> ASTEROID MONITORING AND IMPACT MITIGATION IS SWIFTLY MOVING FROM THE REALMS OF SCIENCE FICTION TO REALITY

FROM THE EDITOR'S DESK:

Planetary defence

Early morning on June 30th 1908, a column of blue light glowed in the sky above the remote Tunguska region of Siberia. Minutes later, a huge explosion and shock wave flattened over 2,000 square kilometres of forest, knocked people from their feet and shattered windows in villages tens of kilometres away. Although no impact crater has ever been found, the mysterious event is attributed to the mid-air explosion of a meteor, potentially 40-190 metres across, making Tunguska the largest cosmic impact event ever witnessed by humans.

Thousands of meteors intersect our planet's orbital path every year. Most burn up in the atmosphere before reaching Earth's surface. Rarely, such as during the Great Meteor Procession of 1860 (see page 18), meteors merely graze the Earth, passing straight through the atmosphere to re-enter space. Others, like Tunguska, are more damaging—whether they reach the ground or not. In February 2013, a 20-metre-wide meteor tore apart in the skies above Chelyabinsk, Russia. The shock wave smashed windows and damaged over 7,000 buildings, injuring around 1,500 people.

Earth's surface is littered with the scars of many damaging asteroid impacts. The most famous, the Chicxulub Crater buried beneath the Yucatan Peninsula, Mexico, is thought to have been created by an asteroid impact ~66 million years ago that drove the extinction of the dinosaurs. The best preserved is the Barringer or Meteor Crater in Arizona, created just 50,000 years ago. And one recently discovered is a 1.2-billion-year old impact crater in northwest Scotland—though its precise location is debated (Amor *et al. J.GSL* 2019; Simms & Ernstson, *J.GSL* 2019).

Given our vulnerability, space agencies across the globe are monitoring our skies—with increasing success. In the early hours of June 22, telescopes at the University of Hawaii detected a small asteroid before it entered Earth's atmosphere. About 12 hours later, a meteor (subsequently determined to be the same object) burned up in the sky above the Caribbean Sea. The event is significant because it marks the first time that astronomers have tracked an asteroid with sufficient lead-in time to issue a warning.

Of course, simply tracking near-Earth objects with the aim of evacuating potential impact sites is insufficient—we must actively mitigate those impacts that are likely to be devastating. To this end, numerous techniques have been proposed, with most aiming to alter the trajectory of an asteroid that is on a collision course with Earth.

One of the more mature proposals is the joint NASA and ESA Asteroid Impact and Deflection Assessment (AIDA) mission. The mission's target is the binary system Didymos, composed of the asteroid Didymead and its satellite, Didymoon, which will pass close to Earth in 2022. During the approach, NASA aims to crash a spacecraft, the Double Asteroid Redirection Test (DART), into Didymoon to alter its trajectory. Three years later, ESA will send a follow-up craft, Hera, to carry out a post-mortem examination.

This may sound like something from a Hollywood movie, but, if successful, this ambitious mission will demonstrate the viability of asteroid deflection as a planetary defence technique, should we ever need to safeguard our world. Science fiction, it seems, is rapidly becoming science fact.

Meteor crater, Arizona

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