability to measure potentially illegal activity and to monitor fishing pressure is critical. Enforcement is a responsibility of individual Member States. They can be notified of suspicious behaviour and have the obligation to ensure that their own vessels comply with EU agreements. In severe cases of non-EU Member States breaching international agreements and failing to take action to correct illegal fishing, the EU can set

RETURN TO CONTENTS PAGE

up embargoes to fish products from those countries. Up until now, enforcement has been based on the collection of data provided by the Member States and on the use of inspectors checking fishing gear and inspecting the registers of fish caught (and comparing them with the quotas). These checks can be done in port, at sea, and using aerial photography. However, they are costly, highly resource-intensive and time consuming (and therefore slow) processes that do not sufficiently act as deterrent for most illegal activity. Most important, they do not allow for timely information at the needed scale. As a result, non-compliance remains a significant problem. The high level of fragmentation in ocean governance further complicates monitoring activities and interventions: responsibilities and competences are spread among different agencies at regional (coastal regions), national and international levels. For example, there are about ten different UN bodies responsible for marine protected areas. In order to have better knowledge of activities at sea, there needs to be more transparency and especially, more collaboration between different institutions. This use case indicates the potential to develop an automated early-warning system that would enable flagging suspicious activities through the linking of available data sets combined with the use of advanced analytical techniques. Such a system would need to be aware of the vessels position over time, the administrative information detailing available quotas and fishing licences for each vessel, and data on the location and characteristics of fish stocks in the sea. Information on the movement of (large) ships would be relevant not only related to illegal fishing, but also for environmental, tax and trade concerns. Coastal information, satellite imagery and information from aircrafts and patrol boats can be combined to form a fuller picture of activity in the ocean. More real-time data on positioning and patterns of large ships would allow more targeted interventions for EU inspectors and more effective legal action. In order to cover the oceans, combined monitoring is used integrating several systems (Box 1):

Currently, satellite imagery is used mostly in research projects. However, authorities such as European inspectors do obtain information from the Vessel Monitoring Systems (VMS). The VMS is a satellite-based monitoring system that regularly provides data on the location, course and speed of vessels to the fisheries authorities of the Member States. Additionally, the Automatic Identification System (AIS) has been progressively introduced in EU fishing vessels above 15 m and is increasingly used by Member States for monitoring and control purposes. Both VMS and AIS use GPS signals, but VMS uses point-to-point satellite communication whereas AIS transponders use broadcast VHF signals. There are also differences between distribution of AIS signals picked up by satellite and those picked up by coastal stations. Data sharing requirements for VMS are also more bureaucratic. Furthermore VMS information is only available to flag state and coastal state unless special arrangements are made for sharing, whereas AIS information can be bought for any area of the planet. Communication costs make VMS expensive so transmission occurs only every hour or so. AIS signals are transmitted approximately every minute. Satellite AIS gives global coverage of the sea but signals are only picked up when a satellite passes above an area. The frequency of signals depends on the amount of satellites scouting a particular area. As it passes, the satellite can pick up more than one signal so that vessel tracks can be observed. On the other hand, due to signal collision, satellites do not pick up all the signals in high ship density areas, making this solution better for open ocean monitoring. In this case, signals picked up by coastal stations can be much more frequent but their range is more limited.

In this case, using a data approach can therefore contribute to a more effective conservation of natural resources (fishing, deep sea mining, protected areas), reduce fragmentation in the governance of sea activities (fostering better coordination and collaboration between different institutions) and provide more transparency through better knowledge of activities at sea.

3.3 The policy context

Over 60% of the world's oceans are beyond national borders. The governance of international waters is highly fragmented, with jurisdictions and actions from of Regional Fisheries Management Organisation, FAO, IOC, International Maritime Organisation or the International Seabed Authority, all under the umbrella legal framework of the UN's Convention on the Law of the Sea. Fragmentation equally concerns the high number of institutions active at international, regional, national and sub-national level. The legal complexity challenges the sustainable management of oceans and there are several points of failure in implementing a coherent policy. For better enforcement, more information is needed on a series of outstanding issues,

RETURN TO CONTENTS PAGE

including monitoring and intervening against illegal fishing, maritime trade, polluting emissions from ships, enforcement of marine protected areas and dumping at sea and monitoring of deep sea mining. The general objective of European Ocean Governance policy is to ensure better international governance of oceans and seas to the benefit of sustainable blue growth. The EC is currently further developing its Blue Growth Strategy and exploring ways in which the EU can support a better, more effective governance of the oceans. The role and function of the EC The Common Fisheries Policy (CFP), adopted in 1983, is the fisheries policy of the European Union (EU). The CFP allows for equal access for fishing vessels from all EU member states inside the European exclusive economic zone (EEZ), stretching 200 nautical miles from its coastline. Within the EEZ, Member States have a 12-mile zone from their own coastlines with exclusive fishing rights for their vessels. At 25 million square kilometres, the EU EEZ is the largest in the world. Figure 7 Exclusive economic zone (EEZ) of the EU In addition to the EEZ, the CFP regulates the catch of Atlantic and North Sea fish stocks using a system of total allowable catches (TACs) that is further divided into national quotas. The CFP also comprises regulations for the control of prices, marketing arrangements and external trade policies. In 2009 the Pew Charitable Trusts, the Coalition for Fair Fisheries Arrangements, the Fisheries Secretariat, the new economics foundation and Seas At Risk and Ecologistas

In addition to the EEZ, the CFP regulates the catch of Atlantic and North Sea fish stocks using a system of total allowable catches (TACs) that is further divided into national quotas. The CFP also comprises regulations for the control of prices, marketing arrangements and external trade policies. In 2009 the Pew Charitable Trusts, the Coalition for Fair Fisheries Arrangements, the Fisheries Secretariat, the new economics foundation and Seas At Risk and Ecologistas 22 en Acción established the OCEAN2012 coalition. It included fishermen organisations, environmental NGOs, consumer organisation and other actors with an interest in sustainable fisheries. Within five years, OCEAN2012 grew from 5 to 193 supporting groups across 24 EU Member States. This prompted European legislators in May 2013 to reach an agreement to “restore fish stocks and to end EU overfishing by 2015 where possible and 2020 by the latest”. In December 2013, the European Parliament (EP) adopted the agreement, coming into force in 2014. In 2014 the EP and the EC decided to allocate greater funding for data collection and enforcement within the European Maritime and Fisheries Fund (EMFF). The EMFF will deploy €6.4b between 2014-2020. Of these funds, 11% will be managed by the EC to support EU-wide objectives in maritime and coastal affairs, such as:

International governance;

Cooperation through exchange of information and best practices;

Public information and support to networking platforms;

and Marine Knowledge.

Member States will manage the rest of the funds. Of the total EMFF funds, €580m have been allocated for control and enforcement activities. These resources will contribute to monitoring compliance with the European Common Fisheries Policy and to protect a fair access to healthy fishing stocks. The three main action lines are:

Access to fishing grounds;

Controlling fishing effort, TACs and quotas; and

Other technical measures to improve selectivity and sustainability pressing current challenges.

Now that the necessary reforms have been introduced in the CFP, the organisations that were part of OCEANA2012 are now closely looking at the implementation of the agreements. For example, Pew is working closely on implementation in the north-western European waters. Enforcement and non-compliance remain significant issues and, as a result, organisations in the field welcome the steps taken by the EC but are watchful for actual implementation. In September 2015, Commissioner Vella emphasised the importance of better ocean governance to the Committee of the Regions NAT Commission and made a case that also included recent pressing issues such as migration. Points of mention were the cooperation in the context of security in the seas and interconnection of existing surveillance systems in the context of the European

RETURN TO CONTENTS PAGE

Maritime Security Strategy. Also, issues such as tackling climate change and identifying better renewable energy resources were put forward as other uses of better ocean information.

3.4 The data process: from data collection to analysis and visualisation Data sources

During the past two years, two initiatives have worked to address the data sourcing, linkage, processing and visualisation challenges related to the automated earlywarning system proposed in this use case, and have built specific prototype demonstrators (see section 3.5 below). These initiatives are the project 'Eyes on the Seas'23, developed by the Pew Charitable Trusts together with the UK Satellite 23 Project Eyes on Seas.

Available at: http://www.pewtrusts.org/en/research-and-analysis/issuebriefs/2015/03/project-eyes-on-the-seas

Ten use cases of innovative data-driven approaches for policymaking at EU level 23 Applications Catapult, and the 'Global Fishing Watch'24 prototype by Oceana, Google and Skytruth. The piloted systems are based on the linkage between positional data from ships, collected mainly from the AIS system, with geographic and administrative data. Fishing vessels over 300 gross tons carry an anti-collision called AIS (Automatic Identification System), whose VHF signal can be picked up by satellite or shore stations. This allows for a monitoring of the behaviour of large ships and for collecting data on their speed, position and heading. AIS systems are codified with unique identifiers for each vessel, which allows identification of the country of origin and crew. The data on AIS is already being collected by coastal stations. For the rest of the ocean, the data can be bought from satellite providers. For example, the 'Project Eyes on the Seas' system combines data sets from the following:

Vessel Monitoring Systems (VMS) via GPS and satellite;

Synthetic Aperture Radar (SAR) satellite;

Automatic Identification Systems (AIS); and

Optical Satellite Sensors for oceanographic and atmospheric data.

These are further linked to other specialist databases that include international fishing and marine reserve boundaries, and oceanic data comprising depth and temperature readings (bathymetry). All the information is centralised in a 'Virtual Watchroom' where analysts can query the data and interesting activity patterns are investigated. Figure 8 Project Eyes on the Seas. The Virtual Watchroom Similarly, the 'Global Fishing Watch' prototype by Oceana, Google and Skytruth (Figure 9), builds dynamic visualisations of ships based on AIS signals, and runs behavioural models. These behavioural models are able to distinguish between fishing and non-fishing ships. In a following step they are assessed by analysts and crosslinked with other datasets that delineate restricted fishing zones.

The data collection process An initiative run by the EC Directorate-General MARE, the European Marine Observation and Data Network (EMODnet)25 is a platform that consists of more than 100 organisations providing marine data. EMODnet is different than the two other initiatives discussed. It provides complementary background information on ocean conditions such as temperature, currents, sediments and marine life. The data and meta-data undergo a standardisation and quality assurance process and are available without restrictions of use (free and open access). This information can be used to enhance the information on ship movements. EMODnet is currently in the second development phase and it is expected that it will be completed in 2020. The rest of the data is available either from commercial providers or the different governments and institutions. AIS data is collected by coastal stations and satellites and it can be bought from commercial providers. In terms of costs, there are providers of data from coastal stations that already have operational online platforms that are supported by subscription models. For example, IHS Maritime sells AISLive/Sea-web subscription plans to their online platform and marinetraffic.com sells subscriptions from 9 to 269 € per month, depending on the requested features. The Oceana prototype gives us an idea of scale and data processing requirements. The process started with a dataset of 3.7 billion data points, comprising two years of satellite collection and covering 111,374 vessels. This dataset is one terabyte in size. Data analytics and visualisation Once the data is available, two stages of analysis are needed, first

RETURN TO CONTENTS PAGE

related to the modelling and the analytics to identify patterns and types of behaviour for ships, second to signal anomalies and suspicious cases. A behavioural classification model is run on the datasets to identify fishing behaviour, based on the vessel's pattern of movement and speed. The Oceana prototype currently covers over 25,000 unique vessels that were identified as carrying out fishing activities, and the final visualisation comprises 300 million AIS data points.

The fishing activity map in the prototype shows data from 3,125 vessels that were independently verified. The 'Project Eyes on the Sea' documentation discusses some of the behaviours that can trigger an alarm. The use of vessel data is linked with marine reserve boundary data. Patterns can be identified that include activity in closed fishing areas or unauthorised switching off of AIS transceivers. While switching AIS transceivers off can be used to try to circumvent detection, global coverage allows detecting when a vessel's position suddenly disappears from the dataset and reappears later elsewhere is flagged (or when vessels are using duplicated AIS identifiers). Also, the system can detect close proximity between vessels, which could signal that some of the cargo is being moved between ships at sea. When an alarm is triggered, a team of trained analysts then investigates it and relevant government enforcement organisations are notified. A supporting evidence package is transferred to the authorities, who then proceed with an appropriate response in case the rules were breached. ESMA and ESTAT are also using AIS data for transport and CO2 emissions analysis, but limited to the European space. Multipurpose use of this data is possible, but should be extended beyond Europe. Use of the data in policymaking.

The systems that have been piloted allow government officials and other independent analysts and groups of experts to identify and monitor activities at sea. Activities that present specific activity patterns will trigger alarms, signalling potentially illegal, unreported or unregulated activities. These systems are early alert systems and can prompt the relevant authorities to take a closer look into specific cases. They are more efficient than current established procedures and reduce the amount of resources that are needed to monitor vast sea extensions and fleets. However, the evidence from these systems will need to be complemented by other proof of wrongdoing. The way this is supposed to work is that evidence of suspicious patterns will be packaged and sent to the proper expert teams within the relevant authorities, and they will have the remit of investigating particular cases.

This is analogous to, for example, systems in the banking domain that flag suspicious credit card charges or bank transfers. When an alarm for suspicious activity is triggered, the case is passed on to a relevant expert team that verifies and checks the situation with the involved parties. The systems will also enable authorities to share information on specific suspicious vessels and patterns of activity, and thus increase international collaboration in information gathering and enforcing activities.

3.5 Reflections on challenges and next steps

Two prototypes are currently testing the feasibility and potential implementation of the idea launched in this use case. In addition, the prototypes allow the set-up and training of the analysis models for this particular application. This is a necessary step before these solutions can be validated and have sufficient legitimacy to be used in policy-making.

At the present stage (early 2016), the two prototypes still have some limitations. For example, the project Eyes on the Seas launched its monitoring activities by focusing on the Chilean territory surrounding the Easter Island, and the Pacific island nation of Palau. The system initially focuses on helping the governments of these territories to enforce these protected marine reserves, and the idea is that it will be able to scale to other larger areas. In contrast, the 'Global Fishing Watch' has a global reach from the outset, but the prototype operates using a snapshot of static data from 2012 and 2013. The idea is that when the system is completed, it will switch to using near real-time data streams, analysing current conditions while still having the capacity to examine historical behaviour. Oceana stated in late 2014 that the system would be fully completed by 2016, depending on funding conditions.

RETURN TO CONTENTS PAGE

15.4 Salmon, sensors, and translation: The agency of Big Data in environmental governance - Francisco Ascui, Marcus Haward, Heather Lovell, 2018

This paper explores the emerging role of Big Data in environmental governance. We focus on the case of salmon aquaculture management from 2011 to 2017 in Macquarie Harbour, Australia, and compare this with the foundational case that inspired the development of the concept of 'translation' in actor-network theory, that of scallop domestication in St Brieuc Bay, France, in the 1970s. A key difference is the salience of environmental data in the contemporary case. Recent dramatic events in the environmental governance of Macquarie Harbour have been driven by increasing spatial and temporal resolution of environmental monitoring, including real-time data collection from sensors mounted on the fish themselves. The resulting environmental data now takes centre stage in increasingly heated debates over how the harbour should be managed: overturning long-held assumptions about environmental interactions, inducing changes in regulatory practices and institutions, fracturing historical alliances and shaping the on-going legitimacy of the industry. Environmental Big Data is now a key actor within the networks that constitute and enact environmental governance. Given its new and unpredictable agency, control over access to data is likely to become critical in future power struggles over environmental resources and their governance.

15.5 The Future of Ocean Governance and Capacity Development (2018)

15.6 Detectability of Objects at the Sea Surface in Visible Light and Thermal Camera Images | IEEE Conference Publication | IEEE Xplore (2018)

[Abstract]

In a number of ocean surveillance and remote sensing applications, visible light and thermal cameras are used to detect and identify objects at the sea surface. Knowing beforehand what the camera can detect or not can be important, yet highly difficult to determine. Optical models such as Modulation Transfer Functions can help in evaluating a camera system, but requires a deeper knowledge in optics, and detailed specifications of each component. The models also does not handle noise coming from the scene background, which in many cases is the major limiting factor of detectability.

In this paper, we evaluate the results of an edge detection algorithm on images from two commercial off-the-shelf camera system - one visual light and one thermal. We then draw conclusions on the detectability of objects which commonly needs to be detected at the sea surface.

15.7 Remote Sensing | Free Full-Text | Remote Sensing of the Polar Ice Zones with HF Radar

Radars operating in the HF band are widely used for over-the-horizon remote sensing of ocean surface conditions, ionospheric studies and the monitoring of ship and aircraft traffic. Several hundreds of such radars are in operation, yet only a handful of experiments have been conducted to assess the prospect of utilizing this technology for the remote sensing of sea ice. Even then, the measurements carried out have addressed only the most basic questions: is there ice present, and can we measure its drift? Recently the theory that describes HF scattering from the dynamic sea surface was extended to handle situations where an ice cover is present. With this new tool, it becomes feasible to interpret the corresponding radar echoes in terms of the structural, mechanical, and electrical properties of the ice field. In this paper we look briefly at ice sensing from space-borne sensors before showing how the persistent and synoptic wide area surveillance capabilities of HF radar offer an alternative. The dispersion relations of different forms of sea ice are examined and used in a modified implementation of the electromagnetic scattering theory employed in HF radar oceanography to compute the corresponding radar signatures. Previous and present-day HF radar deployments at high latitudes are reviewed, noting the physical and technical challenges that confront the implementation of an operational HF radar in its ice monitoring capability.

RETURN TO CONTENTS PAGE

15.8 Frontiers | The Politics of Ocean Governance Transformations | Marine Science (July 2021)

[Abstract]

Recently, oceans have become the focus of substantial global attention and diverse appeals for "transformation." Calls to transform ocean governance are motivated by various objectives, including the need to secure the rights of marginalized coastal communities, to boost ocean-based economic development, and to reverse global biodiversity loss. This paper examines the politics of ocean governance transformations through an analysis of three ongoing cases: the FAO's voluntary guidelines for small-scale fisheries; debt-for-"blue"-nature swaps in the Seychelles; and the United Nations' negotiations for a high seas' treaty. We find that transformations are not inevitable or apolitical. Rather, changes are driven by an array of actors with different objectives and varying degrees of power. Objectives are articulated and negotiated through interactions that may reassemble rights, access, and control; however, there is also the potential that existing conditions become further entrenched rather than transformed at all. In particular, our analysis suggests that: (1) efforts to transform are situated in contested, historical landscapes that bias the trajectory of transformation, (2) power dynamics shape whose agendas and narratives drive transformational change, and (3) transformations create uneven distributions of costs and benefits that can facilitate or stall progress toward intended goals. As competing interests over ocean spaces continue to grow in the coming decades, understanding the processes through which ocean governance transformations can occur—and making the politics of transformative change more explicit—will be critical for realizing equitable ocean governance.

15.9 Remote Sensing | Free Full-Text | Coral Reef Mapping with Remote Sensing and Machine Learning: A Nurture and Nature Analysis in Marine Protected Areas (2021)

Mapping habitats is essential to assist strategic decisions regarding the use and protection of coral reefs. Coupled with machine learning (ML) algorithms, remote sensing has allowed detailed mapping of reefs at meaningful scales. Here we integrated WorldView-3 and Landsat-8 imagery and ML techniques to produce a map of suitable habitats for the occurrence of a model species, the hydrocoral Millepora alcicornis, in coral reefs located inside marine protected areas in Northeast Brazil. Conservation and management efforts in the region were also analyzed, integrating human use layers to the ecological seascape.

Three ML techniques were applied: two to derive base layers, namely geographically weighted regressions for bathymetry and support vector machine classifier (SVM) for habitat mapping, and one to build the species distribution model (MaxEnt) for Millepora alcicornis, a conspicuous and important reef-building species in the area. Additionally, human use was mapped based on the presence of tourists and fishers. SVM yielded 15 benthic classes (e.g., seagrass, sand, coral), with an overall accuracy of 79%. Bathymetry and its derivative layers depicted the topographical complexity of the area. The Millepora alcicornis distribution model identified distance from the shore and depth as topographical factors limiting the settling and growth of coral colonies. The most important variables were ecological, showing the importance of maintaining high biodiversity in the ecosystem. The comparison of the habitat suitability model with species absence and human use maps indicated the impact of direct human activities as potential inhibitors of coral development. Results reinforce the importance of the establishment of no-take zones and other protective measures for maintaining local biodiversity.

15.10 A Remote Sensing Approach to Assessing Habitat Representation in Marine Protected Areas: A Case Study from China's Coastal Seas - ProQuest (2019)

Marine protected area (MPA) networks are likely to be most effective in preserving a wide range of marine biodiversity when they are designed to be ecologically representative, containing samples of all of the different habitats present in a given region of the ocean. Mapping oceanic environments and assessing the environmental representativeness of MPAs is thus of central importance to global marine conservation.

RETURN TO CONTENTS PAGE

This is especially important in areas where information on MPA networks and oceanic environments is scarce or not publicly available, as is the case in China. This study explored the use of remote sensing technology to assess the environmental representation of China's MPA network as of 2015 across the extent of China's Exclusive Economic Zone (EEZ).

Satellite information on sea surface temperature, sea surface salinity, chlorophyll a levels, and water depth across China's EEZ was collected from Nasa's Near Earth Observatory database and used to create broad environmental clusters across the study area. A database of Chinese MPAs was also compiled from a review of Chinese government sources, scientific literature, and independent websites. These MPAs were then mapped over the EEZ's environmental clusters, and the percentage coverage by area of each cluster was calculated.

This study found that a number of distinct environments in China's nearshore shallow waters and deep southern waters are represented with greater than 10% coverage by area in MPAs.

The methodology developed in this study presents an efficient and highly adaptable approach to environmental representation assessment. Furthermore, the database of Chinese MPAs compiled in this study is, to our knowledge, the most complete and detailed list of Chinese MPA network to be made available abroad, providing a wealth of new information on the scope and characteristics of the country's marine conservation program.

15.11 Digitalizing Our Oceans: New Roles For Tech Companies And Workers (July 2021)

Over the past number of years, we have seen several sectors become increasingly digital. It is in those segments of the economy that we interact with on a daily basis where this is most evident, such as media, financial services, manufacturing and medicine.

If you are like me, when you think about the ocean, you are more likely to think about the science aspect: biologists, divers, iceberg tracking, weather, whale and seabird migration. What does not likely come immediately to mind for most is ocean technology. The ocean economy is experiencing digitalization just like every other sector; however, with a lack of communications infrastructure and the challenges of an underwater environment, digital transformation of the ocean is complex.

The ocean covers about 70% of our planet and is a critical part of our journey toward achieving things like climate change goals, food security and improved health outcomes. Yet, there is much that remains unexplored. This is where some of the biggest opportunities for tech companies and tech workers exist.

Getting To Know Our Oceans

It is often said that we know less about our oceans than we do about space. That is quickly changing. New technologies are collecting data about our oceans and ocean assets like never before. For example, sensors, autonomous underwater vehicles and smart buoys are all collecting data in addition to, or as an alternative to, traditional research vessels and human activity, and often at a lower cost.

Collecting this information is one thing, but all of this data also needs to be analyzed. There is much work being done to maximize access and interoperability of this data to support decision-making throughout multiple ocean sectors. This data helps us better understand what occupies the ocean, where those things are and where they are going. This could be everything from marine life to fishing gear. Artificial intelligence and machine learning help analyze data to tackle important challenges like carbon monitoring, rising sea levels and rising water temperatures in the journey to net-zero as well as species' migration to understand impacts on things like fishing and shipping lanes.

With the ocean economy expected to outpace the growth of the global economy more broadly, technology companies can consider applications in the ocean as part of both their growth strategies and their commitments to climate action.

RETURN TO CONTENTS PAGE

Tech Opportunities In The Ocean SectorWhile we often think of traditional roles in the ocean economy — an offshore oil worker, ship captain, a fisherperson, a plant worker — the increase in automation is creating new opportunities for non-traditional workers. Jobs that would have previously been done at sea are increasingly being replaced by roles on land, and there are new opportunities for workers to get engaged in the ocean economy.

We are seeing first-hand that oil platform workers are fewer with high-tech data rooms on land and cables to the platforms facilitating real-time data collection and monitoring. Workers at multiple sites can interface in virtual reality environments. Sensors flag issues for follow-up between offshore and onshore workers. Robots and drones can be controlled remotely to perform inspections in hard-to-reach places in and on the water, reducing safety risks.

Technology is being leveraged to track fish and seafood from sea to plate including sensors and blockchain, providing increased transparency and giving consumers additional information on where their food is coming from and the steps taken to get to their table. Fish processing plants are increasingly automated with fewer workers, and those workers are becoming more focused on robotics, information technology maintenance and cybersecurity to ensure smooth operations of the plant. Artificial intelligence is being leveraged to reduce waste and increase yields.

And finally, the ship captain. As ships become increasingly autonomous, there are fewer works at sea. Data scientists are relying on digital twins to establish predictive maintenance schedules and analyze data collected from multiple sensors to improve the performance of ships and reduce emissions. Ports are also using data to maximize ship traffic flow within their ports.

As we kick off the UN Decade of Ocean, while the digitalization of our oceans has a long way to go, things are starting to move quickly. More and more, we are understanding the ocean's critical role in achieving the world's climate change goals and how the data we collect will not only help us better understand our oceans but also help us make better-informed decisions. This creates new and exciting opportunities for all those in the tech sector with a passion for the ocean.

BOld & Moonshot: Artificial Intelligence for a Blue economy innovation ecosystem | Hellenic (April 2021)

BOld and Moonshot have signed an LOI (letter of intent) to establish the bases and joint lines of work between the participants to develop and commercialise the "Bold Moonshot" ecosystems within the Moonshot software platform.

BOld (Blue Ocean Leading Drivers) contributes with its knowledge and experience in acceleration environments and a proven methodology in developing open innovation in disruptive technology companies (Deep Tech).

Moonshot Innovation is an AI and neural networks platform to create and manage Innovation Ecosystems. It is the first platform with the capabilities to create and manage innovation ecosystems with open innovation tools, and connectivity to manage your own network.

This Strategic Partnership for Blue Economy Ecosystems development establishes the bases and joint lines of work between both companies for the development and commercialization of the "Bold Moonshot" ecosystems. BOld and Moonshot mutually recognize each other as strategic partners for the development of innovation ecosystems through Moonshot's PaaS platform, for which they express their desire and interest to work together developing their respective business areas focused on digitization and, in particular, in the Blue Economy.

RETURN TO CONTENTS PAGE