GLOBAL CATASTROPHIC RISKS 2026 – RISK 5

Near Earth Asteroids

Near-Earth objects (NEO) pose a rare but potentially catastrophic threat, ranging from local destruction to global climate disruption. Although detection and tracking capabilities have improved dramatically, vast numbers of smaller asteroids remain unknown. Understanding these risks, and the governance systems designed to prevent impacts, is essential for strengthening planetary defence and global preparedness.

What is the risk?

NEOs, asteroids and the occasional comet, are objects that travel close enough to Earth's orbit to warrant constant attention. Since the 1990s, astronomers have discovered over 39,000 of them, including more than 11,000 that are larger than 140 metres across. The largest recorded impact, the Tunguska event in 1908, is believed to have been an impactor in the lower end of this size range. It exploded in the atmosphere above the sparsely inhabited East Siberian taiga flattening trees over an area of 2,000 km^2, roughly the size of greater London.

An asteroid the size of a football field, approximately 100 metres, carries the energy of several thousand Hiroshima bombs. The chance of one striking Earth in any given year is extremely small, but not zero. Smaller asteroid impacts are expected to have an average frequency of roughly one per 1,000 years.

There are an estimated 300,000 small asteroids, making these the more likely, near-term threat. When it comes to larger asteroids, larger than 1 kilometre in diameter, scientists estimate that they have discovered and identified more than 96 per cent of the existing large asteroids, 878 individuals to date[1].

What is at stake?

Various sizes of asteroids would have various degrees of impacts, if they were to hit earth.

- **Asteroids >1 km** could alter global climate and threaten civilisation itself.
- **Asteroids 140 m–1 km** would devastate a region or continent, killing millions.
- **Asteroids 50–140 m** could destroy a city if it struck land.
- **Asteroids 20–50 m** usually explode in the atmosphere but can shatter windows and injure people. For example, the Chelyabinsk meteor that struck the Ural region of Russia in 2013.

The *Global Catastrophic Risks Report* by the Global Challenges Foundation is a publication that analyses the greatest threats to humanity's future. The purpose of the report is to raise awareness of these dangers and to encourage international cooperation to prevent them. It also highlights the need for stronger global institutions and innovative governance models to effectively address these complex challenges.

Read the full report here.

What are key factors affecting risk levels?

Three things decide how dangerous an asteroid is:

1. Impact probability — how likely it is to cross Earth's path.
2. Size and makeup — rock, metal or rubble determines how it behaves in the atmosphere.
3. Where it hits — ocean, desert or city.

When an asteroid is identified, astronomers work on defining the orbit, size and composition. This helps determine the impact corridor, the areas on Earth where the impact is most likely to occur. The impact location and potential severity of damage will determine the risk level and the required governmental response, either in terms of disaster preparedness or potential asteroid deflection attempts.

What is being done in global governance to mitigate this risk and where are there gaps?

The United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) and the United Nations Office for Outer Space Affairs (UNOOSA) — the UN entity with a dedicated mandate to advance the peaceful uses of outer space and democratise access to space and its benefits — coordinate international cooperation in space safety and sustainability. To strengthen global preparedness for NEO threats, COPUOS established two specialised agencies: International Asteroid Warning Network (IAWN) and Space Mission Planning Advisory Group (SMPAG). Together, these entities enable the detection, tracking and impact risk assessment of NEOs and support planetary defence measures, such as asteroid deflection. Collectively, these mechanisms make an asteroid impact the only natural disaster humanity has the capability to prevent — if action is taken in time.

- **IAWN** shares global observation data and issues early warnings. The IAWN links together the institutions that are already performing many vital functions, including: discovering, monitoring and physically characterising the potentially hazardous NEO population. One of its purposes is to maintain an internationally recognised clearing house for the receipt, acknowledgement and processing of all NEO observations.
- **SMPAG** is composed of member states with space agencies or intergovernmental entities that coordinate and fund space activities and are capable of contributing to or carrying out a space-based NEO mitigation campaign. SMPAG has 20 members and six observers, as of October 2025, with UNOOSA acting as its secretariat[2].

UNOOSA plays a pivotal role in fostering global cooperation and transparency in space activities, recognising the critical importance of timely and accurate information-sharing in the event of a potential asteroid threat. Should IAWN detect a credible impact threat, it is mandated to provide and disseminate relevant information through UNOOSA to all UN member states.[1] This mechanism ensures that every country — including developing nations with limited technical capacity to track or assess NEO hazards — has timely access to critical data and warnings. Such coordination directly advances the UN General Assembly's annual resolution on international cooperation in the peaceful uses of outer space.[2]

In the event of a credible impact threat, warnings are issued by IAWN if the object is assessed to be larger than 10 metres. If the object is larger than 50 metres and the impact probability is larger than 1 per cent within the next 50 years, SMPAG would start to assess in-space mitigation options and implementation plans for consideration by the member states. With vigilance and sufficient warning, an asteroid impact is a devastating natural disaster that can be prevented.

[1] Discovery Statistics, NASA Center for Near Earth Object Studies https://cneos.jpl.nasa.gov/stats/totals.html

[2] List of SMPAG Members as of 09 Oct 2025. https://www.cosmos.esa.int/web/smpag/smpag_members

RISK 5

Protecting Earth from the asteroid impact hazard

The case of the 2024 YR4 asteroid and international collaboration

BY ROMANA KOFLER

High-impact, low-probability (HILP) events like asteroid threats test global readiness and the strength of international cooperation. The discovery of asteroid 2024 YR4 in 2025 underscored the vital role of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), United Nations Office for Outer Space Affairs (UNOOSA) and global warning networks in coordinating information, guiding planetary-defence efforts and protecting humanity through peaceful uses of outer space.

Global challenges and the space agenda

HILP events are rare but potentially catastrophic occurrences that can have lasting global consequences. The global community is still struggling to overcome the multifaceted challenges of one event, the COVID-19 pandemic, which brought about tremendous loss of life, economic downturns, social disruption and long-term health impacts. Another, perhaps less obvious, HILP scenario that could affect humanity is the impact of a near-Earth object (NEO), such as an asteroid colliding with Earth.

In early 2025, the international community was confronted with precisely such a possibility. When the asteroid 2024 YR4 was identified, initial observations indicated a small but non-negligible probability of impact with Earth in December 2032.

This development served as a real-time assessment of global preparedness. It underscored the importance of the international frameworks, established under the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) and the role of the United Nations Office for Outer Space Affairs (UNOOSA) in facilitating co-operation, information-sharing and collective action in response to potential asteroid impact hazards.

Space plays a critical role as an enabler in addressing global challenges, protecting both people and our planet Earth.

2024 YR4 asteroid: The first ever real-case for international community

At the start of 2025, UNOOSA was notified of a possible impact of the asteroid designated 2024 YR4 on Earth on Dec. 22, 2032. This was shortly after the Asteroid Terrestrial Last Alert System (ATLAS) station of the University of Hawai'i in Chile first reported a potentially hazardous asteroid 2024 YR4 on Dec. 27, 2024 during near-Earth asteroid search operations for NASA. The worldwide network of observatories of the International Asteroid Warning Network (IAWN) subsequently mobilised teams of astronomers across the globe to conduct follow-up observations, inviting them to submit observations to the Minor Planet Centre, a hub for collecting, verifying and disseminating data on the positions, motions and discoveries of asteroids, comets,

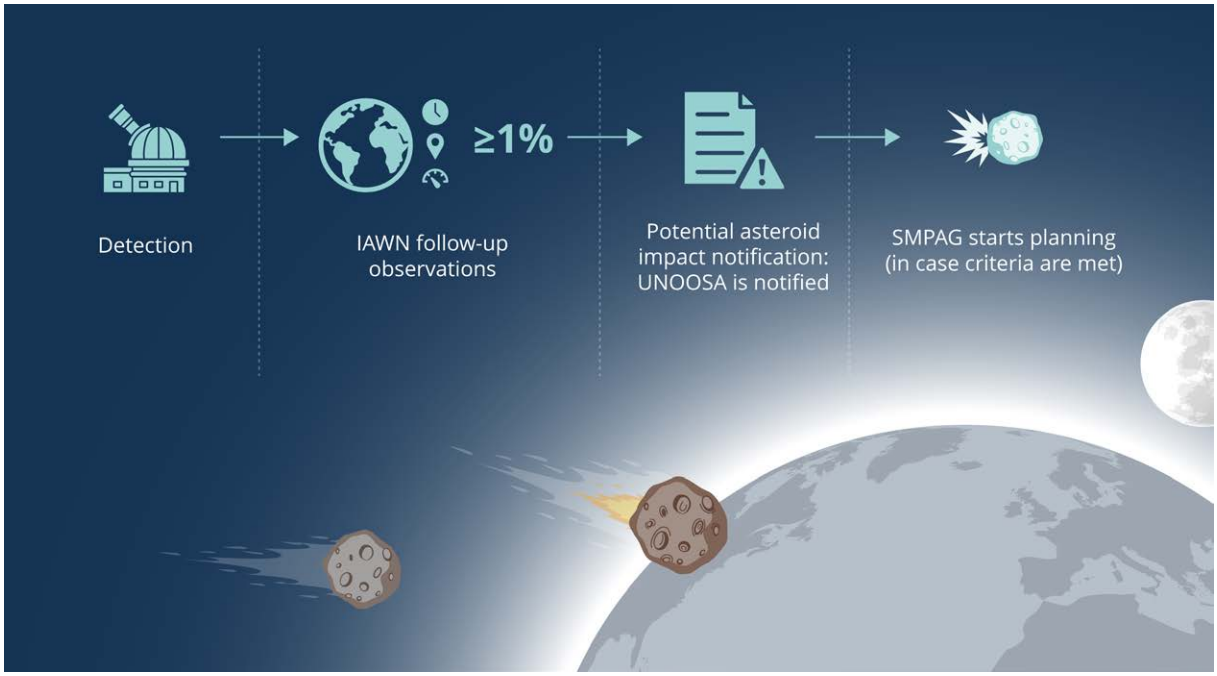
and other small solar system bodies. What followed within days were impact probability calculations, independently verified by multiple authoritative sources, including the three IAWN orbit computation centres: NASA's Jet Propulsion Laboratory Center for Near-Earth Object Studies, the European Space Agency (ESA)'s Near-Earth Objects Coordination Centre and the NEO Dynamic Site.

On Jan. 29, 2025, the day UNOOSA received notification by IAWN of 2024 YR4's potential impact, the impact probability was 1.3 per cent. While low, this exceeded the 1 per cent notification threshold that triggers international warning protocols.[1] For the first time since the adoption of the UN Resolution 70/82 *International cooperation in the peaceful uses of outer space* in 2015, that an asteroid met the minimum reporting criteria, prompting UNOOSA to issue a formal notification to all UN Member States.

At the same time, the Space Mission Planning Advisory Group (SMPAG) — for which UNOOSA serves as secretariat — was also informed. SMPAG brings together 20 space agencies with specialised expertise in planetary defence. It provides coordinated advice on possible deflection or mitigation options when an asteroid exceeding 50 metres in diameter is assessed to have an impact probability greater than 1 per cent within a 50-year timeframe. While SMPAG regularly tests its capabilities on hypothetical cases of asteroid threat scenarios, the 2024 YR4 asteroid provided a real-world test of international response coordination mechanisms for planetary defence.

> **"This was a pivotal moment for the United Nations and for international cooperation in space. It was the first real-time test of our planetary defence protocols, and it showed that preparedness depends not just on technology, but on trust, transparency, and global coordination.**
>
> – **Aarti Holla-Maini**, Director of UNOOSA

The SMPAG Steering Committee reviewed the available data and the warning timeline for 2024 YR4. During meetings in late January and early February 2025, SMPAG concluded that while the probability met the group's thresholds for monitoring, it was too early for specific mission planning. Therefore, SMPAG continued



to closely monitor changes in the impact probability and size estimates.[2]

At the time of the initial notification, the asteroid was estimated to be between 40 and 90 metres in size, with the impact risk corridor estimated to extend across the eastern Pacific Ocean, northern South America, the Atlantic Ocean, Africa, the Arabian Sea and South Asia. Further observations by the James Webb Space Telescope in March 2025 resulted in a revised estimate for 2024 YR4's diameter to be 60 ± 7 metres. If an impact with an asteroid of this size were to occur, it could cause severe blast damage extending up to an 80-kilometre radius from the impact site. Because of its size and speed, an impact with Earth would release energy comparable to 2–30 megatons of TNT — about a thousand times the power of the Hiroshima bomb.[3]

While the probability remained extremely low, the situation warranted continuous attention and monitoring. The visibility period for 2024 YR4 would last through early April 2025, after which the asteroid would become too faint to be observable from Earth until 2028. UNOOSA maintained regular communication with IAWN on the asteroid's trajectory and impact probability, ensuring timely situational awareness to support any required policy or coordination efforts.

The asteroid reached a peak probability of impact with Earth of 3.1 per cent, before eventually dropping to 0.004 per cent (1 chance in 26,000) on Feb. 24, 2025. Through IAWN's final notification, UNOOSA informed Member States that asteroid 2024 YR4 poses no significant risk of impact with Earth over the next century. IAWN will continue tracking the asteroid to refine estimates of its close approach on Dec. 22, 2032, currently projected to pass safely beyond geosynchronous orbit and possibly even beyond the Moon.

How prepared are we? From risk to resilience: Strengthening global preparedness through the peaceful uses of outer space

The international community has shown that deflecting an asteroid is not only theoretically possible, but also technologically achievable. In 2022, in the first-ever planetary defence technology demonstration mission, NASA's Double Asteroid Redirection Test, became the first to successfully alter the movement of a natural celestial body. The mission targeted the asteroid Dimorphos, a small moonlet orbiting the larger asteroid Didymos. Using a kinetic impact deflection technique, the mission demonstrated that Dimorphos's orbital period around Didymos was reduced by approximately 33 minutes. These measurements have drawn on global expertise, using Earth-based telescopes to assess the mission's outcomes and inform planning for future planetary defence efforts. This technique could one day be applied to help prevent a potential asteroid impact with Earth.

Confronting the hazard posed by NEOs involves a multifaceted effort: identifying asteroids that could impact our planet, assessing potential risks and developing mitigation strategies to prevent or minimise damage. Such endeavours cannot be undertaken in isolation. They demand a united response from the global community — a demonstration of solidarity and shared responsibility in safeguarding humanity.

2029: International Year of Asteroid Awareness and Planetary Defence

In 2024, the UN General Assembly proclaimed 2029 as the International Year of Asteroid Awareness and Planetary Defence[4], marking it with an extraordinary astronomical event. On April 13, 2029, the asteroid 99942 Apophis will make an exceptionally close — yet safe — approach to Earth, passing at a distance of about 32,000 kilometres, within the orbit of many geostationary satellites. This rare event will offer

> **"Planetary defence is not science fiction — it is a shared responsibility. The risks are real, but so is our collective capacity to act. UNOOSA is committed to ensuring that every country, regardless of its size or resources, has both.**
>
> **– Aarti Holla-Maini,**
> Director of UNOOSA

a spectacular sight, as Apophis becomes visible to billions of people with the naked eye under clear night skies.

While the asteroid poses no threat of impact, its close passage presents an unprecedented scientific opportunity and a powerful reminder of the importance of global preparedness. Building on this once-in-a-millennium event, the International Year will act as a catalyst for international co-operation, education and public engagement on planetary defence — aiming to inspire humanity to deepen its understanding of near-Earth objects and to safeguard our shared cosmic environment.

UNOOSA is entrusted with ensuring that this global initiative is carried out in close collaboration with UN Member States, space agencies, entities of the United Nations system, and relevant international and regional organisations, as well as other key stakeholders from the scientific and academic communities.

The close approach of Apophis provides a rare and compelling opportunity for space agencies, research institutions and private entities to send missions to a near-Earth asteroid. These missions could advance science, test new technologies or demonstrate capabilities for planetary defence. The International Year aims not only raise awareness of asteroid-related risks and opportunities but also strengthen global capacity in planetary defence, space science and sustainable space governance. It is a reminder that humanity's greatest achievements in space — such as protecting our planet — depend on collaboration, trust and the shared pursuit of knowledge that transcends borders for the benefit of all.

References

[1] IAWN and SMPAG criteria and thresholds for impact response actions, see document A/AC.105/C.1/2017/CRP.25*. https://www.unoosa.org/res/oosadoc/data/documents/2017/aac_105c_12017crp/aac_105c_12017crp_25_0_html/AC105_C1_2017_CRP25E.pdf

[2] See SMPAG Statements on "2024 YR4" at smpag.net

[3] IAWN notification to UNOOSA (29 January 2025, see iawn.net) and JWST Observations of Potentially Hazardous Asteroid 2024 YR4," A. S. Rivkin et al 2025 *Res. Notes AAS*

[4] International Year of Asteroid Awareness and Planetary Defence, 2029; General Assembly Resolution 79/86, see https://www.un.org/en/observances/asteroid-awareness-year

About the author

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