

India's Space Debris

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Context- Recently, the Ministry of Science and Technology informed the Rajya Sabha about the presence of space debris in India.

Key Highlights

- As per the government, India has a total 111 Payloads, 105 Space Debris Objects Orbiting Earth that can have an impact on the sustainability of outer space and future missions.
- ISRO and academia has been periodically carrying Research and studies on the potential and emerging threats from space debris since the early 1990s.
- The ISRO System for Safe and Sustainable Operations Management (IS4OM) was established in 2022 in order to continually monitor objects posing collision threats and to mitigate the risk posed by space debris.
- Till now, 21 collision avoidance manoeuvres have been carried out by ISRO in order to avoid collision threats from other space objects.
- Besides, the government is taking measures to augment domestic capacity for space tourism. For example, ISRO has been conducting feasibility studies for a sub-orbital space tourism mission i.e., the Gaganyaan mission.
- The Gaganyaan programme is engaged in the development of several technologies for human space missions with an objective to demonstrate human spaceflight capability to low earth orbit.
- The government has stressed that all the future missions will be taken up after the accomplishment of the Gaganyaan mission.

Space Debris

- Space debris refers to the artificial objects, including defunct satellites, spent rocket stages, and other man-made objects, which are in orbit around the Earth and pose a risk to operational spacecraft and astronauts.
- **Kessler Syndrome:** It is a theoretical scenario in which a cascade of collisions between artificial objects in low Earth orbit leads to a rapidly increasing amount of space debris, making the use of near-Earth space impossible for a period of time.
- The scenario was proposed by Donald J. Kessler in 1978 and is considered a major concern for the long-term sustainability of human activities in space.
- The potential for a Kessler Syndrome event underscores the significance of efforts to reduce the generation of space debris and to mitigate its impact on the operational space environment.

Important Missions on Removing Space Debris

- **RemoveDebris:** This is the European Space Agency's debris removal demonstration mission in the **low Earth orbit (LEO)** which aims to test and validate multiple active debris removal technologies.
- **e.Deorbit:** It is an European Commission led mission which aims to demonstrate the feasibility of capturing and deorbiting a non-functional satellite using a net and a harpoon.
- **Debris Elimination and Reentry: NASA's Debris Elimination and Reentry (DER) program** aims to reduce the threat of re-entering debris and mitigate the growth of space debris.
- **Space Debris Mitigation Guidelines of the Inter-Agency Space Debris Coordination Committee (IADC):** IADC's guidelines provide a set of best practices for deducting the generation of space debris and mitigating the impact of existing debris on operational spacecraft and infrastructure.
- **Space Debris Capture Experiment:** It is Japanese Aerospace Exploration Agency (JAXA)'s experiment to demonstrate the feasibility of capturing space debris using a device mounted on a spacecraft and also to study the characteristics of space debris.
- **Cleanup Mission:** It is China National Space Administration's (CNSA) to demonstrate the feasibility of cleaning up space debris using a combination of active as well as passive methods.
- **Space Debris Removal System (SDRS):** This is a proposed mission by the Russian Space Agency (Roscosmos) to demonstrate the feasibility of removing space debris from low Earth orbit.

Challenges of Space Debris

- **Tracking and Monitoring:** Space debris moves at high speeds and can be as small as a few millimeters, also making it difficult to accurately track and monitor.
- **Removing Debris:** Removing existing debris from orbit is technically challenging and expensive, and there are legal and political obstacles to overcome.
- **Avoiding Collisions:** Operational satellites and spacecraft must be programmed to avoid potential collisions with debris, which raises the risk of mission failure.

- **Predicting Debris Behaviour:** It is also difficult to predict the behavior of space debris, especially in the event of a collision or other disturbance.
- **Controlling the Growth of Debris:** New debris is constantly being created from failed launches, satellite break-ups, and other events. Preventing the increase of debris requires international cooperation and strict regulations.
- **Protecting Human Spaceflight:** Space debris can pose a threat to human spaceflight and astronauts, as even small pieces of debris can cause crucial damage to spacecraft.
- **Balancing Economic and Political Interests:** The issue of space debris increases important economic and political questions, such as how to allocate the costs of removing debris and who should be responsible for its removal.

Need for removing space debris

- **Protecting Active Satellites:** Removing space debris will reduce the risk of collisions with operational satellites, protecting them from damage and ensuring their continued functionality.
- **Ensuring Safe Human Spaceflight:** Space debris removal will create a safer environment for human spaceflight, removing the risk of collision and damage to spacecraft.
- **Maintaining the Use of Outer Space:** By removing space debris, the use of outer space for scientific, commercial, and military purposes, can be maintained ensuring its continued sustainability.
- **Protecting the Space Environment:** Removing space debris will also help to prevent the long-term impacts on the space environment, reducing the potential for a “debris belt” that could limit future missions.
- **Cost-Effective:** Removing space debris is more cost-effective as compared to constantly avoiding collisions and repairing or replacing damaged satellites.
- **Compliance with International Regulations:** The need for removing space debris is recognized by international agreements, like the Outer Space Treaty, that requires the responsible use of outer space and the prevention of harmful interference with other nations’ activities in space.

Way Ahead

- In summary, the problem of space debris highlights the need for continued efforts to mitigate and prevent the growth of debris in orbit to ensure the sustainability and safe use of outer space for future generations.
- The need to remove space debris is important for the continued safe and sustainable use of outer space.
- Also efforts to remove debris should be a priority for the international community to ensure the continued growth and exploration of space.