Global Challenges Foundation

Asteroid impact

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What is at stake?

The largest near-Earth asteroids (> 1 km diameter) have the potential to cause geologic and climate effects on a global scale, disrupting human civilization, and perhaps even resulting in extinction of the species. Smaller NEOs in the 140 meter to 1 km size range could cause regional up to continental devastation, potentially killing hundreds of millions. Impactors in the 50 to 140-meter diameter range are a local threat if they hit in a populated region and have the potential to destroy city-sized areas. NEOs in the 20 to 50 meter diameter range are generally disintegrated in Earth's atmosphere but even an airburst can cause localized blast and impact effects.

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How much do we know?

Surveys of the NEO population on-going since the 1990s have discovered almost 29,000 NEOs of all sizes as of May 2022. A new record 3087 NEOs of all sizes were discovered in 2021. It is believed that the current surveys have discovered more than 96% of the population of NEOs larger than 1 km in diameter – 878 individual asteroids. In the United States, NASA's Planetary Defense Program has a Congressionally directed objective to discover at least 90% of potentially hazardous asteroids 140 meters and larger in size. As of 19 May 2022, 10,081 NEOs larger than 140 meters have been discovered. This is estimated to be approximately 40% of the total population of NEOs this size or larger.

Smaller asteroids are also continually being discovered, with the reservoir of NEOs with diameters between 50 and 140 meters expected to be approximately 300,000, making these the more likely impact threat in the near term. Impactors of these sizes are expected to have an average frequency of one per ~1000 years. The Tunguska event (1908) is believed to have been an impactor in the lower end of this size range. The total number of NEOs larger than 10 meters could be as high as 50-100 Million.

What are key factors affecting risk levels?

The assessment of the risk presented by a NEO is related to the probability of impact with Earth, the size and composition of the asteroid, and where on Earth the impact occurs. Beyond discovery of NEOs, the risk assessment for a NEO with the potential to impact Earth requires an observational assessment programme to refine knowledge of the orbit and to characterize the size and composition of the asteroid. This could include specialized ground and space based observations, or a spacecraft reconnaissance mission to the asteroid. Accurate orbital knowledge is required to establish the "impact corridor" – the areas on Earth where, given uncertainties in the orbital knowledge, 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.

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The recent sample return missions to the asteroids Ryugu (Hayabusa2) and Bennu (OSIRESREx) contribute considerably to our knowledge of these NEOs. Hayabusa2 returned in December 2020 5.44 g from Ryugu to Earth. The main objectives of these missions were scientific, but the characterisation of natural parameters of these objects is also important for planning of potential future Planetary Defence missions.

On 11 March 2022 the small asteroid 2022 EB5 impacted Earth over the North Atlantic Ocean. This object, which is only 1-3 meters in size, was discovered in space a few hours before impact. It was the 5th object that has been discovered in space by the surveys before an actual impact.

In the event of a credible impact threat prediction, warnings will be issued by the IAWN if the object is assessed to be larger than 10 meters in size. If the object is larger than about 50 meters and the impact probability is larger than 1% within the next 50 years, the 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.

Launch of the first-ever planetary defence technology demonstration mission

The year 2021 witnessed the launch of the first ever planetary defence technology demonstration mission, the Double Asteroid Redirection Test (DART) by NASA in November 2021, which will demonstrate the kinetic impact deflection technique. DART will impact Dimorphos, the small 160-meter companion of the 780-meter large Didymos, in late September 2022.

It will test the capabilities to deflect an asteroid by a high velocity impact of the spacecraft. A few years later ESA will launch the HERA spacecraft to study the impact effects in detail. If successful, these missions will demonstrate that an impact can be avoided by active measures if the object is discovered several years in advance of the potential impact.
SMPAG has started to perform exercises to test its capabilities and coordination in case of realistic impact threats.

These hypothetical exercises are aimed at clarifying the working procedure, form of recommendations and flow of information among SMPAG members with the main goal to define appropriate advice on planetary defence measures, like civil protection or asteroid deflection for decision-makers. The hypothetical exercises will also help identify missing technologies and other potential deficiencies in the field of space based NEO mitigation.