



FACT SHEET

Protecting Earth from Near Earth Objects

Updated June 17, 2009

www.SecureWorldFoundation.com

A free service of Secure World Foundation

TERMS

NEO: Near Earth Asteroids (NEAs) and Near Earth Comets (NECs) whose orbits bring them close to Earth or cross Earth's orbit.

Potentially Hazardous Objects (PHOs): NEOs with a relatively high potential for impacting the Earth.

Potentially Hazardous Asteroid (PHA): A PHO with an orbit that comes within 0.05 astronomical units* of Earth's orbit. There are over 1,000 of these currently known; 200 of these present a non-zero impact risk to Earth.

Introduction

Since the discovery of the Chicxulub crater and its likely association with a mass extinction event 65 million years ago, scientists have discovered more and more evidence that celestial objects have a history of impacting the Earth and affecting its inhabitants. Over the past decade a growing amount of research started to identify the types of objects that pose threats to Earth and potential mitigation strategies. This page generally describes what near Earth objects (NEOs) are; the next page addresses efforts to deal with potentially hazardous ones.

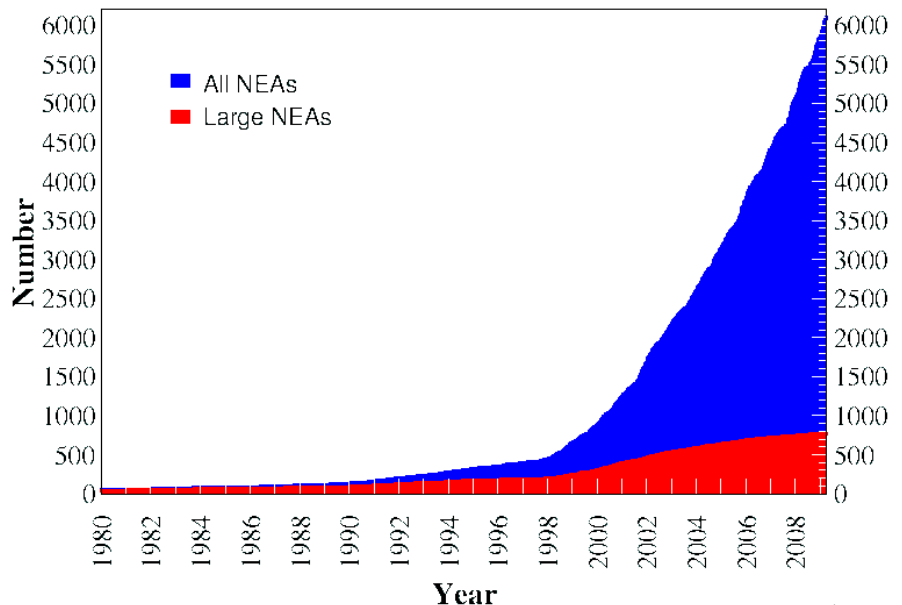
What are NEOs?

NEOs are asteroids and comets whose orbits bring them in proximity to the Earth or intersect the Earth's orbit. NEOs are subdivided into Near Earth Asteroids (NEAs) and Near Earth Comets (NECs). Potentially Hazardous Objects (PHOs) include both NEAs and NECs whose orbits intersect that of Earth's and have a relatively high potential of impacting the Earth itself. As comets represent a very small portion of the overall collision threat in terms of probability, most NEO researchers commonly focus on Potentially Hazardous Asteroids, or PHAs. PHAs are asteroids with orbits that come within 0.05 astronomical units* (6.5 million kilometers) of the Earth's orbit and have a brightness magnitude greater than 22 (equal to about 150 meters in diameter). There are over 1,000 known PHAs. Over two hundred of these currently present a non-zero impact risk to the Earth. This number is expected to jump to tens of thousands in the next 15 years as more of the population is discovered, almost guaranteeing some amount of international decision-making on those objects which present a threat.

Original efforts to find threatening NEOs focused on a so-called "planet-killer" class which are NEOs with a diameter of one kilometer or larger. In 1998, [NASA](#) undertook a survey to discover 90 percent of these objects by 2008. Of the estimated 1,100 objects in this class, NASA is currently tracking 746, or just under 80 percent. In 2003, a NASA Science Definition Team published a [report](#) that recommended the search be extended to include all NEOs down to 140 meters in diameter.³ Impacts of this class of objects are not "planet killers" but would cause massive regional devastation. Discovery of these objects, along with the one-kilometer and larger objects would identify 90 percent of the risk the Earth faces, leaving only the highly unpredictable long period comets as an unknown risk. Future surveys are currently unfunded but plan to utilize new instruments like the [Pan-STARRS](#) and [Large Synoptic Sky Survey](#) (LSST) telescopes. Other efforts to identify NEOs include Canada's [Near Earth Object Surveillance Satellite](#) (NEOsats), which will be the first space-based telescope designed to find and track NEOs, planned for launch in 2010.

There is growing consensus that the greatest threat is not from very large asteroids that can destroy all life on Earth or even large regions, but rather those that have the potential to destroy cities. These are objects approximately 50 meters in diameter, similar to the object that caused the Tunguska explosion in Siberia in 1908. Researchers estimate that there are over 300,000 NEOs of this size, of which approximately three percent are estimated to pose an impact threat. The probability that these smaller objects will impact is much greater than larger objects, striking the Earth on average once every one hundred years as opposed to millions of years for a potential "planet killer".

The primary means of studying the composition of asteroids is through spectroscopy. This technique relies on the fact that each element absorbs different parts of the electromagnetic spectrum. By observing so-called "spectral lines", the surface composition can be inferred. Other techniques include looking at the albedo, or how much light is reflected from the object, and measuring pulses in this light or radar return, which can provide a spin rate. Researchers have discovered that asteroids come in three general types of varying density: carbonaceous chondrites, stony (or siliceous), and metallic. Most asteroids are likely to be loose piles of rubble, held together only by the gravitational attraction of individual pieces. Most asteroids rotate, with rates ranging from several hours to a few minutes per rotation.



* One astronomical unit equals the distance from the Earth to the Sun, or 150,000,000 kilometers (93,000,000 miles).

Known near Earth asteroids, distributed by size. Note the number of discoveries since 1998. Source: Alan B. Chamberlin, Jet Propulsion Laboratory (JPL), 2009.



FACT SHEET

Protecting Earth from Near Earth Objects

Dealing with the threat

Technical research and discussion is ongoing into ways of deflecting an impending NEO collision with the Earth. The goal is to change the object's orbit enough so that it intersects the projected collision point before or after the Earth. Deflection methods can be divided into two categories depending on how much warning time there is for the impact event.

- ◆ **Long lead time:** If the warning times are on the order of years or more, several constant thrust techniques could be used to gradually change the threatening object's orbit over time. For example, a gravitational tractor (conceived by physicist and former astronaut Dr. Ed Lu) uses the gravitational attraction between an asteroid and a nearby spacecraft to "tow" the asteroid into a different orbit.²
- ◆ **Short lead time:** If warning times are relatively short, then kinetic methods of deflection may be effective. These include repeated ramming the NEO with a series of projectiles or detonating a nuclear device close to the NEO. The detonation would cause surface material to superheat and ablate away from the asteroid, thereby pushing it in the opposite direction. In a [2007 report NASA](#) concluded that this nuclear push option was the only currently feasible method, a conclusion that others refuted.³

If there is no warning or deflection is not a possibility, then the only course of action is mitigation which involves disaster preparedness, emergency response, and disaster recovery.

Policy and legal issues

There are many policy and legal issues surrounding potential NEO impacts. In almost every case for detection, warning and deflection, there will be an international context to the decision making. Any nation could be the impact point, but only a very few nations are likely to have the technology and capability to detect the incoming object or attempt a deflection. There may be considerable debate over which is the best deflection method to attempt and some potential options may be deemed politically undesirable. If a constant thrust deflection technique is used, there will be debate over which direction along the risk path the impact point is moved, especially if the deflection mission fails and results in a new, man-made impact location. Additionally, a deflected NEO could be left in a gravitational keyhole which would ensure its return as an impact threat at a later date.

At its core, dealing with an actual impact is not very different from a major natural disaster, such as the 2004 Indian Ocean Tsunami. However, unlike most other major natural disasters such as hurricanes or earthquakes, NEO impacts can occur anywhere and no one nation is more or less likely to be hit. Additionally, the amount of destruction can vary from localized to destruction of a city to regional devastation. All nations will need some level of disaster planning, management, and recovery, and in most cases it will be on a scope far beyond what they have dealt with in the past.

In the United Nations, the UN Committee on the Peaceful Use of Outer Space (COPUOS) formed Action Team 14 in 2001 to specifically deal with NEO-related issues as one of the UNISPACE III recommendations. In September 2008, the [Association of Space Explorers](#) (ASE) released a [major report](#) summarizing the results of a series of workshops that brought together experts from around the world in various disciplines to discuss governance issues related to mitigating asteroid collisions.⁴ The report outlined a series of steps that the United Nations and other bodies can undertake to start the process of determining how best to respond to this threat, and is currently being reviewed by AT14.

Within the United States, there was a major exercise held in the fall of 2008 to highlight some of the legal and policy issues. The workshop brought together 27 subject matter experts from across the US Government, including the military, State Department, NASA, national laboratories, national security, and homeland security. The scenario involved two impacting objects, a 270 meter "rubble pile" landing off the West African coast and a 50 meter metallic body impacting the National Capitol Region in the US. These two different elements were designed to pose as many challenges in deflection and mitigation to the players in as short a time as possible. The top recommendation following the exercise was that the NEO scenario was not captured in existing plans and that this needed to be corrected. All the participants strongly recommended that additional future exercises should be done and include more senior decision makers.



Original Projected Apophis 2036 Risk Path. Source: B612 Foundation.

Footnotes

1. *Study to Determine the Feasibility of Extending the Search for Near-Earth Objects to Smaller Limiting Diameters*, National Aeronautics and Space Administration, Report of the Near-Earth Object Science Definition Team, August 22, 2003. <http://neo.jpl.nasa.gov/neo/neoreport030825.pdf> (accessed June 4, 2009).
2. Lu, Ed and Stan Love. "Gravitational tractor for towing asteroids," *Nature*, Vol. 438, November 10, 2005.
3. *Near-Earth Object Survey and Deflection Analysis of Alternatives*, National Aeronautics and Space Administration, Report to Congress, March 2007.
4. *Asteroid Threats: A Call for Global Response*, Association of Space Explorers report, September 25, 2008.

