An Introduction to Ostrom's Eight Principles for Sustainable Governance of Common-Pool Resources as a Possible Framework for Sustainable Governance of Space

T. Chow, Secure World Foundation, tchow@swfound.org
B. Weeden, Secure World Foundation, bweeden@swfound.org

Abstract
This paper outlines the "tragedy of the commons," reviews Nobel Prize Winner[1] Elinor Ostrom's principles for sustainable governance of common-pool resources (CPR), and relates both to outer space. Ostrom's principles were distilled from decades of studies on dozens of CPR situations. They capture the best practices of CPRs that have been used sustainably for decades or even centuries, thus avoiding the famous "tragedy of the commons" without relying on privatization or a "Leviathan" authority. When viewed in the context of space sustainability and governance, these principles highlight some long-standing challenges and emerging issues. Over the past few years, achieving the long-term sustainability of space activities has become a central goal for many, both at the national and international level. However, while more policymakers and stakeholders are recognizing the importance of space sustainability, none have spelled out an effective governance strategy, and accompanying policies, for accomplishing it. This paper concludes that Ostrom's principles can potentially inform those ongoing policy initiatives and highlight specific areas on which to focus initial space sustainability efforts.

Introduction

Over the last few years, the goal of space sustainability has become increasingly important within the field of space policy. Although many have long recognized the importance of outer space for national and international security and global business, there is a growing realization that the ability to use space for its benefits on Earth is not guaranteed forever. Recent events and trends have only made this alarming fact more clear. In response, many national governments and international bodies are pursuing policy initiatives that they hope will help them achieve the long-term sustainability of the space environment and humanity's activities in space. By framing space as a commons and applying previous scholarly research to this discussion, policy makers can gain insight into possible ways forward in their pursuit of space sustainability.

Space as a Commons

Near-Earth orbit, the part of outer space that enables most of the space-based services and applications that benefit Earth, is a commons. A "commons," or more precisely, common-pool resource (CPR) as Ostrom refers to it, is a resource environment or domain that is characterized by an open access problem: it is difficult to effectively bar other users from accessing and benefitting from that resource. A "CPR is sufficiently large that it is difficult, but not impossible, to define recognized users and exclude other users altogether" [Reference 1]. This is characteristic of the space environment. As space is inherently international, extremely difficult to own in whole or in part, and accessible to any actor who can develop or purchase the means to reach orbit, it is a commons.

A significant amount of academic work has explored the characteristics and challenges associated with CPRs. It is widely recognized that all commons are prone to the sort of environmental challenges currently faced within the space domain such as pollution, congestion, overuse, or irresponsible use. However, sustainable CPR use is possible and has been achieved in other areas. Currently, States, international organizations, private actors, and others are actively pursuing solutions that could make

[1] Elinor Ostrom won the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2009 for her work in economic governance of the commons [Reference 6].

space sustainability a reality. In this pursuit, it is necessary to understand fully the problems inherent to CPRs and how they have already been solved in other domains.

The Commons Problem

In 1968, Garrett Hardin published an influential paper outlining a problem that [Reference 2]. In that paper, Hardin described the "tragedy of the commons," in which humans overuse and deplete a common-pool resource even though it is not in their best interest to do so. This trend of over-exploitation particularly plagues commons because the lack of individual ownership and inability to restrict usage incentivizes actors to consume as much as possible of the shared resource before others do. This race to consume traps actors in a vicious cycle of mismanagement and over-consumption that ultimately leads to irreversible environmental degradation.

The Commons Solution

What is truly tragic about the scenario is that this self-interested behavior is actually not in the best interest of any individual actor. Alternatively, by working together, the resource users could establish a system that benefits everyone involved while also protecting the CPR for long-term use. Hardin did not believe that such a self-organized and self-governed system was attainable. He argued that the only ways to avoid the "tragedy of the commons" was through establishing private property or under the authority of a "Leviathan"-type centralized power. However, thanks to the work of Nobel Prize Winner Elinor Ostrom, the inevitability of Hardinian tragedy has been debunked by the presentation of case after case of resource users effectively self-organizing and sustainably managing a commons themselves. This has enabled those groups to continue enjoying the benefits afforded to them by those CPRs while also ensuring that the commons will continue to benefit future generations.

What about Space?

If space is a commons and commons are prone to degradation and depletion, is the space environment doomed to Hardinian tragedy? In light of recent trends, some would argue yes. First, the number of resource appropriators utilizing space has grown considerably and these actors are using it for a growing number of reasons. It is no longer the territory of just the two superpowers, but rather, is an environment for commercial, military, and civil uses by public and private sectors, developed and developing countries alike. As of August 2011, the number of active satellites currently in orbit had reached roughly 1,000 [Reference 3]; only about half of which are Russian and American [Reference 4]. Furthermore, these hundreds of satellites provide a diverse range of services: from satellite TV to reconnaissance, from weather monitoring to GPS navigation, from satellite imagery of Earth to early warning missile defense. Congestion is worsened by the fact that many of these space objects operate in the same crowded orbits.

Second, key orbits in space are not just crowded with a multitude of actors and their functioning satellites, but also with orbital debris. The U.S. military tracks some 22,000 objects in space between one and ten centimeters in size [Reference 3]. This does not account for the more than four hundred thousand additional pieces of debris that are known to exist but too small to track with current sensors [Reference 3]. At the speed that objects travel in orbit, even a very small piece of debris has the potential to cause significant, and incredibly expensive, damage to an operating satellite. Even more worrisome, debris has threatened the lives of those on the International Space Station.

Third, the proximity of many satellites in high demand orbits leads to another kind of congestion. The radiofrequency spectrum is also a finite resource and certain channels are more sought after than others. Certain types of communications must be transmitted on suitable frequencies. Neighboring

satellites can cause interference when transmitting information too closely to each other. The resource is further restricted by the limited windows of opportunity for successful transmission.

Finally, two specific events in the very recent past have added a sense of urgency to these growing concerns about the crowded nature of space and the threat it poses to space sustainability. In early 2007, China tested an anti-satellite weapon on one of its own expired satellites. This weapons test created a cloud of orbital debris in an important orbit, endangering all those who operate there, including China itself. Two years later, an unexpected collision between an expired satellite and active commercial satellite significantly added to the debris population. As a result, there has been a rapid increase in the amount of cataloged orbital debris in the last five years, making it even more dangerous and expensive to engage in space activities in certain orbits.

Ostrom's Eight Principles

While these realities suggest that space is in danger of a tragic fate, Ostrom's work suggests there is another way forward. Not only does she showcase that CPR users can work together to reverse environmental degradation and sustainably govern their commons, she provides a potential framework for doing so. Her decades of research revealed that all successful cases of commons self-governance had in common eight principles [Reference 1]:

> 1. The CPR has clearly-defined boundaries (effective exclusion of external unentitled parties)
> 2. There is congruence between the resource environment and its governance structure or rules
> 3. Decisions are made through collective-choice arrangements that allow most resource appropriators to participate
> 4. Rules are enforced through effective monitoring by monitors who are part of or accountable to the appropriators
> 5. Violations are punished with graduated sanctions
> 6. Conflicts and issues are addressed with low-cost and easy-to-access conflict resolution mechanisms
> 7. Higher-level authorities recognize the right of the resource appropriators to self-govern
> 8. In the case of larger common-pool resources: rules are organized and enforced through multiple layers of nested enterprises

It is not within the scope of this paper to examine every one of these principles and how it relates to space in depth. However, each principle can provide insight into areas for improvement in the existing space governance regime or next steps for those ongoing policy initiatives. It could be considered a kind of checklist for a space governance regime created to ensure space sustainability.

Adaptive Governance

Further, some of Ostrom's later work emphasizes the need for what she calls "adaptive governance." Sustainable commons governance is best achieved, especially for larger environments like space, when the system of rules is able to evolve and adapt over time as need be. As she puts it:

> "…a set of rules crafted to fit one set of socioecological conditions can erode as social, economic, and technological developments increase the potential for human damage to ecosystems and even to the biosphere

> itself. Furthermore, humans devise ways of evading governance rules. Thus, successful commons governance requires that rules evolve" [Reference 5].

Adaptive governance refers to the way in which the structure of rules, norms, and enforcement mechanisms adapt and evolve over time as information about or characteristics of the commons environment expand or change. The term connotes a positive transformation, implying that an institutional arrangement is able to evolve in order to fit current conditions and needs best.

Like Ostrom's other principles, this concept also sheds light on possible methods for attaining space sustainability. Some have called for a reevaluation of the current international law regime governing space, primarily consisting of the 1967 Outer Space Treaty. Such a process can be extremely difficult politically and can drag on over long periods of time, all while the commons environment further deteriorates. Ostrom's insight of adaptive governance suggests that the current system could be adapted and reinterpreted to meet changing conditions and needs without having to reopen and renegotiate a legally-binding treaty. In many of the cases she examined, resource users were able to collectively tweak or change rules within, and without undermining, the existing system.

Conclusion

In recent years, the space environment has become increasingly crowded and congested; so much so that users of that important domain fear that it may soon become too expensive or risky for them to continue to use it for certain benefits. Fortunately, policy makers and users of space are increasingly recognizing this risk and with it the importance space sustainability. There are a number of ongoing international and national policy initiatives and efforts that are focused on ensuring humanity's ability to access and benefit from space for the long term. By framing space as a commons, it becomes possible to learn from and apply a wealth of academic research and knowledge on CPRs to the space sustainability problem. This paper has briefly done that and has suggested one possible framework of sustainable commons governance that can illuminate the space sustainability discussion. Further study should be done to explore the potential for Ostrom's research to advance the development of sustainable space governance.

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