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IMMEDIATE EFFECTS OF ASTEROID IMPACTS ON THE HUMAN POPULATION

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EXTENDED ABSTRACT

Asteroids that collide with the Earth produce impact effects such as wind blast, overpressure shock, thermal radiation, cratering, seismic shaking, ejecta out throw, and tsunami which may harm the human population. Multiple simulation runs of a 50,000 strong asteroid impactor sample were performed to measure the relative harmfulness of each of the produced impact effects (impact effect dominance) with respect to the human population across the Earth. The impactor sample was set up to reflect the statistical distributions of impact location, angle, and speed of the Near-Earth object (NEO) population as shown in Figure 1.

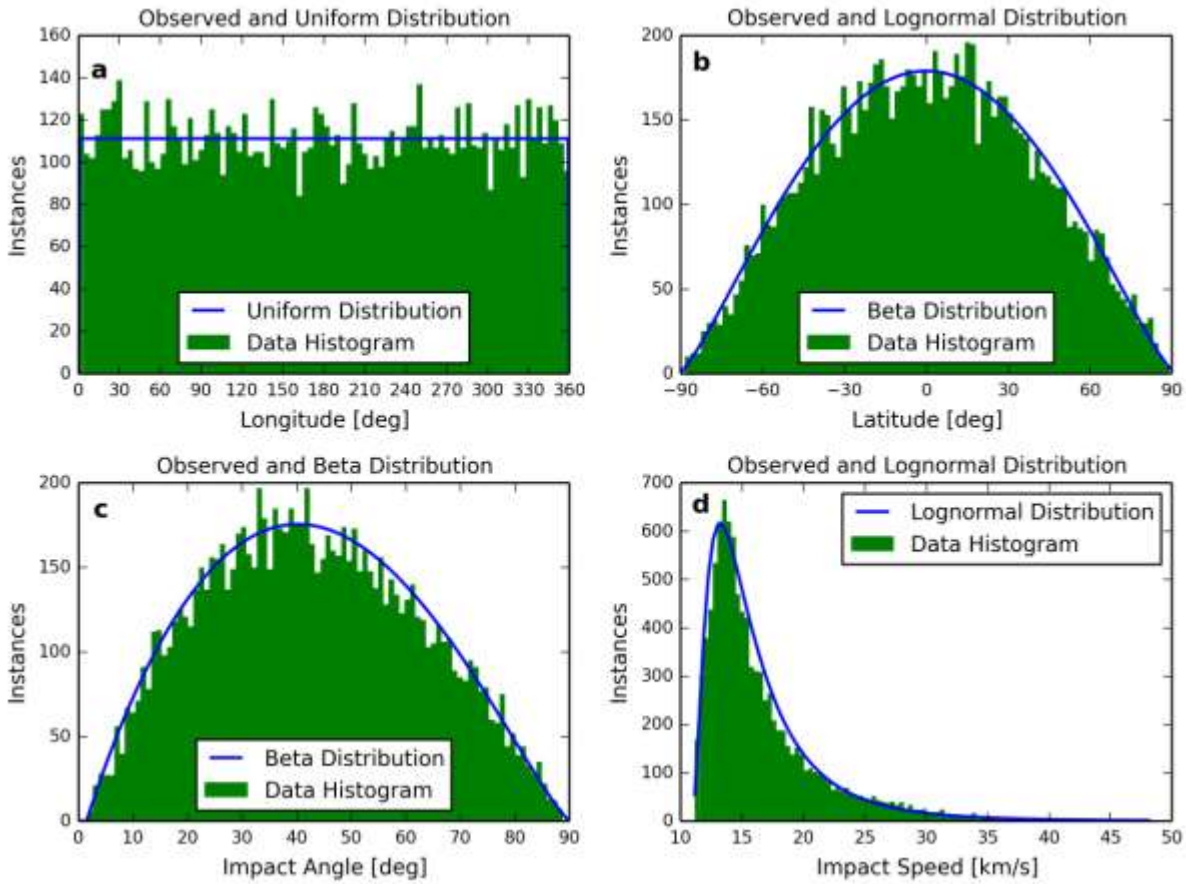

Figure 1: Distributions for impact location, angle and speed. Plot a shows the sample data (green bars) for impact location longitude and the corresponding uniform distribution fit (blue line). Plot b shows the beta distribution that was fitted to sample impact location latitude data. Plot c visualizes the sample data for impact angle and the fitted beta distribution. Plot d shows sample data for impact speed and the corresponding lognormal distribution fit [1].

The sample covered the Earth with the intend of reproducing a wide variety of possible impact scenarios such that insight could be gained into the average loss of human life for an impactor of a given size, what contributions each impact effect has to overall damage and what the variance in the damage is. Figure 2 visualizes the impact location distribution along with the assigned impact angles over Europe.

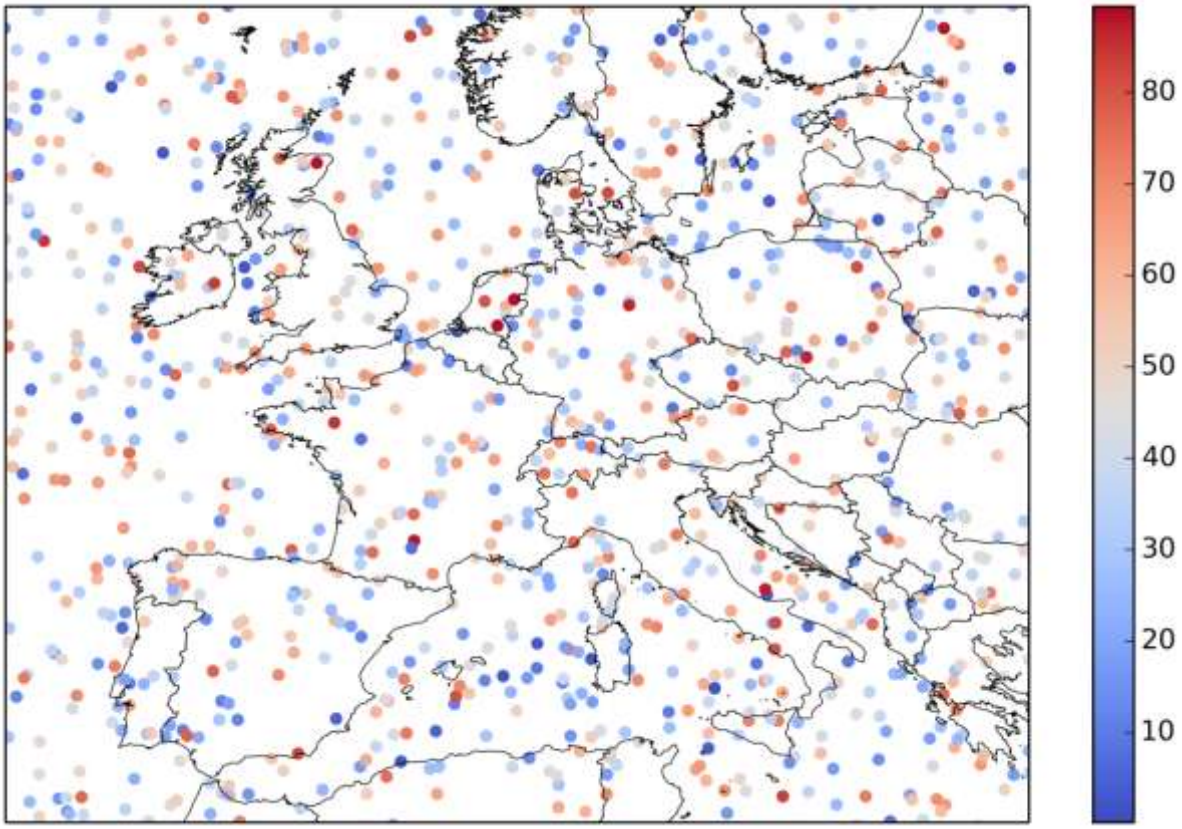

Figure 2: Spatial visualisation of the realised set of impact locations over Western Europe. The colour of the markers reflects the impact angle in degrees where 90° is a vertical impact [1].

The impactor diameter was increased from 0 m to 400 m in subsequent simulation runs and this method allowed to discern how impact effect dominance varied over impactor size. Impact effects for each asteroid were calculated based on its size, impact speed, impact angle, as well as impact location and the effects were propagated over the local population based on the global population map. Figure 3 shows results of the study considering an impactor sample that is distributed around the globe. In Figure 3a, total human loss values per average impactor are shown along with the contribution of each impact effect. In Figure 3b, the relative contribution to overall loss is presented as ratios for asteroid sizes up to 400 m in diameter.

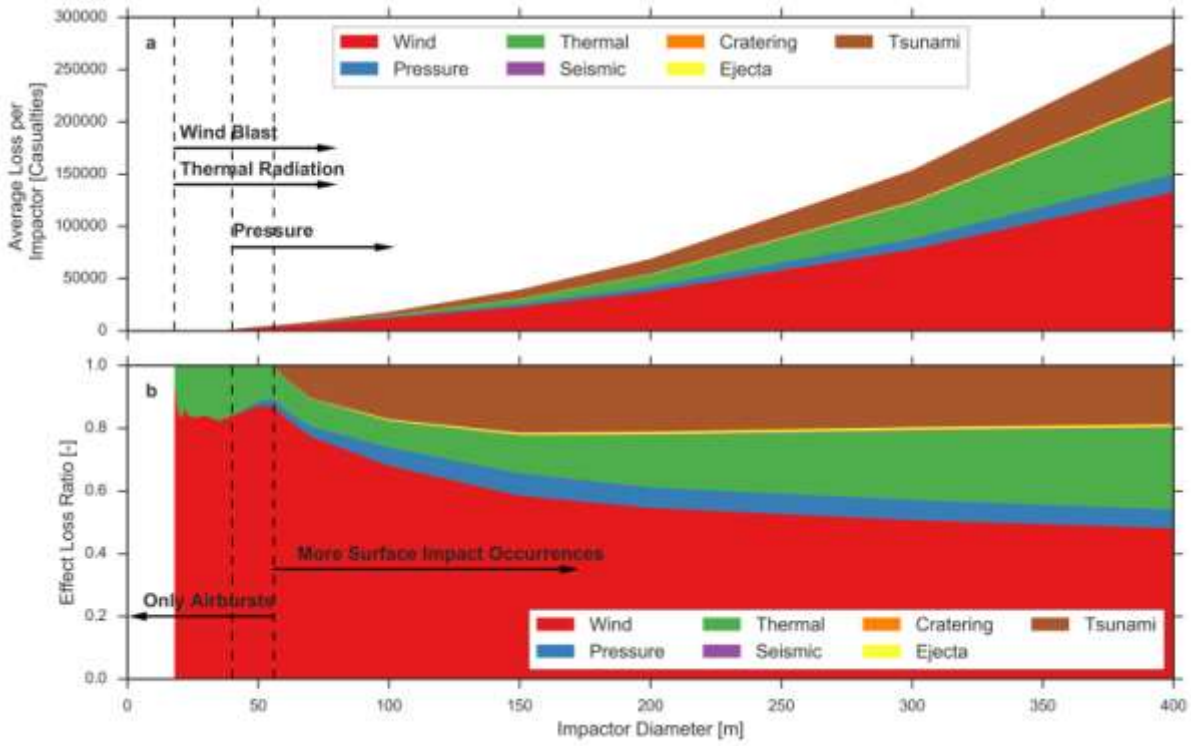

Figure 3: Plot a shows the increase in average casualties per impactor size and highlights the increasing contribution by each impact effect. First casualties due to wind blast and thermal radiation occurred at 18 m. Impactors of 40 m produced the first pressure losses and first surface impacts were recorded for impactors larger than 56 m. Plot b shows the impact effect dominance distribution over the asteroid size range up to 400 m [1].

Additional analysis was performed to investigate the dominance of each impact effect when the sample was restricted to impact over water masses or over land masses. These results show that aerothermal effects are most dominant and that the average land impactor is an order of magnitude more harmful than the average water impactor. Tsunamis are the dominant hazard for water impactors. However, tsunamis only account for about 20% of human losses in the global scenario because land impactors are significantly more harmful overall. Ground related effects (cratering, seismic shaking, ejecta) produce relatively low numbers of casualties. The results help to increase understanding of the asteroid impact hazard and they inform disaster managers about which impact effects should be prioritized in order to formulate effective protection for the population. In addition to insights about impact effect dominance, the results provide expected casualty numbers for the average impactor in the size regime up to 400 m in diameter which yield the most frequent impactors.

An extended description of the study, its results and a discussion thereof are published in [1].

References

[1] C.M. Rumpf, H.G. Lewis, P.M. Atkinson, Asteroid Impact Effects And Their Immediate Hazards For Human Populations, Geophys. Res. Lett. accepted (2017). doi:10.1002/2017GL073191/full.