PLANETARY DEFENSE AND NEAR-EARTH OBJECTS. C. R. Chapman¹ and D. Morrison², ¹Southwest Research Inst. (Suite 300, 1050 Walnut St., Boulder CO 80302; cchapman@boulder.swri.edu), ²NASA Ames Research Center, Moffett Field CA.

The Spaceguard Survey has approximately met its goal of detecting 90% of Near-Earth Asteroids (NEAs) >1 km diameter, and it has also detected thousands of smaller NEAs. A very small NEA, 2008 TC3 (hereafter: TC3), discovered by the Catalina Sky Survey on 7 October 2008, was predicted to impact in Sudan ~20 hours later. Prior to impact, telescopic observations of physical properties (e.g. spectra, spin) were obtained. The impact was recorded and, during subsequent months, hundreds of meteorites (a rare type of ureilite) were collected beneath the atmospheric explosion. This is the first time that an NEA has been predicted to impact Earth and it has done so. While at ~4 m diameter it was not dangerous, exploding in the upper atmosphere, linkage of an NEA with recovered meteorites has been of great scientific value. TC3 was not a fluke, however. Current and future surveys (provided their protocols for searching, data processing, and reporting are optimized) should detect roughly half of all NEAs making final plunges to Earth, providing many hours to weeks of warning. Large search telescopes (LSST and Pan-STARRS) may eventually catalog 90% of NEAs as small as 140 m diameter, but we need not wait for their searches to begin to expect warnings of real impacts. Instead of numerous warnings of low-probability impact possibilities decades from now by 100-m-scale NEAs, we may now expect occasional warnings of certain impacts by NEAs meters to tens of meters in size with just hours to weeks of warning.

Realization of the power of existing telescopes to provide short-term warning modifies how we think about mitigating the dangers of NEA impacts. “Mitigation” used to mean deflection of a threatening NEA by a spacecraft mission (e.g. using a Gravity Tractor for a very small NEA or deflecting an even larger NEA from a “keyhole” to a later impact on Earth; using a Kinetic Impactor, or series of them, to deflect a small-to-moderate sized NEA from impacting Earth; or, as a last resort, using a Nuclear Device in the very unlikely case that a large, >1 km NEA must be deflected to prevent a civilization-threatening impact. While civil defense measures (e.g. warning and evacuation; response and recovery) have long been considered as elements of mitigation, if deflection is not possible or fails or if an impact happens without warning, the lesson of TC3 is that proactive civil defense (e.g. evacuation of ground zero) will be a much more likely scenario than long-term planning for a spacecraft deflection mission. This is because small, yet potentially dangerous NEAs (tens of m size) impact much more frequently than larger NEAs, and the existing and future search efforts have a good chance of predicting such an impact before it occurs...but generally with no time to mount a deflection mission.

Infrastructure that connects astronomers with the emergency management community is currently lacking, at both the national and international level. The National Research Council is scheduled to deliver its first-ever report on this topic to Congress at the end of 2009. Also, processes are underway within the United Nations COPUOS to establish international protocols and infrastructure for dealing with the NEO threat. Just a few months ago, what may have been the largest NEO to strike the Earth in the past 15 years caused an enormous explosion over the Indonesian coastline, and is reported to have indirectly caused the death of a child. As national and international bodies decide how to respond to such reports, activities, and natural events, there will be new opportunities to develop search, reporting, warning, and short- and long-term mitigation procedures that can protect people from the most likely threats from the cosmos.