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Author: Dr. David Finkleman
International Academy of Astronautics, United States

RESILIENT AND SUSTAINABLE SPACE ACTIVITY

Abstract

This paper suggests activities to extend, amplify, and execute measures suggested in studies of the long term sustainability of space activity. We review terrestrial resiliency concepts and suggest how these may be applied in space. We present concrete analysis of these principles with regard to space debris. We use these concepts to suggest measures for sustainability such as international consideration of launch rate constraints. This is analogous to allocating spectrum or rights to many natural resources. We suggest that the interaction of physics, economics, and laws or regulations should be pursued aggressively through collaboration among these interests.

Resilience has been defined and pursued in many venues, particularly ecology and psychology. In all of these, resilience is the ability of a self-organizing system to recover sufficient functionality after disruption. It is not invulnerability. It is not retaining complete, undisturbed functionality. Nonetheless, contemporary trends reveal policy makers who are sometimes enamored of massive redundancy, expensive backups, and complete resistance to disruption. Those are expensive and perhaps infeasible.

There will always be space debris just as there will always be diseases that compromise humankind, but there are sustainable populations despite these disruptions. We show analogous phenomena for space debris. There will always be debris, but there are launch rates, orbit architectures, and spacecraft characteristics that lead to a sustainable and productive cohort while experiencing inevitable collisions and disruptions. It is impossible to eliminate debris, and it is also infeasible to allow as many satellites or whatever type as any party would wish.

Widely used sustainability and resilience techniques are directly applicable to the collective physical, economic, and legal aspects of the space environment. We present a small element of a large productive research and operational opportunity. There are strong and interesting paradigms in water management, grazing and restoration of grasslands, and managing forests. Eliminating dangerous debris is an example of isolating epidemics and restoring health. Shielding against debris is an example of inoculation against diseases. Choosing orbits consistent with both safety and mission needs exemplifies transportation measures in which the fastest route is not always the best route. The controlling measures in all of these are legal and economic as well as physical. We plan further research and hope that the affected communities will join us.