

SC AND TEC (SPACE JUNK)**The need for space sustainability**

❖ **CONTEXT:** U.K. hosted the fourth summit for Space Sustainability in London in collaboration with the Secure World Foundation. In line with the ambitious U.K. National Space Strategy, George Freeman, the Minister of Science, announced a new ‘Plan for Space Sustainability. This plan aims to “set a global commercial framework for the insurability, the licensing and the regulation of commercial satellites.

❖ **What does sustainability in outer space mean?**

- The earth’s orbital environment has more than tripled in the past decade. As the cost of missions reduce and the number of players increase, the complexity of missions and slot allotment issues also increase.
- With the emergence of large constellations and complex satellites, there is a risk of collisions and interference with radio frequencies.
- As the outer space is considered a shared natural resource, the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) in 2019 adopted a set of 21 voluntary, non-binding guidelines to ensure the long-term sustainability of outer space activities.
- One of the hot issues when it comes to space sustainability is orbital crowding. It poses a direct threat to the operations and safety of a mission and is likely to cause legal and insurance-related conflicts. Space debris is another prominent issue. After the completion of a mission, an ‘end-of-life protocol’ requires space objects to be moved to the graveyard orbit or to a low altitude. Neither of the options are sustainable in the long run. Other causes of concern are solar and magnetic storms which potentially damage communication systems.
- Such space weather threats need to be addressed along with the efforts to identify the terrestrial carbon footprint of outer space missions.
- Long-term sustainability looks toward space research and development of technology to ensure the reuse and recycling of satellites at every stage. The U.K. plan proposes active debris removal and in-orbit servicing.

❖ **What does the U.K. plan for space sustainability entail?**

- The U.K. calls for an “Astro Carta” for space sustainability, based on the Artemis Accords model for sustainable space exploration.
- The U.K. Space Sustainability plan mentions primary elements like:
 - To review the regulatory framework of the U.K.’s orbital activity;
 - To work with organisations such as the G-7 and the UN
 - To emphasise international engagement on space sustainability;
 - To try and develop safety and quality-related metrics that quantify the sustainability of activities;
 - To induce additional funding of \$6.1 million on active debris removal.
- The U.K. also confirmed investments in its National Space Surveillance and Tracking Programme, which works on collision assessment services for U.K.-licensed satellite operators.
- Post-Brexit, the U.K. space programme has been transformed. It now hopes to drive the sustainability factor internationally and provide an opportunity for the private sector to develop models that enhance operations’ safety and reduce debris footprint.
- The U.K. aims to draw investments not only from government investors but also from others.

❖ **Where does India stand on space sustainability?**

- The headquarters of the Indian National Space Promotion and Authorisation Centre (In-SPACe) was formally inaugurated in June . One can expect an increased role of the private sector in India’s space activities.
- India hosts promising start-ups like Agnikul and Skyroot, which are developing launch vehicles for small payloads and Dhruva Space, which works on high-tech solar panels for satellites and satellite deployers. India is well on its way to create a subsystem that addresses global sustainability questions.
- The Indian Space Research Organisation (ISRO) has initiated ‘Project NETRA’ to monitor space debris.

- The domestic surveillance system would provide first-hand information on the status of debris, which would aid further planning on protecting space assets.
- In April 2022, India and the U.S. signed a new pact for monitoring space objects at the 2+2 dialogue. The controlled anti-satellite weapons (ASAT) tests and the risk of collisions must be collectively addressed.
- To provide in-orbit servicing, ISRO is developing a docking experiment called ‘SPADEX’. It looks at docking a satellite on an existing satellite, offering support in re-fuelling and other in-orbit services while enhancing the capability of a satellite. This would not only ensure the longevity of a mission but would also provide a futuristic option to combine missions/experiments.

❖ **What next?**

- Outer space in the 2020s can no longer be considered a ‘space race’ because of the cost, when compared to the beginning of this century.
- Today, any entity (government or private) with the necessary access to resources and technology can invest in outer space.
- Sustainable practices in outer space would directly help reduce orbital crowding and collision risk while nurturing future technologies. As the natural course of evolution, the Plan for Space Sustainability, which includes private industries, is a timely move. This would serve as a model for other space programmes.
- However, the broad question of sustainability cannot be driven by one country/entity alone. While most National Space Programs set sustainability standards, a collective effort by all space players, with the active role of the UN COPUOS or the United Nations Office for Outer Space Affairs (UNOOSA), is needed to set equitable standards for the ease of activities.
- Many of the measures for sustainability are resource-consuming and expensive for medium-and-small space programs. In this case, private initiatives of sustainability standards would make accessibility more challenging, giving undue advantage to programs with stable investments.
- The UK’s Astro Carta idea throws light on the need for addressing the principles and rules that guide the activities of entities in outer space. More clarity is required to know the exact framework and guiding principles of the Astro Carta to determine the path it intends to take.
- India has always emphasised cost-effective and efficient missions with problem-solving applications. Its debris footprint is minuscule; it has 114 debris among the 25,182 pieces, of sizes larger than 10 cm, in the lower earth orbits. The emerging private sector could be encouraged with a set of sustainability guidelines to ensure optimum utilisation of resources and increase the safety and productivity of missions.

PRELIMS**1. Large Hadron Collider(LHC)**

❖ **CONTEXT:** The world’s most powerful particle collider, the Large Hadron Collider (LHC), will begin smashing protons into each other at unprecedented levels of energy beginning July 5, 2022.

❖ **The LHC**

- The Large Hadron Collider is a giant, complex machine built to study particles that are the smallest known building blocks of all things.
- Structurally, it is a 27-km-long track-loop buried 100 metres underground on the Swiss-French border. In its operational state, it fires two beams of protons almost at the speed of light in opposite directions inside a ring of superconducting electromagnets.
- The magnetic field created by the superconducting electromagnets keeps the protons in a tight beam and guides them along the way as they travel through beam pipes and finally collide.
- Just prior to collision, another type of magnet is used to ‘squeeze’ the particles closer together to increase the chances of collisions.
- The particles are so tiny that the task of making them collide is akin to firing two needles 10 km apart with such precision that they meet halfway. which runs the particle accelerator complex that houses the LHC.

- Since the LHC's powerful electromagnets carry almost as much current as a bolt of lightning, they must be kept chilled.
- The LHC uses a distribution system of liquid helium to keep its critical components ultracold at minus 271.3 degrees Celsius, which is colder than interstellar space. Given these requirements, it is not easy to warm up or cool down the gigantic machine.

❖ Latest upgrade

- Three years after it shut down for maintenance and upgrades, the collider was switched back on April 2022. This is the LHC's third run, and from July 5 2022, it will operate round-the-clock for four years at unprecedented energy levels of 13 tera electron volts. (A TeV is 100 billion, or 10-to-the-power-of-12, electron volts. An electron volt is the energy given to an electron by accelerating it through 1 volt of electric potential difference.)
- It aims to be delivering 1.6 billion proton-proton collisions per second" for the ATLAS and CMS experiments. This time, the proton beams will be narrowed to less than 10 microns (a human hair is around 70 microns thick) to increase the collision rate. (ATLAS is the largest general purpose particle detector experiment at the LHC; the Compact Muon Solenoid (CMS) experiment is one of the largest international scientific collaborations in history, with the same goals as ATLAS, but which uses a different magnet-system design.)

❖ Previous runs & 'God Particle' discovery

- Ten years ago, on July 4, 2012, scientists at CERN had announced to the world the discovery of the Higgs boson or the 'God Particle' during the LHC's first run.
- The discovery concluded the decades-long quest for the 'force-carrying' subatomic particle, and proved the existence of the Higgs mechanism, a theory put forth in the mid-sixties.
- This led to Peter Higgs and his collaborator François Englert being awarded the Nobel Prize for physics in 2013.
- The Higgs boson and its related energy field are believed to have played a vital role in the creation of the universe.
- The LHC's second run (Run 2) began in 2015 and lasted till 2018. The second season of data taking produced five times more data than Run 1.
- The third run will see 20 times more collisions as compared to Run 1.

❖ 'New Physics'

- After the discovery of the Higgs boson, scientists have started using the data collected as a tool to look beyond the Standard Model, which is currently the best theory of the most elementary building blocks of the universe and their interactions.
- Scientists at CERN hope are to use the collisions to further the understanding of so-called "dark matter".
- This hard-to-detect, hoped-for particle is believed to make up most of the universe, but is completely invisible as it does not absorb, reflect, or emit light.

2. Soil samples from T.N. sent for project at new Parliament site**❖ CONTEXT: The rich cultural history of the Tamils will be featured in a project relating to the new Parliament being constructed by the Union government in New Delhi.**

- Soil samples from five ecological regions mentioned in ancient Tamil Sangam literature — Kurinji, Mullai, Marutham, Neithal and Paalai — have been collected and sent to the capital recently.
- On a request from Delhi, multiple State government departments coordinated to collect the soil samples and sent them to the capital in June.
- A brief synopsis of each sample, such as the place of origin, its geological features and historical importance.
- The soil samples for Kurinji Tinai (mountains and slope) were collected from the Nilgiris, Kodaikanal and Palani Hills in Dindigul district, Kolli hills in Namakkal district, Yercaud in Salem district, Courtrallam in Tenkasi district and Jawadhu Hills in Tiruvannamalai district.
- Soil samples from the foothills of the Eastern and Western Ghats in Coimbatore, Salem, Tirunelveli, Krishnagiri, Theni and Kanniyanumari districts have been collected for Mullai Tinai (forests and grasslands).

- Samples from Thanjavur, Tiruvarur, Coimbatore, Tiruchi, Salem, Tirunelveli and Krishnagiri were collected for Marudham Tinai (plains, valleys and agricultural lands).
- The soil samples for Neithal Tinai (coastal or seashore) were collected from Cuddalore, Nagapattinam, Thoothukudi and Kanniyanumari districts
- For Paalai Tinai (parched wasteland or desert) were collected from Ramanathapuram, Thoothukudi, Sivaganga and Virudhunagar districts.

❖ Agriculture museum

- Tamil Nadu's first Agriculture Budget presented for 2021-22 also announced that a museum for agriculture would be established in Chennai, which would also depict the traditional land classification modes.

3. Alluri Sitarama Raju**❖ CONTEXT:** Prime Minister unveiled a 30-foot-tall bronze statue of Alluri Sitharama Raju at Bhimavaram in Andhra Pradesh as the year-long celebrations of the freedom fighter's 125th birth anniversary began from 4th July.

- Raju is believed to have been born in 4th July Andhra Pradesh in 1897 or 1898. He is said to have become a sanyasi at the age of 18, and gained a mystical aura among the hill and tribal peoples with his austerity, knowledge of astrology and medicine, and his ability to tame wild animals.

❖ Struggle against British

- At a very young age, Raju channelled the discontent of the hill people in Ganjam, Visakhapatnam, and Godavari into a highly effective guerrilla resistance against the British.
- Colonial rule threatened the tribals' traditional podu (shifting) cultivation, as the government sought to secure forest lands. The Forest Act of 1882 banned the collection of minor forest produce such as roots and leaves, and tribal people were forced into labour for the colonial government.
- While the tribals were subjected to exploitation by muttadars, village headmen commissioned by the colonial government to extract rent, the new laws and systems threatened their way of life itself.
- Strong anti-government sentiment, shared by the muttadars who were aggrieved by the curtailment of their powers by the British, exploded into armed resistance in August 1922. Several hundred tribals led by Raju attacked the Chintapalle, Krishnadevapeta and Rajavommangi police stations in the Godavari agency.
- The Rampa or Manyam Rebellion continued in the form of a guerrilla war until May 1924, when Raju, the charismatic 'Manyam Veerudu' or Hero of Jungle, was finally captured and executed.
- The Rampa Rebellion coincided with Mahatma Gandhi's Non-Cooperation Movement. Raju talked of the greatness of Mahatma Gandhi, he was inspired by the Non-Cooperation Movement, and persuaded people to wear khadi and give up drinking. But at the same time, he asserted that India could be liberated only by the use of force, not non-violence.

❖ Presence in culture

- In 1986, the Indian Postal Department issued a stamp in honour of Raju and his contribution to India's struggle for Independence.
- Raju has long been a folk hero in the region, and the 1974 Telugu film Alluri Seetarama Raju, featuring actor Krishna, became very popular.
- S S Rajamouli's 2022 Telugu movie RRR is a fictional account of the friendship between Raju and tribal leader Komaram Bheem, with actor Ram Charan portraying Raju's role.

❖ Political claims

- In July 2019, on the occasion of Raju's 122nd birth anniversary, the government of Y S Jagan Mohan Reddy announced the naming of a district after the legendary freedom fighter, acceding to a long-standing demand of the tribal population of Andhra Pradesh.
- The district of Alluri Sitharama Raju came into being on April 4 2022, made up of Paderu and Rampachodavaram of the existing districts of Visakhapatnam and East Godavari respectively. These two areas have tribal populations of 10.4 per cent and 4.1 per cent, according to a May 2014 estimate by the Andhra Pradesh government.

ANSWER WRITTING**Q. How can biotechnology help to improve the living standards of farmers?**

In India, the majority of the population is involved in agriculture but it is not remunerative enough, especially in areas which did not go through the stages of the green revolution. In this scenario, biotechnology holds good potential to transform agriculture. It can affect all steps of the production chain, from agrochemical inputs to final food processing.

- Under biotechnology, plants, bacteria, fungi and animals whose genes have been altered by manipulation (Recombinant DNA Technology) are called Genetically Modified Organisms (GMO). GMO technology has brought significant changes in agriculture and areas related to it.
- Tissue Culture is the science of cultivating animal/ plant tissue in a prepared medium. Technologies based on this can be harnessed to achieve crop improvement objectives.
- Crops have been made more tolerant to abiotic stresses (cold, drought, salt, heat) so the farmers do not have to worry about the weather conditions and can help plants adapt to environmental stress and climate change.
- It has reduced reliance on chemical pesticides (pest-resistant crops) which is pocket-friendly for the farmers and eco-friendly for the consumer by eliminating harmful chemicals from the ecosystem.
- Post-harvest losses have been reduced by increasing crops' abilities to withstand the transportation period without being perished.
- Efficiency of mineral usage by plants has been increased by it (this prevents early exhaustion of fertility of soil), so a piece of land can be used for a long time for equally good yields.
- It has enhanced the nutritional value of food (like Vitamin A enriched rice) which increases the market value of the product, profiting the farmers and improving human health.
- Plants developed using biotechnology naturally resist specific insects, weed plants and diseases so there is no loss of crop due to these reasons. (Like Bt crops).
- In addition, it has been used to create tailor-made plants to supply alternative resources to industries, in the form of starches, fuels and pharmaceuticals etc. which can boost the agricultural-industrial relations uplifting the farmers.

The benefits of biotechnology are especially meaningful at a time when our global population is growing and our demand for food is increasing, mainly in developing countries. Biotechnology allows farmers to grow more food on less land using environmentally sustainable farming practises which are necessary for them to have a good income and a better living standard. Biotechnology is a powerful tool to feed an increasing world population, but its "positive and negative potential" should be carefully evaluated.

MCQs

1. With reference to United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) consider the following statements
 1. Peaceful Uses of Outer Space (COPUOS) is an ad hoc intergovernmental Committee established by the UN General Assembly Resolution.
 2. India is a founding member of the UNCOPUOS
 3. In the latest UNCOPUOS adopted a set of 21 guidelines to ensure the long-term sustainability of outer space activities which are binding on all the members of the committeeWhich of the above statement/s is/are correct?
 - a) 1 and 3 only
 - b) **2 only**
 - c) 2 and 3 only
 - d) 1 only
2. Terms like Agnikul, Skyroot and Dhruv space recently seen in news are related to which of the following?
 - a) Long range missile developed by DRDO
 - b) Space shuttles developed by ISRO
 - c) **Space technology start-ups**
 - d) Communication satellites

3. To provide in-orbit servicing, which of the following Space agency is developing a docking experiment called ‘SPADEX’?
- a) NASA b) ROSCOSMOS c) JAXA d) ISRO
4. Recently Soil samples from T.N. sent for project at new Parliament site from five ecological regions which are mentioned in ancient Tamil Sangam literature, with regards to the ecological regions and their names consider the followings.
1. Kurinji Tinai - mountains and slope
 2. Mullai Tinai - forests and grasslands
 3. Marudham Tinai - plains, valleys and agricultural lands
 4. Neithal Tinai - coastal or seashore
 5. Paalai Tinai - parched wasteland or desert
- How many pair/s is or are correctly matched?
- a) Only two pairs
b) Only three pairs
c) Only four pairs
d) All the five pairs
5. Consider the following statements with regards to Large Hadron Collider
1. The Large Hadron Collider machine built to study particles that are the smallest known building blocks even less than 10 microns.
 2. The LHC uses a distribution system of liquid nitrogen to keep its critical components ultracold at minus 271.3 degrees Celsius.
- Select the correct statement/s using the codes given below
- a) 1 only
b) 2 only
c) Both 1 and 2
d) Neither 1 nor 2
6. “Project NETRA” recently seen in news is associated with which of the following?
- a) Defence drone developed by DRDO for north eastern border areas
b) Space derbies
c) CCTV installation on National Highways by NHAI
d) Wild life census through Drones by MoFCC
7. UNNATI training programme is associated with which of the following organisation?
- a) ISRO
b) MSMEs
c) Ministry Labour and Employment
d) DRDO
8. Artemis Accords is related to which of the following?
- a) Deep sea mission
b) Antarctica for Global commons
c) Outer space
d) High sea regions
9. Which of the following country is responsible for the concept called “Astro Carta” for space sustainability?
- a) USA
b) India
c) France
d) UK
10. The term ‘IndARC’ sometimes seen in the news, is the name of?
- a) an indigenously developed radar system inducted into Indian Defence
b) India’s satellite to provide services to the countries of Indian Ocean Rim
c) a scientific establishment set up by India in Antarctic region
d) India’s underwater observatory to scientifically study the Arctic region