Asteroids will collide with the Earth in the future and this natural disaster poses a serious threat to populations on Earth. National space agencies search for potentially hazardous asteroids and determine their impact probabilities. Those asteroids that could collide with the Earth in the next decade are published online but it is not reported where these asteroids would impact. Based on the observational record, the previously unknown future asteroid impact distribution has been calculated here. This information is important to characterize the nature of the impact hazard and to shape the international response to this threat. The results show that smaller developing nations face a special dilemma because they cannot actively address the threat yet have a disproportionately high risk and are most vulnerable.

The impact locations of 261 potential impactors, that can collide with the Earth before the year 2100, were calculated and visualized. Using the information on asteroids provided in NASA's and ESA's NEO risk lists, the freely available software OrbiFit was utilized to identify orbit solutions that lie inside the uncertainty region of the asteroid's nominal orbit solution and result in an Earth impact in the future. The impacting orbit solutions are called virtual impactors (VI). The Asteroid Risk Mitigation Optimization and Research (ARMOR) tool was used subsequently to project the impact probability of these VIs onto the surface of the Earth. ARMOR used the VI orbit solution from OrbiFit as initial condition for the trajectory propagation until impact. A solar system model that provided gravitational forces from the Sun, the planets and the Moon (based on the JPL DE430 planetary ephemerides) was employed for the propagation. For each VI all possible impact locations were calculated yielding the impact corridor. Taking into account the width of the asteroid's uncertainty region and the global impact probability, the impact corridor was scaled to represent the impact probability distribution for that VI. This method was applied to all VIs and the result is a set of impact corridors, each in the form of a Gaussian distribution. All impact solutions were combined within a global map and the result is shown in Figure 1. The impact corridors are distributed globally and every region on Earth can be hit by an asteroid.

Conclusions

The authors would like to extend their sincere thanks to Giovanni B. Valsecchi for the productive discussions and assistance in the use of OrbiFit. The work is supported by the Marie Curie Initial Training Network Stardust, FP7-PEOPLE-2012-ITN, Grant Agreement 317185.