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ABSTRACT

Natural Near Earth objects (NEOs) are celestial bodies such as asteroids and meteorites, which may go past the Earth orbit. They imply an impact risk for our planet. Such threat, though improbable, cannot be ignored. The damage produced would not affect only one country but it may have cross – border effects without discrimination. It would affect the ecosystem and human population. On September 2007, the Spaceguard Association of Japan had observed a total of 212 asteroids and 90 comets near the Earth.[i]

The Scientific and Technical Subcommittee of COPUOS stated that "the NEO hazard should be recognized as a global issue that can be effectively addressed only through international cooperation and coordination"[ii]. Therefore, the following questions arise: a) Which activities are the States performing in this field? b) Is there a legal framework that regulates this activity or is it necessary to draft a new one? This paper intends to answer those questions according the following structure: 1) Introduction; 2) Activities carried out; 3) Applicable legal frame; 4) Conclusions

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I. INTRODUCTION

Natural near-Earth objects, such as asteroids and meteorites, are celestial bodies that go across the terrestrial orbit. These objects may impact against our planet and, though improbable, such threat cannot be ignored. The damage caused would not only affect a single State but it would rather have trans-boundary and indiscriminate effects. The ecosystem and the human population would be affected. By September 2007, The Japanese Spaceguard association observed a total of 212 asteroids and 90 comets near Earth.

The COPUOS Scientific and Technical Subcommittee stated that "the NEO hazard should be recognized as a global issue that can be effectively addressed only through international cooperation and coordination."[iii] In that sense, and in compliance with the United Nations General Assembly Resolution 61/111 of 14 December, 2006, a working group on near-Earth objects was established in the framework of the Subcommittee. The

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working group was presided by Mr. Richard Tremayne – Smith. A multi-year plan for years 2008-2010 was recommended[iv], which can be summarized as follows:[v]

2008: Continue inter-sessional work and consider the reports submitted in response to the annual request for information on near-Earth object activities. The presentations would focus on national, regional and international collaborative activity for observation and analysis of near-Earth objects. Drafting of the interim report.
2009: Continue annual reporting on near-Earth object activities, which will include an update on near-Earth object missions and submission of draft procedures related to threat handling at the international level. Review and update the interim report.
2010: Continue analysis on international procedures for threat handling of near-Earth objects. Review progress with international cooperation and collaboration on observations. Review and update the interim report.
In view of the foregoing, some questions arise. First, as regards the cooperation between the States and the work performed by the Working Group created in the framework of the Scientific and Technical Subcommittee, the question is: a) Which activities are the States performing in this field? Since the works are performed in the context of the Scientific and Technical Subcommittee, this issue is not addressed by the Legal Subcommittee. However, no adequate set of rules in this field can be prepared without being aware of the scientific and technical issues. So, the question is: b) Is there a legal framework that regulates this activity or is it necessary to draft a new one?

As regards the methodology applied in this paper, factual issues will be addressed first, making reference to the activities of those involved in this field, to later deal with the legal issues and finally draw conclusions. Due to space limitations, the analysis will be focused in only four States: USA, UK, Germany and the Russian Federation.

II. ACTIVITIES PERFORMED BY THE STATES

Pursuant to the interim Report of the Working Group on near-Earth objects, the first step in addressing the risk posed by a near-Earth object is to detect its presence and infer its size from its trajectory and observed brightness.[vi] Due to space limitations, we will only concentrate on the activities of some States, considering the relevance of the activities performed by those States.

1. UNITED STATES OF AMERICA

This country has created the "*Near Earth Object Program*" of the National Aeronautics and Space Administration (NASA). This program provides funding to five near-Earth objects search teams to operate nine separate 1-metre class survey telescopes across the south-western United States and one in Australia.[vii] The United States also operates two planetary radars capable of observing NEOs. The Goldstone radar is located in southern California, in the Mojave Desert. The second radar, located at Arecibo, Puerto Rico, is owned and managed by the *National Science Foundation* and operated by Cornell University under a cooperative agreement with the Foundation.[viii]
A partnership of astronomers in the United Kingdom, from Durham

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University, Queen's University Belfast and the University of Edinburgh, has joined a group of German and American institutions in using an advanced new telescope, which is equipped with the world's largest digital camera and is located in Hawaii, on the island of Maui, to observe and determine the characteristics of NEOs. [ix]

As part of its NEO observation programme, NASA has established the Near-Earth Object Program Office at its Jet Propulsion Laboratory (JPL). Through the JPL Sentry System, risk analyses are automatically performed on objects that have a potential for Earth impact. Such an analysis usually occurs for an object that has recently been discovered and for which there is not yet a data interval sufficiently long to make its orbit secure.[x] The Sentry System automatically updates the orbits of approximately 40 near-Earth objects per day, and close approach tables are generated and posted on the Internet: http://neo.jpl.nasa.gov/ca [xi]

Approximately five risk analysis cases are performed each day, with each analysis providing 10,000 multiple solutions. That process is also performed in parallel in Pisa, Italy, and by JPL. Since the inception of the Sentry System in 2002, approximately 400 objects have appeared on the Sentry risk page: http://neo.jpl.nasa.gov/risk. For recently discovered objects of unusual interest, the Minor Planet Centre, JPL, and the centre at Pisa will often alert observers that additional future or pre-discovery data are needed.[xii]

The NASA with support from the University of Santa Cruz study the threat posed by impact-induced tsunamis. The University of Arizona has created an easy-to-use, interactive website for estimating the environmental consequences of an impact on Earth. By providing inputs for the distance from ground zero and the projectile's diameter, density, velocity and impact angle, the program will estimate the ejecta distribution, ground shaking, atmospheric blast wave, the thermal effects of an impact and the size of the crater produced. The website is found at http://www.lpl.arizona.edu./impaceffects [xiii]

2. UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND

The British National Space Centre (BNSC) maintains an active role in this field. This leadership role is demonstrated by the United Kingdom's chairmanship of the Action Team on Near-Earth Objects and the Working Group on Near-Earth Objects.[xiv]

Astronomers at Queen's University of Belfast, in cooperation with colleagues in Germany, the Czech Republic, Slovakia and the United States, successfully measured the Yarkovsky-O'Keefe-Radzievskii-Paddack (YORP) effect for the first time, by studying NEO (54509) 2000 PH5 over several years. That theoretical effect causes NEOs to spin up or spin down through the action of being heated by the Sun. The YORP effect is probably the primary method of the creation of binary NEOs and acts in unison with the Yarkovsky effect in delivering asteroids to Near-Earth space.[xv] Astronomers at Queen's University of Belfast continued to obtain astrometric data on NEOs with an identified small risk of hitting the Earth in the next 100 years, with the aim of improving their orbits. As of year 2007, they have measured positions and improved the orbits of over 200 NEOs.[xvi]

At the Open University, a number of experimental programmes aimed at understanding the formation of smaller

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bodies in the solar system are under way. In addition, studies to mitigate and deviate NEOs are conducted.[xvii]

The Astronautics Research Group at the University of Southampton is conducting a research into the effects of NEO impacts on the Earth. This research is focused in the world threat posed by NEOs of a diameter under 1 km. A software tool was developed in the period 2004-2005 to assess how impact-generated effects will affect the human population, and the software was exploited in 2006 to analyse particular impact case studies.[xviii]

The first of these was an evaluation of the casualty numbers resulting from ground and sea impacts in the regional neighbourhood of the United Kingdom, and the second was a study of the effects on the human population resulting from the potential impact of the asteroid 99942 Apophis in 2036. This work is being further advanced with the development of a software tool called the "NEO impactor", which will be used for global studies of the effects of NEO impacts on both the population and on infrastructure. Completion of the research programme was expected in 2007.[xix]

The objective of the work conducted by the University of Glasgow is to develop fundamental optimal control theory and apply it to the interception of hazardous NEOs. Different parameters (time, mass, orbital corrections and maximum deviation) will be optimized.[xx]

The website of the Near Earth Objects Information Centre, http://www.neareathobjects.co.uk, provides a wide range of information about this issue.

3. RUSSIAN FEDERATION

The Russian Federation and the countries of the Commonwealth of Independent States have accumulated significant scientific and technological capabilities. These could be used to develop a planetary defence system to protect the Earth from the threat posed by asteroids and comets.[xxi]

A number of Russian and Ukrainian organizations founded the *Planetary Defence Centre* as a nonprofit-making partnership, with a view to combining the efforts of organizations and experts working in various fields towards the establishment of a planetary defence system.[xxii]

The main activities of the Planetary Defence Centre are as follows:[xxiii]

a) Design of a planetary defence system to protect the Earth from the threat posed by asteroids and comets;
b) Elaboration of possible space threat scenarios and methods and means of countering such threats;
c) Participation in the preparation and conduct of simulation and demonstration experiments to test the components of the planetary defence system;
d) Conduct of public awareness campaigns and other activities.

The activities of the Planetary Defence Centre are based on the conceptual design for the *Citadel* planetary defence system. The Citadel system will consist of an Earth- and space-based service for rapid interception. The interception service will make use of space rockets and nuclear and other resources from the Russian Federation, the United States of America and European and other countries. These resources will include reconnaissance and interceptor spacecraft.[xxiv]

The Space Patrol Project provides for a spacecraft to be built and launched

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towards asteroids passing near the Earth and, in particular, objects moving in meteor showers. The following missions could also be carried out: Prolet (fly-by), Udar (impact), Vnedrenie (penetration) and Perekhvat (interception).[xxv]

4. GERMANY

Scientists at the Institute of *Planetary Research of the German Aerospace Centre* in Berlin-Adlershof have been engaged in international research on near-Earth objects for many years. The work includes observation campaigns for physical characterization of NEOs using major ground-based and space-borne astronomical telescopes. Data reduction and analysis, theoretical investigations and the publication of results in major refereed journals are also major activities of the group in this field. This work is carried out mainly by the *Asteroids and Comets Department* of the Institute by scientists and research students.[xxvi]

An observation programme of NEOs has been implemented in collaboration with Scandinavian institutes (the University of Helsinki, the University of Uppsala, the University of Oslo and the University of Copenhagen). The programme uses the Nordic Optic Telescope on the island of La Palma, Spain, to carry out photometric light curve observations of NEOs and perform astrometric follow-up of NEOs as from 2007.[xxvii]

A strong future participation in the planning of the Don Quijote mission is foreseen. Don Quijote is a mitigation precursor mission of European Space Agency currently under feasibility study by a consortium of European industrial and academic partners. The Institute of Planetary Research is a member of the consortium, which has successfully completed a phase A study of the mission. [xxviii]

An online database of physical properties of all known NEOs is maintained and available at http://earn.dlr.de. The annual reports of the research activities conducted in Germany are available at http://solarsystem.dlr.de/KK and http://elib.dlr.de/perl/search.

5. THE SPACEGUARD FOUNDATION

The purpose of this Foundation is the protection of the Earth environment against the bombardment of objects of the solar system (comets and asteroids). It was officially created on 26 March, 1996 in Rome. Apart from Italy, it is also hosted in different countries such as Germany, Japan, the United Kingdom, etc. This Foundation constitutes a liaison between the general public and the scientific community. It provides the general public and the government agencies with scientific information in easily understandable terms.[xxix]

III. APPLICABLE LEGAL FRAMEWORK

A. THE OBLIGATION TO PREVENT AND INFORM

Maureen Williams understands that the obligation to prevent damage arises from international customary law.[xxx] Generally, two levels of prevention are recognized: a) unilateral measures to be adopted by the source State and b) adoption of rules.[xxxi] Source State means a contaminating State. In my opinion, according to the *prater – legem* equitable principle, this concept involves a State with sufficient technology available to monitor NEOs and prevent any potential

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damage. If such State fails to do so, it is held internationally liable.

The obligation to inform upon contamination is found in Article IX of the Outer Space Treaty. Therefore, based on the arguments presented above, we can conclude that if a State has technology available, is aware of the information and fails to inform the potentially affected State, such behaviour would result in the consequences outlined by Williams, *i.e.* "both States may be involved in a serious and never ending controversy about the limits of the exclusive jurisdiction of the affected State to investigate the activity in question."[xxxii]

B. THE CONSULTATION OBLIGATION ARISING FROM ARTICLE IX OF THE OUTER SPACE TREATY

Aldo Armando Cocca[xxxiii] explains that the drafting of this article was based on the experiences of the US Project West Ford. The project consisted in launching into orbit a ring of tiny dipole antennas (needles). In the first attempt in October 1961, the needles failed to disperse. The second attempt was conducted on 12 May, 1963, achieved the expected results. The mere announcement of the project raised comments and protests, among others, from the International Telecommunication Union. In September 1961, the International Council for Science (ICSU) entrusted the Committee on Space Research (COSPAR) with the analysis of experimental projects and other space related activities which effects were not appropriate for scientific activities and observations. Based on its report, and although the above mentioned experiences caused no noticeably harmful interferences, the COSPAR adopted several resolutions whereby its members were requested to provide reports on these type of projects beforehand, and recommended measures to avoid celestial bodies contamination. According to Bin Cheng[xxxiv], afterwards, the consultation procedure through the COSPAR was satisfactorily implemented, which would explain why two of the great superpowers agreed with the consultation procedure set out in Article IX.

In that regard, Merrills[xxxv] explains that when a government expects that a proposed decision or course of action causes potential damage to another State, the discussions with the affected party may lead to a dispute settlement, thus creating opportunities to settle the controversy. Consultation is particularly valuable because it provides useful information in due time, that is, before any actions are implemented. Therefore, we understand that the consultation obligation is totally applicable to this field, given that the threat of an impact entails a potential damage greater than contamination itself.

C. INTERNATIONAL COOPERATION

Article 1 of the 1967 Outer Space Treaty states the following:

"...There shall be freedom of scientific investigation in outer space, including the Moon and other celestial bodies, and States shall facilitate and encourage international cooperation in such investigation"

Furthermore, Article 3 provides that:

"States Parties to the Treaty shall carry on activities in the exploration and use of outer space, including the Moon and other

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celestial bodies, in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international cooperation and understanding."

Article 9 of the Outer Space Treaty regulates on the following issue:

"In the exploration and use of outer space, including the Moon and other celestial bodies, States Parties to the Treaty shall be guided by the principle of cooperation and mutual assistance and shall conduct all their activities in outer space, including the Moon and other celestial bodies, with due regard to the corresponding interests of all other States Parties to the Treaty..."

According to Manuel Augusto Ferrer (h) "international cooperation is a statutory obligation rather than a mere aim";[xxxvi] and he further states that "international cooperation is an aim that all the international community expects to achieve in all respects, except for cooperation as regards space-related activities, which is already binding upon the States."[xxxvii] Maureen Williams claims that "The Argentine thesis that imposes the international cooperation obligation as of the entry into force of the 1967 Outer Space Treaty, and which considers such obligation a previous requirement to develop space-related activities, is widely accepted by most of the scholars worldwide."[xxxviii]

D. UNITED NATIONS GENERAL ASSEMBLY RESOLUTION 51/122 OF 1996: "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"

In 1996, the United Nations General Assembly adopted without vote resolution 51/122, entitled: 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"
Article 1 thereof provides that "International cooperation in the exploration and use of outer space for peaceful purposes shall be conducted in accordance with the provisions of international law, including the Charter of the United Nations and the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies."

Article 3 states the following:

"All States, particularly those with relevant space capabilities and with programmes for the exploration and use of outer space, should contribute to promoting and fostering international cooperation on an equitable and mutually acceptable basis. In this context, particular attention should be given to the benefit and the interests of developing countries and countries with incipient space programmes stemming from such international cooperation conducted with countries with more advanced space capabilities"

Article 4 provides that:

"International cooperation should be

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conducted in the modes that are considered most effective and appropriate by the countries concerned, including, inter alia, governmental and non-governmental; commercial and non-commercial; global, multilateral, regional or bilateral; and international cooperation among countries in all levels of development"

D .1. LEGAL VALUE OF RESOLUTION 51/122 OF 1996

In 1965, Bin Cheng published a paper posing the following question: "United Nations Resolutions on Outer Space: Instant International Customary Law?"[xxxix] The answer is to deny the meaning of the usual practice and the time factor in the formation of international customary law and base it on the *opinio juris,* as expressed in non-binding resolutions and declarations, as an integral aspect of international customary law. Bin Cheng's position can be supported by the North Sea Continental Shelf case, in which it was stated that a rule of customary international law may arises even in a short period of time.[xl]

Peter Malanczuk considers that the "instantaneous international customary law rule" is associated to certain declarations and resolutions issued by international organizations and to the "soft-law"[xli] phenomenon. According to this jurist, the soft law discussion is mainly related to relevant General Assembly Resolutions, such as the first ones that set out the basic principles of space law, or the 1982 resolution on "Direct Satellite Television Broadcasting Principles", the 1986 resolution on principles related to satellite teledetection or the 1992 resolution on use of nuclear power sources in outer space.[xlii] In my opinion, Resolution 51/122 can be added to the aforementioned list. Malanczuk concludes that certain principles and regulations arise as new rules in the drafting process: even though they are not legally accepted as binding rules, these have a limited early effect in court or arbitration decisions as valid arguments in the interpretation of the law.[xliii]

E. INTERNATIONAL RESPONSIBILITY

In the case "Chorzow Factory" (jurisdiction), the Permanent Court stated that: "it is a principle of international law that the breach of an engagement involves an obligation to make reparation in an adequate form."[xliv] Article 1 of the International Law Commission's Articles on State Responsibility provides that: "Every internationally wrongful act of a State entails the international responsibility of that State"; and Article 2 states that: "There is an internationally wrongful act of a State when conduct consisting of an action or omission: a) is attributable to the State under international law; and b) constitutes a breach of an international obligation of State". Therefore, the States shall be internationally responsible upon breach of the prevention, information, consultation and cooperation obligations.

GENERAL CONCLUSIONS

The activities performed by states such as the United Kingdom of Great Britain, the United States of America, Germany and the Russian Federation have been addressed in this paper without limitation and only as relevant examples due to space reasons.

It is worth emphasizing the **international cooperation** of States with space technology available, such as the German

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observation programme of NEOs in collaboration with Scandinavian institutes (the University of Helsinki, the University of Uppsala, the University of Oslo and the University of Copenhagen). This programme uses the Nordic Optic Telescope located on the island of La Palma, Spain, to carry out photometric light curve observations of NEOs and perform astrometric follow-up of NEOs as of 2007.

Furthermore, the creation of the Spaceguard Foundation entails a quite remarkable mission: informing the population in simple and clear terms to enable them to understand this issue.

From a legal approach, it is worth mentioning that a set of legal obligations arising from the treaties currently in force, and the United Nations General Assembly resolutions, are now comprised by the **international customary law**.

So far, the prevention and information, international cooperation and consultation obligations and the United Nations General Assembly resolution 51/122 of 1996 provide a suitable legal framework to this international issue and, therefore, no new legal instrument need be drafted in this respect. The existing rules are validly applicable to the issue in question, considering the potential risks posed by near-Earth objects. Upon breach of the legal obligations mentioned above, the international responsibility of the States shall undoubtedly arise.

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[i] A/Ac.105/863/Add.2. (5 de Diciembre de 2006). Page. 5

[ii] A/AC.105/C.1/L.290, Page 9

[iii] United Nations. General Assembly. A/AC. 105/C. 1/L. 290, (12 December 2006) Page 8.

[iv] United Nations. General Assembly. A/Ac.105/890. Annex III (6 March 2007). Page. 40.

[v] Ibídem. Page 40.

[vi] United Nations. General Assembly. A/Ac. 105/C.1/L.290 (12 December 2006). Page 2.

[vii] Ibidem

[viii] Ibidem. Page 3

[ix] Ibidem

[x] Ibidem. Page 5

[xi] Ibidem

[xii] Ibidem

[xiii] Ibidem

[xiv] United Nations. General Assembly. A/AC. 105/896 (4 December 2007). Page 5.

[xv] Ibidem, Page 5

[xvi] Ibidem

[xvii] Ibidem

[xviii] Ibídem

[xix] Ibidem. Page 6

[xx] Ibidem. Page 7

[xxi] United Nations. General Assembly. A/AC.105/863/Add.1 (28 March 2006). Page 2

[xxii] Ibidem

[xxiii] Ibidem

[xxiv] Ibidem.

[xxv] Ibidem

[xxvi] United Nations. General Assembly. A/Ac.105/863/Add.2. (5 December 2006). Page 2

[xxvii] Ibidem, Page 3

[xxviii] Ibidem

[xxix] See: http://spaceguard.rm.iasf.cnr.it/SGF/INDEX.html and http://spaceguard.rm.iasf.cnr.it/index.html

[xxx] Williams, Silvia Maureen: *Derecho Internacional Contemporáneo*. Abeledo Perrot. Buenos Aires. 1990. Page 116

[xxxi] Ibídem. Page 117

[xxxii] Ibídem

[xxxiii] Cocca, Aldo Armando: *Consolidación del Derecho Espacial*. Editorial Astrea. 1971. Page 41 and following pages.

[xxxiv] Cheng, Bin: *Studies in International Space law*. Oxford University Press. New York. 1997. Page 257.

[xxxv] Merrils,J. G.: *International Dispute Settlement*. Third Edition. Cambridge University Press. UK. 1998. Page 3.

[xxxvi] Ferrer, Manuel Augusto (h): "Contenidos Éticos y Jurídicos de la Transferencia de Tecnología Espacial" Pág. 223 in Cocca. Aldo Armando, Serie Estudios Internacionales Avanzados: *Ética, Derecho, Ciencia, Tecnología y Cooperación Internacional*. Consejo de Estudios Internacionales Avanzados. Argentina. 1985.

[xxxvii] Ibídem, Page 224.

[xxxviii] Williams, Silvia Maureen. 1990. Page 94.

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[xxxix] As published in Indian Journal of International Law. 1965. Pages 23 and following pages.
[xl] North Sea Continental Shelf Case, ICJ Rep. 1969. P. 4
[xli] Malanczuk, Peter: "Space Law as a Branch of International Law" in Netherlands Yearbook of International Law. Volume XXV. 1994. Martin Nijhoff Publishers. 1994. Page 161
[xlii] Ibidem
[xliii] Ibidem. Page 162
[xliv] PCIJ, Ser. A, Nª 17, p29 (1927).