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Limits to Insurance

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Limits to Insurance

It is inevitable that a meteorite will threaten a major urban centre. It is very unlikely to happen this year or this decade, but some day it will happen. The possible damage will be catastrophic. A typical insurance policy promises coverage, but there are limits to the capacity of insurance to pay. Moreover, damage from an urban meteor strike does not fit the principles of insurance coverage, and insurers may decide to exclude this peril before the strike occurs. National and international policy makers should develop preparedness plans, assuming that they will manage society's recovery from a meteorite strike in a major urban centre, including responsibility for financial matters.

A brief history of insurance

The basic concept of insurance involves many policyholders pooling the modest premiums they pay to cover the random and often significant losses that affect a few. This concept has been in practice for a very long time, and was in place prior to the founding of the modern insurance industry. For example, Chinese literature from more than 5,000 years ago shows that ship captains would stop before entering dangerous waters and redistribute their cargo. Several captains might experience a partial loss if a ship floundered, but none a total loss.

The modern insurance industry formed after the Great Fire of London in 1666. Fire swept through nearly 80 percent of the largely wooden city, destroying more than 13,000 homes and 100 churches including St. Paul's Cathedral (Insurance Bureau of Canada, 2000).

Following the fire, there arose the demand for fire suppression and insurance protection. Insurance grew over the next three hundred years to cover a remarkably broad range of perils.

By 1706, the Sun Fire Office in London was offering coverage on contents as well as dwellings. Insurance companies opened for business in Scotland by 1720, in Germany by 1750, in the United States by 1752, and in Canada by 1804 (Insurance Bureau of Canada, 2000). Insurance is now available around the world. The United Nations has described the industry as an essential foundation for a nation's economic success.

During the early 20th century, there was a major reform in typical coverage. Policies covering named perils like fire and theft were largely replaced by comprehensive, multi-peril or all-risk policies. This included homeowners' and commercial insurance coverage. These policies cover all risks that are not specifically excluded. In addition to property insurance, insurance has become a remarkably flexible mechanism to protect oneself from a wide variety of threats.

The general insurance industry is largely independent from the life insurance industry. Although a meteorite impact would undoubtedly have dramatic affects for both, it is the general insurance industry that is more actively engaged in the assessment and management of natural hazard risk. This paper focuses on the impacts of a meteorite strike on the general insurance industry.

Insurance and natural hazards

Insurance protection is available for damage caused by most natural hazards. There are differences around the world, but a typical all-perils insurance policy in North America and Europe provides coverage against damage caused by hazards that include severe wind, tornado, hurricane, hail, freezing rain, lightning, heavy snowfall, freezing pipes, and meteorites. Additional coverage can often be purchased for sewer back-up and earthquake damage if requested (Insurance Bureau of Canada, 1994).

Some hazards, like flood and landslide damage, are not covered by a standard insurance policy, or endorsements, because they do not satisfy the underwriting requirements. The government may provide insurance-like coverage for these risks but they are typically not covered by private insurers.

Risks should meet three broad criteria before they are accepted as insurable:

- There is a random occurrence of loss;
- A relatively large population is exposed to a risk and is willing to pay for coverage; and
- A relatively small share of the exposed population is likely to incur a loss at any particular time.

Flood and landslide losses are not random. Properties located in areas of high risk are more likely to experience damage. Private insurance is largely not available in such instances.

The impact of a small meteorite strike would meet these three criteria. Damage caused by a meteorite smaller than one metre would affect a small share of the population and

should be an insurable risk. A meteorite exceeding 2,000 metres, however, would end civilization as we know it. It would affect too large a share of the population. The impact of a large meteorite does not meet the criteria of insurability. This paper will explore how large an event could be covered by insurance.

A strike by a meteorite with a diameter of 30 metres in a large urban centre could affect a large share of the exposed population, with most experiencing a loss at the same time. It does not fit the broad criteria used to determine insurability. Nevertheless, at this time most insurance policies provide coverage for damage due to a meteorite strike. This may be the result of the shift from named-peril policies to all-risk coverage. This led to the establishment of insurance coverage for most perils, but only with time have insurers begun to consider and sometimes exclude coverage of certain hazards. One example involves the decision of many insurers over the past few years to exclude damage caused by terrorism from standard coverage.

Insurance coverage of meteorite damage

Damage due to the direct impact of a meteorite is covered under general insurance policies. Generally speaking, given that the terms and conditions of an all-risk policy do not specify any exclusion of meteorite impact per se, insurance coverage will therefore normally exist. Named-perils coverage is no longer common, and the specific wordings of the policy need to be examined. However it would appear that meteorite impact damage is covered under a typical property policy.[1]

In addition to the direct impact, there will be additional damage due to the characteristics and nature of the impact. With respect to secondary effects of a meteorite impact, Munich Re analyzed a typical insurance policy and described the coverage as follows:

Fire

As a meteorite enters the Earth's atmosphere, the object heats up. In the event of an impact on land or explosion, there is a likelihood that fires to nearby buildings or forests may occur. If a fire results from a meteorite impact, this is usually covered under all-perils policies and at this point in time is not excluded.[2]

Explosion

Depending on the size and density of a meteorite, it is possible that the object may explode prior to actually impacting the surface. Such was the case for the object that exploded over Siberia in 1908. If a meteorite does reach the Earth's surface or explodes in the atmosphere, this is viewed as an explosion under a typical property insurance policy. Again, unless specifically noted, this peril is covered in most general property policies across Europe and North America.

Tsunami

Most of the world's surface is covered by ocean (71 percent) so a meteorite may generate a tsunami. Garshnek, Morrison and Burkle (2000) point out that a tsunami resulting from an ocean impact could cause fatalities and damage around the continental margins. Populated areas most immediately at risk include low lying areas like the Netherlands,

[1] Munich Re: "Topics 2001." pg. 41
[2] Insurance Bureau of Canada "Fire-Following – Options for ensuring insurance availability and affordability for homeowners and businesses in Ontario," April 21, 2003

Bangladesh, and the Atlantic coastal communities in North and South America. Major cities at risk due to their elevations include Halifax, Honolulu, Tampa Bay, New Orleans, Calcutta and Amsterdam (Garshnek, Morrison and Burkle, 2000) The catastrophic impact that is thought to have initiated the last Ice Age struck a shallow sea near Chixulub, Mexico and left tsunami deposits in Haiti, Texas and Florida's inlands (Ward and Asphaug, 2001).

Flood

Flood insurance is not normally covered under a typical property insurance plan. Most insurance exclusions refer to the rise of a river or overflow of a body of water. There is a general consensus that flooding caused by the impact of an object striking a body of water would be covered by a typical property insurance policy.

Earthquake

In an all-perils policy earthquake (or shake) coverage exists or an endorsement is available. With the exception of pure impact and pressure wave losses, the destructive results of meteorite impact are by and large included in the scope of coverage of the terms and conditions of insurance generally used throughout the world. It only takes an impact of a meteorite of several metres in diameter to potentially create a severe shake of the ground (Chapman et al., 2001).

In summary, meteorite damage is covered by a typical insurance policy.

Assessing the potential for meteorite damage

More than 100 meteorites are known to have impacted the Earth during the past century. The largest event occurred in 1908. A 30 to 50 metre meteorite exploded over Siberia on June 30th. That event devastated an area of 2,200 km^2 felling or seriously damaging all the trees and leaving the area scarred.

Space observation has revealed approximately one million objects in orbit around the Earth. More than 200 are between 10 and 30,000 metres in size. There is a distinct possibility that a large meteorite could strike Earth within the next century.

The impact can range from minor to catastrophic, depending on the size of the object, density, potential and capacity for detection and deflection, effectiveness of warning systems and the location of impact. A large meteorite strike would likely prompt other hazards including floods, fires, earthquakes and a tsunami. These secondary effects will compound the initial destructive force of the original meteorite strike and could have devastating impacts on the infrastructure of one or possibly more countries (Chapman, 2003).

NASA has undertaken to find by 2008, 90 percent of the objects near earth that are larger than 1,000 metres in diameter. The probability of a substantial impact this century is generally regarded as being low, but it is widely accepted that "a future collision of an asteroid or cometary nucleus with the Earth with catastrophic effects is inevitable unless technology is developed to modify the orbit of such bodies" (NASA, 2002).

If a meteorite larger than a few dozen metres diameter strikes a major urban centre, the insurance industry would sustain losses unlike anything it has experienced in its history. Fires, earthquakes, tsunamis and direct impact damage could overwhelm the capacity of the insurance industry to cope with the number and value of claims. In fact, the industry would likely not be able to cope if a meteorite strikes a major urban centre without the aid and intervention of government and international agencies.

While scientists assess how to defend the Earth from the threat of a meteorite impact, there is still no consensus on how this could or should be achieved. If we are not able to deflect the object and have it bypass the Earth, then we may seek to break it up. This will increase the likelihood of an impact with a densely populated region.

Insurers need to prepare

The insurance industry needs to assess its preparedness for a meteorite strike. Many insurers were not fully prepared when Hurricane Andrew struck Southern Florida in 1992, and again when terrorists attacked the World Trade Center on September 11th 2001. These events have led the industry to re-evaluate its preparedness and capacity to address major events. The industry has begun to establish partnerships with national governments and international agencies to ensure appropriate preparedness and capacity to respond to major events. A meteorite impact is a further example of a low probability/high cost event that must be addressed, and ideally this should take place well before the strike occurs.

When a large meteorite next strikes the Earth, there are a number of possible scenarios that could take place. Chapman, Durda, and Gold grouped meteorite impact consequences into three categories, based on the size of the meteorite. A 'Regional Disaster' will result with the impact of a multi-hundred metre object. The impact will cause localized fires within the immediate impact zone and shaking of the ground within the immediate vicinity of the impact. The resulting crater could be as large as 10,000 metres. Chapman et al. state that such an impact could result in catastrophic events including earthquakes, stratospheric dust or a "global night" as well as fires being ignited globally – additional categories can be found in Figure 1.

The cost of a meteorite impact

Trying to assess the costs of a meteorite strike on the Earth requires numerous assumptions. There have been few strikes of significant impact and size during periods of our recorded history, and meteorites have differing physical make-ups. This adds to the challenge of assessing the possible insured damage. In addition, those impacts that have occurred have been in several international jurisdictions creating virtually no effective insurance model for pricing or valuation. While insurance typically values premiums using historical events as a benchmark, this is not possible for meteorite strikes. We can compare the possible devastation in terms of costs of a meteorite strike with that of other disasters to create a rough assessment of the possible insurable costs of a significant meteorite strike in an urban area.

For this analysis we use the September 11th, 2001 terrorist attacks in New York and compare the impact with the Meteor Crater in Arizona and the Tunguska Incident in Siberia, to assess potential insurance claims with respect to a meteorite strike.

The terrorist attack on the World Trade Center represents the costliest disaster ever faced by the insurance industry. Total claims paid for property damage and business interruption was approximately US$21 billion. The area of devastation as a result of the twin tower attacks was roughly 0.25 km^2 (FEMA 2002)

The Meteor Crater in Arizona was caused by a meteorite approximately 30-50 meters in diameter. The crater that was created as a result of the impact has a diameter of 1,200 metres and an area of 1.13 km^2[3]. This is almost five times the area devastated by the World Trade Center attacks[4]. Severe debris pressure wave damage occurred over a much larger area. In their study, Garshnek et al., note that a meteorite with a diameter of 50 meters could potentially devastate up to 1900 square kms, an area 7,600 times larger than that damaged in New York. The Tungaska Incident, for example, resulted in severe damage over an area 8,800 times larger than that in New York and was also caused by a meteorite 30 to 50 metres in diameter. According to Demographia, that level of devastation is larger in size than the total urban land area for cities such as Toronto, London, Paris, New York and the Tokyo metropolitan area. Thus overall damage that

[3] Relates only to the size of the crater; excludes damage due to ejected material as well as pressure shock and fires

[4] National Aeronautics and Space Administration (NASA), http://neo.jpl.nasa.gov/images/meteorcrater.html

will result with the strike of a meteorite of similar size to the Meteor Crater in Arizona would lead to insurance losses far beyond anything that the industry could cope with.

If a meteorite with a diameter of 30-50 metres had struck the World Trade Center in 2001, then using the level of devastation discussed by Garshnek et al, we might estimate that the direct damage and insurance claims may have approached US$2 - $4 trillion. Such losses are well beyond anything the industry has ever faced, and it is unclear how the industry could continue to function.

It is important to acknowledge that this worst-case scenario combines the very low probability (ranging from one-tenth to one percent on an annual basis) that the Earth is struck by a meteorite larger than 30 metres in diameter, coupled with a low probability that the impact occurs on land (only 29 percent of the world surface is land mass) and that the impact strikes an urban centre (perhaps less than two percent based on the urban area of the United States[5]). The random nature of these events means that the impact will likely be with the ocean, or in a remote region, where the fatalities and insured losses would be greatly reduced. Nevertheless, the example illustrates that a 30 metre object could have a catastrophic impact on the global insurance industry.

Insurers' capacity to pay

The total capital in the world's non-life insurance industry in 2003 was US$1.3 trillion (Swiss Re 2004). As set out above, a meteorite of a few dozen metres in diameter could

lead to damage claims ranging from US$2 - 4 trillion[6] if the impact occurs directly in the heart of a major urban centre like New York, Tokyo or London. This is clearly beyond the capacity of the industry to manage.

Garshnek et al. (2000) point out that there has been analysis of methods to diverting these objects away from the Earth, but very little effort has been devoted to the idea of implementation of a disaster management plan with respect to a meteorite impact. Since insurers presently offer to cover damage caused by meteorite impacts, they will be motivated to participate in this planning.

Conclusion

Large meteorites have struck the earth in the past and will do so again. Insurance policies promise to pay for damage caused by a meteorite impact. Meteorites larger than 2,000 metres would likely cause so much damage that civilization as we know it would come to an end, and few would think about insurance issues. Meteorites larger than a few dozen metres that strike a major urban centre could overwhelm the insurance industry. There is a very low probability that this will occur, but the high consequences imply that the insurance industry should pay more attention to this hazard. Some specific actions the industry should consider:

- Should insurers and reinsurers continue to cover damage from meteorite impact?
- How can insurers encourage loss prevention and preparedness initiatives?

[5] www.demographia.com
[6] Based on total damage values of NYC terrorist attacks x 1500 (the factor by which the area of devastation in NYC must be multiplied by to equal 1900 square kms of devastation as proposed by Garshnek et al.

- How can insurers work with governments and international agencies to manage threats like meteorites that are beyond the financial capacity of the insurers to address alone?

Figure 1

Category: **Environmental Effect**	**Regional Disaster (300 m)**	**Civilization Ender (2,000 m)**	**K/T Extinctor (10-15,000 m)**
Fires -ignited by fireball and/or re-entering ejecta	Localized fire at ground zero	Fires ignited only within hundreds of km of ground zero	Fires ignited globally; global firestorm
Stratospheric dust -obscures sunlight	Stratospheric dust below catastrophic levels	Sunlight drops to "very cloudy day" (nearly globally); global agriculture threatened	Global night; vision is impossible. Severe multi-year impact winter
Other Atmospheric effects: -sulfate aerosols, water injected into stratosphere	None (except locally)	Sulfates and smoke augment effects of dust; ozone layer maybe destroyed	Synergy of all factors yields decade-long winter
Earthquakes	Local ground shaking	Significant damage within hundreds of km of ground zero	Modest to moderate damage globally
Tsunamis	Flooding of historic proportions along shores of proximate ocean	Shorelines of proximate ocean flooded inland tens of km	Primary and secondary tsunami flood most shorelines ~100km inland, inundating low-lying areas worldwide
Total destruction in crater zone	Crater zone ~5-10km across	Crater zone ~50 km across	Crater zone several hundred km across

** Table summarized from Chapman, Durda and Gold, "The Comet/Asteroid Impact Hazard: A Systems Approach", February 2001 SwRI White Paper, *www.boulder.swri.edu/clark/neowp.html*

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