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„THE MANAGEMENT OF NATURAL RESOURCES ON
CELESTIAL BODIES: AN ECOLOGICAL PERSPECTIVE“

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Abbreviations and Acrynomns

CHM	Common Heritage of Mankind
EEDN	Extraterrestrial Environmental Destination Plan
EIA	Environmental Impact Assessment
IAIA	International Association for Impact Assessment
ISRU	In-Situ Resource Utilisation
NEO	Near-Earth Objects
NIEO	New International Economic Order
OST	Outer Space Treaty
PGMs	Platinum Group Metals
REM	Rare Earth Metals
UN	United Nations
UNCLOS III	Third United Convention on the Law of the Sea
UNCOPUOS	United Nations Committee on the Peaceful Uses of Outer Space

Abstract

In recent years the interest in natural resources located in outer space has considerably grown. In particular American private corporations have revealed ambitious plans for the commercial exploitation of these extraterrestrial resources. However, the current body of international space law does not contain a satisfactory regulatory regime to address all the issues that come with the advent of extraterrestrial mining. The Moon Agreement has shown how challenging it is to find agreement on the characteristics of a legal regime. Foremost the division between developed- and developing countries is one hard to overcome. Nonetheless, the effort to find appropriate international solutions to this legal gap cannot subside as it would greatly increase the likelihood of future scenarios in which unilateral actions are preferred above international ones, with the additional risk of threatening the peaceful nature of outer space.

What may seem as a rather unconventional solution to this problem at first will make all the more sense once one starts to have a thorough look at it. It has been argued that one of the greatest potential benefits of extraterrestrial mining are the positive ecological effects it can have back on Earth. By reducing the size of the terrestrial mining industry and its very negative global environmental impact, especially for developing countries, extraterrestrial mining will also pave the way for human settlement in space. With an ecotax raised on the exploitation of natural resources on Earth that will be used for an international effort to develop a sustainable transport system to space, both developing- and developed countries should only have to gain from the exploitation of natural resources on the Moon and other celestial bodies. It will connect the ecological problems caused by terrestrial mining with the ecological benefits extraterrestrial mining can offer; a quintessential example of environmental policy integration.

Zusammenfassung

In den letzten Jahren ist das Interesse an natürlichen Ressourcen im Weltraum deutlich gewachsen. Insbesondere amerikanische Privatunternehmen haben ehrgeizige Pläne für die kommerzielle Nutzung dieser außerirdischen Ressourcen angekündigt. Allerdings enthalten die gegenwärtigen internationalen Weltraumverträge kein befriedigendes Regulierungssystem um alle Probleme zu lösen die der Beginn des Abbaus von extraterrestrischen Ressourcen mit sich bringt. Der Mondvertrag hat gezeigt wie schwierig es ist, eine Einigung über die Einzelheiten einer Rechtsordnung zu finden. In erster Linie ist die Meinungsverschiedenheit zwischen den sogenannten entwickelten Ländern und den sogenannten Entwicklungsländern schwer zu überwinden. Dennoch kann die Bemühung, angemessene internationale Lösungen für diese Rechtslücke zu finden, nicht nachlassen werden, da sie die Wahrscheinlichkeit von Zukunftsszenarien erhöhen, in denen einseitige Maßnahmen gegenüber internationalen von Staaten bevorzugt werden, und das zusätzliche Risiko besteht, den friedlichen Charakter des Weltraums zu bedrohen.

Was anfänglich als eine eher unkonventionelle Lösung für dieses Problem erscheinen mag, wird umso sinnvoller wenn man beginnt einen gründlichen Blick darauf zu werfen. Es wurde argumentiert, dass einer der größten potenziellen Vorteile der Nutzung von extraterrestrischen Ressourcen die positiven ökologischen Auswirkungen auf der Erde sind. Durch die Verringerung der Größe der Bergbauindustrie auf der Erde und ihrer sehr negativen globalen Umweltauswirkungen, vor allem für Entwicklungsländer, wird die Nutzung von extraterrestrischen Ressourcen auch den Weg für die menschliche Besiedlung im Weltraum ebnen. Mit einer Ökosteuer, die auf die Ausbeutung der natürlichen Ressourcen auf der Erde eingehoben wird, und die für eine internationale Anstrengung zur Entwicklung eines nachhaltigen Verkehrssystems zum Weltraum genutzt wird,

können „entwickelte“ und „entwickelnde“ Länder durch die Ausbeutung der natürlichen Ressourcen auf dem Mond anderen Himmelskörpern nur gewinnen. Es wird die ökologischen Probleme, die durch den terrestrischen Bergbau verursacht werden, mit den ökologischen Vorteilen verbinden, die die Nutzung von extraterrestrischen Ressourcen bieten kann; ein wesentliches Beispiel für die Integration der Umweltpolitik.

1. Introduction

In recent years the interest in natural resources located on the Moon and Near-Earth Objects (NEO) has considerably grown, particularly with American private corporations, some of which have long revealed ambitious plans for the commercial exploitation of these extraterrestrial resources. Encouraged by recent advancements in the development of space technologies and backed by the United States governments by means of the SPACE Act of 2015¹ these plans are quicker than ever before making their way from the realm of science fiction and fantasy literature to reality.

The future economic sector of extraterrestrial mining is of particular interest to humankind for two reasons; its promise to establish a space infrastructure that will allow for the exploration and settlement of outer space, and; its potential to take the ecological pressure of human activities off Earth. Both these arguments show the important role the space sector can play in safeguarding the long-term survival of our species. On one hand, a permanent and self-sustaining presence in outer space can serve as an insurance policy in case a catastrophe of apocalyptic scale hits the Earth $\neg$ a massive asteroid impact immediately springs to mind but also the danger of a full-scale nuclear war or an ecological disaster on worldwide scale are not

¹ 2015 US Commercial Space Launch Competitiveness Act.

unthinkable $\neg$. On the other, introducing extraterrestrial resources for the terrestrial market by means of sustainable transportation to and from Earth could significantly lower the risk of a self-inflicted ecological disaster, as it would decrease terrestrial mining. In order to speed up this process the role of the terrestrial mining sector in the destruction of the environment can be no longer ignored. For too long the mining industry has been transfixed on short-term economic benefits instead of the long-term environmental threats it causes. It is precisely this mentality of profit maximisation and the seemingly unshakable dogma it has become over the course of history that has brought us to the precarious environmental situation we are in today. Luckily, it is now widely acknowledged that this lack of ecological awareness is a fundamental flaw in economic thinking that can have no place in tomorrow's world. Concrete action is therefore required. This is far from saying that the right balance between economic gains and ecological losses $\neg$ if it exists at all $\neg$ is soon to be struck, but it indicates that a slow shift towards sustainability is on its way. It is all the more reason why extraterrestrial mining should take place in the right way and for the right reasons. In the face of the ever more apparent and acute threat global warming and the mass destruction of vital ecosystems poses to our long-term survivability, it is, thus, mandatory to not only pay attention to the economic benefits both terrestrial and extraterrestrial mining might bring, but foremost to its ecological losses and potential ecological benefits.

Some hope a fully circular economy will solve the problem by taking away the demand for new resources, but the fact of the matter is that the absolute demand for resources is still on the rise. Even if all resources currently in circulation were to be recycled, it would not be sufficient to meet the demand. Aside from the fact that recycling technology is not yet advanced enough to realise such a scenario, the rapid growth rate of the world population and the growing purchasing power in many

developing countries will cause a higher demand for new resources in any case. Thus, the question remains how to meet the increasing demand. It is doubtful whether expanding the mining industry on Earth is a serious long-term option since demand will surpass the carrying capacity of the planet at some point. Extraterrestrial mining appears to be a sustainable alternative.

Central in the approach of extraterrestrial mining should be the ecological picture; can it take off the ecological pressure on Earth? It only seems to be the case if access to outer space becomes eco-friendly. This is where the terrestrial mining industry can help. The first step is to raise an ecotax on terrestrially mined resources as to make them reflect their environmental impact. Additionally, it can serve as an incentive for both recycling and extraterrestrial mining. The second step is to set up an international fund for the money collected through the ecotax. The fund will invest in recycling technology, environmental recovery programmes and, most importantly for this dissertation, in the development of eco-friendly transportation systems to outer space. The development of new technology will be done by universities and institutions all over the world that will be obliged to exchange their knowledge and expertise with each other. This will enable developing countries to catch up in the nascent private space industry. In order to make this happen, it is crucial that the legal debate concerning extraterrestrial mining will be geared towards an ecological narrative in favour of an economical one. Helpful in this change of mindset can be a reinforced sense of commonality of the human condition. That we as a species all face these same global and universal challenges that do not distinguish between nations, tribes, age, skin-colour or culture. It is not to say that the economic picture should be forgotten altogether. After all, a wide variety of economic arguments exist in favour of extraterrestrial

mining. It is only the much-needed recognition that the ecological arguments should have the top priority.

Most of “outer space law” was developed during the Cold War and therefore evidently echoes the recurrent issues of that era. The government representatives who negotiated the first international space treaties were all but familiar with the concept of private investment in space exploration. Understandably, they were also unaware of the vast deteriorating human impact on the Earth’s environment and the eventual danger to our survivability it would constitute. Not surprisingly, therefore, a legal regime was foreseen which does not establish clear regulations for private parties and which does not reflect the complex relationship between space activities on one hand and the environment, both terrestrial and extraterrestrial, on the other. Even the Moon Agreement of 1979² approaches the regulation of exploitation³ of natural resources in outer space from a predominantly economic point of view. Since this treaty is generally viewed as a failed treaty, it has led several legal scholars to propose alternative legal regimes for the regulation of the exploitation of outer space resources.

Instead of proposing yet another legal regime, this thesis will, thus, seek to provide an ecological perspective on the issue that prioritises long-term human interests both in space and here on Earth. By connecting the environmental crisis on Earth to extraterrestrial exploitative activities it will attempt to overcome conflicting interests in the political arena and move countries away from unilateral actions and from blocking any international solutions to the current legal lacuna concerning the exploitation of extraterrestrial resources. As such, it can be considered a quintessential example of environmental policy integration.

² The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies 1979, United Nations.

³ The term exploitation equals here the regular extraction and refinement of natural resources for commercial purposes. Research, exploration and scientific exploration are not included as they are considered precursory activities to actual exploitation.

The second chapter gives a pictures of what resources private companies hope to exploit in outer space and why these resources are so interesting from an economic and political point of view. The third chapter offers a historical overview and thorough analysis of the Outer Space Treaty⁴, the Moon Agreement and the 1996 Space Benefits Declaration⁵ and discusses their provisions in respect to the exploitation of natural resources. Obtaining a clear idea of how these treaties came into being and what obstacles were present will make it easier to envision a treaty for the management of exploitative activities in outer space. Chapter four treats various legal proposals to deal with the current legal gap considering the management of outer space as well as the SPACE Act of 2015 and why all of these are not contributory to a long-term solution. Chapter five gives an overview of the mining industry here on Earth, how it impacts the environment and which regulations are in place to minimise the impact. It will be explained how this can be useful to the future mining industry off Earth and how both sectors should be legally integrated to ensure that extraterrestrial exploitation will benefit the natural environment on Earth, while being in line with existing space treaties and paying respects to the diverging wishes of developing- and developed countries. Last but not least, the final chapter will conclude why an ecological perspective is key to a future solution in international space law.

⁴ The Declaration of Legal Principles Governing the Activities of States in the Exploration and Uses of Outer Space 1967, United Nations.

⁵ 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, United Nations.

2. The Natural Resources in Outer Space

The amount of natural resources⁶ in outer space⁷ is beyond our imagination. Our solar system alone already contains an unlimited amount of resources located in the Asteroid belt and in the Kuiper belt. However, their remoteness makes their exploitation still unviable in both technological and economic terms. Luckily, there also exist so-called Near Earth Asteroids, or simply NEAs, which have an orbit that brings them near Earth every x years, making them much easier exploitable in the near future. The current count of known NEAs is already more than 10,000, of which more than 800 have a diameter beyond one kilometre⁸. Analyses of asteroids and of meteorites fallen on Earth reveal that NEAs contain valuable resources like gold, metallic nickel-iron, cobalt and platinum group metals (PGMs), and all with a presumed higher concentration than here on

⁶ In these thesis natural resources are considered to be all non-renewable resources located in outer space. This natural matter is primarily found in the form of stars, planets, natural satellites, asteroids, meteoroids, comets and asteroids.

⁷ Outer space begins at an altitude of 100 km above earth's sea level.

⁸ A. Sommariva, 'Rational, Strategies, and Economics for Exploration and Mining of Asteroids', *Astropolitics*, vol. 13, no.1, 2015, p. 26.

Earth⁹. Especially PGMs are highly valuable because of their rarity on Earth and the impossibility to produce them synthetically. Other than for the jewellery industry, they are fundamental to today's economy for their multitude of applications, ranging from the production of electronics to the manufacturing process of chemicals, glass and plastics. Importing extraterrestrial PGMs has the potential to substantially lower the prices of these essential mineral resources as well as of the countless products they are either directly or indirectly involved. From a political point of view bringing PGMs from outer space to Earth bears the promise to reduce geopolitical instability related to the control of and local access to natural resources on Earth, which has caused dozens of civil wars in the developing world¹⁰. Unfortunately, it is unlikely to turn into reality any time soon for the simple fact that the vast majority of NEAs have unfavourable orbital characteristics, thereby limiting the number of asteroids that are actually thought to be accessible with near-future technologies. Nonetheless, those asteroids that do have good orbits are also considered the best mining target for Rare Earth Metals (REM)¹¹. These metals are considered strategic for their high importance to the economy, in particular the high-tech sector, and for defence applications. For security reasons many consider it a troublesome fact that China, as a nondemocratic country that is increasingly challenging Western and American global dominance, has an absolute monopoly on the production of REM¹². Besides lowering the prices importing extraterrestrial REM would also put an end to the complete Chinese control over the market, making other countries less dependent.

Apart from asteroids, the Moon is the other low-hanging fruit in outer space with regard to extraterrestrial exploitation.

⁹ Sommariva, *Astropolitics*, p. 26-27.

¹⁰ Sommariva, *Astropolitics*, p. 40.

¹¹ L. David, 'Is Moon Mining Economically Feasible?' *Space*, 7 January 2015, <http://www.space.com/28189-moon-mining-economic-feasibility.html>, accessed 22 November 2015).

¹² N. Kamenopoulos, D. Shields, Z. Agioutantis, 'Sustainable Development Criteria and Indicators for the Assessment of Rare Earth Element Mining Projects', in Borges (ed.), *Rare Earths Industry*, Elsevier, 2016, p. 87, 95.

Although its exact composition has not yet been determined, its magnitude and relative proximity make it the most obvious destination for future space activities. From a commercial point of perspective, the most interesting resource discovered on the Moon thus far is Helium-3, which is believed to be much more abundant on the Moon than on Earth. Because the Moon, in contrast to Earth, lacks an atmosphere its surface has been absorbing this isotope from solar winds for billions of years¹³. What makes Helium-3 so interesting is its importance to the further development of nuclear fusion technology¹⁴. In theory nuclear fusion as an energy source is far more powerful and cleaner than nuclear fission and could become one of the cornerstones of sustainable energy. Other than Helium-3, the Moon also contains other resources such as aluminium, silicon, titanium and others. However, since these resources are also present on Earth it will be a long time before they become commercially interesting to be sold back on Earth. Before that time arrives, however, they can play a vital role in building up a space infrastructure as transportation costs for resources from Earth to outer space are much higher¹⁵.

The discovery of all these outer space resources significantly alters the perspective on the scarcity of non-renewable resources caused by continuous population growth. Whilst the fundamental economic problem of having seemingly unlimited human wants and needs in a world of limited resources has always existed, human expansion to space changes the game. Indeed, in the face of the vast amounts of extraterrestrial resources the availability of non-renewable resources seems even more so a matter of relative scarcity, not absolute scarcity. Whereas classical “Malthusian philosophy” postulates that resources are limited and that the perpetual population growth

¹³ R. Lee, *Law and Regulation of Commercial Mining of Minerals in Outer Space*, Dordrecht, Springer, 2012, p. 52.

¹⁴ R. Jakhu, M. Buzdugan, ‘Development of the Natural Resources of the Moon and Other Celestial Bodies: Economic and Legal Aspects’, *Astropolitics*, vol. 6, no. 3, 2008, p. 202.

¹⁵ Lee, *Law and Regulation of Commercial Mining of Minerals in Outer Space*, p. 35.

will eventually result in absolute scarcity followed by war, famine and other catastrophes¹⁶, the Ricardian alternative rests on the belief that there are no absolute limits to resource availability¹⁷. There only exists a temporary and relative scarcity of resources which will be reflected in market price which will then boost production of the resource in question, from either newly discovered reserves and reserves that have become economically viable or by the invention of technology that promotes recycling or the very substitution of the resource¹⁸.

The recent plans of commercial endeavours to mine the Moon and Asteroids and the advancement in outer space technology the advent of NewSpace¹⁹ has brought about should also be seen in the light of the relative scarcity of natural resources and pressure from the increasing world population. Not as a short to medium threat to economic growth but as a long-term threat²⁰. Companies like Deep Space Industries and Planetary Resources see opportunities in this expected scarcity and have plans to mine celestial bodies. Their initial focus is on in-situ Resource Utilisation (ISRU), but as transportation costs decrease selling extraterrestrial resources for the home market becomes equally important, if not more²¹. The knife cuts both ways; on one hand their activities will lay the foundation of a space infrastructure that brings permanent and self-sustaining human settlement in space a step closer; and on the other, they will help to build up a space economy that can counter the anticipated scarcity of resources on Earth in the more distant future. If Newspace companies are to be taken by their words their noble goals derive from their alleged ideological motivation.

¹⁶ T. Malthus, *An Essay on the Principle of Population*, London, J. Johnson, 1798, p.61

¹⁷ E. Barbier, *Economics, Natural-Resource Scarcity and Development*, Routledge, 2013, pp. 1-4.

¹⁸ M. Karpagam, *Environmental Economics: A Textbook Door*, New York City, Sterling Publishing Company, 1999, pp. 42-44.

¹⁹ NewSpace generally refers to a movement and philosophy that started in the 1990s and is very closely linked to the emergence of the private spaceflight industry in the United States.

²⁰ Sommariva, *Astropolitics*, pp. 26-27.

²¹ *Planetary Resources*, [website] <http://www.planetaryresources.com/asteroids/asteroids-market-opportunity>, (accessed 12 January 2016).

The company's mission of Deep Space Industries²², for example, is written on their website as follows: "We are journeying to unknown frontiers, and pushing the limits of technology to provide a brighter future for all of mankind". Planetary Resources²³ sees asteroid mining as "the catalyst to move humanity forward on Earth and in Space" and Moon Express²⁴ wants to mine the Moon for the "benefit of life on Earth and our future in Space". Of course, the commitment of enterprises to the greater good is nothing short of admirable. Nonetheless, the fact that these "benefactors", these self-appointed guardians of mankind's future, have actively lobbied for unilateral action on the side of the US government does come across as somewhat contradictory²⁵. A good case in point is Planetary Resources which regards the U.S. SPACE Act of 2015 as a key milestone in their roadmap to access asteroid resources for commercial use in spaceⁱ. However, in which way can the praise of unilateral action, with all the negative consequences it may entail, be reconciled with their mission to move humanity forward both on Earth and in space? What common purpose does unilateral action serve in the eyes of these enterprises other than advancing their economic activities and their anticipated profit? Clearly, their highest priority is making profit even if it implies jeopardising the peaceful and cooperative nature of outer space. Companies cannot be blamed for seeking to maximise their profits $\neg$ blame the current economic system instead $\neg$ but when they do it under the veil of idealism it is loathsome.

It is symbolic for how the current economic system functions; one can start a company for ideological motives but in the end profit maximisation returns to be the decisive factor.

²² *Deep Space Industries*, [website] <https://deepspaceindustries.com/business/> (accessed 12 January 2016).

²³ *Planetary Resources*, [website] <http://www.planetaryresources.com/asteroids/#asteroids-market-opportunity> (accessed 13 January 2016).

²⁴ *Moon Express*, [website] <http://www.moonexpress.com/>, (accessed 13 January 2016).

²⁵ F. Tronchetti, The Space Resources Exploration and Utilization Act: A move forward or a step back? *Space Policy*, vol. 30, 2015, pp. 5-6.

Entrepreneurs, however altruistic their initial motivation may be, see themselves forced to compromise on their ideals in order to reach their goal of setting up a successful company. That explains why a company like Planetary Resources ends up lobbying for a law that is hard to consider a ‘catalyst to move humanity forward’, thereby making people rightly question their true intentions. This case exemplifies why it is so important to have a widely-accepted international agreement for natural resources on the Moon and other celestial bodies. With a well-functioning and full-fledged regulating regime in place, the chance of unilateral actions are minimised and, with it, the danger of risking the peaceful nature of space. A regime that prioritises ecological benefits is even more interesting as it enables companies to stay put with their initial ideological goals of benefiting life on Earth without losing sight of the profitability of their endeavours. It can prove that sustainability and profitability are not by definition mutually exclusive and that profit maximisation can be allowed within in bandwidth determined by the criteria of sustainability. How such a future regime looks like, however, requires a more detailed understanding of the terrestrial mining industry, its ecological footprint, and how these two combined are bound to add to the complexity of human’s relationship with outer space. Before touching upon this issue, however, it convenes to get a thorough grasp of the *corpus iuris spatiales*, and its inadmissible shortcomings with regard to regulations for extraterrestrial exploitation and the ecological agenda.

3. Existing International Space Law for Extraterrestrial Exploitation

The current legal regime is primarily made up of 5 UN space treaties²⁶. These treaties constitute the core binding instruments of international space law to the extent they have been ratified. All of them were negotiated during the Cold War, which heavily influenced their nature. In order to avoid conflicts between the former first- and second world, but also between developed and developing states, these treaties were characterised by their tendency to omit any clear definitions and terms. Regarding economic activities in outer space the framers of the treaties were not likely to foresee the event of private enterprises with plans for space mining, and therefore, did not feel the urge to create legal certainty for these activities. At the time the general view was that space activities would be almost exclusively conducted by states, not by private entities²⁷. With respect to sustainability, the treaties do address some environmental issues, albeit it in a very rudimentary way. By no means is this surprising

²⁶ *United Nations Office for Outer Space Affairs*, [website] <http://www.oosa.unvienna.org/oosa/en/SpaceLaw/treaties.html>, (accessed 22 December 2015).

²⁷ General Assembly resolution 1280 (XVIII) 13th of December 1963.

though if one keeps in mind that the international environmental law movement was still in its infancy at the time of the negotiations. This chapter will analyse the existing body of international space law. The history and evolution of the most important legal documents will be reviewed as well as their importance to the current status of extraterrestrial natural resources and the legality of their exploitation. Particular attention is paid to the principle of the Common Heritage of Mankind; on its origins and the indispensable role it has played on the debate regarding the natural resources in outer space, from the negotiations of the Outer Space Treaty to the present.

3.1 The Common Heritage of Mankind

The Common Heritage of Mankind (CHM) principle was first mentioned by Arvid Pardo, Malta's former ambassador to the United Nations (UN), during the First Committee of the UN General Assembly which deals with political affairs in November 1967. In his famous speech²⁸ he pled for the deep seabed resources to be considered the common property of humanity, thereby introducing the CHM principle into the debates at international legal forums. As of today, a mere three international treaties contain the principle; the Third United Convention on the Law of the Sea (UNCLOS III)²⁹, the UNESCO Universal Declaration on Cultural Diversity³⁰ and the Moon Agreement. As two of the three treaties indicate, the principle is chiefly used in debates concerning the deep seabed, the Moon and Antarctica; another extraterritoriality. The CHM principle has been the most important guiding element in the development of both the Outer Space Treaty and the Moon Agreement.

²⁸ *United Nations*, [website]
http://www.un.org/depts/los/convention_agreements/texts/pardo_ga1967.pdf
(accessed 22 November 2015).

²⁹ General Assembly resolution 37/66 of 3 December 1982.

³⁰ General Assembly resolution 56/156 of 2 November 2001.

Its roots are strongly connected to the concept of *res communis*, a Latin term derived from Roman Law meaning ‘the property of all’³¹. The most salient characteristic of an area regarded as *res communis* is the absence of any recognised state sovereignty and the interdiction or impossibility to make any claim thereto³². In other words, no state is allowed to appropriate a *res communis*. However, the concept differs from the CHM principle in several respects. Whereas the freedoms in an area declared the Common Heritage of Mankind come with restrictions on these freedoms, a *res communis* does not have these restrictions. It does not imply a sense of collective responsibility nor obligation to either one another or to the future of the common area itself. It simply is every man for himself. On the other hand, the CHM principle does create a collective obligation for States to use the area in a sustainable manner and in such a fashion as to foster a sense of equity amongst less developed states. Exactly these latter notions have made the CHM a controversial principle as both developed and developing States have been interpreting it differently, according to their ideological differences³³. Hence, the CHM is a flexible but complex principle that does not have a closed definition; it depends on the context and interpretation.

After the Second World War, many new independent States came into existence as part of the decolonisation process in Africa and Asia. However, many of these States felt that decolonisation would not be complete without a significant economic independence from the developed countries as well³⁴. As a result, the developing countries developed the New International Economic Order (NIEO) theory, which was an

³¹ K. Baslar, ‘*The Concept of the Common Heritage of Mankind in International Law*’, The Hague, Kluwer Law International, 1998, p. 41.

³² ‘*Res communis*’, *Oxford Reference*, [website], 2016, <http://www.oxfordreference.com/view/10.1093/acref/9780195369380.001.0001/acref-9780195369380-e-1816>, (accessed 15 February 2016).

³³ E. Guntrip, The Common Heritage of Mankind: an Adequate Regime for Managing the Deep Seabed? *Melbourne Journal of International Law*, vol. 4, no. 2, 2003, p. 2.

³⁴ P. Agarwala, *The New International Economic Order: An Overview*, New York City, Pergamon Press, 1983, p. VIII.

two-pronged effort to increase the influence of developing states over the direction of the world economy³⁵. On one hand, it envisioned a greater control over economic activity concerning natural resources occurring in areas within national jurisdiction, and on the other, it involved increasing the influence of developing states over resource development in global common areas³⁶ by lobbying for the establishment of international resource regimes³⁷. The CHM principle fitted very well into the NIEO theory and for developing countries came to imply that the resource exploitation in extraterritorialities could not be monopolised by developed nations at the expense of nations that lack the technology or finance to do so. They demanded direct participation in the international management of resource extraction and they wanted the economic benefits to be distributed in their favour³⁸.

The developed nations, at the other end of the spectrum, interpreted the principle to maintain the status quo. They believed that changes in existing economic and legal conditions concerning the common areas could potentially threaten the tradition to regard these areas as open for everyone. In their view the exploiters of resources had to be the ones who determine the equitable pursuant³⁹. Because of these conflicting interpretations of the same concept it is not surprising that no single definition of the principle has ever been universally accepted as the right one. Nonetheless, until the early 1990s most definitions contained five common elements regarding the management of

³⁵ M. Peterson, *International Regimes for the Final Frontier*, New York, State University of New York Press, 2006, p. 155.

³⁶ Global commons is a term used to describe international and global resource domains in which common-pool resources are found. In these domains no State can exercise sovereign rights. Other examples than outer space are Antarctica, the High Seas and the Deep Seabed.

³⁷ Peterson, *International Regimes for the Final Frontier*, p. 155.

³⁸ J. Frakes, 'Common Heritage of Mankind Principle and Deep Seabed, Outer Space and Antarctica: Will Developed and Developing Nations Reach a Compromise', *Wisconsin International Law Journal*, vol. 21, no. 2, 2003, p. 414.

³⁹ Frakes, *Wisconsin International Law Journal*, p. 415.

natural resources located in extraterritorialities⁴⁰. First, the common heritage region must not be subject to appropriations of any kind, and therefore, cannot be owned by any state. Second, national governments are not allowed to manage the respective regions as sovereigns. The resources must be managed by representatives from all countries. Third, all nations must actively share the benefits from the exploitation of these resources with each other. Fourth, the region must be preserved for the benefit of future generations. And last but not least, the affluent nations and the companies which act in their interests will share their knowledge and expertise so as to provide less developed countries more opportunities to catch up economically. The last decennium of the twentieth century, however, saw a radical change in the world order that increased pressure to update the CHM-principle, which will be discussed below.

3.2 The Outer Space Treaty

The Magna Carta of space law is the United Nations Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, or simply the Outer Space Treaty (OST)⁴¹. It was signed in 1967 and was created against the background of the Cold War and the space race between the two superpowers which was sparked by the Soviet Union's Sputnik launch in 1957, the first space activity in human history⁴². Despite the Cold War, or perhaps precisely because of it, the efforts for an international regulation of space activities were conducted within the framework of the United Nations from the very start. Both the superpowers wanted to keep the Moon and outer space out of their cold war competition⁴³. In 1958 the United Nations General

⁴⁰ H. Heim, 'Exploring the Last Frontiers for Mineral Resources: A Comparison of International Law Regarding the Deep Seabed, Outer Space, and Antarctica', *Vanderbilt Journal of Transnational Law*, vol. 23, no. 4, 1990, pp. 824-825.

⁴¹ General Assembly resolution 2222 (XXI) of 19 December 1966.

⁴² NASA, [website], <http://history.nasa.gov/sputnik/>, (accessed 8 March 2016).

⁴³ Peterson, *International Regimes for the Final Frontier*, p. 153.

Assembly established a Committee on the Peaceful Uses of Outer Space ⁴⁴ (UNCOPUOS), which speeded up the negotiations that would eventually lead to the Outer Space Treaty. Just five years later, in 1963, the Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space⁴⁵ was already adopted by the General Assembly. As it contained a handful of fundamental principles it marked a milestone on the way to the Outer Space Treaty.

OST is foremost a treaty of general principles. As such it was not intended to solve and regulate all aspects of space activities. Therefore, it does not contain any guidelines for the regulation of economic commercial activities aimed at exploiting the natural resources of outer space. Of course, this is in part due to the fact that these activities seemed too far-fetched at the time of negotiations and could therefore only complicate matters⁴⁶. Instead, the following treaties were to refine and detail the general legal and moral concepts contained in OST⁴⁷. The main reason why a treaty with general principles was preferred above that of a comprehensive legal code on space activities was the rapid pace of technology development in the emerging space sector, making detailed laws easily outdated⁴⁸. A disadvantage of this approach, however, is that the lack of precise legal definitions of the terms used in the treaty has led to many scholars holding different interpretations on the legal value of its provisions⁴⁹.

The most important article of the Outer Space Treaty, Article I, can be regarded as a microcosm of the entire treaty as it grants freedoms for certain activities, which then are restricted by

⁴⁴ General Assembly resolution 1348 (XIII) of 13 December 1958.

⁴⁵ General Assembly resolution 1962 (XVIII) of 13 December 1963.

⁴⁶ V. Kopal, 'Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies', *Yearbook of Air and Space Law*, vol. 2, 1968, cited in: N. Jasentuliyana (ed.), *Space law, development and scope*, Westport, Connecticut, London, Praeger, 2008, p. 23.

⁴⁷ F. Tronchetti, *The Exploitation of Natural Resources of the Moon and Other Celestial Bodies: A Proposal for a Legal Regime*, Nijhoff, 2009, pp. 19-20.

⁴⁸ Lee, *Law and Regulation of Commercial Mining of Minerals in Outer Space*, p.99.

⁴⁹ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, p. 20.

specified limitations⁵⁰. Article I sets out four essential freedoms or principles; the freedom of exploration; the freedom of use; the freedom of trade and commerce; and the freedom of access⁵¹. The freedom of exploration and use⁵² of outer space quite clearly establishes outer space as a *res communis*⁵³. However, this freedom comes with the duty to carry out these activities for the benefit and in the interest of all countries, irrespective of their degree of economic or scientific development; indeed, outer space shall be ‘the province of all mankind’. Thus, the freedom previously granted is not endless, but comes with a specified limitation. In this case the purpose of the limitation is to make sure that the freedom of exploration and use will both endure and be enjoyed by all, and this is done best by thwarting the possibility of State monopolisation of space activities and by ensuring that these activities will serve the common good of mankind. The tension between freedoms and restrictions in the Outer Space Treaty stems from the fact that the treaty as a whole is a compromise between conflicting interests that all seek to maximise their individual utility⁵⁴. The most obvious example is the division between the developing States which view outer space as the CHM and the developed States which rather see it as a *res communis*. It may not come as a surprise that the most significant as well as controversial notion in OST is ‘the province of all mankind’, as it underscores the interests of developing states which lack the technological and financial means to access and use outer space. The inclusion of this concept brings the OST much more in consonance with legal regulations for the deep seabed and the high seas⁵⁵. Indeed, it is a clear departure from the view of outer space as nothing more than a *res*

⁵⁰ S. Hobe, et al., *Cologne Commentary on Space Law (Vol. 1): Outer Space Treaty*, Carl Heymanns Verlag, 2010, p.27.

⁵¹ Kopal, cited in N. Jasentuliyana, *Space law, development and scope*, p. 19.

⁵² The word ‘exploitation’ is not mentioned in the Outer Space Treaty. However, it is commonplace to presume that the word ‘use’ in the first and second paragraph of Article I also entails exploitation.

⁵³ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, p. 21.

⁵⁴ L. Cooper, ‘Encouraging space exploration through a new application of space property rights’, *Space Policy*, vol. 16, 2003, p. 113.

⁵⁵ Hobe, et al., *Cologne Commentary on Space Law (Vol. 1)*, p. 27.

communis and, therefore, can be interpreted as a precursor of the CHM principle. Even though the exact implications of the notion of ‘province of mankind’ are not well-defined and the OST does not include the active sharing of benefits nor any specification on how benefits are to be shared it clearly resonates the CHM principle insofar that the interests of all countries should be taken in mind⁵⁶. Nevertheless, the province of mankind seems to limit itself to a moral obligation to explore and use for the benefit of mankind. According to Fabio Tronchetti, for example, ‘the province of mankind’ and Article I as a whole merely provides all States with a duty to carry out their space activities through a voluntary sharing process and international cooperation⁵⁷. Some authors have gone further by stating that the absence in the OST of any specifications on how this moral obligation should be translated into practice, makes the concept of the province of mankind void of any implications⁵⁸.

With regard to the legal status of outer space article II of the OST is of particular interest since it establishes the binding principle of non-appropriation for outer space. If one adds this principle to the freedoms stated in article I, the legal status of outer space can be interpreted as a *res communis*⁵⁹. What is also interesting to note is that the first two articles of the treaty create a ‘balance of power’ between spacefaring nations and non-space faring ones⁶⁰. Outer space is free for all but no State is allowed to appropriate it. Article VI is very important inasmuch as it declares that States bear international responsibility for national activities in outer space. These activities can be both governmental or non-governmental. In practice this means that the U.S. government, for example, will be held responsible for the actions of American private space companies. In order to

⁵⁶ L. Viikari, ‘The Legal Regime for Moon Resource Utilization and Comparable Solutions Adopted for Deep Seabed Activities’, *Advances in Space Research*, vol. 31, 2003, p. 2428.

⁵⁷ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, p. 26, 44.

⁵⁸ Lee, *Law and Regulation of Commercial Mining of Minerals in Outer Space*, p. 216.

⁵⁹ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, p. 27.

⁶⁰ Hobe et al., *Cologne Commentary on Space Law (Vol. 1)*, p. 58.

exert authority and supervision of national space activities a State needs to develop adequate legislation. Thus, article VI recognises the need for national space legislation to ensure that non-governmental space activities will be in conformity with the provisions of the OST⁶¹. For future commercial exploitative activities on celestial bodies by the hands of private American companies this means that the U.S. government will have to come up with effective national legislation in order to make these activities in line with the provisions of the OST and to make sure the U.S. government is able to supervise and exert authority over them. Equally important to the basis of national space law is article VII as it creates international liability of States for damage caused by their activities in outer space, which requires some level of national regulation.

Article IX is of special interest for this dissertation as it is the only article of OST that deals with the influence of space activities on both the space environment and the terrestrial environment. It creates the positive obligation for States to pursue studies to avoid harmful contamination of the space environment and adverse changes in the terrestrial environment from the introduction of extraterrestrial matter (back-contamination) by any planned space activity of a State or its nationals. As is the case with many terms in the OST, the term “harmful contamination” is not elucidated. As a consequence, it remains unclear what is intended with it exactly, but one can presume its meaning is rather broad, covering all types of contamination or interference in outer space and both deliberate or accidental alike⁶². An interesting fact is that the article only creates the obligation to assess the possible harmfulness of planned space activities, not already conducted ones. Therefore, if a conducted space activity that has been formerly assessed turns out to be harmful after all, it is questionable if a State can

⁶¹ Hobe et al., *Cologne Commentary on Space Law* (Vol. 1), pp. 73-74.

⁶² Hobe et al., *Cologne Commentary on Space Law* (Vol. 1), p. 176.

be held liable. Which research criteria the required studies on harmful contamination have to follow and what happens if a State does not follow these, is not clear. As with so many other issues, the OST remains rather vague, thereby raising the necessary questions in light of the many planned space activities as of today. Hence, it is pivotal to elaborate these concepts more fully. Not only to guarantee a safe and orderly development of the private space industry, but above all to make clear what purpose extraterrestrial exploitation should serve.

Finally, X, XI and XII all contain guidelines and general obligations for States to exchange information with each other concerning their space activities. The goal hereof is to promote international cooperation in outer space which should not just be for the benefit of the co-operating States, but for developing States as well⁶³. Indeed, without a fair and equitable access to information and knowledge obtained by space activities for all States, the first paragraph of article I will be nearly impossible to live up to⁶⁴.

3.3 The Moon Agreement

At the time of the OST negotiations actual exploiting of natural resources in outer space seemed surreal, making any guidelines for the regulation of these activities unnecessary. Therefore, the lack of clear-cut definitions for terms like ‘benefit’, ‘interest’ and ‘use of outer space’ did not appear to be troublesome. The six Apollo missions, however, changed all this: the landing of actual people on the surface of the Moon brought the exploitation of natural resources in space one metaphoric step closer to reality⁶⁵. This was enforced by the news that the moon rocks that had been brought to Earth by astronauts contained several precious metals. Consequently, speculations

⁶³ Hobe et al., *Cologne Commentary on Space Law (Vol. 1)*, p. 191.

⁶⁴ Hobe et al., *Cologne Commentary on Space Law (Vol. 1)*, p. 195.

⁶⁵ S. Hobe, et al., *Cologne Commentary on Space Law (Vol. 2): Rescue agreement, liability convention, registration convention, Moon agreement*, Carl Heymanns Verlag, 2013, p. 372.

arose on the feasibility and profitability of lunar mining activities accompanied by the necessary concerns on what the legal implications of such an event would be. At the UN a general consensus arose on the urgency of a legal document that would lay out more detailed rules for activities on the Moon and other celestial bodies⁶⁶. Hence, negotiations within UNCOPOUS started in 1970; the year in which Argentina submitted a first draft for a treaty, where all celestial bodies including the Moon and their resources would be declared the Common Heritage of Mankind⁶⁷. In the years that followed many other proposals were done and many discussions took place⁶⁸. Whereas the Cold War tensions had predominated the negotiations of the Outer Space Treaty, the negotiations of the Moon Agreement were foremost characterised by a split along the lines of spacefaring and developed countries on one hand and developing countries on the other. Although both sides were in favour of some kind of sharing regime, they could not reach agreement on the specifics. Eventually, they agreed to postpone an actual agreement until exploitation would be about to come feasible⁶⁹.

As a result, the Moon Agreement only establishes some limited guidelines for a future regime. Nonetheless, it does determine the legal status of future exploitation of natural resources on the Moon and other celestial bodies⁷⁰. After years of drafting and negotiations in 1979 the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, or simply the Moon Treaty or the Moon Agreement was finalised⁷¹. However, it did not enter into force until 1984 with its fifth ratification by Austria. In general the Moon Agreement has received a much lower level of acceptance compared to the OST and is, by some, regarded as much less of an influential and

⁶⁶ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, p. 38.

⁶⁷ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, p. 47.

⁶⁸ UNOOSA, <http://www.unoosa.org/oosa/en/SpaceLaw/treaties.html>.

⁶⁹ Article 11, paragraph 5, the Moon Agreement.

⁷⁰ Hobe, et al., *Cologne Commentary on Space Law (Vol. 2)*, p. 394.

⁷¹ General Assembly resolution 34/68 of 5 December 1979.

successful treaty, even to the point of a failed treaty⁷². Regardless of whether the Moon Agreement truly is a failed treaty or not, the fact remains that it is the only international treaty to deal with the exploitation of extraterrestrial resources and as such could provide useful lessons for future attempts to establish either a new international legal regime or to amend or revise the Moon Agreement itself. After all, it did enter into force.

Being the fifth international agreement concerning human activities in outer space, a great deal of the agreement consists of restating policies of the previous legal space documents. As paragraph 7 of the preamble says itself, the Moon Agreement takes into account the “need to define and develop the provisions of these international agreements”. This is especially true in regard to the OST; many of its principles are reconfirmed or further elaborated. As the name of the treaty already indicates, the Moon Agreement was designed specifically to regulate activities on the Moon and other celestial bodies located within our solar system, not all of the cosmos⁷³. This clear delimitation contrasts to previous international space agreements that have no clear working definition of ‘outer space’⁷⁴. Due to its relative closeness, the Moon, at the time of the drafting, seemed the most obvious destination for the first exploitative activities. For this reason it is set as an example to all other celestial bodies in the solar system, meaning that every time it is referenced to, it equally applies to the rest⁷⁵. Article 2 is very similar to article III of the OST insofar it restates the obligation that all space activities shall be in accordance with international law and promote international cooperation. Article 3, just as article IV of the OST, restates the fact that outer space can only be used for peaceful purposes. Article 4 starts off with the reiteration of article I, paragraph I of the OST with its principles and obligations. The terms ‘benefits’, ‘interests’ and ‘province of

⁷² Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, p. 39.

⁷³ Article 1, paragraph 1, Moon Agreement.

⁷⁴ Hobe, et al., *Cologne Commentary on Space Law (Vol. 2)*, p. 353.

⁷⁵ Article 1, paragraph 2, Moon Agreement.

mankind' are not further specified in the article but a new concept in the form of an appeal is presented; intergenerational equity⁷⁶.

Most interestingly is the environmental focus of the appeal in the sense that present generations have to preserve the space environment in such a way as to not jeopardise the future for generations to come. This is best achieved by measuring space activities against the need to preserve the space environment. Article 4 provides no guidelines on how this should be done in practice but some kind of environmental impact assessment procedure would seem logical. As later will be shown, this article is of pivotal importance for future negotiations on the regulation of outer space resources. The inevitable question that needs answering is what intrinsic value the space environment has and in case it has none, what value does it have for the survival of humanity and for individual human lives. Only when this question has been properly answered, it can be determined what intergenerational equity entails.

Article 5 combines parts of article IX and XI of the OST. The former for its obligations on the exchange of information of mission to the Moon and other celestial bodies and the latter for the duty to inform the world in case space activities $\neg$ i.e. not just missions to the moon or to other celestial but wherever off Earth $\neg$ result in the discovery of phenomena that can endanger human life or health. The question remains what is meant by phenomena and at what point can such a phenomenon be considered a threat to human life.

Article 7 echoes the environmental tone of article IX of the OST and can be seen in the light of the emergence of the 'international environmental law movement' in the early seventies⁷⁷. Understandably, the environmental law terminology was also in its infancy. Nonetheless, some new environmental terms make their appearance in article 7. While the obligation to

⁷⁶ Hobe, et al., *Cologne Commentary on Space Law* (Vol. 2), p. 365.

⁷⁷ Hobe, et al., *Cologne Commentary on Space Law* (Vol. 2), p. 372.

actively conduct research in order to avoid harmful contamination of the environment of the OST is not reiterated in article 7, a new obligation is introduced which obliges States to take adequate measures when using and exploring celestial bodies in order not to disrupt the existing balance of the environment. Both terms 'balance of the environment' and 'disruption' are new and despite their apparent vagueness, a further look at the exact wording of article 7 gives some clarification. It is already indicated that harmful forward and back contamination as well as adverse changes fall under the umbrella of 'disruption'. Interestingly, the use of the adjectives 'adverse' and 'harmful' indicates that changes of the balance of the environment are not by definition prohibited. This makes sense since otherwise the exploitation of natural resources on celestial bodies would be enjoined as it inevitably alters the environment. Therefore, it is likely that harmful and adverse only refer to contaminations and changes of environments that have a negative or destabilising effect⁷⁸.

The next two articles, namely article 8 and 9, deal with the freedom of access to all areas of the Moon and other celestial bodies. Naturally, it comes with the restrictions of article I of the OST as well as all the provisions stated in the Moon Agreement itself: what comes to mind are the environmental restrictions in article 7 and, of course, the CHM-principle of article 11. Article 8 and 9, furthermore, affirm that States Parties interested to engage in the exploitation of natural resources of the Moon and other celestial bodies are granted the right to take the necessary steps to make exploitation possible such as the instalment of stations, personnel, space vehicles and whichever else is required. Much of the text of both articles resembles articles IV and XII of the OST, but with more details and specifications.

As shown above, the Moon Agreement can be regarded as an extension of the Outer Space Treaty as it both reconfirms

⁷⁸ Hobe, et al., *Cologne Commentary on Space Law* (Vol. 2), p. 375.

and elaborates certain principles laid down in it. Notwithstanding, the most important as well as controversial article of the whole treaty is article 11 for the great novelty it adds to the international body of space law: the Common Heritage of Mankind. The first paragraph of this article unambiguously declares the natural resources of the Moon and other celestial bodies to be the common heritage of mankind and states that the implications of this will be further explained in 11.5 and the rest of the Moon Agreement. The latter is important since it means that the CHM-principle is only to be understood by how it is implicated within the agreement itself and not by how it has been used in other treaties such as UNCLOS. Paragraph 2 is a repetition of article II of the OST that bans appropriation of any kind.

A salient fact, however, when taking in mind the scope of the Moon Agreement, is the absence of any specific reference to natural resources, meaning that their appropriation is permitted⁷⁹. However, it is a mistake to think this permission of exploitation is unconditional since the general principle of non-appropriation can be overruled by specific rules in other provisions such as paragraph 5⁸⁰. Paragraph 3 goes on by stating that no entity, whether public or private, and no matter in which Moon activity they are engaged, can attain property or rights over the Moon, its surface, its subsurface and its natural resources in place. Now, this last wording is important since it seems to imply that property rights can be conferred to natural resources that are not in place anymore; in other words, resources that have been removed. The only condition to this is that they have to be removed according to the provisions of paragraph 5. Paragraph 4 reiterates two of the four essential freedoms set out in article I of OST: the freedom of exploration and the freedom of use. Both these freedoms, however, can only be enjoyed under the

⁷⁹ K. Cook, 'The Discovery of Lunar Water: An Opportunity to Develop a Workable Moon Treaty', *Georgetown Environmental Law Review*, vol. 11, 1999, p. 666.

⁸⁰ Hobe, et al., *Cologne Commentary on Space Law* (Vol. 2), p. 395.

terms and conditions set out in the other provisions of the Moon Agreement, and in accordance with international law.

Paragraph 5, the one that has been referred to in the previous, describes the obligation states have to establish an international regime for the exploitation of the natural resources on the Moon and other celestial bodies whenever it becomes achievable. This depends on both commercial and technological advancements in the space sector. In view of the various existing plans to exploit natural resources on celestial bodies it certainly seems the case this time has already arrived. On a different note, paragraph 5 also implies that the exact implications of the fact that the Moon and other celestial bodies have been declared the CHM are not clear yet and that is has to be determined in a later moment. To a certain extent, therefore, the Moon Agreement is self-reflective insofar it recognises its own limited purpose: ensuring that an effective regulatory regime will be established when the times has come by obliging countries to make at least a credible effort to negotiate such a regime. By setting out a few basic criteria and delineations a regime would have to be bound by the Moon Agreement aimed to smoothen these future negotiations. It is precisely for this reason that paragraph 7 is so important; it names four of these criteria the future regime will have to abide by. Especially the last one is highly controversial as it calls for the equitable sharing by all States in the benefits derived from the exploitation of natural resources on the Moon and other celestial bodies. On top of that comes the special consideration that should be given to countries that have made exploitation possible as well as to developing countries. One might say that this is the only time the Moon Agreement plainly offers an asymmetrical benefit to developing countries as they are promised to gain from economic activities they have had no direct contribution to⁸¹. Any concretisation of how the sharing of benefits will come around, however, is left in the dark.

⁸¹ Hobe, et al., *Cologne Commentary on Space Law* (Vol. 2), p. 398.

Nonetheless, it undoubtedly constitutes a noteworthy departure from the OST and caused a whole lot of reluctance amongst the industrialised nations to ratify or even sign the contract⁸². It is important to notice, however, that this unwillingness was, in part, also linked to the negotiations of the United Nations Convention on the Law of the Sea (UNCLOS) of the same year⁸³. The negotiations on the deep seabed resources were a parallel effort to advance the CHM-concept⁸⁴. As a result, their evolution undoubtedly influenced the development of the language used in the Moon Agreement⁸⁵. In fact, the latter is, together with UNCLOS, the only other international treaty to have the CHM principle explicitly mentioned⁸⁶. It caused so much objection of industrialised nations that they were not eager to sign it to say the least⁸⁷. For developing countries, on the other hand, the uncertainty regarding the specifics of the future regime managing the natural resources was a major reason not to sign the Moon Agreement⁸⁸. Without an effective resolution mechanism in place, developing countries feared not to have any promising means of countering unilateral actions on the side of the major space-faring nations.

3.4 1996 Declaration on Space Benefits

As just mentioned, both developing and developed states had their own reasons not to ratify the Moon Agreement. Besides the dissatisfaction developing countries felt over the Moon Agreement, they also continued to be discontent with the vagueness of article I (1) of the OST and how it had left them empty-handed in terms of participation in space activities as well

⁸² Hobe, et al., *Cologne Commentary on Space Law* (Vol. 20), p. 336.

⁸³ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, p. 110.

⁸⁴ Peterson, *International Regimes for the Final Frontier*, p. 156.

⁸⁵ L. Delgado-López, 'Beyond the Moon Agreement: Norms of responsible behavior for private sector activities on the moon and celestial bodies', *Space Policy*, vol. 32, 2014, p. 1.

⁸⁶ Part XI, UNCLOS.

⁸⁷ Hobe, et al., *Cologne Commentary on Space Law* (Vol. 2), p. 391.

⁸⁸ Viikari, *Advances in Space Research*, 2428.

as the benefits derived thereof⁸⁹. They had interpreted article I to imply that international cooperation was a requirement and thought that space-faring countries had willingly neglected this obligation. Therefore, they thought it was time for a stricter and more well-defined legal document that could ensure international cooperation and grant them space benefits; a legal instrument that would call for both forced cooperation and transfers of financial and technological resources from developed to developing States⁹⁰.

Chances of success were dim though. At the time of the OST negotiations the major powers had indeed acknowledged some sort of limitation on outer space as a *res communis*, but they had equally maintained it was their right to decide how the benefits were to be shared and how international cooperation were to come about⁹¹. The little popularity the Moon Agreement had enjoyed was the living proof of how challenging it was to find an acceptable compromise for both sides. However, what neither one had probably foreseen was the fall of communism. This monumental event shook the world order to its foundations and transformed it from a bipolar system into a unipolar one, dominated by the United States. Whereas previously global international relations had been shaped by how countries took their stance with regard to both world powers, now the positions of countries in the international arena were determined by their relation with the United States. The outcome of the cold war could be read as the triumph of capitalism over communism. The NIEO theory, once so popular with developing countries, lost a great deal of its relevance in the face of a world that was increasingly geared towards free-market thinking⁹². Had the developing countries previously hoped for a stricter and fairer

⁸⁹ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, pp. 62-63.

⁹⁰ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, pp. 64, 70.

⁹¹ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, pp. 63-64.

⁹² Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, p. 70.

implementation of the CHM-principle, the collapse of communism crushed that hope and replaced it with the need to revise the CHM-principle. If it were to maintain any significance as a legal term it had to adopt to the new economic and political reality. For the Moon Agreement it meant that its previous unpopularity was accompanied by the notion that it had now also become, in the eyes of some, an outdated treaty.

This bears some similarities with UNCLOS III that, as opposed to the Moon Agreement, included an actual regime which in this case regulated the exploitation of deep seabed resources located outside any state's territorial waters or Exclusive Economic Zones. It was based upon the CHM-principle and developing countries had hoped to see a similar regime appear in the Moon Agreement. However, developed countries, the United States in particular, were so reluctant to ratify UNCLOS III that it eventually led to a renegotiation of the infamous Part XI that dealt with the deep seabed regime⁹³. The Agreement relating to the implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982, or simply, the 1994 New York Agreement was the outcome of these negotiations. It was a clear recognition and accommodation of a variety of national claims and more market-oriented proposals, which in turn eroded the interpretation of the CHM-concept contained in the original convention⁹⁴. It certainly indicated how the new political and economic context had turned the table in favour of developed countries and their interpretation of the CHM-principle. It also gave a new direction to negotiations within UNCOPUOS; bolstering the developed nations' conviction that there was no need for additional legal frameworks to further improve what they saw as an already successful degree of international cooperation in space; while diminishing the hopes of developing countries that new legal

⁹³ D. Anderson, 'Resolution and Agreement Relating to the Implementation of Part XI of the UN Convention on the Law of the Sea: A General Assessment', *Heidelberg Journal of International Law*, vol. 55, no. 2, 1995, pp. 275-289.

⁹⁴ Viikari, *Advances in Space Research*, p. 2432.

steps would be undertaken to ensure a fairer redistribution of space benefits⁹⁵. What had begun as an effort to advance a stricter and fairer implementation of the CHM-principle, therefore, ended up with an opposite result.

As the name already indicates the 1996 Declaration on Space Benefits is just a declaration and, although of considerable importance, is not legally binding. Developing countries had hoped for a new treaty instead. Of equal importance is that the declaration, similar to the 1994 New York Agreement, bends the common heritage provisions toward market principles⁹⁶. Even though it does acknowledge the special needs of developing countries and recognises the importance of international cooperation it removes from the agenda the issues of obligatory transfer of technology or redistribution of space benefits. Moreover, where developing countries had also wished for more clarity of what these space benefits would entail, the declaration leaves this term as undefined as in the OST. In sum, one can say that the relevance of the 1996 Space Benefits Declaration lies foremost in the fact that it has provided a narrower view of how article I (1) of the Outer Space Treaty as well as the Common Heritage of Mankind principle should be interpreted. It has altered two of the five common elements associated with the CHM principle: the active sharing of benefits from exploitation of natural resources and the active sharing of knowledge and expertise with developing countries. A positive note is that the declaration put an end to the North-South debate concentrated instead on the benefits space applications can provide for all mankind.

3.5 The current status of extraterrestrial exploitation

The current problem is the legal lacuna in international law regarding the management of outer space resources. Whether or not one concludes that the current body of international space

⁹⁵ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, p. 72.

⁹⁶ Viikari, *Advances in Space Research*, p. 2430.

law allows for space mining, it is beyond doubt that it is simply not well-equipped to address the multitude challenges presented by the ongoing commercialisation, privatisation, and the increasing rate of innovation in the space industry⁹⁷. On top of that comes the growing prospects for the exploitation of extraterrestrial resources. This gap in space law causes not only legal but also political and regulatory uncertainty for potential investors in space mining and in this way blocks the economic development of outer space, its peaceful character and, most importantly, the potential positive environmental impact the exploitation of extraterrestrial resources can and foremost should have.

3.5.1 Under the Outer Space Treaty

As far as the legal status of exploitation of natural resources on celestial bodies is concerned the OST does not give any satisfactory outcome. On one hand the freedom of use seems to include the freedom of exploitation since the latter can be regarded as a synonym of 'use'. But, on the other, the non-appropriation principle prohibits any form of appropriation in outer space, including the Moon and other celestial bodies. Because 'resources' is not mentioned does not automatically imply that exploitation is legal. As a matter of fact the term 'resources' is nowhere to be found in the Outer Space Treaty, indicating that by 'the Moon and other celestial bodies' they must also mean their resources. What else are celestial bodies made up of than resources? In the end every material is a potential resource. To point out that the Moon Agreement does distinguish between celestial bodies and resources and that, therefore, the OST's omission of the term 'resources' implies a right to exploitation is an anachronistic argument. Consequently, the presumed unaddressed issue of private and commercial exploitative space activities is irrelevant. Since States are

⁹⁷ Viikari, *Advances in Space Research*, p. 2432.

accountable for their actions, private parties are indirectly subjected to the OST provisions and are, therefore, enjoined to engage in exploitative activities. Furthermore, since no mentioning is made of asteroids, meteoroids or comets, it seems likely that they are referred to as celestial bodies. As one can see, the main problem of the OST as a legal regime for extraterrestrial exploitation is its lack of clear-cut definitions for terms like 'benefit', 'interest', 'celestial bodies' and 'use of outer space'. This creates uncertainty for developing countries afraid to be left empty-handed but also for developed countries and their commercial counterparts which may hereby enticed to seek for loopholes.

3.5.2 Under the Moon Agreement

When it comes to the Moon Agreement, the legal status of exploitation is already much better defined. The Moon Agreement stresses some of the principles of the OST, the non-appropriation principle most significantly, and elaborates on some other concepts, e.g. environmental protection. The term 'resources' is used for the first time and private activities are explicitly mentioned. Appropriation of resources that have already been removed is legal, but since this first removal cannot take place without actual exploitation, it is pretty meaningless. The removal or exploitation of resources is only allowed if it happens in accordance with the specific rules determined in the legal regime yet to be established. In all other cases commercial exploitation, in whichever form, is prohibited as indicated in several articles of the agreement. The exact shape the future regime will take is unclear but it will have to conform to the Common Heritage of Mankind provisions of the agreement that call for an equitable sharing of the benefits, intergenerational equity with regards to the environment, and the sharing of knowledge and expertise with developing countries. Until that regime is established, it is unclear if there rests a de-facto

moratorium on the exploitation of natural resources or not. An academic consensus on this issue is unlikely to emerge as both sides have compelling arguments⁹⁸. This lack of clarity combined with the little international support for the Moon Agreement is all the more reason to find an appropriate solution to the legal challenges presented by current plans for commercial exploitation.

3.6 Conclusion

This chapter has treated the existing body of international space law and in particular those legal documents that are relevant to the management of natural resources on the Moon and other celestial bodies. A key concept in the analysis has been the CHM-principle; not just for its appearance in the Moon Agreement, but foremost because a thorough understanding of it is crucial to understanding the *corpus iuris spatiales*. The CHM-principle has both a legal and an ideological dimension. While it lacks a clear-cut definition it originally stood for the idea of internationally regulating an area outside of any national sovereignty to the furtherance of all of mankind in an equal fashion. As a result of the fundamentally opposing way developing and developed States interpreted the term, however, its legal significance in the Moon Agreement was greatly reduced and basically mounted to the commitment to establish an international unified regulatory regime.

The Magna Carta of space law is the Outer Space Treaty of 1967. It grants the freedom of exploration and use of outer space, but couples it to the binding principle of non-appropriation, thereby establishing outer space as a *res communis*. However, unlike a *res communis* in the truest sense of the word, outer space is also declared the ‘province of mankind’, which translates to a moral obligation to conduct space activities for the benefit and in the interest of all countries,

⁹⁸ V. Pop, *Who Owns the Moon? Extraterrestrial Aspects of Land and Mineral Resources Ownership*, New York City, Springer, 2008, p. 146-147.

particularly the less affluent ones. Due to the fact that the OST is foremost a treaty of general principles, it does not contain any guidelines for the regulation of economic commercial activities aimed at exploiting the natural resources of outer space. Hence, a satisfying answer to the question whether it permits exploitation is nowhere to be found. Nevertheless, because the term 'resources' is absent one may assume that whenever the 'Moon and other celestial bodies' are mentioned, it also includes their resources. By this line of reasoning, it follows that the non-appropriation clause also goes for resources, making exploitation illegal.

Besides the OST, the Moon Agreement is also a key document as it is the outcome of the first attempt to regulate extraterrestrial exploitation internationally. In spite of its limited number of ratifications it is a legally binding treaty. Its little popularity is strongly linked to the fact that it is a compromise between two diametrically opposed views of how exploitation should come about. While Article 11 controversially declares the Moon and the other celestial bodies as well as their resources the Common Heritage of Mankind, it remains rather vague how this notion should be implemented in practice. Although a few key issues like property and exploitation rights are dealt with, the Moon Agreement, as a matter of fact, does not establish a regulatory regime but only creates the moral obligation to negotiate one in future, when the time is right. Until that time it is not clear if there rests a moratorium on exploitation; detailed regulation is missing. Even so, the presence of the CHM-principle in the Moon Agreement combined with the UNCLOS experience was reason enough for the developed States to withhold from signing. Contrarily, it was precisely the uncertainty of how a future regime will look like and the fear that it would undermine the spirit of the CHM-principle that prevented developing countries from signing. Disenchanted with the outcome of the Moon Agreement and long-lasting frustration

over Article I (1) of the OST triggered developing countries to propose a new treaty that would better reflect their interests. However, the fall of communism geared the world economy towards free-market principles. It outdated the NIEO theory and vanished all hopes of a more favourable treaty. Instead, the 1996 Space Benefits declaration was signed; a non-legally binding document that eroded the CHM-principle. Although it acknowledged the special needs of developing countries and the importance of international cooperation, it swapped the obligatory character of transfer of technology and redistribution of space benefits for a voluntary character. Moreover, it did not answer the call to concretise the exact nature of the 'space benefits' mentioned in the OST and Moon Agreement.

As announced earlier on, environmentalism plays a very minor role in the treated legal documents. Taking in mind that the environmental movement only came to prominence in the 1970s it should not surprise. The OST only creates the positive obligation for State to pursue studies to avoid harmful contamination of the space environment and adverse changes in the terrestrial environment from the introduction of extraterrestrial matter. The terms 'harmful contamination' and 'adverse changes' are not further specified. Apart from restating this obligation the Moon Agreement also adds the obligation of intergenerational equity with regard to the environment, meaning that present generations must leave the space environment in no worse condition than they found it. What falls under the umbrella of worse condition is not exactly clear but it surely includes harmful and adverse disruptions of the 'balance of the environment'.

4. Proposals for solving the legal gap

Since no substantial advancement in international space law concerning natural resources has occurred since the Moon Agreement, the existence of the *legal lacuna* persists. This is not in the least because of the increasing aversion of developed countries, in particular the United States, to participate in another costly process of negotiations for a new treaty⁹⁹. Meanwhile, private companies are maturing and space commerce is expanding, which in turn increases the urgency to adequately establish “the rules of the game”. The principal dilemma is how in the case of extraterrestrial exploitative activities the right of use and exploration of outer space can be reconciled with the duty to carry these out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development. Several scholars have attempted to find solutions accordingly. These range from the (re)negotiation of the Moon Agreement or a whole new treaty, to the establishment of a code of conduct by future actors in the natural resource exploitation. The United States is a special case since it is the first country to go down the path of unilateral action; it has recently implemented own national legislation to fill in the gap in international law. The Space Act of 2015 is seen as an utterly bold move in the international community as it complicates an

⁹⁹ Delgado-López, *Space Policy*, p. 1.

international solution and while it arguably also undermines the OST. Striking is how the environmental dimension in the proposals and the Space Act alike shines by its absence. It is nothing short of depressing to acknowledge that in the unlikely event that an international regulating regime does come around in the foreseeable future, it will most certainly have missed the opportunity to approach the whole debate from an ecological point of view. Instead, it will be the product of business as usual; a compromise of predominantly financial and economic interests between developing and developed states.

4.1 Renegotiating or revisiting the Moon Agreement

Perhaps the most obvious way to resolve the legal lacuna would be the renegotiation or the revision of the existing Moon Agreement. According to Antonella Bini, the most important concern at the time of the drafting of the Moon Agreement was the guarantee of the peaceful and equitable exploration of outer space¹⁰⁰. Hence, the treaty was not meant to block the development of extraterrestrial resources, but rather to encourage it. The actual reason for its widespread dislike was the lack of any specifications regarding the structure of the international regime it wants to establish in future, not the explicit mention of the CHM-concept¹⁰¹. Even so, the private industry in particular was hold back by the provision to establish an international regulatory regime in future as it interpreted it as a “de-facto moratorium” on commercial activities¹⁰². Moreover, it would be wrong to assume that the private industry did not oppose the explicit mention of the CHM principle as it wrongly thought the latter called for the equal sharing of benefits derived from extraterrestrial resources¹⁰³. In reality, the Moon Agreement only calls for equitable sharing, not equal sharing. What is more, this

¹⁰⁰ A. Bini, ‘The Moon Agreement in the 21st Century’, *Acta Astronautica*, vol. 67, 2010, p. 498.

¹⁰¹ Bini, *Acta Astronautica*, p. 499.

¹⁰² Delgado-López, *Space Policy*, p. 2.

¹⁰³ Jakhu and Buzdugan, *Astropolitics*, p. 229.

equitable sharing comes, as aforementioned, with the provision that those countries which have contributed either directly or indirectly to the exploration of the Moon, shall be given special consideration. Thus, whilst it is true that developing countries do have a privileged position insofar that they are entitled to an asymmetrical benefit of some kind, the entrepreneurial countries equally enjoy a favoured position¹⁰⁴.

In 2009, at the forty-eighth UNCOPUOS session the discussion of the Moon Agreement was reopened. The event reinvigorated Bini's belief that renegotiation was the most viable option¹⁰⁵. During the session, countries recognised that the Moon Agreement had been of limited impact because of the few ratifications it has received over the years, but nonetheless countries agreed that the treaty maintains its legal validity. Being this the case, the need was voiced to discover the exact reasons for the low number of ratifications in order to come up with effective measures to increase the number. According to Bini, this alone proves that the Moon Agreement is not considered a lost treaty by the majority of UNCOPUOS member States; the delegations not merely reaffirmed the legal validity of the Agreement but also seemed willing to discuss it and, possibly, renegotiate it¹⁰⁶. By all means, it is hard to label her conclusions as premature. After all, as aforementioned, the Moon Agreement is an official signed and ratified international treaty, and although it has not been ratified by any major space power it makes sense to argue that the ideas expressed herein have a legal standing thanks to the 'global commons' approach to space instituted by the Outer Space Treaty, even more so now that States have expressed their willingness to re-evaluate it¹⁰⁷.

An argument that also, somewhat paradoxically, speaks in favour of a renegotiation is the renewed relevance the treaty has

¹⁰⁴ S. Hobe et al., *Cologne Commentary on Space Law (Vol. 2)*, p.398.

¹⁰⁵ Bini, *Acta Astronautica*, p. 501.

¹⁰⁶ Bini, *Acta Astronautica*, p. 501.

¹⁰⁷ E. Sadeh et al., 'Public-private models for lunar development and commerce', *Space Policy*, vol. 21, 2005, p. 274.

gained by the U.S. Space Act of 2015, an unilateral action welcomed by American space enterprises because it appears to give them more legal certainty with regard to their future expected claims of ownership of extraterrestrial resources. However, quite on the contrary, the Space Act is likely to instigate a serious renegotiation of the Moon Agreement as it raises awareness amongst many states that without a solid international regulatory framework, it will be predominantly American enterprises that will yield the profits of these resources. Likewise, the Space Act will prove to be counterproductive to the very American commercial parties that lobbied for it once they start to face costly legal challenges from states that deem their plans illegal under international law. The fact that these lawsuits even have the potential to jeopardise their enterprises altogether may fast-forward the realisation that their plans can only succeed with an international regime in place. Thus, the U.S. Space Act of 2015 could actually instigate a serious renegotiation of the Moon Agreement. On a different note, the sole existence of the Space Act also indicates that the exploitation of extraterrestrial resources lies around the corner, and that according to Article 11 (5) of the Moon Agreement the time has come to start negotiations for the establishment of an international regime. As seen in the former chapter the interpretation of the CHM-principle has considerably changed after the fall of communism. The very controversial obligation to actively share the benefits from the exploitation of outer space resources has changed into a more indirect way of sharing benefits, and the mandatory transfer of technology has been substituted for a voluntary one¹⁰⁸. This new interpretation, promoted by the 1996 UN Declaration on Space Benefits¹⁰⁹, aims to avoid an ideological debate on the international order for outer space and concentrates instead on

¹⁰⁸ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, p. 84.

¹⁰⁹ General Assembly resolution 51/122 of 13 December 1996.

the benefits space applications can provide for all mankind¹¹⁰, which in turn should make a renegotiation of the Moon Agreement more achievable. Regardless of one's preferences, most legal scholars share the view that leaving the Moon Agreement in its shadowy existence will only weaken the body of outer space law¹¹¹.

4.2 Negotiating a new treaty

Another possible solution to the legal lacuna is the negotiation of a new treaty, thereby implicitly ignoring the legal implications of the Moon Agreement. To some, the fact that none of the major space-faring nations has ratified the latter might very well cause the provisions of that treaty to be largely irrelevant in most cases¹¹². Indeed, if one agrees with *pacta tertiis nec nocent nec prosunt*, the Moon Agreement cannot serve as a standard for the rest of the international community¹¹³. Notwithstanding, the fact remains that most agree either way that the presence of a legal regime is the only feasible solution to guarantee the safe, peaceful and orderly development of extraterrestrial exploitative activities located on the Moon and other celestial bodies¹¹⁴. In the view of Fabio Tronchetti the current absence of such a regime is evidently one of the main reasons why the actual exploitation of extraterrestrial resources has not yet begun¹¹⁵.

The uncertainty regarding the legal status of the Moon Agreement and the exact meaning of its provisions has indeed kept some companies from investing in potential missions for commercial exploitation¹¹⁶. Without a better international regulatory framework businesses will face the dilemma of lawsuits, but without any equity guarantees developing countries

¹¹⁰ M. Benko and K. Schrogl, 'History and impact of the 1996 UN Declaration on 'Space Benefits'', *Space Policy*, vol. 13, no. 2, 1997, p. 143.

¹¹¹ Peterson, *International Regimes for the Final Frontier*, p. 171.

¹¹² F. Von der Dunk et al., 'Surreal estate: addressing the issue of 'Immovable Property Rights on the Moon'', *Space Policy*, vol. 20, 2004, p. 152.

¹¹³ V. Pop, 'Appropriation in outer space: the relationship between land ownership and sovereignty on the celestial bodies', *Space Policy*, vol. 16, 2000, p. 275.

¹¹⁴ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, p. 236.

¹¹⁵ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, p. 238.

¹¹⁶ Von der Dunk et al, *Space Policy*, pp. 154-155.

will turn down a new framework¹¹⁷. Hence Tronchetti thinks that a legal framework, in order to be successful, should stimulate the full and active participations of both private and public operators in exploitative activities¹¹⁸. It should strike a balance between overregulation and inadequate regulation as to incite private companies to invest more in space technologies but without giving developing countries any meaningful role to play. In Tronchetti's view the Moon Agreement has little chance to be accepted by most countries, not in the least because he thinks article 11 (5) does not have any mandatory force: States are not legally obliged to undertake action in order to establish an international regime to govern the exploitation of natural resources. The only obligation they do have is to at least try in good faith to reach an agreement on a governing regime, thereby reducing one of the most central provisions of the Moon Agreement to a mere *pactum de negotiando*¹¹⁹. On top of that he stresses the fact that the original interpretation of the CHM-concept as it appears in the 1982 UNCLOS as well as in the Moon Agreement has lost its significance¹²⁰. As evidence Tronchetti not only points out the provisions of the 1996 Space Benefits declarations and the 1994 Implementation Agreement of Part XI of UNCLOS, but also those of the several conventions of the International Telecommunication Union¹²¹. In his opinion the legal framework governing the orbit/spectrum resource, an inexhaustible but limited resource, is interesting since it harmonises the concept of equitable opportunities with the market principle of efficiency. Therefore, it should, together with the other two legal documents, be a leading example of how the natural resources on the Moon and other celestial bodies should be managed. Just as the 1994 Implementation Agreement of Part

¹¹⁷ Cooper, *Space Policy*, p. 117.

¹¹⁸ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, p. 239.

¹¹⁹ Tronchetti, *The Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, p. 54.

¹²⁰ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, p. 123.

¹²¹ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, pp.110-118, 188.

XI of UNCLOS, the legal regime Tronchetti proposes establishes an International Authority which has the power to license companies or agencies wishing to exploit extraterrestrial resource. The great advances of such a regulatory body is that it provides private and public entities with permits to extract resources within a specified time and place. By doing that, it takes away the risk of appropriation claims by turning 'real' property rights, actual ownership, into a right of use¹²².

Unlike UNCLOS Tronchetti does not envision a proper Enterprise for its own. Indeed, the idea of a "parallel system"¹²³ for extraterrestrial exploitative activities would be highly impractical, let alone the fact that a mandatory mechanism obliging States or private operators to share their benefits has been historically proven unacceptable to developed States¹²⁴. Nonetheless, Tronchetti has found three potential ways to assure that extraterrestrial exploitative activities will be conducted for the benefit of mankind and for developing countries in particular¹²⁵. The first one is the payment of a fee to the Authority for obtaining a license to carry out mining activities over a delimited extraterrestrial area. The exact amount of such a fee would be determined by the licensee's investment of its exploitative operations in developing States. The more a future operator plans to invest in developing States, the higher the reduction of their fee can be¹²⁶. This system should greatly incite developed States to invest in less affluent States. The second-best option Tronchetti has in mind is to provide a certain percentage of the license fee to the United Nations Programme on Space

¹²² Sadeh et al., *Astropolitics*, p. 270.

¹²³ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, pp. 246, 247, 248. A "parallel system" would be established for exploring and exploiting the international seabed area. All activities in this area would be under the control of an International Seabed Authority, to be established under the convention. The authority would conduct its own mining operations through its operating arm, called the "Enterprise," and would also contract with private and state ventures to give them mining rights in the area, so that they could operate in parallel with the authority.

¹²⁴ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, p. 282.

¹²⁵ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, pp. 283-285.

¹²⁶ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, p. 283.

Applications¹²⁷. Since the 1970s, the UN has promoted management, education and capacity-building in the developing World through the furthering of knowledge and experience of space applications. The developing States would directly benefit from a larger amount of funds for this programme. A last method Tronchetti proposes is to use extracted mineral resources in outer space directly within the territory of the developing States to support their development¹²⁸.

All three of these options somehow harmonise the opposing interests of developing and developed States by inciting the latter ones to invest in space endeavours and by assuring the former ones a piece of the cake. Apart from the fact that Tronchetti wants to get rid of the Moon Agreement, his proposed regime is very reasonable. It offers a workable solution that compromises both sides of the argument without transgressing the body of international space law. Taking in mind the Space Act of 2015 and the trend towards national legislations it represents, the chances of seeing Tronchetti's proposal become reality seem slim, but perhaps with the passage of time it will change. As stated above, the Space Act of 2015 might very well be the wake-up call the international community needed to move things forward again and restart negotiations.

4.3 Harmonising national legislations and establishing a code of conduct

Whichever solution provided may be most desirable or realistic in today's context, it goes without saying that international solutions should always have the preference. The use of space resources clearly demands a strong legal framework, and preferably a comprehensive and international one as it provides legal stability on the long-term, something in the interests of all of mankind¹²⁹. Moreover, since outer space is unambiguously declared the province of mankind in the Outer Space Treaty, it

¹²⁷ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, p. 284.

¹²⁸ Tronchetti, *Exploitation of Natural Resources of the Moon and Other Celestial Bodies*, p. 285.

¹²⁹ Viikari, *Advances in Space Research*, 2432.

seems nothing but fair that all States and all peoples have a say in how a legal outcome should look like. Notwithstanding, some legal scholars suggest other ways of dealing with the gap in space law, either for ideological or pragmatic reasons.

Delgado-López, for instance, proposes the harmonisation of the national legislation of those countries actively involved in space exploration¹³⁰. By creating similar national legislations and coupling them to norms of behaviour for private companies, the base can be laid for a responsible, peaceful, economically productive, and sustainable use of extraterrestrial resources. The main argument Delgado-López brings forward is that the development of legal instruments is rendered impossible by political and diplomatic hurdles, leading to a growing aversion to create new formal legal instruments. Norms and practices, on the contrary, provide the required political flexibility for building consensus as they come with a greater agility¹³¹. Thus, in her opinion the harmonisation of national legislations is a more realistic and effective way to deal with space issue.

But what is to be expected from the creation of a code of conduct for private companies if the difficult but necessary hurdles such as the prohibition on property are not overcome? Since they derive from deeper ideological differences do they not have to be tackled first since their resolution is a prerequisite for a sustainable future? Just because private space actors prefer norms of behaviour to the development of legally binding space documents¹³² does not mean that governments should follow suit. These companies may very well say they seek to promote long-term space sustainability, but it has been proven time and again that profit maximisation is always at the top of their agenda. And if the establishment of norms of behaviour is the easiest way to profit maximisation, they will opt for that. That being the case, one should ask oneself if the interests of all of

¹³⁰ Delgado-López, *Space Policy*, p. 1, 3.

¹³¹ Delgado-López, *Space Policy*, p. 3.

¹³² Delgado-López, *Space Policy*, p. 3.

mankind will be endorsed by these ‘rules of the road’. A more sensible approach comes from Hanneke van Traa-Engelman who also advocates for the development and harmonisation of national legislation to give incentives to private parties but with the long-term aim to reassess the Moon Agreement¹³³. Although its effectiveness may equally prove dubious, important is the fact that the end goal remains the establishment of an international legal regime.

Because property rights in space reveal the deep ideological North-South division, many scholars have focused much more on the clarification of these rights as a possible solution. Brandor Gruner, for example, finds the non-appropriation principle of the OST laudable but holds it very difficult to put into practice since it overturns the long-standing principle in international law of national sovereignty¹³⁴. Instead, he calls for the doctrine of first possession as he believes it will create an adequate incentive for both space exploration and colonisation. In his opinion the first nation to arrive on a celestial body should claim its territory on behalf of all mankind, thereby honouring the ‘province of all mankind’ principle of OST¹³⁵. In addition, Gruner makes a distinction between the void that exists between celestial bodies and the actual celestial bodies. Whereas he regards the former as a *res communis*, he wants to redefine the latter as *terra nullius*, permitting national sovereignty and a private property system based on that of the United States¹³⁶. After a nation has claimed a celestial body it should establish a legal system for property and resources based upon Article 11 (5) of the Moon Agreement¹³⁷. However, the nation retains the freedom to decide how it wishes to share the benefits

¹³³ H. Van Traa-Engelman, ‘Commercialization of space activities: Legal requirements constituting a basic incentive for private enterprise involvement’, *Space Policy*, vol. 12, no. 2, p. 119.

¹³⁴ M. Gruner, ‘A New Hope for International Space Law: Incorporating Nineteenth Century First Possession Principles into the 1967 Space Treaty for the Colonization of Outer Space in the Twenty-First Century’, *Seton Hall Review*, vol. 35, 2004, p. 306.

¹³⁵ Gruner, *Seton Hall Review*, pp. 353-354.

¹³⁶ Gruner, *Seton Hall Review*, p. 353.

¹³⁷ Gruner, *Seton Hall Review*, p. 354.

equitably with developing States. Apart from its incompatibility with the non-appropriation principle of existing space law, the most objectionable aspect of Gruner's proposal is that it disproportionately advances those fortunate nations who come first, thereby irreversibly perpetuating the very economic system that has led to such grave disparities in wealth between nations.

Whereas Gruber overtly calls for the removal of the non-appropriation principle, the theory of "Pseudo Property Rights" does recognise the interdiction on national appropriation but interprets the State's obligation to keep track of nongovernmental activities as an entitlement to install a pseudo-property regime just for their nationals. Instead of formally recognising property claims this regime would rather give a private entity the right to exclude others from their claimed land¹³⁸. Yet another theory concentrates on so-called functional property rights, which derive from the actual State's control over its space objects, whether private or national. Once these objects are at a fixed location for a certain amount of time the area right under the space object as well as its surrounding area would become the property of the State¹³⁹. In a later moment, both the Pseudo Property Rights approach as well as the functional property rights approach could evolve into a so-called 'Reciprocating States Regime' whereby certain States will grant each other non-discriminatory access to outer space resources and will recognise each other's claims¹⁴⁰.

Both these theories can be rebuked. Article II of OST explicitly enjoins national appropriation by claim of sovereignty, by means of use or occupation, or by any other means. The term national appropriation is a curious one as it combines concepts of public law ('national') and private law ('appropriation')¹⁴¹.

¹³⁸ Jakhu and Buzdugan, *Astropolitics*, pp. 224-225.

¹³⁹ Jakhu and Buzdugan, *Astropolitics*, p. 225.

¹⁴⁰ Sommariva, *Astropolitics*, p. 38

¹⁴¹ S. Hobe, 'Adequacy of the Current Legal and Regulatory Framework Relating to the Extraction and Appropriation of Natural Resources in Outer Space', *Annals of Air and Space Law*, vol. XXXII, 2007, cited in S. Hobe, et al., *Cologne Commentary on Space Law* (Vol. 1, p. 50).

Even if the expression is considered only part of public law, the other articles of the OST taken together do seem to imply a ban on private ownership as well¹⁴². Therefore, the supposed loophole in article II regarding private entities does not exist¹⁴³. Still, as far as private property on basis of first arrival and continued occupancy is concerned, one could argue that OST, as it establishes outer space as a *res communis*, leaves room for it. Once a well-functioning institution of private property is up and running, this classical Lockean account of property earned by labour and practice could even be considered an useful way to legitimate property claims based upon first arrival. However, it would certainly not legitimise the institution itself¹⁴⁴. The appropriation of land may occur outside the sphere of sovereignty, but without the endorsement from a sovereign entity it cannot persevere, not even with a national private property institution in place. In all cases it would violate the non-appropriation principle of OST¹⁴⁵. Thus, a national system of property for outer space is illegal *qua definitione*. Even the abovementioned 'Reciprocating States Regime' will have little chance to succeed on the long term. Although settled practices may be established by the acts of the participating States, they are unlikely to become customary law as they lack the conviction that they reflect or amount to law. In this case *opinio juris sive necessitates* prevails over *consuetudo pro lege servatur*. Once again, the UN is, par excellence, the only sovereign entity to regulate property in outer space and any possible solution to the legal lacuna should take that notion as a point of departure.

4.4 The Space Resources Exploration and Utilization Act: legal analysis and political implications

¹⁴² Cooper, *Space Policy*, p. 113

¹⁴³ P. Sterns and L. Tennen, 'Privateering and Profiteering on the Moon and Other Celestial Bodies: Debunking the Myth of Property Rights in Space', *Advances in Space Research*, vol. 31, no. 11, 2003, p. 2434.

¹⁴⁴ T. Milligan, 'Property Rights and the duty to extend human life', *Space Policy* 27, 2011, p. 191.

¹⁴⁵ Pop, *Space Policy*, p.275

Since little progress is made in the realm of international space law, States are increasingly focused on the development of national space laws and policies instead¹⁴⁶. Because States find themselves in different situations it is understandable that they seek legal solutions on a national level which fit their specific needs and requirements. Indeed, national legislation can deal with subjects not sufficiently covered by international space law. As shown above, Article VI and VII of the OST also recognise this need and unequivocally legitimise the development of national space law. It evidently goes without saying, however, that national policies should always be in line with existing international space law. Equally important is the notion that national legislation should not be used to fill in essential legal gaps in international law, and certainly not when it comes from a State that has actively blocked any international solution.

Now, the advent of NewSpace has come along with new private American companies that all have great ambitions in space. These commercial plans are of an unprecedented magnitude and naturally call for appropriate national legislation. Thence, the U.S. government has updated its commercial space legislation by means of the SPACE Act of 2015, which was signed by U.S. president Barack Obama on 25 November of the same year¹⁴⁷. This controversial law is aimed to facilitate commercial space endeavours by explicitly granting 'US citizens to engage in the commercial exploration and exploitation of "space resources", with examples including includes water and minerals'¹⁴⁸. They will be 'entitled to any asteroid resource or space resource obtained, including to possess, own, transport, use, and sell the asteroid resource or space resource'¹⁴⁹.

¹⁴⁶ Jakhu, *Advances in Space Research*, p. 1054.

¹⁴⁷ H.R.2262 - U.S. *Commercial Space Launch Competitiveness Act* (USA).

¹⁴⁸ K. Orphanides, 'Space Act of 2015: American companies could soon mine asteroids for profit', *Wired UK*, 12 November 2015, <http://www.wired.co.uk/news/archive/2015-11/12/how-to-mine-asteroids-for-fun-and-profit>, (accessed 8 June 2016)

¹⁴⁹ H.R.2262 s402.

Whether or not the Space Act of 2015 is in line with the existing body of international space law is very doubtful at best. In the most favourable case one can argue that extraction as foreseen by the Space Act does not violate any treaty since the States' right to explore and 'use' outer space, as granted by Article I of the OST, also includes economic use¹⁵⁰. In addition, the Moon Agreement does not say anything about exploitation prior to the establishment of the international regime, leaving room to argue that, for the time being, it is not prohibited¹⁵¹. However, exploitation of resources cannot occur without some kind of appropriation and this is where problems arise. A claim of ownership is likely to restart the discussion on the status of the Moon Agreement and its provision to establish an international regime once exploitation is about to become feasible¹⁵². More importantly though, is the fact that private ownership cannot exist without a superior authority, e.g. United States, conferring property rights. If the United States were to do this, it would violate the non-appropriation principle of the OST¹⁵³. All the stranger is that the act simultaneously stresses that 'the United States does not assert sovereignty or sovereign or exclusive rights or jurisdiction over, or the ownership of, any celestial body', and that all these activities will be carried out in accordance with U.S. international obligations¹⁵⁴. It is a clear case of a contradiction. Yet another problem is that the Space Act does not provide a regulating mechanism for conflicting claims over space resources. This, in combination with the expectation that the legislation will be challenged by other States, can result in a climate of political competition and even conflict in space¹⁵⁵. Consequently, the Space Act could end up jeopardising the

¹⁵⁰ Tronchetti, *Space Policy*, p. 2.

¹⁵¹ Tronchetti, *Space Policy*, p. 2.

¹⁵² Cooper, *Space Policy*, p. 116.

¹⁵³ Tronchetti, *Space Policy*, p. 3.

¹⁵⁴ H.R.2262 s402, s403.

¹⁵⁵ Sommariva, *Astropolitics*, p. 37.

peaceful nature of space, thereby violating the terms of the UN Charter¹⁵⁶.

Conceded the fact that international negotiations for a legal framework are costly and timely, the American aversion to create a binding international solution seems somewhat a self-fulfilling prophecy: without the will and determination to find a suiting and long-lasting solution, the latter is highly unlikely to come around. Oddly though, the current interpretation of the CHM-principle is much more geared towards free-market thinking as has been demonstrated above. As a result the United States is much better positioned in terms of bargain power than was the case at the time of drafting of the Moon Agreement. Despite this, the fear of a legal regime that would put some sort of equitable sharing of benefits has been in the ascendant all the same¹⁵⁷. The American private industry simply believes that unilateral action is more in their interest as it gives the possibility to operate on a first-come, first-served basis and obtain private property rights over space resources without the meddling of countries who do not conduct any space activities. Short-term goals clearly override long-term goals.

Going by the method of first-come, first-served will imply that it will be not long before vast amounts of extraterrestrial land, or at least the most profitable chunks of it, will be the private property of whichever big private player that happens to come first. In turn, this will not only drive property prices up, but will eventually result in monopolies and other anti-competitive practices that severely slow down the development of space resources. Such a scenario would not just violate OST by taking away the ability of all States to explore and use celestial bodies, it would run counter the interests of the same companies that lobby for it¹⁵⁸. Thus, there are a myriad of reasons to oppose

¹⁵⁶ F. Tronchetti, 'Private property rights on asteroids: Assessing the legality of the ASTEROIDS ACT', *Space Policy*, vol. 30, 2014, p. 194.

¹⁵⁷ Tronchetti, *Space Policy*, p. 5,6.

¹⁵⁸ Sterns and Tennen, *Advances in Space Research*, p. 2439.

unilateral action of any kind; from ideological, to legal and pragmatic reasons.

4.5 Conclusion

This chapter has evaluated several proposals from legal scholars to resolve the legal gap in international space law concerning the exploitation of natural resources on the Moon and other celestial bodies. The most viable option seems to renegotiate the Moon Agreement since it is already a ratified international treaty that at least sets out some basic criteria to which a future regime should conform without going too much in detail. Its Article 11 (5) moral obligation to start negotiations for a regulatory regime when the time has come essentially abates the need to start from scratch through negotiations for a completely new treaty. Whilst it is a valid concern that the bad reputation the Moon Agreement has earned over the decades might trump any enthusiasm to start renegotiations, if Tronchetti is right that the Moon Agreement does not equate to more than a mere *pactum de negotiando*, then, by his rules, the renegotiation of the Moon Agreement or the establishment of a whole new treaty are essentially the same choice. However, Tronchetti overlooks the important fact that the Moon Agreement does deal with fundamental issues like property and exploitation rights, thereby delineating some crucial criteria for a future regime. Adding this to the fact that the CHM-principle has become more market-friendly, the renegotiation of an already valid international legal document seems more achievable than starting the lengthy procedure of negotiating a wholly new treaty.

The alternative proposals to deal with the legal issue of resource management in outer space were merely showcased to strengthen the claim that an international legal framework is the only desirable, just and legally acceptable solution on the long run. In no way is it reasonable to prefer unilateral actions above multilateral action even if circumstances make the former seem more appealing in a first moment. In time it will show that an

international solution is indispensable for the orderly and peaceful development of outer space. Hence, it makes no sense to try to postpone the inevitable. Finally, as stated at the beginning of this chapter, it is concerning to note that environmental issues play a very marginal role in all proposals, unilateral and multilateral alike. The ecological agenda deserves attention not just to prevent that human activity in space will contribute to the creation of another ecological disaster here on Earth or a first one in space, but also because an ecological perspective could be the key to an international legal solution.

5. An Ecological Perspective

As seen in the previous chapters, the *corpus iuris spatiales* deals with environmental issues in a poor and incomplete manner. While this is certainly understandable for the OST and the Moon Agreement since they are products of the *zeitgeist* of the era they were created in, it does not mean that it is still acceptable in today's world. Now that the devastating effect humanity has on the natural environment becomes ever more apparent, nothing seems more important than taking mankind off the path to self-destruction. Therefore, the primary points of discussion on commercial extraterrestrial exploitation should be its potential positive ecological effect on Earth's environment and its contribution to ensuring a future for mankind off Earth. Hopefully a more ecological perspective will prove capable of overcoming the dilemma of how to align commercial plans with the interests of all mankind by concentrating foremost on the distribution of ecological benefits and burdens of exploitation.

However, to make such a narrative persuading a certain feeling of urgency is necessary. The best way to accomplish this is to give a factual overview of how mankind is negatively impacting the environment on Earth it so very much depends on to survive in the first place. For the immensurable role it plays in the bringing about of this imminent ecological disaster but above all for being the equivalent of its future extraterrestrial counterpart, this statistical analysis will concentrate on the mining industry here on Earth.

5.1 Impact of mining on the environment

The human species, by definition, is an exogenic factor on the environment. The ability to develop tools and artefacts from raw material has permitted mankind to bend its environment in order to make it fitting. This dependency on technology for survival and the impact it has had on the environment makes it reasonable to argue that mankind has always lived in a ‘technotope’, as opposed to a biotope. Fire control and the development of agriculture are good cases in point of how humans have turned previously untouched nature into land that served their needs. Over the course of just twelve thousand years the world population has grown from a mere four million at the end of the last glacial period to over seven billion today¹⁵⁹. Naturally, the production and consumption of goods have also sky-rocketed in this period and have even reached a point where some scientists are convinced that mankind’s influence on the global environment is greater than the other way round, marking the beginning of a new epoch named the “Anthropocene”¹⁶⁰. Characterising for this epoch will be how mankind copes with the far-reaching effects of societies’ structures on the global environment. Will environmental sustainability be effectuated when it becomes an increasingly important requirement not just

¹⁵⁹ S. Norra, ‘The biosphere in times of global urbanization’, *Journal of Geochemical Exploration*, vol. 147, 2014, p. 53.

¹⁶⁰ C. Waters et al., ‘The Anthropocene is functionally and stratigraphically distinct from the Holocene’, *Science*, vol. 351, p. 10.

for long-term survivability but also for mid-term survivability? Time will tell. For now, it is important understand what part the mining industry plays in the deterioration of the environment on Earth.

The total mineral production of 2014 was nearly 17,5 billion metric tons, an increase of more than 88 percent from 1984 when the total production amounted to 9,3 billion metric tons¹⁶¹. In the same period the world population grew with 52 percent from 4,8 billion to 7,3 billion, indicating that per capita production has also risen considerably¹⁶². The vast majority of these minerals, no less than 86 percent, however, are mineral fuels¹⁶³. With 106 908 ton, REMs only constitute 0,0004 percent of the remaining 14 percent, whilst PGMs, with 371066 ton just 0,001 percent¹⁶⁴. Due to their rarity and crucial importance to the economy, these commodities are extremely valuable, making them, amongst Helium-3, the first and most obvious targets to mine in outer space for the Earth market. Understandably, one will rightfully question the minimal positive ecological impact the replacement of these commodities by extraterrestrial ones will have, but that is not the point here. What matters is that this first small-scale exploitation of celestial bodies will enable the development of a full-scale extraterrestrial mining industry that can replace much more weighty commodities such as iron which has an annual production of more than 1,5 billion tons¹⁶⁵. Moreover, mining extraterrestrial Helium-3 will eventually pave the way for nuclear fusion, a sustainable alternative for the most gravest of all; fossil minerals. Since the deteriorating effects of the latter are more known it is interesting to show the impact the rest of the mining industry has on nature.

¹⁶¹ C. Reichl, M. Schatz, G. Zsak, 'WORLD-MINING DATA', *International Organizing Committee for the World Mining Congresses*, vol. 31, 2016, pp. 27-28.

¹⁶² United Nations Department of Economic and Social Affairs, *Population Division (2015): the 2015 Revision*, World Population 2015.

¹⁶³ Reichl, Schatz and Zsak, 'WORLD-MINING DATA'. p. 28.

¹⁶⁴ Reichl, Schatz and Zsak, 'WORLD-MINING DATA'. pp. 28, 40, 104.

¹⁶⁵ Reichl, Schatz and Zsak, 'WORLD-MINING DATA'. pp. 43.

As one may expect, non-mineral fuel mining activities are a major cause of the massive degradation of ecological systems all around the world, not to mention the combined amount of greenhouses gasses that are pumped into the atmosphere as a result of it, and that considerably contribute to a well-known global accumulative environmental effect; global warming. Hard-rock mining has been identified as the economic activity that causes the most toxic waste of all economic activities, just to make a point¹⁶⁶. Also, the mining of REMs is pretty notorious for the fact that many REM-bearing ores contain traces of thorium, uranium or both, possibly leading to unwanted radioactivity¹⁶⁷. Due to the oftentimes difficult accessibility of the commodity or to its low concentration in absolute numbers, the process of extraction is generally very wasteful in terms of energy and additional resources such as chemicals and water it requires, let alone the both direct and indirect degradation it inflicts upon other resources present in and around the mining site¹⁶⁸. Mining causes some temporary environmental impacts such as dust, noise affections and blasting effect¹⁶⁹. It also causes longer environmental impacts that range from the erosion of landscapes and fragmentation of natural environments, in part induced by the necessary infrastructure for the transport of commodities such as access roads and railways, to the full-scale physical destruction of natural habitats¹⁷⁰. However, the detrimental effects of uncontrolled mining are in many cases not only long-lasting but accumulative as well, which is very good illustrated by the depletion of water reserves. Water is used for mining itself but also for the chemical processing of ores by which it is followed. Therefore, the larger the supply of water that is

¹⁶⁶ D. Vela-Almeida, G. Brooks, N. Kosoy, 'Setting the limits to extraction: a Biophysical approach to mining activities', *Ecological Economics*, vol. 119, 2014, p. 189.

¹⁶⁷ Kamenopoulos, Shields, Agioutantis, *Rare Earths Industry*, p. 94.

¹⁶⁸ Vela-Almeida, Brooks, Kosoy, *Ecological Economics*, p. 190.

¹⁶⁹ J. Castilla-Gomez and J. Herrera-Herbert, 'Environmental analysis of mining operations: Dynamics tools for impact assessment', *Minerals Engineering*, vol. 76, 2015, p. 89.

¹⁷⁰ A. Durán, J. Rauch, J. Gaston, 'Global spatial coincidence between protected areas and metal mining activities', *Biological Conservation*, vol. 160, 2013, p. 273.

available in a mining site is, the higher the rate of mining can be. The production of one kilogram of gold, for example, needs on average no less than a staggering 691 litres¹⁷¹. The most problematic about the high amounts of water consumption is the fact that it takes away one of the building blocks of any well-functioning ecology¹⁷². And water deficiency will inevitably result in ecological damage. What makes things worse is that mining sites pollute the environment by flows of toxic metals derived from the ore treatment. This heavy metal contamination, often called acid mine drainage, is particularly disturbing since it can enter water stocks and thereby enter all parts of an ecosystem; it can bio-accumulate in crops, plants, herbivores and eventually even in humans¹⁷³. Even more alarming is the fact that years after a mine site has ceased its operations, untreated toxic waste pile-ups can still make its way into the ecosystem¹⁷⁴.

There exists a so-called tipping point beyond which the environmental cumulative effects will irreversibly damage the regenerative capacity of a natural environment, resulting in a permanent negative impact¹⁷⁵. It will be impossible to recuperate these environments to their original conditions¹⁷⁶. This is especially concerning if one takes in mind the overlap or vicinity between mining sites and special protected areas, and the inevitable nefarious effects that will result from it. Terrestrial protected areas play an invaluable role in preserving biodiversity on a local, regional level and even global level and their contamination, therefore, can have global accumulative effects. Despite this, seven percent of all mines in core commodities like iron, zinc, aluminium and copper, lie within protected areas, with an additional 27 percent located on less than ten kilometres from

¹⁷¹ Vela-Almeida, Brooks. Kosoy, *Ecological Economics*, p. 191.

¹⁷² Vela-Almeida, Brooks. Kosoy, *Ecological Economics*, p. 191.

¹⁷³ Vela-Almeida, Brooks. Kosoy, *Ecological Economics*, p. 191.

¹⁷⁴ Vela-Almeida, Brooks, Kosoy, *Ecological Economics*, p. 191.

¹⁷⁵ Vela-Almeida, Brooks, Kosoy, *Ecological Economics*, p. 192.

¹⁷⁶ N. Larondelle & D. Haase, 'Valuing post-mining landscapes using an ecosystem services approach - an example from Germany', *Ecological Indicators*, vol. 18, 2012, pp. 573.

a protected area¹⁷⁷. And when all combined they cover close to 14 percent of all protected areas worldwide¹⁷⁸. The contamination or the annihilation of these protected areas due to mining activities is most worrying for endemic species which frequently depend on specific environmental conditions to survive. The drastic alteration of their habitat can eventually endanger them to the point of extinction, resulting in an irreversible loss of biodiversity. The increased demand for mineral resources, the rise in mineral prices seen over the decades, and the development of new exploitation technologies allow for the exploitation of previously unattractive or non-viable deposits¹⁷⁹. And it does not take an expert to figure out this will lead to the degradation of new ecosystems around the world, and that protected areas are likely to get struck hard as well¹⁸⁰.

More environmental conflicts about mining activities are to be expected as well. This comes on top of the 250 active conflicts that are already going in this very moment, mainly in Latin America¹⁸¹. Indeed, mining activities are not necessarily benefitting the local communities even though they undoubtedly create jobs. The deteriorating effects mining has on the local ecosystems naturally carries a socio-economic dimension too. As aforementioned, mining activities are aimed at exploiting a specific resources, but in the process also end up, both directly and indirectly, degrading other resources. The socioeconomic environment can and often is very much disadvantaged by the presence of a mining site. In case the diminishing quality of air and water does not pose a sizeable threat to the general health of a community living nearby, the indirect effects on agriculture and fishing frequently will¹⁸². A closer look at the map reveals that nearly two-third of all mining activities, including those for fossil

¹⁷⁷ Durán, Rauch, Gaston, *Biological Conservation*, p. 272.

¹⁷⁸ Durán, Rauch, Gaston, *Biological Conservation*, p. 272.

¹⁷⁹ Durán, Rauch, Gaston, *Biological Conservation*, p. 276.

¹⁸⁰ J. Martinez-Alier et al, 'Social metabolism, ecological distribution conflicts, and valuation languages', *Ecological Economics*, vol. 70, no. 2, 2009, pp. 156–158.

¹⁸¹ *Environmental Justice Atlas*, [website] <http://ejatlas.org/>, (accessed 18 August 2016).

¹⁸² J. Toro et al., 'A qualitative method proposal to improve environmental impact assessment', *Environmental Impact Assessment Review*, vol. 43, 2013, p. 12.

fuels, take place in countries that are either unstable or outright dangerous, and that around 60 percent of all mining operations are located in developing countries, including the least developed ones¹⁸³. It may not come as a surprise then that a negative correlation between the economic development of a country and its deposits of natural minerals and fuels exists; the so-called ‘resource curse’¹⁸⁴. In the case of petroleum, in fact, it has already been proven that a country’s wealth in this natural resource has at least three adverse outcomes; it generally makes authoritarian regimes last longer, it creates a fertile ground for various forms of corruptions, and it heightens the chance of violent conflicts in low- and middle-income countries¹⁸⁵. As mentioned at the beginning of this dissertation, already dozens of civil wars over the control and local access to natural resources have stricken the developing world, and with the current outlook it is no less than sad to know that many more conflicts are expected to emerge in future.

But what is the current outlook if one takes all the stated facts in mind and combines these with an expected increase in mining activities? Well, it is rather dim. Predominantly the natural environments of developing countries will be the ones suffering most of expanded activities, while evidence suggests that ecosystems of poor countries will also be hit hardest by global warming and the ongoing climate change¹⁸⁶. Put together, these two will most likely turn the ecosystems of developing countries into the first candidates to reach a permanent stage of no-recovery. To make things worse; the poor and more rural populations of developing countries are more directly dependent

¹⁸³ Reichl, Schatz and Zsak, ‘WORLD-MINING DATA’. pp. 24, 27.

¹⁸⁴ A. Venables, ‘Using Natural Resources for Development: Why Has It Proven So Difficult?’, *Journal of Economic Perspectives*, vol. 30, no. 1, 2016, pp. 161-162.

¹⁸⁵ M. Ross, ‘What Have We Learned about the Resource Curse?’, *Annual Review of Political Science*, vol. 18, 2015, p. 239.

¹⁸⁶ F. Harvey, ‘Global warming will hit poorer countries hardest, research finds’, *The Guardian*, 17 May 2016, <https://www.theguardian.com/science/2016/may/17/global-warming-will-hit-poorer-countries-hardest-finds-research>, (accessed 19 August 2016).

on the local ecosystems to survive¹⁸⁷. In case their environment fails on them, they lack the purchase power to import products they can no longer produce themselves. Because the local population is perforce bound to their territory, their future and hopes are ultimately entangled with the future of the environment they live in.

5.2 The Environmental Impact Assessment

In all this apparent bleakness, some beacon of light exists though: the Environmental Impact Assessment (EIA). By the International Association for Impact Assessment (IAIA) it is described as ‘the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made’¹⁸⁸. The essential purpose of EIAs is to make sure proposed plans will not put human welfare and the conservation of ecosystems at risk. After all, a clean and a safe environment is a basic need for all humans, not some kind of luxury good¹⁸⁹. It is, therefore, odd that no one has managed up to this day to include an environmental notion into the United Nations Charter of Human Rights, despite all the efforts made.

At any rate, regardless of its noble and ambitious goal, the effect of EIAs is still rather undecided. For one thing, EIAs have turned out be very versatile in practice because they are effectuated by qualitative methods¹⁹⁰. This has the negative consequence, however, that in spite of its widespread use there exists no global unified approach, making quantitative research about its effectiveness difficult. More than that, it also makes EIAs more vulnerable to other interests at play. In the United States, for example, EIAs oftentimes occur too late in the decision-making process when irrevocable choices have already

¹⁸⁷ J. Martinez-Alier, ‘The environmentalism of the poor’, *Geoforum*, vol. 54, 2014, pp. 240-241.

¹⁸⁸ *International Association for Impact Assessment*, [website], 1999, http://www.iaia.org/uploads/pdf/principlesEA_1.pdf, (accessed 19 August 2016).

¹⁸⁹ Martinez-Alier, *Geoforum*, p. 240.

¹⁹⁰ Toro et al., *Environmental Impact Assessment Review*, p. 9.

been taken, thereby unnecessarily foreclosing sustainable sound alternatives and possibly overshooting the whole mark of the EIA of guaranteeing a sustainable development and of giving communities a voice in that process¹⁹¹. Asking oneself why the solution in the form of an uniform and rigid EIA approach and procedure has not come around yet, it may be useful to consider the fact that mining companies have a great deal of influence on the whole EIA process. It may very well be the case that because it is against their interest to have their proposals thoroughly assessed, an uniform approach has not been introduced yet nor is to be expected anytime soon either. This is a particularly troubling fact for affected communities in less developed countries, given their strong dependence on effective instruments to organise a meaningful opposition against the powers of multinational mining companies. The EIA should have been their empowering instrument towards human welfare and social justice. Without giving communities the chance to have a say and without a response to their call for transparency and accountability as much as for environmental justice of poor people, companies should not be surprised to lose their social licence to operate¹⁹².

Another frequent critique strongly connected to the lack of a standardised approach is that EIAs are always focused on site-specific environmental impact, and thereby negate the greater impact mining sites have on regional and global scale¹⁹³. Notions of biodiversity and climate change have not yet been included either. The ultimate outcome is that the wide variety of EIAs, as used today, are unfit to provide a broader and comprehensible view of how the mining industry is affecting the environment locally and globally, how these effects are being mitigated, and how these effects could be better mitigated.

¹⁹¹ A. Steinemann, 'Improving alternatives for environmental impact assessment', *Environmental Impact Assessment Review*, vol. 21, 2001, p. 3.

¹⁹² Kamenopoulos, Shields, Agioutantis, *Rare Earths Industry*, p. 92.

¹⁹³ S. Zidonienė and J. Kruopienė, 'Life Cycle Assessment in environmental impact assessments of industrial projects: towards the improvement', *Journal of Cleaner Production*, vol. 106, 2015, pp. 533-534, 539.

Different ideas have been proposed to overcome the EIA's flaws, specifically those related to the lack of quantifiable values and a standard criterion. Examples are the inclusion of a Life Cycle Assessment, of the concepts of biodiversity and climate changes¹⁹⁴, the reduction of the vulnerability of environmental factors or more focus on the potential environmental impact of proposed activities¹⁹⁵. Yet another proposal is to give more attention to the evolution of environmental impacts over time; i.e. the inclusion of so-called environmental accumulative effects¹⁹⁶. Regardless of these ideas, the key point remains that terrestrial mining will always lead to ecological loss, even if the EIAs are globally standardised and all proposed improvements are implemented. A good case in point is the mining industry's successful attempt to innovate in order to increase efficiency and reduce the amount of resources used and the amount of waste generated. Whilst efficiency improved, that same efficiency enabled a higher production, and thus higher profitability, eventually making sites previously viewed as unattractive and undesired because of their low mineral content suddenly financially interesting. As a result, the actual environmental impact per unit of output did not necessarily decrease and in some cases even went up¹⁹⁷. It shows that the final effect of measures deemed as improvements can actually run counter to its original intentions. Well now, one could argue that the precautionary principle should be honoured more frequently. However, the worldwide hunger for mineral resources self-evidently gets priority over the known environmental damage it causes, as well as over the yet unknown or disputed damage. Upcoming countries understandably try to emulate life standards of affluent countries, which will only result in a higher demand of commodities and bigger ecological loss.

¹⁹⁴ Zidonienė and Kruopienė, *Journal of Cleaner Production*, pp. 538-539.

¹⁹⁵ Toro et al., *Environmental Impact Assessment Review*, pp. 9, 13-14. .

¹⁹⁶ Castilla-Gomez and Herrera-Herbert, *Minerals Engineering*, pp. 89, 95.

¹⁹⁷ Vela-Almeida, Brooks, Kosoy, *Ecological Economics*, p. 190.

In sum, one can conclude that it is unrealistic to expect that the mining industry will significantly lower its enormous ecological footprint in the foreseeable future, despite all efforts to achieve the contrary. Landscapes will thus continue to be transformed to the point that recuperation to the original conditions has become impossible, worsening the global accumulative effect of the mining sector as well as disadvantaging local communities.

5.3 The Extraterrestrial Environmental Destination Plan

The purpose of the former two paragraphs is twofold; first, to show the incredible damage done to the environment by the terrestrial mining sector; and second, to demonstrate the difficulties that arise from efforts to reduce the environmental impact. Together they reveal the incontestable fact that environmental degradation, per definition, is an indelible aspect of terrestrial mining. The ultimate risk that the global accumulative effect of terrestrial mining poses urges to look for solutions.

In this light the alternative of extraterrestrial mining becomes all the more compelling. With a sustainable transport system to outer space in place, it has the potential to reduce or even take away the ecological pressure of terrestrial mining¹⁹⁸. The decreased environmental impact would also enable the recovery of agriculture and would give affected communities the chance again to benefit from the ecosystems they live in. Additionally, it would also lessen the chance of resource-related conflicts. It is, therefore, indisputable that extraterrestrial mining, on short-term but especially on long-term, is better from both an ecological and socio-economic point of view.

By no means, however, should these findings be interpreted as a blank cheque for the encouragement of

¹⁹⁸ Although no such a vehicle exists of today, several theoretical concepts have been developed and are being researched by space agencies and companies. See: A. Gohardani et al., 'Green space propulsion: Opportunities and prospects', *Progress in Aerospace Sciences*, vol. 71, 2014, pp. 128-149.

unbridled extraterrestrial exploitation. Not in the last place because the international treaties discussed above would not allow for it, but also because the previous two paragraphs have demonstrated what happens when the preservation of the environment does not get the attention it so very much deserves. In this light the EIA as much as its current shortcoming are particularly interesting for they can give guidance as to how future extraterrestrial exploitative activities should be conducted. The introduction of a so-called Extraterrestrial Environmental Destination Plan (EEDN) for future exploitative space activities makes sense.

5.3.1 Is space an environment?

The consideration of an EEDN immediately brings up a more fundamental question that needs answering: is the space environment a true environment in the sense that it has intrinsic value? There are, grosso modo, two approaches to the space environment. The first one is to consider it a phenomenon for humans to exploit; a means to improve the conditions of people. It is the so-called frontier narrative or development model. The second one is to consider it an environment in the truest meaning of the word; astro-environmentalism. According to the latter approach extraterrestrial environments deserve the same ethical treatment as their terrestrial counterparts should receive. Hence, it calls for environmental ethics to be expanded to outer space¹⁹⁹. To phrase it differently; outer space should be treated like a wilderness that needs to be protected and preserved just as the wilderness on Earth.²⁰⁰ In essence, it is not far from the view that outer space has a big sign 'do not touch' written on it. This is reinforced by the fact that astro-environmentalism supports the idea that the space environment is worth protecting for its own

¹⁹⁹ S. Reiman, 'Is space an environment?', *Space Policy*, vol. 25, no. 2, 2009, p. 80.

²⁰⁰ L. Billings, 'How shall we live in space? Culture, law and ethics in spacefaring society', *Space Policy*, vol. 22, 2006, p. 252.

sake; in other words, it has intrinsic value²⁰¹. Although this view sounds pretty respectable, it is hard to sustain for the following reason: the space environment thus far seems absent of life. Whereas good arguments exist for assigning intrinsic value to sentient beings, the same cannot be said for lifeless matter. Since dead matter knows no feelings, experiences or thoughts it cannot possibly have any interests. Therefore, it cannot have intrinsic value in any other form than as an expression of human's subjectivity. Humans may find the preservation and protection of the space environment very important for aesthetic, philosophical or altruistic reasons but ultimately these are nothing more than the expression of human interests.

As opposed to the wilderness rationale, the frontier narrative or development model tends to view outer space predominantly from a point of view of human interests, which makes more sense²⁰². It is a grave mistake to presume these interests are perfectly aligned with commercial short-term interests though. It is solely the admission that humans live in the first place for their own sake. Therefore, as aforementioned, the development model regards the space environment as a phenomenon for humans to exploit; a means to improve the conditions of people. Taking this anthropocentric view as the point from departure the next thing to determine is how to prioritise all different human interests in the space environment. A categorisation between short- and long-term interests seems no more than logical.

5.3.2 The purpose of the EEDN

The main purpose of the EEDN is to determine first the long-term destiny of a specific space environment, thereby carefully balancing all the human interests involved, after which it is decided whether or not a proposed plan for exploitation fits

²⁰¹ M. Williamson, 'Space ethics and protection of the environment', *Space Policy*, vol. 19, 2003, p. 86.

²⁰² Reiman, *Space Policy*, pp. 81-83.

within this picture. After all, our ability to explore and exploit outer space brings with it the ability to pollute, degrade and even destroy aspects of it²⁰³. Therefore, it is imperative that this question is dealt with in advance lest mankind repeats in outer space the past mistakes on Earth of underestimating the cumulative and long-lasting environmental effects of its actions²⁰⁴. A relevant example in outer space is the increasing problem of space debris in the geosynchronous- and low Earth orbit. It concretises how the lack of a forward-looking policy can allow for the negligence and even endangerment of long-term global interests in favour of short-term commercial interests; just as happened to the environment on Earth. Therefore, solely if it turns out that a space environment does not serve any scientific, aesthetic, touristic, more important commercial or human expansionist purposes now or in future, its permanent alternation or even destruction due to human activities can be legitimised. Although this may come across as radical, one may not forget that the long-term survivability of the human race is far less dependent on the space environment than on the terrestrial environment. And indeed, the space environment is primarily important to the degree to which it can serve mankind, sometimes entailing the complete depletion of it as the best way to further the human long-term agenda. Quite obviously, however, this is not always the case since most environments serve other purposes too.

The value of the EEDN lies in the fact that it compels proposed exploitative plans to fit into the long-term destiny of an environment. To give the particular case of the Moon as an example. The Moon is part of the Earth-Moon system and plays an indispensable role in Earth's ecology and ultimately in our survival on planet Earth. As such, every planned exploitative

²⁰³ M. Williamson, 'Protection of the space environment: the first small steps', *Advances in Space Research*, vol. 34, 2004, p. 2338.

²⁰⁴ W. Kramer, 'Extraterrestrial environmental impact assessments: A foreseeable prerequisite for wise decisions regarding outer space exploration, research and development', *Space Policy*, vol. 30, 2014, p. 216.

activity on the Moon can in no way threaten to disrupt the existing balance of this system. Furthermore, the sight of the Moon has also cultural and aesthetic value and therefore deserves certain preservation. The assignment of certain environmental protected areas on the Moon would be not too far-fetched at all²⁰⁵. In the case of Mars the fact it can be regarded as the most probable place for human settlement makes that any proposed exploitation activity ought not endanger this higher goal in any way. Another crucial example are space environments that potentially harbour alien life. The scientific value of such a discovery easily overrides all other interests. The shortcomings of the current EIA demonstrate the importance of an upfront unified approach for an EEDN to guarantee its effectiveness. To make sure that the body that executes EEDNs is as neutral and objective as possible, it should be appointed internationally. How the exact details of the EEDNs and its implementation are is beyond the purpose of this dissertation.

5.3.3 EEDN's accordance with international space law

When considering the viability of the EEDN a necessary question to ponder is its legality with reference to the existing space treaties. Article IX of the OST and article 4 and 7 of the Moon Agreement spring to mind for their environmental notions. As just discussed, in some cases the plain destruction of certain space environments seems justifiable, but how can this be reconciled with the notions of 'harmful contamination' and 'adverse changes', and with the notion of the 'disruption of the existing balance of the environment'? Since it has just been opined that the space environment lacks intrinsic value and only possesses value to the extent mankind assigns value to it, the terms 'harmful' and 'adverse' can only imply the interference with certain human interests. Indeed, is it legit to speak of contamination in environments where there is nothing to be

²⁰⁵ D. Livingstone, 'A code of ethics for conducting business in outer space', *Space Policy*, vol. 19, 2003, p. 94.

harmfully contaminated to begin with²⁰⁶? For instance, the total exploitation of asteroids in a specific environment will happen for commercial and/or scientific interests, but the transformation it causes to the environment will naturally run counter aesthetic or touristic interests. So, it will only be a harmful contamination insofar as these latter interests are not served by it. The same is true for the ‘disruption of the existing balance of the environment’. In case the existing balance on Mercury, for example, is disrupted one could only oppose it on grounds of various human interests. The three environmental notions, therefore, probably make the most sense when they are applied to long-term human interests²⁰⁷. In this way they are also much easier compatible with the EEDN which is also predominantly preoccupied with the long-term implications of proposed activities. And naturally the conclusion of an EEDN will more than rarely be that the proposed plans to exploit a certain area will too much jeopardise the long-term interests in that same area; in other words, that the proposed plans will change the area adversely with respect to long-term interests of overriding importance.

Article 4 of the Moon Agreement is also of particular relevance not just for the restating of the terms ‘province of all mankind’ and ‘for the benefit and in the interests of all’ of article 1(1) of the OST which will be discussed here below, but also for the obligation it creates to pay interest to present and future generations; the so-called appeal to intergenerational equity. The duty to preserve the space environment in such a way as to not jeopardise the future for generations to come can be perfectly reconcilable with the concept of EEDN as they both aim to safeguard the long-term human interests above all. And

²⁰⁶ Reiman, *Space Policy*, p. 82.

²⁰⁷ As shown in this chapter, the certain absence of life in certain space environments suggests there are no grounds to even make the case for altruism. Without life, there is nothing other than human interest that can suffer from ‘adverse changes’ or ‘contamination’ in certain space areas. However, in the case of potential life such as on Mars, an altruistic argument has some ground and as long as this argument itself falls under a human interest, the EEDN should be perfectly capable of including it.

sometimes the safeguard of those long-term interests paradoxically entails the depletion of specific space environments with the aim to lessen the ecological pressure on Earth.

To conclude, the space environment has no intrinsic value and can be best regarded as a means to improve the conditions of people on Earth and in outer space, and both on short- and on long-term. Any plan to exploit mineral resources on celestial bodies in outer space shall be preceded by a EEDN which first determines the long-term destiny of the targeted area, and then assesses if the proposed plan tallies with it. Also, the environmental notions of the OST and the Moon Agreement should be seen in the same light, thereby principally focusing on how the environmental effects caused by exploitative activities relate to long-term human interests.

5.4 How to make a future regulatory regime just

Whilst the EEDN is certainly a prerequisite to an orderly and fruitful development of the extraterrestrial mining sect, it needs a wider regulatory framework to be effective. This latter will have to be in accordance with the existing space treaties, and hence, has to respect the criteria laid out in the Moon Agreement²⁰⁸. It will have to find a compromise between the right of use and exploration of outer space and the duty to carry these out for the benefit and in the interests of all countries, particularly those less affluent. Just a compromise will not suffice; only a compromise that is acceptable to both developing- and developed countries, and to spacefaring nations and non-spacefaring nations alike²⁰⁹. Not at all an easy task, testified by the persistence of the legal lacuna despite all efforts and proposals to close it.

²⁰⁸ Chapter four has demonstrated why unilateral actions or actions that are not in accordance with the existing body of space law will ultimately be against the interests of everyone, including the very companies or states that seem to be in favour of it in present time.

²⁰⁹ As has been shown in previous chapters, finding an acceptable solution to the legal gap is not at all an easy task. Although several reasonable proposals have been put forward in recent years, none of these have been adopted. See chapter four.

As chapter four has evidenced, most scholars approach this dilemma from a predominantly economic point of view, resulting in proposals with solutions equally focused on economic gains. While this line of reasoning makes sense from a State-perspective, paragraph 5.1 has demonstrated that transnational problems can only be solved by solutions that derive from transnational thinking, not national thinking. From this follows that the legal gap concerning extraterrestrial exploitation can only be sealed by a forward-looking international solution that focuses on the benefit of all mankind, and not just on the economic benefits for certain states²¹⁰. Specified to this case, it means foremost environmental benefits, or ecological benefits if you will. Indeed, one cannot simply ignore the potential of extraterrestrial mining to take the ecological pressure of human activities off Earth. Therefore, the environmental problems associated with terrestrial mining cannot be seen separately from the solution that extraterrestrial mining offers for these problems²¹¹. If this environmental alleviating potential is linked to the fact that extraterrestrial mining is, per definition, a global affair, the demand for not just an international regulatory regime, but one that integrates environmental objectives; in other words, one that recognises the complex relation between mankind and its dependence on the environment, both terrestrial and extraterrestrial, is self-evidently justified. Paradoxically, however, the objective to preserve the environment on Earth might call for the annihilation of certain space environments.

²¹⁰ UNCLOS III immediately springs to mind as it reconciles economic interests of both developing- and developed nations. However, these interests were predominantly economical and very much State-centred. Nonetheless, it illustrates that global affairs are best dealt with in an international manner. Looking at the case of both terrestrial- and extraterrestrial mining and their connection to the global environmental crisis, it should be clear by now that global problems like these are naturally best solved by global solutions.

²¹¹ The ever growing degree of interconnectivity of today's world shows that real solutions for global problems are only those that pay attention to this notion. Therefore, it seems logical to connect the opportunities offered by extraterrestrial mining to the environmental problems caused by terrestrial mining. Indeed, environmental policy integration $\neg$ the process of placing environmental considerations at the heart of decision-making in policies of other sectors $\neg$ is the best way forward. For successful examples see: *Institute for European Environmental Policy*, [website] <http://www.ieep.eu/>, (accessed 16 October 2016).

Here the EEDN should play a role to ensure no hasty and ill-considered endeavours are undertaken that run counter long-term global interests in space environments.

Although a proposal for an international legal solution geared towards the ecological benefits makes sense from a global perspective, it has to make sense from a state-centric perspective as well. After all, what is in the interest of all mankind may very well be against the interest of certain countries. As aforementioned, industrialised nations have always been particularly against the idea of the active sharing of benefits whilst developing nations have been left embittered over the fact that they have never seen their wish to participate in space activities as well as to actively benefit thereof realised. Similarly, the rise in material wealth of industrialised nations has inflicted ecological damage all around the globe, and above all in developing countries. While industrialised countries have almost exclusively enjoyed the economic benefits from their mining activities on Earth, developing countries have suffered grand ecological losses from it, not to mention the socio-economic damage discussed in paragraph 5.1.

Looked at this way, the replacement of mineral resources from Earth by extraterrestrial ones is nothing but gains, so it seems. Western and Chinese companies would reap the economic benefits from extraterrestrial mining, while the world as a whole and especially developing countries would benefit from it ecologically. It would even be in line with article 1 of the OST and, to some extent, with the principle of equitable sharing of article 11.7 of the Moon Agreement. However, it would have a small chance of being accepted by developing countries for the reason that it does not give them any significant economic benefits, nor does it give them a fair chance to participate in outer space activities. Moreover, it would not pay due regard to the historical ecological debt of the developed nations. These have the longest history of pollution and even though a

considerable amount of this pollution has occurred under conditions of excusable ignorance, it has led to an even bigger discrepancy of global wealth distribution²¹².

To compensate, a global ecotax could be introduced on all terrestrial mineral resources extracted from a point in time onwards. Since the vast majority of mining companies come from industrialised nations, and most mineral resources are consumed in industrialised nations as well, it would repay their historical debt. The money raised from this tax could be put in an internationally managed fund that invests in ecological mitigation, recycling technologies and adaptation to climate change. Under which department or office of the United Nations the fund should fall and how it should operate exactly will not be discussed in this thesis. The ecotax would not only begin to reflect better the ecological price society pays for mineral resources, the increase in mineral prices would also encourage the development of recycling technologies. Nonetheless, if an ecotax really wants to inspire its goal it has to be even more ambitious. As abovementioned, the world population and the consumption of mineral resources will both rise to a point where it inevitably leads to increased terrestrial mining, no matter how much resources will be recycled. Therefore, the only possible way to truly minimise the ecological impact of terrestrial mining is by replacing it with extraterrestrial mining. However, one big obstacles stands in the way: transport to outer space is still utterly polluting in terms of greenhouse gas emissions, making it therefore unsustainable and ecologically irresponsible.

Until this changes the actual realisation of current plans for exploitations should not be allowed, or at least strongly discouraged. Quite oddly though, this fact does offer the perfect possibility to bind the terrestrial mining industry with the future extraterrestrial mining industry in such a way as to make it

²¹² G. Duus-Otterstrom, S. Jagers, 'Identifying burdens of coping with climate change: A typology of the duties of climate justice', *Global Environmental Change*, vol. 22, 2012, p. 750.

acceptable for both developed- and developing nations. If the international fund initiated through the ecotax also invests in the development of eco-friendly space launch systems, new ecological damage inflicted by continued terrestrial mining would directly pay for the development of a sustainable alternative. And if the development of these transport systems would happen in an international context $\cap$ meaning that knowledge would be actively shared $\cap$ it would also give developing nations the opportunity to participate in space activities. In the end, everyone, and in particular developing countries, would enjoy the indirect ecological benefits derived of extraterrestrial mining as well as the direct ecological benefits from mitigation and adaptation measures. The international effort to develop a sustainable and clean space launch system would give developing countries the opportunity to participate and build up an own space industry, while developed nations, with all their finances disposable, would still be the first to actual conduct and profit from extraterrestrial exploitation. Also, the EEDN would ensure an international management of the natural resources in outer space.

5.5 Conclusion

In this chapter the full scale of the ecological footprint of the terrestrial mining sector has been demonstrated. It has been shown that the degradation to local, regional and even global ecosystems because of mining is increasing overtime and that the global accumulative effect can reach the point beyond which there is no easy return, supporting the hypothesis that a new epoch named the Anthropocene has begun, in which the human influence on Earth's nature has become greater than the other way round. The mining industry also has negative socio-economic consequences that are especially nasty for developing countries which are already hit hardest by the environmental impact of mining and by the climate change caused by global warming. Therefore, the fact that the per capita consumption of

mineral resources as well as the world population have grown considerably and that this trend is not likely to change any time soon, should raise much concern.

The survival of the human species as much as its wellbeing continue to truly depend on the preservation of the ecosystems on Earth. The EIA, the current effort to mitigate the environmental impact of mining activities, is insufficient because of its lack of a globally unified approach. This makes comprehensive details about the actual environmental impact of mining impossible and greatly reduces its effectiveness. Moreover, the EIA does not pay attention to the effect of mining on regional and global level; it ignores the global accumulative effect of mining. These deficiencies all call for a better approach but, together with the whole ecological crises on Earth, also serve as a learning lesson for the future Extraterrestrial Environmental Destination Plan. The main purpose of the latter is to determine, from a global perspective, the long-term destiny of a specific space environment, thereby carefully balancing all the human interests involved, after which it is decided whether or not a proposed plan for extraterrestrial exploitation fits within this picture.

Since the space environment has no intrinsic value it can only serve human interests. The environmental articles of the OST and the Moon Agreement can also be interpreted from this view of long-term global interests. As a result, the depletion of mineral resources in certain space environments can be justified as they can be imported onto the terrestrial market, thereby replacing terrestrial mineral resources and lessening the ecological pressure on Earth. An important remark, however, is that no technology for sustainable and clean space launch system exists and that in its absence extraterrestrial exploitation is ecologically irresponsible.

To solve the dilemma, the terrestrial mining sector will have to start paying an ecotax on mineral resources. The money raised

by this tax will go to an international fund which invests in the development of recycling technologies, the mitigation of the environmental impact of mining as well as the adaptation of ecosystems to climate changes, and to the internationally coordinated development of a sustainable and eco-friendly space launch system. Whereas the former two will make the mining sector repay the historical ecological burden of industrialised nations and limit its future ecological burden, the latter connects both mining sector by letting the terrestrial one help to make the extraterrestrial one reach its full positive ecological potential. In this way, everyone, and in particular developing countries, would enjoy the indirect ecological benefits derived of extraterrestrial mining as well as the direct ecological benefits from mitigation and adaptation measures. The international effort to develop a sustainable and clean space launch system would give developing countries the opportunity to participate and build up an own space economy, while developed nations, with all their finances disposable, would still be the first to actual conduct and from extraterrestrial exploitation without having to share the financial profits.

6. Conclusions

In this thesis it has been demonstrated how the unimaginable amount of natural resources in outer space $\neg$ contributing to the idea of relative scarcity instead of absolute scarcity of resources $\neg$ have the potential to be a part of the solution of the ecological crisis on Earth. Whilst current American commercial plans for the exploitation of these resources focus on in-situ resource utilisation and building up a space infrastructure, they will pave the way for the importation of extraterrestrial resources for the market on Earth. Selling extraterrestrial gold, metallic nickel-iron, cobalt and platinum group metals, rare earth metals and helium-3, would indeed reduce the incredible ecological as well as socio-economic damage caused by terrestrial mining, especially in developing countries. In order to reach this ecological potential, however, the development of an eco-friendly space launch system is required.

While in essence the advent of extraterrestrial exploitation should be a positive development, the current international space treaties do not establish an international regulatory regime, thereby creating an atmosphere of uncertainty in which a tendency is encouraged to revert to unilateral action and other less desirable alternatives. To understand the details of this legal gap a thorough examination of the current treaties was necessary. Therefore, the Outer Space Treaty of 1967, the Magna Carta of space law, was first analysed. It was shown how it grants the freedom of exploration and use of outer space, but couples it to the binding principle of non-appropriation, thereby establishing outer space as a *res communis*. However, unlike a *res communis* in the truest sense of the word, the OST also declares outer space to be the 'province of mankind', which translates to a moral obligation to conduct space activities for the benefit and in the interest of all countries, particularly the less affluent ones. Due to the fact that the OST is foremost a treaty of general principles, it does not contain any guidelines for the regulation of economic commercial activities aimed at exploiting the natural resources of outer space.

The Moon Agreement does deal with the regulation of extraterrestrial exploitation. Its article 11 declares the Moon and the other celestial bodies as well as their resources the Common Heritage of Mankind, without laying out the exact implications and details however. Although a few key issues like property and exploitation rights are dealt with, the Moon Agreement remains rather vague. As a matter of fact, it does not even establish a regulatory regime but only creates the moral obligation to negotiate one in future, when the time is right. Until that time it is not clear if there rests a moratorium on exploitation. In spite of its limited number of ratifications the Moon Agreement remains a legally binding treaty. Its little popularity is strongly linked to the fact that it is a compromise between two diametrically opposed views of how exploitation should come about.

Disenchanted with the outcome of the Moon Agreement and long-lasting frustration over Article I (1) of the OST triggered developing countries to propose a new treaty that would better reflect their interests. However, the fall of communism geared the world economy towards free-market principles. It outdated the NIEO theory and vanished all hopes of a more favourable treaty. Instead, the 1996 Space Benefits declaration was signed; a non-legally binding document that erodes the CHM-principle. This principle originally stood for the idea of internationally regulating an area outside of any national sovereignty to the furtherance of all of mankind in an equal fashion. But because it lacked a clear-cut definition has ultimately engraved the ideological differences between developing- and developed countries. Although the 1996 Space Benefits declaration acknowledges the special needs of developing countries and the importance of international cooperation, it swaps the obligatory character of transfer of technology and redistribution of space benefits for a voluntary character. Moreover, it does not answer the call to concretise the exact nature of the 'space benefits' mentioned in the OST and Moon Agreement.

This dissertation has also evaluated several proposals from legal scholars to resolve the persisting legal gap in international space law concerning the exploitation of natural resources on the Moon and other celestial bodies. While all proposals are different they are all characterised by the prevalence of economic thinking. As seen before, the Moon Agreement remains a legally binding treaty and for this reason the best proposal is to renegotiate it. Its Article 11 (5) moral obligation to start negotiations for a regulatory regime when the time has come essentially abates the need to start from scratch through negotiations for a completely new treaty. Moreover, the Moon Agreement does deal with fundamental issues like property and exploitation rights, thereby delineating some crucial criteria for a future regime.

The analysis of the *corpus iuris spatialis* also points out the very minor role given to environmentalism. Of course, taking in mind that the environmental movement only came to prominence in the 1970s this is understandable. Nevertheless, the scale to which mining on Earth degrades the natural environment and the insufficient attempts to reduce this impact by means of the IEA, not only makes the case for extraterrestrial exploitation stronger, but equally serves as a warning for how short-term commercial interests tend to dominate the discourse in absence of forward-looking policies. Therefore, this thesis has called for the instalment of a so-called Extraterrestrial Environmental Destination Plans which serves to avoid this scenario by determining, from a global perspective, the long-term destiny of a specific space environments target for exploitation. The few environmental articles contained in the OST and the Moon Agreement should therefore be interpreted from this view of long-term global interests. As a result, the depletion of mineral resources in certain space environments can be justified as they can be imported onto the terrestrial market, thereby replacing terrestrial mineral resources and lessening the ecological pressure on Earth.

However, a precondition is an eco-friendly space launch system which does not yet exist. Therefore, the terrestrial mining sector should start paying an ecotax over the natural resources they mine, which will be put in an internationally managed fund that invests in the development of such a technology through an international effort. By doing this, it will give developing countries the opportunity to participate and build up an own space economy, while developed nations, with all their finances disposable, would still be the first to actual conduct and from extraterrestrial exploitation without having to share the financial profits. To compensate this loss in economic benefits developing countries will enjoy the most ecological benefits from

extraterrestrial exploitation as their ecosystems as well as societies also suffer the most from terrestrial mining.

As such, it strikes a right balance between the right of use and exploration of outer space on one hand, and the duty to carry these out for the benefit and in the interests of all countries, particularly those less affluent, on the other. If countries take this ecological approach in mind a fruitful renegotiation of the Moon Agreement and the solution to the persisting legal gap in international space law should be attainable.

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