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1. **The Environment & Space Study**

Man’s fascination with space exploration and the fiction brought to life over decades by the creativity and imagination of Hollywood, has, over time, spurred even more interest in the possibilities that exist outside of the Earth’s orbit. The origins of space exploration began in the decades prior to 1958, and up to that time was considered a military venture. The American government’s launch of the national Aeronautics and Space Act in 1958 however moved space exploration to take on a broader purpose – that of scientific research and observation. The National Aeronautics and Space Act regulates all activities that pertain to space exploration.

Space exploration however has consequences on economic cost, social impacts and environmental impacts to name a few. It is therefore important that as a world society, we consider the impacts that space exploration can have on the environment.

Every satellite or rocket that is launched into space has a small impact on the planet and the stratosphere, as it emits chemicals which have proven to be contributory factors to the depletion of stratospheric ozone. Rocket engines emit reactive gases that cause ozone molecules to break apart. They also discharge microscopic particles of soot and aluminium oxide, which may increase the rate at which those gases wreak havoc on the environment. The designs of the engines that propel the satellites also matter and have an impact on the environment. But perhaps of most significance is the high level of pollutants which are dumped by space craft’s directly into the upper and middle stratosphere, where the damage can start immediately.

Rocket launches however account for approximately one percent of the total ozone depletion that can be attributed to human causes. That percentage may rise, however, as more traditional pollutants, like CFCs, start to fade from the atmosphere with the implementation of the 1987 [**Montreal Protocol**](http://en.wikipedia.org/wiki/Montreal_Protocol)[[1]](#footnote-1)). IT is expected that over time the number of launches—for purposes of exploration, tourism, and space-based solar power (PDF)—is expected to increase. This area of space exploration is at this time unregulated, and Scientists predict that if left unregulated, by the year 2050, rocket launches could result in more ozone destruction than was ever realized by CFCs.

The expected stratospheric damage has the potential to increase rates of skin cancer and cataracts. While it might be argued that the level of CO2 emissions from space ships might not have a significant impact on the environment, compared with other modes of transport such as aircrafts and motor vehicles, the microscopic particles of soot and aluminium oxide might. Their existence in the stratosphere might be a few years compared with centuries for carbon dioxide, on a per-unit-of-mass basis, they can change the radiation balance in the atmosphere.

Of equal importance is the debris, including old batteries, jettisoned components, and human refuse that is left behind. NASA estimates that there are upward of 500,000 pieces of debris larger than one centimetre currently orbiting the planet.

1. **The Militarization of Space and International Law**

Since the inception of space exploration, military activities and aspirations, particularly of the leading world powers have been dominant. Hollywood’s fictional predictions and speculations appear to be part of arms race and arms control discussions.

It is estimated that approximately 75% of all satellites orbiting earth are performing mainly military tasks such as surveillance, early-warning, communications and navigation. The military importance of satellites has in turn inspired military planners to develop anti-satellite systems. And the feasibility of various space- based weapon systems to be used against targets on the ground or against attacking strategic missiles has from time to time been studied in defence departments. These developments have implications not only for the use of space as such but also for the strategic balance between the leading great powers.

It is important that strategic control of space become a priority of the world powers, including the USA, UK, Russia and China among other countries including my home country of New Zealand. This priority must embrace the matter of anti-satellite weapons as an important part of any strategic plan to control the use of space. The USA’s administration under President Obama’s (soon to be led by a new President), National Missile Defence (NMD) agenda includes space-based NMD systems, which will likely be useful ASAT systems as well.

The United Nations Conference on Disarmament has expressed strong and unanimous opposition to weaponization of space. China and Russia have also begun the drafting of a treaty to ban space weapons. Interestingly though, the United States has refused to enter negotiations on such a treaty. In spite of this apparent resistance however, it is likely that weaponization of space might begin in the foreseeable future, unless there is organised international opposition to the approach. While no comprehensive treaty about space weapons is currently in place, there does exist a legal framework.

Some of the International Treaties that address aspects of the space weapons issue include, the 1967 Outer Space Treaty which represents the second “non-armament” treaty. The first three articles of the Outer Space Treaty of 1967 set principles for the use of space, while the remaining articles guide the behaviour of treaty parties. The first three Articles stipulates that the exploration and use of outer space will be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development and shall be the province of all mankind; it shall be free for exploration and use by all without discrimination and in accordance with international law, and allow free access to all planets. They also state that there should be freedom of scientific investigation in outer space and the facilitation and encouragement of international co-operation. Under these Articles no nation can claim ownership or sovereignty of any part of space through occupation or any other means, and that parties to the Treaty shall carry out their exploration activities in accordance with international law, including the Charter of the United Nations, and in the interest of maintaining international peace and security an promoting international co-operation and understanding.

Articles IV onward deal specifically with the matter of nuclear weapons or any type of weapon of mass destruction (WMD) and prohibits the testing and deployment of any kind of weapon on the moon or other planet; the establishment of military bases and testing of any type of weapon or conduct of military manoeuvres is forbidden. Parties to the Treaty are also responsible for the national activities carried out by corporations and non-governmental agencies of their country and states that recourse that countries would have against nations that are perceived as perfuming non-peaceful activities. This recourse includes possible legal action.

Apart from the 1967 Outer Space Treaty, there are five other Treaties which address space issues. These are: The Limited Test Ban Treaty of 1963 which prohibits nuclear tests and other nuclear explosions in the atmosphere or outer space; the Astronauts Rescue Agreement of 1968 which requires the safe return of astronauts and objects launched into space to their country of origin; the Liability Convention of 1972 established procedures for determining the liability of a state that damages or destroys the space objects of another state; the Registration Convention of 1976 which requires the registration of objects launched into space and the Moon Agreement of 1984, which began the establishment of a regime for exploiting the natural resources of space.

For over 22 years the UN General Assembly has passed resolutions calling for the continued peaceful use of space and the prevention of an arms race in space. Most of these resolutions have been unanimous and without opposition, though interestingly the United States and a few other governments, including Israel, have abstained. Their abstinence has the potential to send a message that they might be supportive of an arms race in space, which is worrying given the strength and power of the United States in world politics.

There have been moves over the last ten years to fill the legal gaps which exist, through proposals from Canada and many Non-Governmental Organisations. New Zealand, is encouraged to play its part in filling these gaps through legal intervention and the enactment of internal legislation in support of the UN resolutions regarding the peaceful use of space. New Zealand is also encouraged to collaborate with other countries such as Australia and Canada to draft working papers in this regard which can be presented to the next UN Conference on Disarmament.

1. **Space Commercialization**

In a special report the Financial Times described space travel as the new frontier. Space travel by private citizens could signal the advent of space commercializing. Commercialization howver would require significant outlay of investment and passionate interest has already been demonstrated by Richard Branson of Virgin, Elon Musk and Jeff Bezos all of whom possess the material wealth to make it a commercial reality with a profit motive.

Investors and entrepreaneurs would however need to find a way to make the venture commercially viable so that it could attract mainstream citizens and become almost a commodity as vacation travel. Once successful experiment has been the Falcon 9 rocket built by SpaceX, which was founded by Elon Musk, launched a rocket that delivers a commercial payload to the international Space Station and returns the rocket’s first stage via a soft landing in the Atlantic Ocean. This venture is a first step at commercialisation from a business point of view, but could lead to mass commercialisation in the future. Blue Origin, founded by Jeff Bezos aims to reduce the cost of space flight as does Richard Branson, whose goal is to develop space tourism.

One of the big issues to overcome would be the safety issue, especially in light of the crash of Virgin Galactic’s Space Ship 11 in which a pilot died. This and other accidents however succeed in placing additional focus on the safety and reliability concerns and improving performance.

The more recent focus on miniaturisation in the form of “cubesats” used for weather forecasting, could be an early step in mass commercialisation of space. Clyde Space based in Glaslow, Scotland produce cubesats that can be used for multiple purposes at a cost of US$50,000 each, compared with US$100 million for a single-purpose satellite. One of the potential commercial uses for small satellites includes better observation of things happening on earth as they occur. It would be important that the relevant rockets can be mass produced, which would reduce the cost significantly.

The commercialisation of space however can have its pitfalls, and can be exploited by the rich and powerful nations and people to the exclusion of others, in spite of the UN Treaty, which focuses mainly on Governments and not the private sector. It is recommended that New Zealand lead the charge in collaboration with other nations and non-governmental organisations in the formulation of controls and regulations for commercial space businesses, legal challenges to what are thought to be abuses or transgressions by businesses operating in space and government regulating or controlling the access to space. We also recommend that there be a focus on longer term solutions which involve education and ensuring that those wanting to conduct business in space have the requisite space experience. This would be a mammoth task, and may not occur in our lifetime, but it is important that the work commences now as we continue to build a better world for generations to come and open up space in a way never seen before, while ensuring that it is protected from exploitation.

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1. **The Montreal Protocol on Substances that Deplete the Ozone Layer is a protocol to the Vienna Convention for the Protection of the Ozone Layer, enforced in 1989, designed to protect the ozone layer by phasing the production of numerous substances that are responsible for ozone depletion.**  [↑](#footnote-ref-1)