

## POLICY CONSIDERATIONS FOR THE REGULATION OF SPACE DEBRIS

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### ABSTRACT

While there is as yet no international legal regulation of space debris, an international legal framework exists with which any proposed regulatory scheme will be required to conform. States, technical experts and international organizations are now studying and beginning to develop space debris policy initiatives in this regard. The purpose of this paper is to offer recommendations for consideration when developing space debris policy and to suggest the adjustments to the existing legal regime which will be required in order to implement these policies. The recommendations herein will draw on principles of space law and environmental law, and will be approached from an environmental perspective. Legal principles underpinning the environmental perspective will be discussed.

### INTRODUCTION

Currently, there is no international legal regulation of space debris. Due to the risks space debris presents to manned and unmanned space activities, efforts are now being undertaken by various members of the global space-user community to lay the foundations for addressing the space debris problem. Technical experts are developing methods for reducing the quantity of space debris and advocating voluntary restraint rather than legal regulation.<sup>1</sup> States involved in the use and exploration of outer space are developing policies to address the question of space debris management.<sup>2</sup> International organizations are studying the technical, economic, legal and policy aspects of space debris and its attendant risks.

The purpose of this paper is to offer recommendations for consideration when developing space debris policy and for adjusting the existing legal regime in order to implement these policies. These policy recommendations will be drawn from two areas of law: international space law and international environmental law. The former provides existing principles relating to environmental protection which should be examined

for their application to the space debris issue. The latter provides both developing and accepted principles of law to be considered when developing a regulatory regime for the management of space debris. Additionally, several policy issues which do not conveniently fall into either legal category will be discussed.

### 1. SPACE LAW: PRINCIPLES RELATING TO ENVIRONMENTAL PROTECTION

The major provisions in international space law for protection of the outer space and Earth environments are Article IX of the Outer Space Treaty and Articles 7 and 15 of the Moon Agreement. Other legal principles governing space activities raise issues regarding the definition of space debris, State jurisdiction and control over space debris, international responsibility for space debris, the identification of space debris, liability for damage caused by space debris, nuclear activities and environmental modification, and harmful interference with satellite telecommunications.

#### 1.1. Major Provisions

##### 1.1.1. Article IX of the Outer Space Treaty

Article IX of the Outer Space Treaty<sup>3</sup> may be viewed as the basic provision in space law for environmental protection.<sup>4</sup> As such, space debris is a harm which falls within the Treaty's scope.

Sentence 1 of Article IX applies the general principles of co-operation and mutual assistance to the exploration and use of outer space and further provides that during such exploration and use, due regard should be given to the corresponding interests of all States Parties to the Outer Space Treaty. The principle of due regard would seem to require that States Parties avoid the creation of space debris and attempt to reduce and remove any space debris causing (a) harmful contamination in outer space, including the Moon and other celestial bodies, (b) adverse changes in the Earth's environment, or (c) potentially harmful interference with space activities. These corresponding interests are provided for in sentences 2, 3 and 4 of Article IX. It is not clear, however, whether "corresponding interests" can be found outside Article IX.

Sentence 2 of Article IX provides for the avoidance of both harmful contamination in outer space, including the Moon and other celestial bodies, and adverse changes to the environment of Earth. Given that "harmful contamination" is not defined, it is unclear which types of space debris, if any, come within its scope.<sup>5</sup> As well, neither harmful contamination nor adverse

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changes are prohibited in sentence 2, but rather are to be avoided through the implementation of regulatory controls, where necessary.

Sentences 3 and 4 of Article IX of the Outer Space Treaty apply to scientific, commercial or governmental space activities which may cause potentially harmful interference with space activities of other States.

Under sentence 3, a State Party conducting a space activity has a duty to undertake international consultation, if that State has a reasonable belief that its space activity would prevent the future use of outer space for scientific, commercial or governmental activities. While the consulting State would seem to be obliged to provide information as to the nature of the activity or experiment for which consultation was sought,<sup>6</sup> there is no requirement that the information be either complete or delivered in time for sufficient study prior to consultation. As well, sentence 3 does not provide for consultation procedures; it does not address the question of settling disputes which may arise during the consultation process; nor does it require that any recommendations resulting from consultation bind the parties.

In sentence 4, if a State Party has a reasonable belief, and can demonstrate, that the space activity of another State would prevent the future use of outer space for scientific, commercial or governmental activities, the former State has a right to request consultation. On accession to the request, the requesting State would seem to have a right to receive from the acceding State any additional information as to the nature of the activity for which consultation is sought,<sup>7</sup> although this information need be neither complete nor timely. Sentence 4 is limited in the same manner as sentence 3. Additionally, there is no obligation for the State conducting the activity to accede to the request for consultation.

States need not be space-capable to initiate a sentence 4 request, but would be required to be parties to the Outer Space Treaty. Such States, wishing to raise concerns about space debris, could request consultation if they were able to (1) detect and identify the space debris and (2) determine which space activity of which State was responsible for that debris.

#### 1.1.2. The Moon Agreement

By virtue of its Article 1, the Moon Agreement<sup>8</sup> includes within its scope the Moon, orbits around or other trajectories to or around the Moon, and other celestial bodies in our solar system.<sup>9</sup> It is unclear whether "orbits" and "trajectories" are to be construed as areas of space or as isolated locations in time. Should these terms be interpreted to mean areas of space, then the scope of the Agreement could include all the space in the plane of the Moon's orbit around Earth and enclosed in that orbit, given that a trajectory to the Moon may be plotted anywhere within that plane.<sup>10</sup>

Article 7 of the Moon Agreement<sup>11</sup> enhances the environ-

mental obligations found in Article IX of the Outer Space Treaty through the expression of standards of conduct to be followed on the Moon and other celestial bodies.

Article 7 paragraph 1 provides that the "existing balance" of the Moon's environment is not to be disrupted and that measures are to be taken to avoid harmfully affecting the Earth's environment. The non-disruption of the existing balance would appear to be a more objective standard than that of "potentially harmful interference" with space activities, found in Article IX of the Outer Space Treaty. The former, therefore, may be more conducive to scientific definition.

Article 7 paragraph 2 obliges States Parties to the Agreement to give notice of all preventive measures taken, thereby increasing the effectiveness of the duty to prevent disruption. This notice may be after the fact, except for the placement of radioactive materials, advance notice of which need only be given to the maximum extent feasible.

Article 15 paragraph 2 of the Moon Agreement provides that a State Party may request consultation either if it reasonably believes that another State Party has breached its duties under the Agreement or is interfering with the rights of the requesting State under the Agreement, or if any activity by another State Party causing potentially harmful interference also disrupts the existing balance of the Moon's environment.<sup>12</sup> Any State Party receiving such a request is obliged to enter into consultation without delay and to attempt to seek a mutually acceptable settlement. If such a settlement is not reached, Article 15 paragraph 3 of the Agreement provides that the States Parties involved are obliged to use appropriate peaceful means to settle the dispute.<sup>13</sup>

The Moon Agreement should not be viewed at this time as a dominant force for preventing harms caused by space debris, however. It has been ratified by only eight States, none of which is, thus far, generally considered to be a space power.<sup>14</sup>

#### 1.1.3. Summation

In sum, Article IX of the Outer Space Treaty and Articles 7 and 15 of the Moon Agreement raise several concerns which should be addressed when developing future policy for regulating space debris:

(a) What are the "corresponding interests" of other States? Should these interests be expanded to include the interests of entities not parties to the Outer Space Treaty? Should these interests include the right to a healthy environment and a corresponding right to the preservation and protection of that environment?

(b) How is contamination to be defined? What is the threshold for "harmful" contamination? Should "harmful contamination" and "adverse changes" be prohibited? If not, how strict should regulation be of conduct which could possibly give rise to such contamination and changes?

(c) Should "potentially harmful interference" be objectively defined and determined by an independent scientific body, as was proposed during negotiations for Article IX of the Outer Space Treaty? Should the "disruption of the existing balance" test set out in Article 7 of the Moon Agreement take precedence over the "potentially harmful interference" test in matters concerning space debris and other environmental hazards?

(d) Should non-parties to the Outer Space Treaty or the Moon Agreement have standing to request consultation? Should consultation be mandatory? Should consultation provisions require that relevant information be made available within a specified period of time? Should the trigger for consultation be the test set out in Article IX of the Outer Space Treaty or the broader test found in Article 15 paragraph 2 of the Moon Agreement? If consultations are unsuccessful in resolving an issue, should dispute settlement provisions be provided? Should decisions of dispute arbiters be binding?

(e) What is the scope of application for environmental protection in the vicinity of the moon?

## 1.2. Other Relevant Issues

### 1.2.1. Definition of Space Debris

International space law treaties contain neither a definition nor a description of space debris. To date, there is no agreement on the legal scope of space debris.<sup>15</sup> Yet the growing risk of damage to persons and property in outer space caused by space debris, particularly in low-Earth orbits, the possible confusion over the literal meaning of "debris", and the need to define the scope of debris all suggest the need for a legal term of art.

Such a legal term is not clearly subsumed under an existing space law treaty definition. The logical and reasonable concepts for this purpose are either "contamination", found in Article IX of the Outer Space Treaty, or "space object", to which reference is made in the Liability Convention<sup>16</sup> and the Registration Convention<sup>17</sup>. It is unclear to what phenomena "contamination" refers.<sup>18</sup> Moreover, international law provides no definition for "space object", only a description.<sup>19</sup> As yet, there is no agreement within the legal community as to which classes of space debris, if any, are included implicitly in the terms "space object" and "component parts".<sup>20</sup>

### 1.2.2. Jurisdiction and Control over Space Debris

If effective remedial action is to be included in a regulatory regime for space debris, consideration should be given to the issues of who is authorized to remove space debris from outer space and when such removal is permitted. Article VIII of the Outer Space Treaty provides that the State of registry of a launched object has the right to make and enforce the law (jurisdiction and control) in relation to that object and its personnel, if any, and that ownership of a space object is not affected by its presence in outer space.<sup>21</sup> These provisions

raise several issues which ought to be resolved.

It is not clear which of the technical classes of space debris fall within the scope of Article VIII of the Outer Space Treaty, and to what extent jurisdiction and control over space objects, and therefore space debris, is permanent. Further, if it is assumed that inactive payloads are included within the scope of Article VIII, there is no agreement on what would be an appropriate method for distinguishing active payloads from inactive ones.

Moreover, given that ownership of a space object is permanent, regardless of its use and condition, and given that the rights of ownership include possession, use and disposal, consent of the State of registry would seem to be necessary prior to any attempt by any legal entity to interfere in any way with that space object. States, therefore, may wish to consider whether the doctrine of permanency should apply to space debris, and whether and to what extent consent from the State of registry should be required prior to the removal of an item of space debris.

### 1.2.3. International Responsibility for Space Debris

Article VI of the Outer Space Treaty provides that States are internationally responsible for the activities of their nationals in outer space, whether these nationals are individuals, corporations or governmental.<sup>22</sup> This responsibility would seem to include the duty of States to authorize national space activities (licensing power) and to supervise these activities continually (inspection power).

However, general principles of international law appear to mitigate against using Article VI of the Outer Space Treaty as a tool for addressing the risk posed by space debris. In order to attribute international responsibility to a State, that State must be bound by a legal obligation to conduct a given class of activities in a certain manner.<sup>23</sup> Any regulatory regime establishing such obligations should be as specific as possible.<sup>24</sup> Therefore, an international legal regime, binding States with specific legal obligations, would seem to be necessary before effective international action on the issue of space debris can materialize.<sup>25</sup>

As well, it is not clear to what extent a uniform, international regulatory regime will be affected by the delegation to individual States of authorization and supervisory functions.

### 1.2.4. Detection and Identification of Space Debris

In order to both remove space debris from outer space and hold States accountable for damage caused by space debris entails a method of identifying a State which can be linked to the debris. In space law, identification of space objects is addressed in the Registration Convention.<sup>26</sup>

Identification of space objects involves two phases: detection and identification. The Registration Convention contains no

provisions for detection. Further, it sets out only the most minimal requirements for establishing a system which could positively identify space objects<sup>27</sup> and makes no provision for compulsory markings, although such markings must be registered if they are used<sup>28</sup>.

Serious thought should be given to rectifying these potentially crippling short-comings. Without an adequate international system for detection, avoidance of the risks posed by space debris will be much more difficult. Once detected, adequate means of identifying a space debris object would assist both in obtaining consent for its removal and in attributing liability and providing compensation.

#### 1.2.5. Liability for Damage Caused by Space Debris

The Liability Convention sets out the space law regime for attributing liability and providing compensation for damage caused by space objects. Basically, if a space object causes damage on Earth or to an aircraft in flight, the injured party need not establish fault in order to be compensated by the launching State for the damage.<sup>29</sup> Where damage is caused in outer space, however, liability of the responsible launching State is based on fault.<sup>30</sup> In this case, the injured party will be required to prove, among other things, that the launching State responsible for the damage did not take reasonable steps to avoid that damage.

Negotiations for the Liability Convention were not focused on damage caused in outer space, and did not consider the question of the risks posed by space debris.<sup>31</sup> Consequently, States have not been able to express in an international forum their views on important issues arising from the Liability Convention on the question of damage caused by space debris. Several of these issues may be framed as follows:

(a) Should the meaning of "damage" include damage to the outer space environment per se?

(b) Should the damage caused be reasonably foreseeable, that is, should damage caused by space debris be of a kind that officials in the field would expect to occur in the circumstances of a given fact situation?

(c) Is it reasonable to rely on a liability regime based on fault for damage caused in outer space by space debris?

(d) Should there be restrictions on those who are eligible to make claims for compensation for damage caused in outer space by space debris? Under the Liability Convention, the following claimants would be excluded: non-party States; nationals of a launching State and non-national participants in the space activity of a launching State (Article VII); persons and property not on board a space object (Article III); and where debris identified as belonging to a launching State causes damage to one or more space objects of the same launching State, owners of all damaged space objects (Article III).

#### 1.2.6. Nuclear Activities and Environmental Modification

The Partial Nuclear Test Ban Treaty,<sup>32</sup> Article IV of the Outer Space Treaty and Article 3 of the Moon Agreement, provide for protection to the outer space environment, the Moon and other celestial bodies to the extent that these instruments prohibit nuclear activities in outer space.

Article I of the Partial Nuclear Test Ban Treaty includes a prohibition against all nuclear explosions in outer space.<sup>33</sup> Article IV paragraph 1 of the Outer Space Treaty prohibits the placement of nuclear weapons in orbit around Earth, in outer space or on celestial bodies.<sup>34</sup> Article 3 paragraph 3 of the Moon Agreement clarifies that the Outer Space Treaty prohibition includes the Moon as a celestial body, and expands the scope of that prohibition to include orbits around and other trajectories to or around the Moon.<sup>35</sup>

Taken together, these provisions would appear to prevent the creation of radioactive space debris resulting from deliberate nuclear explosions, whether for military or peaceful purposes. They do not, however, address the potential risks of radioactive space debris, which could arise if active, retired or stored satellites with nuclear power sources on board were involved in collisions or were otherwise fragmented. In addition, these provisions bind only States Parties to the agreements and do not exclude the possible use of space debris as a means of maintaining national security.

The Environmental Modification Convention<sup>36</sup> prohibits military or other hostile uses of techniques which, through deliberate manipulation, could change the dynamics, composition or structure of outer space.<sup>37</sup> It is unclear whether the application of this treaty is restricted to States Parties. If so, the regulatory effectiveness of the Convention could be severely limited. As well, environmental modification techniques may be used for peaceful purposes, as permitted by international law.<sup>38</sup>

#### 1.2.7. Harmful Interference with Satellite Telecommunications

The ITU Convention<sup>39</sup> and its accompanying Radio Regulations make no provision for protection of the outer space environment per se. While the ITU Convention does provide for avoidance of harmful interference with the radio frequencies of transponders on board space objects, this interference must be caused by the operating radio station of a space object.<sup>40</sup>

Given that it is an operating radio station on board the space object, and not space debris created by that station, which must cause the harmful interference, the ITU Convention would not seem to apply to situations in which interference is caused by space debris.

Despite this apparent legal limitation, the International Radio Consultative Committee ("CCIR") of the International Telecommunication Union ("ITU") undertook a study on physical interference resulting from collisions with and blockages by space debris and recommended that further studies

be undertaken to develop a sound strategy for the disposal of "dead" satellites.<sup>41</sup> In June 1992, Working Party 4A of Committee 4 of the CCIR approved a recommendation that satellites in the geostationary orbit ("GEO") should be transferred at the end of their lives to a "supersynchronous graveyard orbit" at an altitude of at least 300 km above GEO.<sup>42</sup>

## 2. THE ENVIRONMENTAL PERSPECTIVE

Space debris is a potential environmental harm arising from space activities and therefore should be regarded in law as such. Given that international law applies to space law,<sup>43</sup> principles of environmental law found both in customary international law<sup>44</sup> and in treaties and other international legal instruments ought to be considered when developing a regime for the management of space debris. Taken together, these principles constitute the environmental perspective. This section sets out an overview of some principles which provide the foundations for this perspective.

Treaties and other similar instruments bind States parties to the obligations contained therein. Customary international law is merely persuasive to varying degrees and therefore does not create binding legal obligations for States. Nevertheless, binding and non-binding legal instruments both contribute to a valuable pool of options in the search for elements to propose for inclusion in future international environmental instruments. The following principles are presented with this purpose in mind.

### 2.1. Avoid Injury to your Neighbours

Perhaps the best-known principle of customary international environmental law is set out in Principle 21 of the Stockholm Declaration, a non-binding international instrument. Principle 21 provides that States have the sovereign right to exploit their resources according to "their own environmental policies", and also have a responsibility to ensure that their activities do not cause damage to the environment of States beyond their jurisdiction or control.<sup>45</sup> This responsibility extends not only to the territory of other States, but also to the territories beyond the jurisdiction of any State. These latter territories are known as the global commons, one of which is outer space.

This principle has recently been restated as Principle 2 of the Rio Declaration, a non-binding international instrument signed in June 1992 at the Earth Summit held in Brazil.<sup>46</sup> The language of Principle 2 of the Rio Declaration is identical to that of Principle 21 of the Stockholm Declaration, except in one important respect. The latter has been amended so that the sovereign right of States to exploit their own resources is now according to "their own environmental and developmental policies". While this amendment appears to reflect the influence of the principle of sustainable development, to be discussed below, its interpretive effect on the language of Principle 21 is unclear.

### 2.2. The Precautionary Principle

A second, oft-cited principle characterizes the harms which States are required to avoid. In the Trail Smelter arbitration, it was held that a State has a duty to avoid acts causing damage to the territory of other States, if the damage is serious and can be established by "clear and convincing evidence".<sup>47</sup> This standard is a difficult one to meet. First, there is no objective test according to which the seriousness of the damage can be determined. Second and more important, establishing damage by clear and convincing evidence requires the strict application of a "cause and effect" model of evidence based on a balance of probability (that is, 51 per cent). This model is unsuited to the determination of environmental damage. Because damage to the environment is often systemic in nature and therefore becomes evident only after a lengthy period of time, a statistical analysis model based on the probability of risk would appear to be more appropriate.<sup>48</sup>

The growing awareness that a fresh basis is required for proving causation in environmental law gave rise to the development of the precautionary principle, which basically says that "rather than await [scientific] certainty, regulators should act in anticipation of environmental harm to ensure that this harm does not occur ...".<sup>49</sup>

More recently, the precautionary principle has been incorporated in two global international instruments on the environment, both signed at Brazil's Earth Summit: Principle 15 of the Rio Declaration<sup>50</sup> and Article 3 paragraph 3 of the Climate Change Convention<sup>51</sup>. Both provisions limit the application of this principle to cases where the threat of damage is "serious or irreversible". While the provision as it appears in the Rio Declaration is written in a mandatory form, it has no legal force due to the Declaration's non-binding nature. In the Climate Change Convention, a binding international treaty which is not yet in force, the application of the precautionary principle is discretionary.

### 2.3. Prevention and Protection

The traditional approach in international law for remedying damage has been based on the general principle that the State responsible for the damage compensates the injured State on the basis of restitution.<sup>52</sup> Prevention of damage, a central remedy of domestic environmental law in many States, was introduced into the international context as a result of the Lac Lanoux arbitration<sup>53</sup>. The tribunal held that where the use of a shared resource by one State threatens the use of that resource by the other State, the threatening State has a duty to take into account the interests of the State which possibly could suffer damage. This general duty includes a duty to co-operate, a duty to notify and inform and a duty to consult and negotiate.<sup>54</sup> These obligations can now be found in numerous regional international environmental treaties, as well as in the global Vienna Convention on the ozone layer and the Climate Change Convention. The strength of each obligation varies according to the circumstances.

## 2.4. Sustainable Development

In 1983, the United Nations Environment Program established the World Commission on Environment and Development in response to the awareness at the time that State activities had the potential to cause substantial harms to the global environment and, hence, to humanity. The Commission's findings were published in 1987 and are now known as the Brundtland Report<sup>55</sup>.

One of the Report's major conclusions is that sustainable development is necessary for survival of the planet Earth. Sustainable development is viewed as development which meets human needs and, at the same time, protects and conserves the natural environment.<sup>56</sup> A corollary to the sustainable development principle is that all development decisions require that the effect of any development on the environment be taken into consideration. This corresponding principle provides the rationale for environmental impact assessments.

The principle of sustainable development is by no means an altruistic statement ascribing a value to the environment independent of man.<sup>57</sup> Rather, sustainable development is clearly an expression of man's self-interest and, from this perspective, can be seen as economic development which does not harm the environment in order that the biosphere's resources, both renewable and non-renewable, will be available for exploitation by future generations.<sup>58</sup>

## 2.5. Managing Environmental Harms

### 2.5.1. Substantive Principles

To date, *ad hoc*, *laissez faire* techniques have not been successful in dealing with the risks of harm to the environment. Increasingly, general principles for environmental planning and management have been finding their way into global international instruments concerned with environmental law, more noticeably in its non-binding instruments.

The need for environmental management was set out in Principle 2 of the Stockholm Declaration<sup>59</sup> and has been restated in Principle 4 of the World Charter for Nature<sup>60</sup> and in Proposed Legal Principle 3, annexed to the Brundtland Report<sup>61</sup>.

Some basic principles for environmental management are incorporated into one or more of the non-binding instruments mentioned thus far. These principles include management of both renewable and non-renewable resources,<sup>62</sup> the requirement for environmental impact assessments,<sup>63</sup> monitoring for harms,<sup>64</sup> ecological waste management (reduce, reuse and recycle),<sup>65</sup> co-operative inter-State environmental planning,<sup>66</sup> prior notice of and consultation on activities which could have potentially adverse transboundary environmental effects,<sup>67</sup> co-operative development of legal remedies<sup>68</sup> and the sharing of scientific information and technology<sup>69</sup>.

### 2.5.2. The Ozone Layer Regime

The principles mentioned thus far in this section form the general framework for international environmental law and suggest basic rules for managing environmental harms. In recent years, there has been some movement toward the development of global treaty regimes for regulating specific activities which are causing or which are likely to cause specific types of environmental damage. These instruments include the Vienna Convention, its Montreal Protocol and the Climate Change Convention.

Perhaps the most important international agreements to date for the future development of both general principles of international environmental law and regulatory regimes for environmental management are the Vienna Convention<sup>70</sup> for protection of the ozone layer and its accompanying Montreal Protocol<sup>71</sup> on substances that deplete the ozone layer.

The Vienna Convention is a framework agreement, containing general principles applicable to the regulation of any substances which States Parties may agree could have adverse effects on the ozone layer. The Montreal Protocol provides specific control measures for chlorofluorocarbons (CFCs), substances which could have adverse effects on the ozone layer. In June 1990, the Montreal Protocol was amended to accelerate the phase-out of CFCs, to add other ozone depleters to the ban list and to provide financial support to participating Third World countries.<sup>72</sup>

The framework convention-supplementary protocol(s) structure of the ozone layer regime, with its "step-by-step" approach to regulation of environmental harms, is becoming more common in environmental treaty-making.<sup>73</sup> In fact, the recently signed Climate Change Convention reflects the first major step in this process, with its official title reflecting its status as a framework convention.<sup>74</sup> However, unlike the Vienna Convention, the Climate Change Convention sets no timetable for the reduction of greenhouse gases, nor is it accompanied by a protocol for regulating any specific greenhouse gas.

The Vienna Convention also is significant for its potential effect in international environmental law on the general legal principle that a State must be bound by a legal obligation to conduct a given class of activities in a certain manner in order to have international responsibility attributed to it.<sup>75</sup> An exception to this general rule may be found in the doctrine of abuse of rights. This doctrine provides that compensation for damage caused by State activities may arise as a consequence of State activities which are not unlawful according to that State's laws.<sup>76</sup>

The doctrine of abuse of rights is not considered to be a general principle of positive law, but rather a useful agent in developing the law.<sup>77</sup> In the realm of international environmental law, this doctrine could prove to be a useful tool for curtailing activities which have adverse affects on the environment: The doctrine partially erodes the sovereign (exclusive) right of a State to exploit its own resources, if damage occurs outside that State as a result of resource exploitation undertaken pursuant to lawful

acts of that State. Such an erosion of State sovereignty seems reasonable in an environmental context, given that environmental harms cannot be defined in terms of State boundaries.

In the Vienna Convention, it would appear that a version of the doctrine of abuse of rights is found in the "General Obligations" section of the agreement. Article 2 paragraph 1 and Article 2 paragraph 2(b), read together, provide that States are obliged under certain conditions to regulate lawful activities that are found to have or could have adverse effects on the ozone layer.<sup>78</sup>

### 3. SPACE-ENVIRONMENT HYBRID ISSUES

Space debris and its potential effects raise several issues which cannot be conveniently categorized as belonging to the domains of either space law or environmental law. However, in order to deal efficiently and effectively with the policy concerns raised by space debris, the following matters are offered for consideration.

#### 3.1. Ecological Waste Management

Assuming that some form of consent can be obtained for removing space debris objects,<sup>79</sup> methods will have to be developed to dispose of them. Given the environmental imperative, it is fitting that any space-debris disposal system be based on ecologically-sound principles of waste management. The following principles should be considered:

- (a) An ecological waste management system for space debris should provide, where possible, for the reduction, reuse and recycling of space debris objects.
- (b) **Reduction** of space debris ought to be accomplished in part by preventing its creation.
- (c) **Removal** techniques should be devised for space debris objects. These techniques should rely on planned and controlled re-entry, retrieval or disposal.
- (d) Reliance for removal of space debris should not be placed on natural decay techniques.
- (e) **If space debris is recyclable**, efforts should be made to recover the objects by re-entry or retrieval methods. If suitable methods for re-entry or retrieval do not yet exist, active payloads should be placed in temporary storage orbits at the end of their lifetimes to be recovered when the necessary technology has been developed.
- (f) **If space debris is unrecyclable** due to economic or technological factors, unmanned or manned collection systems should be developed to recover and dispose of the objects. Disposal options could include planned and controlled decay,

solar furnaces or solar disposal.

(g) Disposal options should exclude solar system escape and placement in solar orbit.

(h) Disposal in outer space of any radioactive, hazardous or other Earth-based waste should not be an option.

#### 3.2. Earth Orbits as Natural Resources

Current space law makes no mention of low-Earth orbits (LEOs). There is, therefore, a need to determine the legal status of LEOs. There is currently no question that space debris could interfere with the increased levels of activity forecast for LEOs in the near future.<sup>80</sup>

Accordingly, LEOs should be considered limited natural resources, given that space object placement in LEOs affords technical and economic advantages, and in view of the fact that manned space activities in LEOs are restricted to altitudes between 200 and 1,000 km, due to physical and biological factors.<sup>81</sup> To ensure that all States can make optimum use of these limited natural resources, use of LEOs should be subject to any environmental management regime for the regulation of space debris.

#### 3.3. Use of Nuclear Power Sources in Outer Space

The use of nuclear power sources (NPS) in outer space is not prohibited. Given the danger posed by radioactive materials to both living and non-living environments, efforts should be made to avoid collisions with, or any other exposure to, space objects with NPS which pose a risk of radioactive contamination. The following principles should be given consideration:

- (a) Use of nuclear power sources in space objects (NPS objects) should be prohibited, pending the development of economically and technologically suitable alternatives.
- (b) During the time when NPS objects are in use, they should be designed for use and subsequent storage in nuclear safe orbits (NSOs).
- (c) NSOs should contain only NPS objects, and should be regulated as to their number, orbital parameters, and radioactive content.
- (d) When NPS objects no longer pose any risk of radioactive contamination, they should be removed from outer space according to the principles governing the ecological waste management regime.<sup>82</sup>

#### 3.4. Military or Other Hostile Uses of Space Debris

Current space law does not exclude the possible use of space debris as a means of maintaining national security. Very little

attention has been given to the effect of such a use.<sup>83</sup> As yet another means by which the Earth and outer space environments could be seriously or irreversibly contaminated, there is a need to avoid military or other hostile uses of space debris.

Consideration should be given to prohibiting the potential military use of space debris as an offensive weapon and as a camouflage agent. Consideration also should be given to extending this prohibition to environmental modification techniques using space debris, and to any other hostile use of space debris.

## CONCLUSION

Technology is, like Janus, two-faced. It has declared dominion over the natural resources of Earth, has shaped them to humankind's will and, in so doing, has created untold benefits for the inhabitants of this planet. Yet this very same technology carries with it a destructive potential, too often actualized in recent years. Space debris is the space-based manifestation of this dichotomy: the first space environmental problem.

A by-product of the technological magnificence that gave rise to

the space age, space debris currently is recognized by leaders in the space-user community as posing a genuine risk to the use of outer space, with the potential to render useless the limited natural resources of the geostationary orbit and certain low-Earth orbits. This international symposium, a co-operative undertaking with the aims of addressing the risks posed by space debris and seeking solutions to this serious problem, is a powerful confirmation of this concern.

International space law and international environmental law are relatively new legal domains. They are still flexible and fresh enough to contribute significantly to the creation of forward-looking, innovative, practical law and policy both of which acknowledge humanity's urge to explore and create, yet at the same time accept the consequences of the ecological reality that humankind and its activities are a part of nature and not above or beyond it.

If the international community of nations has the collective will to avoid in outer space the problems that technology has thus far spawned, or if such a will can be fostered and encouraged, then perhaps we will see the development of principles of international environmental space law and the creation of a space debris management regime that will serve as an example to future generations in outer space and on Earth.

## ENDNOTES

1. For a comprehensive introduction to the technical aspects of space debris, see N.L. Johnson and D.S. McKnight, Artificial Space Debris (Orbit Books 1987).

2. The two major policy statements to date on space debris are European Space Agency, Space Debris Working Group, Space Debris, SP-1109 (ESA November 1988) and United States, Interagency Group (Space), Report on Orbital Debris (Washington, DC February 1989). But see also, United States, General Accounting Office, Report to the Chairman, Committee on Science, Space, and Technology, House of Representatives, Space Program: Space Debris a Potential Threat to Space Station and Space Shuttle, GAO/IMTEC-90-18 (Washington, DC April 1990) and United States Congress, Office of Technology Assessment, Orbiting Debris: A Space Environmental Problem -- Background Paper, OTA-BP-ISC-72 (Washington, DC September 1990).

3. **Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies**, United Nations General Assembly ("UNGA") Res. 2222 (XXI) 19 December 1966; 610 UNTS 205, 1967 CanTS 19, 18 UST 2410, TIAS 7762 (opened for signature 29 March 1967, entered into force 10 October 1967).

4. Article IX of the Outer Space Treaty, supra, note 3, states:

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 co-operation 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. States Parties to the Treaty shall pursue studies of outer space, including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose. If a State Party to the Treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, including the Moon and other celestial bodies, would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space,



including the Moon and other celestial bodies, it shall undertake appropriate international consultations before proceeding with any such activity or experiment. A State Party to the Treaty which has reason to believe that an activity or experiment planned by another State Party in outer space, including the Moon and other celestial bodies, would cause potentially harmful interference with activities in the peaceful use and exploration of outer space, including the Moon and other celestial bodies, may request consultation concerning the activity or experiment.

5. The author uses four categories for classifying space debris: inactive payloads (former payloads which can no longer be controlled by their operators), operational debris (objects associated with space activities, remaining in outer space), fragmentation debris (products of explosions and collisions) and microparticulate matter (a catch-all category including micron-sized objects, such as solid-propellant rocket motor effluent, paint flakes and thermal coatings, and spacecraft-induced phenomena such as outgassing of heavy molecules and space glow). See Howard A. Baker, Space Debris: Legal and Policy Implications (Nijhoff 1989) 3-9.

6. United Nations, General Assembly Official Records ("UN GAOR"), Committee on the Peaceful Uses of Outer Space (COPUOS), Fifth Session of the Legal Sub-Committee, A/AC.105/C.2/SR.68 (USSR, 13 July 1966) 7.

7. Id.

8. **Agreement Governing Activities of States on the Moon and Other Celestial Bodies**, UN GAOR, A/RES/34/68 (5 December, 1979); opened for signature 18 December 1979, entered into force 11 July 1984.

9. Article 1 of the Moon Agreement, supra, note 8, states:

1. The provisions of this Agreement relating to the moon shall also apply to other celestial bodies within the solar system, other than the earth, except in so far as specific legal norms enter into force with respect to any of these celestial bodies.

2. For the purposes of this Agreement reference to the moon shall include orbits around or other trajectories to or around it.

10. R.T. Swenson, "Pollution of the Extraterrestrial Environment" (1985), 25 Air Force LR 70 at 81-82.

11. Article 7 of the Moon Agreement, supra, note 8, states in part:

1. In exploring and using the moon, States Parties shall take measures to prevent the disruption of the existing balance of its environment, whether by introducing adverse changes in that environment, by its harmful contamination through the introduction of extra-environmental matter or otherwise. States Parties shall also take measures to avoid harmfully affecting the environment of Earth through the introduction of extraterrestrial matter or otherwise.

2. States Parties shall inform the Secretary-General of the United Nations of the measures being adopted by them in accordance with paragraph 1 of this article and shall also, to the maximum extent feasible, notify him in advance of all placements by them of radioactive materials on the moon and the purposes of such placements.

12. Article 15 paragraph 2 of the Moon Agreement, supra, note 8, states:

A State Party which has reason to believe that another State Party is not fulfilling its obligations incumbent upon it pursuant to this agreement or that another State Party is interfering with the rights which the former State has under this agreement may request consultations with that State Party. A State Party receiving such a request shall enter into such consultations without delay. Any other State which requests to do so shall be entitled to take part in the consultations. Each State Party participating in such consultations shall seek a mutually acceptable resolution of any controversy and shall bear in mind the rights and interests of States Parties. The Secretary-General of the United Nations shall be informed of the results of the consultations and shall transmit the information received to all States Parties concerned.

13. Article 15 paragraph 3 of the Moon Agreement, supra, note 8, states:

If the consultations do not lead to a mutually acceptable settlement which has due regard for the rights and interests of all States Parties, the parties concerned shall take all measures to settle the dispute by other peaceful means of their

choice appropriate to the circumstances and the nature of the dispute. If difficulties arise in connection with the opening of consultations or if consultations do not lead to a mutually acceptable settlement, any State Party may seek the assistance of the Secretary-General [of the United Nations], without seeking the consent of any other State Party concerned, in order to resolve the controversy. A State Party which does not maintain diplomatic relations with another State Party concerned shall participate in consultations, at its choice, either itself or through another State Party or the Secretary-General as intermediary.

14. As of 20 February 1992, the eight States Parties to the Moon Agreement were Australia, Austria, Chile, Mexico, The Netherlands, Pakistan, Philippines and Uruguay.

15. For the author's approach to the technical classification of space debris, see, supra, note 5.

16. **Convention on International Liability for Damage Caused by Space Objects**, UNGA Res. 2777 (XXVI) 29 November 1971; 1975 CanTS 7, 24 UST 2389, TIAS 7762 (opened for signature 29 March 1972, entered into force 9 October 1973).

17. **Convention on Registration of Objects Launched into Outer Space**, UNGA Res. 3235 (XXIX) 29 November 1971; 1976 CanTS 36, 28 UST 695, TIAS 7762 (opened for signature 14 January 1975, entered into force 15 September 1976).

18. See, supra, text accompanying note 5. For an analysis of the term "contamination" as it appears in Article IX of the Outer Space Treaty, see Baker, supra, note 5, text accompanying notes 358-364 and 410-416.

19. Both Article I(d) of the Liability Convention, supra, note 16, and Article I(b) of the Registration Convention, supra, note 17, state:

The term "space object" includes component parts of a space object as well as its launch vehicle and parts thereof.

20. K. Spradling, "Space Debris: The Legal Regime, Policy Considerations and Current Initiatives", at 4. A paper prepared for presentation at the 28th Aerospace Sciences Meeting, American Institute of Aeronautics and Astronautics, 8-11 January 1990, Reno, Nevada, USA.

21. Article VIII of the Outer Space Treaty, supra, note 3, states:

A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object and over any personnel thereof, while in outer space or on a celestial body. Ownership of objects launched into outer space including objects landed or constructed on a celestial body, and of their component parts is not affected by their presence in outer space or on a celestial body or by their return to earth. Such objects or component parts found beyond the limits of the State Party to the Treaty on whose registry they are carried shall be returned to that State Party, which shall, upon request, furnish identifying data prior to their return.

22. Article VI of the Outer Space Treaty, supra, note 3, states:

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

23. I. Brownlie, Principles of Public International Law, 3d ed. (Clarendon Press 1979) 434-435.

24. Brownlie, supra, note 23 at 441.

25. Some elements to be considered for inclusion in such a legal regime will be discussed, infra, in "2. The Environmental Perspective".

26. For an analysis of the Registration Convention, see A.J. Young, "A Decennial Review of the Registration Convention" (1986), 11 Annals Air & Space L 287.

27. Only Article IV of the Registration Convention, supra, note 17, indicates the nature of the information to be registered with the United Nations. It states:

1. Each State of registry shall furnish to the Secretary-General of the United Nations, as soon as practicable, the following information concerning each space object carried on its registry:

- (a) Name of launching State or States;
- (b) An appropriate designator of the space object or its registration number;
- (c) Date and territory or location of launch;
- (d) Basic orbital parameters, including:
  - (i) Nodal period;
  - (ii) Inclination;
  - (iii) Apogee;
  - (iv) Perigee;
- (e) General function of the space object.

2. Each State of registry may, from time to time, provide the Secretary-General of the United Nations with additional information concerning a space object carried on its registry.

3. Each State of registry shall notify the Secretary-General of the United Nations, to the greatest extent feasible and as soon as practicable, of space objects concerning which it has previously transmitted information, and which have been but are no longer in earth orbit.

28. Article V of the Registration Convention, supra, note 17, states:

Whenever a space object launched into earth orbit or beyond is marked with the designator or registration number referred to in article IV, paragraph 1(b), or both, the State of registry shall notify the Secretary-General of this fact when submitting the information regarding the space object in accordance with article IV. In such case, the Secretary-General of the United Nations shall record this notification in the Register.

29. Article II of the Liability Convention, supra, note 16, states:

A launching State shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft in flight.

30. Article III of the Liability Convention, supra, note 16, states:

In the event of damage being caused elsewhere than on the surface of the earth to a space object of one launching State or to persons or property on board such a space object by a space object of another launching State, the latter shall be liable only if the damage is due to its fault or the fault of persons for whom it is responsible.

31. See B. Cheng, "Convention on International Liability for Damage Caused by Space Objects" in N. Jasentuliyana and R.S.K. Lee (eds), Manual on Space Law: Volume I (Oceana 1979) 83 at 83-84, and H. Reis, "Some Reflections on the Liability Convention for Outer Space" (1978), 6 J Space L 126 at 127.

32. Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water, 14 UST 1313, TIAS 5433 (5 August 1963).

33. Article I paragraph 1(a) of the Partial Nuclear Test Ban Treaty, supra, note 32, states:

Each of the Parties to this Treaty undertakes to prohibit, to prevent and not to carry out any nuclear weapon test explosion, or any other nuclear explosion, at any place under its jurisdiction or control in the atmosphere; beyond its limits, including outer space; or under water, including territorial waters or high seas.

34. Article IV paragraph 1 of the Outer Space Treaty, supra, note 3, states:

States Parties to the Treaty undertake not to place in orbit around the earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner.

35. Article 3 paragraph 3 of the Moon Agreement, supra, note 8, states:

States Parties shall not place in orbit around or other trajectory to the moon objects carrying nuclear weapons or any other kinds of weapons of mass destruction or place or use such weapons on or in the moon.

36. **Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques**, UNGA Res. 31/72 (10 December 1976); 610 UNTS 151, 31 UST 333, TIAS 9614 (opened for signature 18 May 1977, entered into force 5 October 1978).

37. Article I paragraph 1 of the Environmental Modification Convention, supra, note 36, states:

Each State Party to this Convention undertakes not to engage in military or 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.

Article II states:

As used in article I, the term "environmental modification techniques" refers to any technique for changing -- through the deliberate manipulation of natural processes -- the dynamics, composition or structure of the earth, including its biota, lithosphere, hydrosphere and atmosphere, or of outer space.

38. Article III paragraph 1 of the Environmental Modification Convention, supra, note 36, states:

The provisions of this Convention shall not hinder the use of environmental modification techniques for peaceful purposes and shall be without prejudice to the generally recognized principles and applicable general rules of international law concerning such use.

39. **International Telecommunication Convention -- Nairobi, 1982** (Geneva: ITU, 1982).

40. Article 35 paragraph 1 of the ITU Convention, supra, note 39, states:

All stations, whatever their purpose, must be established and operated in such a manner as not to cause harmful interference to the radio services or communications of other Members or of recognized private operating agencies, or of other duly authorized operating agencies which carry on radio service, and which operate in accordance with the provisions of the Radio Regulations.

Harmful interference has been defined as "[a]ny emission, radiation, or induction which endangers the functioning of a radio navigation service or of other safety services, or seriously degrades, obstructs or repeatedly interrupts a radiotelecommunication service operating in accordance with the Radio Regulations", in R.S. Jakhu, The Legal Regime of the Geostationary Orbit (Doctoral dissertation, McGill University, Montreal, Canada, 1983) note 141.

41. International Telecommunication Union, International Radio Consultative Committee, Report to the Second Session of the World Administrative Conference on the Use of the Geostationary-Satellite Orbit and the Planning of the Services Utilizing It (Geneva 1988) 70.

42. International Telecommunication Union, International Radio Consultative Committee, Working Group 4, Working Party 4A, Draft New Recommendation, "Environmental Protection of the Geostationary Orbit", CCIR Study Groups Doc. 4A/TEMP/92(Rev.2)-E (29 May 1992). It is the author's understanding that if ultimately approved by the members of the ITU, the recommendation would become a standard practice, with compliance on a voluntary basis.

When considering environmental matters, GEO "may be defined as the mean earth radius of 42,164 km +/- 300 km and extending to 15 degrees N/S latitude or a distance of approximately 10,000 km". Ibid., Annex I, paragraph (d).

43. Article III of the Outer Space Treaty, supra, note 3, states:

States Parties to the Treaty shall carry on activities in the exploration and use of outer space, including the moon and other 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 co-operation and understanding.

44. Generally, customary international law arises when there is a general recognition among the States in question that a certain practice is obligatory. See Brownlie, supra, note 23 at 4-12.

45. United Nations, Conference on the Human Environment, Report of the UN Conference on the Human Environment, "Declaration of the United Nations Conference on the Human Environment" (Stockholm Declaration), A/CONF.48/14 (1970), 2-65 and Corr 1 (1972). The Stockholm Declaration is reprinted in (1972), 11 Int'l Leg. Materials 1416. Principle 21 of the Stockholm Declaration, ibid., states:

States have, in accordance with the United Nations and the principle of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.

46. United Nations, Conference on Environment and Development, Adoption of Agreements on Environment and Development, "The Rio Declaration on Environment and Development" (Rio Declaration), A/CONF.151/5/Rev.1 (13 June 1992). The Rio Declaration is reprinted in (1992), 31 Int'l Leg. Materials 876.

47. United States and Canada (Trail Smelter Arbitration) (1931-1941), 3 RIAA 1905 at 1965.

48. For a discussion of the need for alternative proofs of causation when producing evidence in, inter alia, environmental litigation, see J.G. Fleming, "Probabilistic Causation in Tort Law" (1989), 68 Can. Bar Rev. 661.

49. D. Bodansky, "Scientific Uncertainty and the Precautionary Principle" (September 1991), Environment 4 at 4.

50. Principle 15 of the Rio Declaration, supra, note 46, states:

In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

51. United Nations Framework Convention on Climate Change (opened for signature on 9 May 1992), reprinted in (1992), 31 Int'l Leg. Materials 851. Article 3 paragraph 3 of the Climate Change Convention states:

The Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures, taking into account that policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost. To achieve this, such policies and measures should take into account different socio-economic contexts, be comprehensive, cover all relevant sources, sinks and reservoirs of greenhouse gases and adaptation, and comprise all economic sectors. Efforts to address climate change may be carried out co-operatively by interested parties.

52. In Chorzow Factory (Indemnity) (1928), PCIJ, Ser. A, no. 17, the Permanent Court of International Justice stated at 47:

The essential principle contained in the actual notion of an illegal act -- a principle which seems to be established by international practice and in particular by the decisions of arbitral tribunals -- is that reparation must, as far as possible, wipe out all the consequences of the illegal act and re-establish the situation which would, in all probability, have existed if that act had not been committed. Restitution in kind, or, if this is not possible, payment of a sum corresponding to the value which a restitution in kind would bear; the award, if need be, of damages for loss sustained which would not be covered by restitution in kind or payment in place of it -- such are the principles which should serve to determine the amount of compensation for an act contrary to international law.

53. France v. Spain (Lac Lanoux Arbitration) (1957), 12 RIAA 281, trans. in (1959), 53 Am J Int'l L 156.

54. It should be noted that in both Trail Smelter and Lac Lanoux, an agreement was already in place for the settlement of disputes arising during arbitration.

55. UN GAOR, Report on the World Commission on Environment and Development, A/42/427 (4 August 1987) (Brundtland Report), reprinted as World Commission on Environment and Development, Our Common Future (Oxford University Press 1987).

56. See Our Common Future, *supra*, note 55 at 43-46.

57. Such an altruistic view is set out in the non-binding "World Charter for Nature", UNGA Res. 37/7 (28 October 1982), reprinted in (1983), 22 Int'l Leg. Materials 455. The third preambular section to the Charter states in part:

Convinced that ... [e]very form of life is unique, warranting respect regardless of its worth to man, and, to accord other organisms such recognition, man must be guided by a moral code of action, ...

58. See Principles 2 and 3 of the "Summary of Proposed Legal Principles for Environmental and Sustainable Development", as annexed to the Brundtland Report, *supra*, note 55. Principle 2 provides that conservation and use of the environment is "for the benefit of present and future generations". Principle 3 provides that in using the environment's resources, States "shall observe the principle of optimum sustainable yield". Principle 4 of the World Charter for Nature, *supra*, note 57, also refers to management of resources in order "to achieve and maintain optimum sustainable productivity".

59. Principle 2 of the Stockholm Declaration, *supra*, note 45, states:

The natural resources of the earth including the air, water, land, flora and fauna and especially representative samples of natural ecosystems must be safeguarded for the benefit of present and future generations through careful management or planning, as appropriate.

60. Principle 4 of the World Charter for Nature, *supra*, note 57, states:

Ecosystems and organisms, as well as the land, marine and atmospheric resources that are utilized by man, shall be managed to achieve and maintain optimum sustainable productivity, but not in such a way as to endanger the integrity of those other ecosystems or species with which they coexist.

61. Principle 3 of the Annex to the Brundtland Report, *supra*, note 55, states:

States shall maintain ecosystems and ecological processes essential for the functioning of the biosphere, shall preserve biological diversity, and shall observe the principle of optimum sustainable yield in the use of living natural resources and ecosystems.

62. Stockholm Declaration, *supra*, note 45, Principles 3-5; World Charter for Nature, *supra*, note 57, Principles 1-4.

63. Brundtland Report, *supra*, note 55, Principle 5; Rio Declaration, *supra*, note 46, Principle 17.

64. World Charter for Nature, *supra*, note 57, Principles 19, 21(b); Brundtland Report, *supra*, note 55, Principle 4.

65. World Charter for Nature, *supra*, note 57, Principles 10, 12.

66. Stockholm Declaration, *supra*, note 45, Principles 13, 26; World Charter for Nature, *supra*, note 57, Principle 21(a); Brundtland Report, *supra*, note 55, Principles 14, 18; Rio Declaration, *supra*, note 46, Principle 7.

67. Brundtland Report, *supra*, note 55, Principles 6, 16 and 17; Rio Declaration, *supra*, note 46, Principles 18, 19.

68. Stockholm Declaration, *supra*, note 45, Principle 22; Rio Declaration, *supra*, note 46, Principle 13.

69. Stockholm Declaration, *supra*, note 45, Principle 20; Brundtland Report, *supra*, note 55, Principle 15; Rio Declaration, *supra*, note 46, Principle 9.

70. **Vienna Convention for Protection of the Ozone Layer**, UN GAOR, UNEP/IG.535 (opened for signature 22 March 1985, entered into force, 22 September 1988), reprinted in (1987), 26 Int'l Leg. Materials 1516.
71. **Protocol on Substances that Deplete the Ozone Layer** (opened for signature 16 September 1987, entered into force 1 January 1989), reprinted in (1987), 26 Int'l Leg. Materials 1541.
72. See, **Adjustments and Amendments to the Montreal Protocol on Substances that Deplete the Ozone Layer**, UN GAOR, UNEP/OzL. Pro.2/3 (opened for signature 29 June 1990, not yet in force; 20 ratifications required, 2 States have ratified (Canada, New Zealand)), reprinted in (1991), 30 Int'l Leg. Materials 537. See also, L.B. Talbot, "Recent Developments in the Montreal Protocol on Substances that Deplete the Ozone Layer: The June 1990 Meeting and Beyond" (1992), 26 Int'l Lawy. 145. By November 1992, many States were calling for the phase out of the production and consumption of CFCs by the end of 1995, rather than the previous target set for the start of the year 2000. "CFC Curbs May Be Advanced" (11 November 1992) Globe and Mail (Canada), National Edition at A8.
73. W. Lang, "Environmental Treaty-making: Lessons Learned for Controlling Pollution of Outer Space", at 18, 42. A paper presented at the Symposium on Preservation of Near-Earth Space for Future Generations, 24-26 June 1992, Chicago, Illinois, USA.
74. See, supra, note 51.
75. See, supra, "1.2.3. International Responsibility for Space Debris".
76. Brownlie, supra, note 23, at 443.
77. Brownlie, supra, note 23 at 445.
78. Article 2 paragraph 1 and Article 2 paragraph 2(b) of the Vienna Convention, supra, note 70, state:
  1. The Parties will take appropriate measures in accordance with the provisions of this Convention and those protocols in force to which they are party to protect human health and the environment against adverse effects resulting or likely to result from human activities which modify or are likely to modify the ozone layer.
  2. To this end the Parties shall, in accordance with the means at their disposal and their capabilities:
    - ...
      - (b) Adopt appropriate legislative or administrative measures and co-operate in harmonizing appropriate policies to control, limit, reduce or prevent human activities under their jurisdiction or control should it be found that these activities have or are likely to have adverse effects resulting from modification or likely modification of the ozone layer
      - ...
79. See, supra, "1.2.2. Jurisdiction and Control over Space Debris".
80. See, eg, United States, General Accounting Office, Report to the Chairman, Committee on Science, Space, and Technology, House of Representatives, Space Station: Delays in Dealing with Space Debris May Reduce Safety and Increase Costs, GAO/IMTEC-92-50 (Washington, DC June 1992).
81. See Baker, supra, note 5 at 23.
82. See, supra, "3.1. Ecological Waste Management".
83. In their major policy statements on space debris, neither the United States nor the European Space Agency raises the question of military or other hostile uses of space debris. See, European Space Agency, Space Debris, supra, note 2 and United States, Report on Orbital Debris, supra, note 2. For references to military or other hostile uses of space debris, see, Office of Technology Assessment, Orbiting Debris: A Space Environmental Problem -- Background Paper, note 2 at 42 and Baker, supra, note 5 at 19-22.