Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005

JOURNAL OF TOURISM, HOSPITALITY AND ENVIRONMENT MANAGEMENT (JTHEM)
www.jthem.com

PRIORITIZING HEALTH CONCERNS AND ENVIRONMENTAL PROTECTION EQUALLY IN ADDRESSING SPACE DEBRIS FROM OUTER SPACE THROUGH THE PRINCIPLE OF INTEGRATION OF SUSTAINABLE DEVELOPMENT

Marina Abdul Majid [1*]

[1] Research Center for History, Politics and International Affairs, Faculty of Social Sciences and Humanities, Universiti Kebangsaan Malaysia (UKM), 43600 Bangi, Selangor, Malaysia.
Email: marina76@ukm.edu.my/marinamajid76@gmail.com
[*] Corresponding Author

Article Info:

Article history:
Received date: 15.10.2023
Revised date: 13.11.2023
Accepted date: 05.12.2023
Published date: 08.12.2023

To cite this document:

Abdul Majid, M. (2023). Prioritizing Health Concerns And Environmental Protection Equally In Addressing Space Debris From Outer Space Through The Principle Of Integration Of Sustainable Development. *Journal of Tourism Hospitality and Environment Management, 8* (34), 54-77.

DOI: 10.35631/JTHEM.834005.

Abstract:

The controversy surrounding space debris which have re-entered the earth atmosphere has gained prominence for causing environmental contamination among various subsidiary guidelines which constitute the Guidelines for the Long-term Sustainability of Outer Space Activities. Regretfully, most of the subsidiary guidelines have barely referred to health concerns explicitly. While certain forms of space debris can either cause air, water or ground pollution such as fuel from fuel tanks of rockets and satellites or nuclear-powered reactors, how human health is affected has been downplayed. If sustainable development must be achieved, the inclusion of health concerns from space debris must be emphasized as more non-space-faring states are victims of fallen debris that could harm their population. Therefore, the main objective of this research is to assert that environmental contamination and health concerns arising from the space debris left on earth from the outcome of outer space activities must be given equal emphasis in the furtherance on international health law. This is a qualitative study that utilizes a textual analysis in interpreting provisions and relevant paragraphs of selected outer space agreements and soft law documents to identify wordings such as environmental contamination and pollution, health and public health to judge if these documents have adequately addressed the two components of sustainable development. Secondary resources were also consulted. The results of the study show that outer space law has made some strides by embracing sustainable development with an emphasis on environmental contamination and protection from space debris through non-binding soft law documents to complement outer space treaties but neglecting health concerns. The implication is the need to develop international health law by the World Health

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005

Organization (WHO) concerning outer space to address toxic fuels besides the hazards posed by nuclear reactors powering some satellites since scant attention has been given to these matters.

Keywords:

Space Debris, International Sustainable Development Law (ISDL), International Health Law.

Introduction

The controversy surrounding space debris which have re-entered the earth atmosphere has gained elevated prominence as a cause for environmental contamination in the discussion concerning the long-term sustainability of outer space activities. While it may be true that certain forms of space debris can either cause air, water or ground pollution such as the fuel used for fuel tanks from rockets and nuclear satellites, health concerns have relatively been downplayed. If sustainable development is truly to be achieved, a wholesome approach must be taken so as not to ignore the social development aspect which includes the health concerns of space debris. Sustainable development itself has been defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development [WCED], 1987, p. 87). It is asserted that sustainable development consists of three components namely environmental protection, economic development as well as social development. Regretfully, most of the subsidiary guidelines which constitute the Guidelines for the Long-term Sustainability of Outer Space Activities (UNOOSA, 2018) have barely referred to health concerns explicitly although environmental contamination and protection have come to the forefront. Indeed, outer space law has made some milestone achievements in the 21st century by starting to embrace sustainable development outright with a lot of emphasis on environmental contamination and protection from space debris, albeit through producing soft law documents to address the said matter but neglecting to address most health concerns associated with this menace.

Space debris can pollute outer space when collision among satellites occurs, old satellites which have broken down are still orbiting earth or are deliberately shot down and broken into fragments. For the purpose of this research, emphasis will be on the space debris that is produced during the launch of a rocket or spacecraft or those that fall down to earth from outer space to cause environmental contamination and health concerns. It is asserted in this research, that emphasis will have to be given to both environmental contamination and health concerns arising from space debris produced during the launch of a rocket or spacecraft or those that fall down to earth from outer space as these are equally pressing matters that can ill afford to be ignored. However, it would seem that the international bodies and states involved with the discussion about the sustainability of outer space have not explicitly referred to health concerns in the subsidiary guidelines which forms the document Guidelines for the Long-term Sustainability of Outer Space Activities (UNOOSA, 2018). Therefore, the main objective of this research is to assert that environmental contamination and health concerns arising from the space debris left on earth from the outcome of outer space activities must be given equal emphasis in the furtherance on international health law especially. Furthermore, this is also the chance to develop international health law in the context of outer space by addressing health concerns since little attention has been given to this grey area in the attainment of sustainable development.

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005

Within the realm of international law, there is a growing body of literature which addresses International Sustainable Development Law (ISDL). Segger and Khalfan (2004a, p. 103) define ISDL as an "intersection between the three fields of international economic, environmental and social laws". ISDL came into being as a result of fulfilling Principle 27 of the Rio Declaration on Environment and Development of 1992 which intends to promote the further development of international law in the field of sustainable development ("Report of the United Nations", 1992). It will be argued in this research that the principle of integration of ISDL especially which seeks to enjoin the three components of sustainable development to be mutually supportive of one another among international law agreements and that of soft law documents can be a means of assessing if all three components have been addressed equally in a balanced manner without obliterating the other. In another section of this paper, a more detailed description of the principle of integration will be elaborated. The preceding sections of this paper will then cover the methodology being used for this study, environmental contamination and health concerns from space debris activities affecting earth, and to be followed by an analysis of outer space law agreements and soft law documents of relevant international organizations which have addressed environmental contamination and health concerns.

Literature Review

A general consensus currently exists among scholars that the existing five outer space treaties can inadequately address environmental pollution from space debris that animates from the pre-launching process, a collision among satellites and other space objects in outer space itself or the deliberate blasting of old non-functional satellites (Gupta & Agasti, 2022, p. 20; Haroun at al., 2021, p. 65; Pogorzelska, 2013; Popova & Schaus, 2018). At best, the nearest reference to imply that environmental contamination from space debris can be addressed is contained in Article IX of the 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (hereinafter Outer Space Treaty 1967) which addresses "harmful contamination" but has never been defined (Gupta & Agasti, 2022, p. 15; Haroun at al., 2021, p. 65; Pogorzelska, 2013; Popova & Schaus, 2018, p. 6). Even the threshold which can constitute harm remains ambiguous making it hard to decipher what is meant by harmful contamination (Haroun at al., 2021, p. 65). As most of these outer space treaties were drafted towards the end of the 1960s and early 1970s when environmental issues were yet to be brought to the forefront to gain prominence, it is not surprising at all that environmental matters were left out explicitly from these five outer space treaties (Pogorzelska, 2013; Popova & Schaus, 2018, p. 10). As these five outer space agreements have omitted to refer explicitly to environmental contamination, international efforts have been made over time to produce non-binding guidelines that are voluntary for most states to address space debris environmental contamination and mitigation which lacks the force of a binding treaty (Gupta & Agasti, 2022, p. 20). Progress was made in 2007 when the United Nations Committee on Outer Space Affairs (UNOOSA) produced the Space Debris Mitigation Guidelines (UNOOSA, 2010) that provided the meaning of space debris and listed mitigation steps to address this menace although it was voluntary (Gupta & Agasti, 2022, p. 20).

The next major breakthrough in the development of outer space law came in 2011 when the Working Group on the Long-term Sustainability of Outer Space Activities suggested the need to extend the concept of sustainable development into outer space (Pogorzelska, 2013; Pogorzelska, 2015, p. 77). This effort of incorporating sustainable development to be

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005
considered in outer space activities was reflected in a subsequent document entitled Guidelines on the Long-term Sustainability of Outer Space Activities (UNOOSA, 2018) containing many subsidiary guidelines that included those covering the treatment of space debris. While all of these subsidiary guidelines are non-binding soft law documents, the task of this present research is to examine these subsidiary guidelines whether they contain reference to sustainable development, environmental contamination, environmental protection, health and public health matters adequately. This is because space debris need not only cause environmental contamination during the pre-launching process or during the re-entering stage into the earth's atmosphere but may cause harm to human health too.

Some researchers have called upon the need to utilize principles of international environmental law to be applied in outer space with the call to embrace sustainable development (Gupta & Agasti, 2022, pp. 21-24; Haroun at al., 2021, p. 67-68; Pogorzelska, 2013; Pogorzelska, 2015, p. 88). They justify the need to use some of these principles of international environmental law because all this while the five outer space treaties have never made direct reference to address environmental contamination from outer space activities nor explicitly referred the need to achieve sustainable development. It is Article III of the Outer Space Treaty 1967 which stresses that other branches of international law should simultaneously be considered (Gupta & Agasti, 2022, p. 21). Some scholars have thought that the precautionary principle, the polluters pay principle (Gupta & Agasti, 2022, p. 21-23; Haroun at al., 2021, p. 67), the need for an environmental impact assessment (EIA) (Haroun at al., 2021, p. 67; Pogorzelska, 2015, p. 80), the principle of equity (Gupta & Agasti, 2022, p. 23; Pogorzelska, 2015, p. 80), the right of states over the sustainable use of their natural resources (Gupta & Agasti, 2022, p. 24), the transboundary harm principle (Haroun at al., 2021, p. 67), common but differentiated responsibilities (Gupta & Agasti, 2022, p. 24; Pogorzelska, 2015, p. 88), the principle of public participation and, lastly the principle of integration (Pogorzelska, 2015, p. 80) to be applicable in the monitoring of outer space. While these principles could bring more clout to monitor outer space from environmental contamination which would fulfill the environmental protection component of sustainable development, health hazards from space debris that falls within the ambit of international health law has been forsaken.

Indeed, Pogorzelska (2015, p. 80) in scant passing mentions the principle of integration relevant in uniting the components of sustainable development namely environmental protection, economic development and social development when discussing outer space law. Pogorzelska (2015) though has failed to elaborate in detail the role that the principle of integration could play in ISDL in bringing different branches of international law together such as international economic law, international environmental law and international social law. This research will stress upon the importance on international social law of ISDL which covers international health law as health hazards animating from space debris is an under-researched area that needs to be explored if sustainable development in outer space is truly to be fulfilled. In particular, this research is keen to explore the World Health Organization's (WHO's) role in developing international health law in outer space as very scant literature currently exists on this matter giving space to this research to fill in the gap.

Prabhu (2004, p. 328) has suggested that "international health law ought to be on the agenda of all those organizations involved with sustainable development law". While the move has been made in outer space law to embrace environmental protection with the larger goal of achieving sustainable development, it is argued that this move is incomplete without addressing

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005

the social development aspect of health and developing international health law further. Typically, international health law is characterized by soft law documents such as resolutions issued by the WHO and guidelines.

Existing scholarly work have referred to the WHO's definition on health in its Constitution to cover mental well-being which is relevant for claims for damages in the Convention on International Liability for Damage Caused by Space Objects (hereinafter Space Liability Convention) (Nakamura, 2020, p. 10; Sayed & Li, 2023, p. 1130). Mihajlov (1989, p. 12) had also pinpointed towards the further development of international health law when the 1963 Moscow Treaty Banning Nuclear Weapon Test in the Atmosphere, in Outer Space and Under Water prohibited nuclear testing as it would be detrimental to human health and the environment. This raises a salient query whether the consideration of health matters in outer space in relation to space debris need only consider the danger of nuclear power usage. The position in this research is that there are other health hazard issues to be considered besides nuclear power usage that have been downplayed that this research will need to unravel.

More recent discussions on health in relation to the WHO in the outer space context would seem to focus on beneficial health activities. A group of scholars have highlighted the need to consider passengers health in light of the publicity of space tourism and the need to mitigate this matter through risk reduction and response (Harris et al., 2022, p. 995). Another scholar (Zannoni, 2020, p. 628) has highlighted the WHO's involvement in the Space and Global Health initiative whereby remote sensing in outer space can detect disasters to enable timely health response such as the detection of certain diseases spreading namely malaria, cholera and meningitis. Besides these, the WHO's involvement in outer space activities is through the promotion of telemedicine which involves remote inaccessible places (Zannoni, 2020, p. 628). While the WHO may be involved in a few positive activities involving outer space, this research is critical of the WHO for failing to address the health aspects of space debris and publicizing the matter to gain worldwide support. Increasingly, more non-space faring states are victims of space debris but no warning has been issued to states about the possible diseases their population could encounter when dealing with toxic chemicals animating from fuel tanks of rockets from the launching process falling to earth. This is indeed a grey area needing further exploration and this research intends to fill in the void. Some scholars have assumed that the International Health Regulations 2005 (IHR 2005) is capable of addressing the spread of diseases across state boundaries which must be a public health emergency of international concern (Freeland & Kuan, 2023, p. 2). Their view is that the IHR 2005 could apply to the pre-launch phase of rockets and satellites being sent into space or the need to report any incident detrimental to public health after the satellite/spacecraft has returned to earth (Freeland & Kuan, 2023, p. 2). To what extent these claims are true will need further investigation to be conducted by this present research.

Hence in providing a solution to the space debris problem, environmental contamination need not only be prioritized to achieve sustainable development. The international community must equally pay attention to the development of international health law in the context of space debris because this is a weaker league being overlooked and a setback towards the attainment of sustainable development in a balanced manner. Zannoni (2020, p. 631) has said "the link between space and global health is still in its infancy. We are still at the stage of gathering information, identifying who can do what, and defining competencies and the governance structure for a cooperative platform to be established". Therefore, it is hoped that this

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005
research's attempt to explore international health law in the context of outer space debris can fill in the void that Zannoni has mentioned in enriching outer space and international health law.

Methodology

The epistemological position in this study refers to interpretivism. Interpretivism is known as "[t]he study of social phenomena [requiring] an understanding of the social worlds that people inhabit, which they have already interpreted by the meanings they produce and reproduce as a necessary part of their everyday activities together" (Blaikie, 2004, p. 509). A researcher is required to interpret elements within their study that involve human interest in the context of interpretivism. Various approaches have been connected with interpretivism but relevant to this research is hermeneutics.

Hermeneutics is related to the interpretation of texts to illicit meaning (Wernet, 2014, p. 234). Within the domain of law, legal hermeneutics has developed as a science of interpretation relating to the application of legal rules from the foundations of philosophical hermeneutics (Merezhko, 2014, p. 4). The method for interpreting text in legal hermeneutics includes understanding, interpretation, and reference to both the legal text and context (Merezhko, 2014, p. 4). The applicability of hermeneutics to this research concerns the interpretation of provisions within the outer space agreements and paragraphs from soft law documents. Merezkho (2014, p. 8) asserts that legal hermeneutics is applicable to the interpretation of international treaties, hence its relevance to this study.

This research is qualitative and applies a socio-legal approach. The rationale for adopting a socio-legal approach is that this study is multidisciplinary impinging into the areas of law and astronomy, and utilizes social science methods of analysis such as a textual analysis in interpreting provisions of legal documents, and a content analysis. In particular, a legal interpretation of provisions will be made towards these outer space international agreements namely the 1967 Outer Space Treaty, the 1972 Convention on International Liability for Damage Caused by Space Objects (hereinafter Space Liability Convention), and the International Health Regulations (IHR 2005) through a textual analysis to illicit their meaning. The same applies to the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space (UNOOSA, 2010), and the subsidiary guidelines which forms the basis for the Guidelines for the Long-term Sustainability of Outer Space Activities (UNOOSA, 2018) which include:

1) Guideline A2: Consider a Number of Elements when Developing, Revising or Amending, as Necessary, National Regulatory Frameworks for Outer Space Activities;
2) Guideline B1: Provide Updated Contact Information and Share Information on Space Objects and Orbital Events;
3) Guideline B9: Take Measures to Address Risks Associated with the Uncontrolled Re-Entry of Space Objects;
4) Guideline C4: Raise Awareness of Space Activities;
5) Guideline D1: Promote and Support Research into and the Development of Ways to Support Sustainable Exploration and Use of Outer Space; and
6) Guideline D2: Investigate and Consider New Measures to Manage the Space Debris Population in the Long Term

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005

All of these outer space law agreements and soft law documents have been analysed through a textual analysis in interpreting whether they contain any specific wording that refers to environmental protection, environment contamination, the environment, health and public health. These terms were chosen because this would signify whether components of sustainable development namely environmental protection and health matters which forms part of social development issues were truly reflected to fully subscribe to sustainable development.

Secondary resources such as books, book chapters, journals, newspaper articles, magazines, conference papers, working papers and other relevant information obtained from the internet will be utilised in this study and analysed as themes relevant to the sub-topic sections of this paper through a content analysis.

Environmental Contamination and Health Concerns from Space Debris Activities Affecting Earth

Back in January, 1978 the Soviet Union satellite, Cosmos 954 designed to monitor the world's oceans which had a nuclear reactor containing uranium 235 to power it had crashed into the Great Slave Lake area of the Canadian Northern Territories to affect a place called Yellowknife (Launius, 2014). Thousands of pieces of space debris were scattered more than 100,000 square kilometers northwest of Canada (Launius, 2014). This led to the recovery effort known as Morning Light whereby Canada was assisted by the United States (US) Department of Energy (DOE) to recover and analyse the impact of the fallen space debris. Plates, disk rods, and other objects with radiation levels from one to 200 roentgens/ hour were recovered ('Operation Morning Light', 2013). A survey covering the Great Slave Lake area showed that nuclear materials were widely dispersed from the nuclear reactor core ('Operation Morning Light', 2013). In the end it was concluded that the time it takes for half of the space debris material containing radiation to loose its radioactivity would take about 713 million years (Launius, 2014). This led President Jimmy Carter, the then US president to propose a moratorium with regard to the usage of nuclear power for space flight after the Cosmos 954 satellite crashed into Canadian territory but in the end a permanent ban did not take place (Launius, 2014). It certainly took about eight months for the US-Canadian authorities to conduct a massive cleaning up of the contaminated space debris with radiation that costs about $14 million (Canadian) (Bowen, 2020). The Soviet Union finally paid about $3 million (Canadian) after being pressed by the Canadians to pay for damages through the invocation of the 1972 Space Liability Convention (Parks, 2009, p.4). The crashing of the Cosmos 954 satellite apparently had affected the indigenous Dené people who lived at the eastern part of the Great Slave Lake (Dart, 2022). This group of people faced radiation effects with drastically elevated cancer rates (Dart, 2022).

Much earlier in 1964, the US TRANSIT 5BN-3 navigational satellite had malfunctioned while its radioisotope thermoelectric generator (RTG) that contained 2.2 pounds of plutonium fuel had burned up during re-entry into the earth's atmosphere (Launius, 2014). It had been reported in the New Scientists that within a decade of a re-entry of a satellite that uses nuclear power about 5% of its plutonium-238 would remain in the atmosphere (Launius, 2014). This illustrates a case of environmental pollution in the earth's atmosphere.

In another US space mission involving Galileo in 1989, data acquired from the DOE in the US had indicated that any space launch failure could result with 202 cancer deaths which worried activists (Launius, 2014). With regard to the likelihood of an accident occurring, this would

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005

likely occur during a failed launching episode whereby the re-entry of the spacecraft for failing to reach orbit could cause a very low probability maximum case of 9.8 cancer fatalities over a 70-year period among a population of 83,000 persons, that would have an estimate of 16,000 cancer fatalities within the same period of time (Launius, 2014). Activists had filed a lawsuit against the National Aeronautics and Space Administration (NASA) prior to the launching of Galileo by indicating that the RTG of the spacecraft would pose a risk to residents because of the potential carcinogenic effect of plutonium-238 should a widespread ground contamination accident occur to cause environmental pollution and affect human bones and people's lungs (Launius, 2014). In the end, the lawsuit at the US District Court in the District of Columbia ruled in favour of NASA as this agency had fulfilled its requirement of conducting an environmental impact assessment in line with the US National Environmental Protection Act (NEPA) (Launius, 2014). This provided a go-ahead for NASA to launch Galileo which enabled it to explore Jupiter and obtain vital scientific data about this planet's geography. As a nuclear-powered satellite may cause environmental contamination and all kinds of health hazards when an accident occurs, the US has considered replacing the RTGs in a spacecraft with solar arrays to become more environmentally friendly in facing public opposition.

On 31 July, 2022 parts of Sarawak in Malaysia were rained with space debris from the remnants of China's Long March 5B rocket which was bringing the Wentian laboratory into orbit to be attached to the Tianhe main module ('Debris from Chinese', 2022). The debris were specifically remnants from the launcher and booster. At Goodwill Garden, Sepupok near Batu Niah, Sarawak metal fragments were embedded around one meter deep in a compound of a house (Toyat, 2022). Malaysia's Hazmat team, its Fire and Rescue Department and representatives from the Ministry of Science, Technology and Innovation (MOSTI) were at the scene to analyze the metal fragments for fear they may contain radioactive materials to endanger public health (Toyat, 2022). At the Kampung Hulu Nyalau, Samalaju, Sarawak a horseshoe object which was four inches deep was found and also inspected by the Fire and Rescue Department Hazmat team and also the Atomic Energy Licensing Board (AELB) branch in Bintulu (Jay, 2022a, p. 2). Both space debris found at Batu Niah and Nayalau, Bintulu in Sarawak state were flown to the Kuala Lumpur International Airport to be transported to the Chemistry Department for further analysis (Adnan, 2022). A third case involved a grey coloured object with measurements of 2.3 meters long, 1 meter wide and 5-millimeter-thick which was found at an oil palm plantation in Pantu, Sri Aman in Sarawak (Jay, 2022b). Yet again, the Kuching AELB branch and Chemistry Department personnel were called in to inspect the object to ascertain if it was radioactive but it turned out to be safe (Jay, 2022b). A space debris measuring two inches wide and three inches long was also found lodged in the wooden beams of a house rooftop at Rumah Panjang Renyam in Sungai Asan, Sibu in Sarawak whereby MOSTI confirmed that it was free from radioactive and did not emit radiation (Leong, 2022). Since the incident of the Soviet Union's Cosmos 954 in 1978, Malaysia has taken a more cautious approach in dealing with China's space debris from its Long March 5B rocket for fear that any nuclear material would emit harmful radiation to the public who were advised not to touch any space debris found but to call the authorities first. As China's space debris fell into Malaysia's territory, the Malaysian authorities could not discount taking legal action against China based on international outer space treaties (Pillai, 2022). Moreover, China failed in advance to notify the exact coordinates where its space debris from Long March 5B rocket would fall to earth when this state was supposed to warn other states in advance to prepare themselves for the eventual danger ('Debris from Chinese', 2022). Space debris from this Chinese rocket had also fallen in parts of Kalimantan, Indonesia and was anticipated to fall

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005
within the waters southeast of the Philippines city of Puerto Princesa on the island of Palawan ('Debris from Chinese', 2022; Rosa-Aquino & McFall-Johnson, 2022).

In another satellite case known as USA 193 which was used for spying, the satellite had lost power and become uncontrollable when it was launched in 2006 with its hydrazine fuel tank still being intact (Kelley & Johnson, 2011, p. 2; Parks, 2009). The USS Lake Erie navy ship situated near Hawaii that was armed with a SM-3 missile managed to shoot down this spy satellite in February, 2008 piercing its titanium fuel tank (Burns & Baldor, 2008, p. 2). Had the US not destroyed the satellite, its 1,000 pounds full hydrazine full tank would have posed a health hazard to humans if it fell down into a populated area (Burns & Baldor, 2008, p. 1). The mission to destroy the fuel tank was successful as there was a vapour cloud from the explosion of the hydrazine fuel tank. The US had organized hazardous material teams known as Burnt Frost just in case any space debris from the explosion of the satellite would fall down to earth and pollute areas of the US or other nearby countries ('Navy says missile', 2008, pp. 3-4). The Centers for Disease Control and Prevention of the US had also issued a health bulletin alerting health officials and clinicians about the health effects associated with hydrazine just in case any communities would have been affected by any hazardous space debris that fell down ('Navy says missile', 2008, p. 4). In one study which involved workers who were responsible for filling fuel tanks with hydrazine for rockets, it was found that they could be vulnerable to hemato and lymphopoietic cancer, and for bladder and kidney cancer mortality (Ritz et. al, 1999). Moreover, they may also be vulnerable to lung cancer (Ritz et. al, 1999). In another study, it has been said that hydrazine can penetrate into the systemic blood circulation and to cause soil contamination (Trofimov et. al, 2020, pp. 21-22). Therefore, there is the need to develop more environmentally friendly rocket fuel so as not to pollute the environment and endanger human health. Such has been the case of the Indian Space Research Organization (ISRO) that has researched an environmentally friendly propellant to power its satellite and spacecrafts with the hopes of introducing it in the future (Nandakumar, 2018).

The same publicity had engulfed the launching of Elon Musk's Space X and Jeff Bezos's Blue Origin rockets in 2022 when it was publicized that toxic fumes were emitted from the launching of these rockets which can endanger humans nearby the rocket launcher and also the surrounding environment (Jefferson, 2022). Supposedly though, Space X was claimed to utilize an environmentally friendly fuel called RP-1 (Jefferson, 2022). How far this is true remains unconvincing.

It has also been reported that the taiga, where the forests meet between the border of Russia and Kazakhstan and not very far away from the Baikonour cosmodrome that discarded fuel tanks containing hydrazine (UDMH) from Russia's launched rocket have most often been found (Vassilieva, 2012, pp.1-2). Hydrazine purportedly have penetrated the soil and contaminated the water at nearby villages not far from the Baikonour cosmodrome (Vassilieva, 2012, p. 2). Villagers nearby the cosmodrome have reportedly also suffered from anemia, allergies, sore throat and skin diseases which they attribute to the hazardous rocket fuel (Vassilieva, 2012, p. 2). Few studies though have been conducted to show the direct connection between toxic fuel and the said diseases. The rate of cancer among villagers at Karakoksha was also high making the villagers wonder whether this could be attributed to toxic rocket fuel (Vassilieva, 2012, p. 2).

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005

In October, 2017 a three-stage rocket was supposed to be launched at the Plesetsk Cosmodrome using Russia's old satellite launcher Soviet SS-9 to send the European Space Agency's (ESA's) Sentinel-5P satellite that was produced by the Netherlands into orbit (Sevunts, 2017). One of the stages of the rocket would be shed at the Barents Sea, north of Norway while for the second stage it would be shed at the North Water Polynya in Baffin Bay, an Arctic habitat in the vicinity of Canada's Ellesmere Island and Greenland (Sevunts, 2017). The first stage of rocket fuel would carry seven tonnes of hydrazine and the second stage carrying one tonne (Sevunts, 2017). Since 2002, Russia already had a history of shedding its rocket stages containing hydrazine fuel into the Barents Sea and the North Water Polynya for about 10 occasions (Sevunts, 2017). Since the Inuit communities around the Barents Sea and the North Water Polynya rely on marine wildlife for their nutrition and survival, spilling hydrazine fuel would not only kill marine life but would contaminate the food source of this indigenous community. A researcher from the Canada Research Chair in Global Politics and International Law at the University of British Columbia had recommended that health surveys be conducted among Norwegian fishermen fishing around the Barents Sea and the Inuit living near North Water Polynya to identify if hydrazine-related diseases are present among these population (Sevunts, 2017). Water and air samples near the Barents Sea and the North Water Polynya are also to be taken to examine if any environmental contamination as the result of hydrazine pollution occurs (Sevunts, 2017). In this regard, the ESA and the Netherlands have been urged to pay a bit more to use a newer launch vehicle and non-toxic propellent although this may be more costly to save the environment and lessen health hazards (Sevunts, 2017).

Another space-faring state, China has also been guilty of getting its farmers from Guangxi to help pick up space debris in remote places exposing them to the toxic fuel hydrazine when China launched its Long March rocket (Watts, 2010). Supposedly, hydrazine could cause respiratory problems and nausea at low levels, can be absorbed by the skin, can damage the liver and reproductive organs, as well as causing tumours (Watts, 2010).

Thus, besides nuclear reactors to power satellites, rocket fuel such as hydrazine and its fuel tank have been recognized to cause environmental contamination and various health hazards as described in this research. Since this is the case, it has to be examined the extent that the international law governing outer space have adequately addressed these issues and also international health law that will be elaborated in separate sections of this paper.

The Principle of Integration

The principle of integration in the New Delhi Declaration of Principles of International Law Relating to Sustainable Development (hereinafter Delhi Declaration; International Law Association [ILA], 2002) is the enabler that seeks to fuse the three separate areas of environmental protection, economic development, and social development in line with the definition of ISDL. Jodoin (2005, p. 3) asserts that the principle of integration is "the most essential of all seven principles of sustainable development as identified by the [ILA]." The principle of integration serves as "a conceptual framework for 'integrated thinking' in international law relating to sustainable development, which can guide consideration of other principles", becoming the most important principle of the Delhi Declaration (Jodoin, 2005, p. 4). Furthermore, the principle of integration "influences and informs the elaboration, interpretation and application of other principles of sustainable development law" (Jodoin, 2005, p. 4). As indicated by the term, "integration" seeks to reconcile the three separate

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005
components of sustainable development with one another rather than letting them function separately.

The notion of reconciling separate areas of a particular discipline has its own history. Article 1 of the Charter of the United Nations (1945) (hereinafter UN Charter), stresses that "[t]o achieve international c[oo]peration in solving international problems of an economic, social, cultural, or humanitarian character". Indeed, it is viewed that the United Nations (UN) is the "centre for harmoni[s]ing the actions of nations in the attainment of these common ends." Besides the UN Charter, Article 31(3) (c) of the Vienna Convention on the Law of Treaties (VCLT, 1969) also emphasizes that a treaty should be interpreted in light "of any relevant rules of international law applicable between the [P]arties." This requires that varying branches of international law, whether it concerns international environmental law, international trade law or international social law, should not function separately but to reinforce one another rather than being "self-contained islands of international law, de-linked from other branches of international law" (Pauwelyn, 2004, pp. 903-927).

Each branch of international law within the scope of ISDL encompass their own category of issues. Within the realm of international economic law, this would cover the issues of trade in goods and services, economic integration, financial law, development law, international investment law, intellectual property and business regulation (Segger & Khalfan, 2004b, pp. 53-54). Relevant international organisations in the context of international economic law include the World Trade Organization (WTO), Organization of Economic Cooperation and Development (OECD), International Monetary Fund (IMF), UN Conference on Trade and Development (UNCTAD), and the World Bank (Segger & Khalfan, 2004b, pp. 53-54).

Furthermore, international social law is another subsidiary of law that constitute ISDL. International social law encompass international human rights law, international humanitarian law, law of armed conflict, international labour law, international health law, gender, population, food security, and social development (Segger & Khalfan, 2004b, p. 23). The last element of ISDL refers to international environmental law governing various issues extending to biodiversity, the ozone layer, hazardous waste, fisheries, biosafety, climate change, oil pollution, to wildlife and other issues. Figure 1 summarises the various issues covered within the ambit of international environmental law, international social law, and international economic law that form the crux of ISDL.

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005

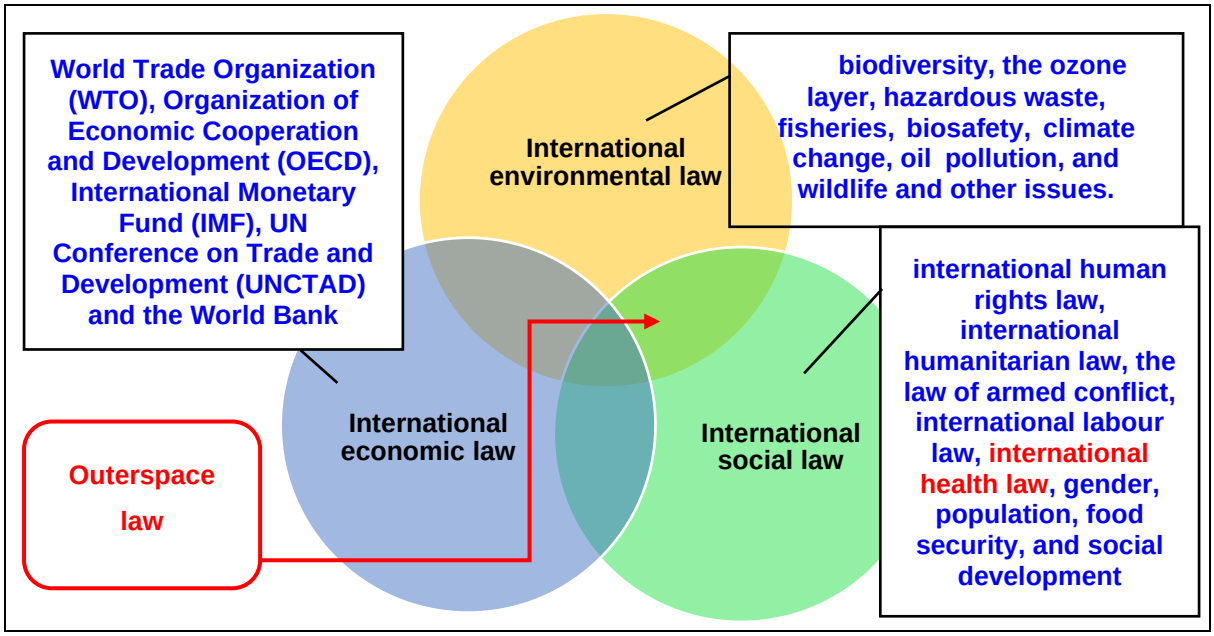

Figure 1: International Sustainable Development Law (ISDL) as a guiding framework for the placement of outer space law that covers environmental and health matters
Source: The diagram drawn is adapted from Segger & Khalfan (2004b)

While ISDL plays the role of connecting international economic law, international social law and international environmental law, a critical view is that ISDL should not be solely restricted to these branches of law. Indeed, there are other branches of international law that can equally subscribe to sustainable development such as outer space law that has covered the environmental aspects of space debris which also brings to the forefront its health implications for humans.

Results of the Analysis

Outer Space Treaties and Relevant Soft Law Documents

The issue of space debris contaminating outer space occurs during accidental collision or an intentional breakup to dispose of aged satellites, during the launching process of a rocket and satellites, as well as the re-entry of space debris into the earth's atmosphere which has brought to the forefront the importance of environmental protection, an aspect of sustainable development. Space debris has been defined as "all man-made objects, including fragments and elements thereof, in earth orbit or re-entering the atmosphere, that are non-functional" (UNOOSA, 2010, p. 1). The five binding treaties that constitute outer space law have not provided a definition for space debris at all. The gravitation of outer space law to embrace sustainable development follows the following milestone. In 1999, the Space Millennium: Vienna Declaration on Space and Human Development (thereafter Millennium Vienna Declaration) indicated that space activities must be in accordance with the direction of sustainable development (Hosseini et. al, 2021, p. 398). Moreover, this same Millennium Vienna Declaration asserted that space research should be useful to assist developing countries (Hosseini et. al, 2021, p. 398). Additionally, the Declaration on the fiftieth Anniversary of Human Space Flight and the Fiftieth Anniversary of the Committee on the Peaceful Uses of

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005

Outer Space in 2001 had "[e]xpress our deep concern about the fragility of the space environment and the challenges to the long-term sustainability of outer space activities, in particular the impact of space debris" (Hosseini et. al, 2021, p. 398). The most momentous breakthrough in linking outer space law with sustainable development came in June, 2011 when the UN Committee on the Peaceful Uses of Outer Space (UNCOPUOS) adopted the Terms of Reference and Methods of Work of the Working Group on Long-term Sustainability of Outer Space Activities that extended the concept of sustainable development into the area of outer space as an issue worthwhile to be examined (Pogorzelska, 2015, p. 77). Over time, the term of sustainable development was converted to sustainability. By June, 2018 UNCOPUOS produced 21 guidelines known as the Guidelines on the Long-term Sustainability of Outer Space Activities (Wolny, 2018).

A few guidelines are of relevance to the discussion on space debris in this research. The guideline to Promote and Support Research into and the Development of Ways to Support Sustainable Exploration and Use of Outer-Space emphasizes that states and international organization must promote technologies to minimize the environmental impact of manufacturing and launching space assets as well as the use of renewable resources. In particular, states and international organizations are urged to consider "the outcome document of the [UN] Conference on Sustainable Development (General Assembly Resolution 66/288, annex), the social, economic and environmental dimensions of sustainable development on earth" (UNOOSA, 2018, p.19). The said guideline goes on further to stress "appropriate safety measures to protect the earth and the space environment from harmful contamination" (UNOOSA, 2018, p.19). In this context, it is noted that a strong emphasis has been given towards environmental protection in the launching of spacecraft while states and the private sector are urged to use environmentally friendly resources for rockets and their spacecraft. Harmful contamination can be understood as causing environmental degradation as a consequence of space debris re-entering the earth atmosphere whether in air or on land, or in space itself as a result of any collision in outer space or the deliberate blasting of any old satellite of no longer in use. Whether harmful contamination can be extended to any health impact on human beings and animals is unclear but could very well imply so.

Another guideline relevant to the discussion on space debris issued by UNOOSA in June, 2018 is to Investigate and Consider New Measures to Manage the Space Debris Population in the Long Term (UNOOSA, 2018, p.19). This guideline stresses on the need to comply with the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space. With regard to controlled or uncontrolled re-entry into the earth atmosphere, it is stressed that the space debris must "not pose an undue risk to people or property, including through environmental pollution caused by hazardous substances" (UNOOSA, 2018, p.20). The wording in this particular paragraph just mentioned intends to address damage as contained in Article 1 of the Space Liability Convention. Article 1 (a) of the Space Liability Convention refers to damage as the loss of life, personal injury or other impairment to health; or loss of or damage to property of States or of persons, natural or juridical, or property of international organizations. While the Space Liability Convention does not refer to environmental pollution, it does refer to the impairment to health which is not stated in the guideline to Investigate and Consider New Measures to Manage the Space Debris Population in the Long Term. Failing to explicitly mention any health effects from space debris shows the drafters' intention to downplay the importance of international health law in the context of outer space.

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005

Of crucial importance is another guideline to Take Measures to Address Risks Associated with the Uncontrolled Re-entry of Space Objects whereby the launching state or intergovernmental organization will have to inform other states the likely location where the hazardous space object will likely drop to enable the latter to prepare in advance any emergency measures as contained in paragraph 1 (UNOOSA, 2018, p.16). In paragraph 6 of the aforementioned guideline, it has been asserted that the state or international intergovernmental organization having control over the fallen space object must furnish the necessary identification information, assist the affected state(s) which are victims of the hazardous space objects to conduct assessment analysis, evacuation and to return the hazardous space objects to the original owner as soon as possible. This is to prevent any harmful effects if any hazardous materials that could survive the process of re-entry to the earth atmosphere as indicated in paragraph 6 (UNOOSA, 2018, p.16). The term "harmful effects" is not defined at all but presumably it could imply harm to humans and animals' health wise or even harm to the environment. It would certainly be wise for the drafters of this guideline to spell out the details what is meant by "harmful effects" rather than leaving this term redundant and subjected to all kinds of interpretation. Then again, this guideline does not mention any hazards directly affecting human health to downgrade the importance of the said matter.

Yet another relevant guideline in addressing space debris is to Provide Updated Contact Information and Share Information on Space Objects and Orbital Events (UNOOSA, 2018, p.10). Paragraph 1 of this guideline requires entities possessing the necessary information to provide in a timely manner information concerning any incoming incident reports and forecasts to the Office for Outer Space Affairs to enable such information to be disseminated to other states. This should be done as soon as possible to prevent any probability collisions in outer space that may pose a risk to human lives, property and/or the environment as also in the case of re-entry of space objects into the earth atmosphere as indicated in paragraph 2 (UNOOSA, 2018, p.10). Notably, this guideline is more forthright in referring to health concerns as it pinpoints directly to the risk to human lives and also addresses the likely harm to the environment.

Moreover, the guideline to raise Awareness of Space Activities is crucial too since Paragraph 1(a) emphasizes to "[p]romote institutional and public awareness of space activities and their applications for sustainable development, environmental monitoring and assessment, disaster management and emergency response" (UNOOSA, 2018, p.18). This must be done in cooperation with public institutions and Non-Governmental Organizations (NGOs) through outreach programmes, education programmes, seminars being broadcasted over the internet and through other means (UNOOSA, 2018, p.18). The public must be aware about national and international policies, legislation, regulations and best practices relating to outer space activities to increase their own knowledge awareness (UNOOSA, 2018, p.18). Paragraph 4 of the said guideline also asserts the need for cooperation between government agencies, NGOs and the industry to also adopt the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space (UNOOSA, 2018, p.18). Notably, the wording of this guideline places a strong emphasis on sustainable development and the environment. However, nothing is mentioned about the downside of space exploration with regard to health concerns from the pollution of space debris falling from outer space or in the launching process of a rocket or spacecraft at all.

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005

With regard to national action to be taken, there is also the guideline to Consider a Number of Elements when Developing, Revising or Amending, as Necessary, National Regulatory Frameworks for Outer Space Activities. Paragraph 1 of this guideline urges states to implement the outer space treaties they have signed and ratified in good faith (UNOOSA, 2018, p.18). Paragraph 2 (c) of this aforementioned guideline also requires states to address "to the extent practicable, risks to people, property, public health and the environment associated with the launch, in-orbit operation and re-entry of space objects". Noticeably, equal emphasis has been given towards both public health and environmental protection in the wording of paragraph 2(c) which addresses the components of sustainable development. Paragraph 2 (d) on the other hand, encourages states to plan their activities in accordance with Sustainable Development Goals with the aim of realizing the sustainability of space and on earth. Much can be learned from the catastrophe of the Soviet Union's satellite, Cosmos 954 which bore a nuclear reactor that crashed into a remote area in Canada called Yellowknife in 1978 that caused millions of Canadian dollars for the cleaning up process that was partially borne by Canada and the Soviet Union having to pay compensation (Hosseini et. al, 2021, p. 392). It is for this reason that the guideline to Consider a Number of Elements when Developing, Revising or Amending, as Necessary, National Regulatory Frameworks for Outer Space Activities in paragraph 2 (e) urges states to implement the Safety Framework for Nuclear Power Source Applications in Outer Space and satisfy the intent of the Principles Relevant to the Use of Nuclear Power Sources in Outer Space through regulatory, legal and technical frameworks to prevent another catastrophe like the Soviet Union satellite crashing into another state's territory which contained a nuclear reactor for deep space exploration. Unless absolutely necessary, only far space exploration from the earth can trigger the usage of nuclear reactors. Otherwise, states have to use alternative forms of power for their rockets and satellites so as not to cause an environmental catastrophe and expensive cleaning up process.

Based on the analysis being conducted concerning the various guidelines that constitute the document Guidelines for the Long-term Sustainability of Outer Space Activities, on the one hand, the international community can be applauded in achieving a milestone in outer space law as finally environmental protection have come to the forefront in the exploration of outer space because of the issue of space debris and with other principles of international law being emphasized such as the principle of cooperation and principle of equity. While this achievement is indeed ground breaking, this has been hampered by the fact that all of the guidelines are soft law documents which are non-binding and states need only voluntarily apply these guidelines unlike binding outer space treaty law (Haroun at. al, 2021, p. 65; Hosseini et. al, 2021, p. 395). Nevertheless, these various guidelines can help fill in the gap and complement some of the outer space treaties that have ambiguous terms that need clarity. Such is the case of Article IX of the 1967 Outer Space Treaty whereby part of the wording of the said provision is indicated below:

> *States Parties to the Treaty shall pursue studies of outer space, including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their* ***harmful contamination*** *and also adverse changes in the* ***environment*** *of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose.*

While the Outer Space Treaty of 1967 is indeed binding on states which have signed and ratified this treaty, scholars (Haroun et. al, 2021, p. 65) have pinpointed the term "harmful contamination" to be unclear as it fails to provide for what constitute for harmful

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005

contamination. Another scholar (Pogorzelska, 2013) highlights that Article IX of the Outer Space Treaty of 1967 was intended to incorporate environmentally responsible behaviour to include space debris within the scope of contamination and to comply with the Space Debris Mitigation Guidelines of 2007. As Pogorzelska (2013) rightly exerts when the five outer space treaties were drafted in the late 1960s, environmental problems were barely given any consideration as it was the beginning of an era of exploring outer space. No one would have foreseen in the 21st century now that outer space would be overcrowded with many state satellites with all kinds of functions and those being non-functional to become space debris. Neither was there a formalized mechanism existing at the end of the 1960s at the UN to monitor environmental matters as the United Nations Environmental Programme (UNEP) only came into being in 1972 with the adoption of the Stockholm Declaration and charting the path for the evolvement of international environmental law (Segger & Khalfan, 2004a, p.17). Therefore, the various guidelines which constitute the document Guidelines for the Long-term Sustainability of Outer Space Activities (UNOOSA, 2018) in a way have paved the way in providing some clarity for some previously ambiguous terms such as that of "harmful contamination" as contained in Article IX of the Outer Space Treaty of 1967. This shows that soft law documents can provide more details with regard to ambiguous terms contained among provisions in outer space treaties to make them much clearer to the implementer.

Although harmful contamination based on the various guidelines contained in the document Guidelines for the Long-term Sustainability of Outer Space Activities have been meant to refer to environmental pollution, it is argued that this term should also extend to health concerns arising from being exposed to space debris which have re-entered the earth atmosphere. This aspect has been down played and deserves a much better emphasis with more and more states now becoming victims to space debris falling from the sky above. This is also a chance to further the development of international health law in the context of outer space in a most timely manner and emphasizing the role that the WHO can play on this matter. Nevertheless, the WHO has played a more subdued role with regard to the health concerns arising from space debris from outer space rather than being assertive on certain issues. Instead, the WHO presently has been collaborating with the Office for Outer Space Affairs with regard to the Space and Global Health Platform in promoting telehealth and the concern of how passengers would be affected health-wise with the promotion of space tourism (UNGA, 2022, p.4). It is stressed that the WHO should play a more proactive role in emphasizing health concerns with regard to the space debris matter rather than merely focusing on the positive aspects of health promotion in outer space.

Rejuvenating the World Health Organization's (WHO's) Role in Addressing Space Debris

In the past, the WHO had already been involved with work concerning outer space. In May, 1966 the WHO at the World Health Assembly (WHA) had produced a resolution entitled Effects of Atomic Radiation (WHO, 1966, p. 18). As early as 1966, the international community was already concern about the testing of nuclear weapons even in outer space as it would have "harmful effects to present and future generations resulting from the increase in the levels of radiation to which man is exposed from nuclear and nuclear weapon tests […]"as indicated in the said resolution (WHO, 1966, p. 18). The concern for present and future generations is a phrase that is now reflected in the definition of sustainable development. This same resolution had stressed that the effects of radiation "may not be fully manifested for several decades in the case of somatic disease (implying cancer) and for many generations in the case of genetic damage" (WHO, 1966, p. 18). This WHO resolution then called for

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005
"countries to respect the spirit and the provisions of the treaty banning nuclear weapon tests in the atmosphere, in outer space and under water" (WHO, 1966, p. 18). Furthermore, this resolution had emphasized the role that the WHO would play at the international level "in the field of health involving ionizing radiation, including protection from radiation hazards and the medical uses of radiation and radioactive isotopes" (WHO, 1966, p. 18). Subsequently, in one WHO document which addressed the topic about "international cooperation in the peaceful uses of outer space", special thanks were being made to the WHO, the International Atomic Energy Agency (IAEA) and International Science Council (ICSU) for participating and contributing to the work of the UN Conference on the Exploration and Peaceful Uses of Outer Space and to work within their area of competence (WHO, 1969, p. 18).

Moreover, the WHO has also worked with the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) that was formed in 1955 (WHO, 1970, p. 47). UNSCEAR has been responsible for receiving and assembling radiological information provided by UN members and specialized agencies (WHO, 1970, p. 47). Moreover, UNSCEAR has the task of increasing available knowledge about the levels and effects of atomic radiation from all sources (WHO, 1970, p. 47). Indeed, the WHO is represented at the yearly meetings of UNSCEAR and exchanges information for technical publications (WHO, 1970, p. 47). Additionally since 1959, the WHO has also worked closely with the Committee on the Peaceful Uses of Outer Space (WHO, 1970, p. 47).

Should there be a large catastrophe involving the dropping and explosion of a nuclear reactor satellite or hydrazine fuel tank that has fallen to earth, this could also trigger the application of the IHR 2005. An explosion of a nuclear reactor from a satellite or fuel tank containing hydrazine on a large scale covering a wide area circumference on a member state's territory may just be a public health emergency of international concern (PHEIC) enough to trigger the usage of the IHR 2005 as this applies to "public health risks of radiation, as well as those of […] chemical origin" (IAEA, 2013, p. 43). The IHR 2005 though is unclear with regard to the threshold of what can constitute a PHEIC whether a catastrophic incident would need to be of an international scale spreading to more than one country's territory and involves a rapid spread of diseases. For cases of a nuclear reactor or hydrazine fuel tank explosion, this is most likely to involve non-communicable diseases which may not spread easily at a rapid pace and may involve hundreds or a few thousand people merely. In such a situation, it is questionable whether this would qualify as a PHEIC as its criteria and threshold is unclear. However, a fallen space debris incident such as a nuclear reactor or hydrazine filled fuel tank may very well break into different parts, fall and spread within a few nearby country territories. A cue can be taken from the case of a China's Long March 5B rocket at the end of July, 2022 in Southeast Asia that involved the spread of space debris in Malaysia, Indonesia and the Philippines ('Debris from Chinese', 2022). This incident was not restricted to the national level but one that was international within the Southeast Asian region. Perhaps this could trigger the applicability of the IHR 2005 because it could very well be a PHEIC within a region.

The IHR 2005 requires states to have national focal points readily available to report anytime to the WHO a PHEIC and have an emergency response plan with necessary teams that include national radiation and chemical safety authorities who can be deployed to the catastrophic site to make an assessment and report of an incident (IAEA, 2013, p. 43). In an event of a nuclear or chemical catastrophe, the WHA has stated "to treat any deliberate use of […] chemical agents and radiological or nuclear attack […] as a global public health threat" (IAEA, 2013, p.

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005

45). WHO states are also encouraged to share expertise, supplies and resources to affected states. There is also a reference to contact points and experts internationally that could be referred when dealing with a nuclear catastrophe of a large scale (IAEA, 2013, pp. 45-46).

However, the IHR 2005 has its drawback since it is mainly concerned with public health risks such as the international spread of diseases which could imply communicable diseases that fastidiously transmit across borders. In clarifying this grey area, the WHO can make an impact by issuing a statement, resolution or guideline in the event of a catastrophic space debris disaster involving a nuclear reactor or hydrazine fuel tank that the IHR 2005 could apply and need not be restricted to communicable diseases spreading across state borders. A word of caution has been made that is "not all events involving radiation present the risks to public health to trigger some of the provisions in the IHR" (IAEA, 2013, p. 46). This could even imply if one to five individuals are being hit by a contaminated space debris with nuclear radiation or parts of a fuel tank that is toxic that this might not be good enough to trigger the IHR 2005. The Department of Public Health and the Environment (PHE), Health Security and Environment Cluster (HSE) of the WHO is the contact point for dealing with nuclear disasters in the event of a nuclear reactor explosion as a space debris.

In making the WHO's role more prominent to link outer space and international health law further, it could always issue a requirement among member states to the IHR 2005 to notify an incident of space debris involving nuclear reactors and its materials used or the chemicals used for a fuel tank in a rocket/ spacecraft and the likely health diseases affected states would encounter among its population with the drop of the hazardous space debris into their territory. This would alert the affected states in advance for an emergency situation. Such a requirement is an addition for the launching state that had launched a rocket or satellite to comply with besides the need to inform the coordinates where the hazardous space debris would likely fall. By the WHO doing this, it could thrust its role to more prominence in addressing health matters pertaining to space debris.

With regard to the WHO monitoring the health consequences of hydrazine, a very old booklet dating back to 1987 merely indicates its usage as a monopropellant in space vehicles and satellites (WHO, 1987). This booklet also indicated that hydrazine can also be an occupational safety and health hazard for those workers involved in spacecraft launching (WHO, 1987). As studies indicating how hydrazine could affect the targeted population exposed to it and the related diseases it would cause are indeed very few in number, the WHO needs to encourage more studies as pertains to toxic hydrazine space debris affecting indigenous groups or those responsible for filling up fuel in rockets. Based on these studies conducted, the WHO can probably sum up if hydrazine can continue to be used as rocket/ spacecraft fuel or more environmentally friendly fuel must be produced by space-faring states.

In sum, this section's analysis of the WHO's role of developing international health law in relation to outer space activities through a binding treaty and other soft law documents has showed its very limited role in doing so. As more non-space-faring states are becoming victims of space debris that could be hazardous, the time is ripe for the WHO to channel all attention through statements and documentation concerning the health hazards of space debris and possible associated diseases to create more awareness among states and its population as this must not be taken lightly. This will enable the WHO to have more clout and not become a redundant organization failing to address health concerns as pertain to outer space. Thus, the

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005
WHO now has the opportunity to develop international health law further in the context of outer space as this is the missing league to truly achieve sustainability in outer space.

Conclusion

In conclusion, while outer space law has increasingly started to pay attention to environmental contamination and sustainable development because of the space debris phenomenon, this does not equally apply to harm to human health from the space debris requiring more action to be taken in international health law by the WHO. This has been reflected by the analysis of the subsidiary guidelines which are contained in the document Guidelines on the Long-term Sustainability of Outer Space Activities which did focus on environmental contamination and protection and have referred explicitly to the attainment of sustainable development. These subsidiary guidelines though can help to clarify the ambiguous term "harmful contamination" to refer to environmental pollution contained in Article IX of the 1967 Outer Space Treaty as soft law documents can support the implementation of treaties which are unclear.

This research has had to examine collaborative work done by the WHO and other international organizations such as the IAEA, UNSCEAR and UNOOSA in addressing nuclear radiation contamination which may apply to hazardous space debris in outer space activities. No specific documentation *per se* has been issued by the WHO itself in dealing with nuclear radiation materials from space debris as a result of outer space activities and its health implications. Indeed, it would be timely for the WHO to produce a specific documentation on this matter.

With regard to dealing with toxic hydrazine contained in fuel tanks of space craft that fall to the earth as space debris, only one WHO guideline that provides some description about the health hazards of hydrazine briefly mentions its usage in space crafts and as an occupational safety hazard among workers having to fill up rockets with this fuel. Barely much studies especially have been conducted to show how hydrazine which could be present among discarded space debris in a fuel tank could affect health authorities responsible for moving it, the local community and indigenous people when they accidentally come into contact and are exposed to this toxic chemical. The implication from this finding is that the WHO has a role to play in encouraging more studies to be conducted about hydrazine used for outer space activities and the form of diseases it would cause the local population, indigenous communities, and workers responsible for filling up this fuel into rockets. The WHO will also need to encourage space-faring states to research and produce more environmentally friendly rocket fuel as not to cause health hazards to various segments of society already mentioned. The more disturbing findings from this research relates to indigenous communities being affected by toxic hydrazine fuel when irresponsible states dump discarded fuel into the sea to affect marine life which is the source of food and livelihood for indigenous communities as in the case of the Barents Sea and North Water Polynya. In one report prepared by the United Nations Department on Economic and Social Affairs (UNDESA) (2015, p. 175), it was highlighted that indigenous people could suffer from environmental pollution with affects their health in the form of space debris. Ironically, it is the UNDESA that is concerned about indigenous people's health being affected by space debris while the WHO has not openly addressed this matter rightfully under its jurisdiction. This raises an environmental justice issue of dumping toxic substances in remote places but not within the launching state's territory itself for fear of health hazards and opposition from their population. The implication from this finding is that there is room to explore international human rights law which also forms the crux of ISDL with regard

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005

to indigenous communities' rights being affected by outer space activities, in particular space debris deposition.

With regard to the utilisation of the IHR 2005 in the context of space debris incidents, any launching state of a rocket/satellite that is aware that a hazardous space debris containing toxic chemicals or nuclear material could very well inform the affected states that will be victims of the fallen space debris such as fuel tanks or nuclear-powered reactors. The launching state must furnish information concerning the form of chemicals being used for fuel or nuclear material powering the satellite such as uranium or plutonium and the likely health diseases that would cause victimized states. This should serve as a means for the affected states to prepare for an emergency affecting its population. This should be an additional requirement to the launching state besides providing the coordinates where a fuel tank containing hazardous chemicals or nuclear-powered reactor would fall from outer space. The problem with the application of the IHR 2005 is that it might apply to a large-scale health emergency worldwide such as communicable diseases whereas a few states may only be victims of hazardous space debris to affect a minority of its population to not trigger the usage of the IHR 2005 itself. All of the actions mentioned would certainly help in the furtherance of international health law development in outer space which now has many loopholes.

Acknowledgement
The author wishes to thank the anonymous reviewer for his/her constructive comments in improving this manuscript.

References

Adnan, T. B. T. M. (Ogos 3, 2022). Objek disyaki serpihan roket China tiba di Kuala Lumpur [Object suspected to be Chinese rocket debris arrived in Kuala Lumpur]. *Sinar Harian*. https://www.sinarharian.com.my/article/214633/berita/nasional/objek-disyaki-serpihan-roket-china-tiba-di-kuala-lumpur

Blaikie, N. (2004). Interpretivism. In M. S. L. Beck, A. Bryman & T. F. Liao (Eds.), *The SAGE encyclopaedia of social science research methods* (pp. 509-511). Thousand Oaks: Sage Publications Inc.

Bowen, D. (October, 2020). When a Russian satellite made Yellowknife a part of Cold War history. *Up Here Canada*. https://www.uphere.ca/articles/when-russian-satellite-made-yellowknife-part-cold-war-history#:~:text=The%20Cosmos%20954%20satellite%20crashed,showed%20up%20within%2024%20hours.

Burns, R., & Baldor, L. C. (February 21, 2008). Satellite debris deemed unhazardous. *NBC News*. https://www.nbcnews.com/id/wbna23273913

Charter of the United Nations, June 26, 1945, 1 U.N.T.S. XVI.

Convention on International Liability for Damage Caused by Space Objects (hereinafter Space Liability Convention), March 29, 1972, 861 U.N.T.S. 187.

Dart, C. (2022, November 14). *In 1978, a Soviet satellite exploded over traditional Dené land. Its effects are still felt today* [Podcast]. CBC Canada. https://www.cbc.ca/arts/operation-morning-light-podcast-soviet-satellite-exploded-traditional-dene-land-1.6650994#:~:text=On%20Jan.,into%20northern%20Alberta%20and%20Saskatchewan.

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005

Debris from Chinese rocket crash found in Malaysia, Indonesia. (August 2, 2022). *India Today*. https://www.indiatoday.in/science/story/debris-from-chinese-rocket-crash-found-in-malaysia-indonesia-1982727-2022-08-02

Freeland, S., & Kuan, W. C. D. (2023). A pandemic in space- Are we ready? *Spacewatch Asia-Pacific*. https://spacewatch.global/2020/05/spacewatch-global-opinion-a-pandemic-in-space-are-we-ready/

Gupta, B., & Agasti, T. (2022). The curious case of Article IX and outer space environment. *Journal of Environmental Impact and Management Policy*, *2*(2), 12–30.

Haroun, F., Ajibade, S., Oladmeiji, P., & Igbozurike, J. K. (2021). Toward the sustainability of outer space: Addressing the issue of space debris. *New Space*, *9*(1), 63–71.

Harris, M., Duda, P. I., Kelman, I., & Glick, N. (2023). Addressing disaster and health risks for sustainable outer space. *Integrated Environmental Assessment and Management*, *19*(4), 994–1001.

Hosseini, S. M., Fathpour, F., & Chanda, S. (2021). Space debris mitigation: Some lessons from international environmental law. *Environmental Policy and Law*, *51*(6), 391–401.

International Atomic Energy Agency. (2013). *Joint radiation emergency management plan of the international organizations*. Vienna: International Atomic Energy Agency. https://www-pub.iaea.org/MTCD/Publications/PDF/EPRJplan2013_web.pdf

International Health Regulations 2005, May 23, 2005, 44 I.L.M. 1011.

International Law Association (ILA). (2002). *New Delhi Declaration of Principles of International Law Relating to Sustainable Development.* Retrieved from http://www.ila-hq.org/en/committees/index.cfm/cid/25.

Jay, Alan. (August 2, 2022a). Horseshoe shaped object found in Bintulu palm plantation, public told to stay away from it. *New Sarawak Tribune*. https://www.aelb.gov.my/v2/news-category/new-sarawak-tribune/#:~:text=Horseshoe%20shaped%20object%20found%20in,to%20stay%20away%20from%20it&text=BINTULU%3A%20Just%20a%20day%20after,private%20palm%20plantation%20here%20yesterday

Jay, Allan. (August 11, 2022b). Third metal object believed to be rocket debris found. *New Sarawak Tribune*. https://www.newsarawaktribune.com.my/third-metal-object-believed-to-be-rocket-debris-found/

Jefferson, R. (May 22, 2022). *Rocket fumes from SpaceX, Blue Origin "hazardous to human health", study finds*. https://www.sciencetimes.com/articles/37795/20220522/rocket-fumes-spacex-blue-origin-hazardous-human-health-study-finds.htm#:~:text=The%20latest%20research%20implies%20that,also%20our%20planet's%20natural%20condition.

Jodoin, S. (2005). *The principle of integration and interrelationship in relation to human rights and social, economic and environmental objectives.* (Centre of International Sustainable Development Law (CISDL) Legal Working Paper). Retrieved from Centre of International Sustainable Development Law: http://www.worldfuture council.org/fileadmin/user.../CISDL_P6_Integration.pdf

Kelley, R. L., & Johnson, N. L. (2012, January). Evaluating and addressing potential hazards of fuel tanks surviving atmospheric re-entry. *Proceedings of the 5th IAASS Conference A Safer Space for Safer World*. 5th IAASS Conference A Safer Space for Safer World, Noordwijk, Netherlands. https://articles.adsabs.harvard.edu/pdf/2012ESASP.699E..47K

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005
Launius, R. D. (2014). Reacting to nuclear power systems in space: American public protests over outer planetary probes since the 1980s. *Acta Astronautica*, *96*, 188–200. https://doi.org/10.1016/j.actaastro.2013.12.004

Leong, A. (August 14, 2022). Rocket debris punctured house roof in Sibu, allegedly from China's Long March rocket. *The Rakyat Post*. https://www.therakyatpost.com/news/2022/08/14/rocket-debris-punctured-house-roof-in-sibu-allegedly-from-chinas-long-march-rocket/#:~:text=A%20piece%20believed%20to%20be,roof%20for%20a%20few%20weeks.

Merezhko, O. (2014). Legal hermeneutics and methodology of law. *European Political and Law Discourse*, *1*(2), 4-10.

Mihajlov, V. S. (1989). International health law: Current status and future prospects. *International Digest of Health Legislation*, *40*(1), 9–16.

Nakamura, K. (2020). Space debris and liability schemes under international law. *Waseda Law Review*, *95*(3), 1–26.

Nandakumar, T. (May 13, 2018). ISRO making green propellant. *The Hindu*. https://www.thehindu.com/sci-tech/science/isro-making-green-propellant/article23874464.ece

Navy says missile smashed wayward satellite. (February 21, 2008). *NBC News*. https://www.nbcnews.com/id/wbna23265613

Operation morning light. (2013). National Nuclear Security Administration, US Department of Energy. https://nnss.gov/wp-content/uploads/2023/04/DOENV_1198-1.pdf

Parks, L. (June 12, 2009). *When satellites fall: On the trails of Cosmos 954 and USA 193*. FLOW Journal. https://www.flowjournal.org/2009/06/when-satellites-fall-on-the-trails-of-cosmos-954-and-usa-193lisa-parks-uc-santa-barbara/

Pauwelyn, J. (2004). Bridging fragmentation and unity: International law as a universe of inter-connected islands. *Michigan Journal of International Law*, *25*, 903–927.

Pillai, V. (August 2, 2022). "Debris" from China rocket re-entry: M'sia not discounting legal action. *Focus Malaysia*. https://focusmalaysia.my/debris-from-china-rocket-re-entry-msia-not-discounting-legal-action/

Pogorzelska, K. (2013, April). *Space debris in the perspective of sustainable development* [Paper presentation]. 6th European Conference on Space Debris, 22-25 April 2013, Darmstadt, Germany. https://conference.sdo.esoc.esa.int/proceedings/sdc6/paper/83/SDC6-paper83.pdf

Pogorzelska, K. (2015). Building upon the development in the law of the sea: The extension of the concept of sustainable development to outer space. *Maritime Safety and Security Law Journal*, *1*, 71–94.

Popova, R., & Schaus, V. (2018). The legal framework for space debris remediation as a tool for sutainability in outer space. *Aerospace*, *5*(55), 1–17.

Report of the United Nations Conference on Environment and Development (UNCED), June 3-14, 1992, *Rio Declaration on Environment and Development*, U.N. Doc. A/CONF.151/26/Rev.1 (Vol. 1) (Aug. 12, 1992).

Ritz, B., Morgenstern, H., Froines, J., & Moncau, J. (1999). Chemical exposures of rocket-engine test-stand personnel and cancer mortality in a cohort of aerospace workers. *Journal of Occupational and Environmental Medicine*, *41*(10), 903–910.

Rosa-Aquino, P., & McFall-Johnsen, M. (August 6, 2022). Mystery wreckage in Malaysia, Indonesia, and Philippines is probably fallen Chinese rocket parts space-debris experts

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005

say. *Business Insider*. https://www.businessinsider.com/photos-mystery-space-debris-borneo-philippines-likely-chinese-rocket-parts-2022-8

Sayed, M. M., & Li, S. (2023). Navigating damages in space activities: Comprehensive understanding of damage in space activities. *Beijing Law Review, 14*, 1123–1141. https://doi.org/10.4236/blr.2023.143059

Segger, M. C. C., & Khalfan, A. (2004a). Principles of international law relating to sustainable development. In M. C. C. Segger & A. Khalfan (Eds.), *Sustainable development law: Principles, practices, & prospects* (pp. 95-171). Oxford: Oxford University Press.

Segger, M. C. C., & Khalfan, A. (2004b). The intersections of international economic, social and environmental law. In M. C. C. Segger & A. Khalfan (Eds.), *Sustainable development law: Principles, practices, & prospects* (pp. 51-91). Oxford: Oxford University Press.

Sevunts, L. (October 9, 2017). Fears toxic splash in Barents Sea and Baffin Bay from Russian rocket. *The Barent Observer*. https://thebarentsobserver.com/ru/node/3021#:~:text=The%20potential%20dangers%20presented%20by,the%20prestigious%20science%20journal%2C%20Polar

Toyat, J. (August 1, 2022). Batu Niah resident discovers metal fragments, believes them to be rocket debris. *The Borneo Post*. https://www.theborneopost.com/2022/08/01/batu-niah-resident-discovers-metal-fragments-believes-them-to-be-rocket-debris/

Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (hereinafter Outer Space Treaty 1967), January 27, 1967, 610 U.N.T.S. 205.

Trofimov, I., Boichenko, S., & Shmanskyi, S. (2020). Analysis of rocket fuels and problems of their application on the example of Ukraine. *Technology Audit and Production Reserves, 6/1*(56), 19–27.

United Nations Department on Economic and Social Affairs. 2015. *State of the World's Indigenous Peoples: Indigenous People's Access to Health Services*. Vol. II. New York: United Nations Department on Economic and Social Affairs.

United Nations General Assembly [UNGA], *Resolution adopted by the General Assembly on 12 December 2022: 77/121.International Cooperation in the peaceful uses of outer space*, U.N. GAOR, 77th Sess., U.N. Doc. A/RES/77/121 (December, 2022).

United Nations Office for Outer Space Affairs [UNOOSA], Committee of the Peaceful Uses of Outer Space. *Guidelines for the Long-term Sustainability of Outer Space Activities*. A/AC.105/2018/CRP.20 (June 27, 2018).

United Nations Office for Outer Space Affairs (UNOOSA). (2010). *Space debris mitigation guidelines of the Committee on the Peaceful Uses of Outer Space*. Vienna: United Nations Office for Outer Space Affairs. https://www.unoosa.org/pdf/publications/st_space_49E.pdf

Vassilieva, M. (August 7, 2012). Russians say space rocket debris is health hazard. *BBC*. https://www.bbc.com/news/world-europe-19127713

Vienna Convention on the Law of Treaties, May 23, 1969, U.N.T.S. 1155.

Watts, J. (January 19, 2010). Health fears over Chinese villagers clearing up toxic rocket debris. *The Guardian*. https://www.theguardian.com/environment/2010/jan/19/health-fears-chinese-rocket-debris#:~:text=Health%20fears%20over%20Chinese%20villagers%20clearing%20up%20toxic%20rocket%20debris,-This%20article%20is&text=Questions%20are%20being%20asked%20about,rockets%20and%20other%20toxic%20debris.

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 8 Issue 34 (December 2023) PP. 54-77
DOI 10/35631/JTHEM.834005

Wernet, A. (2014). Hermeneutics and objective hermeneutics. In U. Flick (Ed.), *The SAGE handbook of qualitative data analysis* (pp. 234-247). London: SAGE Publications Ltd.

Wolny, J. (2018). *The UN Copous Guidelines on the Long-term Sustainability of Outer Space Activities*. Secure World Foundation. https://swfound.org/media/206227/swf_un_copuos_lts_guidelines_fact_sheet_august_2018.pdf

World Commission on Environment and Development (WCED). (1987). *Our common future: Australian edition.* Melbourne: Oxford University Press.

World Health Organisation (WHO). (1970). *United Nations General Assembly and its subsidiary organs.* (Official Records of the World Health Organization No. 181, Executive Board 45th Session, 20-29 January 1970). Geneva: Author.

World Health Organisation [WHO], *Co-ordination with other organizations: The United Nations, the specialized agencies and International Atomic Energy Agency, Twenty Second World Health Assembly,* A22/P&B/9 (June 2, 1969).

World Health Organisation [WHO], *Effects of atomic radiation, Nineteenth World Health Assembly,* WHA 19.39 (May 20, 1966).

World Health Organization. (1987). *Hydrazine*. Geneva: World Health Organization. https://iris.who.int/bitstream/handle/10665/39600/9241542683-eng.pdf?sequence=1&isAllowed=y

Zannoni, D. (2020). Space law. In *Yearbook of international disaster law online* (pp. 626–635). Brill. file:///C:/Users/user/Downloads/yido-article-p626_35%20(2).pdf