# Space Technology- Ensuring a Sustainable Planet for Future Generation

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## Abstract

*Space Technology has become a vital pillar in today's world. Sustainable space technology means achieving sustainable development goals namely, food security, telecommunication, monitoring natural resources, and reducing the risk of natural calamity through the applications of space technology such as earth observation and geolocation. Recent developments include artificial intelligence and machine learning, crowdsourcing, and developments regarding satellite positioning technologies and aerial platforms. There has been much advancement in the field of reusable launchpads and satellite parts, like reusable cryogenic foam insulation, reusable hybrid propellant modules, etc. This article reviews the recent development of more usable space tools and technologies to sustain the earth in different aspects.*

## Keywords

Geolocation; Earth observation; Satellite positioning technologies; Reusable satellites parts

## 1. Introduction

From the beginning of the space age in the last century, we have developed technologies that allow us to explore outer space, live permanently on board the International Space Station, and even safely land humans on the Moon. The technological developments of humankind have been staggering yet, we are reaching the limits of many of Earth's planetary boundaries, depriving the options available to future generations and limiting their possibilities to live on our planet with the same resources available as we did.

It is therefore, time to change the way we live. One possibility is to create a link between new space exploration ventures and sustainable economic, social and environmental development.

## 2. Sustainability pillars

Sustainability assumes that resources are finite and should be used conservatively with a view to long-term priorities and future consequences. The foundation of this concept is made up of three pillars: economy, society, and environment [1]. In the applications of sustainable space technology, we can utilize the data as the two most critical emanating from space: earth observation and geolocation. Further details can be deduced from these two primary applications, including urban planning, and monitoring forestry and desertification impact. The key elements were categorized within those goals, in which space plays a crucial role by helping fight poverty, monitoring crop cultivation, desertification, and other elements that affect poorer areas around the world, as well as monitoring habitats and life on land [1].

## 3. Space technologies for sustainability

The potential opportunities of space-enabled technologies for delivering on sustainable development goals and proposing science, technology, and innovation policy options for harnessing space technology comprise the following sections:

### 3.1.Agriculture

Space-based technology is of great value to farmers, agronomists, national agricultural ministries and departments, and international organizations, who wish to enhance food production and its profit. Rainfall assessments from satellites help farmers plan the timing and amount of irrigation needed for crops. Remote-sensing satellites provide key data for monitoring the soil, drought, crop development, etc. It can also be critical in anticipating and mitigating the effects of food shortages and famines [2].

### 3.2. Information technology

Space-based connectivity helps to make smart societies a reality (including intelligent transport systems, electronic government, e-health, smart energy, and smart agriculture), in both developed and developing countries. These technologies are also facilitating advances in sustainability, banking, and diverse government services. Access to terrestrial networks is limited or non-existent in many parts of the world, particularly in sparsely populated rural or remote areas. Satellite technologies are well-placed for the delivery of broadband services in those areas, either on their own or in combination with other technologies. Expanding access to rural areas is challenging, as population is less dense, further from main networks, and has less purchasing power [3].

### 3.3. Health and its applications

In the public and global health domains, space technology and its applications (including Earth observation and remote sensing; telecommunications, positioning and tracking; and space-based research) play a crucial role in supporting decision-making, improved care, education, and early warning measures [3]. In the context of the COVID-19 pandemic, using geographic information system data, various institutions have been able to publish information on confirmed infections and deaths, which has been useful in epidemiological studies of the virus.

### 3.4. Disaster management

Space-enabled technology applications have become an important element of local, national, and regional disaster risk reduction strategies. Volcano hazards, for example, can be observed through land deformation due to tectonic forces. Drought hazards can be monitored by observing soil moisture, precipitation, and vegetation indices. Earth observation can also be used to map urban and rural areas that have been impacted by natural, technological, and biological disasters, as well as to assess damages and losses. Flooding and tsunami impacts can be directly measured based on the size of the flooded areas visible in satellite images [4].

### 3.5.Environmental management

Earth observation is highly relevant for both monitoring and achieving sustainable development goals. It provides information to support agriculture, fisheries, freshwater, and forestry management. It can also help to monitor activities that are harmful to the environment, such as illegal logging, mining, poaching, etc. Earth observation data from satellites are also used to overcome various challenges such as water management, air pollution, and forest preservation. One example is the observation of precipitation, which is useful for addressing water-related disasters such as floods, typhoons, and landslides [1].

## 4. Recent technological development in space exploration

New technological developments are driving down the costs to use, adopt and adapt space science and technology.

### 4.1.Artificial intelligence and cloud computing

Artificial intelligence and machine learning can enable users to analyze vast amounts of Earth observation data in a faster and more efficient manner. With appropriate in situ observations, and convolutional neural networks, a deep learning method may be used to automate image recognition and classification tasks on remote sensing imagery. As a result, Earth observation data could be analyzed in real-time, minimizing the time and effort needed by human analysts [5]. The cloud computing model is becoming the prevailing mode of work for most medium-scale and large-scale global data sets, including Earth observation applications. This is due to the ability of cloud services to archive large satellite-generated datasets and provide computing facilities to process them. One of the main disadvantages of using cloud services is their lack of interoperability [6].

### 4.2.Emerging satellite and aerial platforms

Firstly, data from continuous recording reference stations for global positioning systems can be used to extract information on atmospheric and tropospheric water content that can be fed into operational weather forecasts to improve the forecasts in many areas. Secondly, experiments are underway in the United States to use data from continuously recording stations for global positioning systems, to monitor the passage of tsunamis across ocean basins, due to the impact on the ionosphere. If a tsunami is detected, its source, likely passage across ocean basins, and potential impact can be predicted 24 hours in advance. Furthermore, satellite Earth observation platforms are developing capabilities to monitor the global wireless spectrum, with applications for monitoring digital divides, wireless penetration drones can serve as an alternative relatively cheap source of Earth observation data compared with satellites and are increasingly being used in crop prediction and food security applications. However, their use tends to be regulated by law in many countries. Thus, despite the relatively higher cost of satellite data, it will likely continue to be used in place of lower-cost drones as a source of Earth observation data [7].

### 4.3.Crowdsourcing

Crowdsourcing is enabled through digital, mobile, and social networking tools that can support efforts to effectively harness space technologies for sustainable development. Crowdsourcing platforms like Ushahidi may help to contextualize information gathered from space technologies using data provided by civil society on the ground. Similarly, crowdsourced image labeling is used by several aid-related non-governmental organizations to manually identify patterns of areas affected by a natural disaster that can be automated with machine learning. Data Collaboratives for Local Impact, a partnership between the United States President's Emergency Plan for AIDS Relief and the Millennium Challenge Corporation, is working in Africa to build an enabling environment for data-driven decision-making to end the AIDS epidemic, improve health outcomes, reduce gender inequality and support economic opportunities for youth [8].

## 5. Barriers to space technology

Despite the decreasing costs of some space technologies and the increasing availability of open-source data, some bottlenecks hinder their application in certain fields and their use in some regions of the world.

### 5.1.Lack of financial resources

The lack of domestic and international financial resources is an obstacle to investing in space programmes in developing countries. In developing regions, it is particularly difficult to develop the private sector in the space industry or to attract private funding. In much of Asia and the Pacific, compared with Australia, Canada, the United States of America, and Europe, there are a few opportunities to commercialize geospatial research and development activities and technologies from space applications [9].

### 5.2.Technology and skill gaps

In many developing countries, lack of capability and expertise to produce satellite information with local resources and provide user support can be a barrier to expanding the use of satellite technologies. There is also an absence of a critical number of personnel with the capacity to generate downstream applications of space technologies. In developing countries, losing even a single expert within an organization can jeopardize efforts within government agencies. This absence of critical mass applies not only to institutions developing space applications but also to government agencies and private sector firms that could be potential users of the technology [9].

### 5.3.Geographical constraints

Some countries face geographical constraints in developing space launch facilities and conducting astronomical research. These constraints can be bridged through international partnerships and cooperation. For example, the Lao People's Democratic Republic, in 2015, launched the Laosat 1 satellite from China. Chile hosts around 50 percent of the world's installed capacity of astronomical observatories due to its unique atmospheric conditions. Many of these are operated by international partners such as Brazil, Canada, Japan, the United States, and the member states of the European Union [9].

## Conclusions

Statistics from 2020 have revealed that around 1,300 satellites have been registered and such a figure is expected to continue increasing, with the likes of SpaceX planning the launch of as many as 42,000 Starlink satellites. Other mega satellite constellations are also planned, which are only set to pile up space debris. So, this is going to be a really serious problem for governments, and the private sectors. Some possible solutions to overcome this challenge include creating more sustainable space tools and technologies like reusable launchpads and reusable satellite parts. A few companies and start-ups have come up in the last few years that are specialized in figuring out methods of capturing space debris, trying to clean it from space, and avoiding it is becoming an accumulating problem.

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