Will climate change bring more earthquakes and tsunamis?

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In this paper, we will look at whether there is a possibility that climate change may impact the likelihood of earthquakes, and whether more communities or countries should consider investing in Earthquake Early Warning Systems (EEWS).

Climate change and earthquake

There has been debate over the years among experts regarding the connection between climate change and earthquakes.

First, one of the most common pseudoscientific methods of predicting earthquakes throughout history has been by looking for "earthquake weather," which links hot, calm weather as preceding an earthquake. Science has shown that no, the weather on a particular day does not have anything to do with an earthquake's cause. An earthquake is caused by a slip on a fault — when the edges of tectonic plates get stuck and the pressure builds, at some point there is a break to release the stress, resulting in an earthquake.

But weather is different from climate. Weather is the atmospheric condition of a certain place on a certain day. "What is the temperature, humidity, wind speed outside my window today?" Climate alludes to a standard pattern of weather of a particular place taken over more than 25 years.

According to USGS, climate change can affect natural disasters. "With increasing global surface temperatures the possibility of more droughts and increased intensity of storms will likely occur. As more water vapour is evaporated into the atmosphere it becomes fuel for more powerful storms to develop. More heat in the atmosphere and warmer ocean surface temperatures can lead to increased wind speeds in tropical storms. Rising sea levels expose higher locations not usually subjected to the power of the sea and to the erosive forces of waves and currents." [1]

The Earth system is the Earth's interacting physical, chemical and biological processes. These processes connect in ways that people do not always realise. Climatic changes in temperature can directly or indirectly affect the water table, which affects tectonic plates. We are seeing glaciers in Greenland and the Antarctic shrink in volume, which contributes to sea level rise. When a giant slab of glacier breaks off it can produce an earthquake because of the low-pressure zone created as water rushes in to the new opening. This moves the glacier itself, and the lessened load on the bedrock causes it to flex releasing a seismic wave.[2]

We seem to be seeing some of the effects of climate change. Hurricanes seem to be increasing in number, getting stronger and lasting longer, as reported by *The Guardian* on Oct. 10, 2018 in their article, "Is climate change making hurricanes worse?"[3]

In their 2009 paper "Slow earthquakes triggered by typhoons"[4], Chiching Liu, et al, touched on how climate change does have a relationship with earthquakes. They argued that the low-pressure centres of these typhoons allow earthquake faults within the crust to move and release accumulated strain.

There is still more to be learned about the earth's geology and earthquakes, but we know that various processes of the Earth are inter-connected. We know that global climate change could mean an increase in frequency or intensity of some natural disasters, and it could have an effect on earthquakes.

Could a link between climate change and earthquakes mean unexpected tsunamis? That is certainly being discussed among experts. For World Tsunami Day on Nov. 5, 2018, UNISDR reported that tsunami losses over the last 20 years cost 251,770 lives and US$280 billion in economic losses (1998-2017), compared with 998 deaths and US$2.7 billion in recorded losses from tsunamis over the previous 20 years (1978-1997). Of course, the 2004 Boxing Day tsunami greatly skews these figures as it was so catastrophic, but even without it there was a marked increase in fatalities attributed to tsunami over the last 20 years. Now we must try to predict what the next 20 years will look like.

EEWS

An increasing number of countries have been putting some sort of Earthquake Early Warning Systems (EEWS) in place, whether comprehensive or limited in scope. They include such countries as: Japan, Taiwan, Korea, Turkey, India, Mexico, United States, Canada, China (select provinces), Italy, Indonesia (earthquake and tsunami system), Philippines (100+ seismic monitoring stations installed for tsunami warning), Australia (seismic network for tsunami warning), and more.

GeoSIG over the past 5 years has experienced an increase in number of enquiries for EEWS systems from all over the world. Some systems have already been implemented and others are being considered. Please see GeoSIG's EEWS video in the following link: https://youtu.be/1fBrSKp8qv0

Coastal regions are popular destinations for people to live or to vacation, but some of these regions are at more risk of tsunami. There is a concern that global climate changes could bring more unexpected tsunamis. This is why many countries with coastal regions (or entirely island nations) are investing in early warning systems to help them with tsunami prediction and warnings. They are actively working to mitigate losses from tsunami, particularly loss of life.

GeoSIG has carried out a considerable amount of work in implementing EEW algorithms which can be adapted to work in different locations where such a solution is to be installed. Please see our EEW information leaflets, to which we will provide links at the end of this paper. Currently, there is no proven method to forecast the precise time of an earthquake, nor its location or magnitude. But by using EEW methodologies it is possible to assess the location and size as soon as an earthquake emerges using its non-destructive primary waves. Warnings about a potential strong shaking can be generated almost instantly until the destructive secondary seismic waves arrive. Coupled with GeoSIG Rapid Response (RR) for example, users can analyse the data in the aftermath of the earthquake in order to determine next steps.

There are limitations of EEWS: the warning times for strong ground motion can be short. It is not possible to provide longer warning times for damaging ground motion because strong ground motion only occurs near the rupture of a sufficiently large earthquake, where there is little wave travel time between the earthquake epicentre and the people nearby. Therefore investing in more instruments may have a direct relationship to the effectiveness of the EEW success.

Conclusion

One of the movements around the globe is to improve resilience to natural disasters so that we are better prepared ahead of time and we reduce the loss of life and property due to unexpected devastation. In the case of earthquakes, the first priority should be to carry out seismic strengthening of schools, hospitals, public buildings and homes. However, investing in EEWS is one way to mitigate these risks and manage disaster risk reduction. It is an investment for the safety of people, which is always worthwhile.

GeoSIG Links:

1. GeoSIG Earthquake Early Warning Rapid Response solution leaflet

2. GeoSIG Implementation of JMA B-Δ Method for Earthquake Early Warning leaflet

3. GeoSIG Earthquake Early Warning Emergency Shutdown leaflet

Sources:

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4. Levitt, Daniel and Kommenda, Niko., 2018, "Is climate change making hurricanes worse?" *The Guardian*. 10 Oct 2018. Retrieved from https://www.theguardian.com/weather/ng-interactive/2018/sep/11/atlantic-hurricanes-are-storms-getting-worse.htm 18 November 2018.