Policy Aspects of Space Debris and Space Sustainability

Technical Advisor
Secure World Foundation
How do we make space sustainability real?

- **Debris Mitigation**
  - Reduce the creation of new debris

- **Active Debris Removal**
  - Reduce the growth in the debris population

- **Space Traffic Management**
  - Minimize the impact of debris on operations

---

**Space Situational Awareness**

**National Regulations and Policy**
MACRO POLICY CHALLENGES

Why is it so hard to get people to act?
What is public policy?

• “The principled guide to action taken by the administrative executive branches of the state with regard to a class of issues in a manner consistent with law and institutional customs” (Wikipedia)

• “The public and its problems” (Dewey 1927)

• “How issues and problems come to be defined, and how they are placed in the political and policy agenda” (Parsons, 1995)

• “How, why, and to what effect governments pursue particular courses of action or inaction” (Heidenheimer et al, 1990)
Policy analysis

• Policy analysis has come to be dominated by economics
  – Definition of several alternative courses of action
  – Weighing the costs and benefits of each alternative
  – Choosing the alternative that best satisfies all the criteria

• Continual push for a more “scientific” (i.e., factual and unbiased) approach to developing, choosing, and implementing a policy option

• In the real world, the process by which policy happens and the people involved in the process play as big (if not a bigger) role than the “science”
Wicked vs tame problems

• Tame problems (mathematics, chemistry, chess) have *clear objectives and resolutions*, and can be resolved through application of scientific methods.

• Wicked problems are those for which a *purely scientific/rational approach cannot be applied* (Roberts 2000)
  – Cannot explicitly define all the variables
  – Stakeholders have radically different worldviews and timeframes
  – Constraints and resources change over time
  – Problem is never resolved definitively
Characteristics of a wicked problem

1. Cannot fully describe the problem without knowing what the solution is (the two are intertwined)
2. No “stopping rule” (no explicitly-defined end state when you know you’re done)
3. Solutions are not right or wrong, but better/worse or good/good enough
4. Each wicked problem is unique and novel
5. Every solution is a “one-shot operation”
6. There is no explicitly defined set of all possible solutions from which the “best possible one” can be chosen
“Super Wicked Problems” have all of the characteristics of wicked problems, plus:

- Time is running out
- Those who are causing the problem are also seeking to provide a solution
- Central authority to resolve the problem is weak or non-existent
- Policy responses discount the future irrationally

...sounds a lot like space sustainability!
Root cause: Collective action problems

- Problems where the group would benefit from everyone taking a particular action, but the cost of doing so makes it implausible for any one individual to do so

- Categorical example: **Prisoner’s Dilemma**

- Many real world examples
  - Pollution
  - Cyber security
  - Management of natural resources
  - Voting

https://www.sovereignman.com/lifestyle-design/the-prisoners-dilemma-10293/
Strategies for tackling wicked problems

- **Authoritative**
  - Put solving the problem in the hands of a few stakeholders who have authority to define problem & develop solution
  - Makes decisions & action easier, but the “experts” can be wrong

- **Competitive**
  - Many players all compete to solve the problem in their own way
  - Improves odds of finding a good solution, but wasteful & can lead to violence (war is a free market with harsher penalties)

- **Collaborative**
  - Seek “win-win” solution instead of zero-sum
  - Shared costs & pooled resources, but increased transaction costs in developing/implementing solution
Conditions for employing a strategy (Roberts 2000)

- Power is concentrated and uncontested - > **Authoritative**
- Power is distributed and contested - > **Competitive**
- Power is distributed and uncontested - > **Collaborative**

- Research shows that people often have to fail into collaboration
  - Only after personal experience with authoritative and competitive strategies can people really understand their shortcomings
  - People have to learn what does not work before they are willing to absorb what are perceived as the “extra costs” of collaboration
  - Goes for interagency process within a government as well as between governments
MICRO “POLICY” CHALLENGES WITH SPACE DEBRIS

Policy, legal, and economic considerations
Main legal challenge is uncertainty

- Just about all of the legal challenges can be grouped into two areas:

  1. *Lack of clarity and consensus on foundational principles*

  2. *50+ year old legal regime that was intended to stabilize the Cold War relationship between nuclear superpowers (but not do much else)*

- It’s a framework that provides broad guidance and direction, but not a lot of specificity

- Nothing explicitly prohibits removing space debris, but the *uncertainty creates resistance to action*
How many “space objects” are there?

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>UNASSIGNED</th>
<th>PAYLOAD</th>
<th>ROCKET BODY</th>
<th>DEBRIS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>UKRAINE (UKR)</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>URUGUAY (URY)</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>UNITED STATES OF AMERICA (US)</td>
<td>0</td>
<td>1275</td>
<td>669</td>
<td>3418</td>
<td>5362</td>
</tr>
<tr>
<td>UNITED STATES/BRAZIL (USBZ)</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>VENEZUELA (VENZ)</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>VIETNAM (VTNM)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ALL (ALL)</td>
<td>3</td>
<td>4156</td>
<td>2053</td>
<td>11264</td>
<td>17476</td>
</tr>
</tbody>
</table>

Not according to USSTRATCOM

So there are 7,316 space objects, right? Not according to USSTRATCOM.
**Costs from space debris to any one operator are low**

- Annual risk of collision in the worst region is about 0.8% per year

- **Worst-case analysis:** Cost to maintain a satellite constellation at 850 km for 20 years

<table>
<thead>
<tr>
<th>Constellation Size</th>
<th>Replenishment Cost ($B, No debris)</th>
<th>Replenishment Cost ($B, Fatal only)</th>
<th>Replenishment Cost ($B, All impacts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small (5 sats)</td>
<td>$19.1</td>
<td>$20 (+5%)</td>
<td>$20 (+5%)</td>
</tr>
<tr>
<td>Medium (20 sats)</td>
<td>$15.5</td>
<td>$16.5 (+6.5%)</td>
<td>$17.16 (+11%)</td>
</tr>
<tr>
<td>Large (70 sats)</td>
<td>$7.6</td>
<td>$8.68 (+13%)</td>
<td>$9.57 (+26%)</td>
</tr>
</tbody>
</table>

*Ailor, Womack, Peterson, and Murrell (2010)*
Insurance is not going to help (much)

Schaub, Jasper, Anderson, and McKnight (2014)
The stark reality of economics

• The odds of developing an economic incentive mechanism for removing space debris in LEO are **extremely small** because there’s **little direct economic value in LEO** (right now)
  – Nearly all the economic activity in space takes place in GEO
    • Total value of global space activities: $280 billion
    • Total private benefits from LEO: ~$3 billion
  – Almost all users of LEO are public entities deriving social benefits

• The **debris problem was almost entirely created by governments** using public money (legacy debt that needs to be dealt with)

• Any **funding of debris removal or mitigation activities is likely to come from public money**
  – Either as governments conducting missions themselves or purchasing services from private sector
STEPS TOWARDS A SOLUTION
The tragedy of the global commons

• Concept of “Tragedy of the Commons” was popularized by a 1968 Science article by Garrett Hardin
  – “Multiple individuals, acting independently and rationally consulting their own self-interest, will ultimately deplete a shared limited resource, even when it is clear that it is not in anyone's long-term interest for this to happen” – Wikipedia

• Hardin suggested only two ways to avoid this tragedy
  – Leviathan (single hegemonic entity to manage the resource)
  – Privatization of the resource

Tragedy is that you can’t solve the problem without destroying the commons
### Space as a Common Pool Resource (CPR)

- **Excludable**: can prevent others from using the resource
- **Rivalrous**: someone else’s use of the resource precludes your own use of it

<table>
<thead>
<tr>
<th>Rivalrous</th>
<th>Excludable</th>
<th>Non-excludable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private goods</td>
<td>food, clothing, cars, personal electronics</td>
<td>Common goods (Common-pool resources)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>fish stocks, timber, coal</td>
</tr>
<tr>
<td>Non-rivalrous</td>
<td>Club goods</td>
<td>Public goods</td>
</tr>
<tr>
<td></td>
<td>cinemas, private parks, satellite television</td>
<td>free-to-air television, air, national defense</td>
</tr>
</tbody>
</table>

*Outer space as whole is a public good, but heavily used regions of Earth orbit (LEO, GEO) are Common-Pool Resources (CPRs)*
Elinor Ostrom

• Won 2008 Nobel Prize in economics for her work on common-pool resources (CPRs)

• Discovered that there are many cases where the tragedy of the commons is false
  – Resources can be managed sustainably without either Leviathan or privatization
  – Resource appropriators self-organize to develop governance model that is suited to local conditions

• Distilled 8 principles which were common to all cases of successfully managed CPRs
1. Clearly-defined **boundaries of the CPR** (effective exclusion of external unentitled parties)

2. Rules regarding appropriation and provision of resources are **adapted** to local conditions

3. Collective-choice arrangements **allow most resource appropriators to participate in the decision-making process**

4. **Effective monitoring** by monitors who are part of or accountable to the appropriators

5. **Graduated sanctions (penalties)** for resource appropriators who violate community rules

6. Low-cost and easy-to-access **conflict resolution mechanisms**

7. Self-determination of the community is recognized by higher-level authorities

8. In the case of larger common-pool resources: organization in the form of **multiple layers of nested enterprises**

Template for what political/legal/economic Mechanisms we might need for space
Success of debris mitigation

- Inter-Agency Space Debris Coordination Committee (IADC)
  - Members are national space agencies
  - 2007 published debris mitigation guidelines
  - Established “protected zones” in LEO and GEO, 25 year rule
  - UN endorsement in 2008, urged States to adopt on voluntary basis

- Some progress on national implementation
  - US, France, Germany, Russia, Canada, UK, Japan, and China have implemented or are working on implementation

- ESA research indicates 40-60% compliance with 25-year rule
  - Less compliance in LEO than GEO
  - No significant increase (or decrease) over last 13 years
UN Group of Governmental Experts (GGE)

- UN Group of Governmental Experts (GGE) on Transparency and Confidence Building Measures (TCBMs) for Outer Space Activities
  - 15 experts (P5 + “representative” 10) nominated by countries
  - Asked to make recommendations for improving security & stability

- Delivered their report in October 2013
  - Information exchange and notifications
  - Risk reduction
  - Contact lists and consultative mechanisms

- Big issue: What next?
Space Code of Conduct

• EU Code of Conduct
  – Started with the French presidency of the EU in 2007
  – One of the first few exercises of EU foreign and security policy powers post-Lisbon Treaty
  – Adopted by EU in 2008, and offered up for international participation

• International Code of Conduct
  – Created in 2012, uses EU Code as basis
  – Multiple rounds of formal and informal international negotiations
  – August 2015 meeting ended with deferring entire issue to UNGA
  – Major disagreements
    • Definition of self-defense in space
    • Inside or outside the UN
    • Focus on security space, “peaceful” space, or both?
UN Long-Term Sustainability Guidelines

• Working Group under the Scientific and Technical Subcommittee (STSC) of the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS)

• Build on success of space debris mitigation guidelines and create voluntary “best practices” for space sustainability
  – Space debris and space operations
  – Space weather
  – National regulations and oversight
  – Sustainable use of space for sustainable development on Earth

• Formally began in 2009, hope to reach consensus by June 2016
General lessons going forward

• Learn from other domains, but don’t copy/paste ideas
  – Air Traffic Management ≠ Space Traffic Management, but there are some useful concepts that might help
• Technical definitions/approaches are good places to start, but don’t ignore politics
  – Wicked problems by definition cannot be solved through purely scientific/rational means
  – Need to have a cultural/behavioral/political dimension as well
• Push for a collaborative solution, but don’t be surprised if it’s the last thing that gets tried
• Recognize that not all stakeholders have the same perspective/priorities
  – Developed spacefaring countries have a different perspective from developing countries
• Focus on developing policy interventions at multiple levels
  – International, national, and individual actor

• Don’t discount value of incremental policies, or starting from coalitions of the willing
  – Start with a core constituency, and increase it over time

• Pay attention to the process & actors involved as much as the actual “solution”
Policy priorities moving forward

• Increased harmony between technical standards and national regulations on debris mitigation across all space actors
  – Increases benefits to those actors who adopt them
  – Creates a path dependency that makes it hard to go back

• Develop norms of responsible behavior in space that reinforce debris mitigation guidelines and other policy interventions
  – Reward good behavior, and criticize bad
  – Polite peer pressure (from NGOs?)

• Increased access to SSA data for all space actors (and the public)
  – Increases awareness of the problem, builds common understanding
  – Reinforces norms of behavior and costs of acting outside the norms
High-level plan of action

- Bilateral and multilateral discussions between States
  - Define self-defense in space
  - Rules of engagement (ROE) for military interactions
  - Are there behaviors/actions that should be off limits?
- National regulation and policy
  - Oversight of commercial on-orbit activities through “space traffic management”
  - Establish civil SSA and space safety authorities/responsibilities
- Satellite operator cooperation
  - Develop and implement best practices and norms of behavior
  - Set example for States, and push them to help make space more predictable for commercial development
Thank You. Questions?

bweeden@swfound.org
References

- Dewey (1927) *The public and its problems*
- Parsons (1995) *Public policy*
- Heidenheimer, Heclo, & Teich (1990) *Comparative public policy: the politics of social choice in America, Europe and Japan*
- Johnson (2014) *Draft International Code of Conduct for Outer Space Activities*, SWF Fact Sheet
- Johnson (2014) *The UN Group of Governmental Experts on Space TCBMs*, SWF Fact Sheet