This article from International Institute of Space Law is published by Eleven international publishing and made available to anonieme bezoeker

IISL-00-IISL.4.11

SECURITY IMPLICATIONS OF NON-TERRESTRIAL RESOURCE EXPLOITATION

Virgiliu Pop, LLM*
PhD Student, Law School,
University of Glasgow
Glasgow, Scotland

"And he doeth great wonders, so that he maketh fire come down from heaven on the earth in the sight of men." - Revelation 13, 13.

Abstract

This paper analyses the legality of Solar Power Satellites (SPS) and Peaceful Nuclear Explosions (PNE), as means for exploiting extraterrestrial natural resources, from the prospective of peaceful uses of outer space. The use of extraterrestrial natural resources for military purposes is also scrutinised. Envisioned as a means for the exploitation of solar energy in outer space, SPS may have military capabilities, varying from their use as electromagnetic weapons to their employment as anti ballistic missile systems and as means of hostile environmental modification. Their dimensions and location may raise on the other hand issues regarding their defence. In order to avoid both their use as means of warfare and their destruction, appropriate safeguards must be in place. Without these, it is unlikely that SPS systems will ever be operating. The exploitation of mineral resources on the moon, asteroids and other celestial bodies may see the need of employing PNE. These have fundamental legal implications in the light of the 1963 Moscow Treaty and of the CTBT Treaty. Finally, the exploitation of extraterrestrial mineral resources may raise a legal debate regarding their use for military purposes. This raises again the never-ending debate of the meaning of "peaceful", i.e. non-military or non-aggressive.

1. Introduction

The prospective of exploitation of solar energy in the Geostationary Orbit and of mineral resources on the Moon and asteroids raises the issue of legality of the exploitation technologies to be used from their military point of view. "The development of a mineral resource regime for the Moon" - considers Bilder - "is likely to have less immediate

* LL.Lic (1996, Vasile Goldis / Babes-Bolyai), LL.M (1998, Aberdeen), PhD Student (Glasgow). Interim Regional Advisor - Europe, Space Youth Advisory Council. Member, European Centre for Space Law. Delegate, Space Generation Forum - UNISPACE III (1999).

Copyright © 2000 by Virgiliu Pop. Published by the American Institute of Aeronautics and Astronautics, Inc., with permission.

This article from International Institute of Space Law is published by Eleven international publishing and made available to anonieme bezoeker

practical military (...) significance than has been the case with the general development of the Antarctic and Law of the Sea regimes"[1]. However, a certain number of technologies that can be used for the peaceful exploitation of non-terrestrial natural resources carry also the potential of being used for warfare. This is true both in the case of the Solar Power Satellites that would exploit solar energy in Earth orbit, and in that of peaceful nuclear explosions that may be used in exploiting minerals from the Moon, asteroids and other celestial bodies. These "dual-use technologies" raise security issues that need to be analysed in detail. In the same time, important problems arise from the possible use of non-terrestrial mineral resources for the manufacture of weapons.

2. Military Uses of Solar Power Satellites

Although Solar Power Satellites were envisioned as an energy program, their use raises significant military implications[2]. Concerns have been expressed regarding the lawfulness of solar power satellites (SPS) under the Outer Space Treaty in the context of their possible use as weapons of mass destruction and under existing arms control treaties in the context of their use as prohibited means of warfare. At the same time, given the significant importance and value of a SPS system, its use raises also the issue of vulnerability[3], hence self defence[4].

2.1. Mass Destruction Capabilities Article IV of the Outer Space Treaty outlaws placement "in orbit around the Earth" of "any (...) kinds of weapons of mass destruction (...)."

Weapons of mass destruction were defined in 1948 by the UN Commission for Conventional Armaments as

> "those which include atomic explosive weapons, radioactive material weapons, lethal chemical and biological weapons, and any weapons developed in the future which have characteristics comparable in destructive effect to those of the atomic bomb or other weapons mentioned above" [UN document S/C.3/32/Rev.1, August 1948].

Given the "evolution" of the means of warfare since 1948, the UN General Assembly passed Resolution 51/37 of 7 January 1997 [A/RES/51/37] in which it expresses its determination

> "to prevent the emergence of new types of weapons of mass destruction that have characteristics comparable in destructive effect to those of weapons of mass destruction identified in the definition of weapons of mass destruction adopted by the United Nations in 1948" and it "[r]eaffirms that effective measures should be taken to prevent the emergence of new types of weapons of mass destruction".

As seen from above, there is no *exclusive* definition of weapons of mass destruction; in 1996, the US Secretary of State Warren Christopher classified the landmines as "weapons of mass destruction in slow motion"[5]. Given the lack of a precise definition, the Office of Technology Assessment of the United States Congress considers that it is unclear "[w]hether an SPS's microwave or laser capabilities would class it as a weapon of "mass destruction" and hence make it illegal under the 1967 treaty", but "it is very likely that such charges would be made in the event of SPS deployment"[6]. In order to analyse their (dis)qualification as weapons of mass destruction, one must examine the possible destructive effects of the SPS technology.

High power microwaves (HPM) are a new means of warfare. The use of microwaves as the means of transmission of energy between the SPS and the ground based collecting rectenna may qualify them as electromagnetic weapons. The most widely acknowledged effect of HPM is "disruption of electronic

This article from International Institute of Space Law is published by Eleven international publishing and made available to anonieme bezoeker

systems", able to "reset computers, cause complete loss of stored data and/or cause microprocessors to switch operating modes"[7]. This would "produce substantial paralysis in any target system, thus providing a decisive advantage in the conduct of Electronic Combat, Offensive Counter Air and Strategic Air Attack"[8]. In the same time, a HPM attack directed at an aircraft "could corrupt the plane's control and navigation systems enough to cause a crash"[9].

Although of a non-lethal nature[10], the effects of electromagnetic weapons are significant, ranging from "nuisance to catastrophic"[11]. This led experts to consider them as "Weapon[s] of Electrical Mass Destruction"[12]. Indeed, the reliance of today's society on electronic and computer systems makes it extremely fragile; a HPM attack would have far more catastrophic effects than the Millennium Bug[13].

Another "mass destruction-like" effect may be presented by the SPS that would use lasers instead of microwaves as means of transmission of energy and that may also have the capacity to cause catastrophic fires on enemy territory. Gerrard and Barber note that " there is some debate as to whether nuclear-powered lasers are [weapons of mass destruction]"[14]. The same may be true in the case of use of orbiting solar mirrors: it may "become technically feasible to concentrate solar energy in certain areas of the earth and thereby cause fires, scorch the earth, or cause floods"[15]. Precedents of the use of solar rays as a weapon exist as far back as the 3rd Century BC, when Archimedes is said to have put fire to the Roman fleet invading Syracuse by using solar rays concentrated by mirrors.

These arguments may qualify the SPS as illegal under article IV of the Outer Space Treaty; at the same time, several counter-arguments can be formulated.

First of all, SPS are not the only means that could be used for electromagnetic warfare – on the contrary, most of the literature is devoted to conventional electromagnetic bombs. Besides this, "unlike traditional weapons of mass destruction, there are no controllable components[16] in an HPM weapon."[17] and this would make treaties that would limit their proliferation "virtually impossible to enforce given the common availability of suitable materials and tools."[18].

Regarding their use as means of causing lethal diseases, it is unlikely that SPSs would become instruments of mass destruction; the small power density of the microwave beam (about ¼ the power density of sunlight) means that, "as a weapon, the SSP is less effective than a squirt gun"[19]. Foldes agrees, considering that the "[c]apability of SPS to cause radiation damage on the ground is small"[20]. Moss believes that a SPS "would not violate the dictates of Article 4 as the SPS is not a weapon. The alignment of the microwave beam would always be under positive control from the receiving station and could be quickly shut off should it stray from the precise path of the rectennas. Furthermore, and most importantly, contact with the microwave energy is not lethal. It has no thermal "zapping" qualities like a laser, nor is it ionising like X-ray radiation"[21].

The question remains, however, whether the SPS could serve as a "Trojan horse" by hiding a mass destruction weapon, be it nuclear, radiological, or chemical, under the peaceful exploitation mask. In order to avoid this situation, a number of safeguards that we will analyse later must be in place.

2.2. ABM Capabilities The bilateral USA-USSR 1972 Anti Ballistic Missile Treaty prohibits in Art. V the development, testing and deployment of ABM systems or components, including space-based ones. Art. II of the ABM Treaty defines the ABM system as a "system to counter strategic ballistic missiles or their elements in flight trajectory".

The SPS system, although not directly aimed at countering strategic ballistic missiles, might be accused of having an ABM "hidden agenda",

This article from International Institute of Space Law is published by Eleven international publishing and made available to anonieme bezoeker

given its real ABM capabilities. Indeed, "[i]t was speculated that a high-energy laser beam could function as a thermal weapon to disable or destroy enemy missiles"[22]. Foldes also considers that one of the most logical offensive uses of SPS can include the "microwave heating of other space objects"[23]. OTA believes that "[a]lthough unlikely, use of the SPS for directed-energy weaponry, either directly, or as a source of energy to be transmitted to remote platforms, or for tracking, would be regulated by the ABM Treaty. Use of the SPS for ABM purposes would hence be banned"[24].

The unilateral deployment of a SPS system either by the USA or Russia would entail the risk of apparent violation of the ABM treaty, and OTA considers that "[r]enewed negotiations may have to take SPS development into account, perhaps by specifying SPS designs that make it unusable as a weapons system"[25].

2.3. Environmental Modification Capabilities

The 1976 Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques forbids State Parties to -

> "engage in military or any other hostile use of environmental modification techniques having widespread, long-lasting or severe effects as the means of destruction, damage or injury to any other State Party" (Art. I.1).

The term "environmental modification techniques" is defined as "any technique for changing - through the deliberate manipulation of natural processes - the dynamics, composition or structure of the earth (...) or of outer space" (Art. II).

OTA believes that the principles of the ENMOD Convention "obviously allow for criticism of some SPS designs as having weather modification potential, requiring restrictions or redesign to reduce such effects"[26]. Still, their weather modification *"potential"* - if we employ OTA's vocabulary - would be more of the concern of the Additional Protocol I to the Geneva Conventions of 12 August 1949 Relating to the Protection of Victims of International Armed Conflicts, 8 June 1977, whose Art. 35.3. prohibits the employment not only of methods or means of warfare "which are intended (...) to cause widespread, long-term and severe damage to the natural environment", but also of those which *"may be expected"* (my emphasis) to cause such effects.

Indeed, according to Bertell, the SPS would be "capable of causing physical changes in the ionosphere"[27].

The "Thunderstorm" SPS (TSPS) imagined by Bernard Eastlund would be used precisely for peaceful weather modification in order to prevent the formation of tornadoes[28]. The development of the TSPS would not violate Art. III.1 of the ENMOD Convention - "The provisions of this Convention shall not hinder the use of environmental modification techniques for peaceful purposes (...)"; nevertheless, fears for its military misuses may arise. "Fear may be justified" - considers Eastlund - "however, such fear should not stop responsible scientists for pursuing areas of research that could significantly save lives and property"[29]. Eastlund formulates guidelines "to handle this issue" - , inter alia "[s]ystem design is to include provisions that prevent military or harmful applications"; "[o]versight committees with international representation will review all plans and experiments" and "[s]pace platforms for severe weather modification should be manned by internationally chosen personnel"[30].

2.4. Other Military Capabilities In the same time, the SPS may have military uses that are not illegal under present regulations. Thus, they may be used as an observation platform[31]; their location in geosynchronous orbits provides "an excellent vantage point from which an entire hemisphere can be surveyed

This article from International Institute of Space Law is published by Eleven international publishing and made available to anonieme bezoeker

continuously" and would provide early warning capability[32].
As the OTA considers, "[m]ilitary satellites for communications and remote sensing are currently used by several countries, and presumably use of the SPS platform for such purposes would not constitute a change in accepted practice"[33].
The SPS potential of jamming of enemy radio communications is considered to be "significant"[34] and one of "the most logical offensive uses of SPS"[35]. Orbital solar mirrors could be used to intimidate the enemy and to illuminate the battlefields during an attack. Given their dimensions, SPS can serve as a "space launching pad"[36] and repair facilities[37]. The SPS "would be able to transmit power to remote military operations anywhere needed on earth"[38].
However, Paragraph 1 of Art. 35 of the Additional Protocol I to the Geneva Conventions of 12 August 1949 Relating to the Protection of Victims of International Armed Conflicts, 8 June 1977, classifies the right of the parties to any armed conflict to choose the methods or means of warfare as "not unlimited", and the military capabilities of SPS may lead states to enter into agreements that would prohibit their use. Once again, the designers must find solutions that would minimise their military use and the policy makers must find appropriate safeguards.

2.5. Self Defence of SPS At the opposite end of the security concerns related to the use of SPS lies their safety; while a "non-owner state" is concerned with the military potential of a SPS, an "owner state" would see a SPS as "a target for any space-capable nation with intentions hostile to the interests of that state"[39].
The use of a geosynchronous orbit makes the SPS "a "sitting duck" for anti-satellite weapons", given "the absolute predictability of these orbits"[40]. Its vulnerability is of high importance, "especially since it could be supplying a large portion of a nation's electricity"[41]. Security issues are raised also by the ground-based rectenna that "would be as vulnerable to terrorist or quasi-military action as other large industrial complexes or power plants"[42].
Indeed, they are not more vulnerable than other ground-based facilities; nuclear plants can as well be attacked or sabotaged. At ground level, self-defence systems are easy to implement; Foldes believes that SPS self defence is in principle "no more difficult than the defence of a similar complexity power plant on the ground"[43]. As the UN Charter is applicable in outer space and it legitimates self defence (Art. 51), the provision of a self defence system for a SPS would in theory not be illegal, as long as the arms installed on the SPS do not contravene to the arms controls treaties in force. It is however difficult to imagine a defence system strong enough to counter an attack and weak enough not to be considered an ABM system.
In the same time, Dembling and Smith are concerned with the establishment of "keep-out zones" in the vicinity of the SPS by "proximity rules", precedents in this direction existing "in the form of offshore territorial limits claimed by various nations"[44]. An even better analogy with the law of the sea could be made with the provisions of the Montego Bay Convention of 10 December 1982 (United Nations Convention on the Law of the Sea), that allows for the establishment of "reasonable safety zones" of about 500 metres around artificial islands, installations and structures in the exclusive economic zone "in which it may take appropriate measures to ensure the safety" both of their and of navigation (Art. 60.4). All ships are complied to respect these safety zones (Art. 60.6.). Safety zones may be also established around scientific research installations (Art. 260). The right of hot pursuit is of applicability in the safety zones established in the EEZ and Continental Shelf (Art. 111.2.). In the same time, safety zones are

This article from International Institute of Space Law is published by Eleven international publishing and made available to anonieme bezoeker

to be established around the installations used for carrying out activities in the Area[45] (Art. 147.2.c.).

Dembling and Smith reckon that proximity rules would have to be reconciled with the non-appropriation principle formulated in Art. II of the Outer Space Treaty, as these "would constitute a claim over an ascertainable portion of outer space"[46]. As a practical solution to this problem, they suggest a "SPS multilateral agreement", that "would be useful to either exempt such zones from the restrictions posed by Article II or to define the world "appropriation" such that the zones would not be within said definition"[47]. However, the "safety zones" established under the Law of the Sea regime are not under state sovereignty, but under its jurisdiction and control; therefore, establishment of analogous safety zones around SPS should not be viewed in violation of the non-appropriation principle. They do not hinder the "mare liberum" and should not hinder the "cosmos liberum".

Finch Jr. considers that the SPS, along with space laboratories, space cities and communication satellites "must never be wilfully destroyed in violation of the 1967 Outer Space Treaty", as they are "the most vulnerable and yet the most materially beneficial outer space activities now known"; he also considers that peace and freedom in outer space is a precondition for the building and operation of SPS[48].

An interesting question is raised by the applicability to SPS of Article 56.1 of the Protocol Additional to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts (Protocol I) of 1977. It prohibits the attacking of "works and installations containing dangerous forces, namely dams, dykes and nuclear electrical generating stations, (...)if such attack may cause the release of dangerous forces and consequent severe losses among the civilian population". We believe that Art. 56.1 would not be applicable as such to SPS, as it contains an exclusive listing of the objectives protected ("namely"); however, mutatis mutandis, it may be used as a starting point in the negotiation of an international regime for the security of SPS. An attack directed at SPS may indeed release dangerous forces: given the impressive mass of a SPS, it may become possible that an explosion would produce debris that would cause significant damage following atmospheric re-entry.

As a practical solution that might eliminate the SPS vulnerability to military attack, Knelman proposes their internationalisation, particularly in the form of a widespread participation[49]. Dembling and Smith agree, stating that "[t]he creation of an international organisation for the ownership and operation of SPS facilities might theoretically be the optimum for alleviating the threats to international security associated with an SPS system", but the practical creation of such an organisation "would seem unlikely"[50].

2.6. Safeguards The possible military uses of SPS are, as shown, impressive. Given this fact, it is sure that most countries will object to their deployment. In order to avoid this, certain safeguards that would limit their use exclusively to peaceful purposes must be in place.

Safavi calls for a special permission from the country underneath the SPS "flying over such territory on scheduled exploitation"; this authorisation "could be given by bilateral agreement" and "should be refused if it were to cause a prejudice to the security (...) [of] the inhabitants or resources existing in the country"[51].

Prado considers that "[v]erification measures can insure that no weapons systems are mounted on the satellite", as "[i]t's hard to hide from view in space"[52]. OTA remarks that "[t]he ABM treaty provides for inspection and verification by "national-technical means, " i.e., by remote surveillance" and that "SPSs

This article from International Institute of Space Law is published by Eleven international publishing and made available to anonieme bezoeker

would need to be monitored by Earth- and space-based reconnaissance means"[53].

Prado reckons that "[o]n site inspection is also possible"[54]. However, Article XII of the Outer Space Treaty opens "to representatives of other State Parties to the Treaty on a basis of reciprocity" only the facilities "on the moon and other celestial bodies". These provisions need to be amended in order to allow inspection also in the outer space and earth orbit; Dembling and Smith believe that "the scope of such SPS inspections could be more broader than those contemplated under Article XII if they were to be conducted by resident inspectors rather than visiting inspectors upon notice"[55].

In the same time, the inspections may be carried out by State representatives or by a specialised body. Fasan asks the members of the International Institute of Space Law in a questionnaire whether "a special agency be set up (...) controlling solar mirrors and other equipment in orbit to ensure its use for peaceful purposes only"[56].

Dembling and Smith finally consider that "international multilateral agreements could serve to minimise potential vulnerabilities of the SPS and could also help minimise potential threats attributed to the SPS by foreign States"[57].

3. Use of Peaceful Nuclear Explosions and of Radioactive Materials

The technology of a nuclear explosive device used for peaceful purposes has no essential distinction from the technology of a nuclear explosive device that would be used as a weapon. Given the prohibition in Article IV of the Outer Space Treaty of installing nuclear weapons on celestial bodies, important security issues are raised by the possible use of peaceful nuclear explosions for the exploitation of extraterrestrial resources and by the presence on the celestial bodies of radioactive materials.

3.1. Use of Peaceful Nuclear Explosions

Peaceful Nuclear Explosions (PNE) were legitimated, inter alia, by the 1967 Treaty for the Prohibition of Nuclear Weapons in Latin America, whose Article 18.1 allows the Contracting Parties to "carry out explosions of nuclear devices for peaceful purposes - including explosions which involve devices similar to those used in nuclear weapons", and by the 1976 Treaty Between the USA and USSR on Underground Nuclear Explosions for Peaceful Purposes (PNE Treaty). Would PNE be allowed for the exploitation of extraterrestrial minerals?

The language of article IV of the Outer Space Treaty - "[t]he use of any equipment or facility necessary for peaceful exploration of the moon and other celestial bodies shall (...) not be prohibited" - suggests that the use of absolutely any exploitation equipment, including nuclear explosion devices, is lawful as long as it is used for peaceful purposes. The same conclusion would arise from article 3.4 of the Moon Agreement that, reiterating the quoted paragraph from Article IV of the Outer Space Treaty, omits the term "facility" but extends this provision to the "use" of the moon.

However, Article III.2.d. of the PNE Treaty forbids, inter alia, "any explosion except in compliance with the provisions of the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water". This 1963 Moscow Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water "flatly bans any nuclear explosion in outer space"[58]; its Article I (1) (a) contains the undertaking of States Parties "to prohibit, to prevent and not to carry out any other nuclear explosions (...) in the atmosphere; beyond its limits, including outer space". Kish considers that these provisions apply "in outer space (...) in the eventual

This article from International Institute of Space Law is published by Eleven international publishing and made available to anonieme bezoeker

atmosphere of celestial bodies" and "to all areas of celestial bodies, including their subsoil", as "[a]rticle I (1) (b) of the [Moscow Treaty] prohibits nuclear explosions outside national territory, namely "...in any other environment if such explosion causes radioactive debris to be present outside the territorial limits of the state under whose jurisdiction or control such explosion is conducted""[59]. Therefore, use of PNE for the exploitation of extraterrestrial minerals would be illegal.

Furthermore, the 1996 Comprehensive Nuclear Test-Ban Treaty (CTBT) signed by most states has outlawed the use of PNE. Initially opposed by China, the CTBT provides for a compromise by providing in article VIII for a Review Conference to be held ten years after its entry into force. The Review Conference may consider "the possibility of permitting the conduct of underground nuclear explosions for peaceful purposes", taking into account "any new scientific and technological developments relevant to this Treaty".

Brooks believes that "perhaps the time is ripe for the UN Space Committee to initiate discussions on whether an exception should not be made for nuclear or other drastic means to alter asteroid orbits". He further reckons that the Space Committee "may also review whether nuclear explosions might not be used on celestial bodies for mineral extraction, with provisions for international consultations and agreed safeguards"[60].

3.2. Use of Radioactive Materials According to the OTA, "uses or deposit of radioactive materials could be involved in exploitation activities"[61]. Specific norms exist regarding use of radioactive materials in outer space and celestial bodies; article 7.2 of the Moon Agreement requires State Parties , "to the maximum extent feasible, [to] notify [the Secretary-General of the United Nations] in advance of all placements by them of radio-active materials on the moon and of the purposes of such placements". The UNCOPUOS Principles Relevant to the Use of Nuclear Power Sources in Outer Space, directed mostly at outer space, are also of relevance to celestial bodies. The aim of principle 3 is to "minimise the quantity of radioactive material in space and the risks involved"; therefore, "the use of nuclear power sources in outer space shall be restricted to those space missions which cannot be operated by non-nuclear energy sources in a reasonable way." It permits however the operation of nuclear reactors "on interplanetary missions". Therefore, the use of radioactive materials on celestial bodies, although lawful, is discouraged. OTA believes that, because of the advance notification requirement in article 7.2 of the Moon Treaty, "[d]epending on the (...) nature of and purposes of radioactive materials to be placed on a celestial body, international opposition, constituting constraints, could certainly arise"[62].

4. Legality of the Use of Non-Terrestrial Natural Resources for Military Purposes

Goldman reckons that "[t]he activity of celestial mining will raise one especially ominous debate in space law", that is "the status of the use of lunar resources in the implementation of the U.S. Strategic Defence Initiative"[63].

Indeed, the use of the non-terrestrial natural resources for military purposes is controversial. Military satellites already use spatial locations, the frequency spectrum and solar energy - all of these being non-terrestrial natural resources. By analogy, one may consider that use of non-terrestrial materials for military purposes would have the same regime. However, the treatment applied to the Outer Space by the Outer Space Treaty is different from the treatment applied to the Moon and the other celestial bodies. Article IV of the Outer Space Treaty states that "[t]he

This article from International Institute of Space Law is published by Eleven international publishing and made available to anonieme bezoeker

Moon and other celestial bodies shall be used by all State Parties to the Treaty exclusively for peaceful purposes", no similar provisions being in place for the outer space. While the spatial locations and the frequency spectrum are outer space resources (not particularly reserved for peaceful uses), the lunar and asteroidal minerals are celestial bodies resources (consecrated for peaceful uses). This raises again the never-ending debate of the meaning of "peaceful": "non-military" or "non-aggressive".

It is sure however that extraterrestrial uranium or plutonium would not be allowed to be used in weapons of mass destruction. The terrestrial varieties are allowed - but the use of the Earth is not consecrated to peaceful purposes only.

Regarding solar energy, it is arguable whether it is a spatial resource (as it is immaterial, like the frequency spectrum) or a celestial body resource (as it is originated in the Sun), and thus whether is or not consecrated for peaceful purposes only. Military reconnaissance satellites already use it, and this is tolerated, perhaps because of their "non-aggressive" nature. However, Cocca calls in his 12th Commandment for the Utilisation of Solar and Related Energies by Means of Space Technology for the "[b]anning of the utilisation of solar and related energies unless for peaceful purposes exclusively"[64]. This is also one of the conclusions of the meeting on the international aspects of the utilisation of solar energy that took place at La Falda, Cordoba, Argentina, in August 1975; the conference concluded, inter alia, that "[t]he development of technology as applied to solar energy shall be carried out taking into account that its use is confined exclusively to peaceful purposes"[65].

5. Conclusion

Without appropriate safeguards in place that would limit and control the military potential of the dual-use technologies, it is unlikely that they would be used in the exploitation of the non-terrestrial natural resources. However, such safeguards can be implemented, and subsequent fears for their use should not be an impediment for the exploitation of the resources of the outer space and celestial bodies. As US Representative Edward Markey says, "[t]he Mafia uses automobiles to make their getaways (...) We don't want to ban automobiles[66]".

Notes

All hyperlinks were checked on July the 2nd, 2000.

[1] BILDER, RICHARD B.; CAMERON, EUGENE N.; KULCINSKI, GERALD R.; HARRISSON JACK H. SMITH, Legal Regimes for the Mining of Helium-3 from the Moon, Wisconsin Centre for Space Automation and Robotics, Madison, WI, 1989. WCSAR-TR-AR3-8901-1, p.72.

[2] BERTELL, ROSALIE, Background of the HAARP Project, <www.earthpulse.com/haarp/background.html > ; KNELMAN, F. H., Solar Power Satellites - Technical, Social and Political Implications, *in* Earth-Oriented Space Activities and Their Legal Implications, Proceedings of the Symposium held on October 15-16, 1981 at the Centre for Research of Air and Space Law, McGill University, pp. 167-199, at p.195.

[3] KNELMAN, *op.cit.*, p.195.

[4] FOLDES, PETER, The Solar Power Satellite - An Overview, *in* Earth-Oriented Space Activities and Their Legal Implications, Proceedings of the Symposium held on October 15-16, 1981 at the Centre for Research of Air and Space Law, McGill University, pp. 123-166., at p.164.

[5] CLARKE, DOUGLAS L., Year in Review 1996: Military Affairs, Encyclopædia Britannica Online. <www.eb.co.uk:180/bol/topic?eu=123843&sctn=1&pm=1>.

This article from International Institute of Space Law is published by Eleven international publishing and made available to anonieme bezoeker

[6] OTA (OFFICE OF TECHNOLOGY ASSESSMENT OF THE UNITED STATES CONGRESS), Solar Power Satellites, NTIS order #PB82-108846, Library of Congress Catalogue Card Number *81-600129*, August 1981, p.157.
[7] PEVLER, A.E., Security Implications of High-Power Microwave Technology, IEE International Symposium on Technology and Society 1997, <www.infowar.com/civil_de/civil_090597a.html-ssi>.
[8] KOPP, CARLO, The Electromagnetic Bomb - A Weapon of Electrical Mass Destruction, *USAF CADRE Air Chronicles, October 1996* <www.hut.fi/~zam/ew/mirror/apjemp.html>.
[9] PEVLER, *op.cit.*
[10] KOPP, *op.cit.*
[11] PEVLER, *op.cit.*
[12] KOPP, *op.cit.*
[13] Most of the "works and installations containing dangerous forces" are electronically controlled; see further the self-defence section.
[14] GERRARD, MICHAEL B.; BARBER, ANNA W., Asteroids And Comets: U.S. And International Law And The Lowest-Probability, Highest Consequence Risk, New York University Environmental Law Journal, 1997 6nyuelj4 Symposium on the Environmental Law Aspects of Space Exploration & Development <www.elj.org/archives/6nyuelj4t.html>.
[15] GOROVE, STEPHEN, International Legal Implications of Solar Energy, *18 Proceedings of the Colloquium on the Law of Outer Space (1975),* pp. 15-17, at p.16.
[16] i.e. components subject to a non-proliferation regime
[17] PEVLER, *op.cit.*
[18] KOPP, *op.cit.*
[19] SUNSAT ENERGY COUNCIL, Space Solar Power Frequently Asked Questions, <www.sunsat-energy.org/Ver.2/sspfaq2.htm>.
[20] FOLDES, *op.cit.,* p.164.
[21] MOSS, RICHARD H., Legal Considerations on the Development and Use of Satellite Solar Power Stations, *20 Proceedings of the Colloquium on the Law of Outer Space (1977),* pp. 374-385, at p.376.
[22] BERTELL, *op.cit.*
[23] FOLDES, *op.cit.,* p.164.
[24] OTA, Solar Power Satellites..., p.157.
[25] OTA, Solar Power Satellites..., p.157.
[26] OTA, Solar Power Satellites..., p.157.
[27] BERTELL, *op.cit.*
[28] EASTLUND, BERNARD J., Mesocyclone Diagnostic Requirements For Thunderstorm Solar Power Satellite Concept, *Proceedings of the Second Conference on the Applications of Remote Sensing and GIS for Disaster Management*, January 19-21, 1999, p.1.
[29] EASTLUND, *op.cit.*, p.2.
[30] *Ibid.*
[31] FOLDES, *op.cit.,* p.164.
[32] BERTELL, *op.cit.*
[33] OTA, Solar Power Satellites..., p.157.
[34] BERTELL, *op.cit.*
[35] FOLDES, *op.cit.,* p.164.
[36] FOLDES, *op.cit.,* p.164.
[37] KNELMAN, *op.cit.,* p.196.
[38] BERTELL, *op.cit.*
[39] DEMBLING, PAUL G.; SMITH, DELBERT D., Solar Power Satellites and Security Considerations: The Case for Multilateral Agreements, *11 Journal of Space Law (1983),* pp. 73 - 82, at p.74.
[40] KNELMAN, *op.cit.,* p.193.
[41] KNELMAN, *op.cit,* p.195.
[42] KNELMAN, *op.cit*, p.196.
[43] FOLDES, *op.cit.,* p.164.
[44] DEMBLING; SMITH, *op.cit.,* p.78.
[45] i.e. sea-bed and ocean floor and subsoil thereof, beyond the limits of national jurisdiction.
[46] DEMBLING; SMITH, *op.cit.,* p.78.
[47] DEMBLING; SMITH, *op.cit.,* p.79.
[48] FINCH, EDWARD R. JR., Energy - Ecospace, *19 Proceedings of the Colloquium on the Law of Outer Space (1976),* pp. 124-134, at p.132.
[49] KNELMAN, *op.cit.,* p.196.
[50] DEMBLING; SMITH, *op.cit.,* p.76.

This article from International Institute of Space Law is published by Eleven international publishing and made available to anonieme bezoeker

[51] SAFAVI, HASSAN, The Legal Aspect Concerning Solar Energy, *21 Proceedings of the Colloquium on the Law of Outer Space (1978),* pp. 67-71, at p.68.
[52] PRADO, M, Environmental Effects - The PowerSat Beam and the Environment <www.permanent.com/p_sps_bm.htm>.
[53] OTA, Solar Power Satellites..., p.157.
[54] PRADO, *op.cit.*
[55] DEMBLING; SMITH, *op.cit.,* p.79.
[56] FASAN, ERNST, Utilization of Energy from Space - Some Legal Questions, *18 Proceedings of the Colloquium on the Law of Outer Space (1975),* pp. 2-6, at p.5.
[57] DEMBLING; SMITH, *op.cit.,* p.74.
[58] BROOKS, EUGENE, Dangers from Asteroids and Comets: Relevance of International Law and the Space Treaties, IISL-97-IISL.3.14, *40 Proceedings of the Colloquium on the Law of Outer Space (1997),* pp. 234-263, at p. 246.
[59] KISH, JOHN, The Law of International Spaces, A. W. Sijthoff, Leiden, 1973, p.185.
[60] BROOKS, *op.cit.,* p.247.
[61] OTA (OFFICE OF TECHNOLOGY ASSESSMENT OF THE UNITED STATES CONGRESS), [Study of the United Nations Moon Treaty] (staff paper, not released publicly by OTA), representing part 3 of the UNITED STATES SENATE, COMMITTEE ON COMMERCE, SCIENCE AND TRANSPORTATION, Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, 96th Congress, 2d Session, Committee Print, U.S. Government Printing Office, Washington D.C., August 1980., p. 328.
[62] OTA, Study of the United Nations Moon Treaty, p.328.
[63] GOLDMAN, NATHAN C., Space Activities: Transforming Space Law, 85-IISL-54, *28 Proceedings of the Colloquium on the Law of Outer Space (1985),* pp. 227-231, at p. 230.
[64] WILLIAMS, MAUREEN, International Law in the Pursuance of Sun Power as a New Source of Energy, *International Relations - The Journal of the David Davies Institute of International Studies (1977),* pp. 24-39., at p.30.
[65] *Ibid.*, p.27.
[66] GEHL, JOHN; DOUGLAS, SUZANNE, Edupage newsletter for 18th June 1999, <www.ee.surrey.ac.uk/Contrib/edupage/current.html>, quoting REUTERS, Panel votes to restrict scrambling technologies, *Baltimore Sun*, Thursday, June 17, 1999.