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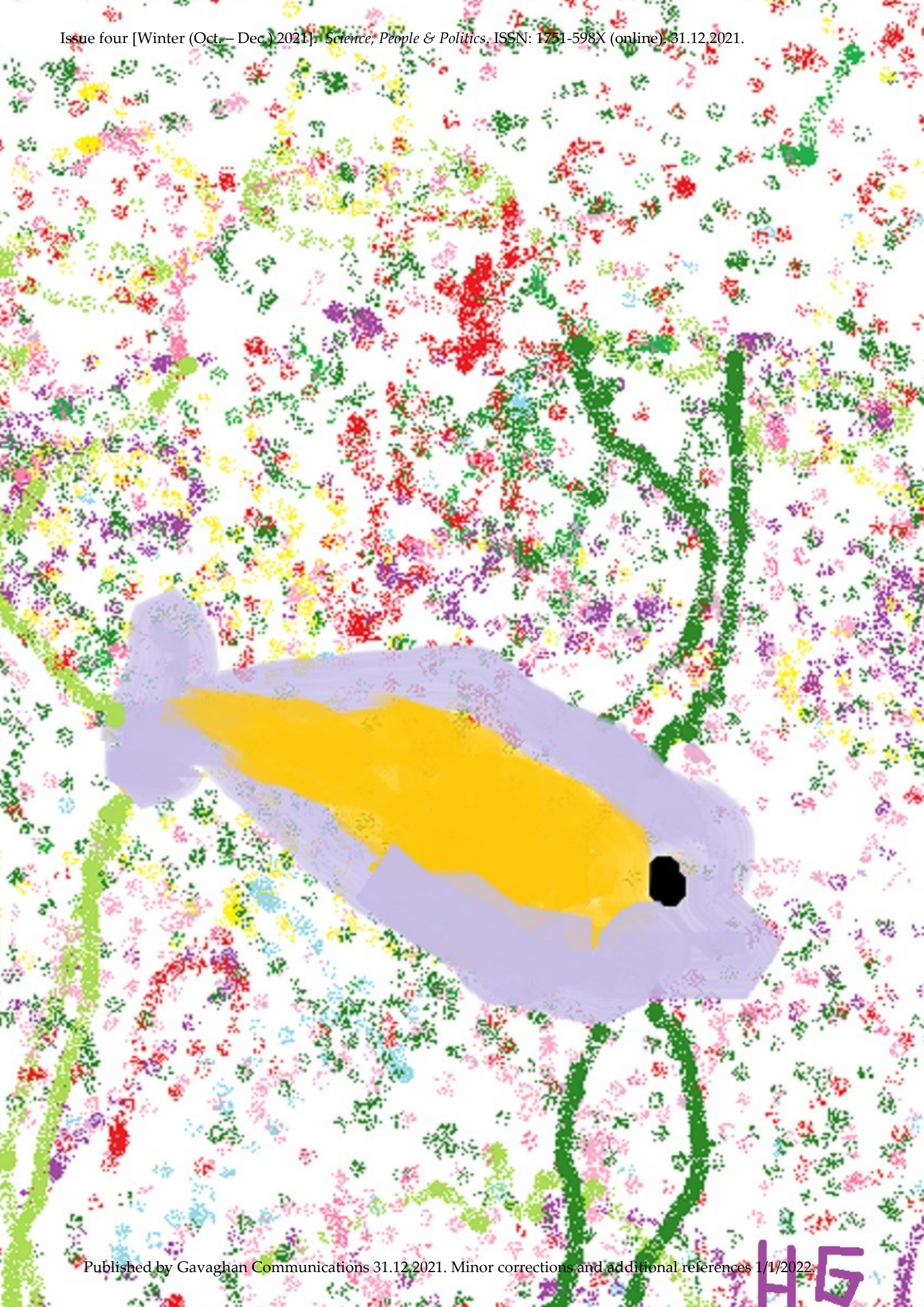

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Science, Poverty, Humanities

By Helen Gavaghan

Science begins with observation. Explanation follows. Oftentimes fanciful to a modern way of thinking, such as charioteers pulling the Sun across the sky. Why observe the Sun's behaviour? For its clear role in providing warmth, light, and energy. Anything with such impact on human well being deserves attention. And in the Britain of the late sixteen hundreds, authorities even found a way to raise revenue from its beneficence by taxing people according to how many windows they had*. An example of science, people (via Parliament) and politics, if ever there was one. Clipping coinage had reduced revenue. Raising tax on windows raised cash – until the tax was repealed in the mid-19th Century.

Perhaps global governments could now raise taxes on arms deals and arms sales. That might be a simple tax for capitalist countries, and more complex for State owned arms manufacturers to administer. In their case, or possibly for capitalist and communist alike, global tax could be raised on international arms dealing – from fighters and aircraft carriers, through to the small arms that prevent nascent democracies coalescing into nationhood. This would mean accounting to separate "profit" from arms deals from other income.

[See other discussion on this topic. https://www.researchgate.net/publication/4775100_Taxation_of_the_Global_Arms_Trade_An_Overview_of_the_Issues]

This would be a new tax. Not replacement revenue because of an unintended consequence from an economic policy, as with the Window tax. Nor should revenue from the proposed new tax be allowed to replace contributions to international aid. The tax collected should go into a ring-fenced account to pay for education, sanitation and humane shelter in refugee camps created to absorb people displaced by conflict.

The tax would be collected by Sovereign nations, and the ring-fenced United Nations' account should be administered by people seconded from such places as the US Internal Revenue Service or the UK's HMRC (Her Majesty's Customs and Revenue), or equivalents in other nations which pay a similar amount of attention to detail. Both HMRC and the IRS pay serious attention to "paperwork". They also calculate to the last penny, and they are

* https://www.nationalarchives.gov.uk/education/resources/georgian-britain-age-modernity/window-tax/

backed by serious enforcement. Now that the world has an International Criminal Court and Interpol, it ought to be possible to ensure money collected by taxing the arms industry ends up spent on improvements to refugee camps. Given the reality of people being displaced by extreme weather, there would need to be two revenue streams going to refugee camps: from tax on arms sales, and from international aid.

At the same time, the arms controllers could increase their efforts to convert swords to plough shares by lobbying governments to establish a new intergovernmental organisation (IGO) with the sole remit of taking control of ALL nuclear weapons, and centralising fusion and fission research that is related to making bombs, not nuclear power. Admittedly, that would be a lot of centrifuges, but some could be melted down! All nations, not only the current nuclear powers, would then name an envoy or two with the highest possible levels of security clearance, who would serve as guardians of the knowledge. Research would be joint. There would be no need for rivalry and excessive spending on nuclear fission bombs. Even hawks ought to be able to back such an idea, because to use a nuclear weapon pollutes the whole world. Such a weapon needs to be under Sovereign control via an IGO with a tight and narrow remit. One which would be insulated from geopolitical pressures.

Having done that, the world could continue its financial journey by expanding the world economy by a globally organised printing of extra money. The International Monetary Fund could run the numbers, such that being born means on reaching 18 one receives a yearly stipend with a particular purchasing power (perhaps the equivalent to £1000 to £3000 at UK purchasing power parity). This will not be an easy assessment or calculation. Earnings and benefits would not be affected. The aim is to give people leeway for when things get tough, but without leaching aspiration. Only the highest earners would not receive the stipend.

My utopian vision further includes the view that we need to make clear that ocean beyond national jurisdiction is for all, not only those with a coastline. Beneficiaries would include Afghanistan, Luxembourg and Switzerland. The world needs to find a way via salients, or air bridges which cannot be closed, and pelagic stations which do not block migratory routes for non-human animals, so that the Ocean, like Space and Antarctica, is there in principle for all nations. Only technology, economics and knowledge close Space and the Antarctic to nations. Ostensibly, the UN Convention on the Law of the Sea covers access for the landlocked, but not quite, because the rights of transit countries limit the landlocked.

Perhaps these ideas would help science and humanities further eliminate poverty. People via politics have tried for a long time to find equitable ways of co-existing. The UN itself is evidence I am not living in cloud cuckoo land.

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NEWS FEATURE AND ANALYSIS

Europe's Ocean View In a Global Setting

Oceans are the cradle of modern life. Without them, biology would be confined to the lithosphere. Higher resolution models of the global and regional oceans and seas are needed if we are to understand, monitor, and benefit sustainably from their health. In October, the EU and allies embarked on a second 7-year regional ocean plan (2021-2017) to contribute to just that aim – and other needs - while maintaining current operational competence for their marine services. Europe's aims could integrate well with the UN's Decade of Ocean Science for Sustainable Development (2021-2030).

By Helen Gavaghan.

Before the Covid pandemic the ocean economy was expected to be worth about US$3 trillion by 2030. The number is provided by the Intergovernmental Oceanographic Commission (ICO) of UNESCO. It is not clear whether the figure means $3 trillion per year, and whether it might be more if the marine classification were different, but it is a big number.

This is the UN decade of the Ocean for sustainable development, and the ICO, which has 150 member states and was formed in 1960, is the lead UN agency.

Trade and navigation, aquaculture, fisheries, recreation, marine, renewable energy and tourism contribute to the turnover. To survive global warming and be compatible with a thriving ocean biodiversity, that economy needs science and technology to significantly enhance knowledge of the ocean and its place within the Earth system of land, water, and air (See Box One. The Global Ocean). For that to happen, say European experts, more international collaboration is needed. So, it is in technical working groups and policy committees that the war will be played out to understand and save the planet from the oceanic depredations of human activity to date.

Europe's knowledge of the global ocean and the continent's regional seas comes from its Copernicus Marine Service (CMS). In September CMS published its fifth annual ocean state report. It is a work that integrates well with the aims of the UN's "Ocean Decade".

Measurements of temperature, acidity, ocean winds, sea-height, salinity, ice volume and surface area covered by ice, come from global networks of ocean buoys, ships, and satellites. The data are fed to computer models; and analyses, predictions, and raw data are available freely to

anyone needing support of the maritime sector. Will a shortage of diatoms, ie microscopic algae, for example, mean the eating is not so good for the zooplankton which feed on them? If so, bigger fish may suffer. From observation of what is happening in its region, CMS can find how and why fish catches vary, perhaps relating that information to plankton type and abundance. Climate, too, plays a part – even if there were no anthropogenic global warming! In cold snaps, sea bass and cod have been observed to be abundant. In warm weather, the fishing industry has caught a higher volume of red mullet.

Why?

During the next seven years, CMS plans integration of ocean, Arctic, and coastal observations. That way politicians, the fishing industry, and scientists will have specifics to talk about as they ponder why the marine life on dining tables differs from time to time, and whether they can or should do anything to oppose changes.

To Copernicus, oceans are divided into the white ocean (ice), carbon and nutrients in the ocean (the biogeochemical or green ocean), and the physical water of the ocean (the blue ocean). The health of white, green, and blue oceans and coastal areas are as intertwined as a tapestry. Tug too hard on one thread, and there may be a small repairable rent, or the whole cloth could disintegrate.

Some areas and processes in the global or regional oceans or seas are known to have more impact than others. The Artic, of course, is a key player. Mess too much with heat and salt balances at latitudes north of 60°N, and global currents could alter the entire planet's living conditions out of recognition. Luckily, as of 2019, which is the last year Copernicus focused on in the fifth ocean state report, the ocean of the polar basin adjacent to the Greenland and Barents seas seemed to be compensating for what otherwise would be dire changes in regional salinity. But there is very likely only a short time before the northern balances of water strata and currents stretch out of recognition, and like an overextended elastic band, recovery might not be possible.

Consider: ice reflects sunlight. If there is less ice, then sunlight warms areas in the Arctic (or Antarctic), which otherwise would have been insulated by thick ice. So, the global warming because of heat radiated back to Earth by greenhouse gases combines with less reflection of Sunlight, and the Arctic warms much more than it would otherwise.

From this simple physics of reduced reflection and increased heat radiation, there is a plethora of secondary effects in the world's oceans. These range from regional reduction in the extent of sea ice, not a happy situation if you are a polar bear. There could be many other impacts, but science does not yet know all the details which could leverage big changes, altering climate patterns or access to food. Hence there is a call for computer models with finer grids, for varied time series, and for more data points. When combined with smaller grids of latitude and longitude, more vertical resolution of measurements, and varied time series, it becomes clear that oceanography is entering the era of big data and artificial intelligence.

For example, AI can apply simple algorithms to very large data sets and interpolate for gaps in

measurements. Something which will always remain significant in oceanography, even if satellites become more sophisticated observers, and scientists have their wish granted for more data collection points. The ocean, simply put, is vast, and total in-situ measurement across its surface and depths seem unlikely, currently, to ever be possible. But who knows what inventions are on the horizon. Perhaps too AI and big data can be deployed to explore heat fluxes in regionally and locally turbulent areas of the ocean. The factors driving those processes could still hold surprises for marine science.

As grids of data become more finely meshed, and types of measurement and model inputs increase, the amount of information to be processed pushes existing computing power to its limits. Future understanding of the marine environment needs advances in computing and processing, as much as in oceanographic sciences.

One indicator of particular interest to Europe's scientists is the nutrient and oxygen condition of Europe's regional seas. That influences how many species from nano to microorganisms are in the marine environment. Such tiny organisms, in particular phytoplankton and zooplankton, are the base of the food chain, and are crucial for life on Earth. How quickly do such tiny creatures die and disintegrate into their constituent elements by the process of remineralization? In some way, not yet fully understood, the depth over which that process takes place changes the quantity of carbon dioxide the biology within ocean surface layers takes from the atmosphere by photosynthesis.

Critical nutrients for marine life include silica, phosphorus, and nitrogen. These are needed for biosynthesis of the complex biological macromolecules that maintain the health and physical integrity of plankton. Excessive nutrients lead to algal blooms in a process known as eutrophication. The blooms can take most of the oxygen locally in sea water, so that fish and other species die. Such blooms may, like the cooling pond of Chernobyl (thanks to Wikipedia for an image), be large enough to be seen by satellite. By contrast, oligotrophy exists in habitats in a marine environment poor in nutrients, or where nutrition in accessible form is limited. Extremes of both processes are not good for maintaining balanced ecosystems.

In general, the open ocean tends toward oligotrophy, while coastal zones, even without human pollution, tend toward eutrophic conditions. Indices of both have been developed during the period covered by the Copernicus Fifth Ocean State Report, but more work remains if subtleties of variation in distribution of oligotrophic and eutrophic conditions in coastal and open seas are not to be glossed over by averages or biased sampling. Eutrophication in 2019 compared with 1998 to 2017 did not exceed the ninetieth percentile, but there were markers of excessive oligotrophy in some coastal zones.

Chlorophyll, responsible for the green in plants and green algae, can signal the extent of algae present. If correlated with a record of fish in the same location, chlorophyll and fish records can give insight into the state of ocean water and its impact on fisheries. A word of caution about the Ocean State 5 report. Usually when scientists write about chlorophyll a, they mean chlorophyll absorbing a specific range of wavelengths. Chlorophyll b absorbs a different range of radiation. The authors say in OSR5 that chlorophyll "a" means chlorophyll algae (which could mean chlorophyll a plus b).

Monitoring ocean and regional sea health starts with observation. Combining readings in different locations adds value to the basic measurement. Trends emerge and give warning that modifications in management of the marine environment are needed. Indeed, for 20 years, the European Union has had directives in place to ensure its member states act responsibly. Ocean monitoring can save money by making clear when regions are healthy and need less attention. Developing warning mechanisms is a central aim also of the UN Ocean Decade.

From a European perspective, the seven seas are the global ocean, the Arctic Ocean, the shallow seas of the North-West European shelf, Iberia-Biscay-Ireland, the Baltic Sea, Mediterranean, and the Black Sea. By contrast, to physical oceanographers, there is one global ocean, roughly divisible into the Pacific Ocean (north and south), the Atlantic Ocean (north and south), and the Indian Ocean. The southern tips of these three form the Southern Ocean around Antarctica.

Two forms of current redistribute energy and material around the globe: those driven by winds, tides, and pressure gradients, and those driven by heat and salinity. The latter sinks vertically and circulates around the globe. Known as thermohaline, it brings the entire ocean into contact with the atmosphere, but over a thousand to a thousand plus years. If that conveyer belt breaks down, as it might if melting ice increases Arctic-ocean salinity to close to global levels. Uniform salinity would mean there was no density difference to part drive the thermohaline current.

At the surface there are gas exchanges. There is much to be learned about the mechanisms driving them. Transitions from the solid phase (ice) to liquid and water vapour are energy intensive. Circa 3.49 to 3.88 parts per thousand of ocean waters are salts.

In such a dynamic and complex system there are inevitably big questions to answer, such as how much of the ocean's kinetic energy is generated by its own intrinsic non-linearity. Or, how much more than was thought do ocean eddies, currents of roughly 100 to 500 km, impact ocean and ocean-atmosphere and climate models? Mesoscale scale eddies might impact ocean-atmosphere modelling and numerical weather predictions more than was thought, and global warming may be changing their pattern. Global Warming, after all, retains more energy in the earth system, and so all kinds of unexpected things might happen.

What happens in ocean eddies is the kind of detail needed if human beings are to protect marine environments and their inhabitants from human action. Irrespective of whether one's belief system is that all biology exists for human use, or has intrinsic rights that humans should protect, there is enlightened self-interest in knowing exactly how the global, regional oceans and seas work and interact. The more science learns, the more science comes to see that not all original interpretations of observations are accurate in every detail. And detail might be critical to species survival, or adaptation, or migration, or evolution. That is the context of the UN's decade of ocean science for sustainable development. What science is doing in Europe is happening in all regions, and the mass of data being collected needs to be compatible and accessible to all, according to the IOC. □

BOX 1. OCEAN GOVERNANCE.

Without oceans, people, and most of the rest of the biology, would die, or would never have lived, so working out how to manage their riches equitably and within agreed international law is worth doing. The UN General Assembly agrees. In 2017 it proclaimed 2021-2030 "The UN Decade for ocean science for sustainable development." Despite covering roughly 70 percent of the world's surface, only 20 percent of the ocean floor has been mapped. Large parts of the ocean have become dead zones as algal blooms have depleted the ocean of oxygen. The damage to corals caused by global warming has become a cause célèbre.

Most maritime zones lie beyond national jurisdiction. Beyond national limits, the UN Convention on the Law of the Sea (UNCLOS) holds sway. Landlocked and maritime countries alike can operate in the open seas. Though geopolitics has a history of depriving and manipulating the access the landlocked have to the sea, where there are marine genetic resources and deep seabed minerals.

UNCLOS has its limitations, but the UN Ocean of the decade is directed to take account of UNCLOS. Faced by climate change, increased trade, advances in shipping, whaling ships, biodiversity protection, sea-bed mining, endangered species, migratory species, plastic waste etc..., UNCLOS needs refinement to protect the ocean environment. Even in the deepest part of the Mariana Trench, for example, scientists have found discarded plastic.

How can such rampant exploitation of the open oceans and sea beds be governed to ensure the global commons is accessible to all, but is not wrecked? How can the landlocked have equitable maritime access by safe land passage across lands with unknown value, and sometimes unknown ownership, when indigenous rights may have been buried beneath territorial expansionism? And how does all of biology share equitably, not only with other human beings, but with biological organisms experiencing and communicating life very differently than people do.

What kind of data do governments need so that they can argue to protect blocks of latitude and longitude, and shipping, and mining rights, and migratory species. Negotiators need to know how the ocean stratification is behaving and possibly changing in different locations as oceans warm – and they are warming. There is general agreement that knowledge is lacking, and ocean science is lagging behind other scientific discipines. A key goal of the UN Decade of Ocean Science for Sustainable Development is to identify the data needed, and to collect, and understand that date, and make sure it is accessible to all. □

BOX 2. THE GLOBAL OCEAN.

There is one ocean. It laps land, and that conveniently enables people to develop names of regions so that the one ocean can be talked about in a way that makes sense to people. Fresh water flows into the marine world from inland waters. Oceans evaporate water into the global and local hydrological cycles. So far, all that is well known.

Shallows, coastal waters, estuaries, and pelagic zones cover nearly three quarters of the Earth. Beneath, there are continental shelves and rises which drop into ocean basins. There are abyssal depths and an abyssal plain. In the Mariana Trench, for example, the ocean bottom plummets to more than 7 kilometres below the surface. Ocean and seas are vast, dynamic spaces with multi-layered localized and regional ecological niches, through which migratory species pass. Changing migratory paths and fish being found at latitudes and longitudes where they have not been seen before can reveal if the ocean is changing, and that is a valuable observational tool in a world of global warming and climate change. That is an area of work where indigenous science may have much to offer.

Currents range from global to local. The thermohaline circulation of the Atlantic Meridional Overturning Circulation could, if global warming forces sufficient change in salinity and temperature, stop, and that would drastically rearrange Earth's climate. Some currents remain at the surface, and ring regional sea basins, for example the Indian ocean gyre and the north and south Pacific and Atlantic gyres. Some currents cling to the littorals, or flow as boundaries of the world's great currents or gyres. Some form eddies of 100 to 500 km width. The energetic importance of eddies is becoming increasingly obvious. The Southern Ocean, too, has lots of kinetic energy. Energy is neither created nor destroyed, but it does expend itself in fury, as it morphs into new forms. □

BOX 3. THE UK AND COPERNICUS.

The trade and co-operation agreement negotiated after the UK left the EU makes it possible for the UK to continue within Copernicus, yet the UK government websites are not clear on this matter, and the Copernicus website does not mention the UK specifically. □

***Copernicus Marine Service Ocean State Report 2021. September 2021.** https://marine.copernicus.eu/access-data/ocean-state-report/ocean-state-report-5

Journal of Operational Oceanography. Volume 14. Supplement 1. September 2021 Special Issue: Copernicus Marine Service Ocean State Report, Issue 5 Supplement.

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MORE ABOUT COPERNICUS.

Copernicus Maritime is part of Copernicus, the EU's Earth observing programme, which falls under the aegis of the European Commission's directorate of defence industry and space, is located at https://ec.europa.eu/info/departments/defence-industry-and-space_en. CMS is funded by the European Commission. Mercator Ocean International delivers CMS. The CMS is also known as the Copernicus Marine Environment Monitoring Service. https://maritime.copernicus.eu. For sectors of the blue economy, see https://marine.copernicus.eu/services/markets. Ocean Monitoring Indicators within the EU ocean monitoring and forecasting service (Copernicus Marine System) are found her: https://marine.copernicus.eu/access-data/ocean-monitoring-indicators. During the second 7-year European plans for ocean observation and management the Copernicus Marine Environment Monitoring Service will develop new information products for worldwide reference.

Further reading, compiled December 2021 by Helen Gavaghan.

Mesoscale eddies. https://www.gfdl.noaa.gov/ocean-mesoscale-eddies/

Steric sea-height. https://sealevel.nasa.gov/understanding-sea-level/key-indicators/steric-height

Solid Earth science working group. https://solidearth.jpl.nasa.gov/PAGES/sea01.html

Phytoplankton. https://oceanservice.noaa.gov/facts/phyto.html#:~:text=Phytoplankton%20are%20microscopic%20marine%20algae.&text=Most%20phytoplankton%20are%20buoyant%20and,proteins%2C%20fats%2C%20and%20carbohydrates.

IODE International oceanographic data and information exchange. https://www.iode.org/

Gyres. https://oceanservices.noaa.gov/facts/gyre.html

Chlorophyll a. In the Copernicus Ocean State Report 5, this is a measure of the algae growing in a marine water body. More usually in remote sensing Chlorophyll a refers to the wavelengths of Sunlight which algae reflect (or absorb – check).

https://ecowatch.noaa.gov/thematic/chlorophyll-a

Ocean decade. https://ioc.unesco.org/ and https://ioc.unesco.org/index.php/

Ocean models. http://stream1.cmatc.cn/pub/comet/MarineMeteorologyOceans/ocean_models/comet/oceans/ocean_models/print.htm

AMOC. Atlantic Meridional Overturning Circulation. https://www.metoffice.gov.uk/weather/learn-about/weather/oceans/amoc

AMOC tipping point. https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/climate/ocean-and-cryosphere-report/srocc_amoc.pdf

MIT Climate Portal. https://climate.mit.edu/explainers/radiative-forcing

What are phytoplankton? https://earthobservatory.nasa.gov/features/Phytoplankton

Steric height. https://sealevel.nasa.gov/understanding-sea-level/key-indicators/steric-height

Satellite collecting observations on salt and fresh-water height. Launch scheduled September 2022.

https://sealevel.nasa.gov/news/228/one-year-from-launch-us-european-satellite-to-track-worlds-water/

Global carbon cycle. Material archived by NASA. Check for updates in content that is not part of the established knowledge of science. For example, since this item was written, much effort globally has been made to reduce reliance on carbon for transport and heating. Though detailed numbers differ, the principles continue to apply.

https://www.earthobservatory.nasa.gov/features/CarbonCycle

Ocean stratification and circulation. Though written in 2000, this article addresses still relevant underlying principles. http://xtide.ldeo.columbia.edu/mpa/Clim-Wat/Climate/lectures/ocean/

Sustainable Development Goal 14. Life Below Water.

https://www.un.org/sustainabledevelopment/wp-content/uploads/2019/07/14_Why-It-Matters-2020.pdf

Remineralization (2017). Remineralization, a process during which zooplankton and phytoplankton decay into their constituent elements on their death , is a factor impacting the ocean's ability to absorb carbon dioxide from the atmosphere.

https://www.nature.com/articles/ncomms14847

Photosynthesis. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5264509/

Machine learning identifies a strong association between warming and reduced primary productivity in an oligotrophic ocean gyre https://www.nature.com/articles/s41598-020-59989-y

All about sea ice. https://nsidc.org/cryosphere/seaice/environment/global_climate.html

Introduction to synoptic meteorology. https://www.weather.gov/jetstream/synoptic_intro

The Ensemble Kalman Filter. (Lecture from the UK Met Office. Assumes literacy in statistics).

http://www.met.reading.ac.uk/~darc/training/ecmwf_collaborative_training/EnKF_Lecture1_Sanita.pdf

HYCOM [Hybrid co-ordinate ocean model] https://www.hycom.org/

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NEW YEAR QUIZ.

Submit responses to info@gavaghancommunications by 1st February 2022. The winner (selected as in a raffle from correct answers) receives a modest prize of £10.00 which will be made by Gavaghan Communications to a charity of the winner's choice. Name your charity in your submission, together with it's charity number. The charity must be based in the UK. Quiz participants may come from any where. Answers and the name of the winning charity will be published in the Spring issue (Issue 2) of *Science, People & Politics* 2022. State in your entry if you wish to have your name, age and affiliation published - Or a combination of those.

1. What are the official languages spoken in Switzerland?
2. Which countries border Afghanistan?
3. Which countries occupy The Horn of Africa?
4. In which year was Pakistan founded?
5. In which year was the Russian Revolution?
6. In which year did Nelson Mandela die, and why is he famous?
7. What is the nationality of Diego Maradona, and why is he famous?
8. How many Olympic gold medals has Dame Sarah Storey won?
9. What is the name of the waterway linking the Atlantic and Pacific Oceans?
10. What job did Indira Gandhi do?

Quiz and answers compiled by Helen Gavaghan