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Pella vilya: Near earth objects—Planetary defence through the regulation of resource utilisation ☆

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ABSTRACT

Reactions to near earth objects (NEOs) in the past decade have run the gamut from expectations of Armageddon-type scenarios to Eureka moments of revolutionary scientific ideas. Concerns over the potentially devastating effects of an unmitigated collision jostle with forecasts of untold economic returns from the utilisation of NEO resources. Drawing from recent analogies and examples from the field of international environmental law, this paper proposes the development of a legal framework for the regulation of NEO resource utilisation. The proposed legal framework also includes a mechanism to ensure the political will and economic investment necessary for technological advances in planetary defence. By twinning the threats and opportunities presented by NEOs, this paper also analyses the position of theme-specific space law development in the overall legal framework of space exploration and traffic management.

1. Introduction

Immense fascination has been generated by Near Earth Objects (NEOs) with public, commercial and scientific interest vacillating between the two extremes of Armageddon- and El Dorado-type scenarios. A catastrophic collision between the Earth and an NEO is a clear "low probability, high consequence event"[1] —while there has been no record of fatalities caused by such a collision, it is now undisputed that various NEO collisions in the past has led to mass localised and global destruction.[2] It must be noted that NEO collisions with the Earth is not a thing of the distant past. There have been several instances of large NEOs colliding with the Earth or exploding in the Earth's atmosphere in the last century, with one of the most significant collisions by a 60-meter asteroid in

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[1] M.B. Gerrard, A.W. Barber, Asteroids and Comets: U.S. and International Law and the Lowest-Probability, Highest Consequence Risk, New York University Environmental Law Journal 6 (1997) 4.

[2] The impact of a 10-kilometer-wide NEO at Chicxulub, Mexico, for example, left a 180-kilometer diameter crater. It has been argued that the impact of this NEO was one of the factors that caused the mass extinction at the end of the Cretaceous Period (approximately 65 million years ago). See W.F. Bottke, D. Vokrouhlicky, D. Nesvorny, An asteroid breakup 160 Myr ago as the probable source of the K/T impactor, Nature 449 (September 2007) 23; for an opposing view see G. Keller, et al., Chicxulub impact predates K–T boundary: new evidence from Brazos, Texas, Earth and Planetary Science Letters 255 (2007) 1.

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Tunguska, Siberia on 30 June 1908.[3] As of 31 August 2008, 208 NEO impact risks are listed by the website of the Near Earth Object Program of the United States' National Aeronautics and Space Administration (NASA).[4] Of these, only one asteroid 2007 VK_{184} is listed with Torino Scale 0,[5] with the other 207 listed as being equal or smaller than 50 m in diameter, and therefore of little or no threat to the general public.[6] However, without prompt preventive action, a large NEO is likely to collide with the Earth at some point, with catastrophic consequences.[7]

On the other hand, it has been demonstrated that NEOs are comprised of minerals that are extremely valuable for various applications.[8] With burgeoning costs of Earth-based resource acquisition and rapidly advancing space-oriented technology, NEO resource extraction and utilisation is fast becoming a reality. Aside from supporting space exploration, the large-scale acquisition and utilisation of resources from NEOs for Earth-based activities may soon become economically and technically feasible.

Presently however, there is a lacuna in the international legal framework with regard to NEOs. Aside from a blanket prohibition on appropriation of outer space,[9] including celestial bodies, there is no mention in any legal texts of NEOs. This is a dangerous void, as without a clear and consistent regulatory framework, there cannot be an effective development of technologies, scientific exploration, and economic policies with regard to NEOs. Coupled with the potential hazards of NEOs and the fact that capital investment into both the deflection and utilisation of NEOs will only be viable with a clear regulatory framework, the need for an enunciation of the international legal standards in this field is increasingly pressing.

A possible legal framework is proposed in this paper that twins the economic utilisation of NEO-extracted resources with the scientific research and development necessary for planetary defence against a possible collision. It is mooted that public funding into NEO deflection and planetary defence is unviable for a long-term, sustained effort. On the other hand, there is at present no legal framework regulating the utilisation of resources from NEOs. This paper makes the case for a comprehensive, doubly-dependent regulatory system, which combines the motivation from economic exploitation of NEO-extracted resources with the public good provided by deflection technologies. Economic policy instruments are proposed, based on an analogy from international environmental law, for a harmonised, integrated approach to NEO utilisation and planetary defence. The historical context relating to the international legal framework and the scientific and economic background of NEOs is first discussed.

2. Context–near earth objects: the good, the bad and the ugly

Issues raised by NEOs typify the classical "the good, the bad and the ugly" debates. The "good" comprise the possibility of economically sound resource extraction and utilization—providing a potential infinite source of presently-scarce resources for both Earth-based applications and space-based exploration. The "bad" relates to the threat caused by an uncontrolled NEO collision with the Earth, and the catastrophic consequences of impact. The "ugly" fact is that the international legal regime is not ready to deal either with the "good" or the "bad" scenarios. This section looks in more detail at these three contextual issues underlying present and future approaches to NEOs.

2.1. The good: NEO resource extraction and utilisation

The Earth's resource base is complex, differentiated, and limited. Resource extraction from the Earth has taken place from the cradle of civilisation.[10] Although supplies of fossil fuels and mineral resources are not likely to be fully depleted for decades, an important junction has been reached in the history of Humanity where the limits of the Earth's resources can be identified.[11] As the most

[3] Other significant collisions include the airborne explosion at Curuca River, Brazil (1930), at Sikhote-Alin, Siberia (1947), over Revelstoke, Canada (1965), over Ontario, Canada (1966), over Alaska, United States of America (1969) and in Honduras (1996). The 1908 Tunguska event incinerated hundreds of acres of forest in Siberia, and had it impacted on a populated area (over St. Petersburg, for example, had it been approximately four hours later), would have caused catastrophic fatalities and damage. The 100 million kilogramme asteroid entered the Earth's atmosphere at about 54,000 kilometres per hour, and exploded at a height of approximately 8.5 km above the ground. The explosion released energy equivalent to 185 times that released by the atomic bomb at Hiroshima. A century on in 2008, the requisite technology required to deflect an NEO such as the Tunguska asteroid is still lacking. See Space Daily, "Tunguska Event Still a Mystery 100 Years On", (30 June 2008), online at http://www.spacedaily.com/reports/Tunguska_Event_Still_A_Mystery_100_Years_OnTunguska_Event_Still_A_Mystery_100_Years_On_999.html/, accessed 31 August 2008.

[4] Online at 〈http://neo.jpl.nasa.gov/〉, accessed 31 August 2008.

[5] The Torino Scale provides an assessment of asteroid and comet impact hazard predictions based on a 0–10 point scale. See D. Morrison et al., Impacts and the Public: Communicating the Nature of the Impact Hazard. in: M.J.S. Belton, et al (eds.), *Mitigation of Hazardous Comets and Asteroids*, (2004). NASA's Near Earth Object Program provides a graphical illustration of the Torino Scale online at 〈http://neo.jpl.nasa.gov/images/torino_scale.jpg〉, accessed 31 August 2008.

[6] NASA Near Earth Object Program, Sentry Risk Table, online at 〈http://neo.jpi.nasa.gov/risk/〉, accessed 31 August 2008.

[7] J.R. Tate, Near Earth Objects—a threat and an opportunity, Physics Education 38(3) (2003) 218.

[8] See on the topic of the utilisation of NEO and near space resources, D. Wingo, *Moonrush: Improving Life on Earth with the Moon's Resource*, (2004); R.P. Binzel, et al., physical properties of near-earth objects, in: W.F. Bottke, et al., (eds.), *Asteroids III* (2002) 264; M.J. Sonter, Near Earth Objects as Resources for Space Industrialization, Solar System Development Journal 1(1) (2001) 1; J.S. Lewis, M.S. Matthews, M. Guerrieri, Resources of Near-Earth Space, (1993); W.K. Hartmann, The Resource Base in Our Solar System, in: B.R. Finney, E.M. Jones, *Interstellar Migration and the Human Experience*, (1985) 26.

[9] Article II, Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space Including the Moon and Other Celestial Bodies, (1967) 610 UNTS 205, hereinafter "Outer Space Treaty". As of 01 January 2008, 98 States have ratified the Treaty, and an additional 27 states have signed it.

[10] See for example M. Lynch, *Mining in World History (Globalities)*, (2004) 3.

[11] See on the topic, F.S. Guthery, *A Primer on Natural Resource Science*, (2008); D. Pirages, K. Cousins, *From Resource Scarcity to Ecological Security: Exploring New Limits to Growth*, (2005); J.J.W. Rogers, P.G. Feiss, *People and the Earth: Basic Issues in the Sustainability of Resources and*