Overview

We utilized a probabilistic asteroid impact risk (PAIR) model to stochastically assess the impact risk due to an ensemble population of Near-Earth Objects (NEOs). Concretely, we present the variation of risk with impactor size. Results suggest that large impactors dominate the average risk, even when only considering the subset of undiscovered NEOs.

Quantifying Hazards

Top: Hazard models are used to compute ground areas associated with overpressure and thermal radiation for four damage levels, shown above. The larger of blast/thermal is used for each damage level, and the affected population is computed. The population fraction in the right column is used to convert population within the damage regions to affected population or casualties.

Bottom: Dominant damage source is shown as a function of object size. Below 300m, the most likely outcome is no casualties. Blast and thermal drive damage for the most cases between 300-600m. Tsunami is the largest fractional damage source for impactors 600-800m, and global effects dominate for objects >900m. Note that this plot showed the fraction of the simulated scenarios driven by each hazard, not the relative rate of casualties.

Risk Assessment

Risk differs from hazard in that it includes the likelihood along with the consequence of an event. This section shows the quantitative risk results using the expected values as well as the output distributions.

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Contour plots represent the annual likelihood that a given population, or greater, will be affected by an object of a given size or smaller. The black line on the contour plots represents the 1-in-a-million per year probability. While the most severe consequences arise from large impacts, significant casualties are much more likely to result from smaller impacts and blast/thermal damage.

This plot shows the cumulative number of expected casualties per year, by damage source, as a function of impactor size. Two primary differences are seen compared to the previous plot. This figure includes the mean consequence and likelihood attributed to each impact scenario. Casualties are driven by local damage for impactors <500m and by global effects for larger objects. The relative consequence of tsunami is low compared to other sources.

We now compare the cumulative annual expected casualties for the total NEO population to the fraction of undiscovered objects. The difference between curves represents the reduction in perceived risk due to object discovery. Below 300m, the curves remain within a factor of 2, but for objects 1km and larger differ by an order of magnitude. This represents the belief that most large NEOs have been detected and pose little near-term threat to the Earth.

Conclusions

Average casualties are dominated by large impacts causing global effects. However, when considering only the undiscovered fraction of NEOs, the average cumulative risk decreases by an order of magnitude. At smaller impactor sizes, the annual expected casualty estimates are dominated by blast and thermal damage.

Acknowledgements and References