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A Probabilistic Framework for Asteroid Risk Assessment

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ABSTRACT

Quantitative assessment of the aggregate risk of asteroid impacts is a critical step in setting priorities among investments in observation and mitigation measures. Historical approaches to asteroid risk assessments have been informative, but can be improved by the use of probabilistic risk analysis techniques. To that effect, we present a new framework based on a probabilistic treatment of a broad set of key impact parameters. Those parameters are then input to a high-level impact effects model that uses population data to calculate the probability distribution of the number fatalities worldwide as well as other proposed risk metrics. We then use a simulation model to estimate a complementary cumulative distribution function for fatalities from asteroid impacts, as well as the probability of a cataclysmic impact, in one 100-year period. The resulting framework is extensible and modular, it can easily be used with other effect models or NEO characteristic data, and can be updated and improved with new observations. As a demonstration of this model, we present an assessment of asteroid risk worldwide and we evaluate the relative risk reduction of possible space-based mitigation methods. The demonstration results suggest that although the expected number of annual fatalities is small, the probability of a catastrophic loss of human lives and property is not insignificant. The results also indicate that some space-based mitigation methods can be very effective in reducing risks even in cases with relatively short lead times. While the issue is not addressed directly, these findings suggest that continued and improved observation remains a key component of reducing the overall asteroid impact risk. Finally, we present possible extensions and improvements of this framework to better inform researchers and planners in their allocation of limited resources for asteroid risk mitigation. We also present some of the lessons learned and some recommendations for future probabilistic risk analyses of asteroid impact threats.

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