

Impact Of Space Travel: Environmental Solution or Liability?

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Research Objective: To look at the environmental impact and sustainability of interplanetary and orbital space travel.

Introduction

For the billions of people who live on this planet, is it worth it to explore the planets that are closest to ours? By looking at the past, the future of space travel can be observed through an unbiased and scientific approach. Due to the newness of space travel, the costs and impacts aren't fully known so to understand current and future space travel, we must use historical data. Here, the impacts of space travel both environmental and societal are weighed to understand what surprising costs further and more repetitive space travel will have and where an EIO LCA fails to understand the costs and benefits.

Inputs

- Applicable sector used for EIO LCA
 - Guided missile and space vehicle assembly
- Pollution comes not only from launch of rockets, but also production industries like²
 - Power Generation
 - Petroleum refinery
 - Chemical manufacturing
 - Iron and steel mills
 - Transportation/ logistics



○ Oil and gas extraction

Results/ Enviromental Cost

Rockets model ⁶	Initial ³ cost 1970 \$ (million)	Inflation ⁵ cost 2002 \$ (million)	CO ₂ e (tons) ²	Energy (TJ) ²
Explore 9 + Scout	3.68	16.95	5040	77.2
Explore 12 + Delta	9.75	45.86	13600	209
Apollo 11 + Saturn V	693.54	3215.66	956000	14600
Mariner 4 + Atlas Agena	41.2	191.02	56800	870
AOS 203 + Saturn IB	56.0	259.65	77200	1180
OA0 2 + Atlas Centaur	130.1	603.03	179000	2750

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Unknown Consequences

- These are impacts not covered in EIO LCAs
- Effect of space debris from launches and satellites
 - Contamination of other planetary environments from foreign earth substances
 - Change from government to privatize space programs

Conclusion

The effects and cost of space travel are mostly still unknown but by using what we now know about growing industries in the past, it is best to take action now rather than later. Current LCA data on any kind of space flight is limited and there are large holes in what is covered by an LCA assessment that need to be addressed.

Future Work

- Research the growing field of space debris
- Create predictions of the future cost of repetitive commercial space flights for LCA
- Explore potential benefits of space travel
- Look beyond just construction of space vehicle

References

1. *Capabilities and Services*. Space Exploration Technologies Corp., (2018).
2. *Free Life Cycle Assessment on the Internet*. Carnegie Mellon, (2002).
3. Newell, H. E., (2010). Chapter 10: Costs. *Beyond the Atmosphere: Early Years of Space Science*. N.p.: Dover Publications, 2010. 161-71. *Beyond the Atmosphere: Early Years of Space Science*. NASA.
4. Kramer, William R. "Extraterrestrial environmental impact assessments – A foreseeable prerequisite for wise decisions regarding outer space exploration, research and development." *Space Policy*, vol. 30, no. 4, 2014, pp. 215-222. OhioLINK Electronic Journal Center, doi:10.1016/J.SPACEPOL.2014.07.001.
5. "US Inflation Calculator." *US Inflation Calculator*. COINNEWS MEDIA GROUP LLC, 11 Mar. 2020. Web. 07 Apr. 2020.
6. "Lists of Rocket Launches." *Wikipedia*. Wikimedia Foundation, 27 Feb. 2020. Web. 07 Apr. 2020.