

Scientists warn humanity does not have effective tools to resist tsunamis

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Maria Gritsevich recalled that the impact of an asteroid into the Gulf of Mexico 65 million years ago led to the extinction of a large number of animal species, including dinosaurs. Credit: UrFU/Grigory Tkachenko

An international team of scientists from 20 countries identified 47

problems that hinder the successful prevention and elimination of the consequences of tsunamis. Based on the carried out analysis, the world's leading experts on natural hazards have outlined directions for further scientific research. The research group's review is published in a special issue of the *Frontiers in Earth Science*.

The main problems identified in the review are related to the large gaps and uncertainties in knowledge about [tsunami](#), the lack of well-documented observations, and imperfect methods of processing available information. One of the reasons is the lack of coordination of the efforts of those countries for which the study and prediction of tsunamis, forecasting the corresponding risks, and preparation for repelling threats are vital.

"Generally accepted approaches have not yet been determined, potentially incompatible probabilistic methods are used in different regions of the world, and different sources of tsunamis are often considered independently of each other," said authors of the research.

Maria Gritsevich, senior researcher at the Extra Terra Consortium laboratory at the Ural Federal University and at the Finnish Geospatial Research Institute, adjunct professor in planetary sciences at the University of Helsinki points out that the asteroid-comet hazard is associated with the origin of the tsunami as well.

"Science knows about more than one million asteroids in the solar system," says Maria Gritsevich. "In total, according to the estimates, more than 150 million asteroids exceeding 100 meters in size revolve around the Sun. Since the ocean occupies more than 70% of the Earth's surface, collision of any of these celestial bodies with our planet may cause a strong tsunami. Let's recall that the impact of an asteroid into the Gulf of Mexico 65 million years ago led to the extinction of a large number of animal species, including dinosaurs."

The main terrestrial sources of the origin of tsunamis are abnormally strong and rapid fluctuations in atmospheric pressure, volcanic eruptions and earthquakes (on land and underwater), crustal movement, and landslides. Often these forces are interconnected. However, humanity does not have reliable historical and detailed modern data to take into account the interdependence of these factors. This leads to a difficulty to predict the time and place of each next tsunami.

Moreover, due to the uncertainties, scientists studying the natural phenomena that cause tsunamis often ignore this connection. Although tsunamis can be even more destructive and deadly. According to the authors of the review, this approach is typical, for example, for volcanologists. As a result, systematic analysis of information about tsunamis in volcano studies is often omitted the authors of the review state. In addition, the power of computer technologies used to predict tsunamis is insufficient to meet the challenges. The numerical models themselves are too complex and costly.

Due to a combination of reasons, many coastal cities, especially in developing countries, are not ready to 'receive' the tsunami, to adequately assess the possible damage and losses. This is reflected, for example, in the construction of buildings and structures. Schools and hospitals, industrial enterprises, harbors, roads and bridges, power plants (including atomic ones), gas and oil storage facilities, and various communications are under the threat of destruction. And most importantly, so are the lives of many people.

"Buildings are often used as evacuation shelters," says the authors of the review. "Tsunamis affect the lower floors of a high-rise building, while seismic loads affect the upper ones. But tsunami effects such as basement erosion and debris impact are rarely modeled. These effects remain to be investigated."

Thus, there is no clear idea about the potential economic damage and costs required to combat tsunamis and their consequences. The quality of disaster risk management—who and what, from what harm, at what cost, and how to protect—often leaves much to be desired. In most cases, assistance arrives late, leaving affected communities in a vulnerable position, especially in the first hours and days after the event, states the authors' review.

"We call for the creation and continuous enrichment of unified databases, for conduction of the necessary research and regular exchange of information, for improving the methods of analysis and modeling, and careful planning of actions in case of cascading natural disasters," says Maria Gritsevich. "We are convinced that with proper funding, with the availability of the necessary scientific equipment and technology, it is quite possible to bridge the gaps in understanding the tsunami phenomenon that we have identified."

More information: Jörn Behrens et al, Probabilistic Tsunami Hazard and Risk Analysis: A Review of Research Gaps, *Frontiers in Earth Science* (2021). [DOI: 10.3389/feart.2021.628772](https://doi.org/10.3389/feart.2021.628772)

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