High Risk of Post-Earthquake Fire Hazard in Dhaka, Bangladesh

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Viewpoint

High Risk of Post-Earthquake Fire Hazard in Dhaka, Bangladesh

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According to a recent survey conducted by the Fire Service and Civil Defense in Dhaka, Bangladesh, more than 400 hospitals and clinics are facing a dreadful risk of fire hazard. The survey also documented that 2000 educational institutions, 600 shopping malls, and more than 20 print and paper media office buildings are also at such a risk [1]. This statistic may not seem very significant, since fire incidents generally do not occur simultaneously at different places. However, a certain condition can trigger fire hazards concurrently over a wide region and a narrow time window. If the City Fire Department receives emergency calls from half of those institutions labeled as risky, responding to all of those cases may not be possible for that department alone. Ironically, during such an event is when the hospitals and clinics are needed most to help the injured citizens, and thus must remain operational. One may ask: What is the possibility of fire occurring simultaneously over a large region? Has such an event happened in the recent past?

In 1906, a fire in the city of San Francisco burned for three days, eventually destroying 25,000 buildings, relocating 200,000 inhabitants from their homes, and killing 3000 people. That large-scale devastating fire started after the city was jolted by an 8-magnitude earthquake. The fire was so devastating that 90% of the total damage was caused by it; only 10% was assumed to be the result of the seismic shaking itself [2].

A similar incident happened in Kobe, Japan, in 1995. The post-earthquake fire destroyed the citywide water supply pipeline, which eventually obstructed the rescue operation of fire-fighters. Although the city had many water storage tanks for emergency needs, the fire-fighters had to carry water from nearby water reservoirs using water tankers. With a hindered rescue operation, the fire decisively caused damage to 5000 buildings [3,4].

Post-earthquake fire is not an unusual incident [5]. As civilization has flourished, the usage of natural gas and electricity has increased by an order of magnitude and buildings have been equipped with complex electrical instruments with longer and more intricate wiring. Due to the presence of combustible natural gas, if a faulty electric device gives off an ignitable electric spark, each building could become the source of a massive blaze. Severe seismic shaking often breaks gas pipelines and electric wiring, which often become a source of ignition for a fire. Water supply pipelines often break and disrupt fire rescue operation, if another source of water is unavailable. The post-earthquake fire is different from an ordinary fire incident in the sense that a post-earthquake fire can be initiated from multiple sources and expands rapidly, which often causes the complete obliteration of the building structure.

Research suggests that for this type of fire, the source is natural gas in 15–50% cases and electricity in 40% cases. Therefore, in the absence of one source (electricity or gas), the intensity of the destruction could be reduced by an order of magnitude [6,7]. In 1994, Northridge, California, experienced a 6.9-magnitude earthquake that caused 14,000 leaks in the gas supply pipeline and initiated 100 building blazes. During that earthquake, the electric supply was interrupted for a few hours. Experts concluded that the situation could have been worse by an order of magnitude without the electric blackout.

Bangladesh is not free from earthquake risk, according to two recent studies that used 10 years of highly accurate state-of-the-art Global Positioning System (GPS) data and 1200 years of earthquake deformation data, via an innovative technique involving coral analysis [8–11]. The objective of those studies was to investigate whether a potential source of a high-magnitude earthquake along the Indo–Myanmar fold belt exists. The results suggested that the Indo–Myanmar fold belt could cause an earthquake of magnitude 8 or higher, if the energy stored in the tectonic plate is released at once during one seismic event, given that a large-magnitude earthquake has not occurred in the last few centuries.

Whatever the magnitude of the potential earthquake is, but especially for earthquakes of magnitude 7 or higher, the intensity in Dhaka would be relatively worse than elsewhere, given that the infrastructure in the capital city is not earthquake-resistant. The city has experienced the consequences of unplanned urbanization, when buildings collapsed without an earthquake, as happened with the Rana Plaza in Dhaka, which collapsed on April 24, 2013 [12]. After almost every incident, it is discovered that building codes were ignored or the design was altered. A survey conducted by the United Nations Development Program (UNDP) and Comprehensive Disaster Management Program (CDMP) documented around 72,000 buildings, built ignoring the building codes and fire codes, as being at high risk of an earthquake—any of which could be the first victim of tremendous seismic shaking [13]. Along with that risk, broken gas pipes and electric short circuits could ignite many fire sources simultaneously and intensify, making the condition worse.

The findings of recent investigations and inspections conducted by the Fire Service and Civil Defense in Dhaka, Bangladesh, are not positive. Most of the buildings in Dhaka City were not built with fireproof infrastructure and are missing required fire extinguishers, fire alarms, and emergency fire exits. The individuals who work in those buildings are not trained on what to do during a fire emergency. The traffic law for letting the fire trucks and ambulances pass when they are in an emergency call is not enforced. In some places, the roads are not wide enough for the fire trucks to maneuver and carry out the rescue operation, such as in the old Dhaka or the neighborhoods in new Dhaka with high-rise buildings. After a large earthquake, the whole city could turn into a place of horror. The city may not have enough hospitals and clinics operational to treat the injured people, since it lacks proper fire-fighting resources. The buildings for the fire stations in Dhaka City may not be at risk of fire, but some of them are certainly not earthquake-resistant.

Research suggests that the risk of post-earthquake fire can be significantly reduced if the flow of electricity and gas can be controlled during an earthquake, since sparks from electrical short circuits serve as ignition agents for starting a fire [7]. Thus, the buildings in the earthquake-prone region should have an automatic or manual shut-off valve to stop the gas flow during an emergency. The building should also have battery-operated exit signs to direct people towards the building's exit during an electricity blackout. High-rise buildings should be equipped with automatic water sprinklers, since the fire department may not have a ladder long enough to conduct a rescue operation. Of course, many other innovative solutions exist, and engineers are working to suggest more, but the execution of the recommended solution is the key to being prepared for any incoming disaster.

The spatial scale of the post-earthquake fire is large, whereas the temporal scale is very short. Considering the scale and intensity of such a potential disaster, local governments should take the initiative to put more funding into disaster mitigation research, as well as early warning systems, such as detection of seismic waves at potential earthquake sources. The intensity of any disaster is reduced if an early warning system is available; for example, reducing the impact of forest fires [14] and water-related hazards [15]. The city fire department may not be able to handle that many cases alone; thus, the government should allocate more funding in providing training and education for citizens so that they know how to react during an emergency. Being prepared is the best option to fight a forthcoming disaster, since Dhaka, as the capital city of Bangladesh, is among the most densely populated cities in the world.

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References

1. A City Where Spectre of Fire Looms. Available online: https://www.thedailystar.net/frontpage/dhaka-fire-not-just-hugely-risky-1721887 (accessed on 1 May 2019).
2. Casualties and Damage after the 1906 Earthquake. Available online: https://earthquake.usgs.gov/earthquakes/events/1906calif/18april/casualties.php (accessed on 1 May 2019).
3. Scawthorn, C.; Yanev, P.I. 17 January 1995, Hyogo-ken Nambu, Japanese earthquake. *Eng. Struct.* **1995**, *17*, 146–157. [CrossRef]
4. Tierney, K.J.; Goltz, J.D. *Emergency Response: Lessons Learned from the Kobe Earthquake*; Disaster Research Center, University of Delaware: Newark, DE, USA, 1997; p. 18.
5. Scawthorn, C.; Eidinger, J.M.; Schiff, A. *Fire Following Earthquake*; ASCE Publications: Reston, VA, USA, 2005; ISBN 978-0-7844-7551-5.
6. Mousavi, S.; Bagchi, A.; Kodur, V.K.R. Review of post-earthquake fire hazard to building structures. *Can. J. Civ. Eng.* **2008**, *35*, 689–698. [CrossRef]
7. Mohammadi, J.; Alaysin, S.; Bak, D.N. Analysis of post-earthquake fire hazard. In Proceedings of the 10th World Conference on Earthquake Engineering, Madrid, Spain, 19–24 July 1992; Volume 10, pp. 5983–5988.
8. Mondal, D.R.; Mchugh, C.M.; Mortlock, R.A.; Gurung, D.; Bastas-Hernandez, A.; Steckler, M.S.; Seeber, L.; Mustaque, S.; Goodbred, S.L., Jr.; Akhter, S.H. Paleoseismic Records of 1762 and Similar Prior Earthquakes Along the South-Eastern Coast of Bangladesh. In *AGU Fall Meeting Abstracts*; American Geophysical Union: Washington, DC, USA, 2014; 2014AGUFM.T43B4712M.
9. Mondal, D.R.; McHugh, C.M.; Steckler, M.S.; Seeber, L.; Goodbred, S.L.; Akhter, S.H.; Mortlock, R.A. Coseismic Deformation of the Great 1762 Arakan Subduction Earthquake Along South-Eastern Coast of Bangladesh. In *AGU Fall Meeting Abstracts*; American Geophysical Union: Washington, DC, USA, 2609.
10. Steckler, M.S.; Mondal, D.R.; Akhter, S.H.; Seeber, L.; Feng, L.; Gale, J.; Hill, E.M.; Howe, M. Locked and loading megathrust linked to active subduction beneath the Indo-Burman Ranges. *Nature Geosci.* **2016**, *9*, 615. [CrossRef]
11. Mondal, D.R.; McHugh, C.M.; Mortlock, R.A.; Steckler, M.S.; Mustaque, S.; Akhter, S.H. Microatolls document the 1762 and prior earthquakes along the southeast coast of Bangladesh. *Tectonophysics* **2018**, *745*, 196–213. [CrossRef]
12. Manik, J.A.; Yardley, J. Building Collapse in Bangladesh Leaves Scores Dead. *The New York Times*, 24 April 2013.
13. Kamal, A.S.M.M. Earthquake Risk and Reduction Approaches in Bangladesh. In *Disaster Risk Reduction Approaches in Bangladesh*; Shaw, R., Mallick, F., Islam, A., Eds.; Disaster Risk Reduction; Springer: Tokyo, Japan, 2013; pp. 103–130. ISBN 978-4-431-54252-0.
14. Smith, A.M.S.; Kolden, C.A.; Tinkham, W.T.; Talhelm, A.F.; Marshall, J.D.; Hudak, A.T.; Boschetti, L.; Falkowski, M.J.; Greenberg, J.A.; Anderson, J.W.; et al. Remote sensing the vulnerability of vegetation in natural terrestrial ecosystems. *Remote Sens. Environ.* **2014**, *154*, 322–337. [CrossRef]
15. Alfieri, L.; Salamon, P.; Pappenberger, F.; Wetterhall, F.; Thielen, J. Operational early warning systems for water-related hazards in Europe. *Environ. Sci. Policy* **2012**, *21*, 35–49. [CrossRef]