CSR in Space

Corporate Social Responsibility Principles for the Space Industries

Author: Thorbjørn Waal Lundsgaard, MPhil, MSc, LLM,
E-mail: thorbjwl@gmail.com
Affiliations: Oxford Brookes University, University of Agder

For video presentation of paper: Click here

Abstract

Laws already exist which govern space, as do corporate social responsibility (CSR) guidelines for companies operating on Earth and a growing movement pushing for legal clarity inter alia concerning property rights in space. Until now, no effort has been made to analyse the mutual implications of these developments-and consequently to produce CSR guidelines based on them, for space. Terrestrial CSR has evolved to fill gaps in national legal and policy frameworks by formulating principles and guidance, sometimes based on soft law instruments. This function of remedying legal uncertainties makes CSR an ideal tool and approach for defining and addressing responsible corporate behaviour in space. CSR Guidelines for Space ought to help public and private actors alike achieve the sustainable commercial exploitation of space resources.

CSR should be taken seriously by space industries because:

1) It can help to guide companies to act in a socially responsible way in areas where legal standards are still developing,
2) It can help ensure a continued "social license to operate" with reference to terrestrial stakeholders,
3) It can help to build renewed support for public and private investment in space science and space industries.

I argue that CSR Guidelines for Space should address the following 10 issues:
Monitoring, Safety, Transparency, Accountability, Conservation, Health, Psychological Health, Environment, Space junk and Respect to Property.

Key words: Space policy, international law, space law, corporate social responsibility, social license to operate, private space industry.

Thorbjørn Waal Lundsgaard, E-mail: thorbjwl@gmail.com

Contents

1. Introduction

The world's limited resources and the prospects of a new economic profiteering adventure in space have resulted in growing interest for harvesting resources from the moon, Mars or Near Earth Asteroids (NEA). While the first space race was between governments, the ongoing second space race is one in which private actors compete in the realms of tourism, transport, exploration and extraction of resources. Revenue in the total space economy was USD 256.2 billion in 2013.[1]

This new field of corporate activity is only partially regulated by law, while corporate social responsibility (CSR) guidelines for companies operating on Earth are not generally apposite to the space environment: certain social and environmental risks attaching to corporate activity on earth (such as those connected to human resettlement, for example) are redundant in space, while at the same time space industries pose unique risks, such as back contamination, and dilemmas, for instance over resource distribution and heritage, to which their terrestrial correlates are not exposed.

This article argues that CSR should apply in space. First it provides an overview of the main areas of business activity in space currently, and highlights potential impacts. This section also briefly describes off-earth mining, as a potentially high-impact sector, and profiles a number of pioneer space companies, to illustrate the range of emerging corporate activities in space. Secondly, it explores international law, especially space law, to ascertain the scope and content of legal standards relating to business activity in space. Thirdly, it considers terrestrial CSR standards and guidelines, and identifies the extent to which the latter transpose to the space environment. Fourth, on this basis, the article proposes a new set of CSR guidelines that, taking into account the character of the unique outer space environment, reflect possible environmental and human impacts of space industries both on earth and in space.

2. Space industries and their potential impacts on terrestrial society

The recent advent of private space industries shows that boundless budgets from superpower states are no longer necessary to secure continued space exploration: today rising numbers of corporations are willing to take the risks associated with space exploration based on projected

[1] OECD. 2014, 'The Space Economy at a Glance 2014', OECD Publishing. http://dx.doi.org/10.1787/9789264217294-en, 10-45. This includes participants that depend on certain satellite capability for a portion of their incomes, e.g. satellite television services suppliers.

future rewards. This section provides a brief introduction to space industries, with an emphasis on new areas such as resource extraction, alongside more established ones such as satellite communications, to offer a window into the future of space exploration and some of its likely accompanying regulatory, social, environmental and ethical challenges.

2.1 The space economy

NASA defines the space economy broadly, as "the full range of activities and the use of resources that create and provide value and benefits to human beings in the course of exploring, understanding and utilizing space."[2] According to the OECD, the global space sector is a high-tech industry comprising a multi-faceted network with approximately 900,000 employees globally in 2013 across public administrations (space agencies, space departments in civil and defence-related organizations); the space manufacturing industry (building rockets, satellites, ground systems); direct suppliers to this industry (components), and the broader space services sector (mainly commercial satellite telecommunications),[3] though excluding universities and research institutions. Revenue in the total space economy was USD 256.2 billion in 2013, distributed between the space manufacturing supply chain (33%), satellite operators (8.4%) and consumer services (58%).[4] Even though OECD countries had the largest share of space resources worldwide in 2013, at USD 50.8 billion[5], with purchasing power parities (PPPs), a growing share of worldwide space industries occur in non-OECD countries, in particular, the Russian Federation, Brazil, India and China, approximately USD 24 billion PPPs.[6]

Though space exploration has a reputation for being costly, by comparison national investments embody a minor fraction relative to GDP in G20 states.[7] In the U.S., which has the largest space programme globally, this accounts for a mere 0.3% of GDP. The annual budget of the European Space Agency (ESA), funded by European Union Member States, is

[2] OECD: 2012, 'OECD Handbook on Measuring the Space Economy', OECD Publishing, 9.
[3] OECD. 2014, 'The Space Economy at a Glance 2014', OECD Publishing. http://dx.doi.org/10.1787/9789264217294-en, 10-45.
[4] OECD. 2014, 'The Space Economy at a Glance 2014', OECD Publishing. http://dx.doi.org/10.1787/9789264217294-en, 10-45. This includes participants that depend on certain satellite capability for a portion of their incomes, e.g. satellite television services suppliers.
[5] Space budget in USD millions, 2013: USA 39 332.2, CHN 10 774.6, RUS 8 691.6, IND 4 267.7, JPN 3 421.8 , OECD calculations based on national data and OECD MEI data, see: OECD. 2014, 'The Space Economy at a Glance 2014', OECD Publishing. http://dx.doi.org/10.1787/9789264217294-en, 18.
[6] OECD. 2014, 'The Space Economy at a Glance 2014', OECD Publishing. http://dx.doi.org/10.1787/9789264217294-en, 10-45.
[7] OECD. 2014, 'The Space Economy at a Glance 2014', OECD Publishing. http://dx.doi.org/10.1787/9789264217294-en, 10-45.

around EUR 4 billion per year.[8] Nor does space research dwarf terrestrial industrial research budgets: the Mars Science Laboratory (MSL), which among other sent Curiosity to Mars has cost $2.5 billion,[9] of a comparable magnitude to the 2013 global exploration and evaluation expenditure of a single company, the Australian miner Rio Tinto, of US$948 million.[10]
In terms of the return on such investments, this needs to be calculated to take account of innovation and spin-offs. As of 2012, NASA has had approximately 1,800 spin-off technologies to sectors such as healthcare and medicine, transportation, manufacturing and materials, and computer technologies.[11] In Europe, space technology transfers to industry include span air purification systems in hospital intensive care wards to radar surveying of tunnel rock to improve the safety of miners.[12] On this basis, across OECD countries, rates of return range are calculated to extend from 1: 1.4 to 4.7.[13] [14] It is also expected that competitive forces accompanying the "privatization" of space industries will reduce costs and increase such returns further, for example, projected to bring down launch costs down from about US$20,000 per kilogram to approximately US$2,000 per kilogram.[15] [16] Thus, the expansion of space competences is an attractive strategic goal, and the number of states and corporations financing space systems is likely to continue to grow.

2.2 Off-earth resource extraction

A potentially high-impact sector within the space economy and one with an obvious terrestrial analogue which has attracted attention in the CSR area is space-mining. To date, asteroids have been the primary focus of interest for extraterrestrial resource extraction, given the high

[8] OECD. 2014, 'The Space Economy at a Glance 2014', OECD Publishing. http://dx.doi.org/10.1787/9789264217294-en, 20-25. ESA had 17 active scientific satellites in 2014, and has designed, tested and operated in flight over 70 satellites, and has developed six types of launchers with its member states and their industry.
[9] Spacenews. 2012, 'MSL Readings Could Improve Safety for Human Mars Missions', http://spacenews.com/msl-readings-could-improve-safety-human-mars-missions/.
[10] Rio Tinto. 2014, Annual report, Delivering sustainable shareholder returns , 38.
[11] NASA. 2014, Office of the Chief Technologist, NASA Spinoffs, www.spinoff.nasa.gov.
[12] ESA. 2014, 'ESA Technology Transfer Programme', www.esa.int/Our_Activities/Technology/TTP2.
[13] OECD. 2012, 'OECD Handbook on Measuring the Space Economy', OECD Publishing. dx.doi.org/10.1787/9789264169166-en.
[14] OECD. 2014, 'The Space Economy at a Glance 2014', OECD Publishing. http://dx.doi.org/10.1787/9789264217294-en, 80. For each million Norwegian kroner (NOK) of ESA funding, Norwegian space sector corporations have on average achieved supplementary revenue through new market advances valued at NOK 4.7 million in 2013. Similarly, every million euros of Danish funding to ESA have produced revenue of EUR 3.7 millionOther country based calculations of financial returns from space investments include Belgium 1 Euro: 1.4 Euros (2010), Ireland 1 Euro: 3.63 (2012), Portugal 1 Euro: 2 Euros (2011), United Kingdom 1 Pound: 1.91 Pound (2010).
[15] Francis Lyall, Paul B Larsen. 2013, 'Space Law: A Treatise', Ashgate Publishing, 430.
[16] SpaceX publishes its launch costs on its website. For its Falcon 9, that number is approximately US$12,600http://www.spacex.com/about/capabilities

concentrations of minerals they may contain[17] (platinum mining sites today are archaeological-asteroid impact sites). Near Earth Asteroids (NEAs) can contain up to 30 elements at concentrations exceeding terrestrial concentrations and up to 10 of which are found in excess of minimum mining concentrations (cut-off grades) on Earth.[18] There may be approximately 20,000 Near Earth Asteroids larger than 100m in diameter[19] and approximately 10 million bigger than 20m in diameter.[20] .[21] [22].[23]. On this basis, a 100m diameter metallic asteroid has a mass of around four million metric tons,[24] and is likely to contain twelve million troy ounces of platinum group metals (PGMs), with a market value of approximately 12 billion US dollars, and 500 million kg of nickel, with an estimated market value of 8 billion US dollars.[25]

In addition, the surface of the moon is of interest to potential miners as the only place in our solar system where high quantities of Rare Earth Elements (REE) are likely to be found, in similar concentrations as on earth.[26] [27].

---

[17] In parts of asteroids, a core-forming process has not taken place, so that Platinum Group Metals (PGMs) are concentrated 1000 times compared to that found in the Earth´s crust and mantle. PGMs are: iridium, osmium, rhodium, platinum and ruthenium. In addition, several asteroids have been blown apart by impacts, exposing chunks of their cores with concentration of resources not found anywhere on Earth.

[18] 40% of NEAs can include PGE + Au, Ni, Co and various base metals in concentrations which exceed current cut-off grades on earth. 15% of NEA may have PGE + Au in geometric concentrations > 4.5 times, and 99% of S/Q-type NEA composed of L-chondrite subgroups may have Pt exceeding, that of terrestrial cut-off grades (Fig 1). Ness, P.K., Compiling a new database of meteorites: Analyses on bulk elemental abundances of meteorites and their implications to future space resources, in Graduate School of Frontier Sciences: Complexity, Science & Engineering2013, The University of Tokyo: Tokyo. p. 546.

[19] Mainzer A., et al., 2011, NEOWISE Observations of Near--Earth Objects: Preliminary Results, Astrophysical Journal, 743, 156.

[20] Brown P.G., et al., 2013, A 500--kiloton airburst over Chelyabinsk and enhanced hazard from small impactors, Nature, 503, 238---241.

[21] Most NEAs are regular chondrites mainly consisting of iron-nickel metal, Dorminey. B. 2014, 'Forex Manna From Heaven: Space Mining And The Peak Metals Crunch', The Financial Times, [accessed 06.09.2014: http://www.forbes.com/sites/brucedorminey/2012/05/28/forex-manna-from-heaven-space-mining-and-the-peak-metal-crunch/]

[22] Dorminey. B. 2014, 'Forex Manna From Heaven: Space Mining And The Peak Metals Crunch', The Financial Times, [accessed 06.09.2014: http://www.forbes.com/sites/brucedorminey/2012/05/28/forex-manna-from-heaven-space-mining-and-the-peak-metal-crunch/]

[23] LL chondrites can contain up to one hundred parts per million of PGMs. Only 20% of M-type asteroids are likely highly attractive as exploration targets. For this reason, early surveying is needed to find LL chondrites which may contain minimal metal deposits e.g.1 to 3 % but which are rich in PGMs, Boucher, D., NORCAT Product Innovation at the Northern Center for Advanced Technology. The space mining cycle. , C. Hanson, Editor April 30, 2012. The concentration of resources in space can be broadly determined remotely (i.e. target identification), but in-situ evaluation to high resolution and complexity is necessary to define a resource for mining

[24] Dorminey. B. 2014, 'Forex Manna From Heaven: Space Mining And The Peak Metals Crunch', The Financial Times, [accessed 06.09.2014: http://www.forbes.com/sites/brucedorminey/2012/05/28/forex-manna-from-heaven-space-mining-and-the-peak-metal-crunch/]

[25] All prices are as of June 2014.

[26] P. Lucey. 2006, ‘Understanding the Lunar surface and space-Moon interactions’. Rev. Mineral. Geochem. doi:10.2138/rmg.2006.60.2

Undoubtedly, there are still obstacles to the economic viability of off-earth ore extraction such as methods for identifying mineral-rich asteroids, and transportation costs. [28] [29] [30] However, overcoming such challenges appears in prospect. At the current rate, completion of asteroid discovery surveys will take approximately a decade.[31] At the same time, it is projected that asteroids with a high percentage of methane and water could be used to produce rocket fuel and used for propulsion, as a form of in-situ resource utilization (ISRU), which is hoped to bring affordable extra-terrestrial operations by minimizing the materials carried from Earth.[32][33] Once such technologies are in place, off earth mining will be viable.[34]

2.3 Pioneer space companies

A number of commercial enterprises, as well as government-funded space programmes, are pushing such technological boundaries forward. Though they might not meet their mission objectives for decades, such "pioneer" space companies indicate the present reality and future

---

[27] The moon has the following resources: Ni, V, Cr, He3+, MgO, TiO2, and Al2O3 in similar concentrations as extracted in earth mining Ganapathy, R., Keays, R. R., Laul, J. C., & Anders, E. 1970, 'Trace elements in Apollo 11 lunar rocks: Implications for meteorite influx and origin of moon', Geochimica et Cosmochimica Acta Supplement, Volume 1. Proceedings of the Apollo 11 Lunar Science Conference held 5-8 January, 1970 in Houston, TX. Volume 2: Chemical and Isotope Analyses. Edited by A. A. Levinson. New York: Pergammon Press, 1970., p.1117.

[28] 'Ore' is a term used to characterize commercially profitable material; it includes not only a consideration of high concentration of a resource, but also the cost of extraction and its price in the market Sonter M.J.,1997,The Technical and Economic Feasibility of Mining the Near Earth Asteroids,
Acta Astronautica, 41, no.4-10, pp.637-647.

[29] A study quantifying the ore value of PGMs and water found that "estimates give very low values for platinum group metals and larger, but still modest, numbers for water, and "limited supply of potentially profitable NEOs [Near Earth Objects]."Martin Elvis. 2013, 'How Many Ore-Bearing Asteroids?', Harvard--Smithsonian Center for Astrophysics Planetary & Space Science, Planetary and Space Science Volume 91, February 2014, P. 20–26, 15.

[30] However, the study only examined platinum-group metals, but C-class asteroids are the platinum-rich ones Eric Anderson. 2014, BBC, Paul Rincon, 'Few asteroids are worth mining, suggests Harvard study', [accessed 22.06.2014: http://www.bbc.com/news/science-environment-25716103].

[31] Beeson C., Galache J.L., and Elvis M., 2013, Scaling Near-Earth Object Characterization, in preparation.

[32] NASA Ames Research Center, Ames Technology Capabilities and Facilities, In-Situ Resource Utilization [retrieved 20.06.2014: http://www.nasa.gov/centers/ames/research/technology-onepagers/in-situ_resource_Utiliza14.html].

[33] One example could be water found on the Moon's South Pole . Water was identified by the Moon Mineralogy Mapper, one of two NASA-sponsored instruments on board Chandrayaan-1. See C.M. Pieters et al., Character and spatial distribution of OH/H2O) on the surface of the Moon seen by M3 on Chandrayaan-1, Science 326(5952):568-572, 2009.

[34] NASA determined the feasibility of mining asteroids for robotic and later human asteroid mining missions. It used the following criteria to evaluate this feasibility: i) that there are accessible, exploitable, and valuable minerals, metals, and possibly H20 in the asteroids; ii) That a sustained market demands exists or will exist on Earth, in space, or both; iii) That the team can develop a transformational mission design to make frequent, repeated missions to an asteroid possible; iv) That the team can design, develop, and produce the innovative spacecraft necessary to carry out the mission, and v) That the team can develop the necessary robotic mineral extraction, beneficiation, processing, and concentration technologies Cohen.M.M. et al. 2013, 'Robotic Asteroid Prospector (RAP), Staged from L1: Start of the Deep Space Economy', NNX12AR04G, (Final Report 9 July 2013, corrected 17 July 2013), Astrotecture, 6.

character of the space industry, and what kind of legal, regulatory and sustainability challenges it may bring. Accordingly this section illustrates the character of the emerging space businesses with a few examples, first in the area of off-earth mining and secondly transportation.

Planetary Resources is a space exploration and resource extraction company, formed in 2010 and backed by a range of high-profile investors. [35] [36] The company's immediate focus is on water mining operations (which as mentioned contribute to lowering the cost of mining metals) and developing low-cost robotic spacecraft to explore resource-rich asteroids,[37] however it later aims to mine PGMs[38], as well as iron, nickel and cobalt for in-situ use, and hydrogen and oxygen as a chemical fuel[39]. Planetary Resources recently deployed the Arkyd 3 Reflight (A3R) spacecraft from the International Space Station (ISS), on a 90-day operation to authenticate various technologies as well as avionics, control systems and software that the company will integrate into a forthcoming spacecraft intended to search for mineable NEAs in the solar system.[40] According to Planetary Resources, its first experiments to extract resources will take place by 2020[41]. On a long term scale, Planetary Resources wants to have fully automated robotic asteroid-based mining and processing missions, with the ability to transport resources around in space or back to earth[42].

As new government and private space facilities are developed and crewed missions travel to the Moon and Mars, Deep Space Industries (DSI) aims to provide their propellants, air and materials. A DSI propellant refinery is envisaged to extract water and hydrocarbons found in carbonaceous asteroids and distil them for space stations, commercial habitats, and

---

[35] Its mission to "apply commercial, innovative techniques to explore space" Planetary Resources. 2013, 'our mission', [accessed 27.07.2014: http://www.planetaryresources.com/mission/].
[36] such as Google billionaires Larry Page and Eric Schmidt, Microsoft mogul Charles Simonyi, filmmaker James Cameron, and Ross Perot, Jr.
[37] Planetary Resources. 2013, 'our mission', [accessed 27.07.2014: http://www.planetaryresources.com/mission/].
[38] 1 ounce = 27 Jul 2014: Platinum: 1725 $USD, Rhodium: 1295$USD, Palladium: 775$USD, Iridium: 1025$USD from mineralprices. 2014, [accessed 27.07.2014: http://www.mineralprices.com/default.aspx].
[39] Lauren Hepler. 2013, 'Planetary Resources' chief asteroid miner on NASA, Larry Page, new space race', [accessed 27.07.2014: http://www.bizjournals.com/sanjose/news/2013/07/16/planetary-resources-asteroid-miner.html?page=all], bizjournals.
[40] Planetary Resources. 2015, 'Planetary Resources' First Spacecraft Successfully Deployed, Testing Asteroid Prospecting Technology on Orbit', accessed 02.10.2015 [http://www.planetaryresources.com/2015/07/planetary-resources-first-spacecraft-deployed/].
[41] Lauren Hepler. 2013, 'Planetary Resources' chief asteroid miner on NASA, Larry Page, new space race', [accessed 27.07.2014: http://www.bizjournals.com/sanjose/news/2013/07/16/planetary-resources-asteroid-miner.html?page=all], bizjournals; Foust. J. 2012, 'Planetary Resources believes asteroid mining has come of age', [accessed 27.07.2014: http://www.thespacereview.com/article/2074/1], thespacereview.
[42] Foust. J. 2012, 'Planetary Resources believes asteroid mining has come of age', [accessed 27.07.2014: http://www.thespacereview.com/article/2074/1], thespacereview

communications satellites.[43] It also plans mount small asteroid missions of its own, selling "locally sourced" minerals from NEAs, such as the "dirt" that will be important to build radiation-blocking shields around long-term human facilities outside the Earth's magnetic field , to orbital customers. As costs drop, such resources can also be exported back to Earth. DSI has been selected by NASA for two contracts to develop core technologies for using asteroid resources.[44] By contrast, exploiting natural resources on the Moon is the focus of Moon Express. Together with another company, Rocket Lab, it will commence un-crewed robotic launches in 2017, sending its MX-1 lander into space aboard Rocket Lab's Electron rocket, in order to take samples and return them to Earth.[45]

In the area of transportation and space tourism, established in 2002, SpaceX, states its goal as making space travel accessible to as many people as possible and is engaged in designing, manufacturing and launching spacecraft and rockets.[46] Similarly, Virgin Galactic wants to be Earth´s foremost "spaceline", and to "[democratize]…access to space for the benefit of life on Earth."[47] Interplanetary Ventures' main goal is to build infrastructure in space, including human settlements, in order to assist humanity´s expansion into deep space.[48]

Notably, and despite of mission statements and objectives which invoke the historical, socially significant and even altruistic nature of their ventures,[49] [50] none of the above companies has published any policies, guidelines, analyses or statements on CSR or otherwise concerning their impacts and relations to terrestrial society.

---

[43] http://deepspaceindustries.com/

[44] the first supports the development of asteroid regolith simulants for terrestrial analysis of technologies for mining and handling of asteroid soil and the second contract funds the study of different approaches to producing propellants from asteroid materials Deep Space Industries. 2015, 'Advanced Space Resource Utilization Technology Projects Supported by New NASA Awards to Deep Space Industries', accessed 02.10.2015 [http://deepspaceindustries.com/advanced-space-resource-utilization-technology-projects-supported-by-new-nasa-awards-to-deep-space-industries/]

[45] Mike Wall. 2015, 'Private Moon Landing Set for 2017' accessed 02.10.2015, [http://www.space.com/30720-moon-express-private-lunar-launch-2017.html?cmpid=514630_20151001_53332566&adbid=10153090715401466&adbpl=fb&adbpr=17610706465].

[46] http://www.spacex.com/

[47] http://www.virgingalactic.com/

[48] http://www.interplanetaryventures.org/

[49] Planetary Resources understands the potential effect on the global GDP could be in the trillions but no further reflections on this matter have been made public Messier. D. 2012, 'New Study Says Asteroid Retrieval and Mining Feasible with Existing and Near Term Technologies', [accessed 27.07.2014: http://www.parabolicarc.com/2012/04/19/new-study-says-asteroid-retrieval-and-mining-feasible-with-existing-and-near-term-technologies/], parabolic arc.

[50] Similarly from Moonexpress, they see their operations as a means to benefit life on "Earth and humanity's future in space" http://www.moonexpress.com/#company.

3. Potential impacts of corporate activity in space

This omission is significant, given the potential impacts, including on Earth, of corporate activity in space. In general, given that space is mostly unexplored and unknown, it is important to be open-minded about possible negative and positive effects our activities in space could have, and CSR standards for space should reflect this uncertainty and consequent need for precaution, as does existing space law (see next section). A number of the currently known environmental and social risks associated with space exploration and commercial space activities are illustrated in this section.

a) Integrity of celestial bodies

Industrial activity in space has potential to cause a wide range of pollution in space and disruption to celestial bodies. Even the little research to date in space has caused pollution, and there are significant amounts of space debris on the Moon, Mars and Venus.[51] Space industries, especially mining, could potentially destroy small-scale asteroids and other celestial bodies,[52] while mining, terraforming (creating earth-like biospheres), colonisation and the building of settlements could lead to irreversible modifications of their surfaces, or large-scale changes to their environments, previously been untouched by mankind. Whereas resource extraction on Earth has often led to serious environmental damage, the question arises whether celestial bodies should receive the same level of environmental protection. [53] Another risk is forward-contamination: all human activity in space must be conducted within closed systems, inevitably entailing a need for safe removal of waste generated, sterilization and decontamination abilities. In-situ resource utilization operations, furthermore, will produce dust particles from resources harvested in space, which could be inhaled, or otherwise contaminate crew when brought back to space stations and celestial body habitats.

b) Back-contamination

"Back-contamination" is the introduction to Earth by returning missions of material originating from Space. Given how little is known about what materials, particularly any

[51] Almár, I.: What Could COSPAR Do to Protect the Planetary and Space Environment? Adv.Space Res. Vol. 30, No.6, pp.1577-1581, 2002.

[52] Phobos, the small Martian moon with its unique system of surface trenches, is often understood as a perfect candidate for extractive activity.

[53] Jakosky has written about the ethical problems that could arise in this respect, and poses these questions: "Does Mars as a planet have any intrinsic value in and of itself? Is there less intrinsic worth in a planet that is devoid of life than in one with an active biosphere? Should we access and use the resources that are available there or should we leave them as they are?"Jakosky. B.M. 1998, 'The Search for Life on Other Planets', Cambridge University Press, Cambridge, UK.

organic materials, may eventually be found in Space, again, a precautionary approach is counselled. Perhaps ironically, the sites of greatest interest to us in terms of identifying alien life forms may also be those most likely to cause us harm: by analogy great damage has been done to ecosystems and humans on Earth by invasive or introduced new species across continents and climate belts.[54] [55] Even if the risk of damage is currently considered low,[56] [57] space missions should have up-to-date tools and training to evaluate and manage conceivable extra-terrestrial biology, before any sample return.[58]

All NASA spacecraft are subject to strict protocols on back and forward contamination, and this is attracts the highest priority in Mars exploration and in the Committee on Space Research's (COSPAR) Planetary Protection Policy.[59] Yet, such procedures have been breached, for example, by NASA's Mars Science Laboratory rover, Curiosity.[60] Thus there needs to be ongoing monitoring and assessment of microbes transported by human operations with real-time monitoring capability in habitats, suit, laboratories and so forth, to address both backward and forward contamination concerns.

[54] "Precisely because Mars is an environment of great potential biological interest, it is possible that there are pathogens on Mars, organisms which, if transported to the terrestrial environment, might do enormous biological damage": Carl Sagan. 1973, 'The Cosmic Connection - an Extraterrestrial Perspective', Cambridge University Press. On the other hand, pathogens adapt to their host, which also means earth never has developed any natural defence against them.

[55] The scenario is further contemplated on by Ledeberg, who writes that: "Whether a microorganism from Mars exists and could attack us is more conjectural. If so, it might be a zoonosis to beat all others. On the one hand, how could microbes from Mars be pathogenic for hosts on Earth when so many subtle adaptations are needed for any new organisms to come into a host and cause disease? On the other hand, microorganisms make little besides proteins and carbohydrates, and the human or other mammalian immune systems typically respond to peptides or carbohydrates produced by invading pathogens. Thus, although the hypothetical parasite from Mars is not adapted to live in a host from Earth, our immune systems are not equipped to cope with totally alien parasites: a conceptual impasse": Lederberg. J. 1999, 'Parasites Face a Perpetual Dilemma', 'The relationships between pathogens and hosts must become delicate balances of adaptation if both parties are to survive', Volume 65, Number 2, 1999 / ASM News, 79.

[56] Any danger from contamination is researched only to understand "extreme worst case scenarios"European Science Foundation. 2012, 'Mars Sample Return backward contamination', 'Strategic advice and requirements', Report from the ESF-ESSC Study Group on MSR Planetary Protection Requirements. July, 2012, 38.

[57] This is also echoed by the US National Research Council: "The risks of environmental disruption resulting from the inadvertent contamination of Earth with putative Martian microbes are still considered to be low. But since the risk cannot be demonstrated to be zero, due care and caution must be exercised in handling any Martian materials returned to Earth."National Research Council. 2009, 'Assessment of Planetary Protection Requirements for Mars Sample Return Missions', 49.

[58] Race. M. S. 1996, 'Planetary Protection, Legal Ambiguity, and the Decision Making Process for Mars Sample Return', Adv. Space Res. Vol. 18 no 1/2 pp (1/2)345-(1/2)350, 349.

[59] COSPARs planetary protection policy. 2011, (20 October 2002; As Amended to 24 March 2011), Prepared by the COSPAR/IAU Workshop on Planetary Protection, 4/02, with updates 10/02; 1/08, 4/09, 12/09, 3/11, Approved by the bureau and council, world space council, Houston, Texas, USA.

[60] NASA made an in-house decision not to send drill bits transported Curiosity through a final cleaning stage, in a departure from the terrestrial safeguarding plans detailed for the Mars Science Laboratory mission. The occurrence has developed into a lesson learned example of failed communication in guaranteeing that planetary defence measures are observed.Space. 2015, 'NASA's Mars Rover Curiosity Had Planetary Protection Slip-Up', accessed 09.09.2015 [http://www.space.com/13783-nasa-msl-curiosity-mars-rover-planetary-protection.html].

c) Space debris

As regards Earth, space debris can be defined as "all manmade objects including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional."[61] Today there are approximately 2000 privately-owned and government satellites orbiting Earth at around 17500 miles per hour and this number is likely to increase with the arrival of *CubeSats*, miniature satellites measuring just 10 centimetres, and weighing 1.3 kilograms whose lower price makes them accessible to large numbers of owners. Satellites may be subject to on-orbit fragmentation caused by accidental or intentional explosions and collisions, or aerodynamic forces as they near atmospheric re-entry,[62] breaking up into tens of thousands of small fragments. Only one satellite each year is destroyed by the estimated 300,000 space junk items orbiting Earth, but the consequences can be serious, as the collision between the Russian Cosmos 2251 and the operational Iridium 33 in 2009 demonstrated. [63] Although in general a less significant source of space debris, space mission activity can leave behind "lens caps, separation and packing devices, spin-up mechanisms, empty propellant tanks or payload shroud",[64] and the intentional breakup of the Fengyun-1C spacecraft in 2007, via a hypervelocity collision with a ballistic object "created the most severe artificial debris cloud in Earth orbit since the beginning of space exploration".[65]

The United Nations General Assembly has recognized "that space debris is an issue of concern to all nations",[66] and that the likelihood of future accidental collisions is "expected to increase as more objects are placed into orbit".[67] International space agencies are trying to reduce or remove space junk completely and several states are developing space debris protocols.[68] [69] However, these efforts face a number of challenges. Compared to Earth, the

[61] Inter-agency space debris coordination committee (IADC). 2007, 'IADC Space Debris Mitigation Guidelines', IADC Action Item number 22.4, Steering Group and Working Group 4, 5.
[62] NASA. 2008, 'Handbook for limiting orbital debris', (approved 2008-07-30) National Aeronautics and Space Administration Washington, DC 20546, 27.
[63] Cubesats have already had their first collision in space: Ecuador´s Cube Satellite 'NEE-01 Pegaso', crashed with debris from a Russian rocket in 2013.Caselli. I. 2013. BBC, 'Ecuador Pegasus satellite fears over space debris crash' [accessed 12.10. 2014: http://www.bbc.co.uk/news/world-latin-america-22635671].
[64] NASA. 2008, 'Handbook for limiting orbital debris', (approved 2008-07-30) National Aeronautics and Space Administration Washington, DC 20546, 26.
[65] NASA. 2008, 'Handbook for limiting orbital debris', (approved 2008-07-30) National Aeronautics and Space Administration Washington, DC 20546, 27.
[66] UNGA. 2013, Resolution adopted by the General Assembly [on the report of the Special Political and Decolonization Committee (Fourth Committee) (A/67/422)] 67/113. International cooperation in the peaceful uses of outer space. A/RES/67/113, Preamble.
[67] NASA. 2008, 'Handbook for limiting orbital debris', (approved 2008-07-30) National Aeronautics and Space Administration Washington, DC 20546, 27.
[68] UNGA. 2013, Resolution adopted by the General Assembly [on the report of the Special Political and Decolonization Committee (Fourth Committee) (A/67/422)] 67/113. International cooperation in the peaceful

Moon does not have an atmosphere that can burn up retired satellites.[70] A "graveyard orbit" increases the risk of "[collisions], explosions and other fragmentations that will increase the orbital debris environment and threaten scientific and commercial missions."[71] Ground-based radar is for now most widely used to track space junk, [72] but if satellites continue to get smaller in size, such systems will experience tracking problems.[73]

d) Socio-economic impacts

Pushing the frontiers of markets beyond Earth is likely to have disruptive effects at home. If mining in space takes off, what effect will it have, for example, on global commodity prices? Who will regulate the entry of off-Earth resources into the terrestrial marketplace? Plentiful, inexpensive rare earth minerals could significantly influence the direction of human civilization. But how should such resources be shared out amongst those who recover them and the rest of the human community? Several states maintain a legal right to development and might be reasonably expected to lay claims on privately-recovered resources.[74] On the other hand, protective interventions by Earth-based producers to fend off competition could put low-profit margin space operators out of business.[75] In any event, social and economic impacts would appear hard to avoid and could reasonably be expected to lead to human conflict.

e) Psychological welfare

The psychological impact from space industry could be enormous. Both for short travel like tourism and long term travel into space that requires a broad range of jobs to be performed

---

uses of outer space. A/RES/67/113, Para 8. Further, the UNGA urges that "States pay more attention to the problem of collisions of space objects" and undertake research to understand and monitor this threat in order to "minimize the impact of space debris on future space missions".

[69] compatible with the Space Debris Mitigation Guidelines of the Inter-Agency Space Debris Coordination Committee and with the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space, endorsed by the General Assembly in its resolution 62/217.

[70] Inter-agency space debris coordination committee (IADC). 2007, 'IADC Space Debris Mitigation Guidelines', IADC Action Item number 22.4, Steering Group and Working Group.

[71] Inter-agency space debris coordination committee (IADC). 2007, 'IADC Space Debris Mitigation Guidelines', IADC Action Item number 22.4, Steering Group and Working Group 4, 5.

[72] The US Air Force´s Space Fence that can follow up to 200,000 items in space

[73] Light-based technology systems coming on-stream. Lockheed martin and Electro Optic Systems have teamed up to develop a space object tracking site in western Australia, giving private and government customers a more detailed picture of space junk. Lockheed martin. 2014,'Lockheed Martin And Electro Optic Systems To Establish Space Debris Tracking Site In Western Australia', [accessed 27.08.2014: http://www.lockheedmartin.com/us/news/press-releases/2014/august/0825-ss-electro.html]

[74] UN Declaration on the Right to Development.

[75] Forbes. 2012,'Forex Manna From Heaven: Space Mining And The Peak Metals Crunch', [accessed 27.08.2014: http://www.forbes.com/sites/brucedorminey/2012/05/28/forex-manna-from-heaven-space-mining-and-the-peak-metal-crunch/].

can have a big psychological impact. The danger from accidents during lift off, performing duties in space, and re-entry into Earth's atmosphere are all surrounded with high dangers. Even though precise circumstances of the situation differ, most extreme environments experience similar features: 1) a high reliance on technology for life support and task performance; 2) notable degrees of physical and social isolation and confinement; 3) inherent high risks and associated costs of failure; 4) high physical/physiological, psychological, psychosocial, and cognitive demands; 5) multiple critical interfaces (human-human, human-technology, and human-environment); and 6) critical requirements for team coordination, cooperation, and communication.[76]

Space flight in particular and its associated factors e.g., isolation, confinement, workload can become significant triggers or sources of stress.[77]

Neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness cover the Big Five. Those who are very neurotic are disposed to psychological pain. Individuals that are very extroverted channel a substantial quantity of energy to others, while individuals who are very open to experience enthusiastically pursue that which is new. Agreeable persons favour communications which are sympathetic instead of single-minded. Individuals that are very thorough display goal aimed behaviour which is ordered, driven, and tenacious.[78]

Presently on the ISS, astronauts have can contact friends and family on Earth nearly at will which offers an important improvement to crewmember happiness.[79]

Storing space is an important problematic issue, as can be seen in journal admissions e.g. "Spent the entire morning unpacking. I am starting to get irritated at the stowage plan…I'm not sure where the ISS designers figured we were going to put all this stuff."[80]

The ISS is infamously messy and that has had an undesirable influence on opportune conclusion of tasks. One astronaut stated a "big victory" once he "finally located a [piece of equipment] that has been lost for over a year. It's the size of a home water heater, so it's hard

[76] Sheryl L. Bishop. 2011, 'From Earth Analogs to Space: Getting There from Here', in NASA. 2011, 'Psychology of Space Exploration: Contemporary Research in Historical Perspective', ed. Douglas A. Vakoch, the NASA History Series, 30.
[77] NASA. 2014, 'Risk of Adverse Cognitive or Behavioural Conditions and Psychiatric Disorders', Human Research Program: Behavioural Health and Performance, 30
[78] NASA. 2014, 'Risk of Adverse Cognitive or Behavioural Conditions and Psychiatric Disorders', Human Research Program: Behavioural Health and Performance, 32
[79] NASA. 2014, 'Risk of Adverse Cognitive or Behavioural Conditions and Psychiatric Disorders', Human Research Program: Behavioural Health and Performance, 48.
[80] Stuster J (2010) Behavioural Issues Associated with Isolation and Confinement: Review and Analysis of Astronaut Journals. National Aeronautics and Space Administration. NASA/TM-2010-216130 (July), 37.

to imagine how it got lost”[81] In the future, exploration space crafts will unavoidably be meaningfully less spacious than the ISS.[82]

Antarctica is possibly the most recognised and frequently researched analog environment.[83] The most common group of psychological illnesses for people that spent the winter in Antarctica was mood disorders; these made up 30.2% of all diagnoses and depressive symptoms were expressively connected to sex, women were at larger risk in addition to military occupation rather than civilian.[84]

For the majority of astronauts, 50%, stress grew during six-month missions. An additional 25 percent stated no noteworthy alteration in stress during the mission, although the outstanding 25 percent described a reduction in apparent stress.[85] Astronauts that recounted growing stress during the mission had a tendency to similarly report less overall sleep time in addition to increased physical tiredness, which amplified tiredness and reduced sleep quality.[86]

Throughout the Shuttle program, 34 behavioural indications and symptoms were stated between the 208 crew members that went on 89 shuttle missions between 1981 and 1989, spending a total of 4,442.8 person-days in space.[87] Based on these numbers, the incidence frequency is 0.11 for a 14 day assignment, roughly one per every 2.87 person-year and the behavioural indications which were most frequently described in the 89 missions, were anxiety and annoyance.[88]

A number of Russian space flight operations in the 1970s and 1980s were concluded premature because of psychological issues.[89] The cosmonauts of the 1976 Soyuz 21 mission to the Salyut 5 space station, were transported back to earth premature because they protested against a strong aroma. The cause for this smell was never established and new cosmonaut teams could not smell it. Because the crew did not get on, hallucination was proposed as a

[81] Stuster J (2010) Behavioural Issues Associated with Isolation and Confinement: Review and Analysis of Astronaut Journals. National Aeronautics and Space Administration. NASA/TM-2010-216130 (July), 38.
[82] NASA. 2014, 'Risk of Adverse Cognitive or Behavioural Conditions and Psychiatric Disorders', Human Research Program: Behavioural Health and Performance, 51.
[83] NASA. 2014, 'Risk of Adverse Cognitive or Behavioural Conditions and Psychiatric Disorders', Human Research Program: Behavioural Health and Performance, 55.
[84] Palinkas LA, Suedfeld P, Steel GD (1995) Psychological functioning among members of a small polar expedition. Aviat. Space Environ. Med., 50:1591–1596, 57.
[85] NASA. 2014, 'Risk of Adverse Cognitive or Behavioural Conditions and Psychiatric Disorders', Human Research Program: Behavioural Health and Performance, 73.
[86] NASA. 2014, 'Risk of Adverse Cognitive or Behavioural Conditions and Psychiatric Disorders', Human Research Program: Behavioural Health and Performance, 73.
[87] NASA. 2014, 'Risk of Adverse Cognitive or Behavioural Conditions and Psychiatric Disorders', Human Research Program: Behavioural Health and Performance, 16.
[88] NASA. 2014, 'Risk of Adverse Cognitive or Behavioural Conditions and Psychiatric Disorders', Human Research Program: Behavioural Health and Performance, 16.
[89] Cooper HFS. 1976, ‘A House in Space’, Holt, Rinehart and Winston, Austin, TX.

likely clarification.[90] Likewise, in 1987, the Soyuz TM-2 mission concluded prematurely due to psychosocial issues.[91]

The premature end of the above missions could have stopped acceleration of behavioural and psychiatric incidences. But, not all events have caused a premature departure to Earth, for example “when a NASA psychiatrist interviewed for a review of sensory stimulation brought up rage in early Mir crews. The rage was attributed to sensory poor environment and inadequate ability to communicate.”[92]

Communal eating is perhaps that most commonly mentioned method of promoting crew cohesion on the ISS.[93]

Another recent retrospective study of flown astronauts found that the most frequently described psychologically enriching aspects of spaceflight had to do with their perceptions of Earth.[94] Earth photography is a self-initiated positive activity of possible importance for salutogenesis (increase in well-being) of astronauts on long-duration missions.[95]

It is essential that scientists, engineers and psychologists design structures, mission activities and designs to defend against psychological and physiological dangers related to long-duration spaceflight, including radiation exposure, bone degradation, and muscle loss.[96] In combination with individual reactions to isolation and confinement, researchers deal with difficulties related to team communications which could be an important restrictive issue for lengthy space missions.[97]

[90] Clark J. 2007, ‘A flight surgeon’s perspective on crew behaviour and performance’, Presented at the Workshop for Space Radiation Collaboration with BHP, Centre for Advanced Space Studies, Sep 2007.
[91] Clark J. 2007, ‘A flight surgeon’s perspective on crew behaviour and performance’, Presented at the Workshop for Space Radiation Collaboration with BHP, Centre for Advanced Space Studies, Sep 2007.
[92] Vessel EA, & Russo S (2015) Effects of reduced sensory stimulation and assessment of countermeasures for sensory stimulation augmentation: A Report for NASA Behavioural Health and Performance Research: Sensory Stimulation Augmentation Tools for Long Duration Spaceflight (NASA/TM-2b015-218576). NASA-Johnson Space Centre, Houston, TX.
[93] NASA. 2014, 'Risk of Adverse Cognitive or Behavioural Conditions and Psychiatric Disorders', Human Research Program: Behavioural Health and Performance, 50.
[94] Julie A. Robinson et al. 2011, 'Patterns in Crew-Initiated Photography of Earth from the ISS—Is Earth Observation a Salutogenic Experience? in NASA. 2011, 'Psychology of Space Exploration: Contemporary Research in Historical Perspective', ed. Douglas A. Vakoch, the NASA History Series, 80.
[95] Julie A. Robinson et al. 2011, 'Patterns in Crew-Initiated Photography of Earth from the ISS—Is Earth Observation a Salutogenic Experience? in NASA. 2011, 'Psychology of Space Exploration: Contemporary Research in Historical Perspective', ed. Douglas A. Vakoch, the NASA History Series, 80.
[96] Jason P. Kring and Megan A. Kaminski. 2011, 'Gender Composition and Crew Cohesion during Long-Duration Space Missions', in NASA. 2011, 'Psychology of Space Exploration: Contemporary Research in Historical Perspective', ed. Douglas A. Vakoch, the NASA History Series, 126.
[97] Jason P. Kring and Megan A. Kaminski. 2011, 'Gender Composition and Crew Cohesion during Long-Duration Space Missions', in NASA. 2011, 'Psychology of Space Exploration: Contemporary Research in Historical Perspective', ed. Douglas A. Vakoch, the NASA History Series, 126.

According to NASA's Health Standards: Crew Health, in "Pre-flight, in-flight, and post-flight crew behavioural health and crewmember cognitive state shall be within clinically accepted values as judged by clinical psychological evaluation."[98]

Current methods for monitoring crew behavioural health and giving social and psychological provision has proven to work on the ISS. Nevertheless, it is not known if the efficiency of the same measures can be upheld over lengthier phases and at "greater distances from Earth where delays in communication, delivery of services, and implementation of countermeasures will occur."[99]

f) Intellectual property of life forms in space or other chemicals

Present law concerning intellectual property is directed by the NASA Authorization Act of 2010.[100] This Act permits the discoverer or inventor to uphold intellectual property rights providing trials and measures are accepted by NASA. It lets organizations benefit financially from its findings given that the findings are similarly shared with NASA including the possibility for additional usage.

The U.S., Canada, Russia, Japan and ESA member States, work jointly to create a judicial outline to describe the rights and duties of the individual member states, along with their jurisdiction over their ISS.

Experimentations conducted on the ISS cover include human physiology, psychology, medicine, biology, science and technology. The pharmaceutical industry above all is recognised as a space which can profit from tests executed on the ISS.

But what regulation and rules relate to these tests? For example, when an astronaut creates a medicinal treatment when aboard the ISS, what patent law should be applied to safeguard it? Simultaneously, is it possible for an inventor to be guarded against the illegal application of a patented invention created in space?

In theory, patents are possible to enforce exclusively inside the national or regional limits of nations. Space, similar to the high seas and Antarctica, is not conditional on nationwide

[98] Jeffrey Kahn, Catharyn T. Liverman, and Margaret A. McCoy. 2014, 'Health Standards for Long Duration and Exploration Spaceflight: Ethics Principles, Responsibilities, and Decision Framework', Committee on Ethics Principles and Guidelines for Health Standards for Long Duration and Exploration Spaceflights; Board on Health Sciences Policy, 34.

[99] Jeffrey Kahn, Catharyn T. Liverman, and Margaret A. McCoy. 2014, 'Health Standards for Long Duration and Exploration Spaceflight: Ethics Principles, Responsibilities, and Decision Framework', Committee on Ethics Principles and Guidelines for Health Standards for Long Duration and Exploration Spaceflights; Board on Health Sciences Policy, 52.

[100] U.S. Congress. 2010, 'National Aeronautics and Space Administration Authorization Act of 2010', S. 3729 — 111th Congress, enacted October 11, 2010.

appropriation. Further, space does not pertain to state sovereignty and is not possible to appropriate through usage, claim or additional methods.[101]

Regarding the use of state patent rules, difficulties happen once a creation is applied or trespassed in space, due to the regulations being appropriate exclusively on the territory of the nation that, by definition, does not include the extraterritorial area of space.[102]

However, countries do keep authority in addition to control of items it flies to.[103]

Consequently, the answer to this judicial hole could be to produce patent law possible to enforce for items in outer space which fall under the authority and control of a state.

Any invention created, applied or sold in space aboard a spacecraft which is affected by the authority and control of the U.S. can be constructed, applied or sold in the U.S. excluding when a worldwide contract stating otherwise is signed.

The difficulty of the legal regime regarding intellectual property rights for ISS is due to the ISS containing dissimilar units delivered by diverse actors. All actors records its flight objects and holds jurisdiction, command and possession of them. The ISS is a mixture of nationally owned space components and not a global space station as such.[104]

The International Space Station Intergovernmental Agreement acknowledges the jurisdiction of all members court of law's and permits for state legislation to be used in the parts owned by the members.[105] Accordingly, the diverse intellectual property legislation of all members must harmonise. For example, when an invention is recognised in a U.S. space component, the 'USA Patent Act' can be used because the creation is considered to have happened on U.S. terrain.

Since extraterrestrial life has not been found, there is no financial worth, cultural worth or territorial links, permitting reasonable intellectual property handling. Yet, when discovery is made, foreseeable political, economic and social demands will probably execute efforts at applying policy concerning extraterrestrial detections.

---

[101] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, Adoption by the General Assembly: 19 December 1966 (resolution 2222 (XXI), Entry into force: 10 October 1967, Art 2.

[102] ESA. 2015, Intellectual property rights: Patents and space related inventions, accessed 20.08.2015 [http://www.esa.int/About_Us/Law_at_ESA/Intellectual_Property_Rights/Patents_and_space-related_inventions].

[103] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, Adoption by the General Assembly: 19 December 1966 (resolution 2222 (XXI), Entry into force: 10 October 1967, Art 8.

[104] ESA. 2015, Intellectual property rights: Patents and space related inventions, accessed 20.08.2015 [http://www.esa.int/About_Us/Law_at_ESA/Intellectual_Property_Rights/Patents_and_space-related_inventions].

[105] ISS. 1998, 'The International Space Station Intergovernmental Agreement', Signed January 29, 1998, Art 21.

4. Existing legal and regulatory frameworks relevant to commercial activity in space

This section examines space law and compares it to terrestrial international law. It looks at what lessons can be learned from these two areas, its legal gaps, and how they can be extrapolated into non-judicial CSR in space guidelines. Since the Commercial Space Launch Act of 1984, written to assist the progress of private space commercialization, private space industry has been legal.

4.1. Space Law

International law governs outer space among other, through the Outer Space Treaty[106] (OST). Yet, private space industry is not specifically mentioned in it. This would appear to leave governments to bear responsibility for the conduct of their private companies in space, on a parallel basis to companies based in their jurisdictions that operate abroad. In other words, given that no special legal instrument currently governs outer space resources, the same principles would seem to apply as we see on earth in relation to extraterritorial regulation of transnational corporations (TNCs) - which is very limited with regard to controlling adverse environmental, and human rights impacts.

Law is not immutable, it will respond to the demands and needs of society, but that process takes a long time. As a reaction to a missing legal framework concerning terrestrial impacts, CSR has evolved to fill gaps with the formulation of principles and guidance, to some extent based on soft law instruments. This shared aspect of legal uncertainty makes CSR a natural platform from which to launch responsible corporate behaviour guidelines for space. CSR guidelines for space ought to help space activities to be a controlled and well-organized enterprise, without putting an end to the commercial exploitation of space resources: “A balance must be found between the impact of any mission and the scientific results or other benefits which may be obtained thereby. Furthermore, certain activities may be sufficiently detrimental to the environment to require restrictions and prohibitions thereof, regardless of any benefits which otherwise may be realized.”[107] Moreover, the non-living planetary environment also possesses an intrinsic value, both in terms of specific areas like the area of the first Moon landing, Valles Marineris or Olympus Mons, but also generally speaking in

[106] Formally the: Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, Adoption by the General Assembly: 19 December 1966 (resolution 2222 (XXI), Entry into force: 10 October 1967.
[107] Sterns, P. and Tennen, L., Preserving Pristine Environments: the Planetary Protection Policy, in: Space Safety and Rescue 1988-89, ed. G.W. Heath, pp.399-420, AAS, San Diego, 1990.

terms of being the object of our solar system and our species origin, so that there is a need to address the conservation of celestial bodies.

Space law takes a precautionary approach - Article 7 of the Moon Treaty states that nations must take measures to prevent adverse changes and introducing extra environmental matter or otherwise, and similarly by introduction of extraterrestrial matter back to Earth[108]. Nuclear weapons are forbidden in any form in space by the OST[109]. Further, the OST says that state parties must conduct studies on how to avoid “harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter”[110].

The financial return from space industry is already insecure, making the voluntary protection of the space environment highly unlikely. Preventive measures and guidelines are more likely to be followed by commercial actors because they are less expensive, and could greatly reduce the risk of accident or damage to crewmembers and equipment.

The 1976 Convention on the Registration of Objects Launched Into Outer Space extends the principle that states absorb jurisdiction over and responsibility for their objects in space. The Convention states that a state must register its launch with a UN registry and thereby manifests their jurisdiction over the vessel or facility[111].

Space law is applicable to and governs space related activities, at a height of approximately 100 km (60 miles) and beyond. Space law is often connected to the Outer Space Treaty and the Moon Treaty, and more broadly the five international treaties and five sets of principles governing outer space which have been elaborated under the auspices of the United Nations Organization[112].

In 1957, states had the first discussions regarding the peaceful use of outer space. Talks between the USSR and the United States made the basis for a range of issues later debated in the UN system. This led to the creation of the Committee on the Peaceful Uses of Outer Space

[108] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies’, Adoption by the General Assembly 5 December 1979 (resolution 34/68), Entry into force: 11 July 1984, Art 7.
[109] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, Adoption by the General Assembly: 19 December 1966 (resolution 2222 (XXI), Entry into force: 10 October 1967, Art 4.
[110] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, Adoption by the General Assembly: 19 December 1966 (resolution 2222 (XXI), Entry into force: 10 October 1967, Art 9.
[111] IAA. 2010, 'Cosmic Study Protecting the Environment of Celestial Bodies', (ed. Hofmann, Rettberg, Williamson
[112] The United Nations Office for Outer Space Affairs (UNOOSA). 2014, ‘Space Law: Frequently Asked Questions’, [http://www.oosa.unvienna.org/oosa/FAQ/splawfaq.html#Q1].

(COPUOS). Five international principles and treaties have been negotiated and drafted in the COPUOS[113].

The operational Outer Space Treaty provisions are that space is only to be used for the benefit of all mankind. Secondly, that all states must have equal access to outer space. In addition, states cannot appropriate space under any claim of national sovereignty, and lastly that states are free to explore and use outer space. These provisions, in the light of the UNCOPUOS debates, demonstrate United States understanding of them to permit any state or privately held company to extract resources from space.

The OST has 102 state parties[114] and as such comprises a rational foundation on which to partly base future CSR guidelines on, be it judicial or non-judicial instruments. As a failed follow up to the OST, the Moon Treaty[115] has 16 state parties, none of which engage in self-launched manned space exploration[116].

In recent times, the interpretation of space law ambiguity has become relevant because several companies, explored above, have presented serious missions to extract resources from space, and plan space tourism with the capital to follow it through. With the emergence of

[113] **Treaties:**
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 (the "Outer Space Treaty"),
The 1968 Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (the "Rescue Agreement"),
The 1972 Convention on International Liability for Damage Caused by Space Objects (the “Liability Convention”),
The 1975 Convention on Registration of Objects Launched into Outer Space (the "Registration Convention"),
The 1979 Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (the "Moon Treaty").
Principles:
The Declaration of Legal Principles Governing the Activities of States in the Exploration and Uses of Outer Space (1963);
The Principles Governing the Use by States of Artificial Earth Satellites for International Direct Television Broadcasting (1982);
The Principles Relating to Remote Sensing of the Earth from Outer Space (1986);
The Principles Relevant to the Use of Nuclear Power Sources in Outer Space (1992);
The Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries (1996).

[114] United Nations Office for Disarmament Affairs (UNODA), 'Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, Status of the Treaty', [accessed 23.06.2015: http://disarmament.un.org/treaties/t/outer_space].

[115] Formally the ‘Agreement Governing the Activities of States on the Moon and Other Celestial Bodies’, Adoption by the General Assembly 5 December 1979 (resolution 34/68), Entry into force: 11 July 1984.

[116] United Nations Office for Disarmament Affairs (UNODA), 'Agreement Governing the Activities of States on the Moon and Other Celestial Bodies', 'Status of the Treaty', [accessed 23.06.2015: http://disarmament.un.org/treaties/t/moon].

corporations like Planetary Resources, Deep Space Industries, and space X, asteroid mining and space tourism may not be far away-intensifying the debate of space ownership.

This has to an extent been helped by The Commercial Space Launch Amendments Act of 2004 (CSLA), which was written to enable the advancement of space industry by reconstructing the regulatory climate and removing doubt related to who is responsible for regulating the field, the Federal Aviation Administration (FAA), and in what manner. CSLA allows space tourists to travel into space at their own risk. Further, it defines what a suborbital space passenger vehicle is, and makes the licensing process for such vehicles clear.

It still leaves questions unanswered about how to legally manage a wide range of issues relating to the extraterrestrial mining and tourism industry. A new treaty could address issues like; can the corporations leave space junk behind on asteroids? How much insurance do they need? What will happen if rare earth minerals flood the market? And settle the matter of private ownership, although property rights exist primarily to protect against theft and vandalism –and space is not in danger from thieving neighbours.

Treaties can take a long time to develop, and it must incorporate adverse legal disciplines like environmental law, corporate law, human rights law, space law etc. This forms an additional argument in favour of non-judicial CSR guidelines for space that in its own form can help to socialize law by identifying and transforming norms into soft law, and perhaps ultimately hard law.

4.2. Commercialization of Space

Companies cannot be held responsible at the same level as states. Yet, beginning in the 1980s, the fast development of commercial space undertakings which trailed the privatization of worldwide telecommunications administrations, e.g. Intelsat and Eutelsat, has prompted the rapid progress of nationwide rules and regulations globally.

Several countries are writing space laws, including states with small space undertakings wanting to entice fresh foreign investments and/or to support the requirements of their space. The creation of laws and regulation for space undertakings is a significant constituent when attempting to establish an ambitious space industry.

Separately, the International Telecommunication Union (ITU) organizes with different countries administrations, the application of the radio spectrum globally and has a vital part in allocating satellite orbits in order to evade conflicts.

From the 1990s deregulation and denationalization in satellite telecommunications, and new admission to marketable and private capital, the planning has developed into increasingly difficult record number of active space nations. In total, 72 state administrations showed intent to "launch satellite networks in 2013 in geostationary and low-earth orbits".[117]

France and the United States have the leading portions of overall current ITU applications (14.5% and 13.4%). Several states in Asia as well as the Middle East have likewise lately submitted projects intended for use within five years, including: China, Japan, Israel, Qatar, Saudi Arabia and United Arab Emirates.[118]

In 1982, the United States for the first time established a policy which encouraged "domestic commercial exploration of space capabilities, technology, and systems for national economic benefit."[119] Recent legislative developments include the 'Spurring Private Aerospace Competitiveness and Entrepreneurship Act of 2015'[120], short title 'SPACE Act of 2015' and the 'U.S. Commercial Space Launch Competitiveness Act'[121] (CSLC). The CSLC Act, in the matter of continuation of the International Space Station (ISS), amended the 'National Aeronautics and Space Administration Authorization Act of 2010'[122], by striking "through at least 2020" and inserting "through at least 2024". This empowers NASA to carry on supporting the commercial space market and supplying demand for space industries to deliver in accordance to NASA's needs. Due to this, NASA is a key economic enabler to the private space industry e.g. by creating a demand for the delivery of crew and cargo to ISS. This synergy between government and industry provides a foundation for economic growth and for the future expansion of space and industry capability. The contracts developed by NASA

[117] OECD. 2014, 'The Space Economy at a Glance 2014', OECD Publishing, http://dx.doi.org/10.1787/9789264217294-en, 44.

[118] OECD. 2014, 'The Space Economy at a Glance 2014', OECD Publishing, http://dx.doi.org/10.1787/9789264217294-en, 44.

[119] NASA. 1982, National Security Decision Directive Number 42, "National Space Policy," July 4, 1982, I (II) (D).

[120] United States Congress. 2015, 'H.R.2262 - SPACE Act of 2015', accessed 02.10.2015 [https://www.congress.gov/bill/114th-congress/house-bill/2262/text].

[121] United States Congress. 2015, 'S.1297 - U.S. Commercial Space Launch Competitiveness Act 114th Congress (2015-2016)', Accessed 02.10.2015: [https://www.congress.gov/bill/114th-congress/senate-bill/1297/text].

[122] United States Congress. 2015, 'National Aeronautics and Space Administration Authorization Act of 2010', accessed 02.10.2015: [http://spaceflight.nasa.gov/outreach/nasa_auth_act_2010.pdf], S. 3729 One Hundred Eleventh Congress of the United States of America.

allowed industry to maintain their intellectual property, enabling them to market their product towards other users.

Further, NASA works with FAA to transition to a commercial space model so that the private space industry knows how to have a core set of requirements and standard that would then satisfy their potential for further government contracts. This is also taking place with the federal communications commission, national telecommunications and information administration and national transportation and safety board.

The CSLC Act also institutes “Government Astronaut” as a distinct class of passengers from crew and space flight participants for government employees transporting to space on commercial vehicles to reflect advances in commercial space providers’ role in NASA crewed launches planned within the window of the bill.

The main purpose of the SPACE Act of 2015 is “To facilitate a pro-growth environment for the developing commercial space industry by encouraging private sector investment and creating more stable and predictable regulatory conditions.”[123]

In addition, with regard to space resource exploration and utilization, the bill states that the president must “promote the right of United States commercial entities to explore outer space and utilize space resources, in accordance with the existing international obligations of the United States, free from harmful interference, and to transfer or sell such resources.”[124]

However, in a statement of administration policy, the executive office of the U.S. president expresses concern about the ability of U.S. companies to move forward with these initiatives absent additional authority to ensure continuing supervision of these initiatives by the U.S. Government as required by the OST.[125]

The bill conserves FAA's capacity to regulate commercial human spaceflight so as to protect the uninvolved community, national security, public health and safety, safety of property, and foreign policy.[126] The SPACE Act of 2015 further requires any participants i.e. passengers to

[123] United States Congress. 2015, 'H.R.2262 - SPACE Act of 2015', accessed 02.10.2015 [https://www.congress.gov/bill/114th-congress/house-bill/2262/text].

[124] United States Congress. 2015, 'H.R.2262 - SPACE Act of 2015', accessed 02.10.2015 [https://www.congress.gov/bill/114th-congress/house-bill/2262/text],

[125] Executive Office of the President, Office of Management and Budget, 'Statement of Administrationn Policy, H.R. 2262 — Spurring Private Aerospace Competitiveness and Entrepreneurship (SPACE) Act of 2015'.

[126] United States Congress. 2015, 'H.R.2262 - SPACE Act of 2015', accessed 02.10.2015 [https://www.congress.gov/bill/114th-congress/house-bill/2262/text], Section: ‘Background and need for legislation.’

waive their right to remedy towards the provider and any related parties in the case of injury to property or person, no matter what degree of negligence is involved.[127]

The FAA's ability to regulate the safety of participant's onboard commercial spacecraft in this context, is postponed because the learning period of the industry is extended through 2025, which exists because it allows the industry to build up experience that could serve as the basis for later regulations and to allow the FAA to gain data to inform framework safety framework that may include future regulations.[128] According to the Commercial Space Launch Amendments Act of 2004, the FAA can only pass such regulations when a grave accident or unintended incident that represented the great danger of such an accident.

The American Association for Justice also remarked that the "unfair and harmful to individuals" liability protections were included "without any hearing or debate regarding whether such protections were necessary and what industry is doing to protect participants and bystanders from harm."[129] Similarly, a coalition of consumer protection organizations,[130] equates the liability provisions with "alarming" immunity and strongly recommends that Congress should not pass "legislation that removes this industry's financial incentive to conduct safe commercial space operations."[131]

The Space Act of 2015 further permits for industry to establish consensus standards in the interim and to organize this with the FAA. Furthermore, the bill guarantees that federal courts review lawsuits as a consequence of accidents because the federal government is the accountable party as stated in the Launch Liability Convention.[132]

[127] United States Congress. 2015, 'H.R.2262 - SPACE Act of 2015', accessed 02.10.2015 [https://www.congress.gov/bill/114th-congress/house-bill/2262/text], SEC. 108. CROSS-WAIVERS.

[128] United States Congress. 2015, 'H.R.2262 - SPACE Act of 2015', accessed 02.10.2015 [https://www.congress.gov/bill/114th-congress/house-bill/2262/text], Section: 'Background and need for legislation.'

[129] The American Association for Justice. 2015, 'Oppose Liability Protections in the SPACE Act of 2015', Letter from Linda Lipsen C.E.O. American Association for Justice to the Committee on Science, Space, and Technology.

[130] Alliance for Justice, Center for Justice & Democracy, Consumer Watchdog, National Consumers League, Network for Environmental & Economic Responsibility of United Church of Christ, Protect All Children's Environment and Public Citizen.

[131] Opposition to H.R. 2262 the "Spurring Private Aerospace Competitiveness and Entrepreneurship Act of 2015" or SPACE Act, letter to U.S. House of Representatives and The Honorable Nancy Pelosi.

[132] United States Congress. 2015, 'H.R.2262 - SPACE Act of 2015', accessed 02.10.2015 [https://www.congress.gov/bill/114th-congress/house-bill/2262/text], Section: 'Background and need for legislation.'

4.3. Property rights in space

The latest development is found in the Spurring Private Aerospace Competitiveness and Entrepreneurship Act of 2015, which states that "any asteroid resources obtained in outer space are the property of the entity that obtained such resources, which shall be entitled to all property rights thereto, consistent with applicable provisions of Federal law and existing international obligations."[133] In a wider context, the Outer Space Treaty Article II states that "*Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means*." This could be understood as prohibiting property rights i.e. extraterrestrial land deals being issued by states to corporations. If this interpretation is correct, corporations and individuals are still free to pursue resource extraction by themselves. Although, this understanding is restrained by OST Article VI

"States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty."

This can be interpreted as permitting private corporations extraction of resources, with the state they origin from as responsible regulators, but this still entails that "state signatories are required by Article Six to authorize space activities of non-governmental entities"[134]. On the other hand, in Gregory William Nemitz vs. NASA, et al., Gregory registered a claim to the asteroid Eros in 2000. NASA sent a satellite to examine the asteroid shortly thereafter. Subsequently, Nemitz demanded that NASA compensated him for parking on his real estate.

NASA responded by saying that "Your individual claim of appropriation of a celestial body (the asteroid 433 Eros) appears to have no foundation in law."[135] All administrative remedies

---

133 United States Congress. 2015, 'H.R.2262 - SPACE Act of 2015', accessed 02.10.2015 [https://www.congress.gov/bill/114th-congress/house-bill/2262/text], Commercialization of space resource exploration and utilization.

134 Joshua Easterson. 2011, 'You can Lead an Astronaut to Water....: Prospects for Legal Use and Water Rights on the Moon and Other Celestial Bodies', in 'New Perspectives on Space Law, Proceedings of the 53rd IISL Colloquium on The Law of Outer Space', (ed. Mark J. Sundahl & V. Gopalakrishnan), IISL, 91.

135 Wayne N. White. 2003, 'Interpreting Article II of the Outer Space Treaty', American Institute of Aeronautics and Astronautics, Proceedings, 46th Colloquium on the law of outer space, p.171 (IISL 2003), 7-8.

were exhausted at NASA, which subsequently led to a similar statement by Ralph L. Braibanti, the Director of Space and Advanced Technology in the Department of States Bureau of Oceans and International Environmental and Scientific Affairs, who wrote that “In the view of the Department, private ownership of an asteroid is precluded by Article II of the [1967 Outer Space] Treaty...Accordingly, we have concluded that your claim is without legal basis.”[136]

The reasoning behind these statements from NASA and the U.S. Dept. of State stem from Article 2 of the OST which says “outer space ... is not subject to national appropriation by claim of sovereign, by means of use or occupation, or by any other means”. According to this interpretation, an asteroid or other celestial body cannot be mined by neither state nor nongovernment body. Further, it states that space is the “common interest of all mankind” and that space “should be carried on for the benefit of all peoples”.

Economic development based on resources in space would have to happen within the realm of the monopolistic regime described in Article 11 (5) (6) (7), where Paragraph 7 (d) states that “An equitable sharing by all States Parties in the benefits derived from those resources, whereby the interests and needs of the developing countries, as well as the efforts of those countries which have contributed either directly or indirectly to the exploration of the moon, shall be given special consideration”, the same rhetoric is echoed in Article 1 of the moon treaty. Nonetheless, the treaty represents the most exhausting international attempt to consider the legal and societal inquiries of exploring and exploiting space.
Article 11 of the moon treaty states that “The moon and its natural resources are the common heritage of mankind, which finds its expression in the provisions of this Agreement and in particular in paragraph 5 or this article.” This means all countries of the world will benefit from the resource extraction, no matter if they have invested capital or other types of risk in it or not.
The moon treaty limits the possibility for private space development e.g. space tourism, resource extraction, space exploration. Space law has not yet settled on the matter of ownership of harvested resources in space. There is no legal guarantee that space resource extraction companies will profit from the resources they mine. Nonetheless, the suggested CSR guidelines in this paper assume private ownership unchallenged.

[136] Virgiliu Pop. 2008, 'Extraterrestrial Aspects of Land and Mineral Resources Ownership', Springer, 42.

A recent challenge to the property laws in space can be found in ‘The American Space Technology for Exploring Resource Opportunities in Deep Space (ASTEROIDS) Act of 2014’. It states that resources extracted in space belong to “*the entity that obtained such resources*”[137]. In addition, the Asteroids act protects such harvested resources from “harmful interference”[138], which can likely be interpreted in the same sense custom and law understands fishing on the high seas described in the Convention on the High Seas and the UN Convention on the Law of the Sea, i.e. a fishing vessel is free to fish without another vessel navigating in a way that causes harm to it. Obviously, these two points are vital for mining companies anywhere.

Article 1 of The Outer Space Treaty (1967) in comparison, states that “*Outer space, including the Moon and other celestial bodies, shall be free for exploration and use by all States*”. The functional term here is “use”. Article 6 states that “*The activities of non-governmental entities in outer space, including the Moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty*”.

This means that the Asteroids act lives up to The Outer Space Treaty´s obligation to supervise its non-governmental entities in space. This is more in line with The United States position on property rights in the UNCOPUOS negotiations which has been that the state will gain property rights to the ore through its labour, and not own the asteroid, moon or other site.[139] The U.S. has often argued that no property rights may be acquired in immoveable’s, but once part of an immovable is transformed into movables (through mining, for example), the latter is amenable for property.[140]

Nonetheless, a suitable regime to agree upon property rights is not in place yet. Until that happens it is hard to envisage investors gambling money on resource extraction in space, on a large industrial scale.

4.4. International law as a framework for CSR in space guidelines

The space law link to international obligations suggests that numerous foundations of responsibility outside United Nations Treaties, in particular stemming from customary international law exist. Certain principles of space law have gained the status as customary

[137] The American Space Technology for Exploring Resource Opportunities In Deep Space (Asteroids) Act, 113th congress, 2D session, Art 4 (a).

[138] The American Space Technology for Exploring Resource Opportunities In Deep Space (Asteroids) Act, 113th congress, 2D session, Art 3.

[139] Christol, Carl Q. 1982. The Modern International Law of Outer Space. New York: Pergamon Press, 39-43.

[140] James J. Hurtak. 1998, 'Legislation and Space Law Concepts Proposed for the Eventual Industrialization of Mars by Man', AFFS Corporation, 5.

international law. In fact, rules have appeared rapidly, and have been called 'instant' customary international law[141]and in addition possibly elevated to jus cogens status.[142] For example, “the character of customary international law can now be assigned without doubts only to the principles in the 1963 Declaration of legal Principles,”[143] and were later transformed into the 1967 Outer Space Treaty, which has not experienced any attempts at derogation and received broad international support.

Providing no more supplementary binding legal mechanisms are agreed by countries, the United Nations outer space treaties as well as recognized customary rules will continue as an outline from where succeeding regulations and laws will arise and be included in the codification process of space law.

There is no sovereignty in space law, “The general regime is, like that of the High Seas or the 1961 Antarctic Treaty, based upon free use and a prohibition of claims to sovereignty by individual states”[144], i.e. Article 1 and 2 in the OST denominate outer space as *res communis*[145].

The convention on the Regulation of the Antarctic Natural Resources is a practical apparatus that can be used to construct CSR guidelines in space or a legal regime to regulate the exploitation of extraterrestrial resources. In addition to providing a model, lessons can be drawn from previous mistakes when creating a legal framework to manage activities in an international field.

The treaty failed because France and Australia did not ratify it, but also because it lacks the potential to guarantee economic incentives for mining operators[146]. In practice this could mean that an operator, who had carried out the prospecting phase, complied with environmental requirements and invested capital and time, may have its request rejected due to the refusal of just one state. Lessons learned in terms of providing a foundation applicable to a legal regime in space, from this process include i) economic incentives for operators and a predictable legal regime regulating mining activities, ii) Sufficient time to provide the

[141] Cheng Bin. 1997, 'Studies in international space law', Claredon Press, 136.
[142] Tare C. Brisibe. 2013, 'A normative system for outer space activities in the next half century', 64th International Astronautical Congress, Beijing, China, IAF, 3.
[143] Vladimir Kopal. 2005, 'Disseminating and Developing International and National Space Law: The Latin America and Caribbean Perspective : Proceedings, United Nations/Brazil Workshop on Space Law', UNOOSA, 18; C. Wilferd Jenks. 1965, 'Space law', Frederick A. Praeger, 186.
[144] James Crawford. 2012, 'Brownlie's Principles of Public International Law', (8th edn), Oxford University Press, 349.
[145] The common heritage of all humankind.
[146] Tronchetti. F. 2009, 'The Exploitation of Natural Resources of the Moon and Other Celestial Bodies', 'A Proposal for a Legal Regime'. Koninklijke Brill NV.

operator with authorization to proceed in mining activities, iii) a simple institutional machinery, and iv) global participation, including opportunities for developing states[147].

In terms of CSR in space, reference can be made to the Conventions provisions targeted at guarding the Antarctic environment from harm. These provisions create criterions for a framework that must be respected when prospecting, surveying and exploring Antarctica. In addition, the Convention, similar to the recently adopted Permanent Court of Arbitration 2011 Optional Rules for Arbitration of Disputes Relating to Outer Space Activities[148], assembles a dispute settlement mechanism, which could be applied in space.

The Convention also puts the primary responsibility for damage to the Antarctic environment to operators, and makes clear that states have responsibility for activities of their nationals as operators, an idea already seen in space law. Part XI of the 1982 law of the Sea Convention, in its original adaptation, the Moon Treaty and the Convention on the Regulation of Antarctic Mineral Resource Activities had a joint fate. The intention was to set standards and regulation partly targeted at making extraction of resources in international areas possible, but failed to recognize property rights.

In the United Nations Convention on the Law of the Sea (UNCLOS), the freedoms of the high seas are limited in Part XII which describes a general obligation to protect and preserve the marine environment. Further, in part VII, Section 2, it describes obligations to conserve and manage high seas living resources[149]. Similarly, space resource extraction must be subject to social, economic, environmental and security regulation.

The non-appropriation principle applies to high seas, Antarctica, deep seabed and outer space. For example, Article 136 of UNCLOS states that the Area and its resources are the common heritage of mankind. The Environmental Protocol to the Antarctic Treaty[150] prohibits “any activity relating to mineral resources, other than scientific research.”[151] Similarly, UNCLOS notes that “no state shall claim or exercise sovereignty or sovereign rights over any part of the

[147] Tronchetti. F. 2009, 'The Exploitation of Natural Resources of the Moon and Other Celestial Bodies', 'A Proposal for a Legal Regime'. Koninklijke Brill NV.

[148] Permanen Court of Arbitration. 2011, 'Optional Rules for Arbitration of Disputes Relating to Outer Space Activities', PCA.

[149] Kimball, Lee A. (2005). The International Legal Regime of the High Seas and the Seabed Beyond the Limits of National Jurisdiction and Options for Cooperation for the establishment of Marine Protected Areas (MPAs) in Marine Areas Beyond the Limits of National Jurisdiction. Secretariat of the Convention on Biological Diversity, Montreal, Technical Series no. 19, 64 pages, 5.

[150] ATS. '1959 Antarctic Treaty', Date of Adoption: 1 December 1959, Date of Entry into Force: 23 June 1961 (Article XIII),

[151] ATS. 'The Protocol on Environmental Protection to the Antarctic Treaty', signed October 4, 1991, entered into force 1998.

Area or its resources, nor shall any State or natural or juridical person appropriate any part thereof".[152]

In terms of environmental protection, in addition to the Environmental Protocol to the Antarctic Treaty, OST Article IX makes clear that parties to the treaty can conduct exploration and research of outer space but must avoid its "harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter." Likewise Article 145 of UNCLOS notes that rules and regulation should be made to prevent, reduce and control pollution and other hazards to the marine environment and protect and conserve the natural resources of the Area. The Principles Relevant to the Use of Nuclear Power Sources in Outer Space, states that "States launching space objects with nuclear power sources on board shall endeavour to protect individuals, populations and the biosphere against radiological hazards."[153]

UNCLOSs legal framework is not directly transferable to space because the unique environment presents a range of new challenges. In any case, CSR in space requires consideration on a broader scale than what is the standard on Earth. These challenges are addressed in this article, with the end result consisting of CSR in space guidelines.

4.5. Liability and transparency

Article VI of the 1967 OST makes states responsible for their national's activities. Article 11 of the 1973 Liability Convention asserts that liability based on fault is recognized for damage in space, which makes public-private partnerships subject to close monitoring of compliance with standards and regulation. The liability convention defines 'damage' covered by the convention as "loss of life, personal injury or other impairment of health; or loss of or damage to property of States or of persons, natural or juridical, or property of international intergovernmental organizations."[154]

Similar to the OST Article 7, Articles IV and II in the Liability Convention also creates an absolute liability for any injury produced by a state's cooperative space efforts. In practice, these kinds of partnerships will administer liability and support a mechanism for project level grievance mechanism and resolve disputes, but in conclusion it means that one state can be held liable for the whole accident.

[152] 1833 UNTS 3; 21 ILM 1261 (1982), Art 137.

[153] UNGA. 'Principles Relevant to the Use of Nuclear Power Sources in Outer Space', A/RES/47/68, 85th plenary meeting, 14 December 1992, Principle 3 (1) (a).

[154] UN. 'The 1972 Convention on International Liability for Damage Caused by Space Objects', entered into force: 1972, Art 1.

The Convention on Registration of Objects Launched into Outer Space (Registration Convention), among other, serves as the foundation for transparency and confidence building measures. It requires that, "When a space object is launched into earth orbit or beyond, the launching State shall register the space object by means of an entry in an appropriate registry which it shall maintain,"[155] which access is full and open.[156] Transparency and confidence building actions indorse joint self-assurance amid countries through positive discourse and augmented alertness and understanding. Transparency and confidence-building measures for outer space activities are intended to increase the security, safety and sustainability of outer space.[157]

4.6. International Code of Conduct for Outer Space

The European Union has proposed an international code of conduct for outer space. A total of 95 UN Member States have participated in the negotiations of the Code of Conduct, which is meant as a transparency and confidence-building initiative.

Unlike this articles proposed non-governmental CSR principles for space which identifies the corporate entity as responsible, the exclusive duty bearers in the Code of Conduct is states.[158] The political and economic climate is subject to change as international affairs and geopolitical interests and focus areas change. For example, Brazil, Russia, India, and China have pointed out that they might not sign the Code of Conduct because they were barely included in its evolution and think it could be a device to restrict the future ability of emerging powers in outer space.[159] Longstanding mistrust between nations, concerns about the agreement not being legally binding, and accusations that the code of conduct is actually just an attempt to prevent a space arms race are all complicating the successful creation of a code of conduct for space that all countries can agree on.[160]

Further, on one hand, under the UN, the U.S. wants to ensure their right to self-defence, and consequently, has been wary of agreeing to a code that would seek to limit the right to self-defence. Because of this, the code has incorporated a reference to Article 51 of the UN

---

155 Convention on Registration of Objects Launched into Outer Space, Signed 12 November 1974, Entered into force 15 September 1976, Art II.

156 Convention on Registration of Objects Launched into Outer Space, Signed 12 November 1974, Entered into force 15 September 1976, Art III.

157 UN. 2013, 'Transparency and Confidence-Building Measures in Outer Space Activities', Office for Disarmament Affairs, 11, 12.

158 EU. 2014, 'International Code of Conduct for Outer Space Activities', Draft -Version 31 March 2014, 4.

159 Micah Zenko. 2011, 'A Code of Conduct for Outer Space', Policy Innovation Memorandum No. 10, Council on Foreign Relations, accessed 23.10.2015 [http://www.cfr.org/space/code-conduct-outer-space/p26556].

160 Keith Moore. 2015, 'EU space code of conduct: The solution to space debris?', 02.10.2015 [http://www.bbc.com/news/science-environment-17448173].

charter.[161] Article 4.2 of the code guarantees, "the inherent right of individual or collective self-defence."[162] On the other, Brazil and several other South American states have noted that the clear mention of Article 51 challenges numerous significant features of the code of conduct. The South American states fear that Article 4.2 of the code will be used to justify weaponing space and create an arms race in space under the veiled claims of defence.

4.7. Human Rights Law in Space -Should human rights apply in space?

Water as a human right "usually and practically falls under national or provincial adjudication"[163].

Human rights have been rationalized as a consequence of inherent human dignity,[164] historically for instance in the American Declaration of the Rights and Duties of Man and French Declarations of the Rights of Man and of the Citizen.[165] The UDHR Art. 1 describes the fundamental principles of human rights as freedom, equality and dignity, referring to "*respect for the inherent dignity of the human person*" even when their liberty is deprived.[166] But in space, the human right to property found in Article 17 of the UDHR is denied in the Moon Treaty. The Moon Treaty Article 11 (3) states that "Neither the surface nor the subsurface of the moon, nor any part thereof or natural resources in place, shall become property of any State, international intergovernmental or non-governmental organization, national organization or non-governmental entity or of any natural person."

Article 15 of the moon treaty denies the human right of privacy guaranteed by Article 12 of the UDHR by stating that "all space vehicles, equipment, facilities, stations and installations on the moon shall be open to other States Parties".

---

161 UN Charter, Article 51:
"Nothing in the present Charter shall impair the inherent right of individual or collective self-defense if an armed attack occurs against a Member of the United Nations, until the Security Council has taken measures necessary to maintain international peace and security. Measures taken by Members in the exercise of this right of self-defense shall be immediately reported to the Security Council and shall not in any way affect the authority and responsibility of the Security Council under the present Charter to take at any time such action as it deems necessary in order to maintain or restore international peace and security."

162 Joseph Rodgers. 2015, 'Negotiating a Code of Conduct for Outer Space Activities', Arms Control Association, accessed 23.10.2015 [https://www.armscontrol.org/blog/ArmsControlNow/2015-06-04/Negotiating-a-Code-of-Conduct-for-Outer-Space-Activities].

163 Joshua Easterson. 2011, 'You can Lead an Astronaut to Water....: Prospects for Legal Use and Water Rights on the Moon and Other Celestial Bodies', in 'New Perspectives on Space Law, Proceedings of the 53rd IISL Colloquium on The Law of Outer Space', (ed. Mark J. Sundahl & V. Gopalakrishnan), IISL, 89.

164 UDHR, Preamble, para .1, Art. 1, Art. 22, Art. 23 (3).

165 Oette. L Bantekaz. I, *International Human Rights Law and Practice* (1 edn, Cambridge University Press 2013) 33

166 See e.g. Vienna Declaration and Programme of Action: "*All human rights are universal, indivisible and interdependent and interrelated*".

4.7.1. A special consideration for developing countries?

No definitive description of common of heritage of mankind exists. The idea holds the impression that certain categories of belongings are owned by everybody, instead of only the persons having the capability to extract or otherwise take advantage of them.[167]

It has been suggested that a revenue sharing plan be established with the Third World, should exploitation of resources on a celestial body get underway.[168] The Right to Development Declaration (RTD) created obligations on developed countries to finance developing countries. Indeed, this possibility has been implicated in resistance of developed countries to legal recognition for RTD. Yet, scholars have argued that RTD "*is unrelated to the financial progress of nations*"[169] does not create a right to be developed and does not create obligations to finance developing countries.[170]

In support of this point is claimed the references in the International Covenant on Economic, Social and Cultural Rights (ICESCR) and International Covenant on Civil and Political Rights (ICCPR) to all peoples' right to "...<u>pursue</u> their economic, social and cultural development",[171] and not to be developed, "in no sense does it imply a right to be developed"[172].

Arguably, the articulation of the RTD has exposed a number of fundamental contradictions or dilemmas at the foundations of the international legal order, namely between its commitments to self-determination and development, on one hand, and its commitment to territorial integrity, on the other.

Law and CSR guidelines in space must avoid similar contradictions in order to be effective, and have financial appeal to private enterprise.

Space industry is a costly activity, limited to very few private actors in the world. Poor countries have less capacity to develop space industries, should they receive special consideration when it comes to benefiting from space industry because of this?

---

167 Jennifer Frakes. 2003, 'The Common Heritage of Mankind Principle and Deep Seabed, Outer Space, and Antarctica: Will Developed and Developing Nations Reach a Compromise?', Wisconsin Journal of International Law 21, 411-413.
168 James J. Hurtak. 1998, 'Legislation and Space Law Concepts Proposed for the Eventual Industrialization of Mars by Man', AFFS Corporation, 855.
169 Bantekaz. I, Oette. L, 'International Human Rights Law and Practice', 488.
170 Alston. P, Goodman. R, Steiner.H . J, International Human Rights in Context: Law, Politics, Morals, 1449
171 ICESCR, Article 1 (1); ICCPR Article 1.
172 Alston. P, Goodman. R, Steriner.H . J, International Human Rights in Context: Law, Politics, Morals, 1449

5. CSR

This section gives a brief overview of the origin and transformation of CSR, in order to establish the foundation for the reasoning and justification behind CSR in space. Viewed as an extension of terrestrial norms, CSR in space relies on the same justifications of social responsibility for private enterprise as do terrestrial CSR.

5.1. What is CSR?

Viewing CSR from the perspective of broader political theory and moral philosophy, the social contract has been suggested as providing its ultimate foundations.[173] When Thomas Hobbes first characterized the social contract, it was with reference to “The mutual transferring of right” to form a “political commonwealth” or “commonwealth by institution.”[174] This transfer, according to Hobbes takes place “…when men agree amongst themselves to submit to some man, or assembly of men, voluntarily, on confidence to be protected by him against all others.”[175]

The effectiveness of legislation and other public measures to enforce more humane company conduct to some extent presumes the willing compliance of businesses themselves, in which perhaps the seeds of CSR can then be found. Published in 1987, “Our Common Future”, also known as ‘the Brundtland report’, was important in introducing the concept of sustainability into public and especially development policies.[176] The 1992 UN Rio summit was highly influenced by the Brundtland report, and laid the foundations for institutionalizing sustainable development at global level.[177]

In terms of the private sector, to date, where sustainable development has been adopted, it has often been on a voluntary basis through CSR standards such as the UN Global Compact.[178]

---

[173] Steven L. Wartick and Philip L. Cochran. 1985, The Evolution of the Corporate Social Performance Model, The Academy of Management Review, Vol. 10, No. 4 (Oct., 1985), 767

[174] Hobbes, Thomas.1651, Leviathan, 1999 The University of Oregon, 647 p.Transcribed from the University of Adelaide mirror of the ERIS Project plain text edition, 116.

[175] Hobbes, Thomas.1651, Leviathan, 1999 The University of Oregon, 647 p.Transcribed from the University of Adelaide mirror of the ERIS Project plain text edition, 152.

[176] Our common future. 1987, Report of the World Commission on Environment and Development: Our Common Future, Gro Harlem Brundtland Oslo, 20 March 1987.

[177] John Drexhage, Deborah Murphy. 2010, Sustainable Development: From Brundtland to Rio 2012, Background Paper prepared for consideration by the High Level Panel on Global Sustainability at its first meeting, 19 September 2010, IISD, 8.

[178] John Drexhage, Deborah Murphy. 2010, Sustainable Development: From Brundtland to Rio 2012, Background Paper prepared for consideration by the High Level Panel on Global Sustainability at its first meeting, 19 September 2010, IISD, 10.

The inclusion of sustainability in the scope of CSR is important because it integrates consideration of long-term issues, impacts and solutions, whenever a corporation engages in a social initiative. In practical terms this means, for instance, that when a corporation concludes a particular extractive operation, it should ensure the environment is in as good or better condition than it found it.

However, the arrival of sustainable development and its linkage to CSR has an importance going beyond the local level. While sustainable development and its three pillars of economic development, social equity, and environmental protection have been increasingly used as principles to guide holistic CSR approaches[179], connecting these to CSR has also, arguably, prepared the way for CSR's connection, and definition with regard to, a range of soft international regulatory standards (now including human rights, particularly in light of the rising influence of "human rights-based approaches to development") and connections drawn between sustainability and human rights (e.g. in the context of climate change mitigation measures), and the current shift from an emphasis on voluntarism to a compliance focus.

The Introduction noted this shift as being illustrated in the recent re-definition of CSR by the EU Commission and its alignment to the UN Human Rights Council's the UN Guiding Principles on Business and Human Rights. To recap, the Commission now defines CSR as "The responsibility of enterprises for their impacts on society", with an associated obligation on enterprises "to have in place a process to integrate social, environmental, ethical human rights and consumer concerns into their business operations and core strategy in close collaboration with their stakeholders"[180], in other words, to undertake "due diligence", as outlined in the UNGPs, in relation to human rights, and OECD Guidelines and IFC Performance Standards, for example, for social and environmental issues defined more broadly.

The European Commission, and other international organizations with a financial or economic mandate have stated their support for the Human Rights Council's 2011 UN

[179] John Drexhage, Deborah Murphy. 2010, Sustainable Development: From Brundtland to Rio 2012, Background Paper prepared for consideration by the High Level Panel on Global Sustainability at its first meeting, 19 September 2010, IISD, 2.

[180] European Commission (EC).2011, Communication from the commission to the European parliament, the council, the European economic and social committee and the committee of the regions, a renewed EU strategy 2011-14 for Corporate Social Responsibility, 6.

Guiding Principles on Business and Human Rights, “a global standard for preventing and addressing the risk of adverse impacts on human rights linked to business activity” (Office of the High Commissioner for Human Rights, OHCHR).

Though the UNGC´s also addresses business and HR, through its two human rights principles, the UNGC is explicitly a CSR initiative for companies to take part in on a voluntary basis. The UNGPs, by contrast, emphasize their foundations on international human rights laws, specifically UN human rights treaties, as giving rise to obligations for states and “responsibility to respect human rights” for companies, and assert that business activities can affect, and need to prevent or mitigate, their impacts on all human rights.

5.2. Why CSR in Space?

CSR should be applied with regard to privatization of space industries because it can help to guide companies to act socially responsible in areas where international law regimes have yet to be developed. Further, CSR developed specifically with regard to space industries that has taken into account international law and space law –as well as relevant terrestrial CSR guidelines, is able to safely guide companies in relation to prevailing norms and law on earth.

5.2.1. Ethics

In terrestrial CSR, the beneficiaries of the CSR policies are often located in the immediate vicinity of company operations. When corporate activity is transferred into space, ‘who should be the beneficiaries’ and judging right from wrong behaviour becomes a bit more complicated. The space law examined uses the ‘common heritage of mankind’ wording to describe the owners of space. Should then the ‘society’ in CSR, in space, be considered the whole world?

5.2.2. Law

Space exploration is an extension of human society into space, it therefore carries these norms with it. CSR fills the legal gap, and space law has the same underlying values as on Earth, just as CSR fills the gaps of terrestrial laws it fills gaps in space law.

5.2.3. Practical Reasons and implications for Companies

CSR is quicker and less complicated to develop and apply than laws and codes of conduct that involves state parties in negotiations. The private industry needs an outward facing socially responsible profile, in parallel with laws being developed. These can in course be restructured as laws progress and come into existence. Yet, as shown in the law section above, this can be a complicated and slow process.

The corporate signatories to the CSR Guidelines for Space commit to adhere to the guidelines to the best of their ability. Although the CSR Guidelines are not legally binding, they offer an accurate view into the evolving status of space law and regulation. The corporation itself can choose to engage in discussions on how to further develop the CSR Guidelines for Space, or remain a passive member. Private space companies vary in many respect, and for this reason the CSR Guidelines for Space are possible to custom fit, creating a unique CSR profile for each distinctive sector or company.

5.3. Unique CSR Challenges in Space

Activity in space provides a new range of challenges for CSR entirely unlike what we see on earth. NASA is focusing their International Space Station (ISS) research on human health during long-duration missions[181] through its Human Research Program (HRP)[182]. The research focuses on psycho-social studies, radiation studies and effects of microgravity on bone,[183] bone and muscle loss and increased intracranial pressure.[184] Early detection and analysis of contamination is important because the ISS is a closed environment.[185] This is why new technologies are developed in this area to increase the rate of detection and analysis of "contaminants in the cabin air (gaseous, particulate, and microbial), in the water, and on the surfaces of the station"[186].

Any Mars, lunar or NEA exploration program must be manned. This is because mining operations are highly sensitive to the quantity, distribution, grade, matrix and grain-size relationships (and whether metal inclusions can be extracted), especially "maintenance is

181 NASA. 2009, 'International Space Station, Science Research Accomplishments During the Assembly Years: An Analysis of Results from 2000-2008', 1.

182 National Research Council. 2014, 'Pathways to Exploration: Rationales and Approaches for a U.S. Program of Human Space Exploration', Committee on Human Spaceflight, National Academy of Sciences, 2-23.

183 NASA. 2009, 'International Space Station, Science Research Accomplishments During the Assembly Years: An Analysis of Results from 2000-2008', 2.

184 National Research Council. 2014, 'Pathways to Exploration: Rationales and Approaches for a U.S. Program of Human Space Exploration', Committee on Human Spaceflight, National Academy of Sciences, 2-23.

185 Understanding the space environment outside of the ISS living space is also critical to life aboard the station and future exploration missions. Quantifying radiation hazards, the effects of
AO, large thermal cycles, and micrometeorites and orbital debris is a large area of research aboard the ISS. NASA. 2009, 'International Space Station, Science Research Accomplishments During the Assembly Years: An Analysis of Results from 2000-2008' 16

186 NASA. 2009, 'International Space Station, Science Research Accomplishments During the Assembly Years: An Analysis of Results from 2000-2008', 16

recognized as a major difficulty in implementing automation"[187], and robotic missions probably do not have the flexibility to make such complex assessments due to the need of human reasoning[188]. In addition, the National Academy of Sciences Committee on Human Spaceflight considers "robotic exploitation of space resources for on-Earth use, to be a highly speculative idea because the cost-benefit equation would need to change substantially in order to make such exploitation commercially viable."[189]

Furthermore, automation of resource extraction projects in space is also made difficult because no mission will ever be identical to the previous, thus learning from repeating actions becomes near impossible, ultimately complicating empirical learning.[190] One example is the "Hayabusa spacecraft…which…made two touchdowns on the surface of asteroid 25143 Itokawa on 20 and 26 November 2005 JST and successfully collected grain particles from the surface of the asteroid."[191] The samples were only a few milligrams (1500 grains, mostly smaller than 10 microns).[192] Any future mission, among other the European Space Agency´s Rosetta mission, will have to cope with different shape of asteroids, different surface and trajectory –complicating the learning curve of robots.

In addition, psychological impacts on humans in space, given the enormous pressure put on them, could potentially cause human errors that jeopardize other humans in space safety and overall mission. Psychological trauma can also be imagined as a result of having to operate under extreme pressure.

In light of this, it is clear that the health and safety of persons in space is of outmost importance for the long term success of activity in space. This is why health, safety and liability measures must receive greater focus than it is given at present in the NRC and UNGP

[187] NASA. 1992, 'Space Resources', (ed. Mary Fae McKay, David S. McKay, and Michael B. Duke), Lyndon B. Johnson Space Center Houston, Texas, NASA SP-509, vol. 3, 138.
[188] NASA. 1992, 'Space Resources', (ed. Mary Fae McKay, David S. McKay, and Michael B. Duke), Lyndon B. Johnson Space Center Houston, Texas, NASA SP-509, vol. 3, 138.
[189] National Research Council. 2014, 'Pathways to Exploration: Rationales and Approaches for a U.S. Program of Human Space Exploration', Committee on Human Spaceflight, National Academy of Sciences, 2-11.
[190] NASA. 1992, 'Space Resources', (ed. Mary Fae McKay, David S. McKay, and Michael B. Duke), Lyndon B. Johnson Space Center Houston, Texas, NASA SP-509, vol. 3, 115.
[191] Nakamura, T., et al., Itokawa dust particles: a direct link between S-type asteroids and ordinary chondrites. Science, 2011. 333(6046): p. 1113-6.
[192] NASA, Marc M. Cohen et al., Robotic Asteroid Prospector (RAP). 2013, 'Staged from L1: Start of the Deep Space Economy', (Final Report 9 July 2013, corrected 17 July 2013), 12.

with its own section carefully detailing safety and health measures specific to space as part of the CSR space guidelines.

6. Terrestrial CSR Guidelines

This section introduces United Nation Guiding Principles for Business and Human Rights (UNGPs), and the Natural Resource Charter (NRC). Reasons are then given for why they are among the best candidates of CSR guidelines, for a merger with existing international and space law, creating a new set of CSR principles and guidelines applicable to apply to the growing set of challenges the world community face with activity in space.

6.1. UN Guiding Principles on Business and Human Rights

The UN Guiding Principles are based on a “three-pillar” framework. This comprises firstly, the state duty to protect against business-related human rights abuses: the UNGPs detail how states should take appropriate steps to prevent, investigate, punish and redress such abuse through effective policies, legislation, regulations and adjudication,[193] clearly set out expectations that MNCs respect human rights[194] and ensure that laws regulating businesses "enable business respect for human rights".[195]
Under the second pillar, the corporate responsibility to respect human rights, MNCs must “…avoid infringing on the human rights of others and should address adverse human rights impacts with which they are involved”,[196] and in relation to weak states i.e. situations where domestic law does not live up to fundamental human rights, MNCs should “…honor the principles of internationally recognized human rights when faced with conflicting requirements”.[197] The third pillar emphasizes that effective remedies should be accessible to victims for business-related human rights abuses, through state-based judicial and non-judicial mechanisms, and non-state based mechanisms.[198] Since 2011, other international organizations have integrated the UNGPs into their own standards addressed to companies, for example, the OECD’s Guidelines for Multinational Enterprises[199], while international

[193] Ruggie. J.G. 'Guiding Principles on Business and Human Rights: Implementing the United Nations 'Protect, Respect and Remedy' Framework' (16 June 2011), Guiding Principle 1.
[194] Ibid, Guiding Principle 2.
[195] Ibid, Guiding Principle 3.
[196] Ibid, Guiding Principle 11.
[197] Ibid, Guiding Principle 23 (b).
[198] Ibid, Guiding Principle 22.
[199] OECD (2011), OECD Guidelines for Multinational Enterprises, OECD Publishing, 3.

financial institutions like the International Finance Corporation have claimed to do the same. In Europe, both the European Union and Council of Europe have adopted formal statements of support for the UNGPs.

Since 2011, UN treaty monitoring bodies, especially the UN Committee on the Rights of the Child and the UN Economic and Social Rights Committee, encouraged by the UNGPs, have increasingly addressed businesses and their responsibilities for human rights.[200] There are also indications that treaty bodies are giving effect to this principle extraterritorially: for example, the UN Committee on Economic, Social and Cultural Rights recently recommended to Norway that it must ensure its investments in foreign companies in third countries are "…subject to a comprehensive human rights impact assessment" and take "…measures to prevent human rights contraventions abroad by corporations which have their main offices under the jurisdiction of the State Party". [201]

6.2. The Natural Resource Charter

The Natural Resource Charter (NRC), have defined a set of non-political precepts[202] which inform governments and non-governmental bodies in administrating natural resources so that the favourable circumstances created by the economic growth, sustainably benefits citizens. Instead of providing a blueprint for institutions on how to manage resources, it construes the general principles that can be utilized to design institutions, and functions as a benchmark for them[203].

The NRC precepts consist of a series of alternatives and decisions governments are confronted by, as regards the resource extraction process. NRC guidelines vary from describing proper conditions for accountable investment, tax terms, and regulation of institutions, administration, contracts and plan of actions for sustainable development.

[200] Committee on the Rights of the Child, UN. Doc. CRC/C/GC/16, General comment No. 16 (2013) on State obligations regarding the impact of the business sector on children's rights', (17 April 2013); Committee on Economic, Social and Cultural Rights, UN. Doc. E/C.12/2011/1, (12 July 2011), 'Statement on the obligations of States parties regarding the corporate sector and economic, social and cultural rights'.
[201] Committee on Economic, Social and Cultural Rights, 'Concluding observations on the fifth periodic report of Norway', (Advance unedited version), (29 November 2013), E/C.12/NOR/CO/5, para. 6.
[202] The principles are divided into 12 percepts: Strategy, consultation and institutions, Accountability and transparency, exploration and license allocation, Taxation, Local effects, State-owned enterprise, Revenue distribution, Revenue volatility, Government spending, Private sector development, Roles of international companies and Roles of international actors.
[203] NRC. 2010.

NRC has additionally generated an assessment framework, facilitating easy evaluation for governments and corporations of their accomplishments in relation to the 12 precepts. NRC was adopted by the African Union in 2011, and helped to shape the African mining vision.[204]

This is done by putting a major emphasis on transparency[205] and accountability. In this respect, according to Collier, the NRC "intended to complement EITI [Extractive Industry Transparency Initiative] in spelling out the entire decision chain by which natural assets can become a blessing instead of a curse"[206].

The EITI, which aims to strengthen governance, improve revenue transparency and accountability in the extractive sector, consists of two main elements. First, companies commit to "publish what they pay" to governments. Secondly, governments publish details of payments they receive from companies.[207] EITI understands openness about the management of resource wealth as key to fair distribution amongst a countries citizen[208]. EITI stresses transparency by governments and companies in the extractive industries and the need to enhance public financial management and accountability[209].

7. CSR Guidelines for Space

This section extrapolates the above into CSR guidelines for Space. It has been careful to base its principles on facts based on the current use of space and being practical in regards to its formulation and application.

CSR guidelines for space apply primarily to the private space industry. Because the guidelines fill a legal gap, they additionally function as a set of guidelines for normative frameworks in law making processes. Due to their broad applicability, the guidelines are subject to change in response to new regulatory and industry developments.

When formulating new regulation it is best to look for existing models of analogous and accepted legal governance and non-judicial regulation, and then modify them to fit the

---

[204] NEPAD. 2011, 17-18

[205] Transparency is poor in extractive sectors worldwide. Only 10 of the 58 countries examined in the Revenue Governance Index publish most of their oil, gas and mineral contracts and licenses, though this group is growing with the recent disclosures by Afghanistan, Ghana and Guinea, Revenue Watch Institute, 2013

[206] Natural resource charter. 2009, 'The Natural Resource Charter and EITI: Building the Foundations of Informed Societies.'

[207] EITI fact sheet. 2013, 1

[208] The EITI Standard. 2013, 9

[209] Ibid.

situation at hand. A further consideration that has been made is for the different characteristics of the space industry. Space tourism, space exploration, astronauts, resource extraction, in-situ resource providers and satellite communications all have different goals and needs. The CSR in space guidelines are therefore formulated in a way which allows applicability across these different areas.

Principle 1: Health

- Considerations for health must be highlighted during all stages of the space activity, including the preparatory stages on Earth and follow up inspections after return to Earth.

If contact with extraterrestrial life occurs, a quarantine facility must be available at all stages of the mission. Medical condition test of the mission members and their possible reaction to pathogens or microbes must be taken regularly. Safety concerns must also include forward and backward contamination risks. Further, safety measures must apply to robots, vehicles and other machines during the mission.

Safety protocols including all the above concerns must be continually re-evaluated based on new experiences, integrating the most current technology, science and strategies. A member of the crew should be appointed to head of safety, with the responsibility for the application of the safety procedures –in case communication to Earth is lost. All crewmembers must undergo safety and security training affecting all stages of the mission. Given the limited knowledge of venturing in space, overcompensating safety measures should be exercised and adjusted according to expert scientific consensus.

Principle 2: Psychological Health

- Special consideration should be paid to the psychological wellbeing of all participants[210] during space missions.

[210] The Spurring Private Aerospace Competitiveness and Entrepreneurship Act of 2015 defines space flight participants as "an individual, who is not crew or a government astronaut, carried within a launch vehicle or reentry vehicle." In the CSR guideline context, ‘participant’ has a broader application which includes all parties directly involved in the space activity on ground and in space.

The extreme conditions space travellers undergo could have negative impacts on an individual´s psychological wellbeing. Training prior to launch and after re-entry to Earth must contain psychological evaluation and aspects to it that prepare the space traveller for the extreme conditions in all stages of the mission.

Principle 3: Environmental

- The environment, consisting of space itself, and celestial bodies must be respected according to extraterrestrial environmental standards, expert opinion and global citizen opinion.

Principle 4: Space Junk

- Space junk is to the detriment of all parties active in space, and its mitigation efforts must therefore be shared by all, proportionate to duration, and type of activities in space.

Space junk mitigation action should be taken at all stages of preparation and operation, with regards to minimize space debris in space.

Space junk guidelines should be developed for each space mission, uniquely fitted to the known and potential space junk. Each mission should be followed by a report, detailing mitigation measures taken to reduce space junk, and develop recommendations based on newfound knowledge.

All spacecraft, and other elements of any space mission, should minimize the space junk emitted into space, and must not go forward unless an acceptable evaluation confirms that damage to the space environment, and any other spacecraft is low in the long-term.

Special mitigation guidelines must be developed for accidental explosions, uniquely fitted to each mission. All spacecraft should be continually monitored, both during operation and preparation to spot malfunctions that could unintentionally leave space junk behind.

Intentional discarding of space junk in space, if possible, must be done in low orbit, so it is short lived. If debris is returned to Earth, it must undergo tests to ensure back contamination is avoided.[211]

[211] Inter-agency space debris coordination committee (IADC). 2007, 'IADC Space Debris Mitigation Guidelines', IADC Action Item number 22.4, Steering Group and Working Group.

Principle 5: Monitoring

- Continued monitoring of harmful contamination is necessary during all stages of the space activity.

Due to increased health risks with radiation, early detection and analysis of contamination is important because space systems are closed environment. The ongoing monitoring is crucial to being able to respond as quickly as possible, and thereby minimize the chances of inflicting harm.

Principle 6: Safety

- All known precautions must be taken to mitigate safety risks for crew in space and on the ground.

The International Association for the Advancement of Space Safety (IAASS) has developed a set of detailed safety guidelines, adapted to space. In addition, the unique space environment requires special consideration to the effect the psychological impact from space travel can have on individual and inter-personal safety.

Principle 7: Transparency

- Transparency in all parts of space industry operations is necessary to nurture an environment of trust between different space industry actors, and the global community.

Principle 8: Accountability

- Space companies must be accountable in the first instance to its home government and its citizens.

Much of the space industry operates in a legal grey zone. As the law relating to space is developed it is important that space industry companies are held responsible according to government investigations and societal norms.

Principle 9: Conservation

- Special consideration must be given to the conservation of celestial bodies and space in its original form because mankind has a shared interest in safekeeping the environment that is responsible for our species origin.

The right to property and environmental impact on celestial bodies should not go beyond what is inflicted through labour, and not extend to the whole celestial body.

Principle 10: Respect to Property

- Property in space must be respected according to applicable laws and norms on earth.

8. Conclusion

This paper has demonstrated the growing need for legal clarity, in an area experiencing increased investor interest, capacity to grow and with the risk of real adverse impacts on earth. CSR guidelines for space companies assist in identifying these risks and assure that they behave in a responsible manner according to the newest developments in space law international law and CSR expectations on Earth.

Terrestrial CSR has evolved to fill gaps in national legal and policy frameworks by formulating principles and guidance, sometimes based on soft law instruments. This function of remedying legal uncertainties makes CSR an ideal tool and approach for defining and addressing responsible corporate behaviour in space.

CSR Guidelines for Space ought to help public and private actors alike achieve the sustainable commercial exploitation of space resources. CSR should be taken seriously by space industries because:

1) It can help to guide companies to act in a socially responsible way in areas where legal standards are still developing,
2) It can help ensure a continued “social license to operate” with reference to terrestrial stakeholders,

3) It can help to build renewed support for public and private investment in space science and space industries.

Bibliography

114th Congress (2015-2016)', Accessed 02.10.2015: [https://www.congress.gov/bill/114th-congress/senate-bill/1297/text].

1833 UNTS 3; 21 ILM 1261 (1982).

Agreement Governing the Activities of States on the Moon and Other Celestial Bodies', Adoption by the General Assembly 5 December 1979 (resolution 34/68), Entry into force: 11 July 1984.

Alliance for Justice, Center for Justice & Democracy, Consumer Watchdog, National Consumers League, Network for Environmental & Economic Responsibility of United Church of Christ, Protect All Children's Environment and Public Citizen.

Almár, I. 2002, 'What Could COSPAR Do to Protect the Planetary and Space Environment?' Adv.Space Res. Vol. 30, No.6.

Alston. P, Goodman. R, Steiner.H . J, International Human Rights in Context: Law, Politics, Morals.

Anders, E. 1970, 'Trace elements in Apollo 11 lunar rocks: Implications for meteorite influx and origin of moon', Geochimica et Cosmochimica Acta Supplement, Volume 1.

Proceedings of the Apollo 11 Lunar Science Conference held 5-8 January, 1970 in Houston, TX. Volume 2: Chemical and Isotope Analyses. Edited by A. A. Levinson. New York: Pergammon Press, 1970.

ATS. '1959 Antarctic Treaty', Date of Adoption: 1 December 1959, Date of Entry into Force: 23 June 1961 (Article XIII).

ATS. 'The Protocol on Environmental Protection to the Antarctic Treaty', signed October 4, 1991, entered into force 1998.

Beeson C., Galache J.L., and Elvis M., 2013, Scaling Near-Earth Object Characterization, in preparation.

Brown P.G., et al., 2013, A 500--kiloton airburst over Chelyabinsk and enhanced hazard from small impactors, Nature.

Carl Sagan. 1973, 'The Cosmic Connection - an Extraterrestrial Perspective', Cambridge University Press.

Caselli. I. 2013. BBC, 'Ecuador Pegasus satellite fears over space debris crash' [accessed 12.19. 2015: http://www.bbc.co.uk/news/world-latin-america-22635671].

Cheng Bin. 1997, 'Studies in international space law', Claredon Press.

Christol, Carl Q. 1982. The Modern International Law of Outer Space. New York: Pergamon Press.

Clark J. 2007, ‘A flight surgeon’s perspective on crew behaviour and performance’, Presented at the Workshop for Space Radiation Collaboration with BHP, Centre for Advanced Space Studies, Sep 2007.

Committee on Economic, Social and Cultural Rights, 'Concluding observations on the fifth periodic report of Norway', (Advance unedited version), (29 November 2013), E/C.12/NOR/CO/5.

Committee on the Rights of the Child, UN. Doc. CRC/C/GC/16, General comment No. 16. 2013, ‘on State obligations regarding the impact of the business sector on children’s rights', (17 April 2013).

Committee on Economic, Social and Cultural Rights, UN. Doc. Convention on Registration of Objects Launched into Outer Space, Signed 12 November 1974, entered into force 15 September 1976.

Cooper HFS. 1976, ‘A House in Space’, Holt, Rinehart and Winston, Austin, TX.

COSPARs planetary protection policy. 2011, (20 October 2002; As Amended to 24 March 2011), Prepared by the COSPAR/IAU Workshop on Planetary Protection, 4/02, with updates 10/02; 1/08, 4/09, 12/09, 3/11, Approved by the bureau and council, world space council, Houston, Texas, USA.

Deep Space Industries. 2015, 'Advanced Space Resource Utilization Technology Projects Supported by New NASA Awards to Deep Space Industries', accessed 02.10.2015 [http://deepspaceindustries.com/advanced-space-resource-utilization-technology-projects-supported-by-new-nasa-awards-to-deep-space-industries/]

Dorminey. B. 2014, 'Forex Manna From Heaven: Space Mining And The Peak Metals Crunch', The Financial Times, [accessed 06.09.2014: http://www.forbes.com/sites/brucedorminey/2012/05/28/forex-manna-from-heaven-space-mining-and-the-peak-metal-crunch/].

E/C.12/2011/1, (12 July 2011), 'Statement on the obligations of States parties regarding the corporate sector and economic, social and cultural rights'.

ESA. 2014, 'ESA Technology Transfer Programme', www.esa.int/Our_Activities/Technology/TTP2.

ESA. 2015, Intellectual property rights: Patents and space related inventions, accessed 20.08.2015 [http://www.esa.int/About_Us/Law_at_ESA/Intellectual_Property_Rights/Patents_and_space-related_inventions].

EU. 2014, 'International Code of Conduct for Outer Space Activities', Draft -Version 31 March 2014.

European Commission (EC).2011, Communication from the commission to the European parliament, the council, the European economic and social committee and the committee of the regions, a renewed EU strategy 2011-14 for Corporate Social Responsibility.

European Science Foundation. 2012, 'Mars Sample Return backward contamination', 'Strategic advice and requirements', Report from the ESF-ESSC Study Group on MSR Planetary Protection Requirements. July, 2012.

Executive Office of the President, Office of Management and Budget, 'Statement of Administrationn Policy, H.R. 2262 — Spurring Private Aerospace Competitiveness and Entrepreneurship (SPACE) Act of 2015'.

Forbes. 2012,'Forex Manna from Heaven: Space Mining and the Peak Metals Crunch', [accessed 27.08.2014: http://www.forbes.com/sites/brucedorminey/2012/05/28/forex-manna-from-heaven-space-mining-and-the-peak-metal-crunch/].

Foust. J. 2012, 'Planetary Resources believes asteroid mining has come of age', [accessed 27.07.2015: http://www.thespacereview.com/article/2074/1], thespacereview.

Hobbes, Thomas.1651, Leviathan, 1999 The University of Oregon, 647 p.Transcribed from the University of Adelaide mirror of the ERIS Project plain text edition.

IAA. 2010, 'Cosmic Study Protecting the Environment of Celestial Bodies', (ed. Hofmann, Rettberg, Williamson

Inter-agency space debris coordination committee (IADC). 2007, 'IADC Space Debris Mitigation Guidelines', IADC Action Item number 22.4, Steering Group and Working Group.
International cooperation in the peaceful uses of outer space. A/RES/67/113.
ISS. 1998, 'The International Space Station Intergovernmental Agreement', Signed January 29, 1998.

Jakosky. B.M. 1998, 'The Search for Life on Other Planets', Cambridge University Press, Cambridge, UK.

James Crawford. 2012, 'Brownlie's Principles of Public International Law', (8th edn), Oxford University Press.

James J. Hurtak. 1998, 'Legislation and Space Law Concepts Proposed for the Eventual Industrialization of Mars by Man', AFFS Corporation.

Jason P. Kring and Megan A. Kaminski. 2011, 'Gender Composition and Crew Cohesion during Long-Duration Space Missions', in NASA. 2011, 'Psychology of Space Exploration: Contemporary Research in Historical Perspective', ed. Douglas A. Vakoch, the NASA History Series.

Jeffrey Kahn, Catharyn T. Liverman, and Margaret A. McCoy. 2014, 'Health Standards for Long Duration and Exploration Spaceflight: Ethics Principles, Responsibilities, and Decision Framework', Committee on Ethics Principles and Guidelines for Health Standards for Long Duration and Exploration Spaceflights; Board on Health Sciences Policy.

Jennifer Frakes. 2003, ‘The Common Heritage of Mankind Principle and Deep Seabed, Outer Space, and Antarctica: Will Developed and Developing Nations Reach a Compromise?’, Wisconsin Journal of International Law 21.

John Drexhage, Deborah Murphy. 2010, Sustainable Development: From Brundtland to Rio 2012, Background Paper prepared for consideration by the High Level Panel on Global Sustainability at its first meeting, 19 September 2010, IISD.

Joseph Rodgers. 2015, 'Negotiating a Code of Conduct for Outer Space Activities', Arms Control Association, accessed 23.10.2015 [https://www.armscontrol.org/blog/ArmsControlNow/2015-06-04/Negotiating-a-Code-of-Conduct-for-Outer-Space-Activities].

Joshua Easterson. 2011, 'You can Lead an Astronaut to Water....: Prospects for Legal Use and Water Rights on the Moon and Other Celestial Bodies', in 'New Perspectives on Space Law,

Julie A. Robinson et al. 2011, 'Patterns in Crew-Initiated Photography of Earth from the ISS—Is Earth Observation a Salutogenic Experience? in NASA. 2011, 'Psychology of Space Exploration: Contemporary Research in Historical Perspective', ed. Douglas A. Vakoch, the NASA History Series.

Keith Moore. 2015, 'EU space code of conduct: The solution to space debris?', 02.10.2015 [http://www.bbc.com/news/science-environment-17448173].

Kimball, Lee A. (2005). The International Legal Regime of the High Seas and the Seabed Beyond the Limits of National Jurisdiction and Options for Cooperation for the establishment of Marine Protected Areas (MPAs) in Marine Areas Beyond the Limits of National Jurisdiction. Secretariat of the Convention on Biological Diversity, Montreal, Technical Series no. 19.

Lauren Hepler. 2013, 'Planetary Resources' chief asteroid miner on NASA, Larry Page, new space race', [accessed 27.07.2014: http://www.bizjournals.com/sanjose/news/2013/07/16/planetary-resources-asteroid-miner.html?page=all], bizjournals.

Lederberg. J. 1999, 'Parasites Face a Perpetual Dilemma', 'The relationships between pathogens and hosts must become delicate balances of adaptation if both parties are to survive', Volume 65, Number 2, 1999 / ASM News.

Lockheed martin. 2014,'Lockheed Martin And Electro Optic Systems To Establish Space Debris Tracking Site In Western Australia', [accessed 27.08.2014: http://www.lockheedmartin.com/us/news/press-releases/2014/august/0825-ss-electro.html]

Mainzer A., et al., 2011, NEOWISE Observations of Near--Earth Objects: Preliminary Results, Astrophysical Journal.

Martin Elvis. 2013, 'How Many Ore-Bearing Asteroids?', Harvard--Smithsonian Center for Astrophysics Planetary & Space Science, Planetary and Space Science Volume 91, February 2014, P. 20–26, 15.

Messier. D. 2012, 'New Study Says Asteroid Retrieval and Mining Feasible with Existing and Near Term Technologies', [accessed 27.07.2014: http://www.parabolicarc.com/2012/04/19/new-study-says-asteroid-retrieval-and-mining-feasible-with-existing-and-near-term-technologies/], parabolic arc.

Micah Zenko. 2011, 'A Code of Conduct for Outer Space', Policy Innovation Memorandum No. 10, Council on Foreign Relations, accessed 23.10.2015 [http://www.cfr.org/space/code-conduct-outer-space/p26556].

Mike Wall. 2015, 'Private Moon Landing Set for 2017' accessed 02.10.2015, [http://www.space.com/30720-moon-express-private-lunar-launch-2017.html?cmpid=514630_20151001_53332566&adbid=10153090715401466&adbpl=fb&adbpr=17610706465].

Nakamura, T., et al., Itokawa dust particles: a direct link between S-type asteroids and ordinary chondrites. Science, 2011. 333(6046).

NASA Ames Research Center, Ames Technology Capabilities and Facilities, In-Situ Resource Utilization [retrieved 20.06.2014:

http://www.nasa.gov/centers/ames/research/technology-onepagers/in-situ_resource_Utiliza14.html].

NASA, Marc M. Cohen et al., Robotic Asteroid Prospector (RAP). 2013, 'Staged from L1: Start of the Deep Space Economy', (Final Report 9 July 2013, corrected 17 July 2013).

NASA. 1982, National Security Decision Directive Number 42, "National Space Policy," July 4, 1982, I (II) (D).

NASA. 1992, 'Space Resources', (ed. Mary Fae McKay, David S. McKay, and Michael B. Duke), Lyndon B. Johnson Space Center Houston, Texas, NASA SP-509, vol. 3.

NASA. 2008, 'Handbook for limiting orbital debris', (approved 2008-07-30) National Aeronautics and Space Administration Washington, DC 20546.

NASA. 2009, 'International Space Station, Science Research Accomplishments during the Assembly Years: An Analysis of Results from 2000-2008'.

NASA. 2014, Office of the Chief Technologist, NASA Spinoffs, www.spinoff.nasa.gov.

NASA. 2014, 'Risk of Adverse Cognitive or Behavioural Conditions and Psychiatric Disorders', Human Research Program: Behavioural Health and Performance.

National Research Council. 2009, 'Assessment of Planetary Protection Requirements for Mars Sample Return Missions'.

National Research Council. 2014, 'Pathways to Exploration: Rationales and Approaches for a U.S. Program of Human Space Exploration', Committee on Human Spaceflight, National Academy of Sciences.

Natural resource charter. 2009, 'the Natural Resource Charter and EITI: Building the Foundations of Informed Societies.'

OECD. 2011. 'OECD Guidelines for Multinational Enterprises', OECD Publishing.

OECD. 2012, ‘OECD Handbook on Measuring the Space Economy’, OECD Publishing. dx.doi.org/10.1787/9789264169166-en.

OECD. 2014, 'The Space Economy at a Glance 2014', OECD Publishing.

Oette. L Bantekaz. I, International Human Rights Law and Practice (1 edn, Cambridge University Press 2013).

Our common future. 1987, Report of the World Commission on Environment and Development: Our Common Future, Gro Harlem Brundtland Oslo, 20 March 1987.

P. Lucey. 2006, ‘Understanding the Lunar surface and space-Moon interactions’. Rev. Mineral. Geochem. doi:10.2138/rmg.2006.60.2

Palinkas LA, Suedfeld P, Steel GD (1995) Psychological functioning among members of a small polar expedition. Aviat. Space Environ. Med., 50:1591–1596.

Permanen Court of Arbitration. 2011, 'Optional Rules for Arbitration of Disputes Relating to Outer Space Activities', PCA.

Planetary Resources. 2013, 'our mission', [accessed 27.07.2014: http://www.planetaryresources.com/mission/].

Planetary Resources. 2015, 'Planetary Resources’ First Spacecraft Successfully Deployed, Testing Asteroid Prospecting Technology on Orbit', accessed 02.10.2015 [http://www.planetaryresources.com/2015/07/planetary-resources-first-spacecraft-deployed/].

Proceedings of the 53rd IISL Colloquium on The Law of Outer Space', (ed. Mark J. Sundahl & V. Gopalakrishnan), IISL.

.

Race. M. S. 1996, 'Planetary Protection, Legal Ambiguity, and the Decision Making Process for Mars Sample Return', Adv. Space Res. Vol. 18 no 1/2 pp (1/2)345-(1/2)350.

Rio Tinto. 2014, Annual report, Delivering sustainable shareholder returns.

Ruggie. J.G. 'Guiding Principles on Business and Human Rights: Implementing the United Nations 'Protect, Respect and Remedy' Framework' (16 June 2011), Guiding Principle 1.

Sheryl L. Bishop. 2011, 'From Earth Analogs to Space: Getting There from Here', in NASA. 2011, 'Psychology of Space Exploration: Contemporary Research in Historical Perspective', ed. Douglas A. Vakoch, the NASA History Series.

Sonter M.J.,1997,The Technical and Economic Feasibility of Mining the Near Earth Asteroids, Acta Astronautica, 41, no.4-10, pp.637-647.

Space. 2015, 'NASA's Mars Rover Curiosity Had Planetary Protection Slip-Up', accessed 09.09.2015 [http://www.space.com/13783-nasa-msl-curiosity-mars-rover-planetary-protection.html].

Spacenews. 2012, 'MSL Readings Could Improve Safety for Human Mars Missions', http://spacenews.com/msl-readings-could-improve-safety-human-mars-missions/.

Sterns, P. and Tennen, L., Preserving Pristine Environments: the Planetary Protection Policy, in: Space Safety and Rescue 1988-89, ed. G.W. Heath, pp.399-420, AAS, San Diego, 1990.

Steven L. Wartick and Philip L. Cochran. 1985, The Evolution of the Corporate Social Performance Model, The Academy of Management Review, Vol. 10, No. 4 (Oct., 1985).

Stuster J (2010) Behavioural Issues Associated with Isolation and Confinement: Review and Analysis of Astronaut Journals. National Aeronautics and Space Administration. NASA/TM-2010-216130 (July).

Tare C. Brisibe. 2013, 'A normative system for outer space activities in the next half century', 64th International Astronautical Congress, Beijing, China, IAF.

The American Association for Justice. 2015, 'Oppose Liability Protections in the SPACE Act of 2015', Letter from Linda Lipsen C.E.O. American Association for Justice to the Committee on Science, Space, and Technology.

The American Space Technology for Exploring Resource Opportunities In Deep Space (Asteroids) Act, 113th congress, 2D session.

The United Nations Office for Outer Space Affairs (UNOOSA). 2014, ‘Space Law: Frequently Asked Questions’, [http://www.oosa.unvienna.org/oosa/FAQ/splawfaq.html#Q1].

Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, Adoption by the General Assembly: 19 December 1966 (resolution 2222 (XXI), Entry into force: 10 October 1967.

Tronchetti. F. 2009, 'The Exploitation of Natural Resources of the Moon and Other Celestial Bodies', 'A Proposal for a Legal Regime'. Koninklijke Brill NV.

U.S. Congress. 2010, 'National Aeronautics and Space Administration Authorization Act of 2010', S. 3729 — 111th Congress, enacted October 11, 2010.
UN Declaration on the Right to Development.

UN. 2013, 'Transparency and Confidence-Building Measures in Outer Space Activities', Office for Disarmament Affairs.

UN. 'The 1972 Convention on International Liability for Damage Caused by Space Objects', entered into force: 1972.

UNGA. 2013, Resolution adopted by the General Assembly [on the report of the Special Political and Decolonization Committee (Fourth Committee) (A/67/422)] 67/113.

International cooperation in the peaceful uses of outer space. A/RES/67/113, Preamble.

UNGA. 2013, Resolution adopted by the General Assembly [on the report of the Special Political and Decolonization Committee (Fourth Committee) (A/67/422)] 67/113.

UNGA. 'Principles Relevant to the Use of Nuclear Power Sources in Outer Space', A/RES/47/68, 85th plenary meeting, 14 December 1992.

United Nations Office for Disarmament Affairs (UNODA), 'Agreement Governing the Activities of States on the Moon and Other Celestial Bodies', 'Status of the Treaty', [accessed 23.06.2015: http://disarmament.un.org/treaties/t/moon].

United Nations Office for Disarmament Affairs (UNODA), 'Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, Status of the Treaty', [accessed 23.06.2015: http://disarmament.un.org/treaties/t/outer_space].

United States Congress. 2015, 'H.R.2262 - SPACE Act of 2015', accessed 02.10.2015 [https://www.congress.gov/bill/114th-congress/house-bill/2262/text].

United States Congress. 2015, 'National Aeronautics and Space Administration Authorization Act of 2010', accessed 02.10.2015: [http://spaceflight.nasa.gov/outreach/nasa_auth_act_2010.pdf], S. 3729

United States Congress. 2015, 'S.1297 - U.S. Commercial Space Launch Competitiveness Act

Vessel EA, & Russo S (2015) Effects of reduced sensory stimulation and assessment of countermeasures for sensory stimulation augmentation: A Report for NASA Behavioural Health and Performance Research: Sensory Stimulation Augmentation Tools for Long Duration Spaceflight (NASA/TM-2b015-218576). NASA-Johnson Space Centre, Houston, TX.

Virgiliu Pop. 2008, 'Extraterrestrial Aspects of Land and Mineral Resources Ownership', Springer.

Vladimir Kopal. 2005, 'Disseminating and Developing International and National Space Law: The Latin America and Caribbean Perspective : Proceedings, United Nations/Brazil

Workshop on Space Law', UNOOSA, 18; C. Wilferd Jenks. 1965, 'Space law', Frederick A. Praeger.

Wayne N. White. 2003, 'Interpreting Article II of the Outer Space Treaty', American Institute of Aeronautics and Astronautics, Proceedings, 46th Colloquium on the law of outer space, p.171 (IISL 2003).