# 1NC Frontline

## 1NC—Asteroids Impact Frontline

### No impact—too improbable or small to require preparation

Bennett 10 [James, Eminent Scholar and William P. Snavely Professor of Political Economy and Public Policy at George Mason University, and Director of The John M. Olin Institute for Employment Practice and Policy, “The Chicken Littles of Big Science; or, Here Come the Killer Asteroids!” THE DOOMSDAY LOBBY 2010, 139-185, DOI: 10.1007/978-1-4419-6685-8\_6]

The smallest falling bodies, those with diameters under a few meters, are of “no practical concern,” says Chapman, and in fact they are to be desired, at least by those who keep their eyes on the skies watching for brilliant fireballs whose burning up in the atmosphere provides a show far more spectacular than the most lavish Fourth of July fireworks. Even bodies with diameters of 10–30 meters, of which Chapman estimates six may fall to earth in a century, cause little more than broken windows. They explode too high in the atmosphere to cause serious harm. The next largest potential strikers of Earth are those in the Tunguska range of 30 meters–100 meters. The shock waves from the atmospheric explosion would “topple trees, wooden structures and ignit[e] fires within 10 kilometers,” writes Chapman. Human deaths could result if the explosion took place over a populated area. Though Chapman estimates the likelihood of a Tunguska occurring in any given century at four in ten, it is worth noting that there is no evidence that such an explosion has killed a single human being in all of recorded history. Either we’re overdue or that 40 percent is high. Moreover, given that the location of such an explosion is utterly unpredictable, it would be far more likely to happen over an ocean or a desert than over, say, Tokyo or Manhattan. The after effects would be minimal, and Chapman says that “nothing practical can be done about this modest hazard other than to clean up after the event.” In fact, “It makes no sense to plan ahead for such a modest disaster… other than educating the public about the possibility.” The cost of a telescopic survey capable of picking up bodies of such diminutive size would be prohibitive. It would be the ultimate Astronomers Full Employment Act. A body of 100 meters–300 meters in diameter would either explode at low altitude or upon impact with the ground; it would be “regionally devastating,” but Chapman pegs the chances of such a catastrophe at 1 percent per century. A small nation could be destroyed by the impact of a body of 300 meters—1 km in diameter, or a “flying mountain” of sorts, which would explode with energy yield ten times more than “the largest thermonuclear bomb ever tested.” If striking land, it would carve out a crater deeper than the Grand Canyon. If it hit a populated area, the death toll could be in the hundreds of thousands. The likelihood of such a collision Chapman estimates at 0.2 percent per century. An asteroid or comet of 1–3 kilometers in diameter would cause “major regional destruction,” possibly verging on “civilization-destruction level.” Chapman puts the chances of this at 0.02 percent per century. The impact of a body more than 3 kilometers in diameter might plunge the Earth into a new Dark Age, killing most of its inhabitants, though the chances of this are “extremely remote” — less than one in 50,000 per century. Finally, mass extinction would likely occur should a body greater than 10 kilometers pay us a visit, though the chances of this are less than one in a million every century, or so infinitesimal that even the most worry-wracked hypochondriac will not lose sleep over the possibility. In fact, for any impact with a Chapman-calculated likelihood of less than one in a thousand per century, he concedes that there is “little justification for mounting asteroid-specific mitigation measures.” The chance of a civilization-ender is so remote that he counsels no “advance preparations” — or almost none. For Chapman recommends further study of NEOs, as well as investigation into methods of their diversion. 82 This is exactly what the NEO lobby wants.

### Status quo solves—NASA is increasing surveys and detection now.

Wall 11 (Mike Wall, writer for Fox News, 6/3/11, [www.foxnews.com/scitech/2011/06/03/truck-sized-asteroid-has-close-encounter-with-earth/](http://www.foxnews.com/scitech/2011/06/03/truck-sized-asteroid-has-close-encounter-with-earth/)) AK

Of course, nobody on Earth wants to be caught unawares by an impending impact with a big, dangerous space rock. So NASA and other astronomers routinely scan the skies for asteroids or comets that may be an impact threat to Earth. NASA is also taking more active measures to learn about potentially troublesome space rocks. The agency recently announced, for example, that it's launching a sample-return mission called OSIRIS-Rex to the asteroid 1999 RQ36 in 2016. A probe will send pieces of the space rock home; they should reach Earth in 2023. Scientists think these samples will contain pristine organic compounds, carbon-based molecules that are the building blocks of life as we know it. Studying these asteroid bits could shed light on the possibility that life on Earth was seeded by an asteroid strike, as some researchers believe. However, 1999 RQ36 is also potentially dangerous, with about a 1-in-1,000 chance of striking Earth in 2182. That impact would likely not be trivial, since the asteroid is 1,900 feet wide (579 meters) — as big as six football fields. Studying 1999 RQ36 and its movements up-close could help scientists refine their understanding of its orbit. This information could help them get a better handle on the space rock's trajectory, and possibly understand how to mitigate or prevent a potential Earth impact, researchers said.

### No risk of nuclear option.

Mills 9 (Cynthia Mills, Freelance science writer, "THE ART OF ASTEROID DEFLECTION", 12/17/09, Discovery News, news.discovery.com/space/near-earth-asteroid-threat.html) AK

There's really nothing to worry about. These guys have got it handled. All they need is to convince Congress they need $500 million and the international community to agree on which direction to go to push a hurtling asteroid off its path of fiery Earth annihilation. These guys are a loose association of scientists, including a retired astronaut and many work for NASA's Jet Propulsion Laboratory. Together they study the risk of an Earth impact from an asteroid big enough to do damage, you know, like the one that caused all the dinosaurs to become extinct. Only they don't call it an "asteroid" -- instead they use a more general term: Near Earth Object (NEO). They concentrate on anything bigger than 140 meters across (but mostly worry about the ones at least a mile across) and traveling on a trajectory that brings them within 4.6 million miles of the earth. They're watching, calculating and ready to do something. These scientists have recruited observatories like Arecibo in Puerto Rico and telescopes in Hawaii and Arizona. They use radar, honed to resolutions down to less than 10 meters to precisely image the surfaces -- looking for places to land. Now, don't conjure up the movie Armageddon for this one; they're not talking exploding the asteroid or even using a nuclear device to deflect it. These are sensitive guys with a far gentler plan -- live and let the icy-rock-of-space-death live. Plus there is too big a chance the asteroid would just reassemble -- gravity bringing the pieces back together in space and continue on its merry way. They will, however, show you a simulation of the 15 square kilometer tower of fire that happens when an asteroid hits. And show you the piece of piece of asteroid-impact-melted-Libyan-desert that was carved into a scarab for King Tut. Instead, they propose to just nudge the errant little planetoid thing. Push it a little bit faster or perhaps a little head-on bump to just slow the thing down a bit -- essentially they want to play bumper cars with asteroids; just to persuade them not to hit the earth as a 200,000-megaton fireball plus cataclysmic shock wave. We're not talking about the puny atmospheric fireball like the one that leveled 800 square miles of trees in Tunguska, Siberia in 1908. That was just a little guy -- maybe 40 meters across.

### No existential risk—empirics.

**Bennett 10** (James, Professor of Economics – George Mason, The Doomsday Lobby: Hype and Panic from Sputniks, Martians, and Marauding Meteors, p. 144-145)

It should be noted that the Alvarez et al. hypothesis was not universally accepted. As Peter M. Sheehan and Dale A. Russell wrote in their paper “Faunal Change Following the Cretaceous–Tertiary Impact: Using Paleontological Data to Assess the Hazards of Impacts,” published in Hazards Due to Comets & Asteroids (1994), edited by Tom Gehrels, “many paleontologists resist accepting a cause and effect relationship” between the iridum evidence, the Chicxulub crater, and the mass extinction of 65 million years ago.15 For instance, Dennis V. Kent of the Lamont–Doherty Geological Observatory of Columbia University, writing in Science, disputed that a high concentration of iridium is necessarily “associated with an extraordinary extraterrestrial event” and that, moreover, “a large asteroid… is not likely to have had the dire consequences to life on the earth that they propose.”16 Briefly, Kent argues that the Alvarez team mistakenly chose the 1883 Krakatoa eruption as the standard from it extrapolated the effects of stratospheric material upon sunlight. Yet Krakatoa was too small a volcanic eruption from which to draw any such conclusions; better, says Kent, is the Toba caldera in Sumatra, remnant of an enormous eruption 75,000 years ago. (A caldera is the imprint left upon the earth from a volcanic eruption.) The volume of the Toba caldera is 400 times as great as that of Krakatoa – considerably closer to the effect that an asteroid impact might have. Yet the sunlight “attenuation factor [for Toba] is not nearly as large as the one postulated by Alvarez et al. for the asteroid impact.” Indeed, the Toba eruption is not associated with any mass extinctions, leading Kent to believe that “the cause of the massive extinctions is not closely related to a drastic reduction in sunlight alone.”17 Reporting in Science, Richard A. Kerr wrote that “Many geologists, paleontologists, astronomers, and statisticians… find the geological evidence merely suggestive or even nonexistent and the supposed underlying mechanisms improbable at best.” Even the iridium anomalies have been challenged: Bruce Corliss of the Woods Hole Oceanographic Institute argues that the major extinctions associated with the K–T event were not immediate and catastrophic but “gradual and apparently linked to progressive climate change.”18 Others argue that a massive volcanic event predating the Alvarezian killer asteroid created an overwhelming greenhouse effect and set the dinosaurs up for the knockout punch. A considerable number of scientists believe that gradually changing sea levels were the primary cause of the K–T Extinction. If either of these hypotheses is true – and a substantial number of geologists hold these positions — then the “killer asteroid” is getting credit that it does not deserve. Even if the K–T Extinction was the work of a rock from space, the Alvarez team credits a “probable interval of 100 million years between collisions with 10-km-diameter objects.”19 The next rendezvous with annihilation won’t be overdue for about 40 million years. We have time.

### No accidental war—failsafes and CBMs.

Rosenkrantz 5 (Steven, Foreign Affairs Officer, Office of Strategic and Theater Defenses, Bureau of Arms Control, Weapons of mass destruction: an encyclopedia of worldwide policy, technology, and history, p 1-2)

Since the dawn of the nuclear era, substantial thought and effort have gone into preventing accidental and inadvertent nuclear war. Nuclear powers have attempted to construct the most reliable technology and procedures for command and control of nuclear weapons, including robust, fail-safe early warning systems for verifying attacks. The United States and the Soviet Union also maintained secure second-strike capabilities to reduce their own incentives to launch a preemptive strike against each other during crisis situations or out of fear of a surprise attack. The two nuclear superpowers worked bilaterally to foster strategic stability by means of arms control and confidence-building measures and agreements. Several confidence-building agreements were negotiated between the two-superpowers to reduce the risk of an accidental nuclear war: the 1971 Agreement on Measures to Reduce the Risk of Outbreak of Nuclear War, the 1972 Agreement on the Prevention of Incidents on and over the High Seas, and the 1973 Agreement on the Prevention of Nuclear War. Following the end of the Cold War, the United States and the Russian Federation have continued to offer unilateral initiatives and to negotiate bilateral agreements on dealerting and detargeting some of their nuclear forces to further reduce the likelihood of a catastrophic nuclear accident. They have concluded agreements on providing each other with notifications in the event of ballistic missile launches or other types of military activities that could possibly be misunderstood or misconstrued by the other party.

# Status Quo Solves

## SQ Solves Asteroid Surveys/Detection

### Status quo surveys solve for extinction-level asteroids.

Morrison 10 [David, Director, Carl Sagan Center for Study of Life in the Universe, “ Impacts and Evolution: Protecting Earth from Asteroids,” PROCEEDINGS OF THE AMERICAN PHILOSOPHICAL SOCIETY VOL. 154, NO. 4, DECEMBER 2010, <http://www.amphilsoc.org/sites/default/files/1540404.pdf>]

Although the impact hazard was treated with substantial skepticism two decades ago when surveys were i rst proposed, it has become conventional wisdom that we should carry out the Spaceguard Survey for asteroids large enough to threaten global disaster (e.g., Posner 2004; Clarke 2007; Slovic 2007; Morrison 2007). The question whether need a much more expensive survey for sub-km asteroids is still being debated, however (Atkinson et al. 2000; Chapman 2000, 2007a; Morrison et al. 2003; Stokes 2003; Sidle 2007; NRC Report 2010). As the original Spaceguard Survey goals are within reach, the residual hazard lies in the few undiscovered asteroids larger than 1 km and in the sparsely sampled sub-km asteroids. The largest hazard will be from tsunamis caused by impactors several hundred meters in diameter, but this is primarily a risk to property since fatalities can be greatly reduced by the application of tsunami warning systems. The most life-threatening hazard from sub-km impacts is associated with airbursts over land. The survey results have already transformed our understanding of the impact risk. For asteroids with diameter of 5 km or more, which is roughly the threshold for an extinction event, our knowledge is complete today. Astronomers have already assured us that we are not due for an extinction-level impact from an asteroid within the next century. Barring a very unlikely strike by a large comet, we are not about to go the way of the dinosaurs. Thus, the rest of this paper focuses on the more frequent impacts by asteroids with diameters from 5 km down to the atmospheric cut-off at about 50 m diameter, spanning the range from global catastrophic disasters at the top end down to local endurable disasters at the lower end of the energy range.

### Prefer Morrison—he is NASA’s expert on asteroids.

Brooks 8 — Michael Brooks, PhD in Quantum Physics, New Scientist, “The end of the world is not nigh”, 23 July 08, <http://www.fhi.ox.ac.uk/__data/assets/pdf_file/0015/5505/The_end_of_the_world_is_not...pdf>, [Zheng]

How about cosmic threats? Though the danger from asteroid impacts remains, we are getting close to charting all the potential world-destroying rocks. "We now know there is no asteroid out there remotely like the one that ended the Cretaceous period," says David Morrison, NASA's leading expert on asteroid threats. "We are not going to go the way of the dinosaurs."

### We can already detect large asteroids—prefer probability

Worden 2 — United States Space Command, Peterson Air Force Base (October 24, S.P., “ Military Perspectives on the Near-Earth Object (Neo) Threat. ” NASA Workshop on Scientific Requirements for Mitigation of Hazardous Comets and Asteroids, <http://www.noao.edu/meetings/mitigation/media/arlington.extended.pdf> pg. 101 )

Finally, just about everyone knows of the “dinosaur killer” asteroids. These are objects, a few kilometers across, that strike on time scales of tens of millions of years. While the prospect of such strikes grabs people’s attention and make great catastrophe movies, too much focus on these events has, in my opinion, been counterproductive. Most leaders in the United States or elsewhere believe there are more pressing problems than something that may only happen every 50-100 million years. I advocate we focus our energies on the smaller, more immediate threats. This is not to say we do not worry about the large threats. However, I’m reasonably confidant we will find almost all large objects within a decade or less. If we find any that seem to be on a near-term collision course–which I believe unlikely–we can deal with the problem then.

## SQ Solves Asteroid Deflection

### SQ solves- current detection and tech sufficient to divert NEOs

Vasile and Colombo 11 (Massimiliano and Camilla, Lecturer Ph.D., Department of Aerospace Engineering; and Ph.D. Candidate, Department of Aerospace Engineering at Glasgow, University, Optimal Impact Strategies for Asteroid Deflection, http://arxiv.org/ftp/arxiv/papers/1104/1104.4670.pdf)

The European Space Agency in particular is now assessing the feasibility of the Don Quijote mission1, due to launch in the first half of next decade, which is intended to impact a spacecraft with a high relative velocity onto an asteroid and measure its deflection. Should this mission fly, this would be the first technological demonstration of our capability to deviate an asteroid if needed. Prevention strategies against a potential hazardous object in collision route with the Earth usually consider a change in momentum of the asteroid, with a consequent variation in the semi-major axis which results in an increase of the Minimum Orbit Intersection Distance (MOID), between the Earth and the object. Several different strategies have been considered to achieve this goal; among them the simplest one is the kinetic impact. In fact, as will be shown in this paper, effective kinetic impacts resulting in a variation of the MOID even of thousand of kilometers seem to be already achievable with the current launch technology with a relatively small spacecraft, provided that the time difference between the momentum change and the potential Earth impact is large enough.

### NASA has effective asteroid response plan.

Green 7 (James, November 8, Dr. Green received his Ph.D. in Space Physics from the University of Iowa in 1979 and began working in the Magnetospheric Physics Branch at NASA's Marshall Space Flight Center (MSFC) in 1980. At Marshall, Dr. Green developed and man­aged the Space Physics Analysis Network, which provided many scientists, all over the world, with rapid access to data, other scientists, and specific NASA computer and information resources NEAR-EARTH OBJECTS (NEOS)-STATUS OF THE SURVEY PROGRAM AND REVIEW OF NASA'S 2007 REPORT TO CONGRESS, http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110\_house\_hearings&docid=f:38057.pdf)//DT

NASA has an NEO contingency notification plan to be utilized in the very un­likely event an object is detected with significant probability of impacting the Earth. The plan establishes procedures between the detection sites, the Minor Planet Cen­ter, the NASA NEO Program Office at JPL, and NASA Headquarters to first quickly verify and validate the data and orbit on the object of interest, and then up-channel confirmed information in a timely manner to the NASA Administrator. These proce­dures were first exercised with the discovery of the object now known as Apophis, which was found in December 2004 in a hazardous orbit but determined to not have a significant probability of impacting the Earth in the near-term. NASA will con­tinue to refine this internal contingency plan, and begin work with other U.S. Gov­ernment agencies and institutions when directed.

### Simulations solve.

David 4 (Leonard David, Space writer for MSNBC, "Scientists simulate asteroid armageddon", 2/24/04, [www.msnbc.msn.com/id/4362785/](http://www.msnbc.msn.com/id/4362785/)) AK

Authorities on defending Earth from a cosmic run-in with an asteroid or comet have gathered here to detail ways to thwart future impacts and deal with the calamity if our planet is struck. An international group of scientists, engineers, space policy makers, and others are taking on the task of improving our ability to defend the planet from possible impact threats. Attention is focused on four fictitious Defined Threat, or DEFT, scenarios that endanger the Earth. The approaching virtual asteroids include D’Artagnon, Athos, Aramis and a long-period comet called Porthos. At this time, none of these names is assigned to a real asteroid or comet. The DEFT scenarios — which include various trajectories and time-to-impact assumptions — are meant to spur designs of rendezvous, intercept and deflection missions and spark discussion of how the world community might prepare for mitigation efforts or a possible disaster from the perspectives of policy and public education. No known comets or asteroids are presently on a collision course with Earth, but scientists say a regionally devastating impact — perhaps within a hundred years, more likely not for a thousand or more — is inevitable. Yet there are no governmental plans to deal with diverting or destroying an asteroid, managing regional evacuations or dealing with the chaos that might ensue from a collision. "Planetary Defense Conference: Protecting Earth from Asteroids," held here Monday through Thursday, is sponsored by The Aerospace Corporation and the American Institute of Aeronautics and Astronautics. Process of being prepared "We’re looking at the entire issue … from the hazard itself through the political and policy issues, as well as disaster mitigation," said William Ailor of The Aerospace Corporation, general chair of the conference. Ailor told Space.com that the meeting will take place every four years. "That way we can assess changes that have, hopefully, increased our abilities to deal with these kinds of threats … and assess current political realities," he said. "We’ve got the capability to do something about a threat now — at least we may have," Ailor said. "Certainly we could, over a period of time, develop some expertise that would allow us to mitigate a reasonably sized threat. "But if we don’t start thinking about this, it’s not going to happen. So that’s the purpose here … to start the process of being prepared."

## SQ Solves Asteroid Exploration

### Asteroid exploration is inevitable with current detection—Vesta proves.

Wall 11 (Mike Wall, space writer for MSNBC, "NASA probe 'on target' for yearlong asteroid encounter", 6/23/11, [www.msnbc.msn.com/id/43518278/ns/technology\_and\_science-space/t/nasa-probe-target-yearlong-asteroid-encounter/](http://www.msnbc.msn.com/id/43518278/ns/technology_and_science-space/t/nasa-probe-target-yearlong-asteroid-encounter/)) AK

A NASA spacecraft is right on target for its yearlong orbital encounter with the huge asteroid Vesta, which is set to begin next month. NASA's Dawn probe is now just 96,000 miles (155,000 kilometers) from Vesta, the second most massive object in the main asteroid belt between Mars and Jupiter, NASA officials announced Thursday. The spacecraft should enter into orbit around the 330-mile-wide (530-kilometer-wide) space rock on July 16. Dawn will then spend a year studying Vesta from above, marking the first time any spacecraft has made an extended visit to a large asteroid. Dawn will begin making science observations in early August. "The Dawn science campaign at Vesta will unveil a mysterious world, an object that can tell us much about the earliest formation of the planets and the solar system," W. James Adams, deputy director of NASA's Planetary Science Directorate, told reporters. "To study this particular asteroid up-close and personal is a very unique opportunity." The end of a long journey Dawn has been chasing Vesta for nearly four years. Since its launch in September 2007, the spacecraft has logged about 1.7 billion miles (2.7 billion kilometers), researchers said. Dawn is now halfway through its final approach to Vesta and has been snapping photos of the space rock with its navigation camera. "Our destination is within sight, and this team is very excited that we're finally closing in on Vesta," said Robert Mase, Dawn project manager at NASA’s Jet Propulsion Laboratory in Pasadena, Calif. The huge space rock's gravity will capture Dawn into orbit on July 16, when about 9,900 miles (16,000 kilometers) separate the pair. At that point, the probe and the asteroid will both be about 117 million miles (188 million kilometers) from Earth. Unlike many other spacecraft that go into orbit around other worlds, this capture won't require any dramatic maneuvers or last-minute burns, researchers said. Dawn has been using its low-thrust ion propulsion system to close in on Vesta's orbit slowly but surely, so it should slip nicely into orbit. A year's worth of science Many researchers classify Vesta as a protoplanet. In the early days of the solar system, it was well on its way to becoming a full-fledged rocky planet — like Earth or Mars — before Jupiter's huge gravity stirred things up in the asteroid belt, preventing further growth, researchers said. Scientists are interested in Vesta partly because it's so big, and partly because it was one of the first rocky bodies to form in our cosmic neighborhood, researchers said. [Photos: Asteroids in Deep Space] "The surface of Vesta will hold a record of the earliest history of the solar system," said Dawn principal investigator Christopher Russell of UCLA.

## Big Asteroids Detected Now

### NASA already found all extinction-level asteroids.

Brooks 8 (Michael Brooks, PhD in Quantum Physics, 08, New Scientist, “The end of the world is not nigh”, 23 July 08, <http://www.fhi.ox.ac.uk/__data/assets/pdf_file/0015/5505/The_end_of_the_world_is_not...pdf>, [Zheng]

How about cosmic threats? Though the danger from asteroid impacts remains, we are getting close to charting all the potential world-destroying rocks. "We now know there is no asteroid out there remotely like the one that ended the Cretaceous period," says David Morrison, NASA's leading expert on asteroid threats. "We are not going to go the way of the dinosaurs."

## Detection Funded Now

### Current space surveys solve detection and are being continued.

Perrotto et al 11 (Trent Perrotto and Dwayne Brown, Headquarters at NASA, Whitney Clavin, Jet Propulsion Laboratory, NASA, "NASA'S Neowise Completes Scan For Asteroids And Comets", 2/2/11, [www.nasa.gov/home/hqnews/2011/jan/HQ\_11-029\_NEOWISE.html](http://www.nasa.gov/home/hqnews/2011/jan/HQ_11-029_NEOWISE.html)) AK

NASA's NEOWISE mission has completed its survey of small bodies, asteroids and comets, in our solar system. The mission's discoveries of previously unknown objects include 20 comets, more than 33,000 asteroids in the main belt between Mars and Jupiter, and 134 near-Earth objects (NEOs). The NEOs are asteroids and comets with orbits that come within 28 million miles of Earth's path around the sun. NEOWISE is an enhancement of the Wide-field Infrared Survey Explorer, or WISE, mission that launched in December 2009. WISE scanned the entire celestial sky in infrared light about 1.5 times. It captured more than 2.7 million images of objects in space, ranging from faraway galaxies to asteroids and comets close to Earth. In early October 2010, after completing its prime science mission, the spacecraft ran out of frozen coolant that keeps its instrumentation cold. However, two of its four infrared cameras remained operational. These two channels were still useful for asteroid hunting, so NASA extended the NEOWISE portion of the WISE mission by four months, with the primary purpose of hunting for more asteroids and comets, and to finish one complete scan of the main asteroid belt. “Even just one year of observations from the NEOWISE project has significantly increased our catalog of data on NEOs and the other small bodies of the solar systems,” said Lindley Johnson, NASA’s program executive for the NEO Observation Program. Now that NEOWISE has successfully completed a full sweep of the main asteroid belt, the WISE spacecraft will go into hibernation mode and remain in polar orbit around the Earth, where it could be called back into service in the future. In addition to discovering new asteroids and comets, NEOWISE also confirmed the presence of objects in the main belt that already had been detected. In just one year, it observed about 153,000 rocky bodies out of approximately 500,000 known objects. Those include the 33,000 that NEOWISE discovered. NEOWISE also observed known objects closer and farther to us than the main belt, including roughly 2,000 asteroids that orbit along with Jupiter, hundreds of NEOs and more than 100 comets. These observations will be key to determining the objects' sizes and compositions. Visible-light data alone reveals how much sunlight reflects off an asteroid, whereas infrared data is much more directly related to the object's size. By combining visible and infrared measurements, astronomers also can learn about the compositions of the rocky bodies -- for example, whether they are solid or crumbly. The findings will lead to a much-improved picture of the various asteroid populations.

## Nuclear Deflection Solves

### Current Nuclear deflection solves—studies show it’s the most effective strategy

Schaffer 7 (Mark, Charania and Olds, Associate Fellow AIAA, CEO and Engineer at SpaceWorks Engineering A.C and John,  Evaluating the Effectiveness of Different NEO Mitigation Options, <http://www.aero.org/conferences/planetarydefense/2007papers/P2-1--Schaffer-Paper.pdf> )

This paper has outlined an effort to develop a process for comparing different NEO mitigation options using a consistent methodology and common analysis assumptions. To accurately model these techniques, an entire mitigation mission from Earth departure to mission completion is simulated. In order to determine the momentum the different options impart to the NEO, interactions with the NEO are approximated by combining published data about each technique with first-order estimates and Newtonian physics. To fairly compare these techniques, additional metrics are considered in the ranking of the different options: applicability to the composition and rotation properties of the NEO, technological readiness, degree of development difficulty, development cost, and deployment cost. The process developed here quantifies these different factors using expert analysis and then, along with the induced change in velocity, determines an Overall Evaluation Criterion (OEC) for each technique. Six different NEO mitigation options are evaluated relative to each other: kinetic impactor, standoff nuclear detonation, chemical rocket, gravity tractor, high Isp rocket, and mass driver. Direct comparisons between the techniques are made by applying identical starting conditions and mission parameters to each deflection option and comparing the OEC of each. The selected mitigation techniques are applied to three sample NEO cases: Apophis, D’Artagnan, and Athos. In the Apophis case, the kinetic impactor, standoff nuclear detonation, and gravity tractor rank highest while the high Isp rocket ranks the lowest. In both the D’Artagnan and Athos cases, the standoff nuclear detonation ranks the highest and the gravity tractor ranks the lowest. Overall, the standoff nuclear detonation is the best performer. Its very high effectiveness, generally applicability to most NEO cases, and low technology requirements allow it to score very highly in this study.

## They Say: “Fragmentation”

### Fragmented pieces miss Earth or burn up in the atmosphere

Zhang et al. 10 (XL, E Ball,C Granier, L Kochmanski, and S D Howe, Centre for Space Nuclear Research, Idaho National Laboratory, Near-Earth object interception using nuclear thermal rocket propulsion, SPECIAL ISSUE PAPER 181, http://journals.pepublishing.com/content/x225kt32h67735w8/fulltext.pdf)

Deflection and destruction of the approaching comet are both viable options. While some proposals suggest avoiding fragmentation because of the potential to create multiple assailants on course for Earth, fragments may cause less damage by spreading out the energy. Fragmentation is the most efficient method of moving the comet, since a larger fragment can deliver the same impulse to the comet with less energy. Given the uncertain composition of a comet and its unknown response to high-yield detonations, not enough information is available to determine whether a surface-burst nuclear explosion would cause it to fragment. If so, the goal should be to spread the pieces out over an area much larger than Earth, so that most will pass by harmlessly. Additionally, the rest should be reduced to a size that cannot penetrate the atmosphere. A strategy incorporating multiple sequential explosions, delivered by separately propelled vehicles, lends itself quite well: after fragmentation by the initial explosion, any large pieces remaining on course for Earth become the new targets for the later interceptions. If, however, the comet remains essentially cohesive, the goal must be to deflect it far enough to definitively avoid impact. In each case, the velocity (of either the main comet body or the majority of the fragments) must be enough that the orbit is displaced by two Earth radii before it crosses Earth orbit. In the first case, this spreads the material over a diameter twice that of Earth, while in the second it ensures a miss by a safe margin. The velocity change VC to accomplish this shift is given as a function of the interception time by the same numerical simulation used for modelling the flight of the interceptors (discussed in section 5.2).

# Probability

## Not Probable

### Long timeframe means there’s no risk.

Siegel 10 (Ethan, theoretical astrophysicist at Lewis and Clark College, “How Afraid of Asteroids Should You Be?” http://scienceblogs.com/startswithabang/2010/11/how\_afraid\_of\_asteroids\_should.php)

But -- and my opinion here definitely runs against the mainstream -- I think this hysteria is absolutely ridiculous. One of the things you almost never hear about are the frequency and the odds of an asteroid strike harming you. If large asteroid strikes happened every few decades, we'd have something legitimate to prepare for and worry about. But if you've only got a one-in-a-million chance of an asteroid harming you over your lifetime -- meaning you are over 100 times more likely to be struck by lightning than harmed by an asteroid -- perhaps there are better ways to spend your resources.

## They Say: “Studies Prove”

### Their authors distort the data.

Bennett 10 [James, Eminent Scholar and William P. Snavely Professor of Political Economy and Public Policy at George Mason University, and Director of The John M. Olin Institute for Employment Practice and Policy, “The Chicken Littles of Big Science; or, Here Come the Killer Asteroids!” THE DOOMSDAY LOBBY 2010, 139-185, DOI: 10.1007/978-1-4419-6685-8\_6]

We should here acknowledge, without necessarily casting aspersions on any of the papers discussed in this chapter, the tendency of scientific journals to publish sexy articles. (Sexy, at least, by the decidedly unsexy standards of scientific journals.) Writing in the Public Library of Science, Neal S. Young of the National Institutes of Health, John P.A. Ioannidis of the Biomedical Research Institute in Greece, and Omar Al-Ubaydli of George Mason University applied what economists call the “winner’s curse” of auction theory to scientific publishing. Just as the winner in, say, an auction of oil drilling rights is the firm that has made the highest estimation — often overestimation — of a reserve’s size and capacity, so those papers that are selected for publication in the elite journals of science are often those with the most “extreme, spectacular results.” 63 These papers may make headlines in the mainstream press, which leads to greater political pressure to fund projects and programs congruent with these extreme findings. As The Economist put it in an article presenting the argument of Young, Ioannidis, and Al-Ubaydli, “Hundreds of thousands of scientific researchers are hired, promoted and funded according not only to how much work they produce, but also where it gets published.” Column inches in journals such as Nature and Science are coveted; authors understand full well that studies with spectacular results are more likely to be published than are those that will not lead to a wire story. The problem, though, is that these flashy papers with dramatic results often “turn out to be false.” 64 In a 2005 paper in the Journal of the American Medical Association, Dr. Ioannidis found that “of the 49 most-cited papers on the effectiveness of medical interventions, published in highly visible journals in 1990–2004… a quarter of the randomised trials and five of six nonrandomised studies had already been contradicted or found to have been exaggerated by 2005.” Thus, those who pay the price of the winner’s curse in scientific research are those, whether sick patients or beggared taxpayers, who are forced to either submit to or fund specious science, medical or otherwise. The trio of authors call the implications of this finding “dire,” pointing to a 2008 158 6 The Chicken Littles of Big Science; or, Here Come the Killer Asteroids! paper in the New England Journal of Medicine showing that “almost all trials” of anti-depressant medicines that had had positive results had been published, while almost all trials of anti-depressants that had come up with negative results “remained either unpublished or were published with the results presented so that they would appear ‘positive.’” Young, Ioannidis, and Al-Ubaydli conclude that “science is hard work with limited rewards and only occasional successes. Its interest and importance should speak for themselves, without hyperbole.” Elite journals, conscious of the need to attract attention and stay relevant, cutting edge, and avoid the curse of stodginess, are prone to publish gross exaggeration and findings of dubious merit. When lawmakers and grant-givers take their cues from these journals, as they do, those tax dollars ostensibly devoted to the pursuit of pure science and the application of scientific research are diverted down unprofitable, even impossible channels. The charlatans make names for themselves, projects of questionable merit grow fat on the public purse, and the disconnect between what is real and what subsidy-seekers tell us is real gets ever wider. 65 The matter, or manipulation, of odds in regards to a collision between a space rock and Earth would do Jimmy the Greek proud. As Michael B. Gerrard writes in Risk Analysis in an article assessing the relative allocation of public funds to hazardous waste site cleanup and protection against killer comets and asteroids, “Asteroids and comets are… the ultimate example of a low-probability/high-consequence event: no one in recorded human history is confirmed to have ever died from one.” Gerrard writes that “several billion people” will die as the result of an impact “at some time in the coming half million years,” although that half-million year time-frame is considerably shorter than the generally accepted extinction-event period. 66 The expected deaths from a collision with an asteroid of, say, one kilometer or more in diameter are so huge that by jacking up the tiny possibility of such an event even a little bit the annual death rate of this never-before experienced disaster exceeds deaths in plane crashes, earthquakes, and other actual real live dangers. Death rates from outlandish or unusual causes are fairly steady across the years. About 120 Americans die in airplane crashes annually, and about 90 more die of lightning strikes. Perhaps five might die in garage-door opener accidents. The total number of deaths in any given year by asteroid or meteor impact is zero — holding constant since the dawn of recorded time

### Studies are on our side--No probability of an impact for multiple reasons

Space Daily 9 ("Crashing Comets Not Likely Cause Of Mass Extinctions", 7/31/09, [www.spacedaily.com/reports/Crashing\_Comets\_Not\_Likely\_Cause\_Of\_Mass\_Extinctions\_999.html](http://www.spacedaily.com/reports/Crashing_Comets_Not_Likely_Cause_Of_Mass_Extinctions_999.html)) AK

New University of Washington research indicates it is highly unlikely that comets have caused any mass extinctions or have been responsible for more than one minor extinction event. The work also shows that many long-period comets that end up in Earth-crossing orbits likely originate from a region astronomers have long believed could not produce observable comets. A long-period comet takes from 200 years to tens of millions of years to make a single orbit of the sun. "It was thought the long-period comets we see just tell us about the outer Oort Cloud, but they really give us a murky picture of the entire Oort Cloud," said Nathan Kaib, a University of Washington doctoral student in astronomy and lead author of a paper on the work being published July 30 in Science Express, the online edition of the journal Science. NASA and the National Science Foundation funded the work. The Oort Cloud is a remnant of the nebula from which the solar system formed 4.5 billion years ago. It begins about 93 billion miles from the sun (1,000 times Earth's distance from the sun) and stretches to about three light years away (a light year is about 5.9 trillion miles). The Oort Cloud could contain billions of comets, most so small and distant as to never be observed. There are about 3,200 known long-period comets. Among the best-remembered is Hale-Bopp, which was easily visible to the naked eye for much of 1996 and 1997 and was one of the brightest comets of the 20th century. By comparison, Halley's comet, which reappears about every 75 years, is perhaps the best-known comet, but it is a short-period comet, most of which are believed to originate in a different part of the solar system called the Kuiper Belt. It has been believed that nearly all long-period comets that move inside Jupiter to Earth-crossing trajectories originated in the outer Oort Cloud. Their orbits can change when they are nudged by the gravity of a neighboring star as it passes close to the solar system, and it was thought such encounters only affect very distant outer Oort Cloud bodies. It also was believed that inner Oort Cloud bodies could reach Earth-crossing orbits only during the rare close passage of a star, which would cause a comet shower. But it turns out that even without a star encounter, long-period comets from the inner Oort Cloud can slip past the protective barrier posed by the presence of Jupiter and Saturn and travel a path that crosses Earth's orbit. In the new research, Kaib and co-author Thomas Quinn, a UW astronomy professor and Kaib's doctoral adviser, used computer models to simulate the evolution of comet clouds in the solar system for 1.2 billion years. They found that even outside the periods of comet showers, the inner Oort Cloud was a major source of long-period comets that eventually cross Earth's path. By assuming the inner Oort Cloud as the only source of long-period comets, they were able to estimate the highest possible number of comets in the inner Oort Cloud. The actual number is not known. But by using the maximum number possible, they determined that no more than two or three comets could have struck Earth during what is believed to be the most powerful comet shower of the last 500 million years. "For the past 25 years, the inner Oort Cloud has been considered a mysterious, unobserved region of the solar system capable of providing bursts of bodies that occasionally wipe out life on Earth," Quinn said. "We have shown that comets already discovered can actually be used to estimate an upper limit on the number of bodies in this reservoir." With three major impacts taking place nearly simultaneously, it had been proposed that the minor extinction event about 40 million years ago resulted from a comet shower. Kaib and Quinn's research implies that if that relatively minor extinction event was caused by a comet shower, then that was probably the most-intense comet shower since the fossil record began. "That tells you that the most powerful comet showers caused minor extinctions and other showers should have been less severe, so comet showers are probably not likely causes of mass extinction events," Kaib said. He noted that the work assumes the area surrounding the solar system has remained relatively unchanged for the last 500 million years, but it is unclear whether that is really the case. It is clear, though, that Earth has benefitted from having Jupiter and Saturn standing guard like giant catchers mitts, deflecting or absorbing comets that might otherwise strike Earth. "We show that Jupiter and Saturn are not perfect and some of the comets from the inner Oort Cloud are able to leak through. But most don't," Kaib said.

## They Say: “Scientific Consensus”

### Most astronomers agree it’s too unlikely.

Bennett 10 [James, Eminent Scholar and William P. Snavely Professor of Political Economy and Public Policy at George Mason University, and Director of The John M. Olin Institute for Employment Practice and Policy, “The Chicken Littles of Big Science; or, Here Come the Killer Asteroids!” THE DOOMSDAY LOBBY 2010, 139-185, DOI: 10.1007/978-1-4419-6685-8\_6]

The closest thing to an impact even distantly related to the “catastrophic” occurred just over a century ago. In June 1908, in an event that is central (because seemingly unique in modern times) to the killer asteroid/comet lobby, the so-called Tunguska asteroid, 70 yards (60 meters) in length, exploded about 8 kilometers above the ground in remote Siberia. Its explosion unleashed 20 or more megatons of energy and “flattened about 2,000 square kilometers of forest.” 30 No human casualties were reported, as this was an unpopulated spot in Siberia. Sharon Begley of Newsweek once quoted John Pike of the Federation of American Scientists as saying that a Tunguska-sized rock from outer space could kill 70,000 people if it hit in rural American and 300,000 if it struck an urban area. 31 Maybe. Although it helps to remember that a Tunguska-sized rock did hit the Earth a century ago, and its human death toll was a nice round number: zero. Does Tunguska have antecedents? As Gregg Easterbrook elucidated in the Atlantic Monthly, geophysicist Dallas Abbott of Columbia University has argued that space rocks of, respectively, 3–5 kilometers and 300 meters struck the Indian Ocean around 2800 B.C. and the Gulf of Carpentaria in 536 A.D. 32 The latter led to poor harvests and cold summers for two years, while the former may have unleashed a planetary flood. Abbott’s evidence is a crater 18 miles in diameter at the bottom of the Indian Ocean, the impact from which she believes a 600-foot-high tsunami wracked incredible devastation. It should be noted, as the New York Times did, that “Most astronomers doubt that any large comets or asteroids have crashed into the Earth in the last 10,000 years.” Abbott and what she calls her “band of misfits” in the Holocene Impact Working Group take a decidedly minority view of the matter, and while that does not mean that they are wrong, it does mean that their alternative estimation of the frequency of 10-Megaton-size impacts — once every 1,000 or so years as opposed to the more generally accepted once every million years — should be viewed with great skepticism. 33 (Easterbrook, ignoring the majority of scientists who dispute Abbott’s contentions, concludes that “Our solar system appears to be a far more dangerous place than was previously believed.”) Easterbrook is a fine science writer but his piece contains certain telltale phrases (100-kilometers asteroids are “planet killers” and NASA’s asteroid and comet-hunting efforts are “underfunded”) that point to an expensive conclusion. He takes up the cause of Dallas Abbott, who complains that “The NASA people don’t want to believe me. They won’t even listen.” Consider this quote: After noting that scientists estimate that a “dangerous” object strikes the Earth every 300,000 to one million years, Easterbrook asks William Ailor of The Aerospace Corporation, “a think tank for the Air Force,” what his assessment of the risk is. Ailor’s answer: “a one-in-10 chance per century.” 3

### Their authors concede an impact is unlikely

Physorg 11 (Science News, "Research team casts light on asteroid deflection", 1/28/11, [www.physorg.com/news/2011-01-team-asteroid-deflection.html](http://www.physorg.com/news/2011-01-team-asteroid-deflection.html)) AK

In 2029 and 2036, the asteroid Apophis (named after the Egyptian god of darkness and the void), at least 1,100 feet in diameter, 90 stories tall, and weighing an estimated 25 million tons, will make two close passes by Earth at a distance of about 22,600 miles. "We don't always know this far ahead of time that they're coming," Dr. Matloff says, "but an Apophis impact is very unlikely." If the asteroid did hit Earth, NASA estimates, it would strike with 68,000 times the force of the atom bomb that leveled Hiroshima. A possibility also exists that when Apophis passes in 2029, heating as it approaches the sun, it could fragment or emit a tail, which would act like a rocket, unpredictably changing its course. If Apophis or its remnants enter one of two "keyholes" in space, impact might happen when it returns in 2036.

## They Say: “Our Authors Are Qualified”

### Their author’s aren’t experts—even then civil defenses solve.

Rozeff 7 [Michael, retired Professor of Finance living in East Amherst, New York. February 21, 2007, “ Asteroid Risk Mitigation, Anyone?,” <http://www.lewrockwell.com/rozeff/rozeff139.html>]

The space fliers and explorers of the ASE pass themselves off as experts on the risks of a catastrophe arriving from outer space; but they are far more likely to be biased observers and commentators than scientists who have no space axe to grind. Robert Roy Britt writes for Live Science. In an article posted two years ago, he pointed out many pertinent facts. At that time, he gave the lifetime odds (over one's entire life) of an asteroid hit as 1 in 200,000 or perhaps as little as 1 in 500,000. Death by lightning has odds of 1 in 84,000, by legal execution 1 in 59,000, by air travel 1 in 20,000, by fire 1 in 1,100, by falling down 1 in 246, and by suicide 1 in 121. He pointed out that there are those who have held to asteroid death odds of 1 in 50,000, however, until more asteroids are catalogued and their movements accounted for. Even at 1 in 50,000, the risk is very low. Famine, disease, and war are the biggest killers on the planet and occur constantly. Two of these are preventable, and one can be ameliorated.

The ASE is making noises about an asteroid 140 meters long called Apophis. Astronomers say that it has a chance of striking the earth on April 13, 2036. This will be a Palm Sunday. The odds noised about in the recent spate of articles are 1 in 45,000 that it hits the earth. It's supposed to miss us by 20,000 miles. If it does hit, the damage could be large, depending on many factors. If it landed in the Pacific Ocean, a likely target, it would create 50-foot tidal waves lasting an hour. The odds of being killed are far lower, as Britt notes, and they vary depending upon where one lives. In the worst eventuality that Apophis hit the earth, the area of impact would by the time it headed for earth be pinpointed. People could then evacuate that area, and the death toll could be greatly reduced. The stated odds do not take human action into account.

# Impact Defense

## No Asteroid Impact

### Even a large asteroid wouldn’t cause extinction- detection and mitigation.

IAA 9 (International Academy of Astronautics, Dealing with the THREAT TO EARTH From ASTEROIDS and COMETS, Available Online at <http://iaaweb.org/iaa/Scientific%20Activity/Study%20Groups/> SG%20Commission%203/sg35/sg35finalreport.pdf)

As discussed earlier, few NEAs >2 km remain undiscovered, so the chances of such an event are probably <1-in-100,000 during the next century. The warning time would almost certainly be long, in the case of an NEA, but with current technology telescopes might be only months in the case of a comet. With years or decades of advance warning, a technological mission might be mounted to deflect an NEA so that it would miss the Earth (and also possibly a comet should new technologies enable similar warning times for them). Moving such a massive NEA would be very challenging. In any case, given sufficient warning, many immediate fatalities could be avoided by evacuating ground zero and longer-term casualties could be minimized by storing food supplies to survive the agricultural catastrophe. Susceptible infrastructure (transportation, communications, medical services) could be strengthened in the years before impact. However, no preparation for mitigation is warranted for such a rare possibility until a specific impact prediction is made and certified. The only advance preparations that might make sense would be at the margins of disaster planning developed for other, “all-hazards” purposes: considering such an NEA apocalypse might foster "out-of-the-box" thinking about how to define the outer envelope of disaster contingencies, and thus prove serendipitously useful as humankind faces an uncertain future.

### Research proves asteroids can’t independently cause extinction

Vieru 9 (TUDOR VIERU, science editor for Softpedia News, "Asteroids Are Not Enough for Extinction Events", 2/18/09, news.softpedia.com/news/Asteroids-Are-Not-Enough-for-Extinction-Events-104837.shtml) AK

Over the years, we've heard numerous theories and hypotheses as to how the dinosaurs went extinct, and what caused the global event responsible for it. We've been thought to believe a comet or an asteroid is more than capable of wiping out all life on Earth, but a new research seems to contradict that. That's not to say that an asteroid wouldn't have the ability to destroy us altogether, but it would also have to do away with the entire planet in the process. For any other cases, the original impact has to be doubled by a secondary extinction event, to ensure that life is completely annihilated. And, according to the latest studies, it would appear that the “honor” belongs to volcanoes, which are the ones stirred up immediately after a comet impacts the crust. Because of the large amount of vibrations and the immense shock, most craters near the impact site, and later others, explode, and the magma trapped underground finally finds its way out. But the true extinction comes from the plumes of these volcanoes, from the ashes and the dust that set around their cones for hundreds of miles. Scientists at the Hobart and William Smith Colleges, led by Nan Arens, argue in a paper published recently in the journal Paleobiology that there are two types of extinction events – “pulls” and “presses.” A “pull” is a sudden event, such as a comet or an asteroid impact, while “presses” are more Earthly phenomena, such as volcanic eruptions that last for millions of years. Their research shows that a “pull” alone is not enough to destroy 90 percent of life on the planet, as it happened during the Permian-Triassic extinction period. Rather, that particular destruction was caused by a volcano in Siberia, which erupted non-stop for well over 200,000 years. This means that it wasn't shock or flying stones that killed all animals, but climate change, as nature became unable to support life, due to all the carbon dioxide in the atmosphere. The global warming process that was triggered by the eruption allowed only for a very short range of creatures to survive, along with trees, which multiplied in order to get more carbon out of the air. Naturally, when both “pulls” and “presses” are combined, the results are devastating. 65 million years ago, when a comet struck the Earth, near the Yucatan Peninsula, the Deccan Traps, a supermassive volcano over what is today India was already erupting. This meant that the dinosaurs never stood a chance of surviving in the shape that they had at the time. As a result, their only living relatives are now some turtles, crocodiles, and a few birds.

## No Comet Impact

### No comet threat—no major changes in LEOs.

Near-Earth Object Science Definition Team 3 (August 22, “ Study to Determine the Feasibility of Extending the Search for NearEarth Objects to Smaller Limiting Diameters ” Prepared at the Request of National Aeronautics and Space Administration Office of Space Science Solar System Exploration Division <http://neo.jpl.nasa.gov/neo/neoreport030825.pdf>)

The relative constancy of the long-period comet discovery rate over the past 300 years, the results from the Sekanina and Yeomans (1984) analysis, the Marsden (1992) type analysis and the above reality check all suggest that the threat of long-period comets is only about 1% the threat from NEAs. Levison et al. (2002) note that as comets evolve inward from the Oort cloud, the vast majority of them must physically disrupt rather than fade into dormant comets; otherwise, vast numbers of dormant long-period comets would have been discovered by current NEO surveys. This conclusion would strengthen the case against there being a significant number of dormant long-period or Halley-type comets that annually slip past the Earth unnoticed. While Earth impacts by long-period comets are relatively rare when compared to the NEA impact flux, the present number of Earth-crossing asteroids drops very steeply for asteroids larger than 2 kilometers in diameter, more steeply than the flux of cometary nuclei (Weissman and Lowry 2003). Hence, it is possible, perhaps even likely, that long-period comets provide most of the large craters on the Moon (diameter > 60 km) and most of the extinction level large impacts on Earth (Shoemaker et al., 1990). The conclusion is that, while a newly discovered Earth-threatening, long-period comet would have a relatively short warning time, the impact threat of these objects is only about 1% the threat from NEAs. More generally, the threat from all long-period or short-period comets, whether active or dormant, is about 1% the threat from the NEA population. The limited amount of resources available for near-Earth object searches would be better spent on finding Earth threatening NEAs with the knowledge that these types of surveys will, in any case, find many of the Earth-crossing, long-period comets as well. Finally, it has been argued that we currently enjoy a relatively low cometary flux into the inner solar system and that some future comet shower, perhaps due to a passing star in the Oort cloud or a perturbation of our Oort cloud by the material in the galactic plane, could greatly increase this flux. The time scale for an increased cometary flux of this type is far longer than one hundred years so that current NEO searches can afford to concentrate their efforts on the more dangerous NEAs.

### No risk of a comet impact—studies prove.

Scientific American 9 ("Comet Formation Theory May Not Be Set in Stone (or Ice)", 7/30/09, [www.scientificamerican.com/article.cfm?id=comets-oort-cloud-extinction&page=2](http://www.scientificamerican.com/article.cfm?id=comets-oort-cloud-extinction&page=2)) AK

Implications for extinction events Kaib and Quinn used their newfound mechanism, as well as the number of observed comets, to set an estimated upper limit on how much material could be in the inner Oort cloud. Given the efficiency of the process by which inner Oort cloud comets can reach the inner solar system, "it would be hard to fit more bodies in there without producing a larger comet flux than we see today," Kaib says. Using that upper limit, the researchers produced a statistical model of how many comets would be expected to have impacted Earth in comet showers over the past several hundred million years. What Kaib and Quinn found was that a suspected bombardment at the end of the Eocene epoch, some 35 million years ago, which some have theorized caused a partial extinction, was likely the largest seen in the past 500 million years. "Statistically speaking, there should be these close stellar passages every 50 million or 100 million years, so that's been proposed as a possible mechanism to produce many of these extinction events," Kaib says. "And so basically we showed that you might be able to produce one minor event, but beyond that they're really not a robust mechanism to produce multiple extinction events." The extension of the findings to unwinding the extinction history on Earth will likely meet with more controversy than will the new mechanism for comet production. "Of course, any extrapolation is dicey," Tremaine says. "I think that's an interesting result but not the most interesting result of the paper because...these sorts of calculations always involve an extrapolation of what we know." Weissman notes that the extinction implications involve comet showers, not comets in general, and that even a diminished profile of showers does not rule out their role in extinctions. "Just because the 'biggest' observed comet shower did not cause a major extinction, that does not mean that other showers will not cause a major extinction," he says, adding it is likely that not the multiplicity of strikes but rather the magnitude of the largest strike can wipe out species.

## No Accidental War Impact

### CTBT verification solves miscalc and accidental war.

Nature News 2 (“Microphones tell asteroids from A-bombs,” July 17, http://www.nature.com/news/1998/020715/full/news020715-4.html)

Ground-based groups of microphones, called infrasonic arrays, can distinguish atomic blasts from exploding asteroids up to a few hundred kilometres away, say Brown, Tagliaferri and colleagues1. The arrays pick up the very-low-frequency sounds that penetrate hundreds of kilometres of the Earth's atmosphere. Multiple arrays pinpoint the position and size of a blast almost as accurately as the satellites used by US Space Command, the researchers show. Right now, there are 12 such arrays. Sixty will be built within the next 5 years as part of the CTBT International Monitoring Network. The rules of the treaty dictate that their data must be available to all. A global array should spot meteor explosions from most areas of the world, says Brown. The infrasonic network will also be important for research. Meteorites smaller than 10 metres across are hard to detect with telescopes, so scientists have little idea of how often they breach our atmosphere. An idea of how frequently small asteroids occur is important for estimating the likelihood of larger ones, such as the one that devastated thousands of square kilometres of Siberian forest in Tunguska in 1908. The microphone array, says Matthew Genge of the Natural History Museum in London, UK, "will help us tell just how many Tunguskas we can expect".

### No nuclear accidents.

Perrow 99 (Charles, Professor of Sociology at Yale, Normal Accidents: Living with High-Risk Technology, p 257-258)

No such encouraging lessons come from the section on nuclear weapons and early warning systems. We will not dwell on “the fate of the earth,” that is, the destructive power of nuclear weapons, but on the limits of human capabilities and the even narrower limits of organizational capabilities. There is much to fear from accidents with nuclear weapons such as dropping them or an accidental launch, but with regard to firing them after a false warning we reach a surprising conclusion, one I was not prepared for: because of the safety systems involved in a launch-on-warning scenario, it is virtually impossible for well-intended actions to bring about an accidental attack (malevolence or derangement is something else). In one sense this is not all that comforting, since if there were a true warning that the Russian missiles were coming, it looks as if it would also be nearly impossible for there to be an intended launch, so complex and prone to failure is this system. It is an interesting case to reflect upon: at some point does the complexity of a system and its coupling become so enormous that a system no longer exists? Since our ballistic weapons system has never been called upon to perform (it cannot even be tested), we cannot be sure that it really constitutes a viable system. It just may collapse in confusion!

# Impacts Outweigh

## Short-Term Impacts Outweigh

### Short-term impacts outweigh—their impact justifies paranoia.

Bennett 10 (James T. Bennett 2010 Eminent Scholar and William P. Snavely Professor of Political Economy and Public Policy at George Mason University, and Director of The John M. Olin Institute for Employment Practice and Policy “The Chicken Littles of Big Science; or, Here Come the Killer Asteroids!” The Doomsday Lobby: Hype and Panic from Sputniks, Martians, and Marauding Meteors Springerlink

Chapman and Morrison have pondered NEOs for many years now, and they admit the inherent ambiguities. Clark Chapman concedes that “there is deep disagreement over whether we should also protect against the impacts that happen every decade or so, like Tunguska” — though the last Tunguska happened not a decade but a century-plus ago. “Even these small events can kill people, but they are a thousand times less likely to do so than are quakes, floods and the other things that kill people all the time.”123 David Morrison says, “It’s truly an apocalyptic vision that you have here,” but he concedes that “there are very human reactions as to whether this one-in-a-million-per-year risk [which may be an exaggerated number itself] is worth worrying about or not.”124 Clark Chapman adds that “such oncein100 million year events are so rare that, despite their apocalyptic horror, they need be of no concern to public officials.”125 (Note the sharp difference in estimates of the chances of a civilization-ending collision.) If a one-in-a-million — or 65 million, or one trillion — year doomsday comet suddenly raced in from the Oort Cloud, there is simply no defense known or even contemplated against it. We would be out of luck. Yet as a team of researchers wrote in Reviews of Geophysics, asteroid and comet collisions “are so infrequent that they are normally disregarded on the timescale of human evolution.”126 Prudence dictates that we not entirely ignore the incredibly remote possibility that such a collision could happen at any time during the next 40 million years, but that same prudence should keep us from panic, and prevent us from public expenditures that cannot be justified by any wisdom this side of sheer Hollywood-sized hysteria. Even without a rogue asteroid banging into the Earth, life as we know it will be impossible on the planet in a billion or more years, when the Sun swells 250 times its current size, into a “red giant” star that will swallow our home planet.127 If you wish to worry about that, fine. Same for those who stay up nights pulling out their hair over the prospect of an Armageddon asteroid. But the rest of us — at least those of us who do not make our living in the NEO detection field — have quite enough else to worry about, including a swelling budget deficit whose size may soon dwarf the rockiest chunks in the Asteroid Belt.

## Climate Change Outweighs

### Climate change outweighs asteroids—prefer probability.

Boslough 10 [Mark, Mitigation Panel Member of Committee to Review Near-Earth-Object Surveys and Hazard Mitigation Strategies, Minority Opinion, “Defending Planet Earth: Near-Earth Object Surveys and Hazard Mitigation Strategies,” pp 126-127, http://www.nap.edu/catalog.php?record\_id=12738]

The original draft of the table entitled “Expected Fatalities per Year, Worldwide, from a Variety of Causes” (Table 2.2 in Chapter 2 of this final report) included the World Health Organization (WHO)1 estimate of 150,000 deaths per year from climate change. The steering committee made a decision to remove the climate data, giving as reasons (1) caution about having any debate on climate change distract from the issue at hand and (2) irrelevance of climate change numbers to the near-Earth object (NEO) threat.

The first reason is inappropriate. Data should not be removed from a report to avoid the potential for political controversy.

The second reason is incorrect. Climate change is more relevant than the other causes in the table, for several reasons:

The portion of the threat above the global catastrophe threshold—which in the model we quote2 constitutes about one half of the expected annual death rate—is primarily a climate change threat. Estimates of deaths from a large impact are largely based on our model-derived scientific understanding of climate change. The 91 deaths per year assumes a catastrophe threshold significantly lower than the current best estimate (3 kilometer-diameter asteroid). It implicitly assumes a high-sensitivity climate and/or strong dependence of death rate on climate change.

Asteroids and climate change are the only two threats in the original table that can have abrupt and global consequences, and to which everyone on the planet is exposed, regardless of their lifestyle or personal behavior. They are also both to some extent preventable, and in both cases mitigation requires international agreements and cooperation. The climate change death rate is therefore more appropriate to compare to the asteroid death rate than the other threats are. Climate can and has changed abruptly. Evidence from Greenland ice cores and other

paleoclimate data show that these spontaneous changes take place much more frequently than do large impacts and on time scales that can exceed human adaptive capacities.3

Asteroids and climate change are the only two threats in the original table that include global catastrophe as a possibility. The best estimate of the global catastrophe threshold diameter for an asteroid is 3 km, but according to Alan Harris,4 all NEOs above this threshold, except for long-period comets, have been discovered. The best estimate of the probability of a global catastrophe this century from an asteroid impact is therefore zero. If Earth and its inhabitants are assumed to be much more sensitive to global change, then a low threshold of 1.5 km (a factor of 8 lower in kinetic yield) can be assumed. Harris estimates around 30 undiscovered asteroids larger than 1.5 km. The probability of impact by one of these before the end of the century is 0.0005 percent. However, recent models5,6 suggest a 2 percent probability of global catastrophe from anthropogenic climate change this century, assuming realistic greenhouse gas emissions scenarios and a threshold temperature change or sensitivity of 8°C. If the threshold sensitivity is 4°C, the probability of global catastrophe exceeds 20 percent. With sensitive assumptions, it is therefore 40,000 times more probable that Earth will be faced with an anthropogenic climate change catastrophe than with an asteroid catastrophe. With best assumptions it is infinitely more probable.

The WHO climate change estimate of 150,000 deaths per year is a lower bound, because of its conservative assumptions that do not include increasing temperatures since 2000. It also does not consider the probability of global catastrophe from human-triggered abrupt climate change comparable to the speed or magnitude of the Bölling/Allerød or Younger Dryas boundaries, which are not impact related.7 The Harris (2009) asteroid estimate of 91 deaths per year is an upper bound, because it assumes a low catastrophe threshold. The inclusion of these figures for intercomparison is the only way to provide policy makers with an objective basis for the prioritization and allocation of resources that is commensurate with the relative threat from various causes.

## Nuclear War Outweighs

### Nuclear war and diseases outweigh asteroids.

Bennett 10 (James, Prof of Economics at George Mason, The Doomsday Lobby: Hype and Panic from Sputniks, Martians, and Marauding Meteors, p. 155)

Given that there “is no known incident of a major crater-forming impact in recorded human history,” argues P.R. Weissman of the Jet Propulsion Laboratory, and since “the credibility of the impact hazard” is justifiably low with the public and governmental decision-makers, we ought to defer the development of a defensive system until such time as technological advances permit us to do so at a reasonable cost.55 There is also, he points out — at the risk of being called chauvinist, no doubt, by the more feverish Earth-savers — the “pragmatic and/or parochial” fact that the United States accounts for 6.4 percent of the total land mass of the Earth, and only 1.9 percent of the total area, including water.56 Thus anything short of a civilization-ending asteroid would be exceedingly unlikely to hit the U.S. By contrast, such threats as infectious diseases and nuclear war present a more real and immediate danger to Americans, and to earthlings in general. Perhaps money would be better spent addressing those matters?

### Prefer Nuclear war—the impacts of an asteroid are reversible.

Bennett 10 (James, Prof of Economics at George Mason, The Doomsday Lobby: Hype and Panic from Sputniks, Martians, and Marauding Meteors, p. 155-157)

For a near-impossible scenario, an awful lot of laser ink has gone into studies of the consequences of an impact. Let’s face it: The topic is sexy. The effects of an Earth-space rock collision with energies below 10 Megatons would be “negligible,” write Owen B. Toon, Kevin Zahnle, and David Morrison of the NASA Ames Research Center, Richard P. Turco of UCLA, and Curt Covey of the Lawrence Livermore National Laboratory, in Reviews of Geophysics. Impacts measuring between 10 Megatons and 10 to the 4th power Megatons — say, comets and asteroids with diameters of less than 400 meters and 650 meters, respectively — would be equivalent “to many natural disasters of recent history.” In other words, death-dealing but manageable in a global sense. Those with an energy range in the 10 to the 5th–6th power Megatons are “transitional” — the fires, earthquakes, and tsunamis would unleash devastation, though the authors do not believe a “global catastrophe” would occur at less than an energy level of 10 to the 6th power Megatons. They do admit to “considerable uncertainty,” noting that previous estimates may have overstated the damage at certain levels of impact, though they say, with great wisdom, that “it is to be hoped that no large-scale terrestrial experiments occur to shed light on our theoretical oversights.”59 They can say that again. The impact upon the Earth of an object of more than 400 meters in diameter crashing into an ocean would be a tsunami, an enormous wave created by the impact of the asteroid or comet upon the ocean floor, which could cause massive numbers of deaths due to drowning, though it would be highly unlikely to cause extinction of the human species. A wall of water — a wave over 60 meters high — would sweep over the impacted ocean’s coasts. The huge and widespread fires would claim uncounted lives, too, and the “opacity of the smoke generated by the fires” would contribute to the sharply reduced level of sunlight upon the Earth. The consequences of an impact with an energy of 10 to the 7th power Megatons could be K–T like, as 100-meters-high tsunamis swamp coastal zones, fires rage around the world, and “Light levels may drop so low from the smoke, dust, and sulfate as to make vision impossible.”60 Photosynthesis, too, becomes impossible, and food supplies disappear. Dwellers in sea and on land perish of fire, starvation, or flood. In the aftermath, survivors would compete with rodents for the available food. (As paleontologists Peter M. Sheehan and Dale A. Russell note, “In the short term domestic cats might play a useful role in protecting food supplies.”61 Humans, they believe, would survive such a catastrophe, though in greatly reduced numbers and for millennia they would be vegetarians practicing subsistence agriculture. No doubt, that sounds appealing to some of the greener readers.) If an impact with a smaller body is sometimes compared to the aftermath of a nuclear war, the fact that in a war the civilian infrastructure is specifically targeted means that it is “much more likely that society could cope with the problems following a small impact better than it could adjust to the problems following a nuclear war,” according to Toon, Zahnle, et al.62 Interestingly, the authors say that acid rain — very much a fashionable environmental cause in the 1980s, though it has since receded before global warming — would not be a widespread problem, although the rain may well be acidified due to the nitric oxide resulting from impact-induced shock waves.