

THE IMPACT OF USING MODERN FIBER-OPTIC CABLES ON THE EXPLOITATION OF THE SEABED (A STUDY WITHIN THE FRAMEWORK OF THE INTERNATIONAL LAW OF THE SEA)

O IMPACTO DA UTILIZAÇÃO DE CABOS DE FIBRA ÓPTICA MODERNOS NA EXPLORAÇÃO DO FONDO MARINHO (UM ESTUDO NO ÂMBITO DO DIREITO INTERNACIONAL DO MAR)

Article received on: 12/1/2025

Article accepted on: 2/27/2026

Shaimaa Ahmed Hussein*

*College of Law, University of Mosul, Mosul, Iraq
shaimaa.23lwp26@student.uomosul.edu.iq

Suhad Abdul-Jamal Abdul-Kareem*

*College of Law, University of Mosul, Mosul, Iraq
Suhad.jamal@uomosul.edu.iq

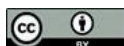
The authors declare that there is no conflict of interest

Abstract

The bed of the sea is described as one of the most significant parts of the seas, the exploitation whereof in self-interest by all states shall be available by any measures due to its economic importance and wealth elements. This has led states to seek ways of making the most of the seabed in modern technological terms. In 1968 Malta had proposed that the underground seabed beyond any national jurisdiction be declared the common heritage of mankind, in which rights would not be exercised unless in accordance with decisions taken by the United Nations General Assembly, so as to maintain its unique character and protect the interest of developing countries. The laying of the latest communication cables on the ocean bed belongs to that group of activities through which men invade and plunder the seabed. The submarine cables are the fundamental pivotal element for global communication infrastructure and carry around 95% of international intercontinental data with extremely high efficiency. Such cables actually have a very old history - the first trans-ocean (submarine) cable was laid in 1850 between France and Britain. Given the technological progress occurring globally, particularly in relation to communications, a legal framework was needed to regulate these cables due to inadequacies of the 1884 Convention for the Protection of Submarine Telegraph Cables, which had been unable to gain universal acceptance and applied only among its state parties. This was followed by the adoption of UNCLOS (1982), which constitutes a dominant international legal framework applicable to

Resumo

O leito marinho é descrito como uma das partes mais significativas dos mares, cuja exploração, no interesse próprio de todos os Estados, deve ser viabilizada por quaisquer meios, devido à sua importância econômica e aos recursos que nele se encontram. Isso levou os Estados a buscar formas de aproveitar ao máximo o leito marinho com base nas tecnologias modernas. Em 1968, Malta propôs que o leito marinho subterrâneo fora de qualquer jurisdição nacional fosse declarado patrimônio comum da humanidade, no qual os direitos não seriam exercidos a menos que em conformidade com decisões tomadas pela Assembleia Geral das Nações Unidas, a fim de manter seu caráter único e proteger os interesses dos países em desenvolvimento. A instalação dos mais recentes cabos de comunicação no leito oceânico pertence ao grupo de atividades por meio das quais os homens invadem e saqueiam o leito marinho. Os cabos submarinos são o elemento fundamental e central da infraestrutura global de comunicações e transportam cerca de 95% dos dados intercontinentais internacionais com extrema eficiência. Esses cabos têm, na verdade, uma história muito antiga — o primeiro cabo transoceânico (submarino) foi instalado em 1850 entre a França e a Grã-Bretanha. Dado o progresso tecnológico ocorrido globalmente, particularmente em relação às comunicações, era necessário um marco jurídico para regulamentar esses cabos devido às inadequações da Convenção de 1884 para a Proteção dos Cabos Telegráficos Submarinos, que não conseguiu obter aceitação universal e



submarine cable laying and that sets out the rights and duties of coastal States as well as those landlocked in relation to this activity. Despite the technological progress (especially development of modern fiber optic cables) new aspects need to be considered more rigorously with respect to ecologic damage and diversities as well as disruption on natural habitats of organisms given, as well as the desire of major industrialized states to control these cables as tools of surveillance and the potential interception of communications transmitted through them. These developments have revealed the insufficiency of the Law of the Sea Convention in regulating the laying of modern submarine cables, especially those introduced in 1988 after the adoption of the 1982 Convention, due to its failure to keep pace with contemporary technological progress, including the installation of modern fiber-optic communication cables on the seabed, particularly in the international area beyond national jurisdiction.

Keywords: Law of the Sea. Submarine Cables Seabed. Common Heritage of Mankind. United Nations Convention on the Law of the Sea (UNCLOS).

era aplicada apenas entre seus Estados-Partes. Seguiu-se a adoção da UNCLOS (1982), que constitui um quadro jurídico internacional dominante aplicável à instalação de cabos submarinos e que estabelece os direitos e deveres dos Estados costeiros, bem como dos Estados sem litoral, em relação a essa atividade. Apesar do progresso tecnológico (especialmente o desenvolvimento de cabos modernos de fibra óptica), novos aspectos precisam ser considerados com maior rigor no que diz respeito aos danos ecológicos e à biodiversidade, bem como à perturbação dos habitats naturais dos organismos, além do desejo dos principais Estados industrializados de controlar esses cabos como ferramentas de vigilância e da potencial interceptação das comunicações transmitidas por meio deles. Esses desenvolvimentos revelaram a insuficiência da Convenção do Direito do Mar na regulamentação da instalação de cabos submarinos modernos, especialmente aqueles introduzidos em 1988 após a adoção da Convenção de 1982, devido à sua incapacidade de acompanhar o progresso tecnológico contemporâneo, incluindo a instalação de cabos modernos de comunicação de fibra óptica no leito marinho, particularmente na área internacional fora da jurisdição nacional.

Palavras-chave: Direito do Mar. Cabos Submarinos. Patrimônio Comum da Humanidade. Convenção das Nações Unidas sobre o Direito do Mar (UNCLOS).

1 INTRODUCTION

Subsea infrastructure, such as fiber-optic cables, is of great importance in contemporary life, as it provides essential global internet connectivity. Its role extends beyond communication to include financial transactions and banking transfers. With the advance of technology and economic growth, dozens of undersea cables connect most countries in different parts of the world. This development has led to a requirement to extend protection for the international field from harmful effects of use of submarine cable, particularly impact on living marine resources and risks of cyber-attacks that have potential to present various inter-state issues including data theft, espionage and digital

piracy. Submarine cables protection in the international area has been facing several challenges given the little legal regulation; that is why this problem was chosen for analysis.

2 IMPORTANCE OF THE STUDY

Research significanceAs technology advances, seabed and the international area as common heritage mankind is more widely used in modern times. Seabed fiber-optic cables are critical not just to communications between the world's states, but also to the transmission of funds and data among them in a faster, more stable manner across seas and oceans. The work also deals with the significance for the marine environment and the biological diversity of the seabed of these cables as well as a need to conserve the international area from detrimental uses of such cables, due to its character as a common heritage for mankind, including protection from impairment against other states' legitimate rights by having them on their continental shelf.

2.1 Research problem

The question posed is to what extent can the commoditification of the sea floor (seabedmining) be managed by the Convention, and is it adequate for ordering fiberoptic cable-use on the ocean floor specifically: as a factual matter, CLOS 1982 secured principles related to cable - laying and also rights of states which are land-locked or coastal. Another question goes in the direction of what kind of legal rights to protect against cable cutting/theft and such activities it can legally grant, given that not every national law has a criminal law provision on them. This research also investigates the environmental effects of these cables in the marine environment.

2.2 Research hypothesis

The author supposes that the fiber-optic cables largely contribute to the process of international communication development and that different international treaties like 1884 Submarine Telegraph Convention and 1982 United Nations Convention on the Law

of the Sea were concluded on their laying across interstitial space. Such contracts are supposed to be enough to solve the issues of submarine cable lay and any risks of theft, interference by tapping of a cable or cyber attack against them.

2.3 Scope of the study

The research concerns the utilization of the seabed in the international area beyond national jurisdiction by means of laying fiber-optic cable with reference to justice and equality in the apportionment of advantages between investing states only.

2.4 Structure of the study

Chapter One: Definition of Submarine Cables

Section One: Definition and development of submarine cables

Section Two: Importance, advantages, and disadvantages of submarine cables

Chapter Two: Legal Regulation of Cables and the Resulting Legal Issues

Section One: Legal regulation of submarine cables on the seabed

Section Two: Legal problems arising from the use of fiber-optic cables on the seabed

The study concludes with a section presenting the findings and recommendations.

3 DEFINITION OF SUBMARINE CABLES

The submarine cables are vital for global communications and are one of the world's most notable examples of international digital infrastructure. Vastly more than 95% of all intercontinental communication relies on them. They serve not only as an internet connection, but also to process financial transactions and mobile banking transfers. Now, as communication by means of invention has become advanced, dozens of these cables have been built binding together most the globe. The technological evolution has resulted in the design of sophisticated fiber optic cables that are used throughout the world by large multinational enterprises. Accordingly, this part covers the idea of submarine cables, their characteristics and evolution.

3.1 Definition and development of submarine cables

3.1.1 Definition and types of fiber-optic cables

Fiber-optic cables are defined as communication media laid on the seabed between two terminal points. They are also described as submarine communication cables forming part of a global network that carries telecommunications between states, with more than 550 underwater cables extending approximately 1.4 million kilometers across the oceans. In addition, they are cables connecting land stations to transmit communication signals across vast oceanic distances.

Data transmission through submarine cable systems constitutes vital underwater communication infrastructure using fiber-optic and other cable technologies. These systems provide high speed and reliability, capable of supporting complex and critical applications such as underwater research communications, oil-exploration platforms, and permanent seabed infrastructure.

Submarine cables generally include power cables and fiber-optic communication cables. Communication cables transmit vast quantities of data and voice signals across oceans and seas, connecting continents and states and serving as a driving force of the modern world, while also opening new prospects for subsea exploitation.

3.1.2 Historical development of submarine cables

Submarine cables are not a recent innovation; rather, their origins date back to early telegraph technology. The first attempt to lay a transatlantic telegraph cable was undertaken by Cyrus West Field, who persuaded British industrialists to finance the first cable in 1858. Due to technological limitations, the cable operated for only one month. Further attempts followed in 1865 and 1866, using the world's largest steamship, SS Great Eastern, with improved technology. By 1870, a cable connected India to Aden, Yemen.

From the mid-nineteenth century until 1911, British submarine cable systems dominated the global market, contributing to the expansion of cable companies. These cables had major economic value for commercial enterprises and administrative and

diplomatic importance for the British government, particularly in wartime communications. During World War I, British telegraph communications remained uninterrupted while German cables were cut worldwide.

Interest later expanded into the Pacific Ocean, where the first cable with a capacity of eight telephone channels was laid between Hawaii and Japan in 1964. Competition then increased among companies from the United States, France, Germany, and other states. By the 1920s, transmission speeds had reached 200 words per minute, strengthening commercial and security interests between continents. Although radio and telephone technologies gained prominence in the 1930s–1960s, submarine cable infrastructure continued to advance.

The most dramatic change of all came in the 1980s with the arrival first of fibre optic cables (invented by a Britishman, Sir Charles K. Kao) and then in 1988 the laying of the world's first transatlantic fibre-optic telephone cable – heralding an era of high-capacity, high-quality data transmission. Fiber-optic systems pass information as light pulses, rather than traditional electrical cables, and so allow for faster speeds carried over very long distances. From 1998 to 2003, about 70 percent of submarine fibre-optic cables were laid in the Pacific Ocean with the worldwide economic growth at that time. In 2009, East Africa became linked to the worldwide web with an undersea fiber-optic cable, despite some temporary hitches because of piracy.

For contemporary examples look no further than the physical interconnection of Chinese civilian and military interests across connected regions, specifically in respect of China's investments in undersea cables such as the PEACE cable which will reduce its susceptibility to foreign surveillance while increasing access to sensitive information.

These are signs of the next phase in global communication. Protection of submarine cables against intentional and accidental damage has been accepted as an imperative under the international law long ago and the United Nations General Assembly has agreed that submarine cable systems represent a critical infrastructure important to global economy and to the national security interests of all states.

3.2 The importance, advantages, and disadvantages of submarine cables

Lots of people have this belief that we still do most of our international communications through satellites and satellites are the principal modality for global information. Though satellites were ubiquitous until the first transatlantic fiber-optic cable was laid in 1988, they have since been outpaced by fiber-optic submarine cables. Today, ~97% of the world's communicated information is ferried by a relatively small number of high reliability and quality submarine fiber-optic cables. These cables must therefore have a considerable importance with however some drawbacks, which will be described in the following.

3.2.1 The significance and benefits of submarine cables lying on the sea bed

3.2.1.1 Fiber optic cables are the backbone of global communication infrastructure

Submarine optical fiber cables are the basis for global communication systems. Resting on the ocean floor — generally no thicker than a garden hose — they ferry enormous amounts of data across oceans. Big digital platforms such as social media networks are dependent on these cables, and most nations rely upon them for communications, financial transactions and military links. They form the very bricks and mortar of Internet and telephone links, and national life-support systems such as shipping, trade and banking. They put national security at risk when they cannot send and retrieve information.

3.2.1.2 Submarine cables as a basis of the world economy

The world economy depends on submarine cables, which send trillions of dollars worth of financial flows daily and thus are a critical artery for the modern digital economy. They grow the worldwide trade and communication by delivering dependable, creative and affordable data-transfer solutions. For instance, the world's largest banks move about \$3.9 trillion daily in funds via cable systems. Submarine cables are more efficient, cheaper and reliable than satellites. Expanding with the internet's growth, they

are a driver of economic growth, job creation and innovation on both a regional and global level - as well as playing an essential role in connecting people to digital opportunities.

3.2.2 The political economy of submarine cables

Almost all global internet traffic travels on fiber-optic cables, whose size and number affect the allocation of wealth, power and knowledge. Their undersea networks have been caught in the cross hairs of geopolitical conflict, particularly among superpowers vying for control over communications systems; that's hardly surprising since submarine cables are known as the backbone of the World Wide Web. This geopolitical contest looks a great deal like a cold war Redux; competing states maneuver to dominate essential infrastructure for commercial and intelligence reasons.

In the United States, for example, the goal has been to have submarine cables built by American firms. A proposed cable by the Chinese firm HMN Tech from Singapore to France was ultimately abandoned after the United States undercut it with a better offer. That is indicative of the U.S. campaign to ensure communications security and curb Chinese technology influence.

Submarine cables are also susceptible to espionage and hostile attack due to their use for the transmission of military data and intelligence. If the cables were to be damaged or cut, they could cripple services, impact military operations, send financial markets into turmoil and severely challenge diplomatic relations around the world. There are also concerns that states can use the locations of cables to carry out surveillance — for instance, via specially equipped submarines that tap or sever cables — rendering them a strategic weakness.

3.2.3 Advantages of fiber-optic submarine cables

1. Ultra-high transmission speed : Fiber-optic lines offer data transmission speeds much faster and more reliable than copper cables by relying on light signals, not electrical current.

2. Strong signal over long distances : They can pass information through very long distances without much signal attenuation and do not easily react to environmental conditions such as change in temperature, being under a liquid or corrosive gases.
3. Immunity to electromagnetic interference : As it transmits using light, electromagnetic interference has no effect on fiber-optic cables, making unauthorized tapping is more difficult and improving data reliability and security.
4. Reduced maintenance requirements : There is typically minimal maintenance once fibre- optic cables are installed, even if they are laid on the bed of the sea at thousands of metres depth unless deliberately crushed or severed.
5. Lower energy consumption : Optical transmission is more energy efficient than electrical signaling, contributing to cheaper operating costs.
6. Lightweight and compact structure : Fiber optic cabling is lighter and smaller diameter than copper cabling, which makes it easier to install as well as cheaper in both terms of time and installation cost and space.

Overall, those features also suggest that fiber optic cables will be the best solution for future high-speed long-distance secure communications networks, which will become the backbone of future global interconnectivity.

3.3 Second: disadvantages of fiber-optic cables

Although fiber-optical cables offer numerous advantages, they must overcome some limitations due to t come in handy while realizing a submarine cable.

1. High initial cost : The fiber optic system is far costlier than a copper system because of special materials, machines/tools and the need for high skilled manpower. This could stymie the small organizations with limited budgets from adopting this.
2. Physical fragility : This design, however, is more fragile than a copper cable since the glass fibers inside it can break if bent too sharply or crushed with too much force during installation and maintenance.
3. Requirement of Specialized equipment and expertise : Sophisticated equipment and personnel skilled in its servicing are needed for installation and maintenance, raising maintenance costs and possible manning problems.

4. Environmental sensitivity : In spite of being immune to electromagnetic interference, fiber-optic cables can still be sensitive to high temperature, humidity or chemical influence that may impair the performance and life span in a harsh environment.
5. Complex repair processes : Fixing cut fiber-optic cables—particularly ones at the bottom of the ocean—demands fine-tuning microscopic strands of glass and specialized tools, and can take significant time to get right, possibly leading to longer service interruptions or pricier bills.

4 CONCLUDING OBSERVATION

Thanks to submarine cables (and particularly fiber optic ones), these have all helped shape global communications significantly, from the first copper telegraph cable in 1858 right through to the fiber optic revolution of 1988. They have turned the world into an increasingly networked digital space, as central to national progress and international monetary activity as it is to geopolitical competition.

Despite their extremely high significance and advantages, however, these cables are confronted with various problems as incapable of deep-deep sea use, breakability, high installation cost issues and such like by a maliciously or accidentally injured one. These threats do not diminish their importance, rather they reinforce the required technological progress and enhanced legislative protections for submarine fiber-optic infrastructure.

4.1 Legal regime of submarine cables and subsequent legal issues

CablesSubmarine communications cables stretching along the seafloor and connecting countries across oceans are a critical part of the global international communications infrastructure. Internationally, freedom to lay submarine cables is widely accepted as a norm of international law, notably the law governing the sea, which provides implications for states' rights and duties to respect their preservation, regulation and upkeep – including legal consequences where such cables are damaged or operations

interfered with. The relevant instruments confirm the freedom to lay cables on the high seas and EEZs, but also grant coastal states the right to regulate and protect within their territorial waters, provided such regulation does not interfere with legitimate international communications.

Legal regime The legal regime for submarine cables relies on some fundamental treaties comprising the 1884 Convention for the Protection of Submarine Telegraph Cables, the 1958 Geneva Convention on the High Seas, and the 1982 United Nations Convention on the Law of the Sea (UNCLOS), which—as noted—sets out clearer rules for laying cables on the high seas, in exclusive economic zones, and on the continental shelf, and defines the rights and obligations of coastal states and other states. This regulatory framework is therefore an integrated system in which international, regional, and national rules intersect in an attempt to balance common interests and promote sustainable development for future generations. Nevertheless, important questions remain: have these international treaties adequately covered the legal and regulatory framework for submarine cables, particularly given continuous technological development? Are they sufficient to address the legal gaps relating to the laying, protection, and environmental impacts of cables—especially in the international area? What legal problems arise from laying cables on the seabed? These issues are addressed below.

4.2 The legal regulation of submarine cables on the seabed

A number of international instruments have been concluded to establish a legal framework for submarine cables. Their purpose is to protect cables, regulate their installation on the seabed, protect them from theft and damage, and also safeguard the seabed and marine organisms from the harmful effects associated with cable laying. The most significant instruments include the following:

4.2.1 First: The 1884 Convention for the protection of submarine telegraph cables

Following repeated incidents of telegraph cable breaks in the North Sea during the 1880s—often caused by fishing vessels—a British cable company appealed to its

government for protection against such attacks. Consequently, the first international convention aimed at protecting submarine telegraph cables was adopted in 1884 and entered into force in 1888. Only 40 states ratified it. The Convention imposed obligations relating to the cutting of communication cables on the high seas. However, it lacked clarity regarding the limits of territorial waters, which at the time differed among states (for example, some applied a three-mile territorial sea). This created difficulties concerning the extent of coastal-state jurisdiction due to conflicting territorial-sea breadths.

The Convention recognized the freedom to lay, maintain, and repair telegraph cables outside territorial sovereignty, and required state parties to enact criminal and civil legislation penalizing the intentional or negligent breaking or damaging of a cable—except where such action was necessary to protect human life or vessels. The Convention consisted of 17 articles. Article 1 addressed cables outside territorial waters, Article 2 dealt with civil and criminal responsibility for cable interruption, Article 3 concerned the responsibility of states granting cable-laying concessions and the duty to use best efforts to protect cable routes, and Article 4 addressed responsibility when a newly laid cable damages an existing cable during laying or repair, requiring the owner of the new cable to compensate for and repair the older cable.

The Convention also supported vessels that sacrificed anchors or fishing gear to avoid damaging a cable by allowing compensation claims from the cable owner—an approach intended to reduce cable breakages. Articles 8–11 addressed judicial jurisdiction in the courts of the flag state of the vessel where the violation occurred, and granted a right of visit to inspect suspicious vessels' nationality and official documents. Article 15 excluded the application of such measures during armed conflict, preserving belligerent rights.

Though to a degree appreciating the value of cables, the 1884 Convention was hardly adequate in a period of great development, as it settled only on thirty-nine countries and addressed only submarine telegraph cables laid at sea. It is useless to deal with modern scientific and technological advance. It was also poorly enforced because not all of the states enacted adequate domestic laws and national law was in some instances inadequate, as it did not establish unequivocally that clandestine cable cutting was a

punishable offence within its territory. The Convention itself gradually lost its importance, except for some articles which were later integrated into other instruments.

4.2.2 Second: The 1958 Geneva Convention on the law of the sea (high seas)

In 1950, the International Law Commission recognized the principle that all states have the right to lay submarine cables on the seabed. The 1958 Geneva Convention addressed submarine cables in Articles 26–30. Article 1 defined the high seas as “all parts of the sea not included in the territorial sea or internal waters of a state.” Article 2 affirmed that the high seas are open to all states and recognized the freedom to lay submarine cables and pipelines.

The Convention thus consolidated core high-seas freedoms while subjecting them to certain limitations aimed at balancing states’ interests. Under Article 26, all states may lay cables and pipelines on the seabed. Coastal states may take reasonable measures for the exploration of the continental shelf, and when exploiting natural resources they must not unjustifiably interfere with the laying or maintenance of cables. The Convention also required cable owners to respect the rights of other states when laying and repairing cables. Articles 27–29 addressed cable protection and imposed obligations on those who cause cable breaks, reflecting provisions similar to Articles 2, 4, and 7 of the 1884 Convention.

The 1958 Geneva Convention was the first instrument to receive broader global engagement compared with the 1884 Convention, and it expanded the scope of cable regulation to include not only communications cables but also high-voltage power cables.

4.2.3 Third: the Second United Nations Conference on the law of the sea (1960)

The 1960 Geneva Conference included 86 states, exceeding participation in the 1958 conference. Its principal objective was to clarify the outer limits and breadth of the territorial sea. Some states advocated a 12-nautical-mile territorial sea, whereas certain major states favored a three-mile breadth, and a compromise proposal of six miles for the territorial sea plus six miles for fishing was discussed. The conference sought a formula acceptable to coastal and other states regarding fisheries regulation, but it failed

diplomatically to produce a treaty or a comprehensive solution to disputes over territorial-sea breadth. It also did not provide specific protection for submarine cables, paving the way for the Third Conference and the conclusion of UNCLOS in 1982.

4.2.4 Fourth: The 1972 International Regulations for Preventing Collisions at Sea (COLREGs)

Although primarily a maritime safety instrument, the COLREGs indirectly contribute to protecting submarine cables by reducing ship collisions that may lead to cable cutting or damage. The Regulations discourage interference with cable ships engaged in cable operations and maintenance. Rules corresponding to 27 and 18 address interactions between cable ships and other vessels. Cable ships are required to display appropriate lights and shapes to distinguish them during day and night operations, and other vessels—especially fishing vessels—are expected to keep clear of cable ships, although the rules do not set a mandatory separation distance.

This illustrates the COLREGs' indirect role in supporting safety at sea and protecting critical underwater infrastructure, even though they were not adopted specifically for cable protection. UNCLOS 1982 later provided the primary legal framework for cable operations and protection.

4.2.5 Fifth: The 1982 United Nations Convention on the Law of the Sea (UNCLOS) and submarine cables

The UNCLOS 1982 was born from and continued to build on rules of the 1958 Geneva regime, and remains the fundamental legal framework for laying&protection of submarine cables at sea. It prescribes the respective rights and duties of coastal and land-locked (and other) States in respect of the laying of cables and their protection.

Sovereign nations have sovereignty over their territorial waters, where states can legislate national laws that govern cable-related activities, impose requirements on the laying of cables as well as issue permits and licenses to companies along addressing environmental and safety issues. Nonetheless, although the UNCLOS incentivises such

actions, several coastal states have failed to implement such regulations domestically leaving a legal vacuum with respect to cable protection.

UNCLOS reconfirms the principle of freedom to lay submarine cables and pipelines on the high sea (articulated in Article 112) just as it was previously recognized in Article 26 of the 1958 Convention. Art 79 covers the placing of pipelines and cables on the continental shelf provided that it does not unjustifiably affect the rational utilization of the resources in the edges zone (the same applies to stretching lines in case of an EEZ). Coastal States may have the power to regulate cables on their continental shelf and within their EEZ if they are associated with resource exploration, exploitation or artificial islands, installations or structures that are under its jurisdiction.

However, in the Area (the international seabed) lying beyond the limits of national jurisdiction, all States have the freedom to lay cables and pipelines on the seabed. UNCLOS additionally obligates states to take into account standing cables when laying a cable, such consideration including the potential for repairing it at a future date. Article 113 requires each State to make it a punishable offence for any vessel flying its flag or for nationals of that State to wilfully or through culpable negligence break or injure a submarine cable in such a way as might interfere with the maintenance of telegraphic communication, subject to an exception where it is necessary owing to stress of weather or other conditions endangering the safety of life at sea; and provided further that all precautions are taken.

Article 114 It shall be the duty of states to bring about that, if a person under their jurisdiction damages existing cables which do not belong to the same owner, whilst laying or repairing his own cable, he shall pay the cost of repairing them. Article 115 deals with compensation for fishermen who have to let go anchors, nets etc., to protect a cable; member states are required to introduce legislation ensuring compensation is payable provided that reasonable care was taken to avoid damage in the first place.

4.3 Assessment of the legal framework in general

The extent of the protection of cables was, however, less than ideal in previous conventions although there was an international acceptance regarding the need for such a measure. The 1884 Convention was a slim agreement of participants and issues that failed

to keep up with the times. Further developments – namely the 1958 Geneva Convention and in the end UNCLOS 1982, extended the legal framework and offered a more explicit basis. However, UNCLOS 1982 did not entirely address regulatory and enforcement loopholes, particularly with respect to cables in the international seabed Area.

The Area is subject to a variety of activities – including mining, fishing and other uses – which can give rise to tensions with the freedom to lay cables in an area that is legally defined as being part of the common heritage of humankind. In addition, the power of the International Seabed Authority is essentially mineral-based only - it has failed to establish any regime specifically relating to the laying of submarine cables – especially for modern fiber optic systems. Other concerns are the absence of specific processes for compensation under Article 115, the tendency of many states to not adhere to Article 113's insistence on criminalization at the national level for cable damage and there are no established procedures in place internationally to prosecute individuals or groups who do intentionally or accidentally cause damage to submarine cables. These gaps are indicative of serious shortcomings in accountability for harms to this vital infrastructure.

This is why the legal regulation of submarine cables under UNCLOS 1982 has not been fully accomplished— more particularly in international waters—owing to that organization's restricted institutional authorization and the dearth of rules designed for contemporary fiber-optic cable networks. The need for legal solutions that does justice to this new phase of technological development is obvious.

4.4 Legal issues concerning fiber-optic cables at the seabed

Modern fiber-optic wires, as I have said before, are like railroads — something a modern state must have because in the modern era, everything is connected by their existence. They are also evidence of sophisticated technology that dictates the use made of the seabed, especially in international waters where fiercer competition for extended exploitation is taking place among companies. While older cables similarly presented legal and practical challenges, modern fiber-optic cable — which is technologically superior but not categorically different — also raises a plethora of critical legal problems:

4.4.1 First: The “Due Regard” problem in the international setting

“Respect” requires states to exercise their rights on the international plane in a manner designed to prevent unnecessary injury or disproportionately adverse effects from occurring either as a consequence of their activities or as an interference in similar rights exercised by others. 43 UNCLOS has taken account of this consideration, but the key challenge is to strike a balance between freedom to lay cables and the need to protect the interests of other states.

Under UNCLOS, all states have the freedom to lay cables in the Area and must show respect for the rights of other states and protect existing cables—especially concerning their reparability. However, it does not specify clear procedures for implementing “due regard,” creating uncertainty during cable installation. Some states seek to expand cable networks to enhance commercial and economic interests, while other states may perceive certain routes as threats to national security or to their maritime activities. This can lead to disputes and may expose cables to intentional cutting or sabotage by states whose interests conflict.

Therefore, states laying cables should take due regard of coastal states and other users, and avoid activities that interfere with other lawful uses of the area such as mining, exploration, and pipelines. Shared use of the international area also exposes cables to natural and human risks, including earthquakes and intentional damage, which underscores the need for international cooperation among cable users. States are further expected to consider existing cables and future repairs when laying new cables.

4.4.2 Second: cybersecurity and cyber threats

Submarine communications cables constitute a vast network on the seabed—often no thicker than a garden hose—yet capable of transmitting enormous volumes of data and functioning as the backbone of the internet. With technological evolution, their uses have expanded beyond data transmission to include reliance by military institutions, oil and gas companies, and scientific communities. Despite their status as critical infrastructure, they remain vulnerable to cybersecurity threats, including deliberate harm to data through

attacks on cable systems by compromising network-management systems that operate cable networks.

Cyberattacks threaten data flows because of the rapid growth of cloud computing and the increasing volume and sensitivity of data transmitted, which can raise international security concerns through interception and espionage. States frequently associated with cyber espionage include the United States, Russia, the United Kingdom, and China, and technological advancement has made tapping and manipulation more effective and harder to detect. A widely-cited case involves a global hacking collective that aimed to attack infrastructure in Oahu by hacking into servers of a private company overseeing an undersea cable between Hawaii and other Pacific areas; U.S. authorities allegedly caught the attack and worked with law enforcement around the world to track down those responsible.

Fears of sabotage by cyber means to critical infrastructure, through targeting cables since 11 September, would be at an even greater premium. This underscores the relevance of international law to cyberattacks against submarine cables. It is partly the speed of cyber operations and the secretiveness of actors which makes it hard for academics as well as subject matter experts to decide on the domain where international law finds application in this area, and then who is the appropriate object of that law – the state itself, or terrorists or criminals acting for themselves.

Discussions have been argued, for example brushed by in UN expert processes about information and communications technologies in the context of international security. Some official statements have indicated that established law of armed conflict principles apply in cyberspace, and the conclusions reached by UN experts have tended to indicate that international law—including the UN Charter—applies to cyber operations and is critical for maintaining international peace and stability.

In the abstract, some provisions of the UN Charter might apply to intentional interdiction of vital cable systems in situations in which this conduct amounts to a threat to international peace and security or act of aggression under a Security Council determination. Similarly, if the interference is an armed attack, Charter limitations on self-defense are satisfied. But the application of these rules to cyber operations is challenging for a number of reasons:

1. many cyber intrusions are non-apparent and entail minimal (if any) physical evidence;
2. determining perpetrators and assigning responsibility can be extremely difficult; and
3. all use of force would be responsive in nature and therefore qualified by necessity and proportionality, so that the least harmful alternative was exploited and retaliation avoided.

Outside the law of war, other regimes — including international telecommunications frameworks and standards bodies — are pertinent to cyberspace issues, but they have not offered binding requirements for protection from intentional cyber damage to cable systems. And so cyber threats are now a major, under-regulated issue for protecting submarine cables."

4.4.3 Third: theft of submarine cables

Submarine cables are vulnerable to danger such as theft, as they are installed on the sea floor. An example given is Vietnam in March 2007, where cables were "lost" with the authorities at one point finding huge spools of cable on Vietnamese territory and special ships rigged for cutting cables. 12-km section of a submarine communications cable stolen, taking 82 percent of the telecoms and internet services down for up to three months. Another case arose after Jamaica in 2008, when it was reported that Cable&Wireless Jamaica had apparently lost \$1.5 million through the process of restoring and repairing cable services because of theft – Likely by perpetrators intending to sell it back into circulation so it could be used. These kinds of actions could cause chaos in such functions as international communications and internet systems, international finance, military logistics, medicine and trade.

The second potential offence, intentional damage and other similar harmful acts by UNCLOS Article 113, focusses on legislative jurisdiction leaving limited scope of any clear enforcement mechanism. By contrast, Article 10 of the Convention of 1884 required certain measures for inspection to be taken by warships purportedly suspect vessels; but, the previous Convention was binding on its signatories only.

There are opinions - from some of the writers - to treat cable theft as piracy under UNCLOS. But applying Article 101's definition of piracy is challenging, because UNCLOS piracy language is first and foremost crafted around the use of violence, detention, or a depredation directed against ships or aircraft—rather than at seabed infrastructure. In addition, the cable protection provisions of UNCLOS (Articles 113–115) do not specifically deal with terrorism, piracy, or more recent intentional attacks on cable systems as those concerns were less relevant to UNCLOS drafters in 1982. Subsequent CT treaties (like the 1997 International Convention for the Suppression of Terrorist Bombings) also include infrastructural attacks under certain conditions, but they do not address in any direct way the cable theft legal questions that are peculiar to South Africa. As a result, theft and deliberate attacks are inadequately covered by an [ill-suited] generic legal system.

4.4.4 IV: environmental effects of international submarine cables

The oceans are home to a wide variety of marine life and help sustain the earth's biodiversity. But new technology has heightened the risk to marine environments from human activity — including laying fiber-optic cables. Despite the necessity of cables as global infrastructure, concerns have been expressed regarding potential negative environmental impacts including pollution, entanglement and habitat alteration.

De-engineering laying new cables can disrupt the seabed with trenching and burial operations to protect cables. Physical ploughing and burial compress the seafloor reducing habitat availability for benthic life. Burial and installation can impact biodiversity through disturbances to habitat, while noise pollution from installation and maintenance vessels could alter the behavior of (and pose a threat to our ecosystem stability) marine mammals like whales and dolphins that use sound for navigation and feeding. Decommissioning by cable installation and maintenance can also result in the removal or destruction of marine plants (such as seagrasses and coral) and displacement of benthic species that utilise particular areas for spawning purposes.

and subsea cables are also susceptible to geological risks like earthquakes. As an example, it was reported that three cable failures in the Red Sea disrupted approximately 25% of Internet connectivity for the Middle East and Europe [18] (Kampfner, 2008),

attributed by some as caused by seismic activity at the time when it happened – demonstrating the susceptibility of subsea infrastructure to nature’s whims.

Submarine cables have therefore a distinct environmental dimension: they interfere with ecosystems and habitats, they are impacted by geological and environmental hazards that can cause ruptures leading to interruptions of international communications. Repairs and replacements may also disorient the seabed habitats through traffic of dedicated vessels.

5 CONCLUSION OF THE DISCUSSION

In considering the technological dimension of submarine cables—most notably fiber optics— it is evident that such cables constitute the lifelines of global communications and an indispensable component of the international economy; as a result, they hold geopolitical importance which engenders rivalry amongst states seeking to wield power through control, surveillance and access to intelligence. Their virtues — speed, long-distance signal strengths, lower energy consumption and lighter weight structure — have enabled them to proliferate, even though they are expensive to put in place initially, fragile and sensitive to the environment and difficult to repair at the depths where many have been sited.

The regulation of submarine cables has been dealt with by international law since the 1884 Convention and later UNCLOS 1982. However, despite UNCLOS rules on the freedom of laying cables and states’ obligations to criminalize cable damage and establish reparation mechanisms for repairs, this framework has been unable to provide security and reliability to submarine cable systems. This is a result of several reasons: several states have not implemented such national criminal laws as was envisaged; the Convention has rather vague enforcement mechanisms; it insufficiently covers modern threats (such as cable theft, sabotage and terror or cyber threats) while implementation details are left somewhat open. Moreover, the International Seabed Authority’s jurisdiction is primarily limited to digging up the seabed and no specialized regulatory regime exists for the transmission of modern fiber-optic cables in the Area.

These lacunae highlight the inadequacy of more precise and contemporary legal rules that cover protection, enforcement, cyber threats, intentional attacks and

environmental considerations - all in a manner sensitive to the fluid technological transformations witnessed by these submarine cable (Infrastructure) systems..

5.1 Conclusion

The study demonstrates the importance of exploiting the seabed and, more importantly, the need for a legal framework that keeps pace with scientific developments relating to the exploitation of the seabed and subsoil beyond the limits of national jurisdiction. Based on the analysis, the study reaches the following findings:

5.2 Findings

1. Submarine cables constitute critical infrastructure for communications and data transmission through modern fiber-optic technology on the seabed—particularly in the international area—given their speed, reliability, and capacity to support communications related to scientific research, commerce and marketing, financial transfers, and other uses.
2. The first international convention for the protection of submarine cables was adopted in 1884, followed by successive international instruments regulating the laying of submarine cables on the seabed. Although the 1982 United Nations Convention on the Law of the Sea (UNCLOS) serves as the core legal framework governing the laying of submarine cables in seas and oceans, it has not been able to address all issues relating to protecting cables from sabotage, theft, and similar threats.
3. Submarine cables have significant impacts on the marine environment, including pollution, turbidity, entanglement, and habitat disturbance. Cable installation disrupts the seabed through trenching and burial operations used to protect cables, due to the equipment employed in excavation. In addition, noise generated by trenching operations and by repair vessels can damage various habitats, particularly affecting marine mammals such as whales and dolphins.

4. The deployment of undersea cables in the sea might offer a potential lever for big powers to use cables for spying and intercepts. Submarine cables are confronted with cybersecurity risks, and even cyberthreats from large industrialized nations.

5.3 Recommendations

1. Enhance international cooperation to protect the seabed from pollution due to harmful uses of technology and exploitation, including laying submarine cables.
2. Foster a solid legal regime addressing the laying of submarine cables on the seabed and refrain from exclusively depending on national laws for penalizing offenders in cases involving cable cutting, theft or other wrongful conduct.
3. Revise the provisions of UNCLOS in light of technological progress or provide an annex dealing precisely with the legal issues involved with laying submarine cables on the seabed. This should entail an amendment of Article 101 Definitions (b) on piracy to extend the definition to encompass destructive acts against submarine cables as instances of maritime piracy, since these acts undermine the security at sea and particularly the stability in the international area.

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Authors' Contribution

All authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

How to cite this article (APA)

Hussein, S. A., & Abdul-Kareem, S. A.-J. (2026). THE IMPACT OF USING MODERN FIBER-OPTIC CABLES ON THE EXPLOITATION OF THE SEABED (A STUDY WITHIN THE FRAMEWORK OF THE INTERNATIONAL LAW OF THE SEA). *Veredas Do Direito*, 23(5), e235690. <https://doi.org/10.18623/rvd.v23.5690>