Global catastrophic risks

Definition

The term Global Catastrophic Risks (GCR) has been introduced by Nick Bostrom. He loosely defines it as “a risk that might have the potential to inflict serious damage to human well-being on a global scale” (Bostrom & Ćirković, 2008). To more clearly delimit what serious damage on a global scale might entail, Bostrom and Ćirković (2008) propose that an event causing ten million fatalities or ten trillion dollars’ worth of economic damage qualifies as a global catastrophe. Depending on the current estimates of economic losses, the COVID-19 pandemic ranges close or even already surpassed the ten trillion-dollar threshold (Cutler & Summers, 2020; Lenzen et al., 2020; Park et al., 2020; United Nations Conference on Trade and Development [UNCTAD], 2021). However, a global pandemic is just one of many different GCR scenarios compiled in Bostrom and Ćirković's book (2008) and in other GCR research. Possible natural GCRs include super-volcanoes, comets, and asteroid impacts; risks from unintended consequences include climate change, pandemics, or artificial intelligence; and risks from malign intent include nuclear wars or biotechnological attacks. Further it is cautioned that new risks emerge as technology develops and that potential risks might be undetected or misjudged due to biases or lack of sufficient knowledge to understand the impact (Sandberg, 2018; Wiener, 2016; Yudkowsky, 2008).

Global catastrophic infrastructure loss scenarios

In this work the expected change in agricultural yield if industrial infrastructure is compromised is examined, therefore, the possible causes for a global disruption to industry are presented more in depth. The premise of all these risks is a global scale disruption of the electrical grid. Due to the global industry’s and society’s dependence on electricity, a global electrical failure would result in a de facto standstill of most industries and machinery. The three dominant potential failures include:

High Altitude Electromagnetic Pulses (HEMP) are a consequence of nuclear detonations high up in the atmosphere. The altitude needed to generate damage over a large area prevents direct damage to humans but may instantaneously cause damage to most electronics. If a nuclear warhead is detonated, the emitted gamma rays interact with the atmosphere and create an intense electromagnetic pulse (EMP) which spreads across large distances at the speed of light. The electromagnetic disruption causes overvoltage in electronics similar to a lightning strike but with a higher intensity (Wilson, 2008). The affected area depends on the power and altitude of the detonation, but Wilson (2008) describes a possible scenario where one detonation could affect the entire contiguous United States. Therefore, a coordinated attack with multiple warheads or the detonation of multiple warheads during a nuclear conflict could lead to large parts of the world being affected simultaneously, resulting in a global catastrophe of unprecedented proportion in the modern era. Especially critical pieces of infrastructure like Large Power Transformers (LPT) could delay recovery for years. LPT are responsible for transforming high voltage electricity used to send energy over long distances to low voltage electricity required for local distribution and consumption, and vice versa (Office of Electricity Delivery and Energy Reliability [OE], 2014). They are mostly highly customized to specific needs which makes their production time and money intensive: under normal conditions LPTs have lead times of 12-24 months (North American Electric Reliability Corporation [NERC] & U.S. Department of Energy [DOE], 2010) or more and cost between $2 to $7.5 million excluding transportation and installation (Electrical Engineering Portal [EEP], 2013). Further, LPTs are very heavy and the US Department of Energy worries about the ability to replace them under crisis conditions (OE, 2014).

A second, similar risk is posed by Solar Storms. Solar activity during storms can present itself in the form of solar flares, coronal mass ejections (CME) or both. Solar flares are bursts of x- and gamma rays and extreme ultraviolet radiation which can disrupt communication technology (National Science and

Technology Council [NSTC], 2019). Weiss and Weiss (2019), however, rate it as a minor risk and rather emphasize the effect of coronal mass ejections on the American power grid. This type of solar activity releases supercharged plasma particles towards earth, creating a geomagnetic storm which acts like a natural EMP towards the electrical grid with potentially devastating consequences (Cooper & Sovacool, 2011; NSTC, 2019; Talib & Mogotlhwane, 2011; Weiss & Weiss, 2019). Like HEMPs, CMEs can permanently damage LPTs and potentially cause power outages lasting for years (NSTC, 2019).

Thirdly, globally coordinated cyber-attacks on many electrical grids or critical industrial infrastructure pose a threat on a global catastrophic scale. Recorded electrical failures, which have been attributed to targeted cyber-attacks, include a nine-hour power outage in up to eight regions in Ukraine in 2015 (Zetter, 2016) and the destruction of enrichment centrifuges in Iran in 2009/2010 by Stuxnet (Wikipedia, 2021).

Apart from the specific scenarios described above, the fragile world hypothesis introduced by Manheim (2020) can also induce or aggravate a loss of industry scenario. Manheim (2020) states that the world has become increasingly more complex, interconnected and most importantly less resilient. The economy's incentives to minimize redundancy have led to systems becoming progressively more fragile and hence more vulnerable to disruptions. According to Manheim (2020) a critical system's fragility can cause global catastrophes even severe enough to result in human extinction. Moreover, fragile systems can significantly worsen the impact of one of the loss of industry scenarios by leading to faster and more severe systems' collapses during a catastrophe.

References

Bostrom, N., & Cirkovic, M. M. (2008). Global Catastrophic Risks. Oxford University Press, Oxford.

Cooper, C., & Sovacool, B. K. (2011). Not Your Father's Y2K: Preparing the North American Power Grid for the Perfect Solar Storm. The Electricity Journal, 24(4), 47–61. https://doi.org/10.1016/j.tej.2011.04.005

Cutler, D. M., & Summers, L. H. (2020). The COVID-19 Pandemic and the $16 Trillion Virus. JAMA, 324(15), 1495–1496. https://doi.org/10.1001/jama.2020.19759

Electrical Engineering Portal (2013, December 30). Large power transformer tailored to customers' specifications. https://electrical-engineering-portal.com/an-overview-of-large-power-transformer-lpt

Lenzen, M., Li, M., Malik, A., Pomponi, F., Sun, Y.-Y., Wiedmann, T., Yousefzadeh, M. (2020). Global socio-economic losses and environmental gains from the Coronavirus pandemic. PLOS ONE, 15(7). https://doi.org/10.1371/journal.pone.0235654

Manheim, D. (2020). The Fragile World Hypothesis: Complexity, Fragility, and Systemic Existential Risk. Futures, 122, 102570. https://doi.org/10.1016/j.futures.2020.102570

National Science & Technology Council (2019). National Space Weather Strategy and Action Plan. https://trumpwhitehouse.archives.gov/wp-content/uploads/2019/03/National-Space-Weather-Strategy-and-Action-Plan-2019.pdf

North American Electric Reliability Corporation, & U.S. Department of Energy (2010, October). High-Impact, Low-Frequency Event Risk to the North American Bulk Power System. https://energy.gov/sites/prod/files/High-Impact%20Low-Frequency%20Event%20Risk%20to%20the%20North%20American%20Bulk%20Power%20System%20-%202010.pdf

Office of Electricity Delivery and Energy Reliability (04.2014). Large power transformers and the U.S. electrical grid. Retrieved from https://energy.gov/sites/prod/files/2014/04/f15/LPTStudyUpdate-040914.pdf

Park, C.-Y., Villafuerte, J., Abiad, A., Narayanan, B., Banzon, E., Samson, J., Tayag, M. C. (2020). An Updated Assessment of the Economic Impact of COVID-19. ADB Briefs 133. https://doi.org/10.22617/BRF200144-2

Sandberg, A. (2018). Human Extinction from Natural Hazard Events. Oxford Research Encyclopedia of Natural Hazard Science. https://doi.org/10.1093/acrefore/9780199389407.013.293

Talib, M., & Mogotlhwane, T. M. (2011). Global Failure of ICT due to Solar Storm: A Worst Case Scenario Ahead. Procedia Environmental Sciences, 8, 371–374. https://doi.org/10.1016/j.proenv.2011.10.058

Weiss, M., & Weiss, M. (2019). An assessment of threats to the American power grid. Energy, Sustainability and Society, 9(1). https://doi.org/10.1186/s13705-019-0199-y

Wiener, J. B. (2016). The Tragedy of the Uncommons: On the Politics of Apocalypse. Global Policy, 7, 67–80. https://doi.org/10.1111/1758-5899.12319

Wikipedia (2021). https://en.wikipedia.org/w/index.php?title=Stuxnet&oldid=1041792130

Wilson, C. (2008). High Altitude Electromagnetic Pulse (HEMP) and High Power Microwave (HPM) Devices: Threat Assessments. Defense Technical Information Center.

Yudkowsky, E. (2008). Cognitive biases potentially affecting judgement of global risks. In N. Bostrom & M. M. Ćirković (Eds.), Global catastrophic risks (pp. 91–119). Oxford: Oxford University Press.

Zetter, K. (2016, January 20). Everything We Know About Ukraine’s Power Plant Hack. WIRED. https://www.wired.com/2016/01/everything-we-know-about-ukraines-power-plant-hack/