Part I

International Space Security Setting

International Space Security Setting: An Introduction

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Peter L. Hays

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Abstract

This article provides an introduction to Section One of the *Handbook of Space Security* by overviewing major issues and themes that frame discourse about space security. Section One contains 14 chapters that include foundational discussions about definitional, governance, theoretical, legal, and deterrence themes for space security as well as more focused discussions about responsive space, cyber security, critical infrastructure, safety, traffic management, sustainability, export controls, and transparency- and confidence-building measures. Together, these themes and issues provide a comprehensive setting for refining and advancing our dialogue about international space security.

1.1 Foundational Themes

Defining and scoping space security is probably the single most important issue for any dialogue about this topic. Traditionally space security was primarily defined in bipolar terms as part of the strategic balance between the United States and the Soviet Union, and it was focused on military and environmental aspects of accessing and using space. ▶ Chapter 2, "Defining Space Security" chapter by

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Michael Sheehan explains how this traditional definition has been expanded to include a broader perspective on security that emphasizes the use of space for security and defense, the security of assets in space against natural and man-made threats, as well as security from threats originating in space. Broadening the scope of space security to include a growing number of significant space actors and emphasize the increasing importance of commercial interests has advantages, but also carries certain risks, including difficulties in addressing these issues in comprehensive yet discreet ways.

Governance and theoretical issues form other foundational aspects of space security. Effective governance is needed for humanity to derive more benefits from space; space governance also seeks to ensure space is used in stable and sustainable ways. Eligar Sadeh identifies two key obstacles to more enlightened space governance: difficulties in attaining collective action in relation to the commons of space and problems with developing shared understanding about strategic stability and advancing strategic assurance for sustainable uses of space as a shared strategic goal. Max Mutschler's chapter describes how international relations theory can be used to explain various patterns of security cooperation in space and illuminates why there have been only limited successes thus far in achieving space security cooperation: Neorealism explains this lack of cooperation with the difficulties to achieve balanced gains; neoinstitutionalism sees the establishment of effective rules and mechanisms to verify the compliance of states as a main hurdle; and from a Constructivist/Liberal perspective the main problem lies in the dominant beliefs about the value of unilateral space policies. More broadly, my chapter asserts that spacepower theory can describe, explain, and predict how individuals, groups, and states can best derive utility, balance investments, and reduce risks in their interactions with the cosmos. Such foundational theory should be more fully developed and become a source for critical insights on finding better ways to generate wealth in space, making trade-offs between space investments and other important goals, reordering terrestrial security dynamics as space becomes increasingly militarized and potentially weaponized, and seizing exploration and survival opportunities that only space can provide.

Chapters exploring the laws of war for space and the role of space in deterrence complete the foundational part of Section One. Professor Steven Freeland explains how regulation of space is embedded in international law and explicates the major themes of the Outer Space Treaty (OST), the main source of space law. As technology advances, space has been increasingly used during the course of armed conflict, notwithstanding the "peaceful purposes" provisions of the OST. Reconciling these seemingly incompatible concepts and developments is difficult and requires an understanding of how and to what extent the international law principles of jus in bello – international humanitarian law – apply to the conduct of these activities. Freeland describes how the rising number of "dual-use" satellites further complicates matters and asserts that there is a growing need to reach consensus on additional legal regulation for armed conflict that may involve use of space capabilities. Ambassador Roger Harrison asserts that whether or not weapons are actually deployed in space, the era in which satellites could operate without potential threat is over. He examines trends that could be encouraged and actions that should be taken to reduce the possibility of space becoming a theater, or a catalyst, for hostilities. He concludes that prospects for strengthening deterrence may not depend so much on state activity as on the nature of the space environment as well as on leadership by commercial space operators.

1.2 International Space Security Focus Areas

Responsive space is a recent catchphrase referring to aspirations for space capabilities to support a wide range of mission areas in flexible ways, become more affordable, and be developed and employed more quickly. Nina-Louisa Remuss explores security-related dimensions of responsive space and examines how the well-known approach developed by the US Department of Defense can inform a European path toward improving responsive space capabilities. Dario Sgobbi and his coauthors examine the strong interrelationships between space and cyber security. Although many aspects of space and, especially, cyber security must be far better developed, the authors assert that using systems engineering concepts and methodologies is key to tackling challenges in both these fields simultaneously and to achieving space systems that are truly cyber secure.

Despite increased emphasis over the past 20 years on critical infrastructure protection as an essential foundation for ensuring the safety and security of citizens and the functioning of states, Markus Hesse and Marcus Hornung find that too often critical space infrastructure is overlooked. For example, Global Positioning System timing signals currently provide the “heartbeat” that synchronizes all global telecommunications networks, yet there is a lack of appreciation for this dependency and underdeveloped policies to ensure protection of this critical space infrastructure. As space infrastructure grows in importance, it is imperative that the United States, European Union, and others find better ways to develop these needed policies. Space safety is necessary for the sustainable development of space yet, as Joe Pelton and his coauthors describe, safety considerations are too often an afterthought for space security issues. Without improved space safety practices and standards from launch, to on-orbit operations, to reentry, billions of dollars of space assets, many astronaut lives, and even people on Earth could all be increasingly in peril. A related topic of growing importance is the concept of space traffic management. William Ailor’s chapter begins by providing an overview of the evolution of the near-Earth space environment, discussing the current situation, and projecting how future developments such as the growing space debris population and active debris removal will affect that environment. Just as the growth in air travel led to air traffic management, assuring that future space systems will have minimal interference to their operations requires a system to warn operators of potential collisions and other hazards: a space traffic management system.

Space sustainability is another recent catchphrase that refers to a set of issues relating to carrying out space activities safely and without interference as well as concerns about ensuring continuity of benefits derived on Earth from space activities.

Peter Martinez, as a long-time international space policy expert, is in an ideal position to review the role of the various relevant United Nations (UN) entities in ensuring space sustainability and provide a detailed review of the Working Group on the Long-Term Sustainability of Outer Space Activities within the Scientific and Technical Subcommittee of the UN Committee on the Peaceful Uses of Outer Space (UN COPUOS). In addition, his chapter discusses the relationship of the work in UN COPUOS with related work being done in the Conference on Disarmament, the UN Group of Governmental Experts (GGE) on Transparency- and Confidence-Building Measures (TCBMs) in Outer Space Activities, and the initiative by the European Union to propose a draft international Code of Conduct for outer space activities. Ulrike Bohlmann explains how the Cold War drove both innovation in space technology and imposition of controls on the export of these technologies. Balancing national security and commercial interests has been and remains difficult due to the Janus-faced, "dual-use" nature of space technology, serving scientific and commercial interests on the one hand and strategic, defense-related objectives on the other. Finally, Jana Robinson, from her perch with the European External Action Service, describes TCBMs as traditional tools of diplomacy and international relations that can be applied to space activities. She reviews the increasing demand for TCBMs, focuses on the multilateral dimension of TCBMs, and overviews the main space TCBM-related efforts to date, including the more recent ones being undertaken in the UN framework and by the European Union.

1.3 Conclusions

This overview of Section One of the *Handbook of Space Security* provides a comprehensive introduction to major issues and themes that shape humanity's dialogue about space security. The 14 chapters in Section One include foundational discussions about definitional, governance, theoretical, legal, and deterrence themes as well as more focused discussions about responsive space, cyber security, critical infrastructure, safety, traffic management, sustainability, export controls, and transparency- and confidence-building measures. These chapters provide a comprehensive foundation for the more detailed and focused discussions of space security themes and issues in the remainder of the *Handbook of Space Security*.

Defining Space Security

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Michael Sheehan

Contents

Abstract

Space security relates to guaranteed access to space and the ability to freely exploit space for various purposes. Traditionally, space security was defined in military terms in relation to the strategic balance between the United States and the Soviet Union. Since the end of the Cold War, a two-dimensional model of military and environmental dimensions of space security has developed. This in turn is beginning to be superceded by a three-sector understanding which distinguishes between the uses of space for security and defense: the security of assets in space against natural and man-made threats and security from threats originating in space. Expanding the definition of space security has advantages but also carries certain risks.

2.1 Introduction

"Space security" is a subject that is much discussed but rarely defined. Traditionally, it has been associated with the military security of states, and this is still the

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predominant understanding of the term. It certainly remains the case that a fundamental aspect of "space security" is the contribution that satellites make to the military security of states and the maintenance of international stability and balances of power, as well as the military threats to satellites and their ability to support international security. However, there has been a widening of the understanding of space security in recent years so that, while the military dimension remains fundamental, other crucial issues have been brought within the scope of the concept.

The pursuit of security has become a fundamental objective of state behavior, and in that sense it was inevitable that the concept would eventually be applied to human space activities. This change reflects to some extent the fact that in the last three decades there has been a significant evolution in the meaning attached to the term "security" more generally. During the Cold War, "security" was understood in specific and very limited ways. Security referred to threats against the state and specifically to the military threats represented by the armed forces of other states or insurgent movements. The problem with this narrow definition of security was that it did not reflect the everyday reality of people in the world. While the armed forces of another country might represent a clear security threat for the people of some countries, in many others they would not, while issues like food and water shortages or endemic diseases would be the issues that presented the real security threats to the survival of populations. A definition of security was needed therefore that could embrace these kinds of diverse problems within a single framework. As a result, while military security was retained as a crucial security sector, new ones such as economic, societal, and environmental securities were added to the concept.

Changes in the understanding of space security mean that it now similarly embraces a broad understanding of the requirement of freedom of access to and use of space by all states who wish to use it for the socioeconomic benefit of their populations. Satellites play a crucial role in international efforts to promote terrestrial environmental security and for many states are vital in terms of their efforts to increase human security. At the same time, the traditional view that space is a place for securing long-standing national objectives is also still prominent. The United States, for example, sees the ability to use space as a vital national interest.

Space security involves a number of different aspects. It includes the security of satellites and spacecraft in orbit, the security of access to space, and also the contribution to the security of people on Earth made by various types of satellites. Although these three dimensions will be looked at separately in this chapter, in reality they are interconnected. The security of satellites in orbit, for example, is crucially affected by what is happening to their ground elements. The human security contribution of satellites is threatened by both military and environmental threats to satellites in space.

2.2 Existing Definitions of Space Security

Since the beginning of the space age in the 1950s, two basic principles have dominated thinking about the relationship of space activities to international law.

These are the concepts of the right of access to space and freedom of navigation in space. There is therefore a consensus among governments that space security involves efforts to ensure the long-term sustainability of Earth orbit for a range of beneficial uses and governments continue to promote freedom of access to and use of space for those same human security purposes.

This is reflected in existing definitions of space security such as that used by Canada, which describes space security simply as "the secure and sustainable access to, and use of, space." The annually published *Space Security Index* uses identical terms to this definition but adds, "and freedom from space-based threats" (Estabrooks 2006, p. 93). A similar but more precise definition by the Space Generation Council, which specifically focuses on its political dimension, is "secure and sustainable access to, and use of outer space in accordance with international laws and treaties, free from the threat of disruption."[1] All these definitions capture the idea that making space "secure" means making it a sustainable environment over the long term for the conduct of human activities in a range of practical areas. It is notable that in these definitions the word "threat" is not limited to purely military issues but rather is implicitly allowed to embrace any potential obstacle to the effective use of the space environment by human beings. The definitions reflect the idea of space as a domain in which states and non-state actors will wish to carry out a variety of legal activities unhindered by dangers created by the activities of others or blocked by either technological issues or the effects of the natural space environment. This has encouraged the increasing popularity of the idea of space as a specific environment and one that is a common heritage of humanity. For the authors of the Space Security Index, "This broad definition encompasses the security of the unique space environment, which includes the physical and operational integrity of manmade assets in space and their ground stations, as well as security on Earth from threats originating in space-based assets" (Jaramillo 2011, p. 7). However, this definition, while broad, still fails to fully capture the important aspect of the contribution made by satellites to security on Earth.

The Space Security Index publication surveys developments in space security by assessing annual changes in eight indicators of space security. These are:

- The space environment
- Space situational awareness
- Laws, policies, and doctrines
- Civil space and global utilities
- Commercial space
- Space support for terrestrial military operations
- Space systems protection
- Space systems negation

Because the SSI definition is not fully comprehensive, it needs to be supplemented. Space security is not something which can be reduced to a single meaning or easily summarized in a single sentence. An emerging definition is

[1]Cornell A, Space Generation Advisory Council

a three-dimensional one which embraces the satellite contribution to human security, such as that proposed by Mayence, which sees space security as being simultaneously:

Outer space for security: the use of space systems for security and defense purposes

Security in outer space: how to protect space assets and systems against natural and/or human threats or risks and ensure a sustainable development of space activities

Security from outer space: how to protect human life and Earth's environment against natural threats and risks from outer space (Mayence 2010, p. 35)

In this tripartite framework, the two existing post-Cold War understandings of space security are present. Space is defined as an area of activity where environmental and potential military threats pose difficulties for its successful routine utilization. However, a third dimension is added, which is the use of space to promote the general security of human beings on Earth through such means as communications for rescue and disaster management, monitoring of extreme weather conditions, improved agricultural production, and so on.

2.3 Military Space Security

Questions of definition are prominent when addressing the issue of military space security. For most of the Cold War period, there were only two states with a wide array of military space capabilities, the Soviet Union and the United States. Because these states deployed dedicated military satellites, there was also a fairly clear dividing line between military and civilian satellites. In the current era, however, neither of these two conditions applies. Space has become a realm where a large and growing community of states depends upon national space assets to a considerable degree, and considerations of affordability have encouraged the multiplication of dual-purpose satellites that serve both military and civilian functions. Many countries have also developed other technologies, such as long-range surface-to-surface missiles, that could be adapted to the antisatellite (ASAT) role or possess technologies such as the European and Japanese robotic resupply spacecraft used to service the International Space Station, which could, at least in theory, also perform as ASATs. In addition, many of the technologies that would be useful for verifying a space arms control agreement would be, by their very nature, potential ASATs themselves, for example, satellites which can maneuver to inspect other satellites or lasers that can track satellites.

As with security more generally, space security during the Cold War was understood in terms of the military security of the state. It embraced roles such as the use of satellites for military reconnaissance, for communications and early warning of ballistic missile attack, and for targeting of weapon systems as well as issue of the threats to strategic stability posed by ballistic missile defenses and potential antisatellite weapon systems. There was also an important focus on the contribution made by reconnaissance satellites used for arms control verification. Toward the end of the Cold War, the capabilities of reconnaissance and navigation

Table 2.1 Intentional threats to satellite systems

Type of threat	Vulnerable satellite systems component
Ground based	
Physical destruction	Ground stations; communication networks
Sabotage	Links
Space based (antisatellite)	
Interceptors (space mines and space-to-space missiles)	Satellites
Directed energy weapon (e.g., laser, electromagnetic pulses)	Satellites and control center/data links
Interference and content oriented	
Cyber attacks (malicious software, denial of service, spoofing, data interception)	All system and communication networks
Jamming	All systems

satellites advanced to the point where the significance of satellites as "force multipliers," capable of directly influencing events on the battlefield, began to affect discussions of space security, particularly in terms of increasing the likelihood of ASAT operations in wartime.

From a military perspective, "space security" encompasses several themes. These include the use of space assets to enhance the effectiveness of terrestrial armed forces (force multipliers), "benign" space militarization in the form of early warning of missile attack and arms control verification, threats to satellites posed by terrestrial and space-based military capabilities, and threats to the space environment posed by military activities. In the longer term, it might eventually also include possibilities of space-based weapons, for either ASAT operations in orbit, space interception of warheads as part of a ballistic missile defense network, or even attacks against ground or air targets from space (Table 2.1).

In this regard, the implications of "space security" differ for those states that rely significantly on space assets for the effectiveness of their military capabilities and those which do not. For those without major military space reliance, the protection of space *itself* as an environment free from debris and electronic interference is the key to space security. Diplomatic efforts to preserve space as a weapon-free environment will also be prominent in order to protect the capabilities represented by commercial- and development-related satellites. For the military space powers however, and particularly the United States, these kinds of requirement are supplemented by the need to pursue the acquisition of policies and capabilities that promise military space security in peace- and wartime and the ability to use satellites as force multipliers which significantly enhance the effectiveness of terrestrial military capabilities but which thereby may threaten the benign physical environment sought by other space powers.

For those states reliant on military space assets, space needs to be a secure environment in which force multiplier military operations can take place. It needs to be populated by satellites and vehicles that are themselves reasonably secure against accidental damage or intentional attack, and in the event of war against an opponent similarly equipped, the capacity to neutralize or eliminate the adversary's military space capabilities needs to exist in order to both deny military advantages to the adversary and protect one's own.

This in turn has many implications. Satellites are systems composed of four distinct elements. These are the orbiting satellite itself, the ground stations that control it, and the uplink and downlink communication channels that enable it to carry out its appropriate functions. If the satellite system is to be made secure, all four dimensions must be protected. Moreover, although popular discussions of "war in space" and antisatellite warfare tend to focus on the use of space-based weapons to destroy orbiting satellites, the reality is that the orbiting vehicle is by far the most difficult part of the satellite system to attack and would, if destroyed by an attack while in orbit, produce highly undesirable side effects in the form of debris fields in orbit. It is much more likely therefore that the "terrestrial" elements of the satellite system would be under the greatest threat in wartime. Nevertheless, although the potential dangers created by the debris issue encourage resort to nondestructive ASAT techniques, the use of destructive kinetic or directed energy weapons against satellites cannot be ruled out as a possibility in wartime should the nondestructive techniques fail to achieve their objectives.

Therefore, in order to use space effectively, ground-based facilities are crucial, as is the atmospheric airspace through which electronic signals travel to and from satellites in orbit. This is not purely a military issue but is also true of human spaceflight, for example, where again the launch sites and ground control are crucial and where the flight to space and return to Earth are highly dangerous and security-specific activities. Thus, the term "space security" embraces more than just activities occurring beyond Earth's atmosphere. In relation to military space security, for example, the existence of reliable launch and ground control facilities and the capacity to reconstitute such capabilities quickly if they should be lost in wartime are important questions, as are the issues of ensuring the continued effectiveness of communications with orbiting platforms. This again means that the secure "space" environment must embrace the physical as well as electromagnetic lines of communication linking the terrestrial and orbiting elements of the space systems.

In an effort to make space a more stable and secure environment for both military and civilian purposes, a number of states have proposed the creation of an arms control regime for space. In attempting to develop such a regime to reduce threats to space systems, definitions are once again important. There need to be reasonably clear definitions of what constitutes a "weapon" in this context and also what constitutes "in space." The Union of Concerned Scientists has offered a series of definitions that attempt to address these issues. A space weapon is defined as "any device or component of a system designed to inflict physical harm through deposition of mass and/or energy on any other object." "Weapons in space" are defined as "those that travel on a complete or partial orbit, or are placed at a stable point beyond Earth orbit." In addition "a component that is part of a system not exclusively based in space, such as a relay for a ground-based laser, would be considered a space-based weapon" (United Nations Institute for Disarmament Research 2004, pp. 45–46).

These definitions are extremely helpful, but it is very difficult for the states and other actors involved in space security to agree on definitions in this area. The Union of Concerned Scientists definition of "space weapon," for example, assumes a destructive attack on the satellite, but a satellite that experiences electronic jamming would not be covered by this definition, because it would not have suffered physical harm. Yet it would still have been attacked and would no longer be able to perform its proper function.

From a strict point of view, any technology that can interfere with a satellite is an ASAT and should therefore be banned or regulated. However, to implement such a policy comprehensively would mean banning a huge range of legitimate space activities, such as launching robotic resupply spacecraft to the International Space Station. There are also arguments for making a distinction between destructive and nondestructive ASAT techniques and concentrating efforts at control on the destructive approaches because they produce long-lasting environmental side effects, whereas nondestructive techniques do not. Producing an arms control agreement in this area is a question of balance and compromise, but it is made much harder by the difficulties in clearly and collectively defining many of the key terms. This is a major obstacle to the achievement of an international treaty that could regulate such technologies. Indeed, it may never be possible to effectively define a space weapon, and the international community may have to abandon attempts to achieve a precise definition if a treaty is to be achieved.

Such an arms control treaty, if it were to be achieved, would essentially be a peacetime confidence-building measure. There needs to be a distinction between the meaning of space security in peacetime and space security considerations in wartime. If the analogy of aviation security is taken, it would embrace governance issues to avoid aircraft collisions, concerns about terrorism, efforts to ensure that technology standards are maintained to ensure passenger safety, and so on. But should the airspace of a particular country or countries become a war zone, there is no assumption that it would be "business as usual"; rather many peacetime activities such as civil aircraft flight would be suspended for the duration of the hostilities but be resumed thereafter. Similarly, the creation of space security is designed to create a stable regime for a variety of peacetime activities, but in wartime, at least war involving two large industrialized states with major space dependence, many of these would have to be suspended. A specific problem for space, unlike airspace, is that certain potential military actions in wartime, by generating clouds of debris, might leave the low Earth orbit environment so damaged that it might be impossible to use it for *any* purposes for decades after hostilities ended. Indeed, Philip Baines of the Canadian Department of Foreign Affairs has declared that government war gaming of scenarios where weapons have been used to attack other satellites to achieve national space security has always produced the same outcome, "the loss of LEO for the next 1,000 years" (Baines 2010, p. 16 (the claim is repeated on p. 17)).

The definition of space security needs to be broader than simply the military dimension, because otherwise it would become synonymous with other concepts such as "space power." David Lupton gave the first formal definition of space power, describing it as "the ability of a nation to exploit the space environment in pursuit of national goals and purposes and includes the entire astronautical capabilities of the nation" (Lupton 1988, p. 7). A later definition by Hyatt et al. termed it "the ability of a state or non-state actor to achieve its goals and objectives in the presence of other actors on the world stage through control and exploitation of the space environment" (Hyatt et al. 1995, p. 6). The parallels seem even more marked when discussions of space power go on to analyze its national, military, civil, and commercial space components; their space-based, ground-based, and launch systems; and the use of terminology such as "environmentally influenced characteristics." All these elements have their counterparts in the concept of space security.

These definitions have obvious similarities to the definitions of space security given below. But space power is not the same thing as space security. The former is a national security concept and relates to national security objectives. The latter is an international security concept and relates to effective international governance of the space environment. It encompasses crucial military issues but is a broader concept than military security.

Nor are problems with defining a distinct meaning for space security limited to the military domain. The emerging difficulties of safely managing orbital space have led to the development of the idea of "space traffic management." The International Academy of Astronautics published a study of the concept in 2006 which defined space traffic management as "the set of technical and regulatory provisions for promoting safe access into outer space, operations in outer space and return from outer space to Earth free from physical and radio-frequency interference" (Constant-Jorgensen et al. 2006). Most of this statement would work just as well as a definition of space security.

The traditional boundaries between the military space sector and other sectors have increasingly broken down since the end of the Cold War. The clear dividing lines between, for example, military and commercial spaces are no longer absolute. One of the striking features of the American military dominance in the 1991 and 2003 Gulf Wars was that there was a massive reliance on civilian satellite systems to accomplish military goals. In 1991, for example, the US military supplemented its military reconnaissance satellites by using the US LANDSAT and French SPOT civilian systems. In addition, over 80 % of all US military communications during the conflict were delivered via civilian communication satellites. At the same time, the Navstar GPS positioning satellite system, designed as a military satellite, has been made available to civilian users and has become an indispensible tool for an astonishing variety of purposes in countries around the world. A large and increasing number of states have deployed dual-purpose satellites which can perform both civilian and military tasks. In addition, many initiatives that would enhance the civilian aspects of space security, such as a "rules of the road" agreement or improved capabilities for tracking orbital debris, would still have military implications, since they would make it easier for military analysts to distinguish between hostile actions and satellite failures caused by environmental factors.

All this might suggest that the distinction between military and civilian spaces should now be dismissed. However, for analytical purposes, the distinction remains important. While it is crucial to be aware of the overlaps between the military and other space sectors and of the policy implications of some of these interconnections, nevertheless, there are key issues that fall distinctively into one sector or another and need to be defined and analyzed on that basis.

2.4 Environmental Space Security

In contemporary studies of space security, it is increasingly common to delineate two distinct subareas. The first is the traditional military domain, both in terms of efforts to make national military space assets more secure and in relation to efforts to delay or prevent the deployment of weapons in space. The second category may be termed environmental space security and involves issues relating to the crowding of Earth orbit, such as the orbital debris problem and the problems of interference in satellite communication frequencies, as well as the disputes over access to orbital slots in geostationary Earth orbit.

The greatly increased use of near-Earth orbital space necessitates seeing space itself as an endangered environment, where human activities in the form of debris created by redundant or damaged spacecraft pose threats to the long-term sustainability of crucial orbital regions. Seeing orbital and interplanetary space as producers of both security and insecurity lends itself also to understanding remote but potentially significant dangers such as asteroid impact as a space security issue and problems such as satellite operation in the Van Allen belts as a space environmental security issue. It is necessary therefore to look at "space security" in terms of these distinct, but interconnected dimensions.

As a geographical region, space is clearly capable of being conceptualized as an example of "environmental security." The United States has recognized this by emphasizing the concept of "space sustainability," that is, the ability of the space environment to continue to be a place where space activities can be successfully conducted. Significantly, the United States believes that the sustainability of the space environment is vital to the US national interests, (National space policy of the United States 2010, p. 3) a crucial statement, since the United States has historically used the phrase, "vital to US national interests," to indicate that this is something the United States considers to be so important that it would be prepared to go to war in order to defend it. While linking the concept of space sustainability to national security may not be politically helpful, the concept has the potential to enrich understandings of space security. It fits easily with a broad "human security" approach to space, it draws attention to the crucial issue of the long-term management and use of space, and it links the military, scientific, and economic dimensions of space security.

Table 2.2 Unintentional threats to satellite systems

Type of threat	Vulnerable satellite system component
Ground based	
Natural occurrences (including earthquakes and floods; adverse temperature environments)	Ground stations; control centers and data links
Power outage	
Space based	
Space environment (solar, cosmic radiation; temperature variation)	Satellites; control centers and data links
Space objects (including debris)	
Interference based	
Solar activity; atmospheric and solar disturbances	Satellites; control centers and data links
Unintentional human interference (caused by terrestrial and space-based wireless systems)	

Source: US General Accounting Office

Although space is effectively infinite in geographical terms, in the current era, the areas of space used by humans are fairly limited and overwhelmingly dominated by activities in Earth orbit. With more states and companies launching satellites, the environment is becoming increasingly crowded, particularly at 36,000 km in the geosynchronous Earth orbit (GEO). Because of this, orbital overcrowding can exist, and thus, despite its size, space is for practical human purposes, a "limited resource" and, surprisingly, a resource that can be "damaged" (at least temporarily), by its users, in the sense of debris or frequency interference preventing a satellite from operating normally. Orbital slots in the most popular orbits and optimum frequencies for satellite communication are in relatively limited supply. There are therefore resource issues in effect.

In 2009, the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) agreed to include the long-term sustainability of outer space activities as a new item in its mandate. It established four working groups to cover the sustainability issue. These addressed:

1. Sustainable space utilization supporting sustainable development on Earth
2. Space debris, space operations, and tools to support collaborative space situational awareness
3. Space weather
4. Regulatory regimes and guidance for actors in the space arena (Table 2.2)

The most dramatic space environment issue concerns the fact that the effective use of orbits, particularly low Earth orbit (LEO), is threatened by the buildup of orbital debris. In other satellite operations, fluctuations in "space weather events" such as solar flares are also an issue. Interference with satellite communication frequencies overlaps with military space security, because such interference can be deliberate or accidental.

There are around 650 operational satellites in orbit, but there are nearly 12,000 pieces of space debris 10 cm or larger being tracked by NASA. In addition, NASA estimates that there are probably several hundred thousand pieces of debris that are too small to currently track but which would still be able to cause damage to satellites and spacecraft. Most of this debris consists of the abandoned upper stages of launch rockets or satellites that have ceased functioning. NASA defines space debris as “any man-made object in orbit about the Earth which no longer serves a useful purpose.” Because of the extremely high relative impact velocities that objects in orbit possess, even comparatively small pieces have very high impact velocities and can have catastrophic effects if they collide with a space vehicle. Like space weather, they can degrade the operation of satellites in a variety of ways depending on the size of the debris. A piece as small as a micron can still do damage to a satellites-sensitive optical systems, while a fragment which is still only a centimeter in size can seriously damage or even completely destroy a satellite. They also pose serious risks to astronauts operating in orbit, particularly when engaged in an extravehicular activity. In addition to these threats, it is possible that a war in space, by creating a dense debris field in LEO, might also cause sufficiently large amounts of sunlight to reflect off the fragments so that there would be serious light pollution, even a permanent “lingering twilight” around the Earth instead of true darkness.

In a broad definition of space security, embracing environmental concerns, space weather is significant. Space weather, charged particles and magnetic fields ejected from the sun, can cause significant disruptions to satellites, ranging from temporary interference with onboard systems to complete failure, particularly for satellites operating in geostationary Earth orbit. Solar flares deliver x-rays, ultraviolet rays, and gamma radiation which can interfere with radar and telecommunications and produce radio interference. The sun also discharges solar proton events which have been shown to have a wide variety of impacts on human security including “satellite disorientation, spacecraft electronics damage, spacecraft solar panel degradation, extreme radiation hazard to astronauts, launch payload failure, high altitude aircraft radiation, shortwave radio fades, ozone layer depletion, cardiac arrest, dementia and cancer” (Marusek 2007, p. 3). Space storms can also heat up the Earth’s atmosphere, causing it to expand and increase the drag on satellites operating in low orbits, thereby shortening their lifetime. Major space weather episodes can also pump up the radiation in the Van Allen belts by as much as 10,000 times their normal levels, damaging electronic components on board satellites. In 2011, the UK added space weather to its national risk register.

2.5 Human Security and Space

Security has been defined as “the assurance people have that they will continue to enjoy those things that are most important to their survival and well-being” (Soroos 1997, p. 236). For something to be defined as a “security” issue, there needs to be a sense in which it poses a real threat to human well-being or survival. If a "security" issue requires that there is such an "existential" threat, can the environmental issues in Earth orbit be seen as security issues? Is interference with the optimum efficiency of a frequency, or damage to an inanimate piece of metal, an "existential threat" in any meaningful sense?

In fact such issues can be seen as security questions and in a very real way. Satellites are used for an enormous range of purposes, and many of them have the potential to produce large-scale loss of life if the satellite capability is lost. A 2011 report by the British Royal Academy of Engineering noted that global navigation systems alone are crucial for the following functions for UK users: "transport, agriculture, fisheries, law enforcement, highways management, services for vulnerable people, energy production and management, surveying, dredging, health services, financial services, information services, cartography, safety monitoring, scientific and environmental studies, search and rescue, telecommunications, tracking vehicles and valuable or hazardous cargoes and quantum cryptography" (Royal Academy of Engineering 2011, p. 13).

Threats to orbiting satellites, whether from military or environmental sources, are crucially important precisely because satellites have come to play such a fundamental part in providing security to human beings on Earth. Because of the expansion in the general meaning of security that has taken place in recent decades, satellites are clearly relevant to providing these kinds of security. Although discussions of space security have historically tended to be dominated by debates about "space weaponization," the reality is that most states and commercial entities exploit space for a vast range of civil purposes, so that space has now become crucial for human prosperity and security on Earth.

The impact of satellite capabilities on human security can be seen in a wide range of areas. One such is disaster management, which has been reflected in the signing of the "Tampere Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations" of 1998 and the "Charter on Cooperation to Achieve the Coordinated Use of Space Facilities in the Event of Natural or Technological Disasters" of 2000. Satellites were used to coordinate disaster relief operations after the Haiti earthquake of 2010 and the Fukushima nuclear accident in 2011.

But the scope of satellite contributions to terrestrial security goes well beyond disaster response and now embraces almost all aspects of human security. Examples include educational programs, including school and college use, but also programs for education of remote rural populations on issues such as crop management and birth control. Meteorology is used by most countries, but in those subject to particularly severe weather such as tropical storms, they serve a crucial purpose in allowing shipping and coastal communities to prepare for the effects of life-threatening weather systems. Satellites play an increasingly important role in the continuation of the green revolution in developing countries, allowing monitoring of environmental damage, from both natural and human causes. Soil temperature and moisture content of soils are monitored from space to allow the choice of optimal planting times; crops are also monitored for the presence of disease infestation and threats such as drought, floods, and migrating pests such as locust swarms. Monitoring of snow lines in areas such as the Himalayas allows early warning of flooding in India and Bangladesh. Satellites are used to detect underground water supplies and mineral resources, to track shoals of fish, and to plan irrigation systems. India uses satellites to assess the quality of land being considered for building or road development, so that areas of high agricultural productivity will not be lost, and uses them to direct its fishing fleets to minimize their time at sea. In January 2012, satellite imagery was used by the United Nations to monitor the conduct of the referendum in southern Sudan on separation and independence from Sudan. On a broader scale, satellite imagery was crucial in detecting the expansion of the holes in the ozone layer and in monitoring the increase in global temperatures and associated effects such as loss of polar ice cover, which confirmed the dangers of global warming. In these and countless other ways, satellites now directly contribute to human security.

This is important in defining space security in two ways. It means that the military dimension of space security is critical not just in terms of the impact such conflict might have on terrestrial warfare, or even of the damage to the space environment itself, but also that the huge knock-on effect on human security must be considered if these satellite capabilities were lost. Secondly, it means that the terrestrial dimension of human security needs to be considered as one of the components of space security in its own right, thereby highlighting the enormous stake that humanity has in the continued secure exploitation of space.

2.6 Risks Involved in Expanding the Definition of Space Security

The advantage of expanding conceptions of space security is that it moves certain issues significantly higher up the political agenda and it also allows the difficulties faced by groups and even individuals to be seen as security concerns, rather than simply the protection of the state. Using the term security, rather than "threat" or "problem," is politically significant. For governments, the word "security" has real political power. An issue that is seen as a security problem moves to the top of the political agenda, jumping ahead of mere "problems" in the queue for resources and political attention. Security also has advantages over alternative terms such as "threat" because it can be related to the broad spectrum of human security.

At the same time, it is also important to note that the move to broader understandings of security, to "securitize" new issue areas, has been controversial and many of the reservations expressed in these debates can be held to apply also in the case of space security. If more and more issues are brought into the realm of "security," there is logically a point at which the term is so all encompassing that in practice it means very little and becomes simply another word for "dangers" or "risks," and eventually the concept would have no coherent meaning and therefore no value as a guide to policy.

One attempt to avoid this problem has been to try to limit the definition of the term “security” to those issues that pose “existential threats” and limit it further to dangers that emanate from the decisions of human beings, rather than to include problems that emerge simply from the workings of the natural environment, such as volcanic eruptions, or, in the case of space, the effects of solar storms or naturally created debris fields (Buzan et al. 1998, p. 21). However, in the case of space, this approach has limited appeal. Space is a particularly hostile environment in which to operate. A definition of space security which did not reflect the very real dangers and difficulties originating in the natural environment would be unrealistic and unhelpful. In addition, there are issue areas where the human and naturally produced dangers intersect. For example, a key aspect of efforts to limit the dangers of antisatellite systems is being able to distinguish between satellite failures that are the result of human aggression and those which have been produced by the effects of the natural environment or, for that matter, simple technological malfunction. A robust definition of space security therefore needs to be able to encompass a very wide range of factors.

There are other risks involved in expanding the term security beyond the military dimension. Attaching the word “security” to an issue makes it more politically important and gives it a degree of priority in terms of government attention and resources, which can be seen as a positive development. But historically, because “security” was traditionally linked to military threats, security has been seen as being related to survival, to being about threats to the existence of a state or group of people. As a result, the use of extraordinary measures to deal with the threat was legitimate, including the use of force. The danger involved in extending the term “security issue” to new areas such as the orbital debris problem therefore is that it will end up being subsumed within a military mind-set, which is inappropriate and which would make the problem harder, not easier, to deal with. Because military security sees “us” as threatened by “them,” for example, the debris issue might come to be seen as a problem created by particular states which should be punished in some way, rather than as an environmental issue for all space-going states that requires cooperative measures to successfully address. Using the term “security” runs the risk that the emphasis will always be on the possibility of violent conflict, rather than human insecurity, and issues would therefore tend to be understood as military disputes rather than foreign policy concerns, which would make them harder to resolve. From this perspective, “de-securitizing” some space issues might well be preferable, since this would make it easier to produce mutually acceptable solutions using cooperative diplomacy. It might still be better to speak of threats or dangers in some contexts, rather than security issues. Expanding the definition of space security needs to be done with an awareness of the issues at stake and the problems involved in so doing.

2.7 Conclusion

Defining space security is difficult, but not impossible, and it is certainly necessary. The definition needs to be broad, so that it encompass human and environmental as well as military dimensions. It should embrace not only the security of man-made objects and humans in space, but also the terrestrial dimensions of launch-sites, ground stations and communications links. In addition it should include the security of terrestrial objects and persons against attacks from space, including the human security implications of such attacks. Thus it should embrace, but expand the definitions given earlier in this chapter. A modified working definition would be secure and sustainable access to, and use of, outer space in accordance with international laws and treaties, free from the threat of disruption, as well as security of terrestrial human and state security from threats emanating from space.

References

(2010) National space policy of the United States. Washington, DC, p 3

Baines PJ (2010) In: UNIDIR Space security 2010: from foundations to negotiations. United Nations Institute for Disarmament Research, New York, p 16 (the claim is repeated on p 17)

Buzan B, Waever O, de Wilde J (1998) Security: a new framework for analysis. Lynne Rienner, Boulder, p 21

Constant-Jorgenson C, Lala P, Schrogl K-U (eds) (2006) Cosmic study on space traffic management. IAA, Paris. http://iaaweb.org/Studies/spacetraffic.pdf

Cornell A, Space Generation Advisory Council

Estabrooks S (2006) Space security 2006. In: UNIDIR Building the architecture for sustainable space security, UNIDIR/2006/17. United Nations Institute for Disarmament Research, Geneva, p 93

Hyatt JL et al. (1995) Space power 2010. Air Command and Staff College, Maxwell AFB, p 6

Jaramillo C (ed) (2011) Space security 2011. Ontario, Waterloo, p 7

Lupton DE (1988) On space warfare: a space power doctrine. Air University Press, Maxwell AFB, p 7

Marusek JA (2007) Solar storm threat analysis. Impact, Bloomington, p 3. http://www.breadandbutterscience.com/SSTA.pdf

Mayence J-F (2010) Space security: transatlantic approach to space governance. In: Robinson J, Schaefer MP, Schrogl K-U, von der Dunk F (eds) Prospects for transparency and confidence-building measures in space. ESPI, Vienna, p 35

Royal Academy of Engineering (2011) Global navigation space systems: reliance and vulnerabilities. Royal Academy of Engineering, London, p 13

Soroos M (1997) The endangered atmosphere: preserving a global commons. University of South Carolina Press, Columbia, p 236

United Nations Institute for Disarmament Research (2004) Safeguarding space for all: security and peaceful uses. UNIDIR, Geneva, pp 45–46