ONLY COMPETITION IAS

DAILY Editorials & Articles

Only Competition

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ONLY COMPETITION IAS

Compete, Learn, Grow

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UPSC 360°

The Hindu Unwrapped - Daily Current Affairs Mastery for UPSC CSE (Clear that it's based on The Hindu editorials / news analyses - very aspirant-friendly)

Significance

The growing congestion of Earth's orbits highlights the urgent need for robust global space governance. Without effective regulation, space debris threatens satellites, communication systems, and future missions. Strengthening international cooperation, enforcing accountability, and adopting sustainable practices are essential to ensure long-term usability, security, and equitable access to outer space resources.

Growing Threat of Space Debris: Challenges and Governance Issues

Introduction

- The rapid expansion of space activities has led to increasing concerns about **space debris (orbital junk)**.
- With the commercialization of space and rising satellite launches, Earth's orbital environment is becoming congested, posing serious risks to operational satellites, space missions, and global communication systems.

What is Space Debris?

Space debris refers to **defunct satellites, spent rocket stages, and fragments from collisions or explosions** orbiting the Earth at high speeds.

Key Characteristics:

- Travels at speeds up to **28,000 km/h**
- Even tiny fragments can cause severe damage
- Mostly concentrated in **Low Earth Orbit (LEO)**

Causes of Space Debris

1. **Satellite Collisions**
   - Accidental collisions create thousands of fragments
   - Example: Iridium-Cosmos collision (2009)
2. **Anti-Satellite (ASAT) Tests**
   - Destruction of satellites generates long-lasting debris
3. **Explosion of Rocket Stages**
   - Leftover fuel causes explosions in orbit
4. **Increasing Satellite Constellations**
   - Mega constellations (e.g., Starlink) increase congestion

Major Risks and Impacts

1. **Threat to Active Satellites**
   - Even small debris can disable communication or navigation satellites
2. **Kessler Syndrome**
   - Chain reaction of collisions leading to exponential debris growth
3. **Impact on Space Missions**
   - Risks to astronauts and spacecraft safety
4. **Economic Consequences**
   - Disruption in:
     - GPS services
     - Weather forecasting
     - Telecommunication networks
5. **Military and Strategic Risks**
   - Space assets are crucial for defense operations

Governance Challenges

1. **Lack of Binding International Laws**
   - Existing frameworks are mostly **voluntary guidelines**
2. **Difficulty in Tracking**
   - Millions of small debris pieces are untraceable
3. **Shared Global Commons**
   - Outer space is not owned by any country → coordination challenges
4. **Commercialization of Space**
   - Private players increasing rapidly, but regulation is weak

Global Efforts

1. **UN Guidelines**
   - UN Committee on Peaceful Uses of Outer Space (COPUOS) guidelines
2. **Space Agencies' Measures**
   - NASA, ESA focusing on:
     - Debris mitigation
     - Safe disposal
3. **Technological Solutions**
   - Active Debris Removal (ADR)
   - De-orbiting satellites after mission completion

India's Position

- ISRO follows **debris mitigation practices**
- After Mission Shakti (ASAT test), India emphasized:
  - Responsible behavior in space
  - Short-lived debris strategy

Way Forward

1. **Strong International Framework**
   - Binding treaties for debris control
2. **Space Traffic Management**
   - Global coordination for satellite movement
3. **Responsible Launch Practices**
   - Limit unnecessary launches
   - Ensure end-of-life disposal
4. **Innovation in Debris Removal**
   - Investment in clean-up technologies
5. **Regulation of Private Sector**
   - Strict compliance norms for commercial players

Conclusion

Space debris represents a growing threat to the sustainability of outer space activities. As dependence on space-based infrastructure increases, ensuring a **clean and secure orbital environment** is essential. Global cooperation, technological innovation, and robust governance frameworks are critical to prevent irreversible damage to the space ecosystem.

MCQs

1. Space debris is primarily concentrated in which orbital region?

(a) Geostationary Orbit

(b) Low Earth Orbit (LEO)

(c) Medium Earth Orbit

(d) Lagrange Points

Answer: (b)

2. With reference to space debris, consider the following statements:

    1. It travels at speeds up to 28,000 km/h.
    2. Kessler Syndrome refers to a cascading chain reaction of collisions.

Which of the statements given above is/are correct?

(a) 1 only

(b) 2 only

(c) Both 1 and 2

(d) Neither

Answer: (c)

3. Which of the following is NOT a major cause of space debris?

    (a) Satellite collisions

    (b) ASAT tests

    (c) Rocket stage explosions

    (d) Solar flares

Answer: (d)

4. Mission Shakti, conducted by India in 2019, was:

(a) A crewed lunar mission

(b) An anti-satellite (ASAT) test

(c) A Mars orbiter mission

(d) A space station module launch

Answer: (b)

Mains Questions

1. "The growing threat of space debris poses serious risks to the sustainable use of outer space." Discuss the causes, impacts, and governance challenges associated with space debris. (15 marks / 250 words)

2. Examine India's approach to responsible space behaviour in the context of its ASAT test and debris mitigation efforts. (10 marks / 150 words)
3. "International cooperation is essential to prevent Kessler Syndrome and ensure long-term space sustainability." Analyse the current global efforts and suggest a way forward. (15 marks / 250 words)
4. **Essay (250 marks)** "Orbital Congestion and the Future of Space: Balancing Exploration, Commercialisation and Sustainability."