FORUM: Environmental Commission (EC)

QUESTION OF: Assessing the implications of undersea infrastructure on underwater ecosystems and biodiversity

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POSITION: President

INTRODUCTION

Underwater infrastructure is a type of infrastructure which has been used by people for ages, with their first use aging back to the times of the Roman civilization, where hydraulic concrete was used so as to create underwater pipes which delivered or stored water and other supplies to the rest of the city, just like in the region of Calabria, where pipes transported water from mainland Italy to Sicily, as the latter was relatively prone to droughts. Their main use, since then, has remained almost the same[1]. To be specific, the transportation of water was an issue of paramount importance in ancient times, and it was mainly resolved through the use of underwater ceramic pipes. The reason why ground based pipes were not used at a large scale level is because they usually lacked stability and they would be more costly to create than underwater pipes. Apart from this reason, underwater infrastructure was later used in order to create common infrastructure in international waters. The first example of this use was the creation of a transatlantic cable connecting the United States of America and England. Its use was initially the enhancement of communication between the two countries through the telegraph. For these reasons, underwater infrastructure has been historically significant for civilizations of the past and of today[2].

However, it is undoubted that the human intervention to the underwater environment with materials foreign to undersea species, has certainly provoked negative implications to marine life and the sea as a whole. In particular, due to the fact that underwater infrastructure mostly consists of metallic structures, the wear and the use of such structures for many years can lead to their oxidation, which

[1] Labate, Victor. "Roman Engineering." *World History Encyclopedia*, 1 Mar. 2016, www.worldhistory.org/Roman_Engineering/.

[2] Little, Becky. "The First Transatlantic Telegraph Cable Was a Bold, Short-Lived Success." *HISTORY*, 28 Oct. 2021, www.history.com/news/first-transatlantic-telegraph-cable.

could potentially lead to extensive pollution in the area due to the particles released in the undersea environment. In addition, the release of such metal ions in the ocean, also has a severe effect in the raise of temperature in oceans, which has been proven to be extremely dangerous for marine species as well, as it leads to the introduction of new, and potentially invasive, species which harm the balance of regional marine life. For instance, 40% of coral reef species have been severely harmed by the rise of temperature [3]in the Gulf of Mexico since the creation of oil rigs in the area[4], a percentage revealing what could be potentially provoked in later years. In addition, the disruption of species' natural habitats is also another issue of concern. In particular, underwater buildings, pipes or metallic structures which sit on the bottom of the sea bed have gravely affected benthic habitats, and species whose survival depends on this environment. However, the lack of development on the field while the number of underwater infrastructure is radically increasing begs the question of what is required to develop sustainable undersea infrastructure whilst having minimal implications to marine species and environment

DEFINITION OF KEY TERMS

Benthic Habitats [5]

Benthic habitats refer to the ecological regions at the lowest level of a body of water, including the sediment surface and sub-surface layers. These habitats are found on the ocean floor, the bottoms of lakes, rivers, and streams, and include a wide variety of organisms such as bacteria, fungi, algae, invertebrates (like worms and crustaceans), and demersal fish. Benthic habitats are crucial for nutrient recycling, sediment stabilization, and supporting diverse biological communities. The term benthic habitats is interconnected to the term of seabed, as it refers to the deepest waters of the sea.

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[3] Wall, Colin, and Pierre Morcos. "Invisible and Vital: Undersea Cables and Transatlantic Security." *Www.csis.org*, 11 June 2021, www.csis.org/analysis/invisible-and-vital-undersea-cables-and-transatlantic-security

[4] Little, Becky. "The First Transatlantic Telegraph Cable Was a Bold, Short-Lived Success." *HISTORY*, 28 Oct. 2021, www.history.com/news/first-transatlantic-telegraph-cable.

[5] Walag, Angelo Mark P. "Chapter 1 - Understanding the World of Benthos: An Introduction to Benthology." *ScienceDirect*, edited by Prince S. Godson et al., Elsevier, 1 Jan. 2022, pp. 1–19, www.sciencedirect.com/science/article/abs/pii/B9780128211618000027.

Environmental Impact Assessment (EIA)[6]

An Environmental Impact Assessment (EIA) is a process that evaluates the potential environmental effects of a proposed project or development before it begins. The assessment considers various factors, including impacts on air and water quality, ecosystems, biodiversity, and human health.

Heavy metals[7]

Heavy metals are a group of metals and metalloids with high atomic weights and densities that are often toxic at low concentrations. Common examples include mercury, lead, cadmium, arsenic, and chromium. Heavy metals can accumulate in living organisms and cause serious health and environmental problems, especially in aquatic ecosystems.

Photosynthetic organisms[8]

Photosynthetic organisms are organisms that can convert light energy, usually from the sun, into chemical energy through the process of photosynthesis. This group includes plants, algae, and certain bacteria. Photosynthetic organisms are essential for producing oxygen and forming the base of the food chain in many ecosystems, including aquatic environments.

Pollutants[9]

Pollutants are substances that, when introduced into the environment, cause harm or discomfort to ecosystems, human health, or other living organisms. Pollutants can be chemical, such as pesticides, heavy metals, and plastics, physical, like heat or radiation, or biological, such as invasive species or pathogens.

Sediment Resuspension[10]

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[6] European Commission. "Environmental Impact Assessment." *Environment.ec.europa.eu*, 2023, environment.ec.europa.eu/law-and-governance/environmental-assessments/environmental-impact-assessment_en.

[7] "Heavy Metal - an Overview | ScienceDirect Topics." Www.sciencedirect.com, www.sciencedirect.com/topics/materials-science/heavy-metal.

[8] Lambers, Hans, and James Alan Bassham. "Photosynthesis." Encyclopedia Britannica, 6 Feb. 2019, www.britannica.com/science/photosynthesis.

[9] "What Are the Common Pollutants Present in Wastewater? | Britannica." Www.britannica.com, www.britannica.com/question/What-are-the-common-pollutants-present-in-wastewater.

[10] Hsu, Tian-Jian. "Sediment Resuspension." Encyclopedia of Estuaries, Aug. 2015, pp. 558–60, https://doi.org/10.1007/978-94-017-8801-4_249.

Sediment resuspension refers to the process by which sediments that have settled at the bottom of a body of water are stirred up and re-enter the water column. This can occur due to natural events like currents, storms, or waves, or through human activities such as dredging or boating.

Turbidity[11]

Turbidity is a measure of the cloudiness or haziness of water caused by the presence of suspended particles, such as sediment, organic matter, algae, and microorganisms. High turbidity can reduce the penetration of light through water, affecting photosynthetic organisms and potentially indicating the presence of pollutants. It is commonly used as an indicator of water quality.

Undersea infrastructure[12]

The term undersea infrastructure refers to human made projects implemented in the underwater environment, in order to facilitate a process that would otherwise be more expensive or difficult to achieve. Such projects can either be in the field of energy production, extraction of natural resources and communications.

BACKGROUND INFORMATION

Types of undersea infrastructure

Underwater communication systems

The first ever large-scale underwater infrastructure project to have been attempted internationally was the creation of a marine communications cable in the English Channel in 1850, connecting the cities of Dover, England and Calais in France. At that time, relaying messages between countries was a procedure that required weeks or even months, and was also highly dependent on

[11] Grobbelaar, J. U. “Turbidity - an Overview | ScienceDirect Topics.” Sciencedirect.com, 2017, www.sciencedirect.com/topics/earth-and-planetary-sciences/turbidity.
[12] Bueger, Christian, and Tobias Liebetrau. “Critical Maritime Infrastructure Protection: What’s the Trouble?” Marine Policy, vol. 155, Sept. 2023, p. 105772, https://doi.org/10.1016/j.marpol.2023.105772.

weather conditions on the sea, as information was mostly sent through ships. Therefore, due to the need for faster communication by using the telegraph, [13]the first ever submarine communications cable was made between England and France, using a copper cable insulated with gutta-percha, which is a type of natural latex. Even though communication was achieved, the cable connecting the two countries was eventually damaged, days after it was used successfully for the first time. However, this attempt prepared the ground for more attempts to create international communications cables, with the first one happening in 1858. In this attempt, a submarine communications cable was made to connect New York city in the United States of America and Liverpool in England[14], using the same materials as the initial communications cable used in the English Channel, with the addition of a thin layer of concrete so as to increase its stability and endurance. However, just like its predecessor, it was destroyed by sea currents just days after its creation.

The first permanent successful submarine cable of this type was created in 1866 between England and the United States of America using copper and gutta-percha insulation. The sole difference in its creation from the initial patent was the addition of more layers of gutta-percha insulation instead of cement, which made the cable more stable and at the same time protected the cable from being damaged by cement, which overtime absorbs water and eventually becomes too heavy for the cable and breaks the outer layer of insulation. [15]

The same patent was used for communication in later years, until the implementation of optic fiber cables in 1970, as they could transmit information in a much faster way than regular copper cables due to the fact that it is transmitted through light, and not as an electric current. Since then, the majority of undersea communication cables consist of optic fibers, while the older copper cables which are not in use have mostly remained at the sea floor, potentially provoking further damage to benthic habitats. Nowadays, advancements have been made in the field of underwater optic fiber cables, so as to minimize possible implications with marine animals and environments[16]

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[13] ---. “Invisible and Vital: Undersea Cables and Transatlantic Security.” Www.csis.org, 11 June 2021, www.csis.org/analysis/invisible-and-vital-undersea-cables-and-transatlantic-security.
[14] Geere, Duncan. “How the First Cable Was Laid across the Atlantic.” Wired, www.wired.com/story/transatlantic-cables/.
[15] History.com Editors. “First Transatlantic Telegraph Cable Completed.” HISTORY, 9 Feb. 2010, www.history.com/this-day-in-history/first-transatlantic-telegraph-cable-completed.
[16] Kerfoot, F. W., and W. C. Marra. “Undersea Fiber Optic Networks: Past, Present, and Future.” IEEE Journal on Selected Areas in Communications, vol. 16, no. 7, 1998, pp. 1220–25, https://doi.org/10.1109/49.725191

Oil and gas undersea infrastructure

Oil and gas underwater infrastructure is another very common type of undersea infrastructure. In particular, the initial idea was formed after the ancient Romans used underwater pipes to store and transport water. However, even though this use of underwater infrastructure is still in use today, underwater pipes and metallic structures are also used for oil and gas transportation and production. To be specific, the concept of onshore drilling for resources such as petroleum and natural gas had begun since the beginning of the nineteenth century, but the first offshore drilling platform was not built until 1896, off the coast of California in the United States of America[17]. These platforms, constructed by mostly metal and concrete, would be based on the seabed for stability and by using specialized machinery, would collect resources from the upper layers of the earth, which were collected on the platforms and would later on be transported by large boats and ships to land. At that time and age, oil was crucial for households and cities in general, as it was the main resource used to power machines and provide light. In later years, such platforms continued to be made in the shores of the US, which later on created the need of transporting the natural resources collected in a faster way than transportation through boats from the offshore platforms to the mainland production factories. For this reason, steel pipes were first introduced in 1901 instead of using boats, so as to transport oil and natural gas to the production factories in mainland US. The way they would do so was by connecting the platform directly to mainland production plants, through large in diameter, thick steel pipes which lie on the seabed. Such pipes reach up to a hundred kilometers in length[18], and it is not unusual for them to sustain damage, which might be extremely harmful for the environment due to oil leakage. Due to the fact that offshore platforms gave countries the possibility of extracting and using natural resources from their natural waters and not only from mainland oil wells, offshore platforms quickly increased in number, especially during the beginning of the Second World War, when the number of oil platforms in the Gulf of Mexico belonging to the government of the United States was approximately three hundred.

At the end of the Second World War, other countries around the globe began investing in the creation of oil platforms in their national waters, with France and the UK being the first countries to start building oil rigs and underwater pipeline systems for oil production and transportation. Since then, large

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[17] English, Trevor. "Offshore Oil Platforms Are Monoliths of Engineering – Here's How They're Built." Interestingengineering.com, 12 Jan. 2020, https://interestingengineering.com/science/the-engineering-and-construction-of-offshore-oil-platforms

[18] ---. "Oil Industry." *HISTORY*, A&E Television Networks, 8 Apr. 2010, www.history.com/topics/industrial-revolution/oil-industry.

private companies, like British Petroleum and Shell have also invested in offshore oil platforms, so as to produce crude oil and natural gas in a less costly way than buying it from countries' governments. In addition, another milestone in the development of oil platforms is the creation of ships specifically designed for transporting oil and other natural resources, called tankers. With their creation, it became easier to transport natural resources from platforms too far away from the shore, which made underwater pipeline systems for many platforms useless.[19]

Undersea platform infrastructure

However, the more recent need of transporting natural gas in liquid form brought underwater pipeline systems back in need for many offshore platforms. In particular, even though by 1980 the need of oil transportation was entirely fulfilled by the use pipes and tanker ships, due to the fact that natural gas became more in use as it was a cheaper natural resource, oil platforms needed to be equipped pipes specifically designed to liquify natural gas in order for it to be transported in a more controlled environment and in an easier way. Such pipes, with the first system created in an American owned platform in the Gulf of Mexico, either transported the liquified natural gas to land, or supplied it to tanker ships responsible for their transportation. Nowadays, more than twelve thousand oil platforms exist, most of them in the Gulf of Mexico and the North Sea[20], while plans are constantly being made about the creation of more offshore oil platforms in South East Asia. Also, the recent development of ships designed to liquify natural gas during transportation has left more and more underwater natural gas pipes unused, while plans to create such systems have been reduced.

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[19] Muir, Thomas, and David Bradley. https://acousticstoday.org/wp-content/uploads/2021/03/Underwater-Acoustics-A-Brief-Historical-Overview-Through-World-War-II-Thomas-G.-Muir

[20] Kaiser, Mark L. *The Construction of Underwater Pipelines in the Gulf of Mexico*. 23 Dec. 2000, www.sciencedirect.com/science/article/abs/pii/S0308597X17304335 .

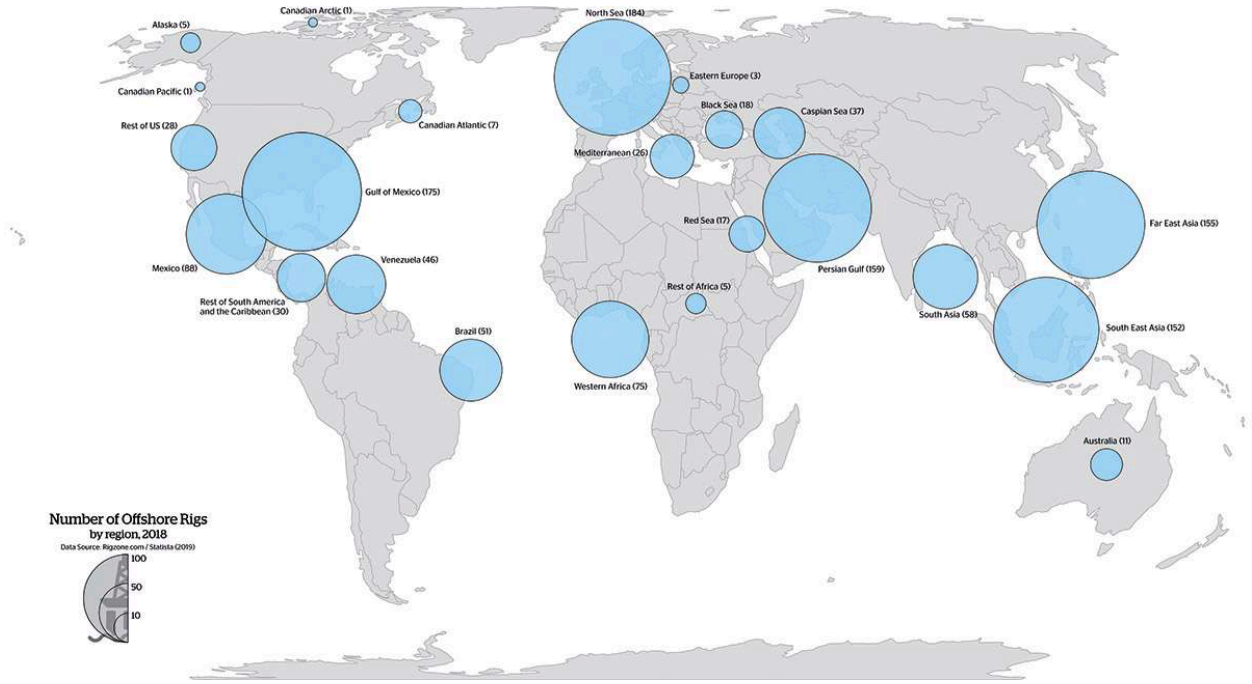

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Figure 1: Offshore oil rigs per region in 2018

Undersea energy infrastructure

In January 1971, a new concept in underwater infrastructure began to unfold. This was the creation of underwater energy systems, specifically designed to absorb energy from waves and water force, and later on transform it to electric energy which can be later on used in the same ways as electric energy produced by another way is. The first system of this type began operating in January of 1971 in France, and it was named the "La Rance Tidal Power Station[22]". The way it functioned was similar to the way wind turbines did, but in water. Later on, similar systems would begin operating in other parts of the world. However, the energy they provided was not sufficient, and therefore they could only be considered as projects, rather than large-scale projects. The first offshore project that provided a considerable amount of energy so as to be distributed on a larger scale was an offshore energy farm built in Aalborg, Denmark in 1991. The way the energy was produced was by a form of wave-crashes through kinetic energy by large waves hitting their walls, generating overall approximately 24 Giga Watts (GW) of

[21] "National Geographic." *Nationalgeographic.org*, 2022, https://education.nationalgeographic.org/.

[22] Evans, Scarlett. "La Rance: Learning from the World's Oldest Tidal Project." *Power Technology | Energy News and Market Analysis*, 28 Oct. 2019, www.power-technology.com/features/la-rance-learning-from-the-worlds-oldest-tidal-project/.

energy in its first year of use, therefore approximately 50% of the regional energy used by that year. Since then, similar undersea power plants have been created in other parts of the globe,with development on energy production through undersea wave crashers or turbines being continuously made. [23]

The effects of underwater infrastructure in marine life

In many cases, underwater infrastructure can provoke serious issues to marine species and the environment. For instance, the cases where an undersea human creation had to be removed due to problems caused to marine life are numerous. The problems caused depend on what the type of infrastructure is and whether it has been properly used by companies which operate them, in accordance with the regulations set by the Environmental Impact Assessment.

Habitat disruption

One of the most common issues caused by underwater infrastructure is the intervention in the natural habitat of marine animals. In particular, in many cases the installation of marine infrastructure will require cables and metallic structures like turbines or pipelines to lay on the seabed, so as to achieve enhanced stability. However, by such structures laying on the seabed, benthic habitats are gravely affected. To be specific, sponges, corals and most types of algae, which are vital for the survival of other marine species, are some species which are severely affected by undersea cables and pipelines on the seabed, which provokes an overall disruption of the marine food chain. In addition, species that live in benthic habitats are some of the slower species in growth development, which means that when disturbed, they might take decades to recover in that specific region. Furthermore, undersea drilling for oil and natural gas might also provoke serious issues on benthic habitats. For instance, in the North Sea, an area known for the existence of natural resources, it has been estimated by the European Marine Board that more than 50% of benthic habitats have been altered due to excessive drilling, [24]and the existence of a large amount of pipelines lying on the seabed. Moreover, this displacement of benthic

[23] Li, Xiaoyan, and Ryo Ikehata. “Fast Energy Decay for Wave Equation with a Monotone Potential and an Effective Damping.” *Journal of Hyperbolic Differential Equations*, vol. 21, no. 02, World Scientific, June 2024, pp. 255–72, https://doi.org/10.1142/s0219891624500085

[24] ---. “The Habitats Directive.” *Environment.ec.europa.eu*, 2024, www.environment.ec.europa.eu/topics/nature-and-biodiversity/habitats-directive_en/.

marine animals can also lead to a differentiation of breeding grounds, another implication affecting the food chain.

Chemical pollution

Chemical pollution is also severely affecting the marine environment. To be specific, cases of leakage of natural resources due to malfunction of pipelines or other types of underwater infrastructure are not rare, even though more and more precautions are taken so as to reduce such cases. However, even a small leakage of such materials can provoke excessive damage in the regional environment, which in most cases is irreversible and requires a great amount of time for the environment to be fully restored and for the issue to be resolved. A recent example of oil leakage in the ocean, is the "Deepwater Horizon" incident on April 10 2010, when an explosion in an oil platform in the Gulf of Mexico caused 700.000 tons of oil to spill inside the ocean and up to August 2024, 26.000 tons of oil still remain on the surface of the sea. The damage caused from this incident is irreversible, and it has provoked irreparable consequences to the local sea environment, as according to the national wildlife federation, more than 5 million fish from any species as well as more than 167.000 sea turtles were killed.[25]

In addition, another implication of undersea infrastructure that can cause chemical pollution is the degradation of materials used in undersea infrastructure. For example, metallic structures used in cables or oil platforms can often oxidize in water after a long time, emitting large amounts of chemicals in the water, causing a rise of temperatures and therefore affecting the lives of marine animals in the region. Also, the insulation used in communications cables might often leak chemicals due to the degradation of plastic in water, which can also affect marine environments

[25] European Parliament. "Biodiversity Loss: What Is Causing It and Why Is It a Concern? | Topics | European Parliament." *Www.europarl.europa.eu*, 16 Jan. 2020, www.europarl.europa.eu/topics/en/article/20200109STO69929/biodiversity-loss-what-is-causing-it-and-why-is-it-a-concern.

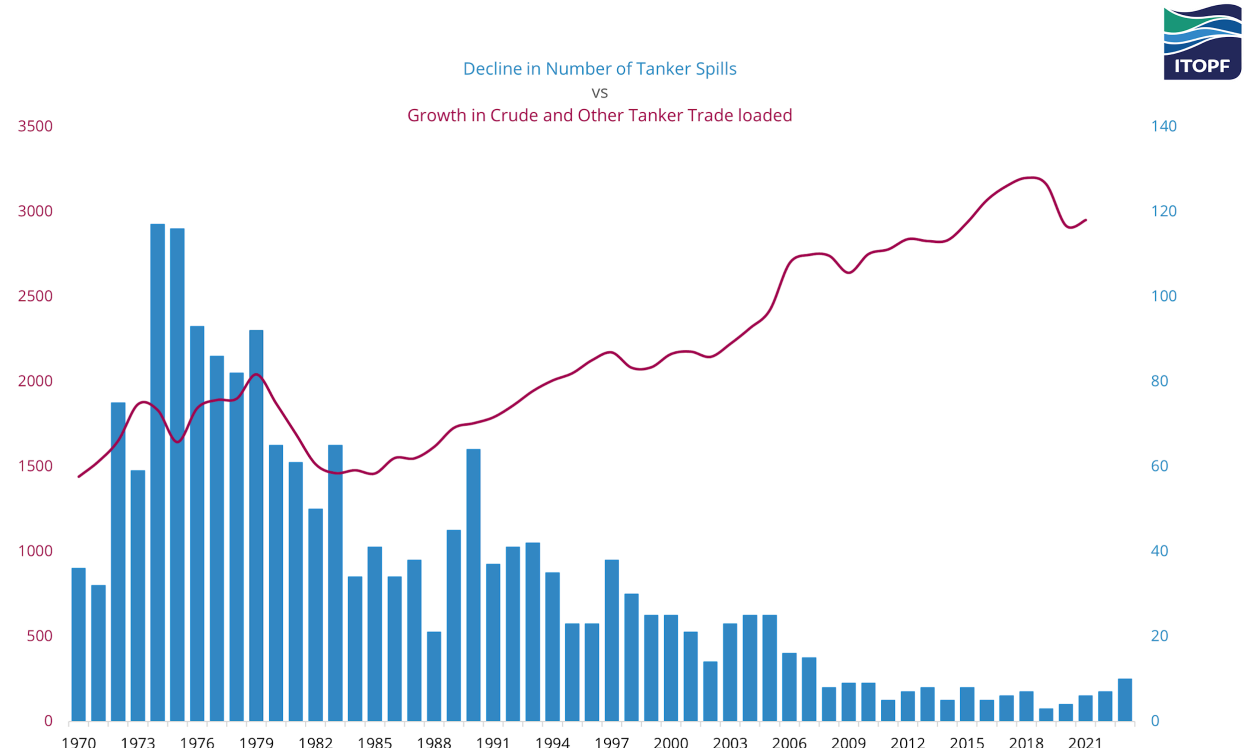

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Figure 2: Number of oil spills caused by tankers 1970-2021

Introduction of invasive species

In many cases, undersea infrastructure can be moved to various places, especially in the case of offshore platforms where parts of oil pipes are taken by tanker ships to another part of the world. However, with the process of oil being transported to other parts of the world, these pipes, which also contain large amounts of water, might bring along species which do not belong to the habitat of the region. In most cases, such species are small organisms, like algae, which cannot directly affect the lives of other marine animals in another region[27]. However, if there are no natural predators of the species in the region, then this might cause its sudden development, which cannot be dealt with without the introduction of artificial predators, like specific chemicals.

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[26] Chen, Jihong, et al. "Oil Spills from Global Tankers: Status Review and Future Governance." *Journal of Cleaner Production*, vol. 227, no. 1, Aug. 2019, pp. 20–32, https://doi.org/10.1016/j.jclepro.2019.04.020.

[27] "What Is an Invasive Species and Why Are They a Problem? | U.S. Geological Survey." *Www.usgs.gov*, www.usgs.gov/faqs/what-invasive-species-and-why-are-they-a-problem.

Change in sediment distribution and ocean currents

In many cases, underwater structures, like turbines can affect how sediments are distributed on the seabed. In particular, this happens due to the change in the flow of water as turbines move, or as the bases of offshore platforms stop water currents. Therefore, by changing the flow of the water, sediment distribution on the seabed can often change, leading to a change on benthic habitats and on the food chain for the animals depending on the lower parts of the ocean. For example, in areas in the Atlantic Ocean near underwater energy farms, it has been detected that almost 80% of benthic species from the region are not present near water turbines.[28]

Underwater energy infrastructure can also have a grave effect on ocean currents. In particular, energy production through wave-crashers can often change water currents in large oceans, potentially affecting breeding zones or the routes of species which migrate through changes in water currents. For instance, Green Sea turtles' migration routes have changed from what they used to be in the previous decade, due to the creation of water turbines in the west coast of the US, which alters their navigation ability and changes their migration routes.

Noise pollution

Many marine animals, and specifically cetaceans like whales and dolphins, are species heavily dependent on sound for their navigation. For this reason, the operation of undersea infrastructure, or the construction of underwater structures can gravely affect the way these animals communicate, hunt and navigate. For example, the sound of oil drilling in deep oceans or the water turbines placed in deep water for energy production are certainly provoking negative implications in the lives of marine animals. In particular, apart from alterations in migratory patterns, mating and feeding, in a study conducted by the International Maritime Organization, it was found that the majority of fish species tested were observed to avoid areas of high noise levels, a result which underlines the potential effect undersea noise pollution might have to species' growth development and reproduction rates.[29]

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[28] Encyclopedia Britannica. "Hydroelectric Power | Definition & Facts." *Encyclopædia Britannica*, 2 Aug. 2018, www.britannica.com/science/hydroelectric-power.

[29] Polidoro, Joseph. "A Few Fixes Could Cut Noise Pollution That Hurts Ocean Animals." *Scientific American*, 23 Feb. 2021, www.scientificamerican.com/article/a-few-fixes-could-cut-noise-pollution-that-hurts-ocean-animals/.

The potential development of underwater infrastructure

Even though some of the outcomes of underwater infrastructure have been irreversible for the marine environment and humanity as a whole, it has undoubtedly contributed in many positive ways to human development. For this reason, many countries' ultimate goal is the creation of underwater infrastructure which poses less dangers to the undersea environment than current projects, with research plans and projects having already begun. The first research project has already been launched by the government of the United States since the beginning of 2024 with the contribution of other private companies and it affects the use of non harmful chemicals for undersea operations and infrastructure, which could definitely aid in having less of an effect on the lives of marine species severely affected by potential leaks by undersea projects[30]. With the use of such chemicals ,therefore, a plethora of issues that marine species are facing could be resolved, such as trouble in breeding sites and the reduction of species in number. The second project, also funded by the government of the United States, affects the creation of undersea structures with sustainable materials which will have no effect on the alteration of species' navigation routes, without the potential danger of chemical pollution. In particular, even though the project began in January 2024 and is only a theoretical model, the main material tested for the creation of undersea infrastructure is blocks of sodium bicarbonate, a material really common in organic structures in nature, like corals. Therefore, with such developments made under the supervision of the EIA, many of the negative implications provoked by undersea infrastructure could be limited and even completely resolved in future years. However, these two research projects have not been sufficiently funded so as to provide viable solutions, even though the resolution of such problems is of paramount importance.[31]

The role of the Environmental Impact Assessment

As mentioned above, the Environmental Impact Assessment (EIA) is critical for identifying the potential environmental consequences in any project that involves using natural resources, or affecting

30 "Inside the Subsea Cable Firm Secretly Helping American Take on China." *Reuters*, 6 July 2023, www.reuters.com/investigates/special-report/us-china-tech-subcom/.

31 US Department of Commerce, National Oceanic and Atmospheric Administration. "Mapping the Gaps in Our Ocean Knowledge with Seabed 2030." *Oceanservice.noaa.gov*, 29 June 2022, www.oceanservice.noaa.gov/news/jun22/seabed-2030.html.

the regional environment. One of the main areas of research of the EIA, is the marine environment and how undersea infrastructure projects can potentially affect the lives of marine species[32]

The way the EIA begins evaluating a project begins from the formation of its initial plans. By calculating the materials potentially required for the implementation of the project, as well as the potential impact the project might have in the regional environment by finding uncovered issues on the construction plans. Therefore, the EIA has the role of judging whether an undersea project can go ahead, or whether it needs to be reworked so that it poses less danger to the regional marine environment.

However, the cases when private companies do not comply with the regulations set by the EIA are not rare. In particular, in order to avoid investing funds in preventive mechanisms, many companies neglect the regulations the EIA set, and therefore, large-scale accidents might be provoked. An example is the "Deepwater Horizon" oil spill, where British Petroil (BP) had not complied with the necessary requirements needed so as to avoid drilling incidents. Other similar, but smaller in effect, examples have happened throughout the years, but even though the EIA has the primary role in evaluating undersea projects, the EIA does not have the legal right to sue specific organizations so as to prevent similar situations happening in the future, and therefore, many cases are left unresolved for years. [33]

MAJOR COUNTRIES AND ORGANIZATIONS INVOLVED

Brazil

Brazil is one of the most involved countries in the development of undersea infrastructure. In particular, Brazil is the leading country in undersea communication cables in South America, as through several projects has attempt to create a telecommunications line connecting Africa and Brazil. Also, Brazil was the country to initiate the project of the South American Cable System (SACS[34]), an undersea cable system connecting countries of the South American continent by sea. In addition, Brazil has invested in offshore natural resource extraction rigs and pipelines, as the government owned oil company Petrobras

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[32] European Commission. "Environmental Impact Assessment." Environment.ec.europa.eu, 2023, www.environment.ec.europa.eu/law-and-governance/environmental-assessments/environmental-impact-assessment_en.

[33] Pallardy, Richard. "Deepwater Horizon Oil Spill." *Encyclopaedia Britannica*, 27 Apr. 2024, www.britannica.com/event/Deepwater-Horizon-oil-spill.

[34] "South American Crossing (SAC) - Submarine Networks." *Submarinenetworks.com*, 2024, www.submarinenetworks.com/en/systems/brazil-us/sac.

is involved in the development of this field, and is partnering with other private or state owned companies so as to ameliorate the conditions occurring in oil platforms.

China

China is one of the biggest inventors in undersea infrastructure as it has invested large amounts of money in order to create oil rigs and underwater pipes in the South China Sea. However, China's research mostly affects the creation of energy production mechanisms, especially in rivers and on the seabed of the South China Sea. So far, accidents which have happened in China's national waters are minimal in number, as legislation on undersea infrastructure for private companies is comparatively stricter than other nations. For instance, there is a specific number of oil rigs a company can control in the country, and if the company exceeds that number, the company must cease the use of the rig.[35]

The United Kingdom

Apart from being one of the key nations in North Sea oil and gas extraction using underwater transportation pipes, the UK was the first country to make plans to extend its underwater telecommunications network so as to reach transatlantic level and achieve enhanced transatlantic communications. It is also one of the leading countries in underwater infrastructure research, especially in the northern part of the country. However, the UK's research past research projects have severely damaged the regional environment, and for 2021, more than 50% of seabed species in UK's national waters have been displaced, and the damage caused to UK's shores has been potentially irreversible for the local environment.

[36]

Saudi Arabia

As the major country in offshore oil extraction in the Persian Gulf, Saudi Arabia is also a leader in researching more ergonomic ways of oil extraction so as to enhance their overall productivity. In addition, Saudi Arabia is developing underwater infrastructure projects to support one of their nation's

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[35] "China Exerts Control over Internet Cable Projects in South China Sea." *Financial Times*, 13 Mar. 2023, www.ft.com/content/89bc954d-64ed-4d80-bb8f-9f1852ec4eb1.

[36] Brook Holand, Loisa. *Seabed Infrastructure: How the UK's Seabed Has Been Damaged*. www.commonslibrary.parliament.uk/seabed-warfare-protecting-the-uks-undersea-infrastructure/

goals called “Vision”, [37]which aims to enhance economic diversification by introducing renewable energy programs. Furthermore, due to the already small variety of marine species in the region, undersea infrastructure has little effect on the regional marine environment. Also, strict legislation on undersea infrastructure has limited potential incidents, as Saudi Arabia has prioritized undersea infrastructure as its main source of income. Therefore, Saudi Arabia has been one of the pioneer countries in the amelioration of underwater infrastructure

International Maritime Organisation (IMO)

The IMO, supervised by the United Nations, is responsible for the prevention of marine pollution caused by underwater infrastructure. It is also responsible for supervising marine navigation which is also a factor that damages marine life. In cooperation with the Environmental Impact Assessment, the IMO proposes new regulations that must be followed by nations or private companies which control undersea infrastructure. In addition, the IMO has the legal possibility of intervening when regulations placed have not been followed, as it has the right of preventing a company or a state from using undersea infrastructure in cases where it can damage the environment. Therefore, the supervisory role of the IMO is crucial for regulating the condition of the undersea environment near undersea structures[38]

International Seabed Authority (ISA)

The ISA which is also an organization regulated by the United Nations is responsible for supervising seabed mining and natural resources extraction. It is also responsible for supervising international seabed areas, which are commonly used for international telecommunication cables and pipelines transporting oil and other natural resources. In addition, the ISA has been crucial in the past for preventing large scale incidents from occurring. Also, the supervisory role of the ISA is also critical, as it is one of the most technologically developed organizations of the UN, as it is responsible for scanning the seabed of some of the deepest parts of the sea in the world.[39]

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[37] “Saudi Vision 2030.” *Vision2030.Gov.sa*, 2019, www.vision2030.gov.sa/en.

[38] IMO. “Structure of IMO.” *Www.imo.org*, www.imo.org/en/About/Pages/Structure.aspx.

[39] “Home | International Seabed Authority.” *Isa.org.jm*, 31 July 2020, www.isa.org.jm/.

National Oceanic and Atmospheric Administration (NOAA)

The NOAA is a US federal agency which is responsible for examining the condition of oceans and the atmosphere. One of its main roles is to provide research on marine environments, which is important for conducting underwater infrastructure projects. Moreover, NOAA is involved in marine spatial planning, which helps balance the development of undersea infrastructure with the need to protect marine wildlife. NOAA has also partnered with other organizations like the European Union so as to resolve issues which have occurred in international waters. Thus, the role of NOAA is crucial not only for the local marine environment of the US, but it is also important for the condition of international waters through partnership with other organizations.[40]

TIMELINE OF EVENTS

Date	Description of Event
10 August 1850	The first ever underwater submarine telegraph cable was placed between England and France
14 March 1884	The first ever convention on the protection of submarine cables is signed
20 June 1924	The first underwater oil pipeline is created in the shore of California, transporting oil from the Gulf of Mexico
16 January 1969	The Santa Barbara oil spill causes irreversible damage to the local environment and is classified as the first oil pipeline accident
10 December 1982	The UN Law of The Sea is signed, and includes regulations about underwater cable and pipeline use, as well as the creation of oil rigs
22 September 1992	The Oslo-Paris convention is signed

[40] NOAA. "About Our Agency | National Oceanic and Atmospheric Administration." *Noaa.gov*, 2018, www.noaa.gov/about-our-agency.

1 August 2003	The ISA begins regulating the exploration of natural resources in the international seabed area
20 April 2010	The biggest oil spill in history happens in the Gulf of Mexico
9 June 2017	The UN Ocean Conference signs the "Call for action" resolution so as to support goal 14 of the SDG's, called "life bellow water"
1 January 2021	The UN Decade of Ocean Science for Sustainable Development commences

UN INVOLVEMENT: RELEVANT RESOLUTIONS, TREATIES AND EVENTS

UN Decade of Ocean Science for Sustainable Development (2021-2030)[41]

This particular initiative was taken by the United Nations so as to reenforce to ameliorate the current state of oceans' health, and promotes research and innovation in the field of underwater infrastructure. So far, it has been successful in its goal, as more than thirty countries members of the UN have commenced research projects focused on ameliorating the current state of undersea structures they control.

Resolution A/RES/71/312

This specific resolution[42], written on June 11 2017 during the UN Ocean Conference, highlights the importance of research in the domain of underwater infrastructure, and urges member states to promote more sustainable ways so as to limit potential issues in marine life in the future. However, since 2017 the rate of accidents caused in undersea structures has not been lowered, which underlines the need of stricter legislation surrounding the issue, as the simple promotion of more sustainable techniques has not aided in limiting the accident cases

[41] UNESCO. "United Nations Decade of Ocean Science for Sustainable Development (2021-2030)." *Unesco.org*, 2021, www.unesco.org/en/decades/ocean-decade.

[42] UN. *RES/71/312*. www.documents.un.org/doc/undoc/gen/n17/207/56/pdf/n1720756./

Resolution A/RES/72/73

This resolution[43] urges members to follow the United Nations Convention on the Law of the Sea as well as other international agreements on sustainable use of underwater infrastructure, as well as promoting common use of underwater infrastructure to prevent pollution. However, this resolution signed on the 5th of December 2017 has promoted minimal development to happen regarding the common use of undersea infrastructure, which just like the previous resolution mentioned, underlines the need of stricter legislation regarding the issue.

PREVIOUS ATTEMPTS TO SOLVE THE ISSUE

The International Cable Protection Committee (ICPC)

This specific non-governmental effort firstly attempted in May 1958 aims to promote and reinforce the efforts of countries to develop sustainable practices for underwater infrastructure, like the installation and the sustainable maintenance of telecommunication submarine cables. Also, it provides a summit for nations which are cable owners as well as stakeholder organizations in order to discuss environmental issues which might be provoked. In addition, the ICPC's goal is the promotion of collaboration between nations stakeholders of undersea cables and pipelines, so as to achieve less possibility of pollution, and minimize the risk of cable disruption. The ICPC plays a key [44]role in raising awareness about the importance of submarine cables, and the cruciality of finding alternative solutions in order to minimize the risk of pollution. However, this effort has been so far unsuccessful, since undersea submarine cables have been one of the major factors contributing to chemical pollution due to the degradation of their plastic insulation, and alternative solutions for minimizing the risk of pollution have not yet been found.

Offshore platform sustainability by Oil and Gas Producers (OGP)

This organization is responsible for representing oil and gas producers in a global context, and is responsible for developing guidelines and regulations related to sustainable use of oil rigs, so as to limit

[43] UN. *RES/72/73*. www.documents.un.org/doc/undoc/gen/n17/327/90/pdf/n9890876./

[44] "International Cable Protection Committee (ICPC)." *Www.iscpc.org*, www.iscpc.org/.

the regional pollution they might provoke. Also, it regulates safety in offshore operations and enhances international cooperation regarding the use of underwater cables. Therefore, the solution attempted by the OGP, is the creation of a regulatory framework overlooking the function of offshore platforms and the sustainability of oil production, so as to reach a safer level of pollution risk. Since 2008, when this specific act was written by the OGP, environmental conditions have improved in the marine environments near offshore platforms and oil rigs, even though this improvement can be attributed to the recent development of more sustainable materials used in such platforms. Also, the rate of accidents in oil platforms has remained the same, underlining that stricter legislation needs to be placed by the OGP so as to achieve minimal pollution risks[45]

Oslo-Paris Convention (1992)

The Oslo-Paris convention, also known as OSPAR[46], took place in Paris 22nd of September 1992, and aimed at protecting the marine life of the North Atlantic Ocean by including measures that limit pollution from offshore and underwater installations. In addition, it aimed at enhancing international cooperation and common use of underwater infrastructure especially at a regional level. It was the first convention to underline the importance of monitoring and assessment for undersea structures, which was later on continued by the EIA. Therefore, the decisions taken in this specific convention have been proven important for the sanity of marine environments, as decisions pointed out the urgent need of monitoring and assessing the state of the ocean and international waters.

POSSIBLE SOLUTIONS

Mitigation of pollution through large scale control mechanisms

One of the main issues with underwater infrastructure is the pollution it might cause to regional environments. Therefore, a potential solution for this issue is the implementation of strategies which aim to reduce pollution in large scale projects. For instance, turbines and other energy producing underwater infrastructure produce loud noises or specific frequencies during operation, which might cause some

[45] "IOGP." IOGP, 2017, www.iogp.org/.
[46] OSPAR Commission. "Convention | OSPAR Commission." *OSPAR Commission*, 2010, www.ospar.org/convention.

species of marine animals to lose the ability to navigate, which might later on cause issues in breeding sites or navigation routes. For this reason, sound-proofing materials can be used in the creation of such mechanisms so as to reduce the effect such machines have in the lives of marine wildlife.

In addition, large-scale filters can be added in offshore platforms so as to reduce the possibility of chemical pollution in case of an accident. Unfortunately, research on the creation of such filters has been minimal by private companies, due to their large cost. However, these could resolve one of the major issues of offshore platforms, which is leakage of natural resources in the ocean. To sum up, this solution is crucial for the continuation of undersea infrastructure in future years, as it is the only way humanity can prevent irreversible damage from happening.

Promotion of a sustainable site selection and use of sustainable materials

Another issue of undersea infrastructure is the fact that in many cases it is built in areas vital for the regional environment, like coral reefs, thus damaging the life of different species in the region. For this reason, the UN could provide a specific map of areas where undersea infrastructure is legal, without taking into consideration the national waters of a country or whether a site is in an international waters area. By taking this decision, the UN can promote sustainable site selection, and specific areas in danger of marine wildlife extinction can be protected by a legal framework. Apart from this, the promotion of sustainable materials that can be used in underwater structures is also of paramount importance, as in many cases the degradation of certain materials in water, such as particular metals or plastic, can provoke serious issues to the regional environment. For this reason, organic materials such as sodium carbonate can be used in the creation of structures underwater, as it would provide a risk free solution, as well as a very stable foundation for offshore platforms to be built on.

Strengthening of regulatory frameworks

The productivity of regulatory frameworks related to the supervision of underwater infrastructure has been criticized by numerous international non governmental organizations, which highlight the importance of a strict regulatory framework which limits the possibility of excess pollution. In addition, laws regulating offshore platforms have failed to deliver a positive outcome [47]on the accident

[47] ---. “Critical Maritime Infrastructure Protection: What’s the Trouble?” *Marine Policy*, vol. 155, Sept. 2023, p. 105772, https://doi.org/10.1016/j.marpol.2023.105772 .

rates, which over the years have remained stable, thus underlining that even though research continues to be conducted, companies controlling offshore platforms have failed to comply with the regulations placed by the EIA or other supervisory organizations. Thus, stricter regulatory frameworks need to be set, so as to set stricter supervision over private-owned oil drilling platforms, which will as a result bring the better condition of the regional marine environment. Stricter regulations can affect the maximum values of pollution that a company cannot exceed, as well as a maximum amount of cables and pipelines that can be used. Also, strengthening of regulatory frameworks need to be done so as to have a better control over the chemicals used in oil drilling operations, which in many cases if leaked, can provoke irreparable damage to the local undersea environment.

Removal of unused undersea infrastructure from the seabed

In many cases, due to the continuous improvements in technology and the invention of more recent technological means, many parts of undersea infrastructure are left unused, lying on the seabed, therefore affecting the lives of marine species inhabiting the area. For instance, thousands of kilometers of unused copper cables used for telecommunication in the past are currently laying on the seabed and due to the process of oxidation, emit harmful chemicals in the habitat of marine wildlife. Therefore, with the simple removal of such unused cables from the sea, benthic habitats affected by the placement of cables could be restored, and regional marine environments could radically improve, as chemical pollution would be limited and benthic environments would no longer be affected by cables taking up considerable space. This procedure however, as simple as it might seem, requires funding from both the governments involved and private owned organizations, with the supervision of UN controlled bodies, such as the IMO. In addition, in many cases oil platforms are left unused as well after an oil or gas source runs out, and as a result, such platforms are left abandoned, potentially species' navigation routes or breeding spots. Therefore, even though this would be a difficult project due to the size of such platforms, it would be beneficial for the environment to remove drilling platforms if they are not currently in use, as nowadays more than 3.000 of them are abandoned.

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