Fact or Fiction?

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Killer Rocks

If you were Mother Earth, which would worry you more—killer rocks that can destroy the biosphere of entire continents, or parts-per-quadrillion of toxins that might cause a few additional cancer deaths per decade? If we could ask nature how it might rank environmental calamities that have occurred so far, all leading contenders would be natural, not man-made. Easterbrook[1] sums it up very nicely:

> "The biosphere that some environmentalists today contend cannot resist so much as an oil spill or an overzealous crew of loggers, has in the past survived the unimaginable multiple whammy of the atmosphere set on fire by a killer rock strike; followed by years of summer frost, megasmog, and acid rain from hell; followed by decades or centuries of continuous global volcanism set loose by the rock's effect on the crust. This point is not made to rationalize oil spills or clear cutting. No human environmental misuse should ever be justified on the grounds that the environment can recover, even if that is true. The point here is simply to compare the sorts of people-caused environmental insults that women and men today reflexively describe as 'disasters' against the genuine disasters nature has survived in the past."

There have been five really massive extinctions of life on Earth, with the most recent occurring about 65 million years ago. An object about 10 km across impacted Earth, ending the Cretaceous period and wiping out the dinosaurs. The energy released was equivalent to the explosion of about a hundred-million megatons of TNT. This is about ten thousand times the energy that would have been released by the simultaneous explosion of all nuclear weapons on earth in the 1980s, before the superpowers started to dismantle their stockpiles.[2]

Asteroids & Comets ... What's the Difference?

A few definitions first. Asteroids are slabs of rock, dirt or metal, while comets contain all this stuff held together by gravity. Comets pose a graver danger, because they approach the earth at about 50 km/sec (>100,000 mph)—about twice the speed of asteroids. A comet would strike earth with about 10 times the energy of a comparably sized asteroid, and only give us about half the time to intercept it in space. Meteorite is the term for anything that hits the earth, whether it is an asteroid or comet.

Astronomers report that Earth has been bombarded by asteroids and comets large enough to cause global environmental catastrophe about once every 300,000 years. This suggests that our "fragile" environment has taken many serious beatings over the years, and has always managed to come back. In the period from 1975 to 1992, military satellites detected 136 large explosions caused by asteroids or comets in the upper atmosphere, averaging eight per year. The typical explosive force was 15 kilotons, which is about the same as the Hiroshima bomb.

Because satellites see only about one-tenth of the Earth at any moment, it is projected that the true rate of upper-atmosphere strikes may be closer to 80 per year.[1] Currently, at least 300 objects greater than 1,000 meters in diameter are known to have orbits that intersect Earth's.

Events on Earth aren't as far-fetched as you might think. In 1908, in a remote northern region of Siberia called Tunguska, a vast fireball exploded with the force of 1,000 Hiroshima bombs. The heat incinerated herds of reindeer and charred tens-of-thousands of evergreens across hundreds of square miles.[3] The area is so remote that few human deaths occurred. However, if the Tunguska rock had arrived on the same trajectory a few hours later, when the Earth had turned a little more, St. Petersburg would have been destroyed—along with most of its inhabitants, and perhaps the course of history, because one of its residents included a certain Vladimir Ilich Ulyanov, also known as Lenin.[2]

In 1989, a 1,000-meter asteroid was discovered only after it had crossed the Earth's orbit at a spot where Earth had been just six hours before. In May 1996, another asteroid of about the same size was discovered only four days before it sped across Earth's orbit, ultimately missing our planet by four hours.[4] If you're really concerned about rocks from outer space, stay away from Wethersfield, CT. In April 1971, a meteorite caused minor damage to a house in this town, and 11 years later, on November 8, 1982, another meteorite damaged a second house in the same town. These two impacts were only about 1 km apart.[5]

What Are the Chances?

Would you believe that the risk of death from an asteroid impacting Earth lies in the same range of

Average Risk of Death to an Individual Over a 50-yr Period, as Estimated from Historical Frequencies & Current Populations

Worldwide: Risk of death from:*	
Asteroid impact	1 in 20,000
Volcanic eruption	1 in 30,000
U.S. only: Risk of death from:*	
Auto accident	1 in 100
Electrocution	1 in 5,000
Airplane crash	1 in 20,000
Hurricane	1 in 25,000
Tornado	1 in 50,000
Lightning	1 in 130,000
Earthquake	1 in 200,000
Fireworks accident	1 in 1 million**
Food poisoning by botulism	1 in 3 million**
Drinking water with EPA limit of trichloroethylene	1 in 10 million**

** From Zebrowski, ref. 4.*
*** From Chapman and Morrison, ref. 6.*

probabilities as the risk of death from a hurricane or airplane crash? This is because of the fact that, even though major asteroid impacts are unlikely in a given year, when they do occur, they have the potential to generate destruction of enormous proportion.[4]

Chapman and Morrison[6] have stated that the chances of a typical U.S. citizen's death from a killer rock from space is much higher than the widely publicized threats from certain carcinogens, poisoning by commercial foods and pills that have been deliberately tampered with, fireworks accidents, terrorist bombs and airline hijacking. The table above lists the risk of death during a 50-yr period resulting from some of life's many hazards.

What to Do?

A NASA workshop in 1992 resulted in a proposal called the "Safeguard Survey," which consisted of a scheme to monitor near-Earth space hazards using a specially built network of telescopes. The start-up cost would be about $50 million, and running costs some $10 million per year. Over a period of 20 to 30 years, Spaceguard could identify all the potentially dangerous asteroids in the inner solar system, and also give a few months' warning of the arrival of a threatening comet.[2] Where are we on this? Morrison[7] has pointed out that there currently are less than a dozen people in the entire world who are searching for NEOs (near-Earth objects)—fewer people, as he puts it, than it takes to run a single McDonald's® restaurant.

We currently spend billions of dollars on many issues that cause us to worry about parts-per-zillion of something that no one can really prove is, or is not, a problem. A paper presented to a Department of Energy conference in 1990, for example, estimated that the cost-per-cancer-avoided in Superfund clean-ups exceeds $15 billion.[8] Some of this zeal is an attempt to save lives of future generations. As Cohen[9] has pointed out, however:

> "The lives saved are those of people living many thousands of years in the future, who bear no closer relationship to us than those now living in under-developed countries, whose lives we disdain to save at one-millionth of these costs. In the second place, there is an excellent chance that a cure for cancer will be found in the next few thousand years, in which case these deaths will never materialize and the money will be wasted."

I don't know about you, but I, for one, would like to see of few of those millions that are being thrown at some hypothetical contaminant be spent looking for killer rocks from outer space. Future generations might well find a cure for cancer and heart disease, but will not be able to prevent outer space from shooting rocks the size of mountains at Earth on occasion. Although it might not occur tomorrow or next year—or in the next thousand years—it will happen again. The best thing we could do for those alive at the time it happens is to start preparations right now.

If you're still skeptical, remember the recent impacts on Jupiter. One of the chunks of the comet Shoemaker-Levy 9 that crashed into Jupiter in July 1994 left dust clouds that grew larger than the whole Earth an hour after impact.[10] This would have wiped out life on Earth as we know it. Milloy[11] says it best. In reviewing a *Washington Post* article that discussed global warming and also killer rocks from space, he says, "Pardon me, but if we're going to be concerned about doomsday scenarios, I would be more concerned about getting clocked by space rubble."

Lastly, if you want to get Hollywood's version of this type of doomsday scenario, see either *Deep Impact* or *Armageddon*, which opened in theaters this past summer. P&SF

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