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Submarine Cable Protection and the Environment

An Update from the ICPC, Written by Marine Environmental Adviser, Dr Mike Clare

Topics Covered in this Issue:

- The need to observe the global ocean
- Offshore hazards and submarine cables
- SMART cables initiative
- Ocean scientific research and the industry

SUBMARINE CABLE PROTECTION AND THE ENVIRONMENT

An Update from the ICPC, Written by the Marine Environmental Adviser (MEA)

PUBLISHER

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EDITOR'S CORNER

For the last few decades, and arguably longer, the world has become closer in reach. Airline travel, the globalisation of economies and financial markets, and the growth of communication technology linking our world's many countries and continents, has brought us together and has shaped our lives as we know them today and what they will be in the future. The COVID-19 pandemic has put a spotlight on this globalisation and our ability to remain interconnected through communications. The pandemic has also put a spotlight on the importance of the internet, and more broadly the infrastructure that supports it, including submarine cables. Submarine cables, with advanced transmission technology, are part of extensive, capable, and intelligent network topologies that criss-cross regionally and internationally. This critical infrastructure facilitates our way of life now more than ever.

There is no doubt then, that submarine cables contribute to sustainable socio-economic development and that protecting submarine cables and their primary purposes for telecommunications is of critical importance. It is also important that the industry endeavours to protect the environment in which submarine cables exist. To that end, the International Cable Protection Committee (ICPC) continues to work towards implementation of the UN's Sustainable Development Goal (SDG) 14 *('Life below water')* in order to conserve and sustainably use the oceans and seas for sustainable development. We aim to do this by promoting sustainable practices in the submarine cable community and raising awareness among seabed users and policy makers of the significance of submarine cables and on the importance and practical implications of the provisions of the United Nations Convention on the Law of the Sea (UNCLOS) for submarine cables and concerning the protection and preservation of the marine environment.

There are ways to make submarine cables more intelligent by leveraging this infrastructure for purposes additional to telecommunications. This publication discusses 'dual use' cables in the form of distributed optical fibre sensing, instrumented cables, and new so-called SMART cables. Within these applications there are opportunities and challenges to explore secondary uses of submarine cables while remaining cognisant of the primary purpose and critical importance of why submarine cables are installed in the first place – without them, these words would not be reaching your device.

Sincerely,
Ryan Wopschall
ICPC General Manager

INTRODUCTION

The links between ocean scientific research and the subsea cable industry are long-lived. Indeed, it was the push to create the first transatlantic communication links using telegraph cables in the mid-1800s that led to some of the earliest scientific deep sea discoveries in the Atlantic, including the discovery of the mid-Atlantic ridge, complex life in the deep sea and the existence of currents in vast water depths [2,3]. Nowadays more than 1.8 million kilometres of subsea telecommunications cables cross the global ocean, connecting continents and remote island states, and enabling the transfer of more than 99% of all digital data traffic worldwide [4,5]. Surveys for new routes, which span some of the greatest depths worldwide [6], continue to provide new deep sea observations of previously unmapped areas [7], while environmental surveys acquired before and after cable installation have provided insights into the rates at which seafloor ecosystems respond to change [8]. Since the early years of telegraph cables, scientists have gained a better appreciation of how varied and dynamic the ocean can be, and of how climate change and human activities can impact its health. Technological developments have enabled major leaps forward in ocean observing; yet, the deep sea remains relatively poorly monitored, particularly in the southern hemisphere. Large-scale international monitoring infrastructure is required to fill knowledge and geographic gaps. In this issue of *Submarine Cable Protection and the Environment* we discuss the needs and challenges involved in sustained ocean monitoring, and introduce the concept of SMART (Science Monitoring And Reliable Telecommunications) cables. This initiative proposes that adding sensors to new subsea telecommunications cables may help to fill some of the outstanding gaps. We specifically discuss the opportunities and challenges facing SMART cables and some of the other approaches for sustained deep sea observations.

Thank you to Professor Bruce Howe at University of Hawai'i at Manoa, ICPC International Cable Law Adviser Mr Kent Bressie and ICPC Executive Members Dr Ronald Rapp and Mr Simon Webster for their contributions.

OBSERVING THE DEEP SEA

- The deep sea plays a critical role in regulating climate change and providing food sources.
- Existing ocean science monitoring programmes focus on relatively shallow waters and miss many regions entirely.
- Sustained observations are required of environmental changes in the deep ocean and of the hazards that can be initiated there.
- Seafloor cables may provide an opportunity to fill some of these gaps, either using optical fibres within cables to monitor the ocean, or by adding sensors to new cables.
- Several instrumented cables are planned for commissioning in the coming years; however, their widespread use is currently limited by a number of logistical and legal challenges.
- Future monitoring is likely to include a combination of bespoke scientific cables and optical fibre sensing along existing commercial cables or out of service systems, to complement wider international scientific initiatives to observe the global ocean.

IS IT PLANET EARTH OR PLANET OCEAN?

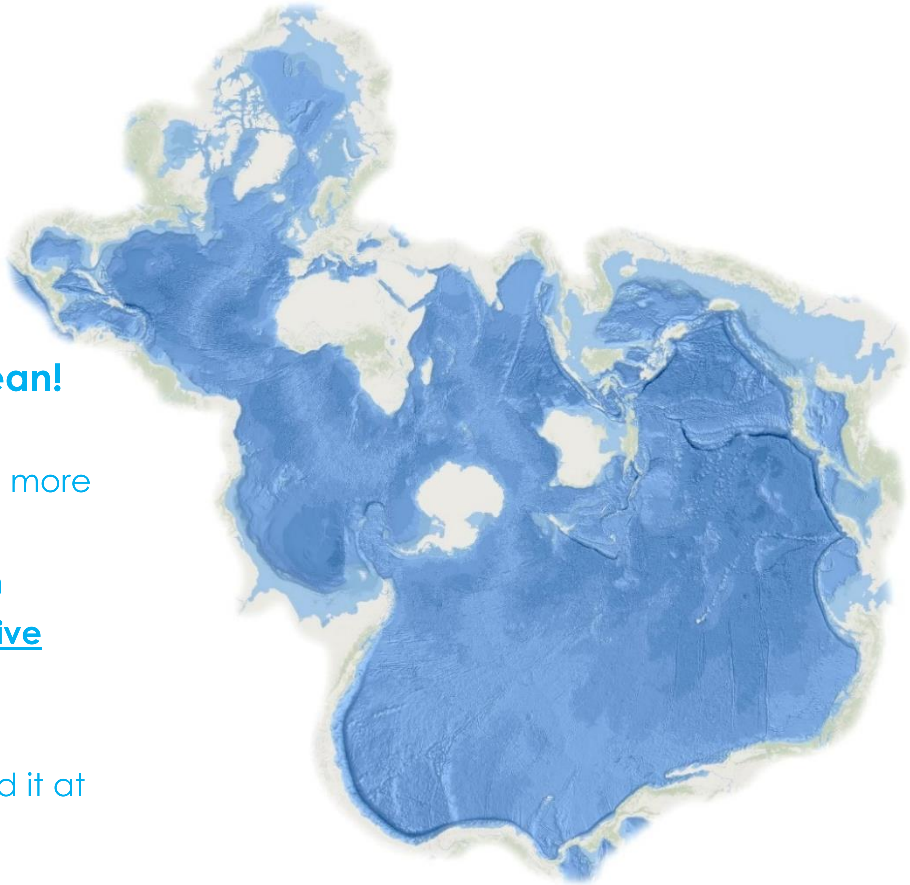
The ocean covers more than two thirds of our planet and more than 40% of the global population lives at least 200 km from a coastline [9]. Yet, it is often easy to forget how important a role the ocean plays in supporting life on Earth and in our daily lives.

- Clean and healthy waters provide important habitats and food sources, underpinning fisheries and tourism. The ocean provides the primary source of animal protein for over a billion people [10,11].
- The ocean represents the largest habitat on our planet, containing abundant and important biodiversity that includes genetic resources that can be used in life-saving medicines [12,13].
- The ocean hosts economically valuable mineral, hydrocarbon, and renewable wind, tidal and wave energy resources [14].
- The ocean helps to buffer the effects of climate change. More than a quarter of carbon dioxide emitted by the burning of fossil fuels has been absorbed by the ocean, and it has taken up more than 90% of the excess heat [15].

The connection between the ocean and human well-being is formally acknowledged by the UN Sustainable Development Goals, primarily through SDG14: '*Conserve and sustainably use the oceans, seas and marine resources for sustainable development*' [16]. It is now well known that climate change, human activities, pollution, overfishing and the extraction of seabed and subsurface resources have the potential to affect the ocean to its deepest reaches [17]. However, precisely to what extent, at which rate and on what scale remains unclear. In the same way a doctor monitors a patient's health through measuring heart rate, blood pressure, lung capacity and so on, there is a need to monitor how the ocean is responding to these different impacts. Ocean Observing Systems are required to make measurements across different spatial and time scales, to characterise the wide-ranging impacts on ocean health, and are essential tools for forecasting future changes in weather and climate [18].

In 1992 a cargo ship in the North Pacific lost a shipping container between China and the USA, spilling nearly 30,000 rubber ducks into the ocean. Thirty years on, these ducks continue to wash up at various places around the world from Alaska to Australia, having been transported vast distances by surface ocean currents [19]. The transfer of pollution around the world clearly demonstrates how different bodies of water are connected by a conveyor belt of ocean currents [20]; collectively making up one global ocean. This concept of a global ocean is particularly well demonstrated by the Spilhaus projection [21] **(Fig. 1).** Unlike conventional world maps, this projection shows an uninterrupted view of the ocean and clearly visualises the direct connections between the different basins.

▼ **Figure 1:** We live on Planet Ocean not Planet Earth. By plotting the continents in a Spilhaus projection, we can clearly see how the ocean is globally connected. (From [21]).



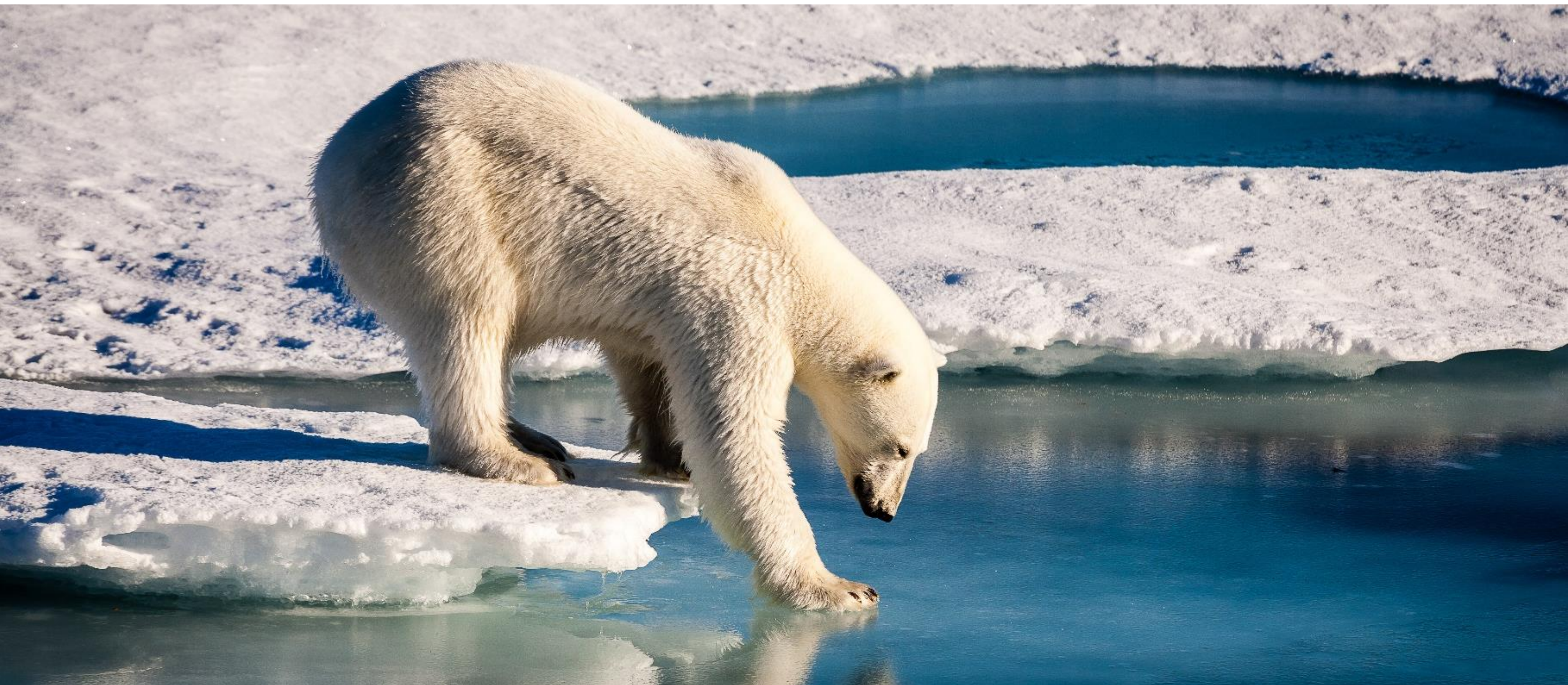
Drop a duck in the ocean!

To save you having to add more litter to the ocean, the *Plasticadrift* research team created an **online interactive tool** to show how surface currents would transport a rubber duck if you dropped it at any point in the ocean.

GROWING INTERNATIONAL COLLABORATIONS TO MONITOR THE HEALTH OF THE OCEAN

The vast extent, great water depths, and often-highly energetic conditions of the global ocean pose many challenges to long-term and high-quality monitoring of the ocean [17]. However, increasing industry activities, technological advances, and international collaborations have dramatically improved our collective capacity and capability to monitor the ocean over recent years [17,18]. Several sustained ocean observing programmes and observatories now make measurements at near-continuous to decadal timescales. One such programme is the Global Ocean Observing System that integrates measurements across the global ocean from arrays of ships, satellites, drifting instrumented floats (that can make measurements up to 4000 m below the sea surface), fixed moorings, autonomous underwater robotic vehicles, animal tracking, and acoustic monitoring that records sounds in the ocean [22,23].

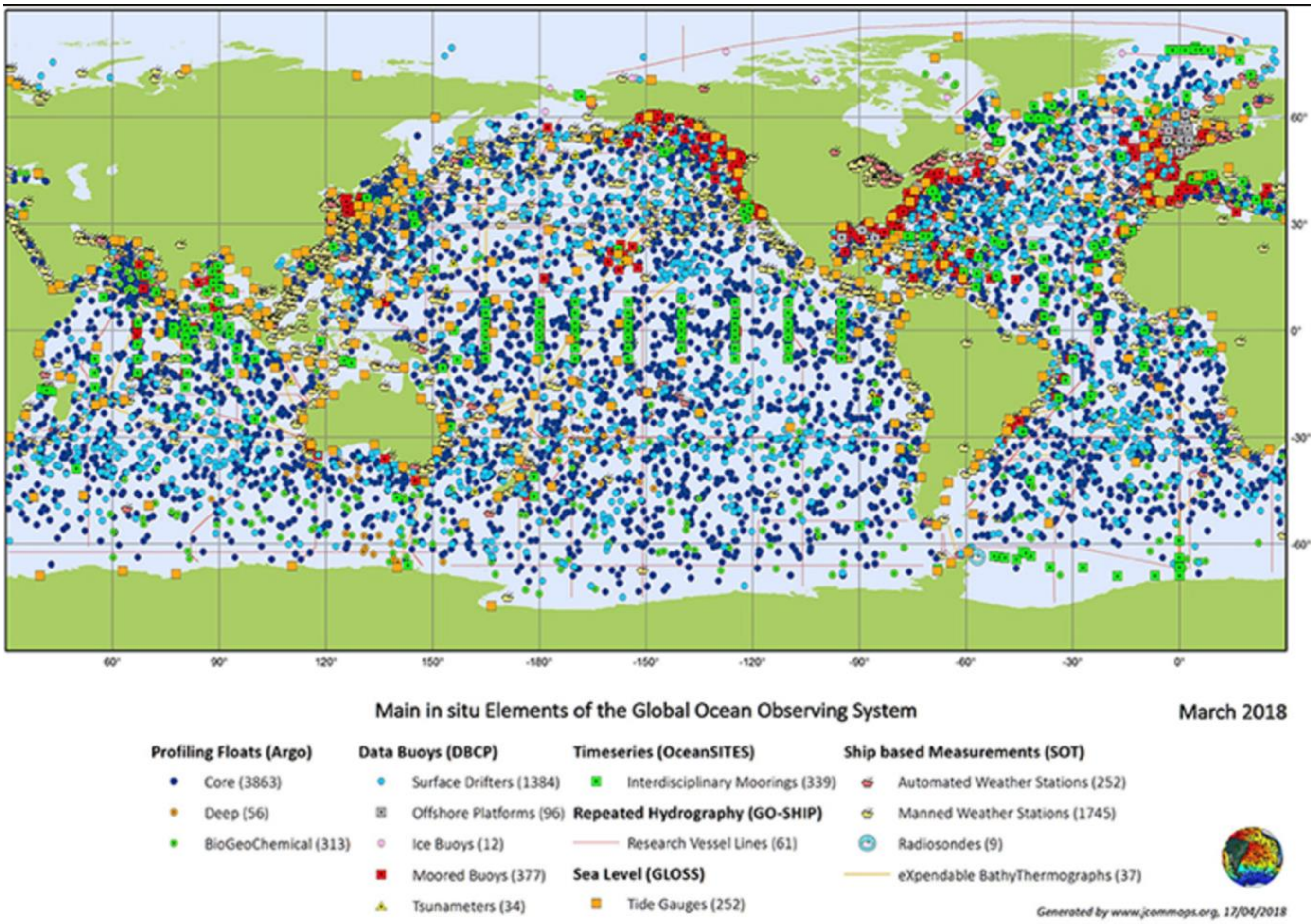
The sheer scale of monitoring locations across the global ocean **(See Fig. 2 on the following page)** has only been possible through international collaborations that coordinate the gathering of data in relation to 'Essential Ocean Variables'; key observable properties of the ocean that reveal its behaviour and response[24]. These variables include physical, chemical and biological properties such as sea temperature, salinity, sea surface height, currents, acidity, carbon and nutrients, oxygen levels, mass and diversity of marine fauna, and noise type and intensity.



A NEED TO OBSERVE THE DEEP SEA

However, even with observations from programmes such as the Global Ocean Observing System, measurements of the deep ocean remain relatively sparse, as most of the measurements are within the top 2000 m of the ocean and are geographically-biased towards the northern hemisphere[18]. This has motivated a Deep Ocean Observing Strategy [25], that also aims to acquire data such as ocean bottom pressure – to understand sea level rise, changes in ocean circulation and provide early warning for offshore hazards such as storm surges and tsunamis that threaten coastal communities [26].

▼ **Figure 2:** Locations where near-continuous ocean measurements were made as part of the Global Ocean Observing System in March 2018, including fixed and mobile sensors. (From Weller et al. 2019)



EARLY WARNINGS OF OFFSHORE HAZARDS

(pages 11-12)

On 15th January 2022, the largest volcanic eruption for at least 30 years occurred at the mostly submerged Hunga Tonga-Hunga Ha'apai volcano, located in the Kingdom of Tonga in the South Pacific [27]. This major eruption ejected ash 55 km into the mesosphere, created pressure waves felt around the world and triggered a tsunami that travelled over 8,000 km, taking lives as far away as Peru [27]. Aside from its power, perhaps the most surprising aspect of this event was the lack of warning. Fortunately, despite the magnitude of the eruption, relatively few lives were lost; however, many other offshore hazards have been similarly unexpected, but have been far more devastating. These include earthquake-triggered tsunamis (e.g., 2004 Indian Ocean earthquake [28]; 2011 Tōhoku Oki earthquake [29]) and volcanic island collapses (e.g., 2018 Anak Krakatau volcanic flank collapse [30]). Such events are most likely to occur along or close to tectonic plate boundaries. Tsunamis can also be triggered in other ways, such as by underwater landslides that can occur far from such plate boundaries [31], while fatal inundation events can also arise from large tropical storms and the resultant surges (e.g., 2009 Typhoon Morakot, Taiwan [32]; 2012 Superstorm Sandy, USA [33]). The lack of early warning mostly results from the limited extent of offshore hazard monitoring networks. Some regions have sparse or no monitoring systems at all, creating what have been termed 'tsunami blind spots' [34].

Many new tools have been developed to start filling these hazard blind spots, and the wider issue of monitoring the deep sea. For example, the September 2020 issue of *Submarine Cable Protection and the Environment* highlighted new ways of detecting and measuring powerful sediment avalanches using acoustic sensors, including those that damaged cables offshore Angola in 2020 [35]. This approach has enabled the first detailed measurements of these hazardous flows, providing new insights into their triggering and behaviour [36]; however, it relies on sensors that are deployed at individual locations. Therefore, such monitoring does not cover large distances, nor does it enable the direct relay of information, and thus cannot be used for early warning.

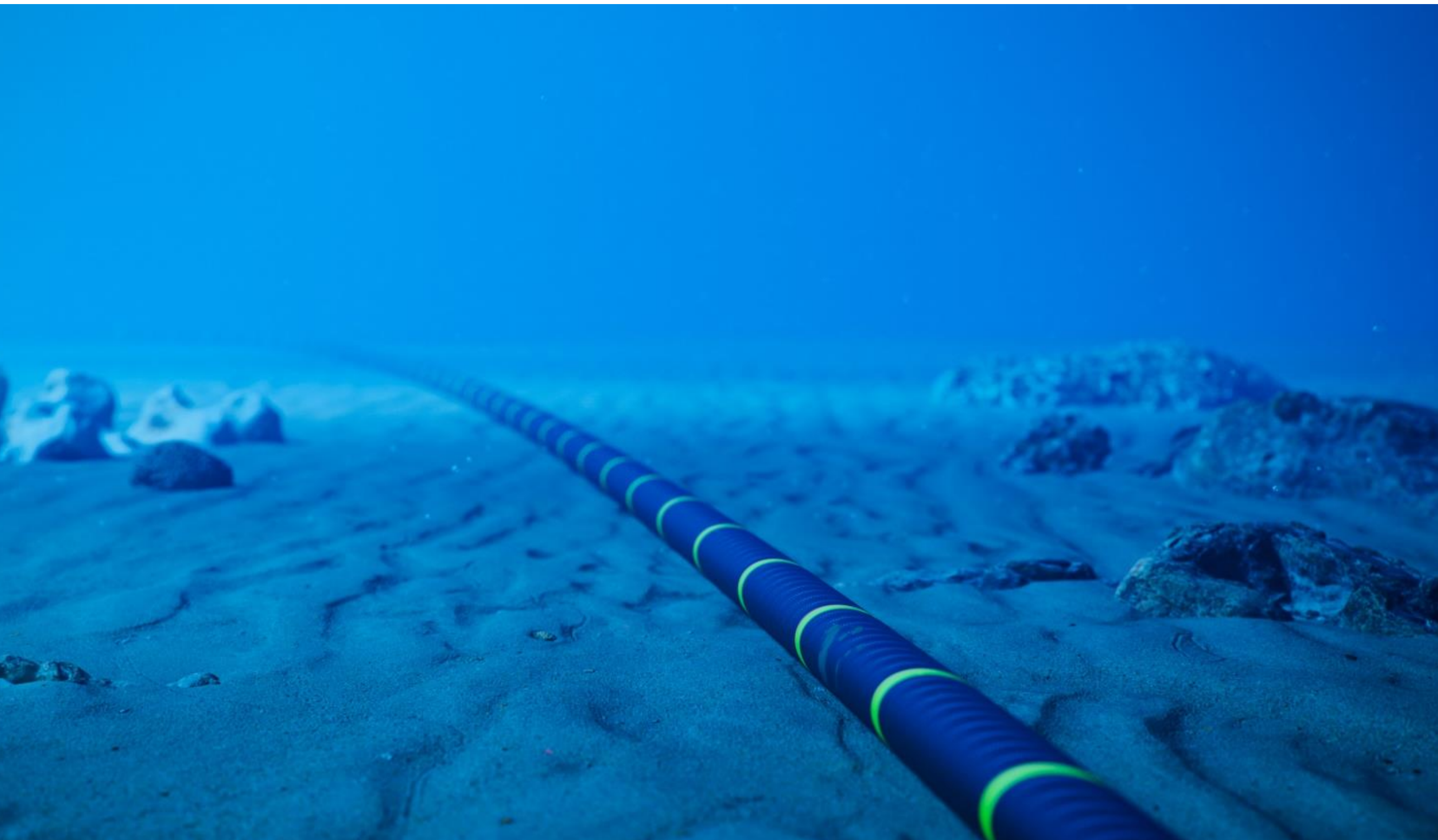
Natural hazards and their impacts on subsea cables

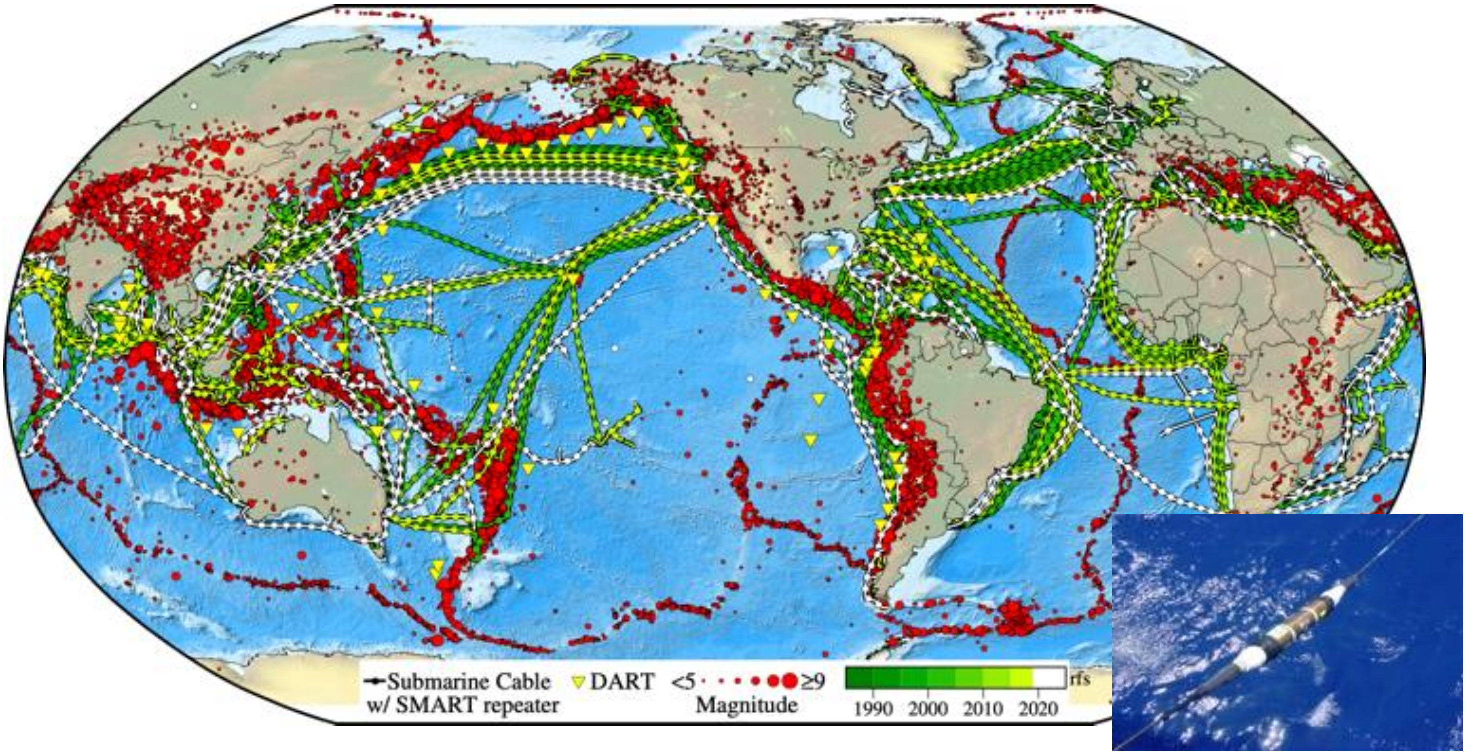
- Recent events have demonstrated how offshore hazards also pose a threat to seafloor telecommunications cables. River floods in 2020 triggered avalanches of sediment in a large seafloor canyon offshore Angola, damaging multiple cables during the early stages of the COVID-19 lockdown [35].
- The only seafloor cable that connected Tonga to the global subsea network was irreparably damaged following the January 2022 Hunga Tonga – Hunga Ha'apai eruption, effectively cutting telecommunications at a critical time for disaster response [37].
- In 2017, Hurricane Irma left millions without internet when floodwaters cut off power and submerged terrestrial data cables [38].

While these events are relatively rare (accounting for <10% of all cable faults worldwide) [1], and cables are routed to avoid hazardous areas as much as possible, the subsea cable industry has an interest in better understanding these and other offshore hazards to ensure the global network remains resilient.

THE SCIENCE AND RELIABLE TECOMMUNICATIONS (SMART) CABLES INITIATIVE (pages 13-18)

A recent initiative proposes to integrate environmental sensors into new regional and trans-oceanic telecommunications cables, to directly measure a number of Essential Ocean Variables. The SMART (Science Monitoring And Reliable Telecommunications) project specifically aims to integrate temperature, pressure, and acceleration sensors into future cable systems to enable sustained monitoring in the deep sea [39]. These sensors would be integrated into repeaters **(See Fig. 4 on page 18);** nodes that are used to amplify the signal that are placed at intervals of 10s-100s of km along a cable. Currently, there are well over one million kilometres of operational undersea cables with repeaters every 50-120 kilometres **(See Fig. 3 on the following page).** By piggybacking on the already planned and evolving cable network, the SMART cables project proposes to extend monitoring of the deep ocean, and would complement other programmes that use satellites, buoys, and in-situ systems [39].





▲ **Figure 3:** The global submarine telecommunication network as of early 2021, comprising 1+ million km of cable, refreshed and expanded on a 10-25-year time scale. Potential SMART repeaters are indicated as dots, nominally every 300 km (actual spacing is 50-120 km). Color (green-white) indicates year ready for service. Red dots show historical earthquakes and magnitude. Yellow triangles are DART tsunami warning buoys. The inset shows a typical repeater (courtesy of Alcatel ASN).

A Joint Task Force (JTF) on SMART Subsea Cables was established in 2012 by the UN agencies International Telecommunication Union, World Meteorological Organization, and UNESCO Intergovernmental Oceanographic Commission [40]. The opportunity to add additional capability to the global network of subsea telecommunications cables is of keen interest to the environmental scientific community, to governments in countries that are particularly vulnerable to impacts of offshore natural hazards, and potentially to the subsea cable industry to better understand threats associated with natural hazards. This initiative is starting to become a tangible reality in several locations, with a number of proposed SMART systems under development. These include: an Italian led demonstration project off Sicily; a Portuguese Continent-Azores-Madeira (CAM) 3700-kilometre ring motivated by the 1755 earthquake and tsunami to be installed in 2024 [41]; a New Caledonia to Vanuatu cable near the earthquake/ tsunami-prone New Hebrides Trench; a French Polynesia cable system from Tahiti to Tubuai measuring over 800 kilometres that could serve as a mid-way station between the megathrust Kermadec Trench on the west and the Peru-Chile Trench on the east, both sources of great earthquakes and tsunamis; a modest Indonesian system across the Makassar Strait that will serve as a pilot and lead to a large scale SMART cable-based tsunami warning system; and Project Koete (Perth-Darwin-Jakarta-Malaysia); New Zealand-Chatham Islands [42].

These new projects will serve as demonstrators to assess how viable the SMART cable initiative may be, as an emerging complementary approach to monitoring the changing global ocean. However, a number of challenges exist that currently limit a global application of the approach:

- While several governments have already pledged support for new SMART cable systems, others remain more reserved, having expressed concern about new capabilities to perform ocean sensing due to perceived infringements of sovereignty, national security, or improper data gathering concerning marine resources [40].

- Although proponents of inclusion of sensors on cables remain nervous talking about security implications, the fact remains that the inclusion of certain kinds of sensing capabilities—or fear that they could be included—could make cables targets for intentional damage. Development and deployment of any sensing technology on commercial telecommunications cables needs to also provide the assurance that the capability does not pose a security threat.

- The primary use of commercial fibre optic cables is to ensure the efficient and stable transfer of digital data and communications. Any additional sensors must not jeopardise the reliability of that primary purpose. A number of cable designers and operators are working with the SMART Joint Task Force to ensure that any integrated sensor packages have no potentially adverse impacts.

- Inclusion of sensors could encourage jurisdictional creep and erode submarine cable protections under international law. Such concerns are not theoretical, as some coastal states have attempted to regulate floats in the Argo ocean observation system. The United Nations Convention on the Law of the Sea gives coastal states the right to impose strict regulations on 'marine scientific research' in the exclusive economic zone extending 200 nautical miles seaward from the coast, even though it does not define 'marine scientific research.'

- Submarine telecoms cables underpin global communications, supporting everything from the global economy to our personal lives [1,4]. The vast majority of cables are funded and built by commercial companies. Additional design requirements or any new and unprecedented technology mandates may make new cable systems commercially unattractive.

- The additional cost to design, manufacture, operate, maintain and repair instrumented repeaters may be hard to justify for commercial companies developing submarine cable systems and may challenge their ability to construct, own and operate a commercially viable cable system asset.

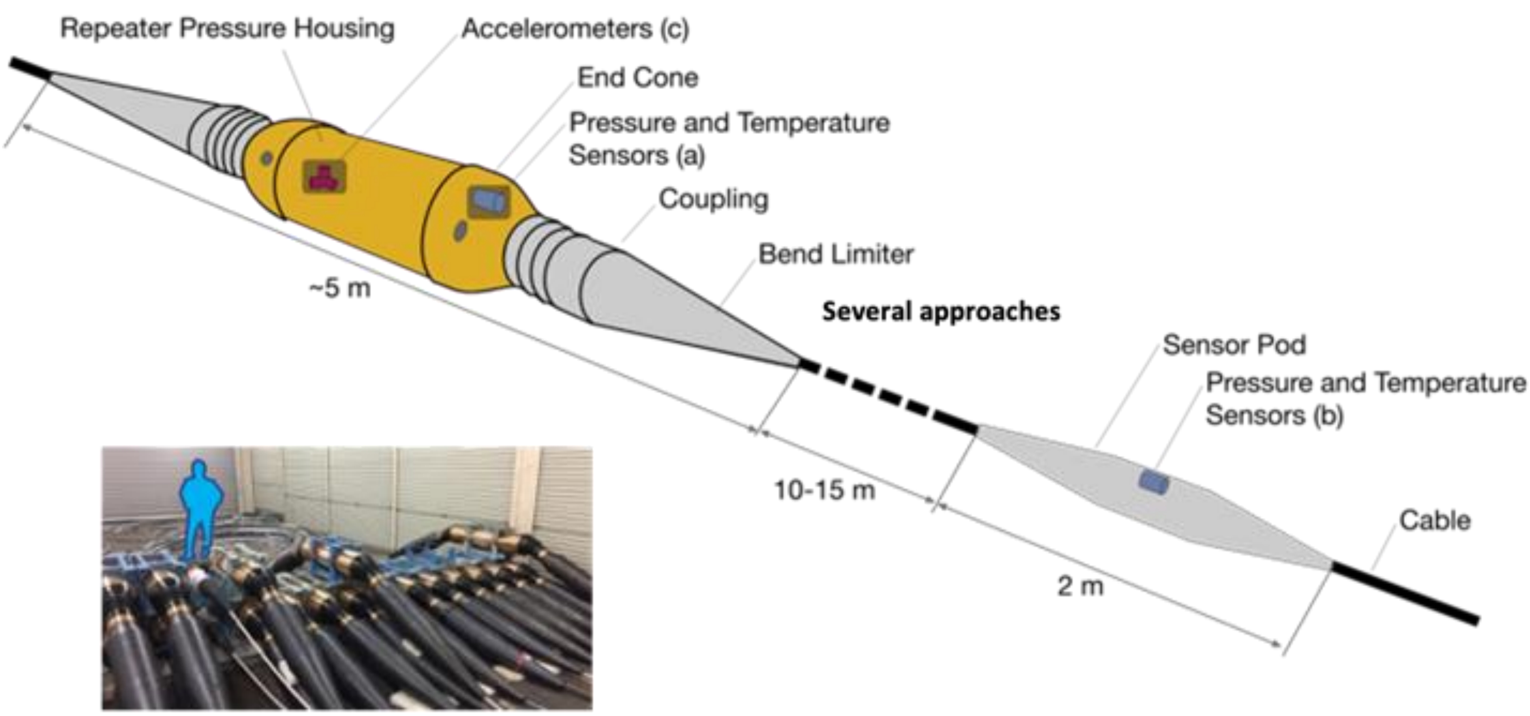
- The business model for how capital expenditures and operational expenditures are combined between private or commercial operations and maintenance of a submarine cable system with that of scientific monitoring, data collection, and instrument maintenance is not yet proven.

- Geographic biases in monitoring are still likely, and many tracts of the ocean will still remain unmonitored. While there is a very dense coverage of cables across the Atlantic Ocean from New England to the United Kingdom, Ireland, France, and the Iberian Peninsula, many areas of the Southern Hemisphere will remain under-represented by cables **(See Fig. 3 on page 14);** a similar issue for the wider Deep Ocean Observing Strategy.

- New bespoke scientific SMART cable systems may therefore be needed to fill gaps where commercial cables will not be laid, such as the **proposal** for a SMART cable to connect New Zealand to Antarctica. Polar settings pose a number of environmental challenges for seafloor cables, so routes will need to factor in the associated risks.

- Commercial subsea cable routes are carefully planned and designed to avoid hazardous areas of seafloor as much as possible, in order to avoid the adverse impacts of natural hazards. Routes that are most efficient for telecommunications may miss important areas for science needs. Dedicated sensor branches off the main telecommunications trunk may be considered in such cases. While it will undoubtedly provide valuable new data, piggybacking SMART sensors on commercial cables will not completely fill the gaps in offshore hazards monitoring unless bespoke scientific. In some cases, a dedicated sensor system cable from shore may make the most sense.

▼ **Figure 4:** Two possible approaches to integrating temperature, pressure, and seismic acceleration sensors into SMART cables, either directly in/on a repeater housing and/or in a nearby sensor pod. For scale, the inset shows repeaters for a trans-ocean cable system (Image courtesy of Bruce Howe).

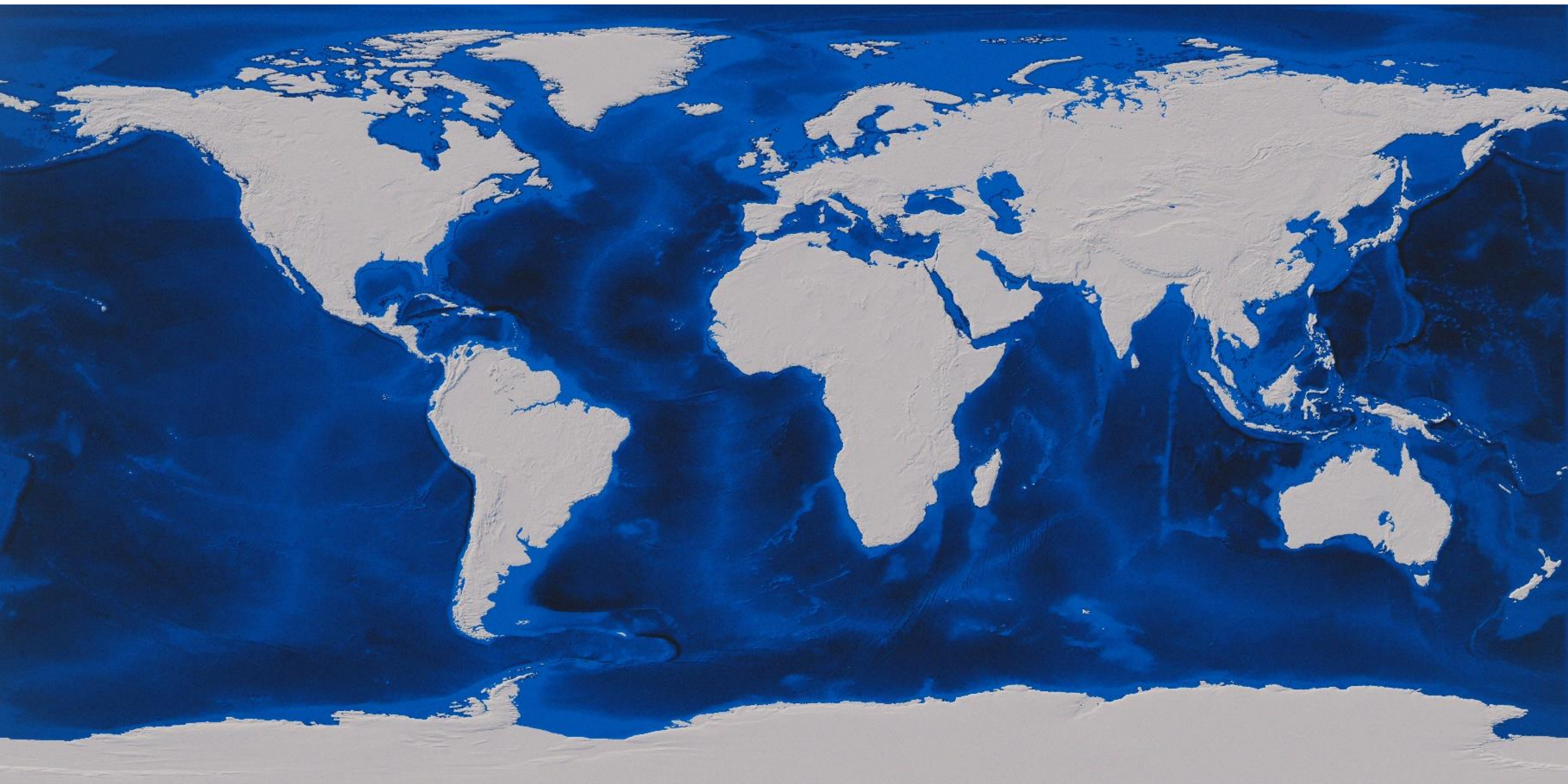


USE OF UNMODIFIED CABLES FOR GLOBAL MONITORING

(pages 19-20)

Traditionally, commercial telecommunications and scientific applications of subsea fibre-optic cables have been independent activities. In addition to the SMART cable initiative, bespoke cables are used in several regions to power and connect seafloor observatories, where environmental science measurements are made at fixed points [43,44]. These observatories provide long-term and sustained measurements at key sites where ocean processes, ecological conditions or natural hazards can be observed in unprecedented detail. SMART cables provide a complementary technology for existing and new science-focused seafloor observatories as they enable measurements to be made long the lengths of the cables that connect them to shore, filling in key gaps that are otherwise unmeasured.

Recent technological developments have enabled the optical fibres that lie at the core of modern submarine telecommunication cables to be used as sensors to monitor the ocean environment, over long distances (up to 10,000s of km) in addition to performing their primary purpose of transmitting data in real time. Cable operators developed this optical fibre sensing as part of routine health checks to detect any faults on the cable system, but soon recognised that an added side benefit of such sensing is the



ability to also detect natural events that generate noise, pressure or ground motions away from the cable [45]. We previously discussed how this emerging technology can be used to detect earthquakes, storms and tsunamis, volcanic eruptions and to monitor changes in seafloor temperature[46-52] (see September 2021 issue of *Submarine Cable Protection and the Environment*). A key advantage of optical fibre sensing is that it can be used on any standard modern telecommunication cable, with real-time measurements made at the same time as telecommunications data transfer. This is typically done on an individual 'dark' fibre used solely for such sensing, but may also be done along traffic-carrying fibres. Unlike SMART cables, optical fibre sensing does not require any modification of the cable itself and hence can be performed on already-installed cables. Indeed, some out of service cables have been donated to scientific research [53], thus providing further value beyond their original planned design life.

Early optical fibre sensing studies made measurements that were averaged along the entire length of cable, to detect the timing and nature of natural processes, such as earthquakes [47]. However, optical fibre sensing is a rapidly developing field, and recent advances have enabled distributed measurements to be performed using optical fibre sensing, that also allow for the source(s) of noise, pressure change, or ground motion to be precisely pin-pointed [45,52,54]. Technological advances continue to extend the reach of such optical fibre sensing, over increasingly large distances that now cover tens of thousands of kilometres [50]. An ever-increasing understanding of the processes that generate sound and ground motions in the ocean means that the application of optical fibre sensing will only continue to grow, enabling new detection and warning of natural hazards and of the impacts of climate change on the oceans.

A LONG HISTORY OF COLLABORATIONS BETWEEN THE CABLE INDUSTRY AND OCEAN SCIENTIFIC RESEARCH (pages 21-24)

There is a growing uptake in the area of optical fibre sensing, including along out of service cables that have been repurposed for scientific means, and more recently on in-service cables, to detect a host of natural processes and hazards. These initiatives represent the continuation of a long-lived collaboration between the subsea cable industry and ocean science research.

- In 1853, Matthew Fontaine Maury, discovered an area of surprisingly high relief seafloor that he called the Telegraph Plateau [55]; now known to be part of the mid-Atlantic Ridge, demonstrating that the deep sea was far from featureless. He made this discovery while producing one of the earliest bathymetric charts of the oceans to identify a route for the first transatlantic cable.
- The Mid-Atlantic Ridge was properly recognised in 1872, during a transatlantic telegraph cable survey aboard HMS Challenger by John Murray [56]. He and others used electrical resistance measurements made along the early transatlantic telegraph cables to acquire

some of the first measurements of temperature at seafloor, as well as deep sea current measurements, revealing that deep waters can be highly dynamic [57].

- In order to ensure that a new telegraph cable between the UK and USA was not installed across irregular terrain, seabed surveys were commissioned in 1857. Thomas Huxley analysed seabed sediment samples from these surveys and discovered that most of the deep North Atlantic seafloor is covered in a chalk-like mud, made up of tiny, shelled organisms called coccoliths [2,58]. This was the first evidence of animal life in the deep sea.
- Shortly after, in 1860, George Wallich observed starfish attached to sounding lines used to survey other cable routes in the deep Atlantic, while Fleeming Jenkin made similar observations when a seafloor cable was recovered from the deep Mediterranean and found to be encrusted in a range of marine life [59]. These were the first conclusive lines of evidence that complex life existed in the deep ocean.
- In the 1950s, Henry Stommel identified seasonal voltage fluctuations on a seafloor telegraph cable, which he related to the interaction of fast-moving seafloor currents with the cable [3]; leading to the discovery of Florida Current – a breakthrough in physical oceanography [3].
- Marie Tharp started working on creating a bathymetric map of the global ocean in 1948, which included soundings made for telegraph cable surveys. The first map was published for the North Atlantic in 1959, with a full world map finally produced in 1977 [60,61]. While the overall picture has not changed fundamentally since those early point soundings, modern survey techniques are providing an even more detailed view of the seafloor, identifying new features such as underwater volcanoes, and deep sea

canyons. Subsea cable routes often occur in poorly surveyed areas, so efforts are made to continue to share those data through initiatives such as Seabed2030, which aims to map the seafloor in detail by 2030 [62].

- In the 1950s, Maurice Ewing and Bruce Heezen worked with subsea cable companies to explain instances of damage on several deep sea cables. Several of these occurred offshore Newfoundland in 1929, and based on the location and timing of these faults, they identified that an earthquake triggered an underwater landslide, that travelled hundreds of kilometres along the seafloor, breaking the cables in its path [63]. This was the first evidence that submarine landslides can occur, and travel at tens of metres per second across vast distances and relatively low angle slopes. To this day, the timing and location of cable faults continues to provide often-surprising new insights into seafloor hazards, such as landslides, earthquakes, volcanic activity and seafloor currents [35,64,65].
- Subsea cables have been used to power and connect to deep sea seafloor scientific observatories to enable long-term and continuous environmental monitoring. These include projects such as the Acoustic Thermometry of Ocean Climate (ATOC) cable offshore California [66], the many cables and instrumented nodes operated by Ocean Networks Canada[44], and the Dense Oceanfloor Network System for Earthquakes and Tsunamis (DONET) cable networks offshore Japan [67].
- In-situ observations of marine life that has attached to and grows on subsea cables, and repeated photographic surveys that document the rate of seafloor recovery in places where cables have been buried have provided abundant insights into how seafloor ecosystems respond to change,

often adapting much faster than previously thought [8,66]. Such studies contribute valuable environmental insights in areas where data would otherwise not have been acquired.

FINAL THOUGHTS

The ocean is vitally important to our daily lives, yet it is under increasing pressure as a result of impacts associated with climate change, pollution and overfishing. There is a clear need to better understand those impacts how the ocean is responding, and also to enhance our ability to detect and warn against natural hazards, whose severity may also change in response to climate change. Sustained and increased scientific international collaborations are required to extend existing ocean monitoring programmes and develop new ones; in particular to fill geographic gaps in the southern hemisphere and more generally in the deep ocean.

Advances in instrumented and optical fibre sensing technology, including those pioneered by the subsea cable industry, provide new opportunities to complement existing and planned scientific initiatives to make sustained ocean observations, and may enable sensing along many commercial cable systems in the future. It should be remembered, however, that the core purpose of commercial submarine telecommunications systems is for data transfer and communications, which underpins almost every aspect of our lives. It is therefore crucial to ensure that any modifications to the design, cost or operations of these cable systems have no potential to affect how these critical infrastructure networks continue to support our digital economy, businesses and personal lives into the future. The future outlook is likely to include a combination of bespoke scientific cabled observatories and SMART cables, complemented by optical fibre sensing along existing commercial or out of service systems, that will collectively increase the global coverage of ocean observing systems.

Please visit www.iscpc.org for further information.

Sharing the seabed in harmony with others

The International Cable Protection Committee (ICPC) was formed in 1958 and its primary goal is to promote the safeguarding of international submarine cables against human made and natural hazards. The organisation provides a forum for the exchange of technical, legal and environmental information about submarine cables and, with more than **170 MEMBERS** from over **60 NATIONS,** including cable operators, owners, manufacturers, industry service providers, and governments, it is the world's premier submarine cable organisation. The ICPC comprises of an 18 Member Executive Committee (EC)-led organisation voted in by its Full Members. In addition to the Marine Environmental Adviser (MEA), General Manager (GM) and Secretariat team, the ICPC also has an appointed International Cable Law Adviser (ICLA) as well as a United Nations Observer Representative (UNOR).

Prime Activities of the ICPC:

- Promote awareness of submarine cables as critical infrastructure to governments and other users of the seabed.
- Establish internationally agreed recommendations for cable installation, protection, and maintenance.
- Monitor the evolution of international treaties and national legislation and help to ensure that submarine cable interests are fully protected.
- Liaison with UN Bodies.

Recommendations:

- Taking into account the marine environment, the ICPC authors Recommendations which provides guidance to all seabed users ensuring best practices are in place.
- Educating the undersea community as well as defining the minimum recommendations for cable route planning, installation, operation, maintenance and protection as well as survey operations.
- Facilitating access to new cable technologies.

Advancing Regulatory Guidance:

- Promoting United Nations Convention for the Law of the Sea (UNCLOS) compliance.
- Championing uniform and practical local legislation and permitting
- Protecting cable systems and ships.
- Aiding education of government regulators and diplomats.

Working with Science:

- Supporting independent research into cables.
- Publishing reviews for governments and policy makers.
- Working with environmental organisations.
- Effective public education via various media.

To learn how to become of Member organisation of the ICPC, please click on join here.

EDITORIAL STAFF

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Editor: Ryan Wopschall

Ryan is the General Manager for the ICPC. He has spent the last 15 years in the telecommunications industry with a focus on inter-national undersea and terrestrial backhaul telecommunications.

Design & Layout: Christine Schinella

As part of her Secretariat role, Christine coordinates marketing activities for ICPC. With a background in graphic design and publishing, Christine has been working in the telecommunications industry since 2000.

FURTHER READING & REFERENCES

Further information on submarine cables and the marine environment can be found in the references and text within the peer-reviewed UNEP-WCMC report via: **'Submarine Cables and the Oceans: Connecting the World'** as well as other resources via: https://iscpc.org/publications.

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