Legal Ambiguities Concerning the Use of Unmanned Aerial Vehicles in Marine Scientific Research

HOW UNMANNED AERIAL VEHICLES CHALLENGE THE REGIME OF MARINE SCIENTIFIC RESEARCH UNDER THE UNITED NATIONS CONVENTION ON THE LAW OF THE SEA – AND HOW THEY NEVERTHELESS MAY BE ACCOMMODATED

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List of Abbreviations

AUV	Autonomous Underwater Vehicle
Chicago Convention	Convention on International Civil Aviation
DoD	Department of Defense
ICAO	International Civil Aviation Organisation
ICJ	International Court of Justice
ICZM	Integrated Coastal Zone Management
IDF	Israeli Defense Forces
IHO	International Hydrographic Organization
IMO	International Maritime Organization
ISA	International Seabed Authority
ISR	Intelligence, Surveillance, and Reconnaissance
ITLOS	International Tribunal for the Law of the Sea
GPS	Global Positioning System
LiDAR	Light Detection and Ranging
LOSC	United Nations Convention on the Law of the Sea
NIVA	Norwegian Institute for Water Research
ROV	Remotely Operated Vehicle
SAM	Surface-to-air missile
UAS	Unmanned Aircraft System
UAV	Unmanned Aircraft Vehicle
UK	United Kingdom
UMV	Unmanned Maritime Vehicle
UNCLOS	United Nations Conference on the Law of the Sea
USA	United States of America
USV	Unmanned Surface Vehicle
UUV	Unmanned Underwater Vehicle
VCLT	Vienna Convention on the Law of Treaties
VLOS	Visual Line of Sight
VTOL	Vertical Takeoff and Landing

List of Cases

Court	Case
International Court of Justice	*Whaling in the Antarctic (Australia v. Japan: New Zealand Intervening)* [2014] ICJ Reports 2014
	Aegean Sea Continental Shelf Case (Greece v Turkey) [1978] ICJ Reports 1978
	Dispute Regarding Navigational and other Related Rights (Costa Rica v Nicaragua) [2009] ICJ Reports 2009
	Case Concerning Rights of Nationals of the United States of America in Morocco (France v United States) [1952] ICJ Reports 1952
	Case Concerning Kasikili/Sedudu Islands (Botswana v Namibia) [1999] ICJ reports 1999
	Legal Consequences for States of the Continued Presence of South Africa in Namibia (South West Africa) Notwithstanding Security Council Resolution 276 [1971] ICJ Reports 1971
Permanent Court of Arbitration	*Iron Rhine Arbitration (Belgium/Netherlands)* [2005] Permanent Court of Arbitration ICGJ 373
	Islands of Palmas (Netherlands/United States) [1928] Permanent Court of Arbitration ICGJ 392
International Tribunal for the Law of the Sea	*M/V 'Saiga' (No 2) (Saint Vincent and the Grenadines v Guinea)* [1999] ITLOS Reports 1999

Chapter I: Introduction

1.1 Introduction

The world's oceans cover more than 70% of the surface of the Earth, a vast space so far only minimally mapped, observed, and explored by means of marine scientific research (MSR) due to the risky and difficult environment.[1] The advent of modern oceanography has allowed for great advances in MSR, and accompanying leaps in technology have facilitated this knowledge acquisition, not least of all through the development of unmanned maritime vehicles (UMVs). The use of UMVs has increased steadily over the last decade in a host of ocean activities,[2] ranging from oceanographic surveys and MSR, to naval and law enforcement operations.[3] In general, UMVs have the ability to 'enhance situational awareness, reduce workload, improve mission performance, and minimize overall risk to both civilian and military personnel, and all at a reduced cost.'[4] Because they reduce the risk to human life, 'unmanned systems are becoming the preferred alternative for dull, dirty, or dangerous missions.'[5] They have enabled the automation of dangerous tasks at sea which were previously carried out manually, as well as the possibility to explore, operate, protect, and carry out safer and more extensive explorations of the ocean.[6] Particularly the field of MSR has greatly benefitted from the steady development of UMV technology; gliders, buoys, floaters, and aerial vehicles are now standard equipment in the carrying out of such research.[7]

Within the three categories of UMVs used in MSR – unmanned surface vehicles (USVs), unmanned underwater vehicles (UUVs), and unmanned aerial vehicles (UAVs) – a novel legal discourse has recently emerged on the latter, and revolves around which legal framework they

[1] National Oceanic and Atmospheric Administration US Department of Commerce, 'How Much of the Ocean Have We Explored?' <https://oceanservice.noaa.gov/facts/exploration.html> accessed 22 June 2022.
[2] Natalie Klein, 'Maritime Autonomous Vehicles within the International Law Framework to Enhance Maritime Security' (2019) 95 29.
[3] 'Drones of the Sea: The Rise of Unmanned Surface Vehicles' (*Naval Technology*, 23 July 2021) <https://www.naval-technology.com/sponsored/drones-of-the-sea-the-rise-of-unmanned-surface-vehicles/> accessed 3 June 2022.
[4] United States Department of Defense, 'Unmanned Systems Integrated Roadmap' (*UNT Digital Library*, 2013) 20 <https://digital.library.unt.edu/ark:/67531/metadc949794/> accessed 3 June 2022.
[5] Raul (Pete) Pedrozo, 'US Employment of Marine Unmanned Vehicles in the South China Sea', *The South China Sea* (Routledge 2019).
[6] Angelo Odetti, 'Special Issue "Unmanned Marine Vehicles II"' Journal of Marine Science and Engineering <https://www.mdpi.com/journal/jmse/special_issues/unmanned_mar_vehicles_II> accessed 22 June 2022.
[7] Ursula K Verfuss and others, 'A Review of Unmanned Vehicles for the Detection and Monitoring of Marine Fauna' (2019) 140 Marine Pollution Bulletin 17, 19.

are governed by.[8] The United Nations Convention on the Law of the Sea[9] (LOSC) extensively regulates MSR in Part 13 (Articles 238 – 265) with view of vessels conducting such research, but there is legal ambiguity over whether UAVs are covered by the LOSC regime, and more specifically Part 13. In particular, legal tension has arisen over the fundamental challenge UAVs pose for the LOSC by virtue of the Convention not addressing UAVs anywhere in the instrument. This raises the question whether UAV-conducted MSR may be covered by Part 13 of the LOSC, or whether instead this technology falls under a right of overflight held in Article 87 LOSC and accordingly the International Convention on Civil Aviation[10] which stipulates the rules of the air.

This legal ambiguity over the regime governing UAVs in MSR has also given rise to political tensions. Some States, notably the United Kingdom (UK) and the United States of America (USA) distinguish between MSR and the closely related survey activities, which include both hydrographic and military surveys, the latter of which may include intelligence, surveillance, and reconnaissance (ISR) gathering. They claim that they enjoy a freedom to conduct such survey activities in the exclusive economic zone (EEZ), without coastal State intervention.[11] This legal position has been justified on the basis of the LOSC distinguishing between 'research' and 'marine scientific research' on the one hand, and 'hydrographic surveys' and 'survey activities' on the other hand.[12] Part 13 of the LOSC also omits any mention of surveys, rendering such activities neither pure nor applied research, subject to coastal State consent.[13] The USA claims, in addition, that survey activities extend also to operational oceanography.[14] Protest has been lodged by States including India and China over survey activities being conducted *inter alia* by the USA and the UK in their EEZs, as China for instance has implemented a consent regime to approve all mapping and survey activities in 'sea areas under

[8] Natalie Klein, 'Maritime Autonomous Vehicles within the International Law Framework to Enhance Maritime Security' (2019) 95 International Law Studies 29.
[9] United Nations Convention on the Law of the Sea 1982 (UNTS 1833, 1834, 1835).
[10] Convention on International Civil Aviation (15 UNTS 295)
[11] Donald R Rothwell and Tim Stephens, *The International Law of the Sea* (2nd edn, Hart Publishing 2016) 357.
[12] Sam Bateman, 'Hydrographic Surveying In Exclusive Economic Zones Is It Marine Scientific Research?', *Freedom of Seas, Passage Rights and the 1982 Law of the Sea Convention* (Brill 2009) 5 <https://brill.com/view/title/15749>.
[13] Rothwell and Stephens (n 10) 357.
[14] ibid.

the jurisdiction of the People's Republic of China'.[15] This has led to increasing tensions in the South China Sea, where these diametrically opposed positions are being executed.[16]

This dissertation analyzes the legal 'grey zone' UAVs conducting MSR operate in and argues that it is of significant importance to the international community to find that UAVs, as a means of conducting MSR, may be regulated by Part 13 of the LOSC on the legal basis of evolutionary interpretation, thus granting the coastal State the right to authorize and regulate MSR in its EEZ, and in order to ensure international legal uniformity.

1.2 Research Question

UAVs constitute versatile, enabling technology capable of significantly enhancing MSR, yet how they are regulated remains unclear. States keen on employing UAVs in the field of MSR are confronted with several potentially overlapping international instruments, of which none are geared specifically to UAVs. The LOSC constitutes the basic treaty addressing States' rights and obligation in any international use of seas and oceans. Therefore, its applicability to UAVs is of key importance.

Given the uncertainties as to the applicable legal regime and the potential tension resulting therefrom, this dissertation seeks to answer the research question:

> *How do unmanned aircraft vehicles challenge the traditional legal framework of marine scientific research in the United Nations Convention on the Law of the Sea, and how may they nevertheless be accommodated?*

In order to answer this question, the use of UAVs in MSR will be set out in detail, including how they are governed internationally through the LOSC. The extent to which this framework accommodates UAVs will be assessed, including how UAVs challenge this instrument due to their nature as aerial vehicles. Finally, the relevance of this research will be demonstrated by means of a case study on the South China Sea, illustrating the potential consequences of leaving

[15] J Ashely Roach, 'Marine Data Collection: US Perspectives', *Asian Yearbook of International Law*, vol 22 (Brill 2016) 184 <https://www.jstor.org/stable/10.1163/j.ctvrxk3zz.13>.
[16] 'South China Sea "Lawfare": Fighting over the Freedom of Navigation' <https://www.giga-hamburg.de/en/publications/giga-focus/south-china-sea-lawfare-fighting-over-the-freedom-of-navigation> accessed 26 June 2022.

an activity such as UAV-conducted MSR unregulated internationally, by way of analogy to the closely related field of survey activities.

1.3 Research Objectives

The overall objective of this paper is to make a contribution to the body of knowledge, as well as clarify ambiguities concerning the use of UAVs in MSR, in view of the increasing use and autonomy of this technology. The specific objectives of this paper are to (1) identify how UAVs are regulated under the LOSC with regard to MSR; (2) identify how UAVs challenge this traditional framework, and how they are nonetheless accommodated for; and (3) demonstrate the risk of finding UAV-conducted MSR not subsumed by the LOSC by means of a case study on the closely related field of survey activities in the South China Sea.

1.4 Research Scope and Terminology

UMVs is the umbrella term for all unmanned vehicles, including USVs, UUVs and UAVs. These vehicles operate remotely, unmanned, semi-autonomously, or autonomously. UAVs are a component of Unmanned Aerial Systems (UAS), a term that refers to the entire system required for the operation of an UAVs, including the 'aircraft, ground control station, and communications system. UAVs can either require a human pilot on the ground, or be fully autonomous without the need for a human operator.'[17] In other words, UAV refers only to the aircraft in the air, while UAS refers to the entire system. In the context of this dissertation, focus will be laid on UAVs, as the legal questions surrounding the ground control system for instance, lie beyond the scope of research.

The research scope is limited to the use of UAVs in MSR, with such research being carried out subject to coastal State consent in the EEZ being the main source of legal tension.

1.5 Research Methodology

The research method adopted for this thesis is doctrinal research. This dissertation will rely on legal analysis of the LOSC by means of the interpretative methodology provided for in Articles 31 and 32 of the Vienna Convention on the Law of Treaties (VCLT). This doctrinal approach is further supported by international jurisprudence, as well as secondary sources such as

[17] 'The Differences Between UAV, UAS, and Autonomous Drones - Percepto' <https://percepto.co/what-are-the-differences-between-uav-uas-and-autonomous-drones/> accessed 3 June 2022.

reports, law journals and books. In order to provide context and relevance of this dissertation, Chapter 2 relies on technological inputs surrounding UAVs.

1.6 Outline

This first Chapter I introduces the subject and poses the research question, outlines the research objective, delineates the research scope, and describes the research methodology. Chapter II delves into the technological components of UAVs, including what novelty they bring to the field of MSR. Chapter III sets out how MSR is regulated in the LOSC, how they challenge the traditional legal frameworks, and the extent to which these provisions accommodate for UAVs. Chapter IV presents a case study on the legal fragmentation which arises as a result of differing perspectives of the USA and China regarding a possible distinction between MSR and survey activities, in order to demonstrate the result of leaving an activity such as UAV-conducted MSR unregulated at an international level. Chapter V summarizes and concludes on the findings of this thesis and provides three pragmatic steps forward. The Annex lists the resources referenced by the research, information on USVs and UUVs, as well as graphics.

Chapter II: The Use of Unmanned Aerial Vehicles in MSR

2.1 Introduction

UAVs vary greatly in size, functionalities, and levels of autonomy, making their classification challenging but not impossible for the purpose of regulating their use under the LOSC. They have a wide application spectrum and dual use capabilities, particularly relevant in the distinction between MSR and survey activities in the EEZ. This chapter will set out the technological aspects of UAVs.[18] A better understanding of what constitutes these vehicles will facilitate the legal analysis undertaken in Chapter 3.

2.2 Classification of Unmanned Aerial Vehicles

There is no universally accepted definition of an UAV. Instead, UAVs may be classified on the basis of different criteria, including their weight, their range, their degree of autonomy, their wing type, and their altitude. Arjomandi *et al*. class UAVs according to their flight range, and altitude.[19] Yang *et al*. distinguish *inter alia* between seaplane UAVs and submarine-launched UAVs, thus further extending the classification of UAVs.[20] For the purposes of this dissertation, the widely adopted classification of the Department of Defense (DoD) of the USA will be utilized, which distinguishes between the following classes:

Micro/nano-UAVs range in size between 30-50 cm.[21] Typically insect-like, these UAVs have flapping or rotary wings, are very light, and capable of landing on small surfaces, including their parent ship. Prominent examples are the Elbit Systems designed MAGNI, a vehicle-launched multi-rotor micro-UAV weighing 2.5kg and capable of carrying 350 gr of payloads,[22] as well as the AVT Australia launched CM62 Micro Gimbal, a 260 gr UAV capable of conducting high performance ISR surveys.[23]

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[18] Refer to Annex for technological aspects of USVs and UUVs for a broader understanding.
[19] Xingbang Yang and Xuan Pei, '15 - Hybrid System for Powering Unmanned Aerial Vehicles: Demonstration and Study Cases' in Massimiliano Lo Faro, Orazio Barbera and Giosué Giacoppo (eds), *Hybrid Technologies for Power Generation* (Academic Press 2022) 439–473 <https://www.sciencedirect.com/science/article/pii/B9780128237939000140> accessed 29 June 2022.
[20] ibid.
[21] 'Classification of the Unmanned Aerial Systems | GEOG 892: Unmanned Aerial Systems' <https://www.e-education.psu.edu/geog892/node/5> accessed 3 June 2022.
[22] 'Elbit Systems Introduces MAGNI, a Vehicle-Launched Multi-Rotor Micro-Drone' (*Elbit Systems*) <https://elbitsystems.com/pr-new/elbit-systems-introduces-magni-a-vehicle-launched-multi-rotor-micro-drone/> accessed 19 August 2022.
[23] Charbel Kadib, 'AVT Australia Launches New ISR Technology - Defence Connect' (*Defence Connect*, 1 June 2021) <https://www.defenceconnect.com.au/intel-cyber/8133-avt-australia-launches-new-isr-technology> accessed 19 August 2022.

Small/mini-UAVs range anywhere between 50 cm and two meters.[24] They are manually launched and feature fixed wings, though some also have a rotary-wing design. Examples include the RQ-11 Raven with a wingspan of 1.4m,[25] and the Turkish Bayraktar.[26]

Medium UAVs usually have a wingspan between five and ten meters and are capable of bearing payloads ranging between 100 to 200 kg.[27] Examples include the General Atomics Aeronautical Systems developed MQ-1C Gray Eagle – an extended range multipurpose UAV,[28] and the UK Watchkeeper with an endurance of 14 hours.[29]

Large UAVs are mainly used in military operations and include for example the MQ-9 Reaper with a wingspan of 20.1 m, a payload of 1,746 kg, and a top speed of 444 km/h.[30]

2.3 Automation vs. Autonomy of Unmanned Aerial Vehicles

At first instance, an important distinction must be made between UAV automation and UAV autonomy. UAV automation refers to a situation in which a UAV operator determines a flight path on the basis of beacons, waypoints, and geofencing for example. 'The [UAV] then flies automatically using an array of sensors, timers, motors, and other electrical components.'[31]

UAV autonomy on the other hand, allows a UAV to make certain decisions independently of human input. 'This is possible through [artificial intelligence] systems that gather data from sensors, satellites, cameras, and videos and then use that data to make decisions. The [UAV's] decision-making process [is not] confined to an algorithm. Instead, an autonomous UAV can learn from its environment and adapt to changing situations.'[32]

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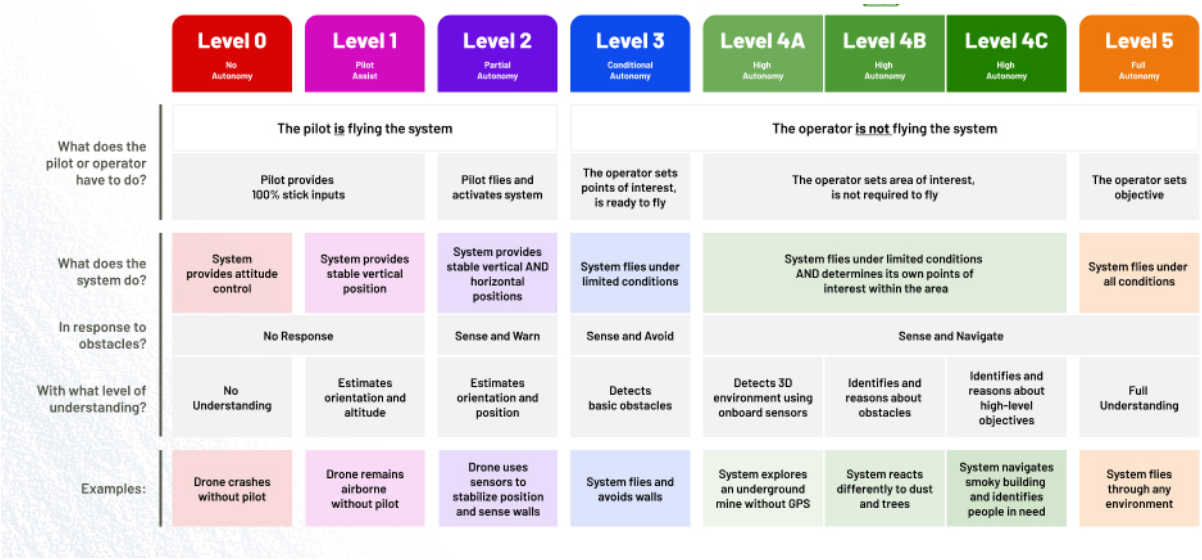
[24] 'Classification of the Unmanned Aerial Systems | GEOG 892: Unmanned Aerial Systems' (n 20).
[25] 'RQ-11 Raven Unmanned Aerial Vehicle' (*Army Technology*, 22 July 2021) <https://www.army-technology.com/projects/rq-11-raven/> accessed 20 August 2022.
[26] 'Bayraktar TB2' (*Baykar*) <http://www.baykartech.com/en/uav/bayraktar-tb2/> accessed 20 August 2022.
[27] 'Classification of the Unmanned Aerial Systems | GEOG 892: Unmanned Aerial Systems' (n 20).
[28] Jacob Luiz, 'US Army Retires Northrop Grumman's MQ-5B Hunter UAV, Replaces It with General Atomics' MQ-1C Gray Eagle | ASAP Aerospace Blog' (*ASAP Aerospace*, 17 July 2015) <https://www.asap-aerospace.com/blog/us-army-retires-northrop-grumman%E2%80%99s-mq-5b-hunter-uav,-replaces-it-with-general-atomics%E2%80%99-mq-1c-gray-eagle/> accessed 20 August 2022.
[29] 'Watchkeeper' (*Thales*) <https://www.thalesgroup.com/en/countries/europe/united-kingdom/markets-we-operate/defence/air-systems-uk/isr-air/watchkeeper> accessed 27 August 2022.
[30] 'MQ-1/MQ-9 Predator/Reaper' (*AeroWeb*) <http://www.facebook.com/AW.MQ1.MQ9/> accessed 20 August 2022.
[31] 'Breaking Down The Levels of Drone Autonomy' <https://blog.cloudfactory.com/levels-of-drone-autonomy> accessed 3 June 2022.
[32] ibid.

There is no authoritative description of the degrees of autonomy of UAVs, but several actors have ventured their own definitions which largely resemble each other.[33] While not authoritative, these definitions nonetheless provide a helpful overview of the nature of the UAVs. For the purposes of this dissertation, the information on the degrees of autonomy stems from a blend of research conducted by DroneAnalyst,[34] and Exyn Technologies which pioneers autonomous aerial robot systems, particularly for GPS-denied environments i.e., environments where, due to the terrain or location, GPS receivers do not function.[35] Currently, UAVs ranging in levels 0 to 4 (see below) are used to conduct MSR. It is especially the more sophisticated level 3 and 4 UAVs, capable of carrying out MSR but also ISR activities that are particularly contentious. Level 5 UAVs have not yet reached the market, however, once they do, they will amplify the legal questions already being raised by level 3 and 4 UAVs.



UAV and 'drone' are to be understood as being synonymous in this context. Source: Exyn Technologies[36]

[33] ibid; 'Breaking Down the Drone Autonomy Hype' (*Drone Analyst*, 21 October 2020) <https://droneanalyst.com/2020/10/21/breaking-down-the-drone-autonomy-hype/'> accessed 3 June 2022; Exyn Technologies, 'Exyn Drones Achieve Autonomy Level 4' <https://www.exyn.com/news/exyn-drones-achieve-autonomy-level-4> accessed 3 June 2022.
[34] 'Drone Analyst - Drone Industry Research and Insights' <https://droneanalyst.com/> accessed 30 June 2022.
[35] Exyn Technologies, 'Company | Exyn Technologies' <https://www.exyn.com/about/company> accessed 30 June 2022.
[36] Technologies (n 32).

Level 0

UAVs at this level require an operator for the entire duration of their flight and are unable to identify or respond to obstacles in their flightpath.[37]

Level 1

Level 1 UAVs have low autonomy, allowing them take into account spatial limitations of their environment, such as walls or ceilings. They are capable of staying airborne without an operator but must remain in the operator's visual line of sight (VLOS).[38]

Level 2

Level 2 UAVs enjoy partial autonomy, although the operator remains in control and the UAV operates in his VLOS. This class of UAV uses a combination of sensors, accelerometers, and GPS systems in order to fly, detect obstacles, and warn the operator of these, though it is unable to avoid them, or navigate independently.[39]

Level 3

UAVs on this level are deemed to have conditional autonomy. The operator is no longer flying the UAV but remains onsite in case of an emergency. These UAVs will feature detect and avoid systems which function on the basis of radio and frequency sensors, in order to avoid collisions with obstacles in their flight path. Level 3 UAVs are capable of landing autonomously.

Level 4

Level 4 UAVs operate on an advanced detect and avoid system without interference by an operator. 'They can freely explore GPS-free and GPS-denied environments, navigate harsh conditions, and identify people in need without needing a pilot on-site, as pilots can monitor level 4 [UAVs] remotely.'[40]

An excellent example of a level 4 UAV is the Exyn Drone[41] capable of exploring complex spaces independently of an operator. It is able to generate maps on its surroundings while

[37] 'Breaking Down The Levels of Drone Autonomy' (n 30).
[38] ibid.
[39] ibid.
[40] ibid.
[41] Technologies (n 32).

tracking its own movement through the environment, rendering it self-reliant.[42] In April 2021, Exyn achieved level 4A autonomy which 'it considers the highest level of aerial autonomy reached within the industry. The key to the achievement is that Exyn drones are immune to GPS signal loss, meaning all spatial and mapping computations are done onboard.'[43]

Level 5

A level 5 UAV would imply full autonomy. Currently, there are no level 5 UAVs in production due to an insufficient regulatory framework. However, these UAVs would be able to exercise full control over themselves in any circumstance without the need for operator intervention – essentially comparable to a UAV operating on an external system.[44]

2.4 Use of Unmanned Aerial Vehicles in MSR

UAVs are capable of providing a synoptic view of large areas, much in the same way as satellites have in the past. While UAVs have not replaced satellites, this technology has significantly supplemented satellite-based data collection. UAVs are characterized by greater precision – as fine as 1 cm in comparison to a satellite with a typical resolution of 30 m x 30 m,[45] flexibility of tasking, low altitude flights depending on the needs of the mission, as well as low airspeed in order to capture and characterize a wide variety of geophysical phenomena.[46] UAVs may, in addition, be flown in dangerous conditions or inaccessible terrain, such as over open water and melting sea ice, or into thunderstorms and tornadoes. Researchers at the Norwegian Institute for Water Research (NIVA) consider UAVs to be the future for nature mapping and monitoring.[47]

A revolutionary component of UAVs is the modular design of their base payload. Payloads refer to the packages that the UAV's platform is capable of carrying, and which is used to

[42] 'Breaking Down The Levels of Drone Autonomy' (n 30).
[43] Rebecca Bellan, 'Exyn Technologies' Drones Achieve Autonomy Milestone with on-Board Mapping' (*TechCrunch*, 27 April 2021) <https://social.techcrunch.com/2021/04/27/exyn-technologies-achieves-highest-level-of-aerial-autonomy/> accessed 20 August 2022.
[44] 'Breaking Down The Levels of Drone Autonomy' (n 30).
[45] 'Researchers Use Drones to Photograph Seaweeds' (*NIVA*) <https://www.niva.no/en/news/researchers-use-drones-to-photograph-seaweeds> accessed 26 June 2022.
[46] Christopher J Zappa and others, 'Using Ship-Deployed High-Endurance Unmanned Aerial Vehicles for the Study of Ocean Surface and Atmospheric Boundary Layer Processes' (2020) 6 Frontiers in Marine Science <https://www.frontiersin.org/article/10.3389/fmars.2019.00777> accessed 3 June 2022.
[47] 'Researchers Use Drones to Photograph Seaweeds' (n 44).

execute the function of the UAV's flight.[48] Accordingly, 'new instruments can be incorporated into new research proposals … [t]hese technological advancements provide the next generation of instrumentation capability for [UAVs]. When deployed from research vessels, [UAVs] will provide a transformational science prism unequaled using 1-D data snapshots from ships or moorings alone.' Newly developed payloads for UAVs include thermal infrared, visible broadband, hyperspectral, and near-infrared hyperspectral high-resolution imaging.[49] In addition, UAVs with the necessary payload are capable of performing 'photogrammetry (measuring objects from pictures) and [structure-from-motion] processing (creating 3D models from multiple images) ... Photogrammetry and structure from motion allow researchers to create maps (orthomosaics) as well as digital surface models from point cloud data, allowing the capture of morphometric measurements of animals in the wild without requiring capture, and to make assessments on the health, weight, and demographics.'[50] The type of UAV chosen is critical to the successful execution of the scientific mission. In the field of MSR, the most common modern type of UAV is a multirotor vehicle, featuring between four and eight motors and rotors.[51]

It is generally understood that the 'use of [UAVs] is a major step toward more effective and efficient operational monitoring and management of natural resources … UAVs offer scientists new opportunities for scale-appropriate measurement of ecological phenomena, delivering fine spatial resolution data'.[52] Additionally, UAVs are significantly less invasive to the subject of study.[53] Beyond the adaptability of the UAVs, these systems in general, particularly the UAVs

[48] Vincent Raoult and others, 'Operational Protocols for the Use of Drones in Marine Animal Research' (2020) 4 MDPI 64, 3.
[49] Zappa and others (n 45).
[50] Raoult and others (n 47) 3.
[51] ibid.
[52] Karen Anderson and Kevin J Gaston, 'Lightweight Unmanned Aerial Vehicles Will Revolutionize Spatial Ecology' (2013) 11 Frontiers in Ecology and the Environment 138, 138–146.
[53] Javier Oña Palomino Lauren Goodman and Angela, 'How Drones Are Improving Marine Science Research in Ecuador' (*latinamericanscience*, 2 January 2020) <http://latinamericanscience.org/drones-ecuador-marine-science> accessed 3 June 2022. A specific field of future UAV application in MSR is fisheries management. Interestingly, although fishes are found in abundance in the ocean, there are virtually no studies relying on UAVs to study these organisms, or to manage fisheries. (Raoult and others (n 57) 25) Instead, 'UAVs are currently aspirational or experimental devices … but have the attention of policy-makers, environmentalists and researchers alike for combatting [Illegal, Unreported and Unregulated] fishing both near and off-shore.'(Hilde M Toonen and Simon R Bush, 'The Digital Frontiers of Fisheries Governance: Fish Attraction Devices, Drones and Satellites' (2020) 22 Journal of Environmental Policy and Planning 125) It has been suggested that the use of UAVs for fisheries studies and management is an area of research that could be vastly expanded. (Raoult and others (n 69) 25) 'Aspects of social interactions and movement could be examined as they have been in sharks … This may include non-destructive fisheries stock assessment techniques for schooling species potentially visible from the surface or document migrations such as those from anadromous fish where water clarity allows.' (Ibid) The viability of this field of potential research is strengthened by the existing use of UAVs to study *inter alia* jelly

capable of performing a vertical takeoff and landing (VTOL), benefit from a reduced operation footprint, portability, lower initial cost as there is no launch and recovery infrastructure to be built and reduced operational costs.[54] An example of such non-invasive marine scientific research conducted by means of UAVs is the Shark UAV Project, launched in 2018. The main purpose of UAVs deployment was to track the high concentration of juvenile sharks in order to identify their nursery areas. This research was conducted by a Phantom Pro 4 UAV, likely classed as a micro-UAV given its 35cm diagonal wing-wing size, which was launched from a small fisher boat.[55]

Despite the advantages UAVs present to the field of MSR, they also carry certain risks. Though beyond the scope of this dissertation, it is worth noting that an argument has been made that UMVs in general may pose security risks that are so substantial to the coastal State, it might preclude them from the regime of innocent passage through the territorial sea as their operation in that maritime zone would be prejudicial *inter alia* to the security of the coastal State pursuant to Article 19 LOSC. The coastal State is permitted in line with Article 25(3) to temporarily suspend such technologies' right to innocent passage in specified areas of the territorial sea, on the condition that such suspension is essential for the protection of the coastal State's security. This is however not relevant to this thesis, as MSR may not be conducted in the territorial sea during innocent passage.

As MSR becomes increasingly important, in part due to its economic potential but also due to the wealth of scientific knowledge it promises, the technological means to conduct such MSR are rapidly developing. This extends to UAVs as demonstrated above, which are becoming more autonomous, capable of conducting an ever-growing host of activities. A more relevant threat, in the context of this thesis is therefore posed by the multiple functions UAVs may serve, principal amongst them being MSR and survey activities, particularly because the

fish, negating the argument that it is the lacking visibility of the fishes that render their study difficult. (Ibid) UAVs are increasingly being used as surveillance tools in order to monitor and control illegal, unregulated and reported fishing, including by States such as Belize, Palau, the USA, and Australia, though whether their use in court will be upheld remains questionable. ('The Use of Drones for Tackling Illegal Fishing' <http://thefishsite.com/articles/the-use-of-drones-for-tackling-illegal-fishing> accessed 30 June 2022.) In terms of fisheries management, both for stock health for example, as well as for MSR studies, the use of UAVs constitutes an interesting, yet so far commercially untapped future field worthy of exploration, particularly in light of recent technological developments in terms of payloads.

[54] Zappa and others (n 45).

[55] Palomino (n 52).

vehicles used to conduct these activities are similar, if not indeed the same.[56] Especially ISR surveys which fall under military surveys, and may divulge tactical information in order to carry out amphibious attacks on a coast for example – thereby raising legitimate State security concerns, may be carried out by UAVs as close as 12nm to the shore, where the EEZ begins.[57] Beyond ISR surveys, UAVs may also collect information which is of direct significance for the exploration and exploitation of natural resources, both living and non-living, which according to Article 246(5)(a) would be a grounds on which the coastal State may withhold its consent for MSR projects in its EEZ. Coastal States may therefore harbor legitimate concern that foreign States may be undertaking disguised activities in their waters, thereby monopolizing, or abusing the information acquired.[58] Were the LOSC and its Part 13 found to be inapplicable, such information which has financial gain implications otherwise to the benefit of the coastal State, may be withheld from the coastal State and exploited instead by the flag State.

In the territorial sea, the coastal State exercises sovereignty over the maritime zone, subject to qualifying rights such as innocent passage. The EEZ however, is a *sui generis* zone, where there is no such presumption. Instead 'freedom of navigation applies and is limited only to the extent that coastal States have been granted jurisdiction over specified matters.'[59] Given the increasingly blurred distinction between MSR and survey activities, the limited extent of the jurisdictional power the coastal State exercises in the EEZ, and the legitimate concern coastal States harbor regarding an abuse of collected information[60], it is thus important that UAV-conducted MSR may be covered by Part 13 of the LOSC. In terms of legal uniformity, the consequence of finding UAV-conducted MSR not covered by the LOSC is that there is no international instrument to regulate this specific activity. As will be demonstrated, while the Chicago Convention exists to regulate the rules of the air, there is no specific regulation of MSR by aircraft. Domestic law then remains, which however, as set out briefly in the introduction and explored further in Chapter 4, is already at odds between States as for example in the South China Sea due to a preliminary disagreement over whether the activities in the

[56] Minchul Kim, 'Cutting the Gordian Knot: Is an Effective Cooperation Regime for Marine Scientific Research in Northeast Asia Feasible?' (2021) 9 The Korean Journal of International and Comparative Law 243, 251.
[57] Daniel J O'Donohue, 'Amphibious Operations' (Joint Chiefs of Staff) 3–02 II–9 <https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp3_02.pdf>.
[58] Kim (n 55) 251.
[59] Henrik Ringbom, 'Legalizing Autonomous Ships' (2020) 34 Ocean Yearbook Online 429, 447.
[60] Kim (n 55) 251.

region constitute MSR or surveying. It is therefore of importance for the coastal State to be able to authorize and regulate this activity pursuant to the LOSC.

2.5 Conclusion

The technological overview of UAVs presented in this chapter aims to facilitate a better understanding of what these vehicles may look like, how they operate, and what advantages and challenges they bring to the field of MSR. This is particularly important moving into Chapter 3 which endeavors *inter alia* to demonstrate how MSR is regulated in the LOSC, with a specific focus on the different maritime zones, as the location of the vehicle conducting MSR has implications for the extent of the coastal State's rights.

Chapter III: The Legal Framework Governing Unmanned Aerial Vehicle-Conducted MSR

3.1 Introduction

The legal framework governing UAV-conducted MSR is ambiguous. It is disputed by some scholars whether UAVs qualify as vessels in the sense of the term used by the LOSC. Furthermore, legal regulation of UAV-conducted MSR could fall under the LOSC, either under the right of overflight stipulated in Article 87, or under the MSR regime contained in Part 13, by means of Article 240 or 246 for example. It could also fall under the Chicago Convention, which, as will be demonstrated below, has been extended by the ICAO to include UAVs. Finally, it may also be regulated domestically. The consequence of finding UAVs not covered by the LOSC's MSR-regime, but only by the right of overflight, or not at all, is that this specific activity may fall outside the scope of coastal State jurisdiction to authorize and regulate. If UAVs are also, or instead, covered by the Chicago Convention, the specific activity of MSR still remains unregulated, as the Chicago Convention has no provisions relating to it. It therefore is unclear how, or by whom, this activity is regulated. The potential consequences of leaving UAV-conducted MSR unregulated at an international level will be demonstrated by means of a case study in Chapter 4 on the closely related field of survey activities, particularly ISR surveys, and the opposing views adopted by the USA and China in the South China Sea. It is worth highlighting already at this point, that while legal fragmentation caused by a lacking international instrument and varying degrees of domestic regulation may not inherently pose an issue and may sometimes even be desired, it could become problematic in the case of UAVs conducting MSR in the EEZ of coastal States, up to 12nm from the coast. This stems specifically from the aforementioned economic potential of the research, its importance to coastal State security, but also from the technological advancements that cause the distinction between MSR and ISR surveys to increasingly bleed together. It is therefore critical to establish whether UAV-conducted MSR in the EEZ may be subsumed by Part 13 of the LOSC. As this chapter will seek to demonstrate, one possible way of finding UAV-conducted MSR subsumed by the LOSC's MSR regime, is through evolutionary interpretation.

This chapter first, sets out the regulation of MSR in the LOSC. Second, the chapter assesses to what extent the use of UAVs to conduct MSR challenges this traditional legal framework. Third, it is determined whether, and how, the LOSC may accommodate UAVs despite the

challenge they pose, and more specifically how they may be subsumed by the MSR regime in Part 13 of the LOSC.

3.2 Legal Status of Unmanned Aerial Vehicles Under the LOSC

The question whether UAVs are vessels in the understanding of the LOSC is yet to be explicitly raised in academic discussion – thus far, the legal debate has mainly revolved around the legal status of USVs and UUVs. Given that UAVs fall into the same category of UMVs, the debate surrounding the question whether USVs and UUVs may be classed as vessels, thereby falling within the scope of the LOSC, is of direct relevance for UAVs by means of analogy, and therefore briefly captured in the following.

Under the Convention, neither the term 'ship' nor the term 'vessel' is defined; both are used interchangeably. Article 91 LOSC holds that each State shall fix the conditions for the grant of its nationality to ships, implying that a ship is defined under national law. International Conventions do not make reference to a crew when defining a ship, nor does national law wed the definition of a ship with a crew.[61] Scholars including Van Logchem have determined that arguments against UMVs constituting vessels in the understanding of the LOSC – though the focus here is specifically on autonomous *cargo* vessels – stem *inter alia* precisely from this lack of definition, and the implication that treaty drafters accordingly saw no need for such a definition as the object for which they were drafting the Convention for were clearly manned vessels.[62] This argument is supported by the fact that 'several provisions can be identified that are tailored to be applied to where a vessel is manned by a master, officers and crew' and that thus, 'certain provisions in the LOSC will lose their relevance, either partly or in full.'[63] Other scholars, such as Hooydonk and Kraska however, are of the opinion that USVs and UUVs are indeed vessels in the understanding of the LOSC, and accordingly covered by the Convention and by the MSR regime.[64] This belief builds on the understanding that the LOSC must keep pace with technological developments in order to maintain its relevance.[65] Hooydonk writes 'it

[61] Henrik Ringbom and Robert Veal, 'Unmanned Ships and the International Regulatory Framework' (2017) 23 Journal of International Maritime Law 100; James Kraska, 'The Law of Unmanned Naval Systems in War and Peace' (2010) 5 Journal of Ocean Technology 28.
[62] Barış Soyer and Andrew Tettenborn (eds), *Artificial Intelligence and Autonomous Shipping: Developing the International Legal Framework* (Hart Publishing, an imprint of Bloomsbury Publishing 2021) ch International Law of the Sea and Autonomous Cargo 'Vessels' 68.
[63] ibid.
[64] Eric Van Hooydonk, 'The Law of Unmanned Merchant Shipping – an Exploration' 20 The Journal of International Maritime Law 403.
[65] Kraska (n 60) 50–52.

may be concluded with a considerable degree of certainty that having a crew on board … is not generally regarded as an essential part of the notion of a ship' and further, that most commentators, including James Kraska, 'undoubtedly rightly assume that for the purposes of the law of the sea unmanned vessels must be regarded as ships. The rules of the LOSC … thus also apply to the operation of unmanned ships.'[66]

The legal discourse set out above illustrates that in the opinion of eminent scholars, UMVs in general should be subsumed by the LOSC in much the same way as manned vehicles are,[67] thereby *implicitly* including UAVs. Even if it is determined that the legal nature of UAVs is not equivalent to that of a 'ship' or 'vessel' in the understanding of the LOSC, the Convention nevertheless applies to UAVs, regardless of the fact that they are unmanned, by virtue of them being aircraft, which are thus subsumed in any case by the right of overflight provided for in Article 87(1)(b) for instance. This point is further explored in Part 3.4.

3.3 MSR as Regulated in the LOSC

MSR is comprehensively regulated in Part 13 of the LOSC, titled 'Marine Scientific Research', though the Convention does not provide a definition of what constitutes MSR. Scholars tend to define MSR as 'any form of scientific investigation, fundamental or applied, concerned with the marine environment, i.e., that has the marine environment as its object.'[68] MSR therefore includes physical oceanography, marine chemistry and biology, scientific ocean drilling and coring, and geological and geophysical research.[69]

The right to conduct MSR is supplemented by general principles held in Articles 240 and 241 – contained in Part 13, applicable to all maritime zones. Accordingly, MSR must be conducted exclusively for peaceful purposes, with appropriate scientific methods, it may not unjustifiably interfere with other legitimate uses of the sea and must be conducted in compliance with regulations adopted in line with the LOSC. Research conducted for military objectives is not in principle prohibited, though the general prohibition on the use of force except for self-defense, and where authorized by the UN Security Council, continues to apply.[70]

[66] Van Hooydonk (n 63) 406.
[67] Soyer and Tettenborn (n 61) 69.
[68] Rothwell and Stephens (n 10) 347.
[69] ibid 348.
[70] ibid 352.

3.3.1 Territorial Sea

In the territorial sea, the coastal State enjoys sovereignty over its internal waters, as well as the 12nm measured from its baselines, the airspace, seabed, and subsoil (Article 2(1)(2)). This sovereignty is qualified through the regimes of innocent passage (Article 17), transit passage (Article 38), and archipelagic passage (Article 52), all of which find their origin in the freedom of navigation.[71] Pursuant to Article 24, the coastal State shall not hamper the innocent passage of foreign ships through the territorial sea in fact or in form except in accordance with the Convention.

Article 19(2)(j) stipulates that the innocent passage of a foreign ship shall be considered to be prejudicial to the peace, good order, or security of the coastal State if in the territorial sea it engaged *inter alia* in the carrying out of research or survey activities. The coastal State may then, according to Article 21(1)(g), adopt laws and regulations in respect of MSR and hydrographic surveys, which it may enforce pursuant to Article 25(1). The coastal State would therefore be able to prohibit the carrying out of MSR, although it may not prohibit the use of sonar for depth sounding, the use of radar, or the monitoring of the ocean and wind currents,[72] as these are considered necessary for the normal operation of a vessel.[73]

If a vessel is found to be engaging in passage through the territorial sea that is not innocent, i.e., prejudicial to the peace, good order, or security of the coastal State, on grounds of conducting research activities for example, the coastal State may take the necessary steps in its territorial sea to prevent such passage pursuant to Article 25(1). Necessary measures as understood in the context of this provision include 'an exchange of communications requesting a delinquent ship to refrain from certain acts, a request that the ship leave the territorial sea immediately, the positioning of vessels to prevent the ship from continuing its passage, the intervention of State authorities such as a Coast Guard or Maritime Police in order to board the vessel to direct it away from the territorial sea, or subject to threat posed to the coastal State by the delinquent ship the use of armed force.'[74]

[71] Tufts University, 'Chapter 3: Freedom of Navigation – Law of the Sea' (*Law of the Sea: A Policy Primer*) <https://sites.tufts.edu/lawofthesea/chapter-three/> accessed 12 August 2022.
[72] Rothwell and Stephens (n 10) 354.
[73] Sam Bateman, 'Hydrographic Surveys and Marine Scientific Research: Differences, Overlaps and Implications' University of Wollongong 31, 6.
[74] Rothwell and Stephens (n 10) 233.

Article 245 holds that coastal States have the exclusive right to regulate, authorize, and conduct MSR in their territorial sea, which may therefore only be conducted with the express consent of the coastal State.

Accordingly, coastal States have sovereignty in their territorial sea, including relating to MSR. This sovereignty may be enforced through Article 25, granting the coastal State the opportunity to both closely monitor activities in this maritime zone, as well as expel those vessels it deems to be conducting research or survey activities.

Article 17 extends the right of innocent passage to *ships* of all States, thus excluding aircraft such as UAVs. Article 18(1)(a) clarifies that passage means 'traversing [the territorial sea] without entering internal waters or calling at a roadstead or port facility outside internal waters', and Article 19(2) sets out which passage by a foreign *ship* is considered to be prejudicial to the peace, good order, or security of the coastal State. Article 20 governs submarines and other underwater vehicles, requiring that these vehicles navigate on the surface and show their flag. Article 25, as set out above, contains the rights of protection of the coastal State, granting it permission to take the necessary steps in its territorial sea to *inter alia* request that vessels leave this maritime zone.

In the territorial sea, coastal States enjoy sovereignty over the airspace. The Chicago Convention stipulates in Article 1, that every State has complete and exclusive sovereignty over the airspace above its territory. The ICAO Secretariat has found that Article 2 of the LOSC – on the legal status of the territorial sea, of the air space over the territorial sea and of its bed and subsoil – is 'fully co-extensive and compatible' with the Chicago Convention.[75] Accordingly, domestic rules governing aircraft apply to this maritime zone, and coastal States have the authority to request aircraft including UAVs to leave the airspace above the territorial sea.

3.3.2 Straits and archipelagic waters

Decisive in the development of the regime of straits and archipelagic waters was the establishment of the 12nm territorial sea, as well as the entitlement of archipelagic States to

[75] 'Airspace above the Territorial Sea' (National Oceanic and Atmospheric Administration 2018) <https://www.gc.noaa.gov/pdfs/Airspace%20above%20the%20Territorial%20Sea%2010-16-18.pdf>.

enclose waters by means of an archipelagic baseline.[76] The former was important because it opened the possibility of enclosing straits of 24nm or less within two overlapping territorial seas. Major maritime powers such as the UK and Italy strongly asserted that 'there was a need for a distinctive regime dealing with international straits, and that the ongoing application of an innocent passage regime … would not have been adequate.'[77] The latter raised important questions concerning passage through waters that were previously considered international straits, but now constituted internal waters.

All ships, including submarine vehicles, enjoy transit passage in straits used for international navigation between one part of the high seas and an EEZ and another part of the high seas and an EEZ pursuant to Article 38 LOSC. Article 39 contains duties of ships and aircraft in transit passage, though these are significantly less extensive than those set out in the innocent passage regime. Further, Part III on transit passage is a balancing act between the free and unimpeded right of ships and aircraft, and the security concerns of strait States.

In general, transit passage grants ships and aircraft more extensive rights than the innocent passage regime does, evidenced *inter alia* by Article 44 which stipulates that transit passage may not be suspended, strait States may not hamper transit passage, and strait States must give appropriate notification of any dangers to navigation or overflight. However, as in the territorial sea, Article 40 stipulates that during transit passage, foreign ships may not carry out MSR or survey activities without the prior authorization of the States bordering the strait. Article 54 renders articles 39, 40, 42, and 44 applicable to archipelagic sea lane passage.

An important distinction to the innocent passage regime in the territorial sea, is that in international straits and archipelagic sea lane passage, aircraft also enjoy the right to transit passage pursuant to Article 38. Interestingly, Article 40 which prohibits the carrying out of MSR without prior authorization, restricts itself to 'foreign ships', without making mention of aircraft specifically. This raises a question whether it was not considered possible to conduct MSR from the air at the time of the Convention's drafting, or whether it was perhaps not the intention of the treaty drafters to include this means of technology to carry out MSR. This question is further explored in Part 3.4 below.

[76] Rothwell and Stephens (n 10) 288.
[77] ibid 249.

The duties of ships and aircraft during transit passage are extensively set out in Article 39 and include pursuant to Article 39(1)(c) the duty to refrain from 'any activities other than those incident to their normal modes of continuous and expeditious transit unless rendered necessary by force majeure or by distress,' strengthening the prior authorization requirement to conduct MSR or survey activities, as these must be explicitly permitted by the coastal State. Accordingly, in this maritime zone, neither MSR nor the freedom of overflight (if it is established that UAVs do not in fact fall under the LOSC MSR regime) solely for the purpose of continuous and expeditious transit may be exercised freely without coastal State overview. The level of enforcement power of the strait State against a delinquent ship is not clear in the LOSC, however a presumption of coastal State power persists in international straits, as it does in the territorial sea. Most applicable to this dissertation, if a vessel or aircraft is found to be in breach of its duty to refrain from any activities other than those incident to their normal modes of continuous and expeditious transit as set out in Article 39(1)(c), which would be the case if the vessel or aircraft engages in MSR without prior consent, the strait State retains its right to self-defense under international law, as well as the 'capacity, consistent with the LOSC, to prohibit passage by a ship or aircraft.'[78] However, the strait State may not hamper or impair legitimate transit passage pursuant to Article 44.

3.3.3 EEZ and Continental Shelf

The EEZ is by comparison to the territorial sea a more recent invention, which serves to grant coastal States sovereign rights to explore, exploit, conserve, and manage the living and non-living resources of the water column, the seabed, and its subsoil up to 200nm from the territorial sea. This maritime zone also serves to prevent a 'tragedy of the commons' scenario due to the unregulated exploitation of marine living resources.[79] An important distinction to note between the EEZ and the territorial sea is that unlike the territorial sea, in the EEZ, the coastal State does not have *ipso jure* entitlement to sovereignty. At the same time however, it is also not a maritime zone in which other States have unfettered freedoms as they do on the high seas for example. Rather, it is an 'amalgam, or 'multifunctional' zone, in which coastal States enjoy sovereign rights in relation to economic resources, and also jurisdiction … for certain other matters'.[80] These 'other matters' include the establishment and use of artificial islands,

[78] ibid 259.
[79] ibid 87.
[80] ibid 88.

installations and structure, MSR, and the protection and preservation of the marine environment pursuant to Article 56(1)(b).

Article 58(1) holds that in the EEZ, all States enjoy the freedom of navigation in the EEZ pursuant to Article 87, and other internationally lawful uses of the sea related to this freedom. This right is qualified by Article 58(3) which stipulates that in the exercise of this right, States shall have due regard to the rights and duties of the coastal State.

Though States have the right to conduct MSR, Article 246(1), which sets out the rules for the conduct of MSR in the EEZ and on the continental shelf, holds that coastal States, in the exercise of their jurisdiction have the exclusive right to regulate, authorize, and conduct MSR in their EEZ and on their continental shelf in accordance with the relevant provisions of the LOSC. The relevant provisions being referenced in this Article refer *inter alia* to Article 56(1)(b)(ii) which contains the jurisdictional rights of coastal States to conduct MSR in their EEZ, as well as Article 58(1) and accordingly Article 87 containing the qualifying freedoms of navigation and overflight, which Article 58(1) references.

Article 246(3) stipulates that the coastal State shall under normal circumstances grant their consent for MSR projects in their EEZ or on their continental shelf. As an exception, Article 246(5)(a) accredits the coastal State the exclusive right to withhold consent for MSR projects of direct significance for the exploration and exploitation of natural resources, whether living or non-living. The qualifying element of 'direct significance' leaves room for clarification, in light of advances in biotechnology which allows 'organisms recovered as part of a 'pure' research program to be the subject of commercial development well after they have been located in, and collected from, the marine environment.'[81] Bioprospecting refers to the search for valuable compounds, genetic materials and native organisms, as well as the extraction and analysis of these for purposes of research and commercial development into products such as pharmaceutical drugs, medical technology, and personal care.[82] It may be argued that on the basis of the process surrounding the actual collection of samples, bioprospecting is pure MSR, and ought to be consented to under normal circumstances by the coastal State.[83] However, it is

[81] ibid 355.
[82] 'Bioprospecting - Antarctic and Southern Ocean Coalition' <https://www.asoc.org/learn/bioprospecting/> accessed 19 July 2022.
[83] Rothwell and Stephens (n 10) 355.

the later steps in the bioprospecting process which involve the commercialization of a discovery that transforms the MSR into applied research of direct significance to the exploitation of a natural resource.[84] Accordingly, MSR with the purpose of later commercialization ought to only advance on the basis of express consent by the coastal State.[85] Article 248(b) obliges States or competent organizations to inform the coastal State of the method and means to be used for MSR in the EEZ or on the continental shelf, including the name, tonnage, type, and class of vessels.

Article 58(1) holds that in the EEZ, in addition to the freedom of navigation, all States enjoy the freedom of overflight pursuant to Article 87, as well as other internationally lawful uses of the sea related to this freedom. As with the freedom of navigation, this right is qualified by Article 58(3) which stipulates that in the exercise of this right, States shall have due regard to the rights and duties of the coastal State. Concerning the right of overflight, the LOSC does not prescribe any specific requirements that ought to be observed by the flag State.[86]

If it is assumed, that MSR may be conducted by UAVs in the airspace above the water column in the EEZ in line with the findings of Proelss,[87] (see Section 3.4) then the provisions regulating MSR in the EEZ apply equally to aircraft and thus UAVs, rendering the activity under the purview of the coastal State consent regime. To this end, Article 248(b) would require of States to inform the coastal State of the name, tonnage, type, and class of UAVs used to conduct MSR. However, if it is established that UAVs are not covered by the LOSC's MSR regime, but instead fall under the Article 87, in conjunction with Article 58, stipulated freedom of overflight and the associated other 'internationally lawful uses' of the sea, UAVs conducting activity from the airspace above the water column would not be subject to the coastal State consent regime.

In the EEZ, the coastal States' enforcement powers are set out in Article 56, divided into sovereign rights and jurisdiction, of which MSR is covered by the latter. Pursuant to paragraph 2 of the provision, the coastal State shall have due regard to the rights and duties of other States

[84] ibid.
[85] Salvatore Arico, Charlotte Salpin, and Institute of Advanced Studies, *Bioprospecting of Genetic Resources in the Deep Seabed: Scientific, Legal and Policy Aspects* (United Nations University Institute of Advanced Studies 2005) 33–34 <http://www.ias.unu.edu/binaries2/DeepSeabed.pdf> accessed 19 July 2022.
[86] Alexander Proelss and others (eds), *United Nations Convention on the Law of the Sea: A Commentary* (CH Beck; Hart; Nomos 2017) 451.
[87] ibid 1658.

and shall act in a manner compatible with the LOSC. Therefore, unlike in the territorial sea for instance, 'coastal States do not have plenary regulatory and enforcement powers in the EEZ … subject … to the possible exercise of unattributed rights under Article 59'[88] which sets out the basis for the resolution of conflicts regarding the attribution of rights and jurisdiction in the EEZ. This point was confirmed by the International Tribunal for the Law of the Sea (ITLOS) in the *M/V Saiga (No 2)* case, when it rejected Guinea's attempt of applying its customs laws to the EEZ.[89] The coastal State's jurisdiction regarding MSR in the EEZ is derived from Article 56 read in conjunction with Part 13, specifically Article 246. The latter provision reads in paragraph 1 that coastal States, in the exercise of their jurisdiction, have the right to regulate, authorize, and conduct MSR in their EEZ and on their continental shelf in accordance with the relevant provisions of this Convention. Specific enforcement powers for violations of the MSR regime are not set out in Part 13 of the LOSC. However, in the context of the prevention, reduction, and control of pollution from vessels pursuant to Part 12, the coastal State is entitled, under various conditions, to require the vessel in its EEZ to give information regarding its identity and port of registry, its last and its next port of call and other information (Article 220(3)) or undertake a physical inspection of the vessel (Article 220(5)). Whether these constitute the same enforcement powers for MSR-regime violations pursuant to Part 13 is unclear.

3.3.4 High seas

Article 87(1)(f) as set out above, holds that the high seas are open to all States, granting them freedom to conduct *inter alia* scientific research subject to Part 6 and 8. Article 257 grants all States the right to conduct MSR in the water column beyond the limits of the EEZ. MSR on the high seas is within the purview of States to regulate themselves, though disputes concerning MSR may fall within the scope of Part 15 if the general principles set out in Article 240 are breached.

3.3.5 The Area

MSR carried out in the Area shall be conducted exclusively for peaceful purposes, by the International Seabed Authority (ISA) and State parties pursuant to Article 143(1)(2) and (3), article 257, and Part 11. The ISA is not entitled to regulate MSR in the Area, except where it

[88] Rothwell and Stephens (n 10) 462.
[89] *M/V 'Saiga' (No 2) (Saint Vincent and the Grenadines v Guinea), Judgment* (1999) Reports 1999 (ITLOS).

conducts the MSR itself. 'Research involving the actual prospecting or exploring for mineral resources would be applied research that could only occur with the approval of the ISA, as MSR of this character would constitute 'activities in the Area'.'[90] Pure MSR is excluded from the ISA control.

3.4 Legal Challenges and Ambiguities Surrounding Unmanned Aerial Vehicle-Conducted MSR in the EEZ

In contrast to the territorial sea, where a presumption of coastal State sovereignty exists, the EEZ has no such presumption. This allows room for ambiguity and tension in the interpretation of the LOSC with regard to this maritime zone. Regarding MSR in the EEZ, the LOSC is challenged by UAVs first and foremost by potentially falling under the freedom of overflight and thus more squarely under the Chicago Convention, which stipulates the rules of the air, regarding airspace, the registration of aircraft, safety, and sustainability. The Chicago Convention draws a distinction between the territories of the contracting parties as defined in Article 2 and the high seas. 'Whereas aircraft over the high seas must, according to Article 12, comply with the rules in force established under the Convention by the ICAO, States are entitled to depart from the international standards and recommended practices adopted by that organization if and to the extent to which aircraft are flying over their territories.'[91] Pursuant to the conflict clause in the LOSC contained in Article 311(2), the 'Convention shall not alter the rights and obligation of States Parties which arise from other agreement compatible with this Convention and which do not affect the enjoyment by other States Parties of their rights or the performance of their obligations under this Convention.' Accordingly, the Chicago Convention and the LOSC are compatible, and both may be applicable. UAVs potentially fall under the Chicago Convention due to their nature as aerial vehicles, and the fact that the LOSC was drafted for purposes of regulating the law of the sea, which at the time of the United Nations Conferences on the Law of the Sea (UNCLOS) (1958 – 1982) was drafted primarily for vessels in the traditional understanding – manned, surface ships, evidenced by the scarce number of provisions contained within the LOSC that make reference to aerial or submarine vehicles.

[90] Rothwell and Stephens (n 10) 361.
[91] Proelss and others (n 85) 451.

This argument is further supported by Article 31(1) of the VCLT, according to which a 'treaty shall be interpreted in good faith in accordance with the ordinary meaning to be given to the terms of the treaty in their context and in the light of its object and purpose.' An exhaustive assessment of the treaty drafters' intention lies beyond the scope of this dissertation. Nevertheless, it is worth highlighting that while reference to aircraft is sustained in the LOSC, for example by Articles 38, 53, and 58, these provisions relate primarily to the rights of transit passage, archipelagic sea lane passage, and the rights of aircraft in the EEZ, respectively, next to the rights that are bestowed upon ships, and less to granting aircraft as extensive rights as ships. It is thus questionable whether it was the treaty drafters' intention for the scope of the LOSC's provisions to extend to aircraft in the same manner as ships, and further, whether the, at the time, relatively novel notion of UAVs was to be encompassed in the understanding of aircraft. Although UAVs – in the past perhaps better described as early, radio-controlled systems, began emerging in earnest in the 1930s and 1940s in the military sector, ahead of UNCLOS I (1952), assault military drones, the precursors of present day UAVs, only became a viable means for military objectives in the 1980s, marked by the successful deployment of UAVs by the Israeli Defense Forces (IDF) against Syrian surface-to-air (SAM) missile batteries on June 9th, 1982, during the 1982 Lebanon War.[92] Such military drones have since multiplied in uses, including non-military objectives such as MSR. The Lebanon War coincided with the signing of the LOSC, indicating that UAVs in today's understanding, were potentially not intended to be included, given that they did not exist in such a capacity. Thus, the lack of any mention in the LOSC of UAVs may raise doubts over whether they were meant to be included in the provisions relating to aircraft.

Rothwell, pledging for a static interpretation of the LOSC (i.e., the Convention is interpreted fully in compliance with the circumstances surrounding its conclusion and entry into force), excludes from the LOSC's MSR-regime that research which is undertaken from the air. He finds that 'not encompassed by the LOSC is MSR undertaken outside of the surface, water column, subsoil or seabed in the marine environment.'[93] He justifies this exclusion on the basis of such ex-situ research techniques not being addressed by Part 13 of the Convention, nor them falling within the reach of coastal State jurisdiction.[94] If UAV-conducted MSR is found to be

[92] Haim Yogev, Ronen A Cohen and Eyal Lewin, 'Revolution in Military Affairs - The Operation Mole Cricket 19 as a Case Study for the Technological Race during the Cold War' (2022) 25 International Area Studies Review 138.
[93] Rothwell and Stephens (n 10) 348.
[94] ibid.

excluded from the LOSC, the aerial vehicles would still be covered by the Chicago Convention, though this instrument does not regulate the specific activity of MSR, excluding it from coastal State consent.

The consequence of UAVs challenging the LOSC in this manner, and a finding that UAVs, perhaps covered by the right of overflight in the LOSC, but more adequately regulated by the Chicago Convention given its stipulation of the rules of the air, is that the specific activity of MSR carried out by UAVs would remain unregulated at an international level. This is due to the fact that the right to overflight does not grant the coastal State the same means of intervention or oversight as the right to authorize and regulate MSR does, and further that the Chicago Convention, despite its Article 8 which relates to pilotless aircraft,[95] does not regulate the specific activity of MSR either. The ICAO has issued a non-binding circular in which it extended Articles 3 *bis*[96], 8[97], 12[98], 15[99], 21[100], 29[101], 31[102], and 33[103] to include or apply to UAVs,[104] but it has also held that the '[d]evelopment of the complete regulatory framework for UAS will be a lengthy effort, lasting many years.'[105] Thus, with a broad but unspecified right of overflight held in the LOSC, while lacking a presumption of power by the coastal State in the EEZ, and in lieu of a provision regulating the specific activity of UAV-conducted MSR in an international instrument, UAVs are left to be regulated to differing degrees under domestic law. The result of such an eventuality is explored in Chapter 4.

3.5 Legal Arguments to Accommodate Unmanned Aerial Vehicle-Conducted MSR Under the LOSC

In light of this challenge, and a static, plain reading of the LOSC which does not find the LOSC's MSR-regime explicitly extended to UAVs, the question arises on which basis UAVs may nevertheless be accommodated for under this regime. The importance of establishing that UAVs are covered not only by the LOSC generally, but specifically by the MSR-regime lies

[95] 'No aircraft without a pilot may be flown without a pilot over the territory of a contracting State without special authorization by that State and in accordance with the terms of such authorization'
[96] Prohibition against the use of weapons against civil aircraft
[97] Pilotless aircraft
[98] Rules of the air
[99] Airport and similar charges
[100] Report of registrations
[101] Documents carried in aircraft
[102] Certificates of airworthiness
[103] Recognition of certificates and licenses
[104] 'Unmanned Aircraft Systems: UAS' (International Civil Aviation Organization 2011).
[105] ibid 4.

in the fact that under the MSR regime, the coastal State has the power to grant its consent to any projects being undertaken in its EEZ, whereas if UAVs are not covered by the LOSC, this coastal State authorization power falls away. For the purpose of this dissertation, this analysis will be undertaken specifically with view of the MSR provisions in the LOSC. As the coastal State exercises full sovereignty over its territorial sea, including on the seabed and the airspace pursuant to Article 2(2) LOSC, the analysis will be further cordoned to the EEZ where the coastal State enjoys jurisdiction with regard to MSR pursuant to Article 56(1)(b)(iii), but is generally expected to grant its consent under normal circumstances (Article 246(3)).

One compelling legal basis on which the Convention's MSR-regime might be extended to UAVs is evolutionary interpretation. Mandrioli defines the dynamic or evolutionary approach as a treaty being observed in light of the moment in which it upholds its legal effects, because this approach attributes a meaning to the treaty provisions which could be different from the original one.[106] Vidigal identifies two ideas of what is meant by the term 'evolutionary interpretation'. The first, is that evolutionary interpretation is 'a routine and unavoidable step in the process of applying a normative framework to changing factual circumstances.'[107] The other is that evolutionary interpretation is a 'means for an adjudicator to update, and perhaps revise, the normative framework itself in order to meet what the adjudicator deems to be the demands of the contemporary world.'[108] Vidigal's second idea is problematic in view of the fact that international law knows no precedent doctrine and judges do not create the law. The first idea remains convincing, in line with Mandrioli's definition, allowing evolutionary interpretation in principle to come into question as Boyle finds there is 'no doubt that the [LOSC] need not be interpreted as if it were a static instrument, cast in stone somewhere around 1982. Many of its terms are likely to be inherently evolutionary.'[109] While it is acknowledged that 'over-ambitious attempts to reinterpret or 'cross-fertilize' treaties by reference to … rules of international law are likely to have only limited success'[110] and that evolutionary interpretation may not constitute a revision or rewriting of the legal text, evolutionary interpretation nevertheless facilitates the continued application of an instrument such as the

[106] Daniele Mandrioli, 'The Rise of Autonomous Ships: Towards an Evolutionary Interpretation of the IMO Treaties of Safety of Navigation?' (2022) 124 Il Diritto Maritimo 168.
[107] Geraldo Vidigal, 'Book Review: Hidden Meanings: Evolutionary Interpretation Between Norm Application and Progressive Development' (2021) 24 203, 204.
[108] ibid.
[109] Alan Boyle, 'Further Development Of The Law Of The Sea Convention: Mechanisms For Change' (2005) 54 International and Comparative Law Quarterly 563, 568.
[110] ibid 569.

LOSC to a modern context where the terms in question are in themselves evolutionary. The International Court of Justice (ICJ) has held in the *Aegean Sea Continental Shelf* case that treaty drafters typically employ 'generic term[s] denoting any matters comprised within the concept' such that, with the evolution of the factual element to which a term refers, 'the presumption necessarily arises that its meaning was intended to follow the evolution of the law and to correspond with the meaning attached to the expression by the law in force at any given time'.[111] Further evidence of this evolutionary interpretation can be found in the *Disputes regarding Navigational and Related Rights* case[112] and the *Iron Rhine* arbitration[113]. The Court's approach in the *Aegean Sea Continental Shelf* case 'is based on the view that the concepts and terms in question were by definition evolutionary, not on some broader conception applicable to all treaties.'[114] To this end, and in line with Boyle's finding above, there are several provisions in the LOSC that could give rise to evolutionary interpretation on the basis of the provision itself, or certain wording contained in the provision, potentially being evolutionary. Principal among these provisions is Article 240(b) titled 'general principles for the conduct of marine scientific research', which reads that in the conduct of MSR *inter alia* the following principle shall apply: 'marine scientific research shall be conducted with appropriate scientific methods and *means* compatible with this Convention'. (Emphasis added)

A static, plain reading of Article 240(b) might find the provision too vague to also certainly apply to UAVs. In light of the preceding argumentation on how UAVs challenge the LOSC, 'means' might be interpreted to relate to more traditional technology to conduct MSR, akin to the technological advances of the time in which the Convention was signed. The result would be that UAVs may not be included in the LOSC's MSR-regime. If, however, evolutionary interpretation applies, an interesting discussion arises on what 'means' may entail present day. Means as provided for in Article 240(b) had been specifically set out in the Internal Single Negotiation Text negotiated during UNLCOS III (1973-1982), which included vessels, platforms, floating stations, aircraft, devices, equipment and mobile or fixed installations.[115]

[111] *Aegean Sea Continental Shelf Case (Greece v Turkey)* [1978] ICJ Reports 1978, p 32 (International Court of Justice); Vidigal (n 106).
[112] *Dispute Regarding Navigational and other Related Rights (Costa Rica v Nicaragua)* [2009] ICJ Reports 2009, p 213 (International Court of Justice).
[113] *Iron Rhine Arbitration (Belgium/Netherlands)* [2005] ICGJ 373 (Permanent Court of Arbitration).
[114] Boyle (n 108) 567.
[115] UNLCOS III, Informal Single Negotiating Text (Part III), UN Doc. A/CONF. 62/WP.8/PART III (1975) OR IV, 171, 177

The Revised Single Negotiating Text however no longer contained these specified means.[116] According to Proelss, the 'deletion of specific means of research has been interpreted as reflecting *the intention to leave the provision open to broad interpretation concerning scientific methods and equipment*.'[117] (Emphasis added). Such a broad interpretation is in line with Mandrioli's definition and Vidigal's first idea of evolutionary interpretation, as well as the ICJ's finding in *inter alia* the *Aegean Sea* case. The steady progression of the use of UAVs in MSR would thus indicate that the use of such systems renders UAVs an appropriate mean to conduct MSR in the EEZ pursuant to Article 240(b).[118]

A further provision in the LOSC that may give rise to evolutionary interpretation is Article 246. The provision stipulates in paragraph 1 that coastal States, in the exercise of their jurisdiction, have the right to regulate, authorize and conduct MSR in their EEZ and on their continental shelf in accordance with the relevant provisions of this Convention. In support of an evolutionary approach to interpretation, Proelss takes the view that the phrasing 'in the exclusive economic zone' does not conclusively answer by what means such MSR may be conducted. He finds that the expression 'MSR in the EEZ' refers to the location of the activity, but that '*activities in the superjacent airspace of the EEZ, and not only activities on the surface or in the water column, are covered by the legal regime of the EEZ.'*[119] (Emphasis added) Soons relies on the reference in Article 58(1) to 'overflight *in* the exclusive economic zone, and considers that MSR by aircraft may be regarded as MSR in the EEZ' while excluding from the scope of Article 246 that research which is conducted by satellites as it is not conducted 'in the EEZ''.[120] Thus, both Proelss and Soons find that MSR may be conducted from the superjacent airspace of the EEZ by aircraft. In light of the ICAO extending the Chicago Convention to subsume UAVs, evidenced by its circular, and the term aircraft not being defined in the LOSC, thus not *excluding* UAVs, the provision may be interpreted so broadly as to extend to UAVs. Interestingly, Van Logchem determines that while the possibility exists UMVs do not constitute vessels or ships in the understanding of the LOSC, 'employing autonomous craft to conduct MSR within another coastal State's EEZ would require the latter's

[116] UNCLOS III, Revised Single Negotiating Text (Part III), UN Doc. A/CONF.62/WP.8/REV.1/PART III (1976), OR V, 173, 180-181.
[117] Proelss and others (n 85) 1621.
[118] Raoult and others (n 47).
[119] Proelss and others (n 85) 1658.
[120] ibid; George Humphrey, 'Marine Scientific Research and the Law of the Sea: By Alfred H.A. Soons Kluwer Law and Taxation Publishers, Deventer, the Netherlands, 1982' (1983) 7 Marine Policy 129.

previous consent (Article 246 of the LOSC)' regardless of whether they meet the definition of a vessel.[121]

Finally, attention ought to be drawn to Article 258, which holds that the 'deployment and use of *any* type of scientific research installations or *equipment* in *any* area of the marine environmental shall be subject to the same conditions as are prescribed in this Convention for the conduct of marine scientific research in any such area.' (Emphasis added) The very broad formulation of the provision by means of the phrase 'any … equipment' invites the argument that, in line with Proelss finding on UAV-conducted MSR, UAVs may be covered by this provision.

3.6 Conclusion

This chapter set out how MSR is regulated in the LOSC, with a specific view of establishing the decreasing rights coastal States enjoy in regulating activities the further they are out at sea. Accordingly, while in the territorial sea and in archipelagic waters for example, the coastal State exercises full control in regulating all activities, including MSR, it only reigns over jurisdictional rights in its EEZ to authorize and regulate MSR. It was further illustrated how the right of overflight generally grants the coastal State less detailed enforcement power, and that particularly in the EEZ, it grants the coastal State almost no enforcement power in case of breach of the MSR-regime for example. This is particularly critical in the case of UAVs, which are capable of conducting MSR, but also contested survey activities such as ISR surveys.

It was then assessed that the primary challenge UAVs pose to the LOSC is that they may fall under the Article 87 stipulated right of overflight instead of the Part 13 contained MSR regime, due to their aerial nature. This carries the consequence that the coastal State would not have any authority to regulate or intervene in UAV-conducted MSR activities in its EEZ, and further that the specific activity of MSR would remain unregulated at an international level. Although the Chicago Convention may be found applicable and has been extended by means of a legally non-binding circular to UAVs, this instrument does not contain specific provisions on MSR. Domestic law would remain to regulate MSR, resulting in legal fragmentation, be it positive or negative.

[121] Soyer and Tettenborn (n 61) 66.

Finally, it was established whether and how the LOSC may nevertheless accommodate for UAVs conducting MSR despite the challenge they pose towards this traditional legal framework. To this end, arguments were first presented as to why the LOSC may not accommodate for this technology, in line with a static reading of the Convention, based primarily on the technological advancements at the time of the LOSC's drafting, which did not yet include UAVs as they exist today. This raises the question whether it was the drafters' intention to include this technology in the formulation of the relevant provisions. The counterargument, that the LOSC may accommodate for UAVs, was then presented, which rests on the concept of evolutionary interpretation.

While the approach of evolutionary interpretation has been criticized for its esoteric character,[122] and has in the past been aside in favor of a static interpretation,[123] it is precisely by means of evolutionary interpretation that the LOSC, as a living treaty, is kept alive and relevant in light of technological advancements.[124] The ICJ has acknowledged the 'primary necessity of interpreting an instrument in accordance with the intentions of the parties at the time of its conclusion'[125] *based on the view that the terms are themselves evolutionary*.[126] An *ex poste* reconstruction of the original intention of the parties must be carried out in full compliance of Articles 31-33 of the VCLT. This complex and uncertain process lies beyond the scope of the dissertation. Instead, this chapter sought to illustrate the latter of the ICJ's two points above i.e., that State parties to the LOSC left room for evolutionary interpretation by maintaining generic, evolutionary terms, particularly in Articles 240 and 246, to be developed outside the Convention subject to technological developments – a finding supported by Proelss and Soons.

[122] Vidigal (n 106) 213.
[123] *Islands of Palmas Case* (1928) 2 Reports of International Arbitral Awards (Permanent Court of Arbitration); *Case Concerning Rights of Nationals of the United States of America in Morocco* [1952] ICJ Reports 1952 176 (International Court of Justice); *Case Concerning Kasikili/Sedudu Island* [1999] ICJ Reports 1999 (International Court of Justice).
[124] Kraska (n 60) 50–52.
[125] *Advisory Opinion on the Legal Consequences for States of the Continued Presence of South Africa in Namibia (South West Africa) notwithstanding Security Council Resolution 276* [1971] ICJ Reports 1971 (International Court of Justice).
[126] Boyle (n 108) 567.

Chapter IV: The Case for Including Unmanned Aerial Vehicles in the MSR Regime of the LOSC – A Case Study on the South China Sea

4.1 Introduction

One crucial vulnerability of the MSR regime as it exists in the LOSC is the ambiguous distinction between MSR and similar marine information-gathering activities such as survey activities, due to a lacking definition of MSR. It is important to note that considering the 'advancement of scientific technology and the importance of knowledge on the ocean, it is paramount for States to conduct research or survey activities in a stable manner.'[127] This dissertation does not contest this point, nor that the former activity rightfully falls under coastal State oversight, and the latter under the freedom of navigation. It is instead the danger posed by the similarity, if not indeed identical nature of the vehicles utilized to carry out both MSR and survey activities that renders a finding of UAV-conducted MSR subsumed by Part 13 of the LOSC important.[128] '[R]egardless of their formal categorization and name … many vessels that undertake marine data collection are equipped with technologies and devices capable of conducting MSR. Most hydrographic surveying vessels also have the capability to conduct oceanographic research and may do so routinely as part of their surveys.'[129] This situation is aggravated in light of the rapid pace of technological developments in the field of UMVs, and particularly UAVs, which, with increasing autonomy, are capable of more independently conducting contested activities including hydrographic surveys, but particularly ISR military surveys.[130] This is accompanied by the risk that foreign States conduct disguised activities as close as 12nm to the shore of a coastal State, monopolizing or abusing the acquired information,[131] which due to its economic or State security relevance ought to potentially fall under the MSR regime, but in any case, under coastal State oversight. If UAVs are not covered by the LOSC's MSR regime, this technology may be utilized to carry out a host of contentious activities without possibility for the coastal State to intervene. This is precisely the case in the South China Sea, where the internationally unregulated activity of surveying – both hydrographic and military surveys, which include ISR surveys, raised the question whether this activity constitutes MSR and thus falls under the coastal State consent regime.

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[127] Kim (n 55) 246.
[128] ibid 251.
[129] ibid.
[130] 'Intelligence, Surveillance, Reconnaissance (ISR)' (*Haivision*) <https://www.haivision.com/resources/streaming-video-definitions/isr-intelligence-surveillance-reconnaissance/> accessed 13 July 2022.
[131] Kim (n 55) 251.

At the outset of the analysis presented in this chapter concerning the differing perspectives of the USA and China regarding MSR, it is important to highlight that there is no clear, straightforward answer to the question. Particularly the USA – a non-party State to the LOSC[132] – and China have assumed diametrically opposing positions regarding this question, which has led to varying degrees of political tension between the two States in the last two decades. Coastal States, in the interest of scientific discovery and consequential profit, but also in the interest of State security, will be eager to find ISR activities subsumed by the umbrella term of MSR, such that they may authorize and regulate any such activities in their EEZ pursuant to Article 246 LOSC. The party seeking to carry out survey and ISR activities on the other hand, will want both to be excluded from the MSR regime in order to avoid an incurring of consent by the coastal State.

Against this backdrop, this chapter will endeavor to set out what constitutes hydrographic surveys and military surveys, which subsume ISR surveys, in an attempt to first provide definitional clarity. It will then present the opposing views of the USA and China regarding hydrographic and military surveys, and MSR respectively. Finally, it will determine why this lack of distinction presents a risk, and how this risk may apply equally to UAVs should they be found to be outside the ambit of Part 13 of the LOSC. Due to the fact that MSR falls under coastal State sovereignty in the territorial sea, as well as in international straits, the focus of this chapter will be on the EEZ, where the coastal State only has jurisdictional rights.

4.2 Definitional Clarity

4.2.1 Hydrographic surveys

The LOSC does not provide a definition of what constitutes a hydrographic survey. Accordingly, recourse is made to the general rule interpretation contained in Article 31 of the VCLT, which reads in paragraph 1 that a treaty 'shall be interpreted in good faith in accordance with the ordinary meaning to be given to the terms of the treaty in their context and in the light of its object and purpose.' The ordinary meaning of a hydrographic survey may be derived from the International Hydrographic Dictionary as being a 'survey having for its principal

[132] It is important to highlight that the USA largely considers the LOSC as constituting customary international law, save for a number of provisions relating primarily to deep seabed mining, and the Area. *See* Ronald Reagan, 'Statement on United States Oceans Policy' (*Ronald Reagan Presidential Library & Museum*, 10 March 1983) <https://www.reaganlibrary.gov/archives/speech/Statement-united-States-oceans-policy> accessed 5 August 2022.

purpose the determination of data relating to bodies of water.'[133] Such a survey may include determining the depth of the water, configuration and nature of the bottom, directions and force of currents, heights and times of the tides and water stages, as well as the location of topographic features and fixed objects.[134] Hydrographic surveys find their origin in the field of MSR, which makes their distinction from MSR in present day difficult.[135] UAVs used for hydrographic surveys are typically fitted with Light Detection and Ranging (LiDAR) scanners in order to conduct shallow-water bathymetry.[136] The International Hydrographic Organization (IHO) appears to find that hydrographic knowledge of the coastal waters constitutes an element of national infrastructure and sustainable development.[137] This would support the argument that hydrographic surveying conducted within the EEZ should fall under the coastal State consent regime, as it would then have economic value to the coastal State.[138]

4.2.2 Military surveys

As with hydrographic surveys, there is no universal definition, nor one provided by the LOSC, of what constitutes military surveys. Neither are any powers of coastal States to regulate such activities expressed anywhere in the Convention. This has resulted in the USA for instance claiming the right 'to engage in military surveys outside foreign territorial seas and archipelagic water' as providing 'prior notice or [requesting] permission would create an adverse precedent for restrictions on mobility and flexibility of military survey operation'.[139] The latter notion, of prior notice creating an adverse precedent, is reflected, to a certain extent, in the Article 87 enshrined freedoms of the high seas, which builds on the concept of movement without adverse interreference by another State, though qualified through certain provisions contained in the LOSC. In order to define military surveys, recourse is thus again made to Article 31(1) VCLT. In lieu of an authoritative dictionary definition, Roach and Smith define military surveys as any activities conducted in the territorial sea, the contiguous zone, straits, the EEZ, or the high seas involving marine data collection for military purposes.[140] These surveys may include

[133] International Hydrographic Organization, 'Survey: Hydrographic' <http://iho-ohi.net/S32/engView.php?page=10>.
[134] ibid.
[135] Bateman (n 72) 12.
[136] Sarah Simpson, 'Hydrographic Survey for UAV, UUV, AUV | Underwater Mapping Equipment' (*Unmanned Systems Technology*, 2021) <https://www.unmannedsystemstechnology.com/expo/hydrographic-survey-equipment/> accessed 14 July 2022.
[137] Bateman (n 72) 14.
[138] ibid.
[139] Roach (n 14) 184.
[140] Ashley J Roach and Robert W Smith, 'Excessive Maritime Claims' (1994) 66 International Law Studies | U.S. Naval War College 248 <https://digital-commons.usnwc.edu/ils/vol66/iss1/>.

oceanographic, marine geological, geophysical, chemical, biological, and acoustic data.[141] Such military surveys are essential for effective submarine operations, as well as anti-submarine and mine warfare, particularly in areas such as the South China Sea where 'oceanographic and underwater acoustic conditions vary widely with uneven bottom topography, fast tidal streams and a relatively high level of marine life'[142] occur. UAVs 'have traditionally been employed in military surveillance missions' due to their versatile and low-cost nature.[143]

4.2.2.1 ISR

ISR is typically conducted for military operations; it is an 'integrated intelligence and operations function that can be defined as a coordinated acquisition, procession, and provision of accurate, relevant, timely information and intelligence.' Information typically collected by ISR systems include optical, radar, and infrared images, as well as electronic signals, acquired by satellites, UAVs, and human intelligence teams.[144] ISR carried out in the EEZ may come within the scope of scientific research and accordingly MSR pursuant to the LOSC.[145] It was determined in the Report of the Tokyo Meeting that the word 'surveys' was used in the LOSC because the treaty drafters consulted the International Hydrographic Bureau of the IHO, where it was understood that 'surveys' related to the territorial sea and international straits, not however to the EEZ.[146] 'Hydrographic surveys meant surveys to enhance the safety of navigation and were not considered marine scientific research. If this is to be the understanding, when surveys are undertaken in the EEZ, they should be under a consent.'[147] Bateman supports this finding, writing that the argument of hydrographic surveys not falling under the purview of the coastal State because they are 'for the benefit of all humankind to make navigation safer' has lost traction in the last decades, including for reasons of 'wider utility of hydrographic data, recognition of its economic value to the coastal State and the implied responsibility of the coastal State for ensuring that hydrographic data in its EEZ is up to date.'[148] This is however

[141] ibid.
[142] Bateman (n 72) 9.
[143] Anam Tahir and others, 'Swarms of Unmanned Aerial Vehicles — A Survey' (2019) 16 Journal of Industrial Information Integration 1 <https://www.sciencedirect.com/science/article/pii/S2452414X18300086> accessed 14 July 2022.
[144] 'Intelligence, Surveillance, Reconnaissance (ISR)' (n 129).
[145] Mark J Valencia, 'The Regime of the Exclusive Economic Zone: Issues and Responses | A Report of the Tokyo Meeting 19-20 February 2003' (Ship and Ocean Foundation; East-West Center 2003) 13 <https://www.eastwestcenter.org/system/tdf/private/EEZTokyoMeeting.pdf?file=1&type=node&id=31954>.
[146] ibid.
[147] ibid.
[148] Bateman (n 72) 17.

heavily contested by major maritime powers including the UK, and the USA, who, as will be set out below, argue that while ISR activities may indeed constitute research, they fall under the freedoms of navigation and overflight in the EEZ and are thus exempt from coastal State consent.[149]

4.3 Differing Perspectives

The opposing stances of the USA and China have resulted in repeated confrontations, amongst others in the South China Sea. In 2009, the USNS *Impeccable* was intercepted and redirected during a 'US surveillance operation in the disputed South China Sea' according to two defense officials.[150] In 2016, following a similar incident in 2001, the USNS *Bowditch*, an oceanographic survey vessel, deployed a UUV which was 'lawfully conducting a military survey in the waters of the South China Sea', according to Pentagon spokesperson Capt. Jeff Davis.[151]

A major point of contention between the USA and China in the South China Sea concerns the regime of prior consent to conduct MSR in China's EEZ. Having domestically implemented the prior consent regime established by the LOSC,[152] China argues a violation of this law by the USA through its execution of ISR missions carried out *inter alia* by the *Bowditch* and the *Impeccable* in its EEZ without permission. The USA contrarily claims the activities to be survey activities exempt from coastal State consent.

4.3.1 USA

In the EEZ, the USA argues that neither hydrographic nor military surveys fall within the scope of MSR. Instead, according to the USA, these activities fall under the regime of freedoms of navigation and overflight, as provided for in Articles 56(1)(b)(ii), 78, and 87(1)(f) of the LOSC, and are consequently excluded from the coastal State consent regime. This argument is based primarily on the wording of the LOSC, in that neither hydrographic nor military surveys are mentioned in Part 13 of the LOSC which focuses instead on MSR, indicating that survey activities are not subsumed by the MSR regime.[153] This argument is bolstered by the fact that

[149] ibid 3.
[150] 'Officials: Ship in China Spat Was Hunting Subs' (*NBC News*, 11 March 2009) <https://www.nbcnews.com/id/wbna29623425> accessed 14 July 2022.
[151] 'China "seizes US Vessel" in S China Sea' (*BBC*, 16 December 2016) <https://www.bbc.com/news/world-asia-china-38347221> accessed 14 July 2022.
[152] Rothwell and Stephens (n 10) 357.
[153] Roach (n 14) 182.

in contrast to the EEZ, the LOSC makes explicit reference to MSR and survey activities as two distinct activities in marine areas under territorial sovereignty, particularly the territorial sea. Article 19(2)(j) LOSC holds research or survey activities to be inconsistent with innocent passage, and Article 21(1)(g) of the LOSC grants the coastal State authority to adopt laws and regulations governing MSR and hydrographic surveys during innocent passage through the territorial sea, confirmed by the fact that the coastal State exercises sovereignty over this maritime zone. The same distinction is made in Article 40 for straits used for international navigation and Article 54 for archipelagic sea lane passage, both of which hold that MSR and hydrographic survey activities may not be carried out while in transit. Given the distinction between MSR and survey activities in the preceding parts, the lack of any such explicit distinction in Part 13 may lead to the conclusion that coastal State consent is not required to conduct survey activities in the EEZ. It is however worth highlighting that more than 15 States now require prior notification before the carrying out of hydrographic surveys for instance, which casts a shadow of doubt over this argument.[154]

Pursuant to the American perspective, the LOSC grants all States, without being subject to coastal State regulation, the right to conduct military activities, including *inter alia* military surveys within the EEZ in accordance with Article 58(3), provided this is done with due regard of the coastal State's rights. These duties of due regard are obligations of conduct and demonstrate that *inter alia* the freedom of navigation and overflight in the EEZ cannot be relied upon in an absolute manner.[155] The USA has invoked its involvement in the drafting process of the pertinent LOSC provisions, as well as the negotiating history of these Articles in support of its position.[156] Pursuant to President Reagan's Statement in 1983, the USA further considers the LOSC as largely representing customary international law, save for provisions on the deep seabed mining regime, as well as the Area.[157]

[154] Proelss and others (n 85) 454. For a comprehensive table of these countries *see* Sophia Kopela, 'The "territorialisation" of the Exclusive Economic Zone: Implications for Maritime Jurisdiction' (2009) <https://www.semanticscholar.org/paper/The-%27territorialisation%27-of-the-Exclusive-Economic-Kopela/a600e692a0d3cb5ad571671b3f8f66bb959c44f5> accessed 9 August 2022.
[155] Proelss and others (n 85) 455; Rolf Einar Fife, 'Obligations of "Due Regard" in the Exclusive Economic Zone: Their Context, Purpose and State Practice' (2019) 34 The International Journal of Marine and Coastal Law 43.
[156] Mark J Valencia, 'Military Activities in Foreign EEZs', *UN Convention on the Law of the Sea and the South China Sea* (Routledge 2015) 50.
[157] Reagan (n 131); Valencia, 'Military Activities in Foreign EEZs' (n 155) 51.

4.3.2 China

China, together with other emerging economies such as India and Brazil,[158] has instead argued that precisely because ISR surveys, as a subcategory of military surveys for example, cannot be neatly divided from MSR, they are in effect the same.[159] This argument is made convincing in view of the fact that, despite a distinction in categorization and name, 'many vessels that undertake marine data collection are equipped with technologies and devices capable of conducting MSR.'[160] Accordingly, most hydrographic survey vessels are also capable of conducting oceanographic research. China has invoked the existence of the consent regime, and the purpose of its inception being the economic value for commercial exploitation of resources and the importance to State security of the information collected by means of ISR surveys, as further proof of this.[161] '[T]rends in technology and the need for broader "hydrographic" data have conflated hydrographic surveying with MSR. Indeed, hydrographic data … and some of its uses are associated with the rights and duties of the coastal State in its EEZ. It is becoming increasingly difficult to argue that hydrographic data collected today will not have some economic or security value in the future.'[162] This perspective is supported by Bateman, who writes that technological developments of the last decades, together with the 'the utility of hydrographic data for purposes much wider than just the safety of navigation, concern for the health of the marine environment, and the increased significance of integrated coastal zone management (ICZM), as well as much State practice' imply that hydrographic surveys conducted in the EEZ constitute MSR and are accordingly subject to the coastal State consent regime pursuant to Part 5 and Part 13 of the LOSC.[163]

China has argued that the EEZ regime, including that which stipulates consent for MSR, does not constitute customary law as the USA has argued but was instead created *sui generis* by the LOSC. It claims that 'because the [USA] is not a party to [LOSC], it has no legitimacy or credibility to unilaterally interpret particular provisions of this "package deal" to its

[158] Kopela (n 153).
[159] Mark J Valencia, 'China's Dilemma Regarding Regime Of Marine Scientific Research In The EEZ – Analysis' (*Eurasia Review*, 17 December 2019) <https://www.eurasiareview.com/17122019-chinas-dilemma-regarding-regime-of-marine-scientific-research-in-the-eez-analysis/> accessed 14 July 2022.
[160] Kim (n 55) 251.
[161] Valencia, 'China's Dilemma Regarding Regime Of Marine Scientific Research In The EEZ – Analysis' (n 158).
[162] Valencia, 'Military Activities in Foreign EEZs' (n 155) 53.
[163] Bateman (n 11) 106.

advantage.'[164] Valencia finds that the intent argument presented by the USA above, i.e., that the information collected during an ISR survey is not intended for the scientific community but for the military, falters in view of a plain reading of Article 258 LOSC.[165] The provision stipulates that the deployment and use of any type of scientific research installation or equipment in any area of the marine environment shall be subject to the same conditions as prescribed in this Convention for the conduct of MSR in any such area. This would render the *Bowditch*, the *Impeccable,* as well as any other instrument, including UAVs utilized to conduct surveys in a foreign EEZ, subject to coastal State consent.[166]

The USA determines the Chinese position as unsupported by State practice nor a plain reading of the LOSC, the Chicago Convention, or other international instruments.[167] It finds that the 'only place in [LOSC] that addresses intelligence collection is Article 19(2)(c). That article restricts foreign ships transiting the territorial sea in innocent passage from engaging in "any act aimed at collecting information to the prejudice of the defense or security of the coastal State."' [168] An analogous limitation is not explicitly mentioned in Part 5 of the LOSC regarding the EEZ. In addition, the USA finds that the information collected during ISR activities, regardless of the means by which it is collected being similar to those used for MSR, is not intended to be used by the scientific community, but instead exclusively by the military.[169]

On a more general note, if the LOSC were found inapplicable to UAV-conducted MSR, the coastal State retains the right to authorize and regulate its use in the territorial sea, as well as in international straits as set out in Chapter 3. However, in the EEZ, where this presumption of power does not exist, China would lack a legal basis for prior authorization, as such a basis is not provided for in customary international law either, which is what would remain in case the LOSC were to fall away. An assessment of customary international law falls beyond the scope of this dissertation. Attention is merely being drawn to the complexity that arises if the legal basis for regulation provided for in Part 13 of the Convention is deemed inapplicable.

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[164] Valencia, 'China's Dilemma Regarding Regime Of Marine Scientific Research In The EEZ – Analysis' (n 158).
[165] Valencia, 'Military Activities in Foreign EEZs' (n 155) 54.
[166] ibid.
[167] Raul (Pete) Pedrozo, 'Military Activities in the Exclusive Economic Zone: East Asia Focus' (2014) 90 International Law Studies | U.S. Naval War College 527 <https://digital-commons.usnwc.edu/cgi/viewcontent.cgi?article=1010&context=ils>.
[168] ibid.
[169] Valencia, 'China's Dilemma Regarding Regime Of Marine Scientific Research In The EEZ – Analysis' (n 158).

4.4 Conclusion

This chapter has sought to illustrate the difficulty in dividing survey activities, hydrographic and ISR as a sub-category of military surveys, from MSR. This stems both from normative uncertainty as well as practical difficulties in distinguishing activities and the vessels used to conduct them. Further, both hydrographic and military survey activities may have economic implications in terms of resource exploitation in the coastal State's EEZ or be relevant to the security of the State, increasing coastal States' concerns that foreign States disguise activities being carried out in their waters in order to monopolize or abuse the information acquired that might bring the activity within the ambit of coastal State consent pursuant to Article 246(5)(a) for example.[170] Indeed, 'some countries sometimes blur distinctions between [MSR] and intelligence collection or hydrographic surveys to elude the jurisdiction of the coastal State.'[171]

The importance of the LOSC accommodating MSR conducted by UAVs becomes evident in light of this lacking distinction. If UAVs were found to be not covered by the LOSC, and survey activities – both hydrographic and military, including ISR – are considered distinct activities to MSR, as argued by the USA, UAVs deployed to conduct either would be operating in an internationally unregulated space and, depending on the maritime zone, fully outside the purview of coastal State consent. The Chicago Convention does not regulate the specific activities of surveying or MSR, and domestic law, as illustrated by the differing positions of the USA and China for example, varies substantially. The result would be that the coastal State is left without authority to authorize or regulate MSR activities conducted by UAVs in its EEZ, nor any such UAV-survey activity which, due to its economic or security value, ought to perhaps be within the ambit of coastal State consent under the MSR regime. This scenario is made increasingly problematic in view of the technological advances set out in Chapter 2. Level 4 UAVs, already capable of autonomy-akin tasks, and fully autonomous level 5 UAVs – though not yet on the market – may further blur the distinction between survey activities and MSR, making it all the more important that the coastal State retains the possibility of authorizing and regulating at least MSR activities in its EEZ. If the vehicles utilized to conduct MSR and survey activities are presently already so similar that a UAV conducting ISR surveys

[170] Kim (n 55) 251.
[171] Valencia, 'The Regime of the Exclusive Economic Zone: Issues and Responses | A Report of the Tokyo Meeting 19-20 February 2003' (n 144) 31.

which if apprehended can be argued to have been conducting MSR or vice versa,[172] the rapid pace of technological developments will serve to widen the legally fragmented space in which UAVs would operate.

Even though it has been demonstrated that there is no clear answer to the question of whether or not survey activities are truly distinct to MSR, the case study highlights the importance of establishing that, in accordance with the findings of eminent scholars in the law of the sea, UAV-conducted MSR may be covered by the LOSC, such that there is pushback against increasingly similar ISR activities carried out by UAVs which are not subject to coastal State consent or regulation. It is acknowledged that any capacity of a coastal State to regulate activities in its EEZ must be balanced against 'other internationally lawful uses of the sea' stipulated in Article 58. It also worth noting that the USA has accused China of hypocrisy, for protesting against ISR activities in its claimed EEZ, while itself conducting similar surveillance operations off the coast of the Philippines and Guam for instance.[173] Nevertheless, the case study of the South China Sea illustrates domestic legal fragmentation, a potential abuse of the MSR regime by excluding survey activities – including that conducted by UAVs –, that have economic or security value to the coastal State from its consent regime, and the accompanying danger if UAV-conducted MSR is also excluded from the MSR regime, which would leave this means of technology unregulated harmoniously at an international level for these activities.

[172] Ralph Jennings, 'Why Drones Matter So Much for China to Control Disputed Sea?' (*VOA*) <https://www.voanews.com/a/east-asia-pacific_why-drones-matter-so-much-china-control-disputed-sea/6179740.html> accessed 24 June 2022.
[173] Steven Stashwick, 'Chinese Research Vessel Surveys Caroline Islands "to Breach 2nd Island Chain"' (*The Diplomat*, 11 October 2017) <https://thediplomat.com/2017/10/chinese-research-vessel-surveys-caroline-islands-to-breach-2nd-island-chain/> accessed 14 July 2022.

Chapter V: Conclusion and Moving Forward

5.1 Conclusion

In the last decades, there have been rapid technological advancements in the field UMVs. In the field of MSR, UAVs present particularly exciting prospects due to their low cost, high maneuverability, and increasing independence, and are generally considered to be the future of research and mapping. While fully autonomous, level 5 UAVs have yet to reach the market, level 4 UAVs are already so versatile in nature that new fields of MSR may be opened up through them, including future fields such as fisheries management for example. At the same time however, questions about their legal regulation, including at an international level through the LOSC's lack of mention of UAVs, invite both legal and political tension. In the context of MSR, this tension is aggravated by the fact that the separation between MSR and survey activities grows increasingly blurry, and that accordingly, as survey activities are equally unregulated internationally but fall beyond the scope of coastal State oversight, UAV-conducted MSR with economic and security implications may be passed off as survey activities. It is thus of importance to find that UAV-conducted MSR may be covered by Part 13 of the LOSC in order to provide clarity and avoid legal uncertainty, as, lacking an international instrument that regulates this specific activity, it would be left to States to regulate domestically. The potential consequences of this happening are illustrated effectively in the South China Sea, where survey activities are left to States to regulate domestically and have resulted in diametrically opposed positions by major maritime powers that continue to cause flaring tensions in an already politically volatile region. This dissertation therefore set out to answer the principal research question *'how do unmanned aircraft vehicles challenge the traditional legal framework of marine scientific research in the Convention on the Law of the Sea, and how may they nevertheless be accommodated?*'

A discussion has arisen around the legal status of UAVs and whether they are covered by the LOSC. In the context of this dissertation, the question was specifically whether UAV-conducted MSR is covered by Part 13 of the LOSC. To that end, it was determined that the primary challenge UAVs pose to the LOSC is the fact that they are aircraft, and that they may accordingly fall instead under the freedom of overflight which is regulated more extensively by the Chicago Convention. While this is in and of itself not an issue, a problem nevertheless arises on two counts. The first is that MSR activities carried out by UAVs in the EEZ of a coastal State, an activity typically under the coastal State consent regime, but if classed under

the freedom of overflight one that escapes this purview, would leave the coastal State without the ability to authorize or regulate such activity in its maritime zone. The second is that the Chicago Convention does not regulate the specific activity of MSR, nor is it geared specifically towards UAVs. This would leave UAVs conducting MSR to States to regulate domestically. Despite this challenge, it is the opinion of eminent scholars in this field, including Proelss and Soons, that MSR may very well be conducted from the airspace above the EEZ. With this possibility established, one manner in which the LOSC's MSR-regime may be made applicable to UAVs is then by means of evolutionary interpretation. It has been determined that State parties to the LOSC left room for evolutionary interpretation by maintaining generic terms, particularly Article 240 and 246 in the context of this dissertation, to be developed subject to technological developments.

Although it is acknowledged that legal fragmentation is not always negative, and in some instances even desired, the potential dangers of leaving UAV-conducted MSR beyond the scope of the LOSC, and instead under the purview of States to regulate domestically, have been illustrated by means of the case study on the South China Sea, where the USA and China have assumed opposing positions regarding the closely related, and perhaps increasingly indistinguishable, field of survey activities. The analysis sought to demonstrate the complexity and multiplicity of layers that exist when international regulation falls away, resulting primarily in the question on what legal basis China may construct its requirement of prior authorization to conduct MSR and the, in its opinion, subsumed activity of surveying in its EEZ. While the coastal State enjoys sovereignty in its territorial sea and any straits it may border, it does not reign over such powers in the EEZ.

The situation in the South China Sea is more critical than other disagreements over international law, such as the 'Whiskey Wars' on Hans Island,[174] in that it has both taxed human lives in the past and continues to threaten to do so,[175] but also in that it occurs so close to shore that it necessarily increases State security concerns of the coastal State. This is due *inter alia* to the fact that MSR and survey activities may be carried out by the same vehicles, except the

[174] Elin Hofverberg, 'The Hans Island "Peace" Agreement between Canada, Denmark, and Greenland | In Custodia Legis: Law Librarians of Congress' (22 June 2022) <//blogs.loc.gov/law/2022/06/the-hans-island-peace-agreement-between-canada-denmark-and-greenland/> accessed 7 August 2022.
[175] 'Snowden Documents Reveal Scope of Secrets Exposed to China in 2001 Spy Plane Incident' (*The Intercept*) <https://theintercept.com/2017/04/10/snowden-documents-reveal-scope-of-secrets-exposed-to-china-in-2001-spy-plane-incident/> accessed 7 August 2022.

former falls under State purview while the latter does not. This is made particularly contentious through the economic value survey activities conducted by other State may have for the coastal State, but also, for example, the possibility of mapping underwater terrain for an amphibious assault as close as 12nm to the shore. Further, there is the issue that by dividing survey activities from MSR activities, while mindful of the fact that a UAV may be carrying out both, a State may be gradually increasing the host of activities it considers as falling under survey activities, beyond the coastal State consent regime. Bearing in mind these considerations, it ought to be of importance to the international community to find UAV-conducted MSR subsumed by Part 13 of the LOSC, in order to avoid legal fragmentation which may result in a similar situation as that witnessed in the South China Sea, but also in order to provide push-back against attempts to pass off MSR with economic potential, or State security concerns as survey activities, thus precluding them from coastal State consent.

Though writing about unmanned vehicles in general, and not specifically about the activity being carried out by them, Kraska's finding nevertheless applies:

> '[If UMVs] were not covered by existing legal frameworks that already apply to ships, submarines, and aircraft, then unmanned vehicles are entering service within a legal vacuum. Judicial economy and avoidance of legal anarchy weigh heavily in favor of applying existing international regimes to emerging unmanned and autonomous systems. There is no realistic option other than to do so, and it would be shortsighted to forgo application to [UMVs] of the detailed, comprehensive, and widely accepted legal regimes in existence.'[176]

5.2 Moving Forward

Pending an authoritative answer by an international Court whether Part 13 of the LOSC may indeed extend to UAV-conducted MSR, three pragmatic recommendations will be set out in the following in order to facilitate the application of the LOSC to UAV-conducted MSR.

First, a guidance note for judges, lawyers, and legal practitioners would be beneficial in which the possible applicability of Part 13 to UAV-conducted MSR is explored in further detail. Included in this guidance note could be best practices from other fields of the law of the sea,

[176] Kraska (n 60) 64.

where the LOSC was extended to cover new developments – technological or otherwise. Boyle writes as an example of such an extension of the LOSC of the phrases 'natural resources' and 'jurisdiction' which were reinterpreted by reference to current general international law.[177] Such a guidance note could also set out practical dilemmas and current knowledge gaps, relating for example to level 5 UAVs. Maritime universities or eminent scholars in the field could author such a guidance note, drawing on the wealth of expertise of its practitioners. In addition, an online or in-person symposium, in which experts in the field are invited to exchange opinions on the subject, and to discuss such a guidance note, could facilitate its application.

Second, in implementing a guidance note, judges, lawyers, and practitioners may benefit from awareness raising activities and training, carried out by maritime universities or eminent scholars. Awareness raising activities could entail exposure visits to a UAV producer and a military base which utilizes UAVs, in order to gain a better understanding of how similar MSR and survey UAVs appear in build, as well as to receive a real-life demonstration of their dual function when it comes to these specific activities, and how difficult it may be to differentiate between them. Training could be linked to a symposium in order to expand on interpretation knowledge of Part 13 to UAV-conducted MSR specifically.

Third, in order to aid both the development of the guidance note and any awareness raising activities and training, a digital repository of incident reports, domestic legal cases, and in the future possibly international legal cases from the ITLOS for example, pertaining to the use of UAVs in MSR or survey activities could be helpful in order to derive best practices and lessons learnt. This relates particularly to those instances where UAVs were used to conduct MSR with viable economic implications for the coastal State under a banner of survey activities in order to illuminate the issue at hand.

[177] Boyle (n 108) 568.

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Further information on USVs and UUVs

USVs

USVs can be defined as 'unmanned vehicles which perform tasks in a variety of cluttered environments without any human intervention, and essentially exhibit highly nonlinear dynamics.'[178] The distinguishing feature to the other two categories of UMVs, is that, as the name suggests, USVs conducting MSR operate on the water surface. They are in that sense, most closely regulated under the LOSC.

USVs have been developed to complete a host of diverse tasks, a majority being designed and utilized for non-lethal missions such as ISR,[179] rendering especially the very small and small USVs particularly well-suited to conduct MSR, but also hydrographic survey and ISR missions.[180] Chapter 4 more closely assessed particularly the latter, more contested survey and ISR missions. USVs provide a host of advantages in comparison to manned vessels, particularly because they 'fill a unique niche with the ability to survey regions for extended periods where ships do not routinely operate, opening up new opportunities for filling persistent gaps in the ocean observing system'.[181]

A pertinent example of a USV contributing successfully to the furtherance of oceanic study is the Saildrone, designed by Richard Jenkins. This USV combines wind-powered propulsion technology and solar powered meteorological and oceanographic sensors to perform data collection for climate, mapping, and maritime security application.[182] The Saildrone operates *inter alia* with regard to fisheries, where it primarily tracks ocean currents, fish biomass, and backscatter. (Refer to Graphic I for operational information on the Saildrone).[183] In a West Coast fisheries survey conducted in 2018, five Saildrones were deployed, sailing more than 18,500 nm in order to collect data on sardines, anchovies, and hake.[184] The survey was deemed novel in that it 'combined observations of zooplankton, fish, marine mammals, and seabirds

[178] Zhixiang Liu and others, 'Unmanned Surface Vehicles: An Overview of Developments and Challenges' (2016) 41 Annual Reviews in Control 71.
[179] 'Unmanned Surface Vehicles (USVs): Defence and Technology Trends' (*Naval Technology*, 9 July 2021) <https://www.naval-technology.com/comment/unmanned-surface-vehicles-usvs-defence-technology-trends/> accessed 3 June 2022.
[180] ibid.
[181] 'Wind & Solar Powered Autonomous Vehicles – Saildrone' <https://www.saildrone.com/technology/vehicles> accessed 3 June 2022.
[182] ibid.
[183] ibid.
[184] ibid.

throughout the California Current Ecosystem to help scientists directly estimate the amount of fish and krill consumed by their natural predators.'[185]

UUVs

UUVs are vehicles that are able to operate underwater without a human occupant. UVVs can be divided into Remotely Operated Vehicles (ROV)s, which are remotely controlled by a human operator, and Autonomous Underwater Vehicles (AUVs), which operate free of human control.[186] AUVs will typically follow a pre-programmed path set at the surface, or have their path dynamically altered to cater to the mission.[187] Once set, this path is followed independently, though the vehicles will not make autonomous decisions. 'Currently, UUVs are revolutionizing oceanography. They have been widely used for in-situ measurements which would be difficult, expensive, and, in some cases, impossible to obtain by using traditional ship-based sampling techniques.'[188] Typical oceanography missions for UUVs include acoustic imagery, optical imagery and water column characterization.[189] Interestingly, a side effect of MSR by means of UUVs in previously unreachable areas such as beneath the polar ice sheets, is a significant advance in knowledge required to ensure later navigation through these regions by arctic bordering States such a Canada.[190] Their use could provide critical information on vulnerable ecosystems in the Arctic for instance.

One example of an ROV-type UUV is the Blueye X3, utilized by the University of Tromsø to 'collect valuable data from under the sea ice in dark conditions and without entering the freezing water.'[191] The Blueye X3 has an endurance of 2 hours under normal operation, weighs nine kg and can dive to depths of over 300m.[192] (Refer to Graphic II for operational information on the Blueye X3)

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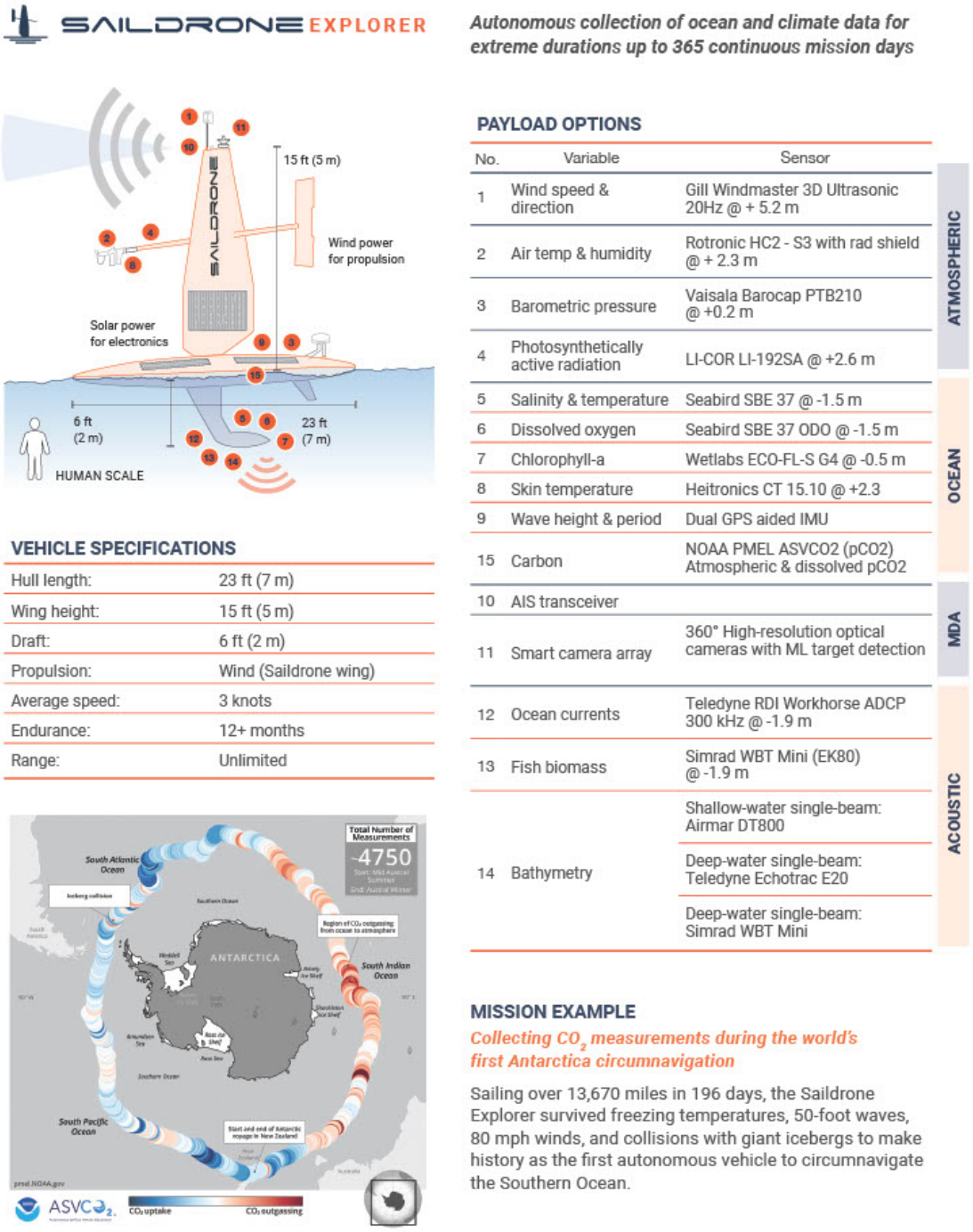
[185] 'West Coast Fisheries Survey – Saildrone' <https://www.saildrone.com/missions/west-coast-survey-2018> accessed 3 June 2022.
[186] Yannick Allard and Elisa Shahbazian, 'Unmanned Underwater Vehicle (UUV) Information Study' (OODA Technologies Inc Montreal, Quebec Canada 2014) 1 <https://apps.dtic.mil/sti/citations/AD1004191> accessed 3 June 2022.
[187] 'What Is an AUV?' (*Virginia Institute of Marine Science*) <https://www.vims.edu/research/units/legacy/cornwallis/auv/index.php> accessed 29 June 2022.
[188] Allard and Shahbazian (n 185) 8.
[189] ibid.
[190] ibid 11.
[191] 'The University of Tromsø Utilizes Underwater Drones for Education and Research' <https://www.blueyerobotics.com/blog/the-university-of-tromso-utilizes-underwater-drones-for-education> accessed 3 June 2022.
[192] 'Blueye X3 | Underwater ROV with Gripper' <https://www.blueyerobotics.com/products/x3> accessed 3 June 2022.

Graphics

Graphic I



Description: Operation information on the Saildrone

Source: 'Wind & Solar Powered Autonomous Vehicles – Saildrone' <https://www.saildrone.com/technology/vehicles> accessed 3 June 2022.

Graphic II

TECHNICAL SPECIFICATIONS
BLUEYE X3

blueye

Drone specifications

Drone

Ingress protection	IPX8
Dimensions	485 x 257 x 354 mm (LxWxH)
Weight in air	8.6 kg (with salt water ballast)
Construction	ABS enclosures, Aluminium pressure enclosures, Polycarbonate (PC) windows
Buoyancy material	HCP 30 Polymer Foam
Maximum rated depth	305 m
Forward speed at normal use	1.5 m/s (3 knots)
Thrusters	4 x 350 W
Run time at normal use	Approx. 2 hours
Operating temperature	-5 to +35 °C

Guest Port 1

Power	5V(2.1A shared), BAT(7A), 20V(2A shared)
Protocols	ETHERNET 10/100Base-T/TX, RS232 (or RS485/RS422), I2C, PWM, UART

Guest Port 2

Power	5V(2.1A shared), BAT(7A), 20V(2A shared)
Protocols	ETHERNET 10/100Base-T/TX, RS232, I2C, PWM, UART

Guest Port 3

Power	5V(2.1A shared), BAT(7A), 20V(2A shared)
Protocols	ETHERNET 10/100Base-T/TX, RS232, USB, I2C, PWM, UART

Camera

Mechanical tilt	-30 to +30 °
Vertical field of view	115 °
Sensor	Exmor R CMOS, 1/2.8 inch
Max image size	1920 x 1080 pixels
Shutter speed	1/30 s – 1/8000 s
Picture max resolution	2M (1920 x 1080)
Picture type	JPEG
Video resolution	FHD: 1920 x 1080 25/30 Fps, HD: 1280 x 720 25/30 Fps
Video type	MP4
Video storage bit-rate	2 to 16 MBit/s
SD card	256 GB

LED lights

Luminous flux	3300 Lumen
Colour temperature	5000 K
Colour rendering index (CRI)	90
Adjustable dimming	Yes

Smart Battery Pack

Nominal Voltage	14.8 V
Nominal Capacity	6500 mAh
Nominal Energy	96.2 Wh
Operating temperature	-5 to +35 °C
Charging temperature	5 to 30 °C

Sensors

IMU	3 axis gyro & accelerometer & magnetometer
Depth sensor	Resolution: 0.2 mbar
Depth sensor operating range	0 to 30 bar
Temperature sensor	+/-1 °C

Tether

Length	150 m
Breaking strength	100 kg
Number of cables	1 twisted pair (copper)
Size	26 AWG

Controller

Compatibility	iOS or Android

Description: Operational information on the BlueyeX3

Source: 'Blueye X3 | Underwater ROV with Gripper' <https://www.blueyerobotics.com/products/x3> accessed 3 June 2022.