Harnessing Space Technology for Sustainable Development

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Introduction

With the effects of climate change being felt more than ever, sustainable space technology—such as space-based solar power and geospatial technology—offers promising solutions for minimizing environmental impact and promoting the responsible use of space resources. These technologies play a vital role in mitigating the impacts of climate change and providing the world with a way towards sustainable development. As described by the United Nations Office for Outer Space Affairs (UNOOSA), "Space-based services and technologies are key in understanding climate change and during the full disaster management cycle; only two examples among countless applications to which space can contribute to."[1] Early steps toward this issue was taken by UNOOSA that established the Programme on Space Applications (PSA) in 1971 to provide Member States with capacity-building tools, education, as well as research and development support.[2] Despite such attempts, there remains a technical and financial gap for many Member States, and as such it is imperative that the international community address how to best overcome the challenges hindering the utilization of space technology for sustainable development.

[1] United Nations Office for Outer Space Affairs. 2024. Space Supporting Sustainable Development Goals: How space can be used in support of the 2030 Agenda for Sustainable Development. https://www.unoosa.org/oosa/en/ourwork/space4sdgs/index.html
[2] United Nations Office for Outer Space Affairs. 2024. United Nations Programme on Space Applications. https://www.unoosa.org/oosa/en/ourwork/psa/index.html

International Space Law–The Outer Space Treaty

In January 1967 the United Nation General Assembly (UNGA) adopted resolution 2222 (XXI) titled, "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies," widely known as the Outer Space Treaty (OST). The OST is comprised of seventeen articles which set the foundation for international space law. Among the articles, Article IV establishes protections for the moon and other celestial bodies, forbidding, "[t]he establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military manoeuvres on celestial bodies..." while stressing that, "[t]he moon and other celestial bodies shall be used by all States Parties to the Treaty exclusively for peaceful purposes." Article IX focuses on ensuring cooperation and mutual assistance regarding space exploration, as well as the emphasis that studies conducted in space avoid "harmful contamination and also adverse changes in the environment of the earth."[3] Ultimately the OST set out to promote international cooperation between states in space exploration and ensure that space activity is conducted with the goal of benefiting all. Aside from the OST in recent years the UN has passed several resolutions such as A/72/65 titled "Transparency and Confidence-Building Measures in Outer Space Activities" which was passed in 2017 and focused on expanding transparency and information sharing in regards to space technology.[4]

However, the issue of sovereignty remains contested. As established in Article II of the OST, "space exploration, including those that involve the Moon as well as any other celestial bodies, are free for exploration by any states, and is therefore not subject to national appropriation, by claim

[3] United Nations Office of Disarmament Affairs Treaties Database. 2024. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies. https://treaties.unoda.org/t/outer_space
[4] United Nations General Assembly. 2017. Transparency and Confidence-Building Measures in Outer Space Activities A/72/65 https://www.unoosa.org/res/oosadoc/data/documents/2017/a/a7265_0_html/A_72_065E.pdf

of sovereignty, by means of use or occupation, or by any other means."[5] With advancements in space technology growing in a rapid fashion both for the civilian and military uses, issues of state sovereignty have arisen internationally regarding transparency, information sharing, and the development of space weapons. Most recently, Russia vetoed a Security Council draft resolution aimed at affirming a weapon-free outer space which called on "all States, in particular those with major space capabilities, to contribute actively to the objective of the peaceful use of outer space and the prevention of an arms race in outer space."[6] Other issues also remain to be resolved regarding Space Technology.

Space Mining

An abundance of resources from gold to iron to silver exists on asteroids floating in space, with estimates that the closest asteroids to Earth could produce a profit of $1.5 trillion.[7] In 2021 during its annual session the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) held informal sessions to consider the theme of 'exploration, exploitation, and utilization of space resources'.[8] This timely discussion came at a crucial turning point as multiple spacefaring nations, such as the United States, Australia, the United Kingdom, China and Russia have advanced far into their plans for space resource extraction. However, at present no international law exists regulating or addressing resource extraction or resources mining in space. As such a legal gray area exists that could lead to monopolization of space resources that could be

[5] United Nations Office of Disarmament Affairs Treaties Database. 2024. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies. https://treaties.unoda.org/t/outer_space

[6] United Nations – UN News. 2024. Russia vetoes Security Council draft resolution on a weapon-free outer space https://news.un.org/en/story/2024/04/1148951

[7] Yarlagadda, S. (2022, April 8). Economics of the Stars: The future of asteroid mining and the global economy. Harvard International Review. https://hir.harvard.edu/economics-of-the-stars/

[8] Oosterveld, V. and A. Campbell. (2021, July 11). Space resource discussions in the UN Committee on the peaceful uses of outer space. Opinio Juris. http://opiniojuris.org/2021/07/11/space-resource-discussions-in-the-un-committee-on-the-peaceful-uses-of-outer-space/

devastating to the economy of certain nations. Asteroid mining could allow one Member State to capitalize on a space extracted natural resource by monopolizing profits or harming another Member State's economy that relies on that natural resource as an Earth-based export. As such it is imperative that the international community address how to establish basic frameworks focused on space resource extraction while keeping in mind the bounds of state sovereignty.

Harnessing Space Technology for Sustainable Development - Natural Resource and Environmental Management through Earth Observation

Turning back to Earth, there has been a considerable expansion in the accessibility of satellite data and signals utilized to observe Earth, called Earth Observation (EO). It is a crucial tool for managing the environment as well as natural resources and provides information that can be used to support agricultural production, forestry, fisheries, and sustainable development.[9] EO can also be used to monitor harmful activities that are bad for the environment such as poaching, fires, illegal mining. EO can also be used to address various challenges such as water management, air pollution and forest preservation. Australia utilizes satellite observation to monitor drought conditions in Murray-Darling Basin. The Japan Aerospace Exploration Agency in collaboration with the Asian Development Bank and the United Nations Educational, Scientific and Cultural Organization (UNESCO) has developed Gsmap, a precipitation monitoring system which utilizes satellite imagery to provides global rainfall maps that can be used to when preparing, predicting, and addressing water related natural disasters such as floods, typhoons and landslides. The utilization of space technology in managing natural resources and the environment through EO are integral to working towards achieving Sustainable Development Goal (SDG) 12 "responsible consumption and production," SDG 13 "climate action," and SDG 15

[9] European Union Agency for the Space Programme. 2024. What is Earth Observation? https://www.euspa.europa.eu/eu-space-programme/copernicus/what-earth-observation#:~:text=EO%20data%20serves%20a%20very,protection%2C%20tourism%20%E2%80%93%20and%20more

"life on land" and, can be further utilized to sustainably develop environmentally conscious infrastructure.[10]

Harnessing Space Technology for Sustainable Development - Health

In recent years, space-based technologies such as remote sensing, telecommunications, and positioning, and tracking have played a growing role in the furtherance of global health goals and have been instrumental in improving decision making and early warning measures. Remote sensing technology has been used in monitoring disease patterns as well as predicting risk areas. Geographic information has been utilized by a number of institutions, such as the South African National Space Agency which has continued to use a geographic information system to monitor potential pandemic hotspots.[11] In 2017 the National Aeronautics and Space Administration (NASA) in collaboration with Peru utilized geospatial data to develop and implement a Malaria Early Warning System.[12] In Zimbabwe during the height of the COVID-19 pandemic local governments were able to take advantage of satellite communication technology and geolocation to better track the virus and provide affordable health care to economically vulnerable communities.[13] The utilization of sustainable space technology by various institutions and governments in the health sector to both provide infrastructure and solutions in times of emergency have been instrumental in working toward achieving SDG 3 "good health and well-being" and can be used to sustainably develop the health infrastructure of both less developed and developed nations.

[10] United Nations Trade and Development. 2021. Exploring Space Technologies for Sustainable Development. https://unctad.org/system/files/official-document/dtlstict2021d1_en.pdf
[11] *Ibid*
[12] National Aeronautics and Space Administration. 2017. Global Precipitation Measurement. https://gpm.nasa.gov/applications/health/using-satellites-predict-malaria-outbreaks#:~:text=With%20funding%20from%20NASA's%20Applied%20Sciences%20Program%2C%20they%20are%20working,and%20prevent%20them%20from%20happening.
[13] United Nations Trade and Development. 2021. Exploring Space Technologies for Sustainable Development. https://unctad.org/system/files/official-document/dtlstict2021d1_en.pdf

Harnessing Space Technology for Sustainable Development - Reducing of Poverty and Ensuring Access to Education

Along with providing methods for sustainable development in the health sector, space technology can be utilized to predict poverty. In 2017, the World Bank used convolutional neural networks and high-resolution satellite imagery to predict poverty rates in Sri Lanka.[14] Methods such as these can be used by developing nations to measure urban population living in slums and the proportion of those who have access to basic health services and infrastructure. In addition, the application of space technology such as satellite telecommunications can be beneficial in providing and establishing education in impoverished or vulnerable communities.

The United Nations Children's Fund (UNICEF) has begun building a tool utilizing high-resolution satellite imagery together with Deep Learning techniques to map every school in the world with the goal to identify vulnerabilities in areas where there are significant information gaps. UNICEF believes this tool will "provide actionable insights by identifying information needs and advocating for optimally positioned resources on the basis of evidence in different areas."[15] Efforts and applications such as these, which utilize space technology to work towards sustainable development in education, help further the SDG 4 "quality education" and help ensure inclusive and equitable quality education.

Harnessing Space Technology for Sustainable Urban Development

Many developing countries face serious hurdles in harnessing science, technology, and innovation (STI) for sustainable development. STI tools can be used to address sustainable

[14] World Bank Group. (Dec 2017). Poverty from Space. https://documents1.worldbank.org/curated/en/610771513691888412/pdf/WPS8284.pdf
[15] United Nations International Children's Emergency Fund – Office of Innovation. 2024. School mapping. https://www.unicef.org/innovation/school-mapping

development challenges. One such tool is geospatial technologies which are a collection of tools that are used to collect, store, analyze and visualize geographic and spatial data to understand the spatial relationships, patterns, and trends on Earth's surface. Some geospatial technologies include: Geographic Information Systems (GIS), which are used to create maps and analyze spatial data, remote sensing, and collect data about the Earth's surface from satellites to assess environmental changes, and Global Positioning System (GPS), which is used for tracking, navigation, and mapping. Geospatial technology has shown great promise, "as a potential solution to fill data gaps and improve data quality, as well as to increase the SDG reporting rate of developing countries."[16]

Within the last two decades access to observation data has significantly improved, providing valuable and insightful information that can be used to help combat global challenges such as climate change, food security, poverty, and land degradation to list a few.[17] Remote sensing has become especially valuable to farmers as well as food manufacturers as it provides key data for monitoring soil, as well as drought and crop development. In addition, rainfall assessments gathered from satellites can help farmers plan the amount of irrigation needed for crops. While GPS technology has supported farmers' improved planning to boost the overall quality and productivity of their crops. Overall, these technologies can be crucial in mitigating the effects of famines and food shortages.[18]

However, the high cost of geospatial technology for the purposes of agriculture have been widely limited to developed countries. Initiatives such as Open Data Cube, which have worked to provide

[16] United Nations Trade and Development. (2024, February 6). Harnessing Space Technological Applications in Sustainable Urban Development.
https://unctad.org/project/harnessing-space-technological-applications-sustainable-urban-development
[17] South African National Space Agency. (2024, August 7). Space for Urban Development: Harnessing Space technological applications in Sustainable Urban Development using Julia Programming Language.
https://www.sansa.org.za/2024/08/space-for-urban-development/
[18] United Nations Trade and Development. 2021. Exploring Space Technologies for Sustainable Development.
https://unctad.org/system/files/official-document/dtlstict2021d1_en.pdf

better access to geospatial data to stimulate the adoption of geospatial technology in developing nations.[19] In 2023, the United Nations Commission on Science and Technology for Development (CSTD) launch the CropWatch Programme which facilitates and simulates the agriculture monitoring of 14 developing countries, all in an effort to advance Sustainable Development Goal (SDG) 2 Zero Hunger. The system that utilizes and integrates satellite data to monitor crop condition in conjunction with other climate data on drought, pest, and disease to improve farm management.[20]

Conclusion

Space technology such as remote sensing, geospatial technology, satellite communication technology, and telecommunication has opened a bright new path toward sustainability and real progress towards achieving the SDG goals. However, there are still many impediments to all Member States, and in particular developing nations, that do not have the resources or capabilities to establish the necessary infrastructure to take advantage of space technology. While great leaps have been taken in collaboration related to new technology and technology sharing, there still remains much more to be done.

Questions to Consider

1. How can the space technological disparity between developed and developing nations be remedied?

2. How should state sovereignty and access to space-based resources be addressed by the CTSD committee?

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[19] *Ibid*
[20] United Nations Trade and Development. (2023, August 23). CropWatch Innovative Cooperation Programme. https://unctad.org/project/cropwatch-innovative-cooperation-programme

3. How, if at all, is your Member State impacted by space technology?

4. Does your Member State think space technology is a viable solution for sustainable development?

5. Is the militarization of space of concern for your state?

6. How should funding be promoted to provide the benefits of space technology to all states?