# Asteroid Affirmative

Asteroid Affirmative 1

\*\*Inherency\*\* 19

Current Programs Fail 20

Current Programs Fail 21

Not Enough Funding 22

Not Enough Funding 23

Not Enough Funding 24

No Current Programs 25

\*\*Asteroid Impact Advantage\*\* 26

Asteroid Impact Inevitable/Likely 27

Asteroid Impact Inevitable/Likely 28

Asteroid Impact Inevitable/Likely 29

Asteroid Impact by 2036 30

Impact Outweighs - Magnitude > Probability 31

Impact Outweighs - Probability > Timeframe 32

Impact Outweighs - Probability 33

Impact Outweighs - Probability 35

Impact Outweighs Nuclear War 36

Small Asteroids = damage 37

Small Asteroids = damage 38

Small Asteroids = damage 39

Small Asteroids = damage 41

Small Asteroids = damage 42

Small Asteroids = damage 43

Huge Asteroid on the way 44

Huge Asteroids on the way 45

Asteroid Impact 🡪 Biological Destruction 46

Asteroid Impact 🡪 Ice Age 47

Asteroid Impact 🡪 Ice Age 48

Asteroid Impact 🡪 Miscalculation 50

Miscalculation - Likely 53

Miscalculation - Likely 54

Miscalculation – Timeframe 55

Asteroid ! – Miscalculation 56

Asteroid Impact – Nuclear War 57

Asteroid Impact 🡪 Wildfires 58

Wildfire ! – Poverty 59

Wildfire ! - deforestation 60

Asteroid ! – Global Communications 61

Asteroid Impact 🡪 Agriculture Disruption 62

Agriculture Disruption ! – Food Shortages 63

Food Shortage ! - War 64

Starvation ! = D Rule 65

Starvation ! = D Rule 67

Starvation ! = D Rule 68

Starvation ! = D Rule 69

Asteroid Impact 🡪 Supersonic Shockwave 70

Asteroid Impact 🡪 Extinction 71

Asteroid Impact 🡪 Tsunamis 73

Tsunamis ! - Economy 74

Tsunamis ! – Underwater Landslides 75

Asteroid Impact 🡪 Climate Change 76

Asteroid Impact 🡪 Climate Change 77

Asteroid Impact > Climate Change 78

Climate Change ! – Disease 79

Asteroid Impact – Laundry List 80

Asteroid Impact – Laundry List 81

Asteroid Impact – Laundry List 82

Asteroid Impact 🡪 Ozone Depletion/UV radiation 83

Asteroid Impact – Harms Ocean Life 84

UV-B Radiation 🡪 DNA damage 85

UV-B Radiation 🡪 Multiple Impacts 86

UV-B Radiation 🡪 Disease 87

Disease ! 🡪 Extinction 88

Disease ! 🡪 Extinction 89

UV-B Radiation ! – Plant Growth 90

UV-B Radiation ! – Ocean Biodiversity 91

Ocean Biodiversity ! – Economic Collapse 92

Biodiversity ! – Cultural Identity 93

Biodiveristy ! – Extinction 94

Biodiveristy ! – Extinction 95

Biodiveristy ! – Extinction 96

Exploding Asteroid 🡪 Kill Millions 97

Exploding Asteroid 🡪 Tsunamis 98

Ocean Impact More Likely 99

Ocean Impact More Likely 100

\*\*Asteroid Mining\*\* 101

Asteroid Detection 🡪 Mining 102

Asteroid Detection 🡪 Mining 103

Asteroid Detection 🡪 Mining 104

Asteroids = resources 105

Asteroid Mining = Profitable 106

Asteroid Mining = Good Idea 107

Asteroid Mining = Economically Feasible 108

Asteroid Mining = Safer & Cheaper 109

All Asteroids can be mined 110

We Have The Tech 111

Mining Solves Economy 112

Mining Solves Economy 113

Economy ! – War 114

Asteroid Mining – Platinum 115

Platinum k2 Oil Dependence 116

\*\*Solvency\*\* 117

Space Based Detection Key 118

Space Based Detection Key 119

Space Based Detection Key 120

Space Based Detection Key 121

Space Based Detection Key 122

Detection – Adaptive Membrane Telescopes 123

Detection – Adaptive Membrane Telescopes 125

Detection – Adaptive Membrane Telescopes - Feasible 126

Detection – Ground Based 127

Deflection – Tractor Beams 128

Deflection – Propulsion 129

Deflection – Asteroid Trapping 130

Deflection – Asteroid Trapping 131

Deflection – Laser Ablation 132

Deflection – B612 Spaceship 133

Deflection – Nuclear 134

Early Detection key 135

Early Detection key 136

Early Detection key 137

Early Detection key 138

Detection Key To Deflection 139

Detection Key To Deflection 140

Detection Key To Deflection 141

Detection Key To Deflection 142

Detection Key To Deflection 143

Plan Key Now 144

USFG Key 145

USFG Key 146

\*\*Add-Ons\*\* 147

Science diplomacy 148

Science diplomacy 149

Impact Extensions 150

Impact Extensions 151

\*\*AFF Answers To\*\* 152

AT U.N. CP 153

AT Privitization 154

AT Privitization 155

AT Privitization 156

AT Politics – Plan Popular 157

AT Politics – Plan Popular 158

AT Politics – Plan Popular with Public 159

AT Politics – Plan Popular 160

AT Poltics – Lobbying 161

AT Politics – NASA Lobbying 162

AT Politics – NASA Lobbying 163

AT Politics – Bi-partisan 164

AT Politics – Congress 165

AT: low probability 167

AT Nuclear Deflection Bad 168

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Observation 1: Inherency

The only detection available for PHO’s are radar telescopes that can see a shallow distance from Earth’s surface. More power is needed.

Bucknam and Gold in 08 [Mark and Robert “Survival” (00396338); Oct/Nov2008, Vol. 50 Issue 5, p141-156, 16p PN] [PHO - potentially hazardous object]

Though radar telescopes, such as the giant 305m dish at Arecibo, Puerto Rico, enable rapid and accurate assessments of PHO size and orbit, they are only useful when the objects pass within a few million kilometres of Earth. NASA recommended against developing a radar specifically for finding and tracking PHOs, stating that ‘orbits determined from optical data alone will nearly match the accuracy of radar-improved orbits after one to two decades of observation’.15 Existing radar telescopes should be used as far as possible to refine predictions of Apophis’s trajectory – either confirming or ruling out the potential for an impact in 2036. In addition to fielding new Earth- and space-based sensors as suggested by NASA, former astronaut Rusty Schweickert called for placing a transponder on Apophis during a close approach in 2013 to help determine whether a 2036 collision is likely.16 This could save years of worrying, or give us extra years to prepare and act. Such a mission would cost on the order of a few hundred million dollars.

There is no funding for more detection telescopes-these are key to survey threatening NEOs

IRWIN I. SHAPIRO et al in 10,( Harvard-Smithsonian Center for Astrophysics, Chair FAITH VILAS, MMT Observatory at Mt. Hopkins, Arizona, Vice Chair MICHAEL A’HEARN, University of Maryland, College Park, Vice Chair ANDREW F. CHENG, Johns Hopkins University Applied Physics Laboratory FRANK CULBERTSON, JR., Orbital Sciences Corporation DAVID C. JEWITT, University of California, Los Angeles STEPHEN MACKWELL, Lunar and Planetary Institute H. JAY MELOSH, Purdue University JOSEPH H. ROTHENBERG, Universal Space Network, *Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies Space Studies Board Aeronautics and Space Engineering Board Division on Engineering and Physical Sciences*, THE NATIONAL ACADEMIES PRESS, <http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf>)

The second mandate, the George E. Brown, Jr. Near-Earth Object Survey section of the 2005 NASA Authorization Act, directed that NASA detect 90 percent of near-Earth objects 140 meters in diameter or greater by 2020. However, what the surveys actually focus on is not all NEOs, but the potentially hazardous NEOs. It is possible for an NEO to come close to Earth, but to never intersect Earth’s orbit and therefore not be potentially hazardous. The surveys are primarily interested in the potentially hazardous NEOs, and that is the population that is the focus of this chapter. Significant new equipment (i.e., ground-based and/or space-based telescopes) will be required to achieve the latter mandate. Neither the White House budgeted nor Congress approved new funding for NASA to achieve this goal, and little progress on reaching it has been made during the past 5 years.

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Plan: The United States Federal Government should fully fund and implement a space based infrared sensor in a Venus-like orbit for the purposes of asteroid detection

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Observation 2: Solvency

Putting an infrared sensor in a Venus-like orbit would increase detection methods by 180% and could detect PHO’s, which threaten Earth.

Bucknam and Gold in 08 [Mark and Robert “Survival” (00396338); Oct/Nov2008, Vol. 50 Issue 5, p141-156, 16p PN] [PHO - potentially hazardous object]

NASA analysed options for better detecting PHOs, ranging from continuing the current terrestrial-based Spaceguard Survey to putting visual or infrared sensors on satellites in space. The existing Spaceguard techniques have little to contribute to the expanded goal of detecting objects on the scale of 140m, and NASA estimates Spaceguard could only detect approximately 14% of the 140m-or-larger PHOs by 2020,10 well short of Congress’ goal of 90%. The addition of a ground-based telescope, such as the University of Hawaii’s planned Panoramic Survey Telescope and Rapid Response System (PanSTARRS 4)11 or the proposed Large Synoptic Survey Telescope (LSST),12 would boost the results to 75–85%, depending on whether NASA shared the telescope with another agency or supported building an additional copy of its own. The most efficient means of finding PHOs would be to place an infra- red sensor in a Venus-like orbit – that is, 0.7 astronomical units from the sun. By itself such a sensor system could find 90% of PHOs larger than 140m by 2020. Furthermore, a space-based infrared telescope would allow scientists to reduce the uncertainties in determining the size of PHOs to 20% from over 200% for optical telescopes.13 A factor-of-two uncertainty – the limit of accuracy with optical telescopes – equates to a factor-of-eight uncertainty in mass. Because the size and mass of a PHO are important characteristics for assess- ing the danger it could pose, the added performance of a space-based infrared telescope warrants serious consideration. Moreover, an infrared telescope in a Venus-like orbit could efficiently detect PHOs that primarily orbit between the Earth and the Sun; these are difficult to detect from Earth and, according to NASA, have a chance of being perturbed by gravity and becoming a threat. The cost of such a system is on the order of $1bn, and the harsh space environment would likely limit its useful life to around seven to ten years.14

Space based telescopes are key to successful detection-they can operate 24/7 and are more efficient

IRWIN I. SHAPIRO et al in 10,( Harvard-Smithsonian Center for Astrophysics, Chair FAITH VILAS, MMT Observatory at Mt. Hopkins, Arizona, Vice Chair MICHAEL A’HEARN, University of Maryland, College Park, Vice Chair ANDREW F. CHENG, Johns Hopkins University Applied Physics Laboratory FRANK CULBERTSON, JR., Orbital Sciences Corporation DAVID C. JEWITT, University of California, Los Angeles STEPHEN MACKWELL, Lunar and Planetary Institute H. JAY MELOSH, Purdue University JOSEPH H. ROTHENBERG, Universal Space Network, *Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies Space Studies Board Aeronautics and Space Engineering Board Division on Engineering and Physical Sciences*, THE NATIONAL ACADEMIES PRESS, <http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf>)

The 2003 NASA SDT study concluded that an infrared space telescope is a powerful and efficient means of obtaining valuable and unique detection and characterization data on NEOs. The thermal infrared, which denotes wavelengths of light from about 5 to 10 microns, is the most efficient color regime for an NEO search. An orbiting infrared telescope that detects these wavelengths and has a mirror between 0.50 and 1 meter in diameter is sufficient to satisfy the goal of detecting 90 percent of potentially hazardous NEOs 140 meters in diameter or greater. Plus, locating an NEO-finding observatory internal to Earth’s orbit is preferable for identifying NEOs that are inside Earth’s orbit. Specific advantages to space-based observations include: • A space-based telescope can search for NEOs whose orbits are largely inside Earth’s orbit. These objects are difficult to find using a ground-based telescope as observations risk interference from the Sun when pointing to the areas of the sky being searched. • Thermal-infrared observations are immune to the bias affecting the detection of low-albedo objects in visible or near infrared light, by observing the thermal signal from the full image of the NEO, providing more accurate albedo measurements (see discussion above). • Space-based searches can be conducted above Earth’s atmosphere, eliminating the need to calibrate the effects introduced by the atmosphere on the light from an NEO. • Observations can be made 24 hrs/day.

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Early detection is key-the government will need years to decades of preparation to deflect an Earth-threatening asteroid.

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In contrast to other known natural hazards, there has been no significant loss of human life to impacts in historical times, due to the low frequency of major impacts and the higher probability of impact in unpopulated (notably the oceans) than populated regions. Unlike the other hazards in Table 2.2, the hazard statistics for NEOs are dominated by single events with potentially high fatalities separated by long time intervals. Should scientists identify a large life-threatening object on a collision course with Earth, tremendous public resources to mitigate the risk would almost certainly be brought to bear. However, options for effective mitigation become much more limited when threatening objects are identified with only months to years, rather than decades or centuries, before impact. Thus, one of the greatest elements of risk associated with NEOs is the public expectation that governments will protect them against any threat from NEOs, coupled with an unwillingness so far of governments and agencies to expend public funds in a concerted effort to identify, catalogue and characterize as many potentially dangerous NEOs as possible as long before a damaging impact event as feasible.

Long warning times allow successful deflection strategies-even large asteroids can be diverted

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With the same warning time of 40 years as discussed for the gravity tractor, one could launch a series of perhaps ten 10-ton impactors to divert the NEO 30 years before impact for NEOs of order ¾ km in diameter and even more than 1 km for very-low-density NEOs. For a 10-year warning time and a crash program to launch 10 spacecraft in say 4 or 5 years, it might be possible to prevent a collision with a ½- km NEO with the gravity tractor; new, heavy-lift launchers such as the Ares cargo launcher might allow delivering 5 times more massive impactors. Multiple impactors provide robustness against random failures and the opportunity to fine-tune the results by varying the number of impacts. Even a single impactor that could be launched within 6 months might change the orbit of a 100-meter NEO, the size that is near the upper limit for use only of civil defense, with a warning time of only 1 to 2 years. Finding: Kinetic impactors are adequate to prevent impacts on Earth by moderately sized NEOs (many hundreds of meters to 1 kilometer) with decades of advance warning. The concept has been demonstrated in space, but the result is sensitive to the properties of the NEO and requires further study.

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Detection is key to the deflection technology the world will need to survive

Keim 09(How to Defend Earth Against an Asteroid Strike By Brandon Keim March 27, 2009, is a Wired Science reporter and freelance journalist <http://www.wired.com/wiredscience/2009/03/planetdefense/> G.L)

Under NASA’s Near Earth Objects program, six U.S. observatories "search every clear night for these kinds of objects. They are tracked, cataloged and stored," said Steve Chesley, an astronomer at NASA’s Jet Propulsion Laboratory. "NASA’s goal is to find 90 percent of those that are one kilometer across and larger. We’re at 82 percent right now, and we’ve only been aggressively searching at current levels for eight to 10 years. Those ones just haven’t flown into view." Chesley declined to comment on the program’s budgetary status, but other astronomers have called for an expansion of its shoestring $4.1 million budget. Congress asked NASA in 2005 to increase its survey efforts, but then-agency director Michael Griffin refused to divert the estimated $1 billion needed for an overhaul away from other projects. "A survey isn’t something you can do just once and close the book and walk away. Even if you’ve discovered an asteroid, you can only predict out so far … a couple hundred years into the future at most. The asteroids need to continue to be observed," said Chesley. "Without early discovery, there are no options. All the deflection technology in the world will not save you if you haven’t discovered the asteroid before it comes to you."

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Observation 3: An Asteroid Strike would be bad

Asteroid threat is realistic and we need to get ready

Shiga 2009 (David) (New Scientist; 9/26/2009, Vol. 203 Issue 2727, p30-33, 4p)

 They can strike without warning and devastate the planet, so it's time to get asteroids firmly in our sights, says David Shiga IT LOOKS inconsequential enough, the faint little spot moving leisurely across the sky. The mountain-top telescope that just detected it is taking it very seriously, though. It is an asteroid, one never seen before. Rapid-survey telescopes discover thousands of asteroids every year, but there's something very particular about this one. The telescope's software decides to wake several human astronomers with a text message they hoped they would never receive. The asteroid is on a collision course with Earth. It is the size of a skyscraper and it's big enough to raze a city to the ground. Oh, and it will be here in three days. Far-fetched it might seem, but this scenario is all too plausible. Certainly it is realistic enough that the US air force recently brought together scientists, military officers and emergency-response officials for the first time to assess the nation's ability to cope, should it come to pass.

An asteroid impact is inevitable-the magnitude of the impact makes it more important than proliferation, warming, or disease

Lawler in 2k7, Andrew (Discover, *WHAT TO DO BEFORE THE ASTEROID STRIKES*, Nov2007, Vol. 28, Issue 1, Academic Search Premiere, accessed 6/27/2011)

**Amid fears about** global **warming, terrorism**, **disease**, **and** nuclear **proliferation, the threat of rocks from space may seem** more **the province of** bad **Hollywood movies** than front-page news. Even professional astronomers have long dismissed asteroids as undistinguished flotsam and jetsam, would-be planets that circle the sun endlessly in a belt between Mars and Jupiter. Their derision left the field of asteroid hunting largely to amateurs and eccentrics. **Only recently have researchers glimpsed the dangers lurking in our deceptively quiet neighborhood**. "**Impacts are a fact of life** in the universe, but when we look up, it's not what we see," says Carolyn Shoemaker, who, together with her late husband. Gene, pioneered ways of spotting asteroids and comets. It was geologists who first noticed the evidence of huge impact craters on Earth that had formed long after the solar system settled into its present form, prompting biologists to speculate on whether those collisions dramatically altered life's evolution. Later, using new technologies on the ground as well as robotic spacecraft, scientists like Shoemaker started to track, catalog, and closely examine the objects. With each new sighting, asteroids turn out to be far more varied, unruly, and bizarre than astronomers dreamed. Many have companions. Some are rubble heaps held together only loosely by their own gravity. Others are extremely dense nickel-iron objects. Their colors can range from a deep dark chocolate to a glinty white. Even the old distinction between comets (dirty snowballs) and asteroids (hard rocks) has become blurred. Some comets eventually turn into asteroids as they burn off their ice and lose their tails while traveling through the warm inner solar system. And comets — which mostly reside in the solar system's far fringes — pop up occasionally in the asteroid belt, They may even be directly responsible for life on Earth. Donald Yeomans, who calculates the orbits for near-Earth objects at NASA's Jet Propulsion Laboratory, says that comets flung out from that belt pummeled our planet shortly after its formation and could have left behind water, possibly creating the conditions that allowed Earth to become a cradle for life. The vast bulk of asteroids — millions of individual objects ranging from 560-mile-wide Ceres to pea-size pieces of space shrapnel — reside in a broad zone between the orbits of Mars and Jupiter, the legendary asteroid belt. If pulled together, all this material would form a mass smaller than Earth's moon, but the immense gravitational force of Jupiter prevents the bits from coalescing into a solid planet. When the rocks approach Jupiter, the occasional asteroid can find itself pushed out of the procession and into deep space; some spin out beyond Pluto's orbit, while others fall toward the sun, each with its own unique orbit. Some even find a home around other planets. Mars's two moons, Phobos and Deimos — along with several of Jupiter's and Saturn's satellites — may be captured asteroids. **What most** interests and **worries scientists** like Chesley and Yeomans, however, **are near-Earth asteroids** — those with orbits disconcertingly close. **Members of this class** apparently **ushered the dinosaurs off the** evolutionary **stage 65 million years ago** and left a three-quarter-mile-wide hole in the Arizona desert less than 50,000 years ago. A few scientists think a near-Earth asteroid on a bull's-eye path might even have reshaped human history (see "Did a Comet Cause the Great Flood?" page 66). **Somewhere in space, one of their kind is orbiting its way to an inevitable rendezvous with Earth: The question isn't if we will be struck again, but when**. **There are scattered reports of deaths by meteorites through recorded history,** like a Chinese chronicle asserting that thousands died during a 1490 meteor shower **One prediction is indisputable: With growing populations comes greater risk. Had the 1908 impact in Siberia landed in an urban area, for example, it would have been as devastating as the 2004 Indian Ocean tsunami**.

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Magnitude outweighs – there’s a difference between existential and non-existential threats

Matheny ‘7 (Jason G Matheny, Prof of Health Policy and Management at the Bloomberg School of Public Health at Johns Hopkins University, “Reducing the Risk of Human Extinction,” Risk Analysis Volume 27 Number 5, Oct. 15 2007, http://www.upmc-biosecurity.org/website/resources/publications/2007\_orig-articles/2007-10-15-reducingrisk.html, TDA)

Even if extinction events are improbable, the expected values of countermeasures could be large, as they include the value of all future lives. This introduces a discontinuity between the CEA of extinction and nonextinction risks. Even though the risk to any existing individual of dying in a car crash is much greater than the risk of dying in an asteroid impact, asteroids pose a much greater risk to the existence of future generations (we are not likely to crash all our cars at once) (Chapman, 2004 ). The "death-toll" of an extinction-level asteroid impact is the population of Earth, plus all the descendents of that population who would otherwise have existed if not for the impact. There is thus a discontinuity between risks that threaten 99% of humanity and those that threaten 100%.

**A single asteroid collision is capable of doing more damage than all nuclear weapons in existence combined. Kunich 97 (Lieutenant Colonel John C.,** Staff Judge Advocate, 50th Space Wing, Falcon Air Force Base, Colorado, Air Force Law Review, 41 A.F. L. Rev. 119, accessed through Lexis, NB)

If you were standing on Kosrae Island off the New Guinea coast on February 1, 1994, you would have seen a blast in the sky as bright as the Sun. This was **caused by a small meteor entering Earth's atmosphere at 15 kilometers per second** (roughly 33,500 miles per hour). Fortunately for you and everyone else nearby, the meteor exploded at high altitude, over a sparsely populated region; **the blast had the force of 11 kilotons of TNT**. n1 This was not your first near-death experience. **On March 23, 1989, an asteroid about 800 meters in diameter narrowly missed the Earth** (by about 6 hours' difference in relative position). **If this asteroid had struck the Earth, the impact would have released energy equivalent to about 40,000 megatons of TNT, or 2,000 standard-size hydrogen bombs.** n2 On an even larger scale, **on December 8, 1992, a large asteroid named Toutatis missed hitting this planet by only two lunar distances.** This was a very lucky day for everyone on Earth, because Toutatis is nearly 4 kilometers in diameter. **n3 If it had hit us, the force of the collision would have generated more energy than all the nuclear weapons in existence combined-approximately 9 million megatons of TNT**.

Scenario: Ice Age

A massive asteroid impact has empirically caused an ice age

Science Daily 07(Extraterrestrial Impact Likely Source Of Sudden Ice Age Extinctions, ScienceDaily (Sep. 25, 2007), <http://www.sciencedaily.com/releases/2007/09/070924172959.htm>, G.L)

In the Proceedings of the National Academy of Sciences, the international team lays out its theory that the mass extinctions in North America were caused by one or more extraterrestrial objects – comets or meteorites – that exploded over the Earth or slammed into it, triggering catastrophic climate change. The scientists believe that evidence for these extraterrestrial impacts is hidden in a dark layer of dirt sometimes called a black mat. Found in more than 50 sites around North America, this puzzling slice of geological history is a mere three centimeters deep and filled with carbon, which lends the layer its dark color. This black mat has been found in archaeological digs in Canada and California, Arizona and South Carolina – even in a research site in Belgium. The formation of this layer dates back 12,900 years and coincides with the abrupt cooling of the Younger Dryas period, sometimes called the “Big Freeze.” This coincidence intrigued the researchers, led by Richard Firestone of Lawrence Berkeley National Laboratory, who thought that the black mat might be related to the mass extinctions. So the researchers studied black mat sediment samples from 10 archaeological sites dating back to the Clovis people, the first human inhabitants of the New World. Researchers conducted geochemical analysis of the samples to determine their makeup and also ran carbon dating tests to determine the age of the

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samples. Directly beneath the black mat, researchers found high concentrations of magnetic grains containing iridium, charcoal, soot, carbon spherules, glass-like carbon containing nanodiamonds and fullerenes packed with extraterrestrial helium – all of which are evidence for an extraterrestrial impact and the raging wildfires that might have followed. Schultz, professor of geological sciences at Brown and an impact specialist, said the most provocative evidence for an extraterrestrial impact was the discovery of nanodiamonds, microscopic bits of diamond formed only from the kind of intense pressure you’d get from a comet or meteorite slamming into the Earth. “We don’t have a smoking gun for our theory, but we sure have a lot of shell casings,” Schultz said. “Taken together, the markers found in the samples offer intriguing evidence that North America had a major impact event about 12,900 years ago.” Schultz admits that there is little decisive evidence about the actual details about the impact and its effects. Scientists suspect that a carbon-rich asteroid or comets were the culprits. The objects would have exploded over North America or slammed into it, or both, shattering and melting ice sheets, sparking extreme wildfires, and fueling hurricane-force winds – all of which could have contributed to changes in climate that led to the cooling of the Younger Dryas period. “Our theory isn’t a slam dunk,” Schultz said. “We need to study a lot more sediments to get a lot more evidence. But what is sobering about this theory of ours is that this impact would be so recent. Not so long ago, something may have fallen from the sky and profoundly changed our climate and our culture.” The U.S. Department of Energy and the National Science Foundation funded the work.

An ice age would incite mass migrations that’d culminate in violence. As a deterrence some countries would declare wars; and others would run scarce of resources because of overpopulation.

Bingel in 7

(Dr. Ferit, Middle East Technical University of Marine Sciences, May 25 Ice Age Possible for Scandinavia?; behav.org)

Within recent months, the Pentagon has released a study about the climate changing and the effect it would have on the world. An abrupt temperature change would come eventually and it would be inevitable. The study was based on information from 8200 years ago when the earth went through the same change. A sudden cooling of the earth appeared after a long, extended heat wave. At this time, the Gulf Stream collapsed. Because of this past data, the study suggests the fate of Europe. Although there is no way to make sure that the information can be used to foresee what will happen to the present day, the study does suggest some startling possibilities. The collapse of the Stream would be more visible in northern Europe for the first five years. The annual rainfall would decrease by 30%, causing a severe drought. An increase in wind would cause the temperature to drop about six degrees. Snow would remain on the ground, making Scandinavia in a constant winter phase. The cold would stretch onto the latter months making the summer cooler then before. Humans could neither develop agriculture or permanant settlements and in turn would move southward onto other parts of Europe, being pushed by the colder, unstable temperature from home. As the population moves, fights and even battles would break out within the mass migration. Resources within other countries would decline because of the sudden increase in population within their own country.  In defense, some countries would declare war. Not only would a climatic change move the population, but the fish, wildlife, water and energy consumption all would be effected. By the end of the decade, Europe's weather would be more of a mirror image of Siberia's or northern Canada's then what it looked like in the past. Unfortunately, the duration of this process could take decades and even centuries.

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Scenario: Miscalculation

**Accidents inevitable without asteroid detection: can be mistaken as a missile strike or nuclear detonation, sparking nuclear conflict.**

Correll ‘3 (national security consultant, former U.S. Air Force space project, PhD in physics from University of Texas, “National Security Implications of the Asteroid Threat” 2/4/03, [www.marshall.org/pdf/materials/120.pdf](http://www.marshall.org/pdf/materials/120.pdf), AG)

In addition to the damage an asteroid impact could cause directly, some researchers have suggested another danger: a small asteroid could be mistaken for a missile strike and precipitate a nuclear conflict. The United States military currently has technology to differentiate between missile attacks, nuclear detonations and asteroid explosions, but many less advanced nations do not. It would seem to be in our nation's best interest to pursue some course of action to prevent the accidental nuclear reprisal by one country against a neighbor based on the mistaken perception that an asteroid impact was a nuclear attack. Could a warning and reporting system be put in place to prevent such a disaster? Before answering this question, it is important to understand the technical, organizational, and diplomatic issues involved.

Nuclear war from miscalc highly probable due to hair-trigger launch policies and failing warning systems – specific to asteroids.

Moore 07 (Carol, anti-nuclear political activist, “Is World Nuclear War Inevitable?” <http://carolmoore.net/nuclearwar/#Accidental> November 2007) JM

Needless to say, the possibility of accidental nuclear war between the United States and Russia increases in an atmosphere of threats and counter-threats, especially relating to specific incidents or ongoing wars -- and especially given Russia's broken down radar and satellite early warning system which cover only a part of Russia's 11 time zones at any one time. Computer and radar glitches, misinterpreted missile launches, unexpected large asteroid explosions -- not to mention a nuclear detonation of unknown origin on either nation -- could lead to a nuclear exchange between the U.S. and Russia. Both nations have only a few short minutes to decide if a real attack is under-way. Launch on Warning "Hair Trigger" Alert The U.S. and Russia both have a nuclear policy of “launch on warning”--a "hair-trigger" alert system. This means that less than 15 minutes after detecting a missile attack -- real or false -- through radar and satellite early warning systems these nation's militaries must launch their 5,000 on-alert nuclear weapons or possibly loose them to a first strike by the other side. And of this 15 minutes, only two or three minutes are allowed for actual deliberation by the Presidents of the United States or Russia. Barely time to get a phone call through on their "red telephones." See a relevant video.

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Accidental launch/miscalc leads to full-scale nuclear war.

**Rosenberg 06** [staff writer“Experts Warn of Accidental Atomic War” http://www.sfgate.com/cgi-bin/article.cgi?file=/c/a/2006/10/06/MNGF9LJSMM1.DTL]

A Pentagon project to modify its deadliest nuclear missile for use as a conventional weapon against targets such as North Korea and Iran could unwittingly spark an atomic war, two weapons experts warned Thursday. Russian military officers might misconstrue a submarine-launched conventional D5 intercontinental ballistic missile and conclude that Russia is under nuclear attack, said Ted Postol, a physicist and professor of science, technology and national security policy at the Massachusetts Institute of Technology, and Pavel Podvig, a physicist and weapons specialist at Stanford. "Any launch of a long-range nonnuclear armed sea or land ballistic missile will cause an automated alert of the Russian early warning system," Postol told reporters. The triggering of an alert wouldn't necessarily precipitate a retaliatory hail of Russian nuclear missiles, Postol said. Nevertheless, he said, "there can be no doubt that such an alert will greatly increase the chances of a nuclear accident involving strategic nuclear forces." Podvig said launching conventional versions of a missile from a submarine that normally carries nuclear ICBMs "expands the possibility for a misunderstanding so widely that it is hard to contemplate." Mixing conventional and nuclear D5s on a U.S. Trident submarine "would be very dangerous," Podvig said, because the Russians have no way of discriminating between the two types of missiles once they are launched. Russian President Vladimir Putin warned that the project would increase the danger of accidental nuclear war. "The media and expert circles are already discussing plans to use intercontinental ballistic missiles to carry nonnuclear warheads," he said in May. "The launch of such a missile could ... provoke a full-scale counterattack using strategic nuclear forces." Accidental nuclear war is not so far-fetched. In 1995, Russia initially interpreted the launch of a Norwegian scientific rocket as the onset of a U.S. nuclear attack. Then-President Boris Yeltsin activated his "nuclear briefcase" in the first stages of preparation to launch a retaliatory strike before the mistake was discovered. The United States and Russia have acknowledged the possibility that Russia's equipment might mistakenly conclude the United States was attacking with nuclear missiles. In 1998, the two countries agreed to set up a joint radar center in Moscow operated by U.S. and Russian forces to supplement Russia's aging equipment and reduce the threat of accidental war. But the center has yet to open. A major technical problem exacerbates the risk of using the D5 as a conventional weapon: the decaying state of Russia's nuclear forces. Russia's nuclear missiles are tethered to early warning radars that have been in decline since the dissolution of the Soviet Union in 1991. And Russia, unlike the United States, lacks sufficient satellites to supplement the radars and confirm whether missile launches are truly under way or are false alarms. The scenario that worries Postol, Podvig and other weapons experts is what might happen if the United States and North Korea come to blows and a conventional D5 is launched against a target there from a submerged Trident submarine. Depending on the sub's location, the flying time to Russia could be under 15 minutes so the Russians would have little time to confirm the trajectory -- using decaying equipment -- before deciding to launch a nuclear strike on the United States.

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And an asteroid impact can independently cause extinction

Chapman 04 (Clark R., planetary scientist, first editor of Journal of Geophysical Research- Planets, PhD MIT, Frontiers, The hazard of near – Earth asteroid impacts on earth, <http://www.b612foundation.org/papers/Chapman_hazard_EPSL.pdf>, Google scholar, NC)

I briefly summarize three scenarios (drawn from many more in [63]), which illustrate the breadth of issues that must be confronted in managing potential consequences of NEA impacts. For each impact disaster scenario, I consider the nature of the devastation, the probability that the event will happen, the likely warning time, the possibilities for post-warning mitigation, the nature of issues to be faced in after-event disaster management, and—of most practical interest—what can be done now to prepare in advance. 6.1. 2–3 km diameter civilization destroyer A million-megaton impact, even though f100 times less energetic than the K–T impact, would probably destroy civilization as we know it. The dominant immediate global effect would be sudden cooling, lasting many months, due to massive injection of dust into the stratosphere following impact. Agriculture would be largely lost, worldwide, for an entire growing season. Combined with other effects (a firestorm the size of India, destruction of the ozone layer, etc.), it is plausible that billions might die from collapse of social and economic institutions and infrastructure. No nation could avoid direct, as well as indirect, consequences of unprecedented magnitude. Of course, because civilization has never witnessed such an apocalypse, predictions of consequences are fraught with uncertainty. As discussed earlier, few bodies of these sizes 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 a NEA, but 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 the NEA so that it would miss the Earth; however, moving such a massive object 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 climate 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 purposes: considering such an 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. 6.2. Once-in-a-century mini-Tunguska atmospheric explosion Consider a 30–40-m office-building-sized object striking at 100 times the speed of a jetliner. It would explode f15 km above ground, releasing the energy of f100 Hiroshima-scale bombs. Weak structures would be damaged or destroyed by the blast wave out to 20 km. The death toll might be hundreds; although casualties would be far higher in a densely populated place, they would much more likely be zero (i.e., if the impact were in the ocean or a desolate location). Such an event is likely to occur in our grandchildren’s lifetime, although most likely over the ocean rather than land. Even with the proposed augmented Spaceguard Survey, it is unlikely that such a small object would be discovered in advance; impact would occur without warning. Since it could occur literally anywhere, there are no location- specific kinds of advance measures that could or should be taken, other than educating people (perhaps especially military forces that might otherwise mistake the event as an intentional attack) about the possibilities for such atmospheric explosions. In the lucky circumstance that the object is discovered years in advance, a relatively modest space mission could deflect such a small body, preventing impact [26

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Scenario: Ocean Strike

Asteroid is likely to hit the ocean – creates huge tsunami waves, according to computer simulations.

Stephens 03 (Tim, Staff Writer @ UC Santa Cruz, “Massive tsunami sweeps Atlantic Coast in asteroid impact scenario for March 16, 2880” <http://news.ucsc.edu/2003/05/355.html> May 27, 2003) JM

If an asteroid crashes into the Earth, it is likely to splash down somewhere in the oceans that cover 70 percent of the planet's surface. Huge tsunami waves, spreading out from the impact site like the ripples from a rock tossed into a pond, would inundate heavily populated coastal areas. A computer simulation of an asteroid impact tsunami developed by scientists at the University of California, Santa Cruz, shows waves as high as 400 feet sweeping onto the Atlantic Coast of the United States. The researchers based their simulation on a real asteroid known to be on course for a close encounter with Earth eight centuries from now. Steven Ward, a researcher at the Institute of Geophysics and Planetary Physics at UCSC, and Erik Asphaug, an associate professor of Earth sciences, report their findings in the June issue of the Geophysical Journal International

Tsunami caused by asteroid would collapse the global economy

Gilster 07(Paul Gilster is the author of “Centauri Dreams: Imagining and Planning Interstellar Exploration” and writer for the Tau Zero Foundation. “*Sizing up the Asteroid Threat*”, April 3 2007, http://www.centauri-dreams.org/?p=1146, TDA)

Indeed, while a 100 meter asteroid could cause relatively localized damage across several countries, doubling the object to 200 meters causes tsunamis on a global scale, assuming an oceanic hit. In terms of casualties, the study sees China, Indonesia, India, Japan and the US as the most vulnerable, though obviously a direct hit on any heavily populated area would be catastrophic. Economically speaking, where the infrastructure is tells much of the tale. Put dense development along the coastlines of economically prosperous areas and you open yourself to the threat of tsunamis and earthquakes emmanating from a wide variety of impact areas. Sweden’s long coastline thus places it in high danger economically, while an impact in the north Atlantic could send devastating tsunamis into both Europe and America. Severe economic effects would clearly result from a strike involving China or Japan. Although we’re currently engaged through projects like the Spaceguard survey in cataloguing NEOs larger than one kilometer in diameter, the smaller objects represented in the Southampton study are largely undetected. The risk of being blindsided by such an object emphasizes our need to develop a space-based observation platform for tracking asteroids of this size, along with providing more accurate information about the movements of larger Earth crossers. Bailey again: “The threat of the Earth being hit by an asteroid is increasingly being accepted as the single greatest natural disaster hazard faced by humanity.”

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Economic downturn causes global war

Mead 9 (Henry , Sr fellow in U.S. Foreign Policy at the Council on Foreign Relations, *The New Republic*, 2/4/09, http://www.tnr.com/politics/story.html?id=571cbbb9-2887-4d81-8542-92e83915f5f8&p=2) ET

So far, such half-hearted experiments not only have failed to work; they have left the societies that have tried them in a progressively worse position, farther behind the front-runners as time goes by. Argentina has lost ground to Chile; Russian development has fallen farther behind that of the Baltic states and Central Europe. Frequently, the crisis has weakened the power of the merchants, industrialists, financiers, and professionals who want to develop a liberal capitalist society integrated into the world. Crisis can also strengthen the hand of religious extremists, populist radicals, or authoritarian traditionalists who are determined to resist liberal capitalist society for a variety of reasons. Meanwhile, the companies and banks based in these societies are often less established and more vulnerable to the consequences of a financial crisis than more established firms in wealthier societies. As a result, developing countries and countries where capitalism has relatively recent and shallow roots tend to suffer greater economic and political damage when crisis strikes--as, inevitably, it does. And, consequently, financial crises often reinforce rather than challenge the global distribution of power and wealth. This may be happening yet again. None of which means that we can just sit back and enjoy the recession. History may suggest that financial crises actually help capitalist great powers maintain their leads--but it has other, less reassuring messages as well. If financial crises have been a normal part of life during the 300-year rise of the liberal capitalist system under the Anglophone powers, so has war. The wars of the League of Augsburg and the Spanish Succession; the Seven Years War; the American Revolution; the Napoleonic Wars; the two World Wars; the cold war: The list of wars is almost as long as the list of financial crises. Bad economic times can breed wars. Europe was a pretty peaceful place in 1928, but the Depression poisoned German public opinion and helped bring Adolf Hitler to power. If the current crisis turns into a depression, what rough beasts might start slouching toward Moscow, Karachi, Beijing, or New Delhi to be born? The United States may not, yet, decline, but, if we can't get the world economy back on track, we may still have to fight.

An ocean asteroid strike is more likely, and depletes the ozone layer leading to high UV rays – causes food shortage, disease, and burning.

Edwards 10 (Lin, science-specialized news reporter for Physorg, “Asteroid strike into ocean could deplete ozone layer” October 27, 2010 <http://www.physorg.com/news/2010-10-asteroid-ocean-deplete-ozone-layer.html>) JM

Scientists in Texas say if a medium-sized asteroid were to crash into the ocean the ozone layer could be depleted, allowing high levels of ultraviolet radiation to reach the surface. Dr. Elisabetta Pierazzo and colleagues from the Planetary Science Institute in Tucson ran computer simulations that revealed if an asteroid 500 m to 1 km in diameter were to hit the Pacific Ocean it would eject enough water vapor and sea salt high enough into the atmosphere to affect the protective ozone layer. The results of the simulations showed the 1 km asteroid could affect an area over 1000 km in diameter, and vast quantities of water and vapor would be ejected up to 160 km high. The scientists say the water vapor would contain chlorine and bromine from the vaporized sea salts, and this would result in significant global depletion of the ozone layer by destroying it faster than it is created naturally. Pierazzo said such an asteroid would produce “an ozone hole that will engulf the entire Earth,” and produce a huge spike in ultraviolet (UV) radiation with levels higher than anywhere on the surface today. The simulations showed the smaller asteroid, 500 meters across, could produce ultraviolet index (UVI) levels of 20 or over in the northern tropics for a period of several months, and the global ozone depletion would be similar to the record ozone holes seen over the Antarctic in the mid 1990s. The 1 km asteroid could produce a spike of 56, and levels over 20 for about two years in both the northern and southern hemispheres. The UVI is a measure of UV intensity, with levels over 10 assumed dangerous. The highest recorded UVI known in recent times has been 20. Pierazzo said previous studies of the effects of asteroid impacts on the ocean have concentrated on tsunamis, but her research found the effects of a medium-sized asteroid strike would also include difficulty in growing crops and would have a long-term negative effect on global food production. She said if there was enough warning of an impending, strike farmers could plant crops with high UV-tolerance and food could be stored to ensure supplies during the period of low productivity. Other effects would include increased rates of skin cancer and cataracts. People may also have to avoid exposure to direct sunlight to avoid rapid sunburn. A UVI level of 56 has never been experienced, and so the effects are uncertain, but it is likely that people would have to remain indoors during daylight to avoid serious sunburn. The study said over 100 asteroids 1 to 2 km in diameter are thought to be orbiting in

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paths that could bring them near to Earth, and many more smaller asteroids appear to be “currently looming undiscovered in the Earth’s neighborhood.” NASA estimates there are around 800 such Near Earth Objects (NEOs). The authors say past research suggests on average an asteroid 500 meters wide or less hits the Earth about once every 200,000 years, while a larger asteroid strike happens around once every 800,000 years. The research covered only the impact of an asteroid hitting the ocean, since such strikes are twice as likely to occur as land impacts. The results are published in the journal Earth and Planetary Science Letters.

**UVB rays threaten kill phytoplankton which vastly decreases biodiversity**

**World Health Oganization 94** (Environmental Health Criteria 160, *Ultraviolet Radiation*, date n/a, http://www.inchem.org/documents/ehc/ehc/ehc160.htm#SectionNumber:11.2, znf)

11.3.1 Effects on phytoplankton Recent UVB aquatic research has concentrated on phytoplankton and the Antarctic ecosystem. As shown in figure 11.2, phytoplankton is at the base of the aquatic food chain/trophic structure and serves as food for primary consumers (e.g., larvae of fish and shrimp), which in turn are consumed by secondary and tertiary consumers (e.g. fish). The production of phytoplankton has been estimated at about 6 x 1014 kg (UNEP, 1989). A loss of 10% would far exceed the gross national product of all countries in the world, assuming any reasonable price for biomass on the market. table 11.1 gives the estimated annual biomass production for plankton and fish. Table 11.1 Estimated annual biomass production at different levels in marine food web and possible loss after 10% decrease at the phytoplankton level (adapted from UNEP 1989 report) Concentrations of phytoplankton in subpolar waters may be 103 to 104 times greater than concentrations of phytoplankton found in tropical and subtropical seas (Jeffery & Humphrey, 1975). Any significant increase in UVB could well diminish growth and productivity of phytoplankton, subsequently affecting all higher trophic levels in the aquatic food web. Therefore, it is not surprising that a majority of recent research has looked at the effects of increased UVB exposure in Antarctic waters. Ongoing research activities include investigations of both direct (physiological and behavioural) and indirect (trophic implications) effects. Phytoplankton dwell in the top layers of the water column (the photic zone) because of their requirement for solar energy (Ignatiades, 1990). Their position within the column is maintained by precise orientation strategies using light, gravity and other external factors as guides. Phytoplankton in the photic zone would be exposed to any increase in solar UV. Most phytoplankton organisms do not possess UVB photoreceptors to guide them away from harmful UV, a situation similar to humans. Previous work demonstrated that mobility/orientation mechanisms in response to light are impaired by solar UV (Häder & Worrest, 1991; Baker & Smith, 1982). The ability of phytoplankton to adjust their position within the water column, in response to constantly changing conditions, may even be affected at ambient UVB levels. Although ambient UVB fluxes may cause damage to some species of phytoplankton, it should be emphasized that there are uncertainties regarding the magnitude of these effects. These included problems of extrapolating laboratory findings to the open sea and the nearly complete absence of data on long-term effects and ecosystem responses. Likewise, there is a need to investigate adaptation mechanisms. Before effects of exposure to solar UVB can be predicted, information is required on seasonal abundances and vertical distributions of marine organisms, vertical mixing, and the penetration of UVB into appropriate water columns. In their natural habitats, organisms are exposed to a wide range of UVB intensities. This radiation has been shown to affect growth, photosynthesis, nitrogen incorporation, and enzyme activity (Döhler & Alt, 1989; Döhler, 1990).

**Ocean destruction will ensure planetary extinction**

**Craig 03** [Robin Kundis,Associate Professor at Indiana University School of Law “Taking Steps Toward Marine Wilderness Protection”, McGeorge Law Review, Winter, 34 McGeorge L. Rev. 155]

 Biodiversity and ecosystem function arguments for conserving marine ecosystems also exist, just as they do for terrestrial ecosystems, but these arguments have thus far rarely been raised in political debates. For example, besides significant tourism values - the most economically valuable ecosystem service coral reefs provide, worldwide - coral reefs protect against storms and dampen other environmental fluctuations, services worth more than ten times the reefs' value for food production. 856 Waste treatment is another significant, non-extractive ecosystem function that intact coral reef ecosystems provide. 857 More generally, "ocean ecosystems play a major role in the global geochemical cycling of all the elements that represent the basic building blocks of living organisms, carbon, nitrogen, oxygen, phosphorus, and sulfur, as well as other less abundant but necessary elements." 858 In a very real and direct sense, therefore, human degradation of marine ecosystems impairs the planet's ability to support life***.*** Maintaining biodiversity is often critical to maintaining the functions of marine ecosystems. Current evidence shows that, in general, an ecosystem's ability to keep functioning in the face of disturbance is strongly dependent on its biodiversity, "indicating that more diverse ecosystems are more stable." 859 Coral reef ecosystems are particularly dependent on their biodiversity. [\*265] Most ecologists agree that the complexity of interactions and degree of interrelatedness among component species is higher on coral reefs than in

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any other marine environment. This implies that the ecosystem functioning that produces the most highly valued components is also complex and that many otherwise insignificant species have strong effects on sustaining the rest of the reef system. 860 Thus, maintaining and restoring the biodiversity of marine ecosystems is critical to maintaining and restoring the ecosystem services that they provide. Non-use biodiversity values for marine ecosystems have been calculated in the wake of marine disasters, like the Exxon Valdez oil spill in Alaska. 861 Similar calculations could derive preservation values for marine wilderness. However, economic value, or economic value equivalents, should not be "the sole or even primary justification for conservation of ocean ecosystems. Ethical arguments also have considerable force and merit." 862 At the forefront of such arguments should be a recognition of how little we know about the sea - and about the actual effect of human activities on marine ecosystems. The United States has traditionally failed to protect marine ecosystems because it was difficult to detect anthropogenic harm to the oceans, but we now know that such harm is occurring - even though we are not completely sure about causation or about how to fix every problem. Ecosystems like the NWHI coral reef ecosystem should inspire lawmakers and policymakers to admit that most of the time we really do not know what we are doing to the sea and hence should be preserving marine wilderness whenever we can - especially when the United States has within its territory relatively pristine marine ecosystems that may be unique in the world. We may not know much about the sea, but we do know this much: if we kill the ocean we kill ourselves, and we will take most of the biosphere with us. The Black Sea is almost dead, 863 its once-complex and productive ecosystem almost entirely replaced by a monoculture of comb jellies, "starving out fish and dolphins, emptying fishermen's nets, and converting the web of life into brainless, wraith-like blobs of jelly." 864 More importantly, the Black Sea is not necessarily unique.

\*\*Inherency\*\*

# Current Programs Fail

**No working PHO deflection method in the status quo.**

Bradley et al 2010 [P. A.; Plesko, C. S.; Clement, R. R. C.; Conlon, L. M.; Weaver, R. P.; Guzik, J. A.; Pritchett-Sheats, L. A.; Huebner, W. F.; American Institute of Physics Conference Proceedings; 1/28/2010, Vol. 1208 Issue 1, p430-437, Los Alamos National Laboratory, PN] [PHO - potentially hazardous object]

In this paper, we describe the threat posed PHOs and mention how they are different from other natural disasters in two important respects. First, a large enough (greater than 1-km diameter) object has the potential to destroy civilization. At 10 km, a PHO would be roughly the size of the K/T impactor and would cause mass extinctions, including possibly that of humanity itself. Unlike other natural disasters where at best we can evacuate an affected area and deal with the damage afterwards, **humanity has the potential to deflect a PHO before it collides with the Earth. There are many ways possible to accomplish this mitigation, but we feel that chemical explosives, kinetic energy impactors, and nuclear munitions are the only technologies that are readily available for the near term.** Of these, we focus on nuclear munitions because they offer the most concentrated source of energy per unit mass. We must emphasize that deflection is our preferred option because we cannot reliably predict the fragmentation and dispersal of an asteroid.

We also describe our technical work on the possibility of using nuclear munitions for deflecting an asteroid or comet nucleus on a collision course with Earth. Our calculations of nuclear bursts with energies of 10, 100, and 1000 kt on spheres 100 m in diameter show that we can impart impulses of up over 500 cm/s. We also show that the composition of the target and distance of the burst from the target have considerable impact on the final center of mass velocity. However, **these calculations do not yet include the material strength of the body, porosity, fractures, or irregularly shaped objects.** We are starting to run calculations that use the shape of asteroid 25143 Itokawa as an example of an irregularly shaped object. **Much work remains to be done and the ultimate goal of our project is to create a catalog of deflection simulations where we vary the distance, magnitude, and targeting of the burst from PHOs of different sizes, shapes, internal structure, and compositions** (Huebner *et al*., 2009). This catalog would provide a playbook that decision-makers can use to guide the range of possible responses to a given PHO threat.

Asteroid detection methods fail in multiple areas of the Status Quo.

Bradley et al 2010 [P. A.; Plesko, C. S.; Clement, R. R. C.; Conlon, L. M.; Weaver, R. P.; Guzik, J. A.; Pritchett-Sheats, L. A.; Huebner, W. F.; American Institute of Physics Conference Proceedings; 1/28/2010, Vol. 1208 Issue 1, p430-437, Los Alamos National Laboratory, PN]

Although we have come a long ways since the Tunguska event of June 30, 1908, there is still much we do not know. Even when finished, planned surveys will still not be complete for objects smaller than 140 meters. Such an asteroid or comet nucleus would be large enough to wipe out an area from New York City to Washington, D.C. Objects smaller than about 140 meters will be difficult to detect with much advance warning simply because they are extremely faint except when they are close to Earth. Although we sent probes to several asteroids and comets, we only have detailed information for a few. We also do not have detailed knowledge of the internal structure of asteroids, especially ones of order 10 to 1000 meters in diameter. An asteroid’s response to an impulsive energy burst --- whether it be high explosives, kinetic energy impactor, or nuclear burst --- will be sensitive to both the composition (ice, rock, rock/ice, or iron) and structure (monolithic piece, fractured, or rubble pile) of the body. While we may be able to determine at least the surface composition of a PHO in advance, we may not be able to determine the internal structure in advance. Any mitigation strategy must account for this uncertainty.

# Current Programs Fail

**Current funding and technology inadequate - NASA will miss 2020 deadline on mandate**

Clark 10 (Stephen, writer, Spaceflight Now, “More Funding Needed to Meet Asteroid Funding Mandate”, January 22nd, 2010, Accessed 7/2/11, AH)

NASA is not doing enough to complete a mandated search for Earth-threatening asteroids and comets because the space agency is not receiving enough money for the problem, according to a National Research Council report. In a report released Friday, scientists said Congress and the administration have not requested or appropriated funding to complete a survey mandated in the NASA Authorization Act of 2005. Called the George E. Brown, Jr., Near-Earth Object Survey, the detection program was tasked with discovering 90 percent of Near-Earth Objects, or NEOs, larger than 140 meters, or 459 feet, by 2020. NEOs of that size would have regional or continental affects if they struck Earth. "You have this conflict between having a very small probability of anything bad happening, versus a terrific impact if there is a bad event," said Irwin Shapiro, chairman of the NEO committee from the Harvard-Smithsonian Center for Astrophysics. Congress asked the National Research Council in 2008 to determine the best way to achieve the George Brown survey. "If there were really a credible threat, money would flow like water, but it may be too late if we don't do anything preparing ahead of time," Shapiro told Spaceflight Now in a Friday interview. NASA currently spends about $4 million per year searching for NEOs, but accomplishing the George Brown survey by the 2020 deadline is now unattainable. "To complete the George Brown survey, you're probably talking about something like $50 million a year, at least to complete it in a reasonable time scale," said Michael A'Hearn, the research committee's vice chairman and an astronomy professor at the University of Maryland, College Park. Knowing where threatening objects are and developing viable mitigation strategies is like buying insurance on your house, Shapiro said. With current technologies, it may take up to a century to find the bulk of the 140-meter class asteroids, according to scientists. "There's no way to do it by 2020 now because there's been no funding for it since it was mandated," A'Hearn said. NASA is close to completing the Spaceguard project, another legislative mandate to find 90 percent of NEOs larger than 1 kilometer, or about 3,300 feet, in diameter. Such objects are large enough to have global affects if they impact Earth. More than 6,700 NEOs have been discovered to date, including more than 800 objects greater than 1 kilometer in size, according to a NASA Web site. A'Hearn said there are no known large objects that pose a credible threat to Earth within the next century, but there are plenty of smaller asteroids that still have not been detected. "If we were to discover one that is about to hit us, we wouldn't know what to do. In that sense, no one is doing enough," A'Hearn said in an interview Friday.

# Not Enough Funding

Current funding is insufficient - more funding from Congress is key

Atkinson 10 (Nancy, Senior Editor, universetoday.com, Asteroid Detection, Deflection Needs More Money, Report Says , January 22nd, 2010, accessed 6/29/11, AH)

Are we ready to act if an asteroid or comet were to pose a threat to our planet? No, says [a new report](http://www.nap.edu/catalog.php?record_id=12842)from the National Research Council. Plus, we don’t have the resources in place to detect all the possible dangerous objects out there. The report lays out options NASA could follow to detect more near-Earth objects (NEOs) that could potentially cross Earth’s orbit, and says. the $4 million the U.S. spends annually to search for NEOs is insufficient to meet a congressionally mandated requirement to detect NEOs that could threaten Earth “To do what Congress mandated NASA to do is going to take new technology, bigger telescopes with wider fields,” said Don Yeomans, Manager of NASA’s Near Earth Object Program Office, speaking at the American Geophysical Union conference last month. However, Yeomans said work is being done to improve the quality and quantity of the search for potentially dangerous [asteroids](http://www.universetoday.com/32459/asteroids/) and [comets](http://www.universetoday.com/40186/comets/). “We have a long term goal to have three more 1.8 meter telescopes,” he said, “and the Large Synoptic Survey [Telescope](http://www.universetoday.com/14424/telescopes/) with an 8.4 meter aperture in 2016. Once these new facilities are in place, the data input will be like drinking from a fire hose, and the rate of warnings will go up by a factor of 40.”. But getting all these facilities, and more, online and running will take continued and additional funding Congress mandated in 2005 that NASA discover 90 percent of NEOs whose diameter is 140 meters or greater by 2020, and asked the National Research Council in 2008 to form a committee to determine the optimum approach to doing so. In an interim report released last year, the committee concluded that it was impossible for NASA to meet that goal, since Congress has not appropriated new funds for the survey nor has the administration asked for them. But this issue isn’t and shouldn’t be strictly left to NASA, said former astronaut Rusty Schweickart, also speaking at the AGU conference. “There’s the geopolitical misconception that NASA is taking care of it,” he said. “They aren’t and this is an international issue.” Schweickart said making decisions on how to mitigate the threat once a space rock already on the way is too late, and that all the decisions of what will be done, and how, need to be made now. “The real issue here is getting international cooperation, so we can — in a coordinated way — decide what to do and act before it is too late,” he said. “If we procrastinate and argue about this, we’ll argue our way past the point of where it too late and we’ll take the hit.” But this report deals with NASA, and committee from the NRC lays out two approaches that would allow NASA to complete its goal soon after the 2020 deadline; the approach chosen would depend on the priority policymakers attach to spotting NEOs. If finishing NASA’s survey as close as possible to the original 2020 deadline is considered most important, a mission using a space-based telescope conducted in concert with observations from a suitable ground-based telescope is the best approach, the report says. If conserving costs is deemed most important, the use of a ground-based telescope only is preferable. The report also recommends that NASA monitor for smaller objects, and recommends that immediate action be taken to ensure the continued operation of the Arecibo Observatory in Puerto Rico, and support a program at the Goldstone Deep Space Communications Complex. Although these facilities cannot discover NEOs, they play an important role in accurately determining the orbits and characterizing the properties of NEOs. Schweikart quoted Don Yeomans as saying the three most important things about asteroid mitigation is to find them early, find them early and find them early. “We have the technology today to move an asteroid,” Schweikart said. “We just need time. It doesn’t take a huge spacecraft to do the job of altering an asteroid’s course. It just takes time. And the earlier we could send a spacecraft to either move or hit an asteroid, the less it will cost. We could spend a few hundred million dollars to avoid a $4 billion impact.” But the report put out by the NRC stresses the methods for asteroid/comet defense are new and still immature. The committee agreed that with sufficient warning, a suite of four types of mitigation is adequate to meet the threat from all NEOs, except the most energetic ones.

# Not Enough Funding

**NASA cannot meet the Congressional mandate in the status quo – No new funding has been allocated towards NEO detection since 2005**

CNN 09 (Betsy Mason, writer for CNN.com, “NASA falling short of asteroid-detection goals”, August 13th, 2009, Accessed 7/2/11, AH)

Without more funding, NASA will not meet its goal of tracking 90 percent of all deadly asteroids by 2020, according to a report released today by the National Academy of Sciences. The agency is on track to soon be able to spot 90 percent of the potentially dangerous objects that are at least a kilometer (.6 miles) wide, a goal previously mandated by Congress. Asteroids of this size are estimated to strike Earth once every 500,000 years on average and could be capable of causing a global catastrophe if they hit Earth. In 2008, NASA's Near Earth Object Program spotted a total of 11,323 objects of all sizes. But without more money in the budget, NASA won't be able to keep up with a 2005 directive to track 90 percent of objects bigger than 460 feet across. An impact from an asteroid of this size could cause significant damage and be very deadly, particularly if it were to strike near a populated area. Meeting that goal "may require the building of one or more additional observatories, possibly including a space-based observatory," according to the report. The committee that investigated the issue noted that the United States is getting little help from the rest of the world on this front, and isn't likely to any time soon. Another report is planned for release by the end of the year that will review what NASA plans to do if we spot a life-threatening asteroid headed our direction. Congress has mandated that NASA discover 90 percent of all near-Earth objects 140 meters in diameter or greater by 2020. The administration has not requested and Congress has not appropriated new funds to meet this objective. Only limited facilities are currently involved in this survey/discovery effort, funded by NASA's existing budget. • The current near-Earth object surveys cannot meet the goals of the 2005 NASA Authorization Act directing NASA to discover 90 percent of all near-Earth objects 140 meters in diameter or greater by 2020. • The orbit-fitting capabilities of the Minor Planet Center are more than capable of handling the observations of the congressionally mandated survey as long as staffing needs are met. • The Arecibo Observatory telescope continues to play a unique role in characterization of NEOs, providing unmatched precision and accuracy in orbit determination and insight into size, shape, surface structure, multiplicity, and other physical properties for objects within its declination coverage and detection range. • The United States is the only country that currently has an operating survey/detection program for discovering near-Earth objects; Canada and Germany are both building spacecraft that may contribute to the discovery of near-Earth objects. However, neither mission will detect fainter or smaller objects than ground-based telescopes.

NASA Budget key to detecting

Mason 09(NASA Falling Short of Asteroid Detection Goals, By Betsy Mason, August 12, 2009 is science editor for Wired.com, G.L)

Without more funding, NASA will not meet its goal of tracking 90 percent of all deadly asteroids by 2020, according to a report released today by the National Academy of Sciences. The agency is on track to soon be able to spot 90 percent of the potentially dangerous objects that are at least a kilometer (.6 miles) wide, a goal previously mandated by Congress. Asteroids of this size are estimated to strike Earth once every 500,000 years on average and could be capable of causing a global catastrophe if they hit Earth. In 2008, NASA’s Near Earth Object Program spotted a total of 11,323 objects of all sizes. But without more money in the budget, NASA won’t be able to keep up with a 2005 directive to track 90 percent of objects bigger than 460 feet across. An impact from an asteroid of this size could cause significant damage and be very deadly, particularly if it were to strike near a populated area. Meeting that goal “may require the building of one or more additional observatories, possibly including a space-based observatory,” according to the report. The committee that investigated the issue noted that the United States is getting little help from the rest of the world on this front, and isn’t likely to any time soon. Another report is planned for release by the end of the year that will review what NASA plans to do if we spot a life-threatening asteroid headed our direction.

# Not Enough Funding

NASA is lacking funding for asteroid detection and can only identify 1/3 of possible threats.

Roeten 10 [Kevin, Conservative Columnist, Nolan Chart, “Asteroid coming to a location close to you,” February 14, 2010, SM, Accessed: 7/11/11, <http://www.nolanchart.com/article7376_Asteroid_Coming_to_a_Location_Too_Close_to_You.html>]

 NEO Discovery Statistics shows many near earth objects that can easily collide with earth during orbit. Lindsey Johnson, (Near-Earth Project Manager/ NASA) said objects ranging from 460 to 3,280 feet can decimate an entire region of earth. In 8/09 only 6,000 of the approximated 20,000 objects which have this capacity for this destruction have been spotted because of a lack of funding by the federal government. Read Spaceflight Now | Breaking News | More funding needed to meet ...asteroid detection mandate. Because of the lack of funding, NASA has been able to identify only 1/3 of the asteroids that could be threats to earth.

NASA lacks the funding needed to reach the mandated goal of 90 percent detection of NEOs

IRWIN I. SHAPIRO et al in 10,( Harvard-Smithsonian Center for Astrophysics, Chair FAITH VILAS, MMT Observatory at Mt. Hopkins, Arizona, Vice Chair MICHAEL A’HEARN, University of Maryland, College Park, Vice Chair ANDREW F. CHENG, Johns Hopkins University Applied Physics Laboratory FRANK CULBERTSON, JR., Orbital Sciences Corporation DAVID C. JEWITT, University of California, Los Angeles STEPHEN MACKWELL, Lunar and Planetary Institute H. JAY MELOSH, Purdue University JOSEPH H. ROTHENBERG, Universal Space Network, *Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies Space Studies Board Aeronautics and Space Engineering Board Division on Engineering and Physical Sciences*, THE NATIONAL ACADEMIES PRESS, <http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf>)

**The United States spends** about **$4 million annually searching for near-Earth objects** (NEOs), according to NASA.1 **The goal is to detect those that may collide with Earth**. **The funding** helps to operate several observatories that scan the sky searching for NEOs, but, as explained below, it **is insufficient to detect the majority of NEOs that may present a tangible threat to humanity**. **A smaller amount of funding** (significantly **less than $1 million per year**) **supports the study of ways to protect Earth from** such **a** potential **collision** (“mitigation”). Congress established two mandates for the search for NEOs by NASA. The first, in 1998 and now referred to as the Spaceguard Survey, called for the agency to discover 90 percent of NEOs with a diameter of 1 kilometer or greater within 10 years. An object of this limiting size is considered by many experts to be the minimum that could produce global devastation if it struck Earth. NASA is close to achieving this goal and should reach it within a few years. However, as **the recent** (2009) **discovery of an** approximately **2- to 3-kilometer**-diameter **NEO demonstrates**, **there are still large objects to be detected**. **The second mandate**, established in 2005, known as the George E. Brown, Jr. Near-Earth Object Survey Act,2 **called for NASA to detect 90 percent of NEOs 140 meters in diameter or greater by 2020**. As the National Research Council’s (NRC’s) Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies noted in its August 2009 interim report (NRC, 2009): Finding: Congress has mandated that NASA discover 90 percent of all near-Earth objects 140 meters in diameter or greater by 2020. **The administration has not requested and Congress has not appropriated new funds to meet this objective. Only limited facilities are currently involved** in this survey/discovery effort, funded by NASA’s existing budget. Finding: **The current near-Earth object surveys cannot meet the goals of the 2005** George E. Brown, Jr. Near-Earth Object Survey **Act directing NASA to discover 90 percent of all near-Earth objects 140 meters in diameter or greater by 2020**

# No Current Programs

No asteroid defense currently being thought of, nor implemented.

**Kaupa and Garretson in 08**, [Douglas and Peter. "Planetary Defense: Potential Mitigation Roles for the Department of Defense." Air & Space Power Journal. XXII, No. 3 (Fall 2008): pg. 34-41. PN]

Since detection efforts began in the mid-1990s, **NASA and supporting teams** (using only ground-based telescopes and a meager budget of $5 million/year) **have catalogued over 4,000 near-Earth asteroids (NEA).** The discovery rate has increased each year during the past decade (fig. 4). **We predict that a subset of the total NEAs shown in figure 4—potentially hazardous asteroids (PHA)—will come within 750,000 km of our home, less than two times the distance between Earth and the moon.** PHAs are too massive to burn up in Earth’s atmosphere. As of November 2006, we have detected 843 of them, 700 larger than 1 km and capable of regional destruction. **No known asteroids target Earth now or for the next several years. However, this information can change rapidly. Nobody knows how long Earth will be spared. Our planet has not been so fortunate in the past. With 843 PHAs and counting, we must seriously consider mitigation options. Rather than debate whether we need planetary defense, we must determine when we will need it.** From a policy perspective, **we know that at least 843 asteroids** prowling our neighborhood **could cause local, regional, or global destruction, so we have just begun to understand the total threat**. We won’t comprehend its full extent until we overcome the “giggle factor” and stop erroneously ascribing such thinking to science fiction. **We need to create contingency plans and establish guidelines as an insurance policy**—a far less expensive proposition than the consequences of suffering a direct hit.

No proven systems for asteroid deflection in existence.

Bucknam and Gold in 08 [Mark and Robert “Survival” (00396338); Oct/Nov2008, Vol. 50 Issue 5, p141-156, 16p PN]

Despite human inventiveness and rapidly expanding knowledge, the ability to detect threatening asteroids and comets is weak, and there are no proven systems for deflecting them. Scientists have identified the problem and analysed possible approaches for addressing it, but no one has begun to implement any of the proposed techniques. The threat of collision from asteroids and comets calls for a three-step approach to mitigating the risks: first, find and track objects that are potentially hazardous to the Earth; second, study their characteristics so as to understand which mitigation schemes are likely to be effective; and third, test various deflection techniques to ascertain the best way to adjust the orbits of asteroids and comets, and possibly field a planetary-defence system. Each of these steps would benefit from international cooperation or agreement. It takes an asteroid like Apophis, or a comet like Shoemaker–Levy 9, to remind us that the threat from space is real. And while the probabilities of a strike are small, the consequences are potentially cataclysmic, making our current state of near ignorance unacceptable.

\*\*Asteroid Impact Advantage\*\*

# Asteroid Impact Inevitable/Likely

Asteroids have fallen to earth and will continue to, we must track and deter these bodies before they reach earth or they could wreak havoc across Earth.

Kerr, 2002 (Richard) (Science; 9/13/2002, Vol. 297 Issue 5588, p1785, 2p, 1 Color Photograph)

Asteroids fall to Earth. They always have and always will, unless humankind finds a way to intervene. If one were to strike tomorrow, it could rain death and destruction on a scale that would threaten civilization's very existence. At a NASA-sponsored workshop[1] held here last week, researchers heard mixed tidings about the asteroid threat. The good news is that the search for civilization-ending asteroids seems to have passed the halfway point and is on track to reach NASA's goal of detecting 90% of them before the end of the decade. On the other hand, astronomers haven't gotten far finding the tens of thousands of smaller bodies that could still wreak havoc across a megalopolis. And if an asteroid of whatever size were detected on a collision course with the home planet, no one would know what to do about it.

# Asteroid Impact Inevitable/Likely

Earth will be hit by an asteroid – it’s only now we’re realizing the danger of the situation.

Dominion Post 2003 (“Answers to averting Armageddon,” September 9, 2003, p. 10., 4/23/11, Lexis-Nexis, znf)

THE inside story of how Britain and America are developing the technology to protect our world from an asteroid impact, Killer Asteroid shows how violent our solar system can be. Our Earth is under constant threat of bombardment. Each year, many fragments of debris hit our planet. Fortunately for us, most are so small that they burn up harmlessly in the atmosphere. However, there are hundreds of larger asteroids orbiting near the Earth. Many scientists now believe that one of these hit the Earth 65 million years ago, killing the dinosaurs, along with 90 per cent of all life on the planet. What's more, it is only a matter of time before the Earth is hit again. British astronomer David Levy says, "The chance that we are going to be hit by a large comet or asteroid is 100 per cent." Killer Asteroid experts warn that nuclear weapons, the most obvious strategy to eliminate an asteroid, may not be able to destroy an approaching asteroid. The same experts, and now the US military, recommend the use of the sun's power to nudge an asteroid away from the Earth. In the same way a magnifying glass is used to set fire to a sheet of paper, the sun's rays could be focused on to the surface of an asteroid, blasting particles of the asteroid into space. This would act like a rocket engine, and might be enough to nudge the asteroid out of harm's way. Until recently, no one took the asteroid threat very seriously. Yet the evidence that we are in danger is on our own doorstep. We need only look at the cratered surface of the Moon to realise that it has been pounded by impacts throughout its history. Why then, if collisions were common, was the surface of the Earth not scarred in a similar way? Unlike the Moon, the geography of the Earth is constantly changing, as continents move, and the landscape is constantly reforming. However, scientists realise that many features they had once dismissed as extinct volcanoes could have been made by asteroids. Then in 1994, something happened which brought home how immediate the danger was. Astronomers realised that comet Shoemaker-Levy 9 was heading straight for Jupiter. The spectacular -- and violent -- impact created an explosion the size of Earth, and was the first time a collision between two astronomical bodies had been observed. Nasa and the British Government sprang into action and came back with a very frightening report: there was a real risk that an asteroid could collide with Earth, and soon. All now admit that it is not if, but when an asteroid hits Earth. The question is: what can we do to stop them?

Asteroids are a threat—in 2009, one passed seven times closer to the earth than the moon.

Macey 2009 (Richard, Sydney Morning Herald, “Asteroid Plays Chicken with Earth,” 4 March, 2009, <http://www.smh.com.au/world/science/asteroid-plays-chicken-with-earth-20090303-8nge.html>, znf)

IT COULD have put an end to our worries about the economy and those sharks at Sydney beaches. At 12.40 yesterday morning, as the city slept, a previously unknown asteroid swept about 60,000 kilometres over the south-western Pacific. In astronomical terms it was a close call. Estimated to be between 30 metres and 50 metres wide, it passed almost seven times closer than the moon. Advertisement: Story continues below "No object of that size, or larger, has been observed to come closer to the Earth," said Rob McNaught, of the Siding Spring Observatory, near Coonabarabran. In 1908 an object possibly up to 50 metres across flattened some 2000 square kilometres of Siberian forest. Mr McNaught said yesterday's asteroid was probably smaller but it could do a lot of damage to a city. If it had crashed into the ocean "I imagine it would produce a tsunami", he said. Funded by NASA to search for asteroids bigger than one kilometre across, Mr McNaught spotted the object on Friday night. Within 24 hours astronomers had calculated it would narrowly miss the planet. Mr McNaught said as the asteroid approached Earth yesterday morning it had glowed 5000 times brighter than on Friday night. "It was so bright I could actually observe it through the cloud. That is very rare," he said. He believed that if 2009 DD45 had been on a collision course with a populated part of the planet, there would have been time to act. "A lot of people falsely claim there is nothing you could do, but there is. If there is an asteroid coming, and you have 24 hours, you can evacuate." About 1000 asteroids are known to have come close enough to be classified as potentially hazardous. While a collision with a one-kilometre-wide asteroid could cause global devastation, Mr McNaught said one that was just 300 metres wide could throw the world into "a short-term winter". Objects bigger than one kilometre wide were likely to hit the world only every few million years but ones large enough to threaten a city crashed "probably once a century".

# Asteroid Impact Inevitable/Likely

20,000 known asteroids pose risk of planetary impact—1,000 of those are flying in orbits that could threaten Earth

Malik 2010(Tariq, Managing Editor, Space.com “NASA’s New Asteroid Mission Could Save the Planet,” 4/16/10, <http://www.space.com/8240-nasa-asteroid-mission-save-planet.html>, znf)

Scientists estimate there are about 100,000 asteroids and comets near Earth, but only about 20,000 are expected to pose any risk of impact. NASA has found about 7,000 of those objects, 1,000 of them flying in orbits that could potentially threaten the Earth in the future, NASA scientists have said. Astronomer Donald Yeomans, head of NASA's Near-Earth Object program office at NASA's Jet Propulsion Laboratory in Pasadena, Calif., said there are about a dozen near-Earth asteroids that could be within reach of manned spacecraft, but most of those are relatively small. To make a crewed mission worth it, the target space rock would likely have to be at least 300 feet (100 meters) wide. For comparison, the space rock that exploded in a magnificent fireball over Wisconsin this week was just 3 feet (1 meter) wide, Yeomans said. "If you could study a few of them up-close, you get a better idea on how best to deflect them," Yeomans told SPACE.com.? And more asteroids are being found all the time. NASA's WISE infrared space telescope is discovering dozens of asteroids every day that were previously unknown. New surveys and spacecraft will add to that space rock bounty over the next 15 years to offer more candidates for a crewed asteroid mission, Yeomans said

Asteroids are a real threat, the chance we are killed by an asteroid in our life time is only slightly more than that of dying in an airplane crash.

National Space Society 97 [Society for the Study and Exploration of Space, NSS Chapters, “Asteroids: Backgrounder and Talking Points,” February 6, 1997, SM, Accessed: 7/11/11]

\*\* Are asteroids a real threat? Yes. Scientists believe the dinosaurs became extinct as the result of an asteroid ten miles in diameter impacting the Earth near what's now the Yucatan 65 million years ago, causing massive earth upheaval, a huge crater and a mile-high tidal wave that swept what is now the eastern United States. The threat of a cataclysmic impact continues today. In 1908 a comet exploded over Siberia with a force of at least ten megatons leveling a forest 50 miles across. On Nov. 22, 1996 a small asteroid hit Honduras and made a crater 165 feet wide. In recent years, scientists have come to recognize just how much of Earth's surface evolution has been rapidly driven by catastrophic events such as asteroid strikes. \*\* What are the odds? Experts estimate that an asteroid capable of cataclysmic impact on life on Earth hits once every 300,000 to one million years, meaning a one in 6,000 or one in 20,000 chance of one hitting in the next 50 years. According to planetary scientists Chapman and Morrison (1991), an individual's chance of dying from large scale devastation caused by a "doomsday" asteroid is 1 in 30,000, slightly higher than the lifetime chance of dying in an airplane crash (1 in 20,000).

# Asteroid Impact by 2036

Asteroids are predicted to strike the Earth by 2036 – we have no planetary defense against them.
Schweickart 2007 (Russell L., Apollo Astronaut, The New York Times, “The Sky Is Falling. Really.” March 16, 2007, <http://www.nytimes.com/2007/03/16/opinion/16schweickart.html>, znf)

AMERICANS who read the papers or watch Jay Leno have been aware for some time now that there is a slim but real possibility — about 1 in 45,000 — that an 850-foot-long asteroid called Apophis could strike Earth with catastrophic consequences on April 13, 2036. What few probably realize is that there are thousands of other space objects that could hit us in the next century that could cause severe damage, if not total destruction. Last week two events in Washington — a conference on “planetary defense” held by the American Institute of Aeronautics and Astronautics, and the release by NASA of a report titled “Near-Earth Object Survey and Deflection Analysis of Alternatives” — gave us good news and bad on this front. On the promising side, scientists have a good grasp of the risks of a cosmic fender-bender, and have several ideas that could potentially stave off disaster. Unfortunately, the government doesn’t seem to have any clear plan to put this expertise into action. In 1998, Congress gave NASA’s Spaceguard Survey program a mandate of “discovering, tracking, cataloging and characterizing” 90 percent of the near-Earth objects larger than one kilometer (3,200 feet) wide by 2008. An object that size could devastate a small country and would probably destroy civilization. The consensus at the conference was that the initial survey is doing fairly well although it will probably not quite meet the 2008 goal. Realizing that there are many smaller but still terribly destructive asteroids out there, Congress has modified the Spaceguard goal to identify 90 percent of even smaller objects — 460 feet and larger — by 2020. This revised survey, giving us decades of early warning, will go a long way toward protecting life on the planet in the future.

Without deflection the asteroid Apophis is going to impact earth with catastrophic results. We have to act now – later is too late.

Noland 2006(David, Popular Mechanics, “5 Plans to Head Off the Apophis Killer Asteroid,”

November 7, 2006. <http://www.popularmechanics.com/science/space/deep/4201569>, znf)

Maybe. Scientists calculate that if Apophis passes at a distance of exactly 18,893 miles, it will go through a "gravitational keyhole." This small region in space--only about a half mile wide, or twice the diameter of the asteroid itself--is where Earth's gravity would perturb Apophis in just the wrong way, causing it to enter an orbit seven-sixths as long as Earth's. In other words, the planet will be squarely in the crosshairs for a potentially catastrophic asteroid impact precisely seven years later, on April 13, 2036. Radar and optical tracking during Apophis's fly-by last summer put the odds of the asteroid passing through the keyhole at about 45,000-to-1. "People have a hard time reasoning with low-probability/high-consequence risks," says Michael DeKay of the Center for Risk Perception and Communication at Carnegie Mellon University. "Some people say, 'Why bother, it's not really going to happen.' But others say that when the potential consequences are so serious, even a tiny risk is unacceptable." Former astronaut Rusty Schweickart, now 71, knows a thing or two about objects flying through space, having been one himself during a spacewalk on the Apollo 9 mission in 1969. Through the B612 Foundation, which he co-founded in 2001, Schweickart has been prodding NASA to do something about Apophis--and soon. "We need to act," he says. "If we blow this, it'll be criminal." If the dice do land the wrong way in 2029, Apophis would have to be deflected by some 5000 miles to miss the Earth in 2036. Hollywood notwithstanding, that's a feat far beyond any current human technology. The fanciful mission in the 1998 movie Armageddon--to drill a hole more than 800 ft. into an asteroid and detonate a nuclear bomb inside it--is about as technically feasible as time travel. In reality, after April 13, 2029, there would be little we could do but plot the precise impact point and start evacuating people

# Impact Outweighs - Magnitude > Probability

if short term probability is low, the magnitude of a larger asteroid impact is infinite because it risks total extinction

IRWIN I. SHAPIRO et al in 10,( Harvard-Smithsonian Center for Astrophysics, Chair FAITH VILAS, MMT Observatory at Mt. Hopkins, Arizona, Vice Chair MICHAEL A’HEARN, University of Maryland, College Park, Vice Chair ANDREW F. CHENG, Johns Hopkins University Applied Physics Laboratory FRANK CULBERTSON, JR., Orbital Sciences Corporation DAVID C. JEWITT, University of California, Los Angeles STEPHEN MACKWELL, Lunar and Planetary Institute H. JAY MELOSH, Purdue University JOSEPH H. ROTHENBERG, Universal Space Network, *Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies Space Studies Board Aeronautics and Space Engineering Board Division on Engineering and Physical Sciences*, THE NATIONAL ACADEMIES PRESS, <http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf>)

Our planet inhabits a hazardous environment. Earth is continually bombarded by cosmic objects. Luckily for us, most are very small and cause no harm to life. Some, however, are large and cause considerable harm. Evidence of these collisions, large and small, is abundant, from the dense defacement of Mercury and the Moon to the craters festooning the surfaces of even small asteroids. Although impacts of cosmic objects on Earth have occurred since its very formation, humanity has been at best dimly aware of these events until very recently. Only two centuries ago it was widely doubted that objects orbiting the Sun could or would collide with Earth. In general, we cannot predict precise times and locations of future impacts, but can make statistical statements about the probability of an impact. Objects larger than about 30 meters in diameter probably strike Earth only about once every few centuries, and objects greater than about 300 meters in diameter only once per hundred millennia. Even objects only 30 meters in diameter can cause immense damage. The cosmic intruder that exploded over Siberia in 1908 may have only been a few tens of meters in size; yet this explosion severely damaged a forest of more than 2,000 square kilometers. Had an airburst of such magnitude occurred over New York City, hundreds of thousands of deaths might have resulted. Assessing risk is difficult primarily due to lack of sufficient data. Our best current estimates are given in Chapter 2, where the risk is presented with its dependence on impactor size and associated average impact frequency, along with damage estimates in terms of lives and property. Figure 1.1 illustrates the estimated frequency of NEO1 impacts on Earth for a range of NEO sizes. For impactor diameters exceeding about 2 to 3 kilometers, world-wide damage is possible, thus affecting all of humanity and our entire living space (the minimum size at which impactors can cause global devastation is still uncertain). While exceedingly rare, the consequences of such a collision are enormous, almost incalculable. This presents the classic “zero times infinity” problem: nearly zero probability of occurrence, but nearly infinite devastation per occurrence.

# Impact Outweighs - **Probability > Timeframe**

Asteroid impacts outweigh any more frequent threats. Their timeframe arguments are logically flawed.

Huebner et al. 09 [W.F. Huebner, L.N. Johnson, D.C. Boice, P. Bradley, S. Chocron, A. Ghosh, P.T. Giguere, R. Goldstein, J. A. Guzik, J. J. Keady, J. Mukherjee, W. Patrick, C. Plesko, J.D. Walker, K. Wohletz, 2009, published in Astronomicheskii Vestnik, 2009, Vol. 43, No. 4, pp. 348–356. PN]

Others have argued that there are many natural disasters such as hurricanes, typhoons, tornados, earth- quakes, tsunamis, and volcanic eruptions that occur much more frequently than impacts of cosmic objects with the Earth. Thus it would behoove us to concentrate our attention on avoiding catastrophes from such events. Three facts undermine this argument. First and perhaps most important, it considers only the probability aspect of risk assessment. Risk assessment requires that likelihood and consequence be convolved. Because the potential consequence of PHOs is so great, consideration of probability alone is not appropriate (Chap- man and Mulligan, 2002). Second, prevention of catastrophic loss from other natural events is based almost entirely on early warning systems. Similarly, such warning systems for PHO detection are in place and are being further improved to identify smaller objects, down to about 140 m in size. Third, there are no known or likely forceful countermeasures for other natural hazards. In sharp contrast it is within our reach to develop countermeasures against the collision of a cosmic object with Earth. All the elements of the technology to defend our planet are in hand; we need only tailor and deploy the technologies to meet the need. !n the discussion that follows, we illustrate a comprehensive plan for countermeasures against collisions of asteroids and comet nuclei with Earth.

**Resist the temptation to prefer immediate impacts over seemingly longer term ones, prefer probability**

**Chapman No Date** (Clark R. , planetary scientist, first editor of Journal of Geophysical Research- Planets, PhD MIT, The asteroid impact hazard and interdisciplinary issues, <http://www.boulder.swri.edu/clark/icsupb05.doc>., Google Scholar, NC)

In my own discussions of the impact hazard in public forums during the past two decades, I have learned several things (not all surprising) about perceptions of this issue, both by lay people and scientists: \* There is a common tendency for people to think of long "waiting times" before the next impact rather than in terms of "chances" of a disaster in the near-term. For the same reason people will build in a hundred-year floodplain, thinking (especially in the aftermath of an actual flood) that a flood won't happen for a hundred years, many people believe that an urgent response to the NEA threat isn't required: we can let the next generation deal with it. Yet many people buy lottery tickets (or avoid very low-probability hazards) with odds of winning (or dying) that are much lower than the chances of a large NEA impact happening this decade. \* People have enormous difficulty judging consequences of different degrees. It is very difficult for me to communicate the differences between a civilization-killing impact and a mass-extinction event (although it would take a thousand of the former impacts to equal one of the latter). Should/will people consider 100 deaths per year (roughly the statistically averaged threat from NEAs) to be serious or not? We live in a society that can become very concerned about the life of a single individual highlighted by the news, yet remain oblivious to the plight of millions in a different context. At the peak of the Rwanda genocide killings, newspaper headlines were instead dominated for a week by the impact hazard (when Comet Shoemaker-Levy 9 fragments were crashing into Jupiter). American society felt that "the world had changed" when ~3000 people died on 11 Sept. 2001, yet the ~3000 American traffic fatalities in Sept. 2001 went unnoticed. Since a large NEA impact has never been witnessed, it is difficult to predict how seriously even properly informed people might react to such a predicted impact. \* People are inclined to visualize the problem as involving an NEA that is on its way in and the way to deal with it is to "blow it up" shortly before it hits. The picture of an NEA orbiting the Sun countless times (and for decades, centuries, or longer) before it hits -- all the while remaining in our cosmic neighborhood, where it is accessible by spacecraft -- is difficult to get across.

# Impact Outweighs - Probability

The risk of death via asteroid is higher than dying in an airplane crash – new NEOs are being surveyed as potentially dangerous every day – the time to act is now.

Broad in 91 (author and a senior writer at The New York Times. Won two Pulitzer prizes, was a Pulitzer finalist, won the Emmy for PBS *Nova*, won a Dupont Award, The New York Times, *Asteroids, a Menace to Early Life, Could Still Destroy Earth; There's a 'Doomsday Rock,' But When Will It Strike?*, June 18, 1991, http://www.nytimes.com/1991/06/18/science/asteroids-menace-early-life-could-still-destroy-earth-there-s-doomsday-rock-but.html?pagewanted-print&src-pm, znf)

"The risk of death," Dr. Chapman continued, "is higher per person than a jet airplane crash. It's more likely than lots of things people worry about, like botulism or fireworks or many carcinogens." The risk is high enough, he said, to suggest the desirability of action. The American Institute of Aeronautics and Astronautics, a society of professional engineers based in Washington, strongly agrees. "We would be derelict if we did nothing," the group said in a position paper last year. Asteroids are craggy remnants from the creation of the solar system that revolve around the Sun, mostly in orbits between those of Mars and Jupiter. Some, however, follow a more eccentric course that takes them across the path of the Earth. So far, 184 Earth-crossing asteroids have been observed and their orbits mapped. New ones are being added at the rate of about two per month. None found so far are expected to hit the Earth soon. On the other hand, it is estimated that only about 10 percent of the big ones have been found so far. Mountains From Space Experts say there are probably 500 Earth-crossing asteroids with diameters of roughly a mile, and perhaps a dozen that are three or more miles wide, making them the size of large mountains. The bigger ones would truly be doomsday rocks. The father of the field is Dr. Eugene M. Shoemaker, a 63-year-old geologist-turned-astronomer with the United States Geological Survey in Flagstaff, Ariz. In the 1950's he closely studied a three-quarters-of-a-mile-wide crater in northern Arizona, which many geologists believed was volcanic in origin. Instead, he proved it was created by a 150-foot-wide asteroid that slammed into the Earth 50,000 years ago. Using a telescope atop Mount Palomar in California, Dr. Shoemaker now heads one of three teams in the United States that hunt for Earth-crossing asteroids. "They're little things" and difficult to spot compared with the stars and planets usually studied by astronomers, he said. "You don't see them unless you use a very large telescope, or unless they come close to the Earth. They're sort of at the threshold of detection." The field has been buttressed by the discovery of numerous asteroid craters around the world that have not yet been totally eroded by the Earth's atmosphere and oceans. If not for these forces, the craters accumulated over the ages would be as prominent as those on the Moon. Dr. Richard Grieve of the Department of Energy, Mines and Resources in Canada compiles a list of confirmed asteroid craters, the total now standing at 131. The list grows by five or six a year. A crater in south Australia is 100 miles across. The largest found so far, measuring 124 miles from rim to rim, is in Ontario. Collisions with Earth have occurred as recently as 1908, when a celestial object exploded near the Stony Tunguska River in Siberia with the force of 12 megatons of TNT. Forests were leveled for dozens of miles around, and horses 400 miles away were reportedly knocked down. Instruments around the world recorded atmospheric shock waves from the blast. Then too, there are near-misses. In 1972 a large asteroid, estimated at up to 260 feet in diameter, or nearly the length of a football field, zipped through the upper atmosphere over the northern United States and Canada, blazing across the sky in a daylight fireball witnessed by thousands of people before it re-entered space. And last January, a small asteroid, perhaps no larger than 30 feet wide, streaked by Earth, within less than half the distance to the Moon.

We’re overdue for our next big asteroid hit—the impact is billions of deaths.Ghayur 7 (A., Lecturer, University Institute of Information Technology, 5/3/2007, NB http://www.aero.org/conferences/planetarydefense/2007papers/P5-1--Ghayur--Paper.pdf)

1694 was the year when a man envisioned a bone chilling scenario after witnessing a Near Earth Object (NEO); “What if it would return and hit the Earth?” The man is now a world renowned scientist, Dr. Edmond Halley, and the object now one of the most famous comets, the Halley’s Comet has returned numerous times without any incident. Human civilization has come a long way since the Dark Ages of mid twentieth century, however, it is only now that the mankind is realizing the veracity of the apocalyptic scenario – a heavenly body colliding with earth – the Hellish nightmare which troubled Dr. Halley. Although the chances of Halley’s Comet plummeting into earth are nearly nonexistent, the chances nevertheless of another NEO colliding head on with earth are very much there. The battle-scared face of moon and the numerous impact craters on earth are a living testament to it. But all this evidence proved insufficient to turn any heads until 1994 when Shoemaker-Levy Nine crashed into Jupiter. The earth-sized storms created on Jupiter surface sent alarms through the echelons of bureaucracy and politics and suddenly a nonexistent apocalyptic nightmare had become a very much possible scenario. Today, we are sitting in the midst of ever increasing human population on this planet Earth, which in turn is sitting amidst ever increasing number of identified NEOs. We are already overdue for our next big hit; last one occurring 65 million years ago at Chixilub. Any impact of that scale would result in deaths and displacement of billions, if not more. Do we have a global network and an institution to respond timely and effectively

# Impact Outweighs - Probability

And you thought airplanes were scary – you’re more likely to die from an asteroid

Lewis 97 (John S. Lewis is a professor of planetary science at the University of Arizona’s Lunar and Planetary Laboratory, former professor of space sciences at MIT. *“Escaping the ultimate disaster--a cosmic collision.”*  Futurist, Jan/Feb97, Vol. 31, Issue 1. EBSCOhost. TDA)

There is a wide range of lethal consequences of asteroid and comet collisions: The death or injury of individuals struck by a falling meteorite affects probably one to 10 people per century. Villages or cities can be struck by showers of meteorites from high-altitude airbursts about once per century. Also about once per century, iron or other physically strong meteorites may resist atmospheric breakup to strike the surface as a single crater-forming body or as a compact shower of iron shrapnel. And low-altitude megaton air-bursts should also strike at populated areas every century or so, setting fires, shattering windows, and demolishing buildings over an area of hundreds to thousands of square kilometers. About half of impact fatalities are caused by the smaller, more frequent, localized events. About a quarter of the total deaths arise from tsunamis caused by impacts (once every 10,000 years), and another quarter from continental cratering events and low airbursts. Every 70,000 to 1 million years, a global billion-casualty killer will strike Earth: Collisions of 10-gigaton objects may occur about every 70,000 years; 100-gigaton explosions occur about once per 250,000 years; and 1,000-gigaton events occur a little more than once per 1 million years. If your projected life-span is about 75 years, that means the probability that you will be killed in a global impact event is **between 0.01% and 0.1%**. By comparison, the probability that you will be **killed in a civil airliner crash is 0.005%.** The long-term average death rate from impacts is 4 billion people per million years, or 4,000 people per year worldwide. The people of the United States make up about 5% of the global population, so the average American death rate from global-scale impacts is about 200 per year. By comparison, the death rate of American citizens from commercial aircraft crashes is 100 people a year.

# Impact Outweighs Nuclear War

**Extinction is categorically different from any other impact—even if they win a nuclear war kills 99 percent of the population, an asteroid strike still outweighs by an order of magnitude.**
**Matheny 7** (Jason G., Department of Health Policy and Management, Bloomberg School of Public Health, 2007, “Reducing the Risk of Human Extinction”, NB
http://jgmatheny.org/matheny\_extinction\_risk.htm)

Even if extinction events are improbable, the expected values of countermeasures could be large, as they include the value of all future lives. This introduces a discontinuity between the CEA of extinction and nonextinction risks. Even though the risk to any existing individual of dying in a car crash is much greater than the risk of dying in an asteroid impact, asteroids pose a much greater risk to the existence of future generations (we are not likely to crash all our cars at once) (Chapman, 2004 ). The "death-toll" of an extinction-level asteroid impact is the population of Earth, plus all the descendents of that population who would otherwise have existed if not for the impact. There is thus a discontinuity between risks that threaten 99% of humanity and those that threaten 100%.

# Small Asteroids = damage

**Asteroid Impacts outweigh all others, even a small asteroid ½ a kilometer in diameter could cause widespread disaster and famine.**

Urias et. Al 96 [Research Paper for Air Force 2025, Planetary Defense: Catastrophic Health Insurance for Planet Earth pg. 7- 8, “Vulnerabilities,” October 1996, SM, accessed: 7/11/11, <http://csat.au.af.mil/2025/volume3/vol3ch16.pdf>]

Regardless of the tendency to downplay the ECO threat, the probability of an eventual impact is finite. When it happens, the resulting disaster is expected to be devastatingly catastrophic. Scientists estimate the impact by an asteroid even as small as 0.5 kilometers could cause climate shifts sufficient to drastically reduce crop yields for one or several years due to atmospheric debris restricting sunlight. Impacts by objects one to two kilometers in size could therefore result in significant loss of life due to mass starvation. Few countries store as much as even one year's supply of food. The death toll from direct impact effects (blast and firestorm, as well as the climatic changes) could reach 25 percent of the world's population. 8 Although it may be a rare event, occurring only every few hundred thousand years, the average yearly fatalities from such an event could still exceed many natural disasters more common to the global population impact by an asteroid even as small as 0.5 kilometers could cause climate shifts sufficient to drastically reduce crop yields for one or several years due to atmospheric debris restricting sunlight. Impacts by objects one to two kilometers in size could therefore result in significant loss of life due to mass starvation. Few countries store as much as even one year's supply of food. The death toll from direct impact effects (blast and firestorm, as well as the climatic changes) could reach 25 percent of the world's population. 8 Although it may be a rare event, occurring only every few hundred thousand years, the average yearly fatalities from such an event could still exceed many natural disasters more common to the global population. Because the risk is small for such an impact happening in the near future, the nature of the ECO impact hazard is beyond our experience. With the exception of the asteroid strike in Shansi, China, which reportedly killed more than 10,000 people in 1490, ECO impacts killing more than 100 people have not been reported within all of human history. 9 Natural disasters, including earthquakes, tornadoes, cyclones, tsunamis, volcanic eruptions, firestorms, and floods often kill thousands of people, and occasionally several million. In contrast to more familiar disasters, the postulated asteroid impact would result in massive devastation. For example, had the 1908 Tunguska event happened three hours later, Moscow would have been leveled. In another event occurring approximately 800 years ago on New Zealand's South Island, an ECO exploded in the sky, igniting fires and destroying thousands of acres of forests. 10 If such an event were to occur over an urban area, hundreds of thousands of people could be killed, and damage could be measured in hundreds of billions of dollars. 11 A civilization-destroying impact overshadows all other disasters, since billions of people could be killed (as large a percentage loss of life worldwide as that experienced by Europe from the Black Death in the 14th century). 12 As the global population continues to increase, the probability of an ECO impact in a large urban center also increases proportionally. Work over the last several years by the astronomical community supports that more impacts will inevitably occur in the future. Such impacts could result in widespread devastation or even catastrophic alteration of the global ecosystem

# Small Asteroids = damage

Earth stands a 1-in-3 chance of colliding with a small asteroid that could cause massive damage.

Spotts in 99 (Christian Science Monitor, THREAT OF ASTEROID COLLISION MAY BE JUST A MOVIE, AFTER ALL, 7/29/99, EBSCO, znf)

With improved detection, scientists now believe fewer big asteroids will hit the earth than previously thought If the astronomical fireworks of "Deep Impact" or "Armageddon" kept you up at night, you can rest a bit easier. Our cosmic neighborhood appears to hold far fewer objects capable of snuffing out life on Earth than previously thought. New research announced this week at an international meeting on asteroids and comets at Cornell University in Ithaca, N.Y., does not mean Earthlings can stop scanning the skies for objects that might hit home, however. Earth's geological record alone suggests that during the 21st century the planet stands a 1-in-3 chance of colliding with an object that could cause heavy local damage, such as the event that flattened a Siberian forest in 1908. And the planet faces anywhere from a 1-in-1,000 to a 1-in-10,000 chance of being hit by an object that could cause what Richard Binzel, a planetary scientist at the Massachusetts Institute of Technology in Cambridge, calls "instant global change." These new, lower numbers do suggest that astronomers may be closer than they thought to reaching their goal of finding and tracking in the next 10 years at least 90 percent of potential Earth-crossing objects that measure over a half mile wide. This is the size range for asteroids that researchers say could cause a catastrophic change in global climate if one hits our planet. Older approaches to spotting near-Earth objects (NEOs) led astronomers to estimate that from 1,000 to 2,000 asteroids with these diameters and higher had the potential to threaten Earth, according to David Rabinowitz, a member of CalTech's Jet Propulsion Laboratory in Pasadena, Calif. "As of today, our best estimate is between 500 and 1,000," he says. Improved search techniques that include new imaging detectors and telescopes specifically dedicated to finding asteroids have helped thicken the growing catalog of NEOs. These efforts scan over two-thirds of the sky and can spot objects 25,000 to 30,000 times fainter than objects humans can see with the naked eye. Combined with more-powerful computer programs developed in the past year to improve long-term orbital predictions, they have enabled the asteroid-hazard community to act more quickly to confirm or knock down the notion that a new object has the potential to threaten Earth over a 50- to 100-year period. Yet, though researchers have been increasingly successful at finding NEOs, keeping track of them has often presented problems. "The problem of follow-up is one of the show-stoppers" in efforts to determine asteroid hazards, says Andrea Milani, an astronomer at the University of Pisa in Italy. Roughly 10 percent of the NEOs astronomers find move in ways that mask them as more harmless asteroids that orbit in a belt between Mars and Jupiter. As a result, when astronomers find them, they write them off and fail to make the follow-up observations critical to determining their orbits and the likelihood of a collision with Earth. In other cases, bad observing conditions prevent astronomers from keeping track of newly found asteroids. Last year, astronomers tried to keep their eyes on an object listed at 1998 OX4, estimated to have a 1 in 10 million chance of striking Earth in January 2046. They tracked it on and off for two weeks before losing it. To boost the chances of recovering newly discovered, quickly lost asteroids, astronomers turn to computer simulations. Instead of scanning the skies frantically, they calculate the object's "killer" orbits, then look in those directions. Dr. Milani likens it to looking both ways before crossing a street. "If a car is not there, you cross. You don't need to know where all the cars in the city are."

# Small Asteroids = damage

Asteroids that are considered small are large enough to create 300ft craters – even those that don’t impact the earth are a threat to human life.

Elizabeth Svoboda 2003 (Discover, Less Danger From Falling Rocks, October 2003, EBSCO, znf)

HAVE SOME PROMINENT SCIENTISTS INADVERTENTLY BEEN PLAYING Chicken Little? Working from computer models, several researchers warned that asteroid impacts could trigger devastating tsunamis with frightening frequency, at least once every 4,000 years. Never fear: Philip Bland, a planetary scientist at Imperial College London, says his improved calculations show that the actual rate is probably much lower. The previous simulations portrayed incoming asteroids as continuous blobs--picture a ball of glue flattening and spreading as it hits a hard surface. Bland developed a more realistic model that allows asteroids to disintegrate on the way in. "We're looking at the forces acting on stone or iron fragments as an object breaks up upon entering the atmosphere," he says. Fragmentation greatly reduces the odds of a major tsunami. To generate a 16-foot-high tidal wave, an object must be about 720 feet wide when it hits the surface. According to Bland's model, few objects that large survive passage through the atmosphere. Asteroid fragments 15 feet wide, capable of forming 300-foot craters, strike Earth every 200 to 400 years, he finds. Chunks large enough to trigger a significant tsunami fall just once every 170,000 years. Bland does not dismiss the danger of asteroids, however. "Even if an asteroid shatters in the atmosphere, it's a substantial threat to human life" he says. The still-mysterious Tunguska Event, an explosion in Siberia in 1908, was most likely caused by a comet or meteorite. Although the object disintegrated in the air, it still managed to flatten 800 square miles of terrain. And scientists still do not really understand how the atmosphere interacts with really large impactors, which will be the next focus of Bland's research. "That would let us see what kind of effect a big comet, for example, might have" he says. PHOTO (COLOR): The Wolf Creek Crater in Western Australia testifies to the destructive power of asteroids on land.

A small asteroid has the capability of causing mass damage – tsunamis, worldwide winter,

Prado 2002 (Mark, “1.7 Earth Impact by an Asteroid: Prospects and Effects”, Asteroids Near Earth—Materials for Utilization, <http://permanent.com/a-impact.htm>)

If an asteroid of size 200 meters hit the ocean (which covers 70% of the Earth), the tsunami (i.e., giant wave) it would create would inflict catastrophic destruction of coastal cities and substantial worldwide human casualties along coastlines. If an asteroid of size 1 kilometer hit Earth, it would cause a dust cloud which would block out sunlight for at least a year and lead to a deep worldwide winter, exhausting food supplies. The latter is what caused the dinosaur extinction, as well as other major extinctions of smaller creatures in geologic time scales. The 200 meter asteroid hits, which are far more common than the 1 km+ hits, wouldn't show up much in geologic histories on a global scale.

New research indicates that even small asteroids can cause massive shockwaves and forest fires

IRWIN I. SHAPIRO et al in 10,( Harvard-Smithsonian Center for Astrophysics, Chair FAITH VILAS, MMT Observatory at Mt. Hopkins, Arizona, Vice Chair MICHAEL A’HEARN, University of Maryland, College Park, Vice Chair ANDREW F. CHENG, Johns Hopkins University Applied Physics Laboratory FRANK CULBERTSON, JR., Orbital Sciences Corporation DAVID C. JEWITT, University of California, Los Angeles STEPHEN MACKWELL, Lunar and Planetary Institute H. JAY MELOSH, Purdue University JOSEPH H. ROTHENBERG, Universal Space Network, *Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies Space Studies Board Aeronautics and Space Engineering Board Division on Engineering and Physical Sciences*, THE NATIONAL ACADEMIES PRESS, <http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf>)

The committee notes that **objects smaller than 140 meters in diameter are also capable of causing significant damage to Earth**. **The most well-known case from recent history is the** 1908 **impact of an object at Tunguska** in the Siberian wilderness **that devastated** more than **2,000 square kilometers of forest**. Previous estimates of the size of this object were on the order of approximately 70 meters in diameter. **Recent research indicates** that **the object could have been** substantially smaller **(30 to 50 meters** in diameter), **with much of the damage it caused due to shock waves from the explosion** of the object **in Earth’s atmosphere**. The committee strongly stresses that this new conclusion is preliminary and must be independently validated. Since smaller objects are more numerous than larger ones, however, **this new result, if correct, implies an increase in the frequency of such events to approximately once per 3 centuries**.

# Small Asteroids = damage

Even relatively small asteroids pack the power of a nuclear weapon-the speed of impact guarantees destruction and secondary natural disasters like tsunamis

Lawler in 2k7, Andrew (Discover, *WHAT TO DO BEFORE THE ASTEROID STRIKES*, Nov2007, Vol. 28, Issue 1, Academic Search Premiere, accessed 6/27/2011)

**The doomsday rock is out there. It's just a matter of time**… **In 2004,** as a massive tsunami roiled through the Indian Ocean killing hundreds of thousands of people, a dozen or so **scientists** quietly **confronted an impending disaster** potentially even more lethal. They had inside intelligence that **a chunk of rock** and metal, **roughly 1,300 feet wide, was hurtling toward a possible collision with the most populated swath of Earth** — Europe, India, and Southeast Asia. Furiously crunching numbers on their computers, the researchers put the odds of impact in the year 2029 at exactly those of hitting the number in a game of roulette: 1 in 37. "We usually deal with one chance in a million," recalls Steven Chesley at NASA's Jet Propulsion Laboratory in Pasadena, California. "This was absolutely extraordinary — I didn't expect to see anything like it in my career." By the end of the day on December 27, 2004, to the relief of the observers, archival data turned up trajectory information that rendered the odds of a collision nil. Nonetheless, **in 2029 the asteroid**, dubbed — Apophis — derived from the Egyptian god Apep, the destroyer who dwells in eternal darkness — **will zoom closer to Earth than the world's communications satellites do**. And April 13, 2036, it will return — this time with a 1-in-45,000 chance of hitting somewhere on a line stretching from the Pacific Ocean near California to Central America. Because Apophis was discovered during one of the world's greatest natural disasters, the worries about the impact went largely unnoticed. But that tense day. December 26, 2004, stunned the small group of astronomers who dutifully detect and plot trajectories of hundreds of thousands of the millions of chunks of rock whizzing around the solar system. **Though too small to end civilization** — unlike the asteroid that may have doomed the dinosaurs — **Apophis could pack a punch comparable to a large nuclear weapon. Traveling at 28,000 miles per hour, it would heat up as it passed through Earth's atmosphere, turning the dark rock into a fiery sun as it arced across the sky**. **Then it would either explode just aboveground** — as one most likely did in 1908, leveling a vast forest in the Tunguska region of Siberia — **or gouge a crater 20 times its size. "If it hit London, there would be no London**," says Apollo 9 astronaut Rusty Schweickart, who had closely followed the discussion of the potential 2029 impact. **Slamming into the ocean, Apophis could create a tsunami dwarfing the one that killed more than 200,000 people around Indonesia**

# Small Asteroids = damage

**Even a small asteroid would cause massive damage-current methods at detection/deflection are inadequate**

Lunau in 2k9 (Kate, Maclean's, Look Out Below!, 6/29/2009, Vol. 122 Issue 24, p42-43, 2p, Academic Search Premiere accessed 6/27/11)

**In 1908, the skies** over Siberia **lit** up **in a** sudden and **massive explosion**: **an asteroid, 40 m wide, had entered earth's atmosphere and was breaking up in a multi-megaton burst**. **Although the asteroid itself didn't make it to the ground, the shock wave and massive fireball that resulted destroyed 2,000 sq. km of forest**, laying waste to the ground below. The Tunguska Event, as it's called, took place in a remote area, so no human lives were lost. **If the blast happened over Toronto, London or Shanghai, it would be another story. Thousands of asteroids**, most of them untracked, **swarm around our planet; some are over 10 km wide. "Right now, the most probable amount of warning we'll have for an asteroid impact is zero, because we don't know where most of them are**," says Robert Jedicke, 46, a University of Hawaii astronomer originally from Niagara Falls, Ont. Jedicke is part of a team at UH's Institute for Astronomy that's working to change that. A new program, called Pan-STARRS, will combine the world's most powerful asteroid-tracking telescope with the largest digital camera ever built. The first of four planned telescopes is set to begin its full scientific mission any day now. "In the past 200 years, we've discovered half a million asteroids," he says. The first telescope alone "should find a comparable number in a single year." Asteroids, which are leftovers from the creation of our solar system, pepper our planet more often than most realize. "Basketball-sized objects come in every day, and Volkswagen-sized objects come in once or twice a year," says Don Yeomans, who manages the Near-earth Object Program Office at NASA's Jet Propulsion Laboratory. **Those under 25 m in diameter cause little damage.** (Sand-sized particles burning up in the atmosphere can be seen from the ground as "shooting stars.") Events like Tunguska happen two or three times every 1,000 years. **Asteroids one kilometre across or wider strike** our planet only about **once or twice every million years, but their impact is devastating on a global scale: 65 million years ago**, **a 12-km asteroid crashed into earth, killing off 70 per cent of all species**, including the dinosaurs. In 1998, NASA set about discovering and tracking asteroids one kilometre in diameter or greater. Scientists now say they've found about 83 per cent of them, and that none threaten us within the next century; but when it comes to those under one kilometre -- including potential city killers, like the one at Tunguska -- it's another story. **A 140-m asteroid "packs about 250 megatons of equivalent energy**," Yeomans says. **"Even five megatons is a substantial nuclear weapon**." The U.S. Congress is now pushing NASA to find asteroids that measure 140 m and up. It's these objects that Pan-STARRS will be hunting for. Tracking asteroids, which are only visible by the reflected light of the sun, requires a telescope with a wide mirror to concentrate light: the fainter the object, the larger the mirror that's needed. Instead of building one giant telescope, which can be prohibitively expensive, Pan-STARRS will combine images from four smaller ones watching the same patches of sky. (PS1, the first of the four, is ramping up to its full-time mission now. All four telescopes, called PS4, will be in use within the next few years.) At a cost of roughly $10 million apiece, they are as powerful as a single 3.5-m telescope, at half the price. Within each telescope will be a 1.8-m mirror and the biggest digital camera ever made, with 1.4 billion pixels over an area of 40 sq. cm. (Your average digital camera has about five million pixels on a chip just a few millimetres across.) "The sheer amount of information we'll be able to generate is amazing," says Jedicke, who notes that each telescope will gather about six gigabytes of image data per minute -- enough to fill up a typical laptop in under an hour. Asteroid detection isn't the program's only goal. Within the next 10 years, Pan-STARRS should be able to catalogue up to a billion stars that have never been seen before within our galaxy, the Milky Way, and a billion new galaxies, too, says project manager William Burgett. It will be searching for comets, brown dwarfs (celestial bodies that are smaller than stars), and unknown planets: Burgett expects to find up to 70 new planets within the next few years. Pan-STARRS will also search for supernovas in distant galaxies. Because these exploding stars have a constant brightness, and thus seem dimmer when they're at a greater distance, supernovas help scientists track the universe's expansion. The project, he says, will provide "huge amounts of information about how our universe works." And what if Pan-STARRS finds an asteroid on a collision course with earth? As long as we have enough warning, it shouldn't be a problem, Jedicke says. In 2005, for example, NASA scientists successfully collided a spacecraft called Deep Impact with a comet. "If we can do that, we can slam a bomb into it, and blow it up," Jedicke says, although he admits that shooting nuclear weapons into space isn't the most popular choice. Scientists could also position a large spacecraft near an earth-threatening asteroid, creating a slight gravitational tug that would pull it off-course. They may have a chance to test this method soon: a 270-m asteroid, called Apophis, is set to make a close approach to earth 20 years from now. Computer models show that, if it passes through a specific 600-m gap, Apophis could swing back to strike the earth in 2036. "If we can move it out of that keyhole, just a little bit, it'll miss us," Yeomans says, noting that a gravity tractor might be a good way to do it. **How many other** Apophis-size **rocks are on a potential collision course with earth? Nobody knows for sure. "One of my colleagues observed that there are more people working in a single McDonald's than there are trying to save civilization from an asteroid**," Jedicke says. Pan-STARRS will help us find those asteroids, one would hope, before they find us.

# Small Asteroids = damage

Even small asteroids can cause massive airbursts-data shows these events are likely

IRWIN I. SHAPIRO et al in 10,( Harvard-Smithsonian Center for Astrophysics, Chair FAITH VILAS, MMT Observatory at Mt. Hopkins, Arizona, Vice Chair MICHAEL A’HEARN, University of Maryland, College Park, Vice Chair ANDREW F. CHENG, Johns Hopkins University Applied Physics Laboratory FRANK CULBERTSON, JR., Orbital Sciences Corporation DAVID C. JEWITT, University of California, Los Angeles STEPHEN MACKWELL, Lunar and Planetary Institute H. JAY MELOSH, Purdue University JOSEPH H. ROTHENBERG, Universal Space Network, *Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies Space Studies Board Aeronautics and Space Engineering Board Division on Engineering and Physical Sciences*, THE NATIONAL ACADEMIES PRESS, <http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf>)

Our understanding of the immediate damage produced by land impacts capable of producing craters is reasonably mature because their effects are constrained by nuclear weapon tests as well as craters on planetary surfaces. For airbursts, however, a lot of work is needed to improve our understanding of their consequences. For example, many groups have studied the 1908 Tunguska blast. **Using insights from nuclear blast data as well as seismograms** and barograph records of the Tunguska event, **scientists estimated that the height of the explosion was about 10 km and that the energy yield was 10 to 20 MT** (Chyba et al., 1993). According to the new estimate of size distribution made by Harris (2009), the average interval between such events on Earth would be on the order of one every 2,z000 years. **Work** by Boslough and Crawford (1997; 2008), however, **indicates that a much lower yield could produce the same effects**. **They found that asteroid airbursts do not act like point explosions in the sky** (e.g., like a nuclear bomb explosion) **but** instead **are more analogous to explosions along the line of descent**. **In an airburst, kinetic energy** (see Appendix E) **is deposited along the entry path, with significant downward momentum** transferred to the ground. Accordingly, **they suggest that smaller explosions with net yields of 3 to 5 MT may be sufficient to produce Tunguska-like impact events**. **If true, the average interval between** Tunguska-like **events** using the Harris (2009) size distribution (see Figure 2.4) **would be on the order of a few hundred years. These results would increase the calculated hazard from smaller objects, perhaps as small as 30 meters or so**. Further research is needed to better characterize this threat

# Huge Asteroid on the way

Asteroids are out there and threaten the Earth. The big one is on its way now.

Mone, 2003 (Gregory) (Popular Science, Sep2003, Vol. 263 Issue 3, p72, 8p, 1 Color Photograph,)

ITS NAME IS 1950DA, IT'S THE SIZE OF A SMALL mountain, and it's headed for Earth. According to one grim scenario, 1950DA will hit its target — most likely water, since there is more water than land on our planet — and plunge to the seabed in a fraction of a second. When the asteroid meets the ocean floor, it will explode, excavating a crater 11 miles wide. A column of water and debris will shoot a few miles into the sky — to the height of a low-flying jetliner. Then skyscraper-high walls of water will head for shore, eventually breaking in the shallows and flooding the coast. The rest you know, if you saw the weepy 1998 asteroid movie Deep Impact. Worse things may already have happened: One theory credits an 11-kilometer-wide asteroid with roasting dinosaurs alive 65 million years ago. The enormous impact sent debris flying back into space — some of it halfway to the Moon. When the asteroid bits reentered the atmosphere, the heat that was generated flash-baked plant and animal life. (Had that not happened, mind you, we probably wouldn't be here today.) 1950DA is minuscule by comparison, though even a still smaller asteroid could take out an entire city with a direct hit. And make no mistake, there are plenty of space rocks out there; one missed Earth by only 75,000 miles in June 2002 — and wasn't spotted until after it had whizzed by.

It’s estimated that 400 asteroids that could cause global havoc haven’t been found and that there are over a million others that could create regional destruction.

Popular Science 03 (Gregory Mone, Popular Science, *Incoming!*, August 6, 2003, <http://www.popsci.com/military-aviation-space/article/2003-08/incoming>, znf)

ITS NAME IS 1950DA, IT'S THE SIZE OF A SMALL mountain, and it's headed for Earth. According to one grim scenario, 1950DA will hit its target — most likely water, since there is more water than land on our planet — and plunge to the seabed in a fraction of a second. When the asteroid meets the ocean floor, it will explode, excavating a crater 11 miles wide. A column of water and debris will shoot a few miles into the sky — to the height of a low-flying jetliner. Then skyscraper-high walls of water will head for shore, eventually breaking in the shallows and flooding the coast. The rest you know, if you saw the weepy 1998 asteroid movie Deep Impact. Worse things may already have happened: One theory credits an 11-kilometer-wide asteroid with roasting dinosaurs alive 65 million years ago. The enormous impact sent debris flying back into space — some of it halfway to the Moon. When the asteroid bits reentered the atmosphere, the heat that was generated flash-baked plant and animal life. (Had that not happened, mind you, we probably wouldn't be here today.) 1950DA is minuscule by comparison, though even a still smaller asteroid could take out an entire city with a direct hit. And make no mistake, there are plenty of space rocks out there; one missed Earth by only 75,000 miles in June 2002 — and wasn't spotted until after it had whizzed by. Now for the good news. First, 1950DA is 877 years away and a 300-to-1 long shot for actually striking the planet and doing the damage in the scenario above, which is part of a simulation recently created by planetary scientists Steven Ward and Erik Asphaug of the University of California, Santa Cruz. And although there are more 1950DAs out there — maybe bigger, maybe due to arrive much sooner — the search for potential killer asteroids is at least under way, though sorely underfunded. Furthermore, a small band of scientists, many of them fueled more by passion than by actual government grants, is working on novel methods to deal with asteroids before they get too close to be diverted or destroyed. (The time spans involved give a new definition to advance thinking: As the foldout on the previous pages shows, some diversion operations would require centuries to work.) NASA is more than halfway through a search for asteroids and comets that come within striking distance of Earth — called "near Earth objects," or NEOs — and are wider than a kilometer. Experts calculate that the chance of an object that size hitting Earth in the next century is only one in several thousand, but the result would be global havoc. After astronomers spot an asteroid in their telescopes, they use radar tracking to get a more precise picture of where it's headed, how fast it's moving, and whether its orbit around the Sun will intersect with Earth's orbit. Before 1950DA's predicted encounter with Earth in 2880, the asteroid will swing around the Sun almost 400 times, while Earth will complete 876 orbits. Of the 600-plus large NEOs tracked thus far, only 1950DA poses any threat at all. But at this stage of the search, there are an estimated 400 potential global killers left to find, not to mention over a million hard-to-spot smaller asteroids capable of regional destruction. (A rock that exploded over Tunguska, Siberia, in 1908 leveled a thousand square miles of remote forest; it was a mere 60 meters wide.) Making the tallying work more tricky are a few long-period comets, which only swing by every few hundred years and are much more difficult to track. The search is only the beginning, and as Jay Melosh, a planetary scientist at the University of Arizona points out, "The question is, If we find one with our name on it, can we do anything?" NASA's search effort receives a paltry $3 million per year, just a fraction of the $25 million that NASA earmarked last year to fix the doors on the Kennedy Space Center's vehicle-assembly building. "I'd like to see more money spent," says David Morrison of NASA's Ames Research Center. But as yet, there's no official program either to build or to test asteroid-deflection technologies.

# Huge Asteroids on the way

The next major predicted asteroid isn’t as rare or as far off as people think. It has the potential to hit in 2036.

Bucknam and Gold in 08 [Mark and Robert “Survival” (00396338); Oct/Nov2008, Vol. 50 Issue 5, p141-156, 16p PN]

**On 13 April 2029, an asteroid the size of 50 US Navy supercarriers and weighing 200 times as much as the USS Enterprise will hurtle past the Earth** at 45,000 kilometres per hour – missing by a mere 32,000km, closer to Earth than the 300 or so communications satellites in geosynchronous orbit. In astronomical terms it will be a very near miss. The asteroid, called 99942 Apophis, is named after an ancient Egyptian god of destruction: for several months **after it was discovered in 2004, scientists were concerned that Apophis might strike the Earth. It still might**, though not in 2029. **If,** on its close approach in 2029, **Apophis passes through what is known as a ‘gravitational keyhole’, its orbit will be perturbed so as to cause it to hit the Earth in 2036 – striking with an energy equivalent to 400 megatonnes of TNT**. Although the chances of a 2036 impact are judged to be just one in 45,000, it is unnerving to recall that until just a few years ago, Apophis was completely unknown to mankind, and that similarly sized asteroids have silently shot past Earth in recent years, only to be discovered after the fact.

Current observational techniques aren’t adequate – especially for the oncoming potential impact in 2036.

Królikowska et al. 09 [Małgorzata; Sitarski, Grzegorz; Sołtan, Andrzej M. Space Researchers at Centre of the Polish Academy of Sciences and Nicolaus Copernicus Astronomical Center “Monthly Notices of the Royal Astronomical Society”; Nov2009, Vol. 399 Issue 4, p1964-1976, 13p, 5 Charts, 9 Graphs PN]

Although the motion of Apophis can be well predicted before its deep close encounter with the Earth on 2029 April 13, the present observations are not adequate to eliminate definitely the possibility of impact with the Earth in 2036 and in many years following this, even in a fully ballistic model. It seems that the seven available radar measurements are not crucial at present for the nominal orbit determination, although historically they were important for indicating that the pre-discovery observations of 2004 March were biased by some systematic errors. It is important to stress that future radar observations will be important to draw conclusions concerning impacts in 2036 and impacts following 2036. In the present paper we inspected the optical astrometric observational material carefully. Our best solution for the passage on 2029 April 13 gives a geocen- tric encounter distance of 6.065 ± 0.081 R⊕ (without perturbations from asteroids, model E) or 6.064 ± 0.095 R⊕ (including perturbations from the four largest asteroids, model E′). Both values are in excellent agreement with the results obtained by Giorgini et al. (2008).

# Asteroid Impact 🡪 Biological Destruction

An asteroid impact would cause long term physical, chemical, and biological destruction

Chapman No Date (Clark R. , planetary scientist, first editor of Journal of Geophysical Research- Planets, PhD MIT, The asteroid impact hazard and interdisciplinary issues, <http://www.boulder.swri.edu/clark/icsupb05.doc>., Google Scholar, NC)

The energetic interactions of an impacting NEA with the atmosphere, ocean, and land generate various immediate, secondary, and perhaps long-term effects -- physical, chemical, and perhaps biological. The most thorough evaluation of the environmental physical and chemical consequences of impacts is by Toon et al. (1997); more recent research, summarized by the SDT (2003), has begun to elucidate the previously poorly understood phenomena of impact-generated tsunami. I now briefly describe the chief environmental effects, for impacts of NEAs >300 m diameter: \* Total destruction in the crater zone: No structure or macroscopic life form would survive being in or adjacent to the explosion crater, a region roughly 30 times the size of the projectile (falling ejecta could be lethal over far greater distances). \* Tsunami: Flooding of historic proportions along proximate ocean shores would be caused by a >300 m impact, but run-up is highly variable depending on shore topography. An extinction-level impact (by a 10-15 km NEA) could inundate low-lying regions adjacent to oceans worldwide. (There is considerable debate and uncertainty about the scale and character of impact-caused tsunami.) \* Stratospheric dust obscures sunlight: 300 m impacts would cause noticeable but relatively minor effects similar to those of the largest volcanic explosions (e.g. the "year without summer" caused by the 1815 explosion of Tambora). For a >2 km NEA impact, sunlight would drop to "very cloudy days" nearly worldwide, threatening global food supplies by cessation of agriculture due to prolonged summertime freezing temperatures. Severe immediate effects (permanent "night" globally) and possible catastrophic long-term climate oscillations result from an extinction-level impact. \* Fires ignited by fireball and/or re-entering ejecta: Even the Tunguska impact, which did not reach the ground, caused trees to burn in the center of the zone where trees were toppled. But fires are of only local-to-regional importance even for a >2 km impact that would have global climate effects due to dust. In an extinction-level event, the broiling of the entire surface of our planet by re-entering ejecta -- and the resulting global firestorm -- would be the chief immediate cause of general death of plants and animals on land. \* Poisoning of the biosphere: Immediate atmospheric effects (sulfate production, injection of water into the stratosphere, destruction of the ozone layer, production of nitric acid, etc.) and subsequent poisoning of lakes and oceans augment the effects of stratospheric dust for a >2 km impact and dramatically worsen the already hellish conditions created by an extinction-level impact. (Birks, at this meeting, suggests that destruction of the ozone layer might be caused by an NEA as small as 0.5 km.) \* Earthquakes: Although local-to-global earthquakes (in response to the cratering explosion of various sized NEAs) would be serious if considered in isolation, they are minor compared with other more damaging and lethal consequences listed above.

# Asteroid Impact 🡪 Ice Age

Asteroids impacts cause debris to block out the sun- leads to ice age- empirically proven

AP 87 (Impact of Asteroid is linked to start of Ice Age on Earth”, The New York Times, <http://www.nytimes.com/1987/03/16/us/impact-of-asteroid-is-linked-to-start-of-ice-age-on-earth.html>, March 16, 1987, CGW)

Scientists say an asteroid they believe hit the Earth 2.3 million years ago was 10 times bigger than had been estimated and that its impact would have created an explosion 172 times larger than the biggest hydrogen bomb ever detonated. One of the scientists, Frank Kyte, a geochemist at the University of California, Los Angeles, said that the blast might have helped create the Ice Age. Mr. Kyte and an associate at the university, John Wasson, are scheduled to present their findings Monday in Houston at the annual Lunar and Planetary Science Conference sponsored by the National Aeronautics and Space Administration. Finding Based on Samples Their study was based on analysis of seafloor sediment samples collected in the 1960's by Florida State University researchers aboard the ship Eltanin. Based on their analysis of bits of asteroid debris in the seafloor sediments, the two geochemists reported in 1981 that an enormous asteroid fragment plunged into the southeastern corner of the Pacific, north of Antarctica and west of the tip of South America. After more studies of the sediments, they have revised their estimate of the asteroid's size to at least one-third of a mile wide and perhaps two-thirds of a mile in diameter. Based on that size and an estimated speed at impact of nearly 45,000 miles an hour, the impact would have created an explosion with a force equivalent to that of about 10,000 megatons of TNT, Mr. Kyte said. That is 172 times more powerful than the largest nuclear test blast. The Soviet Union detonated a 58-megaton H-bomb on Oct. 30, 1961, 12,000 feet above the Novaya Zemlya test site, said Chris West, a Department of Energy spokesman in Las Vegas. ''It's the largest object ever to fall to Earth from which we have recovered intact samples, unmelted fragments,'' Mr. Kyte said. ''Prior to this, the largest asteroidal impact from which we ever recovered meteorites was the Meteor Crater in Arizona.'' The geochemists used the amount of asteroid debris in the samples to estimate the asteroid fragment's size. Mr. Kyte said the estimate was based on conservative assumptions about how debris from such an impact would have been distributed on the sea floor. Sunlight May Have Been Blocked The Earth started getting colder about 3.5 million years ago, and sheets of ice covered parts of the continents from about 1.5 half million years ago to about 10,000 years ago, in the Pleistocene Ice Age. There is evidence that the dramatic cooling that caused the glaciation occurred sometime between 2.2 million and 2.5 million years ago, prompting the geochemists to speculate that their asteroid might have spurred the cooling by throwing up debris that blocked sunlight. ''As of now, there is no concrete evidence of a direct relationship between this impact and any environmental change, but this is an important subject for future research,'' said Mr. Wasson. Because the asteroid debris includes volcanic material, the fragment that hit Earth must have been part of an asteroid that was large enough, perhaps 60 miles in diameter, to have undergone volcanic activity at some time, Mr. Kyte said.

# Asteroid Impact 🡪 Ice Age

Asteroids Create explosions that help create ice age

NYT 87(IMPACT OF ASTEROID IS LINKED TO START OF ICE AGE ON EARTH AP Published: March 16, 1987, <http://www.nytimes.com/1987/03/16/us/impact-of-asteroid-is-linked-to-start-of-ice-age-on-earth.html>, G.L)

Scientists say an asteroid they believe hit the Earth 2.3 million years ago was 10 times bigger than had been estimated and that its impact would have created an explosion 172 times larger than the biggest hydrogen bomb ever detonated. One of the scientists, Frank Kyte, a geochemist at the University of California, Los Angeles, said that the blast might have helped create the Ice Age. Mr. Kyte and an associate at the university, John Wasson, are scheduled to present their findings Monday in Houston at the annual Lunar and Planetary Science Conference sponsored by the National Aeronautics and Space Administration. Finding Based on Samples Their study was based on analysis of seafloor sediment samples collected in the 1960's by Florida State University researchers aboard the ship Eltanin. Based on their analysis of bits of asteroid debris in the seafloor sediments, the two geochemists reported in 1981 that an enormous asteroid fragment plunged into the southeastern corner of the Pacific, north of Antarctica and west of the tip of South America. After more studies of the sediments, they have revised their estimate of the asteroid's size to at least one-third of a mile wide and perhaps two-thirds of a mile in diameter. Based on that size and an estimated speed at impact of nearly 45,000 miles an hour, the impact would have created an explosion with a force equivalent to that of about 10,000 megatons of TNT, Mr. Kyte said. That is 172 times more powerful than the largest nuclear test blast. The Soviet Union detonated a 58-megaton H-bomb on Oct. 30, 1961, 12,000 feet above the Novaya Zemlya test site, said Chris West, a Department of Energy spokesman in Las Vegas. ''It's the largest object ever to fall to Earth from which we have recovered intact samples, unmelted fragments,'' Mr. Kyte said. ''Prior to this, the largest asteroidal impact from which we ever recovered meteorites was the Meteor Crater in Arizona.'' The geochemists used the amount of asteroid debris in the samples to estimate the asteroid fragment's size. Mr. Kyte said the estimate was based on conservative assumptions about how debris from such an impact would have been distributed on the sea floor. Sunlight May Have Been Blocked The Earth started getting colder about 3.5 million years ago, and sheets of ice covered parts of the continents from about 1.5 half million years ago to about 10,000 years ago, in the Pleistocene Ice Age.

Ice Age = Extinction

An Ice Age would cause multiple global conflicts

CNN in 4

(CNN, Science & Space, Supernova, sun combo blamed for mass extinction; <http://www.cnn.com/2004/TECH>)

"The prevailing theory for that extinction has been an ice age," said Adrian L. Melott, a University of Kansas astronomer. "We think there is very good circumstantial evidence for a gamma ray burst." Melott is the leader of a team, which includes some astronomers from the National Aeronautics and Space Administration, that presented the theory Wednesday at the national meeting of the American Astronomical Society. Fossil records for the Ordovician extinction show an abrupt disappearance of two-thirds of all species on the planet. Those records also show that an ice age that lasted more than a half million years started during the same period. Melott said a gamma ray burst would explain both phenomena. He said a gamma ray beam striking the Earth would break up molecules in the stratosphere, causing the formation of nitrous oxide and other chemicals that would destroy the ozone layer and shroud the planet in a brown smog. "The sky would get brown, but there would be intense ultraviolet radiation from the sun striking the surface." he said. The radiation would be at least 50 times above normal, powerful enough to killed exposed life. In a second effect, the brown smog would cause the Earth to cool, triggering an ice age, Melott said. The extinction "could have been a one-two punch," said Bruce S. Lieberman, a paleontologist at the University of Kansas and a co-author of the theory. "Our theory builds on earlier theories" that included an ice age. Before the extinction, the Earth was unusually warm. Melott said climate experts have been unable to find a model that would explain the sudden onset of massive glaciers. "They need something to jump start the ice age," he said. "The gamma ray burst could have done it."

# Asteroid Impact 🡪 Miscalculation

Asteroid impact over land could easily be misconstrued as a nuclear attack.

Shiga in 09 [David, “It's behind you!” Staff Writer for *New Scientist Editorial*, 02624079, 9/26/2009, Vol. 203, Issue 2727, PN]

Now picture this ugly scenario, which worried some participants in the air force exercise: an asteroid flies out of nowhere and explodes over a sensitive nuclear-armed region, like South-East Asia or the Middle East. There's a reasonable chance that such an airburst could be misinterpreted as a nuclear attack. Both produce a bright flash, a blast wave and raging winds.

Such concerns were one reason why, when NASA found 2008 TC3 in its sights, it not only issued a press release but also alerted the US State Department, military commanders, and White House officials, says Lindley Johnson at NASA headquarters, who oversees the agency's work on near-Earth objects. "If it had been going down in the middle of the Pacific somewhere, we probably would not have worried too much more about it, but since it was [going to be] on land and near the Middle East, we did our full alerting," he says.

Current system of asteroid detection inadequate to prevent accidental launch of nuclear weapons and other forms of retaliation: countries cannot distinguish asteroids from attacks.

Selinger ’02. (writer “Asteroid Imact Set of Hiroshima-Sized Air Blast on June 6: Early Warning Center For Asteroids Needed Says USAF” Aerospace Daily 7/11/02, <http://www.rense.com/general27/asteroidimpactsetoff.htm>, AG)

The Department of Defense should set up an early warning center so the information it collects about asteroids, comets and other near-Earth objects (NEOs) can quickly be shared with other countries, according to Air Force Brig. Gen. Simon "Pete" Worden, deputy director for operations at U.S. Space Command. Worden said July 10 at a Capitol Hill space round-table that a June incident involving an asteroid over the Mediterranean Sea underscored the need for a center to warn about natural objects that could cross Earthís orbit. When the asteroid, estimated at five to 10 meters in diameter, collided with the Earthís atmosphere, it released a burst of energy comparable to the nuclear bomb dropped on Hiroshima, Japan, in World War II. If the June 6 burst had occurred over India or Pakistan, which were on the brink of war at the time, it could have been mistaken for a military attack, pushing the two countries into a full-scale conflict, he said. "Neither of those nations has the sophisticated sensors we do that can determine the difference between a natural NEO impact and a nuclear detonation," Worden said. "The resulting panic in the nuclear-armed and hair-trigger militaries there could have been the spark" for a nuclear war. DOD currently gives NEO information to foreign countries on an informal basis, a process that can take weeks. Formalizing the process with a new early warning center could expedite that process, Worden said.

Miscalc Nuclear War O/W

Our nuclear war outweighs yours – war with Russia is the only war scenario that ensures planetary extinction.

Caldicott 2k2 [(Helen- Founder of Physicians for Social Responsibility, The new nuclear danger, p. 7-12)]

If launched from Russia, nuclear weapons would explode over American cities thirty minutes after takeoff. (China's twenty missiles are liquidfueled, not solid-fueled. They take many hours to fuel and could not be used in a surprise attack, but they would produce similar damage if launched. Other nuclear-armed nations, such as India and Pakistan, do not have the missile technology to attack the U.S.) It is assumed that most cities with a population over 100,000 people are targeted by Russia. During these thirty minutes, the U.S. early-warning infrared satellite detectors signal the attack to the strategic air command in Colorado. They in turn notify the president, who has approximately three minutes to decide whether or not to launch a counterattack. In the counterforce scenario the US. government currently embraces, he does [the U.S.] launch[es], the missiles pass mid-space, and the whole operation is over within one hour. Landing at 20 times the speed of sound, nuclear weapons explode over cities, with heat equal to that inside the center of the sun. There is practically no warning, except the emergency broadcast system on radio or TV, which gives the public only minutes to reach the nearest fallout shelter, assuming there is one. There is no time to collect children or immediate family members. The bomb, or bombs-because most major cities will be hit with more than one explosion-will gouge out craters 200 feet deep and 1000 feet in diameter if they explode at ground level. Most, however, are programmed to produce an air burst, which increases the diameter of destruction, but creates a shallower crater. Half a mile from the epicenter all buildings will be destroyed, and at 1.7 miles only reinforced concrete buildings will remain. At 2.7 miles bare skeletons of buildings still stand, single-family residences have disappeared, 50 percent are dead and 40 percent severely injured.' Bricks and mortar are converted to missiles traveling at hundreds of miles an hour. Bodies have been sucked out of buildings and converted to missiles themselves, flying through the air at loo miles per hour. Severe overpressures (pressure many times greater than normal atmospheric have popcorned windows, producing millions of shards of flying glass, causing decapitations and shocking lacerations. Overpressures have also entered the nose, mouth, and ears, inducing rupture of lungs and rupture of the tympanic membranes or eardrums. Most people will suffer severe burns. In Hiroshima, which was devastated by a very small bomb-13 kilotons compared to the current iooo kilotons-a child actually disappeared, vaporized, leaving his shadow on the concrete pavement behind him. A mother was running, holding her baby, and both she and the baby were converted to a charcoal statue. The heat will be so intense that dry objects-furniture, clothes, and dry wood-will spontaneously ignite. Humans will become walking, flaming torches. Forty or fifty miles from the explosion people will instantly be blinded from retinal burns if they glance at the flash. Huge firestorms will engulf thousands of square miles, fanned by winds from the explosion that transiently exceed 1000 miles per hour. People in fallout shelters will be asphyxiated as fire sucks oxygen from the shelters. (This happened in Hamburg after the Allied bombing in WWII when temperatures within the shelters, caused by conventional bombs, reached 1472 degrees Fahrenheit.)" Most of the city and its people will be converted to radioactive dust shot up in the mushroom cloud. The area of lethal fallout from this cloud will depend upon the prevailing wind and weather conditions; it could cover thousands of square miles. Doses of 5000 rads (a rad is a measure of radiation dose) or more experienced by people close to the explosion-if they are still aliv-will produce acute encephalopathic syndrome. The cells of the brain will become so damaged that they would swell. Because the brain is enclosed in a fixed bony space, there is no room for swelling, so the pressure inside the skull rises, inducing symptoms of excitability, acute nausea, vomiting, diarrhea, severe headache, and seizures, followed by coma and death within twenty-four hours. A lower dose of 1000 rads causes death from gastrointestinal symptoms. The lining cells of the gut die, as do the cells in the bone marrow that fight infection and that cause blood clotting. Mouth ulcers, loss of appetite, severe colicky abdominal pain, nausea, vomiting, and bloody diarrhea occur within seven to fourteen days. Death follows severe fluid loss, infection, hemorrhage, and starvation. At 450 rads, 50 percent of the population dies. Hair drops out, vomiting and bloody diarrhea occurs, accompanied by bleeding under the skin and from the gums. Death occurs from internal hemorrhage, generalized septicemia, and infection. Severe trauma and injuries exacerbate the fallout symptoms, so patients die more readily from lower doses of radiation. Infants, children, and old people are more sensitive to radiation than healthy adults. Within bombed areas, fatalities will occur from a combination of trauma, burns, radiation sickness, and starvation. There will be virtually no medical care, even for the relief of pain, because most physicians work within The United States owns 103 nuclear power plants, plus many other dangerous radioactive facilities related to past activities of the cold war. A 1000- kiloton bomb (1 megaton) landing on a standard iooo megawatt reactor and its cooling pools, which contain intensely radioactive spent nuclear fuel, would permanently contaminate an .' area the size of western Germany3 The International Atomic Energy Agency now considers these facilities to be attractive terrorist targets, ' post-September 11,2001. Millions of decaying bodies-human and animal alike-will rot, infected with viruses and bacteria that will mutate in the radioactive-environment to become more lethal. Trillions of insects, naturally ' resistant to radiation-flies, fleas, cockroaches, and lice--will transmit disease from the dead to the living, to people whose immune mechanisms have been severely compromised by the high levels of background radiation. Rodents will multiply by the millions among the corpses and shattered sewerage systems. Epidemics of diseases now controlled by immunization and good hygiene will reappear: such as measles, polio, typhoid, cholera, whooping cough, diphtheria, smallpox, plague, tuberculosis, meningitis, malaria, and hepatitis. Anyone who makes it to a fallout shelter and is not asphyxiated in it, will need to stay there for at least six months until the radiation decays sufficiently so outside survival is possible. It has been postulated that perhaps older people should be sent outside to scavenge for food because they will not live long enough to develop malignancies from the fallout (cancer and leukemia have long incubation periods ranging from

<CONTINUED>

five to sixty But any food that manages to grow will be toxic because plants concentrate radioactive elements.\*/ Finally, we must examine the systemic global effects of a nuclear . , war. Firestorms will consume oil wells, chemical facilities, cities, and forests, covering the earth with a blanket of thick, black, radioactive , I I ' smoke, reducing sunlight to 17 percent of normal. One year or more ' ) , will be required for light and temperature to return to normalper- "r haps supranormal values, as sunlight would return to more than its , , usual intensity, enhanced in the ultraviolet spectrum by depletion of the stratospheric ozone layer. Subfreezing temperatures could destroy the biological support system for civilization, resulting in massive starvation, thirst, and hypothermia.5 To quote a 1985 SCOPE document published by the White House Office of Science and Technology Policy, "the total loss of human agricultural and societal support systems would result in the loss of almost all humans on Earth, essentially equally among combatant and noncombatant countries alike . . . this vulnerability is an aspect not currently a part of the understanding of nuclear war; not only are the major combatant countries in danger, but virtually the entire human population is being held hostage to the large-scale use of nuclear weapons. . . .",! i The proposed START I11 treaty between Russia and America, even if it were implemented, would still allow 3000 to 5000 hydrogen bombs to be maintained on alert."the threshold for nuclear winter? One thousand loo-kiloton bombs blowing up loo cities7-a I c distinct possibility given current capabilities and targeting plans. On January 25,1995, military technicians at radar stations in northern Russia detected signals from an American missile that had just been launched off the coast of Norway carrying a US. scientific probe. Although the Russians had been previously notified of this launch, the alert had been forgotten or ignored. Aware that US. submarines could launch a missile containing eight deadly hydrogen bombs fifteen minutes from Moscow, Russian officials assumed that America had initiated a nuclear war. For the first time in history, the Russian computer containing nuclear launch codes was opened. President Boris Yeltsin, sitting at that computer being advised on how to launch a nuclear war by his military officers, had only a three minute interval to make a decision. At the last moment, the US. missile veered off course. He realized that Russia was not under attack.' If Russia had launched its missiles, the US. early-warning satellites would immediately have detected them, and radioed back to Cheyenne Mountain. This would have led to the notification of the president, who also would have had three minutes to make his launch decision, and America's missiles would then have been fired from their silos. We were thus within minutes of global annihilation that day. ,' Today, Russia's early-warning and nuclear command systems are deteriorating. Russia's early-warning system fails to operate up to seven hours a day because only one-third of its radars are functional, and two of the nine global geographical areas covered by its missilewarning satellites are not under surveillance for missile detection.9 TO make matters worse, the equipment controlling nuclear weapons malfunctions frequently, and critical electronic devices and computers sometimes switch to combat mode for no apparent reason. According to the CIA, seven times during the fall of 1996 operations at some Russian nuclear weapons facilities were severely disrupted when robbers tried to "mine" critical communications cables for their copper!'" This vulnerable Russian system could easily be stressed by an internal or international political crisis, when the danger of accidental or indeed intentional nuclear war would become very real. And the U.S. itself is not invulnerable to error. In August 1999, for example, when the National Imagery and Mapping Agency was installing a new computer system to deal with potential Y2K problems, this operation triggered a computer malfunction which rendered the agency "blind" for days; it took more than eight months for the defect to be fully repaired. As the New York Times reported, part of America's nuclear early-warning system was rendered incompetent for almost a year." (At that time I was sitting at a meeting in the west wing of the White House discussing potentially dangerous Y2K nuclear weapons glitches. Several Pentagon officials blithely reassured me that everything would function normally during the roll-over. But in fact, their intelligence system had already been disabled.) Such a situation has the potential for catastrophe. If America cannot observe what the Russians are doing with their nuclear weapons-or vice versa-especially during a serious international crisis they are likely to err on the side of "caution," which could mean that something as benign as the launch of a weather satellite could actually trigger annihilation of the planet*.*

# Miscalculation - Likely

US-Russia accidental war likely- anything that triggers the “LoW” system will trigger a catastrophic war

Phillips and Starr 8 (Alan, graduated in physics @ Cambridge and Steven, Senior Scientist with Physicians for Social Responsibility, and is the director and coordinator of the Clinical Laboratory Science Program at the University of Missouri, “REPLACE LAUNCH ON WARNING POLICY with Retaliatory Launch Only After Detonation (RLOAD)”, Moscow Institute of Physics and Technology, <http://www.armscontrol.ru/start/>, 2008, CGW)

As long as the United States and Russia retain their arsenals of nuclear-armed intercontinental ballistic missiles, some on high alert, the danger remains of a purely accidental nuclear war between the two countries. Neither side wants this: if it should happen, it would be an utter disaster for both countries and for the entire world – no matter which adversary started it. One of the possible causes of an unintended nuclear war is "Launch on Warning" (LoW) – the policy of launching a retaliatory nuclear strike while the opponent's missiles or warheads are believed to be in flight, but before any detonation from the perceived attack has occurred. Each side is believed to have more than 1000 strategic nuclear warheads ready to launch before the incoming warheads have arrived. Once launched, they cannot be recalled or neutralized. LoW has exposed the world, for at least 30 years, to the danger of a nuclear war caused by nothing but a coincidence of radar, satellite sensor, or computer glitches, and a temporary failure of human alertness to appreciate that the message signaling attack is false. The danger inherent in LoW policy has been appreciated by all concerned since it was first considered in the early 1960's. 3 Priority has been given to reducing this risk, and other risks of unintended or hastily started war, in UN Resolutions and in recommendations from prestigious bodies including the Canberra Commission, the Brookings Institution, the Center for Defense Information, and a recent large conference of Nobel Laureates in Rome, all calling for “lowering the alert status” or similar phrases. These recommendations have not drawn attention to the possibility of simply changing the policy of "Launch on Warning", without lowering alert status or giving up the concept of prompt retaliation. The disaster of an accidental nuclear war has not happened yet, in spite of a large number of false warnings of which at least a few have had very dangerous features. This is a credit to the care and alertness of the military in both Russia and the U.S. It should not be taken as reassurance. A "retaliatory" launch of nuclear weapons on a false warning would result in nuclear war, and the most terrible destruction in both countries, just as surely as a nuclear war started by an actual attack. There would be no chance to review the system to make it safer after one failure of that kind. Although the Cold War is considered over, both Russia and the United States have chosen to retain their LoW capabilities, and they are widely believed to be continuing their LoW policies. If this is the case, it is inexcusably dangerous.

# Miscalculation - Likely

The status quo’s warning system makes accidental war very likely

Podvig 5 (Pavel, Podvig received his degree in physics from MIPT and his PhD in political science from the Moscow Institute of World Economy and International Relations, “Reducing the Risk of Accidental Launch

Time for a New Approach?”, PONARS Policy Memo 328, Stanford University, November 2004, <http://www.gwu.edu/~ieresgwu/assets/docs/ponars/pm_0328.pdf>, CGW)

Since the early warning system is an essential element of a launch-on-warning posture, it is understandable that a number of proposals that aim at reducing the risks of accidental launch suggest helping Russia to repair or upgrade its early-warning system. These proposals included assistance in bringing into operation the radar in Irkutsk or helping Russia to complete deployment of its early-warning satellites. Neither of these projects were implemented, but if they were, they would most likely have increased the risk of an accident by introducing new elements into the already complex system and increasing confidence in its performance. Other projects that were discussed in the context of reducing risk of an accidental launch suggested providing Russia with independent early-warning information, which was supposed to complement the data received by the Russian system. The most advanced of these proposals called for establishment of a Joint Data Exchange Center (JDEC), which would provide both sides with access to their counterpart’s early-warning information. The logic of the project was that in a case of conflicting information from early-warning satellites and radars, the United States and Russia could demonstrate to each other that no attack is underway. Cooperation like this would probably have helped to determine what happened during the January 1995 incident, but it is not certain if it would be of any help in a serious crisis, when each side would have reasons to doubt information provided by its counterpart. To sum it up, the goal of reducing the risks of launch-on-warning postures seems incompatible with the efforts to repair or augment the deteriorating Russian early warning system. Instead, the efforts should be directed at helping Russia change the command and control procedures to accommodate the loss of early-warning capability. These changes would almost certainly result in a shift away from the launch-o n-warning posture, reducing the risk of an accidental launch

# Miscalculation – Timeframe

The timeframe for miscalc is less than an hour

Blair 2K8 [Bruce, President of the World Security Institute and former Minuteman launch officer, February 27, “Increasing Warning and Decision Time (‘De-Alerting’)”<http://disarmament.nrpa.no/wp-content/uploads/2008/02/Paper_Blair.pdf>]

A high degree of vigilance suffuses the entire U.S. and Russian chains of nuclear command and warning, from the bottom all the way to the top. In the warning centers, such as the hub of the U.S. early warning network in Colorado, crews labor under the pressure of tight deadlines to assess and report whether a satellite or land radar sensor indicating a possible threat to North America is real or false. Events happen almost daily, sometimes more than once daily, which trigger this assessment drill that is supposed to yield a preliminary assessment within three minutes after the arrival of the initial sensor data.2 Analogous drills take place under comparable deadlines in Russia. A rush of adrenalin and rote processing of checklists, often accompanied by confusion, characterize the process.3 If their early warning assessment determines that a nuclear missile attack is possibly underway, the entire chain of nuclear command in the United States or Russia would immediately kick into high gear with thousands of duty crews and nuclear support personnel involved. The same rush of adrenalin and rote decision-making by checklist drive a process whose intensity and deadlines practically rule out any chance for careful deliberation. An emergency conference involving the presidents and their top nuclear advisors would be convened, whereupon on the U.S. side the commanding duty officer at Strategic Command headquarters in Omaha would brief the U.S. president on the nature of the apparent attack, the wide array of response options, and their anticipated consequences for Russian physical and human resources. The time allocated for this briefing is as little as 30 seconds depending on the nature of the attack. The U.S. president then would come under intense pressure to absorb this complex set of data, weigh the consequences of the various options, and choose a course of action. His decision window is typically twelve minutes, although under certain extreme conditions it can be much shorter. The extraordinarily brief time for such a momentous decision is driven by four factors: the 30 minute flight time for an intercontinental missile, and about one-half that for an submarine-launched missile; the time required to validate and characterize the attack, using two separate sources of warning data to ensure high confidence; the time required to convene a phone conference of the principals involved in the decision process, and the time required following presidential decision to encode and transmit that decision worldwide to the strategic nuclear forces. Any delay in transmitting the response order runs the risk of losing retaliatory forces to the other side’s attack, thus undermining the calculus of expected damage for the response option chosen by the national leadership. This risk is compounded in the event of a so-called “decapitation strike,” that is, an opening attack on the leadership. Under this circumstance, the integrity of a retaliatory response is greatly compromised, thus calling into question the very calculus upon which nuclear deterrence is based. Given these acute conditions, it is no wonder that as much of the response process as possible is designed to be quasi-automatic. It can reasonably be described as going to war by checklist, enacting a prepared script, with little margin for human error or technical malfunction. The nuclear war machinery on both sides has a hair-trigger quality. And that quality has been a constant in the nuclear equation for decades despite the Cold War’s end. Both of the traditional nuclear rivals still stand ready to inflict apocalyptic devastation on one another in a first or second strike whose essential course would be run in less than one hour.

# Asteroid ! – Miscalculation

High risk of miscalculation – Nuclear tensions override relations.

Mosher & Schwartz 03 (David E., RAND senior policy analyst with expertise in nuclear weapons policy, & Lowell, associate policy analyst, “Excessive Force: Why Russian and U.S. Nuclear Postures Perpetuate Cold War Risks” <http://www.rand.org/publications/randreview/issues/fall2003/force.html>) JM

Russian strategic nuclear forces remain the only current threat to the national existence of the United States. Although the risk of deliberate attack from Russia has sharply fallen since the end of the Cold War, the risk of an accidental or unauthorized use of Russian nuclear forces has arguably risen. For example, Russia’s early-warning system has severely deteriorated, as has the country’s ability to keep its mobile (and thus survivable) nuclear forces deployed. There are additional concerns about the state of Russia’s command-and-control system and the rise of separatist violence. None of the nuclear arms control treaties after the Cold War have dealt with the issue of accidental or unauthorized use of nuclear weapons. Instead, these treaties have concentrated on reducing the total number of nuclear warheads each side wields. While these reductions are extremely important for improving the overall U.S.-Russian relationship, they do little to ease the risks of an accidental or unauthorized nuclear launch. This is because those risks stem from the nuclear postures and underlying nuclear doctrines of each nation, which remain firmly rooted in the hostile relationship forged during the Cold War. Thus, even as U.S.-Russian relations have improved dramatically to the point where the two countries are no longer enemies, they continue to view each other in nuclear terms. This imbalance in the political and nuclear relations between the two countries not only perpetuates the risks of accidental or unauthorized nuclear use but also fundamentally impedes further improvements in relations.

The Russian warning system is aging and empirically fails horribly – they go into high alert at the most innocent detections.

Graham 05 (Thomas, Special Representative for the President for Arms Control, “Space Weapons and the Risk of Accidental Nuclear War” <http://www.armscontrol.org/print/1953> December 2005) JM

The Russian early warning system is in serious disrepair. This system consists of older radar systems nearing the end of their operational life and just three functioning satellites, although the Russian military has plans to deploy more. The United States has 15 such satellites. Ten years ago, on January 25, 1995, this aging early warning network picked up a rocket launch from Norway. The Russian military could not determine the nature of the missile or its destination. Fearing that it might be a submarine-launched missile aimed at Moscow with the purpose of decapitating the Russian command and control structure, the Russian military alerted President Boris Yeltsin, his defense minister, and the chief of the general staff. They immediately opened an emergency teleconference to determine whether they needed to order Russia’s strategic forces to launch a counterattack. The rocket that had been launched was actually an atmospheric sounding rocket conducting scientific observations of the aurora borealis. Norway had notified Russia of this launch several weeks earlier, but the message had not reached the relevant sections of the military. In little more than two minutes before the deadline to order nuclear retaliation, the Russians realized their mistake and stood down their strategic forces. Thus, 10 years ago, when the declining Russian early warning system was stronger than today, it read this single small missile test launch as a U.S. nuclear missile attack on Russia. The alarm went up the Russian chain of command all the way to the top. The briefcase containing the nuclear missile launch codes was brought to Yeltsin as he was told of the attack. Fortunately, Yeltsin and the Russian leadership made the correct decision that day and directed the Russian strategic nuclear forces to stand down.

# Asteroid Impact – Nuclear War

Small asteroids can spark nuclear exchanges that kill millions if not correctly detected and identified.

Jaroff ’02 (Senior editor of Time Magazine, award winning science writer, founding managing editor of Discover magazine degrees in electrical engineering and mathematics from the University of Michigan, “It’s the little Asteroids that Get You”, Time, 9/17/02, [http://www.time.com/time/columnist/jaroff/article/0,9565,351731,00.html](http://www.time.com/time/columnist/jaroff/article/0%2C9565%2C351731%2C00.html)?, AG)

Anyhow, after all that, I had good reason to think that I knew practically everything there was to know about asteroids and their threat to Earth — until this summer, when Brig. Gen Pete Worden, deputy director of the U.S. Space Command, disabused me of that notion. Though the asteroid detection program has so far concentrated on finding the big guys, civilization-ending monsters about six-tenths of a mile across or larger, Worden thinks that the more plentiful, and harder-to-detect smaller ones present a more imminent threat. Many of these asteroids are not massive enough to penetrate the atmosphere and strike Earth. But, as they hurtle into the atmosphere at tens of thousands of miles per hour, friction heats them so rapidly that they explode before reaching the ground. By now, we've all heard of the asteroid, about 300 ft. in diameter, that in 1908 exploded about five miles above the uninhabited Tunguska region of Siberia. The blast, estimated today at 10 megatons, burned and felled trees and killed wildlife over an area of several hundred square miles. And as recently as 1996, an asteroid exploded over Greenland with the equivalent of a 100 kiloton blast. Had either of these intruders from space met their demise over, say, London or New York, hundreds of thousands might have perished. That's bad enough, and we'd certainly better start looking harder for the smaller guys. But, as Worden warns, these diminutive asteroids can trigger a danger even greater that their explosive potential. Last June for example, during the standoff between nuclear powers India and Pakistan, an asteroid no more than 30 feet across exploded over the Mediterranean sea with the force of a one kiloton bomb. Had that blast occurred anywhere over the subcontinent, Worden fears, neither side could have distinguished between a nuclear blast and an exploding asteroid. Mistaking the event as a first strike, they might have launched a nuclear exchange and killed millions. Worden wants the U.S., which has the technology to identify the nature of these air blasts, to set up a warning center that could reassure rival nuclear-armed nations on the subcontinent, as well as in Asia and the Middle East, that they are under asteroid, not nuclear, attack. Until that kind of center is up and functioning, my new asteroid dreams will not have happy endings.

# Asteroid Impact 🡪 Wildfires

A 1.3 km asteroid could disrupt the global climate, ignite massive fires, and wipe out a region the size of Europe.

Mone, 2003 (Gregory) (Popular Science, Sep2003, Vol. 263 Issue 3, p72, 8p, 1 Color Photograph,)

A BAD DAY Here's why attention to asteroid diversion technology is a smart bet, even if impact risks are tiny. The effect of an asteroid 1.3 km in diameter striking Earth would be catastrophic, though the degree of damage would depend on where it hit. If 2004SB were to strike land, it would excavate a crater some 20km wide, ignite fires stretching eight times that far, wipe out a region the size of Europe, and potentially disrupt the global climate. Atmospheric debris would cloud the skies, threatening agriculture worldwide. A water landing, which is more likely, would generate tsunamis capable of flooding coastal cities. In low-lying countries such as Bangladesh, this wave would take hundreds of thousands of lives.

**Forest fires lead to severe infant mortality rate, we’re talking 20,000+ in just regional deaths.**

Harrison et al. 09 [Mark E., Susan E. Page, and Suwido H. Limin. "The global impact of Indonesian forest fires." Biologist 56, no. 3 (August 2009): 156-163., PN]

Following the 1997 fires, an estimated 20 million people in Indonesia suffered from respiratory problems, with 19,800-48,100 premature mortalities (Heil, 2007). In severely affected areas, > 90% of people had respiratory symptoms and elderly individuals suffered a serious deterioration in overall health (Kunii et al, 2002). The Indonesian National Standards Institute classifies concentrations of particulate matter with diameters #10μm in concentrations of over 200μg/m3 as ‘very un- healthy’ and above 300 μg/m3 as ‘dangerous’. These figures are regularly exceeded in smoky years; for example, in Palangka Raya, Central Kalimantan, air quality was rated as ‘unhealthy/very unhealthy/ dangerous’ on 81% of days from September-November 2006 and, in October 2006, 30 of 31 days were ‘dangerous’ (Board for the Control of Environmental Impacts in Palangka Raya Area, 2006), representing a clear health threat (Figure 4). Addition- ally, thick smoke impairs visibility, causing an increase in traffic accidents, and a general lack of public health service and the high cost of health insurance means that treatment is not typically received for smoke-related ailments.

# **Wildfire ! – Poverty**

Forest fires destroy local and surrounding economic progress, as well as lead to regional poverty.

Harrison et al. 09 [Mark E., Susan E. Page, and Suwido H. Limin. "The global impact of Indonesian forest fires." Biologist 56, no. 3 (August 2009): 156-163., PN]

Estimates of the cost of uncontrolled fires to the Indonesian economy differ, but are invariably large. Varma (2003) analysed the costs and benefits of slash-and-burn to the Indonesian economy and conclud- ed that during 1997-1998 Indonesia lost US$20.1 billion as a result of this practice. Economic losses in heavily-affected rural villages can amount to as much as 50% of township income. Haze from the fires can extend to Malaysia, Singapore and Thai- land, shrouding them in smoke and affect- ing transport and economic activities for millions more people, resulting in billions more dollars of economic losses. Clearly, the economic losses associated with un- controlled fires are contributing to poverty and restraining development in the region.

# Wildfire ! - deforestation

Forest fires lead to severely reduced plant production, decimating the food chain and set the grounds for future, forest fires.

Harrison et al. 09 [Mark E., Susan E. Page, and Suwido H. Limin. "The global impact of Indonesian forest fires." Biologist 56, no. 3 (August 2009): 156-163., PN]

Reduced temperatures and light intensity – Smoke blocks out the sun, reducing light intensity and temperature. Photosynthetically-active radiation can decline by up to 92% under thick smoke conditions, negatively influencing plant photosynthesis rates (Davies and Unam, 1999) and possibly reducing food security in the region. Potential influence on ENSO – ENSO has far-reaching effects on world cli- mate. The frequency of El Niño events is thought to have increased since the mid-1970s, due to global warming (Trenberth and Hoar, 1997). This could create a positive-feedback loop: in- creased burning increases atmospheric CO2 concentrations, which raises temperatures, and increases the frequency and severity of ENSO events, thereby increasing the incidence and severity of future fires, etc.

Forests are key to biological life and preventing rapid climate change.

Journal of Medicinal Plants in 09 ['Rapid Deforestation: Threat to a Balanced Atmospheric Composition' 2009, Journal of Tropical Medicinal Plants, 10, 2, p. 312, PN]

Forests play a range of roles: they help prevent desertification of surrounding areas by their water- retaining function, they provide shade, mitigate climate change through transpiration, and provide home for a variety of living organisms. If deforestation continues to progress, some areas will suffer more serious desertification, the atmospheric heat distribution will change, which will in turn change regional and global climates, and the balance of a number of ecosystems will be disrupted. Forests are thus useful in maintaining a balance in the Earth's ecosystems and are indeed important resources that need protecting.

# Asteroid ! – Global Communications

Asteroid strike would shut down global communications

Marusek 07 (James Marusek is a Nuclear Physicist and Engineer “*Comet and Asteroid Threat Impact Analysis*,” Paper presented at the 2007 AIAA Planetary Defense Conference, 5-9 March 2007 http://www.aero.org/conferences/planetarydefense/2007papers/P4-3--Marusek-Paper.pdf, TDA)

Large quantities of ionizing radiation will be produced by the impact and can severely change the environment of the upper atmosphere, producing heavily ionized regions, which can disrupt electromagnetic waves passing through those zones. The trapping mechanism for these high-energy electrons may be similar to that which produces the Van Allen radiation belts. This radiation will cause significant interruption of communications. This will interfere with all surviving telephone, television, computer and radio traffic. There will be so much static in the signal that it will be almost unintelligible. For a large impact, these disturbed regions can easily be global in size and can persist for tens of hours. This could essentially temporarily shut down all worldwide communications.

# Asteroid Impact 🡪 Agriculture Disruption

The Earth is due for an asteroid that would cause agriculture to virtually end and civilization to cease being.

Broad in 91 (author and a senior writer at The New York Times. Won two Pulitzer prizes, was a Pulitzer finalist, won the Emmy for PBS *Nova*, won a Dupont Award, The New York Times, *Asteroids, a Menace to Early Life, Could Still Destroy Earth; There's a 'Doomsday Rock,' But When Will It Strike?*, June 18, 1991, http://www.nytimes.com/1991/06/18/science/asteroids-menace-early-life-could-still-destroy-earth-there-s-doomsday-rock-but.html?pagewanted-print&src-pm, znf)

SOMEWHERE in space at this moment, hurtling toward Earth at roughly 16 miles a second, is the doomsday rock. The question of growing interest to scientists and engineers is exactly when it will approach the planet and whether anything can be done to avoid a catastrophic collision, such as nudging the rock off course with a nuclear blast or two. The doomsday rock is an asteroid large enough to severely disrupt life on Earth upon impact, lofting pulverized rock and dust that blocks most sunlight. Agriculture would virtually end, and civilization could wither and die, just as the dinosaurs and many other forms of life are thought by some to have been wiped out by a massive object from outer space 65 million years ago. So far, no astronomer has located the killer asteroid, which by definition would be a mile wide or larger, would have an orbit that crossed Earth's, and would do so at exactly the wrong moment. But, given enough time, it is inevitable that one will appear. And the odds are that the moment could be relatively soon, in celestial terms. Experts, extrapolating from craters observed on the Moon and from a partial survey of Earth-crossing asteroids, calculate that "a big one" slams into the planet once every 300,000 to one million years. More graphically, that means there is between one chance in 6,000 and one chance in 20,000 of a cataclysmic impact in the next 50 years. "Eventually it will hit and be catastrophic," said Dr. Tom Gehrels, a professor of lunar and planetary science at the University of Arizona who heads a team that searches the sky for killer asteroids. "The largest near-Earth one we know of is 10 kilometers in diameter," or about 6.2 miles. "If a thing like that hit, the explosion would be a billion times bigger than Hiroshima. That's a whopper." The field of asteroid detection and avoidance, once pooh-poohed as laughably paranoid, has grown in size and respectability in the last decade. Last year Congress called for a series of detailed studies after a half-mile-wide asteroid crossed the planet's path at an uncomfortably close distance in 1989. "The Earth had been at that point only six hours earlier," a House report noted. "Had it struck the Earth it would have caused a disaster unprecedented in human history. The energy released would have been equivalent to more than 1,000 one-megaton bombs."

Asteroid impact would destroy agriculture by blocking sunlight with dust which prevents photosynthesis and reduces temperatures.

Chapman in 11 (Clark R. Chapman, planetary scientist at the Southwest Research Institute, Astronomy vol. 39 issue 5 May 2011, *What will happen when the next asteroid strikes?*, http://proxy.foley.gonzaga.edu/login?url=http ://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=60031700&site=ehost-live) DF

In addition, Earth would undergo significant climate changes as Sun-blocking dust is launched into the atmosphere after impact. As dust circles the globe during the ensuing weeks, perhaps crossing the equator into the opposite hemisphere, temperatures would cool dramatically, threatening an agricultural growing season and hence the world's food supply. With more than a year of warning, the international community could mitigate the worst effects before impact: prepare for unprecedented food shortages, the required medical effort, and the possible collapse of the world's economic infrastructure. Maybe humanity could weather the storm without letting fears of the terrible prognosis exacerbate tensions, which would magnify the unfolding tragedy. With foreknowledge, civilization might survive, depending on whether we can stay resilient as we face such a natural disaster.

# Agriculture Disruption ! – Food Shortages

Food shortages can spark conflict – Empirically proven

Thompson 07 (Andrea, writer, livescience.com, “Climate Change can spark war”, November 21st, 2007; Accessed 7/3/11, AH)

History may be bound to repeat itself as Earth’s climate continues to warm, with changing temperatures causing food shortages that lead to wars and population declines, according to a new [study](http://www.livescience.com/7391-climate-change-spark-war.html) that builds on earlier work. The [previous study](http://www.livescience.com/1660-global-warming-fuel-war.html), by David Zhang of the University of [Hong Kong](http://www.livescience.com/7391-climate-change-spark-war.html), found that swings in temperature were correlated with times of war in Eastern China between 1000 and 1911. Zhang's newer work, detailed in the Nov. 19 online edition of the journal Proceedings of the National Academy of Sciences, broadens its outlook to climate and war records worldwide and also found a correlation between the two. "This current study covers a much larger spatial area and the conclusions from the current research could be considered general principles," Zhang said. The research does not represent direct cause-and-effect, but rather suggests a link between climate and conflict. Because water supplies, growing seasons and land fertility can be affected by changes in climate, they might prompt food shortages that could in turn lead to conflicts, such as local uprisings, government destabilization and invasions from neighboring regions, the researchers  speculate. These conflicts and the food shortages that cause them could both contribute to population declines, they add. To see whether changes in climate affected the number of wars fought in the past, the researchers examined the time period between 1400 and 1900, when global average temperatures reached extreme lows around 1450, 1640 and 1820, with slightly warmer periods in between. Using records reflected in tree rings and ice cores, the researchers compared temperature changes to a database of 4,500 wars worldwide that co-author Peter Brecke of Georgia Tech compiled with funding from the U.S. Institute of Peace. The results of the comparison showed a cyclic pattern of turbulent periods when temperatures were low, followed by more tranquil times when temperatures were higher. This correlation doesn't necessarily mean that all-out war is imminent, William Easterling of Pennsylvania State University, who was not affiliated with the work, had said in regards to Zhang's earlier work. However, **the changing distribution of resources could certainly increase international tensions,** he added. **The new study also showed population declines following each war peak. Specifically, during the frigid 17th century, Europe and Asia experienced more wars of great magnitude and population declines than in more temperate times.** Projecting into the future To connect temperature changes of less than 1 degree Celsius (1.8 degrees Fahrenheit) to food shortages, **the authors used price increases as a measure of decreases in agricultural production and found that when grain prices reached a certain level, wars erupted.** Though these historical periods of climate change featured cooler temperatures, current rising global temperatures could still cause ecological stress that damages agricultural production. "Even though temperatures are increasing now, the same resulting conflicts may occur since we still greatly depend on the land as our food source," Brecke said. "The warmer temperatures are probably good for a while, but beyond some level, plants will be stressed," Brecke explained. "With more droughts and a rapidly growing population, it is going to get harder and harder to provide food for everyone, and thus **we should not be surprised to see more instances of starvation and probably more cases of hungry people clashing over scarce food and water**."

# Food Shortage ! - War

Severe food shortages have the potential to spill over into widespread violence

Agrimoney 09 (Agrimoney.com, agriculture news, “Food Shortages ‘may lead to war’ Financier says”, July 1st, 2009, accessed 7/3/11, AH)

**Food shortages**, prompted by loss of arable land and soaring demand, **are to become so severe that they may spill over into widespread conflict** in the 2020s, a respected investment manager has warned. Susan Payne, the chief executive of Emergent Asset Management, said that **demand for food would be raised by growth of 80m a year in world population**, compounded by the impact of increasing affluence on diets. China's consumption of meat, which requires more land to produce than arable crops, had quadrupled to 40 kilogrammes per person per year since the 1980s. However, arable land was coming under pressure from desertification and urbanisation. "We see somewhere around 2020 or beyond there will be **genuine food shortages** that **could easily cause conflict globally**," Ms Payne told a conference in London. Kondratieff cycles This analysis was supported by analysis of so-called Kondratieff cycles, which propose that events in capitalist economies recur over long-term waves, she added**. Commodity price peaks had co-incided with conflicts in periods such as early 1970s, the time of the Vietnam War, and the 1940s, when World War II ended.** However, the prospect of food shortages created opportunities for investment in agriculture, she said, singling out Africa as a particularly promising area for investment. Land prices were typically -800 a hectare in Africa, with Zambian farmland costing ,000 per hectare because of the country's especially plentiful water supply, compared with up to ,000 per hectare in Germany. Yet, properly managed, this land could achieve good yields and had a rich market for its produce on its doorstep. 'Africa's decade' Africa's population, half of which is aged under 18, will grow to nearly 2bn by 2050, overtaking that in India and China, she told the World Agri Invest Conference. "I think this is Africa's decade," said Ms Payne, who was named by Financial News as being among Europe's leading women in finance in 2008 for the second year running. Emergent Asset Management runs an African farmland fund.

# Starvation ! = D Rule

The Argument That Survival Outweighs Sharing Food Relies on a Misunderstanding of Moral Agency—This View Justifies Infinite Atrocities—Because No Such Agent as “the Human Species” Exists, Then We Are Responsible Only to Individuals Who Are Starving

Watson 77(Richard, Professor of Philosophy at Washington University, World Hunger and Moral Obligation, p. 121-123)

Given that the human species has rights as a fictional person on the analogy of corporate rights, it would seem to be rational to place the right of survival of the species above that of individuals. Unless the species survives, no individual will survive, and thus an individual’s right to life is subordinate to the species’ right to survival. If species survival depends on the unequal distribution of food to maintain a healthy breeding stock, then it is morally right for some people to have plenty while others starve. Only if there is enough food to nourish everyone well does it follow that food should be shared equally. This might be true if corporate entities actually do have moral status and moral rights. But obviously, the legal status of corporate entities as fictional persons does not make them moral equals or superiors of actual human persons. Legislators might profess astonishment that anyone would think that a corporate person is a *person* as people are, let alone a moral person. However, because the legal rights of corporate entities are based on individual rights, and because corporate entities are treated so much like persons, the transition is often made. Few theorists today would argue that the state of the human species is a personal agent. But all this means is that idealism is dead in theory. Unfortunately, its influence lives, so it is worth giving an argument to show that corporate entities are not real persons. Corporate entities are not persons as you and I are in the explicit sense that we are self-conscious agents and they are not. Corporate entities are not agents at all, let alone moral agents. This is a good reason for not treating corporate entities even as fictional persons. The distinction between people and other things, to generalize, is that people are self-conscious agents, whereas things are not. The possession of rights essentially depends on an entity’s being self-conscious, i.e., on its actually being a person. If it is self-conscious, then it has a right to life. Self-consciousness is a necessary, but not sufficient, condition for an entity’s being a moral equal of human beings; moral equality depends on the entity’s also being a responsible moral agent as most human beings are. A moral agent must have the capacity to be responsible, i.e., the capacity to choose and to act freely with respect to consequences that the agent does or can recognize and accept as its own choice and doing. Only a being who knows himself as a person, and who can effect choices and accept consequences, is a responsible moral agent. On these grounds, moral equality rests on the actuality of moral agency based on reciprocal rights and responsibilities. One is responsible to something only if it can be responsible in return. Thus, we have responsibilities to other people, and they have reciprocal rights. If we care for things, it is because people have interests in them, not because things in themselves impose responsibilities on us. That is, as stated early in this essay, morality essentially has to do with relations among people, among persons. It is nonsense to talk of things that cannot be moral agents as having responsibilities; consequently, it is nonsense to talk of whatever is not actually a person as having rights. It is deceptive even to talk of legal rights of a corporate entity. Those rights (and reciprocal responsibilities) actually pertain to individual human beings who have an interest in the corporate entity. The State or the human species have no rights at all, let alone rights superior to those of individuals. The basic reason given for preserving a nation or the human species is that otherwise the milieu of morality would not exist. This is false so far as specific nations are concerned, but it is true that the existence of individuals depends on the existence of the species. However, although moral behavior is required of each individual, no principle requires that the realm of morality itself be preserved. Thus, we are reduced to the position that people’s interest in preserving the human species is based primarily on the interest of each in individual survival. Having shown above that the principle of equity is morally superior to the principle of survival, we can conclude again that food should be shared equally even if this means the extinction of the human race. Is there no way to produce enough food to nourish everyone well? Besides cutting down to the minimum, people in the West might quit feeding such nonhuman animals as cats and dogs. However, some people (e.g., Peter Singer) argue that mere sentience—the capacity to suffer pain—means that an animal is the moral equal of human beings. I argue that because nonhuman animals are not moral agents, they do not share the rights of self-conscious responsible persons. And considering the profligacy of nature, it is rational to argue that if nonhuman animals have any rights at all, they include not the right to life, but merely the right to fight for life. In fact, if people in the West did not feed grain to cattle, sheep, and hogs, a considerable amount of food would be freed for human consumption. Even then, there might not be enough to nourish everyone. Let me remark that Stone and Singer attempt to break down the distinction between people on the one hand, and certain things (corporate entities) and nonhuman animals on the other, out of moral concern. However,, there is another, profoundly antihumanitarian movement also attempting to break down the distinction. All over the world, heirs of Gobineau, Goebbels, and Hitler practice genocide and otherwise treat people as non-human animals and things in the name of the State. I am afraid that the consequences of treating entities such as corporations and nonhuman animals—

<CONTINUED>

that are not moral agents—as persons with rights will not be that we will treat national parks and chickens the way we treat people, but that we will have provided support for those who would treat people the way we now treat nonhuman animals and things. The benefits of modern society depend in no small part on the institution of corporate law. Even if the majority of these benefits are to the good—of which I am by no means sure—the legal fiction of corporate personhood still elevates corporate needs above the needs of people. In the present context, reverence for corporate entities leads to the spurious argument that the present world imbalance of food and resources is morally justified in the name of the higher rights of sovereign nations, or even of the human species, the survival of which is said to be more important than the right of any individual to life. This conclusion is morally absurd. This is not, however, the fault of morality. We *should* share all food equally, at least until everyone is well-nourished. Besides food, *all* the necessities of life should be shared, at least until everyone is adequately supplied with a humane minimum. The hard conclusion remains that we should share all food equally even if this means that everyone starves and the human species becomes extinct. But, of course, the human race would survive even equal sharing, for after enough people died, the remained could be well-nourished on the food that remained. But this grisly prospect does not show that anything is wrong with the principle of equity. Instead, it shows that something is profoundly wrong with the social institutions in which sharing the necessities of life equally is “impractical” and “irrational.”

# Starvation ! = D Rule

Giving food is a moral responsibility—we are obligated to share even in the face of human extinction

Watson, 77 (Richard, Professor of Philosophy at Washington University, World Hunger and Moral Obligation, p. 118-119)

These arguments are morally spurious. That food sufficient for well-nourished survival is the equal right of every human individual or nation is a specification of the higher principle that everyone has equal right to the necessities of life. The moral stress of the principle of equity is primarily on equal sharing, and only secondarily on what is being shared. The higher moral principle is of human *equity per se*. Consequently, the moral action is to distribute all food equally, whatever the consequences. This is the hard line apparently drawn by such moralists as Immanuel Kant and Noam Chomsky—but then, morality is hard. The conclusion may be unreasonable (impractical and irrational in conventional terms), but it is obviously moral. Nor should anyone purport surprise; it has always been understood that the claims of morality—if taken seriously—supersede those of conflicting reason. One may even have to sacrifice one’s life or one’s nation to be moral in situations where practical behavior would preserve it. For example, if a prisoner of war undergoing torture is to be a (perhaps dead) patriot even when reason tells him that collaboration will hurt no one, he remains silent. Similarly, if one is to be moral, one distributes available food in equal shares (even if everyone then dies). That an action is necessary to save one’s life is no excuse for behaving unpatriotically or immorally if one wishes to be a patriot or moral. No principle of morality absolves one of behaving immorally simply to save one’s life or nation. There is a strict analogy here between adhering to moral principles for the sake of being moral, and adhering to Christian principles for the sake of being Christian. The moral world contains pits and lions, but one looks always to the highest light. The ultimate test always harks to the highest principle—recant or die—and it is pathetic to profess morality if one quits when the going gets rough. I have put aside many questions of detail—such as the mechanical problems of distributing food—because detail does not alter the stark conclusion. If every human life is equal in value, then the equal distribution of the necessities of life is an extremely high, if not the highest, moral duty. It is at least high enough to override the excuse that by doing it one would lose one’s life. But many people cannot accept the view that one must distribute equally even in f the nation collapses or all people die. If everyone dies, then there will be no realm of morality. Practically speaking, sheer survival comes first. One can adhere to the principle of equity only if one exists. So it is rational to suppose that the principle of survival is morally higher than the principle of equity. And though one might not be able to argue for unequal distribution of food to save a nation—for nations can come and go—one might well argue that unequal distribution is necessary for the survival of the human species. That is, some large group—say one-third of present world population—should be at least well-nourished for human survival. However, from an individual standpoint, the human species—like the nation—is of no moral relevance. From a naturalistic standpoint, survival does come first; from a moralistic standpoint—as indicated above—survival may have to be sacrificed. In the milieu of morality, it is immaterial whether or not the human species survives as a result of individual behavior.

# Starvation ! = D Rule

We have a moral obligation to prevent famine

Singer in 72 [Peter, Ira W. DeCamp Professor of Bioethics at Princeton University and Laureate Professor at the Centre for Applied Philosophy and Public Ethics at the University of Melbourne. He specializes in applied ethics and approaches ethical issues from a secular, preference utilitarian perspective, “Famine, Affluence, and Morality”, Philosophy and Public Affairs, vol. 1, no. 1 (Spring 1972), pp. 229-243 [revised edition], PN]

These are the essential facts about the present situation in Bengal. So far as it concerns us here, there is nothing unique about this situation except its magnitude. The Bengal emergency is just the latest and most acute of a series of major emergencies in various parts of the world, arising both from natural and from manmade causes. There are also many parts of the world in which people die from malnutrition and lack of food independent of any special emergency. I take Bengal as my example only because it is the present concern, and because the size of the problem has ensured that it has been given adequate publicity. Neither individuals nor governments can claim to be unaware of what is happening there. What are the moral implications of a situation like this? In what follows, I shall argue that the way people in relatively affluent countries react to a situation like that in Bengal cannot be justified; indeed, the whole way we look at moral issues - our moral conceptual scheme - needs to be altered, and with it, the way of life that has come to be taken for granted in our society. In arguing for this conclusion I will not, of course, claim to be morally neutral. I shall, however, try to argue for the moral position that I take, so that anyone who accepts certain assumptions, to be made explicit, will, I hope, accept my conclusion. I begin with the assumption that suffering and death from lack of food, shelter, and medical care are bad. I think most people will agree about this, although one may reach the same view by different routes. I shall not argue for this view. People can hold all sorts of eccentric positions, and perhaps from some of them it would not follow that death by starvation is in itself bad. It is difficult, perhaps impossible, to refute such positions, and so for brevity I will henceforth take this assumption as accepted. Those who disagree need read no further. My next point is this: if it is in our power to prevent something bad from happening, without thereby sacrificing anything of comparable moral importance, we ought, morally, to do it. By "without sacrificing anything of comparable moral importance" I mean without causing anything else comparably bad to happen, or doing something that is wrong in itself, or failing to promote some moral good, comparable in significance to the bad thing that we can prevent. This principle seems almost as uncontroversial as the last one. It requires us only to prevent what is bad, and to promote what is good, and it requires this of us only when we can do it without sacrificing anything that is, from the moral point of view, comparably important. I could even, as far as the application of my argument to the Bengal emergency is concerned, qualify the point so as to make it: if it is in our power to prevent something very bad from happening, without thereby sacrificing anything morally significant, we ought, morally, to do it. An application of this principle would be as follows: if I am walking past a shallow pond and see a child drowning in it, I ought to wade in and pull the child out. This will mean getting my clothes muddy, but this is insignificant, while the death of the child would presumably be a very bad thing. The uncontroversial appearance of the principle just stated is deceptive. If it were acted upon, even in its qualified form, our lives, our society, and our world would be fundamentally changed. For the principle takes, firstly, no account of proximity or distance. It makes no moral difference whether the person I can help is a neighbor's child ten yards from me or a Bengali whose name I shall never know, ten thousand miles away. Secondly, the principle makes no distinction between cases in which I am the only person who could possibly do anything and cases in which I am just one among millions in the same position.

# Starvation ! = D Rule

Ignoring famine still leaves the subject morally apprehensible

Andre and Velasquez in 92 [Claire Andre and Manuel Velasquez, “World Hunger: A Moral Response” Issues in Ethics - V. 5, N. 1 Spring 1992, Santa Clara University Abstract, http://www.scu.edu/ethics/publications/iie/v5n1/hunger.html PN]

Giving aid to the poor in other nations may require some inconvenience or some sacrifice of luxury on the part of peoples of rich nations, but to ignore the plight of starving people is as morally reprehensible as failing to save a child drowning in a pool because of the inconvenience of getting one's clothes wet.

In fact, according to Singer, allowing a person to die from hunger when it is easily within one's means to prevent it is no different, morally speaking, from killing another human being. If I purchase a VCR or spend money I don't need, knowing that I could instead have given my money to some relief agency that could have prevented some deaths from starvation, I am morally responsible for those deaths. The objection that I didn't intend for anyone to die is irrelevant. If I speed though an intersection and, as a result, kill a pedestrian, I am morally responsible for that death whether I intended it or not.

# Asteroid Impact 🡪 Supersonic Shockwave

Impact of an asteroid would create a supersonic shock and would devastate anything in its path.

Shiga 2009 (David) (New Scientist; 9/26/2009, Vol. 203 Issue 2727, p30-33, 4p)

Supersonic shock wave. If you were unfortunate enough to be looking up from directly below, the explosion would be brighter than the sun. The visible and infrared radiation would be strong enough to make anything flammable ignite, says Mark Boslough of Sandia National Laboratory in Livermore, California. "It's like being in a broiler oven," he says. Anyone directly exposed would quickly be very badly burned. Even before the sound of the blast reaches you, your body would be smashed by a devastating supersonic shock wave as the explosion creates a bubble of high-pressure air that expands faster than the speed of sound. Planetary scientist Jay Melosh of Purdue University in New York once experienced a shock wave from an experiment that exploded 500 tonnes of TNT, a tiny blast in comparison with the blast from an asteroid. "I was standing on top of a hill about 1.5 kilometres away wearing earplugs," he recalls. Melosh says you would see the shockwave in the air due to the way it refracts light. "It's a shimmering bubble," he says. "It spreads out in complete silence until it reaches you, then you hear a double boom." Melosh was at a safe distance, but at ground zero below an exploding asteroid, the shock wave would be powerful enough to knock down buildings. It would arrive about 30 seconds after the blazing hot flash of light, and could also knock any nearby planes out of the sky, Boslough says. Any surviving buildings would be pummelled by raging winds blowing faster than any hurricane can muster.

# Asteroid Impact 🡪 Extinction

Empirically proven – an asteroid wiped out the Clovis 13,000 years ago.

Abrams in 2008 (Stone-Age Asteroid May Have Wiped Out Life in America, January 2008, EBSCO, znf)

Some 13,000 years ago, the Clovis people wandered North America, hunting ground sloths, mammoths, and other creatures — until hunters and prey both vanished. What happened? A team of scientists now think they know: A miles-wide comet, they announced in May, seems to have exploded just north of the Great Lakes, triggering a 1,000-year cold spell that helped bring on the extinction of the Clovis and the animals. For years, the disappearance of the Clovis culture and sudden extinction of 35 genera of animals were explained by two competing theories. One blamed climate change, although similar change at other times had not resulted in mass extinction. The other fingered the humans themselves: Newly arrived from Asia, the Clovis killed off everything in a murderous spree and subsequently starved. "They would be very strange hunters, if you look at the ethnographic record, to knock out 35 genera that quickly," says Douglas Kennett, an archaeologist at the University of Oregon who conducted the research with 25 colleagues. The key to the new hypothesis is a thin layer of black soil found at more than 50 North American sites. In it are magnetic grains containing iridium, an element thought to indicate extraterrestrial origins. The sediments also contain metallic and carbon spherules, as well as melted charcoal, likely the result of forest fires that swept the continent after the impact. Although no crater has been found, concentrations of these indicators are highest around the Great Lakes. Perhaps the impact was absorbed and erased by the Laurentide Ice Sheet, which at the time reached from the Arctic Ocean to that point, the researchers say. Or maybe the comet exploded before it hit Earth. "Think about it — people would have seen it coming," says Kennett. "This was a bad day."

Asteroid Impact 🡪 Economic Collapse

Asteroid impact would result in various calamities such as earthquakes, food shortages, fires and economic collapse resulting in mass death (\*)

Chapman in 5-11 (Chapman, Clark R., Astronomy, 00916358, May2011, Vol. 39, Issue 5)

I'll leave it to science fiction to describe how individuals, nations, emergency planners, religions, and economic interests worldwide might respond to the ever-more-confident predictions of a cometary calamity as the months pass. But we can estimate what would happen, physically, when the comet struck. First, we can calculate the immediate damage in the region where the object hits. Planetary scientist Jay Melosh of Purdue University in West Lafayette, Indiana, and his colleagues have a starting place for the calculation: They created a website application called "Impact: Earth" ([www.purdue.edu/impactearth](http://www.purdue.edu/impactearth)) where you can plug in values to simulate collision aftereffects. In our scenario, we have a comet 1.5 miles (2.4 km) in diameter, with a density of 1,000 kilograms per cubic meter (the density of ice). It strikes at 20 miles/second (32 km/s) into a rural area of sedimentary rock. At 50 miles (80 km) from ground zero, the fireball of the exploding comet -- which would appear 60 times bigger than the Sun -- would immediately burn us and every flammable thing around us. Surrounding buildings would suffer major damage from the resulting earthquake -- nearly as big as the Chilean one of February 2010 -- that would reach our charred remains about 16 seconds after impact. Some 4 minutes after impact, an enormous airblast with winds approaching 1,200 mph (1,900km/h) would sweep away anything left standing. If we were 300 miles (480 km) away from ground zero, we would likely survive, at least initially. Because we know of the impending impact, we could hide in a well-constructed building to avoid burns from the fireball, protect ourselves from falling rocks, and endure the earthquake and airblast. Either the earthquake about 1.6 minutes after impact or the hurricane-force airblast arriving 24.4 minutes after the impact might badly damage ordinary wood-frame houses. Our best option would be to evacuate far away from ground zero long before the comet approached Earth. But we still wouldn't be safe. What calculations such as "Impact: Earth" don't describe are the global environmental and infrastructure damage, which could disrupt civilization worldwide for months and years to come. For example, as the comet penetrates the atmosphere, chemical reactions would likely destroy Earth's protective ozone layer. Some scientists think there could be an enormous electromagnetic pulse (EMP) that might disable electrical grids around the world and render communications and electronic equipment (including Earth's orbiting satellites) nonfunctional. Unfortunately, we don't know much about the effect; scientists haven't seriously researched impact-induced EMPs. In addition, Earth would undergo significant climate changes as Sun-blocking dust is launched into the atmosphere after impact. As dust circles the globe during the ensuing weeks, perhaps crossing the equator into the opposite hemisphere, temperatures would cool dramatically, threatening an agricultural growing season and hence the world's food supply. With more than a year of warning, the international community could mitigate the worst effects before impact: prepare for unprecedented food shortages, the required medical effort, and the possible collapse of the world's economic infrastructure. Maybe humanity could weather the storm without letting fears of the terrible prognosis exacerbate tensions, which would magnify the unfolding tragedy. With foreknowledge, civilization might survive, depending on whether we can stay resilient as we face such a natural disaster.

# Asteroid Impact 🡪 Tsunamis

Asteroid impacts cause wildfires, devastating tsunamis, immense economic loss, and end with death tolls in the millions

Bucknam and Gold in 08 [Mark and Robert, Mark Bucknam is the Deputy Director for Plans in the Policy Planning Office of the Office of the US Secretary of Defense. He is a Colonel in the US Air Force and holds a PhD in War Studies from King’s College, University of London, as well as a BS in physics and an MS in materials science and engineering from Virginia Tech. Robert Gold is the Chief Technologist for the Space Department at the Applied Physics Laboratory of Johns Hopkins University. He was the Payload Manager for NASA’s Near Earth Asteroid Rendezvous mission. He earned his PhD in physics from the University of Denver. “Survival” (00396338); Oct/Nov2008, Vol. 50 Issue 5, p141-156, 16p PN]

An asteroid like Apophis would cause considerable damage if it collided with Earth. If it hit on land, it would make a crater about 6km across and the shock wave, ejecta and superheated air would level buildings and trees and ignite fires over a wide area.1 If it hit an ocean, it would cause a devastating cycle of gradually diminishing tsunamis. Scientists cannot yet predict the exact point Apophis might impact in 2036, but their current assessment predicts it would be somewhere along a long, lazy backward ‘S’ running from northeastern Kazakhstan through Siberia, north of Japan and across the Pacific Ocean before dipping south to converge with the west coast of North America; running eastward across Panama, Columbia and Venezuela, and finally terminating around the west coast of Africa near Senegal. The mid-point of this line lies several hundred kilometres west of Mexico’s Baja Peninsula, about midway between Honolulu and Los Angeles. The tsunami from an ocean impact would likely inflict horrific human and economic losses – damage from Apophis could certainly surpass the Indian Ocean tsunami of 26 December 2004, which claimed over 200,000 lives and inflicted damages on the order of $15 billion.

**The tsunamis would be huge**

Wagner 03 (Cynthia Wagner is the senior editor of The Futurist. “*Impact! Simulating an Asteroid Hit*.” Futurist, Sep/Oct2003, Vol. 37, Issue 5. EBSCOhost TDA.

Knowing whether something will happen in the future may not be as important as knowing what else could happen if it did. So Ward and his team have developed a computer simulation of an asteroid impact and the tsunami it will cause when it lands in the Atlantic at an estimated 38,000 miles per hour. The scenario, in brief: Upon impact, the asteroid is vaporized in the 60,000-megaton blast, which blows an 11-mile-wide cavity in the ocean. The blast goes some three miles down, excavating part of the seafloor. Water rushes in to fill the cavity, then rings of waves spread out in all directions. Multiple tsunami waves of different frequencies and wavelengths pulsate from the blast site and spread out. The first waves to hit land are small, but the later waves, coming at intervals of three or four minutes, increase in height. Coastal areas are hit the hardest. Two hours after the impact, 400-foot waves swallow the northeastern U.S. coast, from Cape Code to, Cape Hatteras. In four hours, the entire East Coast has experienced waves at least 200 feet high. In eight hours, the waves reach Europe at heights of 30 to 50 feet.

Ocean asteroid impact leads to hundred-foot high waves across the world

Stephens 03 (Tim, Staff Writer @ UC Santa Cruz, “Massive tsunami sweeps Atlantic Coast in asteroid impact scenario for March 16, 2880” <http://news.ucsc.edu/2003/05/355.html> May 27, 2003) JM

The 60,000-megaton blast of the impact vaporizes the asteroid and blows a cavity in the ocean 11 miles across and all the way down to the seafloor, which is about 3 miles deep at that point. The blast even excavates some of the seafloor. Water then rushes back in to fill the cavity, and a ring of waves spreads out in all directions. The impact creates tsunami waves of all frequencies and wavelengths, with a peak wavelength about the same as the diameter of the cavity. Because lower-frequency waves travel faster than waves with higher frequencies, the initial impulse spreads out into a series of waves. "In the movies they show one big wave, but you actually end up with dozens of waves. The first ones to arrive are pretty small, and they gradually increase in height, arriving at intervals of 3 or 4 minutes," Ward said. The waves propagate all through the Atlantic Ocean and the Caribbean. The waves decay as they travel, so coastal areas closest to the impact get hit by the largest waves. Two hours after impact, 400-foot waves reach beaches from Cape Cod to Cape Hatteras, and by four hours after impact the entire East Coast has experienced waves at least 200 feet high, Ward said. It takes 8 hours for the waves to reach Europe, where they come ashore at heights of about 30 to 50 feet

# Tsunamis ! - Economy

Tsunamis collapse the economy - coasts get screwed, the economy is screwed

Durrant 08 (Collin Durrant is the Director of Communications at the Conservative Law Foundation. “E*xperts Say U.S. Coasts and Estuaries Contribute Billions to Economy, but Much is at Risk: New report from Restore America’s Estuaries and The Ocean Foundation Shows High Economic Value of Coasts and Estuaries at Jeopardy Without Restoration and Protection*”. May 21, 2008. http://www.clf.org/newsroom/experts-say-u-s-coasts-and-estuaries-contribute-billions-to-economy-but-much-is-at-risk-new-report-from-restore-america%E2%80%99s-estuaries-and-the-ocean-foundation-shows-high-economic-value-of-coa/, TDA”

A new report released today documents the economic value of the nation’s coastal areas in excess of hundreds of billions of dollars. According to the report, “The Economic and Market Value of Coasts and Estuaries: What’s At Stake?” beaches, coastal communities, ports, and fragile bays that are protected and managed in a sustainable way are economic engines that drive and support large sectors of the national economy. At the National Press Club, Jeff Benoit, President of Restore America Estuaries and Dr. Linwood Pendleton, of The Ocean Foundation’s Coastal Ocean Values Center, detailed their findings, including: Estuaries and coasts comprise only 13 percent of the land area of the United States, but are home to 43 percent of the population. 40 percent of the population works in coastal areas, and the coasts produce a staggering 49 percent of the economic output. In eight coastal states, the estuary regions comprise 80 percent or more of the state’s economy. The Gulf of Maine region (MA, NH, ME) is home to 7.3 million people with an economic value of over $354 billion. The full report can be downloaded at: www.estuaries.org. “The productivity of our coastlines is up there with the Fortune 500’s” said Benoit. “Yet historically, we have overlooked the critical role our coasts play in contributing to the national economy.”

# Tsunamis ! – Underwater Landslides

Tsunamis cause underwater landslides, escalating the impact.

Stephens 03 (Tim, Staff Writer @ UC Santa Cruz, “Massive tsunami sweeps Atlantic Coast in asteroid impact scenario for March 16, 2880” <http://news.ucsc.edu/2003/05/355.html> May 27, 2003) JM

"That's like a raging river, so as these waves cross the ocean they're going to stir up the seafloor, eroding sediments on the slopes of seamounts, and we may be able to identify more places where this has happened," Ward said. He added that the waves may also destabilize undersea slopes, causing landslides that could trigger secondary tsunamis. Ward has also done computer simulations of tsunamis generated by submarine landslides. He showed, for example, that the collapse of an unstable volcanic slope in the Canary Islands could send a massive tsunami toward the U.S. East Coast.

# Asteroid Impact 🡪 Climate Change

Asteroids can trigger climate change resulting in extinction

Reilly in 07 (Reilly, Michael, New Scientist, 02624079, 12/8/2007, Vol. 196, Issue 2633 6/28/2011, AH)

Asteroids and comets may also need to hit carbon-rich targets to wreak havoc on Earth's biosphere. The Manicouagan asteroid landed in ancient gneissic rocks, which contain little carbon, Arthur points out. The same is true of the Popigai impact. On the other hand, the Chicxulub crater is in a continental shelf thick with limestone, carbon-rich sediments and salt deposits. Vaporising these rocks would have sent vast amounts of sulphur dioxide into the atmosphere as well as carbon, initially triggering acid rain and cooling, followed by long-term warming. This might account for the death of more than half of all species on the planet, including the dinosaurs.

Asteroids can trigger nuclear winter-esque conditions resulting in mass extinction

Reilly in 07 (Reilly, Michael, New Scientist, 02624079, 12/8/2007, Vol. 196, Issue 2633; Accessed 6/28/2011, AH)

Why do some asteroid impacts and mega-eruptions wipe out most life on Earth while others leave barely a trace in the fossil record? IT'S a striking feature when seen from above, a circular lake 75 kilometres wide. Manicouagan, also known as the Eye of Quebec, was formed when an asteroid around 5 kilometres across struck northern Canada, gouging out a crater that was originally 100 kilometres wide. That makes Manicouagan (below right) the fifth largest impact crater on Earth, not much smaller than the 170-kilometre Chicxulub crater in Yucatán, Mexico, site of the impact that ended the reign of the dinosaurs 65 million years ago. Many blame the extinction on a "nuclear winter" caused by the dust and sulphate aerosols thrown up by the impact. Clearly the Manicouagan strike, too, must have had a similar impact. For a while it was blamed for the mass extinction that marks the end of the Triassic period 200 million years ago. But a 1992 study produced a surprise: it showed the crater is 214 million years old, too old to be the culprit.

An asteroid impact could trigger climate change, disease, famine, and war

IRWIN I. SHAPIRO et al in 10,( Harvard-Smithsonian Center for Astrophysics, Chair FAITH VILAS, MMT Observatory at Mt. Hopkins, Arizona, Vice Chair MICHAEL A’HEARN, University of Maryland, College Park, Vice Chair ANDREW F. CHENG, Johns Hopkins University Applied Physics Laboratory FRANK CULBERTSON, JR., Orbital Sciences Corporation DAVID C. JEWITT, University of California, Los Angeles STEPHEN MACKWELL, Lunar and Planetary Institute H. JAY MELOSH, Purdue University JOSEPH H. ROTHENBERG, Universal Space Network, *Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies Space Studies Board Aeronautics and Space Engineering Board Division on Engineering and Physical Sciences*, THE NATIONAL ACADEMIES PRESS, <http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf>)

Unlike most other known natural hazards to humanity, such as earthquakes, volcanic eruptions, tsunamis, hurricanes, and tornadoes, NEO impacts present a very large spread of disaster scales ranging from small property damage to global extinction events. Larger impacts may result in global climatic changes that can result in famine and disease, infrastructure failure and, potentially, societal breakdown. Smaller impacts could be misinterpreted and thereby conceivably even trigger wars. While there are numerous small incidents that present little risk to people and property, major impact events occur very infrequently. Impacts represent the extreme example of “low-probability, high-consequence” events. Although the probability of such a major impact within the next century may be small, a statistical risk of such an impact remains. Because of the nature of the impact threat, the expected fatality rate from impacts is an “actuarial” estimate based on calculations with attempted conservative assumptions. All the other estimates are based on attribution of causes of actual fatalities from ongoing threats that may change in the future.

# Asteroid Impact 🡪 Climate Change

Asteroid impacts cause global climate change

Dervis in 8 (Kemal Derviş has been the head of the United Nations Development Programme, the UN global development network, since August 2005., UNU World Institute for Development Economics Research, *The Climate Change Challenge*, 2008) DF

Some of the catastrophic effects of climate change would not, therefore, be unlike Earth being hit by an asteroid. These include, for example, the melting of the Greenland and West Antarctic ice sheets, which would result in very large sea level rises changing the world’s physical and human geography. Changes in the thermohaline circulations (the ‘conveyer belt’ of ocean heat that determines much of the earth’s climate) affecting the Gulf Stream would lead to dramatic changes in global weather patterns. Climate tipping-points could be reached, unleashing selfreinforcing multiplier feedback effects—e.g., saturated carbon sinks, releases of methane from arctic permafrost thawing—that can dramatically amplify temperature increases.

**Asteroid causes climate change**

BBC News in 98 [National TV and Radio services for Scotland, Wales and Northern Ireland, and over 40 local radio stations for England, BBC Online, 10 national radio stations 8 national television channel, they’re legit okay? “Meteorite is possible ice age culprit” Friday, December 11, 1998 Published at 18:16 GMT http://news.bbc.co.uk/2/hi/science/nature/233199.stm, PN]

The discovery of a 3.3-million-year-old meteorite impact site in Argentina has revealed a potential cause for the series of ice ages that has periodically frozen the Earth since that time. The new work has shown that a sharp dip in the ocean temperature occurred at the same time as dozens of species were suddenly wiped out and also when a thick layer of molten rock was formed. A meteorite impact could explain all these, as the extreme pressure at impact would melt the rocks and create a cloud of dust or smoke which would block out the sun's warming light. The impact's disturbance of the ocean circulation and atmosphere could have kick-started the global cycle of ice ages, believes Professor Peter Schultz, an impact specialist at Brown University and who led the work. An extraterrestrial object hit ocean cliffs in southeastern Argentina. "There were no glacial cycles up until this moment," he told BBC News Online. " The weather and the fauna were stable but then there was a sudden pulse recorded in the ocean sediments and coincident with the extinctions.

# Asteroid Impact > Climate Change

Asteroids would cause more damage than climate change.

Bucknam and Gold in 08 (Bucknam, Mark; Gold, Robert. Survival (00396338), Oct/Nov2008, Vol. 50 Issue 5, p141-156, 16p; accessed 6/28/11, AH)

While the estimated costs for dealing with climate change vary enormously, they still provide a useful foil for considering how much to spend to fund defences against asteroids and comets. In late 2007, ‘sceptical environmentalist’ Bjorn Lomborg told Scientific American the impact of global warming would likely cost about 1% of world GDP ($658bn) and should be addressed by spending one-twentieth of 1% of world GDP ($33bn) on new non-carbon-producing energy technology.23 At the higher end of such cost projections, Nicholas Stern, former chief economist of the World Bank, estimated that damages from climate change would amount to 5% or more of world GDP (over $3.29tr).24 Stern claimed that to effectively deal with the problem, global annual expenditures of 1% of GDP ($658bn) would be necessary.25 The upper limit for damage caused by an asteroid or comet could exceed the worst projections likely to be wrought by climate change, while the low-end estimate for climate-change mitigation costs – $33bn – would be sufficient to purchase not only the equipment needed to find, track and study threatening asteroids and comets, but also field an operational system to deflect them. The key is to do something before the next devastating impact – in contrast to the Indian Ocean tsunami of 2004, which saw tens of millions of dollars in improvements to the tsunami-warning system come only after disaster struck.

# Climate Change ! – Disease

Warming leads to increased risk of deadly diseases

CBS News 09 ( “Global Warming May Spread Disease” February 11, 2009 <http://www.cbsnews.com/stories/2002/06/20/tech/main512920.shtml>) JM

Climate warming is allowing disease-causing bacteria, viruses and fungi to move into new areas where they may harm species as diverse as lions and snails, butterflies and humans, a study suggests. Pathogens that have been restricted by seasonal temperatures can invade new areas and find new victims as the climate warms and winters grow milder, researchers say in a study in the journal Science. "Climate change is disrupting natural ecosystems in a way that is making life better for infectious diseases," said Andrew Dobson, a Princeton University researchers and another co-author of the study in Science. "The accumulation of evidence has us extremely worried. We share diseases with some of these species. The risk for humans is going up." Climate changes already are thought to have contributed to an epidemic of avian malaria that wiped out thousands of birds in Hawaii, the spread of an insect-borne pathogen that causes distemper in African lions, and the bleaching of coral reefs attacked by diseases that thrive in warming seas. Humans are also at direct and dramatic risk from such insect-born diseases as malaria, dengue and yellow fever, the researchers said. "In all the discussions about climate change, this has really been kind of left out," said Drew Harvell, a Cornell University marine ecologist and lead author of the study. "Just a one- or two-degree change in temperature can lead to disease outbreaks." Richard S. Ostfeld, a co-author of the study, said, "We're alarmed because in reviewing the research on a variety of different organisms we are seeing strikingly similar patterns of increases in disease spread or incidence with climate warming." Ostfeld is an environmental researcher at the Institute of Ecosystem Studies. In the study, the authors analyzed how warming temperatures already are letting insects and microbes invade areas where they once were barred by severe seasonal chills. They said mosquitoes are moving up mountainsides, spreading disease among animals formerly protected by temperature. They also found some pathogens reproduce more often in warmer temperatures, so there are more germs around to cause infection.

# Asteroid Impact – Laundry List

Asteroids cause a laundry list of impacts

Paine 99 (Michael, scientist/author, space.com, “How and asteroid impact causes extinction”, November 5th, 1999, Accessed 7/11/11, AH)

The world economy grinds to a halt as people take to the hills.   Anarchy sets in, civilization breaks down. Accusations fly over the lack of warning -- where was Spaceguard, the proposed international search effort for large asteroids?  People in Brazil feel less vulnerable than most of the world's population. They are on the opposite side of the Earth from the predicted impact point. But one hour after the impact Brazilians notice some brilliant meteors. Then more meteors. Soon the sky gets brighter and hotter from the overwhelming number of meteors. Within a few minutes trees ignite from the fierce radiant heat. Millions of fragments of rock, ejected into space by the blast, are making a fiery return all over the planet.  Only people hiding underground survive the deadly fireworks display. Within three hours, however, massive shock waves from the impact travel through the Earth's crust and converge on Brazil at the same time. The ground shakes so violently that the ground fractures and molten rock spews from deep underground. Maybe Brazil wasn't the best place to be after all.  The survivors of the firestorms, tsunami and massive earthquakes emerge to a devastated landscape. Within a few days the Sun vanishes behind a dark thick cloud - a combination of soot from the firestorms, dust thrown up by the impact and a toxic smog from chemical reactions. Photosynthesis in plants and algae ceases and temperatures plummet. A long, sunless Arctic winter seems mild compared to the new conditions on most of the planet.  After a year or so the dust settles and sunlight begins to filter through the clouds. The Earth's surface starts warming up. But the elevated carbon dioxide levels created by the fires (and, by chance, vaporization of huge quantities of limestone at the impact site) results in a runway greenhouse effect. Those creatures that managed to survive the deep freeze now have to cope with being cooked.  Many species of plants and animals vanish. The few hundred thousand human survivors find themselves reverting to a Stone Age existence

# Asteroid Impact – Laundry List

There are multiple scenarios for asteroid disasters-even small objects can cause massive firestorms and large strikes risk mass extinctions and climate change

IRWIN I. SHAPIRO et al in 10,( Harvard-Smithsonian Center for Astrophysics, Chair FAITH VILAS, MMT Observatory at Mt. Hopkins, Arizona, Vice Chair MICHAEL A’HEARN, University of Maryland, College Park, Vice Chair ANDREW F. CHENG, Johns Hopkins University Applied Physics Laboratory FRANK CULBERTSON, JR., Orbital Sciences Corporation DAVID C. JEWITT, University of California, Los Angeles STEPHEN MACKWELL, Lunar and Planetary Institute H. JAY MELOSH, Purdue University JOSEPH H. ROTHENBERG, Universal Space Network, *Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies Space Studies Board Aeronautics and Space Engineering Board Division on Engineering and Physical Sciences*, THE NATIONAL ACADEMIES PRESS, <http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf>)

Over the last several decades, research has clearly demonstrated that major impact events have occurred throughout Earth’s history, often with catastrophic consequences. The Chicxulub impact apparently caused a mass extinction of species, possibly resulting from a global firestorm due to debris from the impact raining down across the planet. It may also have caused dramatic cooling for a year or more and global climatic effects that may have lasted a long time (e.g., O’Keefe and Ahrens, 1989). While many species became extinct at this time (including perhaps 30 percent of marine animal genera), many survived and ultimately thrived in the post-dinosaur world. It may be that impacts throughout the history of this planet have strongly helped shape the development and evolution of life-forms. Several recent events and new analyses have highlighted the impact threat to Earth: 1. As Comet Shoemaker-Levy 9 came close to Jupiter in 1992, tidal forces caused it to separate into many smaller fragments that then may have regrouped via self-gravity into at least 21 distinct pieces (e.g., Asphaug and Benz, 1994). These pieces impacted Jupiter in July 1994, creating a sequence of visible impacts into the gaseous Jovian atmosphere. The resultant scars in Jupiter’s atmosphere could be readily seen through Earth-based telescopes for several months. In July 2009, a second object, though much smaller than Shoemaker-Levy 9, impacted Jupiter, also causing a visible dark scar in the Jovian atmosphere. Such clear evidence of major collisions in the contemporary solar system does raise concern about the risk to humanity. 2. In December 2004, astronomers determined that there was a non-negligible probability that near-Earth asteroid Apophis (see Chapter 4 for more details) would strike Earth in 2029. As Apophis is a near-300-meter-diameter object, a collision anywhere on Earth would have serious regional consequences and possibly produce transient global climate effects. Subsequent observations of Apophis ruled out an impact in 2029, and also determined that it is quite unlikely that this object could strike during its next close approach to Earth in 2036. However, there likely remain many Apophis-sized NEOs that have yet to be detected. Also we became aware of the threat from Apophis only in 2004, raising concerns about whether we would be able to mitigate the threat of such an object, should Earth collision be determined to have a high probability of occurrence in the relatively near future. 3. In June 1908, a powerful explosion blew down trees over an area spanning at least 2,000 square kilometers of forest near the Podkamennaya Tunguska River in Central Siberia. As no crater was located, scientists initially argued against an asteroid or comet origin. However, subsequent analysis and more recent modeling (see, e.g., Chyba et al., 1992; Boslough and Crawford, 1997; 2008) have indicated that modest-sized (the Tunguska object may have been only 30 to 50 meters in diameter) objects moving at high supersonic speeds through the atmosphere can disintegrate spontaneously, creating an airburst that causes substantial damage without cratering. Such airbursts are potentially more destructive than are ground impacts of similarly sized objects. 4. A stony meteorite 1- to 2- meters in diameter traveling at high supersonic speeds, created an impact crater in Peru in September 2007. According to current models with standard assumptions, such a small object should not have impacted the surface at such a high velocity. This case demonstrates that specific instances can vary widely from the norm and is a reminder that small NEOs can also be dangerous. 5. On October 6, 2008, asteroid 2008 TC3 was observed by the Catalina Sky Survey (Chapter 3) on an Earth-collision course. Although the object was deemed too small to pose much of a threat, Spaceguard and the Minor Planet Center (Chapter 3) acted rapidly to coordinate an observation campaign over the following 19 hours with both professionals and amateurs to observe the object and determine its trajectory. The 2- to 5-meter-diameter object entered the atmosphere on October 7, 2008, and the consequent fireball was observed over northern Sudan (Figure 2.2) (Jenniskens et al., 2009). Subsequent ground searches in the Nubian desert in Sudan located 3.9 kg (in 280 fragments) of material from the meteorite. These recent events, as well as our current understanding of impact processes and the population of small bodies across the solar system, but especially in the near-Earth environment, raise significant concerns about the current state of knowledge of potentially hazardous objects, and our ability to respond to the threats that they might pose to humanity.

# Asteroid Impact – Laundry List

Asteroids cause every impact – laundry list

Verschuur 95 (Gerrit L. Verschuur is a PHD in Radio Astronomy, author of Impact! The Threat of Comets and Asteroids “*Impact Hazards: Truth and Consequences*,” Sky & Telescope, June 1998, Vol. 95 Issue 6. EBSCO. TDA.)

The horrors deeply traumatized survivors might witness include the broiling of creatures within eyesight of the atmospheric fireball, the widespread triggering of conflagrations as fiery debris originally blasted into space plummets back to Earth, the darkening of the skies by soot and dust plunging the world into "winter" lasting months, the removal of the ozone layer, the formation of poisonous nitrogen oxides that would create corrosive acid rain, and subsequent global warming years later courtesy carbon dioxide released by vaporized rock. Furthermore, the seismic shock of impact would devastate a large area and earthquake-prone regions could release additional pent-up energy in the Earth's crust. Alain Maury, a dedicated asteroid hunter in France, has pondered further effects. "Even without an impact winter," he says, "after the initial fatalities, our banking system goes berserk, all multinational companies -- many of them dealing with food distribution -- do the same, and we do not find our cereal in our supermarket anymore." Michael Baillie (Queen's University, Belfast) believes that modern civilization would collapse after the impact of a 500-meter-wide object. "The trouble is" he says, "that a significantly smaller impact could still do the trick, especially if over an ocean. ... Civilization is a thin veneer. Take away all air travel, restrict global food supplies, demonstrate that the military and governments are ineffective, demonstrate that coastal zones should be avoided, and where would we all be? That is not to mention the problems when all the dead sea life washes up" Alas such scary words, and even evidence from dramatic computer prognostications, tend to be ignored. The most well-known recent impact event occurred in the middle of Siberia in 1908. But even Tunguska's 2,000-square-km area of flattened trees only reinforces the sense of unreality we feel toward the threat. We tend to think that the next one will also that somewhere else, not where we are. Perhaps the best thing that could happen us to the potential danger would be for a minor impact to do enough damage to frighten us into action. More specifically, as Jonathan Shanklin (British Antarctic Survey) notes, "Even a small impact on a politically significant site might be sufficient to institute a major change of direction for our present civilization" The physical consequences of even a small impact will depend crucially on where the object strikes. A hit on a major city such as Washington, D.C., or New York would cause additional political and financial ripples. Should one strike near a nuclear power station, the radiation hazard created by the release of radioactive material from an incinerated reactor might be felt worldwide. But no matter the scale of the catastrophe, the damage to our view of ourselves in the cosmic context will suffer profound trauma. As Baillie hinted, the scenario of an ocean impact is drawing great scientific interest lately. Jack G. Hills and Charles Mader (Los Alamos National Laboratory) estimate that a 5-km-wide asteroid striking the middle of the Atlantic Ocean would produce a tsunami that would swamp the entire upper East Coast of the United States back to the Appalachian Mountains. Delaware, Maryland, and Virginia would be inundated, as well as Long Island and all other coastal cities. It would also drown much of France and Portugal. According to Vitaly Adushkin and Ivan Nemchinov, two Russian scientists involved in modeling explosive events, a small-to-medium 200-meter object smashing into a 5-km-deep ocean at 50 km per second would raise a splash 35 km high in 40 seconds. It staggers the imagination to conceive of such a large curtain of water and debris. Owen Toon (NASA/Ames Research Center) and his colleagues calculate that a 10,000-megaton impact (by a 1-km object) in a 4-km-deep ocean would create devastating tsunamis over an area the size of the Pacific Ocean. Even a mere 5-megaton impact by a very small object in the ocean would generate tsunamis comparable to those produced by the largest earthquakes.

# Asteroid Impact 🡪 Ozone Depletion/UV radiation

Asteroids destroy the atmosphere regardless of where they hit

Courtland 10 (Rachel Courtland is a space and astronomy writer for the New Scientist. “*Ocean asteroid hits will create huge ozone holes*” New Scientist, October 13 2010, http://www.newscientist.com/article/dn19579-ocean-asteroid-hits-will-create-huge-ozone-holes.html, TDA)

To get a sense of how much water might be jettisoned into the atmosphere if these asteroids hit the ocean, the team modelled what would happen if they reached Earth's atmosphere at a clip of 18 kilometres per second, an average speed expected for a near-Earth object, and hit the ocean in the northern hemisphere at a 45-degree angle. As expected, the simulations showed that the larger, 1-km asteroid created the bigger splash, throwing 42 trillion kilograms of water and vapour – enough to fill 16 million Olympic-sized swimming pools – across an area more than 1000 kilometres wide and up to hundreds of kilometres above the Earth's surface. Once in the atmosphere, the water, together with compounds containing chlorine and bromine from vaporised sea salts, destroyed ozone above the Earth's atmosphere at a much faster rate than it is naturally created. Some simulated impacts created depletions that were still felt across the whole Earth a year later. "It will produce an ozone hole that will engulf the entire Earth," Pierazzo says. The longest lasting and most severe depletion – a cut of more than 70 per cent in ozone levels – occurred over much of the northern hemisphere. That's a far bigger hole than the one that was above the South Pole in 1993, when Earth's ozone layer was at its thinnest. The resulting ultraviolet-radiation levels would be higher than anywhere on Earth today, the team writes, presenting a new hazard for human civilisation. While people may be able to protect themselves from the increased threat of sunburn, the intense UV light could also affect our food supply by damaging plants and the phytoplankton that represent the bottom of the ocean's food chain. "That is enough to really cause problems for our civilisation," Pierazzo says. Better understanding these effects could help us prepare in the event of an impact. For example people could plant crops more resistant to UV radiation, she adds. Toon notes that impacts on land or shallow water may ultimately do more damage by kicking up dust that could significantly darken skies and inhibit plant growth. Pierazzo is now working on a model to assess how asteroids that hit dry land would affect the atmosphere.

An asteroid impact in the ocean would destroy the atmosphere and expose society to deadly UV radiation.

Liverpool Daily Post in 2010 (Newspaper, Liverpool Daily Post, Asteroid fear; weird world, October 27, 2010, LexisNexis, znf)

A MEDIUM-sized asteroid plunging into the ocean would destroy much of the ozone layer, leaving the Earth exposed to dangerous levels of ultraviolet radiation, it has been claimed. The impact from a space rock 500m to 1km in diameter would send vast amounts of sea water into the atmosphere where chemicals such as chloride and bromide would strip away significant amounts of ozone which provides a shield against harmful sun rays, according to US expert Dr Elisabetta Pierazzo. The result would be a huge spike in ultraviolet (UV) radiation levels with fair skins burning after just a few minutes of sun exposure, she said in the journal Earth and Planetary Science Letters.

# Asteroid Impact – Harms Ocean Life

**Mussels and other sea life are harmed by asteroid impacts**

**Thompson 7** [Asteroid Impact Would Devastate Sea Floor Life, Too <http://www.livescience.com/1858-asteroid-impact-devastate-seafloor-life.html>]

 During a global catastrophe, the shrimp and mussels that thrive around these vents may be just as doomed as the rest of us. Creatures such as bacteria, shrimp and snails have flourished around hydrothermal vents, despite the fact that no sunlight reaches to the depths of the ocean floor. Instead, colonies get nutrition from the minerals dissolved in the superheated water that spews out from the vents. Through a process called chemosynthesis, microbes convert the heat and minerals produced by the vents into energy. They then provide food to more complex forms of life, such as mollusks, crustaceans and worms. Scientists had thought that because the food source of the creatures living around the vents was independent from the world above that an event such as a giant asteroid collision, which can kick up a cloud of debris that blocks the sun for months or years, wouldn't affect the vent ecosystems. But new research done by Jon Copley of the University of Southampton indicates that the offspring of some of these creatures grow up away from the life-sustaining vents and depend for food on whatever material sinks down from the sunlit surface waters. In fact, the vent inhabitants time the birth of their offspring with the seasons—even though they cannot see the sun. They time the release of their young to the spring bloom of the microscopic plant life that grows on the ocean's surface—stuff that sinks after it dies.

# UV-B Radiation 🡪 DNA damage

**UV-B radiation damages DNA.**

**Jeannie Allen in 2001** (Earth Observatory, *Ultraviolet Radiation*: How It Affects Life on Earth, 09/06/2001, http://earthobservatory.nasa.gov/Features/UVB/, znf)

UV radiation from the sun has always played important roles in our environment, and affects nearly all living organisms. Biological actions of many kinds have evolved to deal with it. Yet UV radiation at different wavelengths differs in its effects, and we have to live with the harmful effects as well as the helpful ones. Radiation at the longer UV wavelengths of 320-400 nm, called UV-A, plays a helpful and essential role in formation of Vitamin D by the skin, and plays a harmful role in that it causes sunburn on human skin and cataracts in our eyes. The incoming radiation at shorter wavelengths, 290-320 nm, falls within the UV-B part of the electromagnetic spectrum. (UV-B includes light with wavelengths down to 280 nm, but little to no radiation below 290 nm reaches the Earth’s surface). UV-B causes damage at the molecular level to the fundamental building block of life— deoxyribonucleic acid (DNA). Electromagnetic Spectrum Electromagnetic radiation exists in a range of wavelengths, which are delineated into major divisions for our convenience. Ultraviolet B radiation, harmful to living organisms, represents a small portion of the spectrum, from 290 to 320 nanometer wavelengths. (Illustration by Robert Simmon) DNA readily absorbs UV-B radiation, which commonly changes the shape of the molecule in one of several ways. The illustration below illustrates one such change in shape due to exposure to UV-B radiation. Changes in the DNA molecule often mean that protein-building enzymes cannot “read” the DNA code at that point on the molecule. As a result, distorted proteins can be made, or cells can die. Diagram of UV Radiation Mutating DNA Ultraviolet (UV) photons harm the DNA molecules of living organisms in different ways. In one common damage event, adjacent bases bond with each other, instead of across the “ladder.” This makes a bulge, and the distorted DNA molecule does not function properly. (Illustration by David Herring) But living cells are “smart.” Over millions of years of evolving in the presence of UV-B radiation, cells have developed the ability to repair DNA. A special enzyme arrives at the damage site, removes the damaged section of DNA, and replaces it with the proper components (based on information elsewhere on the DNA molecule). This makes DNA somewhat resilient to damage by UV-B. In addition to their own resiliency, living things and the cells they are made of are protected from excessive amounts of UV radiation by a chemical called ozone. A layer of ozone in the upper atmosphere absorbs UV radiation and prevents most of it from reaching the Earth. Yet since the mid-1970s, human activities have been changing the chemistry of the atmosphere in a way that reduces the amount of ozone in the stratosphere (the layer of atmosphere ranging from about 11 to 50 km in altitude). This means that more ultraviolet radiation can pass through the atmosphere to the Earth’s surface, particularly at the poles and nearby regions during certain times of the year. Without the layer of ozone in the stratosphere to protect us from excessive amounts of UV-B radiation, life as we know it would not exist. Scientific concern over ozone depletion in the upper atmosphere has prompted extensive efforts to assess the potential damage to life on Earth due to increased levels of UV-B radiation. Some effects have been studied, but much remains to be learned.

# UV-B Radiation 🡪 Multiple Impacts

**Numerous effects of UV-B light: DNA damage, cancer, eye damage, decrease in plankton, and decreased plant growth.**

Brien Sparling in 2001 (NASA, *Ultraviolet Radiation*,5/30/01, <http://www.nas.nasa.gov/About/Education/Ozone/radiation.html>, znf)

Genetic damage DNA absorbs UV-B light and the absorbed energy can break bonds in the DNA. Most of the DNA breakages are repaired by proteins present in the cells nucleus but unrepaired genetic damage of the DNA can lead to skin cancers. In fact one method that scientists use to analyze amounts of 'genetically-damaging UV-B is to expose samples of DNA to the light and then count the number of breaks in the DNA. For example J.Regan's work at the Florida Institute of Technology used human DNA to find that genetically significant doses of solar radiation could penetrate as far as 9 feet into non-turbulant ocean water. The Cancer link The principle danger of skin cancer is to light-skinned peoples. A 1%decrease in the ozone layer will cause a estimated 2%increase in UV-B irradiation; it is estimated that this will lead to a 4%increase in basal carcinomas and 6%increase in squamous-cell carcinomas.[Graedel&Crutzen]. 90% of the skin carcinomas are attributed to UV-B exposure [Wayne] and the chemical mechanism by which it causes skin cancer has been identified [Tevini]. The above named carcinomas are relatively easy to treat, if detected in time, and are rarely fatal. But the much more dangerous malignant melanoma is not as well understood. There appears to be a correlation between brief, high intensity exposures to UV and eventual appearance (as long as 10-20yrs!) of melanoma. Twice as many deaths due to melanomas are seen in the southern states of Texas and Florida, as in the northern states of Wisconsin and Montana, but there could be many other factors involved. One undisputed effect of long-term sun exposure is the premature aging of the skin due to both UV-A, UV-B and UV-C. Even careful tanning kills skin cells, damages DNA and causes permanent changes in skin connective tissue which leads to wrinkle formation in later life. There is no such thing as a safe tan. Someone on the beach gettin to much sun "There is no such thing as a safe tan" FDA Publication Possible eye damage can result from high doses of UV light, particularly to the cornea which is a good absorber of UV light. High doses of UV light can causes a temporary clouding of the cornea, called 'snow-blindness', and chronic doses has been tenitively linked to the formation of cataracts. Higher incidences of cataracts are found at high elevations,Tibet and Bolivia; and higher incidences are seen at lower latitudes(approaching the equator). Damage to marine life The penetration of increased amounts of UV-B light has caused great concern over the health of marine plankton that densly populate the top 2 meters of ocean water. The natural protective-responce of most chlorophyll containing cells to increased light-radiation is to produce more light-absorbing pigments but this protective responce is not triggered by UV-B light. Another possible responce of plankton is to sink deeper into the water but this reduces the amount of visible light they need for photosynthesis, and thereby reduces their growth and reproduction rate. In other words, the amount of food and oxygen produced by plankton could be reduced by UV exposure without killing individual organisms. There are several other considerations: Ultraviolet levels are over 1,000 times higher at the equator than at the polar regions so it is presumed that marine life at the equator is much better adapted to the higher enviromental UV light than organisms in the polar regions. The current concern of marine biologists is mostly over the more sensitive antarctic phytoplankton which normally would recieve very low doses of UV. Only one large-scale field survey of Anarctic phytoplankton has been carried out so far [Smith et.al \_Science\_1992] ; they found a 6-12% drop in phytoplankton productivity once their ship entered the area of the spring-time ozone hole. Since the hole only lasts from 10-12weeks this translates into a 2-4%loss overall, a measurable but not yet catastrophic loss. Both plants and phytoplankton vary widely in their sensitivity to UV-B. When over 200 agricultural plants were tested, more than half showed sensitivity to UV-B light. Other plants showed neglible effects or even a small increase in vigor. Even within a species there were marked differences; for example one variety of soybean showed a 16% decrease in growth while another variety of the same soybean showed no effect [R.Parson]. An increase in UV-B could cause a shift in population rather than a large die-off of plants An increase in UV-B will cause increased amounts of Ozone to be produced at lower levels in the atmosphere. While some have hailed the protection offered by this 'pollution-sheild' many plants have shown themselves to be very sensitive to photochemical smog.

# UV-B Radiation 🡪 Disease

**UV radiation weakens the immune system to invaders.**

**Environmental Protection Agency 2010** (Sunwise Program, *Health effects of overexposure to the sun* , July 01, 2010, http://www.epa.gov/sunwise/uvandhealth.html, znf)

Scientists have found that overexposure to UV radiation may suppress proper functioning of the body’s immune system and the skin’s natural defenses. For example, the skin normally mounts a defense against foreign invaders such as cancers and infections. But overexposure to UV radiation can weaken the immune system, reducing the skin’s ability to protect against these invaders.

UV radiation suppresses the immune system and severely increases risk of disease

CIESIN No Date (Center for International Earth Science Information Network @ Columbia University “Suppression of the Immune System from Increased Ultraviolet-B Exposure due to Ozone Depletion” <http://www.ciesin.org/TG/HH/ozimmun.html>) JM

Excessive ultraviolet-B radiation (UV-B) exposure interferes with the normal functioning of immune systems in animals and human beings. Relatively low doses of UV-B compromise the immunological defenses of the skin, thus limiting the skin's allergic response to local attacks. Higher doses of UV-B can lower an individual's overall immunological response. Damage to the immune system has several implications for an individual's health: increased risk of the incidence and severity of infectious disease, increased risk of malignant melanoma, and diminished efficacy of vaccinations. Longstreth et al. (1991) present evidence indicating skin pigmentation does not serve a protective role for the immune system, as it does in the prevention of skin cancer. Vermeer et al. (1991) also reach this conclusion. Ilyas (1986) and Jeevan and Kripke (1993) emphasize that damage to the immune system due to UV-B could have far-reaching effects for the health of populations.

# Disease ! 🡪 Extinction

Disease will kill off all humans

Yu 09 (Victoria, Dartmouth Undergraduate Journal of Science, writer, “Human Extinction: The Uncertainty of Our Fate”, May 22nd, 2009, Accessed 7-10-11, AH)

RIP Homo sapiens A pandemic will kill off all humans. In the past, humans have indeed fallen victim to viruses. Perhaps the best-known case was the bubonic plague that killed up to one third of the European population in the mid-14th century (7). While vaccines have been developed for the plague and some other infectious diseases, new viral strains are constantly emerging — a process that maintains the possibility of a pandemic-facilitated human extinction. Some surveyed students mentioned AIDS as a potential pandemic-causing virus.  It is true that scientists have been unable thus far to find a sustainable cure for AIDS, mainly due to HIV’s rapid and constant evolution. Specifically, two factors account for the virus’s abnormally high mutation rate: 1. HIV’s use of reverse transcriptase, which does not have a proof-reading mechanism, and 2. the lack of an error-correction mechanism in HIV DNA polymerase (8). Luckily, though, there are certain characteristics of HIV that make it a poor candidate for a large-scale global infection: HIV can lie dormant in the human body for years without manifesting itself, and AIDS itself does not kill directly, but rather through the weakening of the immune system.  However, for more easily transmitted viruses such as influenza, the evolution of new strains could prove far more consequential. The simultaneous occurrence of antigenic drift (point mutations that lead to new strains) and antigenic shift (the inter-species transfer of disease) in the influenza virus could produce a new version of influenza for which scientists may not immediately find a cure. Since influenza can spread quickly, this lag time could potentially lead to a “global influenza pandemic,” according to the Centers for Disease Control and Prevention (9). The most recent scare of this variety came in 1918 when bird flu managed to kill over 50 million people around the world in what is sometimes referred to as the Spanish flu pandemic. Perhaps even more frightening is the fact that only 25 mutations were required to convert the original viral strain — which could only infect birds — into a human-viable strain (10).

Disease can result in the extinction of mammal species – Empirically proven

Keim 08 (Brandon, writer, Wired Science, “Disease can cause the extinction of mammals”, November 5th, 2008, Accessed 7-10-11, AH)

Disease can drive a mammal species to extinction: this doesn’t seem surprising, but until today it hadn’t been proven. And now that it has, members of our own mammalian species might understandably feel uneasy. The extinction in question took place a century ago on Christmas Island, an uninhabited Indian Ocean atoll to which a merchant ship inadvertently carried flea-ridden black rats. Within a decade, both of the island’s native rat species were extinct. Scientists have argued whether the native rats were outcompeted by the newcomers, or fell victim to diseases carried by the fleas. According to DNA analysis of remaining native rat specimens, infection was widespread within the population after contact, and nonexistent before — suggesting that disease caused the die-off. Resolving this argument has implications for another debate, over the hypothesis that disease can be so lethal and contagious as to drive a mammal species extinct. This had been observed in snails and amphibians, but not in mammals. The authors of the study, published today in Public Library of Science ONE, hope conservationists will take heed: accidentally-introduced pathogens could wipe out endangered species. But to me, the findings also have human implications. Some would say that the rats were vulnerable because they lived on an island; but the Earth is an island, too.

# Disease ! 🡪 Extinction

Diseases will have a profound impact on future civilization

Pongsiri and Keesing 10 (M.J. and Felicia, professors of biology “HUMAN EXTINCTION: NOT THE WORST CASE SCENARIO”, December 13th, 2010, Accessed 7-10-11, AH)

Disease will be rife. Infectious disease will likely rise with the loss of biodiversity. Authors of a paper published last year in BioScience suggested that biodiversity loss “can increase the incidence and distribution of infectious diseases affecting humans."1 Authors of a more recent paper appearing in Nature came to a similar conclusion, noting that, in many cases, biodiversity “seems to protect organisms, including humans, from transmission of infectious diseases.”2 Increased population size and proximity to one another will exacerbate the problem. Cancer and environmental diseases will be widespread due in part to the greater toxicity of the physical environment and the foods we eat. Genetic disease is also expected to rise sharply. Michael Lynch, in a recent paper published in PNAS, suggested that the accumulation of deleterious mutuations will have a profound impact on members of industrialized societies within a few hundred years.3 He states: “Without a reduction in the germline transmission of deleterious mutations, the mean phenotypes of the residents of industrialized nations are likely to be rather different in just two or three centuries, with significant incapacitation at the morphological, physiological, and neurobiological levels.” A society in which the majority of people have some degree of inherited or acquired disease won’t be able to function as our current society does. Presently, healthy able-bodied people in Western societies generally support those who are less fortunate.  However, presently, healthy able-bodied people are the norm.  What would happen if we all had some degree of impairment? If we continue on our current path of unbridled consumerism and environmental destruction, the most likely future scenario is not one with flying cars and intergalactic exploration, but one with widespread disease and starvation, in which the quality of human lives is relatively low

Disease causes extinction

South China Morning Post 96 (“Leading the way to a cure for AIDS,” South China Morning Post (Hong Kong), Byline Kavita Daswani, January 4, Available Online via Lexis-Nexis, Accessed 7-10-11)

Despite the importance of the discovery of the “facilitating” cell, it is not what Dr Ben-Abraham wants to talk about. There is a much more pressing medical crisis at hand – one he believes the world must be alerted to: the possibility of a virus deadlier than HIV. If this makes Dr Ben-Abraham sound like a prophet of doom, then he makes no apology for it. AIDS, the Ebola outbreak which killed more than 100 people in Africa last year, the flu epidemic that has now affected 200,000 in the former Soviet Union – they are all, according to Dr Ben-Abraham, the “tip of the iceberg” Two decades of intensive study and research in the field of virology have convinced him of one thing: in place of natural and man-made disasters or nuclear warfare, humanity could face extinction because of a single virus, deadlier than HIV. “An airborne virus is a lively, complex and dangerous organism,” he said. “It can come from a rare animal or from anywhere and can mutate constantly. If there is no cure, it affects one person and then there is a chain reaction and it is unstoppable. It is a tragedy waiting to happen.” That may sound like a far-fetched plot for a Hollywood film, but Dr Ben-Abraham said history has already proven his theory. Fifteen years ago, few could have predicted the impact of AIDS on the world. Ebola has had sporadic outbreaks over the past 20 years and the only way the deadly virus – which turns internal organs into liquid – could be contained was because it was killed before it had a chance to spread. Imagine, he says, if it was closer to home: an outbreak of that scale in London, New York or Hong Kong. It could happen anytime in the next 20 years – theoretically, it could happen tomorrow. The shock of the AIDS epidemic has prompted virus experts to admit “that something new is indeed happening and that the threat of a deadly viral outbreak is imminent”, said Joshua Lederberg of the Rockefeller University in New York, at a recent conference. He added that the problem was “very serious and is getting worse”. Dr Ben-Abraham said: “Nature isn’t benign. The survival of the human species is not a preordained evolutionary programme. Abundant sources of genetic variation exist for viruses to learn how to mutate and evade the immune system.” He cites the 1968 Hong Kong flu outbreak as an example of how viruses have outsmarted human intelligence. And as new “mega-cities” are being developed in the Third World and rainforests are destroyed, disease-carrying animals and insects are forced into areas of human habitation. “This raises the very real possibility that lethal, mysterious viruses would, for the first time, infect humanity at a large scale and imperil the survival of the human race,” he said.

# UV-B Radiation ! – Plant Growth

UVB Radiation of less than 20% has the capability of significantly decreasing biomass in key plans.

World Health Oganization 94 (Environmental Health Criteria 160, *Ultraviolet Radiation*, date n/a, http://www.inchem.org/documents/ehc/ehc/ehc160.htm#SectionNumber:11.2, znf)

The growth of many plant species is reduced by enhanced levels of UVB. The main components of plants affected by UVB are shown in figure 11.1 (UNEP 1989). The ozone filter technique was used to simulate a relative solar UVB enhancement of 20% by providing 54.4 kJ m-2 day-1 (unweighted) or 5.1 kJ m-2 day-1 of biologically effective radiation (UVBBE) through one cuvette and 45.3 kJ m-2 day-1 (unweighted) or 3.6 kJ m-2 day-1 UVBBE through the other cuvette (Tevini et al., 1991b). These were average values measured from May 1990 to August 1990 and are equivalent to an ozone depletion of approximately 10%. Plant height, leaf area, and the dry weight of sunflower, corn, and rye seedlings were significantly reduced, while oat seedling remained almost unaffected (Tevini et al., 1991b). The reduction of hypocotyl growth of sunflower seedlings under artificial UVB irradiation is associated with a UV dependent destruction of the growth regulator indole-3-acetic acid (IAA) and the formation of growth inhibiting IAA photoproducts. The inhibition of elongation in UV-irradiated sunflower seedlings might also be due to the action of peroxidases working as IAA-oxidase, causing a decrease in cell wall extensibility of the hypocotyl epidermis (Ros, 1990). Shading of shoot apex was shown to reduce UVB induced reduction in growth of Vigna seedlings (Kulandaivelu et al., 1993). 11.2.3 Effects on plant function When high UVB irradiances were used in combination with low levels of white light, such as commonly found in growth chambers, effects on photosynthesis were generally deleterious. However, even in the presence of higher levels of white light in green houses and in the field, reductions in photosynthesis of up to 17% were reported in the UVB sensitive soybean cultivar Essex when supplied with UVB equivalent to an 18% ozone depletion (Murali & Teramura, 1987). Solar UVB also reduced net photosynthesis in sunflower seedlings by about 15% when a 12% ozone depletion was simulated by using the ozone filter technique (Tevini et al., 1991c). One reason for the reduction in overall photosynthesis might be due to stomatal closure by enhanced UVB. Recent studies reveal the effects of UVB radiation on tropical plants. Rice is among the most important tropical crops in the world. Sixteen rice ( Oryza sativa L.) cultivars from several different geographical regions when grown for 12 weeks in greenhouses with supplemental levels of UVB exposure equivalent to 20% ozone depletion over the equator (15.7 kJ m-2 day-1 UVBBE) showed alterations in biomass, morphology, and photosynthesis. Approximately one-third of all cultivars tested showed a statistically significant decrease in total biomass with increased UVB exposure. Photosynthetic capacity declined for some cultivars, but only a weak relationship existed between changes in photosynthesis and biomass with increasing UVB exposure. In one of the rice cultivars tested, total biomass significantly increased by 20% when grown under enhanced levels of UVB exposure. Therefore, despite the fact that the effects of UVB are generally damaging, in some cases, it has been reported to have a stimulating effect. Such positive growth effects are presently not easily explainable. Results from this experiment indicate that 1) a number of rice cultivars are sensitive to increases in UVB exposure; 2) the diversity exhibited by rice in response to increased levels of UVB suggests that selective breeding might be successfully used to develop UVB tolerant rice cultivars. Other preliminary screening studies on rice seedlings also corroborate these observations (Coronel et al., 1990).

# UV-B Radiation ! – Ocean Biodiversity

Loss of ocean biodiversity kills all animal and plant life – only microbes will be left

Jackson 8 (Jeremy B. C. Jackson, Center for Marine Biodiversity and Conservation, Scripps Institution of Oceanography, University of California at San Diego, “Ecological extinction and evolutionin the brave new ocean”, PNAS August 12th, 2008 vol 105 no. Supplement 1 11458-11465, available at <http://www.pnas.org/content/105/suppl.1/11458.full>)

Predicting the future is, at best, a highly uncertain enterprise. Nevertheless, I believe we have a sufficient basic understanding of the ecological processes involved to make meaningful qualitative predictions about what will happen in the oceans if humans fail to restrain their style of exploitation and consumption. Failure to stop overfishing will push increasing numbers of species to the brink of extinction—perhaps irreversibly as for Newfoundland cod—except for small, opportunistic species. Unrestrainedrunoff of nutrients and toxins, coupled with rising temperatures, will increase the size and abundance of dead zones and toxic blooms that may merge all along the continents. Even farmed seafood will be increasingly toxic and unfit for human consumption unless grown in isolation from the ocean. Outbreaks of disease will increase. Failure to cap and reduce emissions of CO2 and other greenhouse gases will increase ocean temperatures and intensify acidification. Warmer and lighter surface waters will inhibit vertical mixing of the ocean, eventually leading to hypoxia or anoxia below the thermocline as in the Black Sea. Biogeochemical cycles will be perturbed in uncertain ways as they have been in the past ([94](http://www.pnas.org/content/105/suppl.1/11458.full#ref-94)). Mass extinction of multicellular life will result in profound loss of animal and plant biodiversity, and microbes will reign supreme. These predictions will undoubtedly appear extreme, but it is difficult to imagine how such changes will not come to pass without fundamental changes in human behavior. Moreover, as we have seen, all of these trends have actually been measured to a limited degree in the past few decades. The oceans are becoming warmer and more acidic; eutrophication, hypoxia, and the numbers and sizes of dead zones are increasing in quantity and size; vertical mixing of the open ocean is measurably decreasing; and many of our most valuable fisheries have collapsed and failed to recover. Some may say that it is irresponsible to make such predictions pending further detailed study to be sure of every point. However, we will never be certain about every detail, and it would be irresponsible to remain silent in the face of what we already know.

# Ocean Biodiversity ! – Economic Collapse

**Oceanic biodiversity is key to the economy**

**Hourigan 99 (**Conserving Ocean Biodiversity: Trends and Challenges”

The Living Ocean Treasure. The ocean’s biological diversity—the living resources that compose it and the ecological processes that sustain it—forms a foundation for the quality of human life as well as the raw materials to enrich it. Biological diversity, or biodiversity, refers to the variety and variability among living organisms, and among the ecological complexes of which they are a part. Marine living resources provide essential economic, environmental, aesthetic, and cultural benefits to humanity. Sixteen percent of all animal protein consumed worldwide comes from the ocean. The United Nations Food and Agriculture Organization (FAO) estimates the total value to fishers of the world’s commercial marine catch at $80 billion per year. The comparable value of fishes landed in the United States is $3.5 billion, and commercial fisheries contribute $21 billion to the U.S. economy. Besides food, marine living resources provide myriad products including fertilizers, animal feed, medicines, and aquarium fishes. The value of marine biodiversity extends far beyond fisheries and other products. Marine ecosystems also provide natural goods and services such as carbon storage, atmospheric gas regulation, nutrient cycling, and waste treatment. Coral reefs, mangroves, and kelp forests protect coastal areas from storm damage. Marine algae contribute nearly 40 percent of global photosynthesis. The values of these marine ecosystem services greatly exceed direct use values, yet they generally are not incorporated into economic or policy calculations. Globally, the value of marine ecosystem services has been estimated at $8.4 trillion per annum for open ocean ecosystems, and $12.6 trillion for coastal ecosystems (Costanza et al. 1997). These services depend on marine biodiversity, even though the processes that underlie this dependence are still unclear. As human populations increase, demands have accelerated for food, products, and services from the ocean, as well as for living and recreational space on its shores. The primary threats to marine biodiversity are fisheries operations (both direct overfishing and indirect fishing impacts—e.g., bycatch of non-target and protected species, habitat destruction by trawls and other gear or techniques, and other ecosystem effects that may accompany fishing activities), chemical pollution and eutrophication, physical alteration of coastal and marine habitats, invasions of exotic species, and ultraviolet-B radiation damage to phytoplankton and zooplankton resulting from stratospheric ozone depletion (NRC 1995). Looming on the horizon is the threat of human-caused climate change with potentially major negative effects on tourism, freshwater supplies, fisheries, and biodiversity. These factors also have been identified by the Parties to the Convention on Biological Diversity2 as key threats (UNEP/CBD 1995).

# **Biodiversity ! – Cultural Identity**

Loss of Biodiversity destroys our cultural identity

CBD 10 [Convention on Biological Diversity “Sustaining Life on Earth” <http://www.cbd.int/convention/guide/?id=changing>]

The reduction in biodiversity also hurts us in other ways. Our cultural identity is deeply rooted in our biological environment. Plants and animals are symbols of our world, preserved in flags, sculptures, and other images that define us and our societies. We draw inspiration just from looking at nature's beauty and power. While loss of species has always occurred as a natural phenomenon, the pace of extinction has accelerated dramatically as a result of human activity. Ecosystems are being fragmented or eliminated, and innumerable species are in decline or already extinct. We are creating the greatest extinction crisis since the natural disaster that wiped out the dinosaurs 65 million years ago. These extinctions are irreversible and, given our dependence on food crops, medicines and other biological resources, pose a threat to our own well-being. It is reckless if not downright dangerous to keep chipping away at our life support system. It is unethical to drive other forms of life to extinction, and thereby deprive present and future generations of options for their survival and development.

# Biodiveristy ! – Extinction

Biodiversity loss causes ecosystem collapse and human extinction

Diner, 1994 (Major David Diner head of the JAG Corps, United States Army. Winter 1994, Military Law Review, 143 Mil. L. Rev. 161, p. 170-173)

Why Do We Care? -- No species has ever dominated its fellow species as man has. In most cases, people have assumed the God-like power of life and death -- extinction or survival -- over the plants and animals of the world. For most of history, mankind pursued this domination with a single-minded determination to master the world, tame the wilderness, and exploit nature for the maximum benefit of the human race. In past mass extinction episodes, as many as ninety percent of the existing species perished, and yet the world moved forward, and new species replaced the old. So why should the world be concerned now? The prime reason is the world’s survival. Like all animal life, humans live off of other species. At some point, the number of species could decline to the point at which the ecosystem fails, and then humans also would become extinct. No one knows how many species the world needs to support human life, and to find out -- by allowing certain species to become extinct -- would not be sound policy. In addition to food, species offer many direct and indirect benefits to mankind. 2. Ecological Value. -- Ecological value is the value that species have in maintaining the environment. Pest, erosion, and flood control are prime benefits certain species provide to man. Plants and animals also provide additional ecological services -- pollution control, oxygen production, sewage treatment, and biodegradation. 3. Scientific and Utilitarian Value. -- Scientific value is the use of species for research into the physical processes of the world. Without plants and animals, a large portion of basic scientific research would be impossible. Utilitarian value is the direct utility humans draw from plants and animals. Only a fraction of the earth’s species have been examined, and mankind may someday desperately need the species that it is exterminating today. To accept that the snail darter, harelip sucker, or Dismal Swamp southeastern shrew could save mankind may be difficult for some. Many, if not most, species are useless to man in a direct utilitarian sense. Nonetheless, they may be critical in an indirect role, because their extirpations could affect a directly useful species negatively. In a closely interconnected ecosystem, the loss of a species affects other species dependent on it. Moreover, as the number of species decline, the effect of each new extinction on the remaining species increases dramatically. 4. Biological Diversity. -- The main premise of species preservation is that diversity is better than simplicity. As the current mass extinction has progressed, the world’s biological diversity generally has decreased. This trend occurs within ecosystems by reducing the number of species, and within species by reducing the number of individuals. Both trends carry serious future implications. Biologically diverse ecosystems are characterized by a large number of specialist species, filling narrow ecological niches. These ecosystems inherently are more stable than less diverse systems. “The more complex the ecosystem, the more successfully it can resist a stress. . . . [l]ike a net, in which each knot is connected to others by several strands, such a fabric can resist collapse better than a simple, unbranched circle of threads -- which if cut anywhere breaks down as a whole.” By causing widespread extinctions, humans have artificially simplified many ecosystems. As biologic simplicity increases, so does the risk of ecosystem failure. The spreading Sahara Desert in Africa, and the dustbowl conditions of the 1930s in the United States are relatively mild examples of what might be expected if this trend continues. Theoretically, each new animal or plant extinction, with all its dimly perceived and intertwined affects, could cause total ecosystem collapse and human extinction. Each new extinction increases the risk of disaster. Like a mechanic removing, one by one, the rivets from an aircraft’s wings, mankind [humankind] may be edging closer to the abyss.

Biodiversity is key to preventing human extinction

**Tschakert** 98 [Penn State assistant Professor <https://www.e-education.psu.edu/geog030/book/export/html/307> Humans Extinction]

 As more species go extinct, it becomes more likely for ecosystems to collapse. Given how many species are endangered, it is difficult to put an upper limit on how severe the ecosystem collapses could be. The collapses could be so severe that human extinction is threatened. The current honey bee colony collapse situation illustrates this. Without honey bees, humans would struggle - and perhaps fail - to grow many important crops. As more biodiversity is lost, we may find ourselves learning the hard way how important it is to our civilization and indeed our very survival.

# Biodiveristy ! – Extinction

**Ecosystem collapse causes extinction**

Jayawardena 9 (Asitha, London South Bank University, “We Are a Threat to All Life on Earth”, Indicator, 7-17, http://www.indicator.org.uk/?p=55)

Sloep and Van Dam-Mieras (1995) explain in detail why the natural environment is so important for life on Earth. It is from the environment that the living organisms of all species import the energy and raw material required for growth, development and reproduction. In almost all ecosystems plants, the most important primary producers, carry out photosynethesis, capturing sunlight and storing it as chemical energy. They absorb nutrients from their environment. When herbivores (i.e. plant-eating animals or organisms) eat these plants possessing chemical energy, matter and energy are transferred ‘one-level up.’ The same happens when predators (i.e. animals of a higher level) eat these herbivores or when predators of even higher levels eat these predators. Therefore, in ecosystems, food webs transfer energy and matter and various organisms play different roles in sustaining these transfers. Such transfers are possible due to the remarkable similarity in all organisms’ composition and major metabolic pathways. In fact all organisms except plants can potentially use each other as energy and nutrient sources; plants, however, depend on sunlight for energy. Sloep and Van Dam-Mieras (1995) further reveal two key principles governing the biosphere with respect to the transfer of energy and matter in ecosystems. Firstly, the energy flow in ecosystems from photosynthetic plants (generally speaking, autotrophs) to non-photosynthetic organisms (generally speaking, heterotrophs) is essentially linear. In each step part of energy is lost to the ecosystem as non-usable heat, limiting the number of transformation steps and thereby the number of levels in a food web. Secondly, unlike the energy flow, the matter flow in ecosystems is cyclic. For photosynthesis plants need carbon dioxide as well as minerals and sunlight. For the regeneration of carbon dioxide plants, the primary producers, depend on heterotrophs, who exhale carbon dioxide when breathing. Like carbon, many other elements such as nitrogen and sulphur flow in cyclic manner in ecosystems. However, it is photosynthesis, and in the final analysis, solar energy that powers the mineral cycles. Ecosystems are under threat and so are we. Although it seems that a continued energy supply from the sun together with the cyclical flow of matter can maintain the biosphere machinery running forever, we should not take things for granted, warn Sloep and Van Dam-Mieras (1995). And they explain why. Since the beginning of life on Earth some 3.5 billion years ago, organisms have evolved and continue to do so today in response to environmental changes. However, the overall picture of materials (re)cycling and linear energy transfer has always remained unchanged. We could therefore safely assume that this slowly evolving system will continue to exist for aeons to come if large scale infringements are not forced upon it, conclude Sloep and Van Dam-Mieras (1995). However, according to them, the present day infringements are large enough to upset the world’s ecosystems and, worse still, human activity is mainly responsible for these infringements. The rapidity of the human-induced changes is particularly undesirable. For example, the development of modern technology has taken place in a very short period of time when compared with evolutionary time scales – within decades or centuries rather than thousands or millions of years. Their observations and concerns are shared by a number of other scholars. Roling (2009) warns that human activity is capable of making the collapse of web of life on which both humans and non-human life forms depend for their existence. For Laszlo (1989: 34), in Maiteny and Parker (2002), modern human is ‘a serious threat to the future of humankind’. As Raven (2002) observes, many life-support systems are deteriorating rapidly and visibly. Elaborating on human-induced large scale infringements, Sloep and Van Dam-Mieras (1995) warn that they can significantly alter the current patterns of energy transfer and materials recycling, posing grave problems to the entire biosphere. And climate change is just one of them! Turning to a key source of this crisis, Sloep and Van Dam-Mieras (1995: 37) emphasise that, although we humans can mentally afford to step outside the biosphere, we are ‘animals among animals, organisms among organisms.’ Their perception on the place of humans in nature is resonated by several other scholars. For example, Maiteny (1999) stresses that we humans are part and parcel of the ecosphere. Hartmann (2001) observes that the modern stories (myths, beliefs and paradigms) that humans are not an integral part of nature but are separate from it are speeding our own demise. Funtowicz and Ravetz (2002), in Weaver and Jansen (2004: 7), criticise modern science’s model of human-nature relationship based on conquest and control of nature, and highlight a more desirable alternative of ‘respecting ecological limits, …. expecting surprises and adapting to these.

# Biodiveristy ! – Extinction

Biodiversity is key to extending the lifespan of the human species

Evonobel 10 [<http://actionbiodiversity.org/?p=20> ecological organization]

 Biodiversity is important because all life human science is aware of depends on other life for its own survival. Every living entity, down to the lowest fungus, requires another species in order to survive. Even plants that derive the majority of their energy from the sun and soil rely on elements within the soil that are often drawn from the decomposition of other organisms. When species go extinct, and biodiversity is threatened as a result, other species whose well being depended on the now extinct groups are pushed towards the edge themselves. And for all the accomplishments human civilization has achieved, it is itself still wholly dependent on other lifeforms for its own sustenance. Humans eat plants and animals both, and their bodies cannot receive proper nourishment without consuming a wide variety of organic substances. It is in the interest of human civilization itself to conserve biodiversity even if it may mean constraints on continues economic growth. Conserving biodiversity is of the utmost importance in order to keep the ecosystem capable of sustaining life for the long term. With no other planet within reach that has near to the degree of biodiversity available on Earth, conserving biodiversity in all its various forms is vital to the continued survival of the human species. Not to mention that a world without wild creatures would be rather dull indeed.

**Ignorance of the value of biodiversification leads to our demise as humans**

**Shah 9** ["Loss of Biodiversity and Extinctions." GlobalIssues.org. <http://www.globalissues.org/article/171/loss-of-biodiversity-and-extinctions#LongTermCosts> ]

Increasing demands of globalization and consumption have made a significant impact on biodiversity loss. Areas of high resource extraction are often the regions with the highest species density.  India is home to around 46,000 different species of plants alone, and has as many as 81,000 different species of animals, which accounts for approximately 8% of the world’s biodiversity. Brazil, whose Amazon region is subject to extreme deforestation, is home to 55,000 species of flora, accounting for 22% of the earth’s total.  This destructive activity in such high density areas plays a large role in our current rate of extinction. Various approaches have emphasized the protection for keystone species (organisms with exceptional effects on their environment, proportional to their biomass), endangered species, and areas known as biodiversity hot spots. These regions have especially high densities of biodiversity. The dangers of attempting to set priorities for preservation efforts are due to our ignorance of the value any particular species provides to the web of life, or the options value it might provide in a rapidly changing global environment.

# Exploding Asteroid 🡪 Kill Millions

Even asteroids that don’t make contact with the Earth can kill one million people.

Reilly 2007 (Michael. *"Small Asteroids Can Pack a Mighty Punch."* EBSCO Publishing Service Selection Page. 22 Dec. 2007. Web. 27 June 2011. <http://web.ebscohost.com/ehost/detail?sid-3a6565a7-1bcb-4b05-badc-c418af6ed941@sessionmgr13>. znf)

Asteroids can cause more damage than we expected when they explode in the atmosphere BEWARE the blast from above: small asteroids that explode before they hit the ground may be more dangerous than we thought. Asteroids a few tens of metres in diameter rip through the atmosphere at between 40 and 60 times the speed of sound, and many explode before they hit Earth. Extreme friction and heating can cause these asteroids to flatten into a pancake, which increases drag even more and eventually tears them apart. The resultant "airburst" is thought to be behind the 1908 Tunguska explosion in Siberia, which leveled 2000 square kilometres of forest. Because airbursts spread material over a wide area and there is no impact crater, researchers rely on computer simulations to calculate the size of the asteroids that caused them. Previous calculations for the Tunguska event suggested an asteroid around 50 metres in diameter exploding with a force of between 10 and 20 million tonnes of TNT. Now a computer simulation by Mark Boslough of Sandia National Laboratories in New Mexico shows that a 30-metre asteroid could have been behind the Tunguska blast. That suggests smaller asteroids can do more damage than previously thought - a worry when one considers that objects smaller than 140 metres across are not currently detected as they zip round the solar system. Previous simulations overestimated the size of the bodies responsible for airbursts because they treated them much like a nuclear explosion at a fixed point in the atmosphere, says Boslough. As a result, the damage they caused was thought to be related only to the size and temperature of the blast, and its distance away from Earth's surface. "That neglects something significant, though - momentum," says Boslough. His calculations show that the resulting fireball would continue to rocket towards Earth as it exploded. In the case of Tunguska, this jet didn't quite reach the surface - stalling at an altitude of around 5 kilometres - but a heat and shock wave would have carried on to Earth's surface to do much of the damage. It's becoming clear that previous models aren't right, says Boslough, who presented his results at the annual meeting of the American Geophysical Union in San Francisco this month. "If one of these events hit an area of high population density, it could kill 1 million people."

# Exploding Asteroid 🡪 Tsunamis

Asteroid airbursts over the ocean can cause massive tsunamis that threaten most of the Earth’s population

IRWIN I. SHAPIRO et al in 10,( Harvard-Smithsonian Center for Astrophysics, Chair FAITH VILAS, MMT Observatory at Mt. Hopkins, Arizona, Vice Chair MICHAEL A’HEARN, University of Maryland, College Park, Vice Chair ANDREW F. CHENG, Johns Hopkins University Applied Physics Laboratory FRANK CULBERTSON, JR., Orbital Sciences Corporation DAVID C. JEWITT, University of California, Los Angeles STEPHEN MACKWELL, Lunar and Planetary Institute H. JAY MELOSH, Purdue University JOSEPH H. ROTHENBERG, Universal Space Network, *Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies Space Studies Board Aeronautics and Space Engineering Board Division on Engineering and Physical Sciences*, THE NATIONAL ACADEMIES PRESS, [http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4\_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf)\](http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf%29%5C)

More recent work on airburst events over the ocean suggest that this too is an area of uncertainty. Previous investigations have treated these types of airbursts in a fashion similar to nuclear explosions that deliver their energy from a single point. If this treatment were correct, then the resultant blast waves would not produce a tsunami-type of event. However, **a recent study suggests that NEOs entering the upper atmosphere and exploding there act more like a linear series of nearly simultaneous explosions**. (Boslough and Crawford, 2008) **These blast effects are not as localized as those from the single source models, in which the momentum of the object is carried downwards into the atmosphere and produces a shockwave. If the shockwave were sufficiently strong to depress a wide area of the ocean’s surface, the resultant rebound effect of the ocean would create a classic tsunami. Hence the threat from small NEO airbursts over the ocean might present their most significant hazard to humanity given that most of the world’s population is concentrated on or near oceanic coastlines**.

# Ocean Impact More Likely

Impact over the ocean is more likely, as well as more deadly.

Shiga in 09 [David, “It's behind you!” Staff Writer for *New Scientist Editorial*, 02624079, 9/26/2009, Vol. 203, Issue 2727, PN]

Of course, two-thirds of Earth's surface is ocean. While our atmosphere is likely to protect us from asteroids smaller than 100 metres across, anything larger hitting the ocean - including chunks of Innoculatus's rubble pile - would cause a giant splash that could smash coastal buildings with high-speed volleys of water. The tremendous damage and loss of life that would ensue if multiple cities around an ocean basin were flooded led NASA scientists in 2003 to rate ocean impacts by asteroids as far more dangerous than those on or over land.

Asteroid strikes in the ocean would cause massive damage across the world – surveillance and defense systems could solve this cheaply.

Los Alamos National Laboratory 98 (“RESEARCHERS MAKING WAVES AT LOS ALAMOS” WASHINGTON, D.C., Jan. 7, 1998 <http://carlkop.home.xs4all.nl/strike.html> ) JM

Los Alamos National Laboratory researchers are demonstrating the enormous damage of an asteroid strike -- not from an impact on land but from tsunamis caused by an asteroid hitting Earth's oceans. Computer models show how impacts of various sizes will generate waves that could devastate entire coastlines on several continents. A surveillance and defense system could prevent such a disaster. Astrophysicist Jack Hills of the U.S. Department of Energy's Los Alamos National Laboratory presented his findings today at a news conference and a scientific session at the Washington, D.C., meeting of the American Astronomical Society. A tsunami is a fast-moving ocean wave, usually caused by underwater earthquakes or volcanic eruptions, that runs up on a coastline, causing widespread damage. A tsunami retains its destructive energy while it travels enormous distances. When the wave strikes a continental shelf, its speed decreases and its height increases. An asteroid impact would induce a series of waves that could scour thousands of miles of coastline with walls of water and roiling debris. Hills and his colleague Charles Mader use a detailed numerical simulation with a one kilometer spatial resolution and comparative data from historical tsunami events. The Los Alamos model estimates that an asteroid three miles across hitting the mid-Atlantic would produce a tsunami that would swamp the entire upper East Coast of the United States to the Appalachian Mountains. Delaware, Maryland and Virginia would be inundated, including Long Island and all the coastal cities in this region. It would also drown the coasts of France and Portugal. Alternately, Hills' model shows how much of Los Angeles and Waikiki would be lost if the same rock cratered the ocean between Hawaii and the West Coast. Fortunately, Earth is likely to take a hit from an object that large only once every 10 million years. However, the chance of a strike by a relatively small asteroid is two or three thousand times more likely, or once every few thousand years. Objects larger than about 600 feet across are virtually unaffected by the atmosphere and will reach Earth's surface at nearly full velocity to cause a crater on land or sea. Most of the damage from such an impact would come from a tsunami. For example, the Los Alamos model shows that an asteroid about 1,300 feet in diameter would devastate the coasts on both sides of the ocean with a tsunami more than 300 feet high. Asteroids smaller than the threshold 600 feet across lose most of their energy in the atmosphere but can still cause unprecedented damage. A "small" impactor hit near the Tunguska River in central Siberia in 1908. Though it never hit the ground, the shock wave flattened 800 square miles of forest. An impact like Tunguska, which hit with a force a thousand times greater than the Hiroshima bomb, occurs over land every 300 years on average. Hills and Mader have received Laboratory funding for an additional three years of model development. They expect increasingly sophisticated models to predict more extensive coastal damage than previously calculated. And Hills would like to see the research yield a practical plan of defense. "An impact from the smaller asteroids is one disaster that is preventable," Hills said. But to deflect an asteroid on a collision course, first it must be seen ahead of time. Then a nuclear-armed rocket must be ready to intercept it. A nuclear blast in space could either shatter or re-direct the incoming asteroid, Hills said. Currently, there is no such surveillance or defense capability in place. "It's a problem that could be solved for much less than the cost of one hurricane. We could just set it up and be done with it," said Hills.

# Ocean Impact More Likely

If an asteroid hit the earth it would most likely hit the ocean

[Nick Strobel](http://www.astronomynotes.com/contact.htm) 2010 (June 4, <http://www.astronomynotes.com/solfluf/s5.htm>, PhD -- Astronomy -- University of Washington,)

The oceans cover about 75% of the Earth's surface, so it is likely the asteroid will hit an ocean. The amount of water in the ocean is nowhere near large enough to "cushion" the asteroid. The asteroid will push the water aside and hit the ocean floor to create a large crater. The water pushed aside will form a huge tidal wave, a tsunami. The tidal wave height in meters = (distance from impact)-0.717 × (energy of impact)0.495/ (1010.17). What this means is that a 10-km asteroid hitting any deep point in the Pacific (the largest ocean) produces a megatsunami along the entire Pacific Rim

\*\*Asteroid Mining\*\*

# Asteroid Detection 🡪 Mining

Once an asteroid is detected it can be placed into high Earth orbit using mass drivers and mined for recourses.

Space Studies Institute No Date [Institute committed to completing the missing technological links to make possible the productive use of the abundant resources in space, Space Studies Institute, “Asteroid Deflection,” No Date, SM, Accessed: 7/11/11, <http://ssi.org/reading/papers/asteroid-deflection/>]

 SSI funded studies of asteroid detection, asteroid tracking, and mining of asteroids. We also studied the concept of assembling a mass driver engine in orbit, sending it to an Earth-approaching asteroid, and then using the mass driver to modify the asteroid’s orbit. This research was conducted with the goal of guiding the asteroid into a High Earth Orbit where it could be mined for its minerals. But such a technological capability, once developed, has obvious applications should we ever need to divert an asteroid from an Earth-intercepting course. For a long while, the conventional wisdom on this issue was that one would use nuclear explosives for this purpose. But according to a paper published in the June 4th, 1998 issue of Nature, this may not be as easy as previously thought. It points out that many asteroids are multi-lobed. A nuclear detonation might be largely absorbed by one lobe, with little course deflection resulting in the whole. The paper theorizes that the average asteroid may not be so much like a solid rock as an aggregate of fragments loosely held together by fine dust. If this “flying gravel pile” theory is correct, a nuclear detonation might pulverize an approaching asteroid, converting one big problem into many little ones. A mass driver engine, by contrast, could provide the low, steady, continuous thrust needed to change an asteroid’s course gradually, using the asteroid’s own material for reaction mass. The ability to modify an asteroid’s course via mass driver certainly promises to usher in a new era where space resources are freely available for construction projects in High Earth Orbit, and holds out promise for obtaining resources in a way which is not damaging to the environment of Earth. But it is just barely conceivable that this same technology might also help to avert a catastrophe of major proportions. In any event, a major program of asteroid mining can only make the Earth safer as the centuries pass. As it happens, those asteroids which cross the orbit of the Earth (and thus pose the greatest hazard) are also the ones most economically attractive for space-resource use. It is good that humanity is becoming more aware of the threat posed by Earth-crossing asteroids. But at the same time we should also become more aware of their vast economic potential.

**Asteroid Detection is a vital first step to mining them**

Crandall, Gorman, and Howard 11 (William- MBA Founder Space Wealth BC, Larry- Professor of Finance Cal Poly and Peter-Ph. D Senior Scientist Exelixis Inc, “Is Profitable Asteroid Mining A Pragmatic Goal?”, Space Wealth, 23 February 2011, [http://spacewealth.org/files/Is-P@M-Pragmatic-2011-02-23.pdf](http://spacewealth.org/files/Is-P%40M-Pragmatic-2011-02-23.pdf), CGW)

Platinum group metals are abundant in certain types of near Earth asteroids (NEAs). NEAs that are mineralogically similar to one of the most common types of “observed fall” meteorites offer PGM concentrations (4.5 ppm) 30 that are comparable to those found in profitable terrestrial mines (36 ppm). Other meteorites suggest that some asteroids may contain much more valuable metal. 32 The PGM value of a 200 m asteroid can exceed $1 billion, or possibly $25 billion. Over 7,500 NEAs have been detected. Close to a fifth of these are easier to reach than the moon; more than a fifth of those are ≥200 m in diameter: 200+ targets. President Obama requested, and Congress has authorized, a fourfold increase in detection funding ($5.8 m to $20.4 m/year). 36 This could lead to ~10,000 known 200 m NEAs in a decade. Detection is just a start. The costs to locate, extract, and process asteroid ore are not well understood. Before significant private capital is put at risk, we need to learn more. In cooperation with other forward looking nations, the U.S. should purchase an option to develop asteroid resources by investing in the knowledge required to mine asteroids. We can then choose to exercise this option if terrestrial PGM supplies do in fact collapse. Asteroids may also be able to supply other metals that are increasingly at risk. There are several candidates: In 2009, the U.S. imported 100% of 19 key industrial metals. To seek the “fullest commercial use of space,” NASA should buy down the risk of asteroid mining ventures by investing in R&D that can give us the tools to discover, analyze, and process asteroid ore, and deliver it safely to Earth, and to Earth orbit. NASA, with other space agencies, should run demonstrations for this globally important program so that, as the GAO likes to put it, useful “knowledge supplants risk over time.”

# Asteroid Detection 🡪 Mining

New asteroid detection technology will increase awareness of mining opportunities

Abundant Planet 10 (abundantplanet.org, “The Age of Asteroid Mining”, no specific date, 2010, Accessed 7/11/11, AH)

Future [NEA](http://www.lpi.usra.edu/books/AsteroidsIII/pdf/3048.pdf) [sample-return missions](http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=41064) are planned by the engineers at JAXA ([Hayabusa 2](http://b612.jspec.jaxa.jp/mission/e/hayabusa2_e.html)), as well as [several](http://www.jspec.jaxa.jp/080110Final_IPEWG-ProgramBook.pdf) other [groups](http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=43784) in the [European Space Agency](http://www.lpi.usra.edu/meetings/acm2008/pdf/8023.pdf) and at [NASA](http://ti.arc.nasa.gov/projects/neo_study/pdf/IAC-07-slides.pdf). (NASA’s [Dawn](http://dawn.jpl.nasa.gov/mission/index.asp) spacecraft, launched in September 2007, [aims for](http://dawn.jpl.nasa.gov/mission/Dawn_overview.pdf) two [main belt](http://en.wikipedia.org/wiki/Asteroid_belt) asteroids.) Missions to analyze, monitor, [respond to](http://www.space-explorers.org/ATACGR.pdf), and, if necessary, [move](http://www.b612foundation.org/) potentially hazardous NEAs ([PHAs](http://www.digitalspace.com/projects/neo-mission/docs/Blair_ADM03.pdf)), such as [Apophis](http://neo.jpl.nasa.gov/apophis/Apophis_CORRECTED_PREPRINT.pdf), have also been [planned](http://www.planetary.org/programs/projects/apophis_competition/winners.html). One such mission is projected to [cost less than](http://planetary.s3.amazonaws.com/projects/apophis_competition/apophis_winner_houyi.pdf) $20 million. The Hayabusa mission to Itokawa [cost $170 million](http://www.planetary.org/explore/topics/space_missions/hayabusa/facts.html). To date, [over 7,000](http://neo.jpl.nasa.gov/stats/) NEAs have been identified. Of these, 15% are [easier to reach](http://echo.jpl.nasa.gov/~lance/delta_v/delta_v.rendezvous.html) than the moon. New telescopes, such as [Pan-STARRS](http://en.wikipedia.org/wiki/Pan-STARRS) and the [LSST](http://en.wikipedia.org/wiki/Large_Synoptic_Survey_Telescope) (generating “[terabytes of data/night](http://abundantplanet.org/files/arXiv-0902.3683v1-2009-02-20.pdf)”), are expected to detect [half a million more](http://www.space-explorers.org/ATACGR.pdf) (500,000) over the next 15 years. This will significantly increase awareness of both Earth-impact risks and [business opportunities](http://abundantplanet.org/files/Space-Ast-Profitably-Exploiting-NEO-Gerlach-2005.pdf).

**Asteroid Detection allows us to find asteroids to be mined, it also allows us to discover asteroids that have already been mined by other Alien beings.**

Smithsonian Science 11 [Scientific Research Institution, Smithsonian Institution, “Evidence of asteroid mining in our galaxy may lead to the discovery of extraterrestrial civilizations,” April 5, 11, Accessed: 7/11/11, <http://smithsonianscience.org/2011/04/evidence-of-asteroid-mining-in-our-galaxy-may-lead-to-the-discovery-of-extraterrestrial-civilizations/>]

With Earth’s population moving toward 7 billion, humankind may someday need to look to space to help feed its need for precious metals, iron ore and other raw materials. Asteroids are a logical place to look for such resources as they contain enough gold, platinum, iron and nickel to perhaps one day make the technological challenges of mining them economically feasible. In fact, say astrophysicists Duncan Forgan of the Institute for Astronomy at the University of Edinburgh and Martin Elvis of the Harvard-Smithsonian Center for Astrophysics, if intelligent and more advanced civilizations exist on other planets then its a good bet that some of these civilizations turned to asteroid mining long ago. If so, the hallmarks of their mining activities, such as unusual dirty halos of cast-off dust and debris around large asteroids, might be detectable from earth. In a recent paper Forgan and Elvis detail what type of signs astronomers might look for with optical, thermal and spectral telescopes to detect such mining activities. For example, a deficit of certain elements in the debris cloud around and near an asteroid may indicate elements which have been removed through mining. An unnatural ratio between large and small asteroids in a region may indicate where larger asteroids have been targeted and broken up through mining activity. Asteroid mining also should leave distinct thermal signatures as drilling on a large scale would require great energy, and also create glassy silicas such as obsidian. As telescopes on Earth become more and more refined such tell-tale signatures of targeted mining of asteroids should become easier to detect than they are today, the scientists say. “Asteroid mining may be a common milestone in the development of space-faring civilizations, and therefore if intelligent civilizations are common, then these observational signatures would also be common,” Forgan and Elvis write in their paper. To be detectable from Earth, asteroid mining “must be prolific and industrial-scale, producing large amounts of debris and disrupting the system significantly,” the astronomers write. In humankind’s continuing search for extra terrestrial intelligence signatures of targeted asteroid mining may be among the first clues to alert us to the presence of other intelligent, technological life forms in our galaxy.

# Asteroid Detection 🡪 Mining

Detection leads to mining

Murrill and Whalen 98 (Mary Beth Murrill and Mark Whalen are spokespeople for NASA’s Jet Propulsion Lab. Mark Whalen “*JPL will establish Near-Earth Object Program Office for NASA,*”JPL Universe, July 24, http://neo.jpl.nasa.gov/program/neo.html, TDA)

This activity is not only for hazard assessment, he said, but also to identify optimal opportunities for ground-and space-based observations of these objects and "to identify which bodies might be exploited for their mineral wealth in the next century. Asteroids offer extraordinary mineral resources for the structures required to colonize the inner solar system and comets, and with their vast supplies of water ice, could provide life-sustaining water as well as the liquid oxygen and hydrogen required for rocket fuel." "It seems ironic that the very objects that bear watching because they could threaten Earth are the same ones that are most easily accessible to future space missions - missions that might exploit their considerable resources," he said.

# Asteroids = resources

One asteroid can provide over 800 tons of raw materials, as well as be used for transportation at insanely low costs

Rather et al. 2010 [John; Powell, James Maise, George "New Technologies and Strategies to Exploit Near Earth Asteroids for Breakthrough Space Development."

AIP Conference Proceedings; 1/28/2010, Vol. 1208 Issue 1, p566-570, 5p, 3 Black and White Photographs, PN]

Even one captured ten-meter diameter dust and rock “rubble Pile” asteroid can enable a vast improvement in human safety for travel from low Earth orbit to the vicinity of the moon or beyond. Robotic devices can burrow into the asteroid and reform its material into useful configurations. Ample material, amounting to more than 800 metric tonnes per trapped asteroid, will be available for radiation shielding to enable regular travel through the Van Allen belts. About 1 kg per square centimeter of shielding material surrounding interior habitats for human passengers will provide protection as effective as the atmosphere at the Earth’s surface and will therefore eliminate hazards to humans from solar flares and energetic cosmic particles. Transformed asteroids also can be steered into convenient elliptical orbits that make use of their considerable inertia to transport “hitch-hiking” passengers and cargo up from low Earth orbit at very low cost. Basically, the natural gift of large orbital momentum can be utilized without launching it from the Earth. There will be no threat to the Earth from such methods because the objects remain small enough that they would be disrupted in the atmosphere before reaching the surface if they should accidentally be perturbed into impact trajectories. Routine momentum exchange with hitch-hiking orbital transfer payloads may require a low thrust solar-plasma engine attached to the asteroid for continuous station keeping, but this is a minor detail. Ultimately, asteroids that osculate the orbits of Earth and Mars (or the asteroid Main Belt) can be similarly modified to provide safe and comfortable human transport for long duration trips.

Asteroids have a lot more minerals than earth

Sonter 2006 (Mark Sonter is a mining industry expert and fellow at the National Space Society, *“Asteroid Mining: Key to the Space Economy,”* Space.com, February 9, http://www.space.com/2032-asteroid-mining-key-space-economy.html, TDA)

The Near Earth Asteroids offer both threat and promise. They present the threat of planetary impact with regional or global disaster. And they also offer the promise of resources to support humanity's long-term prosperity on Earth, and our movement into space and the solar system. The technologies needed to return asteroidal resources to Earth Orbit (and thus catalyze our colonization of space) will also enable the deflection of at least some of the impact-threat objects. We should develop these technologies, with all due speed! Development and operation of future in-orbit infrastructure (for example, orbital hotels, satellite solar power stations, earth-moon transport node satellites, zero-g manufacturing facilities) will require large masses of materials for construction, shielding, and ballast; and also large quantities of propellant for station-keeping and orbit-change maneuvers, and for fuelling craft departing for lunar or interplanetary destinations. Spectroscopic studies suggest, and 'ground-truth' chemical assays of meteorites confirm, that a wide range of resources are present in asteroids and comets, including nickel-iron metal, silicate minerals, semiconductor and platinum group metals, water, bituminous hydrocarbons, and trapped or frozen gases including carbon dioxide and ammonia. As one startling pointer to the unexpected riches in asteroids, many stony and stony-iron meteorites contain Platinum Group Metals at grades of up to 100 ppm (or 100 grams per ton). Operating open pit platinum and gold mines in South Africa and elsewhere mine ores of grade 5 to 10 ppm, so grades of 10 to 20 times higher would be regarded as spectacular if available in quantity, on Earth. Water is an obvious first, and key, potential product from asteroid mines, as it could be used for return trip propulsion via steam rocket. About 10% of Near-Earth Asteroids are energetically more accessible (easier to get to) than the Moon (i.e. under 6 km/s from LEO), and a substantial minority of these have return-toEarth transfer orbit injection delta-v's of only 1 to 2 km/s

# Asteroid Mining = Profitable

**Asteroids have huge economic benefits**

Ross 2001 (Shane D. Ross is an assistant professor of dynamical studies at Virginia Tech, “*Near-Earth*

*Asteroid Mining.*” Cal Tech: Space Industry Report, December 14 2001, Pg 6.

http://www.nss.org/settlement/asteroids/NearEarthAsteroidMining(Ross2001).pdf. TDA)

Kargel [1997] estimated that one metallic asteroid of modest size (1 km) and fair enrichment in platinum group metals would contain twice the tonnage of PGMs already harvested on Earth combined with economically viable PGM resources still in the ground. At recent prices, this asteroid’s iron, nickel, PGMs, and other metals would have a value exceeding that of the world’s proven economic reserves of nonmetallic and metallic mineral resources. The availability of asteroid metals would lower market prices. Even then, the value of the asteroid derived materials would be enormous.

# Asteroid Mining = Good Idea

Asteroids that have been diverted from Earth can then be mined for their resources.

Lewis 97 (John S. Lewis is a professor of planetary science at the University of Arizona’s Lunar and Planetary Laboratory, former professor of space sciences at MIT. *“Escaping the ultimate disaster--a cosmic collision.”*  Futurist, Jan/Feb97, Vol. 31, Issue 1. EBSCOhost. TDA)

Why not blow it up? Bad idea. If we split an approaching one-gigaton object into 10 equal pieces of 100 megatons of energy each, they'd strike Earth like a giant shotgun pattern. The main effect of breaking up the threatening impactor would be to increase the damage done. The disruption of a threatening impactor is clearly not a sensible option unless we are certain that almost all of its fragments can be diverted so as to miss Earth. But if we have the ability to divert dozens of pieces, why not elect the simpler option of gently diverting the whole thing? The idea of diverting the course of an asteroid that is several hundred meters in diameter seems breathtakingly ambitious. Yet, human mining activities routinely crush, excavate, and move comparable volumes of rock. There is an important factor that makes this scenario much less daunting: We are merely trying to avoid a single predicted impact with Earth. Suppose our asteroid-search team finds a 250-meter body that is due to hit Earth dead center a few hundred years from now. This same body has probably been crossing Earth's orbit for 10 million to 100 million years without an impact. If we can just ease it by Earth without an impact on this one occasion, we may well buy ourselves another 30 million years to figure out what to do the next time it threatens us. So the real problem is not to devise a permanent fix; it is to avoid a specific near-term event. We might give the asteroid a small sideways nudge so that, when it reaches Earth, it will skim by to one side of the planet rather than strike it directly. Or we could accelerate or decelerate the asteroid along its direction of orbital motion so as to change its orbital period slightly. This would cause the asteroid to cross Earth's orbit a little ahead of or behind the impact schedule it was following, and hence cross Earth's orbit at a point ahead of or behind Earth. There are many methods available for making such small changes in the velocity of an asteroid. One of the favorite techniques proposed by military experts is to explode a small nuclear warhead well clear of the surface of the asteroid. But simply launching an existing intercontinental ballistic missile at the asteroid would not work: Such vehicles cannot achieve escape velocity to reach an asteroid on its orbit around the Sun. Further, missile guidance systems are designed to operate for the half-hour of an intercontinental trip--not the weeks or months required for the trip to an asteroid. The mission would have to be accomplished by a military warhead combined with a NASA planetary spacecraft bus that provides guidance and power Readers concerned about the environmental impact of such an explosion should realize that the asteroid would not be contaminated to any significant degree by radioactive bomb debris, since the surface layer would be boiled off by the blast. The bomb vapor would be swept out of the solar system by the solar wind at a speed of about 600 kilometers per second. The net result of the asteroid deflection is really a twofold benefit to Earth: A devastating impact would be avoided, and there would be one less nuclear warhead on Earth.

# Asteroid Mining = Economically Feasible

Improvements made with each mining trip operation decreases costs and boost efficiency

Gerlach 2005 (Charles Gerlach is the CEO Gerlach Space Systems, *“Profitability Exploiting Near-Earth Object Resources.”* Given at the International Space Development Conference in Washington DC, May 192005, http://abundantplanet.org/files/Space-Ast-Profitably-Exploiting-NEO-Gerlach-2005.pdf, pg 1-2. TDA)

When viewed in the context of traditional mining practices, the NEO Miner platform represents a classic example of a disruptive technology. Disruptive technologies bring to the market very different value propositions than have been available previously. Generally, disruptive technologies initially underperform established products in mainstream markets, but they have other features that a few fringe (and generally new) customer value. Products based on disruptive technologies are typically cheaper, simpler,smaller, and frequently more convenient to use. Neo Miner does not represent an incremental improvement to traditional resource production processes. It is a radical departure that is smaller and cheaper than a traditional mining operation and many, in some ways, be considered inferior. However, it has the potential to be highly disruptive of traditional mining methods. As a disruptive technology, initial success is likely to fuel rapid improvements in performance and reductions in cost. The use of multiple landers with modular components is a powerful tool for risk reduction that enables the capture of economies of scale that can dramatically drive down the cost of this equipment over time. Once successful operation of the platform is demonstrated, it will become viable to build landers using assembly-line production processes and deploy multiple missions to one or more asteroids simultaneously, producing significant marketable quantities of resources for sale in terrestrial markets and for use on orbit. In addition, it will be possible to update the NEO Miner platform in each successive generation based on data and experiences gathered through each deployment. This could enable dramatic improvements in the functionality of the landers as well as drive down their cost to a point that dozens of missions with hundreds of landers can be launched. This approach has the potential to dramatically drive down the cost of utilizing asteroid resources on Earth and beyond.

Asteroid mining is the only feasible way to colonize space - trucking resources Earth is costly and inefficient whereas getting them from asteroids is cheap and has a stellar economic benefit.

**Bonsor 2k** (Kevin, Bachelors degree in Journalism from Georgia Southern University writer for How Stuff Works and Discoverynews.com, “How Asteroid Mining Will Work”, accessed from [www.sps.aero](http://www.sps.aero), November 10th 2000, NB http://www.sps.aero/Key\_ComSpace\_Articles/LibTech/LIB-029\_How\_Asteroid\_Mining\_Will\_Work.pdf)

If you enjoy science fiction, then you know that the thought of colonizing the moon makes for some incredibly imaginative stories. But there is a good possibility that lunar cities will become a reality during the 21st century! Colonizing Mars is another option as well. Right now, one of the biggest problems with the idea of a moon colony is the question of building supplies. There is no Home Depot on the moon, so the building supplies have to come from somewhere. The only place to get the supplies right now is the Earth, with the space shuttle acting as a truck. Using the space shuttle in this way is something like using FedEx to get all of the materials for building a house to a construction site -- It's incredibly expensive and not very efficient! Asteroids may be a much better place to get the supplies. Early evidence suggests that there are trillions of dollars' worth of minerals and metals buried in asteroids that come close to the Earth. Asteroids are so close that many scientists think an asteroid mining mission is easily feasible.

# Asteroid Mining = Safer & Cheaper

Asteroid mining is the best - Terrestrial mining methods expensive and toxic

Gerlach 2005 (Charles Gerlach is the CEO Gerlach Space Systems, *“Profitability Exploiting Near-Earth Object Resources.”* Given at the International Space Development Conference in Washington DC, May 192005, http://abundantplanet.org/files/Space-Ast-Profitably-Exploiting-NEO-Gerlach-2005.pdf, pg 1-2. TDA)

Like most terrestrial mining processes, platinum production requires large investments in mining and processing equipment and the people to operate that equipment. Developing a new mine can cost as much as $1 billion, not including ongoing operating and refining costs. In addition, using today’s most cost-effective methods, platinum production is a toxic enterprise, requiring tremendous amounts of chlorine, ammonia, and hydrogen chloride gas, which are all released as part of the process. Large amounts of effluents are left at the end of the process – several hundred pounds of toxic effluents per grain of platinum and other PGMs, including metals such as iron, zinc, nickel, as well as other metals that are part of the ore but not commercially viable to extract. The process also generates harmful sulfates. While major producers are now using more environmentally-sensitive means to mitigate pollution, the sheer volume of material involved and the minute quantity of valuable PGMs per ton of ore mean that terrestrial production processes inevitably harm the environment. A robotic asteroid mining platform will use a radically different process. If the compositional data discussed in Section 2 is correct, the robotic miner will be starting with a grade of platinum group elements that is as high as that at the end of the third stage of the terrestrial production process.

# All Asteroids can be mined

Every asteroid we discover can be mined – even the small ones are worth trillions

Lewis 97 (John S. Lewis is a professor of planetary science at the University of Arizona’s Lunar and Planetary Laboratory, former professor of space sciences at MIT. *“Escaping the ultimate disaster--a cosmic collision.”*  Futurist, Jan/Feb97, Vol. 31, Issue 1. EBSCOhost. TDA)

There is another way of looking at near-Earth bodies: as opportunities rather than threats. A large proportion of the most-threatening objects are also the most-accessible bodies in the solar system for spacecraft missions from Earth. These bodies are the most-promising sources of raw materials for a wide range of future space activities. They may provide the propellants for future interplanetary expeditions, the metals for construction of solar power satellites to meet Earth's energy needs in the third millennium, the life-support materials and radiation shielding to protect space colonies, and the precious and strategic metals needed by Earth's industries. For instance, the smallest known metallic asteroid, 3554 Amun, contains over $1 trillion worth of cobalt, $1 trillion worth of nickel, $800 billion worth of iron, and $700 billion worth of platinum. The total value of this single small asteroid is approximately equal to the entire national debt of the United States. By comparison, the uncontrolled impact of Amun with Earth would deliver a devastating 7-million-megaton blow to the biosphere, killing billions of people and doing hundreds of trillions of dollars worth of damage. Thus we come to our final, and most startling, discovery: The stick that threatens Earth is also a carrot. Every negative incentive we have to master the impact hazard has a corresponding positive incentive to reap the bounty of mineral wealth in the would-be impactors by crushing them and bringing them back in tiny, safe packages, a few hundred tons at a time, for use both in space and on Earth. Remember that we will almost certainly have hundreds to thousands of years of warning time before a threatening global-scale impact. We need not be driven to rash and risky actions taken precipitously under threat of death. We will almost certainly have plenty of time to deal with the problem. Dealing with near-Earth objects should not be viewed grudgingly as a necessary expense: It is an enormously profitable investment in a limitless future. It is a liberation from resource shortages and limits to growth. It is an open door into the solar system--and beyond.

# We Have The Tech

Ballute tech allows reentry with mined material – cheap, lightweight, and durable

Gerlach 2005 (Charles Gerlach is the CEO Gerlach Space Systems, *“Profitability Exploiting Near-Earth Object Resources.”* Given at the International Space Development Conference in Washington DC, May 192005, http://abundantplanet.org/files/Space-Ast-Profitably-Exploiting-NEO-Gerlach-2005.pdf, pg 1-2. TDA)

One final challenge is the cost-effective return of processed resources to Earth for sale. A major energy cost of the return mission is to decelerate the payload so as to achieve Earth-capture. Fuel requirements for propulsive braking and capture into orbit or for atmospheric entry render many asteroid resource concepts impractical. There are various options for reducing velocity from hyperbolic to a bound planetary orbit upon return. One method is to rely on propulsive braking using propellant carried to the asteroid and back or by using asteroid-derived propellant. This is the simplest approach, but it is undesirable because it either adds additional fuel to the mass of the payload sent to the asteroid or it reduces the quantity of material that is returned to orbit and requires an additional system for producing asteroid-derived propellant in. A second option is to rely on aero-braking or aero-entry using an Earth-fabricated aerobrake. A traditional aero-brake would likely require too much mass too make it viable. Some engineers have proposed in situ construction of an aero-brake from asteroidal materials, although this would appear too complex of a task given current robotic systems. Yet another option is to use lunar fly-by to remove hyperbolic -v will naturally insert the returning craft into highly elliptical Earth orbit (HEEO) with no stress on the payload and no consumption of propellant. Navigation and timing constraints must be met to ensure the requisite low altitude pass over the Moon at the proper time in its orbit to provide maximum velocity loss. A maximum velocity reduction of 1.5 km/sec. has been quoted for a single lunar flyby. This corresponds to an object returning on a transfer orbit of Q = 1.25 AU, from an aphelion mining mission; and an object returning on a transfer orbit of q = 0.83 AU from a perihelion mining mission. For this type of option, the most desirable targets for lunar flyby capture are those asteroids with aphelia less than 1.25 AU or perihelia more than 0.8 AU Given these constraints, ballute technologies provide an intriguing solution to this problem, potentially negating the requirement for propulsive braking or complex and time-consuming orbital maneuvers to use the gravity of other bodies to place a return container into Earth orbit or to enable entry into the Earth’s atmosphere for recovery on the ground. Ballutes are inflatable structures designed to act as aero-shells and parachutes. There relatively compact, lightweight systems duplicate the functions of a much heavier aero-shell. The most mature ballute technology available is the Inflatable Re-Entry and Descent Technology (IRDT) demonstrator originally developed by NPO Lavochkin as part of the Mars-96 mission to support entry and descent of a Mars penetrator lander (Figure 19). The IRDT employs an inflatable envelope able to withstand the extreme hypersonic flight environment of re-entry. It provides a lightweight, cost-effective aero-shell that can be used for aero-braking and aeroentry. Use of the ballute system will enable aero-braking and aero-entry concepts that should greatly reduce fuel requirements. The ballute system also enables precision landing of the heavy payload in an unpopulated recovery area. The inflatable technology offers great advantages due to its low volume and mass. As noted in the previous section, the return containers incorporated into each lander are designed so that they can be docked and mated with the ballute system on the orbiter for return to earth. These containers provide mandrels for depositing platinum as well as chambers for secure return of samples and hardened data storage systems. Use of this type of return craft enables precise delivery of a large payload including unprecedented quantities of data. Since the cost of data storage hardware is decreasing very rapidly, terabytes of data can now be returned in compact, hardened data storage systems contained in each of the return containers. Data can be mirrored between data storage systems in each container mitigating concerns about the failure of or destruction of the data in one or more of the containers during re-entry and landing. This capability will make possible the return hundreds of hours of high-definition video plus other data that would otherwise be impossible to return due to limited bandwidth for deep space communications. As noted in Section 3, the ability to return so much high-definition video is a source of revenue by itself. It also will enable engineers to study processes and telemetry as never before in order to re-design and improve processes for future missions. Finally, it can be used as a powerful marketing tool.

# Mining Solves Economy

**Resources are becoming scarcer on earth - forcing us to aggressively search the environment for lower grade materials at higher financial and environmental costs. Asteroids are key to solving the resource shortage and the financial and ecological problems that it brings.**

**Gerlach 2005** (Charles, CEO Gerlach Space Systems, “Profitability Exploiting Near-Earth Object Resources” delivered at 2005 International Space Development Conference in Washington D.C , May 19-22 2005, NB

http://abundantplanet.org/files/Space-Ast-Profitably-Exploiting-NEO-Gerlach-2005.pdf)

We are approaching an important crossroads in history as we begin to experience the concrete global implications of limited supplies of many of the key natural resources upon which our industrial civilization is built. While we will not fully exhaust supplies of fossil fuels and other critical resources for decades or even centuries, we have reached a point where we can identify indisputable limits and begin to more fully appreciate their potential consequences. Fortunately, we have time to learn to better conserve existing natural resources and seek new supplies. Faced with these emerging realities, space resources – especially the resources of near-Earth space – become increasingly viable and even attractive options. Though limited, the resource base of our planet is complex and differentiated. As we have increasingly exploited its resources, we have aggressively explored the Earth in search of the most accessible deposits of ores and fuels. As we have used up the most accessible resources, we have had to dig deeper, accepting lower grade materials that are more costly to produce both in terms of financial investment and damage to our environment. Independent of local resource scarcities and variations on individual planets, our solar system is differentiated on a large scale. Just as processes of crustal evolution have produced concentrations of useful materials at different depths and locations on the Earth's surface, general processes of solar system evolution have produced concentrations of different resources in different parts of the solar system. These processes have produced vast supplies of a variety of materials distributed in zones, ranging from metalrich silicates near the Sun through concentrations of organic and rocky material in the mid-solar system to concentrations of ices in the outer solar system. Melting has also concentrated metals in asteroidal cores exposed later by collisions and fragmentation.

Asteroid Mining solves – large amount of resources key to economy.

Ross. 01. ( Shane D. Ross is an assistant professor at Virginia Tech in the Department of Engineering Science and Mechanics. “Near-Earth Asteroid Mining” 12-14-01. [http://76.75.200.144/settlement/asteroids/NearEarthAsteroidMining(Ross2001).pdf](http://76.75.200.144/settlement/asteroids/NearEarthAsteroidMining%28Ross2001%29.pdf). TQ)

Asteroid mining is a concept that involves the extraction of useful materials from asteroids. Due to their accessibility, near-Earth asteroids (those asteroids that pass near the Earth, also known as NEAs) are a particularly accessible subset of the asteroids that provide potentially attractive targets for resources to support space industrialization. Many materials could be extracted and processed from NEAs which are useful for propulsion, construction life support, agriculture, metallurgy, semiconductors, and precious and strategic metals (see Table 1). Volatiles such as hydrogen and methane could be used to produce rocket propellant to transport spacecraft between space habitats, Earth, the Moon, the asteroids, and beyond. Rare-earth metals could be used to manufacture structural materials as well as solar photovoltaic arrays which could be used to power space or lunar habitats. These solar cells could also be used in a constellation of solar power satellites in orbit around the Earth in order to provide electrical power for its inhabitants. Precious metals such as platinum, platinum-group metals (PGMs), and gold are also available. 1.1 Space Industrialization The industrialization and settlement of space is likely to be brought about primarily by increasing commercial activities in space, worth several billion dollars per year, including the following existing activities: telecommunications, direct broadcast television, navigation (e.g., the Global Positioning System), remote sensing, and metereological services. Low Earth orbit (LEO) satellite constellations will roughly double the annual income of these services over the next decade (Sonter [1997]).

# Mining Solves Economy

Mining for resources is key to the economy

Campbell 9’

(Michael D. Campbell et.al Educational Material Development Developing Industrial Minerals, Nuclear Minerals and Commodities of Interest via Off-World Exploration and Mining QJ)

**Identifying and mining nickel, cobalt, and a variety of other commodities that are in short supply on Earth, or those that could be mined, produced, and delivered more cheaply in space than on Earth could contribute to and drive the world‟s technology and associated economy to a scale never before contemplated.** T**his is based, of course, on the assumption that the economics are favorable. Large multi-national, quasi-governmental industrial groups** are likely to develop over the next few decades to handle projects of such magnitude, if they haven‟t already begun to assemble. In the beginning, the economics would likely be underwritten by governmental support, **perhaps by a group of governments cooperating in funding and technology but followed later by some governments funding programs to accommodate their own particular self-interests.**

**Asteroid mining solves everything: economy, tech, war and environment**

Ross in 2001 **(**Shane D. Assistant Professor [Engineering Science and Mechanics](http://www.esm.vt.edu/) at [Virginia Tech](http://www.vt.edu/). Space Industry Report *Near-Earth Asteroid Mining* December 14, 2001. Google Scholar. TS)

 Many terrestrial resources, such as precious metals and fossil fuels, are running out. As new terrestrial sources are sought, materials are obtained at increasing economic and environmental cost. Society pays for this depletion of resources in the form of higher prices for manufactured goods, would-be technologies that are not developed for lack of raw materials, global and regional conflicts spurred by competition for remaining resources, and environmental damage caused by development of poorer and more problematic deposits. Utilization of asteroid resources may provide a partial solution to the problem, as they hold the potential for becoming the main sources of some metals and other materials. Precious metals and semiconducting elements in iron meteorites, which form the metallic cores of asteroids, are found in relatively large concentrations compared to Earth sources. In such sources, it may be possible to extract up to 187 parts per million (ppm) of precious metals, which includes Au, the Pt-group metals (Pt, Ru, Rh, Pd, Os, and It), Re, and Ge. More than 1000 ppm of other metals, semiconductors, and nonmetals may may one day be extracted and imported by Earth from asteroids, such as Ag, In, Co, Ga, and As.

# Economy ! – War

Continued economic decline will result in global war.

Mead 9 (Walter Russell Mead, [Henry A. Kissinger](http://en.wikipedia.org/wiki/Henry_A._Kissinger) senior fellow for [U.S. foreign policy](http://en.wikipedia.org/wiki/U.S._foreign_policy) at the Council on Foreign Relations. The New Republic, http://www.tnr.com/politics/story.html?id=571cbbb9-2887-4d81-8542-92e83915f5f8&p=2)JFS

So far, such half-hearted experiments not only have failed to work; they have left the societies that have tried them in a progressively worse position, farther behind the front-runners as time goes by. Argentina has lost ground to Chile; Russian development has fallen farther behind that of the Baltic states and Central Europe. Frequently, the crisis has weakened the power of the merchants, industrialists, financiers, and professionals who want to develop a liberal capitalist society integrated into the world. Crisis can also strengthen the hand of religious extremists, populist radicals, or authoritarian traditionalists who are determined to resist liberal capitalist society for a variety of reasons. Meanwhile, the companies and banks based in these societies are often less established and more vulnerable to the consequences of a financial crisis than more established firms in wealthier societies. As a result, developing countries and countries where capitalism has relatively recent and shallow roots tend to suffer greater economic and political damage when crisis strikes--as, inevitably, it does. And, consequently, financial crises often reinforce rather than challenge the global distribution of power and wealth. This may be happening yet again. None of which means that we can just sit back and enjoy the recession. History may suggest that financial crises actually help capitalist great powers maintain their leads--but it has other, less reassuring messages as well.If financial crises have been a normal part of life during the 300-year rise of the liberal capitalist system under the Anglophone powers, so has war. The wars of the League of Augsburg and the Spanish Succession; the Seven Years War; the American Revolution; the Napoleonic Wars; the two World Wars; the cold war: The list of wars is almost as long as the list of financial crises. Bad economic times can breed wars. Europe was a pretty peaceful place in 1928, but the Depression poisoned German public opinion and helped bring Adolf Hitler to power. If the current crisis turns into a depression, what rough beasts might start slouching toward Moscow, Karachi, Beijing, or New Delhi to be born? The United States may not, yet, decline, but, if we can't get the world economy back on track, we may still have to fight.

# Asteroid Mining – Platinum

Asteroid Mining is necessary for elements like platinum and planetary defense

Valentine 7’

(Dr. Lee S. Valentine is the Executive Vice President of the Space Studies Institute in Princeton, New Jersey, Critical Trajectories for the Human Settlement of the High Frontier, NEW TRENDS IN ASTRODYNAMICS AND APPLICATIONS III. AIP Conference Proceedings, Volume 886, pp. 123-130 (2007),

**The evolution from small tourist stations of the next decade to large space hotels will make economical the use of fully closed life-support systems. These could be considered the first space colonies. Derivatives of these commercial space hotels may form suitable Moon and asteroid mining habitats. Using nonterrestrial materials is a key to opening the space frontier. Dozens of rendezvous missions to Near Earth Objects will be needed to assay their resources and to plan rational NEO diversion. The development of NEO mining techniques serves two purposes, raw materials supply and planetary defense.** We need economical trajectories to and from these bodies. These trajectories must not only be economical in terms of delta V or time, but in dollars, and in the time value of money, factors not generally considered by the OMB. Satellite solar power stations may be a $500 billion per year market worldwide and cheap nickel steel from asteroids may be an enabler of power satellite construction. One asteroid of the right size and composition in a suitable orbit could open this market. **Platinum group metals may be an important export, either as a primary product, or as a byproduct of nickel steel alloy production. Other products, derived from carbon, may also be important. The first economical product from an asteroid mine is likely to be water, for propellant or life-support and radiation shielding in space hotels.**

# Platinum k2 Oil Dependence

PGM K2 end dependence on petroleum but there’s not enough supply now. Asteroid mining will provide that back up.

Gerlach 05 (Charles L. founder and CEO of Gerlach Space Systems LLC 2005 INTERNATIONAL SPACE DEVELOPMENT CONFERENCE National Space Society *Profitably Exploiting Near-Earth Object Resources* May 19–22, 2005. Google Scholar) TS

Fuel cell adoption may ultimately become the most important dynamic in the platinum market. Platinum is critical to fuel cell performance because it is critical to achieving the required levels of fuel cell power density and efficiency. It is essential to the catalysis of anodic and cathodic reactions in the stack. It is important to the catalysis of reforming, shift, and preferential oxidation reactions in the fuel processor. The fuel cell industry's demand for platinum and other PGMs is expected to eventually dwarf all other sectors and will place an incredible strain on the supply of platinum and the environment.

Just as O’Neill43 justified investment in the development of his massive L5 space colonies with the need to construct space solar power satellites (SSPS) to meet the world’s growing energy needs, exploitation of asteroid resources in part be justified by the desire to find new, more environmentally friendly ways to meet our energy needs in the face of fossil fuel depletion. One step that can be taken to address growing fossil fuel demand is to shift from a petroleum economy to a hydrogen economy, where the gasoline internal combustion is replaced by hydrogen fuel cells. However, one potentially serious roadblock to this shift is the requirement for platinum as a catalyst in fuel cells,44 with limited platinum reserves and high platinum production costs may slow or even halt fuel cell adoption (Figure 10).

Oil dependency makes war inevitable with China and tanks any hope of relations with other countries – alt. sources solve

Reynolds, American Surveyor, 10

(Lewis , American Surveyor, “Seven Dangerous (and Surprising) Side Effects of US Dependence on Foreign Oil”, August 4th, http://www.amerisurv.com/content/view/7708/, accessed 6-20-11, AH)

It creates strained foreign relations and sets the stage for an unstable future. The entire U.S.-Middle East foreign policy has been structured around the obvious importance of the region for the world’s oil supply. Policy makers don’t like to discuss it openly, but oil is always the elephant in the room when it comes to U.S. foreign relations—even with nations outside the Middle East. One of the great questions in the context of geopolitical struggle for oil is whether the great oil consuming nations—which will soon include the U.S., China, Russia—will view one another as allies, competitors, or some combination of both. The U.S. has love-hate relationships with both countries. There is historic rivalry between the U.S. and Russia leading back generations. The relationship with China is murky at best. Events are already in motion that could set the stage for a U.S.-Chinese confrontation. Oil consumption continues to grow modestly in the U.S., but in China it is exploding. On a global scale, oil consumption will certainly continue to grow into the foreseeable future, yet there are considerable questions as to whether global production can be increased much beyond current levels if at all. With both the U.S. and China needing oil, competition is inevitable. Responsibility lies with both sides to take actions to avoid the long progression toward a conflict. A Sino-American energy war is far too likely if both countries continue on their present courses without developing substantial alternative energy sources.

\*\*Solvency\*\*

# Space Based Detection Key

Space based infrared detection technologies are accurate and fast

NASA ’06 (“2006 Near Earth Object Survey and Reflection Study”, Nasa Office of Program Analysis and Evaluation, Pg. 34, December 28, 2006, http://www.b612foundation.org/papers/NASA-finalrpt.pdf, TDA)

With the exception of technology maturity, space-based infrared systems have the same advantages as space-based optical systems. For infrared systems this technology is maturing rapidly. Space-based, passively cooled infrared systems also have additional advantages. They require smaller apertures than optical systems of equal detection efficiency and provide more accurate estimates of object sizes. The object size uncertainties are less than 50% compared with 230% for visual detectors. A two-band infrared system could lower the size uncertainties to about 20%. These space-based systems also are much less affected by the problem of source confusion. There are about 100 times fewer infrared sources per square degree at an infrared wavelength of 8 microns compared with the number of visible sources at 0.5 microns. In addition, space based infrared systems have lower downlink data rate requirements than space-based visible detector systems. Space-based infrared systems were the most capable (sensitive) of the alternatives considered.

# Space Based Detection Key

Space based detection key - Earth Based optical systems are inaccurate and ineffective

NASA ’06 (“2006 Near Earth Object Survey and Reflection Study”, Nasa Office of Program Analysis and Evaluation, Pg. 34, December 28, 2006, http://www.b612foundation.org/papers/NASA-finalrpt.pdf, TDA)

Because these optical systems must view through Earth's atmosphere, ground systems have drawbacks. Ground-based optical systems cannot operate during daylight or twilight and are subject to interference from weather, atmospheric turbulence, scattering from moonlight, and atmospheric attenuation. These systems cannot easily operate close to the galactic plane because atmospheric turbulence and scattering cause source confusion. Significant atmospheric attenuation in the infrared-spectral region prevents these systems from accurately determining NEO sizes. These systems also will have difficulty finding objects in inner-Earth or Earth-like orbits. They have fewer discovery opportunities because they are available only at the beginning and end of each night. Additionally, ground-based systems have intangible programmatic issues related to site and infrastructure maintenance. These issues are made worse if the telescopes are sited on foreign territory to achieve the best observing conditions and operate for decades.

Transponders are necessary to track asteroids because radar is limited to near-earth distances.

Bucknam, Mark and Robert Gold in 8 (Former Council Military Fellow, Survival, *Asteroid Threat? The Problem of Planetary Defence*, [http://web.ebscohost.com/ehost/pdfviewer/pdfviewer?sid-4d559d5c-113d-420a-befe-99ff529968a5%40sessionmgr11&vid-6&hid-10](http://web.ebscohost.com/ehost/pdfviewer/pdfviewer?sid=4d559d5c-113d-420a-befe-99ff529968a5%40sessionmgr11&vid=6&hid=10), DF)

Though radar telescopes, such as the giant 305m dish at Arecibo, Puerto Rico, enable rapid and accurate assessments of PHO size and orbit, they are only useful when the objects pass within a few million kilometres of Earth. NASA recommended against developing a radar specifically for finding and tracking PHOs, stating that ‘orbits determined from optical data alone will nearly match the accuracy of radar-improved orbits after one to two decades of observation’. 15 Existing radar telescopes should be used as far as possible to refine predictions of Apophis’s trajectory – either confirming or ruling out the potential for an impact in 2036. In addition to fielding new Earth- and space-based sensors as suggested by NASA, former astronaut Rusty Schweickert called for placing a transponder on Apophis during a close approach in 2013 to help determine whether a 2036 collision is likely. 16 This could save years of worrying, or give us extra years to prepare and act. Such a mission would cost on the order of a few hundred million dollars.

# Space Based Detection Key

Space based detection key – it’s more effective and circumvents glare

Rather et. al 2010 (John Rather is a former assistant director for NASA, founder of Rather Creative Innovations Group, James Powell, George Maise, AIP Conference Procedings, “New Technologies and Strategies to Exploit Near Earth Asteroids for Breakthrough Space Development”, January 28 2010, Vol. 1208 Issue 1, pg. 566-570, EBSCOhost, TDA)

If advantageous use is to be made of ten-meter-class objects, much better ways must be implemented to find them and react to their approach in real time. The first step is to develop specialized detection systems to extend the complete census of these small, very faint objects down to ten-meter diameters. Present NEO discoveries and orbital determinations are mostly made by nighttime observations from the Earth’s surface. Small objects having semi-major axes less than one AU spend much time closer to the sun than the Earth and thus have a significant bias against discovery by Earth-based observations. While present automated search methods will eventually catalog most NEOs having diameters larger than 30 meters, an efficient and inexpensive method is needed to extend the complete census to the much more numerous smaller objects. The required system must also address the problem of finding the largely unknown population that remains lost in the sun’s glare. Space-based optical/infrared methods will remain the primary initial discovery tools of very small NEOs, but radar also has important roles for identifying both useful and/or hazardous objects. All-sky, “24-7” radar searches are not practical because of inverse fourth power signal attenuation characteristic of radar transmission and reflection. Relatively large transmitting/receiving apertures are required to attain adequate signal-to-noise at ranges of tens of millions of kilometers, but the associated narrow beams make whole-sky 4 steradian searches expensive and time consuming. Many small objects would pass undetected without a very large number of dedicated radars. If the initial discoveries are efficiently made by space-based optical/infrared methods, however, handoff to a few dedicated radars on the Earth can then perform the vital functions of precision tracking, imaging, geological appraisal, and management of spacecraft rendezvous dynamics. With all of the above constraints in mind, we propose a near-term, relatively low cost but highly efficient combination of detection technologies as the first step to exploitation of small ten-meter class NEOs. This combination consists of a small spacecraft equipped with a scanning wide-field optical/infrared surveillance telescope located at the sun/earth L2 Lagrange region near the tip of the Earth’s shadow (a similar location to the James Webb telescope but no threat to it), and three 12-meter aperture millimeter-wavelength radars situated in appropriate locations around the Earth to enable full-time, whole-sky access on short notice. The shadowed spacecraft can efficiently cover 4[pi] steradians every six hours. The primary function of the spacecraft is to hand-off each discovery to the radar system while the NEO is still about twenty million kilometers from the Earth. Synergistically, the spacecraft will also identify high-velocity dangerous objects coming from the direction of the sun. The requisite spacecraft and radars are completely within the existing states-of-the art, and the entire system should be realizable within four years for a cost of less than $200 million. A study should also be performed soon to investigate whether early deployment of the radars alone could work effectively in combination with existing space assets such as the Wide-field Infrared Survey Explorer (WISE) mission. The latter very low-cost strategy might expedite near-term initiation of the complete census of ten-meter diameter NEOs.

# Space Based Detection Key

Space detection methods key – fewer telescopes needed to effectively, accurately, and quickly discover NEO’s of all sizes

Bekey ‘07(Ivan Bekey is the president of Bekey Designs Inc. and former Director of Advanced Programs in the Office of Space Flight at NASA. “*Extremely large yet very low weight and low cost space based telescopes for detection of 140 meter diameter asteroids at 5.7 AU, and obtaining 6 year warning times for 1 km diameter comets*”. White Paper presented at the March 2007 Planetary Defense Conference at George Washington University in Washington D.C. April 16, 2007. <http://www.aero.org/conferences/planetarydefense/documents/Bekey%20White%20Paper.pdf> TDA)

Asteroids smaller than ≈ 250 m size are difficult to detect and are very numerous, and can cause extensive and severe regional damage if not mitigated. The very large numbers of such asteroids demand fast search routines with large aperture telescopes, and much observing time will be needed. Larger ground telescope apertures have the advantage of increased search and detection distance, but the resultant narrower fields of view mean that many ground telescopes will be needed, preferably spread around the Earth and in both North and South hemispheres. These are large and expensive undertakings, and as astronomical instruments their observing time will have to be shared by NEO observers. As fundamentally, ground telescopes are generally limited to about 40-80 hours/month observation time due to daylight, seasons, clouds, moonlight, and night sky brightness, depending on location, exacerbating the pressure on observing time. Space telescopes, in contrast, can observe the sky for small asteroids full time, gaining a factor of 720/80 - 9 to 720/40 -18. Thus 9-18 fewer space telescopes of the same aperture will be needed--ideally only one. This space telescope can be placed in solar orbit at 1 AU or at the Sun-Earth L2 point where it will be permanently shadowed by the Earth. There it can continuously scan the sky up to about ± 150 degrees solid angle away from the Sun. Long-period comets ≈ 1 km size or larger are much less probable than asteroids to impact the Earth. However NEOs 10 km or greater are much more likely to be comets, and thus comets can be extremely destructive and must be taken seriously. They can have very low albedo and usually have no coma beyond the orbit of Jupiter. They generally arrive from the Oort cloud, and many are new apparitions for which there is no data. Their extremely eccentric trajectories make their velocities very large when they cross the earth’s orbit. Because of these factors they are very difficult to detect far away, and thus current discovery and warning times using ground telescopes are usually less than a year and frequently 1/2 year or less. Furthermore their outgassing and coma development as they approach the Sun makes precision epehemeris prediction problematical. Because of these difficulties long-period comets are usually placed into the “too hard” category and unfortunately ignored at this time.

# Space Based Detection Key

Space Based detection methods empirically successful

Sommer 05 (Doctorate in Policy Analysis at the Pardee Rand Graduate School. “*Astronomical Odds*

*A Policy Framework for the Cosmic Impact Hazard*” Pardee Rand Graduate School Dissertation Series. June 2005. EBSCOhost. TDA)

As a final note, over the years, different designs for space-based NEO survey telescopes have been proposed.73 There are advantages and disadvantages, as listed in Table 2.7, and uncertainties will be resolved only with the launch of an actual system.74 Although not specifically looking for NEOs, a space platform known as the Solar and Heliospheric Observatory (SOHO) has been the most prolific comet discoverer in history, finding over 750 new comets since 1996.75

# Detection – Adaptive Membrane Telescopes

Adaptive Membrane Telescopes blow regular space telescopes out of the water – lightweight, maintainable, and cool as the Fonz

Bekey ‘07(Ivan Bekey is the president of Bekey Designs Inc. and former Director of Advanced Programs in the Office of Space Flight at NASA. “*Extremely large yet very low weight and low cost space based telescopes for detection of 140 meter diameter asteroids at 5.7 AU, and obtaining 6 year warning times for 1 km diameter comets*”. White Paper presented at the March 2007 Planetary Defense Conference at George Washington University in Washington D.C. April 16, 2007. <http://www.aero.org/conferences/planetarydefense/documents/Bekey%20White%20Paper.pdf> TDA)

Current space telescopes are powerful scientific tools free of atmospheric and diurnal limitations that have produced a wealth of scientific information and unforgettable images. But space telescopes are hideously expensive, a principal reason being that their optics and structures are high precision, heavy, and manpower intensive to develop. This is principally because they are built using ground telescopes as models—that is constructing and launching a monolithic device with final required precision which must resist launch stresses. As a result the large apertures required for long-period comet and small asteroid detection are seen as daunting, far term, and risky space programs which are not imaginable, less affordable. But this does not have to be so. We have to completely change the design and development paradigms, so as to make use of the space environment instead of fighting it as do conventional designs. This white paper addresses a means of accomplishing that. A new principle is used in the propose space telescope: Replace precision apertures and structures with information. This capitalizes on the fundamental attributes of space in which mass is expensive while information and its processing are lightweight and cheap . The following concept description follows funded feasibility studies performed by the author initially for NASA/NIAC and then in much greater detail and with 5 subcontractors for the NRO. To implement the principle we will use a membrane primary that is active over its entire surface, and is initially shapeless. This membrane will be limp and “Saran Wrap-like”, and untensioned. It will be folded like a blanket and launched . Once in final orbit it will unfold into an initially shapeless, though very roughly planar (± 1 meter) surface, and only then will it be actively shaped so as to attain the desired figure. The figure of this primary reflector will be set and maintained by closed loop control using software, and will form the first stage of a two-stage correction system, thus figure accuracies required can be nearly a millimeter. With respect to the usual major telescope truss, not even advanced conventional designs have yet thought it through all the way, since there is no need for any truss in space--telescope trusses are a carryover of earth-bound thinking. Since g forces do not have to be resisted in orbit there is no need to have a truss to hold the elements at precise separations, and precision stationkeeping can be used just as well instead, forming a virtual truss. Both the formation flying and the primary figure adjustment can be made responsive to outside disturbances, and closed loop correction control introduced. Thus the telescope’s separated parts and flimsy membrane primary (together with a second stage of correction) can be maintained in a configuration whose performance can be indistinguishable from that of a conventional telescope with a solid or segmented aperture and fixed precision truss. The functioning of the adaptive membrane is illustrated in Figure 4. The telescope consists of an unsupported and unstretched (not inflatable) adaptive piezoelectric bimorph film membrane, whose figure and surface accuracy are continuously corrected using an electron beam scanning its entire back surface. The beam causes charge to be deposited selectively which induces local bending of the piezo bimorph. The signals for the beam-induced charge density required at any location on the membrane are generated in response to a precision figure sensor which detects both gross and fine scale characteristics of the membrane surface, which are then turned into beam commands by a computer. This Adaptive Membrane technique is the heart of the new space telescope concept, which is described in principle, though not to scale, in Figure 5. There will be residual errors in the primary, caused by finite electron beam size, power limits, and metrology limits, not exceeding a fraction of a millimeter. These will be corrected by a second stage of correction, which is composed of a liquid crystal plate located in a separate focal assembly at a point in the optical train where a real image of the primary exists. This liquid crystal is driven by a voltage obtained from the figure sensor, which generates a 2-dimensional spatial distribution of the residual errors of the membrane surface after the adaptive piezoelectric correction loop has done all it can. This voltage causes a 2D distribution of the index of refraction across the liquid crystal, which in turn affects the speed of light though it, responsive to the residual errors of the primary. The aberrated light from the primary is thus corrected as it transits this liquid crystal, resulting in a phase-corrected coherent image. The net effect of the two stages of correction is to generate a near-diffraction limited image with a lightweight primary membrane that started initially only roughly flat and wrinkly. The complete space telescope concept using two stages of correction, with all

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*CONTINUED FROM ABOVE*

elements formation-flown rather than connected by trusses, is illustrated in figure 6, this time to scale, and using an f/10 primary as an example. The focal assembly is stationkept at the focal point of the primary, 250 m on its axis. The figure sensor is stationkept at the center of curvature of the primary, at 500 m. on axis. The focal plane is located at one end of the focal assembly, which accomplishes reimaging via small secondary and tertiary mirrors, and also contains the liquid crystal. The large f number of the spherical primary used in the example, together with aspheric design of the secondary and tertiary mirrors, results in vanishingly small spherical aberrations, astigmatism, and coma, and makes for a relatively flat primary which is easier to shape by the piezoelectric forces than if the f number were smaller, though smaller number primaries are also possible. This design does not look anything like a traditional space telescope but it functions exactly the same. Since the piezoelectric primary membrane must be perpetually shaded from sunlight to prevent temperature damage to the piezoelectric characteristics of the film, a plain opaque membrane sunshade of crude figure is interposed between the Sun and the primary and kept there if the system is in solar orbit. In operation all the telescope elements would be rotated and translated as an ensemble , maintaining the axial configuration of Figure 6, to point to the desired target sky region. Actually the best plan would be to limit most maneuvers of the primary membrane to only rotation, avoiding translational stresses and propellant, with all other elements of the telescope translating as well as rotating. Once the ensemble pointed in the right direction fine pointing control would be imposed, slaved to the image on the focal plane. After all dynamic perturbations damped down, observations could begin. Viewing objects within several degrees of the telescope axis would then be accomplished by moving only the small fast steering mirrors, without rotating or translating any other telescope components. Repointing to a different target area would be accomplished by rotating the entire ensemble of elements more slowly, and repeating the procedure.

# Detection – Adaptive Membrane Telescopes

Adaptive Membrane Telescopes are lightweight and inexpensive

Bekey ‘07(Ivan Bekey is the president of Bekey Designs Inc. and former Director of Advanced Programs in the Office of Space Flight at NASA. “*Extremely large yet very low weight and low cost space based telescopes for detection of 140 meter diameter asteroids at 5.7 AU, and obtaining 6 year warning times for 1 km diameter comets*”. White Paper presented at the March 2007 Planetary Defense Conference at George Washington University in Washington D.C. April 16, 2007. <http://www.aero.org/conferences/planetarydefense/documents/Bekey%20White%20Paper.pdf> TDA)

All elements of the telescope will be designed using microminiaturized components, and can be astonishingly lightweight, as shown in Figure 8 for a 25 meter clear diameter primary aperture. The weight is that of the complete telescope, not just the primary mirror. All weights are the result of conceptual-level designs. The areal densities attained are 0.07 kg/m 2 for the primary mirror assembly and 0.53 kg/m 2 for the entire telescope. These are phenomenally lower than attainable by any other known technique. The weight of telescopes designed with this technique, as well as those of Hubble and JWST-based designs, were scaled with aperture diameter and the curves appear in Figure 9. It is seen that the weight advantages of the present space telescope concept are compelling, being 4 orders of magnitude lighter than Hubble-type designs and 2 orders of magnitude lighter than JWST designs In order to visualize the dramatic advantages offered by this new design paradigm it is compared to three other conceptual level space telescopes, each of them 25 meters aperture diameter. Two of them are the Hubble and JWST technologies extrapolated to 25 meter apertures, and one is a new technology telescope using an advanced allinflatable non-adaptive one-stage corrected telescope design concept. These are illustrated in Figure 10. It is seen that the Adaptive Membrane structureless design is 4 orders of magnitude lighter than the one scaled using Hubble-type technologies, which would weigh millions of kg. It is also 2 orders of magnitude lighter than one scaled using JWST technologies, which would weigh some 20,000 kg. It is 20 times lighter than the best inflatable membrane design concept, which would still weigh some 4,000 kg. In contrast a 25 meter diameter telescope using the Adaptive Membrane structureless concept will weigh less than 300 kg! While it is always hazardous to estimate costs for new technology telescopes, if cost continues to scale as weight, as it has done for essentially all past and current technology space systems, the cost of a telescope using the techniques described herein could well approach the same 2-4 orders of magnitude reduction as the weight. If that were the case then a 25 meter diameter space telescope would have a cost in the tens of millions rather the tens of billions it would cost if built using JWST technology and techniques. An example of a NEO/astronomical neardiffraction-limited telescope in solar orbit is shown on Figure 11. If the telescope had a 100% filled apertures of 25 meters diameter its total weight would be 260 kg; for a 100% filled aperture of 50 meters diameter its weight would be 600 kg; and for a 100% filled aperture of 75 meters diameter the total weight would be 1,100 kg. In addition a 250 meter diameter 10% sparse aperture telescope was sized, and would only weigh 1,600 kg

# Detection – Adaptive Membrane Telescopes - Feasible

Adaptive Membrane Telescopes are technologically feasible – developed in less than ten years

Bekey ‘07(Ivan Bekey is the president of Bekey Designs Inc. and former Director of Advanced Programs in the Office of Space Flight at NASA. “*Extremely large yet very low weight and low cost space based telescopes for detection of 140 meter diameter asteroids at 5.7 AU, and obtaining 6 year warning times for 1 km diameter comets*”. White Paper presented at the March 2007 Planetary Defense Conference at George Washington University in Washington D.C. April 16, 2007. <http://www.aero.org/conferences/planetarydefense/documents/Bekey%20White%20Paper.pdf>)

The basic concept applied to a 25 meter telescope was defined and shown to be feasible in funded team studies led by the proposer, performed initially for NIAC and then in much greater depth and with 5 subcontractors for the NRO. The principal technologies that need to be matured are the primary reflector, the liquid crystal second stage corrector, and the metrology and propulsion techniques necessary for precision formation flying. The primary membrane reflector requires development of piezoelectric film materials resistant to the space environment and having smooth surface; demonstration of membrane folding and deployment via shape memory material coating; and demonstration of closed loop shaping using a remote electron gun. Of these the latter is underway in the laboratory by The Aerospace Corporation. The estimated TRL is 3. The liquid crystal corrector must developed and demonstrated to have at least 500 waves of correction capability simultaneously with low scatter and reasonable time constant. Early laboratory experiments have pointed the way, though its estimated TRL level is 2. Precision formation flying requires development of microgyros and sunsensors, which are underway; RF and optical metrology sensors which are being developed for related space applications; development and demonstration of micromachined FEEP thrusters, which is underway by DARPA at an estimated TRL level of 2-3. Simulation of a complete system including metrology and micropropulsion is also needed, and its estimated TRL level is 3. Thus the overall estimated TRL level of the space telescope system is more than 2 but less than 3. These are not extremely difficult developments. Some of the required technologies are already being pursued in the laboratory, and a roadmap exists for their demonstration in space. Since the technologies are simpler and inherently require many fewer man-hours for development than conventional space telescopes, it should not take more than about 5 years to demonstrate them, first in the lab working separately and then in space with a small scale experiment with all technologies working together. It is because of this that it is likely that a complete 25 meter diameter aperture space telescope could probably be fielded in about 10 years. Phase A industry studies must be performed with the author’s feasibility studies as a starting point. Phase B and C would then follow. A single space telescope would suffice. The likely cost of such a development would be astonishingly small compared to costs of conventional space telescopes. Thus an affordable and powerful means of detecting, tracking, and cataloguing asteroids smaller than 140 meters at great distances could be implemented relatively rapidly. This same telescope could also provide long distance detection of new apparition long-period comets, providing warning times of 6 years or more on typical 1 km diameter comets.

# Detection – Ground Based

Ground based observations are key to accurately detecting NEOs-NASA should fully fund the Arecibo and Goldstone stations

IRWIN I. SHAPIRO et al in 10,( Harvard-Smithsonian Center for Astrophysics, Chair FAITH VILAS, MMT Observatory at Mt. Hopkins, Arizona, Vice Chair MICHAEL A’HEARN, University of Maryland, College Park, Vice Chair ANDREW F. CHENG, Johns Hopkins University Applied Physics Laboratory FRANK CULBERTSON, JR., Orbital Sciences Corporation DAVID C. JEWITT, University of California, Los Angeles STEPHEN MACKWELL, Lunar and Planetary Institute H. JAY MELOSH, Purdue University JOSEPH H. ROTHENBERG, Universal Space Network, *Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies Space Studies Board Aeronautics and Space Engineering Board Division on Engineering and Physical Sciences*, THE NATIONAL ACADEMIES PRESS, <http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf>)

On the other hand, the committee concluded that **vigorous, ground-based characterization at modest cost is important for the NEO task. Modest funding could support optical observations of already-known and newly discovered asteroids and comets to obtain some types of information on this broad range of objects, such as their reflectivity** as a function of color, **to help infer their** surface **properties and mineralogy**, and their rotation properties. In addition, the complementary radar systems at **Arecibo and Goldstone are powerful facilities for characterization within their reach in the solar system**, a maximum of about one-tenth of the Earth-Sun distance. **Arecibo**, which has a maximum sensitivity about 20-fold higher than Goldstone’s, but does not have nearly so good sky coverage as Goldstone, **can** for example, **model the three-dimensional shapes of** (generally very odd-shaped) **asteroids**, **and estimate their surface characteristics**, **as well as determine whether the asteroid has a** (smaller) **satellite** or satellites **around it, all important to know for planning active defense**. **Radar can also accurately determine orbits of NEOs**, from a few relatively closely spaced (in time) observations, **which has the advantage of being able to quickly calm public fears** (**or** possibly, in some cases, **show** that **they are warranted**). Finding: **The** Arecibo and Goldstone **radar systems play a unique role in the characterization of NEOs, providing unmatched accuracy in orbit determination**, and insight into size, shape, surface structure, and other properties for objects within their latitude coverage and detection range. Recommendation: **Immediate action is required to ensure the continued operation of the Arecibo Observatory at a level sufficient to maintain and staff the radar facility. Additionally, NASA and NSF should support a vigorous program of radar observations of NEOs at Arecibo and NASA should support such a program at Goldstone for orbit determination and characterization of physical properties. For both Arecibo and Goldstone continued funding is far from assured, not only for the radar systems, but for the entire facilities. The incremental annual funding required to maintain and operate the radar systems even at their present relatively low levels of operation, is about $1 million at each facility (**see Chapter 4). The annual funding for Arecibo is approximately $12 million. Goldstone is part of the Deep Space Network and its overall funding includes additional equipment for space communications.

# Deflection – Tractor Beams

**Tractor beam technology can also be used to clean up space debris.**

Sinko and Schlecht in 10 (John E. Sinko, Micro-Nano Global Center of Excellence, Graduate School of Engineering, Nagoya University, and Clifford A. Schlecht, Institute for Materials and Complexity, AIP Conference Proceedings, *CO2 Laser Ablation Propulsion Tractor Beams*, EBSCO, DF)

One concept that is receiving significant attention as an application for laser propulsion is the removal of orbital space debris. Such debris poses a serious hazard to space stations, satellites, and spacecraft, and reduces the lifetime and functionality of in-space systems [17]. When discussing how to approach space debris, the size of the object is a major deciding factor. For small particles, targeting a wide region of space over a long period of time may be feasible, but it does run the risk of interfering with or disabling existing satellites. For large objects (say, perhaps 10 cm or larger) these methods may not be feasible, as ablative thrust may be expected to be relatively small, due to the large masses of such objects

One possible solution for large objects is to 'tag' them with an inexpensive, cooperative thrust system that can then be targeted by an external energy source in order to allow remote control and ultimate removal of the object from orbit. Rendezvous of this kind of "cooperative target system" with actual target objects can be expected to be a significant challenge. On the other hand, once tagged, an object could be targeted over a long period of time, potentially accumulating significant thrust. It might be possible to introduce a small, cheap, rocket-propelled interceptor to bring the cooperative system into the orbit of the target object and facilitate attachment. The promise of this application appears adequate to justify research and development on methods to tag passive objects in order to support remote control. The question is whether such systems can be produced without exceptional cost.

**Gravity tractors can deflect asteroids if warned early**

Cowen in 5 (Science News Vol. 168 Issue 20, *Protecting Earth*, http://web.ebscohost.com/ehost/detail?sid-81 397736-0b01-4228-a1a0-dcf41729918c%40sessionmgr4&vid-1&hid-11&bdata-JnNpdGU9ZWhvc3Q tbGl2ZQ %3d%3d) DF

Now, two NASA scientists, both also astronauts, suggest a simpler, safer, and much more plausible way of diverting an offending asteroid. Their method relies on the gravitational tug of a massive, unmanned spacecraft to pull the rock away from a damaging rendezvous with Earth. The gravitational tractor, as the researchers call their proposed craft, would require the sustained power of a nuclear-propulsion system to reach the asteroid and perform the maneuvers that would be required to deflect it. For general space exploration, NASA has already proposed a fleet of suitable vehicles, although their funding is currently uncertain. As envisioned by Ed Lu and Stan Love of NASA's Johnson Space Center in Houston, the gravitational tractor would hover some tens of meters from a spinning asteroid. Only the force of gravity would connect the two. Careful control of the tractor's thrusters would keep the craft close to the asteroid as it slowly pulled the rock off its collision course. Given enough lead time, it would take just a year for a 20-ton spacecraft to drag a 200-meter-wide asteroid weighing about 60 million tons away from Earth's path, Lu and Love calculate in the Nov. 10 Nature. Towing would have to begin at least 20 years before the projected collision.

# Deflection – Propulsion

**Electric propulsion technologies are on the way and will be able to deflect threatening asteroids**

Walker in 8 (Dr. Roger Walker, Dr. Dario Izzo, Cristina de Negueruela, Dr. Leopold Summerer Advanced Concepts Team, European Space Agency, Dr. Massimiliano Vasile Dipartimento di Ingegneria Aerospaziale, Concepts For Near-Earth Asteroid Deflection Using Spacecraft With Advanced Nuclear And Solar Electric Propulsion Systems, <http://www.esa.int/gsp/ACT/doc/PRO/ACT-RPR-PRO-2005-ConceptsForNear.pdf> DF)

The study has assessed the maximum deflection capability achievable with spacecraft using highpower, high specific impulse electric propulsion and advanced power system technologies likely to be available within the next decade or so. Using the maximum current launcher lift capacity into low Earth orbit, a 15-20 ton-class spacecraft can perform rendezvous, spin axis re-orientation and deflection of a 10 megaton (approx. 200 m) Earth-impacting asteroid within a minimum response time of 10-20 years. Hence, it can be concluded that electric propulsion deflection is very effective for this class of asteroid, considering that typical warning times are of the order of 10-50 years. Larger asteroids of 300 m have a mass over three times larger and therefore it can be expected that response times would be in the 30-60 years range, which is still reasonable. It should be noted that these sizes of asteroids would represent the peak of the impact hazard once existing surveys have retired the risk from km-sized bodies with potential to cause global devastation.

# Deflection – Asteroid Trapping

Bringing NEO’s into Earth’s orbit is an important first step in protection, reduction of costs and resource development of space.

Rather et al. 2010 [John; Powell, James Maise, George "New Technologies and Strategies to Exploit Near Earth Asteroids for Breakthrough Space Development."

AIP Conference Proceedings; 1/28/2010, Vol. 1208 Issue 1, p566-570, 5p, 3 Black and White Photographs, PN]

Abstract. The past two decades have brought a profound expansion of knowledge of near earth objects (NEO). If creatively exploited, NEOs can significantly increase human safety while reducing costs of exploration and development of the moon, Mars and the solar system. Synergistically, the ability to defend the Earth from devastating impacts will become very effective. A spherical volume having a radius equivalent to the moon’s orbit, 400,000 km, is **visited every day by approximately ten NEOs having diameters of ~10 meters, while ~30 meter diameter encounters occur about once per month. Because these objects are usually very faint and only within detectable range for a few days, they** require specialized equipment to discover them with high probability of **detection and to enable accurate determination of orbital parameters**. Survey systems are now being implemented that are cataloging many thousands of objects larger than 30 meters, but **numerous advantages will result from extending the complete NEO census down to 10 meter diameters.** The typical compositions of such **NEOs will range from** ~80% that are low density dust & rock “rubble piles” to **perhaps 2% containing heavy metals** – properties well known from meteorite samples. **It is quite possible that there will also be some fragments of short period comets that are rich in water ice and other volatile components.**

Small NEO’s can be positioned to deflect larger PHO’s that would otherwise cause apocalyptic scenarios if they collided with Earth.

Rather et al. 2010 [John; Powell, James Maise, George "New Technologies and Strategies to Exploit Near Earth Asteroids for Breakthrough Space Development."

AIP Conference Proceedings; 1/28/2010, Vol. 1208 Issue 1, p566-570, 5p, 3 Black and White Photographs, PN]

Fast repositioning of NEOs is necessary for certain missions. A large solar concentrator can be permanently attached to selected, captured, small asteroids for high-thrust generation. This capability is the key to a practical defense against in-coming high velocity Earth-threatening objects. “Well-behaved” NEOs will have velocities of a few kilometers per second relative to the Earth, while objects from the outer solar system can have velocities up to 70 km/sec. Since kinetic energy scales with the square of the velocity, the destructive potential of collisions with even small objects is tremendous. The relative velocity of 3.5 km/sec provides a convenient mnemonic: a collision of any mass at this relative velocity liberates the equivalent energy of the same mass of high explosive TNT. Thus 7 km/sec yields four times more energy, and 70 km/sec 400 times more. This leads to the ability to defend against fast incoming objects not by rendezvous with them but simply by placing small NEOs directly in their path.

# Deflection – Asteroid Trapping

Using a solar concentrator, a NEO could be viably trapped for use at a low cost within a few years.

Rather et al. 2010 [John; Powell, James Maise, George "New Technologies and Strategies to Exploit Near Earth Asteroids for Breakthrough Space Development."

AIP Conference Proceedings; 1/28/2010, Vol. 1208 Issue 1, p566-570, 5p, 3 Black and White Photographs, PN]

Fast reaction times after discovery will enable reaching useful NEOs and capturing them or modifying their orbits for future use. One technological approach could utilize a very large, low weight solar concentrator to first power its associated plasma-propelled spacecraft to a fast rendezvous with the chosen NEO. The spacecraft would be equipped with small rocket-propelled 1000 kg probes that would be launched at high velocity into the approaching NEO to coarsely reduce its delta-v. The solar concentrator spacecraft would then rendezvous with the NEO and evaporate material from it to further decelerate and steer it precisely into a trapped orbit of the Earth. A separate prese/ntation at this meeting (Powell *et al*., 2010) provides details of a 100 meter diameter solar concentrator and its magnetically inflated cable (MIC) deployment system capable of providing ~10 megawatts of solar energy at the focus. The MIC concentrator can be packaged and deployed from a five cubic meter container weighing less than 20,000 kg that can be launched into space by Titan IV or Ares I-class rockets. It would be convenient to initially deploy and test the solar concentrator/rendezvous spacecraft in low orbit near the space station after which it would propel itself to high orbit to await NEO rendezvous opportunities. Incidentally, this would provide an important extended mission for the space station. When necessary, the concentrator spacecraft could return to low orbit for servicing and refueling. Compared with more traditional rocket alternatives for performing equivalent missions, the proposed system could be deployable at relatively low cost within a few years.

Capture of NEO’s in the Earth’s orbit shields us from radiation, allows for creation of habitats, collection of immense solar energy, and boost industrial growth on Earth through heavy metals.

Rather et al. 2010 [John; Powell, James Maise, George "New Technologies and Strategies to Exploit Near Earth Asteroids for Breakthrough Space Development."

AIP Conference Proceedings; 1/28/2010, Vol. 1208 Issue 1, p566-570, 5p, 3 Black and White Photographs, PN]

In this paper we will propose a set of new technologies and strategies for exploiting NEO resources that can yield important space development breakthroughs at much lower costs than existing concepts. **Solar powered “Tugboats” deployed at the space station can rendezvous with carefully selected NEOs and steer them into captured orbits in the lunar L4 & L5 regions. Robotic equipment will then modify them for a plethora of benefits.** Notably, **the problem of radiation shielding against the Van Allen belts, solar flares and cosmic rays will be solved. Free transportation from low earth orbit to the moon and beyond will be feasible via shielded habitats in elliptical orbits. Large, comfortable habitats for long duration trips to Mars and beyond can be built. Propulsion for orbital transfer and maneuvering of heavy payloads can be accomplished by solar energized ejection of NEO materials. Industries can be developed based upon reconditioning materials for use in space and recovery of heavy metals for use on Earth.**

# Deflection – Laser Ablation

Laser Ablation is great – feasible and long term catch all solution

Campbell 03 (Jonathan W Campbell is a NASA astrophysicist and research scientist at the National Space Science and Technology Center; Phipps, Claude; Smalley, Larry; Reilly, James; Boccio, Dona. “ AIP Conference Proceedings, May 13 2003, Vol. 664 Issue 1, Pg 512-513. EBSCOhost. TDA)

Many issues and engineering solutions need to be addressed in order to land on a NEO and place nuclear devices or other trajectory altering systems there. Although the cost of any NEO protection system will likely be significant, any system requiring a deep-space rendezvous would also require sufficient warning of an impact to be implemented. Additionally, a failure of such a defense system may not allow for a second mitigation effort to be attempted before the object impacts the Earth. A better system would be one that is "on station" and could be used routinely to shape asteroid orbits over long periods of time so that they do not pose a potential threat. The system should also be able to handle the wide range of materials and sizes that constitute the NEO population (current or yet to be discovered). Phased Array Laser Systems (PALS) could be developed and placed in space, either orbiting or lunar based. Space-based laser constellations (SBL) are presently under development and will be flown during the next decade. The feasibility for a PALS based system is discussed below. Laboratory experiments using a 20 kW pulsed laser have shown that the impulse imparted to aluminum targets due to the ejected plasma cloud gives an average surface pressure p = 6,5 x 10' N/amz, or equivalently, an acceleration a = 1.25 x l0"˜ m/sz. Thus, with present technology, an array of laser beam directors can be aimed at an asteroid, meteoroid, or a comet, providing sufficient power to ablate its surface. It is simply a matter of putting in place a sufficient number of lasers to accomplish the mission.

More Laser Ablation – Fast and leads to mining

Campbell 03 (Jonathan W Campbell is a NASA astrophysicist and research scientist at the National Space Science and Technology Center; Phipps, Claude; Smalley, Larry; Reilly, James; Boccio, Dona. “ AIP Conference Proceedings, May 13 2003, Vol. 664 Issue 1, Pg 514-515. EBSCOhost. TDA)

If the collision scenario depicted in Figure l was encountered The PALS firing with a good aspect 'dom L, and sufficient lead time (as shown in the figure,) would have 2-3 months to move the asteroid away from a collision path with the Earth. Only with a sufficiently capable detection system would there be adequate time in advance for the PALS to deflect the asteroid away from the Earth. This fact stresses the need for coupling with PALS an early warning system using optical and/or radar imaging techniques. The AV of 5 km/s is an example of an impulse that yields a "miss distance." In this case, the simulation yields that the asteroid passes in front of the Earth by L25 Earth diameters. An approach requiring significantly less power for PALS would be a gradual shift in the orbit by a long duration, low intensity impulse. This lower energy impulse would reshape the orbit over a long time period, perhaps several orbits. Ideally, for the asteroidal orbit shown in Figures l, 2 and 3, it might conceivable to move the asteroid into an orbit that removes any potential threat to the Earth. From a non-defensive standpoint, it is interesting to contemplate asteroid orbit modification for the purpose of scientific exploration and/or commercial exploitation (i.e., asteroid mining). This application of a PALS may be particularly feasible for small asteroids (less than 100 rn) in orbits that are "easily" modified to a desired rendezvous location for processing.

# Deflection – B612 Spaceship

B612 spaceships are more controlled than any other type of deflection.

Lu 04 (Edward Lu is the head of the B612 Foundation, “*Why Move an Asteroid?*” Testimony before the Subcommittee on Science, Technology and Space of the Senate Commerce Committee, April 7 2004, http://www.astrobio.net/index.php?option=com\_retrospection&task=detail&id=972 TDA)

Why does the asteroid need to be moved in a "controlled manner"? If the asteroid is not deflected in a controlled manner, we risk simply making the problem worse. Nuclear explosives for example risk breaking up the asteroid into pieces, thus turning a speeding bullet into a shotgun blast of smaller but still possibly deadly fragments. Explosions also have the drawback that we cannot accurately predict the resultant velocity of the asteroid -- not a good situation when trying to avert a catastrophe. Conversely, moving an asteroid in a controlled fashion also opens up the possibility of using the same technology to manipulate other asteroids for the purposes of resource utilization. How can this be accomplished? This mission is well beyond the capability of conventional chemically powered spacecraft. We are proposing a nuclear powered spacecraft using high efficiency propulsion (ion or plasma engines). Such propulsion packages are currently already under development at NASA as part of the Prometheus Project. In fact, the power and thrust requirements are very similar to the Jupiter Icy Moons Orbiter spacecraft, currently planned for launch around 2012. The B612 spacecraft would fly to, rendezvous with, and attach to a suitably chosen target asteroid (there are many candidate asteroids which are known to be nowhere near a collision course with Earth). By continuously thrusting, the spacecraft would slowly alter the velocity of the asteroid by a fraction of a cm/sec --enough to be clearly measurable from Earth. What will we learn from this? It is important to remember that this mission is merely a first attempt to learn more about the mechanics of asteroid deflection. There are a number of technical complications, as well as many unknowns about the structure and composition of asteroids. However, the way to make progress is to build, fly, and test. Much of what we will learn is generic to many proposed asteroid deflection schemes, with the added benefit of being able to answer important scientific questions about asteroids themselves. The best way to learn about asteroids is to go there. How does this fit into the new Exploration Initiative at NASA? In the near term, this mission would be an ideal way to flight test the nuclear propulsion systems under development as part of the Prometheus Project. It could also serve as a precursor to a crewed mission to visit an asteroid. Such missions have been proposed as intermediate steps to test spacecraft systems for eventual longer term crewed missions to Mars.

# Deflection – Nuclear

Nukes effective -- one-size fits all deflector

NASA ’06 (“2006 Near Earth Object Survey and Reflection Study”, Nasa Office of Program Analysis and Evaluation, Pg. 131-132, December 28, 2006, http://www.b612foundation.org/papers/NASA-finalrpt.pdf, TDA)

The use of nuclear explosives was found to be the most effective alternative in the near term. While an explosion on or below the surface of a threatening object is 10-100 times more effective than a detonation above the surface, the standoff detonation would be less likely to fragment the target. Nuclear options require the least amount of detailed information about the threatening object. A nuclear standoff mission could be designed knowing only the orbit and approximate mass of the threat, and most impulsive missions could be carried out incrementally to reach the required amount of deflection. Additional information about the object's mass and physical properties would perhaps increase the effectiveness, but likely would not be required to accomplish the goal. The study examined conventional explosives, but found they were ineffective against most threats.

Nuclear explosions could deflect solid PHOs. For non-solid asteroids, gravity tractors will be used because explosions will have lesser effects.

Bucknam, Mark and Robert Gold in 8 (Former Council Military Fellow, Survival, *Asteroid Threat? The Problem of Planetary Defence*, [http://web.ebscohost.com/ehost/pdfviewer/pdfviewer?sid-4d559d5c-113d-420a-befe-99ff529968a5%40sessionmgr11&vid-6&hid-10](http://web.ebscohost.com/ehost/pdfviewer/pdfviewer?sid=4d559d5c-113d-420a-befe-99ff529968a5%40sessionmgr11&vid=6&hid=10), DF)

If two objects are on a collision course, it is necessary only to speed up, or slow down, one of them early enough to prevent the collision. Changing Earth’s orbital velocity would likely be impossible; it is, however, theoretically possible to change the orbital velocity of a smaller PHO. The smaller the PHO, the easier it would be to affect its velocity, and the earlier attempts were made, the smaller the required change would be to avert a collision. NASA’s March 2007 report stated plainly that using stand-off nuclear explosions to deliver an impulsive force to a PHO would be 10–100 times more effective than other means of deflecting PHOs. Nonetheless, other tools and techniques, including kinetic impactors, gravity tractors, focused solar and laser energy, and rockets to change a PHO’s orbital velocity were identified and analysed An asteroid resembling a massive pile of sand and gravel might be impossible to push with a rocket or to affect by slamming into it with a kinetic impactor. However, a gravity tractor could, theoretically, hover nearby and – using the gravitational pull between itself and the rubble pile – fire rockets to gradually pull the pile faster or slower in its orbit. The gravity-tractor scheme is the least efficient and least technologically mature option. Indeed, NASA concluded that a gravity tractor would likely prove useful only for the smallest PHOs, and even then decades would be needed for the tractor to effect the desired change in velocity. However, for cases where only a very small deflection is required – keeping Apophis from hitting the gravitational keyhole in 2029, for example – the gravity tractor may be the simplest solution.

With limited warning time nuclear weapons can destroy a dangerous asteroid

Tyson in 95 (Peter Tyson is the Managing Editor of Earthwatch and a contributor to Technology Reviw, Technology Review vol. 98 iss. 2, *Cometbusters*, http://proxy.foley.gonzaga.edu/login?url-http://search.ebscohost. com/login.aspx?direct-true&db-a9h&AN-9502076494&site-ehost-live) DF

Physicists agree that the only way to generate enough energy to deal with a large object on short notice would be with a nuclear device. "A nuclear weapon has the highest energy per unit mass, and we're limited right now by the amount of mass we can put in space," says Gregory Canavan, a physicist at Los Alamos National Laboratory who coedited the proceedings of the 1992 NASA interception workshop. Either a U.S. Titan missile or a Proton, which the Russians routinely use to launch military payloads into low-earth orbit, could be used as a booster rocket, he says. To ensure that the object or objects were destroyed and not merely fragmented, with pieces still raining down on earth, Edward Teller, the developer of the hydrogen bomb, says simply that he would send up enough explosives to make sure the job was done right. "In other words," he says, "we are very sick, I have a cure, and my only concern is to achieve overkill."

# Early Detection key

Now is key- by developing deflection now, we have time to implement methods to deal asteroids over time rather than in an emergency situation.

Lu and Love ’05 (Lu: B.S. electrical engineering from Cornell University, PhD in applied physics from Stanford University, NASA missions specialist. Love: BS in physics from Harvey Mudd College, masters in scince from University of Washington, PhD in philosophy, NASA astronaut, “A Gravitational Tractor for Towing Asteroids”, 9/20/05, <http://arxiv.org/abs/astro-ph/0509595v1>, AG)

The mean change in velocity required to deflect an asteroid from an Earth impact trajectory is ~3.5×10−2 /t m/s where t is the lead time in years4. Thus, in the example above, a 20 ton gravitational tractor can deflect a typical 200m asteroid, given a lead 2 time of about 20 years. The thrust and total fuel requirements of this mission are well within the capability of proposed 100kW nuclear-electric propulsion systems2, using about 4 tons of fuel to accomplish the typical 15 km/sec rendezvous and about 400 Kg for the actual deflection. For a given spacecraft mass, the fuel required for the deflection scales linearly with the asteroid mass. Deflecting a larger asteroid requires a heavier spacecraft, longer time spent hovering, or more lead time. However, in the special case where an asteroid has a close Earth approach followed by a later return and impact, the change in velocity needed to prevent an impact can be many orders of magnitude smaller if applied before the close approach5. For example, the asteroid 99942 Apophis (2004 MN4), a 320m asteroid that will swing by the Earth at a distance of ~30000km in 2029, has a small 10−4 probability of returning to strike the Earth in 2035 or 20366. If it indeed is on a return impact trajectory, a deflection ∆v of only ~10−6 m/s a few years before the close approach in 2029 would prevent a later impact (Carusi, personal communication). In this case, a 1 ton gravitational tractor with conventional chemical thrusters could accomplish this deflection mission since only about 0.1 Newtons of thrust are required for a duration of about a month. Should such a deflection mission prove necessary, a gravitational tractor spacecraft offers a viable method of controllably steering asteroid 99942 Apophis away from an Earth impact.

# Early Detection key

Late detection worsens the situation by limiting planning time

Morrison in 2 (David Morrison, NASA Astrobiology Institute; Alan W. Harris, NASA Jet Propulsion Laboratory; Geoffrey Sommer, RAND Corporation; Clark R. Chapman, Southwest Research Institute; Andrea Carusl, Istituto di Astrofisica Spaziale, Rome; *Dealing with the Impact Hazard*, 2002, http://www.lpi.usra.edu/books/AsteroidsIII/pdf/3043.pdf) DF

It is facile but probably misleading to focus on a sce- nario where an NEO progresses in a step function from zero threat to Earth impactor. The threat that stays a threat will experience an overall rise in impact probability, as the er- ror ellipse shrinks while Earth stays within it. Many more threats than not, however, will suddenly see their impact probability go to zero as the error ellipse shrinks to exclude Earth or shrinks to exclude dangerous keyholes for the case of a resonant return. This feature of the evolution of im- pactor uncertainty will encourage those who wish to defer commitment to interception or who just want to keep the public purse closed. The net effect is that the system reac- tion time will need to be much shorter than the warning time from the point of confirmed threat. This already-chal- lenging situation will only be worsened by failure to ex- amine scenarios and develop appropriate contingency plans. To date the NEO community has not made much effort to pursue such options or enter into dialogue with government organs that deal with security issues.

Early detection of asteroids is absolutely critical to deflecting them—scientists’ best deflection strategies require hundreds of years.

Mone, 03 [Popular History, “IN COMING!”, sept 2003, pg1. <http://web.ebscohost.com/ehost/detail?sid=c0b281e1-71b241728218b1bdb21b08b5%40sessionmgr104&vid=7&hid=113&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#db=hxh&AN=10542000> mjf]

The asteroid interception and diversion experts are mostly hobbyists — planetary scientists, astronomers and engineers who think up these strategies on their own time. But the ideas are plentiful: As our gatefold shows, the path from detection to mitigation could include low-thrust engines, solar sails, standoff nuclear explosions and more. Melosh, for example, has been focusing on the use of solar collectors, which could concentrate sunlight on an asteroid, vaporizing enough material to gradually nudge the rock off course. Until recently, this idea amounted to little more than a series of conceptual sketches bolstered by calculations. Then Melosh learned of L'Garde, a California company that makes smaller versions of the exact collectors he needs. With a few adjustments, he says, his strategy could be put to work tomorrow. It would take years for sunlight to redirect an asteroid, however, so advance notice is absolutely critical. Ditto for tactics that would involve painting an incoming asteroid or covering its surface with white glass beads — both approaches would make the asteroid more reflective, increasing the tiny reaction forces produced when sunlight is radiated back into space. Over several centuries, the cumulative effect of these slight forces would alter the asteroid's velocity and cause a miss. "You let the Sun do the work," says Jon Giorgini of NASA's Jet Propulsion Laboratory (JPL), one of the scientists who projected 1950DA's orbit out to 2880. "The key," says Donald Yeomans, who heads the NEO Program Office at JPL, "is you've got to find them early. If they're on an approach trajectory and you've [only] got a few months, there's not much you can do." Given ample time, an effective defense strategy might require that a probe be launched to study the structure of the incoming body. Not all asteroids are the solid objects familiar from museum meteorite displays. Some are porous, others are collections of rubble loosely held together by gravity. Exploding a nuclear bomb nearby might nudge a dense asteroid off track, but it could break a brittle one into pieces, effectively multiplying the threat by creating smaller but still lethal rocks. Each threat, in other words, requires an adjustment of strategy. "You need to find out [the asteroid's] density, find out its mass, its porosity, its composition, because all these things are important if you want to effect some kind of mitigation or deflection," says Yeomans.

# Early Detection key

It is possible to deflect asteroids, but we MUST detect them at least 30 years in advance.

Mone, 03 [Popular History, “IN COMING!”, sept 2003, pg1. <http://web.ebscohost.com/ehost/detail?sid=c0b281e1-71b241728218b1bdb21b08b5%40sessionmgr104&vid=7&hid=113&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#db=hxh&AN=10542000> mjf]

Also possible is a dock-and-push approach, in which a spacecraft parks on the asteroid's surface, fires its thrusters, and alters the trajectory. Robert Gold of the Applied Physics Laboratory at Johns Hopkins University says the probe he designed for NASA's Near Earth Asteroid Rendezvous mission — the first to land on an asteroid — could divert a hundred-meter-wide object, which is large enough to wipe out the Washington Beltway. "If you found [the asteroid] 30 years in advance, that little 6-foot by 6-foot spacecraft could provide enough impulse to make it miss Earth," he says. Still, as Yeomans warns, none of this will work without advance notice. Currently, NASA expects to find only about 90 percent of the NEOs large enough to cause global catastrophes. The remaining 10 percent are too dark for today's telescopes, or too difficult to distinguish from the many asteroids that orbit harmlessly in the solar system's main asteroid belt between Mars and Jupiter. Andrea Milani, of the Space Mechanics group at the University of Pisa in Italy, wants to find the hidden large NEOs and extend the survey down to objects as small as 300 meters across. Both goals require a new generation of ground-based telescopes capable of detecting fainter objects, and possibly space-based observatories to peer into obscure areas of the solar system. The ground-based, 8.4-meter Large-aperture Synoptic Survey Telescope is one possibility, but its $120 million price is the equivalent of 40 years of the current search budget.

Adequate warning is key to develop the necessary combination of mitigation strategies

IRWIN I. SHAPIRO et al in 10,( Harvard-Smithsonian Center for Astrophysics, Chair FAITH VILAS, MMT Observatory at Mt. Hopkins, Arizona, Vice Chair MICHAEL A’HEARN, University of Maryland, College Park, Vice Chair ANDREW F. CHENG, Johns Hopkins University Applied Physics Laboratory FRANK CULBERTSON, JR., Orbital Sciences Corporation DAVID C. JEWITT, University of California, Los Angeles STEPHEN MACKWELL, Lunar and Planetary Institute H. JAY MELOSH, Purdue University JOSEPH H. ROTHENBERG, Universal Space Network, *Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies Space Studies Board Aeronautics and Space Engineering Board Division on Engineering and Physical Sciences*, THE NATIONAL ACADEMIES PRESS, [http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4\_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf)\](http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf%29%5C)

Realistic mitigation is likely to include more than one technique if for no other reason than to provide confidence. In any case of mitigation, civil defense will undoubtedly be a component whether as the primary response or as the ultimate backup. Finding: No single approach to mitigation is appropriate and adequate to fully prevent the effects of the full range of potential impactors, although civil defense is an appropriate component of mitigation in all cases. With adequate warning, a suite of four types of mitigation is adequate to mitigate the threat from nearly all NEOs except the most energetic ones.

# Early Detection key

Adequate warning of a dangerous asteroid would allow preparation for the best deflection strategies

IRWIN I. SHAPIRO et al in 10,( Harvard-Smithsonian Center for Astrophysics, Chair FAITH VILAS, MMT Observatory at Mt. Hopkins, Arizona, Vice Chair MICHAEL A’HEARN, University of Maryland, College Park, Vice Chair ANDREW F. CHENG, Johns Hopkins University Applied Physics Laboratory FRANK CULBERTSON, JR., Orbital Sciences Corporation DAVID C. JEWITT, University of California, Los Angeles STEPHEN MACKWELL, Lunar and Planetary Institute H. JAY MELOSH, Purdue University JOSEPH H. ROTHENBERG, Universal Space Network, *Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies Space Studies Board Aeronautics and Space Engineering Board Division on Engineering and Physical Sciences*, THE NATIONAL ACADEMIES PRESS, [http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4\_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf)\](http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf%29%5C)

Prediction of a very unlikely but possible impact by a dangerously large (30 to many hundreds of meters diameter) NEO in the next decades. While such predictions will be common in future years, especially after next-generation telescopic surveys become operational, the initial responses should emphasize refining the prediction and possible preparations for NEO deflection missions. The chances of such an impact occurring during the next century are tens of percent. Should the probability of an impact increase to certainty and the regional locale of ground-zero become identified, then preparations should begin to minimize the potential losses to life and property in the event that deflection measures fail or are not implemented. These preparations would involve augmenting provisions for shelter, medical care, food for displaced persons, provision for pets, and so on, including advanced planning for communications, evacuation, and so on.

Sufficient warning of civilization-threatening asteroids allows the best mitigation tactics

IRWIN I. SHAPIRO et al in 10,( Harvard-Smithsonian Center for Astrophysics, Chair FAITH VILAS, MMT Observatory at Mt. Hopkins, Arizona, Vice Chair MICHAEL A’HEARN, University of Maryland, College Park, Vice Chair ANDREW F. CHENG, Johns Hopkins University Applied Physics Laboratory FRANK CULBERTSON, JR., Orbital Sciences Corporation DAVID C. JEWITT, University of California, Los Angeles STEPHEN MACKWELL, Lunar and Planetary Institute H. JAY MELOSH, Purdue University JOSEPH H. ROTHENBERG, Universal Space Network, *Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies Space Studies Board Aeronautics and Space Engineering Board Division on Engineering and Physical Sciences*, THE NATIONAL ACADEMIES PRESS, [http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4\_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf)\](http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf%29%5C)

**Prediction of a possible impact by a potentially civilization-destroying** (and species destroying) **NEO in the next decades. This** potential **catastrophe would be unprecedented** in human history. **Reliance could be placed on efforts to avert the disaster, by orbital change**. But, prior to successful change (or after unsuccessful change), **if the impact is within a decade of happening, concurrent international efforts could begin to ameliorate the consequences of any impact that might occur, noting that there is likely to be a tendency for the entire social structure to collapse. These efforts will be most effective if they attempt to increase the robustness of all elements of society**, ranging from appropriate risk communications and warning, provision for medical care, provision of food/water/shelter, shoring up the global financial/electronic/social/law-enforcement infrastructures, preparing for inevitable response-and-recovery operations

# Detection Key To Deflection

Only focus on detection makes deflection technology politically/financially viable.

Urias Et. Al 96 (John M. Urias is the Vice President of Programs at Raytheon Integrated Defense Systems, retired colonel in the US Air Force. Ms. Iole M. DeAngelis, Maj Donald A. Aher,n Maj Jack S. Caszatt, Maj George W. Fenimore III, Mr. Michael J. Wadzinski. “Planetary Defense: Catastrophic Health Insurance for Planet Earth”. October 1996. Pg 26. <http://csat.au.af.mil/2025/volume3/vol3ch16.pdf> TDA)

Ready-to-go subsystems with ECO mitigation capabilities do not currently exist, though many scientists believe nuclear weapons could provide near-term protection with modification. Many potential nonnuclear defense subsystems have been identified in the past, and we have proposed several more, though we admit they are on the fringe between reality and imagination. Regardless of type, we are not convinced that mitigation subsystems need to be developed in the near term or even prior to 2025. It is perhaps better for us to encourage and wait for technology breakthroughs to drive the direction of these subsystems. If we develop a capable detection subsystem and it detects an ECO of concern, then a timetable for complete mitigation subsystems development and deployment will be necessary and priority for funding will be justified. By 2025 safer, cheaper, and more politically acceptable mitigation systems than the current nuclear systems should be available.

Timed Detection is key to Deflection

Borland 07(Small Asteroids May Be More Dangerous Than Believed By John Borland, December 19, 2007, <http://www.wired.com/wiredscience/2007/12/small-asteroids/>, reporter for Wired.com G.L)

In their simulation, researchers found that a small asteroid striking the atmosphere would be compressed by the resistance of the air. As that pressure increases, the incoming stone would ultimately explode in an "airburst," creating powerful jets of hot gas shooting downward faster than the speed of sound. The additional energy from this explosion caused them to revise earlier estimates of the impact’s strength. Scientists had initially estimated the energy of the Tunguska explosion to be the equivalent of between 10 megatons and 20 megatons of TNT. Boslough and his colleagues now say it was more likely to be just three to five megatons – meaning a far, far smaller body was involved. But the damage it did was undeniable. What this means, they say, is that estimates of asteroid danger might need revision too. Smaller objects are statistically more likely to hit Earth than larger ones – and this analysis shows that even relatively small bodies can cause widespread devastation. "Any strategy for defense or deflection should take into consideration this revised understanding of the mechanism of explosion," says Boslough.

# Detection Key To Deflection

Dual use capabilities of Deflection/Detection tech and the scientific advancements necessary for development have multiple benefits

Urias Et. Al 96 (John M. Urias is the Vice President of Programs at Raytheon Integrated Defense Systems, retired colonel in the US Air Force. Ms. Iole M. DeAngelis, Maj Donald A. Aher,n Maj Jack S. Caszatt, Maj George W. Fenimore III, Mr. Michael J. Wadzinski. “Planetary Defense: Catastrophic Health Insurance for Planet Earth”. October 1996. Pg 59-60. <http://csat.au.af.mil/2025/volume3/vol3ch16.pdf> TDA)

A PDS system has many potential dual-use capabilities, with or without modification, such as earth and space surveillance, space debris detection and mitigation, ballistic missile defense, and as a space-based offensive weapons system. The overall system is, however, only one of many benefits of a decision to embark on a PDS research, development, and deployment effort. The technologies required for the PDS would be, in of themselves, major benefits of such a program. Indeed, revolutionary deep-space detection methods, quantum communications, ultra-fast computer processing, large data-storage capabilities, high specific impulse propulsion, high kinetic energy systems, high power-directed energy systems, mass driver/reaction engines, solar sail and collector systems, chemical, biological, and mechanical “eaters,” magnetic and force field generation, tractor beams and gravity manipulators, and the ability to manhandle large objects in space and move them into more desirable orbits present significant technical challenges. Once developed, however, these new technologies will, in effect, change our lives, as military and commercial spin-offs and dual-use capabilities from these new technologies will dramatically stimulate the global economy. As deep-space detection allows us to reflect, we may find answers to energy shortages and sources of dwindling critical resources. It is conceivable that not only would the PDS serve as a defensive system for EMS protection, it also could be used to maneuver selected asteroids into stable earth orbits for various operations. A particularly interesting benefit involves mining asteroids for their rich deposits of metals and other valuable minerals. A thought brings into focus a space mining company making frequent trips into space to mine the asteroid that presented the original global threat. Further, controlled asteroids could be used as space bases or platforms 60 for space stations or space colonies. Indeed, such possibilities would enhance the attractiveness of the PDS effort due to their economic potential.

Asteroid detection is key to our survival – We could prepare for an impact

Nelson 2010 (University of California, Berkeley, Ph.D, <http://www.tulane.edu/~sanelson/geol204/impacts.htm>)

Impacts are the only natural hazard that we can prevent from happening by either deflecting the incoming object or destroying it.  Of course, we must first know about such objects and their paths in order to give us sufficient warning to prepare a defense.  Sufficient time is usually thought to be about 10 years.  This would likely give us enough time to prepare a space mission to intercept the object and deflect its path by setting off a nuclear explosion.  Currently, however, there are no detailed plans.  But, even if we did not have the ability to destroy or deflect such an object, 10 years warning would provide sufficient time to store food and supplies, and maybe even evacuate the area immediately surrounding the expected impact site.

# Detection Key To Deflection

Even small asteroids can wipe out large metropolises, but detecting asteroids early can help deflect the asteroids that could kill thousands.

Lenard and Hotes, 00 [AIP Conference Proceedings, “Technology needs for asteroid and comet trajectory deflection of a Tunguska-sized object using fission propulsion” pg1, <http://web.ebscohost.com/ehost/detail?vid=4&hid=113&sid=c0b281e1-71b2-4172-8218-b1bdb21b08b5%40sessionmgr104&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#db=a9h&AN=5985175> mjf]

 Recent motion pictures (ZanucMBrown, 1998) and other publications have identified the potential for civilization ending events based on impacts by large asteroids. The Near-Earth Asteroid Interception Workshop identified the size threshold for such events as l-2 km diameter objects impacting the Earth. While the report appeared to downplay the effect of smaller objects, -100 meters in diameter, the damage associated with these objects can be devastating to a major metropolitan area. The 1908 Tunguska asteroid was estimated to be -70 meters in diameter and leveled an area about 25 km in radius (Hill and Goda, 1992). Impact frequency appears to be inversely related to asteroid impact energy, i.e., inversely with the cube of their diameter out to a diameter of a few kilometers (Canavan and Solem, 1992), assuming the velocity is roughly constant. A review of some data, therefore indicates that while collision by an object of lo-20 km size, (thought to be the size responsible for the extinction of the dinosaurs), is rare, collisions of an object capable of destroying a major metropolitan area, for example, Los Angeles - is much more frequent, perhaps occurring as often as twice per century (Morrison, 1992). Figure 1 shows the approximate impact frequency as a function of impact or size. Figures 2 and 3 show the effect of impact or size, and damage radius as a function of asteroid type and impact velocity. Clearly, based on the potential for severe damage, it is important to mitigate the effects of a Tunguska-sized object when ever feasible. While the initial asteroid detection studies indicated low probability for damage of a city, we believe this is due to an improper scaling of future population trends, consequently, the analysis erred on the low side of the damage distribution. We here discuss the technology requirements to move a Tunguska-size object employing known detection and propulsion technologies. The most important feature of any asteroid or comet deflection scheme is early detection and reliable orbit analysis.

# Detection Key To Deflection

Thousands of asteroids are hurling towards the Earth; only by detecting these asteroids can we begin to deflect them.

Dahir, 92 [Technology Review, “Asteroid Alert”, pg 1., nov/dec 1992, <http://web.ebscohost.com/ehost/detail?sid=c0b281e1-71b2-4172-8218-b1bdb21b08b5%40sessionmgr104&vid=5&hid=113&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#db=a9h&AN=9211166153> mjf]

It goes something like this: Thousands of asteroids, some weighing millions of tons, are whizzing about in space. One of these orbiting menaces is eventually destined to crash into earth, ending life as we know it. If scientists can detect the destructive mass in time, they can deflect it with a Herculean assault of lasers and nuclear weapons and save the world. The trouble, says Gehrels, a planetary scientist at the University of Arizona, is that hardly anyone is taking the threat seriously. Only a handful of astronomers are trying to track the errant asteroids. And no plan exists for dealing with any that might be on a collision course. The theory that deadly asteroids may smash into the earth is far from science fiction. "It's absolutely feasible to believe it could happen," says David Morrison, chief of the Space Science Division at the NASA Ames Research Center in California. "And it's not overstating the case to say an asteroid impact threatens civilization." The scenario is that a collision with earth by an asteroid one kilometer or greater in diameter would send a cloud of dust particles into the stratosphere large enough to spread out like a thin film over the planet and block the sun. The whole earth would turn to darkness, surface temperatures would fall drastically, and most plant and animal life would die. Many believe this phenomenon has occurred at least once before. In 1980, the father and son team of Luis and Walter Alvarez at the University of California at Berkeley, studied geographic layers of the earth and found high levels of minerals known to be common in meteors but uncommon to earth. Their hypothesis, that an asteroid or shower of asteroids was responsible for the extinction of dinosaurs 66 million years ago, is now widely accepted. According to Richard Binzel, associate professor of earth, atmospheric, and planetary sciences at MIT, some 5,000 objects in space pose a collision threat to earth. Of those, about 2,000 are large enough to wreak global havoc, while the smaller ones might knock out a city or even level an entire country. Most asteroids are contained in the asteroid belt between Mars and Jupiter. But over the millennia, a number of asteroids began to oscillate in their orbit around the sun because of the countervailing gravitation forces of nearby Jupiter. Some eventually broke free and took off on new orbits that now intersect with that of earth. At present, only 200 of these objects, or about 5 percent, have been identified and charted. When Binzel generates a diagram superimposing the orbits of near-earth asteroids over the orbit of the earth for any given month, he finds the number of intersections remarkable. "Then when you look at this diagram and realize the paths charted represent only a small percentage of the near-earth asteroids out there," he says, "the reality sets in that impacts are a natural, inevitable process in planetary evolution." After a year-long study headed by Morrison, NASA recently urged Congress to spearhead an international effort, dubbed "Space Guard," to set up a worldwide network of six telescopes dedicated to discovering and tracing near-earth objects. Two of the telescopes would be located in the United States, with the others in Russia, India, Australia, and France. Morrison estimates the network would cost $50 million to build and $10 million a year to operate, for the 20 to 25 years he estimates would be required to track the remaining near-earth objects and determine if and when a collision might occur.

# Detection Key To Deflection

Once NASA detects an Asteroid, it has years to plan an effective response. There are other ways to deflect an asteroid, not just nuclear weapons.

New York Times, 92 [New York Times, http://proquest.umi.com/pqdweb?index=18&did=964694701&SrchMode=2&sid=3&Fmt=3&VInst=PROD&VType=PQD&RQT=309&VName=PQD&TS=1310424490&clientId=10553]

In "Star Warriors on Sky Patrol" (Op-Ed, March 25), Robert L. Park makes the error of tarring good and important science with the same brush he applies to an overenthusiastic emphasis on nuclear weapons. There may or may not be merit in using nuclear weapons to deflect asteroids or comets that we someday might find to be on a collision course with Earth. But that isn't the point. According to David Morrison, an astronomer who headed the first National Aeronautics and Space Administration workshop on this subject: **"**You take a complete census, track their orbits and calculate whether they are a danger. If you find one that is, then you have decades or even centuries to plan a response. You don't have to rush out and build missiles and arsenals." But there are proper, effective and low-cost efforts we can conduct now. One of these, recommended by Mr. Morrison's workshop, is to accelerate detection of earth-crossing asteroids at a cost of about $10 million a year. Even Mr. Park calls this "a reasonable price for peace of mind." Another such program is the integrated sensor test program, nicknamed Clementine. Its goal is to test and demonstrate, by flying past an asteroid named Geographos, which will cross Earth's orbit in August 1994, the sensors and autonomous navigation techniques needed by a device to deflect an asteroid aimed at the earth. NASA requested the mission and strongly supports it because it will generate, at no cost to NASA, comprehensive and accurate topographical and mineralogical data on both the asteroid and the moon, which Clementine will orbit on its way to meet Geographos. Moreover, Clementine is projected to cost less than $50 million spread over the next three years, and that money has been budgeted. So what's the problem? The mission is financed by the Defense Department's Strategic Defense Initiative Organization, which sees Clementine as an ideal mechanism for testing sensors and guidance systems developed for military needs on a mission that can also meet nonmilitary scientific goals. But because S.D.I. is involved in antimissile weapon technologies, there is danger that Clementine -- as well as the much-needed asteroid detection program proposed by Mr. Morrison's workshop -- may be lumped together with the highly controversial nuclear weapon issue that has so inflamed Mr. Park, even though neither Clementine nor asteroid detection has anything to do with nuclear weapons or their designers .A position paper by my organization on the potential hazards of Earth approaching asteroids motivated Congress to request the two NASA workshops, the second of which so incensed Mr. Park. We believe that the first workshop's recommendation for accelerating asteroid detection is an ideal outcome of our paper. But we are particularly pleased by the Clementine mission, which not only takes the first rational step toward preventing an ultimate catastrophe, but also delivers much-needed scientific data, affords an opportunity to learn how to do truly low-cost space missions, and, best of all, shows that we really can beat swords into plowshares. JERRY GREY Director, Science and Technology Policy, American Institute of Aeronautics and Astronautics Washington, April 2, 1992

# Plan Key Now

**And, there is a good chance that an asteroid might hit us before 2200 – Funding now key to any chance at success**

**Firth 10** (Niall; Bio-Tech editor, dailymail.co.uk, Massive asteroid could hit Earth in 2182, warn scientists, July 28th 2010, Accessed 7/1/11, AH)

A massive asteroid might crash into Earth in the year 2182, scientists have warned. The asteroid, called 1999 RQ36, has a 1-in-1,000 chance of actually hitting the Earth at some point, before the year 2200 but is most likely to hit us on 24th September 2182. It was first discovered in 1999 and is more than 1,800 feet across. If an asteroid of this size hit the Earth it would cause widespread devastation and possible mass extinction. And scientists say that any attempt to try and divert the asteroid will have to take place more than 100 years before it is due to hit to have any chance of success. If the asteroid had not been spotted until after 2080 it would be impossible to divert it from its target, they warned in a new research paper. While the odds may seem long, they are far shorter than that of the asteroid Apophis, which currently has a 1 in 250,000 chance of striking Earth in 2036. A competition was launched in 2008 by the Planetary Society for designs for a space probe to land on Apophis and monitor its progress. Potential opportunities for the asteroid to hit Earth in the year 2182. ‘The total impact probability of asteroid '(101955) 1999 RQ36' can be estimated in 0.00092 –approximately one-in-a-thousand chance-, but what is most surprising is that over half of this chance (0.00054) corresponds to 2182,’ Sansaturio said. The asteroid is now behind the Sun and will next be observable only in the spring of 2011. Scientists have estimated and monitored the potential impacts for this asteroid between now and 2200 using two different mathematical models

# USFG Key

US key

Shiga in 09 [David, “It's behind you!” Staff Writer for *New Scientist Editorial*, 02624079, 9/26/2009, Vol. 203, Issue 2727, PN]

But participants in the planning exercise worried that if an asteroid posing an imminent threat to a populated area were discovered, and the situation were not handled properly, panic and lack of coordination could lead to chaos on the roads. Spahr was not involved in the exercise, but shares those concerns. "With a three-day warning, you can walk away and be safe. But it scares me, given how poorly we've handled things of this nature in the past," he says, citing the failure to fully evacuate New Orleans ahead of hurricane Katrina in 2005. "I'm picturing people panicking and driving the wrong way on the freeway, screaming 'Oh my god, it's going to kill us!'" To prevent panic and disorganised movement, it is crucial for authorities to develop an evacuation plan and communicate it to the public as soon as possible after discovery of the dangerous object, since such discoveries are posted automatically online and would cause a media firestorm.

US Key – UN/International actors are bogged down in procedural and political questions

Dinerman 09 (Taylor Dinerman is a regular contributor to the Hudson Institute writer on military and civilian space activities “*The new politics of planetary defense*” Space Review Online, July 20, 2009. http://www.thespacereview.com/article/1418/1. TDA)

While the US is obviously going to have to take the lead in any effort to detect and possibly deflect any celestial object that might do our planet harm, it will have to consult with others, both to keep other nations informed and to help make the choices needed to deal with the threat. Yet in the end, it is likely that the decision, if there is one, will rest with the President of the United States. He or she is the only world leader today with the wherewithal to deal with such a threat. This is why any planning effort that leans to heavily on international institutions may endanger the whole planet. The process inside an organization like the UN would simply get bogged down in procedural and political questions. US leaders may find that the system would be paralyzed while, for example, nations argued over deflection or destructions methods or who would control and pay for them. Precious time would be lost while nations would consider their own best interests in supporting one approach or another. If the US is have any claim to global leadership in the 21st century it will have to unambiguously take the lead in planetary defense. It should do so in an open way and be ready to listen to everyone’s concerns and ideas. But if the Earth is to be effectively protected, the ultimate decisions will have to be American. In this case “global governance” could end up setting the stage for a disaster.

Congress wants NASA to discover 90% of all near-earth objects and the U.S is the only country that has the technology for the detection

Mason 09(NASA Falling Short of Asteroid Detection Goals, By Betsy Mason, August 12, 2009 is science editor for Wired.com, G.L)

Congress has mandated that NASA discover 90 percent of all near-Earth objects 140 meters in diameter or greater by 2020. The administration has not requested and Congress has not appropriated new funds to meet this objective. Only limited facilities are currently involved in this survey/discovery effort, funded by NASA’s existing budget. The current near-Earth object surveys cannot meet the goals of the 2005 NASA Authorization Act directing NASA to discover 90 percent of all near-Earth objects 140 meters in diameter or greater by 2020. The orbit-fitting capabilities of the Minor Planet Center are more than capable of handling the observations of the congressionally mandated survey as long as staffing needs are met. The Arecibo Observatory telescope continues to play a unique role in characterization of NEOs, providing unmatched precision and accuracy in orbit determination and insight into size, shape, surface structure, multiplicity, and other physical properties for objects within its declination coverage and detection range. The United States is the only country that currently has an operating survey/detection program for discovering near-Earth objects; Canada and Germany are both building spacecraft that may contribute to the discovery of near-Earth objects. However, neither mission will detect fainter or smaller objects than ground-based telescopes.

# USFG Key

The US has more resources to detect asteroids-even if international cooperation is likely, US unilateral action can solve and serve as a key jumpstart to coordination

IRWIN I. SHAPIRO et al in 10,( Harvard-Smithsonian Center for Astrophysics, Chair FAITH VILAS, MMT Observatory at Mt. Hopkins, Arizona, Vice Chair MICHAEL A’HEARN, University of Maryland, College Park, Vice Chair ANDREW F. CHENG, Johns Hopkins University Applied Physics Laboratory FRANK CULBERTSON, JR., Orbital Sciences Corporation DAVID C. JEWITT, University of California, Los Angeles STEPHEN MACKWELL, Lunar and Planetary Institute H. JAY MELOSH, Purdue University JOSEPH H. ROTHENBERG, Universal Space Network, *Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies Space Studies Board Aeronautics and Space Engineering Board Division on Engineering and Physical Sciences*, THE NATIONAL ACADEMIES PRESS, [http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4\_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf)\](http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf%29%5C)

The probability of a devastating impact in the United States is small compared to the likelihood of an impact in other nations, most with far fewer resources to detect, track and defend against an incoming NEO. The NEO hazard, however, is such that a single country, acting unilaterally, could potentially solve the problem. Although the United States has a responsibility to identify and defend against threats with global consequences, the United States does not have to bear the full burden for such programs. There have been several international efforts to characterize objects in the near-Earth environment, but these studies have generally been driven by scientific curiosity and were not designed to address the risk of NEOs. As NEO survey requirements evolve to fainter objects and mitigation strategies are refined, additional resources will be necessary that could be provided by other developed countries. International partnerships can be sought with other science organizations, notably but not exclusively space agencies, in the areas of surveys, characterization, and mitigation technologies. NEO discovery rates and survey completeness could be significantly enhanced through coordinated use of telescopes owned and operated by other nations. Future NEO space missions, carried out either by the United States, other nations, or a cooperation of countries could be optimized for characterization that enables development and refinement of mitigation strategies. Space missions to test such strategies could also be developed on a cooperative basis with other nations, making use of complementary capability. While a coordinated intergovernmental program is needed to address the full spectrum of activities associated with NEO surveys, characterization, and mitigation, an important first step in this direction would be to establish an international partnership, perhaps of space agencies, to develop a comprehensive strategy for dealing with NEO hazards.

\*\*Add-Ons\*\*

# Science diplomacy

The plan bolsters US leadership in space science, enhancing international science diplomacy

IRWIN I. SHAPIRO et al in 10,( Harvard-Smithsonian Center for Astrophysics, Chair FAITH VILAS, MMT Observatory at Mt. Hopkins, Arizona, Vice Chair MICHAEL A’HEARN, University of Maryland, College Park, Vice Chair ANDREW F. CHENG, Johns Hopkins University Applied Physics Laboratory FRANK CULBERTSON, JR., Orbital Sciences Corporation DAVID C. JEWITT, University of California, Los Angeles STEPHEN MACKWELL, Lunar and Planetary Institute H. JAY MELOSH, Purdue University JOSEPH H. ROTHENBERG, Universal Space Network, *Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies Space Studies Board Aeronautics and Space Engineering Board Division on Engineering and Physical Sciences*, THE NATIONAL ACADEMIES PRESS, [http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4\_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf)\](http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf%29%5C)

Many scientists, especially among the world’s planetary scientists, have been concerned for well over a decade with the danger posed to Earth from the impact of an asteroid or comet. Officials from various nations have echoed these concerns. Thus, a substantial and important component of the existing international cooperation is the informal contact between professional scientists and engineers, mainly of space-faring nations, but also including official representatives from some other countries. International conferences and small meetings, as well as the Internet, allow experts in different aspects of space science and technology, including asteroid detection and mitigation, to personally know their counterparts in other nations. Such connections often lead to offers of, or requests for, aid in solution of common problems arising in the course of their work. Veterans of the United States or Russian space programs often participate either openly or behind the scenes in the European Space Agency and the Japanese Space Agency, and Indian and Chinese space activities. Nuclear-weapons designers in both Russia and the United States have often met to discuss use of nuclear explosives to effect asteroid orbit changes. In the event of a sudden emergency due to discovery of a threatening NEO it is likely that people forming this international network will be the first to communicate with one another and consider responses to the threat. For instance, when an observatory in Arizona discovered NEO 2008 TC3 only 19 hours before its impact in Sudan, the informal network of amateur and professional astronomers in many countries responded in time for thousands of observations of the object to be made and communicated to the MPC, thus allowing an extremely accurate prediction of the time (<1 min error) and location (<1 km error) of impact. Formal integration of these elements, with agreed to plans, roles, and responsibilities is needed well in advance of the identification of any specific threat. The United States is in a unique position to lead the sustained effort required to marshal the international community to ensure preparedness.

# Science diplomacy

Science diplomacy solves the climate change, resource wars, disease, prolif, terrorism and CBWs

Federoff ‘8 (Nina, 4/2, Science and Technology Adviser to the Secretary of State and the Administrator of USAID, Testimony Before the House Science Subcommittee on Research and Science Education, http://legislative.nasa.gov/hearings/4-2-08%20Fedoroff.pdf)

The welfare and stability of countries and regions in many parts of the globe require a concerted effort by the developed world to address the causal factors that render countries fragile and cause states to fail. Countries that are unable to defend their people against starvation, or fail to provide economic opportunity, are susceptible to extremist ideologies, autocratic rule, and abuses of human rights. As well, the world faces common threats, among them climate change, energy and water shortages, public health emergencies, environmental degradation, poverty, food insecurity, and religious extremism. These threats can undermine the national security of the United States, both directly and indirectly. Many are blind to political boundaries, becoming regional or global threats. The United States has no monopoly on knowledge in a globalizing world and the scientific challenges facing humankind are enormous. Addressing these common challenges demands common solutions and necessitates scientific cooperation, common standards, and common goals. We must increasingly harness the power of American ingenuity in science and technology through strong partnerships with the science community in both academia and the private sector, in the U.S. and abroad among our allies, to advance U.S. interests in foreign policy. There are also important challenges to the ability of states to supply their populations with sufficient food. The still-growing human population, rising affluence in emerging economies, and other factors have combined to create unprecedented pressures on global prices of staples such as edible oils and grains. Encouraging and promoting the use of contemporary molecular techniques in crop improvement is an essential goal for US science diplomacy. An essential part of the war on terrorism is a war of ideas. The creation of economic opportunity can do much more to combat the rise of fanaticism than can any weapon. The war of ideas is a war about rationalism as opposed to irrationalism. Science and technology put us firmly on the side of rationalism by providing ideas and opportunities that improve people’s lives. We may use the recognition and the goodwill that science still generates for the United States to achieve our diplomatic and developmental goals. Additionally, the Department continues to use science as a means to reduce the proliferation of the weapons’ of mass destruction and prevent what has been dubbed ‘brain drain’. Through cooperative threat reduction activities, former weapons scientists redirect their skills to participate in peaceful, collaborative international research in a large variety of scientific fields. In addition, new global efforts focus on improving biological, chemical, and nuclear security by promoting and implementing best scientific practices as a means to enhance security, increase global partnerships, and create sustainability.

# Impact Extensions

Sharing science and technology is key to Chinese-American relations, disease, earthquakes, energy production, and environmental production, but the U.S. needs to take leadership. The plan is key.

Pickering and Agre, 10 [Sign On San Diego, “Science diplomacy aids conflict reduction” Feb 20, 2010, <http://www.signonsandiego.com/news/2010/feb/20/science-diplomacy-aids-conflict-reduction/> mjf]

Over two foggy days in April, a group of high-ranking Chinese science and education leaders and some American counterparts met at a University of California San Diego faculty club to discuss an issue crucial to both nations: educating future generations in the ethical standards surrounding the conduct of research. The meeting was low-key – no TV cameras, no headlines – but from the start, its potential for high impact was clear. Not so many years ago, during the Cold War, the two nations were locked in conflict. Now they were collaborating to strengthen science for the 21st century. The talks were emblematic of a promising global trend that features researchers, diplomats and others collaborating on science and, in the process, building closer ties between nations. Even countries with tense government-to-government relations share common challenges in infectious diseases, earthquake engineering, energy production and environmental protection. The White House and Congress have made welcome moves to embrace the potential of science diplomacy, but in the months and years ahead, they will need to exert still more leadership and make sure the effort has the resources needed to succeed.

Science and technology are key to diplomatic relations with North Korea and the Middle East.

Pickering and Agre, 10 [Sign On San Diego, “Science diplomacy aids conflict reduction” Feb 20, 2010, <http://www.signonsandiego.com/news/2010/feb/20/science-diplomacy-aids-conflict-reduction/> mjf]

Now, science diplomacy may help America open a door toward improved relations with Pyongyang, too. Last December, six Americans representing leading scientific organizations sat down with their North Korean counterparts. High-level science delegations from the United States in recent months also have visited Syria, Cuba and Rwanda, not to mention Asian and European nations. America’s scientific and technological accomplishments are admired worldwide, suggesting a valuable way to promote dialogue. A June 2004 Zogby International poll commissioned by the Arab American Institute found that a deeply unfavorable view of the U.S. in many Muslim nations, but a profoundly favorable view of U.S. science and technology. Similarly, Pew polling data from 43 countries shows that favorable views of U.S. science and technology exceed overall views of the United States by an average of 23 points. Within the scientific community, journals routinely publish articles cowritten by scientists from different nations, and scholars convene frequent conferences to extend those ties. Science demands an intellectually honest atmosphere, peer review and a common language for the professional exchange of ideas. Basic values of transparency, vigorous inquiry and respectful debate are all essential.

# Impact Extensions

Sharing science and technology builds Russian and American relations—plan increases science to share diplomatically with Russia.

Turkeain and Wang, No Date [International Science and Technology Center, “Building an International Network of Knowledge” <http://www.istc.ru/istc/istc.nsf/va_WebPages/ScienceDiplomacyEng> mjf]

In the decades since the depths of the Cold War, scientists and engineers in the United States and Russia have built a special bond. As relations between their governments have shifted from acute tension to the thaw of détente to friendship and back to mutual wariness, our researchers have worked side-by-side on a range of successful projects. This cooperation has been critical in building and enhancing relationships that, while outside of the political realm, have helped to promote understanding and trust among the our people. And the relationships produced important science in fields ranging from physics, health, and space exploration to the development of Internet-based information-sharing networks and the control of nuclear proliferation. Today, the world is a vastly different place than it was 40 years ago, or even 10 years ago. Though tensions remain among countries, we no longer struggle with the strong polarization of national philosophies that characterized the Cold War. At the same time, common issues confront us on a global scale. The current financial crisis, international terrorism, the changing climate, and competition over energy supplies all show how interrelated we are. National leaders are ever more aware of the reality that solving these and other challenges will require the innovative power of science, engineering and technology. Russia’s leaders understand that, and U.S. President Barack Obama does, too. These developments suggest that science diplomacy is entering an important new era, and that, if it is employed to help nations share knowledge and seek common solutions, it can be a powerful force of prosperity and peace.

Science and technology developments, similar to the plan, are key to U.S.-Russia relations.

 Turkeain and Wang, No Date [International Science and Technology Center, “Building an International Network of Knowledge” <http://www.istc.ru/istc/istc.nsf/va_WebPages/ScienceDiplomacyEng> mjf]

The Russia-U.S. relationship has tended to be bilateral, but as the world grows more interconnected, this will have to evolve. Nations on every continent are investing in science and research capacity: South Korea and China have been transformed, seemingly overnight, by investing in innovation. Cuba has become a world leader in biomedical research. Rwanda is wiring itself for the Internet, and has begun to distribute thousands of computers to its young students. Argentina, as it develops its capacity in biotechnology and nanotechnology, is building cooperative science relationships not just in Latin America, but with Europe, Africa and the Arab world. However different these nations are, each recognizes that science and technology will be the currency of the future; investments today will pay off in economic growth and societal development tomorrow. It is in this context that international science cooperation provides the opportunity to build bridges between countries, both through governments and through civil society relationships. To be most effective, such an approach needs commitment from all interested parties—not just scientists and engineers, but policy-makers, the foreign policy community, educators and the public.

\*\*AFF Answers To\*\*

# AT U.N. CP

UN won’t do plan - historically doesn’t care, and would waste time debating about laws we haven’t signed

Sommer 05 (Doctorate in Policy Analysis at the Pardee Rand Graduate School. “*Astronomical Odds A Policy Framework for the Cosmic Impact Hazard*” Pardee Rand Graduate School Dissertation Series. June 2005. EBSCOhost. TDA)

Chapter Two discussed past U.N. involvement in the NEO hazard issue. This has consisted of one co-sponsored conference devoted to the subject in 1995 and a passing mention included in the final declaration of the UNISPACE III conference in 1999. Should activities related to NEO mitigation gain momentum, it could be expected that issues associated with the militarization of space would become contentious. The U.N. forum for resolving these issues would be the Committee on the Peaceful Uses of Outer Space (COPUOS), with its executive arm, the U.N. Office for Outer Space Affairs (OOSA), located in Vienna. COPUOS is the body responsible for interpretation of the “five treaties,” the international treaties that collectively form the basis of international space law. The U.N. Conference on Disarmament in Geneva has higher oversight over space militarization issues, however.20 Of the five treaties, the ones most relevant to the NEO impact hazard (specifically, interception of threatening NEOs) are the Outer Space Treaty (discussed in Chapter Two in connection with the use of nuclear devices or “warheads” in space) and the Liability Convention. The latter “provides that launching States are liable for damage caused by their space objects on the Earth’s surface” and could become relevant if an interception attempt(or experiment) results in fragments of a disrupted NEO impacting the Earth absent some type of “hold harmless” agreement.21 Should NEO resource exploitation (mining of asteroids and comets for their metal or mineral content) ever approach reality, the Moon Treaty would become relevant. This treaty sets up the basis for the future regulation of the exploration and exploitation of space resources. Although considered to be in force as a matter of international law, among the spacefaring nations only India has signed the treaty.22

# AT Privitization

**Congress fighting privatization – Commercial spacecraft pose too many risks**

**Moskowitz 11** (Clara Moskowitz, SPACE.com Senior Writer, NASA Chief Defends Space Budget Proposal to Congress, 02 March 2011 Time: 03:02 PM ET; Accessed 6/30/11, AH)

Some **lawmakers object to the new privatization push because they don't trust**[**commercially built spacecraft**](http://www.space.com/10440-millionaire-private-space-capsule-splashes-successful-maiden-voyage.html)**to be as safe as vehicles owned and operated by NASA**. "**Trying to stimulate commercial competition is a worthy goal that I support, but not at the expense of ensuring the safest or most robust systems for our astronauts**," Hall said. "**There are simply too many risks at the present time not to have a viable fallback option.**" Bolden disagreed that private spacecraft are any less safe than NASA's, which have traditionally always been built, and operated, through commercial contractors anyway. The new model, he said, was mainly a different acquisition format. "Safety of our crew is always my priority," Bolden said. "The best, most efficient, perhaps fastest way to do that is by relying on the commercial entities. Anyone who would try to convince you that American industry cannot produce is just not being factual." Commercial spaceflight did have some backers in Congress today, including Dana Rohrabacher (R-Calif.), who introduced a letter signed by over 55 space leaders promoting the private space industry. "These credentialed experts are urging that NASA fully fund the use of commercial companies to carry crew to the station because it is a strategy that is critical for the nation's success in our space efforts," Rohrabacher said. He compared having the [government](http://www.space.com/11008-nasa-chief-space-budget-congress.html) manage, operate and build all the space transportation vehicles today to people who wanted the government to manage all aircraft 20 or 30 years ago. The debate comes as Congress is trying to settle on a [budget for the 2011 fiscal year](http://www.space.com/10995-government-shutdown-budget-nasa.html). So far, NASA and the rest of the federal government have been operating with 2010 funding levels under the current continuing resolution. Today the Senate passed a House resolution that would extend funding another two weeks to buy them a little more time, but the outlook for a longer-term budget is not yet decided. While some in Congress are aiming to make drastic cuts to many federal programs, others are seeking to protect funding for NASA. Obama's 2012 budget request would keep NASA at 2010 funding levels. "It's extraordinary that you're defending the president's budget," Johnson told Bolden. "I think it's grossly inadequate and I hope that we can help a little bit."

# AT Privitization

No push for asteroid mission politically in the Status Quo. Opposed to private investors.

**Watson in 2010** [Traci, USA Today Staff Writer, “Landing on an asteroid: Not quite like the movies” USA Today; 6/21/2010 <http://web.ebscohost.com/ehost/detail?sid=5f60dff7-e94d-4570-a844-1f42b8a35322%40sessionmgr14&vid=1&hid=13&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#db=a9h&AN=J0E163697150710> PN]

Almost 50 years after President Kennedy proposed sending a man to the moon "before this decade is out," Obama has set an equally improbable goal. He has proposed a 2025 date for NASA to land humans on an asteroid, a ball of rock hurtling around the sun. The moon is 240,000 miles away. A trip to an asteroid would be 5 million miles -- at a minimum. Why go? If the mission ever gets launched, it would mark a milestone just as significant as Neil Armstrong's "small step" on the moon, experts say. To go to an asteroid, humans would have to venture for the first time into "deep space," where the sun, not the Earth, is the main player. An asteroid trip "would really be our first step as a species outside the Earth-moon system," says planetary scientist Andy Rivkin of the Applied Physics Laboratory. "This would be taking off the training wheels." Asteroids have always been passed over as a destination for human explorers. Then-president George H.W. Bush wanted NASA to go to Mars, while his son, George W. Bush, chose the moon. During the past six years, NASA spent $9 billion building a spaceship, rocket and other gear to help reach the second Bush's goal of returning humans to the lunar surface by 2020. In February, Obama took steps toward killing Bush's moon program, which was beset by technical troubles and money woes. Two months later, in a speech at Cape Canaveral, Obama announced that the astronauts' next stop is an asteroid. So far, the Obama administration has been quiet on the need for a major sum of money to accomplish his goal. And unlike Kennedy, who used Sputnik to promote the moon mission, Obama doesn't have a geopolitical imperative to justify the goal. Congress is resisting Obama's change of direction, which could delay investment in the program. If Obama wants to bolster his cause, there's a rationale he could cite: An asteroid could wipe out as many human lives as a nuclear bomb. The dominant scientific theory posits that dinosaurs went extinct because of a direct hit from an asteroid as wide as San Francisco. A space rock big enough to kill thousands slams into Earth every 30,000 years, according to a January report from the National Research Council. That scenario provided the rationale for asteroid missions in various Hollywood movies, including Armageddon. The 1998 film, which starred Bruce Willis, grossed more than $200 million at box office in the U.S. and more than $500 million worldwide. It went on to be a staple on cable television. But if Americans think they have an understanding of the challenge of going to an asteroid, they're wrong. "I loved the movie," says Laurie Leshin, a top NASA official who is involved in the early planning stages of an asteroid mission, although "it was completely inaccurate." Obama's plans for NASA have drawn many opponents, including Armstrong, but their criticism centers on the administration's reliance on private space companies to ferry astronauts to orbit. The goal of an asteroid hasn't been questioned as much.

# AT Privitization

**Private companies are restricted to the launch and operation of spacecrafts in orbit – anything development of satellites or tech is believed to be too risky.**

New Zealand Herald 2010 (The New Zealand Herald, US to encourage private firms to run space trips, February 2, 2010, Lexis, znf)

The Obama Administration is proposing in its new Budget spending billions of dollars to encourage private companies to build, launch and operate spacecraft for Nasa and others. Getting astronauts into orbit, which the National Aeronautics and Space Administration has been doing for 49 years, is so old hat that someone other than the Government can do it, it seems. Going private would free the space agency to do other things, such as explore beyond Earth's orbit, do more research and study the Earth with better satellites. And it would spur a new generation of private companies - even some with internet roots - to innovate. But there's some concern about that - from former Nasa officials worried about safety and congressional leaders worried about lost jobs. Some believe space is still a tough, dangerous enterprise not to be left to private companies out to make money. Government would lose vital knowledge and control, critics fear. Proponents of private space, an idea that has been kicking around for nearly 20 years, point to the airline industry in its infancy. Initially the Army flew most planes. But private companies eventually started building and operating aircraft, especially when they got a guaranteed customer in the US Government to deliver air mail. That's what Nasa would be: a guaranteed customer to ferry astronauts to the International Space Station until 2020. It would be similar to the few years Nasa paid Russia to fly astronauts on its Soyuz after the Columbia accident in 2003. "With a US$6 billion [$8.43 billion] programme you can have multiple winners," said John Gedmark, executive director of the Commercial Spaceflight Federation. The White House has said it will add US$5.9 billion to the overall Nasa budget over five years; Mr Gedmark believes most or all will go to commercial space initiatives. Mike Gold, corporate counsel at Bigelow Aerospace, which is building the first commercial space station and is a potential spacecraft provider, believes the Government should have privatised astronaut launchings decades ago. "It will force the aerospace world to become competitive again and restore us to our glory days." Last year as part of the stimulus package, Nasa said it would give out US$50 million in seed and planning money for the idea of a commercial spaceship. Several firms expressed interest and Nasa will soon pick a winner or winners. American University public policy professor and space expert Howard McCurdy said this was not as radical as it seemed. The shuttle was built not by Government workers but by Rockwell International, a private company. In 1996 the Clinton Administration outsourced some shuttle operations to a private company. "This is something that Nasa has been drifting towards in the last 25 years," Mr McCurdy said. But New York University professor Paul Light said: "My general caution is be careful about what you give away. It's awful expensive to get it back." - AP

# AT Politics – Plan Popular

Plan popular – Obama pushing budget increase now, no trade-off with space exploration

Lawler and Reardon 11 (Andrew Lawler and Sara Reardon on 14 February 2011, 5:11 PM, Climate Science, Asteroid Detection Big Winners in NASA Budget; Accessed 6/30/2011, AH)

NASA will have to live with a stagnant budget—again. The [$18.7 billion proposed](http://www.nasa.gov/pdf/516674main_FY12Budget_Estimates_Overview.pdf) by the Administration is the same amount as 2010 and 2011, and science funding would continue to hover at about $5 billion. But in the details are significant winners and losers. Earth science would grow from $1.439 billion to $1.797 billion in 2012, though House of Representatives Republicans are sure to attack a program focused on understanding global change. Meanwhile, Mars exploration—which this year stands at $438 million—would spike at $602 million next year, but plummet to less than half that amount by 2016. Funds for near-Earth object observations would quadruple to $20.4 million. And NASA Chief Financial Officer Elizabeth Robinson said the agency will kill a dark-energy mission in the hope that it can collaborate more cheaply with the European Space Agency. She added that details on how the agency will fund a massive cost overrun in the James Webb Space Telescope won't be ready until this summer. NASA Administrator Charles Bolden acknowledged that "tough choices had to be made," adding that these are "really difficult fiscal times." The priority in such times, he said, was safe and efficient transportation of crew and equipment into low earth orbit. The budget for human exploration was kept at $2.81 billion to fund development of a Multi-Purpose Crew Vehicle to carry humans and a Heavy Lift Launch Vehicle to launch it. An enhanced reliance on commercial industry to provide these vehicles for human spaceflight, Bolden said, was "the frugal thing for us to do and the prudent thing for us to do. … We can't do everything." Pressed on human landings on Mars and asteroids, Bolden said it was too early to give definitive dates. Perhaps Mars in the 2030s and asteroids by 2025, but "if we can do things better, some of those dates may accelerate. We're going to have to make small steps."

Plan popular – Will pass once Obama and Congress reach deals on deficit and debt ceiling

DiMascio 6-29 (Jen, writer, aviationweek.com, “NASA Funding Mired In Budget Politics”, 6/29/11, accessed 7/1/11, AH)

With a lingering stalemate on the deficit and debt ceiling and leftover problems from the previous fiscal year, developing a budget to fund NASA for the coming fiscal year is messier than usual. “It’s a quagmire,” says Sen. Barbara Mikulski (D-Md.), chair of the Senate Appropriations Commerce Justice Science subcommittee. “It’s a fiscal quagmire.” The committee is still sorting through the fiscal 2011 budget, as NASA only just recently submitted its spending plan for fiscal 2011 to Congress. “Right at this moment, we are looking at the consequences of the [continuing resolution],” Mikulski says. On top of that, Congress and the White House have yet to reach a deal on how to address the deficit and the debt ceiling. Without that deal, the Senate Budget Committee has not provided a budget resolution. And without a budget resolution, the appropriations committees have no guidance concerning how much money individual agencies will receive in fiscal 2012. The military construction and veterans affairs subcommittee moved ahead with its spending bill June 28, but other subcommittees are still waiting. “Until we get what our allocation is going to be we can’t quite mark up our bill,” Mikulski says. In the meantime, the appropriations committees dealing with NASA are working with the agency to obtain additional information. The big question, however, remains what will happen with the heavy-lift space launch system (SLS), the details of which Sen. Jay Rockefeller (D-W.Va.), the chairman of the Senate Commerce, Transportation and Science Committee, has been pushing to receive (Aerospace DAILY, June 24). Despite the slowdown in the Senate, the House Appropriations process has been humming along; the Commerce Justice Science subcommittee is still scheduled to mark up its version of the spending bill July 7 — a deadline that will come with or without NASA’s input on SLS.

# AT Politics – Plan Popular

Public and Government sectors in favor of asteroid deflection

Shiga in 09 [David, “It's behind you!” Staff Writer for *New Scientist Editorial*, 02624079, 9/26/2009, Vol. 203, Issue 2727, PN]

Far-fetched it might seem, but **this scenario is all too plausible. Certainly it is realistic enough that the US air force recently brought together scientists, military officers and emergency-response officials for the first time to assess the nation's ability to cope, should it come to pass**.

**They were asked to imagine how their respective organisations would respond to a mythical asteroid** called Innoculatus **striking the Earth after just three days' warning**. The asteroid consisted of two parts: a pile of rubble 270 metres across which was destined to splash down in the Atlantic Ocean off the west coast of Africa, and a 50-metre-wide rock heading, in true Hollywood style, directly for Washington DC.

The exercise, which took place in December 2008, exposed the chilling dangers asteroids pose. Not only is there no plan for what to do when an asteroid hits, but our early-warning systems - which could make the difference between life and death - are woefully inadequate. **The meeting provided just the wake-up call organiser Peter Garreston had hoped to create. He has long been concerned about the threat of an impact. "As a taxpayer, I would appreciate my air force taking a look at something that would be certainly as bad as nuclear terrorism in a city, and potentially a civilisation-ending event," he says.**

Obama and NASA back asteroid missions

Shiga in 2010 [David, “NASA mulls sending part of space station to an asteroid”. Staff Writer for New Scientist Editorial, 02624079, 8/21/2010, Vol. 207, Issue 2774, PN]

Having scrapped plans for astronauts to return to the moon, in April President Barack Obama backed the idea of an asteroid mission. NASA engineers brainstormed how to carry out such a mission and the resulting proposals were discussed last week at a conference in Washington DC.

One idea is to dismantle the station after it is retired in 2020 and use one of its crew compartments, possibly the Tranquility module (pictured below), as part of an asteroid-bound spacecraft that would be assembled in orbit. That would avoid the need to launch such a craft from Earth.

The asteroid mission will "occur at about the time that the space station is near retirement", said Brian Wilcox of NASA, who presented the ideas at the conference. "So one has to wonder, is it possible to use assets from the station as part of your mission complement?"

Of course, the plan will rely on the space station remaining in good working order for another 15 years. That looked more hopeful this week after astronauts successfully replaced an ammonia pump that had failed on 31 July. The failure knocked out half the station's cooling system and forced part of it to be shut down.

More Evidence

Shiga in 2010 [David; “We're flying to an asteroid - but which one?” By: Shiga, David, Staff Writer for New Scientist Editorial, 02624079, 5/1/2010, Vol. 206, Issue 2758, PN]

DECIDING to send astronauts to an asteroid is all very well, but now NASA will have to find the few space rocks that are suitable to visit, and work out how to rendezvous safely. Last month, US president Barack Obama announced the next destination for NASA astronauts would be an asteroid, as early as 2025. The goal would be to gain experience of safely sending humans far from Earth, as a stepping stone towards longer journeys to Mars. Studying the interior of an asteroid up close could also prove important if we ever need to deflect one. Yet achieving the goal will mean overcoming daunting challenges.

# AT Politics – Plan Popular with Public

The imminent threat of the asteroid will avoid political fights and create public awareness and enthusiasm.

Worden 2000 (Brigadier General S. Pete Worden, Worden is a US Air Force officer with a background as a research astronomer, “NEOS, Planetary Defense and Government – A view from the Pentagon” CCNet-Essasy, published February 7th, 2000.

What then should we do? What role should the US Government, and  specifically the US DoD play in what

everyone agrees is an  international concern? I believe we in the US DoD can and should agree  to modify our space surveillance systems to identify and track all  potentially threatening NEOs--probably down to about the 100 meter  class. In parallel, in situ studies of NEOs using low-cost  microsatellite missions should begin immediately. These missions can  and should involve NASA, ESA, other European space agencies as well as  the US DoD. These missions can use new technology to rendezvous,  inspect, sample, and even impact NEOs to study their composition and  structure. With an estimated cost of about $10-20M per mission,  including data reduction and launch, this is an affordable program.   Here is where I would focus the growth of official interest in NEOs as  evidenced by the recent UK decision to stand up a formal program. And finally, I would propose focusing on the very small end of  NEOs--100 meters diameter or less. At any given time there are probably  tens of objects 10 meters or larger in cislunar space. These are easily  accessible to the low-cost microsatellite mission. Should we worry now about mitigating the NEO hazard? I would say no,  until a bona fide threat emerges. This will avoid much of the political  consternation that has arisen in the past from nuclear weapon experts  advocating weapons retention and even testing in space. After all, we  can't reliably divert an NEO until we know much more about its   structure. This we'll get from a decade of dedicated microsatellite  missions. Some of these missions may even have as a side experiment  moving very small (10-50 meter class) NEOs by impacting them. This  could give us much of the necessary experience should a true threat  emerge in the near future. Another benefit of a focused international NEO space mission suite is  public awareness and enthusiasm. From a scientific standpoint, these  are primordial objects--the stuff of which we were made. People  throughout the world, as well as the entire scientific community, will  truly embrace such an exciting endeavor. Moreover, space visionaries  often look to the NEOs as the raw material of eventual space  industrialization. We originally chose the title "Clementine" for the  1994 lunar and NEO probe launched by the DoD for this purpose. An old  American song about a frontier miner's daughter, Clementine, was the  origin of the mission's name. We hoped to evoke not only the spirit of  the frontier but also to leverage the appeal that valuable lunar and   asteroid mineral resources might have. In summary, I believe we have an opportunity to harness public  interest, government attention and existing expertise on the NEO  problem. An objective program should have two complementary parts.   First, to detect and to catalog virtually all threatening objects.   This can be considerably easier and cheaper if the US DoD can be  persuaded to adopt it as part of its current space surveillance  mission. Second, we should mount a modest, low-cost program to fully  characterize the composition and structure of all classes of NEOs. The  latter can and should be an international effort involving space  agencies around the world. When, and not until, we find a likely threat  is the time to work hard on mitigation.

# AT Politics – Plan Popular

Science is uniquely popular seen as creating jobs and economic prosperity

Mervis 11 (Jeffrey Mervis, deputy news editor of Science magazine, based in Washington, D.C., where he oversees the journal's news coverage of science policy issues, “How Science Eluded the Budget Ax – For Now”, *Science* Vol 332 no. 6028 pp.407-408 , April 22nd, 2011,

When details of the 11th-hour budget compromise that kept the U.S. government running emerged last week, it became clear that science programs fared relatively well. True, most research agencies will have less to spend this year than they did in 2010 (see [table](http://www.sciencemag.org.ezproxy.baylor.edu/content/332/6028/407/F2.expansion.html)), and the totals generally fall well short of what President Barack Obama had requested when he submitted his 2011 budget 14 months ago. But the legislators and Administration officials who struck the spending deal managed to slice $38.5 billion from a total discretionary budget of $1.09 trillion without crippling research activities. How did that happen? First and foremost, both Republicans and Democrats were working off a quiet but powerful consensus on the importance of science to economic prosperity. Last fall, Congress authorized steady increases for three key science agencies in a renewal of the America COMPETES Act, and Obama's recent statements on the 2011 negotiations emphasized the need to continue investing in clean energy and medical research as the overall budget is cut. Second, Senate Democratic leaders had crafted a spending plan in March that, although it failed to pass the full Senate, showed how it could be done. Finally, the so-called cardinals, who chair the 12 appropriations panels in the House of Representatives and the Senate that oversee every federal agency, found ways to protect research while trimming other programs to satisfy the deal's bottom line. “There was no magic to it,” explains Representative Frank Wolf (R–VA), whose panel has jurisdiction over the National Science Foundation (NSF), NASA, and the National Oceanic and Atmospheric Administration and the National Institute of Standards and Technology within the Commerce Department. “Science has been a priority for me and the other longtime members of the committee because you're talking about jobs and about helping America maintain its economic leadership,” says the veteran legislator, who entered Congress in 1981. “There has not been any controversy about this.” His appropriations counterpart, Senator Barbara Mikulski (D–MD), says she hopes that consensus will translate into “smart cuts that don't cost us our future. I support science funding that can spur American discovery and ingenuity to create jobs for today and jobs for tomorrow.”

# AT Poltics – Lobbying

Major players like Boeing lobby for NASA. Political Capital not needed.

Associated Press 2011 [“Boeing spends $4.1M lobbying on space, defense” Associated Press, 06.30.11, 09:56 PM EDT  <http://www.forbes.com/feeds/ap/2011/06/30/business-industrials-us-boeing-lobbying\_8544876.html>, PN]

WASHINGTON -- Airplane maker and defense contractor Boeing Co. spent almost $4.1 million in the first quarter lobbying the government on space issues, pilot training, and other aerospace and defense issues. Boeing gets about half of its revenue from defense work and space exploration. Its lobbying included NASA funding, funding for the International Space Station, commercial spaceflight and science education. It also lobbied on commercial aviation issues including aviation safety, foreign repair stations, and a revamped, satellite-based system for air navigation. Boeing also took an interest in funding for the Federal Aviation Administration.

Alabama Congress-woman supports pushing plan in Congress.

Do in 2011 [Trang, Staff Writer for WAFF48News, “Rep. Terri Sewell to be voice for TN Valley on NASA affairs”, *Jun 10, 2011 5:53 PM,* <http://www.waff.com/story/14884640/rep-sewell-to-be-voice-for-tn-valley-on-nasa-affairs-in-washington>, PN*]*

Huntsville, AL (WAFF) -North Alabama leaders are looking for help from other parts of the state to maintain Huntsville's space legacy. Alabama's 7th District Congresswoman Terri Sewell met with the Tennessee Valley's "Second to None" committee on space exploration Friday morning. Although Sewell represents a district to Madison County's south and west, she was actually born in Huntsville. She said ensuring that North Alabama continues to be at the forefront of space and technology is good for the entire state. "I believe that the city of Huntsville is a shining example of all that is right about American innovation and technology and science," Sewell said. "And so I'm here to listen and to learn and to be a better advocate on behalf of the whole state." NASA's Constellation program is essentially dead, but the Marshall Space Flight Center on Redstone Arsenal is now the program manager for the heavy-lift module of the next rocket to be developed. Though just a freshman representative, Sewell is a member of the House Science and Technology committee, which local leaders hope will give North Alabama an additional voice in Washington

Florida Senator not only personally supports NASA policy development, but also is key in his re-election.

Stern in 2011 [S. Alan | Guest columnist, S. Alan Stern is a planetary scientist and aerospace consultant. He formerly was NASA's associate administrator in charge of science. 12:00 a.m. EDT, June 24, 2011 “Commercial space ready to take the lead” Orlando Sentinel, <http://www.orlandosentinel.com/news/opinion/os-ed-alan-stern-062411-20110623,0,6205009.story>, PN]

Earlier this month, I and several others spoke in the Florida Forward public event in Orlando, at which U.S. [Sen. Bill Nelson](http://www.orlandosentinel.com/topic/politics/government/bill-nelson-PEPLT007414.topic) outlined his work to forge a space future via the new NASA authorization bill he helped write. Authorization bills are important legislation, but they do not appropriate funds — appropriations bills do that. So the senator must now work to pass appropriations for commercial space activities that can bring needed jobs to Florida. I, for one, offer to help. Sen. Nelson has been a leader to whom other senators turn when considering issues relating to space. With NASA's crucial commercial space budget under attack, he has a golden opportunity to lead the fight for this funding. If he does, he'll be putting an ace in his deck for the 2012 campaign. If he doesn't, he'll cede this powerful card to others, including those who seek his Senate seat.

# AT Politics – NASA Lobbying

Various groups are lobbying for NASA and the continuation of space exploration—their spending and size forms a large presence in Congress.

Royanye, 7/11 [OpenSecretsBlog, “Bachmann Hires Former Gingrich Staffers, NASA in Lobbying Crosshairs and More in Capital Eye Opener: July 11” 7/11/11, <http://www.opensecrets.org/news/2011/07/bachmann-hires-former-gingrich-staffers.html> mjf]

Despite the end of the space shuttle program, lobbying in the aerospace industry remains strong. During the first quarter of 2011, a total of 78 groups lobbied NASA. Some of these groups include Space Exploration Technologies and the Aerospace Industries Association of America. Although lobbying data is only available through the first quarter, the number of groups that have lobbied NASA so far in 2011 is not far behind the total number of groups that lobbied in 2010 and 2009. In 2010, 107 clients lobbied NASA, and 101 did in 2009, research from the Center for Responsive Politics indicates. The Aerospace Industries Association of America spent about $226,000 lobbying during the first quarter of this year. The group lobbied of behalf of the shuttle launch and a sustainable vision for space exploration, among other things. Aside from lobbying NASA, more than 100 organizations lobbied on issues relating to aerospace during the first quarter of 2011, research from the Center for Responsive Politics shows. The NASA Aeronautics Support Team is one of those groups lobbying in the aerospace industry. During the first quarter of 2011, this group spent $30,000 lobbying on aerospace issues. Specifically, it lobbied on include funding for NASA and aeronautics and exploration funding, lobbying reports show. Second-quarter lobbying data, which could indicate if there was an increase in lobbying as the final launch date approached, will be available on OpenSecrets.org later in July, after filings are submitted to Congress on July 20.

NASA funding has bipartisan support in the House of Representatives—Representatives want to protect NASA jobs in their home state.

Matthews, 09 [Orlando Sentinel, “Florida lawmakers lobby Obama for more NASA funding” 11/23/09, <http://blogs.orlandosentinel.com/news_space_thewritestuff/2009/11/flo.html> mjf]

More than 80 U.S. House members wrote President Barack Obama today, urging the White House to increase NASA funding by up to $3 billion annually so that the agency can accelerate plans to send astronauts beyond low-Earth orbit. The letter, spearheaded by Democratic U.S. Rep. Suzanne Kosmas of New Smyrna Beach, attracted the support of most Florida House members and several lawmakers from California and Texas. Those three states are directly tied to NASA’s human spaceflight program. “We believe an increased level of funding is essential to ensure NASA has the resources needed to meet the mission challenges of human space flight,” wrote the lawmakers, including U.S. Reps. Bill Posey, R-Rockledge, and Alan Grayson, D-Orlando. NASA plans to retire the space shuttle in 2010 but is not expected to build a replacement before 2017, a gap that should decimate the NASA workforce. Lawmakers have asked for more NASA funding to accelerate the next program or pick another program that could do the job. The letter was aimed at showing the White House that NASA funding has broad funding in Congress, although the 81 signatures representless than 20 percent of the 435-member House. Surprisingly, the list did not include the signatures of two key House lawmakers: U.S. Rep. Bart Gordon, D-Tenn, who chairs the House Science and Technology subcommittee and U.S. Rep. Gabrielle Giffords, D-Arizona, who heads the subcommittee on Space and Aeronautics. U.S. Rep. Alan Mollohan also did not sign the letter. The West Virginia Democrat chairs the House subcommittee that oversees NASA funding.

# AT Politics – NASA Lobbying

The American public is willing to lobby on behalf of NASA—the citizen lobbyists represent 30 states and lobbied to a majority of House Representatives.

Powell, 10 [Chron Houston and Texas News, “Unpaid lobby goes to bat for NASA”, 5/21/11, <http://www.chron.com/disp/story.mpl/metropolitan/7017018.html> mjf]

Rice University doctoral candidate Laurie Carrillo flew to Washington, D.C., on her own dime to stump for NASA, one of 152 students and other unpaid citizens who have taken up the call to save space agency programs by knocking on the doors of Capitol Hill. “Maybe 20 percent of the people are still neutral, sort of wait-and-see. But their antenna are up, and I think that's really heartening,” said the native of San Antonio who began her distinguished academic career at Rice with a $48,000 scholarship from NASA headquarters. Frank Centinello, 27, a resident of Buffalo, N.Y., and a doctorate student in aerospace at MIT, is another of the so-called citizen lobbyists from 30 states. “I don't see this as fighting for my livelihood so much as fighting for planetary science and human space exploration,” said Centinello, who was with a delegation that visited his home state congressman, Rep. Brian Higgins, D-N.Y. The two doctoral candidates and 30 other students served as the vanguard in a canvassing operation across Capitol Hill by business leaders and local government officials that was quarterbacked by the Bay Area Houston Economic Partnership. The effort by Citizens for Space Exploration relied upon students and business people across the country to gain access to lawmakers or staff members as teams visited 355 of the 535 House and Senate offices this week. “I haven't met any opposition yet. But I'm kind of looking forward to that, actually, because it would make for a more interesting discussion,” said Centinello. The onslaught is one more maneuver by pro-NASA organizations and lawmakers to turn back the Obama administration's proposal to end the $108 billion back-to-the-moon program.

# AT Politics – Bi-partisan

Space-based policies have bi-partisan support in Congress.

Gasser in 2011 [Andrew, President of TEA Party in Space, Retired Air Force/Navy Aviation General that worked in close contact with NASA, “More Bi-Partisanship on the Hill” <http://www.teainspace.com/more-bi-partisanship-on-the-hill/>, PN]

In a bi-partisan letter, Senator Patti Murray (D-WA) and Senator Saxby Chambliss (R-GA) wrote a letter asking for competition of the booster portion only. This is important as well. The calling for competition with SLS is important for NASA; however, it is more important for the taxpayer. TPIS is a non-partisan organization. Whenever we see senators on either side of the aisle being fiscally responsible and embracing the free market, we need to acknowledge it. Being fiscally responsible is not a liberal or conservative, democrat or republican. It is just common sense. Senator Warner also penned the following: It is clear the SLS will be a critical component of our national space program in the coming years. As we move forward with difficult and necessary budget decisions, it is essential for NASA to prove it takes seriously its responsibility to spend taxpayer dollars in a manner that is efficient, sustainable, and cost-effective. Language like this needs to be commended where ever it is found. We need to hear a lot more of this coming from both sides of the aisle. Senators now calling for competition with SLS include Senators Feinstein (D-CA), Boxer (D-CA), Shelby (R-AL), Warner (D-VA), Murray (D-WA), and Chambliss (R-GA).

Plan Bipartisan – Committee on Science and Technology will push

Spaceref.com 07(“*Subcommittee Questions NASA's Plan for Detecting Hazardous Asteroids* “, http://archives.democrats.science.house.gov/press/PRArticle.aspx?NewsID=2036, TDA)

The U.S. House Committee on Science and Technology's Subcommittee on Space and Aeronautics today examined the status of NASA's Near-Earth Object (NEO) survey program, reviewed the findings and recommendations of NASA's report to Congress, and sought to assess NASA's plans for complying with the NASA Authorization Act of 2005 regarding NEOs. "NASA's NEO survey program is our 'insurance policy' against getting taken by surprise by an incoming asteroid. Much progress has been made in detecting and cataloging the largest NEOs over the last decade. However, much more remains to be done," said Udall. "We need to survey the smaller but still potentially hazardous asteroids that could do significant damage if they impact or explode above the Earth's surface. While the probability of such a direct hit is low, we in Congress have a responsibility for the safety of American citizens and we have directed NASA to come up with a survey plan. NASA didn't deliver a plan that would get the job done. I will continue to work with NASA and hold the agency accountable until their plan is complete." NEOs are asteroids and comets of varying sizes whose orbits come near to that of the Earth, thereby posing a potential threat of collision at some point in the future. The Committee has a long history of bipartisan interest in the potential threat posed by NEOs, in opportunities offered by NEOs for scientific research, and as potential extraterrestrial sources of minerals and other materials over the long run. The Committee's involvement began in the early 1990s under then-Chairman George Brown with legislation directing NASA to conduct workshops on detecting and intercepting NEOs.

# **AT Politics – Congress**

Asteroid detection and deflection garners strong support in Congress

Asaravala 05 (Amit, reporter for Wired Science Online, “Congressman Backs Asteroid Agency” <http://www.wired.com/science/space/news/2005/06/67697> 6.01.05) JM

A plan to assign a government agency the task of protecting the Earth from a catastrophic asteroid strike is being endorsed by a senior member of the U.S. House Science Committee. But a related space mission to track an asteroid that may hit Earth in 2036 can't seem to get off the ground. Rep. Dana Rohrabacher (R-California) said in a phone interview on Friday that he supports former Apollo astronaut Russell Schweickart's proposal to assign responsibility for dealing with threatening asteroids to a government agency. Rohrabacher said he will push Congress and the president to "take action on this by the end of the year." The appointed agency would have the authority to deflect or destroy a threatening asteroid, most likely with the help of NASA and the Defense Department. It would also mobilize emergency-response teams if an asteroid impact could not be avoided. Schweickart first proposed the idea last month, during a presentation at the International Space Development Conference in Arlington, Virginia. Both Rohrabacher and Schweickart acknowledge the chance of an asteroid strike is extremely small. But they argue that the consequences of an impact make it necessary to prepare in advance. "I think it's worthwhile for us," said Rohrabacher. "If something can destroy something the size of Rhode Island and disrupt the ecosystem of the world, it's important to us." So far, NASA's response to the idea has been positive.

Time frame for a asteroid hit is unpredictable and Congress supports saving the planet

Keim 09(How to Defend Earth Against an Asteroid Strike By Brandon Keim March 27, 2009, is a Wired Science reporter and freelance journalist <http://www.wired.com/wiredscience/2009/03/planetdefense/> G.L)

In troubled economic times, it’s often hard to convince the government to fund space science. Heck, at least those much-studied fruit flies live on our planet. But there’s one field of research that the public should be happy to support: keeping the Earth from being pummeled by asteroids. And there is no shortage of ideas for how to do this. Earlier this month, a skyscraper-sized asteroid passed within 50,000 miles of Earth — a galactic hair’s breadth separating the planet from an impact like one that flattened 800 square miles of Siberian tundra in 1908. Then there’s an asteroid spotted in 2004 and called Apophis. Astronomers originally thought it might hit Earth in 2029. Then they decided that it couldn’t. Finally they moved back the clock to 2036. The uncertainty is understandable, but not exactly reassuring. And even if Apophis misses, some other rock big enough to put a serious dent in Earth and everything living here will take dead aim for us someday. It’s just a matter of time. Some researchers put the odds of a civilization-wrecker at one in the next 300,000 years, others at 1 in 10 for the next century. But when our luck finally runs out, humanity will have something even more useful: guns. As described in the scheduled proceedings of the upcoming first International Academy of Astronautics Planetary Defense conference, engineers have come up with plenty of ways to nudge an Earth-bound asteroid off-course, or failing that, obliterate it from its existence. Here are some of their ideas.

Congress wants Space programs

Space politics 11(Posey wants to go back to the Moon April 7, 2011 at 8:48 am · Filed under Congress, NASA, <http://www.spacepolitics.com/2011/04/07/posey-wants-to-go-back-to-the-moon/>, )

Congressman Bill Posey (R-FL) has been vocal recently about making human spaceflight NASA’s top priority in a constrained budget environment. Now he’s more specific: not only does he want to support human spaceflight, he wants NASA to return to the goal from the Vision for Space Exploration of sending humans back to the Moon, and is making a longshot bid to make that happen. In an op-ed in Florida Today on Thursday, Posey says he plans to introduce legislation “calling for NASA to resume the goal set forth in the 2005 NASA Authorization Act to return to the moon.” In the op-ed, Posey reiterates a number of past arguments about supporting human spaceflight, including its role as an “economic driver” and its military importance (again, as in his statement recently to the House Budget Committee, likening space to “Earth’s Golan Heights.”) He doesn’t go into detail, though, about why a return to the Moon would do more on those fronts than something like the administration’s plans for human missions beyond Earth orbit that don’t, at least in the foreseeable future, including missions to the lunar surface. “We must make the moon mission our highest priority within a NASA budget that is becoming increasingly distracted with other less important pursuits,” he argues. “The moon is achievable within the budget constraints that are necessary to secure America’s future.”

# AT: low probability

The plan is like an insurance policy-even the low probability is worth it because we prevent the disaster from occurring.

IRWIN I. SHAPIRO et al in 10,( Harvard-Smithsonian Center for Astrophysics, Chair FAITH VILAS, MMT Observatory at Mt. Hopkins, Arizona, Vice Chair MICHAEL A’HEARN, University of Maryland, College Park, Vice Chair ANDREW F. CHENG, Johns Hopkins University Applied Physics Laboratory FRANK CULBERTSON, JR., Orbital Sciences Corporation DAVID C. JEWITT, University of California, Los Angeles STEPHEN MACKWELL, Lunar and Planetary Institute H. JAY MELOSH, Purdue University JOSEPH H. ROTHENBERG, Universal Space Network, *Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies Space Studies Board Aeronautics and Space Engineering Board Division on Engineering and Physical Sciences*, THE NATIONAL ACADEMIES PRESS, <http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf>)

Although the possibility of a large NEO impact with Earth is remote, conducting surveys of NEOS and studying means to mitigate collisions with them can best be viewed as a form of insurance. It seems prudent to expend some resources to prepare to counter this collision threat. Most homeowners, for example, carry fire insurance, although none expects her or his house to burn down any time soon. The distinction between insurance for the collision hazard and other “natural” hazards, such as earthquakes and hurricanes, is that we now have the possibility to detect and prevent most serious collisions. In the case of earthquakes, for example, despite efforts, primarily in China, Japan, and the United States, we cannot yet reliably predict either the epoch or the severity of an earthquake. We do nonetheless fund the analog of an insurance policy through studies of this hazard and through the design and construction of earthquake-resistant structures, and in development of plans for response and recovery. The goal is to reduce both the number of fatalities and the damage to property from earthquakes. According to available figures from the NRC report Improved Seismic Monitoring⎯ Improved Decision-Making: Assessing the Value of Reduced Uncertainty,6 the United States alone now spends well in excess of $100 million annually on this suite of efforts. The annual United States death rate from earthquakes, averaged over the past two centuries for which data are available, is approximately 20 per year, with 75 percent of that figure attributed to the 1906 San Francisco earthquake, mostly from related fires. For Japan, both the expenditure and the fatality figures are far larger. China and other parts of Asia have also suffered massive casualties from earthquakes. The September 2009 earthquakes that caused loss of life in Indonesia, Samoa and American Samoa highlight this ongoing threat to human life. Given the low risk over a period of, say, a decade (see Chapter 2), how much should the United States invest in this insurance? This question requires a political, not a scientific, answer. Yet the question bears upon the committee’s charge. The committee was asked to recommend the optimum approach for each of the tasks, with the definition of “optimum” left to the committee. A unique characteristic of the NEO research premiums, which distinguishes them from the usual types of insurance, is that the entire premiums would be directed towards the prevention of the catastrophe. In no case, however, is it wise to consider application of techniques more than a few decades into the future. The technologies available at that time would likely be both more efficient and more effective, rendering present approaches obsolete. This is not to suggest waiting for those future technologies, leaving Earth unaware and threats to Earth unmitigated in the meantime.

# AT Nuclear Deflection Bad

Nuclear deflection is a reliable method and can prevent fragmentation

IRWIN I. SHAPIRO et al in 10,( Harvard-Smithsonian Center for Astrophysics, Chair FAITH VILAS, MMT Observatory at Mt. Hopkins, Arizona, Vice Chair MICHAEL A’HEARN, University of Maryland, College Park, Vice Chair ANDREW F. CHENG, Johns Hopkins University Applied Physics Laboratory FRANK CULBERTSON, JR., Orbital Sciences Corporation DAVID C. JEWITT, University of California, Los Angeles STEPHEN MACKWELL, Lunar and Planetary Institute H. JAY MELOSH, Purdue University JOSEPH H. ROTHENBERG, Universal Space Network, *Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies Space Studies Board Aeronautics and Space Engineering Board Division on Engineering and Physical Sciences*, THE NATIONAL ACADEMIES PRESS, [http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4\_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf)\](http://www.fas.harvard.edu/~planets/sstewart/reprints/other/4_NEOReportDefending%20Planet%20Earth%20Prepub%202010.pdf%29%5C)

Nuclear outputs are well determined from tests. Just as with kinetic impactors, the greatest uncertainty in their use lies in the NEO response, particularly our understanding of shock propagation through low-density material and of the large variety of NEO structures and behavior upon impact that could be encountered. Consider as examples: Asteroid Itokawa, like many asteroids, appears to consist of rubble weakly bound together by gravity. It was found to have a bulk density of about 2 g/cm3 (Abe et al., 2006), i.e., a porosity near 40 percent. Some asteroids, such as Eros have densities near that of solids, but are probably heavily fractured (Britt et al., 2003). However, 2001 0E84 is a large (~1-kilometerdiameter) body rotating so rapidly that it must be very strong and is therefore not very porous; (6187) 1986 DA is essentially a solid iron NEO.1 All other known fast-spinning bodies are small (<200 meters diameter). There are also low-density objects, like asteroid Mathilde, where observed craters suggest a very porous surface with larger efficient shock dissipation. The bulk density of cometary nuclei is likely <1 g/cm3. NEOs have a wide range of shapes, sizes, and densities. The bulk density of those asteroids for which it is known is comparable with that of materials used in nuclear effects simulations (e.g., gravel ≈ 1.5 g/cm3 and gravel with sand ≈1.9 g/cm3). The sophisticated computer simulations discussed here were used to model one of many possible structures, a 1-kilometer-diameter structure with a high-density core of 2.63 g/cm3 surrounded by a surface layer of 1.91 g/cm3. Experimental results indicate that high porosity can significantly reduce the shock strength and rebound of shocked material (Holsapple, 2004). The impulse from a given energy coupled into a porous surface is lower than it would be for a nonporous solid, and the ejecta is reduced. A complete and adequate crushing model is necessary to determine the shock effects on a porous body. High porosity dissipative surfaces lead to quantitatively similar uncertainties for both nuclear explosives and kinetic impactors, and an impactor mission to study asteroid structure would provide useful data for both approaches. The limited set of conditions studied in the simulation described below begin to examine uncertainties in important physical properties, so as to understand the application of nuclear explosions to NEO orbit change. They are not exhaustive, and there is much more to learn about the effects of shape, spin, and structure. Except for NEOs 10 kilometers in diameter or larger, it is generally likely that nuclear explosives can provide a more than large enough ΔV, with little material loss and with essentially no danger of fragmentation.