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The International Politics of Orbital Debris: A Case Study of Governance in Space

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Abstract

This thesis is an examination of the governance of near Earth space, specifically focusing upon the problem of orbital debris. The debris population is constituted of objects which are trapped in the Earth's orbit, due to the enormous velocities at which they travel their presence poses a threat to active space programmes. This analysis identifies the technical parameters of the problem, however its principle focus is the political environment within which it exists. Therefore, it examines the existing governance which manages human activity in space. This specifically addresses space law and the institutions which regulate behaviour in near Earth space. The complexities of rights of use in the global Commons, along with the outstanding questions relating to them, are examined as they form an important aspect of political framework within which the problem exists.

The theoretical analysis draws upon debates surrounding the management of common resources. This contrasts the approaches of Garrett Hardin and Elinor Ostrom which are examined both in terms of their theoretical assertions and their ability to relate to the empirical evidence.

The latter stages of the thesis focus upon the response to debris that has been witnessed; the focal of which is the Inter-Agency Debris Co-ordination Committee (IADC), which is central to the collective response to orbital debris. As such it has aided the formation of the norms and values which characterise the social environment within which the problem is addressed.

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Introduction

Space, as Douglas Adams observed, is big.[1] However space debris, or orbital debris as it is also known,[2] is not to be found in the vastness of the cosmos, it is confined to the relatively small area of Earth orbit, which is also referred to as near Earth space. In this location it poses a serious threat. Debris is the product of human activity, as such it has been accumulating since the first satellites achieved orbit in the late 1950s. As early as 1967 the former US Secretary of State Dean Rusk commented, with reference to dead objects in orbit, '[t]here is an awful lot of junk up there at this time.'[3] In the years which have followed the amount of 'junk', and the speed at which it travels, has become identified as a serious threat.

This thesis is an examination of the implications of debris not; from a technical perspective, rather it seeks to question the political framework within which the problem exists. The knowledge base drawn upon is not that of the natural sciences, instead the research addresses issues largely located within the discipline of International Relations. Primarily the narrative will explore themes of governance and cooperation between political actors. The thesis is primarily ideational in nature as the inquiry focuses upon the knowledge based epistemic community which has formed in response to the debris problem. In turn this leads to a study of the Inter-Agency Debris Co-ordination Committee (IADC), which is a creation of the episteme and has been the primary mechanism for international cooperation. The empirical evidence found will create an understanding of the governance of near Earth space, which will facilitate an examination of the conditions under which cooperation occurs when a resource is shared between sovereign actors.

Examining the social environment surrounding the debris problem cannot be meaningfully conducted in isolation. During the last five decades the increasing amount of human activity in near Earth space has created a set of norms, both formal and informal, which collectively constitute a governance regime. This thesis seeks to analyse this evolving regime, through focusing upon debris. Although the response to debris is only one part of

[1] Douglas Adams; *The Hitch-Hiker's Guide to the Galaxy* (London: Heinemann, 1995), p. 63.
[2] The two terms are used interchangeably to refer to same subject. Orbital debris is more accurate, as the problem with the objects referred to is that the Earth's gravity has trapped it in the planet's orbit. However, the former term is more widely used. Here within they are both used and are considered to convey the same meaning.
[3] Quoted in Carl Q. Christol; 'Protection of Space from Environmental Harms' *Annals of Air and Space Law* Vol. IV (1979), p. 434.

this regime, it is an increasingly important aspect, therefore analysis of the debris problem reveals much concerning the broad governance of near Earth space.

Debris is a current and unresolved problem which poses a threat to humanity's continued utilisation of space based resources. Remedial action in the present will prevent a crisis from emerging in the future. However, although the examination of the politics surrounding space debris is of interest in relation to the formation of policy, it also poses questions of a theoretical nature concerning the utilisation of resources which are outside the boundaries of sovereign states. Within the discipline of International Relations it draws upon the themes of international cooperation, governance and the nature of epistemic communities.

The Problem of Recognition

When the implications of debris were first realised, by a relatively small group of technical experts, the most pressing issue in addressing the problem was recognition. It can often occur that such problems are conceived as being contained with the realms of science fiction. However, debris is a serious and current geo-political issue, in need of a concerted international response. Space debris is not related to contact with extra-terrestrials or the conquest of other planets, it is a direct product of human activity.

Problems which have association with space are frequently dismissed as fanciful extrapolations from science fiction. The British Liberal Democrat MP, Lembit Opik, has raised issues surrounding the potential damage of a meteorite impact upon Earth, doing so within the realms of the political is regarded at a minimum as idiosyncratic.[4] Alternatively, it is seen as ridiculous. However, when objectively analysed, without the presence of the word 'space', the problem can be seen as a natural threat which has the potential to kill thousands, along with the mass destruction of property and infra-structure. In such terms governmental action investigating the problem appears to be perfectly reasonable, indeed it can be viewed as no more exotic than the erection of the Thames barrier to prevent flooding.

An initial consideration of orbital debris could readily assume that it is no more serious a threat than meteorite damage. Indeed, as debris remains in space the threat could

[4] 'BBC News profile Lembit Opik' < http://news.bbc.co.uk/1/hi/uk_politics/2121896.stm >.

be perceived as even more remote. Space is unimaginably vast, as such how could a lost bolt pose a serious threat? This thesis will show that debris poses a serious technical problem, the remedy to which requires an examination of a political and legal problem. It cannot be simply dismissed on the basis that it exists in space, indeed it will be shown that space based resources are of such importance that economically the preservation of the space environment is vital. As a threat to human life and society, debris poses a far smaller threat than a major meteorite impact, however the problem is more immediate and whereas the effects of such a meteorite impact are subject to speculation there is a broad consensus concerning the dangers associated with debris.

The Usefulness of Analysing Space Policy

Analysing the policies that states adopt in their exploitation of space, and the management of the debris problem, is an interesting academic exercise in itself, however its usefulness can be measured on a larger scale. It can be reasonably assumed that, in the near future, an increasing amount of human activity will be conducted in space. This incorporates several areas: commercial, scientific and military. However, the rules and conditions under which this activity will be conducted are far from being an ontological given, rather they will be created both through negotiation and more importantly as a consequence of action. The initial ideas which contributed to the emerging governance of space were formed soon after the ability to place objects in orbit was achieved, the essential principles of space law being contained in the *Outer Space Treaty* (1967). However, the problem of debris presents a relatively early instance, in the era of space flight, when positive action is required by all actors in order to resolve a collective problem. Due to the inherent tendency of international law, and more generally state policy, to be formed with reference to precedent, the ultimate response to debris will be informative as to how future state interactions in space may occur. Therefore, through an analysis of the regime which is emerging in response to the debris problem, an indication can be seen as to the larger system of governance by which future human action in space will be managed.

The majority of international agreements and treaties tend to be in response to a specific issue, they are attempting to resolve a problem, or pre-empt one, in so doing they

are reactive.[5] However, in the instance of the emerging space regime, there is a strong argument that the shape of the future is still unknown. It could not be denied that it is known who the principle state actors in future space operations will be, however to an extent the state of ignorance remains because it is not known how they will seek to exploit space to their individual interest. Further, the commercial benefits of space technology are not known, which leads to a lack of knowledge concerning what opportunities will be available. Therefore, when governmental organisations actively create governance structures for space they reveal an indication of how they envisage future interactions. In the specific arena of space policy, evidence can be found which contributes to the classical international relations debate between Realism and Liberalism. What is unique about this forum is that space policy, although influenced by precedent, commences to a limited extent, from a pre-social condition. The lack of directly applicable historical precedent creates a large degree of flexibility; from the point when human activity first spread into space it was possible that a Realist state of nature or a Liberal regime would be constructed as a consequence of the courses of actions chosen.

The Larger Political Environment

Space is legally considered to be part of the global Commons. The principle that national sovereignty would not, and should not, apply to outer space has been present throughout debates concerning space law. In the ten years prior to the completion of *The Outer Space Treaty*, the United Nations General Assembly repeatedly voted to this effect.[6] Domestically within the United States the fundamentally international character of space was acknowledged in some of the first legislation concerning its usage. The United States Communications Satellite Act of 1962 declared that communications technology should be used to serve all countries.[7] Resources located in the global Commons are unique in an area of private property and Westphalian states; they are not owned by an individual neither are they incorporated within the boundaries of a state. As such their governance presents a range

[5] An argument could be made that such documents as the UN Charter, which seek to establish general norms of international society constitute 'blue sky' thinking. However, the UN Charter was a response to the failure of the League of Nations, and the events of the Second World War, and was therefore reactive. It is the assertion of this thesis that the overwhelming majority of international treaties, which could be seen as not dealing with a specific problem, are in fact reflections of a problem which have occurred relatively recently to the negotiation of the treaty.

[6] Eilene Galloway; 'Applicability of Space Treaties to Uses of Outer Space' *Annals of Air and Space Law* Vol. 1 (1976) p. 207.

[7] *Ibid.* p. 206.

of problems which would not be present if they were located within a homogenous territorial political unit.

The problems associated with debris, and the implications which responses towards it have, do not exist in complete isolation, they reflect other issue areas producing an interchange of values. However, it is not merely other resources which are typically thought of as being Commons, such as the High Seas and the atmosphere, with which parallels can be drawn. The difficulties concerning the management of common resources are to be found in many forms of social interaction. Instances which require collective action interact with the same problems which are associated with the global Commons. For example, if one person evades paying their fare on public transport, it would make very little difference to the collective situation. If the example of the London Underground is considered, then millions of people use the service and one person not paying for their journey will have very little effect in terms of the total revenue of Transport for London. In this instance the individual is literally a free rider; society as a whole (or at least the vast majority of those travelling on the Underground) are carrying the costs involved in providing the service. The individual not paying their fare is receiving the benefit of travelling but is not bearing any of the cost (assuming that they are not caught). Indeed, if the person can be certain that they will not be caught, then not paying their fare is the economically rational course of actions (setting aside any legal or moral arguments) because they will receive the same service but will not incur any financial burden.

In such an instance, the actions of one individual make very little difference to the collective outcome. However, there is a critical tipping point, when a significantly large number of people evade paying their fare then financially the whole system will collapse. This can be considered to be 'the tragedy of the Commons'; it is individually rational for every individual not to pay their fare but the collective outcome is the resource being lost to all users. Clearly, the provision of ticket barriers, and inspectors is intended to stop such an instance from occurring. The important factor is that behaviour which is rational for one will have little effect, but when that behaviour is replicated by a large number of people it results in the destruction of common resources. In order to preserve such resource means of regulating individuals' behaviour is required.

Political problems, of a global nature similarly are associated with the preservation of common resources. In this arena they become more complex because they do not occur under the sovereignty of one state. Thus, when considering the problem of global climate change and the carbon emissions of aircraft, the option of imposing taxation upon aviation fuel is politically complex as it would require concerted action by several states, not only to be effective but also in order to be acceptable to various domestic electorates. However, there does appear to be a change occurring, wherein previously radical approaches towards the global Commons are becoming 'thinkable' within the mainstream. In October 2005 President Chirac of France proposed an aviation fuel tax, the funds generated would be used to aid development programmes.[8] In part this suggestion is founded upon the fact that aviation fuel is damaging a common resource, therefore the money 'paid' for the 'right' to damage that resources should be distributed to those most in need. Such a notion conceptualises common resources as being owned by every-one rather than no-one.

Examination of space debris, and the larger issue of governance in near Earth space, reflects the issues associated with any common resource. It therefore draws upon other policy areas, whilst simultaneously contributing to the general understanding of the means by which common resources can be managed.

Historic Location

Terrestrial environmental problems are cumulative in nature. For example it is impossible to accurately consider the destruction of the Amazon rainforest without placing it in its historical context. In order to aid economic development Western and central Europe states reduced their forests from 95% of the land mass to 20% at present, whilst the United States cleared 75% of its forest within 100 years after 1790.[9] Thus the social processes which have led to the current situation of global climate change have historic origins which can be traced from the decline of nomadism and the rise of agriculture. Hence the argument that developing states should limit deforestation of their territory has to answer the counter position that developed states have already destroyed their forests and enjoyed the resulting economic benefits, albeit in ignorance of the global environmental effects. Developing states

[8] 'The Westminster Hour' BBC Radio Four 30th October 2005.
[9] Clive Ponting; 'Historical perspectives on sustainable development' *Environment* Vol. 32, No. 9 (November 1990), p. 4.

are simply following the same course of actions, the difference being that by the point when they acted the long term effects where known.

When considering the damage to Earth orbit, a similar course of events is witnessed. It is the states which first had the ability to launch objects into orbit that have polluted the environment of near Earth space, in so doing they have enjoyed the commercial and military benefits associated with its utilisation. As such the capacity of states which have not had active space programmes to utilise near Earth space has been adversely effected.

There is a difference between the two instances; the consequences of global climate change will effect all states. At present most states will remain largely unaffected by the direct effects of debris. Although it will ultimately have economic effects upon all states, they will be borne disproportionately by those whose economies are dependent upon space based technologies. As such, should the worst case debris scenario occur and several orbits become useless, unlike global climate change it would not pose a threat to life upon the planet. The direct effect of space debris, being focused upon a small number of states, is not merely a quantitative change from the problem of global climate change, it also has a qualitative effect upon the possible outcomes. Over a longer timeframe, it is to be presumed, that more states will wish to utilise space based resource. However, at present it is a relatively small number who are doing so and they are responsible for the active response to the debris problem.

Geographic Location

Although the physical location of debris is not a matter of debate, the social environment within which it exists is one in which geographic factors are in flux. 'Globalisation' is a term so often used that it has become almost without meaning. However, there are certain features which appear to be common to most academic usage of the term John Baylis and Steve Smith identify the key areas in which a new form of globalised politics can be seen as:

1. There has been an economic transformation, such that 'national economies' are no longer closed.

2. Communications have been completely transformed, such that there are instant global telecommunications; as a consequence an event can have repercussions on the other side of the planet.
3. A global culture is emerging, such that urban areas throughout the planet now resemble each other.
4. Meanwhile, the world is increasingly becoming homogenous, the differences between different peoples are disappearing.
5. Time and space are seemingly collapsing. Modern communications are making previous notions of geography and chronology irrelevant.
6. There is an emergence of a 'global polity' which is challenging the traditional notion that politics is practiced within the nation state. This process is manifest in the transference of allegiances to sub-state, transnational and international bodies.
7. Individuals are beginning to develop a sense of a cosmopolitan culture, in which local actions have an impact upon global issues.
8. There is a growing emergence of a 'risk culture' which perceives threats that are coming into existence, such as environmental degradation, as global in nature and recognises the inability of states to resolve such problems.[10]

The issue of debris is fundamentally interwoven with the phenomenon of globalisation. Although the purpose of this thesis is not to reflect upon notions of globalisation, its consideration is important as it provides the social background against which the problem exists. As such it is not only useful for interpretative purposes but also as it contributes to the framework within which policy makers and academics operate.

The communications revolution, the spread of a global culture and the collapse of space-time, are only technologically possible because of the utilisation of near Earth space. In short, should the debris problem escalate to the worst case scenario, in which it is no longer possible to utilise near Earth space for the purposes of telecommunications, the process of globalisation would be significantly slowed.

Meanwhile, the presence of debris is a clear example of the new 'risk culture'; it is literally a global problem, which states cannot individually redress. The new emerging

[10] Steve Smith and John Baylis; 'Introduction' in Steve Smith and John Baylis (eds.); *The Globalisation of World Politics* (Oxford: Oxford University Press, 1997), p. 9.

problems can be seen, in part, to be a product of the spread of human activities, to the extent that they almost entirely cover the planet. This is coupled with an interconnectedness which undermines territorial sovereignty has made states extremely sensitive to events at great distance. This interconnectedness increases the difficulty of states in attempting to take unilateral action. The nature of the debris problem is such that states are both sensitive to each other's actions, and they are unable to resolve the problem individually.

An aspect of the globalisation phenomenon absent from the debris problem is the role of private individual citizens, and emergent political associations which undermine traditional state-orientated models. Most probably because the issue does not have an immediate and identifiable effect upon individuals there is virtually no public knowledge or interest in the subject. The problem of space debris has not been characterised by the emergence of a new form of polity of concerned individual citizens, however the existence of the epistemic community, and its actions, shows a new form of polity emerging which defies traditional conceptions of political boundaries. The collective response to debris is founded upon a small number of individuals, not a mass movement, and their behaviour is a challenge to the manner in which International Relations as a discipline traditionally conceptualises the world. There is no evidence of a transference of allegiance away from the state, but events are occurring which cannot be properly analysed through the sole model of the sovereign state.

Ontology

States are the primary actors with reference to space policy, as it is they who have the capacity to create space law and norms which are associated with it. Further, objects which are launched into orbit are done so under the authority of states, as such states act as the gatekeepers to Earth orbit. This control, by states, is demonstrated in the fact that private organisations wishing to place an object into orbit require a licence from a state. Therefore the state will be the primary focus of attention, or rather the governments of states. This is not to make a Realist claim that states are natural, inevitable or permanent, rather it is an acknowledgement of the role which states play in the governance of near Earth space.

However, the analysis will move beyond simply examining 'the state'. Through broadening the ontology, a network of institutions will be found that are located within

different territorial boundaries and have constructed a shared normative framework in order to address the debris problem. The examination of this governance regime will reveal that it is the product of a strong and active epistemic community, which has coalesced around a scientific consensus and a recognition of the need for coordinated and collective action. In so doing it raises questions as to whether the broader governance of near Earth space is being changed or transformed.

Methodology

The research conducted for this thesis has drawn upon a wide variety of sources. The knowledge base which has been drawn upon has comprised elements from astronautical science, international law and International Relations.

Current political debates concerning the utilisation of space often focus upon the issue of military weaponisation. Although this is undoubtedly one of the most important issues concerning space, this thesis does not address it, other than when it has direct implications for the debris problem. There are two basic justifications for this; firstly weaponisation is a vast issue in its own right and secondly the responses to the two issues are very different in character. They exist in broadly the same social sphere, however the defining feature of the debris problem has been a strong cooperative initiative, whereas weaponisation is characterised by different actors having objectives which are not mutually compatible. In broad terms, interaction with reference to debris is positive-sum, whereas concerning weaponisation it is zero-sum.

A large advantage when researching debris, as opposed to weaponisation, is the availability of information. Data concerning debris is not militarily sensitive, therefore it is largely available in the public domain.[11] Conducting research into the political framework within which debris is addressed has been largely without bureaucratic impediment, not least because the major conferences concerning debris are open to academics and there is a general high level of access to technical experts and policy makers. Such direct engagement

[11] It has been suggested that during the Cold War the USSR was reluctant to reveal its capacity to monitor debris, as doing so would have exposed that its tracking system was poor, which had obvious implications concerning incoming Inter-Continental Ballistic Missiles.

has allowed the thesis to be constructed upon evidence from both primary and secondary sources.

The conduct of the inquiry has engaged with an ideational element. It has been explicitly accepted that ideas, conceptualisations and norms play an important role in the response to debris. The analysis also considers the role of material factors, specifically in the form of structural forces which limit the ability of actors to behave according to their own volition; most specifically such factors are considered with reference to Waltzian neo-Realism. Although structural factors are considered, they are not considered to be prohibitive to new social forms being created. Therefore, it has been possible for an evolution of the governance of near Earth space to occur, such that it can respond to circumstances as they change.

Structure of the Thesis

The problem of debris is a new arena in which policy is being created. The chapters in this thesis will seek to analyse the problem by drawing up the literature of International Relations, complemented by a an analysis of rights of use, the technical aspects of the problem and space law. In so doing the intention is to firstly understand the specific problem which debris presents, then map the existing governance which exists in near Earth space and finally to examine the governance regime being constructed to address the debris problem.

The first chapter presents two differing approaches to the Commons. The first is Garrett Hardin's approach, known as 'the tragedy of the Commons'. Hardin argues that open Commons will be over used and therefore remorselessly fall into tragedy. This is contrasted with the work of Elinor Ostrom, who argues that under certain circumstances cooperation will occur when individuals are utilising a common resource. They are frequently utilised approaches to common resources and they present very different perspectives. Hardin's work is founded upon Rational Choice Theory; Ostrom develops this into a 'second generation' wherein different possibilities emerge.

The second chapter examines the technical aspects of the debris problem. This is not intended as a contribution to the natural sciences and their understanding of debris. The

purpose of the technical aspects in the chapter is only to clarify the parameters of the problem, such that the political implications can be properly understood. The examination reveals that although there are potential technical solutions, they cannot constitute a holistic remedy.

In the following two chapters the problem is placed into context through an examination of space law and the institutions which govern near Earth space and their relationship to debris. This provides an understanding of the existing governance of space, as space law provides the basic principles upon which it is founded and the institutions have created specific interpretations of those legal provisions.

The examination then moves forward to consider the issues related to the 'rights of use in space'. To a large extent this is an area which is unresolved, as the basis upon which resources can be utilised is not entirely clear. Rights of use are important in any social circumstance, but they are especially important when considering debris because the manner in which a resource is utilised has an effect upon the environment within which that resource is located.

Having established the background detail concerning debris, the active international response to debris is then considered. This will reveal that the existing institutions have engaged with the debris problem and sought to contribute to ameliorating the problem. Meanwhile, a specific institution, the Inter-Agency Debris Co-ordination Committee (IADC), has been formed in order to provide a framework within which a common scientific understanding of the problem can be developed and the appropriate response can be identified.

The final chapter will consider the broad implications of the debris problem. Specifically, it will consider the empirical evidence in relation to the theoretical approaches offered by Hardin and Ostrom. Further, it will seek to understand what knowledge can be extracted from the debris problem to be applied to the discipline of International Relations. The primary question being asked is whether the debris problem has a unique set of characteristics or whether extrapolations can be made from it concerning the manner in which interaction occur in the international sphere.

Summary

The purpose of this thesis is to map the existing near Earth space governance structure with specific reference to orbital debris. It also considers the evolution of governance which is occurring such that the debris problem can be successful addressed. In doing so it draws upon debates concerning the global Commons, and seeks to make a contribution to the literature concerning their governance. As the debris problem has not yet been resolved, this thesis charts the course which policy has thus far taken, drawing upon technological and scientific issues, along with debates internal to the discipline of International Relations.

Chapter One:
Differing Approaches to the Commons:
Garrett Hardin and Elinor Ostrom

Introduction

Although relatively short, Garrett Hardin's essay *The Tragedy of the Commons* has been hugely influential.[12] However, it is far from being universally accepted. As will be shown, Elinor Ostrom develops the themes and arguments proposed by Hardin in order to present a radically different conceptual outcome.

The essential question that both authors are addressing is the manner in which resources that are not private property can be conceptualised; in turn this leads to a question of whether they can be successfully managed whilst being communally owned.

It is important to consider the differing approaches when conducting research into common resources, such as near Earth space. Ultimately, they present visions in which there is no capacity for real cooperation and therefore communal resources will be destroyed, or that there are means through which individual actors can recognise their shared interests and therefore a common purpose in preserving resources.

This chapter will commence with Hardin's theory, in part because it appeared first chronologically. More importantly because much of what has been written since it was published, including Ostrom's work, concerning the Commons has been in response to Hardin's thesis. Having presented the notion of a 'tragedy of the Commons', the possibility of cooperation in an environment were actors are free to behave as they wish will be examined, through the work of Robert Alexrod. Finally, the work of Ostrom will be examined in detail in order to appreciate the conditions and environment within which she asserts that cooperation is possible.

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[12] Garrett Hardin; 'The Tragedy of the Commons' *Science* Vol. 162 (December 1968). For example, it has been reproduced over fifty times in journals and collected volumes, Gordon Foxall; 'A Note on the Management of the Commons' *Journal of Agricultural Economics* Vol. 30, No. 1 (1979), p. 55.

Hardin's Position

The essence of Hardin's reasoning is that individuals using a common resource will, by individually rational acts, produce a collectively irrational outcome. By means of illustration he conceptualises a Common pasture, in which the rational act for every individual actor is to introduce one more animal to the herd. The individual will gain the positive utility of owning the extra animal for which the cost, in terms of land usage, will be shared by all who use the pasture. Once an extra animal has been added to the land, it then becomes logical for the individual to add another head of cattle and so on. However, should every individual pursue this course, then the Common land will become over exploited and useful to no one.[13] Thus, Hardin's tragedy is that any free Commons will inevitably become a wasted resource, and this occurs due to every individual making a rational choice.

In abstracted terms it can be considered that Hardin's argument has applied the logic of Rational Choice Theory (RCT) to the specific instance of a shared pasture. RCT conceptualises agents as behaving in a rational manner in order to maximise their goals. However, this does not mean that actors will always behave in the same way; they will act in a manner which maximises their goals. Two different actors may have different goals. Therefore, if an agent has a preference for oranges, they will behave in a manner that maximises the number of oranges available to them; whilst an agent who favours apples will similarly attempt to maximise their access to that fruit. However, because both have different objectives they will behave in different ways. In their pursuit of fruit, one would go to a tropical climate and the other to a temperate zone. Although they behave differently, they still are both behaving rationally. In Hardin's example this matter is simplified as all agents are attempting to maximise the number of cattle which they own, and therefore the amount of profit which they can make. As all agents have the same objective, so they will all behave in the same manner.

Within Hardin's conceptualisation there are two means to avoid tragedy, both of which require a new form of governance to have control over the resource. Either the Common can be ruled by a leviathan, or it can be privatised.[14] In each of these instances responsibility ceases to be collective, either it is assumed entirely by the power of which all

[13] Hardin, *op. cit.*, p. 1244-1245.
[14] *Ibid.* p. 1245.

stand in awe or alternatively, individual actors are granted exclusive responsibility for a specific part of the Common. Each route creates a new sovereignty; through privatisation there are many sovereigns controlling small parts of the resource or there is a hegemon which has sovereignty over the whole resource. Importantly it witnesses the termination of collective rule.

Hardin's work is one manifestation of RCT. From the perspective of the discipline of International Relations it shares broad similarities with Waltzian neo-Realism. The intellectual framework of neo-Realism is drawn from micro-economic theory, as such it is founded upon a rational actor model.[15] The difference between it and RCT is largely to be found in terms of presentation, RCT provides an abstracted account of the actions of agents, whereas neo-Realism applies broadly the same reasoning to the field of International Relations. Importantly as with Hardin's illustration the actors in neo-Realism, states, all share the same objective – survival. Therefore, when faced with the same circumstances they can all be expected to behave in the same manner.

There are empirical examples which support Hardin's position, the lack of successful collective action concerning global climate change has a high degree of correlation with Hardin's hypothesis. In this instance it is found that all states are individually committing actions which are destroying a common resource. Further the destruction of that resource will be to the detriment of all,[16] although the severity of the effects which individual states are expected to experience will vary, as will their capacity to respond to those effects. Despite a broad scientific consensus to the effect that global climate change is occurring, there is no effective broad inter-state effort to take action sufficient to address the problem. Indeed the supporters of Hardin would look at such measures as the Kyoto Protocols as further evidence of remorseless tragedy, for seemingly actors have attempted to form a means of protecting their collective interests and despite the

[15] Robert O'Brien; 'International Political Economy and International Relations: Apprentice or Teacher' in John MacMillan and Andrew Linklater (eds.); *Boundaries in Question* (London: Pinter, 1995), p. 96.

[16] It is to be assumed that global warming will be to the individual detriment of all states, there could be an argument made concerning such areas as Siberia becoming hospitable farm land, as such certain states could theoretically make net gains from climate change. However, the lack of predictability concerning the effects of climate change are such that no state could assume that it would make net gains. Further the general global destabilisation would most probably negatively effect even those states which made any gain from climate change.

severity of the threat action could only be taken which was not sufficiently strong to be effective.

Towards a Second Generation of Rational Choice

Niccolo Machiavelli asserted that 'men are naturally bad, and will not observe their faith towards you, you must in the same way, not observe yours to them.'[17] His position is founded upon a belief in the nature of the human condition. Hardin's approach inevitably leads, to such a conceptualisation yet it does so through a belief in the social structures within which humans operate. That is it is the environment in which actors find themselves that dictates their behaviour, it is not due to individual characteristics of the actors. Hardin's work is not a moral comment upon the nature of humanity, other than to the extent that greed is naturalised, and humans will always seek to maximise their individual utility. Elinor Ostrom commences her appraisal of the problems of cooperation with the observation that society itself is founded upon successive generations cooperating when faced with 'social dilemmas'.[18]

There are two questions which arise from this: first how is it possible for cooperation to occur; and second, why does cooperation some times arise, whilst some times tragedy unfurls? In answer to the first question, the work of Robert Alexrod is illuminating.

Axelrod conducted a series of simulations in which various strategies, provided by experts in game theory, of the Prisoner's Dilemma were tested against each other.[19] 'The Prisoner's Dilemma' provides a framework for exploring the possibility of cooperation when faced with potential advantages from unilateral action. It is the allegory of two individuals, Alf and Bert, caught committing a robbery and suspected of murder. Alf is certain to be convicted of robbery and be sentenced to 2 years on that charge. However if he implicates Bert on the murder charge, he will be given immunity, whilst Bert will receive a life sentence. Yet, if Bert should implicate Alf for murder as well then they will both be sentenced to 10 years. Finally, Alf could refuse to testify against Bert, whilst Bert implicates

[17] Niccolo Machiavelli (translated by C.E. Detmold); *The Prince* (Ware: Wordsworth, 1997), p. 68.
[18] Elinor Ostrom; 'A Behavioral Approach to the Rational Choice Theory of Collective Action *Presidential Address, American Political Science Association, 1997' American Political Science Review* Vol. 92, No. 1 (March 1998), p. 1.
[19] Robert Axelrod; *The Evolution of Co-operation* (London: Penguin Books, 1990).

Alf, in that instance Alf will receive a life sentence and Bert immunity. There are thus four possible outcomes. Alf's decision to co-operate, or defect is based upon his expectations of Bert's actions, and the two are not allowed to communicate.[20] The options available for Alf, and their consequences can be considered thus:

	Alf Cooperates	Alf Defects
Bert Cooperates	2 Years	Immunity
Bert Defects	Life	10 Years

Table 1.1: Possible outcomes for Alf

This dilemma can be applied to any situation requiring mutual cooperation, wherein ignorance of the other actor's actions result in each party having to make a decision which is, to an extent, a guess. Or more generally, to any situation where a trusting action from one party can be met with an act of betrayal from another. Ultimately, from the perspective of each actor there are four possible outcomes, two with negative and two with positive utility. The following matrix shows the utility outcomes for 'player one', the arbitrary figures represent the utility of each outcome, values denote the degree of utility. Although the values are arbitrary, when the game is applied to reality the values are based upon the perceptions of those playing the game.

	Player One Cooperates	Player One Defects
Player Two Cooperates	1	2
Player Two Defects	-2	-1

Table 1.2: Utility outcomes for player one

[20] Martin Hollis and Steve Smith; *Explaining and Understanding International Relations* (Oxford: Clarendon Press, 1991), p. 124.

The optimal outcome for both actors, if they were acting in concert, is gained through cooperation. Yet this route is discouraged by the fact that both are offered the temptation of a greater utility through defecting. The route of defection is also encouraged due to the problem of 'other minds'; one actor cannot be certain what the other actor is thinking. The other player of the game may appear to be making cooperative actions, but it cannot be known whether this is a prelude to betrayal.[21]

There are idealisations within the Prisoner's Dilemma, which limit its applicability to empirical instances. Most importantly, the model describes a single instance, or 'one shot game'. This is not how the majority of social interactions occur, actors are engaged in repeated contact with each other. Thus, in game theory, a 'supergame' is a more accurate means of understanding states' interactions, in this model the game is played repeatedly, therefore defecting in one round has an effect upon actions in the next.[22] This repeated scenario encourages co-operation, not due to egalitarian motives, rather because when both parties know that the game will continue over a protracted time period, long term cooperation allows both to avoid repeated negative utility, at the expense of relinquishing the possibility of a single instance of maximum utility. In short, through cooperating they can repeatedly draw positive utility from the game scenario, without damaging each other, thus they can create a virtuous circle.

The supergame can be conceptualised with reference to Alf and Bert. If two criminals were exceptionally inept in their life of crime and repeatedly arrested, however remained lucky enough not to have sufficient evidence for conviction without a confession, then if each party repeatedly refuses to give a confession (defect) so they would build 'honour among thieves' or generically mutual confidence.

Alexrod's experiment, testing various different strategies in the Prisoner's Dilemma, found that 'tit for tat' was the most successful method, an approach which co-operates unless the other player defects, and then only defects once as a 'punishment'. Further, the simulation found that the most successful strategies were those which were not the first to defect.[23]

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[21] *Ibid.* pp. 171-176.
[22] *Ibid.* p. 126.
[23] Axelrod, *op. cit.*, pp. 27-54, esp. pp. 33-34.

This is, of course, only evidence of the most effective method to employ in a game, yet it indicates that even in an anarchic situation defection is not by definition the most effective strategy to employ. Alexrod builds upon this premise to suggest how cooperation may emerge in an anarchic social situation. He perceives three stages, firstly in a world of unconditional defection if small clusters of people have the possibility of repeated interactions, it is possible for reciprocity to be introduced into the situation. Secondly, reciprocity can thrive in a world where other strategies are being employed. Finally, when cooperation has been established upon the basis of reciprocity it can protect itself against less cooperative behaviour.[24] Viewed from such a perspective Charles Darwin's theory of evolution by natural selection[25] can be seen not to be simply the survival of the fittest, but also survival of those best able to cooperate. Thus, rather than the notion of nature being 'red in tooth and claw', the process can be seen as one in which individuals are selected in favour of those who create cooperative structures. Therefore, a pre-social environment is not fundamentally one in which 'defecting' is the optimal route, rather it is possible for cooperation to emerge out of it. When considering the creation of social structures, the work of Alexrod suggests that cooperation may be the best means through which individuals can flourish, even when commencing from an anarchic environment.

This section commenced with two questions, firstly how is it possible for cooperation to emerge out of anarchy and secondly why does reality sometimes witness tragedy and some times cooperation. The work of Alexrod provides an explanation for how cooperation can be mutually beneficial. In order to understand the process of cooperation, and the circumstances under which it occurs, Elinor Ostrom seeks to build upon the work of Rational Choice Theorists, such as Hardin; the result is a world view in which the rational act for agents can be to cooperate for mutual benefit, Ostrom describes herself as being a 'second generation rational choice theorist'.

[24] *Ibid.* pp. 20-21.
[25] Charles Darwin; *The Origin of Species* (London: Wordsworth, 1998).

Second General Rational Choice Theory

Elinor Ostrom proposes a new approach to problems of collective action, or 'social dilemmas' as she terms them. This approach is behavioural[26] and founded upon an extensive empirical base.[27] As was seen above Hardin's work is parsimonious when considered within the parameters which he defines, however the latent tensions within it limit its applicability to real world instances. Ostrom seeks to redress such problems in a 'second generation of Rational Choice Theory'.

In her considerations Ostrom conceptualises the options available in a different manner to that of Hardin. In a similar fashion to Alexrod she looks to evolution, noting that '[o]ur evolutionary heritage has hardwired us to be boundedly self-seeking at the same time that we are capable of learning heuristics and norms, such as reciprocity, that help achieve successful collective action.'[28] Thus, rather than a remorse tragedy brought about by rational self-seeking decisions, humans are capable of achieving collective action precisely because it can be beneficial to self-seeking individuals. Thus there is more to consider in Ostrom's conceptualisation than in Hardin's. For Hardin all that is important are the structural constraints which surround decision makers, which will remorsely control the decisions made. However, Ostrom allows an element of agency to exist, the structural controls are still in place, yet actors are able to respond to them in differing ways. This capacity for innovation is an essential difference in the second generation of RCT. Ostrom specifically notes that in 'highly unpredictable environments, a long period of trial and error is needed' before a sustainable means of managing a common resource is established.[29]

Hardin requires his herdsmen to walk remorsely towards an outcome which is irrational for all of them, albeit as a consequence of individually rational actions. Ostrom considers the rationality of actors differently, from her perspective they are able to see that their actions are leading to an irrational outcome and therefore they can attempt to prevent it. Through repeated interactions, as was discussed with reference to the supergame in the Prisoner's Dilemma, individuals encountering a social dilemma can seek out an optimal

[26] Ostrom (1998), *op. cit.*, p. 1.
[27] Elinor Ostrom; *Governing the Commons* (Cambridge: Cambridge University Press, 1990), esp. pp. 18-21
[28] Ostrom (1998), *op. cit.*, p. 2.
[29] *Ibid.* p. 8.

outcome.[30] Thus, the tragedy is not inevitable, rather it can be averted, however, avoiding tragedy is not inevitable, rather it is dependent upon a complex combination of characteristics and circumstances.

Common Property Resources

Ostrom's work draws upon the empirical evidence concerning Common Property Resources (CPRs). There are two basic characteristics that define CPRs; firstly 'excludability', the resource is controlled in such a fashion that access to it can be controlled. There is an obvious difficulty in guaranteeing that specific individuals can be excluded from any resource. Given that the term 'Common' has connotations of openness, excludability is not readily associated with it. However, the Commons, as they existed in Medieval England, were more complex than Hardin's simple parable suggests. They were not open to all; rather the usage of the resource was restricted to certain individuals, although they did not have private property rights over the Common.[31] Alternatively fish stocks, as an example of a Common resource, may appear to be a Common completely open for all to use, however there is still a degree of excludability, an inland fish stock will only be open to those living suitably near to it, whilst to exploit salt water resources an actor would require the means and ability to sail to the supply. The condition of excludability should not only be thought of as a product of geographic accident, it can also be a product of legality as it was in the instance of the Mediaeval Commons.

The second characteristic of a CPR is 'subtractability', meaning that the amount consumed by one actor has an effect upon the availability remaining for another user.[32] A simple example of this is a common fishery; if one person catches a fish, then the total mass of fish available is reduced for every other actor. Therefore, individuals do not act in complete isolation, their actions have consequences for others.[33]

An early example of a regime governing commonly owned land is found in a village called Törbel in Switzerland; it had a common property regime in the 13th Century. Under

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[30] *Ibid.* p. 11.
[31] Susan Cox; 'No Tragedy on the Commons' *Environmental Ethics* Vol. 7, No. 1 (Spring 1985), pp. 53-55.
[32] Ostrom, *op. cit.*, pp. 30-33.
[33] David Feeny, Fikret Berkes, Bonnie J. McCay and James M. Acheson; 'The Tragedy of the Commons: Twenty-Two Years Later' *Human Ecology* Vol. 18, No. 1 (1990), pp. 3-4.

this structure, citizens communally own pasture lands; the right to use the common resources was an expression of citizenship, and did not automatically pass to some one who bought private property in the village. It should be noted that private property still exists, as villagers own certain resource individually, whilst others are common property. Nettings argues with reference to this, that common ownership and private property coexisting, within a small social grouping, suggests that the reason some resources remained communal is because that it is considered to be the most effective means by which they can be utilised.[34]

Scarcity and demand are the key factors when considering all property relations, including CPRs, if a resource is of sufficient quantity that there is a glut and it ceases to be an economic good. Two travellers in a desert could not establish a property regime to govern their claims to own sand, firstly neither has demand for the product, secondly there is such volume that should one attempt to charge for the use of 'their' resource, the other could simply collect sand from the open resource. However, were one traveller in possession of water, they would control a scarce resource and thus be able to establish a property regime. Property should be conceptualised as a social means through which the scarcity of goods is managed.

Characteristics and Features of Resources Management Systems

In relation to whether resources become governed by a successful regime, Ostom specifies that it is not possible to define specific rules which will indicate whether success will be achieved.[35] However, as the empirical evidence reveals that cooperation occurs far more often than would be expected according to Hardin's formulation,[36] Ostrom offers factors which have an effect upon whether cooperation arises, these separate into three categories: attributes of the resource, attributes of the appropriators and design principles which are shared by resource institutions which have survived over the long term.

The attributes of resource which Ostrom identifies are as follows:

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[34] Ostrom (1990), *op. cit.*, pp. 61-65.
[35] Elinor Ostrom; 'Reformulating the Commons' in Joanna Burger, Elinor Ostrom, Richard B. Norgaard, David Policansky and Bernard D. Goldstein (eds.); *Protecting the Commons: A Framework for Resource Management ion the Americas* (Washington D.C.: Island Press, 2001), p. 28.
[36] *Ibid.* p. 20.

- Feasible improvement – The resource has not reached the stage wherein its decline is such that there is no prospect in preserving it. In such a case the efforts involved in preserving it would be futile.
- Indicators – The condition of the resource needs to be measurable according to reliable and valid indicators, which are available frequently and at relatively low cost.
- Predictability – The availability of the resource needs to be relatively predictable.
- Spatial extent – The resource needs to be of a limited size, relative to the technology available, such that those using it can be aware of what is occurring with relevance to it.[37]

The relevant attributes of those using the resource are:

- Salience – The resource is important to those who are utilising it.
- Common understanding – There is a shared view of the resource, as such those using it understand how their actions have an effect upon it and each other.
- Low discount rate – The future benefits which those using the resource expect to gain from it will have a low discount rate. As such, there is not an easily identifiable alternative, therefore wholly consuming the resource would not be easily off set due to a substitute resource.
- Trust and reciprocity – Those using the resource trust each other to abide by the terms which they have agreed to.
- Autonomy – The appropriators of the resource are not subject to a higher authority which can instruct their behaviour.
- Prior organizational experience and local leadership – The actors using the resource have learned from direct experience, or the experience of others, a required amount of organizational capacity.[38]

The design principles which Ostrom identifies characterise those forms of organisational structures which have been successful in managing a common resource over a significant time frame. Variation between different examples results in the situation wherein it is not possible to identify the specific rules which are successful; it is only possible to

[37] *Ibid.* p. 22.
[38] *Ibid.* p. 22.

identify broad design principles which have provide commonality.[39] Those categorised by Ostrom are as follows:

- Clearly defined boundaries – There is clarity concerning who has rights to use the resource and those who do not.
- Congruence – The costs for using the resource are largely proportional to the benefits of using it and the right to use the resource is related to present environmental factors.
- Collective-choice arrangements – Those who are affected by the rules governing the resource are largely able to adjust the rules which govern the resource.
- Monitoring – The actions of those who use the resource need to be monitored, either by actors accountable to those using the resource or the by the consumers themselves.
- Graduated Sanctions – The degree of punishment a violator of the agreements receives is variable according to the severity of their violation.
- Conflict-Resolution Mechanisms – There are readily available and inexpensive means to address conflicts arising between those using the resource.
- Minimal Recognition of Rights to Organize – The ability of those using the resource to create their own rules and structures is not subject to interference from a higher (governmental) political authority.
- Ostrom also suggests that when a common pool resource is part of a larger whole, then the regulation should be organised in multiple layers.[40]

Two variables which are most easily measured are the size and heterogeneity of groups, Ostrom considers these to be unresolved matters. It may seem most probable that a smaller group is most likely to result in cooperation, as the number of individual interests will be limited. However, her empirical evidence reveals that there are examples of large groups which have successfully established self sustaining means of regulation. Similarly, concerning heterogeneity it may also appear obvious that all those using the resource having equal dependency upon it will result be conducive to cooperation. However, Ostrom observes that if one actor is more dependent upon the resource than the others, then they may be willing to take a leadership role and bear more of the costs.[41]

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[39] *Ibid.* p. 28.
[40] *Ibid.* p. 29.
[41] *Ibid.* pp. 31-34.

Summary

Ostrom argues that until the 1986 National Academy of Sciences' Panel on Common Property the approach of Hardin was applied to all common resources, thus assuming tragedy.[42] In her examination, of the response of various social groups to the problem of communal resources, she notes that the real problem faced is explaining why cooperation occurs in some instances and not in others.[43] This was resolved by Hardin through a process of abstraction, such that few variables are considered and there is only one possible outcome for a resource which communal owned. Ostrom, however, presents a more elegant ontology, one in which the tragedy predicted by Hardin may occur, but a conceptualising in which there are other possibilities.

It is Hardin's proposition that common resources cannot be effectively managed and without either privatisation or the intervention of a leviathan the resource will be destroyed, there is no other possibility. Whereas Ostrom proposes a reality in which agents have the capacity to act with originality or inventiveness, thus they can change the social circumstances in which they find themselves, it is therefore 'a world of possibility rather than of necessity.'[44]

The analysis of this thesis can now proceed to consider the circumstances which are specific to the problem of orbital debris. The problem of debris is located within the communal resource of near Earth space, the purpose of the rest of this thesis is to establish whether the tragedy, described by Hardin, or the possibility for cooperation, as outlined by Ostrom, is the most useful theoretical tool with which to consider the debris problem. The following chapters will present the relevant empirical evidence which will finally be compared to the theoretical approaches which Hardin and Ostrom have presented.

[42] *Ibid.* p. 20.
[43] Ostrom (1998), *op. cit.*, p. 9.
[44] *Ibid.* p. 16.

Chapter Two:
Technical Parameters of the Debris Problem

Introduction

The previous chapter considered the theoretical constructs which can be used to conceptualise the nature of resources which are communally owned. As such, it has established the parameters within which such problems can be examined. This chapter builds up the conceptual framework by considering the technical issues associated with the problem of debris. Together these two chapters clearly establish the nature of the problem which this thesis is to consider. As has already been discussed the purpose of this thesis is not to provide an account of the debris problem from the perspective of the natural sciences. However before the political implications can be assessed and considered it is necessary to comprehend the basis of the scientific problem.

Debris is sometimes referred to in debates concerning the weaponisation of space.[45] However, the problem of debris stretches much further than the issue of weaponisation, it has implications for all debates concerning the use of space: military, commercial and scientific. Further, the manner in which the problem is addressed, draws upon debates concerning the conceptualisation of areas located outside of territorially bound nation states.

Debris is fundamentally international in character, it is created by many states, it physically exists outside of states and it does not recognise the national origin of other objects in space, a piece of debris generated by one state can destroy any other's satellite or indeed its own. Therefore the problem of debris is not only its actual presence, it also poses a challenge to the way in which near Earth space is conceptualised.

The debris population in Earth orbit is the product of more than five decades of human activity in space. A 1999 U.N. technical report into the issue defined it thus:

> Space debris are all man-made objects, including their fragments and parts, whether their owners can be identified or not, in Earth orbit or re-entering the

[45] For example see Bruce M. DeBlois; 'The Advent of Space Weapons' *Astropolitics* Vol. 1, No. 1 (Summer 2003), p. 47.

dense layers of the atmosphere that are non-functional with no reasonable expectation of their being able to assume or resume their intended functions or any other functions for which they are or can be authorized.[46]

The four key aspects of this definition, which provide great clarity to the examination of debris, are that:

(1) debris is the product of human activity

(2) fragments of space craft are considered to be debris

(3) the debris population is constituted of non-functional objects

(4) debris is to be found in Earth orbit.

To conceptualise the problem of debris a nautical parallel is of use. A small boat at sea has a very low probability of collision with a large vessel; the oceans are vast and in relation the number of ships is small. However, if that same small boat is considered in the English Channel then it is in far greater danger, as the Channel is a busy shipping lane used far more than a stretch of open sea. This situation is replicated in space, the cosmos as a whole is of incomprehensible size, however human activities are located in a very small, and very useful part of that vastness. Thus a craft from Earth would be in very little danger, from space debris, were it travelling the enormous distances between planets, however if that craft is still within Earth orbit it has a greatly increased probability of impact with debris.

The debris population is a mixture of objects which have accumulated in orbit since the first Sputnik was launched on 4th October 1957,[47] the majority is 'dead satellites, spent rocket stages, discarded equipment, and fragments from satellite break-ups'.[48] However to appreciate the extent of the problem it should be remembered that every thing left in orbit constitutes debris, this means that flecks of paint, lost bolts,[49] lens caps,[50] and even 'fecal

[46] U.N.; *Technical Report on Space Debris* (New York: United Nations, 1999a), p. 2. The report however notes that there is no consensus agreement upon the meaning of the term.
[47] Nikolay N. Smirnov (a); 'Preface', in Nikolay N. Smirnov (ed.); *Space Debris: Hazard Evaluation and Mitigation* (London: Taylor and Francis, 2002), p. ix.
[48] Nicholas L. Johnson and Darren S. McKnight; *Artificial Space Debris* (Malabar, Florida: Krieger Publishing Company, 1991), p. 1.
[49] Joel R. Primack; 'Debris and Future Space Activity' in James Clay Moltz (ed.); *Future Security in Space: Commercial, Military and Arms Control Trade-Offs* (Monterey Institute of International Studies, July 2002), p. 18.
[50] Leonard David; 'Tossed in Space' *Foreign Policy* No. 136 (May/June 2003), p. 68.

matter'[51] are part of the problem. Further since the launch of Sputnik more than 4,300 missions have been conducted in Earth orbit, which constitute a total in excess of 5,000 tons being sent there.[52]

To comprehend the danger, which even a fleck of paint can pose, it is necessary to consider Newton's second law of motion:

Force = Mass x Acceleration[53]

The force involved in a collision dictates the damaged caused. Therefore, although many pieces of debris have very small mass, they can cause a large amount of damage because collisions involving them have enormous acceleration, more specifically deceleration. Pieces of debris travel at very high speeds which are virtually instantly reduced to zero on impact. Thus, they move from moving very rapidly to being stationary very quickly, it is this change which provides the enormous deceleration. Although many pieces of debris have very low mass, any collision in which they are involved will have enormous deceleration and therefore a large force.

The velocity of a piece of debris relative to another object in low Earth orbit (LEO) is approximately 9-11km/second,[54] ten times faster than a high powered rifle bullet.[55] To provide an example, travelling at this speed the distance from London to New York would be covered in a little under ten minutes. Further, a collision with a 1cm aluminium sphere, travelling at the velocities associated with LEO, would be the equivalent of an impact with a 400lb safe travelling at 60mph.[56]

The nature of collisions with large amounts of energy creates further problems. The energy involved is such that, upon impact, a piece of debris will liquify. Therefore instead of

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[51] Arthur C. Clark; 'Toilet of the Gods' in Arthur C. Clark (ed. Ian T. Macauley); *Greetings Carbon-Based Bi-Peds* (London: Voyager, 1999), p. 490.
[52] M. Yakovlev; 'The "IADC Space Debris Mitigation Guidelines" And Supporting Documents' in D. Dansey (ed.) *Proceedings of the 4th European Conference on Space Debris* (Darmstadt, Germany: European Space Agency, 2005), p. 595.
[53] Theodore P. Snow; *The Dynamic Universe* (St. Paul, MN, West Publishing Company: 1991), p. 88.
[54] Johnson and McKnight, *op. cit.*, p. 68.
[55] Primack in Moltz (ed.), *op. cit.*, p. 18.
[56] 'What Are The Risks Posed By Orbital Debris', *Centre for Orbital and Reentry Debris Studies* < www.aero.org/cords/debrisks.html >.

one piece impacting with a satellite, there may be many thousands of smaller particles causing damage.[57] In short, sufficient energy is involved in such impacts to cause enormous damage to satellites.

The most dramatic instance of debris impact occurred in 1983 when a 'small pit'[58] was found in the window of the U.S. Shuttle *Challenger*.[59] Analysis revealed that it was caused by a fleck of paint, approximately 0.2 millimetres in diameter.[60] Had a larger object hit the shuttle, the window could either have broken or been damaged, to such an extent, that it would not have been able to re-enter the Earth's atmosphere. The enormous danger of incidents, such as this, is emphasised by the fact that there is in excess of one million flecks of paint in orbit.[61]

Figure 2.1: Impact damage from a fleck of paint on the Shuttle window.[62]

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[57] U.S. Congress, Office of Technological Assessment; *Orbiting Debris, A Space Environmental Problem - Background Paper* (Washington D.C.: U.S. Government Printing Office, 1990), p. 5.
[58] Astronaut Sally Ride quoted in Primack in Moltz (ed.), *op. cit.*, p. 20.
[59] Dawn Levy; 'Sally Ride Speaks On The Tactical Role Of Space and War' *Space Daily* < www.spacedaily.com/news/milspace-02n.html >. It is worthy of note that although many sources refer to this incident, the name of *Challenger* is not often mentioned. The quoted source does not refer to the damage and the name of the Shuttle in the same paragraph. It appears that following the fatal disaster, involving that Shuttle, its name is collectively avoided.
[60] U.S. Congress, *op. cit.*, p. 2.
[61] Nicholas L. Johnson; 'Monitoring and Controlling Debris in Space' *Scientific American* (August 1998), p. 64.
[62] Taken from, Johnson and McKnight; *op. cit.*, plate at front of book.

Any object, placed in orbit, will immediately be exposed to risk from debris impacts. The International Space Station was found to have impact holes after it had been in orbit for less than two weeks.[63] The constant barrage of debris particles, which space based facilities experience, has also been demonstrated by the breakage of exterior light bulbs on the *Mir* space station.[64]

Thus far there has only been one recorded instance of debris disabling an active satellite; in July 1996 a French satellite, Cerise (#23606), was hit by a fragment of a used Ariane rocket stage, at a velocity of 14km/second.[65] Any thing placed into orbit requires a rocket to propel it out of the Earth's gravity. When the necessary altitude is reached, the active satellite breaks away, leaving the rocket stages to orbit as debris. The Cerise rocket stage impact caused a section of the satellite to break off, but it was ultimately able to continue its mission.[66] It is worthy of note that the rocket stage involved was also of French origin, which as will be discussed later, is of legal importance. This collision occurred at an altitude of 670km,[67] which has one of the higher debris densities in LEO.[68]

There have however been other occasions on which objects in orbit have collided. In January 2005 the third instance of an in orbit collision occurred, when a spent US rocket body, which had been in orbit for more than three decades, and a Chinese rocket body collided. This incident did not appear to result in a problematic amount of debris being created, only three new large objects were detected. Previously, in 1991, the Soviet satellite Kosmos 1934 was involved in a collision with debris from its sister satellite Kosmos 926.[69]

Three serious collisions in over forty years of space activity may appear of little concern. However there have been other instances of satellite failures which may have been due to collision with debris,[70] the breakup of the Soviet Kosmos 1275 is strongly suspected

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[63] U.N. Document A/AC.105/770; (30th November 2001), p. 8.
[64] U.S. Congress, *op. cit.*, p. 40.
[65] D. Davidov, S. Kulik, M. Mikhailov, S. Chekalin, M. Yakovlev, Yu. Bulinin; 'Measures Undertaken by the Russia Federation for Mitigating Artificial Space Debris Pollution' in Dansey (ed.), *op. cit.*, p. 53 and V.A. Chobotov; 'Orbital Debris Hazards Assessment and Mitigation Strategies' in Smirnov (ed.), *op. cit.*, p. 10.
[66] Johnson (1998), *op. cit.*, p. 67.
[67] Yakovlev in Dansey (ed.), *op. cit.*, p. 591.
[68] U.N. (1999a), *op. cit.*, p. 20.
[69] Nicholas L. Johnson (a); 'Orbital Debris Research in the U.S.' in Dansey (ed.), *op. cit.*, p. 6.
[70] Johnson and McKnight, *op. cit.*, p. 19, T. Yasaka 'Geostationary Orbit Pollution and its Long-Term Evolution' in Smirnov (ed.), *op. cit.*, p. 116 and U.S. Congress, *op. cit.*, pp. 14-15.

to be the result of debris impact.[71] Also many collisions with debris have caused holes in space facilities, but not enough damage to disable the system, for example the Hubble Space Telescope was found to have an impact hole 19mm in diameter in 1993.[72] Such an impact on another craft, especially a manned one, could have been fatal. Therefore, the assumption should not be made that current space craft are capable of surviving in the future debris environment.

The importance of debris is that it is a growing problem which requires mitigation in the present to avoid critical problems in the future.[73] In this respect there is a clear parallel to be drawn with another environmental problem, global warming: when the first warnings were made, possible effects where not projected to occur for several decades.[74] Similarly, the potential future problems which debris will cause require policy makers to adopt a long term perspective. Specifically, there is a need to ensure mitigation techniques are adhered to in the present, in an effort to prevent the escalation of the debris population towards more hazardous levels.

As specified in the U.N. Technical Report, the problem of orbital debris is not to be found in the vastness of space. Objects such as the recent probes sent to Mars pose virtually no threat to human activity in space for any foreseeable time frame. Rather cause for concern arises from objects trapped in the Earth's gravity, which remain orbiting the planet. The problem is exacerbated as human activity in space has almost nothing to do with the vastness of the cosmos, rather it is limited to a small shell around the planet.[75] Because of this limitation, the increasing amount of debris is a political as well as a scientific problem.

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[71] Office of Science and Technology Policy (U.S. Government); *Interagency Report on Orbital Debris* (Washington: 1995), p. 19.
[72] U.N. Document A/AC.105/770, *op. cit.* p. 8.
[73] John A. Simpson; 'Introduction' in John A. Simpson (ed.); *Preservation of Near-Earth Space For Future Generations* (Cambridge: Cambridge University Press, 1994), p. 3.
[74] Current research indicates that there is a direct linkage between global warming and orbital debris. As the greenhouse effect traps heat within the atmosphere, so the temperature in space is lowered, which also means that atmospheric density is lowered, as such there are fewer molecules for space debris to impact with, and the effect of atmospheric drag is reduced. The reduction of the drag effect could lead to the number of objects of 1cm and above, rising by 30% from standard projections by the end of the 21st century. H.G. Lewis, G.G. Swinerd, C.S. Ellis, C.E. Martin, 'Response of the Space Debris Environment to Greenhouse Cooling' in Dansey (ed.), *op. cit.*, p. 243.
[75] Dietrich Rex; 'The Current and Future Space Debris Environment As Assessed in Europe', in Simpson (ed.), *op. cit.*, p. 37.

The Location and Nature of Earth Orbits

Before debris is considered it is necessary to understand why the environment in which it is found is of such importance. There are two areas in which debris is a significant problem, Low Earth Orbit (LEO) and Geostationary Orbit (GEO).[76] These two orbits are the most utilized, and between them, they account for 80% of the artificial objects in Earth orbit.[77] The presence of debris in any orbit is a form of pollution; it is matter in an environment as a bi-product of human action and it poses a hazard to further activity.

LEO is the lowest altitude at which orbit can be sustained, it exists up to approximately 2,000km from the surface of the Earth,[78] and it is in this area that the majority of debris exists.[79] There is a simple reason why LEO is the most polluted section of near Earth space; it is the area which has been utilised most. A wide range of satellites are to be found there, including those conducting astronomical observation,[80] along with those for meteorology and navigation.[81] As this orbit provides optimal viewing of the planet it is also used for military surveillance satellites.[82] There are also projected future means in which LEO will be utilised; the most promising being pharmaceuticals based upon crystals grown in the absence of gravity[83] and as a launching point for manned missions to other planets.[84]

GEO exists much further away from the planet than LEO, it is located in a ring around the Earth's equator, at a mean altitude of approximately 36,000km.[85] GEO is extra-ordinarily useful as satellites within it have the appearance of being fixed in the sky when

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[76] H. Klinkrad; 'ESA Concepts for Space Debris Mitigation and Risk Reduction' in Simpson (ed.), *op. cit.*, p. 110.
[77] T. Donath, T. Schildknecht, P. Brouse, J. Laycock, T. Michal, P. Ameline and L. Laushacke; 'Proposal for a European Space Surveillance System' in Dansey (ed.), *op. cit.*, p. 32.
[78] Joseph P. Loftus; 'Preface', in Joseph P. Loftus (ed.); *Orbital Debris from Upper-Stage Breakup* (Washington D.C.: American Institute of Aeronautics and Astronautics, 1989), p. vii.
[79] Johnson and McKnight, *op. cit.*, pp. 2-3.
[80] Joel R. Primack; 'Protecting the Space Environment for Astronomy', in Simpson (ed.), *op. cit.*, p. 71.
[81] Smirnov (a) in Smirnov (ed.), *op. cit.*, p. ix.
[82] Primack in Moltz (ed.), *op. cit.*, p. 20.
[83] Isaac T. Gillam IV; 'Business in Orbit: The Commercial Use of Space' *Journal of International Affairs* Vol. 39, No 1 (Summer 1985), pp. 116-120.
[84] J.E.S. Fawcett; *Outer Space* (Oxford: Clarendon, 1984), pp. 22-23.
[85] I.H. Diederiks-Werschoor; *An Introduction to Space Law* (Deventer, Netherlands: Kluwer Law and Taxation Publishers, 1993), p. 19.

viewed from the planet's surface.[86] Several authors refer to it in terms of a 'unique natural resource',[87] Yasaka goes further stating that its importance is such that in terms of human welfare its contribution could never be over emphasised.[88] This orbit was first identified by Arthur C. Clark in a 1945 paper,[89] wherein he calculated the altitude at which an object would remain stationary in the sky.

The threat of debris is brought into focus by the immense importance of geostationary orbit; satellites located there allow for instant telephone, television and e-mail contact from any point on the planet, they are the 'back-bone' of global communications.[90] Such revolutionary means of communications, provided by satellite technology, have been a primary force in the phenomenon of globalisation.[91] The origin of these communications can be traced to 1967 when one television broadcast 'Our World' linked twenty four countries for the first time, a broadcast witnessed by 400,000,000 people.[92] Technology used in GEO has developed in the last twenty years such that direct satellite broadcasts are possible to homes with a receiver dish.[93] It is by this means that the Sky satellite network is broadcast in the U.K.; more importantly, from a political perspective, it is the means by which al-Jazeera can broadcast, without restriction, to countries throughout the Middle East. The utilisation of satellite based communications in developing states provides a means to overcome the extreme shortage of inland lines.[94]

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[86] Howard A. Baker; *Space Debris: Legal and Policy Implications* (Dordrecht, Netherlands: Martinus Nijhoff Publishers, 1989), pp. 25-26.
[87] Johnson and McKnight, *op. cit.*, p. 77, John Vogler; *The Global Commons* (Chichester: John Wiley and Sons, 1995), p. 100 and Rex in Simpson (ed.), *op. cit.*, p. 37. This is a definition which has also been recognised by the government of the United Kingdom of Great Britain and Northern Ireland, U.N. Document A/AC.105/620; (21st November 1995), p. 5.
[88] Yasaka in Smirnov (ed.), *op. cit.*, p. 113.
[89] Vogler, *op. cit.*, p. 113. Clark refutes that he 'discovered' geostationary orbit as six other people would have found it, within a year, if he had not published his paper. He was however the first to put the idea in print in a paper entitled 'Extraterrestrial Relays'. Arthur C. Clark; 'Letter From Sri Lanka' in Arthur C. Clark, *op. cit.*, pp. 443-444.
[90] Arthur C. Clark; 'For Cherene, Tamara, and Melina' in Arthur C. Clark, *op. cit.*, p. 521.
[91] Vogler, *op. cit.*, pp. 109-113.
[92] Each country party to the broadcast had a section in which to showcase their culture, the British entry was a live premier performance, by The Beatles, of John Lennon's new composition *All You Need Is Love*. Ian MacDonald; *Revolution in the Head* (London: Pimlico, 1995), p. 209 and Ray Coleman; *Lennon* (London: Pan Books, 1995), p. 559.
[93] Vogler, *op. cit.*, p. 111.
[94] *Paper Tigers: The Scramble for Space Spectrum* International Telecommunications Union Website < http://www.itu.int/newsarchive/pp02/media_information/feature_satellite.html >.

The usefulness of satellites is not limited to hi-tech telecommunications; satellite imagery can be utilised to predict the optimal location to plant crops in harsh conditions.[95] The importance of accurate meteorological information, which can only be provided by satellites, is to be measured by saved lives. Clark notes that these satellites have already saved thousands, and would have saved more in a single instance when a cyclone was tracked across the Bay of Bengal, but the warning did not reach the population on the ground in time, as a consequence half a million people were killed.[96] Satellite technology can also benefit developing states, as it allows accurate scanning of agricultural land in order to ensure its optimal usage.[97]

In the two orbits where debris is a problem, currently the greatest risk of collision exists in LEO. The probability of impact in GEO is approximately 100 times smaller than in the more crowded LEO.[98] GEO is a less dangerous environment due to three main factors:

(1) there is a smaller satellite population

(2) there is a wider spatial distribution; because the orbit of GEO is further from the planet than LEO, it has a greater circumference

(3) the relative velocities in GEO are much lower; they are approximately 500m/sec.[99]

Although satellites in GEO are, at present, exposed to a lesser risk of collision, in the longer term GEO presents greater cause for concern because of its uniquely useful character. Also, as will be discussed below, debris in GEO will remain in orbit for a much longer time period. Whilst recent measurements suggest that there have been fragmentations in GEO, which have previously been undetected.[100]

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[95] Peter S. Thacher; 'Space Technology and Resource Management' *Journal of International Affairs* Vol. 35, No. 1 (Summer 1985), p. 155.
[96] Arthur C. Clark; 'For Cherene, Tamara, And Melina' in Arthur C. Clark, *op. cit.*, p. 521.
[97] Anders Hansson and Steven McGuire; 'Commercial space and international trade rules: an assessment of the WTO's influence on the sector' *Space Policy* Vol. 15 (1999), p. 199.
[98] National Research Council (U.S.). Committee on Space Debris; *Orbital Debris: A Technical Assessment* (Washington D.C.: National Academy of Science, 1995), p. 4.
[99] U.N. (1999a), *op. cit.*, p. 28.
[100] H. Klinkrad, F. Alby, D. Alwes, C. Portelli and R. Tremayne-Smith; 'Space Debris Activities in Europe' in Dansey (ed.), *op. cit.*, p. 26.

The greatest threat which orbital debris poses is to objects in orbit. However, it also poses potential dangers to people and property on the surface of the planet.[101] This danger arises from defunct space objects which survive re-entry into the atmosphere, and then pose a threat when crashing to the ground. However, given the vast surface area of the planet, and the proportion of which is occupied, this danger is of far less concern than the difficulties which debris presents in orbit. Further, many of the larger objects which return into the atmosphere do so in a controlled re-entry, they are therefore deliberately targeted at the high seas.[102]

In January 2005, an American rocket stage survived re-entry into the planet's atmosphere. A large piece of the object crashed close to Bangkok; its proximity to a large city demonstrating the dangers of such re-entries.

Figure 2.2: Remnant of a US rocket which returned to Earth in Thailand.[103]

[101] Sergey Kulik; 'The Russian Federation Space Plan 2006-2015 and Activities in Space Debris Problems' in Dansey (ed.), *op. cit*, p. 11.
[102] Such an instance occurred in December 2002 when the Astra-1K satellite was deemed to be unable to reach its required orbit, it was therefore deliberately brought back into the atmosphere over the Pacific Ocean, such that it posed virtually no risk to human life or property. Klinkrad *et al.* in Dansey (ed.) *op. cit.*, p. 28.
[103] Johnson (a) in Dansey (ed.), *op. cit.*, p. 9.

Measuring Space Debris

There are two means by which orbital debris can be measured; either through ground based detection or from space based observations.

Remote, or ground based detection, consists of radar used to assess LEO and optical measurements utilised for GEO.[104] Radar measurements provide more detailed data concerning debris, it can ascertain the following:

(1) orbital elements

(2) motion of the object around the Earth

(3) size and shape of the object

(4) orbital lifetime

(5) ballistic coefficient

(6) mass

(7) material properties.[105]

Radar measurements are reliable at observing objects which are greater then 10cm in diameter.[106] Currently U.S. Space Command is tracking 10,000 objects in orbit, of which only 600 to 650 are active satellites,[107] whilst the Chinese Centre for Space Science and Applied Research is tracking over 9,000 which are considered to pose a threat to their Shenzhou V spacecraft.[108] However the population, including those which are too small to

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[104] U.N. Document A/AC.105/707; (14th December 1998), p. 3.

[105] U.N. (1999a), *op. cit.*, p. 5.

[106] The Russian and American catalogues contain details of objects as small as 10cm, therefore the 10cm referred to throughout, is in relation to the objects which are catalogued. U.N. (1999a), *op. cit.*, p. 5. and D. Mehrholz, L. Leushacke, W. Flury, R. Jen, H. Klinkrad and M. Landgraf; 'Detecting, Tracking and Imaging Space Debris' *ESA Bulletin* No. 109 (February 2002), p. 128.
< www.fas.org/spp/military/program/track/mehrholz.pdf >.
The diameter 10cm refers to debris trackable at an altitude of 1,000km, some radar detection systems can detect debris of 5cm in diameter at altitudes up to 500km. Sensitivity further from the planet is developing, an example of this is the Chilbolton Observatory, in Hampshire (U.K.), which can observe objects as small as 5cm in diameter up to an altitude of 1,000km, U.N. Document A/AC.105/770, *op. cit.*, p. 5

[107] Lubos Perek; 'Space Debris Mitigation and Prevention: How to Build a Stronger International Regime' *Astropolitics* Vol. 2, No. 2 (Summer 2004), p. 216. This may appear to infer that 6% of the artificial objects in orbit are active, however this number is decreased when the number of inoperative objects which are not tracked are considered.

[108] 'China Reports Progress in Space Debris Research'; *People's Daily*.
< http://english.peopledaily.com.cn/200308/13/eng20030813_122263.shtml >.

track, has been estimated to be more than twice the number of trackable objects.[109] Recently the number of small piece of debris (less than 10cm) has been estimated to be between 50,000 and 150,000.[110]

Telescopic measurement, used to observe GEO, is less sensitive and can only measure objects greater than 1m in diameter.[111] This technique is conducted preceding dawn and after sunset, when the object is in sunlight whilst the background of the sky is dark. Because GEO is so distant, measurements of that region are not be very specific, however optical measurements by NASA suggests that GEO has 'an appreciable population of debris.'[112] Currently the known population of GEO is constituted of 1124 objects, which pass through the orbit, of that population only 346 are controlled in their orbital slots.[113] There had been an assumption that an accuracy in detection of 1m was capable of detecting the majority of objects in GEO, however recently an 'unexpectedly large number of faint objects' have been discovered in the region, suggesting that the population is higher than initially suspected.[114] Because the relative velocities of objects in GEO is far lower than those in LEO,[115] the inability to track smaller pieces of debris is not as great a problem as it at first appears. Impacts at lower speeds are less energetic, as such smaller items pose a lesser risk.

A more comprehensive perspective of the debris population is provided through space based measurements. The most basic application of this technique is the analysis of objects retrieved from orbit. Items which have been examined in this fashion include windows from the Shuttle,[116] Eureca (European Retrievable Carrier) and replaced sections on the Solar Max satellite.[117]

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[109] N.N. Smirnov (b); 'A Mathematical Model for Space Debris Evolution, Production and Self-Production' in Smirnov (ed.), *op. cit.*, p. 35.
[110] Donath *et al.* in Dansey (ed.), *op. cit.*, p. 31.
[111] National Research Council, *op. cit.*, p. 2.
[112] U.N. (1999a), *op. cit.*, pp. 7-8.
[113] Rudiger Jehn, Vladimir Agopov and Cristina Hernandez; 'End-of-Life Disposal of Geostationary Satellites' in Dansey (ed.), *op. cit.*, p. 373.
[114] Reto Musci, Thomas Schildknecht, Tim Flohrer and Gerhard Beutler; 'Concept for a Catalogue of Space Debris in GEO' in Dansey (ed.), *op. cit.*, p. 601.
[115] Objects in GEO travel at approximately 3km/sec in the same direction, therefore an impact is most probable if an object has developed eccentricities in its orbit, they would occur at less than 800m/sec. K. Nakashima, T. Hanada, Y. Akahoshi, T. Harano, Y. Machida and S. Fukushige; 'Low-Velocity Catastrophic Impact on Micro Satellites' in Dansey (ed.), *op. cit.*, p. 701.
[116] U.S. Congress, *op. cit.*, p. 35.
[117] Office of Science and Technology Policy, *op. cit.*, p. 3.

The Long Duration Exposure Facility provided a six year study of the LEO environment, it was intended to remain in orbit for two years, however the loss of the *Challenger* shuttle delayed its retrieval.[118] To the naked eye more than 32,000 impact craters were visible when it was examined.[119] However, the analysis of such objects is not simple; any thing exposed to the Earth orbit environment will have many impact craters, thus there is a technical difficulty in ascertaining whether a collision involved debris or a natural micro-meteoroid.[120] This form of analysis has only been conducted for LEO, as the expense of retrieving an object from GEO is prohibitive.[121]

Space based observations can also be conducted *in situ* by debris sensitive detectors. DEBIE (Debris In-Orbit Evaluator) is one such device, it is on board ESA's Proba craft launched in 2001.[122] This measures the mass and velocity of sub-millimetre particles, that impact upon a target sensor.[123] This principle is to be further utilised by a Large Area Debris-Collector (LAD-C) to be deployed on board the International Space Station, which will have a $10m^2$ collection area.[124] An earlier approach to space based measurements was adopted by the infra-red astronomical satellite (IRAS), launched in 1983: this orbited the Earth pointing away from the planet, scanning for the presence of debris.[125] This technique, as it did not measure impacts, was not as sensitive as DEBIE.

There are two maintained databases which collate information on the debris population, the space objects catalogue of the Russian Space Monitoring System[126] and the United States Space Command catalogue;[127] currently the European Space Agency is considering developing its own space surveillance system.[128] Data gathered can be used to model the debris environment, which allows a more thorough understanding of the

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[118] U.S. Congress, *op. cit.*, p. 35.
[119] Office of Science and Technology Policy, *op. cit.*, p. xiv.
[120] U.N. (1999a), *op. cit.*, pp. 9-10.
[121] *Ibid*, p. 9.
[122] 'Proba Marks One Year On Orbit' *Space Daily* < www.spacedaily.com/news/robot-02q.html >.
[123] U.N. Document A/AC.105/731; (20th December 1999), p. 4 and 'DEBIE Sensor Unit' *Metorex* web site < www.metorex.fi/pages/space_products/debris.html >.
[124] Johnson (a) in Dansey (ed.), *op. cit.*, p. 7.
[125] U.N. (1999a), *op. cit.*, p. 11.
[126] Russian LEO observations are conducted principally by the radar facilities of the Space Monitoring System. Whilst for optical observations, of GEO, the facilities of the Russian Academy of Science are utilised. U.N. Document A/AC.105/659/Add.2; (14th February 1997), p. 2.
[127] U.N. Document A/AC.105/707, *op. cit.*, p. 10.
[128] Musci *et al.* in Dansey (ed.), *op. cit.*, p. 601.

population and facilitates predictions of future risks. Models of the LEO environment are considered to be relatively thorough, however there is more uncertainty concerning the situation in GEO.[129]

Types of Debris

The overwhelming majority of artificial objects orbiting the Earth serve no useful function. Operational satellites constitute approximately 5-6% of the trackable objects which humanity has placed in orbit.[130]

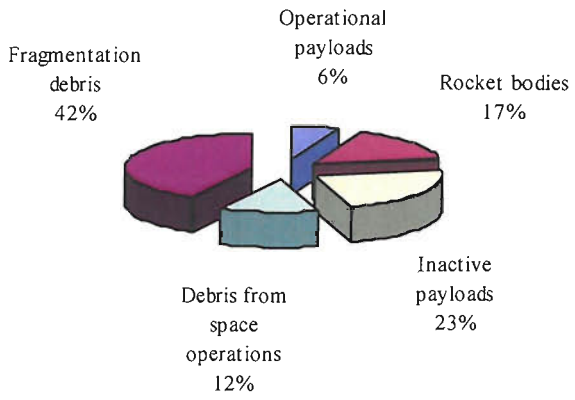

Figure 2.3: Earth's artificial satellite population by type.[131]

The total mass of debris, in Low Earth Orbit, is in the region of 2,300 metric tons.[132] This divides into four different categories, inactive payloads (largely no longer functional satellites), rocket bodies, operational debris (such as bolts released during satellite

[129] U.N. Document A/AC.105/731, *op. cit.*, p. 5.
[130] Theresa Hitchens; 'Space Debris: Next Steps' (1st April 2004)
< www.cdi.org/friendlyversion/printversion.cfm?documentID=2164 >.
Johnson and McKnight *op. cit.*, p. 23 and DeBlois, *op. cit.*, p. 47.
It should be remembered that this refers to the objects which have been observed in orbit. The total population of defunct objects, including those which cannot be tracked, will be many times greater than the total which are known.
[131] These figures are average values taken from the following sources:
U.S. Congress, *op. cit.*, p. 2.
'Instituto de Astrofisica de Canarias' < www.iac.es/telescopes/ogs/notapressE.html >.
Orbital Debris Hazards and Mitigation Strategies report by the American Institute of Aeronautics and Astronautics.
< http://pdf.aiaa.org/downloads/publicpolicypositionpapers/OrbitalDebris-1999.pdf >.
[132] Chobotov in Smirnov (ed.), *op. cit.*, p. 3.

deployment) and debris resulting from the fragmentation of satellites.[133] The vast majority of the total mass of orbital debris is to be found in large objects;[134] in 1998 there were approximately 1,500 useless rocket bodies in orbit.[135] That the bulk of the debris mass is 'contained' in large objects is fortunate, as they can be tracked. If debris is measured by the number of individual objects, rather than total mass, then the largest constituent is solid rocket exhaust.[136]

The population of debris in LEO is rising towards a critical situation known as the 'Kessler Syndrome'. At this point, there are so many objects in orbit that even without additional satellite deployments, the population will rise due to cascading as a result of random collisions causing larger objects to fragment. The total mass would remain constant, however it would be redistributed in favour of smaller objects.[137]

Fragmentations can be divided into three categories, accidental failures of propulsion systems, deliberate actions and unknown causes.[138] Deliberately destroyed satellites are usually military, either those that have come to the end of their life time which their owners do not want to be inspected by others,[139] or those tested as part of space weaponry systems.[140] Fragmentation is considered a serious threat, therefore when satellites are placed in orbit, the remaining fuel is vented from spent rocket stages to reduce the possibility of accidental explosions.[141] It has further been proposed that batteries on board space craft should be designed such that they will not result in fragmentations when the craft

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[133] Nicholas L. Johnson; 'The Earth Satellite Population: Official Growth and Constituents' in Simpson (ed.), *op. cit.*, p. 10.
[134] Large objects constitute over 90% of the total mass, National Research Council, *op. cit.*, pp. 63-77. Rocket bodies are considered to be the greatest debris type by mass. U.S. Congress, *op. cit.*, p. 17.
[135] Johnson (1998), *op. cit.*, p. 62.
[136] *Ibid*, p. 65.
[137] Donald J. Kessler and Burton G. Cour-Palais; 'Collision Frequency of Artificial Satellites: The Creation of a Debris Belt' *Journal of Geophysical Research* Vol. 83, No. A6 (June 1978), pp. 2637-2646.
[138] U.S. Congress, *op. cit.*, p. 18.
[139] Between 1962-1986 the Soviet Union launched 712 photographic satellites, six of which could not be controlled into making the required re-entry. In order to stop other states examining them they were destroyed in orbit, one such destruction resulted in 800 detectable pieces of debris. Johnson and McKnight, *op. cit.*, p. 15.
[140] U.S. Congress, *op. cit.*, pp. 18-19.
[141] Donald Kessler; 'The Current and Future Environment: An Overall Assessment' in Simpson (ed.), *op. cit.*, p. 33 and Chobotov in Smirnov (ed.), *op. cit.*, pp. 17-19.

becomes defunct.[142] This process of pacification is important as non-pacified upper rocket stages have been involved in a third of all known fragmentations in orbit.[143]

The requirement for mitigation measures is illustrated by the fragmentations which have been observed; eight separate occasions have individually produced over 240 pieces of debris.[144] During the period October 1957 to December 2003, analysis by NASA has revealed that there were 186 incidents of space objects exploding.[145]

Should the Kessler Syndrome occur; the Earth would be surrounded by a permanent 'debris belt', just as Saturn has a ring around it. Although such chain reactions remain theoretical at present, expert opinion holds that two altitudes in LEO may have already reached 'critical density', 900km to 1,000km and 1,500km.[146] The possibility of chain reactions is the most dangerous aspect of debris production;[147] demonstrated by the fact that 85% of all debris greater than 5cm in diameter may be the product of fragmentation of upper rocket stages or spacecraft.[148] The seriousness of such a scenario is a danger which may be realised in the near future, if no remedial action is taken. Expert opinion holds that if a 'business as usual' approach is followed, then within 35 years collisions will begin to dominate the debris population in Earth orbit.[149] A large increase in the number of collisions would present a grave danger to active satellites, of more concern is that it could lead to cascade collisions and the Kessler Syndrome.

Assessments of GEO are less specific than those for LEO, due to the available data, however there are more than 250 objects there;[150] as such the region is considered to be crowded already.[151]

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[142] Inter-Agency Space Debris Coordination Committee; *Report of the IADC Activities on Space Debris Mitigation Guidelines Presented to: 40th Session of the Scientific and Technical Subcommittee United Nations Committee on the Peaceful Uses of Outer Space* (2003) p. 10. < www.iadc-online.org/docs_pub/IADC_UN_Presentation_40_2003.pdf >.
[143] Inter-Agency Space Debris Coordination Committee; *Activities And Views on Reducing Space Debris From Launch Vehicles, Presented to: 38th Session of the Scientific and Technical Subcommittee*, p. 7. < www.iadc-online.org/docs_pub/IADC_UN_Presentation_Feb01.pdf >.
[144] U.S. Congress, *op. cit.*, p. 18.
[145] Davidov *et al.* in Dansey (ed.), *op. cit.*, p. 53.
[146] National Research Council, *op. cit.*, p. 7.
[147] U.S. Congress, *op. cit.*, p. 20.
[148] U.N. (1999a), *op. cit.*, p. 32.
[149] Klinkrad *et al.* in Dansey (ed.), *op. cit.*, p. 30.
[150] Chobotov in Smirnov (ed.), *op. cit.*, p. 8.
[151] Johnson and McKnight, *op. cit.*, p. 77.

Mitigation of debris

The most effective, and economic, means to address the debris problem is prevention, rather than cure. Due to extreme velocities associated with objects in Earth orbit, there is little which can be done to pacify existing debris, therefore the efforts to resolve the problem have focused upon preventing more debris from being generated.[152] There are various techniques which can be employed in order to limit the initial production of debris.

One source of debris is explosive bolts, released during satellite deployment. Before debris was identified as a serious problem this offered a means of easily ensuring that bolts did not interfere with the active spacecraft after deployment. Trapping mechanisms are now utilised in order to prevent bolts from orbiting as debris.[153] Similarly, active steps are being taken to capture such items as lens caps and nozzle covers.[154]

These techniques, along with measures such as venting fuel from rocket stages, seek to limit the growth in the debris population. The practice of pacifying spent rocket stages seeks to prevent them exploding; if the procedure is not conducted ultra-violet radiation from the Sun can cause the barriers between the remaining fuel and the oxidizer to deteriorate, the two chemicals would then explode on contact.[155]

However once debris is created, the impressive technology which allows near Earth space to be utilised, presents little technical assistance to ameliorate the problem. This echoes Hardin's discussion of physical problems for which there is no technical, only a political, solution.[156]

Two practical measures can be taken to protect active space craft from debris, either avoiding collision or protection such that impacts do not cause severe damage. Avoidance is based upon the ability to track debris and manoeuvre away from it, therefore in LEO it can only be effectively employed for debris larger than 10cm in diameter. Tracking and

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[152] Perek, *op. cit.*, p. 215.
[153] J-L Marce; 'Space Debris: How France Handles Mitigation and Adaptation', in Simpson (ed.), *op. cit.*, p. 115.
[154] U.N. (1999a), *op. cit.*, p. 31.
[155] Perek, *op. cit.*, p. 217.
[156] Hardin, *op. cit.*, pp. 1243-1248.

manoeuvre has been used during shuttle missions to avoid collisions with debris;[157] such an occasion received widespread attention in 1993 when the Shuttle *Endeavor* had to manoeuvre in order to avoid a Russian rocket stage.[158] The danger of large objects, which can be tracked, should not be under-estimated; in 1992 a 500kg object passed within 300m of the *Mir* space station at a relative speed of 12.7km/second.[159] This is not a unique event, debris frequently passes near to the International Space Station.[160]

Shielding is an obvious means of protection. If a space craft is to be exposed to high velocity impacts then 'strong walls' should ensure that it is not critically damaged. However shielding is only completely effective for debris up to 1cm in diameter;[161] it is not technically possible to protect against all objects with a diameter greater than 1cm[162] and for objects larger than 10cm shielding is ineffective.[163] A financial concern regarding shielding is that it adds extra weight to be launched from the Earth; the heavier a satellite the more expensive it is to put into orbit and, other than protection, shielding adds nothing to efficiency or usefulness of a satellite.[164] More importantly shielding cannot protect every part of a satellite; antenna and solar arrays have to be exposed in order to perform their purpose.[165]

The employment of shielding is not a technically simple solution. 'Whipple' bumpers are designed to break up an oncoming particle and absorb the resulting energy.[166] However shielding has to be 'tuned' to specific mass and velocity of debris, therefore one shielding design cannot be effective against all pieces of debris.[167] In order to provide protection the International Space Station will utilise over 200 types of shielding against debris and micro-meteoroids.[168]

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[157] U.N. (1999a), *op. cit.*, pp. 15-16.
[158] Molly K. Macauley; 'Economics of Space', in Eligar Sadeh (ed.); *Space Politics and Policy: An Evolutionary Perspective* (Dordrecht, The Netherlands: Kluwer Academic Publishers, 2002), p. 195.
[159] Davidov *et al.* in Dansey (ed.), *op. cit.*, p. 53
[160] Yakovlev in Dansey (ed.), *op. cit.*, p. 591.
[161] *Ibid*, p. 34.
[162] W. Flury; 'European Space Agency Activities on Orbital Debris' in Smirnov (ed.), *op. cit.*, p. 27.
[163] U.N. (1999a), *op. cit.*, p. 34.
[164] Bernard Bloom; 'Human Survivability Issues in the Low Earth Orbit Space Debris Environment' in Simpson (ed.), *op. cit.*, p. 63.
[165] Johnson and McKnight, *op. cit.*, pp. 87-88.
[166] U.N. Document A/AC.105/681; (17th December 1997), p. 8.
[167] U.S. Congress, *op. cit.*, p. 25.
[168] U.N. (1999a), *op. cit.*, p. 35.

Shielding can be achieved more simply by using the mass of a space craft itself, specifically by exposing non-sensitive areas to debris in order to protect important systems and crew areas. This practice is utilised by the Shuttle which, when possible, is orientated 'with the payload bay towards Earth and the aft of the orbiter in the forward direction', such positioning, is safer by a factor of 20 relative to the worst possible orientation.[169] The *Mir* space station was similarly positioned using its own non-critical areas as a means of protection.[170]

Debris Sinks

The debris threat is exacerbated as nature offers little practical assistance. 'Sinks' are mechanisms by which pollution is removed from an environment. Perhaps the most widely cited are rain forests, which remove anthropogenic carbon dioxide from the atmosphere.[171] In effect there are only two means by which debris is pacified: natural decay into the atmospheric sink and active removal.[172]

The one natural sink for debris is atmospheric drag, a phenomenon which only occurs in LEO. This is theoretically very simple, in LEO some atmosphere still exists, although it is very thin. When debris hits a part of the atmosphere it loses velocity; this lowers its orbit and increases the probability of it encountering more atmospheric particles. This process slowly draws the debris into the atmosphere where it 'burns up'.[173] The mechanics of this phenomenon are linked to the eleven year cycle of the Sun; when it is at its hottest the atmosphere expands and cleanses more debris.[174] It is through burning up that natural meteoroids are removed from Earth orbit. However the process of being caught in the Earth's gravitational field, as the planet travels through space, to burning up in the

[169] U.N. Document A/AC.105/681, *op. cit.*, p. 8.
[170] U.N. (1999a), *op. cit.*, p. 35.
[171] Peter Barnes; *Who Owns The Sky?* (Washington, D.C.: Island Press, 2001), pp. 81-84.
[172] Kessler and Cour-Palais, *op. cit.*, p. 2643.
[173] When debris burns up it rarely present a further problem, as what little survives only arrives on the planet surface as dust. On the rare occasions when objects survive uncontrolled re-entry they almost always, and inevitably, crash into unpopulated areas. However, the sight of debris burning up in the upper atmosphere has been the cause of reported sighting of Unidentified Flying Objects. Leo Enright; 'UFO linked to secret Russian mission' *The Irish Times* (10th April 1993), David Clark 'Britain's X-Files: The House of Lords UFO Debate' *Fortean Times* Vol. 201 (September 2005), p. 40 and Nick Pope; 'Britain's Real X Files' *Daily Mail* (2nd February 2005).
[174] Johnson in Simpson (ed.), *op. cit.*, p. 14.

atmosphere takes only a few minutes for meteoroids, the timescale for debris stretches from days to millennia and possibly longer.[175]

Debris at altitudes between 200km and 400km is expected to re-enter the atmosphere within months,[176] whilst orbits up to 500km are considered to be self cleansing, within a few years.[177] However LEO extends 2,000km from the planet's surface. At the higher reaches of LEO drag has little significant effect, except in the extreme long term. In geostationary orbit there is virtually no atmosphere thus debris will remain there, for all practical purposes, indefinitely.[178] One of the world's leading authorities on debris, Donald Kessler, observed that solar radiation will slowly push debris out of GEO. However for objects larger than 1cm in diameter this would take over 60,000 years and possibly a million years.[179] Nicholas Johnson and Darren McKnight estimate that atmospheric drag is so weak that an object, in GEO, would only lose 1km in altitude over a 1,000 years.[180]

It has been suggested that an Orbital Manoeuvring Vehicle could remove debris from orbit,[181] one such technique would utilise a large balloon to 'sweep up' debris and carry it into the atmosphere. However this concept has not been developed as at present, and for the near future, it is not considered to be cost-effective.[182] The Japanese Aerospace Exploration Agency (JAXA) has continued research into the idea, which suggested that removing 100 pieces of debris from a crowded LEO altitude would reduce the risk of collision by 30%. JAXA's research further explored the possibility of using an Electro-Dynamic Tether System in order to capture debris.[183] Lubos Perek suggests that the lack of legal clarity concerning third parties removing debris from orbit has resulted in research concerning the active removal of debris being discouraged.[184]

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[175] National Research Council, *op. cit.*, p. 1.
[176] Office of Science and Technology Policy, *op. cit.*, p. 6.
[177] U.S. Congress, *op. cit.*, p. 16.
[178] U.N. Document A/AC.105/681, *op. cit.*, p. 6.
[179] Kessler in Simpson (ed.), *op. cit.*, p. 30.
[180] Johnson and McKnight, *op. cit.*, p. 80.
[181] Andrew J. Petro and David L. Talent; 'Removal of Orbital Debris' and Andrew Petro and Howard Ashley; 'Cost Estimates for Removal of Orbital Debris' in Loftus (ed.), *op. cit.*, pp. 169-182 and 183-186.
[182] National Research Council, *op. cit.*, p. 7.
[183] Takashi Nakajima; 'Debris Research Activities in Japan' in Dansey (ed.), *op. cit.*, p. 21.
[184] Lubos Perek; 'Managing Issues Concerning Space Debris' in Dansey (ed.), *op. cit.*, p. 587.

Presently a norm is emerging that at the completion of its useful lifetime a satellite, in LEO, should either be brought back into the Earth's atmosphere, or left in an orbit where it is expected to encounter drag. Twenty five years is considered to be a reasonable limit for the amount of time a defunct system remains in orbit before it re-enters the atmosphere.[185]

The active removal of debris is only possible for objects still under control. Also LEO is the only orbit in which this activity is economically viable, as an enormous amount of fuel would be required to deorbit an object in GEO.[186] Recent ESA-funded research has explored the possibility of active removal of debris in GEO,[187] yet the intention there is to move objects away from the planet not towards it.

GEO is protected from over-crowding by moving satellites to a higher altitude, known as a graveyard orbit. This is becoming standard practice for satellites which are approaching the end of their useful life; they are commanded to burn the rest of their fuel in order to leave GEO.[188] However, this procedure requires positive action from satellite operators, as the fuel required to move a satellite 300km out of GEO could maintain its position for three months.[189] This represents a financial cost to operators, as the three months lost, represent 2% of a 15 years operational life time.[190] However, many GEO satellite operators have accepted this procedure, as reducing satellite life-spans is in their individual, as well as collective, interests if it preserves the GEO environment.[191] The procedure is technically difficult, it is not attempted for every satellite and is not successful in all instances when it is attempted.[192] Further, for those satellites which are raised to a

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[185] Inter-Agency Space Debris Coordination Committee; *Report of the IADC Activities on Space Debris Mitigation Guidelines Presented to: 41st Session of the Scientific and Technical Subcommittee United Nations Committee on the Peaceful Uses of Outer Space* (2004) p. 16
< www.iadc-online.org/docs_pub/IADC-UNCOPUOS-final.pdf >.
[186] U.N. Document A/AC.105/680/Add.1; (2nd February 1998), p. 5.
[187] U.N. Document A/AC.105/817; (15th December 2003), pp. 15-16.
[188] Yasaka in Smimov (ed.), *op. cit.*, p. 114.
[189] U.N. Document A/AC.105/681, *op. cit.*, p. 6. The IADC recommends that a satellite should be moved a minimum of 235km, in order for it to be considered securely removed from GEO. Inter-Agency Space Debris Coordination Committee; *Report of the IADC Activities on Space Debris Mitigation Guidelines Presented to: 39th Session of the Scientific and Technical Subcommittee United Nations Committee on the Peaceful Uses of Outer Space* (2002) p. 5
< www.iadc-online.org/docs_pub/IADC_Present.2002-final.pdf >.
[190] K. Kensinger, S. Duall and S. Persaud; 'The United States Federal Communications Commission's Regulations Concerning Mitigation of Orbital Debris' in Dansey (ed.), *op. cit.*, p. 573.
[191] U.N. (1999a), *op. cit.*, pp. 39-40.
[192] Perek, *op. cit.*, p. 218

higher orbit, Kessler has argued that this may not be sufficient to protect GEO, as the satellites may 'drift' back to that orbit.[193]

GEO can be further protected through the careful positioning of satellites in that region. Given that there is a limited number of slots which are available in the GEO ring, the resource is finite and when being utilised by one actor is unavailable to others. Co-location is a method which limits the amount of space which is occupied, by this means multiple satellites share approximately the same position in geostationary orbit, the usage of different frequency bands prevents harmful interference.[194] Although this technique increases the feasible population of satellites in GEO, by placing satellites closely together, it increases the possibility of collision, and hence the production of more debris. As such, the relative orbits of co-located satellites are required to be measured as accurately as possible.[195] There have been a number of cases in which operators have successfully co-located satellites, but in instances where the satellites are not operated by the same company, it is considered less desirable due to cost and logistical difficulties.[196]

The most important factors to consider with reference to GEO is that it is a uniquely useful region and that cleansing GEO, should it become cover crowded with debris, is not feasible either economically or technically.[197]

Conclusions

That debris has yet to cause serious financial loss, due to impacts with active satellites, should not be considered as evidence that such occurrences are not a grave possibility in the near future. Long term forecasts suggest that if no remedial action is taken, then by 2100, the number of collisions in LEO will increase by a factor of 40 or 60.[198] Further, the importance of access to near Earth space cannot be underestimated: commercially, satellites revenues alone were estimated to be worth $85.1billion in 2001;[199]

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[193] Kessler in Simpson (ed.), *op. cit.*, p. 33.
[194] 'Atrexx Satellite Glossary' < www.atrexx.com/index.cfm?fuseaction=service&id=101 >.
[195] N.V. Vighnesam and Anatta Sonney; *Precise Relative Orbit Estimation of INSAT Missions* < www.issfd.dlr.de/papers/P0100.pdf >.
[196] Kensinger *et al.* in Dansey (ed.), *op. cit.*, p. 572.
[197] Dietrich Rex; 'Will Space Run Out of Space' *Space Policy* Vol. 14 (1998), p. 97.
[198] Davidov *et al.* in Dansey (ed.), *op. cit.*, p. 57.
[199] DeBlois, *op. cit.*, p. 32.

militarily, the technology of modern warfare requires the presence of space based resource; and scientifically, debris poses a threat to the exploration of the universe and its origins.[200] In short, any policy which addresses space issues is affected by the presence of debris.

The three means through which the debris problem can be addressed are: understanding, prevention and preparation.

In order to address any problem, a thorough understanding is necessary. There is still much astronomical research to be conducted into the subject of debris, perhaps most significantly measuring the debris population in GEO. However understanding debris is not limited to physical realities; it is necessary to understand the political constructs through which near Earth space is conceptualised. Any approach designed to protect near Earth space, will influence the political reality within which it exists. Protection against debris will introduce a form of governance to the Commons of space; how this is put into practice will have a practical effect upon political constructs surrounding the global Commons.

Preventing the production of debris is a policy which has already been initiated. The established practices of venting fuel from rocket stages to negate the possibility of fragmentations,[201] and removing defunct satellites from GEO, are important steps towards the protection of near Earth space. Further attention to the design of space craft, and their operations, presents another means of limiting debris production. The notion of prevention also raises important questions concerning the nature of space. The Commons, as a social phenomena, are founded upon the assumption that the actions of individuals will not have a significant effect upon others; resources are considered to be sufficiently plentiful that no requirement for regulation exists. Debris provides a perspective which suggests this is not the case in near Earth space; rather it infers a potentially finite resource which demands regulation for the purposes of preservation. Effective regulation will require co-operation, which is a vital factor in any effort to deal with a problem, such as debris, that is inherently

[200] Astronomical satellites are capable of measuring the distance past of the universe, which is not possible from the surface of the planet because of atmospheric interference, examples being the Cosmic Background Explorer (COBE) and the Hubble Space Telescope, Primack in Simpson (ed.), *op. cit.*, pp. 71-72. Debris also interferes with the field of vision for ground based observation of the heavens, U.N. (1999a), *op. cit.*, p. 17.

[201] The United States introduced debris limitations guidelines in 1997 which required energy storage devices to be depleted when defunct, U.N. Document A/AC.105/751/Add.1; (29th January 2001), p. 3.

international in character. As Dietrich Rex notes when the in an atmosphere of world wide economic competition, 'no country will accept additional costs for measure of space debris avoidance if it cannot be sure at the same time that competitors will pursue the same course'.[202]

Debris is also of importance when considering the possibility, and indeed desirability, of weaponising space. The most comprehensive recent study into space policy conducted within the political governance of the USA was the 2001 'Rumsfeld Commission', this argued that history showed air, land and sea had been used for warfare, therefore military conflict in space was a 'virtual certainty'.[203] Such a certainty would, in light of debris, be detrimental to the interests of all actors. Further a large number of deliberate satellite fragmentations in Earth orbit, would create a new form of Mutually Assured Destruction. Should one state destroy another's satellites, it would do so with no guarantee that the debris generated would not, in turn, destroy its own space based resources.

Targets to limit the production of debris are important as they attempt to prevent the problem from escalating. However they do not remedy the debris which is already present in Earth orbit. Given that debris already exists, and that a certain amount will, seemingly inevitably, be produced by space activities, it is necessary for policy makers to be involved in preparation for the dangers it presents. The importance of preparation is emphasised when the possibility of the Kessler Syndrome is considered. It is therefore incumbent for preparations to be made, upon the assumption that near Earth space will become a more hostile environment.

The policy of protection will be required to influence all aspects of space activity. As such, space craft especially those with a crew, will have to be protected against the dangers of impact. This will require both strong shielding, as well as the development of more sensitive tracking equipment in order to ascertain where the greatest threat exists. However, protection should not merely be of craft in orbit, it must also seek to protect near

[202] Rex, *op. cit.*, p. 105.

[203] The methodology which created this claim was questionable, the reasoning was thus, every medium (air, land and sea) had been the arena for conflict, therefore it was almost inevitable that space would also be subject to warfare. *Report of the Commission to Assess United States National Security Space Management and Organization* (Washington D.C., 11th January 2001) p. 10.

Earth space itself. This will produce a requirement to consider the necessity of utilising certain space based resources, addressing whether the utility which they offer can be justified in comparison to the damage which their deployment and operation will have upon Earth orbit.

The most important technical fact, in consideration of debris mitigation techniques, is that shielding and tracking combined cannot provide complete protection from objects between 1cm and 10cm in diameter. These are too small to be accurately tracked and too large for shields to protect against.[204]

Therefore space debris presents a real and growing danger to human activity in space; activity which is fundamental to modern society. There is no simple technical solution, what is required is an effort to reduce debris production. This is a political problem. Johnson and McKnight noted, in 1991, that the central issue of debris is recognition;[205] this is not a technical matter it is a serious political issue. As will be demonstrated since this observation was made there have been considerable policy developments designed towards addressing the issue.

In summary, debris is a technical problem for which there is no simple solution. Tracking and shielding are means of mitigating against the effects of the problem. However, the enormous time periods during which debris will remain in orbit; create the situation where prevention is the only truly effect means of addressing the problem.

[204] Bloom in Simpson (ed.), *op. cit.*, p. 56.
[205] Johnson and McKnight, *op. cit.*, p. 99.

Chapter Three:
Space Law

Introduction

The problem of debris has not arisen in an area lacking in social norms and conventions. Space law, along with institutions, provides a governance framework which supports a series of values upon which coordinated approaches to the debris problem can be formed. This chapter will analyse the constituents of space law; the first section will address the general principles of space law. The second will specifically focus upon the issue of liability, particularly as it was applied after the crash of the satellite Kosmos 954.

Part One – The Principles of Space Law

A Realist would maintain that because there is no power, of which all states stand in awe, international law will always be weak and broken at will by powerful states. However, history reveals that the regulations of international law are often observed. Therefore, it most useful to consider international law as a mechanism which supports values in global politics. As such, states exercise influence through their participation in regime frameworks; therefore inclusion leads to more power than the practice of isolationism.[206] It will be shown in a later chapter that institutions also provide a mechanism through which values are be supported and created in the international sphere. However, the two are somewhat different, as laws are clearly written and their applicability to situations can be studied. In contrast, the role of institutions is more fluid and adaptable as they can adapt more quickly than a treaty can be negotiated or renegotiated.

Before the details of space law are considered, it must be observed that it is a part of international law and is no more exotic than its terrestrial equivalent. The purpose of space law is to create norms of behaviour in the human exploration and exploitation of space, it is not to govern encounters with 'little green men'.[207] As with all international law, space law only applies to those recognised as 'international persons' this largely, although not

[206] G. John Ikenberry; 'The End of the Neo-Conservative Moment' *Survival* Vol. 46, No. 1 (Spring 2004), p. 16.
[207] Bin Cheng; *Studies in International Space Law* (Oxford: Clarendon Press, 1997), p. 1x.

exclusively, means states.[208] There is reference to non-state actors within space law, however this is to affirm that they are to be governed by states, and that states bear responsibility for the behaviour of non-state actors.[209] Therefore international law can be considered as being of states, by states and for states.[210]

Constituents of Space Law

There is some dispute as to what are the sources of international law, however they were defined by the Statue of the International Court of Justice (Article 38) as:

- International Conventions, or treaties
- Custom
- General principles of law as recognised by civilised nations
- Judicial Decisions.[211]

When considering the law of outer space, treaties are by far the most important factor. Customary international law consists of those rules whose existence is revealed by the behaviour of states[212]. Until relatively recently the majority of international law was in customary form,[213] however since the 19th Century there has been a tendency towards its codification, into treaties, such as the Vienna Conventions.[214] Such treaties remain as evidence of customary international law, therefore if a treaty is codifying customary law, a state is bound to its provisions regardless of whether it is a signatory or not. This is not a claim that the state is subject to the treaty itself, rather that it is bound to the custom which the treaty reflects.[215]

Customary international law is more quickly created and more adaptable than treaties; rather then a tortuous process of negotiation it is formed through practice. For

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[208] Malcolm N. Shaw; *International Law* Fifth edition (Cambridge: Cambridge University Press, 2003), pp. 175-246.
[209] For example see *The Outer Space Treaty* Article VI.
[210] Cheng, *op. cit.*, p. 173.
[211] Michael Akehurst; *A Modern Introduction to International Law* 5th edition (London: George Allen & Unwin, 1984), p. 23.
[212] *Ibid.* p. 25.
[213] J.G. Starke; *Introduction To International Law* 9th edition (London: Butterworth, 1984), p. 34.
[214] *Ibid.* p. 34.
[215] Akehurst, *op. cit.*, pp. 26-27.

example states claiming exclusive fishing rights 200 miles from shore has never been codified in a treaty, however it has become such a widespread practice, without legal objection, that 'it can probably no longer be regarded as illegal'.[216]

In 1976 the Manual of the International Court of Justice argued that in order for customary international law to be in existence then the practice must be demonstrated to be so established as to be binding upon the other party.[217] Clearly, as the debris problem has only been relatively recently identified, there is no such common practice with reference to the production of debris. However, there are customs that exist within space law. From 1914 onwards it had been accepted that states would not accept the right of free passage through their air space, therefore a customary law quickly came to be recognised.[218] This contrasts with the condition in Earth orbit, where states accept satellites spying on their territory. The absence of an objection to this practice can be seen as a customary international law. It is possible that the initial stages of a response to the debris problem will be considered to constitute customary law, whereby states voluntarily limit their production of debris, such that it will then become considered as an accepted norm of international behaviour.

The most basic of the general principles of law, are know as *jus cogens*, these are a body of principles which are considered to be so basic that there can be no derogation from them. Thus, a treaty which permitted piracy would not be legal, as it would seek to sanction that which is unsanctionable.[219] As will be discussed below, there is a basic principle in international law that states should not adversely effect each other. The basic principles which exist have the purpose of prohibiting the most abhorrent behaviour, as such they do not have the intention of addressing a specific, and technical, problem such as debris.

A lack of specificity is also the case when looking for sources of space law in judicial decisions. There have been no significant cases brought to an international tribunal concerning space activities. Thus, the judgements available are only those which can be seen as indicating an analogous relationship to the debris problem.

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[216] *Ibid.* p. 271.
[217] Starke, *op. cit.*, p. 39.
[218] Akehurst, *op. cit.*, p. 286.
[219] Starke, *op. cit.*, pp. 53-55.

Therefore, it is treaties which form the major part of space law, and thus form the framework within which the debris problem can be conceptualised. Bin Cheng is explicitly clear that before any specific treaty regarding space came into force it was not a lawless place. Rather all treaties regarding the interactions between states are as applicable in space as they are on the planet's surface.[220]

There was however some debate concerning this principle in the early stages of the creation of space law. Hamilton DeSaussure identifies two views which were taken concerning its development. The first was articulated by Ambassador Jha of India, who argued that space was a radically new environment requiring a new legal system. In opposition to this, the Soviet author E.G. Vassilevskaya, presented the position that terrestrial laws can be transferred to space.[221] It is not surprising that it was accepted that all international law applies in space, for its provisions seek to govern the behaviour of states. Therefore as states move the arena of their conduct into space, in so doing they take international law with them.

To date the specifics of space law are found in five treaties:

- *Treaty On Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies* (1967) commonly referred to as 'The Outer Space Treaty'
- *Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space* (1968)
- *Convention on International Liability for Damage Caused by Space Objects* (1972)
- *Convention on Registration of Object Launched into Outer Space* (1976)
- *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies* (1979) referred to as 'The Moon Agreement'[222]

[220] Cheng, *op. cit.*, p. 228-229.
[221] Hamilton DeSaussure; 'An Integrated Legal System for Space' *Journal of Space Law* Vol. 6, No. 2 (1978), p. 181.
[222] 'United Nations Office for Outer Space Affairs'
< www.oosa.unvienna.org/SpaceLaw/treaties.html >.

There have also been five declarations of legal principles by the United Nations General Assembly concerning space law.[223] However these are only the opinions and recommendation of the General Assembly, as such they are not legally binding.[224] Also none of them relates specifically to the issue of debris, therefore they will not be examined further.

All five of the above treaties have entered into force.[225] However *The Moon Agreement* has only been ratified by eleven states,[226] of which none are major space faring powers. The principle exists, in international law, that no state can be bound to a treaty without its consent.[227] This poses a serious problem concerning *The Moon Agreement*; the only states which it could practically effect are not bound by its provisions. Therefore the following considerations are qualified by the fact that so few states have ratified the document. Whether the treaty ultimately becomes redundant will depend upon the political circumstances should the Moon become economically useful.[228]

An immediate problem in addressing debris, through space law, is the period in which the treaties were written; they originated before debris had been identified as a problem. One of the earliest warnings concerning debris was made by the Japanese Institute of Space and Astronautical Science in 1971,[229] however it was not until the work of Kessler, and others, in the late 1970s that the full extent of the problem began to emerge.[230] Further, the problem did not enter in the 'mainstream' of considerations concerning space until the

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[223] *Ibid.*
[224] Cheng, *op. cit.*, p. 160.
[225] The last to do so was *The Moon Agreement* which entered into force in June 1984, Christopher C. Joyner; 'Legal Implications of the Concept of The Common Heritage of Mankind' *International and Comparative Law Quarterly* Vol. 35, No. 1 (June 1986), p. 196.
[226] United Nations; *United Nations treaties and principles on outer space: Status of international agreements relating to activities in outer space as at 1 January 2005* (Vienna: United Nations, February 2005).
[227] Cheng, *op. cit.*, p. 169. There does exist 'customary international law'; rules considered to exist although they are not written, which can be viewed as applying to all states. However *The Moon Agreement* could not be considered as such, *ibid.* pp. 203-205.
[228] Susan Buck; *The Global Commons* (Washington: Island Press, 1998), p. 152.
[229] Susumu Toda; 'The Current and Future Space Debris Environment as Assessed in Japan' in Simpson (ed.), *op. cit.*, p. 128.
[230] Donald Kessler; 'Current Orbital Debris Environment' in Loftus (ed.), *op. cit.*, p. 3. For example see Kessler and Cour-Palais, *op. cit.*, pp. 2367-2646. One of the first papers to examine the legal aspects of the problem was also published at this time, Christol (1979), *op. cit.*, p. 433-458.

end of the 1980s.[231] European research into debris was given particular impetus when, in 1986, an Ariane orbital stage exploded creating 488 pieces of trackable debris.[232] As no treaties have been written since debris has been identified as an issue of importance, it is not surprising that there is no legal definition of what either 'orbital debris' or 'space debris' mean,[233] this lack of clarity remains despite the United Nations have discussed a definition for ten years.[234]

Perek perceives this lack of legal clarity as a problem in addressing the issue, for all objects in space, including their component parts, remain the property of states and therefore under their sovereign control. Therefore, from a literal reading of the law, if a piece of debris is threatening an active satellite, only the state from which the piece of debris originated would have the right to either deflect or destroy it.[235]

In response to this problem, Perek argues that there should be a reappraisal of the objects orbiting the Earth, wherein satellites should be designated as being valuable or worthless. Those which states would wish to claim as being valuable, are expected to be active satellites, those in parking orbits (to be subsequently reactivated), specific scientific satellites and inactive military satellites, which maintain value because of the potentially sensitive data which they are carrying. His argument for this typology is founded upon the difficulty in clearly establishing whether a satellite is active or inactive.

Those objects designated as being worthless would be declared to be space debris and cease to have legal protection. Small objects, such as the component parts of satellites would automatically be designated as debris. Under Perek's proposal all states would have the authority to remove objects which were designated as being worthless.[236] At present this proposal remains largely speculative, as there are no viable technical means proposed for the active removal of debris.

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[231] At this point the European Space Agency and the United States Congress both produced reports on orbital debris. Perek in Dansey (ed.), *op. cit.*, p. 587.
[232] Klinkrad *et al* in Dansey (ed.), *op. cit.*, p. 25.
[233] Office of Science and Technology Policy, *op. cit.*, p. 45.
[234] Perek in Dansey (ed.), *op. cit.*, p. 587.
[235] Perek, *op. cit.*, p. 219.
[236] *Ibid.* pp. 219-221.

Nature of territory in international law

In international law, as it has developed since Grotius, there has been three types of territory. The closed discourse of Westphalian thinking tends to render the student of International Relations blind to this fact, but the world does not consist exclusively of nations states. The other types of territory are *res nullius* and *res extra commercium*,[237] the former are areas which although not presently national territories may be acquired. Whilst *res extra commercium* similarly exists beyond national territories but is not subject to appropriation. These protected places constitute the global Commons. Examples of territories other than nation states are subject to debate, but Antarctica represents what remains of *res nullius*, for the *Antarctic Treaty* only requires signatory states to suspend their territory claims not renounce them.[238] The high seas are beyond territorial claim and constitute *res extra commercium*.

The 1979 *Moon Agreement* was the first treaty to create a fourth type of territory, *territorium commune humanitaties*, areas which belong to humanity as a whole and constitute the Common Heritage of Mankind (CHM).[239] As the title infers these areas are not subject to appropriation because they are already owned by every one. As the concept of CHM has not been significantly put into practice, there is substantial confusion over its position in international law,[240] however the key political feature is that 'resources are to be shared by all nations irrespective of their technological capabilities'.[241]

Although the Moon and other celestial bodies have been classified as CHM, space itself, including that comprising Earth orbit, was not included in *The Moon Agreement*. Its

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[237] Cheng, *op. cit.*, p. 357.
[238] The *Antarctic Treaty* (1959), Article IV states: 'Nothing contained in the present Treaty shall be interpreted as: (a) a renunciation by any Contracting Party of previously asserted rights of or claims to territorial sovereignty in Antarctica'. And further 'No acts or activities taking place while the present Treaty is in force shall constitute a basis for asserting, supporting or denying a claim to territorial sovereignty in Antarctica or create any rights of sovereignty in Antarctica'.
[239] Cheng, *op. cit.*, p. 405.
[240] Joyner, *op. cit.*, p. 190. The concept of CHM has been given form in the International Seabed Authority < www.isa.org.jm > created by UNCLOS III. However, that organisation has yet to wield the amount of influence which the concept infers.
[241] Thomas Brauninger and Thomas Konig; 'Making Rules for Governing the Global Commons' *Journal of Conflict Resolution* Vol. 44, No. 5 (October 2000), p. 610. This concept was contained in the first General Assembly declaration of principles concerning space, *1962 (XVIII) Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space*, this was a foundation for *The Outer Space Treaty.*

status is defined by *The Outer Space Treaty*, which declares space to be the 'province of all mankind'.[242] Therefore non-planetary space is *res extra commercium*, free for all to use, and not subject to appropriation. Vogler states that the word 'province' means that space is *res communis*[243] 'a thing that is for the use of all because it is not subject to private ownership'.[244] Because the vacuum of space is a Commons it does not have protection, as the Moon does, under the provisions of the Common Heritage of Mankind.

Although the *OST* does prohibit national appropriation of space, it does not deny state's sovereignty over their own activities. Thus Article XII of the treaty, which provides for space stations and installations being visited by representatives of other states, contains the notion of jurisdiction as the right to visit is reciprocal and subject to reasonable notice.[245] Further, liability as it is contained within space law, both in the *OST* Article VI and the *Liability Convention*, affirms that states maintain responsibility for their actions. States are also responsible for non-governmental organisations based, or launched from, within their terrestrial jurisdiction, demonstrating that sovereignty also continues in the form of responsibility.[246] A clear analogy with the High Seas is thus demonstrated, although the territory belongs to no state, a vessel moving within the area is still subject to national sovereignty by nature of the flag to which it is registered. Thus in the international vacuum of a Commons, an individual craft remains within the bubble of sovereignty.

There is clear empirical evidence that states consider near Earth space to be a Commons; specifically through the actions which they conduct and those they permit from others. States rarely object to the presence of 'spy satellites' in orbit, rather they are generally accepted as beneficial to global security,[247] indeed they are referred to in arms control treaties as 'technical means of verification'.[248] However despite this current

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[242] *The Outer Space Treaty* (1967), Article I.
[243] Vogler, *op. cit.*, p. 115.
[244] The concept is first found in Roman law, Cheng, *op. cit.*, p. 1ii.
[245] Stephen Gorove; 'Sovereignty and the Law of Outer Space Re-Examined' *Annals of Air and Space Law* Vol. II (1977), p. 316.
[246] *Ibid.* p. 315 & 320.
[247] DeBlois, *op. cit.*, p. 30.
[248] SALT II is such an arms control treaty. Hans Mark; 'War and Peace in Space' *Journal of International Affairs* Vol. 39, No. 1 (Spring 1985), pp. 6-7.

conceptualisation, it should not be considered that the notion of space as a Commons was inevitable.[249]

Environmental Protection Under Current Space Law

Although near Earth space is constituted as a Commons, it is not without regulation. The international treaties governing space form an agreed framework within which activity occurs there. This has implications for the debris problem.

Since the 1972 U.N. Stockholm Conference on the Human Environment the concept *sic utere tuo ut alienum non laedas* (use your property so as not to injure your neighbour)[250] has been explicit within international law.[251] The behaviour of states, in broadly following the principle reveals that it can be considered to be part of customary international law. The principle is given form in several of the space treaties, specifically Article IX of *The Outer Space Treaty* which asserts, '[i]n the exploration and use of space' states are required to act 'with due regard to the corresponding interests of States Parties to the Treaty'. The principle is also contained in Article 8 of *The Moon Agreement*, which states that '[a]ctivities of States Parties . . . shall not interfere with the activities of other States Parties on the moon'.

A certain reading of this principle could be applied to debris. States have a duty to conduct their activities in a fashion which does not detrimentally effect the pursuits of others, as debris does so it could be contrary to the treaty regulations. Whether this interpretation would be acceptable is open to debate; it would certainly be within the spirit of the law, however the law could be more rigidly interpreted as only requiring states not to *deliberately* effect others. Certainly opinion appears to favour the notion that there is 'no legal incentive to avoid generating orbital debris.'[252]

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[249] When debates which were eventually to lead to *The Outer Space Treaty* commenced, the U.S.S.R. was initially in favour of outer space being an extension of air space. The superpowers agreed on a Commons structure, in part, because it was in both of their strategic interests. M.J. Peterson; 'The Use of Analogies in Developing Outer Space Law'; *International Organization* Vol. 52, No. 2 (Spring 1997), esp. pp. 246-247 & 256-257.

[250] Howard A. Baker; 'Regulation of Orbital Debris' in Simpson (ed.), *op. cit.*, p. 183.

[251] It is contained in Principle 21 of the Stockholm Declaration, Vogler, *op. cit.*, pp. 35-36.

[252] U.S. Congress, *op. cit.*, p. 10.

A further important facet in the concept of non-interference is its intended scope. In effect it is little more than a commitment, by states, not to cause damage to each other; it does not seek protection of space as an aim in its own right, as such violation would require a state to be inconvenienced. As all space-faring states are responsible for the production of debris, for one to claim inconvenience due to another is extremely unlikely, as in the process it would bring attention to the debris it has produced.

Article IX of *The Outer Space Treaty* specifically provides for environmental protection:

> 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.[253]

The wording of this section reveals the inadequacy of current space law in dealing with debris; it only addresses itself to the environments of Earth and the celestial bodies. It can be presumed that when this treaty was written, space was considered to be infinite in size, therefore an environment not in need of protection. Howard Baker comments upon this weakness, arguing that the problem is due to the manner in which space was conceptualised when the treaty was written. Space was considered to be area to be experimented upon, but with no intrinsic value in itself. Therefore, states could behave as they wished, provided that they did not affect each other; with reference to this analysis they could produce as much debris as they wished, thus the limitations upon states are 'ambiguous and minimal'.[254]

Baker further asserts that the manner in which the *Outer Space Treaty* was written resulted in the weakness of Article IX; UNCOPUOS proceeds upon a consensus approach, as such there are inevitably many compromises.[255] Although there is undoubted validity to this, in fact it is extra-ordinarily difficult to conceptualise under what alternative arrangements the treaty could have been drafted. Given the nature of the Westphalian state

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[253] *The Outer Space Treaty* (1967), Article IX.
[254] Howard A. Baker; 'Protection of the Outer Space Environment: History and Analysis of Article IX of the Outer Space Treaty' *Annals of Air and Space Law* Vol. XII (1987), pp. 165-168.
[255] *Ibid.* pp. 165-166.

system, should a treaty not be negotiated by consensus, then any state can refuse to be a signatory to it. As such, the greatest utility is to be found in a consensus but holistic treaty, rather than a more stringent treaty which is not inclusive of key actors. Neither approach to treaty making can be considered as ideal, however given the two alternatively available the former is preferable. Thus, the provisions of Article IX may be accurately considered to be insufficient, however they were most probably the best available.

Article IX also provides the requirements incumbent upon states if they believe that 'an activity or experiment' they are planning will detrimentally effect 'other States Parties'[256] This provision is particularly weak; the Japanese and Lebanese delegations, during its negotiation, observed that it requires states to consult but does not require the to take any action.[257] Therefore in terms of protecting Earth orbit this commitment is virtually useless.

Prior to the completion of the *Outer Space Treaty (OST)*, whilst the principles were still being negotiated, the USSR and USA had a disagreement concerning Project West Ford. This was an American experiment which was to release 480 million copper needles, of less than 2cm in length; they were to form a ring around the Earth to which the USSR objected. The copper filaments (dipoles) where intended to be used to reflect radio signals from the planet back to another point on the planet's surface. Some of the dipoles are still in orbit, four decades after their launch, adding to the debris problem.[258] The Soviet objection cited the principle, being discussed in UNCOPUOS, that states should not behave in a fashion which may harmfully interfere with the activities of other states. The Soviet position was that this necessitated prior consultation and consent, however in turn this was objected to as it gave states the power to veto each others activities.[259] Thus, even before the *OST* was signed, the difficulty in the provisions of Article IX were being demonstrated, for there is no international standard by which activities can be judged to ascertain whether they are in keeping with the provisions of the treaty. This is exacerbated by the absence of a mechanism to resolve disagreements.

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[256] *The Outer Space Treaty* (1967), Article IX.
[257] Cheng, *op. cit.*, p. 257.
[258] Spacecraft: West Ford Dipoles < www.aoe.vt.edu/~cdhall/Space/archives/000289.html >. Some of the Dipoles which remain in orbit can be tracked at < www.heavens-above.com/satinfo.asp?lat=37.23274&lng=-80.42841&alt=0&loc=Blacksburg&TZ=EST&SatID=602 >.
[259] Baker (1987), *op. cit.*, pp. 145-147.

Liability for Damage Caused by Debris

There is provision, in space law, for compensation to be claimed, should a state be liable for damage to another's property. Article VII of *The Outer Space Treaty* refers to the concept of liability, its provisions maintain that the state of registry has liability, along with the state from whose territory a launch physically occurs, to another state party to the treaty, for damage caused by an 'object or its component parts on the Earth, in air space or in outer space'.[260] There are three important factors to be considered here; firstly liability is shared between the state of registry and the state which is host to the launch (should there be a difference).

Secondly, reference is made not only to 'objects' placed in space but also their component parts. A vast amount of debris is not whole 'space objects', rather it is parts which have broken loose or the results of fragmentations. Whether due to the foresight of those who drafted the treaty or not, this Article applies to all debris.

The third important factor is the locations in which liability occurs. When the treaty was written most concern focused upon objects re-entering the atmosphere and causing damage on the ground. However, this Article does not limit itself to incidents on the planet's surface, it is inclusive of damage caused in space.

The principles of this Article are elaborated upon in the *Liability Convention.* This latter treaty was an attempt to establish agreed standards between all states concerning liability; Yun Zhao argues that actually it does little more than establish 'goals for a space law adjudicator'.[261] However, although it may be criticised for being limited in scope, it does provide further insight into liability in outer space. In Article III it deals with damage caused in orbit, stating:

> 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

[260] *ibid.* p. 237-239.
[261] Yun Zhao; 'The 1972 Liability Convention: time for revision?' *Space Policy* Vol. 20 (2004), p. 117.

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.[262]

The definition of the word 'fault' could be endlessly debated; does failure to remove a satellite from GEO at the end of its life span constitute fault? Further, would liability be incurred if a piece of debris impacted with a space object, and there was evidence that the launching state had not pursued all possible means of debris mitigation? There is an argument to be made that when the notion of liability is taken in consideration with Article IX of *The Outer Space Treaty*, then the duty not to interfere with the activities of other states requires each state not to produce debris, therefore the production of debris would be considered as a 'fault'. However this could not be considered as legally certain.

It is worthy of note that the use of the term 'launching state' within the *Liability Convention* is defined, in Article I, as referring to both a state which procures a launch and another should a launch physically occur within its territory. This is expanded upon on in Article IV, which asserts that liability for compensation shall be divided between states according to the degree to which they are at fault.[263]

The *Liability Convention* is simply not designed to manage the problem of debris. As mentioned previously the one documented occasion when debris damaged a satellite both objects originated in the same state, France,[264] and therefore under Article VII the convention did not apply.[265] Thus, there has yet to be an occasion when a party could seek to invoke the provisions of the convention due to debris. The *Liability Convention* is further limited because it only seeks to address damage done to property in space. It places no importance upon the protection of space, as an environment, in its own right.[266] The second part of this chapter will consider a case study concerning the use of the *Liability Convention*;

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[262] *The Liability Convention*, Article III.
[263] Cheng, *op. cit.*, pp. 328-330
[264] In July 1996 a French satellite was disabled by a fragment of a French rocket stage. Chobotov in Smirnov (ed.), *op cit.*, p. 10.
[265] Article VII of *The Liability Convention* states, 'The provisions of this Convention shall not apply to damage caused by a space object of a launching State to: (a) nationals of that launching State'.
[266] Pamela L. Meredith; 'A Legal Regime for Orbital Debris: Elements of a Multilateral Treaty' in Simpson (ed.), *op. cit.*, p. 216.

for although it may not have been designed to address the debris problem, it is the legal instrument which most closely relates to the problems associated with debris.

Cheng notes that debris exists in a legally dubious area. He believes the question of ownership stands in the way of a solution to the problem; as it is unclear whether a state has the right to remove debris created by another state.[267] A U.S. Congress report, into debris, noted that legal opinion leaned towards the position that objects in space remained the property of states regardless of whether they continued to serve a useful purpose.[268] Therefore, the question arises as to whether a state should be able to disown objects which it has placed into space.[269] Clearly Perek's proposals to allow states to designate an object which they have launched to be worthless, would argue in favour of states being allowed to renounce the ownership of the debris that they have created.

Permitting states to declare defunct objects to be debris, would grant any state with the ability to cleanse Earth orbit, the legal authority to do so. However Article VIII of *The Outer Space Treaty* clearly states that an object remains under state jurisdiction when placed in space,[270] therefore a literal reading of the law would require states not to interfere with objects launched by other states, regardless of whether they were defunct and therefore debris. However, this can also be seen to serve a useful, if unintended, purpose, objects in space remain the property of launching states, as such they also remain the problem of launching states. Should debris be disowned, states would be removed from any potential legal liability or responsibility, potentially making a solution to the problem more distant.

When the *Liability Convention* was completed it did not provide legal remedies for all possible scenarios, 'a number of relatively exotic questions' remained unanswered.[271] As orbital debris had not been identified as a significant problem when the treaty was written, it is an issue which although the principles of the treaty apply to it, those principles were not

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[267] Cheng, *op. cit.*, pp. 506-507.
[268] U.S. Congress, *op. cit.*, p. 9.
[269] Cheng, *op. cit.*, pp. 506-507.
[270] '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' *The Outer Space Treaty* (1967), Article VIII.
[271] Such an example being injuries sustained in space or on a celestial body, it was accepted at the time that in future a new specific treaty may be required to resolve such situations. Herbert Reis; 'Some Reflections on the Liability Convention for Outer Space' *Journal of Space Law* Vol. 6, No. 2 (1978), p. 128.

designed to respond to the problem. This limits the relevance of the treaty, as debris is the most significant current threat posed to space based activities. Debris does not stand alone as an issue to which the application of the *Liability Convention* is problematic; the Intergovernmental Agreement in 1998 which provided for the creation of the International Space Station created a 'broad cross-waiver' for liability between participating states. The necessity for this waiver was the complexity of a venture in which multiple states are participating within one project, a scenario which is does not resonate with the design of the treaty.[272]

Although such a waiver could address the legal issues surround debris, it would not provide a physical solution to the problem. It would remove the possibility of states taking legal action against each other with reference to incidents involving debris impact, but it would not prevent such incidents from occurring. Further, an argument could be made that such a waiver would, potentially, be detrimental to a solution to the debris problem being sought. If states had legal immunity from claims due to damage caused by their debris, then they would have less reason to attempt to ameliorate the problem. There is also a low probability of such an agreement being reached as the difficulty in ascertaining the origin of pieces of debris, and proving negligence, results in the situation wherein it is unlikely that such claims for compensation would be made.

The Debris and Legal Issues Concerning the Weaponisation of Space

The suggestion that the militarization of space is a new phenomenon is misleading, much of the investment made in space has been due to potential military benefits. However there is a distinction to be drawn between the militarization, which has thus far occurred, and current proposals to weaponise space.[273] As weaponisation remains only a possibility, thus far a military conflagration has not occurred in space. Such an event would generate an enormously harmful quantity of debris. Primack observes that explosions in space are dissimilar from their portrayal in films; after an explosion fragments do not quickly disperse. Rather, a military explosion could lead to clouds of debris remaining in orbit for generations.[274]

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[272] Zhao (2004), *op. cit.*, p. 119.
[273] Karl P. Mueller; 'Totem or Taboo: Depolarizing the Space Weaponization Debate' *Astropolitics* Vol. 1 No. 1 (Summer 2003) pp. 4-28 and DeBlois, *op. cit.*, 29-53.
[274] Primack in Moltz (ed.), *op. cit.*, p. 18.

Although the treaties comprising space law make references to the word 'peaceful', there is little legal provision to maintain peace in space. In Earth orbit there are two forms of protection, firstly the 1963 *Partial Test Ban Treaty* (PTBT) prohibited nuclear explosions in space,[275] the PTBT has since been superseded by the 1996 *Comprehensive Test Ban Treaty,*[276] however the United States has not ratified the latter treaty.[277] This ban is reinforced by Article IV of *The Outer Space Treaty* which commits states not to place 'weapons of mass destruction' in 'orbit around the Earth'. Importantly there is no provision to prevent 'conventional' weapons being utilised to destroy space based resources.[278]

The word 'peaceful' has become ambiguous and subject to considerable interpretation.[279] A current trend insists it means 'non-aggressive' rather than 'non-military',[280] indeed the U.S. Government's 'Rumsfeld Commission' explicitly states that this is the American interpretation.[281] This broad definition goes beyond spy satellites monitoring arms control treaties, which can reasonably be considered both military and peaceful. Rather it has resulted in extensive militarization of Earth orbit, to the extent that virtually every aspect of modern high technology warfare is dependent upon satellite based technology.[282] When considered in terms of debris this does not provide a problem as the majority of these resources are for communications, targeting and monitoring. However actual weaponised warfare in space would most probably involve Anti-Satellite (ASAT) weapons, either kinetic kill vehicles, conventional explosives or direct energy weapons.[283] Utilisation of the latter two would create a considerable amount of debris as the target object would explode, however kinetic kill vehicles would produce an even greater quantity of

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[275] The full title of this document is *Treaty Banning Nuclear Weapons Tests in the Atmosphere, Outer Space and Under Water* it states in Article 1: 'Each of the Parties to this Treaty undertakes to prohibit, to prevent, and not to carry out any nuclear weapons test explosions, or any other nuclear explosion, at any place under its jurisdiction or control: (a) in the atmosphere; beyond it limits, including outer space; or under water, including territorial waters or high seas'.
[276] Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organisation 'History of the Comprehensive Nuclear-Test-Ban-Treaty (CTBT)' < www.ctbto.org >.
[277] Rebecca Johnson; 'Beyond Article XIV: Strategies To Save the CTBT' *Disarmament Diplomacy* Vol. 73 (October-November 2003) < www.acronym.org.uk/dd/dd73/73ctbt.htm >.
[278] Mark, *op. cit.,* p. 15
[279] Fawcett, *op. cit.,* p. 109.
[280] Cheng, *op. cit.,* p. 515.
[281] *Report of the Commission to Assess United States National Security Space Management and Organization*, *op. cit.,* p. 17.
[282] Vogler, *op. cit.,* p. 98.
[283] Mueller, *op. cit.,* p. 7.

debris, as they seek to manoeuvre along side a satellite and then explode. The weapon is loaded with fragments in order to create a cloud of debris and destroy the target.[284]

Both the U.S.A. and the U.S.S.R. have experimented, in orbit, with ASAT technology. Prior to the Soviet leader Yuri Andropov calling a moratorium in 1983, the USSR had tested a satellite interceptor ASAT system approximately twenty times.[285] However the decision, by both states, to suspend tests in orbit can be seen as evidence of a regime intended to protect Earth orbit.[286] An inclination towards protection was further demonstrated by the U.S.S.R., prior to its dissolution, by adopting the practice of conducting deliberate fragmentations at very low altitudes where the resulting debris would burn up within ninety days.[287]

Should a broad interpretation of the word 'peaceful' be accepted, it is conceivable that ASAT devices would be legal. Notwithstanding it does appear clear that their use would be against the spirit of *The Outer Space Treaty.* Concerning debris the important fact to consider is that space law provides no protection for the environment of near Earth space, against the potentially devastating consequences of weaponization.

Part Two: Liability Within Space Law – The Case of Kosmos 954

In order to further examine the principles contained within space law, and their potential applicability to the debris problem, this section conducts an inquiry into the events surrounding the crash of a nuclear powered satellite into Canadian territory. The incident has now been largely forgotten, although occasional references to it appear in popular Canadian culture.[288] Its importance is because it is the most useful instance in which the liability provisions of space law have been tested.

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[284] Primack in Moltz (ed.), *op. cit.*, p. 21.
[285] Paul B. Stares; 'Reagan and the ASAT Issue' *Journal of International Affairs* Vol. 39, No. 1 (Summer 1985), p. 84.
[286] Vogler, *op. cit.*, pp. 105-106.
[287] U.S. Congress, *op. cit.*, p. 39.
[288] For an example see, Douglas Coupland; *Eleanor Rigby* (London: Harper Perennial, 2005) p. 192. In which a character discovers a piece of radioactive debris, in Canada, from a Soviet era nuclear powered satellite.

The United Nations Office of Outer Space Affairs (OOSA) highlights two specific security issues which effect humanity's activities in space: the use of nuclear power and space debris. Although it is debris which currently raises the greatest concerns, the use of nuclear power has resulted in the testing of the notion liability as it is contained within space law.

The two issues present different legal and technical challenges, principally due to the locations in which they pose a danger. Debris may be a threat on the ground should it survive re-entry to the atmosphere, however this threat is negligible in comparison to the risk which is poses in orbit. In contrast nuclear power sources pose the greatest concern on ground level. Legally the two problems have to be considered separately as a differing degree of liability exists depending upon where an incident occurs. A further differentiation between the two problems concerns remedial action, addressing one problem can have a detrimental effect with reference to the other.

In a typical year more than 50 large objects fall back to the Earth from orbit.[289] Simply due to the geography of the Earth the majority of objects, both natural and artificial, that enter the atmosphere, and survive the process of re-entry, land in the oceans.[290] Larger objects, such at the Soviet *Mir* space station, re-enter the atmosphere in a controlled fashion, and what remains of the object after 'burning-up' on re-entry is deliberately targeted at the high seas. However, such instances demonstrate that remedial action towards the debris problem in orbit, concerning large objects, can result in physical danger being caused on the surface of the planet.

Almost five decades of space travel have produced few instances of damage being caused by objects returning from space. However, the presence of debris in Earth orbit creates the increased possibility of the *Liability Convention* (1972)[291] being used as a means to resolve international disputes. Despite being in effect for several decades the treaty is largely untested, however it was exercised, although not to its full extent, in a case between the USSR and Canada.

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[289] Yakovlev in Dansey (ed.), *op. cit.*, p. 595.
[290] S. Neil Hosenball; 'Nuclear Power Sources In Outer Space' *Journal of Space Law* Vol. 6, No. 2 (1978), p. 119.
[291] The full title of the treaty is *Convention on International Liability for Damage Caused by Space Objects* the full text can be found at < www.unoosa.org/pdf/publications/STSPACE11E.pdf >.

On 24th January 1978 a Soviet satellite, Kosmos 954,[292] accidentally crashed into north western Canada. The fragmented parts of the satellite were scattered over an area the size of Austria,[293] and included some of its power source, 30 kilograms of enriched uranium.[294] These events, and the subsequent claim for damages, made by the government of Canada, provide an insight into the notion of liability as it is contained within space law, revealing difficulties inherent in its application.

Kosmos 954 was launched on 18th September 1977.[295] The *Convention on Registration of Objects Launched into Outer Space* (1976), requires that every object 'launched into Earth orbit or beyond' is registered with the Secretary-General of the United Nations, and that a registry shall be maintained of all such objects,[296] this is to include the '[g]eneral function of the space object'.[297] The purpose of the treaty is to create a mandatory international database which would 'assist in their identification and would contribute to the application and development of international law governing the exploration and use of outer space'.[298]

In respect of the treaty, the Soviet government recorded the launch with the Secretary-General, declaring its purpose as '[i]nvestigation of the upper atmosphere and outer space'.[299] However, Kosmos 954 and its sister satellites were, in fact, designed for surveillance of marine vessels.[300] This role inevitably made them subject to potential accidents. In order to monitor ships they sought to bounce active radar signals off the target vessel; to do this effectively they needed to remain in a low orbit, as moving twice as far away from the target reduces the strength of such signals to a sixteenth of their initial

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[292] The satellite is also often referred to as 'Cosmos 954'.
[293] U.S. Congress, *op. cit.*, p. 3.
[294] Johnson (1998), *op. cit.*, p. 64.
[295] United Nations Documents A/AC.105/INF.368 (22nd November 1977), A/AC.105/217 (6th March 1978) and A/AC.105/236 (22nd December 1978).
This document was submitted to the United Nations in accordance with the *Convention on Registration of Objects Launched into Outer Space* (1976), which commits states to register objects which are launched into space with the Secretary General of the United Nations.
An initial press report of the launch, before the satellite crashed, quoted the launch date as 19th September, 'Soviets Launch New Salyut' *Aviation Week & Space Technology* (3rd October 1977).
[296] Article II, Paragraph 1.
[297] Article IV, Paragraph 1.
[298] Preamble of the treaty.
[299] United Nations Document A/AC.105/INF.368, *op. cit.*.
[300] John Lawrence; 'Nuclear Power Source in Space a Historical Review' *Nuclear News* November 1991.

intensity. Therefore, the satellites were placed only 150 miles from the surface of the planet, just above the point where atmospheric drag would prevent orbit from being sustained.[301] At such a low altitude there is an increased risk of the craft re-entering the atmosphere should it encounter a problem. Moreover, in low orbits, solar cells cannot be used as a power source, as they would create too much drag, therefore a small nuclear reactor powered the satellite.[302]

The Soviet Union perceived other advantages in utilising a nuclear power source, specifically it increased the operational efficiency of the satellite and improved the weight and size characteristics.[303] Yet these advantages were accompanied by the inherent risk of atomic energy should an accident occur. It is important to consider that in orbit a nuclear power source does not pose a significant radiation threat. There is no organic life in space, further the Sun itself produces large amounts of radiation. The danger is posed either through an accident at launch or due to re-entry into the planet's eco-system. Due to such potential dangers, at the end of their operational life time the Kosmos surveillance satellites were raised to a higher orbit where there was little danger of re-entry.[304] Kosmos 954 was intended to reach an altitude of 900km-1,000km[305] which would have allowed its power source 1,000 years to decay.[306] By the time that the Kosmos 954 had completed its operational life time it was estimated to contain 1,000,000 curies of alpha, beta and gamma radiation, roughly the equivalent of a small atomic explosion.[307] Although the satellite would still be orbiting the Earth, the Soviet belief was that it would be a sufficient distance away that it would never pose a problem to human activity.

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[301] 'Space Junk; Return of the Native', *The Economist* (1st October 1988).
[302] *Ibid.*
[303] These aspects were explained by the Soviet delegate Boris Maiorski to the U.N. Committee on the Peaceful Uses of Outer Space. Eilene Galloway; 'Nuclear Powered Satellites: The U.S.S.R. Cosmos 954 and the Canadian Claim'; *Akron Law Review* Vol. 12, No. 3 (Winter 1979), p. 406.
[304] 'Cosmos Reentry Spurs Nuclear Waste Debate', *Aviation Week and Space Technology 30th January 1978.*
[305] Nicholas L. Johnson (b); 'A New Look at Nuclear Power Sources and Space Debris' in Dansey (ed.), *op. cit.*, p. 551.
[306] 'Space Nuclear Power Technology' *NASA Space Link* <http://spacelink.nasa.gov/NASA.Projects/Human.Exploration.and.Development.of.Space/Human.Space.Flight/Shuttle/Shuttle.Missions/Flight.031.STS-34/Galileos.Power.Supply/Space.Nuclear.Power.Technology >.
[307] Paul G. Dembling; 'Cosmos 954 and the Space Treaties' *Journal of Space Law* Vol. 6, No. 2 (1978), p. 131.

The practice of placing defunct satellites with nuclear power sources on board into a relatively high orbit, where they would pose no danger, and the fission fragments could naturally decay, appeared to be an unproblematic solution when it was put into practice, in the 1970s. However, this is now in contradiction with the efforts to preserve near Earth space from the problem of debris. Orbits close to the planet are now conceptualised as a resource, in need of protection. As such, leaving nuclear power sources in orbit to decay, is in conflict with the presently emerging international norm that satellites should not remain in LEO for more than 25 years after the end of their operational life time. Nicholas Johnson suggests that this conflict could be resolved by the usage of storage orbits above LEO.[308] As the orbits selected would be used infrequently, it is believed that, the debris would pose little threat.

The causes for the crash of Kosmos 954 are not entirely clear, the Soviet news agency, TASS, reported that the satellite experienced a sharp depressurization on 6th January 1978 due to unknown reasons. It appears probable that this was due to a fuel tank being exhausted, either due to a leak or some form of explosion. This would have preventing the satellite's engines from firing and may have caused a downward thrust towards a lower orbit, and eventual re-entry.[309] A Soviet spokesman, Leonid Sedov, explained this sequence of events as the consequence of Kosmos 954 being involved in an impact with another craft. If this was the case, it would have been an early instance, perhaps the first, of a satellite being adversely effected by an impact with debris. Such an impact may have prevented any efforts made to control the satellite and prevent its fragmentation.[310]

When the satellite re-entered the planet's atmosphere, the majority of it did burn up.[311] The design of the satellite was intended to ensure that the nuclear reactor would completely burn up;[312] this did not happen and the Canadian authorities subsequently recovered approximately 0.1% of Kosmos 954's nuclear power source.[313] At launch Kosmos

[308] Johnson (b) in Dansey (ed.), *op. cit.*, p. 554.
[309] Dembling, *op. cit,* p. 130.
[310] Johnson and McKnight, *op. cit.*, p. 93.
[311] 'United Press International' Report (7th January 1983).
[312] 'Canada: Claim Against the Union of Soviet Socialist Republics for Damage Caused by Soviet Cosmos 954' *International Legal Materials* Vol. 18, p. 903.
[313] 'The Cosmos 954 Accident' *Healthy Environments and Consumer Safety* (Part of the Canadian government's website) < www.hc-sc.gc.ca/hecs-sesc/neprd/nep-events/cosmos.htm >.

954 had weighed approximately 5 tons;[314] fragmentation in the upper atmosphere, reduced it to approximately 4,000 pieces.[315] Most importantly, several thousand pieces of debris were later reported to be 1mm spheres, which had cores of nearly pure Uranium-235, these were scattered over an area of several hundred kilometres.[316]

When the recovery operation was complete, the effects of Kosmos 954 upon the natural environment were not considered to be significant.[317] Further, although some local residents were exposed to small amounts of radiation none suffered any serious harm,[318] and there was no detectable contamination of 'air, water or food supplies'.[319] It was fortunate that the debris had fallen into a largely uninhabited region, rather than a dense urban population. Despite the relative good fortune, regarding this particular incident, there are two important factors to consider; firstly it was not a unique event, nor is there reason to believe that such an impact, or one more serious, could never occur again. Secondly, the cost of repairing the damage entitled Canada to make a formal claim for reparations against the USSR, and thus exercise liability as it is contained within space law.

Legal Framework Within Which The Crash Was Managed

The 1967 *Outer Space Treaty* (OST)[320] establishes the broad principles upon which the exploration and exploitation of space occurs. Article VI of the treaty places responsibility upon states for their national activities conducted in space, or upon celestial bodies. Zhao considers liability being placed on a launching state problematic, when launches may be conducted by private companies.[321] However, this issue should not be considered to be of great concern, as states licence launches which are conducted from their

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[314] Dembling, *op. cit.*, p. 126.
[315] United Nations Document A/AC.105/236, *op. cit.*.
[316] Lawrence, *op. cit.*.
[317] *Ibid.*
[318] James Oberg; 'The Probe That Fell To Earth' *New Scientist* (6th March 1999).
[319] 'Space Nuclear Power System Accidents' *NASA Space Link* <http://spacelink.nasa.gov/NASA.Projects/Human.Exploration.and.Development.of.Space/Human.Space.Flight/Shuttle/Shuttle.Missions/Flight.031.STS-34/Galileos.Power.Supply/Space.Nuclear.Power.System.Accidents >.
[320] Its full title is *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*. The full text of the treaty can be found at:
< www.unoosa.org/pdf/publications/STSPACE11E.pdf >.
The USSR was a depository government for the treaty, whilst Canada was a party to it from 1967
< www.state.gov/t/ac/trt/5181.htm >.
[321] Zhao (2004), *op. cit.*, p. 118.

territory, as such they have the capacity to ensure that a licensee complies with the international standards to which the state has committed itself.

The *OST* continues, in Article VII, to place liability upon a launching state for damage caused to any other state party to the treaty, by an object which it has launched. Article VIII of the treaty also has implications in the case of Kosmos 954, it commits states to return, to the state of registry, objects which accidentally land in their territory.

The *Astronauts Agreement* (1968),[322] to which both Canada and the USSR were party,[323] re-enforced Article VIII of the *OST*. Although primarily concerned with the treatment of personnel in space, the *Astronauts Agreement*, in Article 5, addresses objects which return from space. In accordance with the treaty's provisions, Canada informed the USSR that component parts of one of its space objects had been located in Canadian territory.[324] Further, with reference to Paragraph 1 of Article 5 of the treaty, Canada informed the Secretary General of the United Nations that the remnants of Kosmos 954 had been found in its territory.[325]

Paragraph 3 of Article 5 provides for the return of objects, and their component parts. This requirement had little importance, the objects recovered were radioactive waste, as such the Soviet Union did not express a desire to have them returned. On 20th February 1978 the USSR formally notified Canada that it could dispose of the recovered items at its discretion.[326]

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[322] The full title of the treaty is *Agreement on the Rescue of Astronauts the Return of Astronauts and the Return of Objects Launched into Outer Space.* The full text of the treaty is available at: < www.unoosa.org/pdf/publications/STSPACE11E.pdf >.

[323] The USSR was one of the depository governments for the treaty (Article XIV), whilst Canada signed it in 1968 and ratified it on 20th February 1975 < http://pubx.dfait-maeci.gc.ca/A_BRANCH/AES/env_commitments.nsf/0/4ac0c900f6f6d1e985256b6c004aeba7?OpenDocument >.

[324] The USSR was formally informed on 8th February 1978, 'Canada: Claim Against the Union of Soviet Socialist Republics for Damage Caused by Soviet Cosmos 954', *op. cit.*, pp. 910-911.

[325] United Nations Document A/AC.105/214 (8th February 1978). The United Nations provides a list of object found which have been reported through their offices, available at: < www.oosa.unvienna.org/sdnps/unlfd.html >.

[326] The Canadian legal documents from which this information is taken notes that they are an unofficial translation of the Soviet Union's statement. 'Canada: Claim Against the Union of Soviet Socialist Republics for Damage Caused by Soviet Cosmos 954', *op. cit.*, pp. 915-916. The USSR reiterated this position on 21st March 1978 *ibid*, pp. 922-923.

The treaty also provides states with a means to request assistance from the launching state, in the recovery of objects which have landed in their territory.[327] Although it had the right to do so Canada did not request physical Soviet assistance in the recovery operation.[328] Paragraph 4, of Article 5, specifically deals with occasions when hazardous materials are found to have landed within the territory of a state. In such circumstances, the launching state is obliged to take immediate actions in order to 'eliminate possible danger'. It would appear that under the terms of this paragraph, Canada had the authority to request that the USSR itself retrieved the material from Canadian territory, then dispose of it elsewhere. Paragraph 5 of the same Article refers to the costs involved in recovering crashed space objects; these are to be borne by the launching state, as with a similar general principle contained within the *OST*.[329] This notion was giving a more specific legal form in a latter treaty which was designed to specifically address issues of liability.

The *Liability Convention*[330] does not stand in isolation, it builds upon the principles of the *OST* and the *Astronauts Agreement*. The treaty was produced by the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) after nine years of negotiations,[331] the process of completing this treaty was considered by Herbert Reis, a legal advisor to the American Mission to the United Nations, as one of the most difficult in the post-war era.[332] It was this treaty which provided Canada with the primary legal basis upon which it made its claim for compensation. This was not the only option available; had it wished the *Vienna Convention on Civil Liability for Nuclear Damage* offered an alternative legal recourse.[333]

Ironically, during the drafting of the *Liability Convention*, the USSR had argued that 'nuclear damage' should be excluded from the convention, and addressed in a separate

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[327] Paragraph 2 of the Article 5.
[328] Galloway (1979), *op. cit.*, p. 411.
[329] Articles VI and VII.
[330] The USSR is one of the three depository governments for the *Liability Convention* (Article XXIV). The treaty entered into force on 1st September 1972, when it received its fifth ratification (Cheng, *op. cit.*, p. 286), Canada acceded to the treaty on 20th February 1975 < www.fco.gov.uk/Files/kfile/015_DamageSpaceObjects.pdf >.
[331] Cheng, *op. cit.*, p. 286. Cheng provides a thorough account of the drafting process and review of the text of the treaty, pp. 286-356.
[332] Reis, *op. cit.*, p. 125.
[333] Stephen Gorove; 'Cosmos 954: Issues of Law and Policy' *Journal of Space Law* Vol. 6, No. 2 (1978), p. 144.

treaty. This was virtually unanimously opposed by the other members of the Legal Sub-Committee of UNCOPUOS, and in 1969 the Soviet objection was withdrawn.[334]

The initial articles of the *Liability Convention* clearly reveal its applicability in this instance; Article I defines a space object as including 'component parts of a space object'. It continues in Article II stating that, '[a] launching State shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the Earth'. There is little doubt concerning the relevance of this article, as the identity of the object which crashed into Canadian territory was never disputed. Although there was no loss of life, or serious health implications, resulting from the crash of Kosmos 954 the damage to Canada property, specifically its environment, permitted the treaty to be invoked.[335]

Because the USSR never denied the radioactive fragments located in Canada were of Soviet origin,[336] the compensation claim proceeded rapidly; Article X of the *Liability Convention* requires that a state makes its claim for compensation within one year of the damage occurring, or the identification of the responsible party, should that not be immediately known. Due to the latter clause not being relevant Canada was able to act promptly. The legal process was given increased pace and clarity as the USSR made it clear, before Canada made a claim, that it was willing to pay compensation.[337]

Stephen Gorove observes that, although neither term has been formally defined, within space law the terms 'liability' and 'responsibility' have differing meanings although they are closely connected. The former refers to liability which a state bears for damage caused by objects which it has launched into orbit, whereas the latter refers to the more general international responsibility which a state has for its activities in outer space. Therefore responsibility denotes the norms of behaviour that apply to states and their representatives.[338]

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[334] Cheng, *op. cit.*, pp. 323-324.
[335] Article I
[336] 'Canada: Claim Against the Union of Soviet Socialist Republics for Damage Caused by Soviet Cosmos 954', *op. cit.*, pp. 902-905.
[337] Gorove (1978), *op. cit.*, p, 138.
[338] Stephen Gorove; 'Liability in Space Law: An Overview' *Annals of Air and Space Law* Vol. VIII (1983), pp. 373-379.

The concept of 'liability' in space law is further complicated because of the potential applicability of international law, domestic law and foreign law.[339] In the case of Kosmos 954 arguments could have been made that liability should have been addressed under Soviet law, as the satellite originated there, or Canadian law as the damage occurred in its territory.

Within the *Liability Convention* there are differing degrees of liability in accordance with the location in which damage is caused. Liability is limited when an incident occurs in air space, or in outer space, as the treaty states that when damage is caused 'other than on the surface of the Earth' liability is dependent upon their being fault in the actions of a state.[340] This has clear implications for scenarios involving debris, as the damage would be caused in outer space. In order for the treaty to be used successfully, there would be a necessity to prove fault. However, when damage is caused on the surface of the Earth, such as the case of Kosmos 954, the highest degree of liability is incurred, covering virtually all damage caused, without restriction.[341] In theory, this could have resulted in the USSR being liable to pay an enormous amount, however, as the satellite landed in an uninhabited region, there was no loss of life due to the crash nor was their damage to private property. However, because of the nuclear power source on board, the area needed to be decontaminated and the Soviet Union was liable for the cost of this clean up; Canada accordingly made a claim against the USSR.

The Soviet Union could have pleaded exception from liability under Article VI if it demonstrated that the events were a result of gross negligence by Canada,[342] this would have been a difficult argument as Canada was a fixed target with which the satellite collided. Similarly when considering debris, it is difficult to imagine how an object damaged by debris could be considered to be grossly negligent if it were merely orbiting the Earth.

In consideration of damages the *Liability Convention* states that they should be paid to restore the claimant 'to the condition which would have existed if the damage had not occurred'.[343] It is notable that the purpose of the treaty is to grant restorative not punitive

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[339] *Ibid.* p. 373.
[340] Cheng, *op. cit.*, pp. 326-328.
[341] *Ibid.* pp. 320-323.
[342] Dembling, *op. cit.*, p. 133.
[343] Article XII.

damages, which suggests the assumption has been accepted that any damage which occurs will be the product of accidents, rather than belligerent intent. Clearly there would only have been a very weak argument to suggest that the USSR should have been subject to punitive damages, as the incident was the product of an accident, although the USSR had made the decision to place a nuclear powered satellite in a very low, and therefore hazardous, orbit. With reference to the debris problem, punitive damages would not appear to be appropriate either as a large amount of the current debris population was produced before the problem was identified, further what is still produced is not done so deliberately. However, should explosions occur in orbit due to the use of weapons, then a far stronger philosophical argument would exist for punitive damages to be demanded by a third party whose resources were damaged as a consequence. Yet it is difficult to conceptualise a scenario in which a punitive notion of liability could be introduced into space law.

Canada originally made a claim for C$6million[344] in damages and costs, whilst the total price of the clean up was estimated to be as high as C$14million.[345] The difference between the two amounts, is due to Canada claiming for only reasonable costs and those which it could accurately calculate.[346] Ultimately, in 1981, the Soviet Union agreed to pay C$3million[347] due to the damage caused, however it did not admit liability for the incident.[348]

As the Soviet Union offered an acceptable payment, there was no requirement for the provisions relating to settlement of the disputes to be invoked.[349] If Zhao's criticism of the *Liability Convention* is accepted, that it does little more than establish the basis for adjudication, [350] then in such instances as this, it would serve a useful purpose. Had the USSR and Canada not reached agreement through diplomatic negotiations within one year

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[344] The Canadian claim was for the exact figure of $6,041,174.70 (Canadian). 'Canada: Claim Against the Union of Soviet Socialist Republics for Damage Caused by Soviet Cosmos 954', *op. cit.*, p. 899.
[345] 'Canada-Soviets Sign Satellite Damage Pact' *The Associated Press* (2nd April 1981).
[346] 'Canada: Claim Against the Union of Soviet Socialist Republics for Damage Caused by Soviet Cosmos 954', *op. cit.*, pp. 906-907.
[347] The sum was in Canadian not American dollars, in US dollars the figure was approximately $2.55million, Andrew Cohen; 'Canada Settles With Russia for Satellite Crash', *United Press International* (2nd April 1981).
[348] 'Canada-Union of Soviet Socialist Republics: Protocol on Settlement of Canada's Claim for Damage Caused by 'Cosmos 954'' *International Legal Materials* Vol. 20. p, 689 and Fawcett, *op. cit.*, pp. 26-27.
[349] U.S. Congress, *op. cit.*, pp. 32-33.
[350] Zhao (2004), *op. cit.*, p. 117.

of a notification of a claim being made,[351] concerning the amount of compensation to be paid, the *Liability Convention* has provision for a Claims Commission to be established. This body would be composed of three members who would investigate the basis of the claim, one member being appointed by each party whilst the third member, the chair, would be appointed by mutual consent.[352]

In the opinion of Margaret Carlson, had the USSR and Canada failed to reach an agreement, the practical limitations of the *Liability Convention* would have been exposed. The treaty provides for a Claims Commission to be established, however it does not grant it binding authority upon the disputing parties.[353] Bin Cheng notes that should both parties in the arbitration process not agree with the verdict of the Claims Commission it shall reach a final decision, which is not subject to appeal. However, this remains a 'recommendatory award', there is no legal mechanism to make the decision of the Commission binding; parties can only be bound by its finding if they chose to be so.[354] 'Recommendatory awards' are not without precedent in international law; Advisory Opinions of the International Court of Justice are a similar form of decision.[355] Although they may not appear to be an ideal mechanism for the resolution of a dispute, this should not be considered a particular weakness of the *Liability Convention*, rather it is a reflection upon an international system in which there is no authority which can enforce decisions upon states.

The USSR's actions, or lack of action, during the recovery operation did not violate the principles of space law, partially because space law attempts to resolve issues *post hoc*, rather than manage crisis situations. The Soviet Union did not provide an early warning that their satellite was going to crash into Canadian territory, although it is questionable whether the location of the crash was predicted with any useful degree of accuracy. Neither did it, in the opinion of Canada, provide full answers to questions concerning the nature of Kosmos 954 when the Canadian authorities were attempting to ascertain the potential damage

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[351] Article XIV.
[352] Articles XIV – XX.
[353] Margaret B. Carlson; 'Space Law Launches Increasing Number of Lawyers' *Legal Times* (14th June 1982).
[354] Article XIX Paragraph 2, provides states with the right to make the findings of the Commission binding.
[355] There was disagreement concerning this structure, in effect of which, Canada, Japan, Iran and Sweden abstained when votes were taken in the First Committee and the General Assembly on votes to approve the draft convention. Cheng, *op. cit.*, pp. 353-354.

caused.[356] Although this was against the spirit of co-operation which exists in the *Liability Convention*, that treaty does not stipulate that such details should be provided; its purpose is to regulate damage claims *post hoc*, rather than govern crisis situations.

Article XXI of the *Liability Convention* addresses instances wherein the crash landing of a space object 'presents a large-scale danger to human life or seriously interferes with the living conditions of the population or the functioning of vital centres'. In such instances all parties to the treaty, especially the state to whom the object is registered, shall 'examine the possibility of rendering appropriate and rapid assistance'. Due to the geographic nature of the territory in which the fragments of Kosmos 954 landed, there was no large scale danger, therefore Canada did not have a legal basis upon which press the USSR into providing information pertaining to the satellite. Further, the weak wording of the treaty would only have required the USSR to examine its position. Canada's terse diplomatic language suggests a large degree of irritation with the USSR regarding their release of information.[357]

In relation to space debris the case of Kosmos 954 has implications for whether debris can be considered as 'space objects' in the legal sense of the term. The claim for damages by the Canadian government, and the subsequent payment by the Soviet Union, reveals that both parties considered the constituent parts of the satellite to be 'space objects' and therefore legally the possession, and responsibility, of the USSR. Although the legal status of debris remains a subject of debate between scholars,[358] this practical instance strongly suggests that states remain liable for the resulting debris, when space objects fragment. Given that a large amount of debris in orbit is the product of fragmentations this legal precedent is of potentially great importance.

The Kosmos 954 incident highlighted a central weakness in the *Registration Convention*; the Soviet Union, for strategic reasons, provided a misleading, or at a minimum an incomplete, description in the record of objects launched into space. This was not a factor in the legal considerations arising from the crash of the satellite, however it provides an example of the difficulties associated with the register. The intention of the treaty was to

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[356] 'Canada: Claim Against the Union of Soviet Socialist Republics for Damage Caused by Soviet Cosmos 954', *op. cit.*, pp. 902-905.
[357] See *International Legal Materials* Vol. 18, pp. 913-915 and 917-919.
[358] Perek in Dansey (ed.), *op. cit.*, p. 589.

create a mechanism by which orbits could be managed, through the maintenance of a database of all objects placed into near Earth space. However, because it is incomplete, and as Kosmos 954 demonstrates contains inaccurate information, it has become virtually useless and 'serves little practical or legal purpose'.[359]

The lack of importance associated with the *Registration Convention* is reflected in the number of states which have ratified it, only forty-six.[360] Perek argues that a more holistic acceptance of the treaty would strengthen it;[361] certainly it is the case that a complete and accurate database would only be possible if states supplied complete and accurate information. Such a complete register would be beneficial in managing such problem as space debris and nuclear power sources crashing to the Earth.

Conclusions

The five treaties relating to space are but the specific parts of space law, all other treaties governing inter-state relations also apply in space. In its current form space law offers little protection from debris, as none of its regulations are designed to address the issue.[362] This legal deficit is exacerbated by the Commons status of near Earth space, which provides states with the freedom to act as they wish, and pollute as they wish. Importantly this extends to military matters and allows states to conduct activities which will result in vast quantities of debris. The conservation measures, which exist under space law, are designed to protect states from damage caused by other states, rather than protecting the space environment as an aspiration in its own right. That they are not readily applied to a long term cumulative problem, such as debris, demonstrates their limitations.

In order to thoroughly protect near Earth space a new conceptual approach is required. To be effective it must reconsider the nature of Earth orbit, no longer considering it to be open for all to use, but conceptualising it as a potentially finite, fragile and remarkably important resource. This new approach would address the preservation of near

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[359] Johnson in Simpson (ed.), *op. cit.*, p. 9. Despite its extremely limited utility, the registry is available on the web < http://registry.oosa.unvienna.org/oosa/index/qfm_TITLE.stm >.
[360] 'Convention on Registration of Objects Launched into Outer Space'
< www.unoosa.org/oosa/en/SORegister/index.html >.
[361] Perek, *op. cit.*, p. 223.
[362] U.R. Rao; 'Space Debris - Mitigation and Adaptation' in Simpson (ed.), *op. cit.*, p. 124.

Earth space as a legitimate goal in its own right, rather than current space law which addresses conservation only to the extent that states should not inconvenience each other.

In 1978 Karl-Heinz Bockstiegel noted that space law was insufficiently equipped to resolve disputes, although they were seemingly inevitable.[363] In the three decades which have passed little has occurred to make space law better able to resolve issues of liability, whilst the presence of debris has increased the possibility that it may be required to address such issues.

There is a clear differentiation to be highlighted concerning Kosmos 954 and potential instances of damage caused by debris, specifically the location in which damage occurs. The Soviet satellite damaged Canadian property on the surface of the planet whereas the primary, almost exclusive, threat of debris exists in orbit. As such a differing level of liability applies, therefore a direct comparison is not possible. However, as Kosmos 954 remains the most useful instance in which the provisions of space law and specifically the *Liability Convention* have been tested, it provides a valuable insight to the mechanics of liability and their application, revealing the institutional framework within which a claim under the *Liability Convention* would be conducted.

The *Liability Convention* is designed to restore the situation which existed before damage occurred. This restorative intention means that the treaty does not have the purpose of providing immediate assistance to resolve an incident in which liability arises. This is unsurprising as the document is intended to present a legal remedy. Yet in focusing upon restitution, the treaty negates the area in which the launching state could be of most assistance, remedying the immediate difficulties involved in a crisis situation. The most useful assistance which the USSR could have given Canada was not the payment of damages; it would have been prior warning that Kosmos 954 was going to enter Canadian territory, then supplying specific information as to radioactive nature of the satellite. The *Liability Convention* is notably silent concerning the immediate assistance which should be provided to a state that is subject to a crash, other than when the incident has produced extreme circumstances.[364]

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[363] Karl-Heinz Bockstiegel; 'Arbitration and Adjudication Regarding Activities in Outer Space' *Journal of Space Law* Vol. 6 No. 1 (Spring 1978) p. 17.
[364] Extreme circumstances, and the appropriate response, are considered in Article XXI.

Gorove believes that the case of Kosmos 954 brought to the fore the 'uncertainties and inadequacies' of the legal framework within which future such situations would be addressed.[365] A similar situation now applies when considering potential claims for compensation due to space debris; the *Liability Convention* is untested in its capacity to resolve such an incidence. In the case of Kosmos 954 the treaty operated effectively, whilst it also demonstrated areas in which it created legal uncertainty.

If Leonid Sedov's claim, that Kosmos 954 was struck by another craft, is correct this could have dramatically altered the question of liability. If the other craft was not of Soviet origin, the state which launched it may have been at fault for the entire sequence of events. Such a scenario would have certainly made the legal proceeding far more complex. As the Soviet government in effect accepted liability by paying damages to Canada, there are three possible explanations. Firstly Kosmos 954 was struck by another craft and that craft was also of Soviet origin. Alternatively, it may be that the Soviet Union ultimately decided that there had not been a collision with another craft. Finally, it is possible that the USSR could not prove the origin of the piece of debris which struck Kosmos 954, due the debris being small and untrackable. Therefore, it was unable to pursue the relevant launching state for compensation. It appears to be improbable that the USSR believed that debris from another country was responsible for the satellite's demise, but decided to pay compensation regardless. Yet given the difficulty of accurately ascertaining what occurs in orbit this would be a probable scenario for future instances of debris impact.

The Kosmos 954 incident revealed a great deal concerning the structures and provision created by the *Liability Convention* and these are relevant to potential future claims for damages caused by space debris. However, a key difference between the two cases does not relate to legal matters, rather it is the political climate during the era. The Cold War is a central feature in the narrative of Kosmos 954. The satellite was used for the purpose of spying upon American maritime activities, as such it was partially the political situation which led to a nuclear powered satellite operating in such a low, and therefore dangerous, orbit. The Cold War climate also had an enormous influence upon the recovery operation. The Canadian government's position was that it requested information concerning the design of the satellite in order to conduct an effective operation. Whilst the

[365] Gorove (1978), *op. cit.*, p. 146.

same questions, to the Soviet government, were interpreted as inquiries not relevant to the recovery operation, but as an effort to extract strategically useful information.[366]

Therefore, when considering the role of the treaty in reference to potential problems which may arise in future, it is firstly important to note the enormous re-orientation there has been in global politics. Further, when considering instances involving orbital debris, it should be remembered that there is common interest in avoiding problems, and sharing information, as opposed to the zero-sum interactions relating to crashed spy satellites.

A substantial difference between Kosmos 954, and a potential incident of a satellite being damaged by debris is the availability of information. When an object crashed into Canadian territory there was no doubt that it was the Soviet craft Kosmos 954; should a satellite be damaged in orbit there would be far less certainty. The most probable scenario is that the debris responsible would be too small to be tracked, therefore it would be impossible for liability to be proved. Should the origin of the debris be known, the situation would still not be simply resolved. For when damage occurs in space, the provisions of the *Liability Convention* require fault to be shown; this would be difficult to prove in the instance of a dead satellite, spent rocket stage or stray bolt. Also in the absence of access to the physical evidence the possibility remains that a state may simply deny that the object involved was its property.

This chapter has showed that although space law provides principles concerning the development and exploitation of space which are broadly accepted; its provisions are not readily applicable to the problem that debris presents. Therefore, when examining the debris problem, space law can provide precedents and direction, but it does not contain a simple legal solution. The area in which it offers most relates to liability, yet even in this instance it can be seen that it encounters difficulties and the origin of much debris cannot be identified. Therefore, in order for the problem to be effectively addressed it is necessary for further political forms to be created to seek remedial action.

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[366] For full details of the positions of the two governments see: Canada: Claim Against the Union of Soviet Socialist Republics for Damage Caused by Soviet Cosmos 954', *op. cit.*, pp. 899-930.

Chapter Four:
Institutions Governing Near Earth Space

Introduction

As was seen in the previous chapter, there are a series of inter-related values and rules which space law provides in order to facilitate the orderly behaviour of states when utilising near Earth space. These formal principles (the space treaties) are complemented by a less formal network of institutions (both those with organisational structures, and those which are founded upon principles and accepted practice) which provide a governance framework. The institutions which this chapter will examine will divide into two broad sections: those which are transnational and those which act within states, however boundaries between states are often blurred as institutions interact with each other.

This chapter will introduce the following transnational institutions: the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS), the International Academy of Astronautics (IAA), the International Standards Organisation (ISO) and the International Telecommunications Union (ITU), it will not examine the Inter-Agency Debris Coordination Committee, as that will be considered in a later chapter because it is a specific response to the debris problem. The political structures and agreements surrounding the International Space Station will also be examined, for they can be considered to constitute an ideational institution. Hedley Bull identified the institutions of international society as, 'the balance of power, international law, the diplomatic mechanism, the managerial system of the great powers and war'.[367] The importance of Bull's conceptualisation is that the institutions are ideational in nature. Thus, through their behaviour actors can create an ideational institution in order to provide a mechanism for collective action. This will be the definition of an institution adopted in this chapter; whether formal or informal in structure, it is a mechanism through which behaviour, in the international sphere, is regulated.

The institutions acting within states which will be examined are: the Federal Communications Commission (FCC) and the British National Space Centre (BNSC). The choice of these institutions is due to the availability of information, as reports and reflections

[367] Hedley Bull; *The Anarchical Society* 2nd Edition (Basingstoke: MacMillan, 1995), pp. 68-71 & 95-222.

upon these two bodies are readily accessible. They can also be considered to be typical of the institutional arrangements in Western states concerning space policy. There is an obvious requirement for states, such as China, to have a means of regulating space launches but due to the nature of such states, the bureaucratic means through which the matter is addressed is not readily open to academic research.

The purpose of this chapter is not to analyse problems specific to the debris issue, but to consider the framework which was already in place when debris was identified as a problem. Therefore the institutional framework that it examines is that which was in place before the debris problem was identified.

Part One – Transnational Institutions

United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS)

UNCOPUOS was established in 1959 its purpose has been defined as being:

> To review the scope of international cooperation in peaceful uses of outer space, to devise programmes in this field to be undertaken under United Nations auspices, to encourage continued research and the dissemination of information on outer space matters, and to study legal problems arising from the exploration of outer space.[368]

The key issues which the UN has charged UNCOPUOS with considering are:

- the activities and resources of the United Nations, the specialised agencies and other international bodies relating to the peaceful uses of outer space;
- international cooperation and programmes in the field that could appropriately be undertaken under United Nations auspices;
- organizational arrangements to facilitate international cooperation in the field within the framework of the United Nations; and

[368] 'UN Committee on the Peaceful Uses of Outer Space, UN Office for Outer Space Affairs – A Brief Overview' < http://ihy2007.org/img/COPUOS-OOSA_final.ppt >.

- legal problems which might arise in programmes to explore outer space.[369]

The most significant role which UNCOPUOS has played is the drafting of the space treaties, in the 1960s/70s, and it was during this undertaking that it was most active.[370] The treaties were the product of the Legal subcommittee, the other subcommittee addresses Scientific and Technical matters. Both of these operate on the basis of consensus, which has become a norm of governance in space; as such every member effectively has a veto. However, this was not inevitable. There was a strong body of opinion, when the committees were established, that they should proceed on a majoritarian basis.[371] At present UNCOPUOS has sixty five member states, including all states with significant space programmes. Notably, as the original membership of 24 has expanded, the new members have created an approximate regional balance.[372] As a consequence of the committee proceeding on a consensus basis there 'a great deal of behind-the-scenes consultation'.[373] This results in a situation wherein the means by which observed outcomes are arrived at cannot be readily understood nor definitively identified. Bin Cheng notes that the legal sub-committee of UNCOPUOS devotes much time to the discussion of procedure rather than substance. He argues that this occurs because the critical stages of negotiations are always conducted in private, thus what occurs in public sessions is the recommendation of that which has already been agreed in private by powerful states.[374]

Since the last space treaty was completed, in 1979, UNCOPUOS has been responsible for the drafting of the five General Assembly Declarations concerning space, and it has held three UNISPACE conferences, in 1968, 1982 and 1999, which have sought the promotion, and application, of the values of the UN drafted space treaties.[375]

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[369] 'United Nations Committee on the Peaceful Uses of Outer Space: History and Overview of Activities'
< www.unoosa.org/oosa/COPUOS/cop_overview.html >.
[370] The USA and USSR both adopted the position in 1966 that a space treaty was required, between that time and 1979 UNCOPUOS produced five space treaties, Cheng, *op. cit.*, p. 220. Cheng provided a comprehensive account of the negotiations which resulted in the five treaties.
[371] Cheng, *op. cit.*, p. 128.
[372] 'UN Committee on the Peaceful Uses of Outer Space, UN Office for Outer Space Affairs – A Brief Overview' < http://ihy2007.org/img/COPUOS-OOSA_final.ppt >.
[373] Cheng, *op. cit.* p. 165.
[374] Cheng, *op. cit.*, p. 272.
[375] 'UN Committee on the Peaceful Uses of Outer Space, UN Office for Outer Space Affairs – A Brief Overview' < http://ihy2007.org/img/COPUOS-OOSA_final.ppt >.

UNCOPUOS is provided with support by the United Nations Office for Outer Space Affairs (UN-OOSA). The role of UN-OOSA is not limited to facilitating the operations of UNCOPUOS, it is also charged with providing developing countries with information concerning the use of space based resource, along with following 'legal, scientific and technical developments relating to space activities, technology and applications in order to provided technical information' to states and international organisations.[376]

International Academy of Astronautics (IAA)

International Academy of Astronautics (IAA) is also active in governance of space. The IAA, founded in 1960, describes itself as being 'based on the tradition of the great classical scientific academics of the 17th century...which fostered scientific enquiry and the exchange of ideas and new information'. It seeks to provide a forum in which the leading experts in the field of astronautics are in contact with each other 'to explore and discuss cutting-edge issues in space research and technology, and to provide direction and guidance in the non-military uses of space and the ongoing exploration of the solar system.'[377]

The IAA is best considered as providing a formal institutional framework within which those with expert knowledge can conduct their activities. The IAA defines its purposes as being:

- to foster the development of astronautics for peaceful purposes,
- to recognise individuals who have distinguished themselves in a branch of science or technology related to astronautics,
- to provide a program [sic] through which the membership can contribute to international endeavors [sic] and cooperation in the advancement of aerospace science, in cooperation with national science or engineering academies.[378]

[376] 'United Nations Office for Outer Space Affairs (UN-OOSA)'
< www.unoosa.org/ooas/en/OOSA/index.html >.
[377] International Academy of Astronautics web site:
< http://iaaweb.org/content/view/136/234/ >.
[378] International Academy of Astronautics web site:
< http://iaaweb.org/content/view/136/234/ >.

The institutions which provide governance for near Earth space, are closely interconnected. This is demonstrated through the IAA having observer status at UNCOPUOS.[379]

International Standards Organization (ISO)

The International Standards Organisation (ISO)[380] is comprised of the standards institutes of 155 countries;[381] it seeks to provide values applicable to all its members. Universality has obvious implications for trade and the ISO has a strategic relationship with the World Trade Organization.[382] The ISO defines the purpose of its standards as being to

- make the development, manufacturing and supply of products and services more efficient, safer and cleaner.
- facilitate trade between countries and make it fairer.
- provide governments with a technical base for health, safety and environmental legislation, and conformity assessment.
- share technological advances and good management practice
- disseminate innovation
- safeguard consumers, and users in general, of products and services
- make life simpler by providing solutions to common problems.[383]

As a non-governmental body the ISO does not have legal authority, therefore its recommendations are voluntary. This apparent weakness is countered by the fact that standards are developed by national technical experts according to consensus, as such they are intended to be universally applicable and require universal approval. ISO proposals can only become legally binding if individual countries chose to legislate upon the suggested values.

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[379] U.N. Document A/AC.105/620, *op. cit.*, p. 6.
[380] Its web site can be found at < www.iso.org >.
[381] 'Discover ISO – Meet ISO' < www.iso.org/iso/about/discover-iso_meet-iso.htm >. The national standards organisation for the UK is best known for the 'kite mark' which appears on goods meeting the required standard.
[382] < www.iso.org/iso/en/aboutiso/introduction/index.html >.
[383] 'Discover ISO – What standards do'
< www.iso.org/iso/about/discover-iso_meet-iso/discover-iso_what-standards-do.htm >.

The ISO considers itself as being a bridge between the public and private sectors. The members, which are national standards organisations, are part of their domestic governmental frameworks, whereas other members are private corporations. However, through cooperation within the ISO structure consensus is sought.[384]

The ISO presents an instance of a phenomenon in international relations: cooperation occurring for mutual benefit. The standards which the ISO promotes could be ignored by any state, as it has no powers of coercion. However, it is mutually beneficial that the standards which the ISO promotes should be accepted. An historical precedent, relating to the importance of standarisation, can be seen with reference to this, in the manner by which as the capacity of nation states emerged, so they were able to enforce standard weights and measures, thus facilitating trade.[385] Although the standards developed by the ISO are more complex, their usage facilitates trade through creating certainty which is beneficially to all parties. The standards also have a second purpose; they establish safe parameters, and environmental standards, within which practices can be conducted and products can be manufactured, this clearly provides an incentive for them to be followed.[386] Thus, although the ISO cannot force its standards to be followed, they are perceived as being objective standards adherence to which is beneficial to all individuals.

The standards which the ISO creates are the product of technical committees; these are constituted by 'experts from the industrial, technical and business sectors which have asked for the standards, and which subsequently put them into use'.[387] In recent years the ISO has commenced work, utilising knowledge rich experts, to create applicable standards for safe practice in space missions.[388]

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[384] 'Discover ISO – Meet ISO' *op. cit.*.
[385] Hendrik Spruyt; *The Sovereign State and Its Competitors* (Princeton, Princeton University Press, 1994), pp 158-163.
[386] 'Discover ISO – Why Standards Matter'
< www.iso.org/iso/about/discover-iso_meet-iso/discover-iso_why-standards-matter.htm >.
[387] 'Discover ISO – Who Develops ISO Standards'
< www.iso.org/iso/about/discover-iso_meet-iso/discover-iso_who-develops-iso-standards.htm >.
[388] John Davey and Emma A. Taylor; 'Development of ISO Standards Addressing Mitigation of Orbital Debris' in Dansey (ed.), *op. cit.*, p. 565.

International Telecommunications Union (ITU)

The International Telecommunication Union (ITU) is a special agency of the United Nations,[389] it exists under the authority of the Economic and Social Council, along with such organisations as the International Monetary Fund and World Meteorological Organization.[390] The ITU 'carries out the important activities of coordination, standardization and international regulation to enable telecommunications systems to operate seamlessly across borders'.[391] Currently membership of the Union is almost universal, it is comprised of 189 states[392] along with 625 non-state actors, largely private sector telecommunications companies.[393] It was founded as the International Telegraphic Union in 1865 as a means of managing the international transfer of data.[394] Regulation to govern the utilisation of radio frequencies, preventing harmful interference first began at the start of the twentieth century.[395] A primary motivation for the international efforts at this time was to stop the British company Marconi from monopolising the frequency spectrum, by preventing stations from using equipment other than their own. The International Radiotelegraphic Convention (1906) marked the start of efforts to protect the frequency spectrum.[396] Thus, at this early stage of global telecommunications an attempt to effectively privatise the resource was prevented by an international consensus which maintained the common status of the resource. In this respect there has been over a century of international governance addressing the usage of the terrestrial radio frequency spectrum.

At the post Second World War radio frequency conferences the United States envisaged an International Frequency Registration Board as a form of international court; it would have powers to manage the radio frequency spectrum in an 'effective and efficient

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[389] Meredith in Simpson (ed.), *op. cit.*, p. 219.
[390] For the full organisational structure within which it exists see < www.un.org/aboutun/chart.html >.
[391] Yun Zhao; 'The ITU and National Regulatory Authorities in the Era of Liberalization' *Space Policy* Vol. 18 (2002), p. 295.
[392] < www.itu.int/members/index.html >.
[393] < www.itu.int/cgi-bin/htsh/mm/scripts/mm.list?_search=SEC&_languageid=1 >.
[394] Daya Kishan Thussu; *International Communication: Continuity and Change* (London: Arnold, 2000), p. 17.
[395] Ram S. Jakhu; 'The Evolution of the ITU's Regulatory Regime Governing Space Radiocommunication Services and the Geostationary Satellite Orbit' *Annals of Air and Space Law* Vol. VIII (1983), p. 381.
[396] Donald J. Fleming, E.D. DuCharme, Ram S. Jakhu and W.G. Longman; 'State Sovereignty and the Effective Management of a Shared Resource: Observations Drawn From Examining Developments in the International Regulation of Radiocommunications' *Annals of Air and Space Law* Vol. X (1985), pp. 332-333.

manner'. However, the consensus achieved at the conference only granted administrative and semi-judicial functions.[397]

The beginning of the space age brought a new arena for the ITU, the first object placed in GEO was NASA's satellite Syncom 2 on 26th July 1963,[398] it was in the same year that the ITU began to regulate the GEO slots.[399] As discussed in chapter two the GEO ring provides satellite positions which when viewed from the ground give the satellite the appearance of being stationary. 40% of the Earth's surface can be covered by a single satellite in GEO, as such three satellites are required to give complete coverage of the planet's surface.[400] However, due to the uneven positions of the Earth's land mass not all GEO slots are of equal worth, some give coverage of both Europe and north America, whilst others give coverage largely of the Pacific Ocean. Positions in GEO are finite, satellites cannot be placed too closely together as this creates the possibility of collision, further if they are not sufficiently separated signals become subject to interference,[401] consequently there are only 180 GEO slots.[402] The explicit purpose of the regulation which the ITU operates in GEO is to prevent radio frequency interference, this however results in a *de facto* regulation of positioning of satellites.[403]

The role which the ITU performs in the governance of near Earth space is most accurately conceptualised as being a means to manage a common property resource (CPR). The available slots in GEO constitute a CPR. They have the characteristic of excludability as not every state has the technical capacity to place satellites into orbit. Secondly, the characteristic of subtractability is present; when a slot has been occupied, by the satellite of one actor, it is no longer available to other actors.

As with the ISO the ITU does not have powers of enforcement. Indeed, that international organisations lack enforcement powers leads to the phenomenon of anarchy,

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[397] *Ibid.* pp. 338-339.
[398] Andrzej Gorbiel; 'The Legal Status of Geostationary Orbit: Some Remarks' *Journal of Space Law* Vol. 6, No. 2 (1978), p. 171.
[399] Vogler, *op. cit.*, p. 113.
[400] Paris J. Arnopoulos; 'A Situation Study of the Orbit-Spectrum Issue (Model and Application)' *Annals of Air and Space Law* Vol. VIII (1983), p. 288.
[401] Fawcett, *op. cit.*, p. 52.
[402] There are 360 degrees in the orbit, however each satellite requires two degrees in order to operate. Thussu, *op. cit.*, p. 94.
[403] Johnson and McKnight, *op. cit.*, p. 6.

which is broadly considered to be the defining feature of international relations. As such, issues and problems concerning the ISO and ITU, are largely those which are faced by all bodies which seek to influence the behaviour of states. The principle question which can be asked immediately is: what prevents states from ignoring the GEO allocations which are made? At present the scenario exists, as it does with the ISO, that cooperation within the institutional framework is to mutual benefit. Actors need there to be political stability concerning the usage of GEO slots; it is very expensive to place satellites in GEO, therefore a requirement exists that they will be able to function without restriction once there. As such, the states which use GEO satellites can be conceptualised as being locked into a 'supergame' wherein defection does not offer long term benefits. Further, once a GEO slot is occupied, by one satellite, placing another satellite there would create harmful interference and the potential for collision, not only for the existing satellite but also for the new. The means through which the ITU allocates slots in GEO will be considering in the following chapters which considers rights of use.

The International Space Station

The nature of the International Space Station (ISS) as it has developed is a product of the post-Cold War environment. Political movement towards it commenced in 1988 when the USA, the European Space Agency, Japan and Canada reached agreement to cooperate in order to create a joint space station.[404] However, it was six years later that Russia joined the programme.[405] With the huge reduction in political tension after the Cold War, the benefits of cooperation where obvious; space activities are phenomenally expensive, therefore states benefit from sharing costs. Further, there were benefits to be found relating to technical matters, 'know how' and access to facilities.[406] When the Russians joined the programme they brought with them knowledge from the *Mir* space station (Russia provided 50% of the orbital elements of the ISS), also when the American shuttle fleet was unable to fly due to safety concerns the Russians continued to supply the station.[407] The suggestion has also been made that bringing Russia into the ISS programme was strategically important as it

[404] Cheng, *op. cit.*, p. 630.
[405] A. Yakovenko; 'The Intergovernmental Agreement on the International Space Station' *Space Policy* Vol. 15 (1999), p. 79.
[406] Anna Maria Balsano; 'Intellectual Property Rights and Space Activities' *Space Policy* Vol. 11 (1995), p. 206.
[407] Yakovenko, *op. cit.*, pp. 84-85.

prevented Russian rocket scientists from selling their knowledge on the open market.[408] Regardless of the motivations involved, at present the ISS is 'largely a cooperative undertaking between the USA and Russia'.[409]

Whilst cooperation brought benefits it also brought difficulties. One such problem related to a long running debate concerning what the word 'peaceful' means in space law. There are two interpretations: it either means that space is to be used for non-military purposes, or for non-aggressive purposes. It was agreed that the ISS is a civilian station and therefore not open to military usage.[410] In relative terms this problem was easily resolvable, as it could be answered with a definitive use of language; more complex were issues concerning control of the programme and legal issues most especially those concerning liability.

One of the terms under which the ISS project proceeded was that decisions would be reached by consensus. However, should no consensus be achieved, then the USA would have a deciding vote. The adoption of this approach reflected the size of the financial contribution that the USA made. Yet there was one exception to this, should Russia not agree with the decision, it would not be bound by it.[411]

As was discussed, in the previous chapter, space law places liability upon the state of registration, and the launching state, for damage that maybe caused. However, the ISS is a space object which has been launched by various states and contains modules belonging to various states. Cheng asks the question, '[i]f the various elements belong to the so-called 'Four Partners' are to be separately registered in different States, as in fact it has been so decided, which country will have jurisdiction when an astronaut from a module registered in one State visits a module registered in another State?'[412]

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[408] Joan Johnsson-Freese; 'The New US-Sino Space Relationship: Moving Towards Cooperation; *Astropolitics* Vol. 4 No. 2 (2006), p. 144.
[409] John M. Sarkissian; 'Return to the Moon: a sustainable strategy' *Space Policy* Vol. 22 (2006), p. 124.
[410] Cheng, *op. cit.*, p. 652.
[411] Yakovenko, *op. cit.*, p. 82.
[412] Cheng, *op. cit.*, p. 473.

In order to resolve the legal questions which the ISS created, an 'unprecedented system of legal norms regulating activities' was created.[413] The legal structure governing the ISS comprises three layers: (1) the inter-governmental agreement between 'Governments concerning Cooperation on the International Space Station'; (2) bilateral Memoranda of Understanding (MOU) between different partner states; (3) a 'Code of Conduct of a Cosmonaut', which defines the rights and duties of individuals on board the station.[414]

As was discussed in the previous chapter, the issue of liability is a crucial aspect of space law. Due to the intimate manner in which various different space agencies cooperate concerning the ISS it is difficult to envisage a means by which exact liability could be established for an instance in which damage occurs. Due to the complex nature of the problem:

> the partner states agree[d] to waive all claims against each another partner state, its contractors, users or customers for damage (direct, indirect and loss of profits) as a result of activities to develop the ISS[...] In addition, each partner state undertakes to extend the cross-waiver of liability to its agencies or institutions or private persons, unless such claims related to bodily injury to, or other impairment of health of, or death of a natural person.[415]

Therefore, in order to avoid potentially highly complex legal problems, and to facilitate the construction and usage of the ISS, the decision was essentially made that the *Liability Convention* would not apply in this instance. Thus, there was an implicit acceptance that any damage caused between member states would be the product of misfortune and there would be no compensation due.

Part Two – Domestic Institutions

Within all the states that have major space programmes there are domestic authorities responsible for the regulation of commercial satellite operators. For the purposes of this examination, and reflecting the available information, the Federal Communications

[413] Yakovenko, *op. cit.*, p. 81.
[414] *Ibid.* p. 82.
[415] *Ibid.* p. 83.

Commission of the United State and the British National Space Centre will be examined. There is no evidence that the authorities of other countries do not behave in a manner substantially different from these two organisations, as such they can be considered to be typical cases.

Federal Communications Commission (FCC)

The United States' Federal Communications Commission (FCC) was established by the Communications Act of 1934 with responsibility for licensing the usage of the radio frequency spectrum by private corporations. It is a governmental agency directly accountable to the Congress. It is 'charged with regulating interstate and international communications by radio, television, wire, satellite and cable.'[416] The Communications Act gave the FCC power to regulate private radio stations in the 'public interest'.[417]

In order to receive a licence to broadcast in the United States, an application must be made to the FCC. As technological capacity has expanded, so has the role of the FCC, satellite operators now also require an FCC licence. In such instances, basic technical information has to be provided, along with the orbit into which the satellite will be placed. There are approximately 90 satellites in geostationary orbit, and a further 170 in other orbits, which operate under licence from the FCC. In order to be granted such a licence it is necessary to follow FCC rules, which are founded upon the need to preserve a 'public good', the frequency spectrum.[418] The FCC is also integrated into an international network; it often cooperates with the 'radio administrations' of other countries in order to address instances of satellite interference.[419]

Essentially the FCC acts as a gatekeeper for American commercial broadcasting and satellites that are to be placed into orbit. It has control over who can broadcast and with reference to satellites, it can control the conditions under which satellites operate. Therefore, in order for an American corporation to launch a satellite it has to comply with the standards of the FCC.

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[416] 'About the FCC' < www.fcc.gov/aboutus.html >.
[417] Kensinger *et al* in Dansey (ed.), *op. cit.*, p. 571.
[418] *Ibid.* p. 571.
[419] Richard H. Buenneke; 'Protection of Commercial Satellite Communications Infrastructure' *Astropolitics* Vol. 2, No. 2 (2004), p. 253.

The British National Space Centre (BNSC)

The 1986 UK Outer Space Act (OSA)[420] gives licensing power for satellite operations to the Secretary of State for Department of Trade and Industry (DTI), this power is effectively operated by the British National Space Centre (BNSC) which is hosted by the DTI and operates UK space policy.[421]

The primary functions of the BNSC are to:

- co-ordinate UK civil space activity;
- support academic research;
- nurture the UK space industry; and
- work to increase understanding of space science and its practical benefits.[422]

The BNSC has three stated long term objectives:

- to enhance the UK's standing in astronomy, planetary and environmental sciences;
- to stimulate increased productivity by promoting the use of space in government, science and commerce; and
- to develop innovative space systems, to deliver sustainable improvement in the quality of life.[423]

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[420] The full text of the Outer Space Act can be found at:
< www.bnsc.gov.uk/assets/channels/about/outer%20space%20act%201986.pdf >.
[421] R. Crowther, R. Tremayne-Smith and C. Martin; 'Implementing Space Debris Mitigation Within the United Kingdom's Outer Space Act' in D. Dansey (ed.), *op. cit.*, pp. 577-578.
Information pertaining to the BNSC being hosted by the DTI can be found at:
< www.bnsc.gov.uk/content.aspx?nid=5589 >.
The BNSC is owed and operated by 11 partner organisations, six of which are government departments, the others being public sector institutions, the full list of partners can be found at:
< www.bnsc.gov.uk/content.aspx?nid=5597 >.
The largest single source of funding for the BNSC is the Particle Physics and Astronomy Research Council (PPARC):
< www.bnsc.gov.uk/content.aspx?nid=5551 >.
[422] 'What is BNSC' < www.bnsc.gov.uk/content.aspx?nid=5543 >.
[423] *Ibid.*

Under the terms of the OSA licences granted are required to be consistent with the United Kingdom's international obligations;[424] most specifically this applies to the four space treaties to which the UK is party.[425] Further, the OSA does not allow the Secretary of State to grant licences which would jeopardise 'the safety of persons or property', on this basis permission to operate in orbit 'requires the licensee to conduct his operations in such a way as to prevent the contamination of outer space'.[426]

The most common licence that the BNSC grants is a 'payload licence'. In such instances the satellite's specifications are assessed; this will include checking altitude control systems, the orbit to be used, the power storage mechanism and safety procedures.[427]

Integration is a common feature of the governance network concerning space. This is demonstrated by the BNSC which is one of the founding members of the European Space Agency (ESA).[428] Also the UK regularly contributes documentation to the UNCOPUOS. The UK is also a member of the International Standards Organisation and the International Telecommunications Union. There is also British participation in the International Space Station, specifically through ESA.

Conclusions

There is no one body which can be said to govern near Earth space. Rather the governance network which exists is constituted of different actors fulfilling specialist roles. The international organisations that have been identified contribute different elements to the governance network. The United Nations Committee on the Peaceful Uses of Outer Space to a large extent has, historically, been the primary location in which the governance of near Earth space has been created. This is due to it being the forum in which the space treaties were created; this statement is made with the assumption that the institutional form of UNCOPUOS includes behind the scenes negotiations and trading, not merely that which occurs in open sessions.

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[424] This provision is contained in Article 4 of the Act.
[425] The United Kingdom has neither signed nor ratified *The Moon Agreement.* United Nations; 'Status of international agreements relating to activities in outer space as at 1 January 2006' UN Document ST/SPACE/11/Rev.1/Add.1
[426] Crowther *et al* in Dansey (ed.), *op. cit.,* p. 577.
[427] *Ibid.* p. 579.
[428] 'BNSC and ESA' < www.bnsc.gov.uk/content.aspx?nid=6185 >.

As organisations the International Telecommunications Union and the International Standards Organisation are not primarily concerned with space; they were both formed before space became a major area of commerce and scientific research. However, they have become incorporated into the governance network as a need for their specialist knowledge has developed. The ISO has provided a forum in which universally acceptable and useful standards could be created which are beneficial to all space users. It does not require power of enforcement precisely because the standards are useful to all space users.

The ITU became active in the regulation of space activities because those activities included utilising the electro-magnetic spectrum via satellite. The regulation that the ITU provides is not greatly different from that which it does terrestrially: its purpose is to prevent harmful interference from occurring in the usage of the frequency spectrum. However, as a consequence of providing regulation in order to protect against interference, it has also been necessary for the ITU to govern the usage of slots in GEO.

The International Academy of Astronautics fulfils a different type role with reference to near Earth space, compared to the other organisations considered. The IAA does not have any regulatory powers, either enforceable or voluntary; rather it provides a forum within which technical experts are able to share knowledge. As such, the IAA is concerned with the technical nature of problems concerning the governance of space, rather than directly addressing the creation of political remedies.

The importance of the International Space Station is that it provides political remedies. The ISS is a remarkable technical achievement, but the political agreements which allowed it to be created are also of interest. Such was the necessity of international cooperation, in order to create the station, that states were willing to enter into agreements which would not have been thinkable under other circumstances. There are two particularly notable aspects to the political agreements which paved the way for the ISS; firstly, that the United States was given power to make decisions when a consensus could not be found and, secondly, that the states have provided each other with a cross-waiver to nullify issues of liability.

The two domestic institutions which have been highlighted, the American Federal Communications Commission and the British National Space Centre have differing duties. The FCC is primarily concerned with the regulation of the electromagnetic spectrum, whereas the BNSC is an agency which has specific responsibility for space policy. However, they both act as 'gatekeepers' for private actors wishing to place satellites in orbit and have the power to enforce safety standards. Other space faring countries also have agencies which fulfil such a role. For example, France does not have any specific space law; French space activities are governed by the UN treaties which France has ratified.[429] However, as these treaties are broad declarations of principles, there is a margin for interpretation. The authority to interpret a domestic legal structure from the international treaties rests with the Technology Directorate in the Ministry for Research and New Technologies and the CNES, the French national space centre.[430] This is a broadly similar structure to that of the United Kingdom and has the same policy outcome, that government is able to enforce standards upon private companies.

It is important to note that the domestic and international institutions do not exist in isolation; the situation is characterised by different agencies providing differing aspects of regulation. The net result is that space is not an area devoid of regulation. Space law provides the broad principles upon which human activity in space is conducted, whilst the institutions discussed in this chapter provide more specific rules and regulations to facilitate the orderly exploration and exploitation of space.

The evidence in this chapter reveals that the problem of debris does not exist in isolation. Prior to debris being identified as a problem, a series of systems and values have been created which limit actor's behaviour, resulting in collective and individual benefit. Thus, when the specific problem, of debris, is considered it is an issue that has occurred in a social environment which provides precedents of cooperation.

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[429] France has ratified the first four space treaties, it has signed, but not ratified *The Moon Agreement*, 'Status of international agreements relating to activities in outer space as at 1 January 2006' UN Document ST/SPACE/11/Rev.1/Add.1

[430] Jean-Yves Trebaol; 'French Policy and Practices for the Registration of Space Objects' in Dansey (ed.), *op. cit.*, p. 586.

Chapter Five:
Rights of Use in Near Earth Space I:
Precedents and Themes

Introduction

The following two chapters will seek to explore the basis under which common resources can be utilised, specifically under the terms that exist in space law. The narrative will commence with a discussion of the Global Commons, ascertaining their unique legal character in the contemporary world. The general examination of the Commons will then proceed to consider, in detail, the specific Commons of space; in so doing, particular attention will be paid to the conceptualisation of rights of use, as they exist within space law. This will require an examination of both the *Outer Space Treaty* and *The Moon Agreement*, for they offer different perspectives concerning how extraterrestrial resources can be explored and exploited. Most importantly the notion of Common Heritage of Mankind (CHM), as it is contained within *The Moon Agreement*, will be considered in detail, for it presents a radical view of the governance of the Commons which places the concepts of justice and preservation at its heart.

Rights of use are essential to most economic and social interactions; whenever a resource is utilised there are questions associated with rights of use. In near Earth space the issue of rights of use is notably unclear. This relates to the issue of debris, as it could be viewed that unclear regulation is a permissive cause for the debris problem. Further, it is necessary to consider the rights of use as they relate to the global Commons, as the Commons are legally very different from territory contained within Westphalian states. As the debris problem is located within a global Common it is necessary to consider the governance of the Commons and whether alterations to it would have a significant effect upon effort to ameliorate the debris problem.

The examination in this chapter will provide the background to the rights of use issue concerning near Earth space. The following chapter will then address the specific methods through which the issue has been addressed, and the problems that are outstanding.

The Global Commons

In an era of Westphalian states, and the pre-eminence given to private property, the global Commons are an oddity.[431] The physical characteristics, and resources contained, in the Commons provide them with very different characters, but they are bound together as areas beyond the reach of national appropriation. There are some differences in the areas identified as constituting the global Commons, however Buck considers them to be 'Antarctica, the high seas and deep sea-bed minerals, the atmosphere and space'.[432] This is the generally accepted catalogue, although space and the atmosphere can be considered as constituting several separate Commons: for example Per Magnus Wijkman separates space into 'orbits' and 'the electromagnetic spectrum', he also divides the atmosphere into 'the ozone layer' and 'the carbon dioxide balance'.[433] The *Moon Agreement* also differentiates the Commons, as it separates the vacuum of space from the Moon, and 'other celestial bodies within the solar system, other than the earth' (Article 1), as these bodies are incorporated into what is called the 'Common Heritage of Mankind' (CHM). The importance of these distinctions, particularly those made by Wijkmann, is that they identify the attributes of the resources, rather than the physical area that they occupy, which suggests that governance of the Commons should focus upon their resources rather than their physical locations.

When analysing matters concerning the exploitation of space the *Outer Space Treaty* (OST) is the principle legal instrument of importance. It is that treaty which designates space, and the celestial bodies, to be a global Commons: Articles I and II stipulate that it is an area which is free for all states to use, and that it is not subject to national appropriation. Sylvia Williams argues that before the *OST*, in 1967, these areas constituted *res nullius*, an area that was not part of a nation state, which could be occupied by a state and become part of its territory. After the *OST* it became *res extra commercium*, literally a thing that cannot be owned by any body.[434] This alteration can be considered as firmly established in international law, as all space faring states are signatories to the

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[431] Per Magnus Wijkman; 'Managing the Global Commons' *International Organization* Vol. 36, No. 3 (Summer 1982), p. 513.
[432] Buck, *op. cit.*, p. 1. This list concurs with the Commons as identified by Vogler: Vogler, *op. cit.*, p. 2.
[433] Wijkman, *op. cit.*, p. 511.
[434] Armel Kerrest; 'Outer Space: Res Communis, Common Heritage or Common Province of Mankind?' < http://fraise.univ-brest.fr/~kerrest/IDEI/Nice-appropriation.pdf >.

OST.[435] Yet this is of limited importance as before 1967 no state had an effective capacity to claim jurisdiction in space, therefore during the period when space has been a viable, exploitable resource it has been a Commons. However, the possibility of 'another way' should not be readily dismissed. Not least as for a brief time, following the launch of Sputnik, it appeared that states would claim sovereignty over parts of outer space.[436]

It was the imminence of the Moon landings which gave impetus to the signing of the *OST*. Bin Cheng notes that as space technological development was occurring swiftly, the super-powers perceived it as 'vitally important' to have legal principles in place before a manned Moon landing; this was the driving force in the 'extraordinary speed' in which the conclusion of the *OST* was reached.[437] It is important to note the legal precedent which the *OST* set: it was the first instance when states have renounced claims to sovereignty prior to physically arriving at an area which they had the ability to occupy and claim.[438] Therefore, when considering the fact that near Earth space is a Commons, it has to be remembered that this has not occurred as an accident of history; it is not a resource which has been 'left over' and not claimed by any state. Rather, establishing space, and the celestial bodies, to be a Commons was a deliberate act which was brought about by states, principally the USA and USSR, because they perceived it to be in their individual, as well as collective, interests.

Similarly, it should be considered that the Commons as they are understood are a social construct: physically there may be little difference between them and the territories of nation states. This is especially emphasised when considering Antarctica, which although inhospitable, is land just as the other continents are; yet the other continents are constructed exclusively of Westphalian states.[439] Further, the atmosphere is considered to be one of the global Commons, however to a large extent it overlaps with sovereign air space. Therefore,

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[435] United Nations; *United Nations treaties and principles on outer space: Status of international agreements relating to activities in outer space as at 1 January 2005*, *op. cit.*.
< www.unoosa.org/pdf/publications/ST_SPACE_11_Add1_Rev2E.pdf >.

[436] D. Goedhuis; 'Influence of the Conquest of Outer Space on National Sovereignty: Some Observations' *Journal of Space Law* Vol. 6, No. 1 (1978), p. 40

[437] Cheng, *op. cit.*, pp. 205-219. Space law as a body developed with remarkable speed throughout the 60s and 70s. Galloway (1976), *op. cit.*, p. 210.

[438] Sylvia Maureen Williams; 'International Law Before and After the Moon Agreement' *International Relations (London)* Vol. 7, No. 2 (1981), p. 1176.

[439] It is difficult to think of any areas other than Antarctica which could be considered not to be part of a state. Embassies are not part of the state in which they are located, but they are the sovereign territory of the state they represent. Small entities such as the Monaco and Vatican City are states in their own right. The only land, outside of Antarctica, which could be argued not to be part of a state are buildings belonging to the United Nations, most especially their headquarters in New York.

the atmosphere is a Commons when considered in environmental terms, such as its capacity to absorb carbon dioxide emissions, and the depletion of stratospheric ozone. Although the 'air' which constitutes the atmosphere is a Commons, the 'air space' through which is passes, is under territorial jurisdiction.[440] Thus, a Commons and sovereign territory coexist; while a state controls the air space above its territory, simultaneous that gaseous space constitutes the atmosphere which is considered to be part of the global Commons. The important fact this reveals is that human conceptualisations make areas, or resources, part of the global Commons. Their status is not due to a pre-determined 'natural order'.

The differing resources which the global Commons contain can be conceptualised in two categories: those which are considered to be renewable and infinite, and those which are considered to be exhaustible and finite. The high seas, the atmosphere and space are conceptualised as renewable, whilst Antarctica, the deep sea-bed minerals and the celestial bodies (including the Moon), are exhaustible. This conceptualisation is not necessarily scientifically accurate, rather it is inherent in their status within international law. The differentiation between the two forms of Commons is reflected in the emerging governance concerning near Earth space. Low Earth Orbit is considered to exist in a sufficient high quantity that there is little need for regulation, other than with reference to debris. Whereas, the number of slots available in Geo-Stationary Orbit is strictly limited and therefore the ITU provides regulation over their usage.

The inexhaustible Commons are legally characterised by a lack of restrictions. The freedom of the seas has been established since Grotius;[441] exploitation of, and damage to, the atmosphere and space have only been possible relatively recently, however both have followed the same 'open' nature as that of the high seas. Although agreements have placed limitations upon the freedom of activities in these areas, such as *The Third United Nations Convention on the Law of Sea* (UNCLOS III)[442] and the *Framework Convention on Climate Change* (FCCC),[443] their status in international law is founded upon the principle that there is a sufficient quantity of the resource for all to use. Although the validity of this assumption has been called into question, this has not produced a momentum to alter their legal status.

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[440] Vogler, *op. cit.*, p. 124.
[441] Luc Cuyvers; *Ocean Uses and Their Regulation* (Chichester: John Wiley & Sons, 1984), p.47.
[442] The full text of UNCLOS III is available at:
< http://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf >.
[443] The full text of the FCCC is available at:
< http://unfccc.int/resource/docs/convkp/conveng.pdf >.

O.J. Lissitzyn noted, when space exploration was beginning and before the creation of any of the space treaties, that it was very unlikely that the legal regime constructed for outer space would resemble that for Antarctica. The basis for Lissitzyn's position was that a continent is finite whilst space is infinite.[444] However, as it is a physical land, Antarctica potentially has much to offer as a precedent for extra-terrestrial resources considered to be finite. This would be the case concerning the resources of celestial bodies, the number of satellites that can be placed in GEO and the carrying capacity that near Earth orbit has for debris.

Politically Antarctica is governed by a long standing regime formed by the *Antarctic Treaty*;[445] this treaty makes the continent remarkable as it is the remnants of *res nullius*, the treaty only requires signatory states to suspend their territory claims not renounce them.[446] As such, the Antarctic is not a Commons with a structure designed to govern the legal exploitation of its resources. The treaty does not provide any means by which the Antarctic resources can be utilised, it only places such questions permanently on hold. Indeed, at present states are considering their positions concerning the Antarctic, and its resources. Thus exposing the difficulty of the present regime, as it suspends claims to sovereignty, rather than resolving them.

The remaining Common to be examined, the resources of the deep sea-bed, provides an informative, and revolutionary, conceptualisation of the global Commons. The treaty which governs the sea-bed, UNCLOS III, was negotiated during the same period as the *Moon Agreement*; further they are the only two instances in which the notion of CHM is expressed.

It could be argued that the notion of CHM has as long a history as the notion of the Commons because a certain protective conceptualisation of the Commons leads almost inevitably to CHM. That is, if those utilising a Common are only considered to be its

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[444] O.J. Lissitzyn; 'The American Position on Outer Space and Antarctica' *The American Journal of International Law* Vol. 53, No. 1 (January 1959), pp. 126-131.
[445] The full text of the *Antarctic Treaty* is available at:
< www.antarctica.ac.uk/About_Antarctica/Treaty/treaty.html >.
[446] The *Antarctic Treaty* (1959), Article IV, states, 'Nothing contained in the present Treaty shall be interpreted as: (a) a renunication by any Contracting Party of previously asserted rights of or claims to territorial sovereignty in Antarctica'.

stewards, not owners, then the necessity to pass on the resource as it was found to future generations is closely aligned with the notion of CHM. The first formal legal usage came in 1967, when in a speech to the UN General Assembly the Maltese Ambassador Arvid Pardo argued that the deep sea-bed should be considered as the 'Common Heritage of Mankind'.[447] Previous to Pardo's speech there had been research addressing governance of the global Commons; in 1952 the Assistant Director of the Legal Department of the United Nations, Oscar Schachter, suggested that outer space and celestial bodies should be 'the common property of all mankind over which no nation would be permitted to exercise its domination'.[448] In 1954, inspired by technological developments which made their exploitation possible, Professor Cocca was developing the theory of *res communis humanitaties* whereby outer space and celestial bodies would be 'of mankind and for mankind'.[449]

Despite the passage of four decades since Pardo's speech, the concept of CHM remains embryonic. Joyner argued, in 1986, that the most accurate appraisal which can be made is that it '*may* indicate an *emergent* principle in international law'.[450] Yet, since then the International Seabed Authority has been founded, under the provisions of UNCLOS III, which strongly suggests that CHM is a real aspect of international law. Although there is still a lack of clarity concerning the CHM, it has commonly agreed features, these are:

- the area is not subject to national sovereignty ('the area' is that portion of the sea-bed which is governed by UNCLOS III)
- all countries are to share in the management of the area
- benefits from the area are to be distributed evenly
- the area is to be used exclusively for peaceful purposes
- the area should be open for scientific research.[451]

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[447] Vogler, *op. cit.*, p. 7.
[448] Nicolas Mateesco Matte; 'The Common Heritage of Mankind Principles in Outer Space: Towards a New International Order for Survival' *Annals of Air and Space Law* Vol. XII (1987), pp. 316-317.
[449] Williams, *op. cit.*, p. 1176.
[450] Emphasis in original, Joyner, *op. cit.*, p. 199.
[451] There is debate as to whether the fifth item is actually a component of CHM, See Kilaparti Ramakrishna; 'North-South Issues, The Common Heritage of Mankind and Global Environmental Change' in Ian H. Rowlands and Malory Greene (eds.); *Global Environmental Change and International Relations* (Basingstoke: MacMillan, 1992), p. 156.

The importance of the CHM, as was briefly discussed in the chapter concerning space law, is that it argues that resources are not subject to appropriation by nation states as they are already owned collectively by humanity as a species. Further, the notion of 'heritage' infers that it is not merely the case that resources are owned by everyone in the present, but that the rights of future generations to use them should be preserved.

Space is incomprehensibly vast in size, as such initially there appears to be little need to preserve it for future generations. However, the presence of orbital debris has the potential of rendering sections of near Earth space useless. Therefore, the CHM can be seen as a radical means of reconceptualising near Earth space such that the rights of future generations to use it are protected. Further, due to the potentially astronomical sums of money that commercial activities in space could generate, an argument exists that utilising the CHM would provide for all nations to benefit in those activities.

The *Moon Agreement* addresses the themes associated with the CHM, but it is UNCLOS III which provides a clear regime structure within which they are expressed. Before the details of UNCLOS III are considered, it is important to note that the United States, as the most powerful actor, has not ratified the treaty. However, domestically the US has enacted the 'Deep Seabed Hard Mineral Resources Act' (1980), which regulates the activities of United States companies in their exploitation of the sea-bed. The Act established a regime within the US, and therefore between US companies, which provided legal protection for commercial activities. Therefore, US companies are prevented from exploiting the resources of the seabed which have already been prospected by another US company. In relation to each other US firms are given protection against legal uncertainty.[452] In this respect the domestic legislation has the same effect as UNCLOS III seeks at an international level. However, as third world states would observe, it does not include the redistributive elements which are included in UNCLOS III.

UNCLOS III and the Revolutionary Nature of CHM

Article 11 of the *Moon Agreement* states that the satellite and 'its natural resources are the common heritage of mankind', however other than stating the principles which

[452] Eligar Sadeh, David Livingston, Thomas Matula and Haym Benaroya; 'Public-Private Models for Lunar Development', *Space Policy* Vol. 21, No. 2 (2005), pp. 269-270.

should therefore be applied, it does not provide further detail. The essence of these principles is that an international regime should be founded in order to manage the resources of the Moon, such a regime would then be responsible for 'an equitable sharing' of the benefits derived from lunar resources. However there is no explanation concerning the nature and structure of this regime, thus for a lunar regime to be created another treaty, complementary to the *Moon Agreement*, would be required. To appreciate the potential nature of the CHM regime, the only example available is that envisaged by UNCLOS III.

It was during the protracted negotiations of UNCLOS III that the CHM was first debated. Although this was the initial forum in which the notion was discussed, the resulting treaty was not completed until after the *Moon Agreement*, therefore it was the second treaty to contain the concept. Whereas the *Moon Agreement* does little more than confer the status of CHM, Part XI of UNCLOS III provides considerable detail of an 'extraordinarily complicated legal regime'[453] designed to put the concept into practice.

The first consideration to be made, when examining the International Seabed Authority (ISA), is that it does not govern the sea-bed as a whole; UNCLOS III allows states to continue to lay cables and pipelines on the sea-bed without the consent of the Authority.[454] The purpose of the regime is to manage the exploitation of the resources of the deep sea-bed.[455] In practice this means polymetallic nodules, on the ocean floor, which contain metals such as nickel, manganese, copper and cobalt. At the time of the UNCLOS III negotiations, it appeared that harvesting these nodules would imminently become commercially viable.[456] The institution which UNCLOS III founds, in order to manage those mineral deposits, is extra-ordinary. Should it come to fully operate as envisioned by the treaty, then it would be new form of entity within International Relations. Presently the Authority does exist, it came into being on 16th November 1994, following the entry into force of UNCLOS III, and became fully autonomous in June 1996.[457] However, it is not yet

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[453] R.R. Churchill and A.V. Lowe; *The Law of the Sea* 3rd edition (Manchester: Manchester University Press, 1999), p. 229.
[454] *Ibid.* p. 239.
[455] UNCLOS III Article 133 defines 'resources' as 'all solid, liquid or gaseous mineral resources in situ in the Area at or beneath the sea-bed, including polymetallic nodules'.
[456] 'Resources of the Seabed'
< www.isa.org.jm/en/publications/IA_ENG/ENG1.pdf >.
[457] 'International Seabed Authority' < www.isa.org.jm/en/about/default.asp >.

fulfilling the role envisaged, as discoveries of more readily available land based metal deposits have made those on the deep sea-bed uneconomic.[458]

The most radical implications of the ISA can be viewed through the conceptual tool of a 'domestic analogy'.[459] The ISA would behave as a national government would be expected to do with regard to its own citizen; yet in this instance it is states which become the 'citizens'. There is scope for speculation concerning the degree to which the ISA could be considered a direct transference of a domestic structure to the international level, yet there does appear to be a clear instance of a 'domestic analogy of values',[460] wherein concepts which have their origin in domestic society have been transferred to the international arena.

UNCLOS III states: 'The Area [the sea-bed] and its resources are the common heritage of mankind' (Article 136), and as a consequence '[a]ll rights in the resources of the Area are vested in mankind as a whole on whose behalf the Authority shall act.' (Article 137). The Area, the part of the ocean floor which does not fall within territorial seas, comprises 60% of the total sea-bed.[461] The claim to common ownership is such that the Sri Lankan Ambassador to the Law of the Sea Conference, Christopher Pinto, asserted that 'if you touch the nodules at the bottom of the sea, you touch my property. If you take them away, you take away my property.'[462]

Although the resources are claimed for humanity as a whole, the Westphalian order is maintained, as the structures of the institution are not an attempt to create a co-operative society in which every member of the species is entitled to participation. Rather states are the international persons to whom the treaty refers. The intention, to conduct activities on the sea-bed such that there is an 'equitable sharing of the financial and other economic benefits' (Article 140) does not refer to an equitable distribution between individuals, rather it is clearly states who are to benefit, on behalf of their citizens.

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[458] Churchill and Lowe, *op. cit.*, p. 253.
[459] Bull (1995), *op. cit.*, pp. 44-49.
[460] Hidemi Suganami; 'Reflections on the domestic analogy: the case of Bull, Beitz and Linklater'; *Review of International Studies* Vol. 12, No. 2 (1986), pp. 152-153.
[461] Churchill and Lowe, *op. cit.*, p. 239.
[462] Kevin B. Walsh; 'Controversial Issues Under Article XI of the Moon Treaty' *Annals of Air And Space Law* Vol. VI (1981), p. 491.

Rene-Jean Dupuy critiques the concept of humanity as a whole owning a resource. If the entire species in given property rights, then who can act on its behalf? The answer within UNCLOS III is states, however as Dupuy notes even if the United Nations were to be given the power to administrate the resource, then it is still a product of the state system, representing states rather than peoples.[463] These problems lead him to consider that the term 'mankind' is an open concept, the meaning of which will come to be defined by future practice.[464]

The most remarkable aspect of the ISA, is the fashion in which the revenues it generates are to be distributed. In order of priority (according to Article 173) the destination of revenues are:

1) administrative expenses

2) equitable distribution between states, with special attention being made to the needs of developing countries

3) providing funds for the Enterprise (the body of the ISA which will physically conduct the mining).

4) compensating states which have been effected by market changes due to activities in the Area.

The second area of financial distribution reveals an important facet of the CHM. It shows an inclination towards social justice, as the structure is inclined towards assisting the developing world. The usage of the word 'equitable' rather than 'equal' provides for the distribution of funds to be conducted on a basis other than all states receiving an identical amount or distribution being weighted according to population. Either of these would be at best neutral in addressing the poverty of developing states. The word 'equitable' in conjunction the commitment to act with 'particular consideration [to] the interests and needs of developing States and of peoples who have not attained full independence or other self-governing status' (Articles 140 & 160), suggests that developing states can expect to receive more than an equal share.

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[463] Rene-Jean Dupuy; 'The Notion of Common Heritage of Mankind Applied to the Seabed' *Annals of Air and Space Law* Vol. VIII (1983), p. 347.
[464] *Ibid.* p. 353.

The commitment of the ISA to address the particular needs of the developing world is further emphasised by the fourth area in which resources are to be distributed. The obligation to aid states effected by activities in the Area is fully examined in Article 151, which affirms that aid shall be given 'to assist developing countries which suffer serious adverse effects on their export earnings or economies resulting from a reduction in the price of an affected mineral or in the volume of exports of that mineral, to the extent that such reduction is caused by activities in the Area.'

Within these two areas, to which funds generated by the ISA will be distributed, a concept from the domestic can be clearly seen as being transferred to the international realm; that the source of governance/authority should act in a fashion which does not have an adversely negative effect upon the weakest members of society. Indeed these two areas of distribution can be seen as going further. The ISA is to be redistributive in its actions, providing greater assistance for developing states than to wealthy states. There is a continuity of thought to be found in this process. Progressive rates of income tax and welfare payments to the unemployed, are expressions of the same notion of social justice. Thus, although the aims of the ISA are novel within the international, they are in fact the product of transferring well established concepts in the domestic.

The 'social' character of the ISA is not limited to the distribution of finances. The Authority is to facilitate the spread of 'technology and scientific knowledge' to developing states: in the first instance to acquire the means to exploit the Area itself; subsequent to this, technology is to be transferred to developing states 'under fair and reasonable terms and conditions' (Article 144).

The legal status of the ISA is also worthy of note, as it is fundamentally supranational in character. UNCLOS III provides the Authority with full legal freedom from the state system. As such, it is granted 'immunity from legal process' (Article 178), its staff in their actions on its behalf will also have immunity (Article 182) and its property 'shall be exempt from restrictions, regulations, controls and moratoria' (Article 180). The Authority's exemption from the control of states, is further emphasised as it is not to be subject to taxation or customs duties (Article 183).

Thus, the International Sea-bed Authority, as it is envisaged within UNCLOS III, is an extra-ordinary body. It is a supra-national institution, free from the interference of nation states. This is not remarkable in itself, but the form of governance which it creates is. Conceptually the ISA borrows from the domestic notions of social justice, applying them to the interactions of states concerning mineral deposits on the ocean floor. As such it does not treat all states as equals, rather it positively discriminates in favour of the financially weakest. Further, the ISA creates a new legal framework in which property, the sea-bed, is owned. The system is distinct in two ways: firstly the property is owned, and to be exploited, by mankind as a whole; secondly its ownership and exploitation exists outside of the structure of a Westphalian state.

Given that the provisions of UNCLOS III concerning the resources of the deep sea bed include common ownership of a resource to the exclusion of private capital, it is unsurprising that they proved to be controversial. Before UNCLOS III came into force, United Nations Secretary General Javier Perez de Cuellar brought about changes, in order to make it more practical and more acceptable to developed states.[465] These modification were contained in the *Implementation Agreement*[466] which explains the reason for altering the terms of Part XI as a consequence of, '[r]ecognizing that political and economic changes, including in particular a growing reliance on market principles, have necessitated the re-evaluation of some aspect of the regime for the Area and its resources.'[467]

This renewed conceptualisation of the CHM permits states and private entities to apply for the right to exploit the resources of the sea-bed, under licensed terms from the International Sea-bed Authority.[468] It maintains the existence of the Enterprise as an organ for the exploitation of the sea-bed resource, however as the *Implementation Agreement* seeks to be a more 'practical' situation that is reflective of market conditions, the initial operations of the Enterprise are to be conducted as joint ventures.[469] The means by which prospective private mining operations select their target region is also subject to specific

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[465] Buck, *op. cit.*, pp. 90-91.
[466] The full title of the treaty is *Agreement relating to the implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982.*
The full text of the treaty is available at:
< www.un.org/Depts/los/convention_agreements/texts/unclos/closindx.htm >.
[467] *Agreement relating to the implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982*; Preamble.
[468] *Ibid.* Annex Section One, Paragraph 6.
[469] *Ibid* Annex Section Two, Paragraph 2.

regulation. The private actor is to prospect two sites of equivalent worth, it will then receive one of the sites and the other will be reserved for common exploitation.[470]

The *Implementation Agreement* further addresses the subject of the transfer of technology; potentially this is hugely important to the principles of CHM, as the utilisation of the sea-bed as a mechanism to facilitate the transfer technology is a means to aid the development of third world states. Under the terms of the *Implementation Agreement* technology is to be obtained in accordance with the 'conditions of the open market'. Should the technology not be available upon the open market, then the Authority may request that states cooperate in its acquisition.[471] This is clearly a large movement away from the position that technology should be transferred because developing states have the right to be aided in their development. Instead of a mechanism by which a right to development is acknowledged, the *Implementation Agreement* changes the conditions of the transfer of technology to being little more than any other market based transaction.

The terms under which minerals from the Area can be brought to the market are also addressed by the *Implementation Agreement*: states are prohibited from subsidizing activities in the Area, and minerals from the Area shall not be given preferential treatment in the open market.[472] Here the new focus provided by the *Implementation Agreement* can be seen. Under the original terms of UNCLOS III one of the primary concerns in selling the sea-bed minerals was that developing states should not be adversely effected. However, the new focus is upon maintaining the integrity of the open market, hence lessening the 'socially responsible' inclinations of UNCLOS III.

Despite the changes to the manner in which the sea-bed resources will relate to the market, within the new provisions, economic assistance to lesser developed states remains in place.[473] An economic assistance fund will be created using funds generated which are not required for the administrative expenses of the Authority, in keeping with the vision which UNCLOS III expresses. The *Implementation Agreement* alters UNCLOS III but it does not take it outside of the provisions of the CHM. Rather it lessens the challenge that CHM could

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[470] Vogler, *op. cit.*, p. 66.
[471] *Agreement relating to the implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December* 1982; Annex Section Five.
[472] *Ibid.* Annex Section Six.
[473] *Ibid.* Annex Section Seven.

be seen as posing to free market economics. However, the seabed still remains owned by humanity as a whole and funds generated from the exploitation of the seabed will still be directed towards the developing world.

Reflections upon the importance of CHM

The Commons present a problem, reflected in Pardo's proposed solution, specifically in the word 'heritage'. Pierre Joseph Proudhon asks: who has the right to sell a Common? If a state, or collection of states, does so then it not only deprives the present generation, but also future generations. Therefore, he emphasises that the true worth of a Common is not only its current value; it is also the potential value to future generations. As such, a state can only be considered to be in 'possession' of the Common, it cannot be considered to be the 'proprietor' of a Common.[474] Thus, when asking the question 'who owns the Commons of space', the notion of heritage would assert that it is not merely every one, or indeed no one, in the present, it is also the generations yet to be born. Such all inclusively of ownership, or its negation, has to be conceptualised not only spatially, but also temporally.

M. Yakovlev notes that 'measures are needed to preserve the near-Earth space environment for future generations'.[475] Here the importance of justice between generations, as expressed within the CHM, can be seen to be given form. For the debris problem will be far more serious in the future, unless remedial action is taken in the present.

Considering near Earth space as a resource to be preserved for the future, leads into a reappraisal of how it should be conceptualised. The terms of the debate can be moved away from merely, 'what should be done in order to allow the present optimal usage of near Earth space', to 'what are the ethical implications of the present usage of near Earth space'.

As discussed in the chapter considering space law, during the period when the *Outer Space Treaty* was written, space was considered to be a region of no intrinsic value in itself. From the perspective of green politics this position would initially appear to be completely

[474] Pierre Joseph Proudhon; *What Is Property?* Translator: Benj. R. Tucker (New York: Howard Fertig, 1966), pp. 105-106.
[475] Yakovlev in Dansey (ed.), *op. cit.*, p. 591.

unacceptable. An *ecocentric* approach would reconceptualise the importance of human needs; rather than them being of paramount (and arguably exclusive) importance, the number of interests is broadened. Therefore, the needs of the ecosystem can become an important motivation for action.[476] However, although Earth orbit is obviously part of 'the environment' as it is a natural part of the physical world, it is not an ecosystem as there is no (known) life naturally present there. This conceptualisation is founded upon the belief that 'the environment' is constituted of that which is natural, and not the product of human agency, therefore it is not merely limited to the Earth's ecosystem.

The ethical argument of ecocentricism is founded upon the belief that placing human needs above those of the non-human world is fundamentally flawed. It has led to enormous environmental degradation; therefore it should be replaced with an appreciation of the non-human world.[477] Such an approach cannot simply be applied to the Commons of near Earth space, as it is not part of the eco-system. Therefore, the presence of debris, even should it reach critical levels, will not pose a threat to any life.[478] Thus, the ethical argument can be presented in two other ways. Either near Earth space should be preserved because it has a 'wilderness value', or that it should be conserved in order for future generations to have simple access to space based resources. This second ethical argument would draw upon the notion of Common Heritage of Mankind, for it would assert that Earth orbit is not only the property of the present generation, to do with as it pleases, but rather future generations also have a claim to ownership, therefore every generation has a duty of stewardship such that it can be inherited in good order.

The CHM can also be seen to resonate with the notion of 'ecological sustainability'. This concept defines the situation wherein a resource is managed without compromising the ability of future generations to use it according to their requirements. Importantly, it is an approach which may result in the resource not being utilised in the optimal economic fashion. Further, the term is neither exclusively anthropocentric nor resource-centric.[479] Therefore, in order for sustainability to be achieved, human needs, in the present, are not to be considered as the only issues which need to be addressed. At this point, it is necessary,

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[476] David Pepper; *Modern Environmentalism: An Introduction* (London: Routledge, 1996), p. 15.
[477] Matthew Paterson; 'Green Politics' in Scott Burchill and Andrew Linklater (eds.); *Theories of International Relations* (Basingstoke: Palgrave, 2001), p. 281.
[478] The assumption is being made here that the vacuum of space is devoid of life.
[479] Feeny *et al, op. cit.*, p. 5.

again, to consider that there appears to be few other 'stake holders' concerning near Earth space, as it is devoid of organic life. Although this is true, it does not removed the twin issues of preserving the resource for the future, and the 'wilderness value' of space.[480] It has also been suggested that parts of space, such as the site of the first lunar landing, have historic value and should be preserved on that basis.[481]

Jim Dator comments upon these issues, moving way from the initially dominant position, that space is an object to merely be experimented upon, he argues that such problems as debris require a new moral perspective of responsibility towards the future, as such an ethic does not exist in traditional religious/ethnic systems, nor in economic or political theory. His contention is that such perspectives are the product of a time before it was possible for the 'present' to seriously damage the prospects of 'the future'.[482] Again this bring the debate back to the notions contained within the CHM. Even if that concept is dismissed, or considered to be impractical, what cannot be denied is that it contains ideas which address the deficiencies in the present order, in an effort to preserve resources for the future.

Nicolas Matte, suggests that the CHM provision was the product of 'a world-wide awareness of the rapid depletion of natural resources'.[483] Such an account lacks an appreciation for the other factors which lead to the rise to importance of the CHM. Specifically, an awareness that there were resources in the global Commons which were not infinite, the campaign of a new international economic order in the 1970s and the prospect of the Commons being used by developed states to further increase their relative wealth in comparison to the developing world. When the CHM was considered with reference to the resources of the deep sea-bed it offered a 'win-win' scenario for all states. At the time that UNCLOS III was drafted it was believed that in the near future the resources of the deep seabed would become extremely economically valuable. Therefore, the amount of resources available was to be increased, that increase was therefore to be distributed 'equitably', and

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[480] Linda Billings; 'How Shall We Live in Space? Culture, law and ethics in spacefaring society' *Space Policy*, Vol. 22 (2006), p. 252 and Charles Cockell and Gerda Horneck; 'A Planetary system for Mars' *Space Policy* Vol. 20 (2004), pp. 291-295.
[481] T.F. Rogers; 'Safeguarding Tranquillity Base: why the Earth's Moon base should become a World Heritage Site' *Space Policy* Vol. 20 (2004), pp. 5-6.
[482] Jim Dator; 'What Has Posterity Ever Done For Me?' *International Space University – Stockholm Summer Session* < www.futures.hawaii.edu/dator/space/posterity.pdf >.
[483] Matte, *op. cit.*, p. 321.

favouring the third world. However, the increases in wealth which the poor states were potentially to gain, were not at the expense of the rich states. Rather it was new wealth that was being created. It was only in relative, not absolute, terms that the West was going to be less wealthy.

The treaty UNCLOS III and the organisation of the ISA are vitally important when considering means through which the global Commons can be governed, for they present a radical view of the possibilities available. The notion of CHM asserts that there is a limit upon the expansion of territories, and resources, controlled by nation states. Beyond that limit are resources which are to be owned by mankind as a whole. The ISA presents a similarly radical approach in its interpretation of the CHM: it is an organisation which is not simply designed to exploit resources in the global Commons for the maximum economic gain, rather it is fundamental to its approach that social issues should be of the greatest importance. Therefore, when the resource of the sea-bed is exploited, it is to be done for the common benefit of mankind, most especially those in economic undeveloped countries. Also, the benefits of exploitation of the resources, are to undertaken so with sensitivity to the heritage which future generations will inherit.

When considered with reference to the *OST* it can be seen that the CHM complements the provision of that treaty. For the *OST*, in Article II, prohibits the appropriation of celestial bodies by nation states. However, it does not resolve the problem which it creates; specifically how extraterrestrial resources should be utilised. The notion of CHM answers that question, by allowing the exploitation of common resources only by mankind as a whole through the actions of the International Seabed Authority and for the benefit of mankind as a whole.

Objections to Common Ownership

The principles of common ownership, and non-appropriation, contained within the CHM, and therefore the *Moon Agreement*, have brought forth critical voices. However, it must be considered that such principles do not exist in isolation; they are also reflected in

Arthur M. Dula, the founder of a high technology law firm, once described the *Moon Agreement* as extending 'the communist manifesto to the entire solar system', due in part to his belief that the Soviet Union understood the term 'common heritage' to mean 'common property' and therefore the CHM would prohibit the private ownership of lunar resources.[484] Leigh S. Ratiner, a US negotiator during the Law of the Sea Conference, described as unbelievable the idea that the United States as one of the few nations with the technological capacity to exploit the sea-bed should put it under a 'system of international socialism'.[485]

Dula and Leigh are correct that the CHM prohibits private ownership from the deep sea-bed, the Moon and celestial bodies, but it is far from being the spread of a red communist tide. Glenn Reynolds also offers a series of objections to the *Moon Agreement*, all primarily based upon the restriction of free enterprise: the process of utilising resources to the benefit of all mankind is considered to be 'slow, cumbersome and prone to blackmail' and the redistributive nature of the treaty would discourage, or prevent, the development of lunar resources.[486] The treaty is further, erroneously, criticised for banning property rights; this negates the fact that the *OST* stated that space, and celestial bodies, were not subject to appropriation.

Virgiliu Pop convincingly argues that it is not merely the legal provisions of the *OST* which limit the existence of private property in space. Rather, that outside of the protection of the nation state normal private property rights cannot exist. In order for private property rights to exist there is a need for a higher authority to enforce them; either a state or other recognised entity.[487] The *Moon Agreement*, and previously the *OST*, do not ban private property rights, rather they codify their non-existence. As the resources were never part of a territorial state this was already established in common international law.

An argument could be made that military might presents a means through which property rights could be enforced in the Commons of space, as a powerful state could

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[484] Carlson, *op. cit.*.
[485] Matte, *op. cit.*, p. 322.
[486] Glenn Harlan Reynolds; *Key Objections to the Moon Treaty.*
< http://nsschapters.org/hub/pdf/MoonTreatyObjections.pdf >.
[487] Virgiliu Pop; 'Appropriation in Outer Space: The Relationship Between Land Ownership and Sovereignty on The Celestial Bodies' *Space Policy* Vol. 16 (2000), p. 277.

merely assert its claim to sovereignty and then distribute private property rights within the area which it had claimed. Whether this is strategically possible is open to debate, however what is not in doubt is that it would be illegal under the provisions of the *OST*. Further the political backlash which any such state would be subject to would be considerable.

An acceptance that a free enterprise economy is the inherently the most efficient economic system leads to the belief that property rights are the only possible means by which economic activity can effectively occur. From this perspective economic development of space at a minimum requires 'pseudo' property rights, whereby an individual state would offer corporations exclusive licences, in order to exclude other enterprises from using a particular technique, therefore making the commercial environment more conducive to investment.[488] This is an important feature of UNCLOS III: it creates a stable property regime, wherein the expense of prospecting the sea-bed can be conducted in the knowledge that competitors will not encroach upon that financial investment. Although the USA has remained outside of the ISA structure, it has recognised the need for stability through the 'Deep Seabed Act'.[489]

The fundamental flaw in the reasoning, that stability similar to that which exists domestically can be created by an individual state, is a lack of appreciation of the international character of space technology. Should one state, even the USA with its dominant position in space, limit a certain technique (or grant exclusive licence to use a certain part of space) it would not be in the position to prevent other states from permitting such a technique; unless there was an international treaty which gave individual states the authority to do so. Therefore, a private enterprise could secure a launch from another state and then utilise a technique for which another state has granted an exclusive licence.

In short national property rights, whether pseudo or not, are meaningless in space, as it is fundamentally international in character. National governments are not able to either guarantee rights of property or permission for the exclusive usage of a technique. Property rights, in the global Commons, can only be meaningful if they are operated through international agreement. Yet, it should not be considered that private property rights are a

[488] Sam Dinkin; 'Property rights and space commercialisation' *The Space Review* < www.thespacereview.com/article/141/1 >.
[489] Sadeh *et al*, *op. cit.*, pp. 269-270.

natural means through which resources can be exploited, neither are they inevitable. The necessity for stability when investment is made, and the need for international cooperation to coordinate the usage of a resource is best demonstrated in the regime which regulates the usage of satellite slots in GEO, which will be considered in the following chapter.

Conclusions

This analysis has demonstrated that there is no universal system that exists in order to regulate the Commons. Indeed, protecting them presents a serious difficulty to Westphalian states. In this respect the perspective of Hardin is mirrored, as a Commons exist which are open for all to use without a leviathan governing the resources. If a common resource within a state is to be protected, then the national government has the power to do so. For example, the preservation of 'green belts' around cities is considered to be a public good, therefore in order for them to be preserved governments enact legislation. In the most extreme instance a government may choose to nationalise a resource in order to protect it, for the common good.

As the international sphere is fundamentally anarchic, it is not possible for any authority to impose such limitations upon the usage of a common resource. To an extent, it could be argued, that the existence of states is a reflection of the logic which Hardin argues: from an original nothingness states have emerged which have controlled certain areas and resources, and then provided governance over that which they control. They are a form of external privatisation and internal leviathan. However, the Commons are the areas and resources which have remained outside of that process of regulation, in large part their physical characteristics are such that they could not be brought under the control of a single state.

Antarctica is often considered to be an example of an effective regime, as it has preserved the wilderness value of that continent. Yet, as the analysis of the *Antarctic Treaty* revealed, the present governance achieves little more than permanently freezing questions concerning the exploitation of its resources. A very strong argument could be made that it is not the provisions of the *Antarctic Treaty* which have protected that continent, rather it has been the economic inefficiency of attempting to exploit its resources. Certainly, the treaty does not provide a precedent for how common resources could be effectively exploited.

Analysing the other resources which constitute the global Commons has also revealed that regulation is more simple for those resources which can be considered to be inexhaustible, rather than those which are finite. A broad interpretation of the regulation of the inexhaustible commons could be that actors are allowed to behave as they wish, provided that they do not inconvenience others. This is demonstrated in the governance of the High Seas, which broadly has the effect that states can do as they wish. International law has not established clear precedents for instances wherein the usage of a resource by one actor will have a significant effect upon the access of other actors.

There are two forms which 'exhaustible Commons' can be sub-divided into: those which are renewable but have a limited supply and those which are inherently finite. The ability of geostationary orbit to have satellites placed into it is an example of the former, whilst the polymetallic nodules on the ocean floor are an example of the latter. As will be discussed in the following chapter, space law has devised means of addressing resources which are limited in supply but renewable, however the situation concerning truly exhaustible Commons is far less clear. The importance of the example of the UNCLOS III provisions concerning the deep sea-bed cannot be underestimated. There are those who would dismiss the notion of common ownership, either for ideological reasons or because of questions surrounding its practicality, but what cannot be denied is that it is an attempt to resolve important questions. Concerning exhaustible extra-terrestrial resources, the question is framed in terms of the *OST* which prohibits appropriation. The notion of Common Heritage of Mankind then presents a means through which that non-appropriation can be managed. If the CHM is dismissed, then the question of non-appropriation is left unresolved. What is clear is that regulating behaviour concerning the finite Commons is more complicated; however it is inherently these areas which require more protection. International law is more effective when the situation exists wherein there is a sufficiently large amount of a resource that actors can utilise as much as they wish.

What the Common Heritage of Mankind argues is that in order to ensure that a resource is used equitably (both with reference to the present and future generations), then a new form of governance should be created. A central purpose of that form of regulation should be the preservation of the resource. It should not follow the logic of unregulated market principles, which could result in the resource being over exploited for the benefit of a

small group in the present. It further answers the question of how a resource which is owned by no-one can come into some form of ownership, for it argues that the resource will become the property of mankind as a whole. The *Implementation Agreement* changed the terms under which the CHM was to operate, most especially it was moved towards a more market orientated approach concerning the actual exploitation of the resource. However, it did not alter the fundamental fact that the resource was the property of mankind as a whole, it was to be exploited for the benefit of the entire species and the rights of future generations were to be protected.

The suggestion that ownership of resources outside of the nation state being bestowed upon mankind as a whole, resonates with the perspective of Ostrom. For both contend that a new form of regulation is required, which are neither privatisation or a leviathan, rather actors collectively create a communal mechanism through which resources can be exploited in an equitable and stable fashion.

Chapter Six:
Rights of Use in Near Earth Space II:
Present Regulation and Problems

Introduction

The previous chapter examined the difficulties concerning rights of use in the global Commons. The analysis in this chapter will build upon this to examine the possibilities and problems which remain unresolved, specifically concerning near Earth space. It will be shown that although space law establishes principles upon which space can be utilised, these principles are broad and in need of interpretation. The present means through which the International Telecommunications Union (ITU) permits satellites to be used in geostationary orbit (GEO) will be considered, for it effectively governs rights of use in GEO. Finally, the problem of private property will be considered, as space law leaves a large degree of ambiguity concerning the issue. This part of the thesis will then conclude with reflections upon how the present governance of rights of use in near Earth space effects the debris problem and whether the present property relations are sustainable as human activity in space expands.

The Registration of Satellites

The use of satellite communications in space is perhaps the most notable instance in which rights of use have been demonstrated in space. The system that exists to govern the usage of satellites, reveals a great deal concerning the present allocations of rights of use in space. The International Telecommunications Union (ITU), which was introduced in the previous chapter, is the primary institution which has responsibility for the governance of the GEO ring.

Before considering any details concerning the right to deploy satellites there is an initial consideration which needs to be made. The majority of near Earth space is best conceptualised as being a resource which presently has a sufficiently large carrying capacity for all users to utilise as much as they wish, although debris does pose a serious threat to this. However, GEO, because of its unique nature, has a far lower carrying capacity. There is

a fixed and limited number of positions which satellites can occupy in GEO. Therefore, unlike the majority of near Earth space, GEO possesses the quality of scarcity of supply. As a consequence of this, a distinct regime has emerged to govern GEO which does not address the remainder of near Earth space.

During the post-Second World War re-examination of international communications, a debate emerged concerning the 'right of priority', whereby a state could register a frequency and then permanently occupy it. This would have made the frequency the property of the state. Ultimately, the approach of 'international recognition' was favoured; this allowed states to occupy frequencies provided they did not alter the usage which was made of them.[490] By accepting such an approach states permitted each other a broad usage of the frequency spectrum, but prevented themselves from 'squatting' whereby an unused frequency would be claimed. This development showed international regulation moving away from co-ordinating state's activities, to assuming a management role over a scarce resource.

Although international recognition protected states' ability to use the frequency spectrum without interference from others, it did not address issues of equality. In December 1961 the United Nations General Assembly voted in favour of Resolution 1721 (XVI) which expressed the belief that satellite communications should be available to all on a non-discriminatory basis.[491] Although General Assembly resolutions are not legally binding, this reflects the belief that resources, especially those which are 'common' should be allocated on an equitable basis; an idea which was to become more vocal in the 1970s through the campaign for a New International Economic Order.

The 1973 ITU Convention Article 33(2) commits states to using the radio frequency spectrum and geostationary orbit efficiently and economically.[492] However, this is only a commitment by states to self regulation, it does not contain real enforcement mechanisms. This leads to a potential long term problem: as developed states were the first to place satellites in GEO, they have effectively claimed long term rights of use,[493] therefore they

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[490] Jakhu (1983), *op. cit.*, pp. 394-396.
[491] *Ibid.* p. 399.
[492] Priyatna Abdurrasyid; 'The Outer Space Treaty and the Geostationary Orbit' *Annals of Air and Space Law* Vol. XII (1987), p. 133.
[493] Arnopoulos (1983), *op. cit.*, p. 294.

tend to favour future allocations reflecting the current order, rather than being reorganised into a fairer system. This can be seen as analogous to notions of 'grandfathering' in terms of global greenhouse emissions, when present and future targets are set in accordance with past practice. To those who are 'losers' in such regimes this is perceived as perpetuating the inequalities of the past. This problem was legislated upon by the World Administrative Radio Conference (WARC) Resolution No. 4 of 1979 which gave the user of a GEO slot the right to replace a non-operating satellite with a new one occupying the same slot. There is a strong argument to be made that this in effect supplied the user with *de facto* ownership of the position.[494]

The approach of the ITU towards the allocation of the frequency spectrum, and as a consequence slots in GEO, has been described as operating 'closer to an economic *market* then a political *community*'.[495] Such an absence of community is reflected in the way in which orbital slots and the frequency spectrum are allocated, that is on a 'first come first served' basis, wherein a state requests a slot which is then assigned to it, subject to technical approval.[496]

It is notable that until recently the ITU provided licences to operate satellites in orbital slots without payment; states merely made a registration in order to occupy a place in GEO, they did not have to pay to utilise it. This free access to a resource provides operators with enormous benefits. The business associated with global telecommunications was estimated to be in the region of $100billion in 2000.[497] Such freedom of access contrasts starkly with the auctions which have been held in various states selling the right to use the frequency spectrum for the third generation of mobile phones. In the UK alone the government raised £22billion selling such licences.[498] Similarly, the senior Republican, and former US Presidential candidate, Bob Dole, was quoted as saying, '[t]he bottom line is that

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[494] Abdurrasyid, *op. cit.*, p. 134.
[495] Emphasis in original, Arnopoulos (1983), *op. cit.*, p. 295.
[496] Vogler, *op. cit.*, p. 118.
[497] Alain Dupas; 'Commercial Led Option' in Moltz (ed.), *op. cit.*, p. 58.
[498] 'UK Mobile Phone Auction Nets Billions' *BBC News* (27th April 2000).
< http://news.bbc.co.uk/1/hi/business/727831.stm >.
The government's 'Radiocommunications Agency' website details the auction process is available at:
< www.spectrumauctions.gov.uk >.
The press release covering the five winning bids is located at:
< www.spectrumauctions.gov.uk/press/200427.htm >.

the [broadcast] spectrum is just as much a national resource as our national forests. That means it belongs to every American equally. No more, no less.'[499]

The right to economically exploit the frequency spectrum within the state results in corporations having to pay vast sums of money, whereas the right to use the frequency spectrum, outside of the nation state, is not sold at any significant price. Payments made certainly do not reflect the revenues generated. Most importantly there is an expectation and acceptance that fees have to be paid in order to gain a licence within states, but without states there appears to be the antithesis: an expectation that resources may be used without significant financial restriction. An argument exists that the assumption that resources should be free to use results in a lack of appreciation of the importance of protecting such resources. This is especially so if those exploiting the resource are private corporations which are inclined towards considering business cycles which may be conducive to over exploitation.

It has become a universally accepted international norm that positions in GEO cannot be occupied without licensing from the ITU. This not only applies to government operations but to commercial satellites as well. However, in both instances, the request is always made through the national administrations, as such they remain the 'gate-keepers' for access to orbit. The ITU is responsible for distributing the technical information concerning the role of the satellite to all member states, who then have an opportunity to comment upon any potential difficulties with their existing programmes. Should difficulties be identified, the ITU provides formal mechanisms through which they can be addressed; the national administrations work multi-laterally to resolve such problems, which often requires adjustment of technical parameters, such that problems of interference are removed. Once technical consensus has been reached the orbital slot is allocated.[500]

Countries with active space programmes and those without have had long standing differences concerning the ITU. The differing perspectives focus upon whether GEO allocations should be made upon *a priori* planning or *a posteriori* claims. This debate produces two rival positions: that slots in GEO should be reserved for future usage by those who currently do not use them, but who may require them in future or that usage should be

[499] Barnes, *op. cit.*, pp. 38.
[500] *Paper Tigers*, *op. cit.*.

founded upon existing needs which reflect past usage. At the 1985 World Administrative Radio Conference (WARC), when the issue was perceived as becoming pressing due to the increased usage of GEO satellites, a compromise position was adopted: developing countries were guaranteed the right to use GEO slots when they required them.[501]

Thus, although near Earth space is legally an open Common, when considering the deployment of satellites, a process of governance exists. It does not have powers of enforcement, however it is characterised by a large degree of cooperation between states, not least as they multilaterally negotiate the difficulties in the technical specifications of satellite systems. There is a strong incentive for states to cooperate in this regime: if two satellites attempt to occupy the same GEO position, or frequency, the possibility of collision or electromagnetic interference would be equally harmful to both parties. Therefore, all states are vulnerable to the consequences of a lack of regulation and have shared incentives to cooperate. Moreover, states with many satellite resources consequentially are more exposed to the possibility of damage.

The ITU has provided a stable mechanism through which the usage of GEO has been managed. However, it is important to consider that it has done so against a favourable background. It has not had to face a situation of excess demand. Presently it has been responsible for managing the resource; it has not had to make decisions concerning allocation. Were it to face such a problem then the regime would be extremely thoroughly tested.

Paper Satellites

The ITU regime is not without difficulties, most notably those associated with 'paper satellites'. In 1985 there were 24 satellites providing telecommunications services, by 2002, due to global demand, there were an estimated 150. Meanwhile, the process of allocating an orbital slot to a satellite by the ITU is technically complex and lengthy. As a consequence of these twin factors states have adopted the practice of 'over filing', whereby orbital positions and frequency bands are claimed by states which do not actually need them. The allocations are then by default 'reserved' for possible future usage, or re-sale to other

[501] Cees J. Hamelink; *The Politics of World Communication* (London: Saga Publications, 1994), pp. 77-79 & 87-89.

operators at a later date. As the ITU did not originally charge member states for the coordination of satellite positions, and there was no penalty for not utilising an allocated slot, it is perhaps not surprising that states have adopted this practice: indeed it reflects the rationality of Hardin's remorseless tragedy. These allocated, but unused, orbital slots are known as 'paper satellites'.[502]

The problem of paper satellites is reflected in the quarterly reports which the ITU produces, which detail the number of entries it has for satellites.[503] There are some instances when a satellite is entered twice in the account; over and above this there is still a large discrepancy between the number produced and the actual number of satellites in orbit, caused by paper satellites.[504] The ITU recognises this issue as one of the most difficult problems that it is facing. Although there is a consensus concerning the scale and urgency of the problem, there is disagreement concerning how it should best be resolved.

Notably, within the USA, the Federal Communications Commission limits the effect which paper satellites can have upon commercial operators. A request for a GEO slot is required in its 'orbital debris mitigation statement' to account for any objects which the satellites may have a risk of collision with. However, it is only necessary to consider ITU filings which are operational, or progressing towards launch; it does not require systems which are only filed with the ITU (paper satellites) to be considered.[505]

The payment of fees presents a possible solution to this problem. However the proposal was long resisted by countries with many satellites, which have argued that it would be restrictive upon industry. Some developing states have also disputed the validity of fees, arguing that it would be a restriction upon free and open access to orbit. However, the 1998 Minneapolis Plenipotentiary Conference agreed to introduce a new fees system for new satellite applications made to the ITU, this was intended to be a form of remedial action

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[502] *Paper Tigers*, *op. cit.*.
[503] The ITU quarterly reports are available at:
< www.itu.int/ITU-R/space/snl/ >.
The most recent report is located at:
< www.itu.int/ITU-R/space/snl/download/pdf/SNL_full.pdf >.
[504] Perek, *op. cit.*, pp. 223-225.
[505] Kensinger *et al* in D. Dansey (ed.), *op. cit.*, p. 572.

addressing paper satellites. Yet, the new fees are tiny in comparison to the cost of developing and launching a satellite, as such their effectiveness remains to be proved.[506]

The problem of paper satellites reveals an inherent weakness within the ITU system for allocating satellite positions. The ITU exists as a means of coordinating the activities of interested parties. However, should a party wish to defect from that cooperation, as Hardin's parable suggests they inevitably will, then the ITU does not have enforcement mechanisms to adequately control this. In this instance, the act of defection is not such that it will destroy the resource, rather it is claiming more of the resource than the individual actor requires at present. In part it can be seen that the ITU's process for allocating GEO positions passively encourages the overfilling of claims for GEO slots. Because the process is time consuming and rigorous, it is in the interests of states to make more claims than are necessary, thus creating paper satellites, in order to have the slots readily available should they need them in the future. Paper satellites demonstrate the weakness inherent in the existing system. The CHM presents a radical alternative of not only an equal right of access to the resource of GEO, as is presently governed by the ITU, but also an equitable distribution of the income created by the usage of GEO.[507] However, such egalitarianism may not present the most practical of options. Wealthy, developed countries have argued against orbital slots being assigned to less developed countries, for they lack the required technology to use them, therefore the resource would be wasted.[508]

Private Property and the Global Commons

As has been demonstrated the global Commons are unique areas, a consequence of this uniqueness is that the existence of private property within them is unclear. A possession taken into a Common does not have its ownership altered: a ship on the high seas remains the property of its owners and an object in space remains the property of the state that launched it. The lack of clarity relates to the appropriation of resources which are found in the Commons, this is a matter which remains open to debate and controversy.

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[506] *Paper Tigers*, *op. cit.*.
[507] Paris Arnopoulos; 'The International Politics of the Orbit-Spectrum Issue' *Annals of Air And Space Law* Vol. VII (1982), p. 234.
[508] *Ibid.* p. 219.

Modern nation states are fundamentally intertwined with the existence of private property. Bentham and Mill viewed the protection of property and goods to be one of the four economic objectives of government, and the most critical.[509] The purpose of this section is to examine the applicability, and possibility, of property rights outside of the nation state, in the global Commons.

There are two polemic positions which exist in relation to private property. Marx believed that the state had already taken a side in class conflict, and that class divisions arose because of the existence of private property. Further Engels argued that gender discrimination commenced with the emergence of private property, as before this time societies had been matriarchal.[510] However, the counter argument is that private property is natural and that its existence is to the general good of society. Therefore, with reference to the preservation of environmental resources, the belief is that private property rights would ensure that individuals would not over use communal resources.[511] This clearly reflects Hardin's critique of open Commons. What is undeniable from either position, is that property relations are crucial within societies.

Those who defend the utility of resources being owned communally argue that private property does not guarantee that a resource will be protected. David Feeny *et al* consider the example of an individual owning private property rights over a slow growing trees or whales; it would be economically irrational to bring the species to full maturity. Therefore, the owner of private rights over whales would be presented with the most profitable course of action, that is to maximise benefit in the present, for the yield from sustainable harvesting the resource over a long time frame would not be economically practical. Therefore, the economically rational course of action would result in the extinction of the species.[512] Yet, the actions would be economically rational, as owners would be behaving as 'short term, profit-maximising actors who possess complete information.'[513]

Such reasoning can be easily linked to debris, as the worst case scenario of large sections of Earth orbit becoming too hazardous to use is not projected to occur for some

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[509] David Held; *Models of Democracy* 2nd edition (Cambridge: Polity, 1996), p. 96.
[510] *Ibid.* pp. 122-130.
[511] Pepper, *op. cit.*, p. 57.
[512] Feeny *et al, op. cit.*, p. 9.
[513] Ostrom in Burger *et al* (eds.), p. 18.

time. Therefore, within a business cycle it may be considered that it is in the economic interest of a private actor, with property rights to a section of near Earth space, not to concern themselves with long term protection of the resource. However, the potential long term revenues to be generated through the usage of Earth orbit suggest that the long term protection of the resource would be in the economic interests of an actor owing private property rights.

Marx was critical of the state for having been partial in class conflict by taking a role in property relations. Paul Sweezy explicitly argues that as societies develop one class gains a dominant position, and then creates a state structure which will enforce property relations which are in its interests.[514] Although Marxism's critics would, undoubtedly, question the value judgement made here, it could not be doubted that 'the state guarantees property relations, which is a crucial aspect of the power structure.'[515] The importance of the state in preserving property rights is such that between 1992 and 1996, the United States placed conditions upon the government of Uganda relating to property rights. In order for aid to be released, a requirement was that the security of property should be guaranteed.[516] Meanwhile, as arguments are made concerning capital becoming freed from the state due to globalisation, multinational companies still depend upon the state to provide stability of property rights.[517] Thus in the initial consideration of property, it is important to ascertain that it is inherently linked to the state, and that private property is a phenomenon which occurs within the defined borders of a Westphalian state; for the state provides stability and protection of property relations.

The global Commons, including space, exist outside of the nation state, therefore 'normal' property rights as protected by the state cannot exist there. Normal property rights require a sovereign authority to act as guarantor of contract, and as perceived legitimate authority, within a given territory.[518] Thus, the question of whether private property rights

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[514] Paul M. Sweezy; *The Theory of Capitalist Development* (New York: Monthly Review Press, 1942), pp. 242-243.
[515] Graeme Gill; *The Nature and Development of the Modern State* (Basingstoke: Palgrave, 2003), p. 10.
[516] N. Kasfir, J. Geist, T. West, M. Brown and C. Sabbatini; *Democracy and Governance Assessment* (Kampala, Uganda, 1996), pp. 25-27.
[517] Gill, *op. cit.*, p. 248.
[518] Pop, *op. cit.*, p. 277.

can exist in the global Commons, and if so who is responsible for enforcing them, is fundamentally international in character.

Further, if the argument is to be made that private property should be introduced to space, then a question arises as to how private property rights can be introduced to a Commons where they did not previously exist. Although citizens in modern states are surrounded by private property, the concept itself has clouded origins and is subject to much debate. It is the most curious of social phenomena, for although it is ubiquitous, its exact meaning remains undefined,[519] whilst simultaneously being often used in conversation, seemingly, without any difficulty in understanding.[520] The origins of property are shrouded in mystery; academic literature does not provide a satisfactory account of property's history.[521] Proudhon notes, concerning property's problematic nature, '[i]f property is a natural, absolute, imprescriptive, and inalienable right, why, in all ages, has there been so much speculation as to its origin - for this is one of its distinguishing characteristics.'[522]

However, its long history domestically placates the troublesome nature of this situation; property may be artificial, but it has the appearance of being natural. An individual can buy a piece of land, the person selling that piece of land can prove that they bought it legitimately, and the ownership can most probably be traced back through several centuries. The presence of a long history silences questions concerning legitimacy, as the point of origin is lost in the past. However, the global Commons present a completely different situation. To introduce private property there would require private property to emerge out of nothingness. If a person were to attempt to 'buy' a piece of land on the Moon, or the permanent right of use for a slot in GEO, the question arises: whom should they pay? How can an object be bought, when the original ownership is not known?[523]

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[519] Property has to be considered as being geographically and temporally specific. To a nomadic society in the past the concept of 'owning' land would no doubt have been very difficult to comprehend. They may have had a conceptualisation ownership concerning animals but this would not have necessarily have translated into considering land 'ownable'.

[520] J.W. Harris; *Property and Justice* (Oxford: Clarendon Press, 1996), pp. 6-7.

[521] L.T. Hobhouse; 'The Historical Evolution of Property, In Fact and In Idea' in Charles Gore (ed.); *Property* (London: MacMillan, 1915), pp. 3-5.

[522] Proudhon, *op. cit.*, p. 52.

[523] Despite the ethical and legal questions which surround any claim to ownership of non-terrestrial resources, it is possible to 'purchase' lunar plots on the internet. The claim dates back to 1980 when Dennis M. Hope sought to exploit a 'loop-hole' in the *OST*; the treaty prevents states claiming ownership, but does not specifically exclude individuals, therefore in American domestic law he claimed ownership of the Moon. Mr Hope is currently President of the Galactic Government, or as he

Bogota Declaration

There has been one significant attempt to introduce private property relations into space, specifically geostationary orbit, through the *Bogota Declaration*. Part of the origin of that document was the lack of differentiation between air space and outer space. The need, in principle, to define the difference has long been recognised by states.[524] However, there are practical difficulties associated with achieving an agree definition. An obvious solution would be that air space finishes at the point where the atmosphere ceases. However the atmosphere does not come to a simple stop, rather it slowly fades away; traces of it are still present in GEO, 36,000km from the surface of the Earth. The gradual process of the atmosphere fading is rather akin to the colours on a rainbow. From a distance it is obvious that there are distinct colours present but upon closer examination one colour does not simply stop and another start, rather they fade into one another. Similarly there is not a point where the bubble of the atmosphere stops and the vacuum of space commences, rather they blend into one another.

A solution to this question was proposed by the International Law Association, in 1968, which argued that the limit of outer space to be the lowest altitude at which a satellite could achieve orbit on 27th January 1967, the date on which the *OST* was open for signature.[525] This would have the advantage of being a clearly physically defined region, but it would still be arbitrary, as it is a reflection upon the technology available in 1967, rather than being an altitude with distinctive physical attributes. Other proposals have included an altitude based upon 'gravitational effect...the van Karman line,[526] the limit of flight, the limit or end of the atmosphere, arbitrary heights like 100km from the equator or one-hundredth of the Earth's radius (64km) etc.'[527] In short, there is no simple answer to this complex legal problem. However, to a large extent, at present it is not a problem, as the

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is also known 'The Head Cheese' < www.lunarembassy.com >. Although what Mr Hope is doing may not make sense legally, it has proven to be profitable, sales of his lunar plots are reported to be worth £5million. 'How to set up a moon base' *BBC News* (26th August 2005) < http://news.bbc.co.uk/1/hi/magazine/4177064.stm >.

[524] D. Goedhuis; 'Some Observations on the Problem of the Definition and/or the delimitation of Outer Space' *Annals of Air and Space Law* Vol. II (1977), p. 307.

[525] *Ibid.* p. 302.

[526] The van Karman line is at an altitude of 100km above sea level. From this point upwards the existence of the Earth's atmosphere is negligible for aeronautical purposes.

[527] Ram S. Jakhu; 'The Legal Status of the Geostationary Orbit' *Annals of Air and Space Law* Vol. VII (1982), pp. 338-339.

undefined area between air space and outer space is not utilised, other than as a means of passage to outer space.

The *Bogota Declaration* (1976) was founded upon this uncertainty. It was an effort by eight equatorial countries to claim ownership of geostationary orbit.[528] It was based upon the rather spurious claim that GEO is a territorial extension of these states and therefore not covered by the *OST*.[529] This argument drew upon the 'scientific' position that it was gravity originating in their territories which created GEO. The notion is factually incorrect, as it is the gravity of the planet as a whole, which contributes to the stable status of GEO.[530] The claim was not taken seriously by non-equatorial states, however it is not easy to dismiss immediately because no clear delimitation exists between air space and outer space.[531] The equatorial states built upon this lack of clarity, arguing that GEO was a phenomenon created by the Earth, therefore it was should not be considered as part of 'outer space'.[532] The signatories to the *Bogota Declaration* were also erroneous in this regard, as the presence of the Sun is also required in order to create the gravitational balance of GEO. However, their argument did highlight the vagueness of Article II of the *OST*. Despite the lack of legal clarity which the *Bogota Declaration* sought to exploit, it revealed a general consensus that national appropriation was not an aspect of the dialogue concerning Earth orbit. Therefore near Earth space was not to be considered *res nullius*.

When considering the governance of near Earth space, one of largest flaws in the *Bogota Declaration* highlights a necessary condition for a successful regime. The equatorial states provided no explanation as to how they were proposing to exercise authority in geostationary orbit.[533] A clear argument concerning power politics emerges; whether the equatorial states were legally justified in their efforts, they did not have the military capacity to enforce their claim. Practically it is very difficult to conceptualise how authority could be expressed in orbit. The United States could act as a leviathan, however, as discussed

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[528] They were Brazil, Colombia, Congo, Ecuador, Indonesia, Kenya, Uganda and Zaire, Carl Q. Christol; *The Modern International Law of Outer Space* (Oxford: Pergamon Press, 1982), p. 465. The Bogota Declaration was preceded, in October 1975, by the Colombian representative to the United Nations arguing for territorial control over GEO, above the equatorial states, Gorbiel, *op. cit.*, p. 172.
[529] Vogler, *op. cit.*, p. 101.
[530] Buck, *op. cit.*, p. 159.
[531] Cheng, *op. cit.*, p. 455.
[532] Goedhuis (1978), *op. cit.*, pp. 289-290.
[533] *Ibid.* p. 292.

elsewhere, the use of weapons in space, is currently not possible, and neither is it practical. Therefore, as the difficulties in the *Bogota Declaration* showed, any effective system of governance has by necessity, to be cooperative.

The *Bogota Declaration* was never observed by non-equatorial states. And in 2001 UNCOPUOS expressed its agreed opinion that GEO was part of outer space, this was intended to end the long running debate which had been given voice by the *Bogota Declaration.* The agreed opinion of UNCOPUOS is a weak legal instrument, if indeed it is a legal instrument,[534] yet it revealed that the principle organ of space law did not consider the claims of the *Bogota Declaration* to be meaningful. This has, most probably, concluded the issue from a practical perspective, however it still reveals important aspects of space law and its development.

What is most interesting about the response to the *Bogota Declaration* is that it is potentially dismissing not only one claim to ownership of GEO, but also the idea that GEO can be owned. The clear consensus of states is that the equatorial states could not own GEO because it was part of outer space, therefore it was subject to the provisions of the *OST* and consequently not subject to appropriation. Fundamentally, this leads back to the question of whether something that is not subject to national appropriation can be owned in any other capacity. If the notion is accepted that a sovereign authority is required in order to grant stable, legal and practical private property rights, then the idea of introducing private property into space is very difficult to apply.

Present Legal Status Concerning Property in Space

The inter-relationship between property and sovereignty is complex. In order for stable private property to exist in space, it would be necessary for some form of sovereignty to ensure it. However, there are two important initial considerations which need to be made. Firstly, limited sovereignty does exist in space, as a space craft remains under the sovereign control of a state. As such, it carries sovereignty in a 'bubble', just as a ship on the High Seas remains under sovereign control. This in founded upon the second consideration, which is contained within Article VIII of the *OST*, that a state maintains 'jurisdiction and control' of any object or person which it launches into space.

[534] Perek in Dansey (ed.), *op. cit.*, p. 587.

The questions which remain, with reference to private property and space, are largely concerned with those resources which already exist in space and are finite in their capacity. In effect, this refers to the resources of the celestial bodies, satellite positions in GEO and the carrying capacity of Earth orbit for debris. The space treaties do not provide detailed explanation of how these issues are to be resolved.

A simple means through which private property could be introduced into the commons of space, would be for a state to make a sovereign claim, and then distribute the property rights as it wishes. Manfred Lachs, chaired the legal sub-committee of UNCOPUOS during the period when the *OST* was created. He considers there to be three means by which a claim to sovereignty could be made: discovery, contiguity and an area of space bordering upon air-space. It is his opinion that none of these could be considered as an adequate basis for making a claim to sovereignty in space.[535] Therefore, if this analysis is accepted, the 'normal' means through which private property is created and sustained cannot be applied. This emphasises the fact that a form of property relations are required to govern space which are different from what has previously existed.

The most useful interpretation of the *OST*, concerning rights of use, is that it establishes a problem. It prohibits appropriation of extra-terrestrial resources, but it does not explain under what terms they can be commercially used; although, it does allow them to be used for scientific purposes. This is not a great problem when considering resources which can be considered as part of an inexhaustible Common, or at least a resource which exists in sufficient quantity that there is no scarcity of supply. The majority of near Earth space, most especially LEO, can be considered to exist within these parameters. However, GEO presents a different problem, as it is a finite resource. The ITU has averted discussions concerning rights of appropriation, as technically it is only responsible for the organisation of the radio frequency spectrum. Further, at present there is not a sufficiently high demand for satellite positions in GEO for it to be considered as a truly finite (albeit renewable) resource.

However, the issue of off planet property rights remains unclear, most especially when exhaustible resources should be appropriated for commercial reasons. The CHM, as

[535] Carol Q. Christol; 'Article 2 of the 1967 Principles Treaty Revisited' *Annals of Air and Space Law* Vol. IX (1984), p. 239.

contained within *The Moon Agreement* offers a solution to the question which the *OST* poses, specifically that extra-terrestrial resources should be owned collectively. Indeed, Glenn Harlan Reynolds argues that the principle purpose of *The Moon Agreement* was to resolve the status of property rights.[536] The difficulty arises in the means through which it seeks to achieve this. Following the collapse of the Soviet Union, international politics has been heavily focused towards a liberal free market consensus, to the extent that there is very little practical dissent from its logic. To those who advocate the inherent supremacy of free market economics, the CHM has troubling overtones associated with inefficient, public sector industries, or indeed communism. From this perspective the route towards successful development of space resources, for the general good of humanity, is paved with private capital. The argument being simple: it is only private enterprise which can effectively meet the requirements of humanity (as expressed in the market place), therefore it is necessary to get private capital active in space as quickly as possible.

One of the strongest arguments in favour of the introduction of private property, and private enterprise, into space activities was proposed by Eligar Sadeh *et al.* Their argument is that the introduction of private enterprise will result in the optimal usage of non-terrestrial resources. Therefore, the *OST* had created 'a regime that is counter to the goal of encouraging the development of outer space.'[537] Their belief is that in order to rectify this situation governments should look to promote Public Private Partnerships (PPP). Under this model, governments would take actions in order to lessen risk, and secure return on investment, such that private sector operators will be willing to invest in space projects.[538]

The model of PPP is viewed as being preferable to the two other possibilities, that Sadeh *et al* perceive. The first of these is the American frontier model, in which there is little regulation, and consequently a high risk environment. The other being an imperial model, as historically occurred and was characterised by wealth being created by 'colonies, war, sweat shops and political control'. This is considered to also create a high risk political environment.[539]

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[536] Glenn Harlan Reynolds; 'The Moon Treaty: Prospects for the future' *Space Policy* Vol. 11 (1995), p. 115.
[537] Sadeh *et al*, *op. cit.*, p. 270.
[538] *Ibid.* pp. 267-268.
[539] *Ibid.* p. 274.

What this analysis ignores is the possibilities of development which are not slavishly devoted to free market thinking. That possibility is founded upon communal ownership, and is best given form in the Common Heritage of Mankind. Further, CHM is compatible with the existence of private enterprise, as is demonstrated by the International Seabed Authority, as it was modified by the *Implementation Agreement*. The ownership of the resource remains common whilst private sector actors are able to tender for the right to exploit that resource. This form of PPP is superior in two forms. Firstly, it provides a more clear explanation of how ownership exists, where it previously appeared not to. Secondly, it does not require the substantial re-writing of space law and the consequent political difficulties.

Sadeh *et al* observe the importance of events which have occurred in the US domestically, for example the US Congress Commercial Space Act 1998 called for NASA, and other agencies, to 'acquire space science and Earth science data from commercial providers.'[540] Further, the 'Deep Seabed Hard Mineral Resources Act' is seen a potential model for the ownership of extraterrestrial resources, as it would provide stability of ownership and protect return on investment.[541] The first instance is largely a matter of the United States as an individual state; internally it can opt for whatever balance of public and private it wishes. However, the 'Deep Seabed Hard Mineral Resources Act' is a curious potential model. The purpose of the Act is to create the situation where a US firm cannot encroach upon the investment made by another US firm. This fails to understand that extra-terrestrial resources can be exploited by actors from another country and domestic regulation cannot create stability of ownership in this respect. Further, the US government does not have the ability to create real rights of property concerning extra-terrestrial resources, as they are already prohibited by the *OST* which the US is party to. As von der Dunk *et al* observe, 'once a rule at the international level applies to a particular state, such a rule, legally speaking, cannot be simply set aside or ignored at the national level.'[542]

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[540] *Ibid.* p. 269.
[541] *Ibid.* pp. 268-269.
[542] F.G. von der Dunk, E. Back-Impallomeni, S.Hobe and R.M. Ramirez de Arellano; 'Surreal estate: addressing the issue of 'Immovable Property Rights on the Moon' *Space Policy* Vol. 20 (2004), p. 151.

The present situation is the extra-terrestrial resources are not 'real estate under the present legal situation' in order to make them such a regime needs to be created.[543] It is simply not possible for this to be created by one state in isolation. Removal of the *Moon Agreement* is not a sufficient condition for space development.[544] If it is ignored then the question of how property can exist without a sovereign authority still remains.

The Problem of Property in Space And Debris

As this chapter and the previous one have demonstrated the issue of rights of use in space are ill-defined. The present situation in which rights of use are unclear should be a situation in which the tragedy of Hardin is likely to occur. The lack of regulation should be conducive to actors behaving in an uncoordinated manner and destructive manner. There are three broad means which could be adopted concerning space and property.

Firstly, a system of private property could be adopted. As has been shown this would be extremely difficult to implement both practically and politically. Concerning debris it would at best be neutral concerning efforts to ameliorate the problem. The number of actors who with authority would increase and there would be less means of regulating them. However, if they controlled a large part of the resources of space they would be responsible for their long term preservation, which could encourage protection. The danger is that private actors would be more concerned with short term business cycles and therefore not inclined to bare the cost of actions which minimise the production of debris.

The second option is for the implementation of the CHM or similar principles. Of the three options it is this which will be the most effective in addressing the debris problem. A fundamental aspect of the CHM is that resources should be used in a manner which acknowledges the right of future generations to utilise it. Debris poses a threat to the access of future generations; therefore the CHM presents an ideal mechanism through which to protect the resource. However, the CHM very unlikely to be implemented due opposition from Western states.

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[543] *Ibid.* p. 156.
[544] Reynolds (1995), *op. cit.*, p. 117.

The third possibility would be a hybrid of the other two options. It would be required to create the stability of ownership which the CHM does, but it would almost certainly not contain the social justice elements. At present the ITU presents the closest example of such a structure. As it is managerial in nature is presents a means through which actors can have stable relations with each other but it does not attempt to govern other than in the minimal manner which states have agreed that it will. Such an approach could be conducive the debris problem being effectively address, if addressing the debris problem were part of its mandate.

It is of interest that the debris problem has not become part of the debate concerning rights of use, as the following chapter will reveal it has largely been addressed in terms of a technical problem. However, although the two issues have not been aligned, the issue of rights of use has large implications for that of debris. A strong and stable rights of use regime should create the situation in which debris can be effectively addressed. As Hardin wrote a situation characterised by an absence of regulation has the capacity for a tragic outcome. The present situation concerning rights of use can certainly be considered as one which does not provide a framework which would be expected to aid the resolution of a collective action problem such as debris.

Conclusions

As has been observed, there is a need to create a stable legal regime in order to allow for the resources located in the Commons of space to be exploited effectively. The most significant question which arises, as it does with all resources, is how to strike a balance between short term economically efficient exploitation of the resource and its long term protection.

Debris presents the biggest problem concerning rights of use and protection. Any usage of Earth orbit will result in the production of some debris. The balance which needs to be achieved is how much it should be utilised, in the present, whilst protection it as a resource for future generations.

The idea of 'the invisible hand' concerning free market economics would suggest the individuals making single rational actions will produce a cumulatively rational outcome.

However, this suggestion is opposed by Hardin's notion that individually rational actions result in a collectively irrational outcome.

There is no reason to assume that the introduction of as much private property as possible will result in the protection of near Earth space as a resource. As discussed above, the preservation of environmental resources often require actions which exist over a longer term than the ordinary business cycle. The optimal route to achieve the preservation of the resource if for it is be governed by a regime which has the protection of the resource as one of its primary objectives. Debris has shown that space is not merely vast in size. Rather parts of it, such as Earth orbit, are incredibly fragile and can only be utilised in a fashion which is sensitive to their fragility.

The present status of space, and its resources concerning rights of use is far from being resolved. By prohibiting national appropriation the *Outer Space Treaty* created a legal problem which has yet to be resolved in terms of finite resources being exploited.

Currently, the strongest regulation that exists in Earth orbit concerns the usage of geostationary orbit, and it is governed by the International Telecommunications Union. One of the most interesting features of this regime is that it is holistic; all actors appear to be willing to work within its structures. In part the success of the ITU can be attributed to that fact that it does not have large objectives. It does not attempt to govern near Earth space as a whole, rather it coordinates the usage of geostationary orbit. As all users of GEO require it to be used in an orderly fashion they all have an interest in ensuring that the ITU is successful. Further, at present the demand for usage of GEO slots has not risen to a sufficiently high level to create conflict concerning how those rights are distributed.

The presence of 'paper satellites' reveals the weakness of the ITU system, as the deliberate 'over filing' exploits the lack of enforcement mechanisms available to the ITU. It further suggests that in its present form the ITU does not have the capacity to enforce standards which would result in the preservation of near Earth space. However, as with its role in creating orderly means through which GEO can be utilised, it is possible that it could play a prominent role in 'coordinating' rather than 'enforcing' standards.

The biggest difficulty surrounding rights of use is the question of private property. Space law does not adequately define how finite space resources can be economically exploited. Rather, the *OST* creates a question, by outlawing appropriation, but does not then answer it. One of the consequences of this is a lack of legal certainty. This would almost certainly mean that if any actor attempted to utilise the finite resource governed by the *OST* they would face political and legal confrontations. The *Moon Agreement* attempts to resolve this question through introducing the Common Heritage of Mankind. Although this has not received much support from states, it achieves the essential condition of stability. Any other proposal would also have to find a means of achieving this. Further, it would have to answer the politically divisive question of how property rights appear out of nothingness. Inevitably there would be those who would argue, as Bob Dole did with reference to the domestic broadcast spectrum, that there are resources which are communally owned.

The response to the *Bogota Declaration* clearly reveals that the international consensus will not accept a group of equatorial states making a claim to ownership over geostationary orbit. But it can also be seen to show the difficulties associated with claims to exclusive ownership. The *Bogota Declaration* had three significant flaws: firstly its scientific basis was notably weak, secondly the states involved had no means of enforcing their claim to ownership and thirdly it was attempting to create exclusive ownership over that which had previously been seen as communal. Any other attempt to create property rights in space will also have to address these problems.

In terms of debris the aspect of rights of use which is of most importance, is the issue of preservation: how is the resource to be used, such that it will not be destroyed in the process? Hardin's argument is that privatisation will result in usage and responsibility being located with the same actors and therefore they will seek to preserve the resource for prosperity. However, as has been previously discussed it is not practical for separate parts of Earth orbit to be privatised. Yet it would appear that the worst possible scenario would be for a total lack of regulation, wherein damage could occur without reproach. At present there is some legal restriction upon rights of use, primarily in the form that states are responsible for space activities which have been launched from their territory. Further, states are regulated to the extent that their actions should not interfere with other states. Despite these restrictions, the strongest present motivation for near Earth space to be utilised in a manner which is not harmful is enlightened self interest. If states wish to continue using space in the

future, it is necessary to preserve it in the present, but there is no legal mechanism to ensure this, primarily because the present arrangements make no attempting to address the issue of preservation.

The future form that regulation of rights of use in space will take is unclear. The issue at hand is how to create a regime which is stable, will preserve the resource for the future, and will be recognised as being sufficiently equitable that it will not collapse into political chaos. But as Linda Billings states the present inclination to make the usage of outer space 'Western' is 'akin to [the United States'] push to make the Middle East 'democratic', in that it does not address in any depth what sort of legal, ethical and social structures and values will be appropriate to these unfamiliar cultural environments.'[545]

[545] Billings, *op. cit.*, p. 254.

Chapter Seven:
The Active Response to Debris

Introduction

The previous chapters of this thesis have established the political and legal environment within which the debris problem exists. It has been seen that the problem exists within part of the global Commons, therefore it is not subject to a strong system of regulation. This creates an environment which is not inherent conducive to cooperation occurring. The evidence reveals that the response to the problem occurs against a deeply problematic background; most especially because space law does not offer a clear remedial course of actions and as the right of use in near Earth space are not resolved.

Having established the background against which the debris problem exists this chapter will examine the response that has occurred. In doing so it will also reflect upon the manner in which theoretical constructs can be used in order to provide explanation of the events which are observed.

There are two parts to the chapter. The first will consider the international response to debris. This comprises the institutions which are already active concerning near Earth space and the Inter-Agency Debris Co-ordination Committee (IADC), an institution which has been created to directly respond to the problem. The second section will explain how the active response can be explained in terms of governance and the epistemic community. In doing so it will reveal how international relations theory has moved away from considering the realm to be dominated by states which are unitary rational actors. It will consider the idea of governance, and explore its explanatory ability with reference to the protection of the terrestrial environment. Further, the concept of trans-boundary epistemic communities will be assessed. It will reveal that there is an intimate connection between an epistemic community and the institutional response to debris.

Part One: Practice

This section will firstly address the institutions that have previously been discussed in this thesis, in order to reflect upon their responses to the debris problem. It will then considered the Inter-Agency Debris Co-ordination Committee (IADC), which has been specifically created in order to address the problem of debris.

The existing domestic institutions

This section will examine the institutions which regulate activities in the UK and the USA. Together they are considered to present typical instances of what occurs in domestic regulation. The available information concerning Western countries reveals that they also have institutions which fulfil similar roles. There is little information available concerning other states with active space programmes but they too will require domestic regulation.

In June 2004 the Federal Communication Commission, of the United States, adopted a comprehensive set of rules which placed requirements upon American registered satellite operators concerning the disposal of dead satellites. It was established because of the perception that the presence of debris could 'affect the cost, reliability, continuity, and safety of satellite operations, and of the services they provide to the public'.[546] Therefore, the terms upon which the FCC granted licences permitted, and required, it to enforce debris mitigation standards.

The standards which the FCC has adopted provide specific regulations for satellites in GEO, those in other orbits are controlled on a case-by-case basis,[547] reflecting the more fragile and important nature of GEO. The intervention by the FCC was founded upon the belief that economic incentives alone were insufficient to result in the private sector disposing of satellites in a fashion that would protect GEO.[548] This course of action is important, as it recognises the need for political governance in near Earth space. In so doing, it inherently rejects an economically liberal approach, that unhindered markets will ultimately achieve the common good. It is founded upon the belief that private corporations,

[546] Kensinger *et al* in Dansey (ed.), *op. cit.*, pp. 571-572.
[547] *Ibid.* pp. 573-574.
[548] *Ibid.* p. 573.

as actors, have a tendency to follow a path towards the tragedy of the Commons, as they will act with regard to only short term interests. Therefore, domestically within the United States some justification for Hardin's Rational Choice assumptions can be seen; a federal agency has acted as a leviathan in order to prevent individuals from acting in a manner which is contrary to their own (and collective) long term interests.

It is notable that the reason for the FCC's decision to intervene is partially because the 'planned business activities' of operators exist on a much shorter time frame than the potential effects of debris in GEO.[549] Although there is unlikely to be a strong link concerning the exchange of ideas and values, these actions reflect the conceptualisations which underpin the notion of the Common Heritage of Mankind, specifically that resources need to be actively protected in the present for the benefit of future generations as actions have long term repercussions upon resources which will be felt when the current agents are no longer active.

As discussed in the second chapter, with reference to technical aspects, the co-location of satellites provides a means by which the finite resources of GEO can be made available to more users. The FCC permits co-location however operators which wish to do so are required to make an assessment of the potential dangers, especially concerning collision, to other satellites in that slot.[550] Should an operator employ this practice, or any other, they do so at their own risk: being reviewed by the FCC and receiving a licence does not change the liability which an operating company bears for its satellites.[551] As responsibility is not removed from operators they are kept within the governance framework.

The FCC is not alone in applying standards concerning space policy within the USA. Most obviously in the public sector NASA sets standards for it own activities (under direction from the Federal Government). In 1988 the Reagan administration's National Space Policy required NASA's activities to be debris sensitive.[552] Meanwhile, in order to launch an object from US territory it is necessary to receive a licence from the Federal

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[549] *Ibid.* p. 573.
[550] *Ibid.* p. 572.
[551] *Ibid.* pp. 574-575.
[552] Johnson (a) in Dansey (ed.), *op. cit.*, p. 5

Aviation Authority (FAA).[553] Thus within one country the governance addressing debris is characterised by heterarchy.

The system of regulation in the United Kingdom is directed by the British National Space Centre (BNSC). The BNSC is required to ensure that all UK activities are compliant with the space treaties that the state is party to. As has been discussed these treaties do not address the issue of debris, however their broad principles are open to an interpretation which is applicable. With respect to this the UK administration has adopted a policy of requiring satellite operators to conduct their activities in a manner which limits the amount of debris produced; an interpretation of the requirements of international space law that an individual's activities should not impair those of another.[554]

The primary legal instrument which empowers the BNSC is the Outer Space Act (OSA). This Act prevents licences being granted for launches which would jeopardise 'the safety of persons or property', as permission would require 'the licensee to conduct his operations in such a way as to prevent the contamination of outer space'.[555] The OSA was written in the mid-80s at which time the full extent of the debris problem was not identified, however the Act is open to sufficient interpretation that it remains applicable. The provision of the Act that an operation should not result in 'physical interference' is interpreted as addressing the possibility of collisions with active satellites, whilst provisions against 'contamination' are used to require satellites operators to address end of mission disposal.[556]

The FCC in the USA and the usage of the Outer Space Act in the UK provide two examples of the form of regulation which applies to debris. The FCC governs communications technology and has addressed debris due to the threat it poses to domestic US telecommunication. The UK Outer Space Act has been used by the BNSC as a mean to form and support its broad space policy, part of which is to seek remedial action to the debris problem.

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[553] Davey and Taylor in Dansey (ed.), *op. cit.*, p. 566.
[554] See *The Outer Space Treaty* (1967), Article IX.
[555] Crowther *et al* in Dansey (ed.), *op. cit.*, p. 577.
[556] *Ibid.* p. 579.

International Institutions

This section will return to the international institutions which have already been identified as being active with reference to near Earth space. It will examine the response to debris by the International Academy of Astronautics, the International Standard Organisation, the United Nations Committee on the Peaceful Used of Outer Space (UNCOPUOS) and the International Telecommunications Union.

The International Academy of Astronautics has a specific committee addressing debris.[557] In 1992 the IAA circulated a paper entitled, 'A Position Paper on Orbital Debris', that called for internationally accepted debris controls and 'a forum to coordinated multilateral agreements, and other measures'[558] A year later it issued a position paper which called for various measures to be taken in order to mitigate the debris problem. These included raising dead satellites in GEO 300-400km above the GEO ring, the prohibition of deliberate break-ups in long lived orbits and the venting of fuel from rockets to prevent the risk of future explosions.[559]

The IAA is a forum in which experts are able to exchange knowledge. In so doing they contribute to the creation of an intellectual framework concerning the debris problem which has been a crucial development. To this effect the IAA had provided an agreed definition of debris.[560] The IAA also has contributed to the debates which have resulted in the international norms now collectively regarded as being established. Not only does the IAA interact informally, through its contribution to ongoing debates, but it also has a formal linkage to UNCOPUOS having observer status within the body.[561]

In 1993 the International Standards Organisation (ISO) established a Space Systems and Operations Sub-Committee.[562] The body has provided standards applicable to the general exploration of space, for example 'ISO 17666:2003, Space systems - Risk management', which is intended to provide internationally useful guidelines in general space

[557] Johnson (1998), *op. cit.*, p. 67.
[558] David S.F. Portree and Joseph P. Loftus; *Orbital Debris: A Chronology* (January 1999) NASA document NASA/TP-1999-208856, p. 83-85.
[559] UN Document A/AC.105/620, *op. cit.*, p. 6.
[560] Rex, *op. cit.*, p. 95.
[561] UN Document A/AC.105/620, *op. cit.*, p. 6.
[562] Davey and Taylor in Dansey (ed.), *op. cit.*, p. 569.

operations.[563] In May 2002 an ISO technical sub-committee[564] concluded that there was a requirement for a set of engineering design standards to enable effective implementation and verification of debris mitigation guidelines,[565] subsequently an Orbital Debris Coordination Working Group was created.[566] By April 2005, the ISO had agreed two standards projects concerning debris, and four Work Item Proposals (NWIP) were in active development.[567]

The standards that the ISO seeks to establish are intended to help mitigate the debris problem, founded upon international discussions and interagency agreements.[568] It has a working relationship with the International Academy of Astronautics and United Nations Committee on the Peaceful Uses of Outer Space; as such the ISO can be considered to be embedded into the system of governance for near Earth space. Notably, the interactions in which it is involved are based upon the exchange of information and knowledge.

As the body which created the five space treaties, the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) codified the principle values of space law. However, as the response to debris has been characterised by the exchange of information and the maintenance of values, rather than the enforcement of rules, there has been a limited role for a body largely concerned with legal matters. The principle contribution made by the United Nations system concerning debris is a considerable catalogue of documentation,[569] amongst which is its definitive 1999 'Technical Report on Space Debris'[570] but it has not been at the forefront of seeking a political or technical solution to the problem. Lotta Viikari argues that the changing scientific evidence and the presence of private actors have caused further attempts to create a new space treaty failing to even have agendas set.[571] However, as

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[563] 'ISO gives space sector new management tool to reduce projects risk' (1st September 2003) < http://www.iso.org/iso/en/commcentre/pressreleases/archives/2003/Ref869.html >.
[564] Sub-committee TC20/SC14. The permanent members of the is subcommittee, who have the right to vote on standards are: Brazil, Canada, China, France, Germany, Italy, Japan, Russia, UK, USA and Ukraine.
[565] Davey and Taylor in Dansey (ed.), *op. cit.*, p. 566.
[566] Klinkrad *et al* in Dansey (ed.), *op. cit.*, p. 29.
[567] The first agreed project is concerned with the propellant remaining in unmanned crafts, the second with 'routes to compliance and management of debris mitigation'. Davey and Taylor in Dansey (ed.), *op. cit.*, p. 567.
[568] *Ibid.* p. 565.
[569] The documentation can be found at:
< www.unoosa.org/oosa/en/docsidx.html >.
[570] The 'Technical Report on Space Debris' can be found at:
< www.unoosa.org/pdf/reports/ac105/AC105_720E.pdf >.
[571] Lotta Viikari; 'Time is of the essence: making space law more effective' *Space Policy* Vol. 21 (2005), p. 2.

will be seen, the circumstances which have negated the potential of a new treaty being formed, has created a conducive environment for a specific institution to be created.

The specific role of the International Telecommunications Union (ITU) is only to govern the usage of the orbital frequency spectrum. However, in 1993, it adopted a recommendation that at the end of their operational lifetime satellites should be raised 300km out of GEO.[572] Should the political will exist, it is not difficult to theoretically envisage a situation whereby in order to be granted a licence to operate in orbit, an application would have to demonstrate that it would make a minimum contribution to the debris population. Most obviously the recommendation that a satellite is moved out of GEO could be made a requirement of a licence.

Further, given that applications to the ITU, by private corporations, have to be submitted through a national government, internal legal frameworks provide a means for enforcing ITU standards upon private actors. However, whether the ITU could be a strong actor enforcing debris mitigation standards is questionable as it has been subject to criticism for being 'a bureaucracy rife with political contradictions'.[573]

The Inter-Agency Debris Co-ordination Committee

The Inter-Agency Debris Co-ordination Committee (IADC) was founded in 1991[574] and is the most significant active international organisation addressing debris. Its pre-eminence is, in part, because no other organisation attempts to play the role that it does. However, more important is its membership, which is universal of all states with significant space programmes. Although it does not have legal authority to enforce the decisions which it makes, it has perceived political authority. This is coupled with a recognition that the measures which it promotes are not only in the collective interest, but also in the individual interests of states. As a consequence its guidelines are broadly accepted.

All member states have a degree of 'ownership' in the decision making process of the IADC, which contributes to the authority of its decisions. The organisation is composed

[572] Perek, *op. cit.*, p. 218.
[573] Jeffrey Boutwell, Theresa Hitchens and James Clay Moltz; 'Enhancing Space Security by Improving Stakeholder Cooperation', *Astropolitics* Vol. 2, No. 1 (Spring 2004), p. 102.
[574] Klinkrad *et al* in Dansey (ed.), *op. cit.*, p. 26.

of a Steering Group and four Working Groups,[575] and it is mandatory for all members to be represented at meetings of the Steering Group; a similar stipulation applies to the Mitigation Working Group. For the other Working Groups, it is desired that all members should be represented, but it is not required. The Working Groups are intended to be composed of 2-3 experts from each member state.[576] Thus, the institution's structure ties all members into its decision making processes, it is fundamentally orientated towards seeking consensus.

International consortia or specialist agencies of the United Nations can participate in the IADC through invitation to specific meetings,[577] however membership is limited to states actively undertaking space debris research programmes,[578] as such the organisation is constituted of only those states with direct interests in space. There is clearly a strong pragmatic case for such a structure, as including other countries would hamper the efficiency of the organisation. In so limiting its membership, the IADC reveals a great deal concerning its purpose. Unlike the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS), the organisation is not intended to provide a 'democratic' voice for all. It is a practical body seeking to facilitate the development and spread of scientific knowledge. That the IADC is intended to aid the spread of scientific knowledge, in an effort to address the debris problem, makes clear that it is a fundamental part of an emergent governance structure addressing the debris problem. It further shows that what is being constructed is not a holistic regime to provide governance for near Earth space, it is specifically focused upon addressing the issue of debris.

The framework surrounding the IADC highlights a structure typical of governance. Within Europe debris research activities are conducted at national level, by such organisation as the British National Space Centre (BNSC), the French Centre National d'Etudes Spatiales (CNES) and the German Deutsches Zentrum fur Luft- und Raumfahrt (DLR). These form part of the European Space Agency (ESA), and the IADC itself.[579] Yet diffusion is not merely into a pyramid structure of national and transnational agencies. Much of the research conducted is done so under contract by 'industry, institutes, and academia in

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[575] The four working groups are Measurements, Environment and Data Base, Protection and Mitigation.
[576] *Terms of References for the Inter-Agency Space Debris Coordination Committee (IADC)* (5th October 2004), p. 6 < www.iadc-online.org/index.cgi?item=torp >.
[577] *Ibid.* Annex 1, Article 3.
[578] *Ibid.* Annex 1, Article 3.
[579] Klinkrad *et al*, in Dansey (ed.), *op. cit.*, p. 29.

Europe.'[580] Thus, the governance framework is multi-layered, and although the IADC is the focal point around which the most important activities occur its position is completely dependent upon the other agencies which surround it.

Within this institutional framework the Terms of Reference of the IADC describe its purpose thus:

> The primary purpose of the IADC is to exchange information on space debris research activities between member space agencies, to facilitate opportunities for cooperation in space debris research, to review the progress of ongoing cooperative activities and to identify debris mitigation options.[581]

Two important factors emerge from this statement. Firstly, the IADC has an ideational element to it, and secondly that it can be perceived as being a Commons regime. It is explicitly stated that the organisation is intended to provide the mechanism for the exchange of information between members, revealing a clear ideational interaction between actors. The knowledge based element of the IADC actually defines the way in which debris is conceptualised. Takashi Nakajima,[582] of the Japanese space agency JAXA, notes that not only has the IADC been the forum for discussion, it has shaped the way in which the problem has been understood.[583] Thus, if considered from the perspective of a socially constructed reality, the IADC has behaved in such a way that it is has formed the parameters within which the problem can be conceptualised and understood.

A broad definition of a Commons regime is a body that seeks to regulate the collective way in which individuals utilise a resource for their collective benefit. The IADC's main objective has been described, in a paper written by senior figures in various national space agencies, as being 'the exchange of technical information, and the

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[580] *Ibid.* p. 30.
[581] *Terms of References for the Inter-Agency Space Debris Coordination Committee (IADC)* (5th October 2004), Article 1.
[582] Takashi Nakajima is the point of contact between the IADC and JAXA
< www.iadc-online.org/index.cgi?item=torp >.
As well as a Project Manager within JAXA
< www.jaxa.jp/news_topics/vision_missions/PM_messages/index_e.html >.
[583] Nakajima in Dansey (ed.), *op. cit.*, p. 22.

identification of effective mitigation measures'.[584] If this is reconsidered into abstract terms, the purpose of the organisation is to create a means by which users of a common resource can utilise it in a manner that will preserve it for future usage. Indeed the Terms of Reference continue, 'the IADC is established to identify, plan, and assist in the implementation of joint cooperative activities that are of mutual interest and benefit.'[585] The mutual interest and benefit is the preservation of a Commons resource. Although the IADC does not describe itself in such terms, it is a Commons regime.

IADC - Outcomes

The research conducted within the framework of the IADC has been paramount in the technical response to the debris problem. The 'IADC Protection Manual' is a product of the Working Group 3, Protection; it is an exhaustive guide to the technicalities of the debris problem, running to a total of 228 pages.[586] The 'Protection Manual' has also created the terms within which dialogue is conducted, as with reference to the risk of debris impact it has created a 'standard methodology and the principle software codes'.[587]

Meanwhile, Working Group 4, Mitigation, has produced the 'IADC Space Debris Mitigation Guidelines'[588] The guidelines divide to four broad areas: limiting debris during normal operations, minimising the potential for on-orbit break-ups, post-mission disposal and prevention of on-orbit collision.[589] They have been supplemented by the development of an IADC document 'Support to Guidelines' which is intended for use by designers of space craft, such that the safety of future space missions, with reference to debris, can be

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[584] Klinkrad *et al* in Dansey (ed.), *op. cit.,* p. 29.
[585] *Terms of References for the Inter-Agency Space Debris Coordination Committee (IADC)* (5th October 2004), p. 5.
[586] The full text of the 'Protection Manual' can be found at:
< www.iadc-online.org/docs_pub/IADC.PM.v3.3.04.04.2004.pdf >.
[587] F. Schafer, M. Lambert, E. Christiansen, S. Kibe, H. Stokes, H.-G. Reimerdes, S. A. Meshcheryakov, F. Angrilli and Han Zengyao, 'The Inter-Agency Space Debris Coordination Committee (IADC) Protection Manual', in Dansey (ed.), *op. cit.,* p. 40.
[588] Yakovlev in Dansey (ed.), *op cit.,* p. 591.
The IADC Mitigations Guidelines can be viewed at
< www.iadc-online.org/docs_pub/IADC-101502.Mit.Guidelines.pdf >.
[589] Davey and Taylor in Dansey (ed.), *op. cit.*, p. 567.

improved.[590] Presently the guidelines are under review, an update being expected in the near future.[591]

The IADC's research has resulted in the key recommendation that objects in LEO should re-enter the atmosphere a maximum of 25 years after the end of their operational life time.[592] The value of 25 years was the product of research conducted by the Working Group 2, Environment and Data Base, which also considered the disposal period of 0 years and 50 years. A balance had to be achieved: defunct objects being immediately removed from near Earth space would result in greater protection, however it would require more fuel. Twenty five years was considered to provide the optimum utility as it required only a 'fraction more fuel' than 50 years, whereas 0 years required 'very significant exponential increases in the fuel required for the de-orbit manoeuvre'.[593] Here again the notion of constructed values can be seen, the Working Group has in essence decided what is a legitimate value. This is not to suggest that it is incorrect, rather that it had three possible scenarios of 0 years, 25 years and 50 years, of which on the basis of fuel expenditure and preservation of Earth orbit one value was chosen. As this value has now been broadly accepted within the space faring community, the IADC has created the terms within which debate occurs.

The IADC has also issued guidance concerning objects in GEO. It is formed an agreed formulae which recommended that satellites should be raised a minimum of 235km out of the geostationary ring.[594] The consensus on this value was reached in 1997. From then until 2004 of the 117 satellites in GEO that reached the end of their active life, 39 were re-orbiting in accordance with the IADC recommendations, whilst only 37 were simply abandoned without an attempt to re-orbit.[595] Therefore, although the principles which the IADC asserts are largely theoretically uncontested, consensus in principle does not by default result in objectives being followed in practice.

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[590] Yakovlev in Dansey (ed.), *op. cit.*, p. 591.
[591] Davey and Taylor in Dansey (ed.), *op. cit.*, p. 565.
[592] This value was the product of research conducted by Working Group 2 (Environment and Data Base), and presented to the IADC in April 2002. *Minutes of 20th Meeting of the IADC.* Copy on file with the author.
[593] *End of Life Disposal of Space System in the Low Earth Orbit Region* Complied by Working Group 2: Environment & Database of the Inter-Agency Debris Coordination Committee (IADC) 1st March 2002. Copy on file with the author.
[594] Some satellites are recommended to be moved more than 235km from GEO, this is dependent upon the solar pressure coefficient, mass and cross sectional area of the satellite. Jehn *et al* in Dansey (ed.), *op. cit.*, pp. 373 - 378.
[595] *Ibid.* p. 373.

It is erroneous to suggest that actors not following the standards promoted by the IADC is the fault of that institution, it is akin to suggesting that the United Nations itself has failed to stop a war. The institutions are only as effective as their members' action allow them to be. The IADC guidelines, as with all principles of the IADC, 'represent a vision statement and a goal to be achieved, and they are not requirements-driven'. There is no enforcement mechanism and the 'implementing agency can choose to limit the scope of its implementation of these measures at a national level, or tailor their implementation on a case-by-case basis to different missions.'[596] This reveals the scope and intention of the IADC: it is fundamentally cooperative in nature it does not have, claim to have, nor seemingly aspire to having coercive powers, not least because those who would be coerced are those who constitute the body. States operating within the framework of the IADC, which is all the significant actors, are doing so as they recognise that cooperation is not only for the collective good, but also in their individual interests. This is applicable not only to states' adherence to the standards, but also in their proliferation of knowledge through the mechanism of the institution.

The enforcement of standards applicable to the protection of the global ecosystem largely depends upon shame.[597] The principle mechanism which encourages compliance with standards is the peer pressure applied by other actors. Similarly in this instance there is no mechanism to force actors to follow the generally accepted standards. What the IADC has achieved is the creation of an ideational framework within which values exist concerning the conduct of activities in near Earth space. The promotion of these values includes their being presented to UNCOPUOS. As such the IADC is strategically located within the governance framework: it has the perceived authority to decide upon values which are dispersed through the community of stakeholders.

IADC Interactions with other Agencies

The IADC does not exist in isolation: the other institutions which are active concerning the problem and the IADC's interactions with them reveal a diffuse power

[596] Davey and Taylor in Dansey (ed.), *op. cit.*, p. 566.
[597] Peter M. Haas; 'Social constructivism and the evolution of multilateral environmental governance', in Aseem Prakash and Jeffrey Hart (eds.); *Globalization and Governance* (London and New York: Routledge, 1999), pp. 114-116.

structure. The IADC remains crucial within that structure not because of a legal claim to supremacy but because of the knowledge basis which it represents.

Although knowledge is dispersed from the IADC, it also flows into the organisation, the European Space Agency maintains an 'IADC Common Database and Re-Entry Event Database' in support of risk assessment in orbit.[598] The structure of the IADC itself by necessity means that knowledge is flowing upwards into it, as those who constitute its Working Groups are representatives of member agencies.

Knowledge accumulated by the IADC is not static, it flows outwards to other institutions. The Federal Communications Commission bases its licensing decisions 'upon the IADC recommendation that spacecraft at the end of life remain in the LEO region for no longer than 25 years'.[599] Research conducted by the IADC has resulted in a norm being followed by other institutions, due to recognition that it is in all actors' interests. In this respect the inter-actions between the FCC and the IADC constitute part of the system of governance concerning debris which transcends and penetrates the state. The rules which the FCC adopted concerning the disposal orbit for objects in GEO are based upon the formulae devised by the IADC.[600] Therefore, a norm established by a trans-national institution has penetrated the state through its acceptance by a domestic institution.

Similarly the International Standards Organisation has been in discussion with the IADC, since 2001, to ascertain the role it can perform in promoting debris mitigation standards.[601] Part of this dialogue is conducted by the ISO working group on debris which maintains 'permanent contacts with [the] IADC.[602]

The flow of information and values between the IADC and other institutions, can also be witnessed in interactions with the International Academy of Astronautics; as the objects which the IAA called for have been incorporated in the work produced by the IADC.[603]

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[598] Klinkrad *et al* Dansey (ed.), *op. cit.*, p. 29.
[599] Kensinger *et al* in Dansey (ed.), *op. cit.*, p. 574.
[600] *Ibid.* p. 573.
[601] Davey and Taylor in Dansey (ed.), *op. cit.*, pp. 566 & 568.
[602] UN Document A/AC.105/817, *op. cit.*, p. 5.
[603] UN Document A/AC.105/620, *op. cit.*, p. 6.

As membership of the IADC is limited to states that are active with reference to debris, there is an argument to the effect that it is undemocratic. The IADC is creating norms which will affect the utilisation of a resource, which is legally open for all to use. This 'non-democratic', or depending upon perspective 'pragmatic', approach of the space faring states can be seen to have produced positive effects, as a collectively agreed set of values is in place. Further, exclusion has not been complete: in 2001 UNCOPUOS endorsed the IADC's action in creating an international consensus.[604] The interaction between 'included' and 'excluded' has also been shown in the IADC's guidelines being presented to UNCOPUOS[605] and they have acted as a foundation for a mitigation document produced by UNCOPUOS itself.[606]

There has been significant interaction between the IADC and UNCOPUOS, the research of the former having been presented to the latter.[607] The importance which UNCOPUOS has placed upon addressing the debris problem is quoted in the IADC 'Protection Manual'.[608] Yet largely it is possible to view the governance system addressing orbital debris without considering the UN system. In part this can be explained in terms of the problem being addressed at a policy/technical, rather than legal, level. As a consequence UNCOPUOS has become peripheral to the main debates. If there had been a will to create a space debris treaty then UNCOPUOS would have become a central forum. What is most significant in the 'exclusion' of UNCOPUOS is the existence of the IADC, wherein states with active space programmes took the decision to create an organisation designed to be pragmatic rather than inclusive of states not directly involved, as a consequence bypassing the UN system.

In the coordinated response to the debris problem, knowledge is the key factor. This is both of a technical nature and relating to norms that create a framework within which policy is formulated. The IADC through its interactions with other agencies has promoted

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[604] Crowther *et al* in Dansey (ed.), *op. cit.*, p. 577.
[605] UN Document A/AC.105/817, *op. cit.*, p. 4.
More details of the IADC presentation are contained in UN Document A/AC.105/C.1/L.260
[606] Davey and Taylor in Dansey (ed.), *op. cit.*, p. 565.
[607] The documents relating to the IADC presentation to UNCOPUOS can be found at:
< www.iadc-online.org/index.cgi?item=docs_pub >.
[608] *IADC Protection Manual* Version 3.3. (April 2004), p. 6-8.
< www.iadc-online.org/docs_pub/IADC.PM.v3.3.04.04.2004.pdf >.

values which resulted from its research. As such a social environment has been actively created with the intention of preserving near Earth space.

Part Two: Ideas and Concepts

The Concept of Governance

As a tradition of International Relations, Realism is not merely the dominant form, it is also that which has advocated, most strongly, the approach that the state is to be considered as a unitary actor and the only one of real importance. This conceptualisation is a common feature throughout Realist thought; Carr obverses that when the words 'Great Britain' and 'Italy' are used, they are not analogous to the British or Italian people, rather they are a reference to the actions of the state.[609] An inherent assumption exists that the government is the 'voice' of the state and further that the government is of one mind. Therefore, the state is effectively considered to be separate from the population, and acting independently from it, with a will of its own, indeed from this perspective the population is of no particular importance. Kenneth Waltz similarly conceives the state as being a single agent, arguing that in order to understand International Relations, it is necessary to leave aside the internal factors of individual states and focus upon the international environment, hence conceptualising the state as a unitary actor.[610]

The notion of governance challenges this view. In the most basic terms it can be considered to be study of social organisations which govern (perform the functions of government) without the formal structures of government. From such a perspective, within International Relations, there is a network of organisations which permeate and transcend the state. Young defined governance thus:

> At the most general level, governance involves the establishment and operation of social institutions – in other words, sets of rules, decision-making

[609] E.H. Carr; *The Twenty Year's Crisis* Second edition (Basingstoke: MacMillan, 1970), pp. 146-152.
[610] Kenneth N. Waltz; *Theory of International Politics* (Reading, Mass.: Addison-Wesley, 1979).pp. 71-73, further the central argument of Waltz earlier book is that the international should be explained through blindness towards the domestic, Kenneth N. Waltz; *Man, The State and War* (New York: Columbia University Press, 1959).

> procedures, and programmatic activities that serve to define social practices and to guide the interactions of those participating in these practices.[611]

An important feature of this definition is that there is an ideational aspect to the concept; it is based upon perceptions and beliefs. Elke Krahmann further emphasises that governance relates to 'the coordination of social relations in the absence of a unifying authority at the sub-national, national or international levels'.[612] From this perspective the activities, traditionally associated with government, are dispersed through multiple levels.

Conceptualising International Relations from the perspective of governance requires a reconsideration of ontological questions, as there are a vastly increased number of actors which have been considered to be of importance. However, perhaps the greater challenge is epistemologically: what exists is neither static nor certain, rather new social forms can be created. Thus, there is a requirement to consider factors which are ideational as well as material, yet material factors are still considered to be of importance. The essential differentiation between the ideational and the material is defined by Colin Hay thus:

> Materialists refuse to accord much significance to the role of ideas, insisting that notions of causality must be couched in material (normally institutional, political or economic) terms. Idealists, by contrast, argue that in so far as one can posit a notion of reality, that reality is itself the product of 'discursive construction'. Quite simply, there is no external or pre-discursive reality outside of our constructions and imaginings of it.[613]

Peter Haas argues that ideas are the 'genetic material of international governance'. As such, in a neo-Darwin style, they are generated and those selected continue and thrive. Unlike evolutionary theory by natural selection, ideas are not created randomly, they are the product of knowledge established over time, and those which survive are not necessarily 'the best', rather they are those which authoritative actors select. It should not be assumed, as Rational Choice Theory does, that those making decisions have perfect knowledge and

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[611] Oran R. Young; 'Rights, Rules, and Resources in World Affairs' in Oran R. Young (ed.); *Global Governance* (MIT Press: London, 1997), p. 4.
[612] Elke Krahmann; 'Conceptualising Security Governance' *Cooperation and Conflict* Vol. 38, No. 1 p. 11.
[613] Colin Hay; *Political Analysis* (Basingstoke: Palgrave, 2002), pp. 56-57.

only make decisions in their best interests. The ideas which thrive in such an environment become embedded within institutions and accepted as norms, therefore influencing the manner in which decisions are made.[614] This is a clear challenge to the conceptualisations which provide the meta-narrative for Realism and Rational Choice Theory. In the framework of governance agents are not assumed to have perfect knowledge when they make a decision, because of this there is a necessary ontological shift. If ideas are of importance, then considering material factors alone is no longer sufficient.

The challenge which governance creates also has methodological implications. The increased complexity of many international issues has resulted in the situation wherein remedial actions taken with reference to one problem will have consequences upon other issues areas.[615] From a methodological perspective, this raises questions as to how an analysis can be conducted: increased inter-connectedness means that any investigation has to be widely focused upon multiple factors in order to draw a holistic interpretation of a phenomenon. There is an obvious solution to this in terms of studying the consequences of a certain course of actions, as the focus can be directed towards only those aspects which are deemed to be of importance. However, it becomes more difficult when the orientation of analysis is altered to attempt to understand why an observed phenomenon occurs. Therefore, it is simple to understand to follow the consequence of an action, but it is far more difficult to understand the causes of an action. If events are the product of multiple factors, then how is a sufficiently broad study to be conducted which can be inclusive of all causal facts? Fortunately, when studying the political environment within which the debris problem is addressed the issues areas are relatively narrowly focused, as such the methodological challenge of governance is not as great as it is with reference to other international issues.

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[614] Haas in Prakash and Hart, *op. cit.*, p. 115.
There is a strong similarity between this conceptualisation and Richard Dawkins' notion of 'meme' as the cultural equivalence of a gene. The meme being an idea which is passed from mind to mind, the method selection in this instance being whether the person decides to propagate the meme by passing it on. Richard Dawkins; *The Selfish Gene* 2nd edition (Oxford: Oxford University Press, 1989), pp. 189-201 esp. pp. 192-193.

[615] Peter M. Haas and Ernst B. Haas; 'Learning to Learn: Improving International Governance' *Global Governance* Vol. 1 No. 3 (September-December 1995), pp. 257-258.

Governance and the Environment

Peter Haas observes that ideas inform collective decision making, and that the enforcement of international environmental treaties 'depends largely upon shame.'[616] Both of these factors can be considered to be related to the ideational: decisions are made according to the ideas, and perception of values. The values do not have an existence in their own right, it is the interpretation of them which is important. Meanwhile, compliance with agreements is founded upon the perception of improper conduct.

The social environment within which ideational factors can play a role exists in the governance of near Earth space. This Common is not governed by a specific and complete codified body of rules. The space treaties which regulate state's activities are broad declarations of principles, as such before they can be applied to specific circumstances they have to be subject to a process of interpretation. This lack of clarity results in the importance of ideational factors, ideas dictate how the broad declarations of the treaties are interpreted, and consequently the standards by which states should behave.

Oran Young, commenting upon the present world order, argues that there has never been a greater demand for governance, as a consequence of the growing interdependence between members of international society.[617] Whilst in a critique of the Westphalian order, Susan Strange identified issues which expose the current order as being inherently flawed. One such issue being environmental degradation, as it is a problem which cannot be addressed by the traditional state acting in isolation. Further the state does not necessarily have a vested interest in resolving transnational environmental problems, therefore there is a need for a new form of governance.[618]

The protection of the global environment provides one of the most clear instances in which the model of governance can be applied to the international sphere. The efforts to provide environmental protection have had a clear ideational element: before action was

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[616] Haas in Prakash and Hart (eds.), *op. cit.*, pp. 114-116.
[617] Oran R. Young; 'Global Governance: Toward a Theory of Decentralized World Order', in Young (ed.), *op. cit.*, p. 273.
[618] Although the Westphalian system is considered to be failing Strange does not believe it is necessarily about to collapse in the near future, possibly because there is no apparent alternative to it. Susan Strange; 'The Westfailure System' *Review of International Studies* Vol. 25 No. 3 (1999), pp. 345-354.

taken the terms within which the problem could be conceptualised were in need of construction. Further, the response which has emerged is not composed of a single institution, rather it is a composite in which multiple actors have contributed, with the collective aim of addressing the 'ecological externalities of economic globalization.'[619]

The scientific evidence appears to clearly state that the necessary changes to global socio-economic behaviour have not occurred in order to remedy the threats to the global environment. However, from a political perspective international environmental governance can still be considered to be a success with respect to its ideational basis, as the essential values of the system of governance are broadly accepted. The material aspect of the response to environmental damage is also best characterised by governance, it is largely decentralised whereby states are not the only active agents, but they share rights and duties with international institutions and non-state actors.[620]

The dynamics which occur within a state, when considered from a governance perspective, are of great importance. The maintenance of standards concerning the global ecosystem in pluralistic societies is influenced by a range of internal forces.[621] This is evidently not the case with debris: the issue is not in the public eye and it is addressed at a governmental/technical level; space debris forms part of a discourse which has no resonance with the general population. In this instance the pressure for remedial action does not come from traditional lobby groups or the general public, it is from direct stake holders, largely national space agencies. As such it is pressure from within the state, such pressure can then coalesce into trans-national networks.

Epistemic Communities

Many modern global problems, such as debris, are of a complex technical nature. This has created a heavy reliance upon the knowledge of specialists. In turn the networks and connections between such experts, as providers and legitimators of knowledge, have become significant.[622] Such transboundary networks of knowledge rich-experts are described as 'epistemic communities'. The essential features of these communities being

[619] Haas in Prakash and Hart (eds.), *op. cit.*, p. 103.
[620] *Ibid.* pp. 103-104.
[621] *Ibid.*, p. 125.
[622] Haas and Haas, *op. cit.*, p. 257.

that they are 'usually self-recruiting around some paradigm linking their lore to some aspect of a problematique', the members share a common approach and seek to place their knowledge and perspectives within bureaucracies and government in order to shape policy.[623] Peter Haas describes epistemic communities thus:

> An epistemic community is a network of professionals with recognised expertise and competence in a particular domain and an authoritative claim to policy-relevant knowledge within that domain or issue area.[624]

He further identified the characteristics which define such communities, these can be seen to be readily related to the response to debris:

1. 'a shared set of normative and principled beliefs, which provide a value-based rationale for action'. There is a shared group of normative beliefs, these focus upon the dangers which debris poses. The most fundamental belief being that debris is a hazard which is collectively faced by all space faring states, and that it requires collective action in order to be effectively resolved. Therefore, a set of values exists to direct actions towards mitigating the debris problem.
2. 'shared causal beliefs...[which] serve as the basis for elucidating the multiple linkages between possible policy actions and desired outcomes'. Some of the global problems which epistemic communities seek to address can lack clarity when causal mechanisms are considered, for example climate change remained a contested concept for decades before a broad scientific consensus emerged. The conceptualisation of the debris problem has been characterised by clarity concerning causation. The nature of debris (artificial objects in Earth orbit) is clearly known, as is the means by which the debris population arrives in Earth orbit. Therefore, once the amount of debris in orbit had been identified as a problem, there was an obvious causal mechanism. This has a clear linkage with policy and desired outcomes, specifically that policy should seek to mitigate debris with the desired outcome of preserving the environment of Earth orbit.
3. 'shared notions of validity – that is, intersubjective, internally defined criteria for weighing and validating knowledge in the domain of their expertise'. The notions of

[623] *Ibid.* p. 260.
[624] *Ibid.* p. 3.

validity shared by the episteme have been created by the community itself: on this basis discourse can occur in a meaningful manner. It should be remembered that the validity sought is founded upon technical scientific methods, it does not contain the complexity of policy orientated problems wherein competing requirements of individual actors have to be considered when ascertaining validity.

4. 'a common policy enterprise – that is, a set of common practices associated with a set of problems to which their professional competence is directed, presumably out of the conviction that human welfare will be enhanced as a consequence'. The shared common enterprise is clearly a resolution to the debris problem, such that Earth orbit will be preserved. However, it is far from clear that the purpose of the episteme is to preserve a Common, for either egalitarian or philosophical reasons. Rather the most accurate consideration is that the goal of preservation has been adopted as it is in the individual self interest of those who have the ability to pursue the objective. The reasoning which motivates this epistemic community poses a further challenge to the Rational Choice explanation of Hardin as the agents, through co-operation, are seeking a situation which is communally desirable as well as optimal for each individual.[625]

The notion of epistemic communities emphasises two very important, and interesting factors, which can be notably lacking from traditional International Relations theory: the role and impact of ideas and thoughts, along with the importance of groups and individuals acting within and across states, and consequently the effect which both have upon 'state' behaviour. Examinations of epistemic communities focus upon the significance of 'transnational networks of expertise',[626] the criteria for entry into these communities is knowledge.

In various fields the effects of epistemic communities can be seen: for example Peter Haas accounts for the success of anti-pollution measures in the Med Plan as a direct consequence of the actions of an epistemic community. In this instance a group of ecologist and marine scientists established an international agenda and subsequently directed their

[625] The factors are taken from Haas, the analysis is original. See Peter M. Haas; 'Introduction: Epistemic Communities and International Policy Coordination' *International Organization* Vol. 46, No. 1 (Winter 1992), p. 3.
[626] Olav Schram Stokke; 'Regimes as Governance Systems' in Young (ed.), *op. cit.*, p. 57.

individual states towards supporting that agenda.[627] The importance of the episteme is that it established a set of common principles and norms, this conceptual framework was then the basis for specific rules to address pollution. The principles further gave authority to other domestic groups of scientists who were able to exert pressure upon their governments.[628]

Thus, the importance of the episteme is seen; it is a mechanism through which a common conceptualisation of a problem is created. Subsequent to this act of creation the ideas generated permeate through the boundaries of states, influencing individual governments' policies towards a common shared goal. Unlike a materialistic view of international relations, in this instance states are not behaving in a specific way because of pre-given forces, rather their actions are the product of a shared and constructed set of ideas. It should, however, be noted that the ideational form is not random, it is the product of expert knowledge, as a consequence it has a strongly perceived claim to legitimacy, not least because policy makers do not have the specific knowledge to challenge the world view constructed by experts.

It is the assertion of this thesis that there is a strong epistemic community actively addressing the problem of orbital debris. However, measuring the effect of such a collection of individuals is not simple, as by default to do so would require proving a negative.

There is strong empirical evidence for the existence of an epistemic community. The IAA can readily be viewed as being part of an epistemic community, it defines its purpose as being 'based on the tradition of the great classical scientific academics of the 17th century...which fostered scientific enquiry and the exchange of ideas and new information'.[629] This definition could easily be taken as that of an epistemic community. It also resonated with the notions of an epistemic community, as identified by Haas; the people with whom the IAA is concerned are those with an expertise and competence concerning astronautics and can have an authoritative claim to specialist knowledge within this issue area.

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[627] Peter M. Haas; 'Do regimes matter? Epistemic communities and Mediterranean pollution control' *International Organisation* Vol. 43, No. 3 (Summer 1989), p. 384.
[628] *Ibid.* p. 401.
[629] International Academy of Astronautics web site:
< http://iaaweb.org/content/view/136/234/ >.

Further evidence can be found in the European Space Agency which has now held four space debris conferences, representatives from all space faring states are present at these conferences and it appears that knowledge is freely exchanged. It should further be remembered that the majority of those present are either members of national space centres, or work on contract for them, as such they are in the employment, either directly or indirectly, of states. Here a counter-argument could be raised; how can it be known that all knowledge is being freely exchanged and in fact states are not withholding information, or indeed providing false information?[630] To prove this point would be to prove a negative, however what is known is that there is no overt claim by any party that others are behaving in a way which is contrary to the collective goal.[631] Thus, employing Occam's Razor, the position that knowledge is being freely exchanged is that which requires fewest assumptions. A further forum for the exchange of information is a journal, 'Space Debris' which is specifically devoted to the technical study of the phenomenon.[632]

The desirability for an episteme is reflected in the following quotation, taken from an introductory paper to the 4th European Conference on Space Debris. It is notable that the paper is co-authored by principle contacts between several national space agencies and the IADC:

> To be effective, debris mitigation measures need to be applied by all space faring nations on an equal-terms basis. This can be best achieved, if a common understanding of the debris related problems and of recommended actions exists.[633]

The purpose which is described is exactly that of an episteme; it is seeking to form a transboundary community of knowledge in order to address the problem. Further, it has an understanding of the requirements of policy, as it is seeking to form a collective set of norms and values which will be sensitive to the requirements, and demands, of national space

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[630] I am grateful to Professor Ken Newton for directing me towards considering these questions.
[631] It should be noted that unattributable comments may be heard to the effect that the Russians are not as cooperative as other states. The accuracy of such suggestions has not been possible to ascertain, as a consequence neither is it possible to know whether this is due to cultural/institutional/linguistic factors or deliberate intransigency on behalf of the Russians.
[632] The journal is published by Springer Press, and edited by Ph. Anz-Meador, William Flury and Donald Kessler.
[633] Klinkrad *et al* in Dansey (ed.), *op. cit.*, p. 26.

policies. Thus, there is a reflection of the Med Plan as described by Peter Haas, in which a collective vision created by an episteme is influencing the policies of individual states, primarily through the authority of the knowledge base accumulated.

There are two broad challenges which could be made to the suggestion that there is an active, and influential, epistemic community addressing the debris problem. The first would be to deny that epistemes exist, or if they do that they have very little, or no, influence. The second approach would be to acknowledge that epistemes exist, but that the collection of individuals with knowledge concerning debris does not constitute an epistemic community. The first challenge is difficult to absolutely refute, as doing so requires a challenge to fundamental ontological assumptions. If it is accepted that epistemic communities exist, then it can be seen that in response to orbital debris one exists.

Further evidence for the existence of an episteme can be seen when considering the means by which the community defines its own membership parameters and reproduces itself. The criteria for access to the community is knowledge: those contributing to the debate in the IADC are experts from within academia and industry.[634]

The debris episteme should not be considered to exist in isolation, neither did it emerge from a social vacuum. Rather the actions of epistemic communities have a long history in creating the social norms associated with telecommunications technologies. The early conferences addressing the management of the radio frequency spectrum were characterised by the role of technical experts. They did not seeking to balance political interests as traditional diplomats would, rather they adopted a normative approach, seeking to establish an effective means of preserving the resource. This was characterised by their 'efforts usually [aiming] at constructive cooperation in a particular technical field', whilst the influence of diplomats was considered to be 'retarding'.[635] The present debris epistemic community is acting in a similar manner, however it is difficult to make a clear distinction between national interests and establishing an effective means to protect the resource. The methodological difficult in measuring such a difference is that the outcomes which satisfy both motivations are essentially identical, therefore specifying which is causing actors to

[634] *Ibid.* p. 30.
[635] Charles Henry Alexandrowicz; *The Law of Global Communications* (London: Columbia University Press, 1971), p. 94.

behave in a given manner becomes a matter of conjecture. A financial explanation would suggest that the members of the episteme are seeking to preserve the resource because it is in the interests of the governmental agencies which employ them, but this does not constitute a conclusive explanation, as it does not provide a causal narrative.

Observing the effect of the Episteme

The importance of an episteme is not merely that it exists, rather it is the effect which is has upon policy and practice. This chapter has argued that institutions are the key factors in addressing the debris problem. However, if they are of such importance, it is necessary to explain how they came into existence. The argument here is that the IADC is the most important institution addressing the debris problem; if it is of such importance then it must surely be necessary to account for its existence. What will now be seen is that the existence of the IADC, and the norms which it is associated with, are the product of the epistemic community.

Peter Haas and Ernst Haas consider there to be a process whereby an episteme expresses a view which becomes the dominant perception in an issue area. It can then 'capture' a government, and shape their world view, other governments are then similarly 'captured'. Ultimately, through this process an episteme can claim executive power.[636] The process by which the episteme concerning debris has come to prominence has not featured conflict. The spread of ideas has occurred without intellectual resistance. As discussed with reference to technical issues, the problem of space debris was first identified in the late 1970s, in the following years the importance of the threat it poses became generally accepted. However, this was not a process wherein there was considerable debate concerning the reasons for the presence of debris, nor the means of remedying the situation. The problem which had to be addressed was, as Nicholas Johnson and Darren McKnight observed in 1991, one of recognition.[637] When space debris gained the recognition that its seriousness demanded there was no intellectual struggle between competing perspectives. Therefore, the process of 'capture' has been one in which the ideas of become accepted as being important within government.

[636] Haas and Haas, *op. cit.*, p. 261.
[637] Johnson and McKnight, *op. cit.*, p. 99.

The debris epistemic community was born within the apparatus of government. As has been referred to, the overwhelming majority of those addressing the technicalities of the problem are in the employment of, or funded by, national governments. It has not been the case that they have 'captured' the governance agency from outside; rather they have been in its employment whilst in the process of identifying debris as a problem. Thus, it is not accurate to think of the importance of debris becoming embedded in the decision making process as a consequence of the authoritative positions which individuals have managed to achieve. Rather the idea of debris being a problem has permeated into the decision making structure, without any change of personnel or institutional culture being necessary. This is in large part because debris has been addressed at the level of low politics, therefore there has been little intellectual struggle concerning its relevance and importance.

In the case of the debris epistemic community, the episteme does not exert external pressure upon the decision making process. Rather it exists *within* the decision making process, as it always has. Those conducting research into the physical problem of debris, are almost exclusively (financially) tied to government organisations.[638] Although they have financial linkages to government institutions it is important that they remain intellectually independent, alterations to policy and responding to the complexities of a problem, are only possible if there are open conduits to carry ideas from academia, think tanks and industry.[639]

Despite the episteme being embedded within governmental organisations it still has a great deal of independent power due to the technical nature of the problem. A consequence of this is the technocrat being able to make decisions which would never be expected to reach the desk of the elected politician. The technocrat effectively has power which the elected politician cannot exercise due to the knowledge base required, whilst given the inclusivity of the epistemic community the technocrat invariably is a member of the episteme.

As a consequence of the 'dictatorship of the technocrat' a strong argument could be made that the debris episteme has been effective because it operates at the level of low politics. In contrast the problem of global climate change exists within high politics. This

[638] At the 4th European Conference on Space Debris, the authors of the presented papers were effectively exclusively attached to governmental organisations. Although a large number were working outside of the public sector, they were tied into governmental contracts.
[639] Haas and Haas, *op. cit.*, p. 263.

leads to the question of whether an issue being addressed at the level of high politics has the consequence of all decisions becoming highly politicised, and therefore controversial, such controversy would then in turn demand the attention of elected politicians. At the level of low politics the bureaucrat/technocrat maintains direct control over the issue, as such fewer people are involved in the decision making process and it operates more effectively. This perspective could be countered on the basis that those problems which exist at the level of high politics are inherently more controversial. Therefore, it is not the level of the government machine at which they are addressed which causes a less productive response, rather it is inherent to the nature of the problem itself.

Thus, it can be seen that an issue which has been addressed at the level of low politics has resulted in effective international action, whereas one which is part of high politics has remained ineffectively resolved. However, this does not prove a causal link there may be a third factor, the nature of the issue, which dictates both outcomes. In which case, the nature of the issue decides whether it is contained within high or low politics, and is the primary factor dictating whether it is possible for an effective international response to be created. It is very difficult to see how a clear causal linkage could be proved in such an instance as there is a methodological 'chicken and egg situation', is it because the issue is addressed by technocrats that international agreement is reached, or is it because the issue is relatively uncontroversial, and therefore more easily solved, that it is addressed by technocrats rather than elected politicians?

In part the 'non-political' nature of the debris problem can be identified because of the origin of debris itself. As it is the product of activities in orbit, it is not surprising that the USA and the former USSR are responsible for the overwhelming majority of debris,[640] as they have utilised space most frequently. In turn, having the most space based resources makes these states the most vulnerable to the risks of debris, not least from debris which they have produced themselves.[641] Therefore the more capacity which a state has to produce debris, the greater the interest it has in ensuring that debris is not produced.

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[640] Dator, *op. cit.*.

[641] Robert McDougall and Phillip J. Barnes; 'Military Approaches to Space Vulnerability: Seven Questions' in Moltz (ed.), *op. cit.*, p. 15.

The proportionality between exposure to danger from debris and responsibility for the production of debris, results in governments not being able to 'externalise' responsibility for the problem. If it were possible to reasonably argue that debris is the fault of an external 'other', then it would be far more probable that it would be addressed at the level of 'high politics', but the proportionality of responsibility and exposure, places pressure on it to remain as a technical matter. This can be seen in other areas of environmental protection, where it is possible for a government to place the blame upon other governments for the problem, and therefore make it external to their behaviour.

The issue of proportionality is coupled with the principle reason why the problem of debris has not become politicised; its presence does not benefit any one, the only gain that actor can perceive in the production of debris is not having to bear the costs of mitigation measures. Therefore, the goal of limiting debris is one which all participants are able to share, all members of the episteme have this goal, and there is no reason for such an issue to become part of high politics. This cohesiveness may ultimately be tested should proposals to weaponise space be fulfilled. In this instance within a single state or government there will potentially be those proposing weaponisation, and those opposing such a policy on the basis of the debris created.

It is a matter of speculation whether the embeddedness of the debris episteme within the decision making processes would have a significant effect concerning weaponisation. It appears most probable that as weaponisation is a highly politicised issue area that it would result in debris, at least partially, becoming a matter of high politics. Even if weaponisation should occur, or indeed open military conflict in space, this would not preclude the continuation of efforts to mitigate debris being produced by accident or neglect, but it would raise questions concerning their utility.

In the present situation, wherein weaponisation and debris can still be conceptualised separately, the effectiveness of the epistemic community can be clearly seen. The analysis concerning institutions identified the IADC as the central body around which the governance regime is constructed: knowledge of the epiteme allows the true nature of the IADC to be seen. It is not a large international organisation with a formal headquarters and secretariat, it is a forum for ideas to be exchanged and developed. Indeed the IADC can be considered to be ideational in structure itself, it exists because its members will it to exist

through their beliefs and actions; the importance of its existence is not due to formal structure. Its creation is best explained not by material forces, or power politics, rather it is the product of the epistemic community, it was created by authoritative individuals within the episteme as a means of coordinating their response to the problem.

As a tool of the epistemic community, and a manifestation of it, the IADC has defined the terms in which the problem is conceptualised. The Protective Working Group has created 'a standard methodology for meteoroid/debris risk assessments, a means to cross calibrate risk assessment tools, documentation of reliable ballistic limit equations, procedures and results used to calibrate member hypervelocity impact test facilities, and description of validation activities for hypervelocity impact simulation codes.'[642] To reconsider this statement in an abstract form, the epistemic community has provided a common means for addressing the problem, in so doing it has created a means by which knowledge can be considered to be valid.

The final question which needs to be asked concerning the epistemic community is whether an active and vibrant episteme is a necessary or sufficient cause for addressing such global problems as debris. This has implications for whether the social circumstances surrounding debris can have applicability to other situations. Comparison is the only means of addressing a question such as this, when considered in relation to global climate change there is presently, in both issues areas, a broad scientific consensus concerning the requirement for remedial action. However, debris has been subject to policy initiatives which have the capacity to resolve the problem, whereas climate change remains far from being adequately addressed. The major difference between the two problems, as has been discussed, is the necessity for change within society in order for mitigating action to be effective. Thus, in another issue area an active and strong epistemic community has not been a sufficient cause to provide effective action. Therefore, it appears most accurate to consider the space debris episteme a necessary cause for remedial action, but not a sufficient cause. It is necessary because of the effects the episteme has had upon policy and action, but comparison with climate change suggests that its effectiveness is in large part a product of the social circumstances in which it operates.

[642] Schafer *et al* in Dansey (ed.), *op .cit.*, p. 40.

Conclusions

This chapter has presented two, related, theoretical ideas which provide an intellectual framework for conceptualising the response to the debris problem. Governance moves the discussion of IR away from an exclusive focus upon states as unitary rational actors. It provides a role for ideas alongside material forces. Perceptions become important, therefore events are not to be considered as solely explicable due to the movement of great social forces, which control the behaviour of actors. Rather, the ideational element means that the manner in which actors conceptualise circumstances will effect their reaction to them. Secondly, the notion of governance expands and broadens the ontology of the discipline. States are no longer the only actors of importance, rather institutions and individuals can play an active role in providing the functions of government, without formal structures.

The notion of epistemic communities argues that there are trans-national networks of knowledge rich experts who form self-recruiting communities. These collectives are founded upon the basis of knowledge. The complex technical nature of many modern problems, such as debris, has resulted in the situation wherein decision makers are dependent upon such knowledge rich experts. The academic interest in epistemic communities is due to the belief that they do not passively produce knowledge, rather they have active policy objectives. Therefore, their actions are directed towards a specific goal, usually the improvement of human welfare. The collective response to debris fits the criteria concerning an episteme as defined by Haas. To accept that an episteme is responsible for the witnessed response is the explanation which requires fewest assumptions.

This chapter has argued that taken together these two ideas explain what has occurred with reference to debris. Those institutions which were already active in reference to near Earth space have all contributed to the governance arrangements concerning debris. However, it is the Inter-Agency Debris Co-ordination Committee (IADC) that has been the principle focal point of the governance network, and the IADC is a product of the epistemic community. Meanwhile, the epistemic community remains firmly embedded within state institutions. Because debris has remained conceptualised as a technical, and not 'high politics' issue, it has remained in the domain of technocrats. Those technocrats are best considered as being members of an epistemic community.

When considering the global response to debris the field of experts with a technical understanding of the problem is relatively small, and constitutes an epistemic community. The previously discussed IADC provides a clear forum within which the episteme is active. That membership of the committee is limited to those states, represented by scientific experts, active in the field of debris research, emphasises that knowledge is a criteria for entry to this community. The institutions which exist do so because an active body of experts is employed within them, providing the necessary knowledge and skills

The IADC provides a forum within which the principle stakeholders can formulate agreed standards and an agreed response to the problem. As such it has the intention for creating the ideational structure within which the problem can be conceptualised. The 'IADC Space Debris Mitigation Guidelines' and the 'IADC Protection Manual' have formed the basis upon which the problem is defined, along with the requirement for an effective response. Further, the IADC is integrated into institutions which were already in existence, and it is involved in the exchange of knowledge with them, as would be expected with reference to the notion of governance.

The network of institutions, identified in this chapter, permeates the state, the values which the IADC has created are enacted in a domestic setting by national institutions. There is a clear dynamic interchange between the organisations, as it is the national institutions which collectively constitute the IADC.

Peter Haas and Ernst Haas argue that in the absence of a dominant state, a clear universal vision or world government then responses to global problems are dependent upon institutional frameworks.[643] Such reasoning can only be partially applied to the response to debris, as the relevant institutions, most especially the IADC, have provided clear leadership. Yet, the strength of the response to debris is not merely due to this factor; several of the other aspects identified are also of importance. The United States, the strongest state involved in near Earth space, clearly and openly supports the institutional framework.[644] Further, there is a transparent set of shared values concerning debris, which amount to a

[643] Haas and Haas, *op. cit.,* p. 256.
[644] Johnson (a) in Dansey (ed.), *op. cit.,* p. 9. Nicholas Johnson is the chief scientist for orbital debris at NASA, and head of its delegation to the IADC, when he writes that the USA supports the UN, ISA and IADC, it can be considered to be a definitive statement.

universal vision. In relation to the identified means of addressing a global problem the response to debris is notable as being characterised by such favourable social conditions.

The various institutions which have been considered all have the intention of addressing the debris problem and they are doing so through a shared conceptualisation of the challenges which are present. However, the ITU has a role which results in debris only being addressed as a peripheral issue, since its purpose it to regulate the usage of the radio frequency spectrum rather than creating norms for the general usage of space. More importantly, for the purpose of this analysis, it constitutes a different conceptualisation of Commons governance. The ITU regulates the use of a Common Property Resource, whereas the regime built around the IADC is approaching near Earth space as a resource of effectively unlimited supply, providing that the debris problem can be effectively remedied. This allows the IADC a greater degree of freedom, as it does not have to make choices concerning the allocation of resources. The actions it seeks to promote are intended to maintain 'supply' of access to near Earth space at a sufficiently high level that states will not face competition. Because GEO is far more limited in capacity, the ITU is addressing a problem in which the resource has the quality of scarcity.

The preceding analysis is comprehensive of the governance surrounding debris, yet in so doing it reveals that it is limited only to debris. The regime which is emerging is issue specific; it is not an attempt to found a system which will govern near Earth space as a whole. A separate, although complementary regime, exists through the ITU in order to manage GEO orbital slots. It is notable that as membership of the ITU is far broader than that of the IADC, and because it is regulating a Common Pool Resource, it has had to address more politicised issues. The bureaucratic inertia of the ITU, and UNCOPUOS, created the social environment within which there was a need for an organisation such as the IADC to allow the episteme to interact within an efficient structure.

The IADC can be considered to be a success, not because the debris problem has been solved, but because it has formed an effective and functioning social environment within which the problem has the potential to be resolved. Yet, it has done so against the background of a favourable set of circumstances Firstly the problem is one in which all actors interact in a positive-sum environment; it is beneficial to all that the issue should be resolved. Unlike global climate change there are no vested interests that discourage

cooperation. Secondly, there is a clear solution to the problem. What is required is the necessary technical measures to reach that solution; as such remedial measures have not had to counter intellectual challenges concerning the most appropriate course of actions. Thirdly, a solution to the debris problem would not require the 'supply' of access to near Earth space to be limited unlike slots in GEO, which removes competing interests and negates arguments concerning distribution and fairness.

Chapter Eight:
International Relations and Orbital Debris

Introduction

This chapter will draw upon the evidence which has been discussed throughout the thesis in order to examine the lessons which can be brought to International Relations from studying the issue of orbital debris. The analysis in this thesis commenced with an investigation into the differing approaches to the Commons as conceptualised by Garrett Hardin and Elinor Ostrom. It is now possible to return to these theories in order to fully contrast what they assert with the empirical evidence concerning debris. The evidence of this thesis has found that there is a close resemblance between Ostrom's formulations and the empirical evidence concerning debris. In order to establish why Ostrom can best explain this situation, rather than Hardin, this chapter will question how the correlation between fact and theory can be explained

The evidence concerning Hardin and Ostrom can be extrapolated to International Relations theory, as there is a broad symmetry between the Rational Choice argument of Garrett Hardin and neo-Realism. Similarly, the cooperative approach of Elinor Ostrom resonates with neo-Liberal institutionalist thought. Having done so, it will then be possible to analyse whether the problem of orbital debris presents a unique circumstance, or whether broader lessons for international relations theory can be extracted from it.

Neo-Realism and Garrett Hardin

As was discussed in the first chapter Garrett Hardin's 'tragedy of the Commons' is a manifestation of Rational Choice Theory (RCT). Had Hardin been writing within the realm of International Relations his theoretical approach would have resulted in the neo-Realist school of thought as Kenneth Waltz did, ten years after Hardin's essay was published. Neo-Realism is one specific manifestation of Rational Choice Theory, just as 'the tragedy of the Commons' is in an abstracted form. Logically the two are identical. Indeed, Colin Hay describes Realism as Rational Choice Theory applied to international relations, wherein

states are the actors of interest.[645] Neo-Realism is founded upon the systemic logical inevitabilities of Rational Choice Theory.

Realism exists in a variety of forms, however they all share family traits and neo-Realism is presently the dominant form. Lynn-Jones and Miller identify six attributes which unite the Realist traditions. Firstly, that within the international realm, states are the most significant actors. Secondly, anarchy is the defining feature of that international realm. Thirdly, the behaviour of states is designed to maximise security and power. Fourthly, states generally behave in a rational manner in order to achieve their goals. Fifthly, military might or the threat of it, is a means which states often use in order to achieve their objectives. Sixthly, 'aspects of the international system – especially the distribution of power among states – are the most important causes of the basic patterns of international politics and foreign policy'.[646] This chapter will focus specifically upon the neo-Realist tradition for two reasons. Firstly, it is the most commonly ascribed to tradition of Realism, and arguably the dominant theory within the discipline. Secondly, as will be shown, there is a broadly symmetrical relationship between neo-Realism and Hardin's tragedy.

Mark Imber notes that Realism is primarily concerned with the state, its survival and the protection of sovereignty; as such it does not readily concern itself with environmental protection.[647] Although it is certainly true that the Realist is not especially concerned with questions pertaining to the protection of the global Commons, in no way does this mean that the logic and principles of Realist thought cannot be applied to questions concerning governance of the Commons. Not least because Garrett Hardin revealed that RCT, and therefore neo-Realist thought, could very readily be applied to environmental problems.

However, as a tradition Realism has not been prone to consider environmental factors, and consequently those interactions between states which required collective action. E.H. Carr wrote that power existed in three forms, military power, economic power and the power over opinion.[648] Although later Realists would focus almost exclusively on military power, even Carr's broader approach did not readily consider those factors which required

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[645] Hay, *op. cit.*, p. 17.
[646] Sean Lynn-Jones and Steven Miller; *The Perils of Anarchy, Contemporary Realism and International Security* (Cambridge, MA: MIT Press, 1995), pp. ix-x.
[647] Mark Imber; *Environment, Security and UN Reform* (Basingstoke and London: St. Martin's Press, 1994), p. 6.
[648] Carr (1970), *op. cit.*, pp. 99-130.

concerted multilateral action. Hans J. Morgenthau did acknowledge that environmental factors were of importance to national power, yet he countered this by describing them as 'relatively stable', thus he was not especially concerned with them when considering interactions between states.[649]

Conceptual Tensions within Hardin's Tragedy

Before considering the inter-relationship between Hardin's 'tragedy of the Commons' and neo-Realism, there are some important factors concerning Hardin's work which need to be considered. 'The tragedy of the Commons' is described within a relatively short essay, it has the appearance of being a very tightly defined argument. However, careful analysis of it reveals that it is constructed upon a series of idealisations which remain latent in Hardin's text.

Susan Cox considers the 'tragedy of the Commons' to be ultimately flawed. Cox's position is that it has been so often repeated and memorised that it has become 'truth' despite the fact that is actually a fiction.[650] The following stage of the analysis will seek to understand the latent idealisations within Hardin's model, in order to ascertain why his claim to universality can be undermined. It shall be examined with reference to: the existence of greed; the independence of agents; the categorisation of decisions as subjective/objective; the possibility of change; the creation of complex social agents and the existence of agent's individual characteristics.

Matthew Paterson observes that Hardin's work naturalises human greed.[651] In so doing it commits a sleight of hand, which can be common place in positivist epistemologies. It takes a phenomenon then simply assumes it to be a given which exists prior to the theory itself. As such it is natural and its existence does not have to be justified. Neither is a theoretical explanation of its existence necessary. Such thinking is clearly demonstrated in the neo-Realist manifestation of RCT. Waltz, the founding author of the theory, maintains that it does not require a theory of the state.[652] It could be critically observed that through a

[649] Han J. Morgenthau; *Politics Among Nations* 5th edition (New York: Alfred A. Knopf, 1978), pp. 120-123.
[650] Cox, *op. cit.*, p. 49.
[651] Paterson in Burchill and Linklater (eds.); *op. cit.*, p. 258.
[652] Waltz (1979), *op. cit.*, pp. 71-73.

careful 'naturalisation' of difficult aspects of a theory, such as human greed or the existence of the state (for the state is a fundamentally cooperative entity, which must have emerged from somewhere), these theories are using a positivist epistemology as a means to obscure weaknesses in their accounts of reality. In this respect naturalisation can be considered to be occurring because the theory is maintaining that an event or object is natural or normal, therefore its existence does not have to be accounted for. For example, within neo-Realism, the state is naturalised: from the point at which the theory commences the state already exists. Therefore, Waltz does not have to provide an account of the origin of the state, for in the social world which Waltz discusses the state already exists, as it is 'natural'. Naturalisation, therefore, becomes a reification of an abstraction.

Hardin's argument is also lacking when addressing the role of agents themselves. It does not attribute the tragedy to the will of the actors, rather it is a consequence of the structure into which they are locked.[653] This is consistent with the theory as agents are not considered to have any true independence. Such an approach is common to Rational Choice Theories; these theories neglect to account for an individual acting in a manner which is not 'rational', for example acting with either irrationality or with inventiveness.[654] Although agents are not considered to have any capacity to act in their own right, they are assumed to have near perfect knowledge of the situation in which they are trapped. Consequently, they do not have any real choice, for there is only one course of action open to them, the rational choice.[655] Thus, the assumption of a RCT is that every agent can perceive every course of action available and be able to assign utilities to the various possible outcomes, then make the rational decision to maximise their utility. This can clearly be applied to the debris problem, as it would prevent the actors involved for being inventive in their approach to the problem: that is to think of it in an original manner. Therefore, they would be unable to change the circumstances in which they found themselves and create a new approach to the problem.

Nicholas Onuf questions the objective nature of 'rational decisions', for although an individual may attempt to make a rational choice, that decision may not appear to be rational to an outsider, whilst it would remain internally perceived as being so. For example, a belief

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[653] Hardin, *op. cit.*, pp. 1244-1245.
[654] Richard K. Ashley; 'The Poverty of Neo-Realism' *International Organization* Vol. 38, No. 2 (Spring 1984), p. 267.
[655] Hay, *op. cit.*, p. 103.

that a human sacrifice to a god during winter is necessary in order to bring about spring could be considered as perfectly rational to the person making the sacrifice. Every year the sacrifice is made and every year the spring arrives, because the god is pleased. Although from a contemporary perspective this may appear to be completely irrational, it could be considered to be rational from the perspective of the person involved because of a belief in a clear causal relationship between the action and the consequence. Thus an action which is considered to be rational from one perspective can also be considered to be irrational from another perspective. This disjuncture, between the internal and the observed, suggests that the existence of human fallibility creates grave difficulties for the application for RCT.[656] Such theories as Hardin's tragedy of the Commons require reality to operate as a mechanism, devoid of human agency and without random variables. Individual perception is such a variable which they struggle to account for.

The possibility of change is also lacking from the tragedy of the Commons, as it is with neo-Realism. Their joint conceptualisation of the world is positivist and the assumption exists that the structural forces which control agents' actions exist prior to any interaction, indeed they have existence in their own right, independent of agency. Therefore, any event which occurs is simply the same phenomena of the past reoccurring, as it is caused by the same structural forces. It is not surprising that Hardin cannot account for instances in which Commons regimes emerge, just as neo-Realism cannot account for the emergence of the Westphalian order.[657] Clearly the debris problem has encountered genuine change, as near Earth space has been reconceptualised as a resource which needs to be protect and a new institutional form has been created.

The absence of change is coupled with an absence of history from RCT theories. Because agency does not have the capacity to alter the environment within which it is located, there can only be a 'timeless present', the past and future cannot be qualitatively different from what currently is.[658] This is an obvious benefit to any theory as it does not have to justify any origins; the world has always been as it is and will always be as it is.

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[656] Nicholas Onuf; 'Constructivism: A User's Manual', in Vendulka Kubalkova, Nicholas Onuf and Paul Kowert (eds.); *International Relations in a Constructed World* (London: M.E. Sharpe, 1998), p. 60.
[657] Andrew Linklater; 'Neo-Realism in Theory and in Practice' in Ken Booth and Steve Smith (eds.); *International Relations Theory Today* (Cambridge: Polity, 1997), pp. 254-255.
[658] Ken Booth 'Dare not to know: International Relations Theory versus the Future', in Booth and Smith (eds.), *op. cit.*, p.332.

Therefore, the theory is not required to justify its own existence; as reality does not change, the theory has always been valid and will always be. Reality is purely created by structure, as that structure existed prior to social interaction it has always existed and always will, in essence the structure has existence in its own right. Thus, when a new environment is considered, such as Earth orbit, in the timeless present the stage setting may have changed but from a RCT perspective the script remains the same. Although this gives a theory a consistent, and simple, internal logic, it does pose questions as to how accurate a representation of reality the theory actually is. The principle criticism is that such theories have not placed any limitations upon their own applicability; therefore they have asserted that they are universal, in all places and times. This means that the theory does not have to explain under what circumstances it is relevant, but it also undermines it because instances occur when it is not applicable.

The difficulty concerning change is also manifest in agents reconsidering their objectives. As an actor cannot act with innovation, how can it alter its existing position when external factors remain constant? As such the tragedy of the Commons would be utterly unable to explain an instance in which individuals come to appreciate that cooperating, in order to protect the resource and therefore limit their short term gains, is a preferred course of actions.

A further difficulty in the theory, concerning the role of agents is more clearly viewed when abstracting from the herdsmen of Hardin, to the more complex social agent of the state. When considering the social world, within the RCT of neo-Realism, the assumption is present throughout, that order can only occur within the state. R.B.J. Walker makes this argument with reference to Realist states, asserting that the anarchy outside of the state is required in order to give existence to that which occurs in opposition, the internally ordered political unit.[659]

Therefore, if the attempt is made to analyse near Earth space through the paradigm of Hardin's herdsmen, the assertion would have to be made that states are unitary actors, incapable of cooperation between themselves. Yet here the flaw of a lack of history in such theories is exposed. The state is a cooperative entity, within which individuals have made

[659] R.B.J. Walker; *Inside/Outside: International Relations and Political Theory* (Cambridge: Cambridge University Press, 1993), esp. pp. 159-183.

their interests collective. If it is possible for this level of cooperation to occur in order for the state to come into existence, then the assertion that there cannot be cooperation between states in order to form trans-national governance, becomes a statement of belief. A statement which stands in opposition to historical precedent and which, without supporting evidence, is little more than an act of faith.

The orientation of RCT towards entirely structural explanations is such that it negates individual characteristics of agents, which has resulted in the approach producing a limited account of International Relations. Because neo-Realism attempts to locate all explanation of events in the international sphere to the anarchic interstate system, 'the units [states] have no identity independent of the structural whole'.[660] Given that neo-Realism was born during the Cold War, there was some justification for a rejection of the internal structures of states as being important. Both the USA and USSR considered the other to be the antithesis of itself. However, despite being internally opposites, they followed foreign policies which were broadly similar.[661] Hence there appeared to be justification in the belief that any state, no matter what its internal composition, would act in an identical fashion to any other state, because ultimately its actions would be determined not by itself, but by the international system in which it is located. Thus, from the perspective of Waltzian Realism, within the international system there are no differentiating characteristics, 'a state is a state'.[662] The instance of debris may appear to support this supposition, as all states with active space programmes appear to be acting in a similar fashion. However, although this supports the idea that they are all being directed by structural factors, it does not prove it. The phenomenon can also be explained in terms of them individually realising that it was to their benefit to cooperate.

However, as neo-Realism was a child of the Cold War so the end of that period presented an incredible challenge; the school of thought had completely failed not only to predict the change but was also not able to adequately explain it *post hoc*. Therefore, the allegation arises that neo-Realism, as a representative of RCT when applied to International Relations, does not provide an accurate account of the world. Rather it was created in order to justify the world as it existed during the Cold War. As such, it would cease to be a theory,

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[660] Ashley, *op. cit.*, p. 235.
[661] Linklater in Booth and Smith (eds.), *op. cit.*, pp. 242-243.
[662] Waltz (1979), *op. cit.*, pp. 71-73.

and becomes instead a descriptive model. Such a criticism could chronologically be raised concerning Waltz's 1979 work, which argued that nuclear bi-polarity was the most stable international form, an order which was manifest at the time that Waltz was writing.[663]

Family Similarities between 'The Tragedy of the Commons' and Neo-Realism

It was in Waltz work that the Realist tradition coalesced with Rational Choice Theory. He believes there are three elements to the 'real world' the individual, the state and the state system.[664] His analysis argues that it is the international system and its anarchic character which are the principle cause of events within International Relations. Waltz places states ontologically prior to the international system; therefore it is the actions of states which create everything which Waltz focuses upon.[665] The states Waltz conceptualises have real qualities, it is therefore of no importance who examines a state; object and subject are independent.

His construction of the anarchic system is based upon micro-economic theory. As this does not need a theory of the firm, so Waltz maintains that his theory does not require a theory of the state.[666] In a Waltzian world not only is there no theory of the state, but there is no theory of history; he believes three thousand year old texts reveal the same anarchic state system as exists in the present;[667] also there is no concept of a future that is qualitatively different from what exists, there is only a 'timeless present'.[668]

A brief examination of the nature of Waltzian states is in order, to properly appreciate the world which he comprehends. Firstly, states are the only actors which are of real importance in International Relations and they behave as rational choice actors.[669] Thus, any two states placed into the same set of circumstances will behave in the same way, the rational way which is dictated by the international system. To complete the description of the state the adjective 'unitary' is required. Waltz acknowledges this as a basic assumption

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[663] *Ibid.*
[664] Waltz (1959), *op. cit.* and Waltz (1979), *op. cit.*.
[665] Ashley, *op. cit.*, p. 240.
[666] Waltz (1979), *op. cit.*, pp. 71-73.
[667] *Ibid.* pp. 66 & 186.
[668] Booth in Booth and Smith (eds.), *op. cit.*, p. 332.
[669] Chris Brown; *Understanding International Relations* (London: MacMillan: 1997), pp. 55-56.

of his theory.[670] Perhaps purposefully he is not explicit concerning its implications, for it means that 'a state' acts with one purpose, it is bestowed with near consciousness, as 'states make decisions'. But in this world there are no differentiating characteristics 'a state is a state'.[671] Here the symmetrical relationship with Garret Hardin begins to emerge. The herdsmen of Hardin all act in exactly the same fashion, when presented with the same circumstances. Further, in the case of the herdsmen they are inherently unitary as they are individuals. As such, ontologically the herdsmen of Hardin are analogous to the states of Waltz.

Waltz is a positivist, as is Hardin, although Waltz denied this, describing himself as a Kantian.[672] However Kantian is not a term commonly given to an epistemological position. Further as Booth,[673] George,[674] Devetak[675] and Walker[676] have already considered Waltz's work to be a positivist, this piece will also proceed from that reasonable premise.

Positivism has been the dominant epistemology of International Relations throughout the majority of its existence as a distinct discipline.[677] The positivist believes that the world is 'real' and exists 'out there' waiting to be discovered and understood,[678] thus objects in that world have meaning which is inherent to themselves and can be examined.[679] There is debate within the social sciences concerning epistemology, specifically whether importance should be focused upon ideas or material forces. Positivism rejects ideational factors completely it is purely materialistic. Thus there is no role for ideas or perceptions.[680] Further, as Waltz believes that structure is of primary importance and it applies in every instance he is of the holistic as opposed to the individualistic tradition.

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[670] Waltz (1979), *op. cit.*, p. 118.
[671] *Ibid.* pp. 71-73.
[672] Fred Halliday and Justin Rosenberg; 'Interview With Ken Waltz' *Review of International Studies* Vol. 23, No. 3 (1998), p. 379.
[673] Booth in Booth and Smith (eds.), *op. cit.*
[674] Jim George; *Discourses of Global Politics: A Critical (Re)Introduction to International Relations* (Boulder, Colorado: Lynne Rienner, 1994).
[675] Richard Devetak; 'Critical Theory', in Burchill and Linklater (eds.), *op. cit.,* p. 160.
[676] Walker, *op. cit.*.
[677] Steve Smith; 'The Self-Images of a Discipline' in Booth and Smith (eds.), *op. cit.,* p. 14.
[678] Hollis and Smith, *op. cit.,* p. 203.
[679] George (1994), *op. cit.,* p. 21.
[680] Hay, *op. cit.,* pp. 56-57.

Here again the symmetry between Waltz and Hardin can be seen. The social forces which exist, and control the actions of the Hardin's herdsmen, are real and have existence independent of the herdsmen. As Alexander Wendt notes the structure of Waltzian neo-Realism is defined entirely by material forces, '[t]he kinds of ideational attributes or relationships that might constitute *social* structure, like patterns of friendship or enmity, or institutions, are specifically excluded from the definition'.[681] Therefore, it is the circumstances of the situation, not the will or actions or agents, which control events. The control in the situation is exercised by such materialistic and structural forces, the herdsmen are powerless to control their social environment. Epistemologically, the tragedy of the Commons can only be positivist; the rules exist independently of agency, the phenomenon observed is not due to the herdsmen's ideas or perceptions but the material forces which as have real qualities independent of agency.

Waltz uses the example of a stag hunt to explain human behaviour,[682] then uses the hunters as a model for state behaviour. In doing so he has not *explained* what a state is, it remains a pre-social actor.[683] In Waltz's world states simply are, he has no theory of the state a fact which he acknowledges.[684] As states simply exist, their origin and purpose is not considered. Therefore it is possible to simply categorise all states as being ontologically the same. Should one state make decision A in circumstance B, then all states when faced with B will act in manner A. This position is supported by Waltz's positivist epistemology. Because he believes that reality exists in its own right there is no need to explain the actions of a state, it simply acts as it acts due to material forces; why is not a question which is adequately addressed. There is a tension here which underlies neo-Realism; the state is believed to exist in an anarchic world, however at some point the issue of domestic anarchy must have been resolved in order for the state to come into being.[685] Here it is seen that there is something fundamentally problematic with neo-Realism. However positivism can be seen to distract attention from these difficulties because the neo-Realist perspective appears to be

[681] Alexander Wendt; *Social Theory of International Politics* (Cambridge: Cambridge University Press: 1999), p. 16. Emphasis in original.
[682] Waltz (1959), *op. cit.*, pp. 167-168.
[683] George (1994), *op. cit.*, pp. 122-123.
[684] Waltz (1979), *op. cit.*, pp. 71-73.
[685] Ashley, *op. cit.*, pp. 247-248.

'common sense' and plausible[686] therefore the positivist can claim that reality must exist because it can be 'seen' to exist.

The second criticism of Waltz is that he has no concept of time. Yet because his focus is upon holistic forces he does not need one if he can show that the system is atemporal. Waltz uses history to proclaim that neo-Realism is timeless, thus the current order is 'the natural order'.[687] The whole of history is simply a repetition of what has gone before, a nuclear stand off between capitalism and communism is the same phenomena as the Peloponnesian war, and it is always controlled by international anarchy. Thus, Waltz's proposal concerning the benefits of the spread of nuclear weapons[688] can be seen to be internally logical because his theory of International Relations is the balance of power[689] and nuclear weapons created a balance of power during the Cold War. Thus, he has discovered regularity which is 'real' as it exists in a positivist world, no change occurs due to the passage of time and thus the spread of nuclear weapons is not to be feared. Once again there is a notable symmetry with the work of Hardin here. 'The tragedy of the Commons' is also considered to be atemporal as it represents a universal truth of what will happen to an unregulated Common. Hardin does not merely write that the tragedy of the Commons may occur, rather he argues that it will inevitably occur. However, for both approaches (although in fact they are one approach with different actors) should their positivist assumptions about a 'real world' be falsified then their premises would also fall.

Yet this is not a probable scenario, for the prospect of the basic assumptions being undermined is not a matter which need concern neo-Realism, nor the 'tragedy of the Commons, as they are subtly *defended* by positivism. The positivist systemic framework allows certain objects to be considered as ontologically real. Once the neo-Realist has made this move, a closed discourse is created where there is only one possible explanation. Thus if the problem is anarchy, defined in terms of sovereignty, the solution of balance of power is already inevitable.[690] This 'positivist defence' allows neo-realism to be 'self enclosed and

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[686] Justin Rosenberg; 'What's The Matter With Realism' *Review of International Studies* Vol. 16, No. 4 (1990), p. 297.
[687] Ashley, *op. cit.*, p. 228.
[688] See Scott D. Sagan and Kenneth N. Waltz; *The Spread of Nuclear Weapons* (W.W. Norton, New York, 1995).
[689] Waltz (1979), *op. cit.*, p. 117.
[690] George (1994), *op. cit.*, pp. 224-225 and Rosenberg (1990), *op. cit.*.

self affirming'.[691] In short, once a set of objects are designated as being ontologically real they will allow for a certain solution to be found; in positivism it is the real materialist ontology which inevitably leads to a solution.

Thus, it can be seen that both the 'tragedy of the Commons' and neo-Realism are systemic approaches which require there to be a 'real world' which is external to their theories. They assert that they have a 'scientific' approach to reality which measures that which exists, specifically grand social forces, which dominate the events that they are concerned with. To Hardin the herdsmen act the way in which they do, not because they choose to but because they are attempting to maximise profit and are dominated by the social circumstances in which they find themselves. Similarly for Waltz, behaviour in the international realm can be explained because of the anarchic character of the system.

The empirical evidence that has been presented in this thesis reveals that the response to debris has not been that of 'the tragedy of the Commons', rather there has been a concerted international effort to address the problem. That the evidence does not fit the theory is not the most troublesome aspect for these approaches. Rather the greatest problem is that a claim to universality has been falsified. That cooperation has occurred in a Common reveals that there is more occurring than a mere 'blind interaction' between actors trapped by great social forces.

Thus, the first important lesson for International Relations theory can be seen: the claim to universality which RCT/the tragedy of the Commons/neo-Realism make has been severely undermined. This chapter has explored the meta-narrative assumptions which support such thought and found a strong intellectual tradition which suggests that the positivism epistemology has been used in order to defend these approaches from having to address questions concerning their origins and applicability. It should also be considered that the materialist discourse in which these positivist traditions are entwined is also problematic. This thesis has shown the crucial role played by the epistemic community, which is inherently ideational. This in another matter which neo-Realism/the 'tragedy of the Commons' both fail to account for; they rely solely upon material forces to explain reality, and as such they cannot account for the role, and importance, of ideas. The ontological assumptions of neo-Realism stand in opposition to the evidence in this thesis. In Hardin's

[691] Ashley, *op. cit.*, p. 228.

parable, the herdsmen are the only actors of interest, which is not a difficulty as he is reflecting upon his abstracted version of reality. However, neo-Realism created a dialogue in which states are the only actors of importance, all others are considered to be of no significant importance. Therefore, the actions of individuals in creating a trans-national network of knowledge would not be important, whereas this thesis has found it to be absolutely essential in explaining the response to debris.

Hardin's Theory and the Technical Nature of the Debris Problem

Hardin proposed two means by which the tragedy of the Commons could be avoided: either the resource could be privatised or a leviathan could govern it. These means of management cannot be easily applied to Earth orbit; it is inconceivable that according to the political territory below, specific sections of Earth orbit could be privatised, such that outer space would become an extension of air space. The very word 'orbit' refers to the circular paths which satellites have to take in order to avoid being dragged towards the planet by gravity. Therefore, were near Earth space to be divided according to the political territory beneath it, a satellite would have to pass through several state's territories in order to sustain orbit.

It is physically possible that specific orbits could be privatised, as such an actor would own an altitude and be responsible for activities which occurred there. Yet, there are two major flaws in such a proposal. Firstly in order to reach higher orbits it would be necessary for craft to pass through territories belonging to several actors, given that in so doing rocket stages, or other items of debris, could be jettisoned there are seemingly insurmountable difficulties in guaranteeing rights of passage and access. The second, and more problematic, difficulty for such privatisation is that all altitudes are not all of equal worth. In Hardin's example of a pasture, it is easy to conceive of each herdsman being given a piece of land which is roughly equal to that assigned to ever other herdsman. When considering altitudes above the Earth, some are far more economically and practically useful than others. For example geostationary orbit is the most highly sort after of all; its utility is demonstrated by the fact that it is the only one which has an explicit formal regime to govern its usage.[692] The lack of equality concerning orbits is also demonstrated with

[692] The International Telecommunications Union, regulates the orbital slots in geostationary orbit, this is principally to prevent interference, which would occur if frequencies were used which were too

reference to accessibility: those allocated higher orbits, would face the economic problem of having to expend greater amounts of fuel in order to reach them. Therefore, in practical political terms, it is inconceivable that states would willingly agree that their actions should be limited to a specific orbit, even if that altitude should be granted to them exclusively.

As the route of privatisation, proposed by Hardin, is impractical for Earth orbit attention falls upon his proposition of a leviathan to govern the resource. In the absence of world government, the only realistic actor which could achieve hegemony in space is the United States of America. The Rumsfeld Commission, which was the most extensive recent government review into US space policy, envisaged military conflict in orbit as a 'virtual certainty'. Therefore it promotes a vision of the USA as a hegemon, although the word is not used directly. The report emphasises that the USA should seek to promote the peaceful use of space,[693] whilst guarding against a 'space pearl harbor'[694] through maintaining US technical superiority[695] and improving its capacity to project power, 'in, from and through space'.[696] In short, the vision of a peaceful usage of space is conducted under the benign hegemony of the USA.

Yet it is far from the present situation that the US could express its will in space to such an extent that all other states would stand in awe of it as a leviathan. Currently, it is the case that the US is the dominant power in space, however although it undoubtedly can influence others, it is not sufficiently powerful to control their actions. Therefore, it does not have the capacity to act as the leviathan which Hardin conceptualises governing near Earth space.

As neither of the means of managing a Commons proposed by Hardin are applicable to near Earth space, it would suggest that from his perspective the resource is destined to become useless to all actors.

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close to each other. In effect this means that it regulates the placing of satellites in orbit it is not a regime intended to regulate the issue of debris. Vogler, *op. cit.*, p. 193.

[693] *Report of the Commission to Assess United States National Security Space Management and Organization*, *op. cit.*, p. 15.

[694] *Ibid.* pp. 8, 13 & 15.

[695] *Ibid.* p. 18.

[696] *Ibid.* p. 16.

However, the evidence of near Earth space reveals a situation in which Hardin's warning proved to be false. Neither the route of privatisation or the imposition of order by a leviathan have been followed, however regulation has emerged. The actors who utilise the resource, near Earth space, have collectively created forms of regulation in order to avert the tragedy of the Commons. In doing so they have demonstrated the logic of cooperation, as by jointly observing rules, they have protected the resource for the community as a whole and for themselves individually. A consequence of this is that states have limited their actions, they have not behaved as a herdsman of Hardin would, consuming as much of the resource as possible, regardless of the future consequences.

Ostrom and Neo-Liberal Thought

If Realist thought tends toward a Machiavellian view of the human condition, then Liberal thought allies itself with a Kantian view. Similarly, as there is a symmetrical relationship between Hardin and neo-Realism, so Elinor Ostrom's work has familial characteristics with neo-Liberal institutionalist thought. Both Ostrom and neo-Liberalism seek to examine situations in which ordered social relations can be established out of either an anarchic situation or one lacking in clearly defined regulations.

Liberalism as a tradition has origins in the Enlightenment, the belief in modernity. From this perspective humanity can move towards a perfect form through rationality. Thus, a historic destiny exists and history itself is linear.[697] Neo-liberalism as a school of thought originated in the work of Robert Keohane and Joseph Nye. As with classical liberalism and neo-Realism it is a positivist tradition,[698] therefore it perceives facts and rules which exist independently of the observer. Thus, if a rule is followed a resultant action will inevitably occur, hence the Enlightenment perspective that reason and the scientific method constitute inevitable progress to a more utopian world. Although both Liberalism and neo-Realism share a positivist tradition, they utilise it in a radically different fashion. To neo-Realism it results in a timeless present, whereas Liberalism perceives the social circumstances, the external forces, as not being prohibitive to humanity's progress towards a more perfect

[697] John A. Vasquez; 'The Post-Positivist Debate: Reconstructing Scientific Enquiry and International Theory After Enlightenment's Fall'; in Booth and Smith (eds.), *op. cit.*, pp. 219-220.
[698] Smith in Booth and Smith (eds.), *op. cit.*, p. 14.

social order. As such Liberal thought can be thought of as a 'project' as it has a definite objective in mind. Further neo-Liberalism is not an exclusively materialist discourse.

Keohane and Nye's work has to be temporally located in the 1970s when, not least due to the SALT treaty, the Cold War and the threat of nuclear war had receded. The realist paradigm, a war of all against all, no longer appeared to explain what was happening at the global level. Thus, neo-Liberalism conceptualised the world in terms of complexity; national security as the primary factor in International Relations had given way to inter-dependence.[699] From this perspective international anarchy can be overcome if states seek to make absolute gains, rather than relative gains. The world is therefore no longer zero-sum,[700] thus even the relative gains argument in favour of war ceases to have validity.

The idea of international co-operation can be explained through the Prisoner's Dilemma. The neo-Liberal perspective argues that states are locked into a 'supergame' of the Prisoner's Dilemma, therefore the long term optimal outcome is for them to cooperate for mutual benefit. As has been seen in a supergame, it ceases to be logical for a state to defect, for short term benefit, when they can cooperate for long term benefit. Waltz himself commenced his 1959 work with the observation that '[a]sking who won a given war, someone has said, is like asking who won the San Francisco earthquake.'[701] Liberal thought builds upon the futility of such zero-sum interactions and seeks to argue that in terms of mutual self interest it is to the benefit of states to co-operate within a regime. Regimes being defined by Keohane and Nye as 'procedures, rules, or institutions [by which] governments regulate and control transnational and interstate relations.'[702] It is important to note that regimes are not necessarily organisations with formal structures, rather ideational elements, such as rules, are also considered to play a role in the relations between states.

Hedley Bull identified an aspect of the international order which also has relevance to the neo-Liberal perspective, namely the 'domestic analogy'. This is the notion that ordered society is maintained within the state because all citizens stand in awe of the state's power, therefore order would be brought to inter-state affairs if all states were subject to a

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[699] Robert O. Keohane and Joseph S. Nye; *Power and Interdependence* (Boston: Little, Brown and Company, 1977), pp. 6-8.
[700] *Ibid.* pp. 10-11.
[701] Waltz, *op. cit.*, p. 1.
[702] Keohane and Nye, *op. cit.*, p. 5.

common authority.[703] When this principle is applied from a neo-Liberal perspective the purpose of regimes, and specifically institutions, becomes clear; they are the means by which states form a common authority whose rules they have created, but agree to be bound by. Although they cannot provide the hegemonic authority of a domestic government, they can introduce order and stability to the interactions between states. As was discussed above, approaches to International Relations which consider governance also seek to highlight the importance of organisations which perform the functions of government in the absence of government.

As stated above, Liberal thought contains a teleological aspect as humanity is moving towards a more perfect social order. History is therefore understood to present a gradual process of cohesion in the international sphere. For although there have been great human catastrophes a new system has always emerged to restore order. Thus, although the collapse of the League of Nations and the Second World War was a great tragedy, it was followed by the creation of a better global organisation, the United Nations. Timothy Dunne considers the UN to be the manifestation of neo-Liberal thinking, for it recognises the needs of the Great Powers whilst seeking to be inclusive of non-state actors.[704]

The nature of interaction from a neo-Liberal perspective is also different from that of neo-Realism; emphasis is placed upon the importance of absolute, rather than relative gains and the importance of institutions as a means to overcome the problem of international anarchy.[705] These characteristics can be seen in the active response to the presence of space debris. Further, the debris problem is fundamentally characterised by inter-dependence, in response to which neo-Liberalism can be caricatured by the simple statement that 'regimes fix problems'. This approach appears to have a high degree of correlation with what has occurred internationally in response to the debris situation. However, it does not provide a comprehensive explanation, for although it can account for the behaviour of states in one global Common, it cannot readily explain why in other Commons tragedy still seemingly remorselessly occurs.

[703] Bull (1995), *op. cit.*, pp. 44-50.
[704] Timothy Dunne; 'Liberalism', in Baylis and Smith (eds.), *op. cit.*, pp. 153-154.
[705] Smith in Smith and Booth (eds.), *op. cit.*, p. 23.

The acknowledgement of regimes as significant actors is not unique to the Liberal tradition, Realism also contains the possibility for regimes to be founded, although not necessarily as a recognition of collective interests. As has been previously discussed, although the United States is the most militarily capable state in space, it does not constitute a hegemon. From a Realist perspective it would be necessary, or at least strongly desirable, for a hegemon to exist in order to found a regime and then exert pressure upon other states to abide by it. This does not appear to be a valid description of the response to space debris. The practice which states are engaged in, the formation of a remedial regime, is not the product of coercion, rather it is seemingly founded upon the recognition of collective interest. In opposition to the Realist notion of regime formation, Peter Haas has observed that neither technological change, nor changes in the power distribution in the international system can explain the emergence of international environmental regimes.[706] Thus, although in a Realist paradigm the existence of environmental regimes can be acknowledged, there is a still a great difficulty in explaining where, when and why they will emerge. Further, neo-Realism has an ontology which is almost exclusively state-centric; if other actors are considered to be of any importance it is almost exclusively because they can be used as a tool of states. Therefore, within neo-Realism regimes do not have ontological importance in their own right, rather they are important if they are being used by states in order to achieve their objectives.

Empirical evidence into the approach which governments have adopted towards the problem of debris, and the creation of structures to address it, can be found in the documents which national space agencies have produced. In a paper co-authored by one of the key figures concerning debris mitigation at British National Space Centre, reference is made to the fact that remedial action towards the problem has to be made in a coordinated manner, in part to ensure that individual preventative measures will not 'penalise operational effectiveness'.[707] Thus, as Ostrom and neo-Liberal institutionalism describe, a situation has emerged wherein parties are communicating in order to form a regime which allows them to continue to exploit a communal resource. What is occurring has a high degree of correlation with the Prisoner's Dilemma scenario and a set of rules are being constructed which through practice will, most probably, come to be considered as an ideational institution. Here the

[706] Haas in Prakash and Hart (eds.), *op. cit.*, p. 106.
[707] Crowther *et al* in Dansey (ed.), *op. cit.*, p. 577. Richard Tremayne-Smith, one of the co-authors, is the principle contact between the British National Space Centre and the Inter-Agency Debris Co-ordination Committee.

importance of ideational factors can be seen, as actors are able to create a social reality according to their perceptions and beliefs.

As can be seen, there is a high degree of correlation between Ostom and neo-Liberal institutionalist thought. They are both concerned with the importance of cooperation for mutual benefit; as such absolute gains are more important than relative gains. Further, institutional forms, whether physical or ideational, are considered as important as they present the means through which actors can regulate their behaviour and create virtuous circles for mutual benefit.

Having considered the evidence concerning debris, it is possible to consider the characteristics of a Common which Ostrom identified as being important in order to facilitate the possibility of cooperation:

- Feasible improvement – Debris has not yet reached the stage where there is no possibility of improvement. Although certain orbits may be approaching the level of debris population wherein the Kessler Syndrome would occur, this is only a possibility for a few altitudes. Indeed, the possibility for improvement is very strong, as the greatest cause of concern regarding the preservation of near Earth space is not a reflection upon its present status, but the dangers posed to its future circumstance.
- Indicators – As has been discussed in this chapter, there is strong data available concerning the debris population. Although it has limitations, especially concerning small pieces of debris, it is sufficiently accurate to be able to establish trends in the debris population, and therefore whether remedial action is effective. The indicators are not available at low cost, as Ostrom has indicated as being preferable, however given the budgets of national space operators they are not prohibitively high. Further, such resources as large telescopes are not built exclusively to detect debris; as the fixed cost of their existence is already paid for, the marginal cost of their usage to detect debris is relatively low.
- Predictability – The availability of near Earth space's capacity to be used for satellites is entirely predictable. The only factor which makes its capacity uncertain is damage caused by human activity.

- Spatial extent – Near Earth space, relative to the usual areas of human activity, is enormous, although it is tiny in contrast with the vastness of the cosmos. However, the technology available means that its size does not prohibit those who utilise it from being aware of what is occurring there.[708]

Similarly, the attributes of the resource and their importance concerning cooperation, as defined by Ostrom, can be used to analysis the debris problem:

The relevant attributed of those using the resource are:

- Salience – As was explored in the second chapter, systems which are dependent upon satellite technology are integral to modern Western lifestyles.
- Common understanding – Those people and institutions, with the capacity to enact measures to protect near Earth space are technical experts, they therefore have a common scientific understanding of the resource. Further, the scientific evidence which asserts that it is manmade debris that is posing a threat is not contested, or at least there is no evidence of it being contested.
- Low discount rate – There is no resource available that could serve as an alternative. If the industries and resources which depend upon near Earth space were to have their access to it terminated, there would be crippling consequences for the global economy.
- Trust and reciprocity – When considering the epistemic community this thesis found evidence that a high degree of trust between actors exists, this is manifest in the cooperative mechanisms which have been formed, and the lack of allegation of non-reciprocal behaviour.
- Autonomy – The question of autonomy depends upon the ontological position which is adopted. If the state is considered to be the object of research, then within International Relations, it is abnormal to consider it as not being autonomous. Adopting national space agencies as the object of research, they can be seen as being, to a large extent, autonomous as their technical expertise grants them independence from high politics.

[708] The factors, although not the analysis are taken from: Ostrom in Burger *et al* (eds.), *op. cit.*, p. 22.

- Prior organizational experience and local leadership – The issue of space debris does not exist in isolation, rather it occurs against a background constituted of laws and norms governing legitimate activity in space.[709]

Finally, the design principles, identified by Ostrom, concerning a successful regime to govern a Common can now be contrasted with the debris problem, in order to consider whether they can provide an insight into why the response to the debris problem has been largely positive. Ostrom's design principles, and their relevance to debris, are as follows:

- Clearly defined boundaries – Although all states have the legal right to use space as a resource, and private actors only have the right to use it with legal permission from a state, in effect there is a far smaller number of states which are concerned with this problem. The states which have the technical capacity to utilise space and therefore be responsible for the debris problem is small and well known.
- Congruence – The costs and benefits of utilising near Earth space as a resource are very closely related. As has been discussed, those who are most responsible for the production of debris, are those who have the most assets at risk from it. Also the ability to utilise the resource is related to the maintenance of its present environmental balance.
- Collective-choice arrangements – Ostrom argues that those who are affected by the rules concerning the resource should also be able to alter those rules. As has been seen, the IADC is the principle means through which the debris problem is addressed, its membership is inclusive of all the states which are affected by the debris problem and are required to take remedial action. The organisation also requires participation from all members in its key committees, therefore all those affected by the rules are able influence the nature of those rules.
- Monitoring – The response to this issue is two fold. Concerning large pieces of debris (such as dead satellites and spent rocket stages) it is possible to monitor whether they are being disposed of in a responsible manner. Further, as the use of tracking is very sophisticated the origin of a new large piece of debris would be readily known. Concerning small pieces of debris, it is not possible for external parties to measure the production of such items as bolts and lens-caps. However, the

[709] The factors, although not the analysis are taken from: Ostrom in Burger *et al* (eds.), *op cit.*, p. 22.

mutual cooperation in devising means to mitigate against the production of debris leads to the situation wherein actors can expect others to follow the standards as they have invested in creating them.

- Graduated Sanctions – There is a discontinuity between Ostrom's design characteristics and the evidence concerning debris with reference to sanctions. The purpose of the IADC is to encourage mutual cooperation, it does not have punishment mechanisms. Further, the 'regulations' that it produces are expressly designed as being 'guidelines' they do not contain enforcement mechanisms, rather their purpose is to disseminate best practice. Over a longer time period this situation may become a problem. At present the situation is characterised by cooperation; should this cooperation collapse then there are no enforcement mechanisms to ensure that standards are observed.
- Conflict-Resolution Mechanisms – There are no readily available means to address conflict concerning the majority of near Earth space. However, other than in GEO, there is little need. Presently, it is only GEO that has the characteristic of scarcity, and the ITU seeks to resolve problems which arise in this regard. The assumption that the IADC proceeds from is that the supply of access to the majority of Earth orbit can be maintained at such a level that there will be a sufficient quantity for all to use. As with the issue of graduated sanctions, this is an area which may be the source of difficulties in the future, should the policy environment concerning debris cease to be characterised by cooperation.
- Minimal Recognition of Rights to Organize – In an abstracted view it is states who design the organisational elements concerning near Earth space, and as has long been established in International Relations, they are not subject to a higher authority. In practice it is the specialist space agencies of states who design the regulatory process. However, as this thesis has argued, because the problem has not been politicised, they are not subject to interference from a higher political authority, not least as it is assumed that they are acting in the best interests of their respective governments.
- Elinor Ostrom also suggests that when a common pool resource is part of a larger whole, then the regulation should be organised in multiple layers. This is clearly the case with the overall governance of near Earth space. Although the IADC is the primary organisation addressing the problem of debris, it is part of a greater whole

which provides regulation. However, as has been seen there are strategic relationships which bind all of the institutions together.[710]

The research that Ostrom has conducted into the means through which co-operation can be achieved is also illustrative when considering debris. As has been stated, there is the relatively small number of actors involved in addressing the debris problem. Although Ostrom notes that the general effect of the size of a group is unclear,[711] it appears that in this instance, the limited number of actors involved has helped to create the circumstances in which a common understanding of the problem could be created. The number of agents involved in this instance is low as very few states launch satellites into orbit. In 2002 only seven actors, Russia, the United States, Europe,[712] Japan, China, India and Israel, conducted launch activities,[713] whilst in the five year period 1998-2002 only ten did so, Brazil, North Korea and Ukraine being the three other states.[714]

The limited number of actors involved is further emphasised as during the five year period up to 2002 Russia, the US, Europe and China were responsible for over 90% of all launches.[715] Thus, when considering the possibility of cooperation to address the issue of debris, it is of importance that there is a limited number of agents. Further, all of the major actors are members of the Inter-Agency Space Debris Coordination Committee (IADC), the principle international body seeking to produce solutions to ameliorate the problem.[716]

The level of cooperation found in this instance does not occur in isolation, rather at present cooperation characterises the international usage of space; recently Cassini-Huygens was a joint ESA/NASA mission to investigate Saturn,[717] whilst the International Space

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[710] The analysis in this section is original, the design principles are those of Ostrom. See Ostrom in Burger *et al* (eds.), p. 29.
[711] Ostrom in Burger *et al* (eds.), *op. cit.*, pp. 31-34.
[712] Europe is considered to be a single state for this purpose, which although not politically accurate, is so with regard to space activity, as the European Space Agency conducts a single space policy. Europe may not be 'sovereign' when the word is being used as a noun, but when considering space activities it is so if the word is utilised as a verb.
[713] 'Commercial Space Transportation: 2002 Year in Review' *Associate Administrator for Commercial Space Transportation: Federal Aviation Administration* (January 2003), p. 7. < http://ast.faa.gov/files/pdf/2002yir.pdf >.
[714] *Ibid.* p. 12.
[715] *Ibid.* p. 5.
[716] Membership details of the IADC can be found at < www.iadc-online.org >.
[717] < www.bnsc.gov.uk/default.aspx?nid=4395 >.

Station draws upon the resources of 16 countries.[718] Space activities are currently substantially different from the Cold War inspired rivalry of the Moon race. Thus, with reference to space policy, there is prior organizational experience.

The number of actors with the capacity to regulate the production of debris is also limited by Article VI of the *Outer Space Treaty* which places responsibility upon states for the actions of non-governmental agencies,[719] therefore international law has limited those accountable to nation states. When private actors make a launch it is under licence from the state which they are located within. The exclusion of non-state actors, from the decision making process removes a level of analysis problem which is present when considering other environmental problems, such as anthropogenic carbon dioxide. Considering global greenhouse gas emissions there are three broad levels of analysis at which the problem could be said to exist: governments, private corporations and individuals. States are able to take a lead in addressing the problem, however private corporations and individuals are still required to take positive action as well. Private corporations can argue that their sole responsibility is to the wishes and interests of their shareholders. They may offer more environmentally friendly products but consumers will decide if they are willing to pay for them in the market place. Finally the individual may be concerned with the global environment but is playing the Prisoner's Dilemma on a grand scale. As such the consumer knows that their single actions will not have any significant effects. There is no clear explanation of which level responsibility is, or should be, located which in turn hampers remedial action.

When the problem of orbital debris is considered the limited number of actors facilitates the alleviation of the problem. In broad terms states are the only agents involved, in the instances where non-state actors play a role it is under the direct control of states. The removal of multiple levels of responsibility directly encourages the possibility of a successful resolution.

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[718] The project members are the United States, Russia, Japan, Canada, Brazil and the 11 members of the European Space Agency < www.shuttlepresskit.com/ISS_OVR >.

[719] '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 assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty.'

Similarly heterogeneity can be considered to be of importance when considering remedial action; the suggestion being that when a group shares a common cultural understanding they will be more inclined toward cooperation.[720] This can be seen to be the case when analysing the debris problem, as it is largely addressed at a technical level. Therefore, although the states involved may be characterised by different governments with different objectives, those who address the problem can be seen to constitute an epistemic community. Despite the national allegiances which exist, those directly attempting to find a resolution are bound together by their shared awareness of the need to find a collective solution. Further, if the states involved are considered at a more general level, although they may be considered to lack heterogeneity, they have the shared need to protect Earth orbit in order to preserve their individual space based resources.

When considering the evidence which this thesis has presented concerning debris, it can be seen that there is a broad correlation between what has occurred and the cooperative approaches of Elinor Ostrom and neo-Liberal institutionalism. In this instance absolute rather than relative gains have been of paramount importance. Further, there is a clear logic in all actors participating to redress the problem, because they are all exposed to risks from the consequences of inaction. Possibly the most important differentiating factor in the debate between neo-Realism and neo-Liberalism is the ontological conceptualisation. The evidence of the response to debris reveals that institutions are important as actors in their own right, they are not merely instruments of states. This differentiation is also present in the debate between Hardin and Ostrom, for Hardin does not conceptualise any real possibility of cooperation or communication in his parable, Ostrom however places the notion of actors being able to communicate and create new social forms which are to their mutual benefit at the heart of her approach.

The emergence of cooperation, and the creation of structures, can be seen to resonate with Ostrom's perspective. States are behaving rationally, but not in the fashion which Hardin perceived rationality leading inevitably towards. Rather, they have recognised mutual interests and therefore cooperation is perceived as the rational approach. In this respect they are behaving as if in a 'supergame', wherein it is rational to accept a suboptimal outcome in every interaction, in return for reciprocity resulting in long term benefits over the course of repeated interactions. Perhaps most importantly the development of

[720] Ostrom in Burger *et al* (eds.), *op. cit.*, pp. 31-34.

institutions, and ideas, concerning the governance of space has resulted in a common understanding of the problems encountered and the optimal means of addressing them. This has resulted in states progressing in a cooperative manner because their practice has given form to the institutions which have been created, this in turn forms a virtuous circle as the institutions created then influence future state behaviour.

Reflections upon the Theoretical Debate and Empirical Evidence

This section will seek to clarify the discontinuity that has emerged in the chapter thus far. Two rival approaches have been presented, which are seemingly mutually exclusive. However, there are proponents of both approaches and they exist within the same reality. Therefore, the question to be addressed is: why does the debate between these two rival positions continue? The following analysis will reveal that in part the two approaches can coexist because they are answering subtly different questions.

David Singer observed that in any scholarly inquiry there is a choice to be made: whether to focus upon the macro or micro level, meaning either an analysis of the component or the system as a whole. He illustrates this point with reference to a world map: projected from the equator the image is distorted from at the poles, and vice versa.[721] Neo-Realism is almost exclusively systemic, that it is seeks a macro level holistic understanding of the world. Waltz does not dispute that there is a role for agency, however he holds it as a constant in order to theorise about structure. It appears to be an established fact that in any effort to view either structure or agency it is necessary to negate the other level of analysis: as David Singer observed there is a problem of projection whenever a phenomenon is viewed from either level.[722]

This problem can be seen in both neo-Realism and the tragedy of the Commons. Because they seek to highlight the importance of structure, and attempt to explain all social interactions in terms of it, they have been abstracted to the extent that often empirical evidence simply does not correspond with their predictions. The number of idealisations has resulted in an ontology which is almost exclusively focused upon a small number of actors

[721] David Singer; 'The Level-Of-Analysis Problem in International Relations' *World Politics* Vol. 14, No. 1, (1961), pp. 77-92.
[722] *Ibid.* pp. 77-92.

and materialistic forces. This results in other actors and ideational forces having extremely destabilising consequences. In this instance the role of an epistemic community, and the institutional forms which it has created, are highlighted as being of primary importance. However, neo-Realism has conceptualised a world in which states and the material structure are all that is of importance. As has been noted, neo-Realism defines the problem of International Relations in terms of sovereignty and anarchy,[723] therefore the solution of balance of power is already inevitable. The empirical evidence presented in this thesis also shows that if the social environment is defined in such terms, then there is a distinct inability for the theory to explain actual events.

Martin Hollis and Steve Smith propose a typology of International Relations which can be divided into two categories; those which seek to explain and those which seek to understand. The explaining tradition is extremely closely related to the Realist school of thought. In essence it seeks to bring scientific rigor to the discipline. As a product of behaviourism it looks to find theories and laws which can explain human behaviour. Hollis and Smith find origins in the work of Carr and Morganthau, as they are seeking to bring a new approach to the discipline, removing the 'prescriptive and utopian' elements which had dominated the early 'idealist' phase of the discipline, replacing it with pragmatism and an understanding of 'how things really are'.[724] The approach of treating International Relations as a science which can be objectively assessed reached its apex with Waltz 1979 work.[725]

The alternative is 'understanding', this approach seeks to comprehend the world from the unit level. Therefore, if explaining is 'top down', understanding is 'bottom up'. Alternatively, it can be seen that 'explaining' attempts to explain actors in terms of the system, whilst 'understanding' attempts to explain the system in terms of the actors. To comprehend the world from this perspective a much broader approach is required, it is necessary to draw upon a wide range of sources and events, then attempt to extract patterns and meaning.[726] There is a simple retort to this approach, that all such scholars achieve is to describe what is happening, they do not actually bring any true meaning to it, thus it becomes 'journalistic' rather than 'academic'.

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[723] George (1994), *op. cit.*, pp. 224-225 and Rosenberg (1990), *op. cit.*.
[724] Hollis and Smith, *op. cit.*, pp. 45-67.
[725] Waltz (1979), *op. cit.*.
[726] Hollis and Smith, *op. cit.*, pp. 68-91.

It can be seen that the approach of Ostrom can be readily aligned with the understanding approach to International Relations. It is attempting to portray a detailed view of the social world but in terms of Singer's notions of projection, it lacks a view of the systemic whole. However, it does provide a much more richly detailed view of events than the systemic approach of Hardin/Waltz is able to.

There is a further differentiating factor between the two approaches, which is related to the role of agency. From the perspective of both Hardin and Waltz, the agents are trapped into a remorseless, indeed tragic, course of events. The approaches of Ostrom and neo-Liberalism allow agency a far greater role; hence their ability to change the social circumstances in which they find themselves. This has the consequence that there can be a 'moral dimension' to actions. Systems theories are essentially amoral, because there is no capacity for actors to behave outside of a specific way, whereas if agents are free to act as they wish, then they can actively choose to create a 'better order'. Subtly, and often implicitly, both Ostrom and neo-Liberalism are asking 'ought' questions. Such considerations in International Relations appeared to have been removed after the 'failure of the discipline' to prevent the Second World War.

Ostrom's work can be interpreted as a 'guide' to constructing a successful and viable regime in order to govern a Common resource. She is promoting the conditions under which cooperation is probable; the dissemination of this information appears to have the implicit purpose of increasing the probability of cooperation. Therefore, if the question asked is 'how can the resource be protected', then Ostrom is arguing what 'ought' to be done. Such an approach leaves open the criticism that what is being proposed is not a theory but prescription. Further, that Ostrom is not addressing 'why' questions, which would characterise a theory, but 'how' and 'ought' questions.

Thus, it can be seen that there are clear distinctions in why the two approaches can exist in the same reality, because although they are looking at the same phenomena they are asking different questions and therefore interpreting it in different ways. The systems logic of neo-Realism is looking for instances wherein the balance of power is the outcome of interactions. Because of the manner in which it defines its ontology these instances can be found. The cooperative approaches of Ostrom and neo-Liberalism are not looking to find broad explanations of what is occurring in a system, but to identify the circumstances which

enable cooperation to occur. As one focuses upon the structure and the other upon the actions and positions of agents, it can be seen to endorse Singer's notions of the inherent difficulties of projection when considering structure and agency.

Implications of the debris situation for International Relations

The evidence presented in this thesis has provided strong support for the notion that cooperation can occur in response to a specific collective problem. However, the remaining question is what lessons can be extracted from this instance for the discipline of International Relations as a whole.

Firstly, it must be established that what has been demonstrated is that in the instance of orbital debris, the response is best explained by notions of cooperation as they are given form by Elinor Ostrom, rather than the inevitable tragedy as described by Garrett Hardin. Therefore, it is the neo-Liberal institutional comprehension of the international order, rather than that of neo-Realism which is most useful. This is not to claim that such a broad conclusion can be drawn for the whole of International Relations.

The claim that Hardin's RCT can account for what will occur, by necessity, in an open Common is false, not least as the hypothesis does not explain the emergent response to space debris. However, although it is does not possess universal applicability, it can be seen to work in certain instances. Thus, it is not a complete theory of what will occur in an open Common, rather it is a description of what may occur. It is specific to instances in which the 'herdsmen', or generically actors, do not create a framework for collective action. This, in turn, leads to a series of other questions concerning the circumstances under which Hardin's model is accurate, and the variables which exist in those circumstances when it is applicable.

It cannot be denied that Hardin's parable is useful in examining the problems associated with an open Common. However, the difficulties within it expose that it is not a complete and universal explanation. His 'inevitable' tragedy is founded upon idealisations concerning individuals not facing any social constraints, access being completely open, demand outstripping supply (which is heightened by human greed) and actors being unable

to change the structure within which they are located.[727] When these variables are changed, or not present, it will be seen that a different response to managing the Commons is conceptually possible.

This thesis has not claimed that the tragedy of the Commons cannot occur when a resource is located in the global Commons. Indeed, the problem of climate change has shown that international cooperation does not occur simply because a problem is important. It is informative to contrast these two issues areas, for the contrast reveals that those characteristics which they do not share be can seen to explain the differing responses.

Debris and climate change have encountered notably contrasting international responses. The most striking differentiating factor between the problems of climate change and space debris is the consequences of remedial action. The full financial and practical costs of ameliorating the debris problem are not known. However, it appears certain that the financial costs, although high, will be manageable. Further redesigning space operations to be 'debris sensitive' will require effort, but this will not jeopardise the usage of space.[728] In the instance of climate change, the requirements upon states are clearly far more wide ranging, since developed countries are founded upon carbon based economies, thus to effectively address the problem it is necessary to challenge the core functions of states. Haas observed that there is a general pattern that costs of actions to resolve environmental problems tend to be 'concentrated and short term, whilst the benefits are diffuse and long term'.[729] This is certainly the case with climate change. However considering debris it is not only costs which are concentrated, benefits can also be considered to be so. As such, the relative simplicity of a solution for the debris problem appears to increase the probability of a regime to govern remedial action being created.

Further, the destructive action associated with climate change has a direct benefit for the actors involved, specially the rewards of an industrialised economy. For the debris problem, although states gain from having space based resources, they do not benefit from the actual production of debris, other than through avoiding the cost of amelioration. As the

[727] Feeny *et al, op. cit.,* p. 12.
[728] This is founded upon the assumption that such an approach is possible. There could be a 'hard' environment preservation approach arguing that the pollution of near Earth space, by any operations, is such that they should be strictly limited in an effort to preserve the resource in as near perfect condition for future generations as is possible.
[729] Haas in Prakash and Hart (eds.), *op. cit.,* p. 107.

production of greenhouse emissions is essential to the economic order of industrialised states, so there is a strong disincentive towards taking remedial action, unlike the instance of debris, where the space industry would benefit was such action being taken.

The actors involved also have an effect upon the social environment within which decisions have been made. As has been noted, there is a close correlation between those who pollute near Earth space, and those faced with the consequences of that pollution. For climate change, those responsible for the majority of the pollution are not expected to be those faced with the greatest problems. Actors are obviously separated geographically; the separation of actors temporally, concerning debris, does not appear to have been a detrimental factor in seeking remedial action. Therefore, states appear to be willing, in the case of debris, to take remedial actions in order to preserve the resource for future generations. The number of actors with interests in the environmental problems is also important; the small number of actors concerned with the debris problem appears to have increased the possibility of cooperation. Climate change concerns all states, which in turn increases the number of interests involved and increases the possibility of discontent. Further, all states concerned with debris are required to take broadly similar remedial actions, unlike climate change which requires varying responses from different actors.

Although to the general population of the planet the risks of climate change are far greater than those of debris, this is not the case for all actors involved. When the industrialised states producing greenhouse gases are considered, they are those who are most able to survive the predicted worst case scenario. Whereas, if the worst case scenario for debris is considered, and the most important orbits become useless, then no actor's interests will survive. Therefore, although debris can be considered to be a lesser problem, for those who are capable of affecting a solution, the worst case scenario is not survivable.

The projected consequences also differ between the two instances. In the case of climate change there is a broad scientific consensus that the global climate is changing as a product of human activity.[730] However, there is no clarity towards the extent of those changes, further there is no political consensus concerning the preferable course of action.

[730] Bjorn Lomborg argues that the threats to the global climate have been misunderstood. He does not dispute the rise in emissions of anthropogenic carbon dioxide but, based upon his interpretation of official statistics, he does dissent from the consensus view of its consequences. Bjorn Lomborg; *The Skeptical Environmentalist* (Cambridge: Cambridge University Press, 2001), esp. pp. 258-324.

Western political opinion contains a broad spectrum, from positions which are little removed from denying that climate change is a problem, to radical ecologists arguing for complete socio-economic reform to counter the problem, and encompassing those who argue in favour of technological solutions to survive the effects rather than address the causes. The response to debris is far more certain, there is a scientific consensus concerning the problem, the nature of the problem is understood as are the consequences of no remedial action being taken.[731] Debris is further characterised by a broad political consensus concerning the necessity for action and the appropriate form it should take.

In sum, there are qualitative differences between the two instances of climate change and space debris which these create notably different social environments within which actors are able to make decisions. Considering the notion that agents create institutions by the decisions they make, it can be seen that it is possible for two problems with family resemblances to result in two very different international responses due to the circumstances unique to both. In such a manner it is possible for Hardin's tragedy of the Commons and a cooperative notion to coexist within a single reality.

There are key characteristics which make the debris problem well suited for a cooperative solution to be accepted, the contrast with climate changes brings them into sharp focus. The argument of this thesis is that it is the existence of these factors which has resulted in the problem being addressed in an effective manner. The important lesson for International Relations on this point is two fold: firstly that these issues are important. Secondly, it is expected that if these factors were present in another issue area, then cooperation would again occur, provided that they there were not eclipsed by other more dominant factors which are not present in the present situation. These factors, in large part resonate with the attributes of the resource, the attributes of those using the resource and the design principles as identified by Ostrom.

- A close relationship between those who will face the consequences of the problem, and those who can take effective remedial action. This is clearly the case with debris, as it is the states who have active space programmes who are exposed to the

[731] For a comprehensive description of the nature of the debris problem see, Johnson and McKnight, *op. cit.*.

risk of debris impacts, they are also the states who are responsible for the production of debris.

- Proportionality between the amount of action which actors are required to take and the amount that they utilise the resource. When considering debris, the actors who have the largest space programmes are those who are required to carry the largest financial burden in remedying the problem. Proportionally they are the actors who also use the resource most, and derive the great benefits.
- A common understanding of the problem, and the solution, and communication between the relevant actors. This has been the case with debris. Indeed, the technical understanding of the problem is the product of research which has been conducted collectively by states with active space programmes. Further, the problem has been characterised by a concerted programme of communication and the free exchange of information between the relevant actors.
- A relatively cheap solution, which can be enforced upon all the private and public actors involved. Although redesigning space programmes may be expensive, in comparison to the enormous revenues which can be generated through satellite revenues it can be considered as small, or at least manageable. Importantly, because of the legal framework which surrounds the launch of satellites, it is almost impossible for private satellite operators to behave as 'free riders' concerning remedial action. Further all states with active space programmes have shown a willingness to enforce standards.
- The nature of the problem has not been politicised. As has been discussed debris has been addressed as a technical issue, it has not been characterised by political debate. The evidence suggests that a problem remaining at the level of 'low politics' results in consensus being more probable. Whether it is the nature of the problem that results in the problem being 'low politics' or being in the realm of 'low politics' defines the nature of the problem, remains unclear.
- The number of actors involved is small. As Ostrom described the exact influence of the size of the group upon consensus being achieved remains unclear. However, in this instance there are a small number of actors involved, and they are heterogeneous. The nature of the actors involved appears be conducive to the issue not being politicised.

- The consequences of inaction are clear and immediate. There is no doubt that if action is not taken then the capacity to utilise near Earth space as a resource will be either severely handicapped or entirely destroyed.
- Lack of an alternative. As a resource, near Earth space is unique. If considered only in terms of satellite technology there is no technical alternative which can provide the communications and monitoring capacity that is available through utilising near Earth space.

The instance of debris also provides lessons concerning the utility of neo-Realism. What is particularly interesting is that a theory which claims to have universal applicability can be seen as accurate in some instances and not in others. Hardin and Waltz are right that structures which lack a central authority of which all stand in awe have a tendency to lead towards 'tragic' outcomes. However, they present a highly abstracted view of reality and do not allow for actors to communicate or behave in an original fashion. What the tragedy of the Commons and neo-Realism actually reveal is something more subtle: that such a social environment is a permissive cause for 'tragedy' to occur, it may indeed be a necessary cause. But Hardin and Waltz push the parameters of their approaches too far and claim that the structures they describe are the only necessary cause. The essential feature being that agents consider their social reality to be zero-sum, that they do not communicate with each other or consider that they are able to change the social environment in which they find themselves.

In Waltz' defence he acknowledges that his methodology is to examine the world looking for 'laws'; should an action occur then the law will reveal the inevitable consequence.[732] The discovered laws can then be coalesced at which point the scholar has constructed a theory, which is a model of the real world.[733] The important point is that Waltz' world is a model of the real world, it is therefore an abstraction. However, the evidence presented in this thesis, along with many other empirical studies, shows that the abstraction is worryingly divorced from reality. The problem is that in order to create a holistic theory the degree of abstraction required has resulted in a theory which is unable to explain the real world. However, the theory still contains the important fact that 'anarchic'

[732] Waltz (1979), *op. cit.*, pp. 1-2.
[733] *Ibid.* p. 7.

self-help systems have a tendency to produce 'tragic' consequences, although they are not sufficient causes, they are certainly permissive and most probably necessary causes.

Conclusions

Examining the issue of orbital debris can provide some important insights to the discipline of International Relations. Firstly, in order to understand the implications for the discipline it is necessary to consider the theoretical basis of the Rational Choice Theories of Waltz and Hardin. This thesis has found them unable to explain the active response to debris, further it has been found that the primary reason for this is because of inherent structural flaws with the theoretical approach.

Neo-Realism is proposed as being 'common sense' and an obvious explanation of the world; this is founded upon its positivist epistemology which allows it to assert that it is only describing the world as it is, for the world exists independently of theory. The difficulty for neo-Realism is that because it asserts that rules are the product of structure and exist independently of agency, whatever events occur that do not coincide with neo-Realist predictions then the theory is severely undermined because of its claim to universality. The critical authors which this chapter has examined have contributed to a narrative in which positivism is used to subtly defend the claims of neo-Realism.

Primary among the problems which neo-Realism presented are the abstractions which it has. It has an ontology which is almost exclusively state-centric and because of its structural basis is materialist. As a consequence, for the response to debris neo-Realism notably struggles, as the primary actors have been institutions and an epistemic community, further it is almost impossible to accurately conceptualise the response to debris without considering the importance of ideational factors.

In contrast to neo-Realism, neo-Liberal institutionalism is capable of providing an account which closely corresponds to the empirical evidence observed. However, it does have to answer the criticism that as opposed to providing a theoretical account of what is occurring, it is actually only providing description. In the typology of Hollis and Smith, it is most accurate to consider neo-Liberalism as providing understanding, as it has a tendency to examine the actions observed, rather than the systemic whole. As a consequence it seeks to

provide a bottom up explanation, examining the agents primarily and the systemic whole from their perspective.

The essential proposition of neo-Liberalism, and Elinor Ostrom, is that cooperation can occur to the mutual benefit of all parties involved. In this respect there does appear to be a degree to which a prescriptive element is present. The assumption appears to be that actors are more interested in absolute, rather than relative, gains therefore they ought to cooperate in order to improve their position, and the position of the society in which they exist as a whole. As has been discussed Liberal thought does have a teleological element within it which conceptualises humanity moving towards more perfect social structures; this element has continued to be present in Liberal thought when adapted to the international level.

The design principles which Elinor Ostrom has identified, as characterising successful Commons regimes, were introduced in the first chapter. Having considered the empirical evidence throughout the thesis, it is now possible to see the correspondence between it and Ostrom's design principles. In large part the circumstances surrounding debris can be seen to be synchronous with what Ostrom describes, as such it indicates that this is a favourable environment for cooperation to emerge. Ostrom observes that 'conflict-resolution mechanisms' and 'graduated sanctions' are of importance in facilitating cooperation. They are not present in this instance, however the nature of the debris problem is such that they are not of great importance. One of the principle characteristics of the debris problem is the proportionality between those exposed to the risk of debris and their degree of responsibility. Therefore, enlightened self-interest encourages cooperation and dramatically reduces the requirement for sanctions and means of conflict resolution.

The most important question which this chapter has examined is: how can neo-Realism and neo-Liberal coexist within the same social reality. The answer to this is located in the questions which they are asking of the world. Because neo-Realism has a highly abstracted view of International Relations, in which anarchy and sovereignty are the key issues of concern, it cannot look elsewhere than the systemic logic characterised by the tragedy of the Commons. As such, its critics would observe that it is not examining the same reality that neo-Liberalism is considering, as neo-Realism is considering such a highly abstracted view. Because neo-Liberalism is a 'bottom up' tradition it is considering a different conceptualisation of reality.

Although there is much to be critical of in neo-Realism's idealisations it has produced an important insight. It has identified necessary, perhaps even sufficient, conditions for a 'tragic' outcome to occur. The claim to universality can be falsified, but what cannot be dismissed is importance of circumstances which it conceptualises as being conductive toward Hardin's tragedy of the Commons.

The final lesson for International Relations which can be extracted from the study of orbital debris are the eight features of the debris problem which this thesis has identified. Collectively they create an environment which is highly conducive to cooperation occurring. From the perspective of the discipline it would be most interesting to find a similar instance in which most, or all, of these characteristics are found and examine the active response to that problem.

Conclusion

The human relationship with the physical world has changed. Had humanity ceased to exist a century ago, then physically the Earth would not have shown many signs of the species ever having existed.[734] However, technology has given humanity the ability to damage the natural environment in ways which it will take nature centuries to heal. Debris can be considered in these terms; as a consequence of human activity in space, damage to a physical environment could remain over a time scale which is almost unimaginable. As with other problems concerning the natural world remedial action for the debris problem requires a concerted political effort.

In essence orbital debris is an environmental problem, yet it is one which draws upon many debates, both internal and external to the discipline of International Relations. Studying the problem, and the response to it, reveals a great deal concerning the governance of near Earth space but also contributes to the general understanding of the discipline.

Recognition of Space Debris

This thesis commenced with a consideration of the level of recognition which is given to the problem of debris. When the issue first emerged onto the political agenda Nicholas Johnson and Darren McKnight identified recognition as the most important aspect of the problem.[735] In the years since they made this observation there has been a growing awareness of the importance of space debris. The institutions, and epistemic community, which are addressing debris reveal that it is clearly not considered to be merely an aspect of science fiction.

Debris is increasingly recognised as a legitimate aspect of space policy, the 'Rumsfeld Commission', in 2001, made reference to debris[736] but only to the effect that it could be erroneously used to explain the hostile destruction of a space system. More recently, in 2006, the United States' space policy specifically addressed the issue of debris,

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[734] Douglas Coupland; *Girlfriend In A Coma* (London: Flamingo, 1998), pp. 265-266.
[735] Johnson and McKnight, *op. cit.*, p. 99.
[736] *Report of the Commission to Assess United States National Security Space Management and Organization*, *op. cit.*, p. 14.

stating that it was US policy to limit the production of debris and that it would take a leadership role in efforts to resolve the problem.[737]

The collective effort directed towards debris currently appears to be an impressive level. There is sufficient attention paid to the problem that it is addressed effectively. However, it has not become the subject of such attention as to become highly politicised. The problem being addressed at the level of the technocrat has proved to be an effective route for collective action to proceed effectively.

In recent years orbital debris has moved into the 'mainstream' of space policy. Sufficient remedial action has not yet been taken, however recognition in itself was a necessary condition for remedial action to occur and it is a matter which has now been addressed.

Parameters of the Orbital Debris Problem

It is the physical circumstances within which orbital debris is located that defines the terms of the political problem which it creates. Although all pieces of debris pose a danger, it is those that are medium sized which present the greatest threat, as they are too small to be tracked whilst also too large for shielding to be an effective defence. Presently there is no technical solution which can adequately address such objects in Earth orbit. However, shielding and tracking should not be considered as constituting complete remedial action for all other sizes of debris. The 'Kessler Syndrome' suggests that a high population of small pieces of debris could be catastrophic, as random collisions at an altitude with a high debris population could result in chain reactions wherein the total mass of debris will remain constant, but it will be redistributed towards a vastly increased number of small objects. Thus, the optimal course of action is limiting debris production.

The absence, or near absence, of natural sinks from near Earth space heightens the dangers of debris. The Inter-Agency Debris Coordination Committee (IADC) guidelines seek to bring pieces of debris into the atmospheric sink, within 25 years of the end of their

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[737] < http://news.bbc.co.uk/1/shared/bsp/hi/pdfs/18_10_06_usspace.pdf >.
The context of this document can be found at, 'US adopts tough new space policy' *BBC News* (18th October 2006) < http://news.bbc.co.uk/1/hi/world/americas/6063926.stm >.

operational lifetime, in order to preserve Earth orbit. Satellite operators are also encouraged to dispose of objects in GEO by raising them to a graveyard orbit. Re-orbiting and atmospheric drag represent the only two sinks for debris. Importantly, although some debris in LEO will naturally re-enter the atmosphere, in order for the sinks to be effective it is necessary for direct action to be taken, which requires the use of fuel and therefore extra cost. For the sinks in near Earth space to be truly effective it is necessary for collective action to be employed.

The political parameters of the problem are more complex than its physical dimensions. Space law provides broad principles for the human exploration and exploitation of space, but it is not sufficiently detailed to have direct applicability to debris. Although its principles are used as a means for directing the collective response, this is largely only the norm that states should not interfere with each other's activities in space. There is no evidence of any desire among the space powers to draft a new treaty to address the problems associated with debris.

If power politics is used as a means of analysing the international response to debris, then the USA is undoubted the state with the greatest capacity to express its power in space. However, although it is the strongest power, it does not have the capacity to express coercive military might in space. Further, its position is not such that other states stand in awe; it has power but it does not have overwhelming power. Although NASA has the largest space budget, the USA does not have the capacity to force other states to accept its policy objectives. In terms of space debris the USA has expressed its intention to cooperate with other states, and institutions, in order to create remedial solutions.[738] There is no evidence to support the proposition that any state is using force to coerce others into accepting its perspective on the debris problem, rather the empirical evidence asserts that the issue is addressed in a cooperative fashion wherein collective interests are motivating states to cooperate.

The Present Status of Governance in Space

Currently, the nature of governance in space is not fully resolved, it is an emerging political sphere being created according to human activity. The broad principles of this

[738] Johnson (a) in Dansey (ed.), *op. cit.*, pp 9-10.

governance were created by the space treaties, but these require interpretation before they can be applied. With reference to debris, there has been a broad consensus that the provisions within space law concerning non-interference should be interpreted as meaning that the production of debris should be actively avoided. It does not follow directly that this is a consequence of the power and influence of space law, rather it could merely be the enlightened self interest of the relevant stakeholders.

The greatest strength of space law is that the principles it asserts are widely accepted, with the exception of those contained in *The Moon Agreement*. However, it is far from being without difficulties, its provisions are not specific and require a considerable degree of interpretation. As the collective response to debris has been characterised by cooperation, the vagueness of space law has not proved to be a difficulty in this instance. However, as human activity continues to spread into space, the capacity of space law to be subject to differing interpretations will most probably become a source of dispute, in this process it will weaken the perceived authority of the space treaties.

The Registration Convention is an obvious current weakness in space law as in effect it does not work. Were it to have achieved its aim of developing a complete database of objects in orbit, it would serve a useful purpose in countering the debris problem. However, it is largely ignored by states and serves no significant role in managing the debris problem. The *Liability Convention* provides a mechanism whereby compensation could possibly be claimed due to damage caused by debris, however it is only restorative having *post hoc* applicability. It does not have, nor seek to have, the capacity of providing mitigation. As has been discussed, the crash of Kosmos 954 provides the most thorough examination that the *Liability Convention* has been subject to, however it is not directly applicable to the possible scenarios that surround debris. The treaty contains differing degrees of liability according to where damage occurs; for an incident in Earth orbit to be addressed by the *Liability Convention* it would have to be shown that there was fault in the actions of a state. By necessity this would also require positive identification of the origin of a piece of debris. Such requirements severely limit the usefulness of the treaty in this issue area.

The lack of specific applicability of the space treaties to the problem of debris creates the need for other forms of regulation to manage the situation.[739] Although it should be remembered that any law is only as effective as it is enforceable, this is particularly the case with international law as there is no judicial power with the capacity to enforce its provisions. Therefore, if space law were to provide measures which were directly applicable to the debris problem, it would still be necessary for states to show willingness to cooperate with such regulations.

The international governance which has been formed in response to the debris problem has been characterised by shared objectives, which in turn has led to an effective cooperative structure. The creative process is best considered to have commenced with a broad epistemic consensus concerning the nature of the problem and the most effective course of remedial action; this episteme and related consensus permeates national borders. From this ideational basis it was possible for institutions to address the problem directly. This has taken three broad forms. Firstly existing international organisations such at the ISO and IAA have taken an active interest in addressing the problem. This has been coupled with domestic bodies, such as the BNSC and FCC, seeking to apply debris mitigation standards. Finally, there has been the creation of a new institution, the IADC, to provide a forum in which ideas concerning debris can be formulated and propagated. It forms the cornerstone of the governance structure addressing debris.

The broader governance of space should not be expected to follow the same patterns as the response to debris has shown. The characteristics of the debris problem have made it fundamentally cooperative in character, other issues will be subject to competing interests. The issue of weaponisation will almost certainly be perceived by states as being zero-sum in nature. The allocation of resources, such as GEO positions and lunar resources, will have the characteristic of a Common Pool Resource, wherein the amount which one actor consumes will affect the supply available to others, are also expected to be approached as zero-sum scenarios.

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[739] Writing in 1978 when the four broadly accepted space treaties had already been created Hamilton DeSaussure noted that human activity could not 'long endure in a legal vacuum'. To this effect he believed that as a greater amount activity was conducted in space, so more legal problems would arise and there would be more need for legal structures. In effect this need has been addressed not through further legislative measures but through norms and governance. DeSaussure, *op. cit.*, p. 180.

The Development of Governance in Space

The key aspects of governance, which this thesis has highlighted, are: the importance of ideas, a broad ontology encompassing actors other than the state and that there are emerging problems, most notably in the global environment, which are beyond the capacity of the Westphalian order to effectively address. The importance of ideas in systems of governance implies that there is a capacity for change within the existing order. The response to debris shows the manner in which the broad system of governance for space is able to adapt and respond to new circumstances. This indicates that this, and other, governance arrangements, are not the product of timeless material structures, rather they are capable of being changed by the ideas, and perceptions, of actors.

The emergence of norms associated with the governance of space is difficult to measure. A norm is fundamentally ideational; practice reflects the existence of norms but it does not prove their existence. Further, practice ceasing to indicate the existence of a norm does not prove that the norm did not previously exist. Following the crash of Kosmos 954 the practice of using nuclear power sources was suspended, this appeared to be an emerging norm. However, recent scientific research has revealed a renewed interest in using nuclear power sources, thus undermining the suggestion that a norm had been created or countering that it may have been a weak norm. In considering the debris problem practice suggests that norms are emerging concerning the necessity of protecting near Earth space. It is anticipated that these norms will remain in place as long as they are perceived as being in all parties' individual interests.

The present situation indicates that in the near future more distinct forms of governance may emerge to manage LEO and GEO. This is already evident as the ITU allocates slots in GEO, whereas the greater capacity of LEO means that it is not subject to such control. Not only is the number of slots in GEO finite, the orbit is also more vulnerable; without deliberate human intervention there is no debris sink. This thesis has questioned the rights of use in the global Commons when a resource is finite. In LEO there is a sufficient capacity that there is no requirement for such rights to be created. However, in GEO and upon heavenly bodies, the possibility exists that demand could significantly exceed supply. The existence of excess demand would not inherently mean the

establishment of a property regime, however it would require a form of governance different from that which meets the demands of the debris problem.

The questions surrounding the status of the Moon, specifically whether it is a Commons or part of the Common Heritage of Mankind, reveal the incomplete nature of governance in space. The present situation also reveals that the Moon, and possibly GEO, require a form of governance different from other parts of space. As has been discussed there are two broad types of Commons, those which are finite and those which are inexhaustible. Their different characters demand differing forms of regulations. A distinct possibility exists that the governance of space will be constituted by different regimes. The major requirement in LEO relates to debris and its mitigation. GEO has a similar need to be protected from the effects of debris, however the limited supply of GEO slots also creates a need for further regulation. The Moon, and other celestial bodies, present a new range of challenges concerning how their resources are to be used, and rights of access. Finally, the vacuum of inter-planetary space is of such incomprehensible magnitude that as an environment, and resource, it has little need for regulation. Thus, there is a possible scenario wherein the governance of space will have discrete elements intended to regulate specific aspects.

There would be a precedent to be found in this instance with the governance of the global environment, wherein there is no one holistic regime, rather individual regimes address different issues. It is the Montreal Protocol which address the issue of ozone depletion, whilst the Framework Convention on Climate Change addresses issues of greenhouse gases. Although there is some symmetry between the two, in that they are attempting to coordinate collective action in order to resolve a common problem, they are quite distinct. It is conceivable that the governance of space will develop in a similarly specific manner. There are four broad areas which present unique circumstances: the void of interplanetary space, LEO, GEO and the resource of the celestial bodies. The problem of debris would only be of practical importance for regimes addressing LEO and GEO.

There is further reason for suspecting that the broad system of governance for space will be different in character to that which has emerged in response to debris. One of the key factors which has made cooperation desirable for all stakeholders is the proportionality between those responsible for producing debris and exposure to risk. This is coupled with

the limited number of actors who have the capacity to produce debris, and regulate it, which reduces the capacity of any actor to 'free-ride'. For example, if the USA continued to recklessly produce debris it would still have to face the consequences of the pollution which it was producing. Such conditions create a social environment conducive to actors participating within a common framework. When considering other aspects of human activity in space it would be erroneous to assume that collective and self interests will be so closely aligned. The interests of states concerning access to natural resources and placing weapons in Earth orbit will most probably be characterised by conflict, creating radically different circumstances within which the system of governance will develop.

Notions of Property and Equality

Examining the empirical evidence concerning the debris problem has rendered this examination silent, in places, concerning issues of equality. Consequently it could be accused, as Hedley Bull's work has been, of placing order ahead of justice. However, Bull concluded *The Anarchical Society* with the observation that his study of order should be complemented by a study of justice.[740] Similarly, the ideas which this thesis examined deserve to be further considered through an examination of notions of justice. The international response to debris has been essentially managerial in nature: a problem has been identified and the powerful actors have decided upon a course of actions which is to their collective advantage. The chapters in this thesis concerning rights of use have placed the problem of debris in a wider context, within which there are important issues which remain unresolved. The important connection between debris and the rights of use, is that space is essentially an open Common which is free for all to use, or abuse, as they wish. There is no strong legal mechanism to ensure that actors using space as a resource do so in a manner which is sensitive towards its preservation.

Consideration of issues surrounding governance in space brings into focus a fact concerning the global order which can be easily overlooked. The physical world is not constructed exclusively of nation states, rather there are four types of territory: Westphalian states, *terra nullius* (unclaimed territory), *res communis* (the Commons) and *res communis humanitaties* (the Common Heritage of Mankind). Although *terra nullis* is now limited to only Antarctica, and its resources are presently beyond the capacity of modern technology to

[740] Bull (1995), *op. cit.*, p. 308.

economically exploit, the resources of the Commons are vitally important to the present social order. Largely the usage of the High Seas and Earth orbit have proceeded upon the basis that there is sufficient quantity of the resources that they are not in need of regulation. Debris, however, has revealed that in Earth orbit there is a need for some control upon the individual actions of states. The notion of the Common Heritage of Mankind (CHM) asserts that resources in the global Commons should not be merely managed efficiently but that they should be exploited according to principles of justice.

The CHM brings to the fore the fact that there are other matters worthy of inclusion within a dialogue concerning the usage of the global Commons, those relating to equality both geographic and temporal. The concept of CHM proposes a view of governance, within which questions of equality are fundamental. The response to space debris has been focused upon maintaining access to Earth orbit at a sufficiently high level that supply significantly exceeds demand. In the typology which this thesis has utilised it will not be a Common Pool Resource because the amount which one actor uses will not have an impact upon the supply available to other actors. However, demand exceeding supply is a condition which, it is anticipated, may soon come to characterise usage of Geostationary Orbit.

The CHM seeks to incorporate issues of equality into the management of the resources which exist in the global Commons and for which there is the possibility of excess demand. The notion of a Common allows a resource to be conceptualised as either owned by every one or no one, CHM specifically designates the resource as being owned by every one. Further, the concept of ownership is not limited to the present it also seeks to be inclusive of future generations. Because the CHM seeks to regulate the economic exploitation of a resource, its applicability is largely limited to those which are finite, such as mineral deposits on the sea-bed or lunar deposits of Helium-3 and water. It is difficult to conceptualise a scenario in which the concept would be applied to those resources which international law effectively considers to be without limits of supply such as the high seas.

Access to Earth orbit, which is what debris threatens, within international law is conceptualised as being without limit upon supply. Although the CHM could be applied as a form of licence in order to place an object in orbit, there does not appear to be any practical possibility of this occurring. In itself this situation reveals the very different nature of the global Commons from resources contained within a Westphalian state, as licences and

payments are required in order to use such common resources as the frequency spectrum. Utilising the CHM for satellites in Earth orbit would present a means of introducing regulation, such that in order to place an object there debris mitigation standards would have to be addressed. This is not least because an aspect of the CHM is the principle that resources should be preserved such that they will be available in the future; resolution of the debris problem is specifically targeted at preserving a common resource for future usage.

However, merely as a practical means of addressing debris mitigation there appears to be little need for such a reconceptualisation as actors are developing standards, whilst Earth orbit remains *res communis*. There still remains an argument that whilst Earth orbit is a Common resource then all should benefit from its utilisation. Yet it appears very unlikely that such a development will occur, not least because of the counter-argument that all can benefit from free and open access to a resource which is effectively not limited in supply.

As discussed above different aspects of space have requirements for different forms of governance. If it is accepted that debris does not create a strong case for an area to be designated as the CHM this does not negate the possibility of its application in other issue areas. The application of the CHM to both GEO and resources located upon celestial bodies presents a stronger and more convincing argument than its usage to resolve the debris issue. *The Bogota Declaration*, wherein equatorial states attempted to claim ownership of GEO, and *The Moon Agreement* both reflect the belief that the resources located in these two areas should not be simply left open, but should be subject to both regulation and reflect notions of equality. Although there may be a strong philosophical argument to support such a conceptualisation, it appears remote that the space faring powers would be willing to concede to such regulation. Yet this stance does not simply resolve the matter, the existence of paper satellites in GEO, and the need for stability of 'ownership' concerning the investigation and exploitation of lunar resources, reveal that a form of regulation is both desirable and necessary.

The nature of the regulation that develops will be of great interest. If it is necessary to limit the demand for slots in GEO, the most obvious means of doing so is for the ITU to charge a fee for a licence. In order to lower demand significantly such a fee would have to be high, which in turn would result in significant funds being raised. It is to be expected that the consequences of inaction would have to be extremely clear and serious before this would

be accepted by highly industrialised states. If the distribution of the funds generated is based on considerations of equality and justice, then a reflection of the CHM would clearly be seen. The commitment, made at the 1985 World Administrative Radio Conference (WARC), to ensure that all states have access to GEO slots, when they need them, also inevitably leads to a discussion concerning equality. If such allocations are made, without payment, it is difficult to imagine that it will not still reflect a perceived notion of equality.

There is an historic irony concerning the resources which have been designated as CHM and as a consequence become subject to preservation measures for the benefit of future generations. Of all global Commons it could be argued that the Moon and the seabed are least in need of protection. The Moon is a dead satellite, without an ecosystem to damage. In order to preserve it for the future it is only necessary to avoid deliberately damaging in, unlike the terrestrial environment or near Earth space, it is not fragile. Whilst the polymetallic nodules on the ocean floor which were the purpose of the CHM provisions in UNCLOS III, are pieces of metal lying on the seabed; recent preliminary research appears to indicate that it is possible for them to be harvested and the ocean floor to return to its original state in with a number of years.[741]

However, due to the political circumstances when resources became designated as the CHM, the atmosphere, Antarctica, the High Seas and near Earth Space remained as open Commons. Here a tragedy more real that that of Hardin is exposed, for the Commons which have been left open for all to exploit, are those which are in reality most vulnerable.

Contrasting Earth orbit with the seabed, the difference between renewable and non-renewable resource is highlighted. The resources of the seabed have been designated as the CHM, they are intended to be utilised with respect to the requirements of future generations. However, there is a finite amount of polymetalic nodules on the ocean floor, as such the only way to manage this finite resource with respect to future generations is to either leave a quantity for them to use, or to distribute the wealth generated such that it will benefit future generations. This provides a stark contrast with Earth orbit; in respect to the ability of humanity to place satellites there it is a renewable resource. Yet it is possible for the present

[741] Hjalmar Thiel, Gerd Schriever and Eric J. Foell; 'Polymetallic Nodule Mining, Waste Disposal, and Species Extinction at the Abyssal Seafloor' *Marine Georesources and Geotechnology* Vol. 23, No. 3 (July 2005), pp. 209-220.

generation to cause damage such that it will become a worthless resource. Therefore a key feature of the CHM, inter-generational equality, is precisely that required to effectively address the problems posed by debris. This does not mean that preservation of near Earth space requires the utilisation of CHM, only that the concept contains a necessary philosophical idea.

In short, the global Commons are unique, and somewhat unusual, areas in an era of bounded territorial states. Whether they are conceptualised as being owned by every one or no one has a large impact upon the form, or absence, of regulation associated with them. The concept of CHM not only offers a means through which they can be regulated effectively, it also explicitly addresses notions of equity. When considering the governance of space with specific reference to the problem of orbital debris there appears to be little demand or need for such a conceptualisation to be employed, largely because acting collectively stakeholders are attempting to address the problem. However, other resources located in space are revealing themselves to have different characteristics, and they are subject to different problems, as such effective regulation of these resources may require a more radical perspective concerning the nature of the Commons to be adopted. Although the CHM may never come to have a significant effect upon International Relations in its own right, as the *Implementation Agreement* of UNCLOS III suggests, it raises important questions concerning equality and the right to utilise resources located within the global Commons.

The issue of private property remains unresolved concerning the resource in space. It is reasonable to anticipate that it is one which in the future will be the source of considerable controversy. The suggestion that private property is essential for the efficient development of a resource neglects that fact that space law, to an extent, prohibits private property. If it is to be argued that private property needs to be introduced, then a coherent argument has to be made that can explain how private property emerges out of nothingness.

The most important aspect of a property regime concerning space is that it should provide stability of ownership. Within the Westphalian state creating stability of property relations is one of the essential roles of government. Whether a property regime for space is founded upon private property, or otherwise, what is most important is that that it is stable. Debris reveals that part of that stability needs to be measures to ensure that the resource is

preserved for future generations. As issues concerning the rights of use are unresolved, they will be one of the most contentious issues concerning the usage of space in the coming years. The other contentious issue will be weaponisation, which will be discussed below.

Ontological Observations

A traditional account of International Relations seemingly inevitably commences with an awareness of the state. Indeed the state is an entity which is simply a given, it exists prior to any social interaction. Hence the dominant theory of the discipline, neo-Realism can make the claim that it does not require a theory of the state.[742] This pattern has continued within the more recent reflective theories which the discipline has produced. Steve Smith observes that Alexander Wendt's constructivism still commences at a point where the state is an ontological given.[743]

It appears extra-ordinary that a discipline should consider it acceptable to have an entity as its ontological focus, and yet be unable to incorporate its existence into its theoretical frameworks. For a theory of International Relations to be complete it should be able to provide a theory of the state. This position leads to the greatest problem with Realism: not only does it not provide a complete and accurate account of the world, its failure to either predict or in *retrospect* be able to explain, the end of the Cold War reveals that it fails to do so. Although no theory could provide a complete account of the world, the primary difficult with Waltzian neo-Realism is that it has abstracted the world to such a large extent that it is applicability is limited, almost exclusively, to a bi-polar balance of power. The most serious problem with this tradition of thought is the effect which it has had upon the study of International Relations. The Realist claim to provide the unquestionable truth of the world order has resulted in International Relations being largely a closed and backward discipline.[744]

Therefore, within the discipline the hegemony of Realism has had the effect of making many perspectives upon the international realm seemingly impossible to

[742] Waltz (1979), *op. cit.*, pp. 71-73.
[743] Steve Smith; 'Wendt's World' *Review of International Studies* Vol. 26, No. 1 (January 2000), p. 160.
[744] George (1994), *op.* cit., p. 127 and Jim George; 'Of Incarceration and Closure: Neo-Realism and the New/Old World Order' *Millennium* Vol. 22, No. 2 (1993), p. 202.

conceptualise. Indeed the visualisation of the world usually offered by the discipline clearly shows the ontological assumptions which it is seemingly so reluctant to bring into open dialogue. A map of the world as it is usually presented is covered in differently coloured nation states, whilst the projection renders Antarctica invisible. The global Commons are only present in the form of the High Seas. Just as symbolically, a political map presents a world constituted exclusively of nation states, so Realism typically confines thinking within International Relations to an ontology composed exclusively of nation states. As Justin Rosenberg observed, if the problem, which International Relations seeks to address, is anarchy defined in terms of sovereignty, the solution of balance of power is already inevitable.[745]

The focus upon nation states, to the exclusion of other possibilities, makes certain problems inherently unsolvable. Debris is such a problem. Not only is it physically located outside of the state but it also requires thinking which, from a Realist perspective, is distinctly unorthodox. Such closed discourse concerning the 'international' is not a recent phenomenon. Following the American nuclear attacks upon Japan, David Lilienthal and Under-Secretary of State Dean Acheson compiled a report, for the American government, which argued for the internationalisation of nuclear weapons.[746] After the Soviet Union first tested a nuclear weapon, making the momentum towards an arms race seemingly unstoppable, Lilienthal sitting on a committee to consider its implications, stated that 'we have no other course' was not the correct assessment of the situation rather it should be said that, 'we are not bright enough to see any other course'.[747] Thus, in one of the most important occasions, in the 20th Century, when 'internationalisation' was considered as a possible solution, Lilienthal clearly believed that the problem was not with the structure within which the problem existed, rather the possibility existed to conceptualise the problem in a different manner and thus bring about a solution.

The problem of debris and broader questions of governance in space have clear parallels with the difficulties associated with the birth of the nuclear era. The optimal solution requires a large amount of international cooperation, indeed the notion of Common

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[745] Rosenberg (1990), *op. cit.*, pp. 285-303.
[746] H.E. Wimperis; 'Atomic Energy Control: The Present Position' *International Affairs* Vol. 24, No. 4 (October 1948), p.517.
[747] Gregg Herken; *The Winning Weapon: The Atomic Bomb in the Cold War 1945-1950* (Princeton: Princeton University Press, 1981), p. 304.

Heritage of Mankind would involve internationalisation, under broadly similar conditions as were considered for nuclear weaponry. A resource would be governed under a system of international regulation, to be administered for the collective benefit of humanity. As such this problem presents a challenge to the manner in which International Relations is conceptualised.

Stephen Lukes' third dimension of power considers the choices which an individual would make were they free from the social conditions which they have been exposed to. Thus, it is an insidious power which is difficult to measure.[748] When his conceptualisation is considered the danger which the Realist tradition poses to reflections upon global politics becomes clear; it prevents the consideration of certain possibilities. Not only are they illegitimate knowledge, but they become literally unthinkable. The effective management of the global Commons, of which Earth orbit is part, requires thinking in a non-traditional manner. According to Lukes' typology, power has been exercised as it is generally considered that only through the nation state can resources can be either utilised or protected.

This thesis has demonstrated that the ontological assumption that the state is the only actor of importance is fundamentally incorrect in this instance. Conceptualising a social order composed entirely of states could account for cooperation when considering the tool of the Prisoner's Dilemma, however it only provided a broad outline concerning the possibility of cooperation. In essence all this approach was able to assert is that actors have the capacity to interact for mutual benefit, most especially if they are able to communicate and do not expect others to defect. Theoretically useful although this is, it is a monochrome view of events. A more elegant explanation was possible when considering organisations other than the state. In so doing a perspective was created in which the narrative was able to assert more than, simply that, states many chose to cooperate; rather it was able to describe the mechanisms through which cooperation occurs.

Hardin and Ostrom

Garrett Hardin presents a difficult argument; although a claim to universality can be dismissed on the basis of empirical evidence, it does appear to be a valid description under

[748] Stephen Lukes; *Power A Radical View* (London: MacMillan, 1974).

certain circumstances. This does not mean that the approach can be considered to be 'partially true', since it is founded upon the universal claim that an open Common will tend towards tragedy because individually logical actions will result in a collectively irrational outcome. The theory is entirely founded upon the structural constraints within which agents are located and this emphasis on structure permits and requires the claim to universality. The undermining of such a claim results in a more complex view; if Hardin's tragedy occurs in one instance but not in another, what are the variables which dictate whether it will occur?

The structure which Hardin perceives is founded upon latent assumptions. Firstly, human greed is considered to be natural and without limitation. From this perspective, in pursuit of greed individuals follow a path which leads to the destruction of a common resource. Secondly, as with all Rational Choice Theories, there is a requirement that individuals are able to make a rational choice, as such they require free and full access to information and have no capacity to act with individuality or originality. This means that the actions of every individual will be the same when presented with the same circumstances, they are not able to act with originality or inventiveness. This has particular difficulties when considering the decision making process, since it is the individual which makes a decision and their perception of what is rational, as well their best interest, is inherently subjective. Thus, the rational assumptions of the theory depend upon the subjective interpretation of actors. The absence of a capacity for individuals to act inventively leads to a third assumption in Hardin's tragedy, that there is no role for time. As all events are decided by the social structure which exists independent of agency, everything exists in a timeless present, there is no capacity for the past or future to be qualitatively different from what currently is. Finally, the theory assumes that actors do not communicate with each other. As they are utterly self dependent they have no capacity to interact in a meaningful way with other actors. Because there can be no communication there can be cooperative organisations to manage resources. Of all the assumptions within the theory this is the most problematic, as the empirical evidence shows that there are regimes which govern common resources, most notably as featured in the work of Elinor Ostrom.

Ostrom provides a more detailed conceptualisation of how communal resources are approach and managed. Unlike Hardin she does not make a claim to universality, rather she presents an analysis which is focused upon actors, their decisions and perceptions. Where Hardin states that in circumstances A consequence B will occur unless route C is followed

instead, Ostrom argues in the circumstance A consequence B may occur and provides the factors which would facilitate consequence B. As was demonstrated in the previous chapter Ostrom's characteristics of a Common largely resonate with the situation concerning debris.

Perhaps the principle difference which Hardin and Ostrom make in their conceptualisations is the ability of actors to communicate with each other in order to improve their circumstances and learn from such interaction. Hardin appears to accept the situation wherein his herdsmen continue to force as many cattle into the field as is physically possible and yet no one stops to question whether this is not a foolish course of events. Ostrom allows those using the resource to stop and question if there is not a better way in which to manage the resource. This does not mean that they will find the most efficient means of management; tragedy may still occur, but it does mean that there is a possibility for a better way to be found.

A large factor which allows for Hardin and Ostrom to provide such radically different accounts is the level of analysis from which they conceptualise the problem. Hardin is concerned with the structure, as is neo-Realism, therefore he is only able to make broad, and undetailed, statements. In comparison, Ostrom focuses upon the actions of agents, thus allowing for a much more detailed explanation of events. It also allows for a wider possibility of outcomes to occur. Because Hardin relies upon structure for his explanation when faced with the same circumstances agents will always behave in the same way, however Ostrom gives them the capacity to act creatively.

Although Hardin's tragedy severely struggles to account for the response to space debris, when the empirical evidence is considered the social circumstance surrounding global climate change appears to provide an instance in which a tragedy of the Commons is occurring, just as Hardin's theory describes. The complex negotiations, and positions adopted, with reference to climate change can be summarised in an abstracted form thus: actors are behaving in a way which presents them with short term individual benefits, however the net long term result is highly detrimental not only to communal but also individual interests. Although there is communication between actors, they have not been successful in forming an effective response; Hardin's supporters would most probably note that ineffective communication is little different from no negotiations. Cooperation would present the best case scenario for all actors, but they are unwilling to adopt such a course of

action. A clear analogy exists with reference to Hardin's herdsmen adding one more head of cattle to the communal herd.

Such a scenario contrasts starkly with the cooperative response to debris, wherein actors have shown a willingness to alter their actions, which has a financial implication. Yet many of the same states which are responsible for the largest emission of greenhouse gases are those who are willing to cooperate in order to ameliorate the debris problem. This thesis found a means to explain cooperation concerning orbital debris through the Prisoner's Dilemma, specifically by considering the 'supergame' wherein social interactions are repeated. Although each participant in the supergame is required to negate the possibility of a maximum utility gain in one interaction, by doing so they create the scenario in which both players can gain a positive utility from every interaction. Debris presents an obvious situation in which repeated actions occur, and therefore actors can cooperate over a protracted time scale for mutual benefit. However climate change presents an almost identical scenario. The possibility of cooperation is enhanced wherein agents share common objectives and are able to communicate with each other, however identifying these characteristics does not separate the instances of climate change and space debris as they are common to both.

Despite the common features which they share, there are factors which differentiate the problems of global carbon emissions and orbital debris. Firstly, there is a broad scientific consensus concerning debris, and that consensus has existed since the problem was initially researched. When the presence of debris in orbit was identified, its origins were clear. Although the appreciation of the scale of the problem took longer to identify, it was never subject to a scientific challenge. There has never been a significant body of scientific work asserting that debris is not a consequence of human activity, neither has it been suggested that its presence does not pose a serious problem. Although it did take many years for the scale of the problem to be fully appreciated, this was a consequence of ignorance rather than objection. Most importantly there is a clear consensus concerning the consequence of inaction; the debris population will grow significantly and certain altitudes will become useless. The severity of inaction is not subject to absolute clarity, however the direction in which inaction will lead is not disputed. The scientific facts concerning global climate change are far more complex. Although there are those who dissent, the fact that greenhouse emissions are changing the global environment is generally accepted, however the exact

consequences of climate change are uncertain. The clarity concerning debris, and uncertainty surrounding greenhouse gas emissions provides a clear differentiation between the two instances.

Questions surrounding survivability are also clearer in relation to debris; it is considered certain that inaction will have disastrous consequences for space users. However, it appears probable that developed states, responsible for the majority of greenhouse gas emissions, will be most able to adapt to their consequences. When this factor is coupled with the direct connection between those responsible for producing debris, and those with resources exposed to the risk of impact, a clear motivation for remedial action can be seen. Although on a global, and human, level the potential dangers of climate change are far more severe than those associated with debris, there is a degree of detachment between those who can take effective measure to resolve the situation and those faced with the most serious consequences. Those who benefit from the usage of space are directly able to take actions which will preserve it for their own future usage. Further, the number of active stakeholders concerning orbital debris is much smaller than those concerned with global environmental change. Although proving a definitive account of the importance of the number of actors involved would require proving a counterfactual, assumptions and extrapolations can be made. As Ostrom has hypothesised limited number of actors addressing a collective problem increases the possibility of accurate communication occurring, it also reduces the number of vested interests involved. It cannot be argued that a limited number of actors will definitely result in an increased degree of cooperation, but it does increase the possibility of a shared understanding of the problem being constructed.

The greatest difference between these two environmental problems is the cost of remedial action. Although space agencies have faced costs incurred by researching the problem of debris, and will face further financial burdens in the course of taking remedial action, these are insignificant compared to the costs associated with addressing climate change. Significant remedial action concerning greenhouse emissions would require restructuring Western economies away from carbon dependency. The debris problem can be adequately addressed without any need for such drastic action. Issues concerning space are also further simplified by the nature of the decision makers involved. National space agencies control access to Earth orbit and are therefore able to enforce mitigation standards,

whereas every individual consuming carbon based products plays an active role in decision making in relation to climate change.

It can be seen that there are very different circumstances surrounding these two environmental problems associated with the global Commons. It is this empirical evidence which provides an explanation for why seemingly remorseless tragedy can occur in one instance whilst cooperation characterises the other. This raises questions as to whether Hardin's basic formulation can be developed such that it is able to account for such variation. In so doing it alters the terms of what Hardin is attempting to argue, for it ceases to be a universal 'fact', the logic of which cannot be disputed. Rather the attempt to reconstruct his model is undertaken with the aim of creating an approach which can explain why a seemingly remorseless tragedy can occur in one instance and not in another.

The structure into which states are locked, which appears to prevent their cooperation concerning climate change, is best considered to be ideational. It has existence largely because it is believed to have existence. If it were a material force which acted upon all instances when states shared resources located in the global Commons, there would have to be an explanation of why states can deviate from it and are willing to cooperate concerning the preservation of near Earth space. If it is an ideational factor then, as Alexander Wendt observed, anarchy is what states make of it.[749] However, although such a socially constructed approach allows the International Relations theorist to conceptualise an order within which it is possible for cooperation to occur concerning debris, whilst tragedy is seemingly remorselessly followed concerning climate change, it is not without difficulties. The primary difficulty with this constructivist conceptualisation is that it leaves the relationship between agency and structure ambiguously defined. Structures socialise agents into certain modes of behaviour, yet social structures are created by the actions of agents. This leads to a circular reasoning which methodologically is incredibly difficult to analyse. Thus, in descriptive terms such thinking allows for an apparently accurate view of the social environment, however in so doing it fails to adequately provide a methodological approach by which the dynamic relationship between structure and agency can be holistically conceptualised.

[749] Alexander Wendt; 'Anarchy is What States Make of It: The Social Construction of Power Politics' *International Organizations* Vol. 46, No. 2 (Spring 1992), pp. 391-425.

Hardin's work can further be seen to be of utility if his claim to universality is set aside. Hardin claims that an open Common will have a tragic outcome, unless the system of governance is changed either through the imposition of a leviathan or through the resource being privatised. He is therefore arguing that an open Common is a sufficient cause for tragedy to occur. Debris proves that it is not a sufficient cause. The present situation in Earth orbit should be an ideal case in which Hardin's tragedy should occur. There is no actor which could behave as a leviathan and privatisation is not physically possible, and yet tragedy is not occurring. What this thesis has found is that Hardin has discovered something subtly different, he has found a permissive cause to tragedy, which is also probably a necessary cause.

The notion of an open Common being a permissive cause is relatively simple; it means that tragedy may occur because there is nothing in an open Common to prevent it from occurring. It is also most probably a necessary cause for a common resource; that is for a tragedy of over use to occur, as described by Hardin, then an open Common existing is necessary. It is therefore required that the Common should be open and lacking in regulation, but the Common being open and lacking in regulation is not sufficient *in its own right* to instigate tragedy. Hardin's observation and analysis is important, but it is not what he claims it to be.

Broader Lessons for International Relations

The study of debris reveals some important aspects of the international realm which are relevant for the study of international relations. Firstly, it highlights the importance of a broad ontology. The present social order governing near Earth space is in part created by the actions of states, but states are not self-consciously aware, unitary rational actors. The actions of 'states' are largely those which are carried out by national space agencies; a reference to 'the American position', in terms of debris, largely refers to the position adopted by NASA, which will be created within parameters designated by the executive. Yet national space agencies are not the only domestic institutions of importance; within the USA it is not only NASA that is actively addressing the debris problem, the Federal Communications Commission (FCC) also applies mitigation standards.

The domestic structures are integrated into a broader network of governance. It transcends the borders of states and encompassing international institutions. The International Academy of Astronautics (IAA) and International Standards Organisation (ISO) have both promoted and aided the development of measures to reduce the threat of debris. The United Nations Committee on The Peaceful Uses of Outer Space (UNCOPUOS) has played a relatively minor role in addressing the problem, principally because remedial efforts have not focused upon a new space treaty.

The actions of the International Telecommunications Union (ITU) reveal an aspect of the broader governance of space, although it is only associated with the management of GEO. As discussed above GEO is best considered to be a Common Pool Resource (CPR); it is a situation in which demand potentially, and perhaps inevitably, will exceed supply.[750] In part because it is managing a CPR the ITU has engaged in a dialogue concerning equity. It has made a commitment that developing states will have access to GEO when they require it. However, the actions of the ITU concerning GEO have not resulted in an effective and efficient means of managing the resource. The most notable problem it faces is that of 'paper satellites' whereby operators are claiming GEO slots which they do not have the capacity, or intention, of currently utilising but are seeking to reserve for future usage. The management of GEO has not proved to be sufficiently strong for the resource to be optimally used. However, the ITU does have the theoretical capacity to enforce debris mitigation as part of its application process for a GEO slot, should it choose to become more active in resolving the problem.

Against the background of the existing governance framework for near Earth space the creation of the Inter-Agency Debris Coordination Committee (IADC) has resulted in an institution which has proved to be the focal point for debris mitigation. The IADC is not designed to govern near Earth space as a whole rather it is a means through which stakeholders can cooperate in order to seek a resolution to the problem. The key characteristics of the organisation are that it is inclusive of all stakeholders, it is perceived as being legitimate and it has no powers of coercion. It only produces guidelines, the extent to

[750] Whether this occurs will be dependent upon the development of communications technology. Frequency scarcity for commercial broadcasting has been largely removed by the advent of digital technology. It is possible that developments in technology will result in satellites being able to carry dramatically increased amounts of information, and therefore increase capacity/supply such that there will not be excess demand.

which a member chooses to apply those standards, if at all, is its own prerogative. The principle achievement of the body is the establishment of the technical and policy parameters within which the debris problem is conceptualised. The members of the IADC, through its creation, circumvented the existing governance framework and produced a new dedicated organisation which has succeed in creating the political environment within which the problem can be successfully addressed.

Ideas and knowledge form the basis of the IADC's role. National agencies, academia and industry conduct research, which creates the knowledge base flowing into the IADC. From this information collective decisions are made concerning the measures appropriate for the preservation of near Earth space, these ideas then flow outwards from the IADC. This dynamic interchange of ideas permeates state borders and renders them, in terms of the flow of knowledge, irrelevant.

Yet ideas do not spontaneously appear from nothingness. This research has located the origins of knowledge concerning the technical issues surrounding debris, and the creation of the IADC, to be a consequence of a strong and active epistemic community. This episteme has not followed the usual path described for such a body; it did not have to engage in a struggle to establish its perspective as the dominant view, neither did not have to 'capture' governments in any strong sense to propagate its vision. Rather the debris epistemic community was born within governmental organisations, and in order to achieve dominance it was only necessary to disseminate its ideas, not engage with a counter perspective. This process has resulted in there presently being one dominant perspective concerning the debris problem.

When considered as part of the process towards remedial action, the epistemic community is best envisioned as a necessary cause, although not a sufficient one. The episteme is required because its knowledge base creates the framework within which the problem can be conceptualised and addressed. However, there currently exists a relatively strong episteme addressing the problem of climate change, but this has not resulted in notable progression towards remedial action. Therefore, the success of the debris episteme, although extensive, has to be considered as occurring against a background of favourable social circumstances.

Methodologically showing that an epistemic community exists, and further that it has an influence upon outcomes, is difficult as it is an inherently ideational concept. It can be proven that a body of experts exist and that they engage in informed debate, although whether that in itself constitutes a community can be contested. What is more difficult to ascertain is the effect which such activities have upon the policy making process. In relation to the debris episteme this matter can be seen as more simple than in other issue areas because debris is addressed, within government, at the level of the technocrat. The primary decision makers tend to be members of the episteme, as they are the only people within government with the technical capacity to understand the problem.

A counter argument to the notion of epistemic communities would focus upon a Realist conceptualisation of power politics. From this perspective the shape of the international response to debris would be the product of the power of the USA, forcing other actors to follow a specific course. What such an approach singularly fails to account for is a causal mechanism: if the USA is coercing other states to approach the debris problem in a specific manner, then through what means it is exerting power? There is no evidence available supporting the suggestion that coercion rather than cooperation is the defining feature of the response to debris. Therefore, although an account of the response to debris founded upon the concept of an epistemic community could be accused of being amorphous, a contrary narrative proposing power politics would require more assumptions.

This analysis has also identified eight characteristics which are conducive to a cooperative response occurring with reference to a collective problem. Those factors are: a close relation between those faced with the consequences of the problem and those who can take effective remedial action; proportionality between the amount of action an actor is required to take and the amount which they utilise the resource; a common understanding of the problem, and the solution, and communication between the relevant actors; a relatively cheap solution being available which can be enforced upon all the private and public actors involved; the nature of the problem not being politicised; the number of actors involved being small; the consequences of inaction being clear and immediate.

The relative importance of these factors can largely only be speculated upon when only one instance is considered. What would be of most interest would be another

international problem which displayed some, but not all of these characteristics, and then comparing its outcome with that of the debris problem.

Future Research Agenda

This thesis examined the governance of near Earth space focusing almost exclusively upon the issues surrounding orbital debris. However, this is only one aspect of the governance framework; although not discussed in detail, the issue of weaponisation is the most heavily debated current issue in relation to the governance of near Earth space. Yet that debate has largely been conducted without reference to the consequence of military conflagration in space in terms of debris. This analysis of one space policy problem should most properly be integrated into the broader debate, as a debate concerning weaponisation without consideration of debris fails to comprehend the true consequences of military conflict in space. An expansion of research to examine weaponisation would not be without methodological difficulties. The debate concerning debris is largely conducted in open dialogue, whereas the military nature of weaponisation results in issues being considerably more sensitive. Obviously this would have no impact upon the theoretical debate concerning its merits, but it would have serious implications when examining the positions which different governments have adopted and the emergent regimes.

It should not, of course, be considered that 'governments' have adopted unitary positions concerning weaponisation. This thesis has shown that the most detailed perspective is revealed when looking at the institutional mechanisms within the state. Similarly, concerning weaponisation it is anticipated that looking within the 'unitary rational actor' will reveal a most illuminating perspective. The most relevant precedent may be Graham Allison's *Essence of Decision*,[751] wherein different elements within a single government favour different policy objectives. In this instance, it would be expected that within the United States' administration NASA's concerns relating to debris and the scientific exploration of space would give it a natural disinclination concerning weaponisation, whilst the Department of Defense would view it as a necessary means of asserting and defending US power.

[751] Graham Allison, *Essence of Decision* (Boston: Little, Brown and Company, 1971).

The second key issue which is in need of resolution is; upon what basis and under what terms can space resources be utilised? This is not of such importance concerning 'infinite' resources, or more accurately those of which there is an abundant supply, but it has a significant effect upon resources such as GEO slots and more directly consumable resources such as lunar mineral deposits. The most fundamental aspect of this problem is whether private property rights can exist in the global Commons and whether they are an optimal means of using a resource which is currently common.

Summary

Within the discipline of International Relations, Realism seemingly emerged victorious from the first great debate. However, through specific ontological assumptions, about what exists and its importance, evidence can be found to support either Realism or Liberalism. The emergence of an international consensus seeking to address the debris problem can be seen as clear evidence of a Liberal world order in this issue area, yet this is occurring simultaneously with an apparent slow movement towards the weaponisation of space.

The most important piece of knowledge that the study of orbital debris offers to the discipline of International Relations is the conditions under which common resources located outside of nation states can be managed effectively for mutual benefit. Firstly, this knowledge is important as it reveals that such a process is possible, secondly it suggests the social conditions under which it can occur.

The study of debris is only one aspect of the governance of near Earth space, albeit a very important facet. In order to continue mapping this system of governance it is necessary to incorporate further issues which are relevant to space policy, specifically issues of equity concerning access to space resources and weaponisation.

Glossary

IAA – International Academy of Astronauts

BNSC – British National Space Centre – British Agency responsible for space projects.

CHM – Abbreviation used for the Common Heritage of Mankind.

CNES – Centre National d'Etudes Spatiales – French national space centre.

DLR – Deutsches Zentrum fur Luft- und Raumfahrt – German national space centre.

ESA – European Space Agency – European Agency responsible for space projects.

FCC – Federal Communications Commission: The agency responsible for managing the radio frequency spectrum in the USA, and according for American registered satellites.

GEO – Geostationary Orbit: A uniquely useful orbit, located in a ring at approximately 36,000km above the equator of the Earth. At this altitude the rotation of a satellite entirely synchronous to that of the planet, therefore it will appear fixed in the sky when viewed from the planet's surface. The that the satellite will always be in the same position relative to a fixed position on the planet makes it especially useful for telecommunication. As this is a highly used orbit, it accordingly has a high debris population.

IADC – Inter-Agency Debris Co-ordination Committee: A multi-national institution consisting of the major space powers, with the specific purpose of addressing the debris problem.

ISO – International Standards Organisation.

ITU – International Telecommunications Union: Global institution which regulates the usage of the frequency spectrum, including its usage by satellites.

JAXA - Japanese Aerospace Exploration Agency.

LEO – Low Earth Orbit: The lowest altitude at which a satellite can maintain orbit. Unlike GEO, it is not a naturally defined region, and is considered to exist up to 2,000km from the planet's surface. Despite the popular conception, the Earth's atmosphere does exist in LEO, however it is very thin; this results in the lower reaches of the orbit being naturally self-cleansing over a period of years or decades. Given the cost implications of raising satellites from the surface of the planet, LEO is the most heavily utilised area of near Earth space, containing a wide variety of satellites, it is also the region in which virtually all crew carrying missions are conducted. As this orbit is the most used, it has the highest debris population.

NASA – National Aeronautics and Space Administration – US Agency responsible for space projects.

OST – Abbreviation used for the *Outer Space Treaty.*

UNCOPUOS – United National Committee for the Peaceful Uses of Outer Space

United States Space Command – The organisation providing unified a command structure within the US Department of Defense for space operations.

Bibliography

Priyatna Abdurrasyid; 'The Outer Space Treaty and the Geostationary Orbit' *Annals of Air and Space Law* Vol. XII (1987), pp. 131-139.

Douglas Adams; *The Hitch-Hiker's Guide to the Galaxy* (London: Heinemann, 1995).

Agreement Governing the Activities of States on the Moon and Other Celestial Bodies
< www.unoosa.org/pdf/publications/STSPACE11E.pdf >.

Agreement on the Rescue of Astronauts the Return of Astronauts and the Return of Objects Launched into Outer Space
< www.unoosa.org/pdf/publications/STSPACE11E.pdf >.

'Agreement on the Rescue of Astronauts' (Summary Information)
< http://pubx.dfait-maeci.gc.ca/A_BRANCH/AES/env_commitments.nsf/0/4ac0c900f6f6d1e985256b6c004aeba7?OpenDocument >.

Michael Akehurst; *A Modern Introduction to International Law* 5th edition (London: George Allen & Unwin, 1984).

Charles Henry Alexandrowicz; *The Law of Global Communications* (London: Columbia University Press, 1971).

Graham Allison, *Essence of Decision* (Boston: Little, Brown and Company, 1971).

Antarctica Treaty (1957)
< www.antarctica.ac.uk/About_Antarctica/Treaty/treaty.html >.

Paris Arnopoulos; 'The International Politics of the Orbit-Spectrum Issue' *Annals of Air And Space Law* Vol. VII (1982), pp. 215-240.

Paris J. Arnopoulos; 'A Situation Study of the Orbit-Spectrum Issue (Model and Application)' *Annals of Air and Space Law* Vol. VIII (1983), pp. 287-303.

Richard K. Ashley; 'The Poverty of Neo-Realism' *International Organization* Vol. 38, No. 2 (Spring 1984), pp. 225-286.

'Atrexx Satellite Glossary'
< www.atrexx.com/index.cfm?fuseaction=service&id=101 >.

Robert Axelrod; *The Evolution of Co-operation* (London: Penguin Books, 1990).

Howard A. Baker; 'Protection of the Outer Space Environment: History and Analysis of Article IX of the Outer Space Treaty' *Annals of Air and Space Law* Vol. XII (1987), pp. 143-171.

Howard A. Baker; *Space Debris: Legal and Policy Implications* (Dordrecht, Netherlands: Martinus Nijhoff Publishers, 1989).

Anna Maria Balsano; 'Intellectual Property Rights and Space Activities' *Space Policy* Vol. 11 (1995), pp. 204-209.

Peter Barnes; *Who Owns The Sky?* (Washington, D.C.: Island Press, 2001).

'BBC News profile - Lembit Opik' < http://news.bbc.co.uk/1/hi/uk_politics/2121896.stm >.

J. Kelly Beatty, Carolyn Collins Petersen and Andrew Chaikin (eds.); *The New Solar System* (Cambridge: Cambridge University Press, 1999).

Linda Billings; 'How Shall We Live in Space? Culture, law and ethics in spacefaring society' *Space Policy*, Vol. 22 (2006), pp. 249-255

'BNSC – BNSC partners' < www.bnsc.gov.uk/content.aspx?nid=5597 >.

'BNSC – Cassini-Huygens' < www.bnsc.gov.uk/content.aspx?nid=5618 >.

'BNSC – How we are funded' < www.bnsc.gov.uk/content.aspx?nid=5551 >.

'BNSC – How we work' < www.bnsc.gov.uk/content.aspx?nid=5589 >.

Karl-Heinz Bockstiegel; 'Arbitration and Adjudication Regarding Activities in Outer Space' *Journal of Space Law* Vol. 6 No. 1 (Spring 1978) pp. 3-18.

Ken Booth and Steve Smith (eds.); *International Relations Theory Today* (Cambridge: Polity, 1995).

Jeffrey Boutwell, Theresa Hitchens and James Clay Moltz; 'Enhancing Space Security by Improving Stakeholder Cooperation', *Astropolitics* Vol. 2, No. 2 (Spring 2004), pp. 99-106.

Thomas Brauninger and Thomas Konig; 'Making Rules for Governing the Global Commons' *Journal of Conflict Resolution* Vol. 44, No. 5 (October 2000), pp. 604-629.

'Broadcasting House'; *BBC Radio Four* (Sunday 26th November 2000).

Chris Brown; *Understanding International Relations* (London: MacMillan: 1997).

Bryan Brumley; 'Nuclear Debris Expected To Rain To Earth This Week' *The Associated Press* (1st October 1988).

Susan Buck; *The Global Commons* (Washington: Island Press, 1998).

Richard H. Buenneke; 'Protection of Commercial Satellite Communications Infrastructure' *Astropolitics* Vol. 2, No. 2 (2004), pp. 237-259.

Hedley Bull; *Justice in International Relations (1983/84 Hagey Lectures)* (Ontario: University of Waterloo, 1984).

Hedley Bull; *The Anarchical Society* Second edition (Basingstoke & London: MacMillan, 1995).

Scott Burchill and Andrew Linklater (eds); *Theories of International Relations* (Basingstoke: Palgrave, 2001).

Joanna Burger, Elinor Ostrom, Richard B. Norgaard, David Policansky and Bernard D. Goldstein (eds.); *Protecting the Commons: A Framework for Resource Management ion the Americas* (Washington D.C.: Island Press, 2001).

'Canada: Claim Against the Union of Soviet Socialist Republics for Damage Caused by Soviet Cosmos 954' *International Legal Materials* Vol. 18, pp. 899-930.

'Canada-Soviets Sign Satellite Damage Pact' *The Associated Press* (2nd April 1981).

'Canada-Union of Soviet Socialist Republics: Protocol on Settlement of Canada's Claim for Damage Caused by 'Cosmos 954'' *International Legal Materials* Vol. 20. p. 689.

Margaret B. Carlson; 'Space Law Launches Increasing Number of Lawyers' *Legal Times* (14th June 1982).

E.H. Carr; *The Twenty Year's Crisis* Second edition (Basingstoke: MacMillan, 1970).

E.H. Carr; *What is History?* (Harmondsworth: Penguin, 1975).

Bin Cheng; *Studies in International Space Law* (Oxford: Clarendon Press, 1997).

'China puts its first man in space' *BBC News* (15th October 2003) < http://news.bbc.co.uk/1/hi/world/asia-pacific/3192330.stm >.

'China Reports Progress in Space Debris Research'; *People's Daily.* < http://english.peopledaily.com.cn/200308/13/eng20030813_122263.shtml >.

'China sets date for the Moon' *BBC News* (20th May 2002) < http://news.bbc.co.uk/1/hi/sci/tech/1997747.stm >.

Carl Q. Christol; 'Protection of Space from Environmental Harms' *Annals of Air and Space Law* Vol. IV (1979), pp. 433-457.

Carl Q. Christol; *The Modern International Law of Outer Space* (Oxford: Pergamon Press, 1982).

Carl Q. Christol; 'Article 2 of the 1967 Principles Treaty Revisited' *Annals of Air and Space Law* Vol. IX (1984), pp. 217-264.

'Chronological lists of ratifications of, accession and successions to the Convention and the related Agreements as at 20 September 2005' *United Nations*

<www.un.org/Depts/los/reference_files/chronological_lists_of_ratifications.htm#The%20United%20Nations%20Convention%20on%20the%20Law%20of%20the%20Sea >.

R.R. Churchill and A.V. Lowe; *The Law of the Sea* 3rd edition (Manchester: Manchester University Press, 1999).

Arthur C. Clark (ed. Ian T. Macauley); *Greetings Carbon-Based Bi-Peds* (London: Voyager, 1999).

David Clark; 'Britain's X-Files: The House of Lords UFO Debate' *Fortean Times* Vol. 201 (September 2005).

Charles Cockell and Gerda Horneck; 'A Planetary system for Mars' *Space Policy* Vol. 20 (2004), pp. 291-295.

Andrew Cohen; 'Canada Settles With Russia for Satellite Crash', *United Press International* (2nd April 1981).

Ray Coleman *Lennon* (London: Pan Books, 1995).

'Commercial Space Transportation: 2002 Year in Review' *Associate Administrator for Commercial Space Transportation: Federal Aviation Administration* (January 2003), p. 7.
< http://ast.faa.gov/files/pdf/2002yir.pdf >.

James Connelly and Graham Smith; *Politics and the Environment: From Theory to Practice* (London: Routledge, 2003).

Convention on International Liability for Damage Caused by Space Objects
< www.unoosa.org/pdf/publications/STSPACE11E.pdf >.

'Convention on International Liability for Damage Caused by Space Objects' (Summary Information)
< www.fco.gov.uk/Files/kfile/015_DamageSpaceObjects.pdf >.

Convention on Registration of Objects Launched into Outer Space (1976)
< www.unoosa.org/pdf/publications/STSPACE11E.pdf >.

Lawrence A. Cooper; 'Encouraging space exploration through a new application of space property rights' *Space Policy* Vol. 19 (2003), pp. 111-118.

'Cosmos Reentry Spurs Nuclear Waste Debate', *Aviation Week and Space Technology* (30th January 1978).

Douglas Coupland; *Girlfriend In A Coma* (London: Flamingo, 1998).

Douglas Coupland; *Eleanor Rigby* (London: Harper Perennial, 2005).

Susan Cox; 'No Tragedy on the Commons' *Environmental Ethics* Vol. 7, No. 1 (Spring 1985), pp. 49-62.

Eric Crewe; 'Review of Zecharia Sitchen; *Genesis Revisited: Is Modern Science Catching Up With Ancient Knowledge* (Bear and Co: Santa Fe, New Mexico, 1991)', *Fortean Times* Vol. 67, p. p. 59.

Luc Cuyvers; *Ocean Uses and Their Regulation* (Chichester: John Wiley & Sons, 1984).

D. Dansey (ed.); *Proceedings of the 4th European Conference on Space Debris* (Darmstadt, Germany: European Space Agency, 2005).

Charles Darwin; *The Origin of Species* (London: Wordsworth, 1998).

Jim Dator; 'What Has Posterity Ever Done For Me?' *International Space University – Stockholm Summer Session*
< www.futures.hawaii.edu/dator/space/posterity.pdf >.

Leonard David; 'Tossed in Space' *Foreign Policy* No. 136 (May/June 2003), p. 68-69.

Leonard David; 'Building a Better Moonbase'
< www.space.com/businesstechnology/technology/moonbase_biz_021002-1.html >.

Richard Dawkins; *The Selfish Gene* 2nd edition (Oxford: Oxford University Press, 1989).

'DEBIE Sensor Unit' *Metorex*
< www.metorex.fi/pages/space_products/debris.html >.

Bruce M. DeBlois; 'The Advent of Space Weapons' *Astropolitics* Vol. 1, No. 1 (Summer 2003), pp. 29-53.

Paul G. Dembling; 'Cosmos 954 and the Space Treaties' *Journal of Space Law* Vol. 6, No. 2 (1978), pp. 129-136.

Hamilton DeSaussure; 'An Integrated Legal System for Space' *Journal of Space Law* Vol. 6, No. 2 (1978), pp. 179-192.

Daniel Deudney; 'Environment and National Security', *Millennium* Vol. 19, No. 3 (1990), pp. 461-476.

I.H. Diederiks-Werschoor; *An Introduction to Space Law* (Deventer, Netherlands: Kluwer Law and Taxation Publishers, 1993).

Sam Dinkin; 'Property rights and space commercialisation' *The Space Review*
< www.thespacereview.com/article/141/1 >.

'Discover ISO – Meet ISO' < www.iso.org/iso/about/discover-iso_meet-iso.htm >.

'Discover ISO – What standards do'
< www.iso.org/iso/about/discover-iso_meet-iso/discover-iso_what-standards-do.htm >.

'Discover ISO – Who Develops ISO Standards'
< www.iso.org/iso/about/discover-iso_meet-iso/discover-iso_who-develops-iso-standards.htm >.

'Discover ISO – Why Standards Matter'
< www.iso.org/iso/about/discover-iso_meet-iso/discover-iso_why-standards-matter.htm >.

S.E. Doyle; 'Re-entering Space Objects: Facts and Fiction' *Journal of Space Law* Vol. 6, No. 2 (1978), pp. 107-117.

Rene-Jean Dupuy; 'The Notion of Common Heritage of Mankind Applied to the Seabed' *Annals of Air and Space Law* Vol. VIII (1983), pp. 347-353.

'Earth's Big Bang Created the Moon'
< www.spacedaily.com/news/water-99b.html >.

End of Life Disposal of Space System in the Low Earth Orbit Region Complied by Working Group 2: Environment & Database of the Inter-Agency Debris Coordination Committee (IADC) 1st March 2002. Copy on file with the author.

Leo Enright; 'UFO linked to secret Russian mission' *The Irish Times* (10th April 1993).

Barbara Faughnan and Gregg Maryniak (eds.); *Space Manufacturing 5 Engineering with Lunar And Asteroidal Materials* (New York: American Institute of Aeronautics and Astronautics, 1985).

J.E.S. Fawcett; *Outer Space* (Oxford: Clarendon, 1984).

David Feeny, Fikret Berkes, Bonnie J. McCay and James M. Acheson; 'The Tragedy of the Commons: Twenty-Two Years Later' *Human Ecology* Vol. 18, No. 1 (March 1990), pp. 1-19.

Donald J. Fleming, E.D. DuCharme, Ram S. Jakhu and W.G. Longman; 'State Sovereignty and the Effective Management of a Shared Resource: Observations Drawn From Examining Developments in the International Regulation of Radiocommunications' *Annals of Air and Space Law* Vol. X (1985), pp. 327-351.

Thomas Fletcher; 'Review of *The Global Commons* by Susan Buck' *Political Geography* Vol. 19, No. 8 (November 2000), pp. 1044-1048.

Gordon Foxall; 'A Note on the Management of the Commons' *Journal of Agricultural Economics* Vol. 30, No. 1 (1979), pp. 55-58.

Robert L. Friedhiem and William J. Durch; 'The International Seabed Resources Agency Negotiations and the New International Economic Order' *International Organization* Vol. 31, No. 2 (Spring 1977), pp. 343-384.

Eilene Galloway; 'Applicability of Space Treaties to Uses of Outer Space' *Annals of Air and Space Law* Vol. 1 (1976) pp. 205-212.

Eilene Galloway; 'The United States Congress and Space Law' *Annals of Air and Space Law* Vol. III, (1978), pp. 395-407.

Eilene Galloway; 'Nuclear Powered Satellites: The U.S.S.R. Cosmos 954 and the Canadian Claim'; *Akron Law Review* Vol. 12, No. 3 (Winter 1979), pp. 401-415.

Jonathan Galloway; 'Game theory and the law of outer space' *Space Policy* Vol. 20 (2004), pp. 87-90.

Jim George; 'Of Incarceration and Closure: Neo-Realism and the New/Old World Order' *Millennium* Vol. 22, No. 2 (1993), pp. 197-234.

Jim George; *Discourses of Global Politics: A Critical (Re)Introduction to International Relations* (Boulder, Colorado: Lynne Rienner, 1994).

'Genesis: Search for Origins'
< http://genesismission.jpl.nasa.gov/science/mod3_SunlightSolarHeat/FusionChemistry/index.html >.

Anthony Giddens; *New Rules of Sociological Method: A Positive Critique of Interpretative Sociologies* (Hutchinson & Co.: London, 1976).

Anthony Giddens; *A Contemporary Critique of Historical Materialism* (London and Basingstoke: MacMillan, 1981).

Anthony Giddens; *Sociology* 3rd edition (Cambridge: Polity Press, 1997).

Graeme Gill, *The Nature and Development of The Modern State* (Basingstoke: Palgrave, 2003).

Isaac T. Gillam IV; 'Business in Orbit: The Commercial Use of Space' *Journal of International Affairs* Vol. 39, No 1 (Summer 1985), pp. 115-120.

John Gittings and Tim Radford; 'The Moon - a giant leap for the Chinese who spy business opportunity in space' *The Guardian* 21st May 2002.

D. Goedhuis; 'Some Observations on the Problem of the Definition and/or the delimitation of Outer Space' *Annals of Air and Space Law* Vol. II (1977), pp. 287-309.

D. Goedhuis; 'Influence of the Conquest of Outer Space on National Sovereignty: Some Observations' *Journal of Space Law* Vol. 6, No. 1 (1978), pp. 31-46.

Andrzej Gorbiel; 'The Legal Status of Geostationary Orbit: Some Remarks' *Journal of Space Law* Vol. 6, No. 2 (1978), pp. 171-178.

Charles Gore (ed.); *Property* (London: MacMillan, 1915).

Stephen Gorove; 'Sovereignty and the Law of Outer Space Re-Examined' *Annals of Air and Space Law* Vol. II (1977), pp. 311-321.

Stephen Gorove; 'Cosmos 954: Issues of Law and Policy' *Journal of Space Law* Vol. 6, No. 2 (1978), pp. 137-146.

Stephen Gorove; 'Liability in Space Law: An Overview' *Annals of Air and Space Law* Vol. VIII (1983), pp. 373-380.

Peter M. Haas; 'Do regimes matter? Epistemic communities and Mediterranean pollution control' *International Organization* Vol. 43, No. 3 (Summer 1989), pp. 377-403.

Peter M. Haas; 'Introduction: Epistemic Communities and International Policy Coordination' *International Organization* Vol. 46, No. 1 (Winter 1992), pp. 1-35.

Peter M. Haas and Ernst B. Haas; 'Learning to Learn: Improving International Governance' *Global Governance* Vol. 1 No. 3 (September-December 1995), pp. 255-284.

Alan Hall; 'Moon Ice', *Scientific American* (9th March 1998).

Fred Halliday and Justin Rosenberg; 'Interview With Ken Waltz' *Review of International Studies* Vol. 23, No. 3 (1998), pp. 371-386.

Cees J. Hamelink; *The Politics of World Communication* (London: Saga Publications, 1994).

Anders Hansson and Steve McGuire; 'Commercial space and international trade rules: an assessment of the WTO's influence on the sector' *Space Policy* Vol. 15 (1999), pp. 199-205.

Garrett Hardin; 'The Tragedy of the Commons' *Science* Vol. 162 (December 1968), pp. 1243-1248.

Michael Hardy; 'The Implications of Alternative Solutions for Regulating the Exploitation of Seabed Minerals' *International Organization* Vol. 31, No. 2 (Spring 1977) pp. 313-342.

J.W. Harris; *Property and Justice* (Oxford: Clarendon Press, 1996).

Colin Hay; *Political Analysis* (Basingstoke: Palgrave, 2002).

'Heavens Above' < www.heavens-above.com >.

Grant Heiken, David Vaniman and Bevan M. French (eds.); *Lunar Sourcebook* (New York: Cambridge University Press, 1991).

David Held; *Models of Democracy* 2nd edition (Cambridge: Polity, 1996).

David Held; 'Democratic Accountability and Political Effectiveness from a Cosmopolitan Perspective' *Government and Opposition* Vol. 39, No. 2 (Spring 2004), pp. 364-391.

Gregg Herken; *The Winning Weapon: The Atomic Bomb in the Cold War 1945-1950* (Princeton: Princeton University Press, 1981).

John H. Herz; *International Politics in the Atomic Age* 6th paperback impression (New York and London: Columbia University Press, 1970).

Theresa Hitchens; 'Space Debris: Next Steps' (1st April 2004) < www.cdi.org/friendlyversion/printversion.cfm?documentID=2164 >.

Martin Hollis and Steve Smith; *Explaining and Understanding International Relations* (Oxford: Clarendon Press, 1991).

Thomas F. Homer-Dixon; 'On The Threshold: Environmental Changes as a Cause of Acute Conflict', *International Security* Vol. 16, No. 2 (Fall 1991), pp. 76-116.

S. Neil Hosenball; 'Nuclear Power Sources In Outer Space' *Journal of Space Law* Vol. 6, No. 2 (1978), pp. 119-123.

'How to set up a moon base' *BBC News* (26th August 2005) < http://news.bbc.co.uk/1/hi/magazine/4177064.stm >.

Adrian Hyde-Price; 'European Security Governance – or 'The Emperor Has No Clothes', unpublished paper from 3rd European Consortium for Politics Research General Conference (September 2005). Copy on file with author.

'IADC Document Registration List' < www.iadc-online.org/index.cgi?item=docs_pub >.

IADC Protection Manual Version 3.3. (April 2004). < www.iadc-online.org/docs_pub/IADC.PM.v3.3.04.04.2004.pdf >.

'IADC Space Debris Mitigation Guidelines' < www.iadc-online.org/docs_pub/IADC-101502.Mit.Guidelines.pdf >.

'Ice on the Moon' < http://nssdc.gsfc.nasa.gov/planetary/ice/ice_moon.html >.

'Ice on the Moon: Stake a Claim' < http://lunar.arc.nasa.gov/printerready/science/results/lunarice/stake.html >.

G. John Ikenberry; 'The End of the Neo-Conservative Moment' *Survival* Vol. 46, No. 1 (Spring 2004), pp. 7-22.

Mark Imber; *Environment, Security and UN Reform* (Basingstoke and London: St. Martin's Press, 1994).

'Instituto de Astrofisica de Canarias' < www.iac.es/telescopes/ogs/notapressE.html >.

'Inter-Agency Space Debris Coordination Committee' < www.iadc-online.org >.

Inter-Agency Space Debris Coordination Committee; *Activities And Views on Reducing Space Debris From Launch Vehicles, Presented to: 38th Session of the Scientific and Technical Subcommittee*

< www.iadc-online.org/docs_pub/IADC_UN_Presentation_Feb01.pdf >.

Inter-Agency Space Debris Coordination Committee; *Report of the IADC Activities on Space Debris Mitigation Guidelines Presented to: 39th Session of the Scientific and Technical Subcommittee United Nations Committee on the Peaceful Uses of Outer Space* (2002)
< www.iadc-online.org/docs_pub/IADC_Present.2002-final.pdf >.

Inter-Agency Space Debris Coordination Committee; *Report of the IADC Activities on Space Debris Mitigation Guidelines Presented to: 40th Session of the Scientific and Technical Subcommittee United Nations Committee on the Peaceful Uses of Outer Space* (2003).
< www.iadc-online.org/docs_pub/IADC_UN_Presentation_40_2003.pdf >.

Inter-Agency Space Debris Coordination Committee; *Report of the IADC Activities on Space Debris Mitigation Guidelines Presented to: 41st Session of the Scientific and Technical Subcommittee United Nations Committee on the Peaceful Uses of Outer Space* (2004).
< www.iadc-online.org/docs_pub/IADC-UNCOPUOS-final.pdf >.

'International Academy of Astronautics'
< http://iaaweb.org/content/view/136/234/ >.

'International Organization for Standardization' < www.iso.org >.

'International Seabed Authority' < www.isa.org.jm >.

'International Space Station Overview' < www.shuttlepresskit.com/ISS_OVR >.

'ISO gives space sector new management tool to reduce projects risk' (1st September 2003)
< http://www.iso.org/iso/en/commcentre/pressreleases/archives/2003/Ref869.html >.

'Introduction by JAXA Project Managers'
< www.jaxa.jp/news_topics/vision_missions/PM_messages/index_e.html >.

ITU 'Membership' < www.itu.int/members/index.html >.

ITU 'Membership List'
< www.itu.int/cgi-bin/htsh/mm/scripts/mm.list?_search=SEC&_languageid=1 >.

ITU 'Quarterly Publication of the Space Network List'
< www.itu.int/ITU-R/space/snl/download/pdf/SNL_full.pdf >.

ITU 'Space Network List' < www.itu.int/ITU-R/space/snl/ >.

Robert Jackson and Georg Sorensen; *Introduction To International Relations* (Oxford: Oxford University Press, 2003).

Ram S. Jakhu; 'The Legal Status of the Geostationary Orbit' *Annals of Air and Space Law* Vol. VII (1982), pp. 333-352.

Ram S. Jakhu; 'The Evolution of the ITU's Regulatory Regime Governing Space Radiocommunication Services and the Geostationary Satellite Orbit' *Annals of Air and Space Law* Vol. VIII (1983), pp. 381-406.

Joan Johnsson-Freese; 'The New US-Sino Space Relationship: Moving Towards Cooperation; *Astropolitics* Vol. 4 No. 2 (2006), pp. 131-158.

Nicholas L. Johnson; 'Monitoring and Controlling Debris in Space' *Scientific American* (August 1998), pp. 62-67.

Nicholas L. Johnson; 'Protecting the GEO environment: policies and practices' *Space Policy* Vol. 15 (1999), pp. 127-135.

Nicholas L. Johnson and Darren S. McKnight; *Artificial Space Debris* (Malabar, Florida: Krieger Publishing Company, 1991).

Rebecca Johnson; 'Beyond Article XIV: Strategies To Save the CTBT' *Disarmament Diplomacy* Vol. 73 (October-November 2003) < www.acronym.org.uk/dd/dd73/73ctbt.htm >.

Christopher C. Joyner; 'Legal Implications of the Concept of The Common Heritage of Mankind' *International and Comparative Law Quarterly* Vol. 35, No. 1 (June 1986), pp. 190-199.

N. Kasfir, J. Geist, T. West, M. Brown and C. Sabbatini; *Democracy and Governance Assessment* (Kampala, Uganda, 1996).

Rudolf Keller; *Electrochemical Processing of Space Resources* (January 2002) < http://electrochem.cwru.edu/ed/encycl/art-s01-space-proc.htm >.

Robert O. Keohane and Joseph S. Nye; *Power and Interdependence* (Boston: Little, Brown and Company, 1977).

Armel Kerrest; 'Outer Space: Res Communis, Common Heritage or Common Province of Mankind?' < http://fraise.univ-brest.fr/~kerrest/IDEI/Nice-appropriation.pdf >.

Donald J. Kessler and Burton G. Cour-Palais; 'Collision Frequency of Artificial Satellites: The Creation of a Debris Belt' *Journal of Geophysical Research* Vol. 83, No. A6 (June 1978), pp. 2637-2646.

Elke Krahmann; 'Conceptualising Security Governance' *Cooperation and Conflict* Vol. 38, No. 1 (2003), pp. 5-26.

Vendulka Kubalkova, Nicholas Onuf and Paul Kowert (eds.); *International Relations in a Constructed World* (London: M.E. Sharpe, 1998).

John Lawrence; 'Nuclear Power Source in Space a Historical Review' *Nuclear News* November 1991.

Dawn Levy; 'Sally Ride Speaks On The Tactical Role Of Space and War' *Space Daily*
< www.spacedaily.com/news/milspace-02n.html >.

Marc A. Levy; 'Is The Environment A National Security Issue' *International Security* Vol. 20, No. 2 (Fall 1995) pp. 35-62.

O.J. Lissitzyn; 'The American Position on Outer Space and Antarctica' *The American Journal of International Law* Vol. 53, No. 1 (January 1959), pp. 126-131.

David Livingston; 'A code of ethics for conducting business in outer space' *Space Policy* Vol. 19 (2003), 93-94.

Joseph P. Loftus (ed.); *Orbital Debris from Upper-Stage Breakup* (Washington D.C.: American Institute of Aeronautics and Astronautics, 1989).

Bjorn Lomborg; *The Skeptical Environmentalist* (Cambridge: Cambridge University Press, 2001).

Stephen Lukes; *Power A Radical View* (London: MacMillan, 1974).

'Lunar Embassy' < www.lunarembassy.com >.

Sean Lynn-Jones and Steven Miller; *The Perils of Anarchy, Contemporary Realism and International Security* (Cambridge, MA: MIT Press, 1995).

Ian MacDonald; *Revolution in the Head* (London: Pimlico, 1995).

Niccolo Machiavelli (translated by C.E. Detmold); *The Prince* (Ware: Wordsworth, 1997).

John MacMillan and Andrew Linklater (eds.); *Boundaries in Question* (London: Pinter, 1995).

Hans Mark; 'War and Peace in Space' *Journal of International Affairs* Vol. 39, No. 1 (Spring 1985), pp. 1-22.

'Mars pictures reveal frozen sea' *BBC News* (21st February 2005)
< http://news.bbc.co.uk/1/hi/sci/tech/4285119.stm >.

Karl Marx; *The Eighteen Brumaire of Louis Bonaparte* trans. Eden and Cedar Paul (London: George Allen and Unwin Ltd., 1943).

Nicolas Mateesco Matte; 'The Common Heritage of Mankind Principles in Outer Space: Towards a New International Order for Survival' *Annals of Air and Space Law* Vol. XII (1987), pp. 313-335.

Alasdair McLean; 'PFI in the sky, or pie in the sky? – Privatising military space' *Space Policy* Vol. 15 (1999), pp. 193-198.s

D. Mehrholz, L. Leushacke, W. Flury, R. Jen, H. Klinkrad and M. Landgraf; 'Detecting, Tracking and Imaging Space Debris' *ESA Bulletin* No. 109 (February 2002).

W.W. Mendell (ed.); *Lunar Bases and Space Activities of the 21st Century* (Houston: The Lunary Planetary Institute, 1986).

'Mining and Manufacturing on the Moon' < http://aerospacescholars.jsc.nasa.gov/HAS/cirr/em/6/6.cfm >.

Minutes of 20th Meeting of the IADC. Copy on file with the author.

James Clay Moltz (ed.); *Future Security in Space: Commercial, Military and Arms Control Trade-Offs* (Monterey Institute of International Studies, July 2002).

'Moon map aids discovery', *BBC News* (2nd December 1998) < http://news.bbc.co.uk/1/hi/sci/tech/226053.stm >.

Han J. Morgenthau; *Politics Among Nations* 5th edition (New York: Alfred A. Knopf, 1978).

Karl P. Mueller; 'Totem or Taboo: Depolarizing the Space Weaponization Debate' *Astropolitics* Vol. 1 No. 1 (Summer 2003) pp. 4-28.

David Mutimer (ed.); *Control But Verify: Verification and the New Non-Proliferation Agenda* (Toronto: York Centre for International and Strategic Studies, 1994).

'Nasa plans return to Moon by 2020' *BBC News* (19th September 2005) < http://news.bbc.co.uk/1/hi/sci/tech/4261522.stm >.

'Nasa's new Moon plans' *BBC News* (20th September 2005) < http://news.bbc.co.uk/1/hi/sci/tech/4262168.stm >.

National Research Council (U.S.). Committee on Space Debris; *Orbital Debris: A Technical Assessment* (Washington D.C.: National Academy of Science, 1995).

'No Water Detected From Lunar Prospector Impact', NASA Press Release (13th October 1999) < http://nssdc.gsfc.nasa.gov/planetary/text/lp_pr_19991013.txt >.

James Oberg; 'The Probe That Fell To Earth' *New Scientist* (6th March 1999).

Office of Science and Technology Policy (U.S. Government); *Interagency Report on Orbital Debris* (Washington: 1995).

'Online Index of Objects Launched into Outer Space' UN Office for Outer Space Affairs < www.unoosa.org/oosa/osoindex.html >.

Gerard O'Neill; *The High Frontier* (New York: Anchor Books, 1982).

Orbital Debris Hazards and Mitigation Strategies report by the American Institute of Aeronautics and Astronautics.

< http://pdf.aiaa.org/downloads/publicpolicypositionpapers/OrbitalDebris-1999.pdf >.

'Organization Chart of the United Nations' < www.un.org/aboutun/chart.html >.

Elinor Ostrom; *Governing the Commons* (Cambridge: Cambridge University Press, 1990).

Elinor Ostrom; 'A Bahvioral Approach to the Rational Choice Theory of Collective Action: Presidential Address, American Political Science Association', *The American Political Science Review* Vol. 92, No. 1 (March 1998), pp. 1-22.

Outer Space Act 1986 (UK)
< www.bnsc.gov.uk/assets/channels/about/outer%20space%20act%201986.pdf >.

'Overview of the ISO system'
< www.iso.org/iso/en/aboutiso/introduction/index.html >.

Paper Tigers: The Scramble for Space Spectrum International Telecommunications Union Website
< http://www.itu.int/newsarchive/pp02/media_information/feature_satellite.html >.

Lubos Perek; 'Space Debris Mitigation and Prevention: How to Build a Stronger International Regime' *Astropolitics* Vol. 2, No. 2 (Summer 2004), pp. 215-226.

David Pepper; *Modern Environmentalism: An Introduction* (London: Routledge, 1996).

M.J. Peterson; 'The Use of Analogies in Developing Outer Space Law' *International Organization* Vol. 52, No. 2 (Spring 1997), pp. 245-274.

Clive Ponting; 'Historical perspectives on sustainable development' *Environment* Vol. 32, No. 9 (November 1990), pp. 3-12.

Virgiliu Pop; 'Appropriation in Outer Space: The Relationship Between Land Ownership and Sovereignty on The Celestial Bodies' *Space Policy* Vol. 16 (2000), pp. 275-282.

Virgiliu Pop; 'The men who sold the Moon; science fiction or legal nonsense?' *Space Policy* Vol. 17 (2007), pp. 105-203.

Nick Pope; 'Britain's Real X Files' *Daily Mail* 2nd February 2005.

David S.F. Portree and Joseph P. Loftus; *Orbital Debris: A Chronology* (NASA/TP-1999-208856), (NASA: Houston, January 1999).

Aseem Prakash and Jeffrey Hart (eds.); *Globalization and Governance* (London and New York: Routledge, 1999).

Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organisation 'History of the Comprehensive Nuclear-Test-Ban-Treaty (CTBT)'
< www.ctbto.org >.

'President Bush Announces New Vision for Space Exploration Program' White House Press Release (14th January 2004).

'Prime Minister Announces Mission to Moon'
< www.isro.org/pressrelease/Aug16_2003.htm >.

'Proba Marks One Year On Orbit' *Space Daily*
< www.spacedaily.com/news/robot-02q.html >.

Pierre Joseph Proudhon; *What Is Property?* Translator: Benj. R. Tucker (New York: Howard Fertig, 1966).

'Radioactive Piece of Soviet Satellite Round' *Facts on File World News Digest* 17th February 1978.

'Radiocommunications Agency – Spectrum Auctions'
< www.spectrumauctions.gov.uk >.

Herbert Reis; 'Some Reflections on the Liability Convention for Outer Space' *Journal of Space Law* Vol. 6, No. 2 (1978), pp. 125-128.

Jason Reiskind; 'Towards A Responsible Use of Nuclear Power in Outer Space – The Canadian Initiative In The United Nations' *Annals of Air and Space Law* Vol. VI (1981), pp. 461-473.

Report of the Commission to Assess United States National Security Space Management and Organization (Washington D.C., 11th January 2001).

'Resources of the Seabed'
< www.isa.org.jm/en/publications/IA_ENG/ENG1.pdf >.

Dietrich Rex; 'Will Space Run Out of Space' *Space Policy* Vol. 14 (1998), pp. 95-105.

Glenn Harlan Reynolds; *Key Objections to the Moon Treaty.*
< http://nsschapters.org/hub/pdf/MoonTreatyObjections.pdf >.

Glenn Harlan Reynolds; 'The Moon Treaty: Prospects for the future' *Space Policy* Vol. 11 (1995), pp. 115-120.

T.F. Rogers; 'Safeguarding Tranquillity Base: why the Earth's Moon base should become a World Heritage Site' *Space Policy* Vol. 20 (2004), pp. 5-6.

Justin Rosenberg; 'What's The Matter With Realism' *Review of International Studies* Vol. 16, No. 4 (1990), pp. 285-303.

Justin Rosenberg; *The Empire of Civil Society* (London: Verso, 1994).

Ian H. Rowlands and Malory Greene (eds.); *Global Environmental Change and International Relations* (Basingstoke: MacMillan, 1992).

'Russian Space Agency to Build Power Plant on Moon' < www.mosnews.com/news/2005/07/27/lunarfuel.shtml >.

Mike H Ryan and Ida Kutschera; 'Lunar-based enterprise infrastructure – hidden keys for long-term business success' *Space Policy* Vol. 23 (2007), pp. 44-52.

Eligar Sadeh (ed.); *Space Politics and Policy: An Evolutionary Perspective* (Dordrecht, The Netherlands: Kluwer Academic Publishers, 2002).

Eligar Sadeh, David Livingston, Thomas Matula and Haym Benaroya; 'Public-Private Models for Lunar Development', *Space Policy* Vol. 21, No. 2 (2005), pp. 267-275.

Scott D. Sagan and Kenneth N. Waltz; *The Spread of Nuclear Weapons* (W.W. Norton, New York, 1995).

John M. Sarkissian; 'Return to the Moon: a sustainable strategy' *Space Policy* Vol. 22 (2006), pp. 118-127.

Markus G. Schmidt; *Common Heritage or Common Burden?* (Oxford: Clarendon Press, 1989).

Harrison H. Schmitt; 'Return to the Moon' (December 2002) < http://fti.neep.wisc.edu/pdf/fdm1190.pdf >.

'SELenological and Engineering Explorer "SELENE"' < www.jaxa.jp/missions/projects/sat/exploration/selene/index_e.html >.

Malcolm N. Shaw; *International Law* Fifth edition (Cambridge: Cambridge University Press, 2003).

Michael Sheehan; *International Security: An Analytical Survey* (London: Lynne Rienner Publishers, 2005).

John A. Simpson (ed.); *Preservation of Near-Earth Space For Future Generations* (Cambridge: Cambridge University Press, 1994).

David Singer; 'The Level-Of-Analysis Problem in International Relations' *World Politics* Vol. 14, No. 1, (1961), pp. 77-92.

'SMART-1' < www.esa.int/esaMI/SMART-1/index.html >.

Nikolay N. Smirnov (ed.); *Space Debris: Hazard Evaluation and Mitigation* (London: Taylor and Francis, 2002).

Steve Smith; 'Wendt's World' *Review of International Studies* Vol. 26, No. 1 (January 2000), pp. 151-163.

Steve Smith and John Baylis (eds.); *The Globalisation of World Politics* (Oxford: Oxford University Press, 1997).

Theodore P. Snow; *The Dynamic Universe* (St. Paul, MN, West Publishing Company: 1991).

'Soviets Launch New Salyut' *Aviation Week & Space Technology* (3rd October 1977).

'Space Junk; Return of the Native', *The Economist* (1st October 1988).

'Space Nuclear Power System Accidents' *NASA Space Link* <http://spacelink.nasa.gov/NASA.Projects/Human.Exploration.and.Development.of.Space/Human.Space.Flight/Shuttle/Shuttle.Missions/Flight.031.STS-34/Galileos.Power.Supply/Space.Nuclear.Power.System.Accidents >.

'Space Nuclear Power Technology' *NASA Space Link* <http://spacelink.nasa.gov/NASA.Projects/Human.Exploration.and.Development.of.Space/Human.Space.Flight/Shuttle/Shuttle.Missions/Flight.031.STS-34/Galileos.Power.Supply/Space.Nuclear.Power.Technology >.

'Spacecraft: West Ford Dipoles' < www.aoe.vt.edu/~cdhall/Space/archives/000289.html >.

Hendrik Spruyt; *The Sovereign State and Its Competitors* (Princeton, Princeton University Press, 1994).

'Spy Satellite Reactor Now in a Safe Orbit, Its Trackers Report' *The New York Times* 5th October 1988.

Paul B. Stares; 'Reagan and the ASAT Issue' *Journal of International Affairs* Vol. 39, No. 1 (Summer 1985), pp. 81-94.

J.G. Starke; *Introduction To International Law* 9th edition (London: Butterworth, 1984).

Susan Strange; 'The Westfailure System' *Review of International Studies* Vol. 25 No. 3 (1999), pp. .345-354.

Hidemi Suganami; 'Reflections on the domestic analogy: the case of Bull, Beitz and Linklater'; *Review of International Studies* Vol. 12, No. 2 (1986), pp. 145-158.

Paul M. Sweezy; *The Theory of Capitalist Development* (New York: Monthly Review Press, 1942).

Timothy D. Swindle; 'Testimony Before the Subcommittee on Space and Technology About Lunar Science and Resources: Future Options', *House Committee on Science* (1st April 2004) < http://www.house.gov/science/hearings/space04/apr01/swindle.htm >.

'Telescopes see 'distant planet'' *BBC News* (4th April 2005) < http://news.bbc.co.uk/1/hi/sci/tech/4408187.stm >.

Terms of Reference for the Inter-Agency Space Debris Coordination Committee (IADC) (5th October 2004)
< www.iadc-online.org/index.cgi?item=torp >.

Peter S. Thacher; 'Space Technology and Resource Management' *Journal of International Affairs* Vol. 39, No. 1 (Summer 1985), pp. 151-166.

'The Convention for the Establishment of a European Space Agency' (30th May 1975) *International Legal Materials* Vol. 14 (1975), pp. 864-908.

'The Cosmos 954 Accident' *Healthy Environments and Consumer Safety* (Part of the Canadian government's website)
< www.hc-sc.gc.ca/hecs-sesc/neprd/nep-events/cosmos.htm >.

'The Earth's Moon' < http://kosmoi.com/Science/Earth/Moon/ >.

'The Moon' < www.ex.ac.uk/Mirrors/nineplanets/luna.html >.

'The National Aeronautics and Space Administration Authorization Act, Fiscal Year 1991'
< http://thomas.loc.gov/cgi-bin/bdquery/z?d101:SN02287:@@@L&summ2=m& >.

The Third United Nations Convention on the Law of Sea (UNCLOS III)
< http://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf >.

'The University of Wisconsin – Madison, Fusion Technology Institute'
< http://fti.neep.wisc.edu >.

'The Westminster Hour' *BBC Radio Four* (30th October 2005).

Hjalmar Thiel, Gerd Schriever and Eric J. Foell; 'Polymetallic Nodule Mining, Waste Disposal, and Species Extinction at the Abyssal Seafloor' *Marine Georesources and Geotechnology* Vol. 23, No. 3 (July 2005), pp. 209-220.

Daya Kishan Thussu; *International Communication: Continuity and Change* (London: Arnold, 2000).

Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies
< www.unoosa.org/pdf/publications/STSPACE11E.pdf >.

'UK Mobile Phone Auction Nets Billions' *BBC News* (27th April 2000)
< http://news.bbc.co.uk/1/hi/business/727831.stm >.

Richard H. Ullman; 'Redefining Security', *International Security* Vol. 8, No. 1 (Summer 1983), pp.129-153.

'UN Committee on the Peaceful Uses of Outer Space, UN Office for Outer Space Affairs – A Brief Overview' < http://ihy2007.org/img/COPUOS-OOSA_final.ppt >.

United Nations Convention on the Law of the Sea: Agreement relating to the implementation of Part XI of the Convention 10 December 1982.
< www.un.org/Depts/los/convention_agreements/texts/unclos/closindx.htm >.

U.N. Document A/AC.105/INF.368 (22nd November 1977)

U.N. Document A/AC.105/214 (8th February 1978)

U.N. Document A/AC.105/217 (6th March 1978)

U.N. Document A/AC.105/236 (22nd December 1978).

U.N. Document A/AC.105/620; (21st November 1995).

U.N. Document A/AC.105/659/Add.2; (14th February 1997).

U.N. Document A/AC.105/681; (17th December 1997).

U.N. Document A/AC.105/680/Add.1; (2nd February 1998).

U.N. Document A/AC.105/707; (14th December 1998).

U.N. Document A/AC/105/C.2/L.210, *Review of the Status of the Five International Legal Instruments Government Outer Space* (1998).

U.N. Document A/AC.105/731; (20th December 1999).

U.N. Document A/AC.105/751/Add.1; (29th January 2001).

U.N. Document A/AC.105/770; (30th November 2001).

U.N. Document A/AC.105/817; (15th December 2003).

U.N. Document A/AC.105/850, 'Report of the Legal Subcommittee on its forty-fourth session, held in Vienna from 4 to 15 April 2004' (28th April 2005)
< www.unoosa.org/pdf/reports/ac105/AC105_850E.pdf >.

United Nations Framework Convention on Climate Change (FCCC)
< http://unfccc.int/resource/docs/convkp/conveng.pdf >.

United Nations; 'Principles Relevant to the Use of Nuclear Power Sources in Outer Space'
< www.unoosa.org/oosa/SpaceLaw/nps.html >.

United Nations; 'Status of international agreements relating to activities in outer space as at 1 January 2006' U.N. document ST/SPACE/11/Rev.1/Add.1
< www.unoosa.org/pdf/publications/ST_SPACE_11_Rev1_Add1E.pdf >.

U.N.; *Technical Report on Space Debris* (New York: United Nations, 1999)
< www.unoosa.org/pdf/reports/ac105/AC105_720E.pdf >.

United Nations treaties and principles on outer space: Status of international agreements relating to activities in outer space as at 1 January 2004 (Vienna: United Nations, February 2004).

United Nations; *United Nations treaties and principles on outer space: Status of international agreements relating to activities in outer space as at 1 January 2005* (Vienna: United Nations, February 2005).
< www.unoosa.org/pdf/publications/ST_SPACE_11_Add1_Rev2E.pdf >.

'United Nations Office for Outer Space Affairs'
< www.oosa.unvienna.org/SpaceLaw/treaties.html >.

'United Nations Register of Space Objects Launched into Outer Space'
< www.unoosa.org/oosa/en/SORegister/index.html >.

'UNCLOS III Implementation Agreement Overview – Convention & Related Agreements'
< www.un.org/Depts/los/convention_agreements/convention_overview_part_xi.htm >.

'United Press International' Report (7th January 1983).

'UNOOSA Index of Online Documents'
< www.unoosa.org/oosa/en/docsidx.html >.

'US adopts tough new space policy' *BBC News* (18th October 2006)
< http://news.bbc.co.uk/1/hi/world/americas/6063926.stm >.

U.S. Congress, Office of Technological Assessment; *Orbiting Debris, A Space Environmental Problem - Background Paper* (Washington D.C.: U.S. Government Printing Office, 1990).

U.S. Department of Energy, Office of Nuclear Energy, Science, and Technology; *Nuclear Power in Space* (Washington, D.C) < www.ne.doe.gov/pdf/npspace.pdf >.

'U.S. National Space Policy'
< http://news.bbc.co.uk/1/shared/bsp/hi/pdfs/18_10_06_usspace.pdf >.

U.S. Department of State overview of the 'Outer Space Treaty'
< www.state.gov/t/ac/trt/5181.htm >.

N.V. Vighnesam and Anatta Sonney; *Precise Relative Orbit Estimation of INSAT Missions*
< www.issfd.dlr.de/papers/P0100.pdf >.

Lotta Viikari; 'Time is of the essence: making space law more effective' *Space Policy* Vol. 21 (2005), pp. 1-5.

John Vogler; *The Global Commons* (Chichester: John Wiley and Sons, 1995).

F.G. von der Dunk, E. Back-Impallomeni, S.Hobe and R.M. Ramirez de Arellano; 'Surreal estate: addressing the issue of 'Immovable Property Rights on the Moon' *Space Policy* Vol. 20 (2004), pp. 149-156.

Jon Von Neumann and Oskar Morgenstern; *Theory of Games and Economic Behaviour* (Princeton: Princeton University Press, 1947).

R.B.J. Walker; *Inside/Outside: International Relations and Political Theory* (Cambridge: Cambridge University Press, 1993).

Immanuel Wallerstein; *The Capitalist World-Economy* (Cambridge: Cambridge University Press, 1979).

Kevin B. Walsh; 'Controversial Issues Under Article XI of the Moon Treaty' *Annals of Air And Space Law* Vol. VI (1981), pp. 489-498.

Kenneth N. Waltz; *Man, The State and War* (New York: Columbia University Press, 1959).

Kenneth N. Waltz; *Theory of International Politics* (Reading, Mass.: Addison-Wesley, 1979).

Kenneth Waltz; 'Realist Thought and Neorealist Theory' *Journal of International Affairs* Vol. 44, No. 1 (Spring/Summer 1990), pp. 21-37.

Mark Weber, Stuart Croft, Jolyon Howorth, Terry Terriff and Elke Krahmann; 'The Governance of European Security' *Review of International Studies* Vol. 30, No. 1 (January 2004), pp. 3-26.

Alexander Wendt; 'Anarchy is What States Make of It: The Social Construction of Power Politics' *International Organizations* Vol. 46, No. 2 (Spring 1992), pp. 391-425.

Alexander Wendt; *Social Theory of International Politics* (Cambridge: Cambridge University Press, 1999).

'What Are The Risks Posed By Orbital Debris', *Centre for Orbital and Reentry Debris Studies*
< www.aero.org/cords/debrisks.html >.

Dr David Whitehouse; 'China sets its sights on the Moon' *BBC News* (3rd December 2003)
< http://news.bbc.co.uk/1/hi/sci/tech/3288043.stm >.

Per Magnus Wijkman; 'Managing the Global Commons' *International Organization* Vol. 36, No. 3 (Summer 1982), pp. 511-536.

Sylvia Maureen Williams; 'International Law Before and After the Moon Agreement' *International Relations (London)* Vol. 7, No. 2 (1981), pp. 1168-1193.

Mark Williamson; 'Space ethics and protection of the space environment' *Space Policy* Vol. 19 (2003), pp. 47-52.

H.E. Wimperis; 'Atomic Energy Control: The Present Position' *International Affairs* Vol. 24, No. 4 (October 1948), pp. 515-523.

A. Yakovenko; 'The Intergovernmental Agreement on the International Space Station' *Space Policy* Vol. 15 (1999), pp. 79-86.

Oran R. Young (ed.); *Global Governance* (MIT Press: London, 1997).

Yun Zhao; 'The ITU and National Regulatory Authorities in the Era of Liberalization' *Space Policy* Vol. 18 (2002), pp. 293-300.

Yun Zhao; 'The 1972 Liability Convention: time for revision?' *Space Policy* Vol. 20 (2004), pp. 117-122.