Natural Hazards and Disaster

Natural Hazards and Disaster

Lab in Class 3: Risk Assessment

- Hazard, Disaster, Risk
- Probability
- Global Risks

Questions

Citations:

“Risk is a word that has various meanings to people of various fields (Adams, 2014).”

At the end of the document:

“Adams, J., (2014). Managing Risk: framing your problems, BoeringerIngelheim Alumni Seminar, SchlossGracht, Cologne 9-11”

Questions

Q1.1

In your own words, describe how the term risk is defined in different disciplines/ fields, and what definition we are using in the class. Please, include references (others than what is on the class slides) for the definitions you provide.

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“Risks are hazards for the world at large”

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In your own words, describe how the term risk is defined in different disciplines/ fields, and what definition we are using in the class. Please, include references (others than what is on the class slides) for the definitions you provide.

"Risks are hazards for the world at large"

Risk are not hazards, but some hazards can create a risk if someone/something is exposed to the

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How do we define a hazard and a disaster in the context of the class, and what is the connection between a hazard and a disaster? Give an example of a hazard and the resulting disaster and describe the connection.

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"… caused by the process of flooding and heavy winds …"

"The disaster would be the lives lost and all the homes and structures that were destroyed due to the floods and storm damage"

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"… caused by the process of flooding and heavy winds …"

"The disaster would be the lives lost and all the homes and structures that were destroyed due to the floods and storm damage"

When we talk about the process, we are not referring to the hazard (flood, wind, which are part of the hurricane) but rather how human and infrastructure respond and cope with flood/wind. This can be very different (see e.g. Katrina, Sandy, Harvey) leading to very different disasters cause by similar hazards

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- Risk distribution is uneven in space

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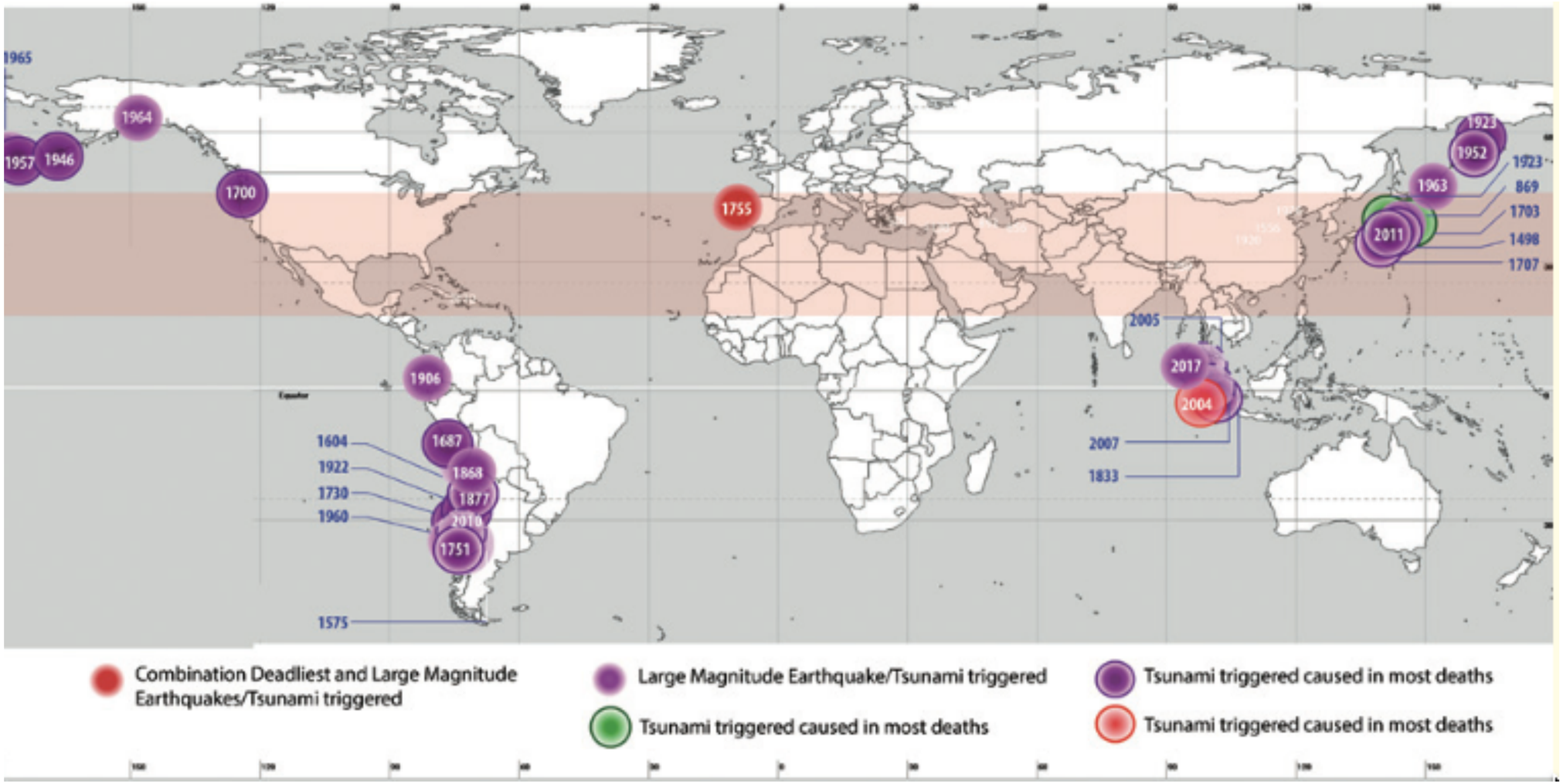

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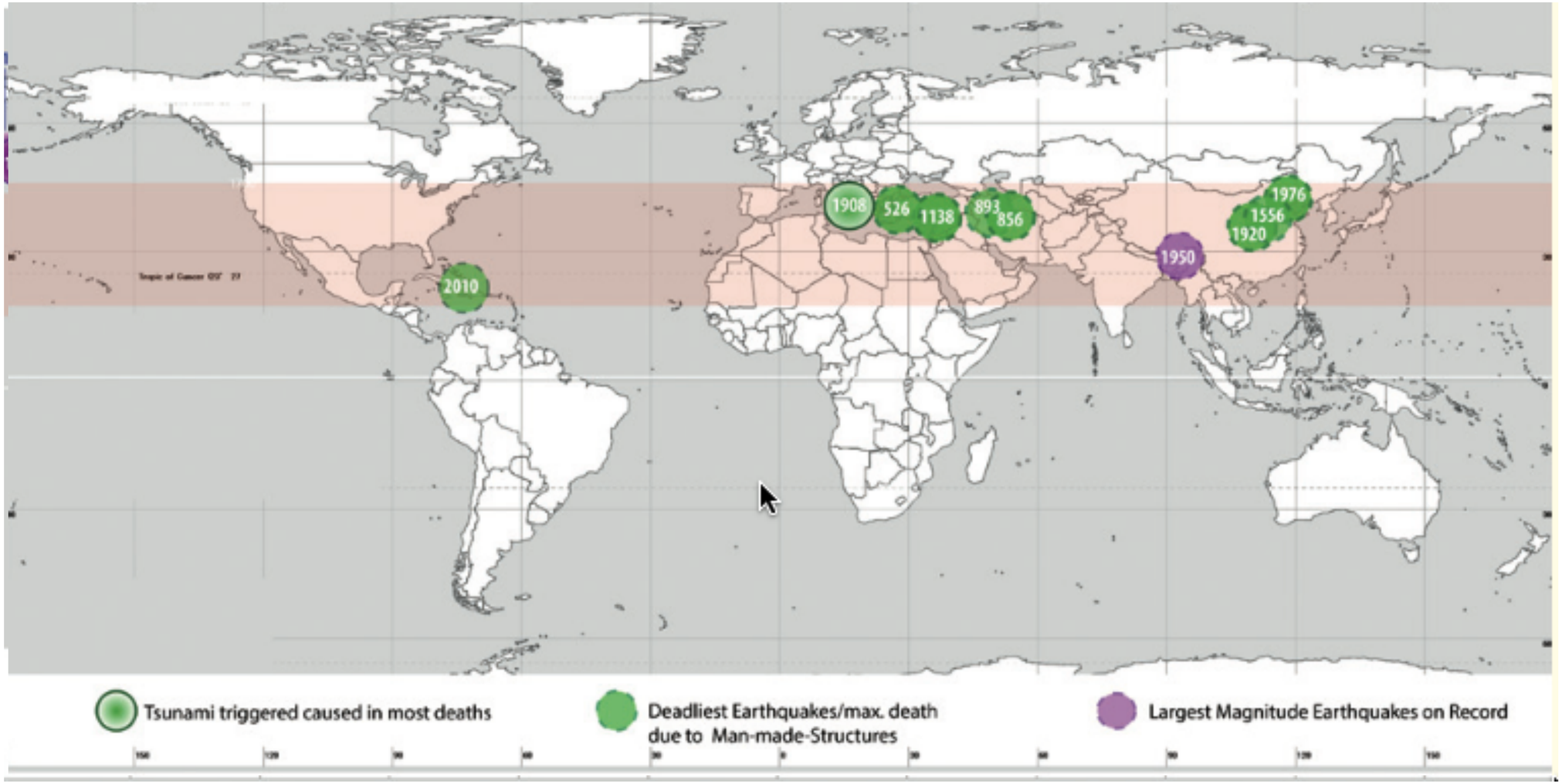
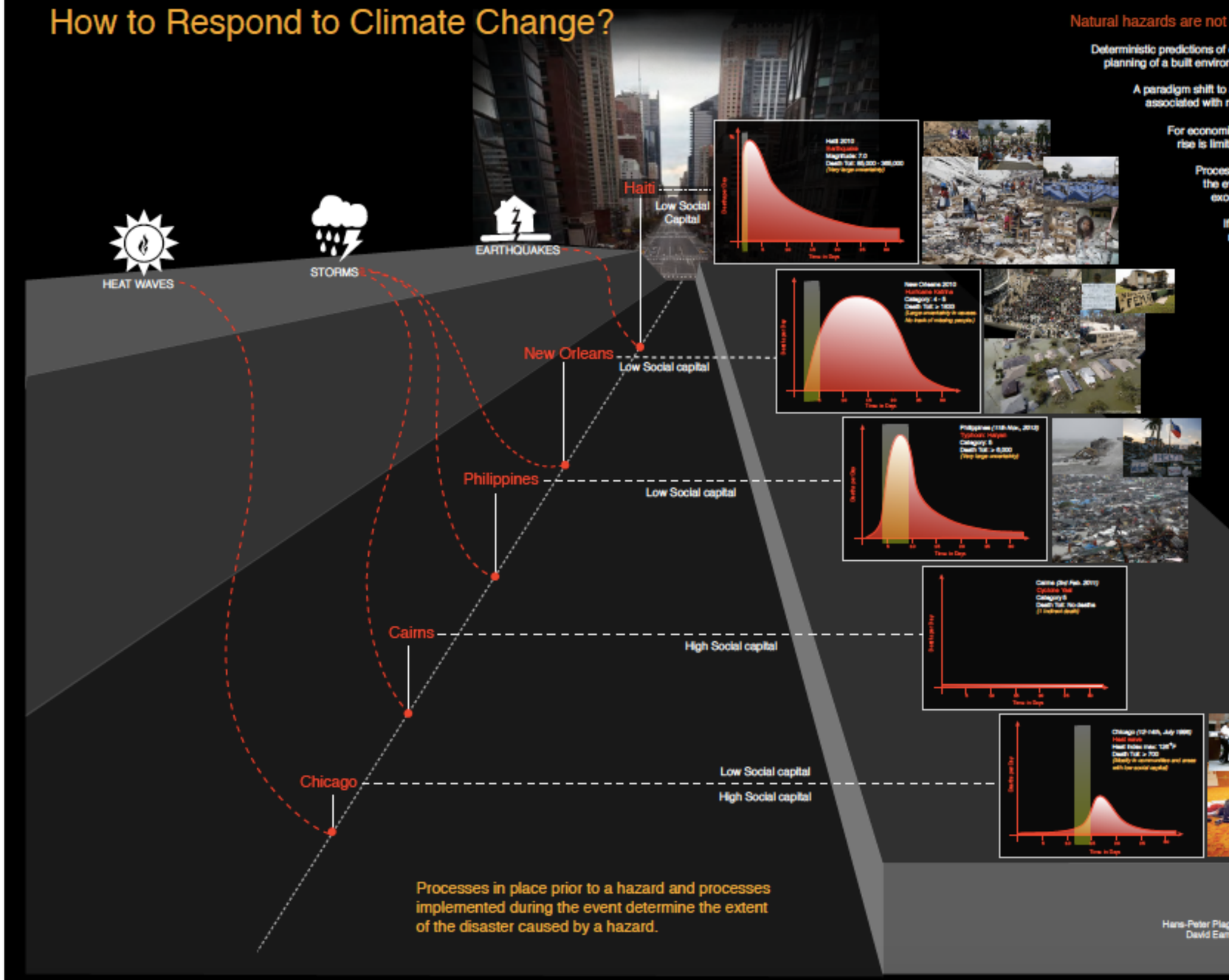


Deterministic or Probabilistic - Robustness or Resilience: How to Respond to Climate Change?



Processes in place prior to a hazard and processes implemented during the event determine the extent of the disaster caused by a hazard.

Natural hazards are not the disaster!

Deterministic predictions of climate change and sea level rise do not provide a basis for feasible planning of a built environment with thresholds that will not be exceeded by extreme events.

A paradigm shift to a probabilistic approach is needed, taking into account the risk associated with rare, extreme events.

For economic reasons, mitigation of impacts of climate change and sea level rise is limited, and rare surprising events will exceed thresholds.

Processes in place prior to a hazard and processes implemented during the event determine the extent of the disaster caused by hazards that exceed thresholds.

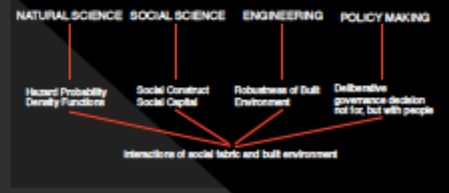
If an event exceeds thresholds of the built environment, the resilience of the social fabric determines the processes and extent of the disaster.

Resilience depends strongly on social capital. 'Social capital' refers to dense social networks with norms and social trust that allow community members to share interests, communicate valuable information, and identify opportunities to collaborate for the benefit of the entire community. Disaster risk reduction requires resilience and an increased social capital.

A best practice is needed that can utilize uncertainties and surprises to increase robustness, strengthen resilience, and reduce fragility of the social system during times when infrastructure fails.

A paradigm shift is needed to a new science-policy interface.

A Science - Engineering - Policy Paradigm



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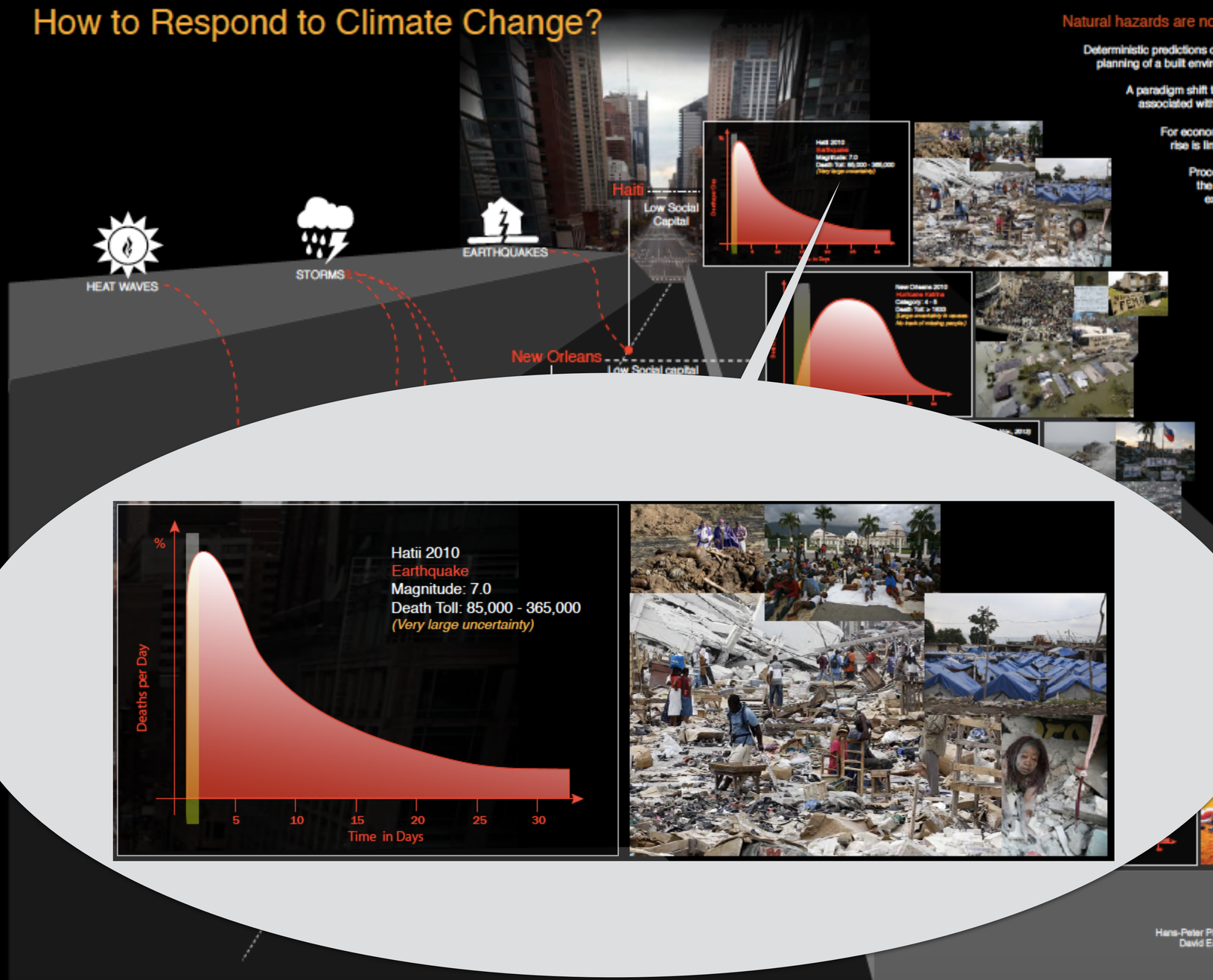

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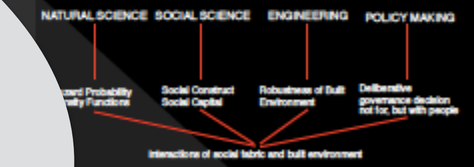

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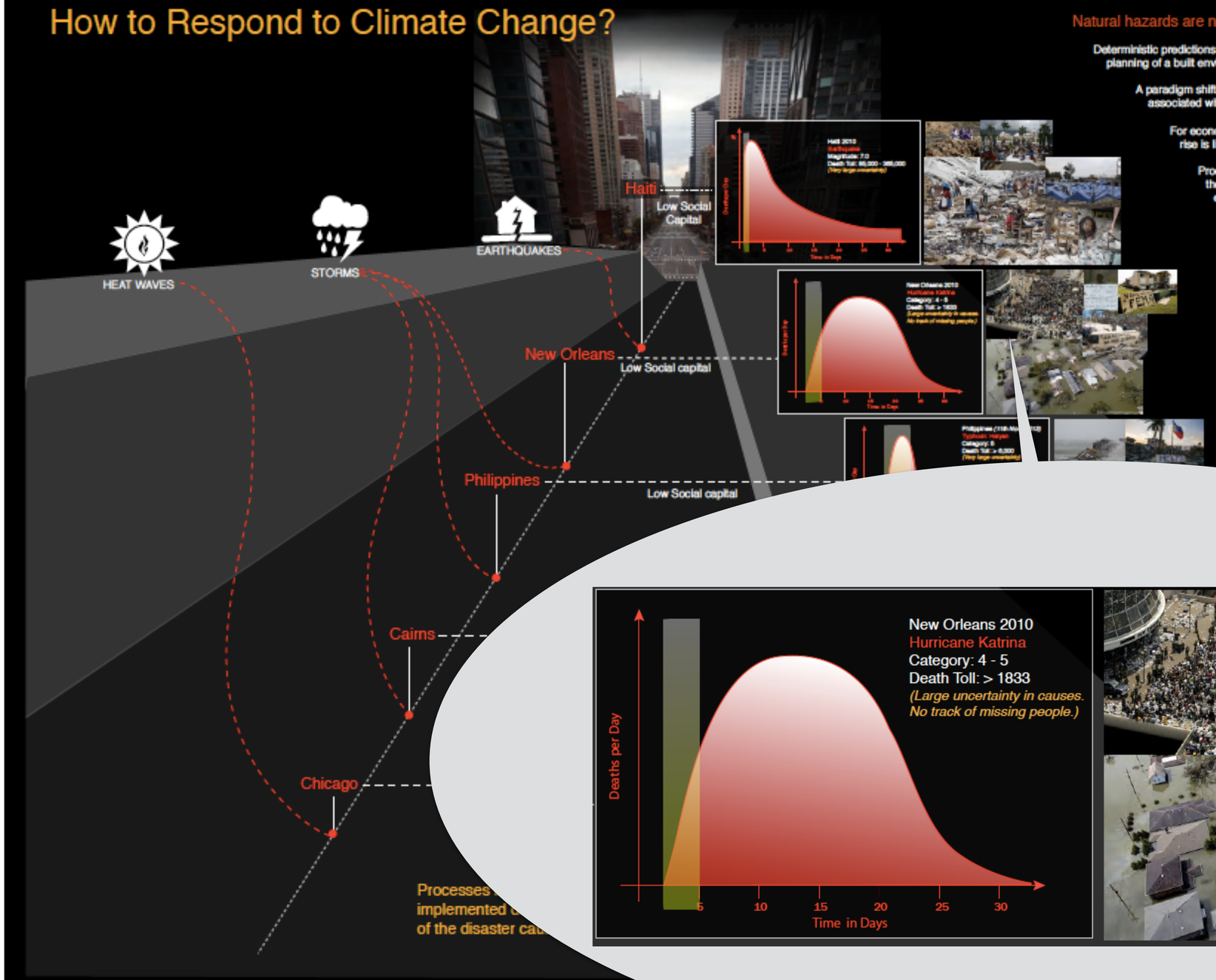

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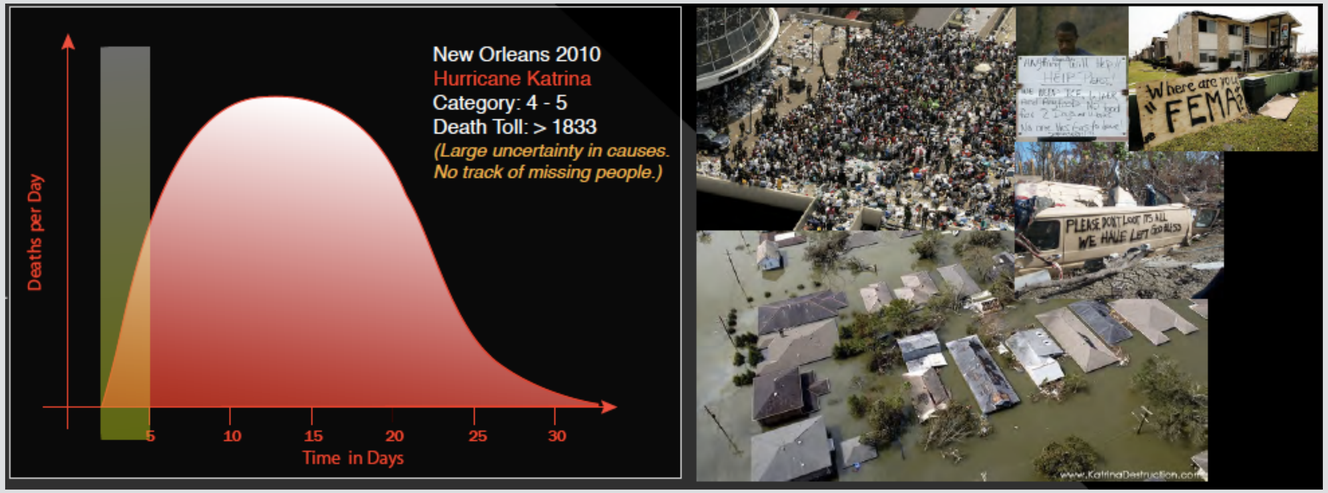

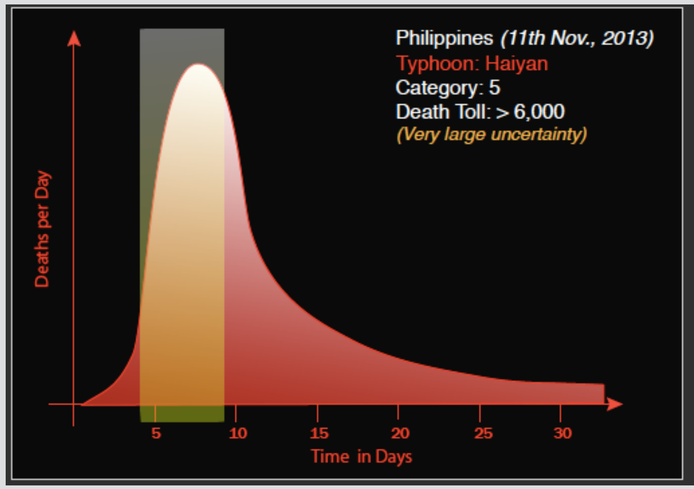

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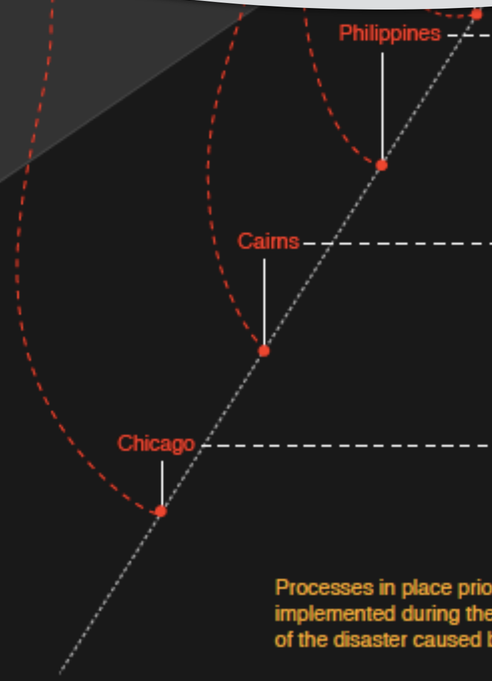

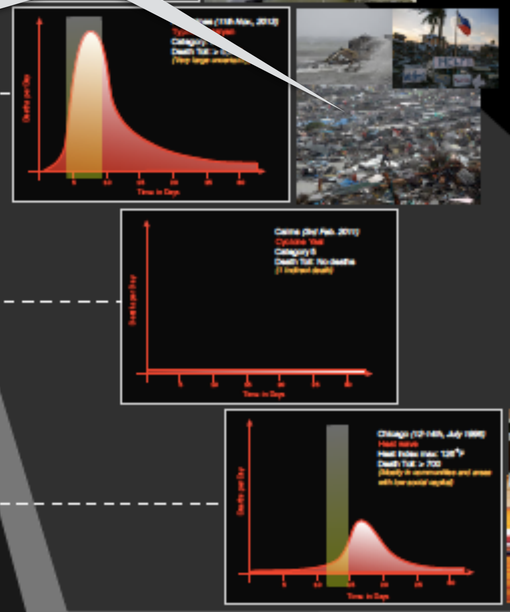

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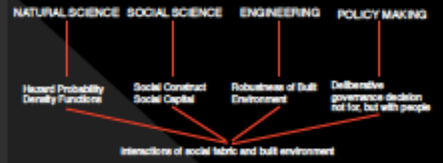

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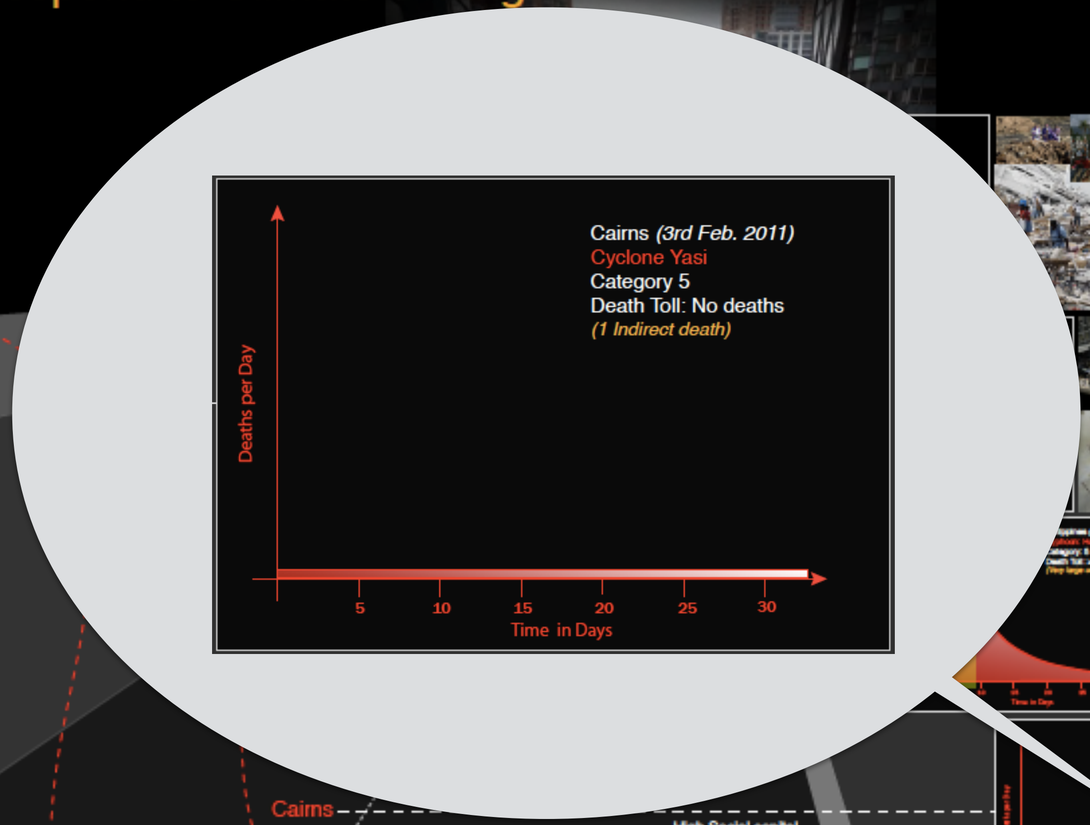

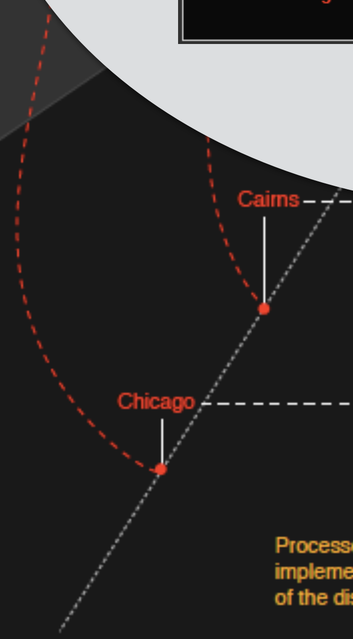

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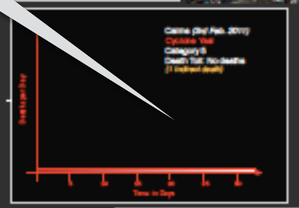

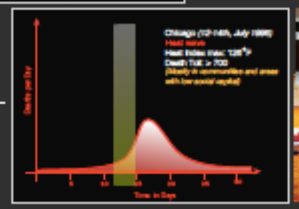

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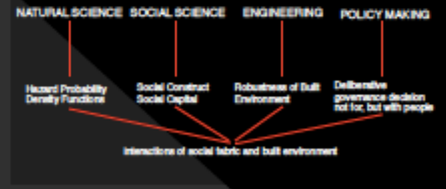

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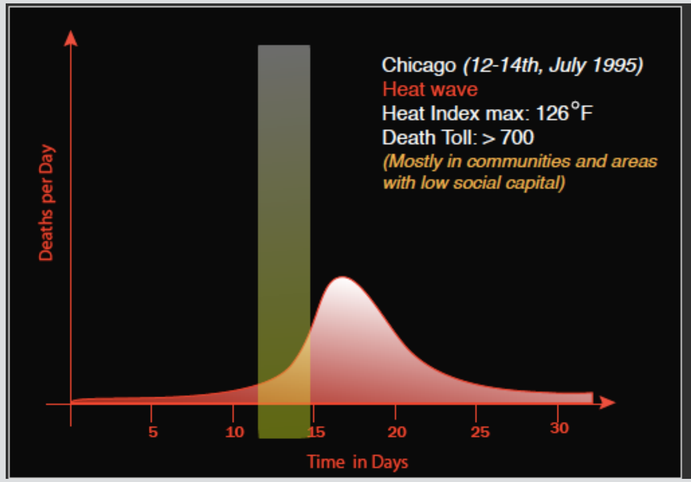

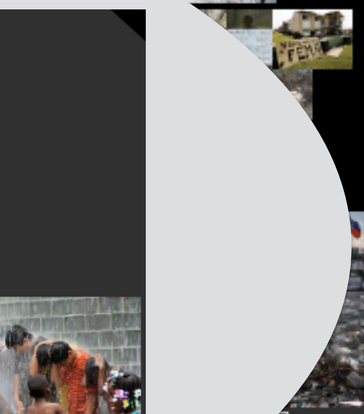

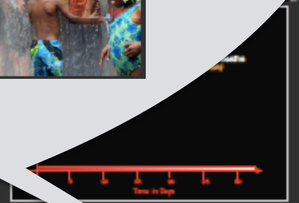

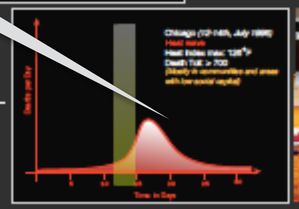

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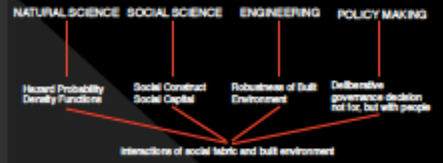

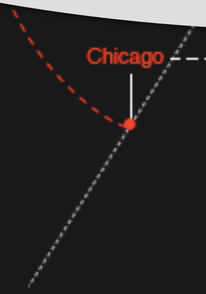

Low Social capital

High Social capital

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Q1.3

Explain the concept of a 100-year or 500-year event and use the Poisson Distribution to compute the probability that we have one or more of a 100-year or a 500-year event in a century. Note that how you answer this question will let me know whether I need to invest more time with you to explain the distribution. I have update the slides of class 2 to provide more details on how to use the equation for the Poisson equation.

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"The actual use of the Poisson Distribution is not something I understand enough to even attempt a direct explanation, or use of the formula."

Poisson Distribution

Poisson Formula. In a Poisson experiment, in which the average number of successes within a given region is μ, the Poisson probability is:

$$P(x=k;\ \mu) = (e^{-\mu})\ (\mu^k)\ /\ k!$$

where x is the actual number of successes that result from the experiment.

$e \sim 2.71828$

$$P(x=k;\ \mu) = \frac{\mu^k}{e^{\mu} * k!}$$

The factorial k! is:
0! = 1
1! = 1
2! = 1*2 = 2
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Probability of exactly one 100-year flood to occur in a specific century?

$\mu = 1$, $k = 1$, $P=?$ $\quad P = 1^1/(e^1 * 1!) = 0.368$

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Probability of one or more 100-year flood to occur in a specific century?

$\mu = 1,\ k \geq 1,\ P=?$ $\quad P = 1 - P(x=0,1) = 1 - 0.368 = 0.632$

The factorial k! is:

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Q1.4

Based on the reading list for class 2, comment on the major threats humanity is exposed to. In your assessment, are non-human threats more severe than human-caused threats? Again, your answer to this question will help me to assess at what level future questions should be.

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Extreme Events:

- **Extinction Level Events**: more than a quarter of all life on Earth is killed and major species extinction takes place.
- **Global Catastrophes**: more than a quarter of the world human population dies and that place civilization in serious risk.
- **Global Disasters**: global-scale events in which a few percent of the population die.
- **Major Disasters**: disasters exceeding $100 Billion in damage and/or causing more than 10,000 fatalities.

Modified from Hempsell (2004)

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“I believe non-human threats are more severe”

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Really?

"I believe non-human threats are more severe"
Instead of "I believe …" I would have preferred "Based on the assessment by …"

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"Humanity has been overcoming natural hazards without too much difficulties for thousands of years"

Really?

"Extreme weather events are more severe than human-caused events."
Really?

"I believe non-human threats are more severe"
Instead of "I believe …" I would have preferred "Based on the assessment by …"

Really?

Questions

The New York Times

November 6, 2011

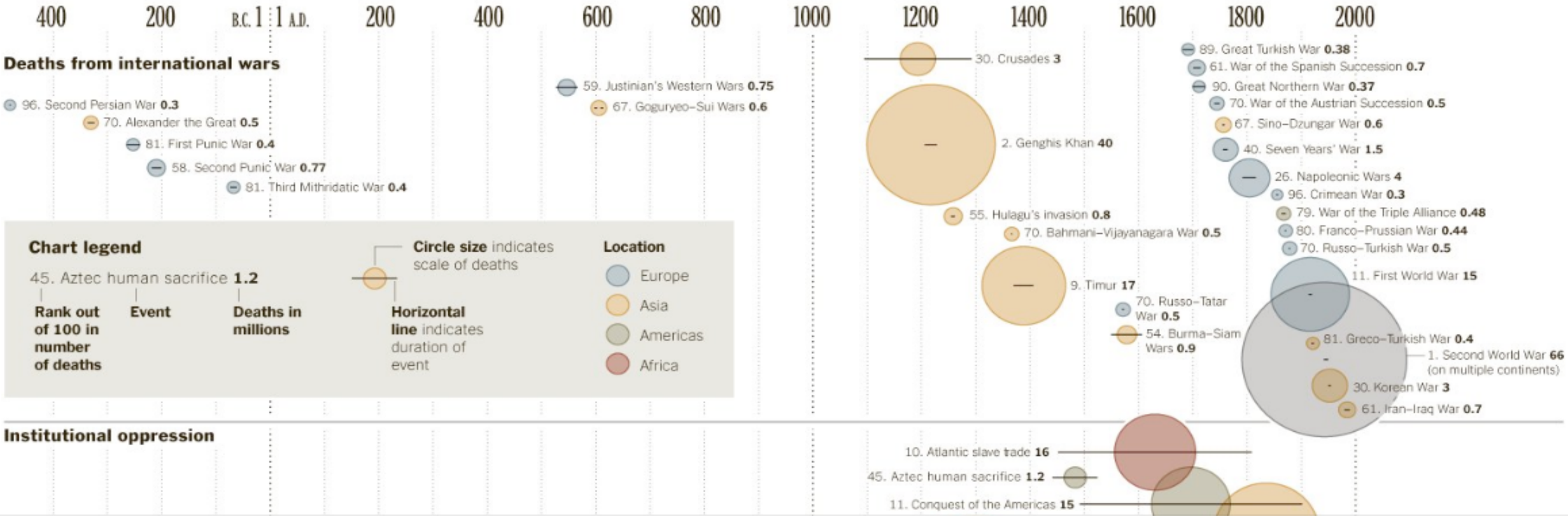
http://www.nytimes.com/imagepages/2011/11/06/opinion/06atrocities_timeline.html?action=click&contentCollection=Opinion&module=RelatedCoverage&region=EndOfArticle&pgtype=article

DATA POINTS

Population Control, Marauder Style

Last week, the United Nations announced that the world's population had reached seven billion, but there have been times when it headed in the opposite direction, and not in pleasant ways. The savagery of the Mongol conqueror Genghis Khan may have culled the global population by about 11 percent; two bloody upheavals in China — the An Lushan Rebellion and the collapse of the Xin Dynasty — each may have felled about 6 percent of humanity. Those are but 3 of the 100 worst atrocities in history, as cataloged by Matthew White in "The Great Big Book of Horrible Things," an amusing (really) account of the murderous ways of despots, slave traders, blundering royals, gladiators and assorted hordes. Estimating the tolls from such horrors is an inexact science, given war's nature and the mysteries of antiquity. The deadliest "multicides" are more plentiful in recent centuries, given that there were more people to kill and better ways to kill them on a grand scale. Even so, killings as a percentage of all humanity are probably declining. Below, the sweep of human brutality in a timeline.

BILL MARSH



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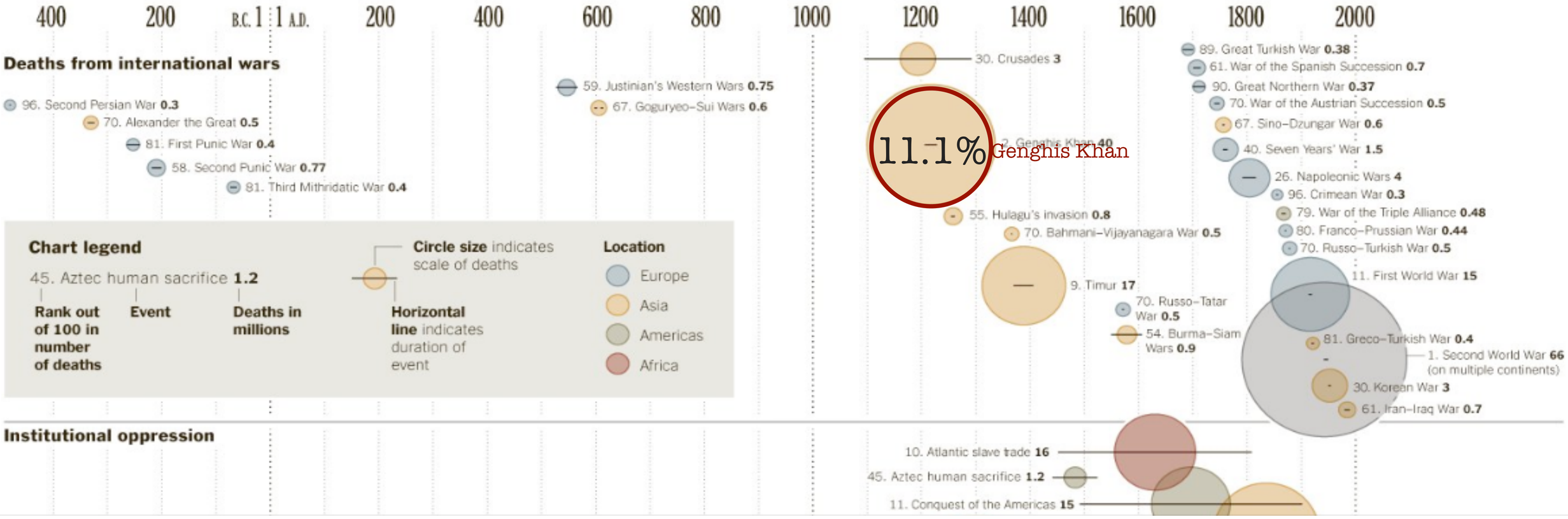
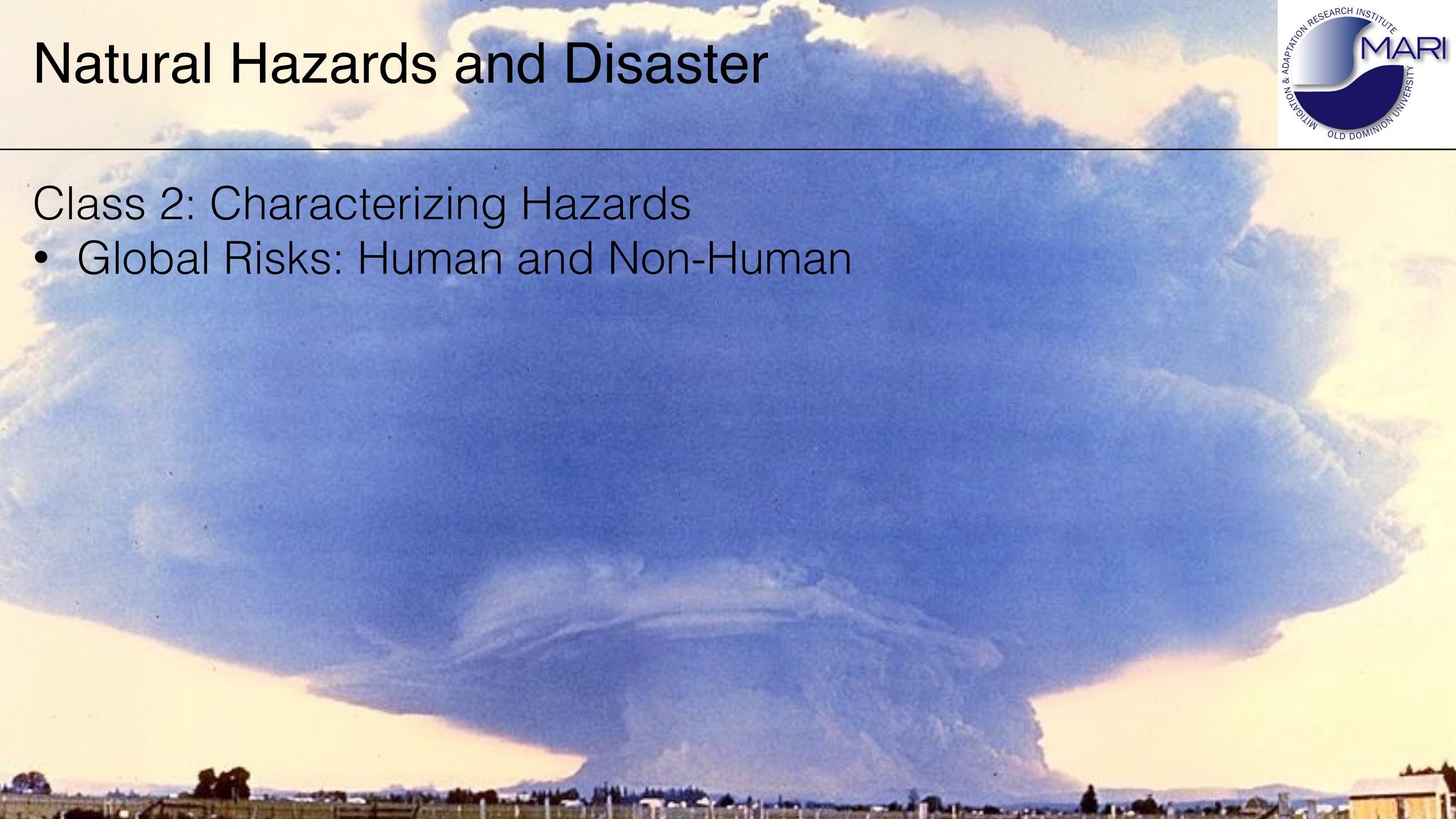


hpplag@mari-odu.org

Natural Hazards and Disaster



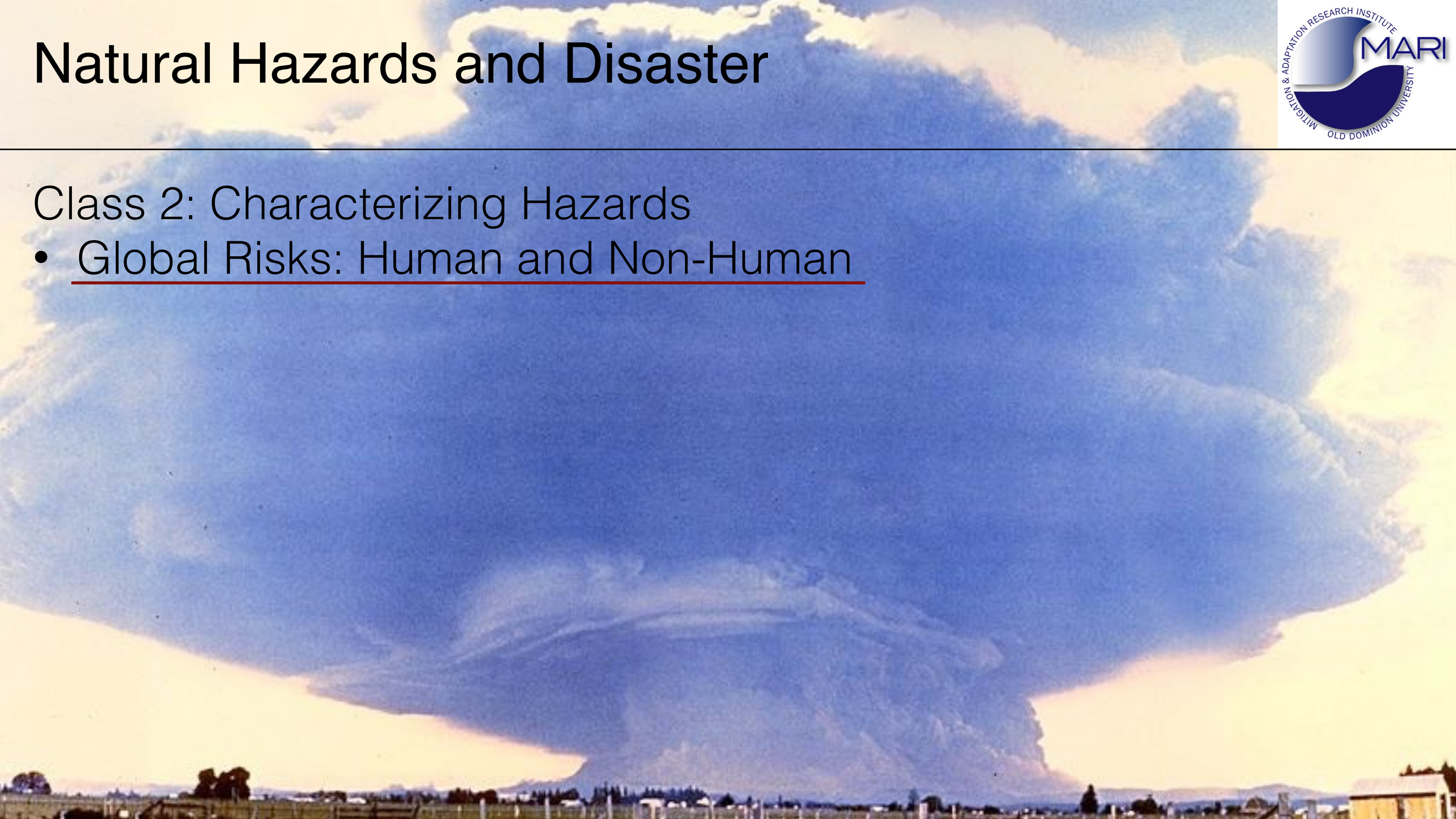
Class 2: Characterizing Hazards

- Global Risks: Human and Non-Human

Natural Hazards and Disaster

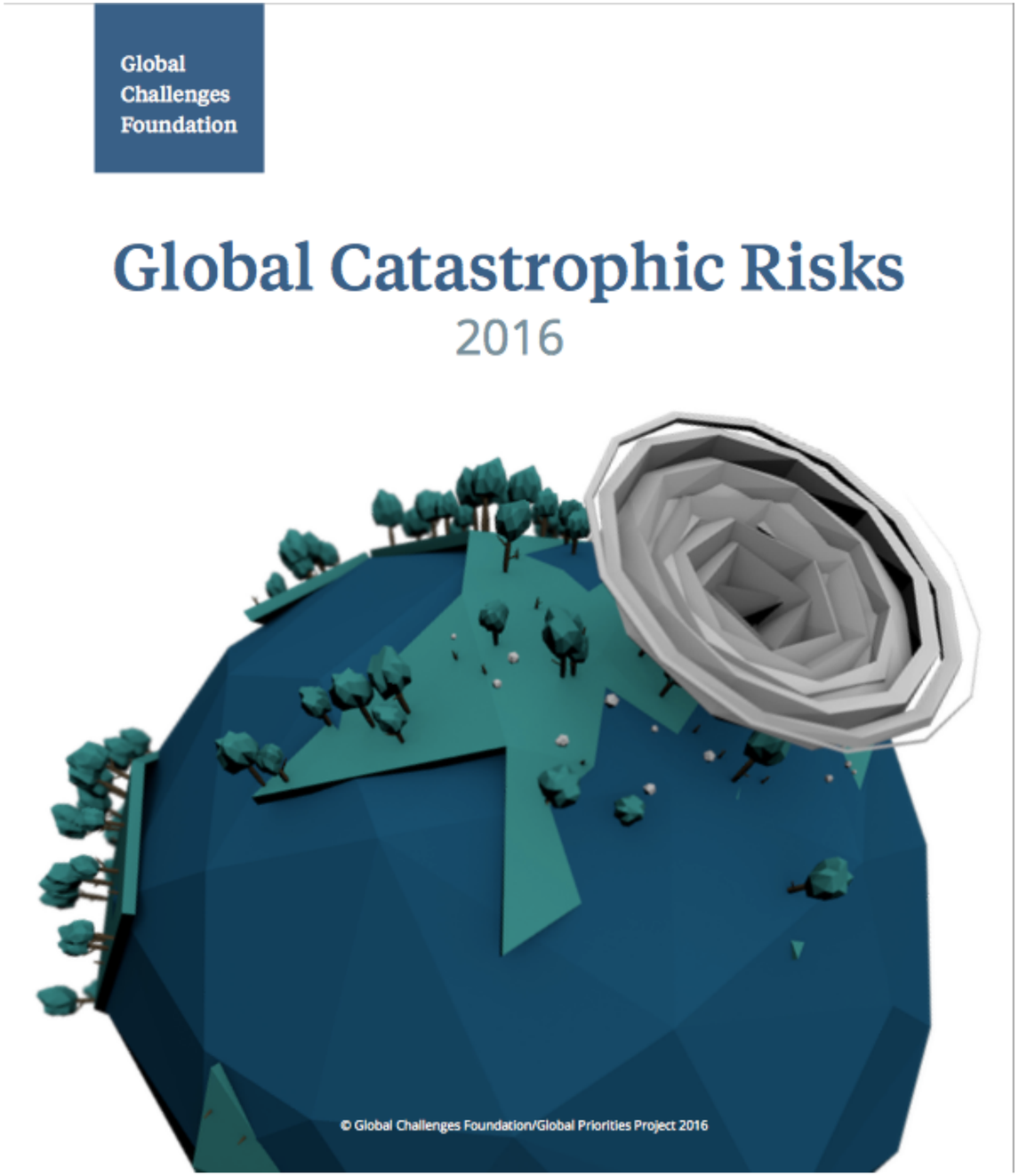
Class 2: Characterizing Hazards

- Global Risks: Human and Non-Human



Global Risks: Human and Non-Human

Global Risks: Human and Non-Human

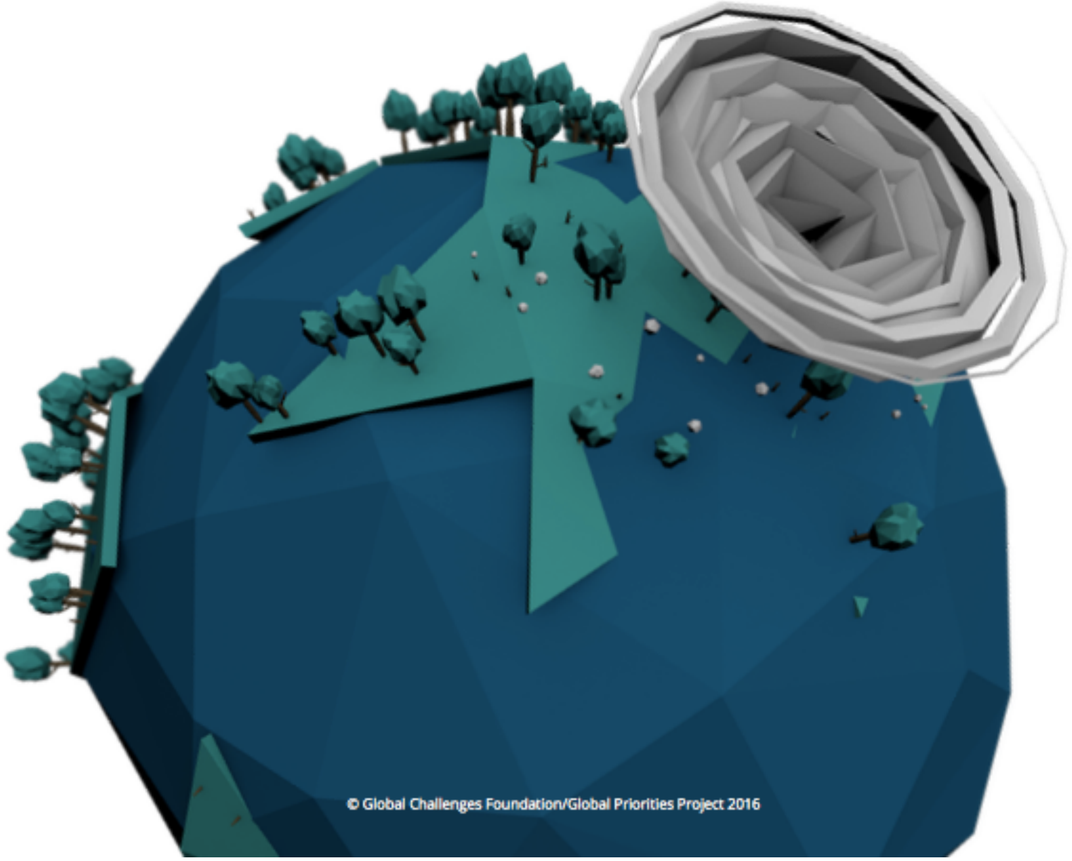


Global Risks: Human and Non-Human

Global Challenges Foundation

Global Catastrophic Risks

2016



Global Challenges Foundation

GLOBAL PRIORITIES PROJECT

in association with

Future of Humanity Institute
UNIVERSITY OF OXFORD

OXFORD MARTIN SCHOOL

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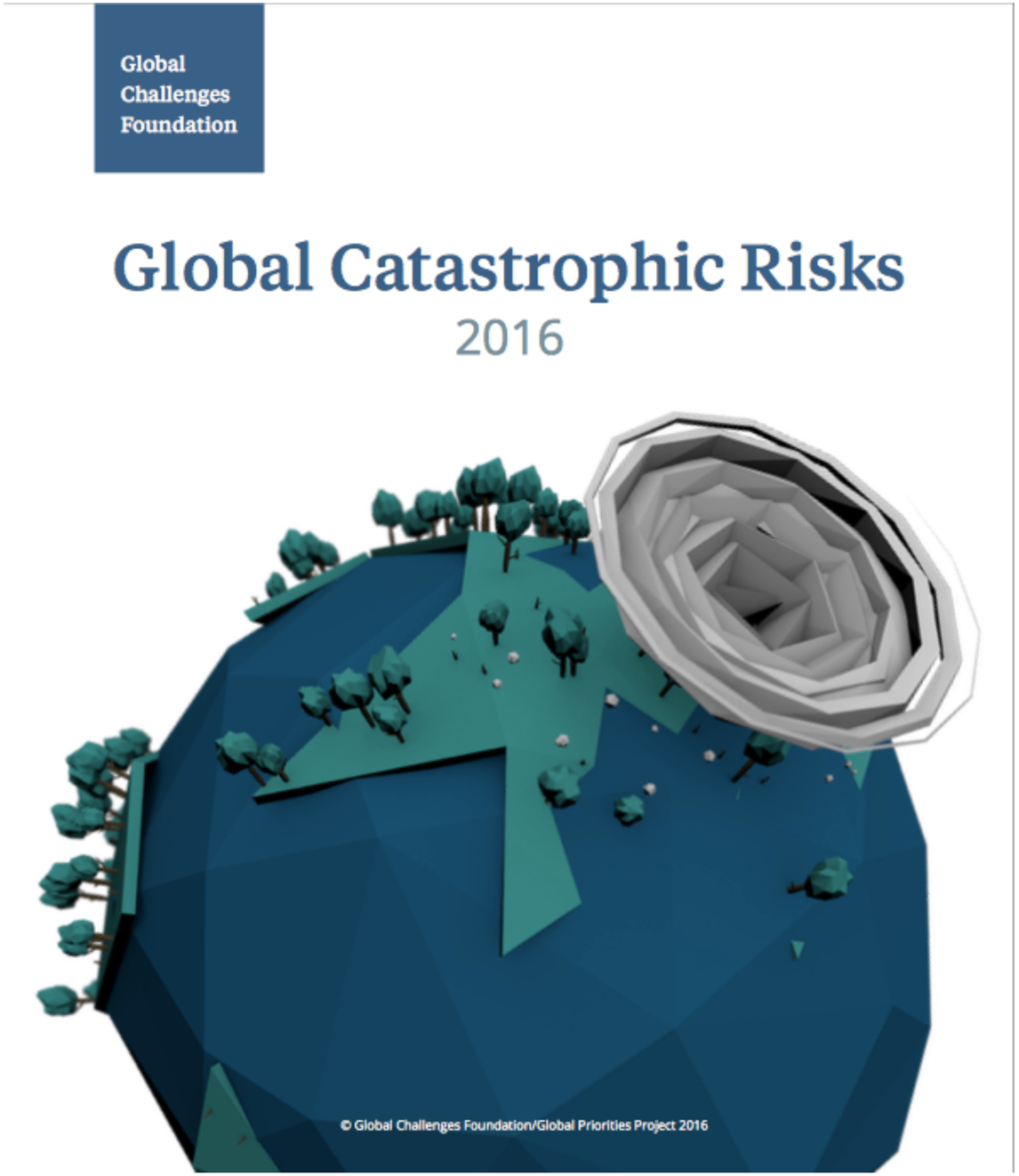
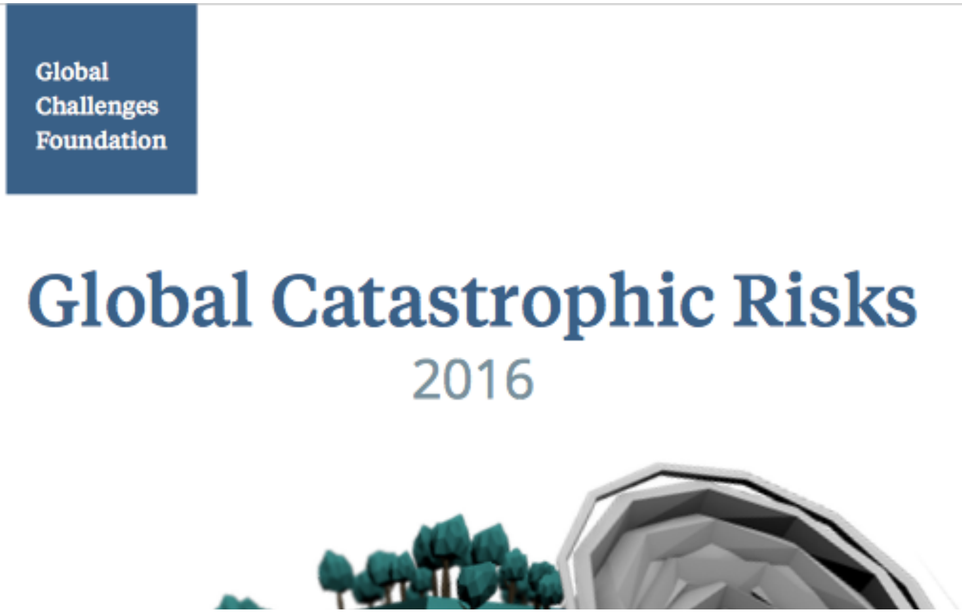
Global Risks: Human and Non-Human



THE GLOBAL CHALLENGES FOUNDATION works to raise awareness of the Global Catastrophic Risks. Primarily focused on climate change, other environmental degradation and politically motivated violence as well as how these threats are linked to poverty and rapid population growth. Against this background, the Foundation also works to both identify and stimulate the development of good proposals for a management model – a global governance – able to decrease – and at best eliminate – these risks.

THE GLOBAL PRIORITIES PROJECT helps decision-makers effectively prioritise ways to do good. We achieve this both by advising decision-makers on programme evaluation methodology and by encouraging specific policies. We are a collaboration between the Centre for Effective Altruism and the Future of Humanity Institute, part of the University of Oxford.

Global Risks: Human and Non-Human



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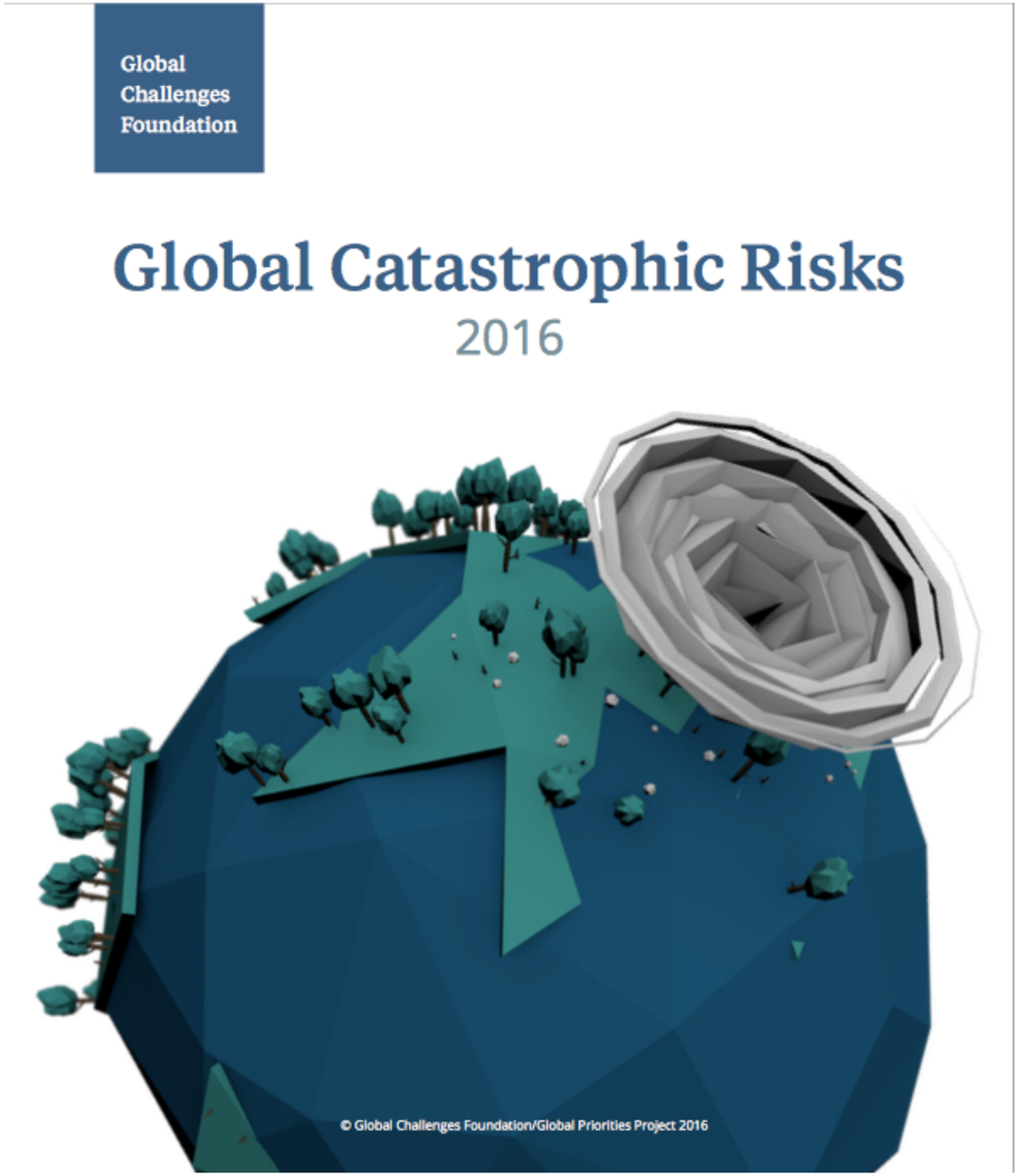
Extreme Events:

- **Extinction Level Events**: more than a quarter of all life on Earth is killed and major species extinction takes place.
- **Global Catastrophes**: more than a quarter of the world human population dies and that place civilization in serious risk.
- **Global Disasters**: global-scale events in which a few percent of the population die.
- **Major Disasters**: disasters exceeding $100 Billion in damage and/or causing more than 10,000 fatalities.

Modified from Hempsell (2004)

Global Risks: Human and Non-Human



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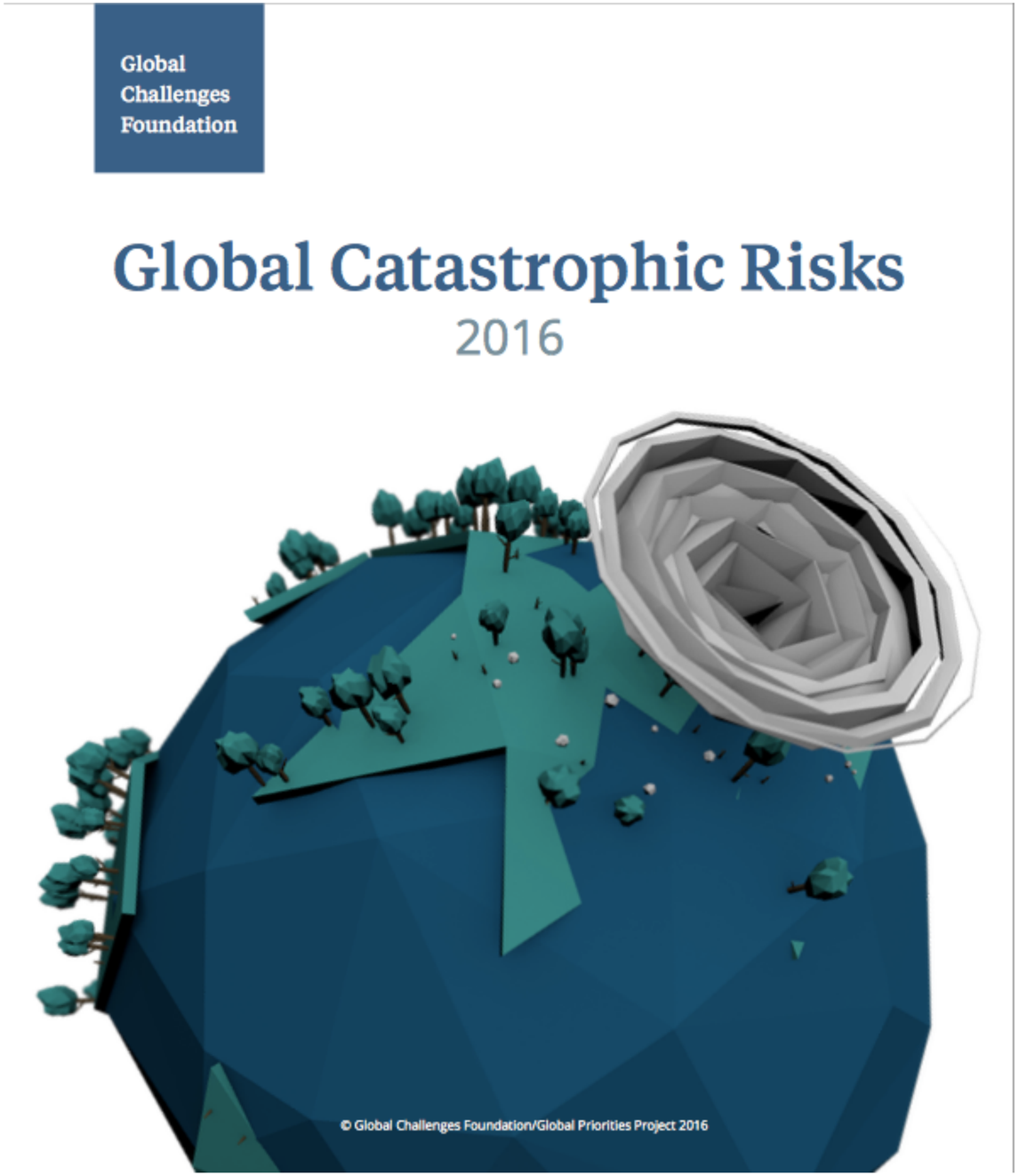
Global Risks: Human and Non-Human



Global Risks: Human and Non-Huma

Global
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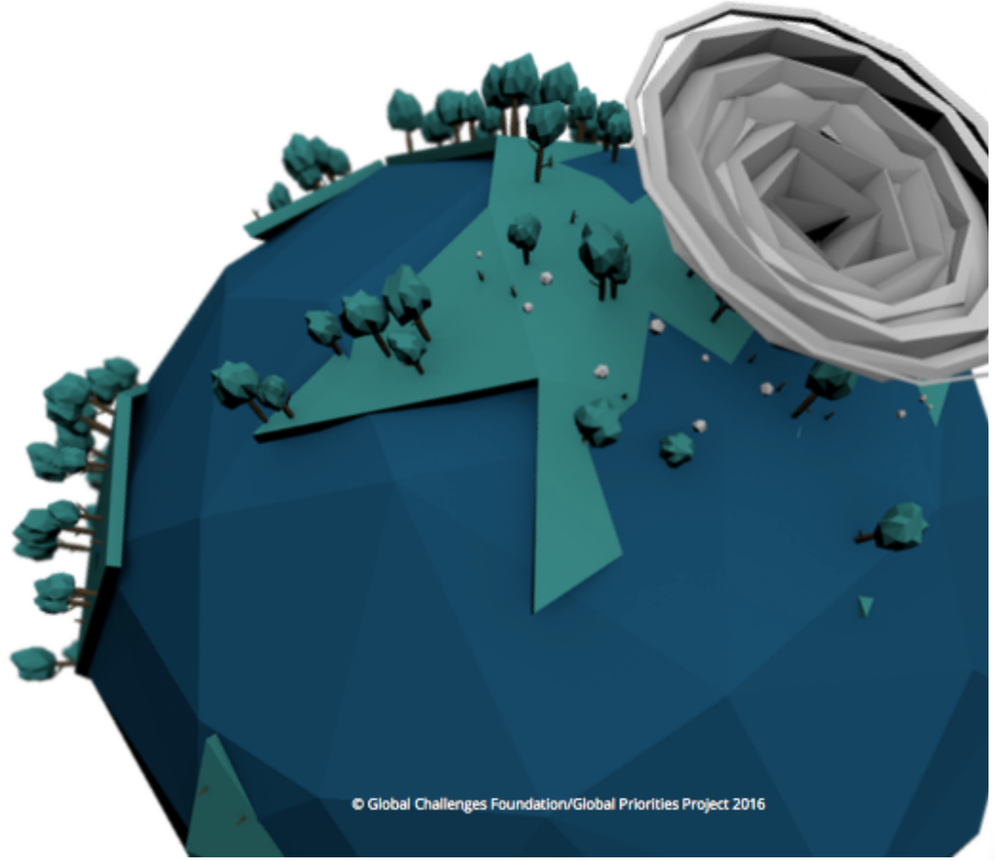
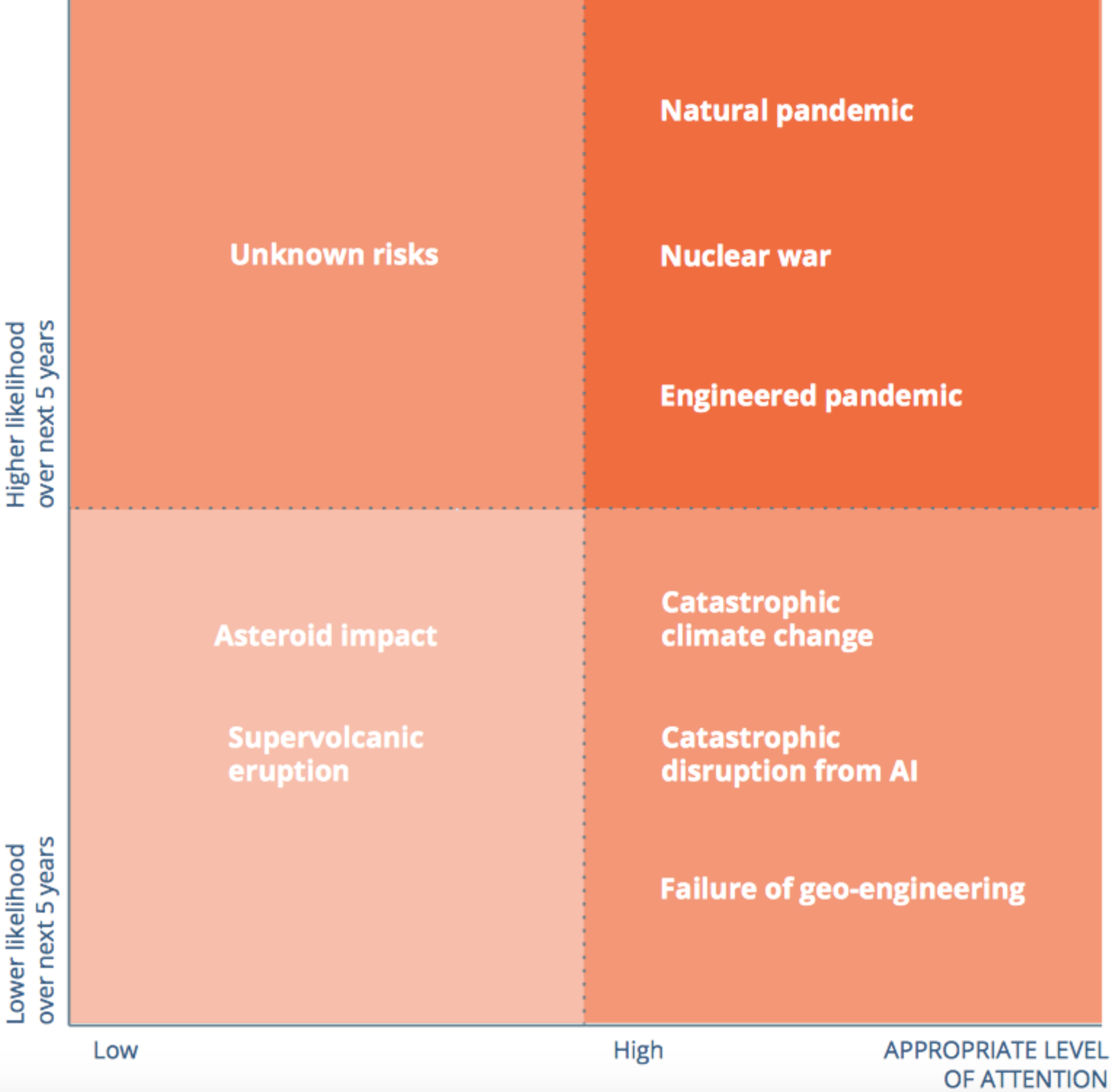
Foundation

Global Catastrophic Risks
2016





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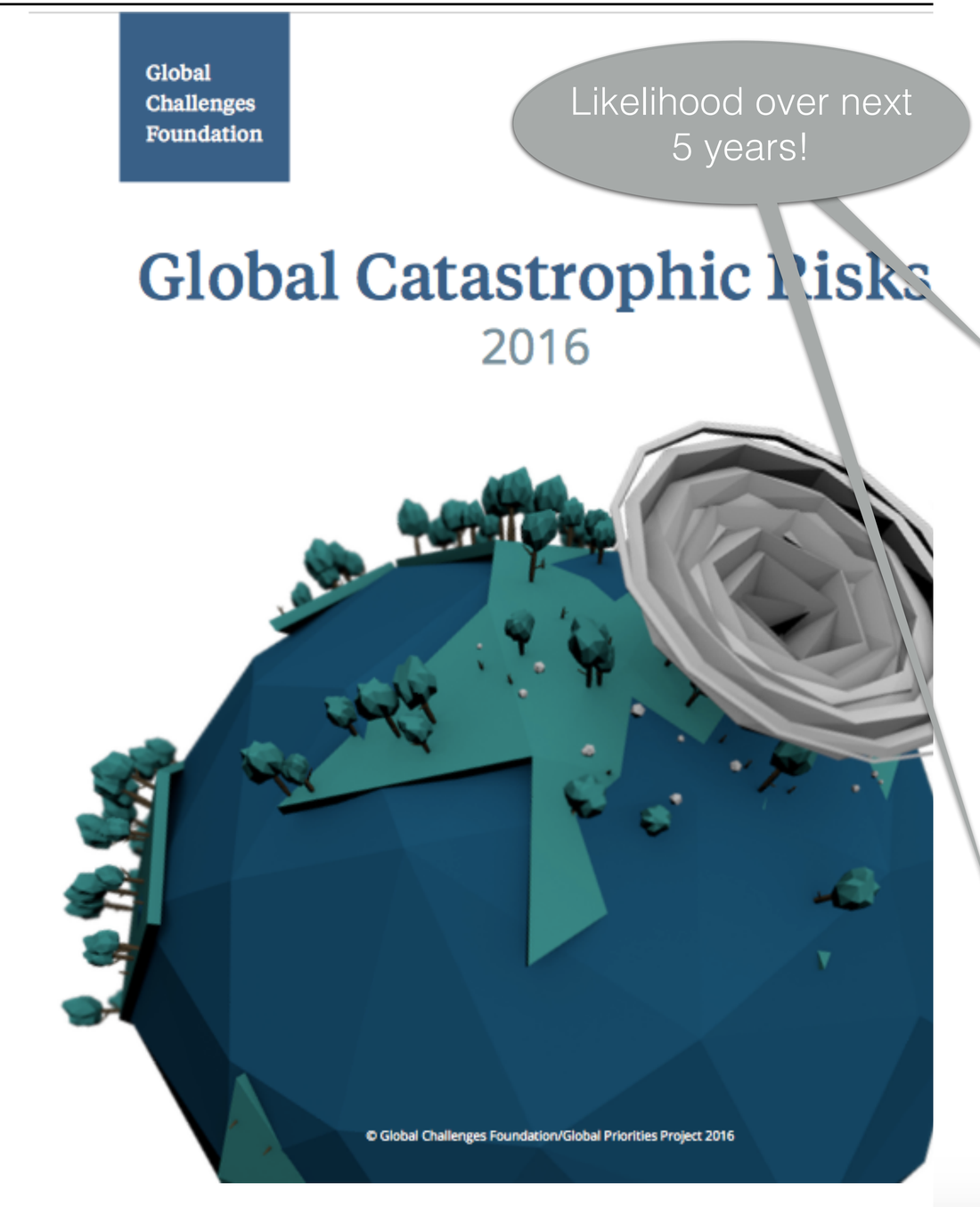

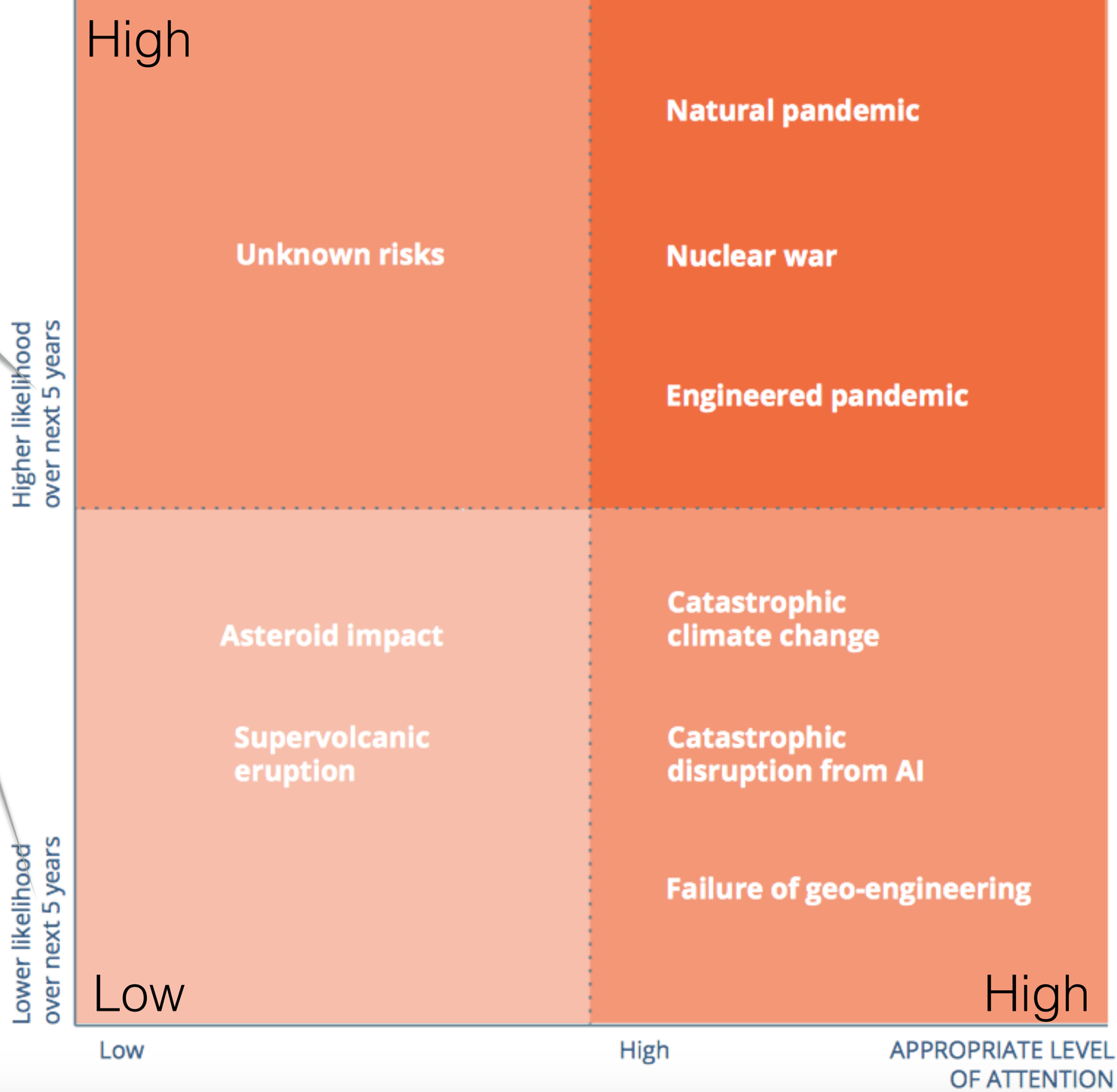

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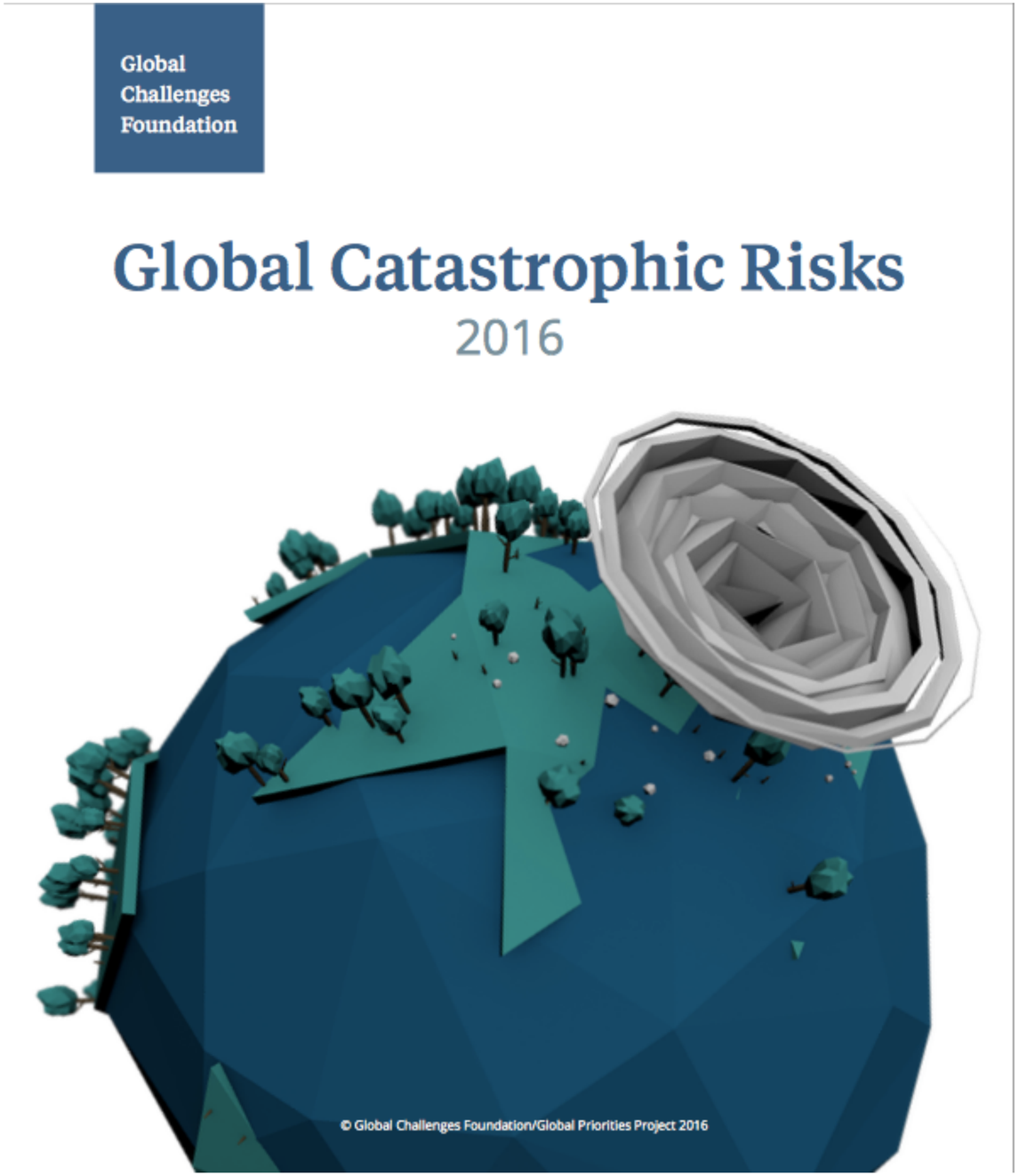

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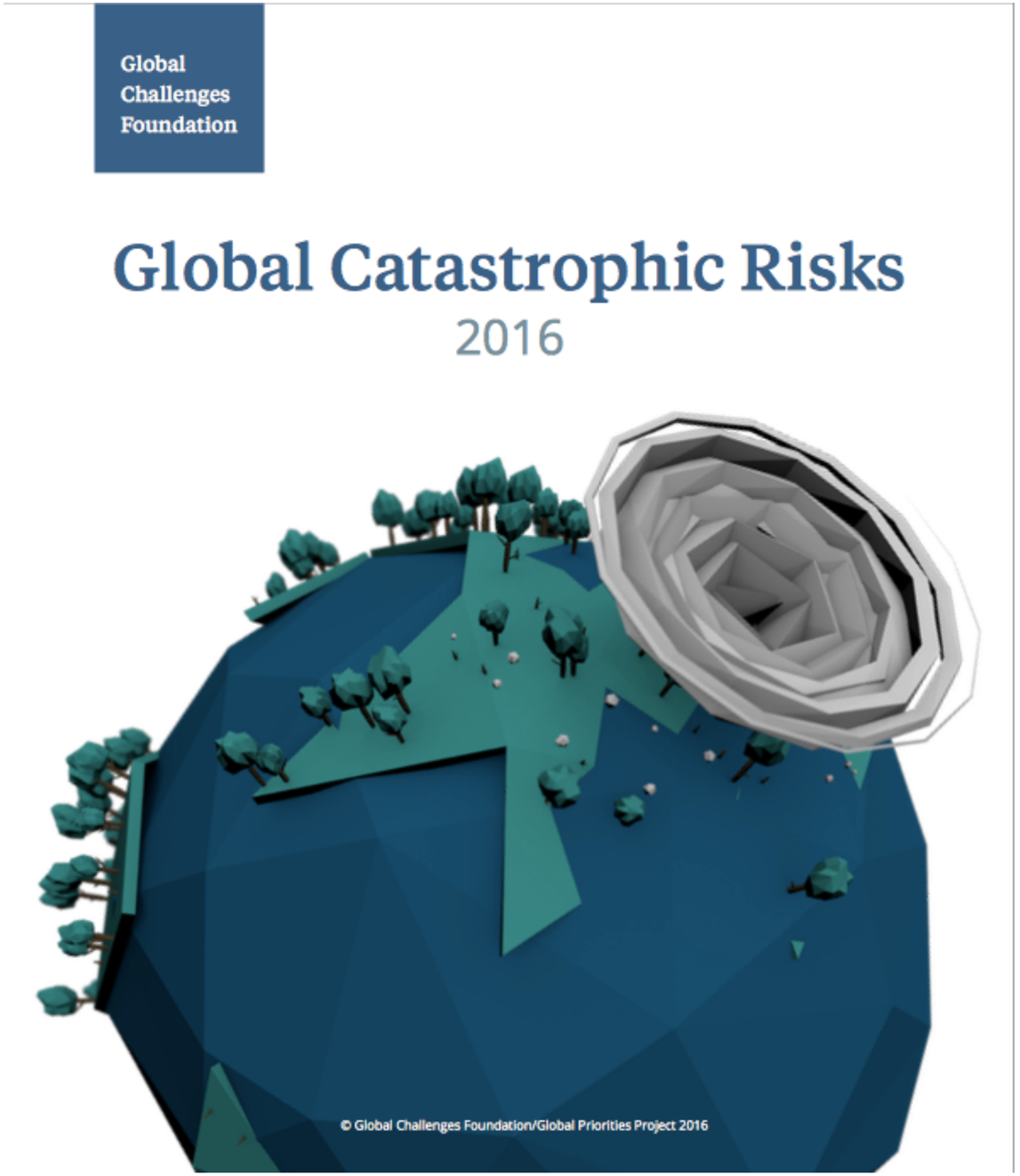
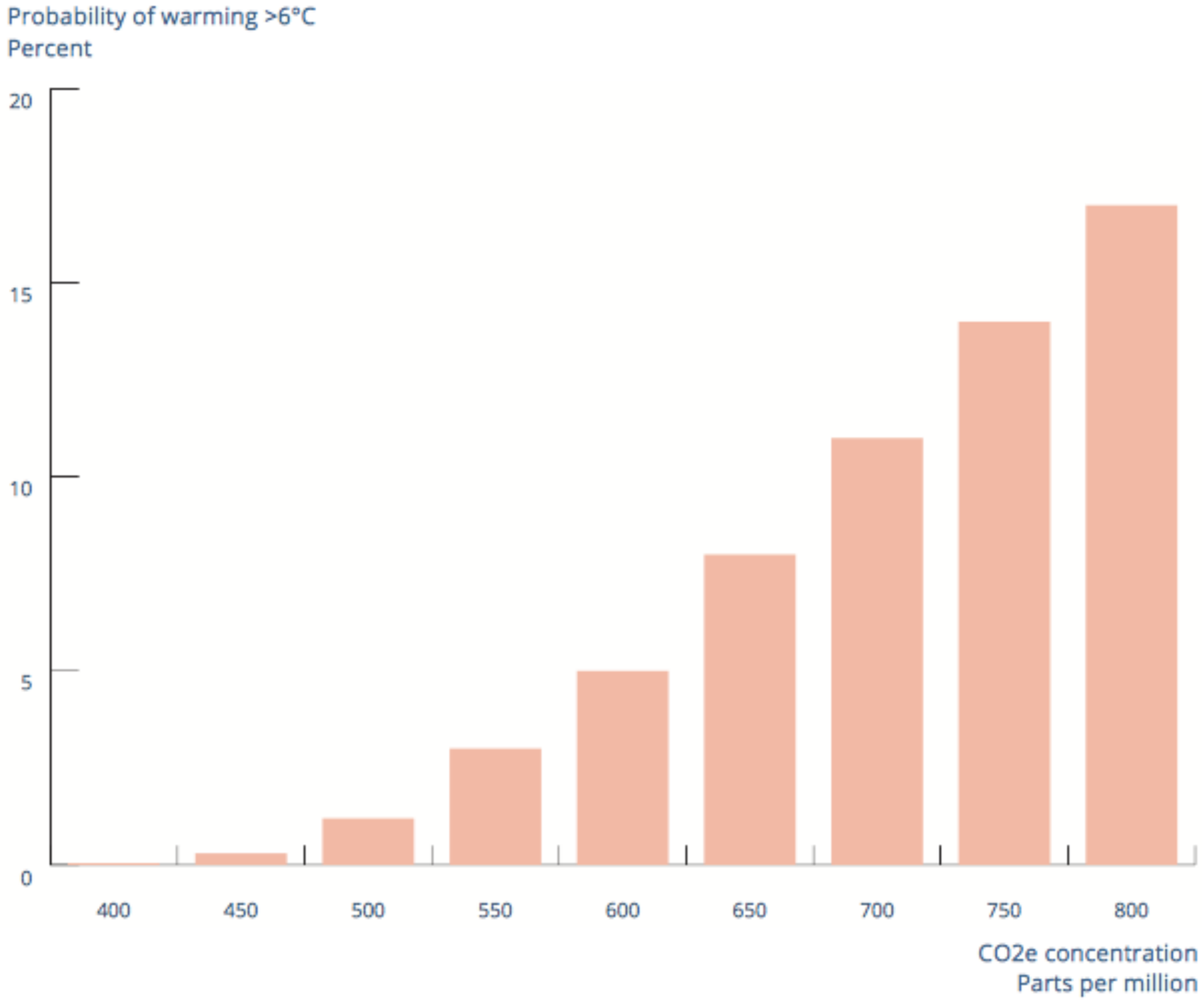


FIGURE 2.1. THE CHANCE OF EXTREME CLIMATE CHANGE

The probability of warming of 6°C for different atmospheric concentrations of greenhouse gases.[39]



Global Risks: Human and Non-Human

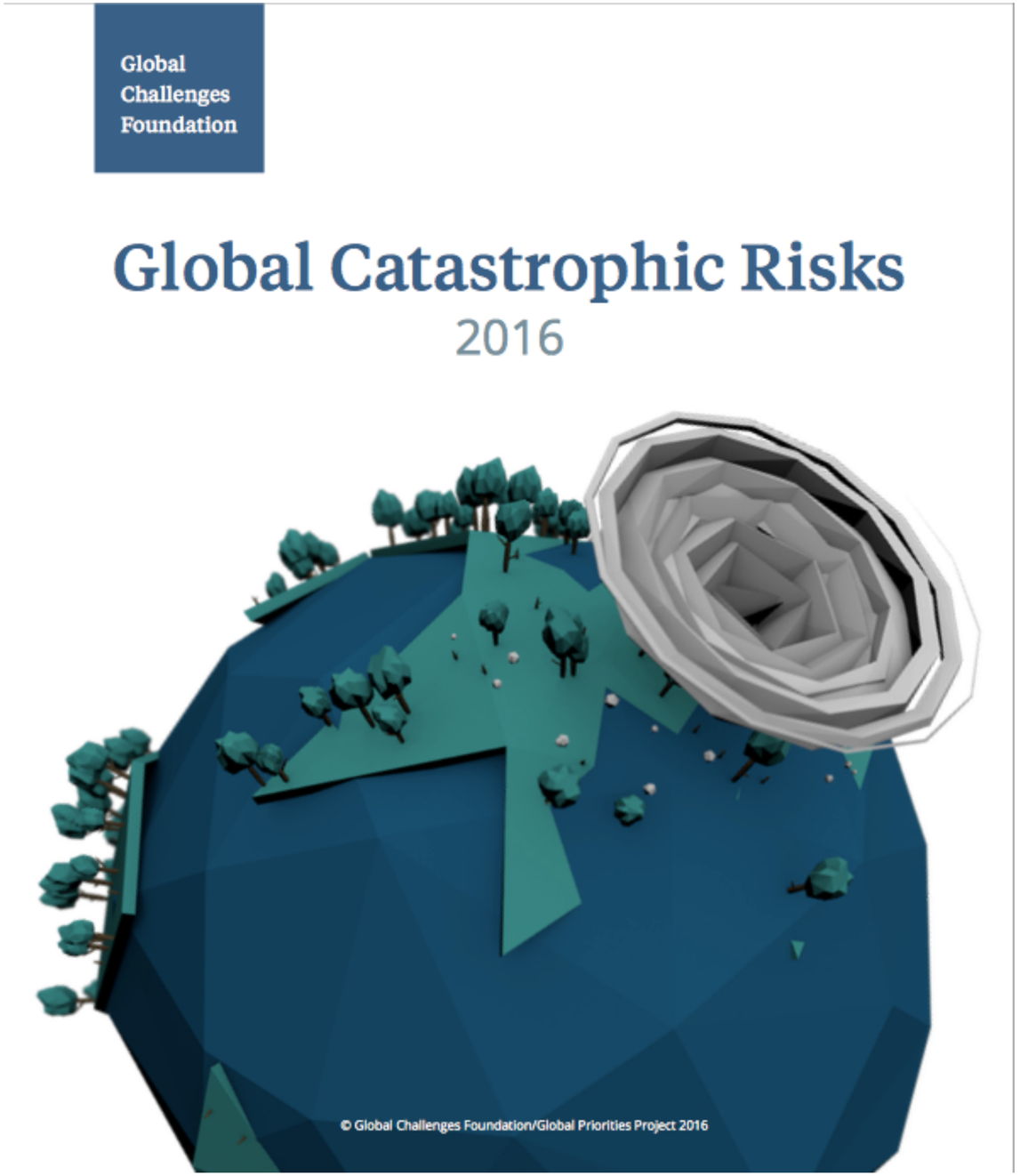
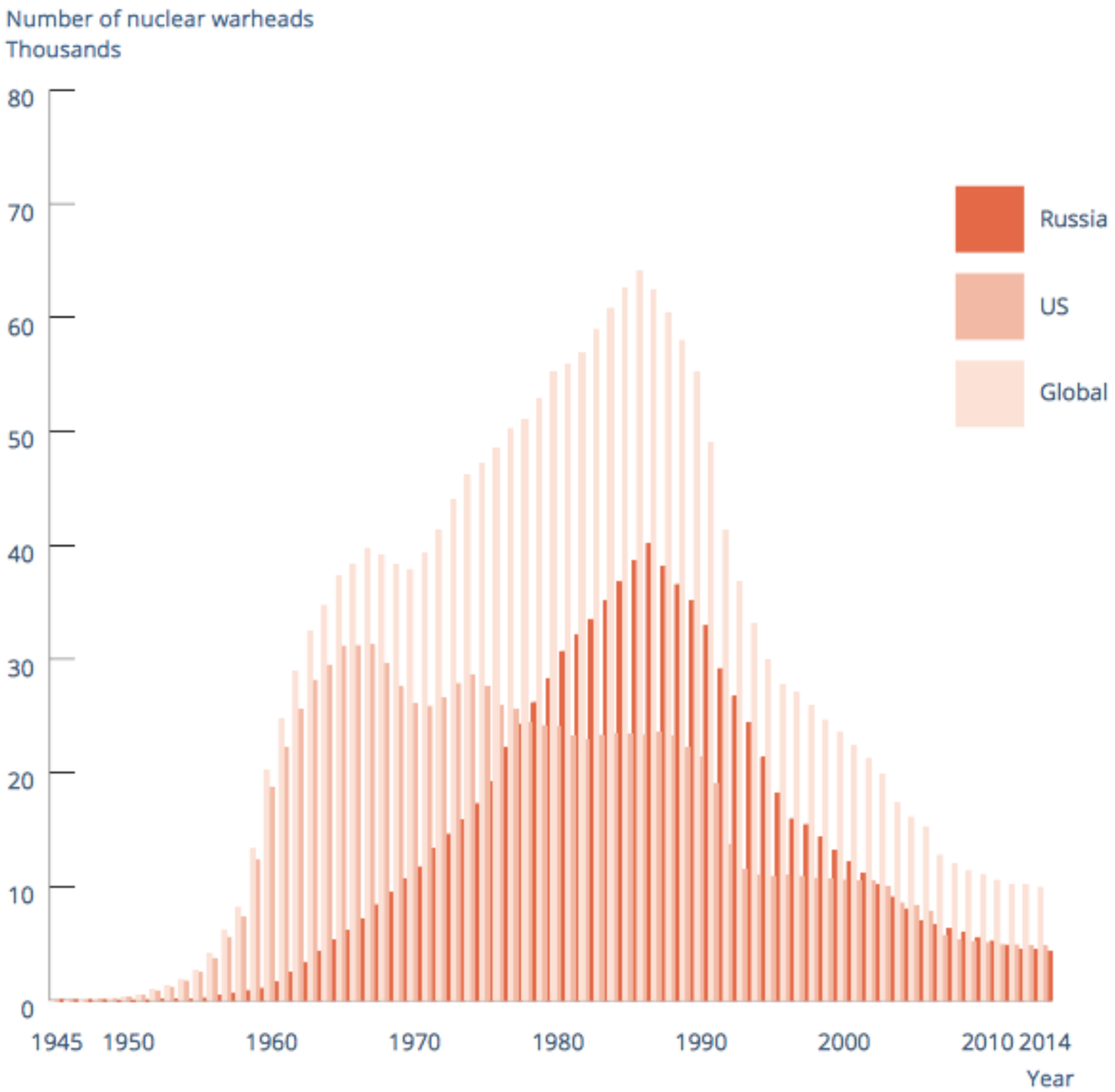


FIGURE 2.2.1. NUCLEAR ARSENALS OF THE US, RUSSIA, AND THE WORLD FROM 1945 UNTIL TODAY [59]



Global Risks: Human and Non-Human

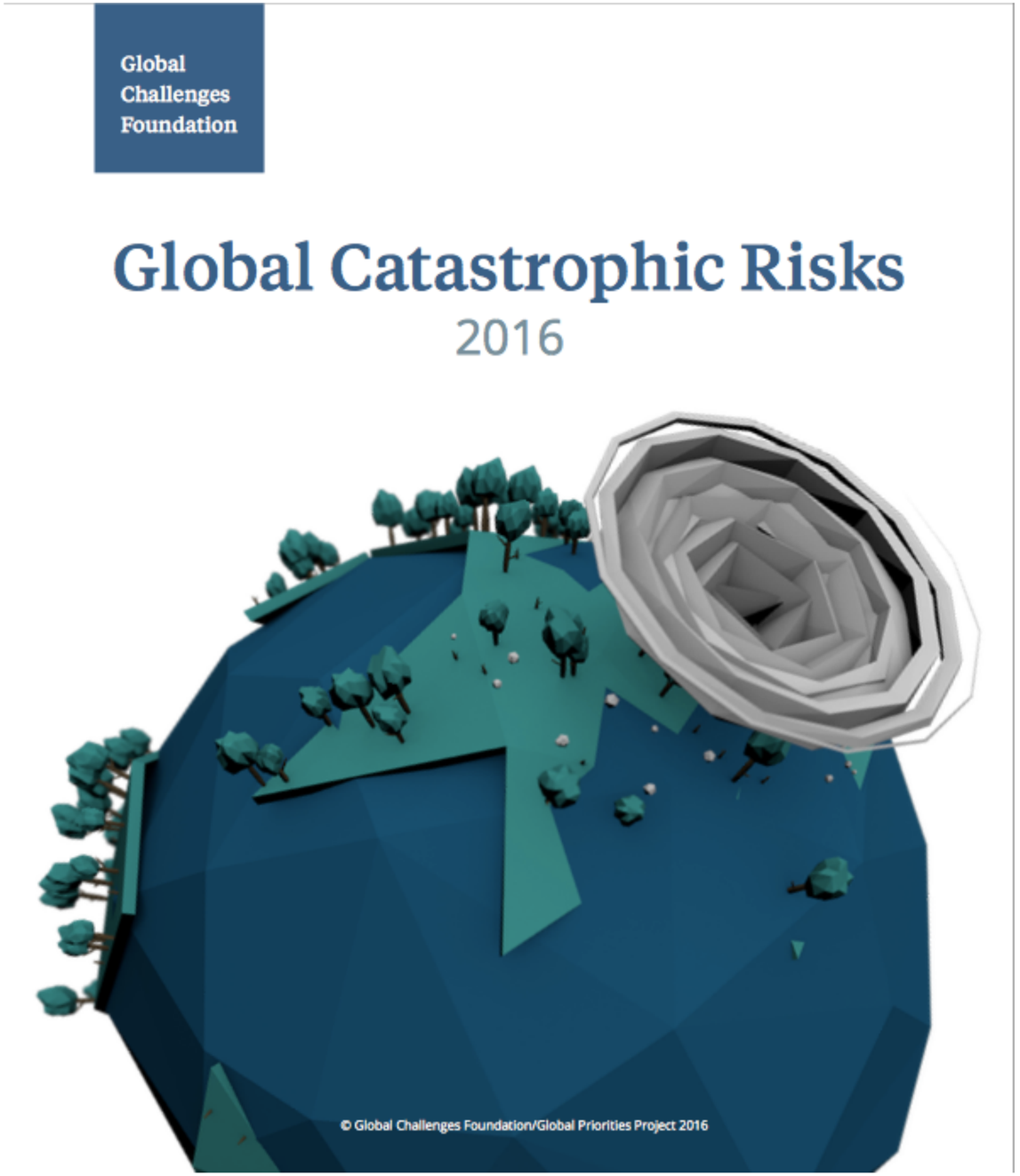
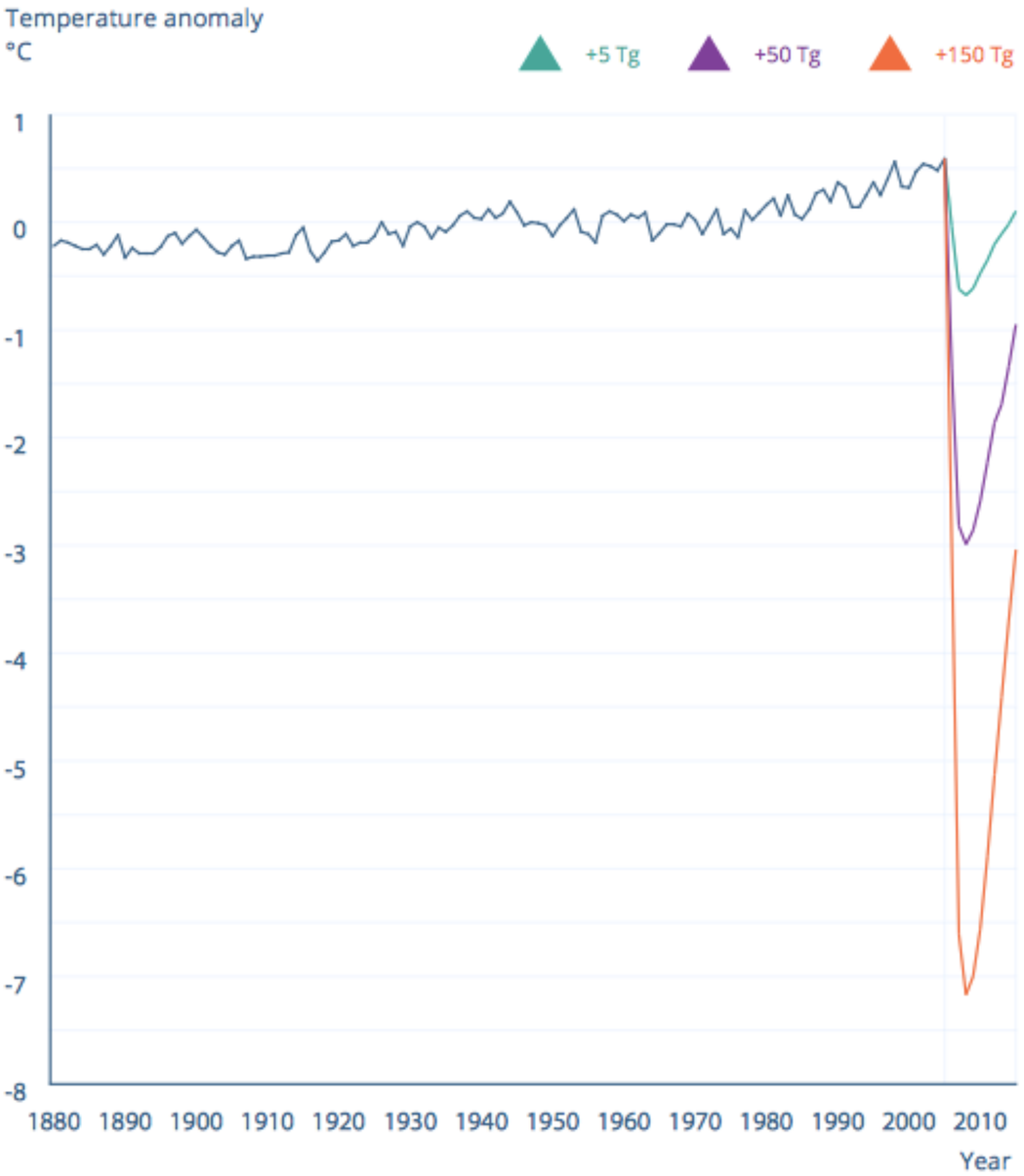
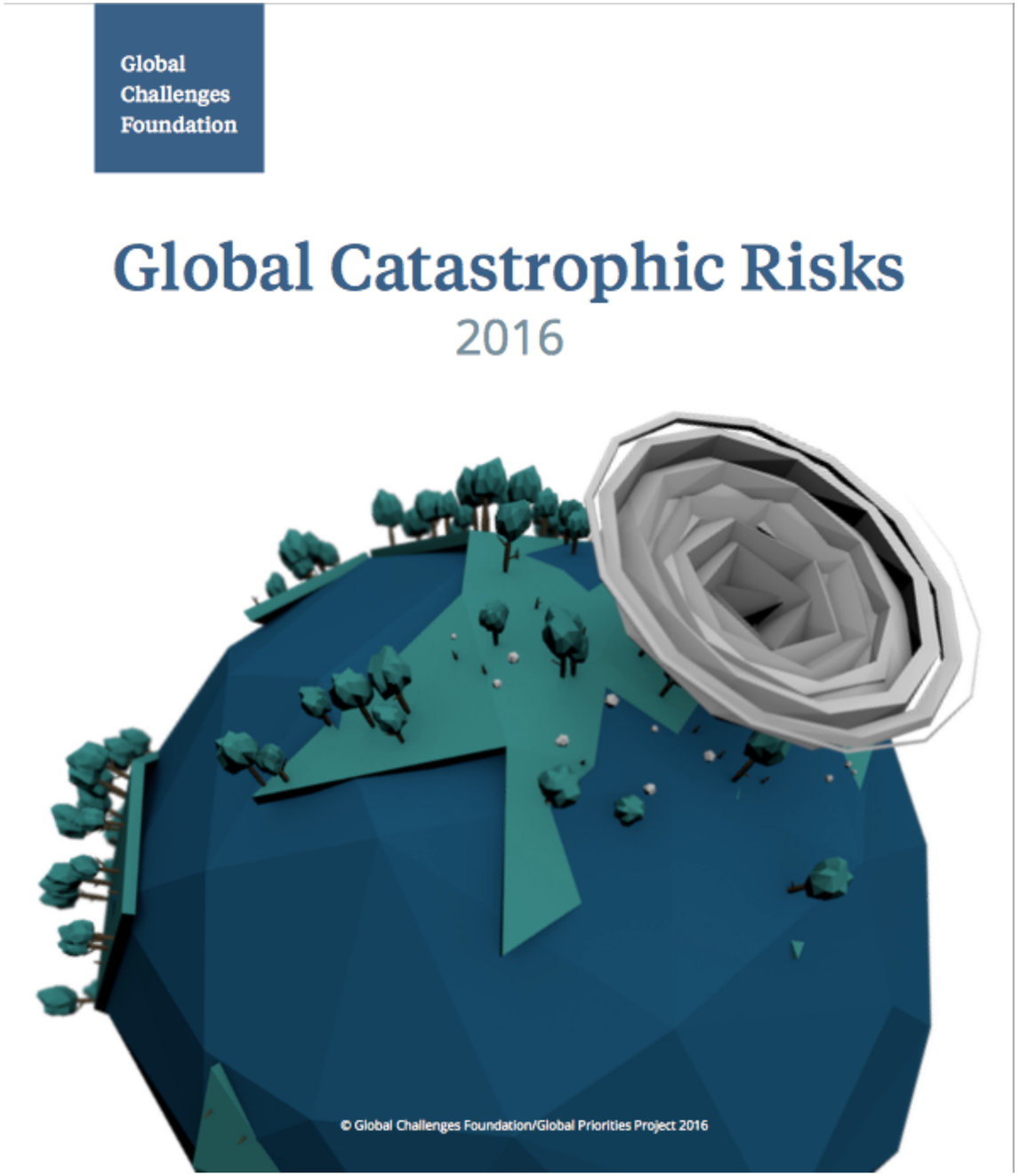


FIGURE 2.2.2. GLOBAL TEMPERATURE ANOMALY FROM NUCLEAR WINTER

Global average surface air temperature change from a release of 5 Teragram, 50 Teragram, and 150 Teragram of particular matter in the context of the climate change of the past 125 years.[61]

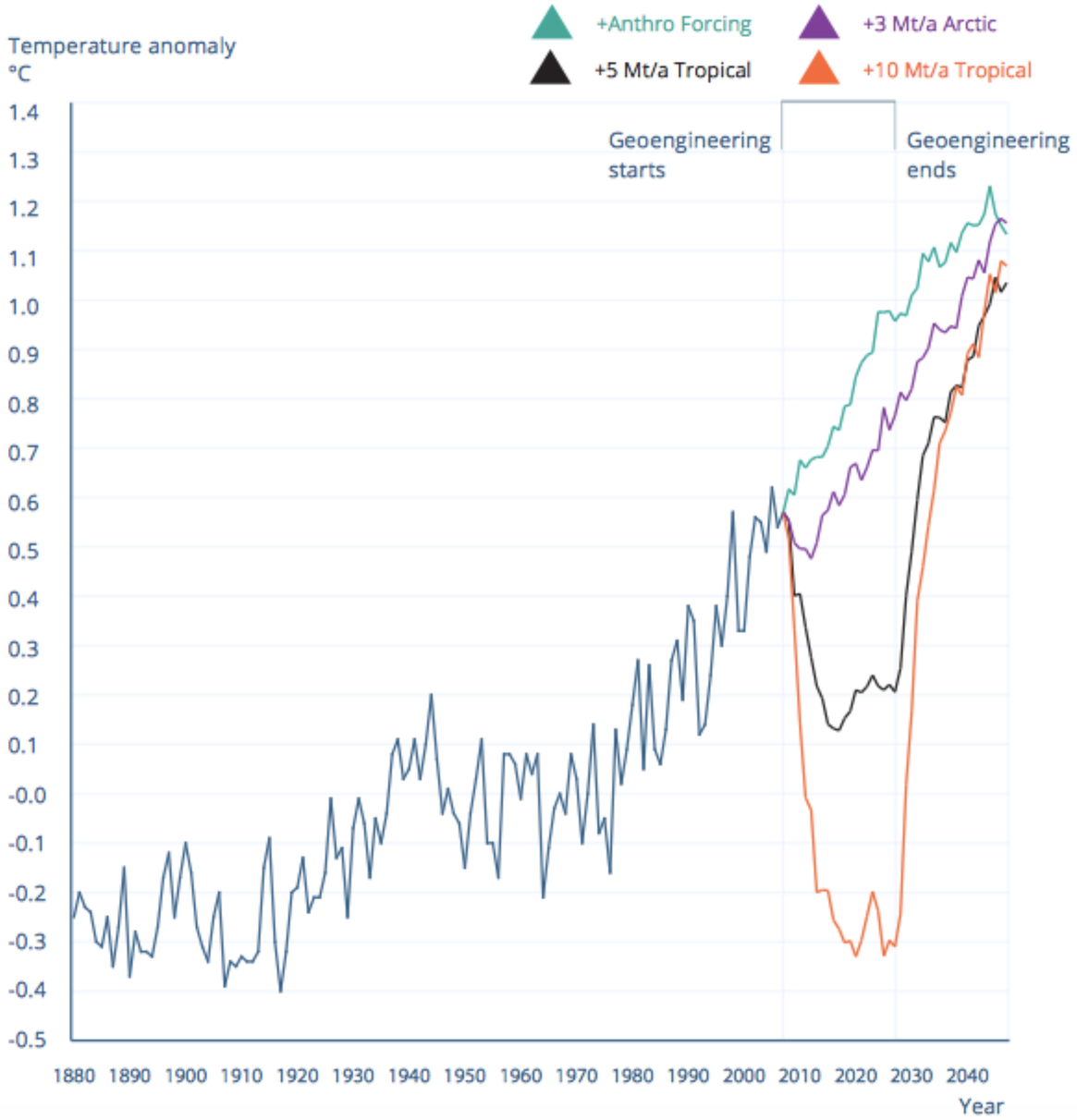


Global Risks: Human and Non-Human



2.5.2. GLOBAL TEMPERATURE ANOMALY FROM GEO-ENGINEERING FOLLOWED BY TERMINATION

Global average surface air temperature change from business as usual emissions, injection of 3 megatons/annum (Mt/a) of SO2 in the Arctic, 5 Mt/a of SO2 in the tropics, and 10 Mt/a SO2 in the tropics.[130]



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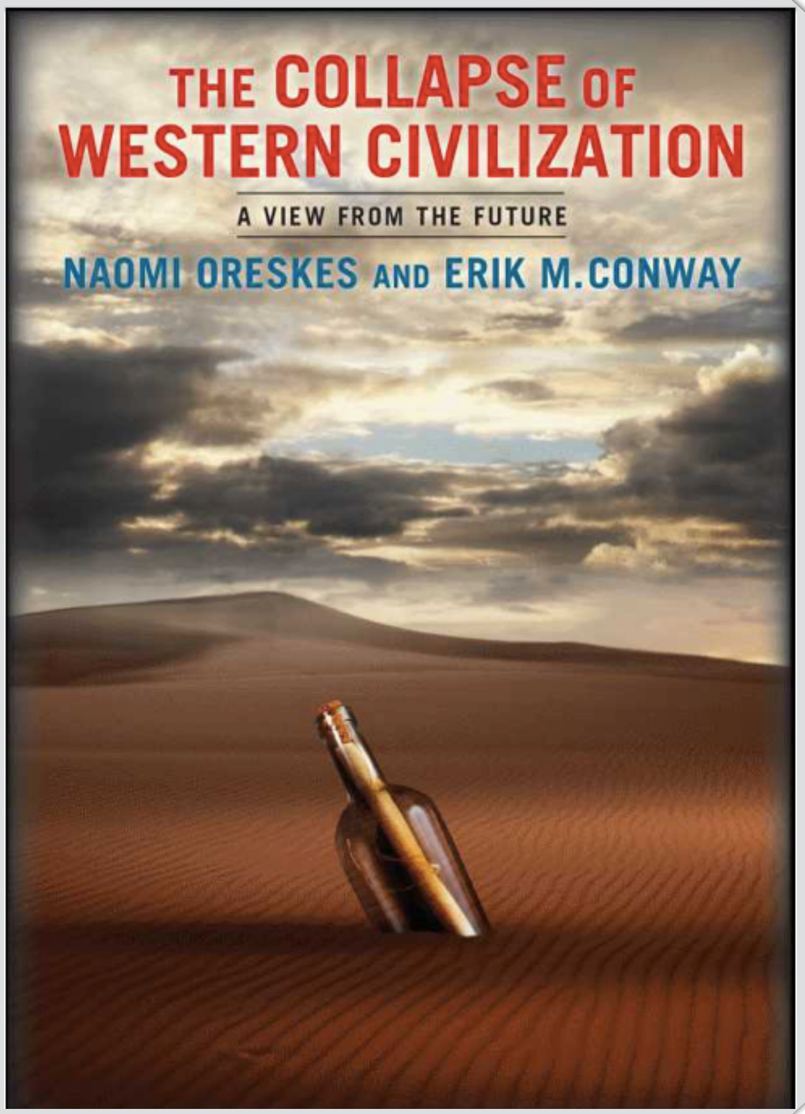

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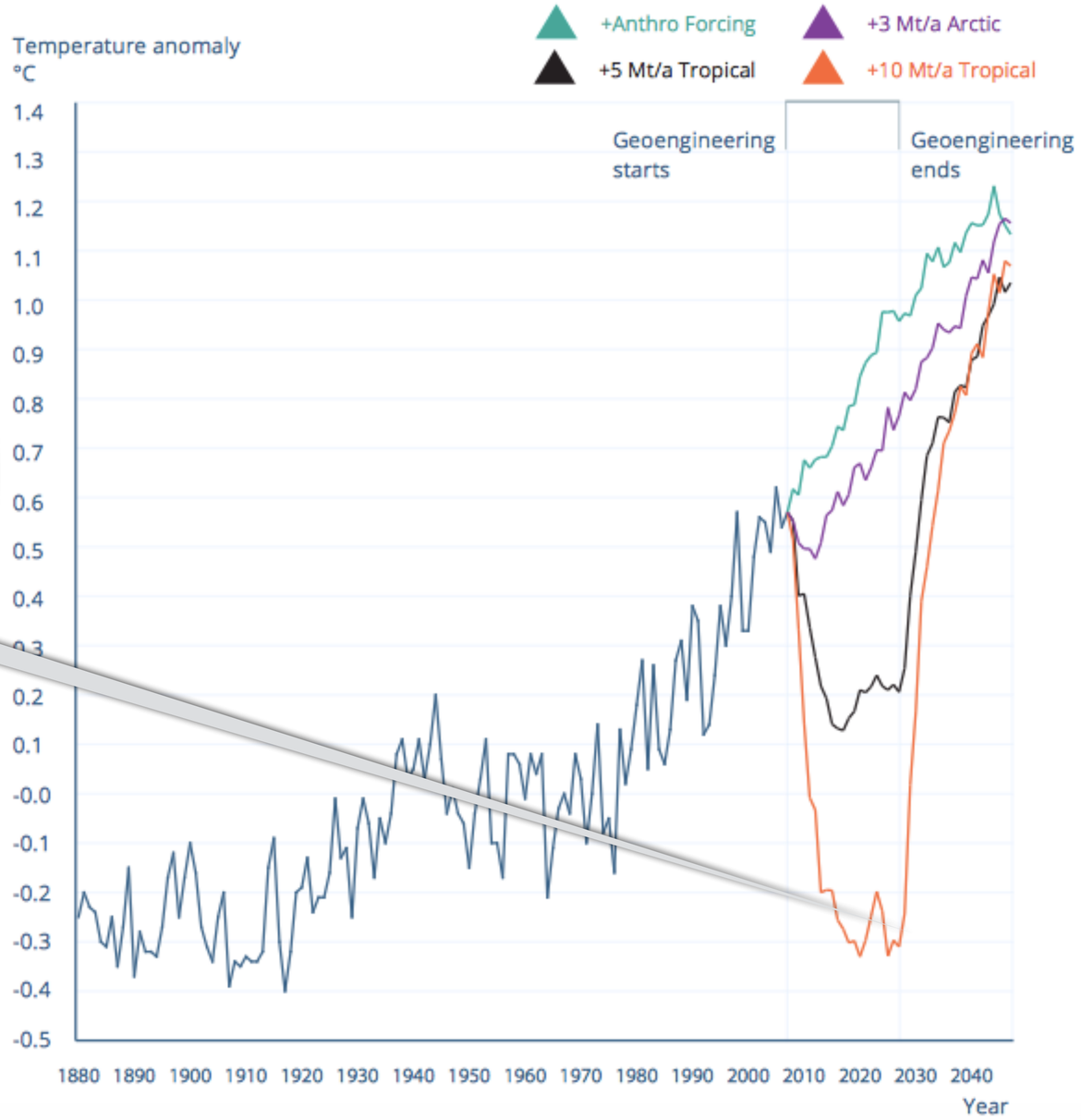

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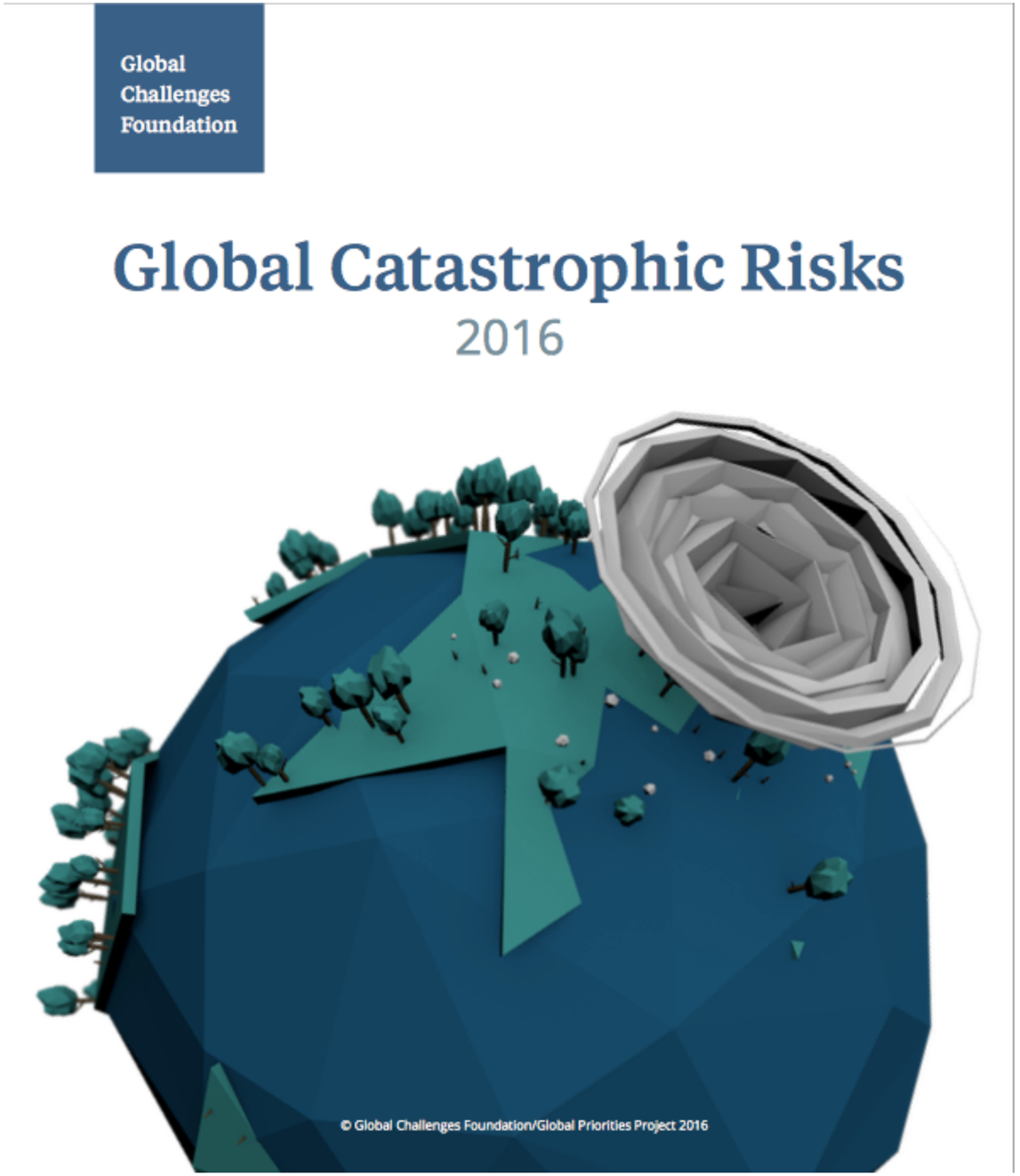

Food stockpiles and the ability to rapidly increase production of alternate sources of food would increase resilience to a broad range of risks.

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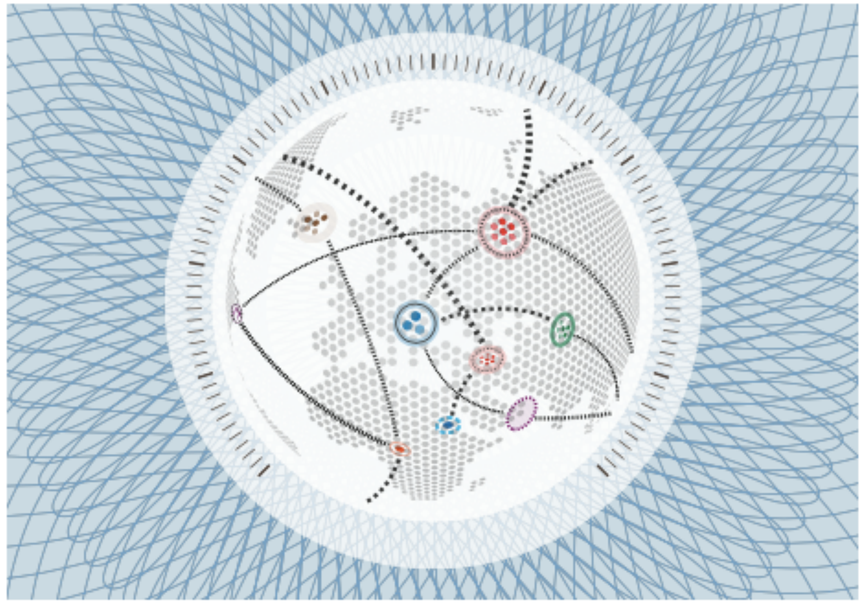

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Figure 2: The Evolving Risks Landscape, 2007-2017

Top 5 Global Risks in Terms of Likelihood

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1st	Breakdown of critical information infrastructure	Asset price collapse	Asset price collapse	Asset price collapse	Storms and cyclones	Severe income disparity	Severe income disparity	Income disparity	Interstate conflict with regional consequences	Large-scale involuntary migration	Extreme weather events
2nd	Chronic disease in developed countries	Middle East instability	Slowing Chinese economy (<6%)	Slowing Chinese economy (<6%)	Flooding	Chronic fiscal imbalances	Chronic fiscal imbalances	Extreme weather events	Extreme weather events	Extreme weather events	Large-scale involuntary migration
3rd	Oil price shock	Failed and failing states	Chronic disease	Chronic disease	Corruption	Rising greenhouse gas emissions	Rising greenhouse gas emissions	Unemployment and underemployment	Failure of national governance	Failure of climate-change mitigation and adaptation	Major natural disasters
4th	China economic hard landing	Oil and gas price spike	Global governance gaps	Fiscal crises	Biodiversity loss	Cyber attacks	Water supply crises	Climate change	State collapse or crisis	Interstate conflict with regional consequences	Large-scale terrorist attacks
5th	Asset price collapse	Chronic disease, developed world	Retrenchment from globalization (emerging)	Global governance gaps	Climate change	Water supply crises	Mismanagement of population ageing	Cyber attacks	High structural unemployment or underemployment	Major natural catastrophes	Massive incident of data fraud/theft

Top 5 Global Risks in Terms of Impact

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1st	Asset price collapse	Asset price collapse	Asset price collapse	Asset price collapse	Fiscal crises	Major systemic financial failure	Major systemic financial failure	Fiscal crises	Water crises	Failure of climate-change mitigation and adaptation	Weapons of mass destruction
2nd	Retrenchment from globalization	Retrenchment from globalization (developed)	Retrenchment from globalization (developed)	Retrenchment from globalization (developed)	Climate change	Water supply crises	Water supply crises	Climate change	Rapid and massive spread of infectious diseases	Weapons of mass destruction	Extreme weather events
3rd	Interstate and civil wars	Slowing Chinese economy (<6%)	Oil and gas price spike	Oil price spikes	Geopolitical conflict	Food shortage crises	Chronic fiscal imbalances	Water crises	Weapons of mass destruction	Water crises	Water crises
4th	Pandemics	Oil and gas price spike	Chronic disease	Chronic disease	Asset price collapse	Chronic fiscal imbalances	Diffusion of weapons of mass destruction	Unemployment and underemployment	Interstate conflict with regional consequences	Large-scale involuntary migration	Major natural disasters
5th	Oil price shock	Pandemics	Fiscal crises	Fiscal crises	Extreme energy price volatility	Extreme volatility in energy and agriculture prices	Failure of climate-change mitigation and adaptation	Critical information infrastructure breakdown	Failure of climate-change mitigation and adaptation	Severe energy price shock	Failure of climate-change mitigation and adaptation

Economic | Environmental | Geopolitical | Societal | Technological

Source: World Economic Forum 20017-2017, Global Risks Reports
Note: Global risks may not be strictly comparable across years, as definitions and the set of global risks have evolved with new issues emerging on the 10-year horizon. For example, cyberattacks, income disparity and unemployment entered the set of global risks in 2012. Some global risks were reclassified: water crises and rising income disparity were re-categorized first as societal risks and then as a trend in the 2015 and 2016 Global Risks Reports, respectively. The 2006 edition of the Global Risks Report did not have a risks landscape

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Global Risks in Terms of Likelihood

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Global Risks in Terms of Impacts

Figure 2: The Evolving Risks Landscape, 2007-2017

Top 5 Global Risks in Terms of Likelihood

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2nd	Chronic disease in developed countries	Middle East instability	Slowing Chinese economy (<6%)	Slowing Chinese economy (<6%)
3rd	Oil price shock	Failed and failing states	Chronic disease	Chronic disease
4th	China economic hard landing	Oil and gas price spike	Global governance gaps	Fiscal crises
5th	Asset price collapse	Chronic disease, developed world	Retrenchment from globalization (emerging)	Global governance gaps

	2013	2014	2015	2016	2017
1st	Severe income disparity	Income disparity	Interstate conflict with regional consequences	Large-scale involuntary migration	Extreme weather events
2nd	Chronic fiscal imbalances	Extreme weather events	Extreme weather events	Extreme weather events	Large-scale involuntary migration
3rd	Rising greenhouse gas emissions	Unemployment and underemployment	Failure of national governance	Failure of climate-change mitigation and adaptation	Major natural disasters
4th	Water supply crises	Climate change	State collapse or crisis	Interstate conflict with regional consequences	Large-scale terrorist attacks
5th	Mismanagement of population ageing	Cyber attacks	High structural unemployment or underemployment	Major natural catastrophes	Massive incident of data fraud/theft

Top 5 Global Risks in Terms of Impact

	2007	2008	2009	2010
1st	Asset price collapse	Asset price collapse	Asset price collapse	Asset price collapse
2nd	Retrenchment from globalization	Retrenchment from globalization (developed)	Retrenchment from globalization (developed)	Retrenchment from globalization (developed)
3rd	Interstate and civil wars	Slowing Chinese economy (<6%)	Oil and gas price spike	Oil price spikes
4th	Pandemics	Oil and gas price spike	Chronic disease	Chronic disease
5th	Oil price shock	Pandemics	Fiscal crises	Fiscal crises

	2013	2014	2015	2016	2017
1st	Major systemic financial failure	Fiscal crises	Water crises	Failure of climate-change mitigation and adaptation	Weapons of mass destruction
2nd	Water supply crises	Climate change	Rapid and massive spread of infectious diseases	Weapons of mass destruction	Extreme weather events
3rd	Chronic fiscal imbalances	Water crises	Weapons of mass destruction	Water crises	Water crises
4th	Diffusion of weapons of mass destruction	Unemployment and underemployment	Interstate conflict with regional consequences	Large-scale involuntary migration	Major natural disasters
5th	Failure of climate-change mitigation and adaptation	Critical information infrastructure breakdown	Failure of climate-change mitigation and adaptation	Severe energy price shock	Failure of climate-change mitigation and adaptation

Economic | Environmental | Geopolitical | Societal | Technological

Source: World Economic Forum 20017-2017, Global Risks Reports
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Global Risks: Human and Non-Human

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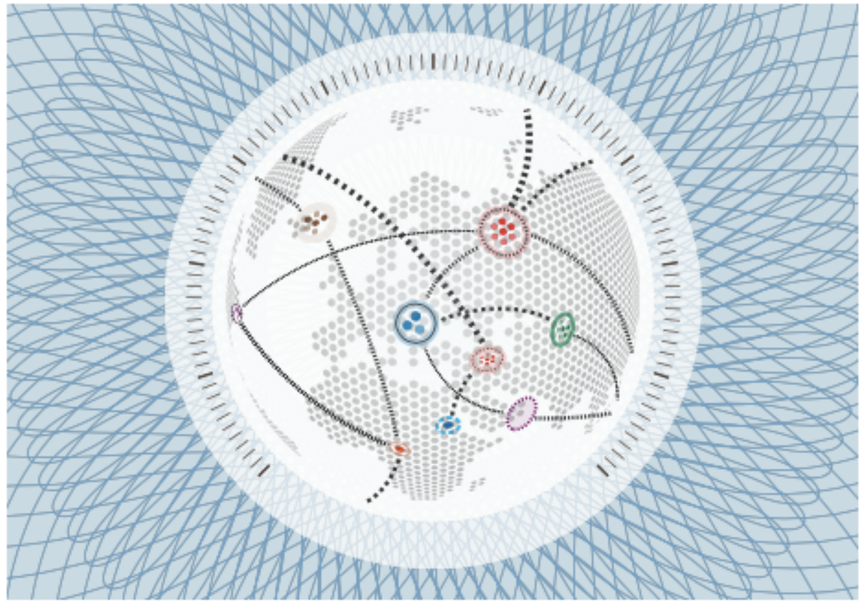

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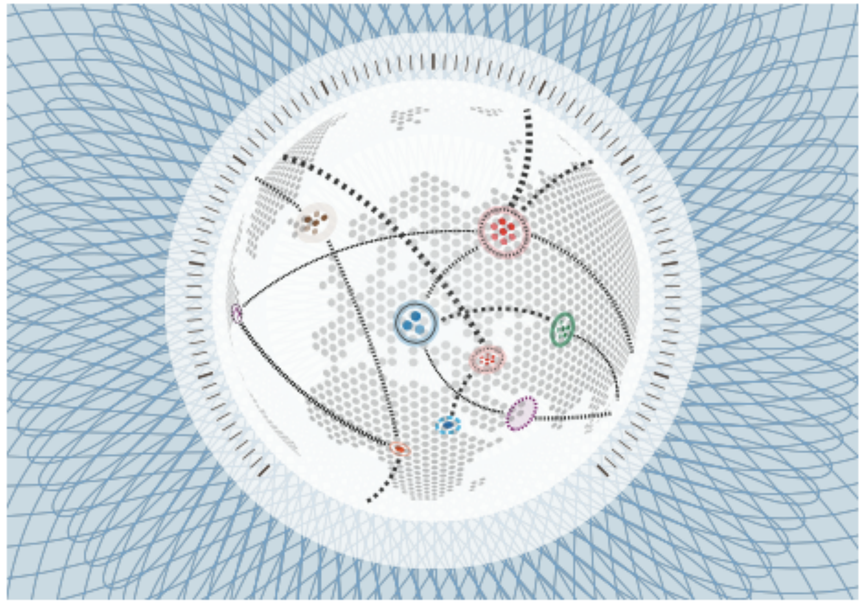

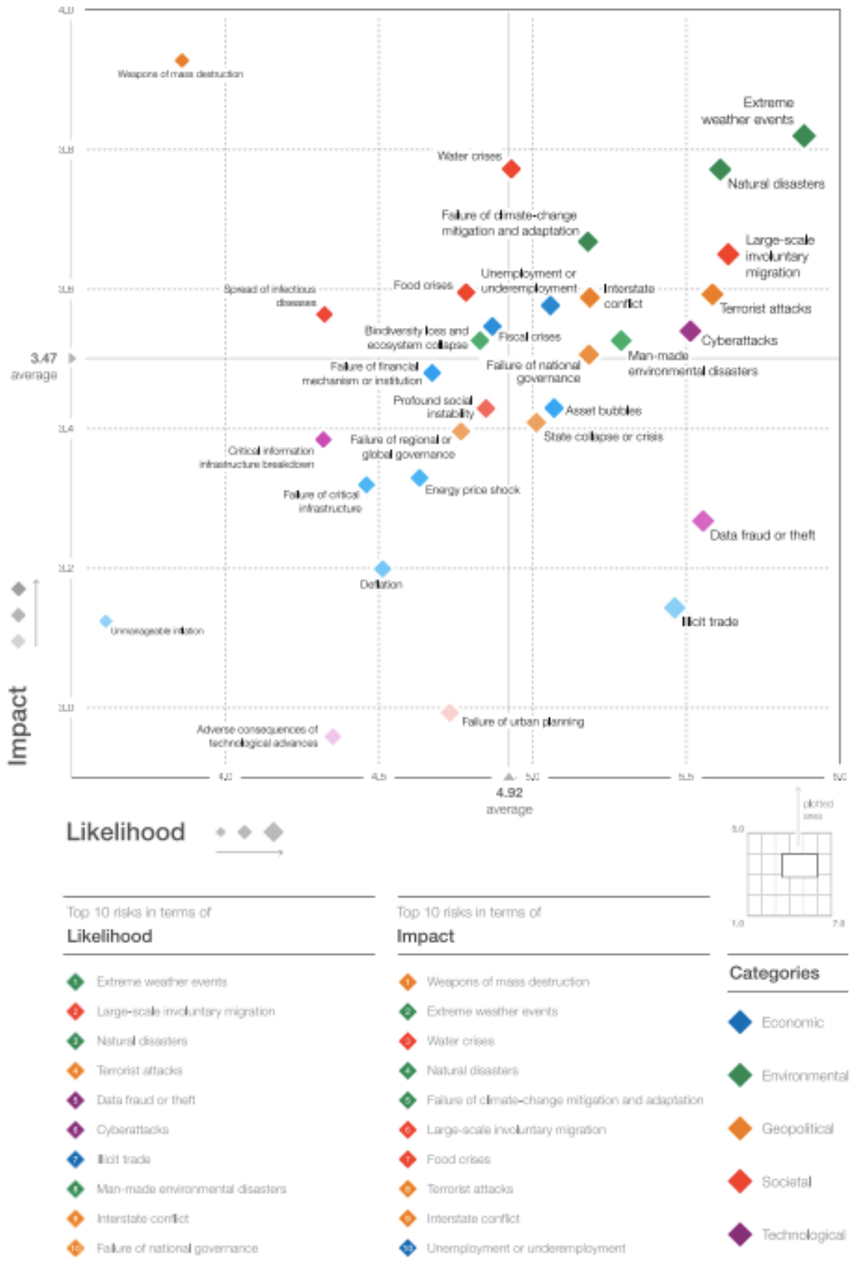

Source: World Economic Forum Global Risks Perception Survey 2016
Note: Survey respondents were asked to assess the likelihood of the individual global risk on a scale of 1 to 7, 1 representing a risk that is not likely to happen and 7 a risk that is very likely to occur. They also assess the impact on each global risk on a scale of 1 to 5 (1: minimal impact, 2: minor impact, 3: moderate impact, 4: severe impact and 5: catastrophic impact). See Appendix B for more details. To ensure legibility, the names of the global risks are abbreviated; see Appendix A for the full name and description

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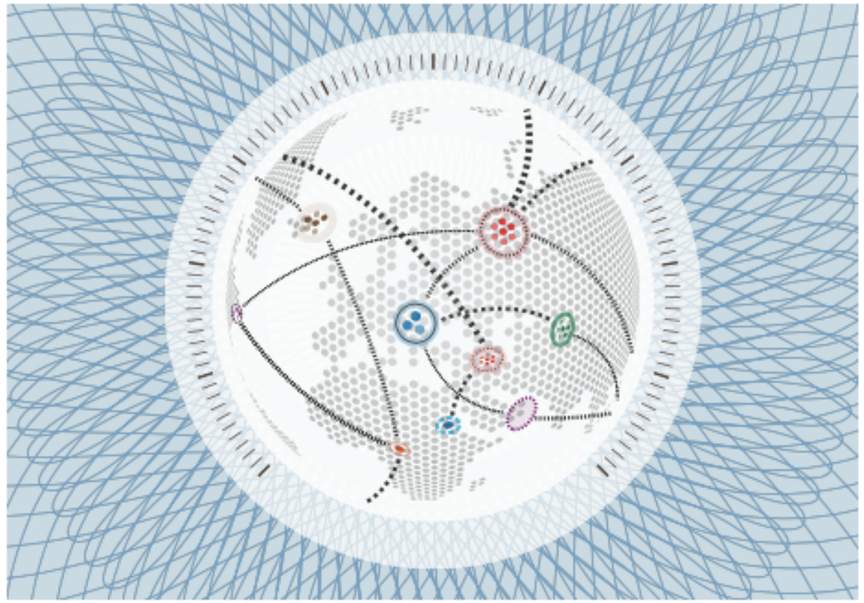
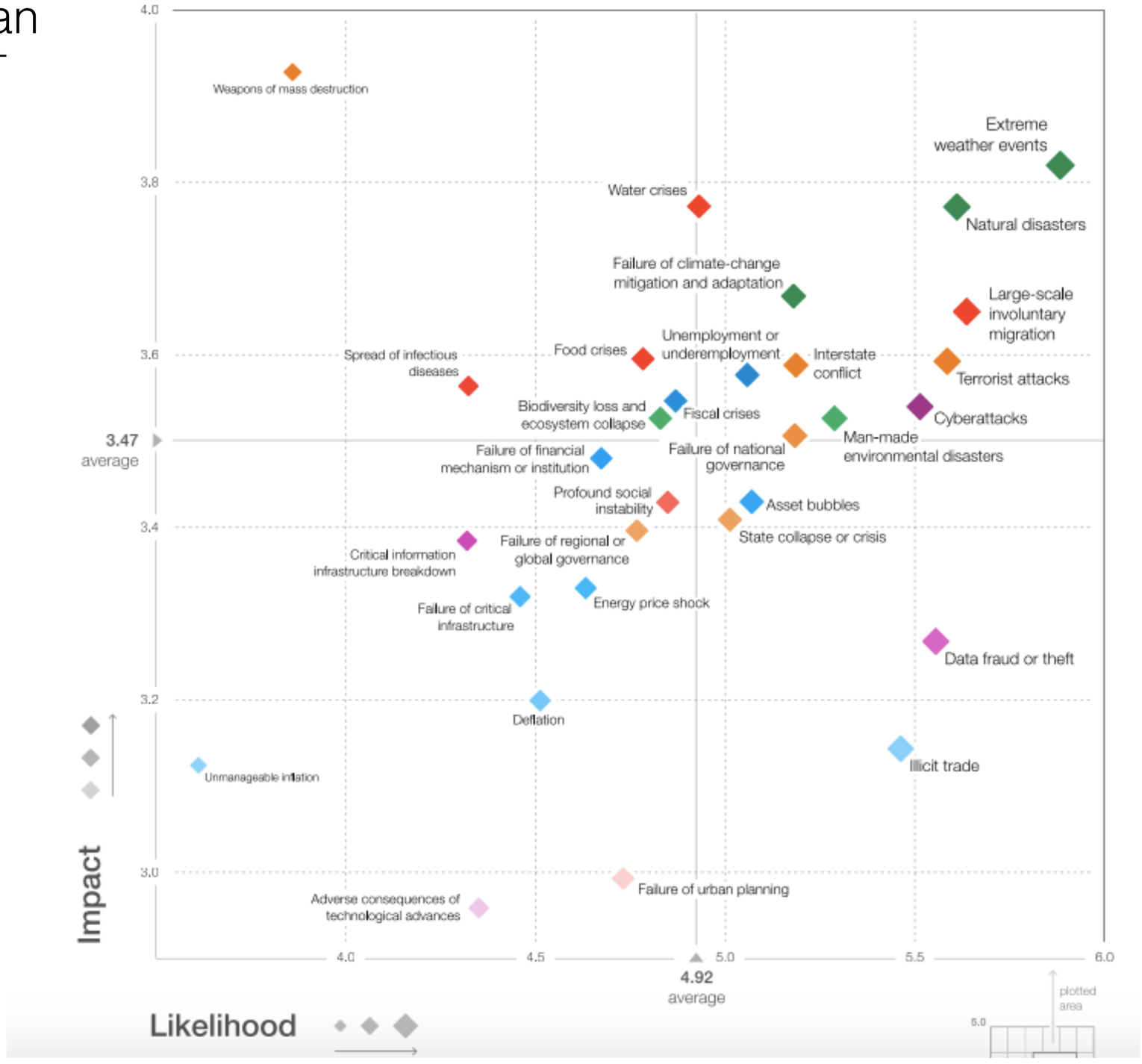




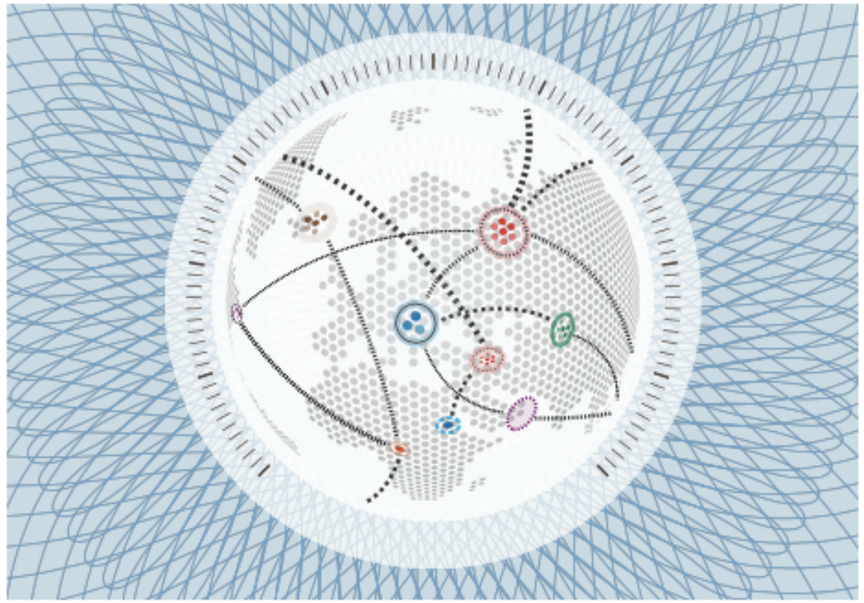
Global Risks: Human and Non-Human

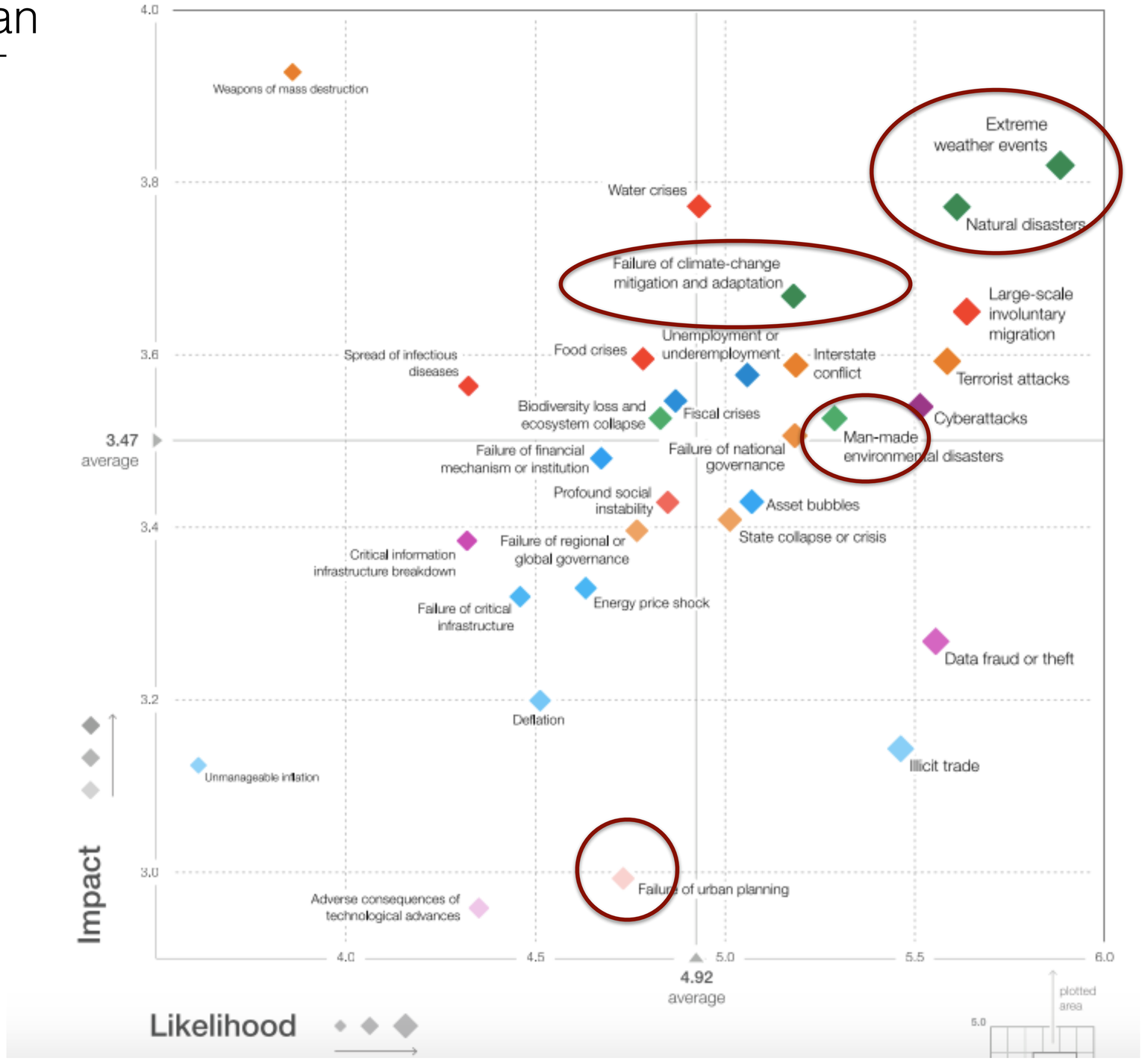
WORLD ECONOMIC FORUM

COMMITTED TO IMPROVING THE STATE OF THE WORLD

Insight Report

The Global Risks Report 2017
12th Edition





Global Risks: Human and Non-Human

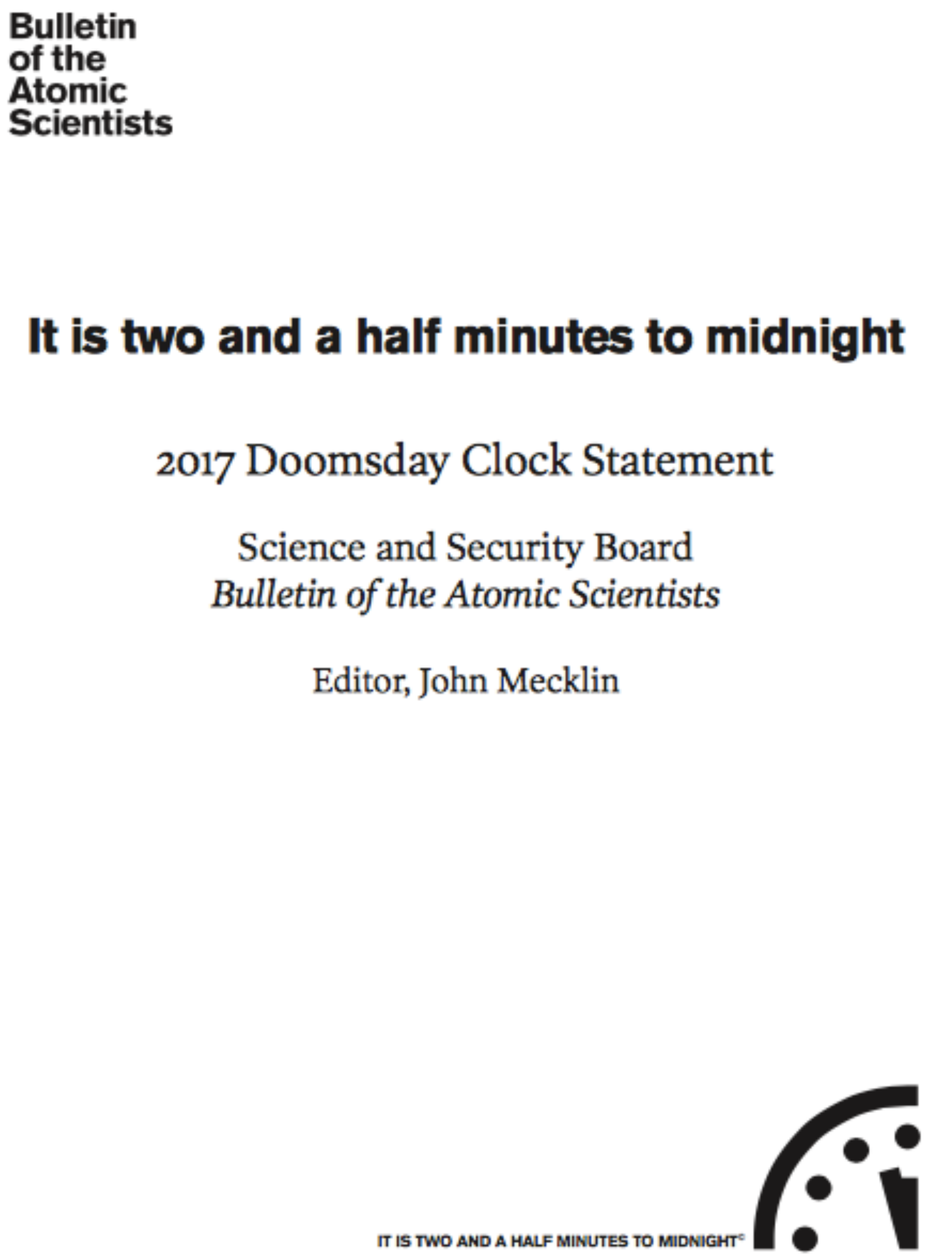
Bulletin
of the
Atomic
Scientists

It is two and a half minutes to midnight

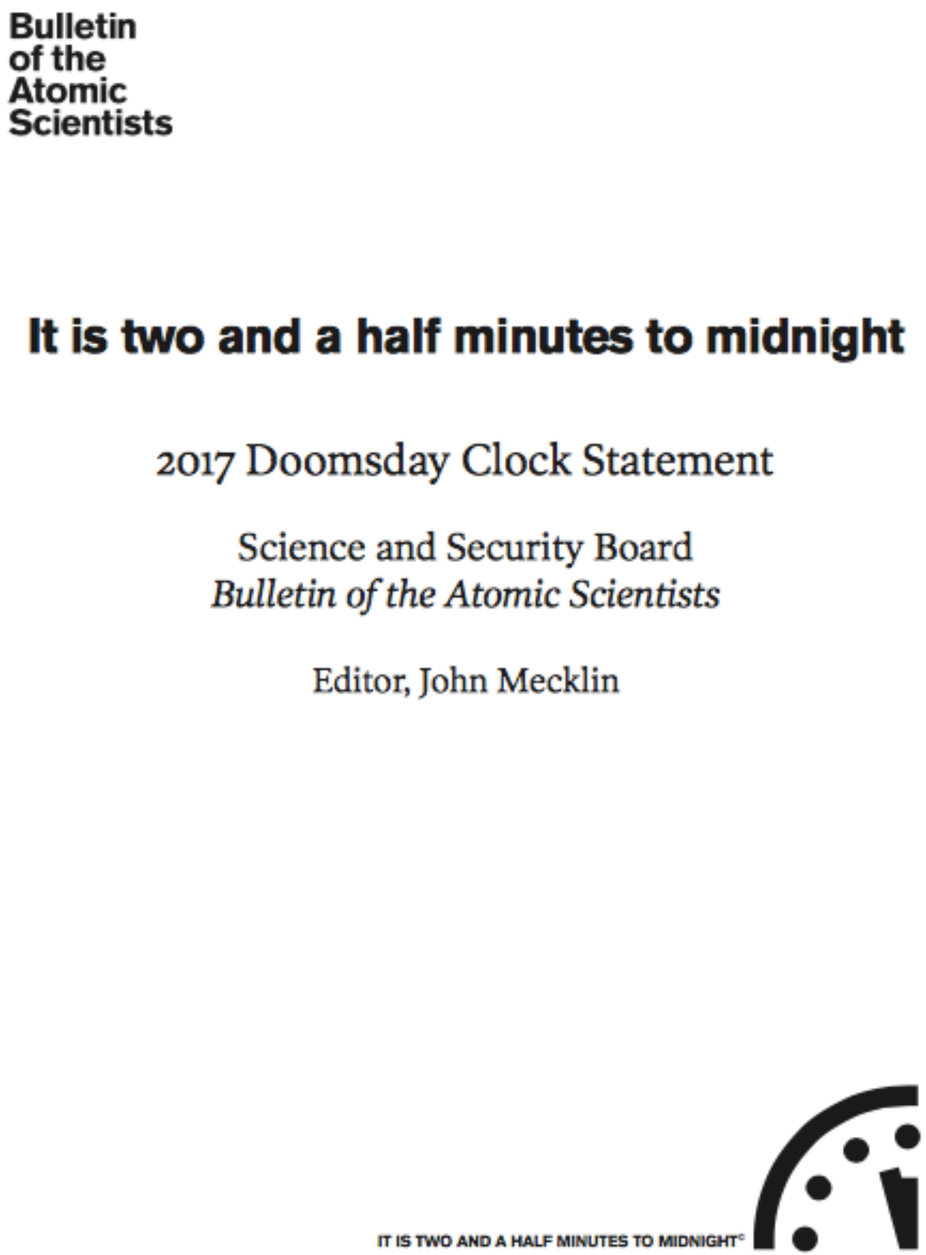
2017 Doomsday Clock Statement

Science and Security Board
Bulletin of the Atomic Scientists

Editor, John Mecklin



Reducing risk: Expert advice and citizen action. Technology continues to outpace humanity's capacity to control it, even as many citizens lose faith in the institutions upon which they must rely to make scientific innovation work for rather than against them. Expert advice is crucial if governments are to effectively deal with complex global threats. The Science and Security Board is extremely concerned about the willingness of governments around the world—including the incoming US administration—to ignore or discount sound science and considered expertise during their decision-making processes.



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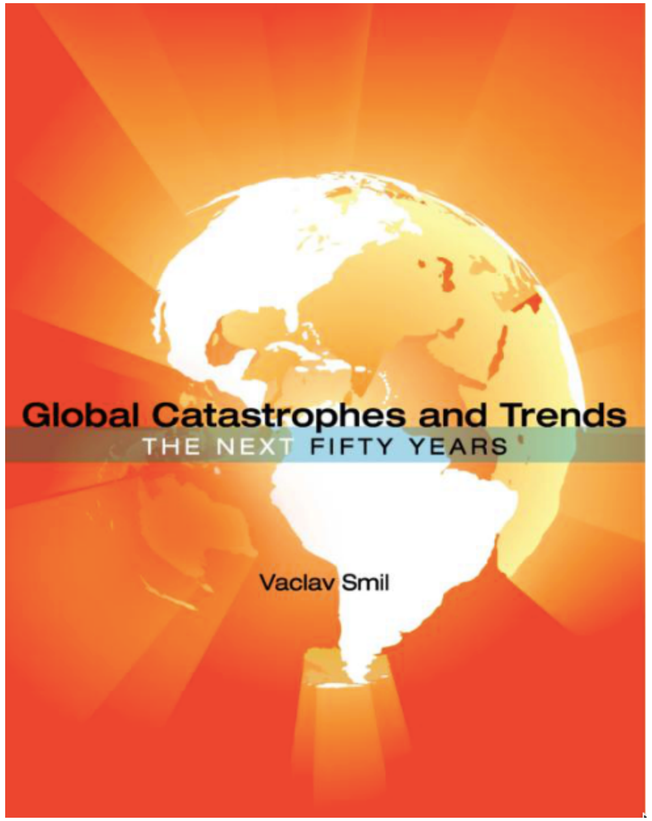
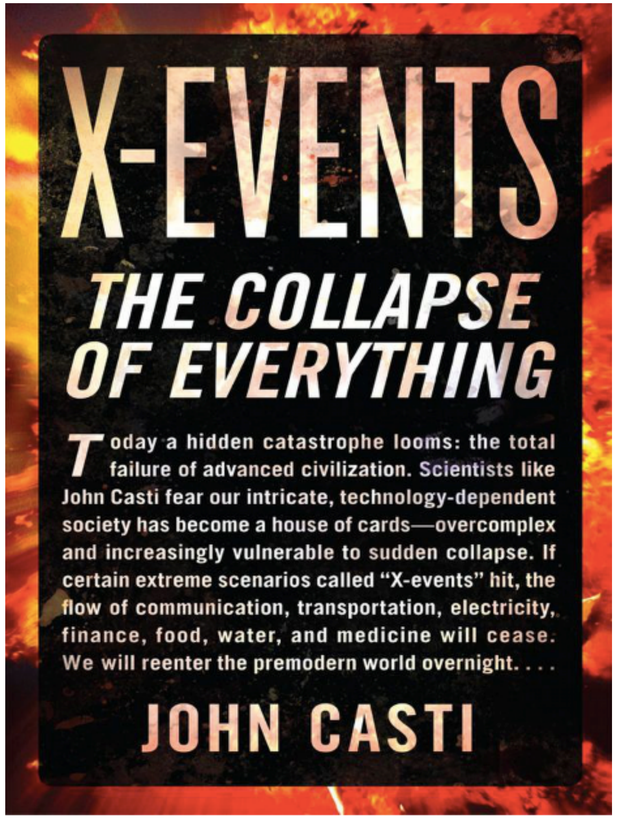
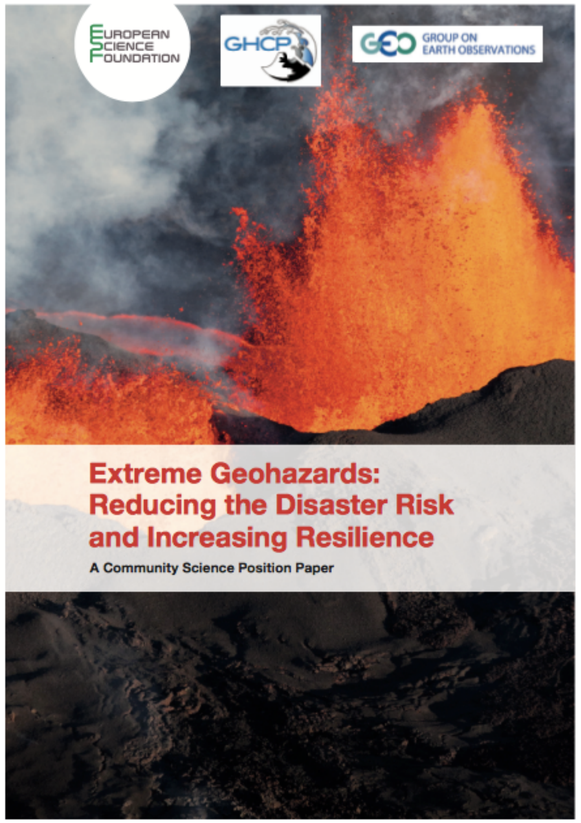
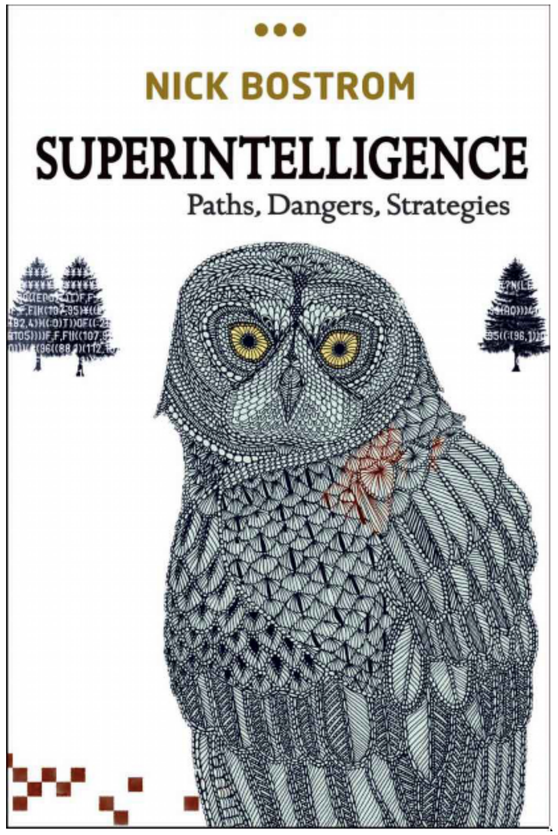
Global Risks: Human and Non-Human









Terrorism:

Bouzar, D., Escaping Radicalism. Scientific American Mind, May/June 2016, 41-43.
Dutton, K., Abrams, D., 2016. Extinguishing the threat. Scientific American Mind, May/June 2016, 44-49.
Reicher, S. D., Haslam, S. A., 2016. Fueling Extremes. Scientific American Mind, May/June 2016, 35-39.

Natural Hazards and Disaster

Natural Hazards and Disaster

Class 3: Observing Hazards

- A dynamic Planet
- Observing Systems for a Dynamic Planet
- Extraterrestrial hazards
- Observing Geometry
- Observing Gravity
- Observing Dynamics

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A dynamic Planet

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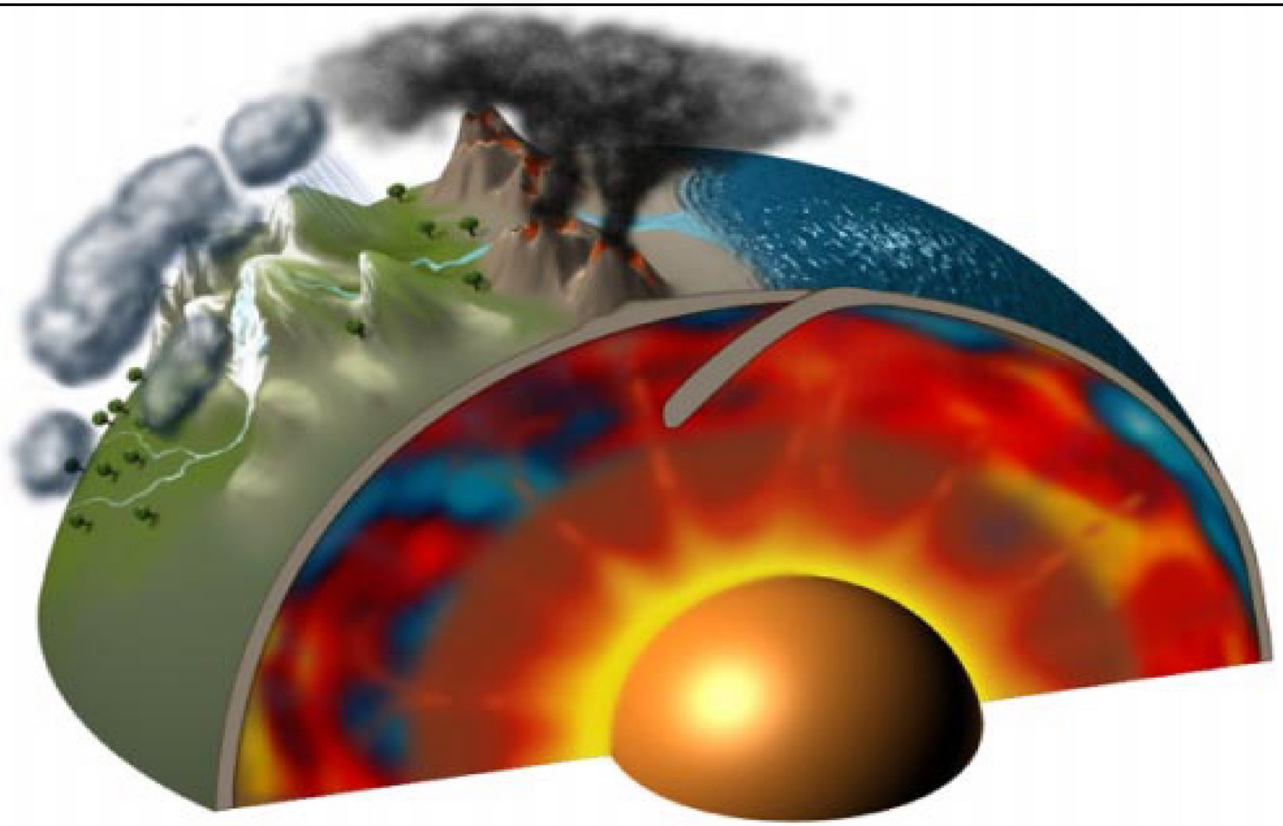

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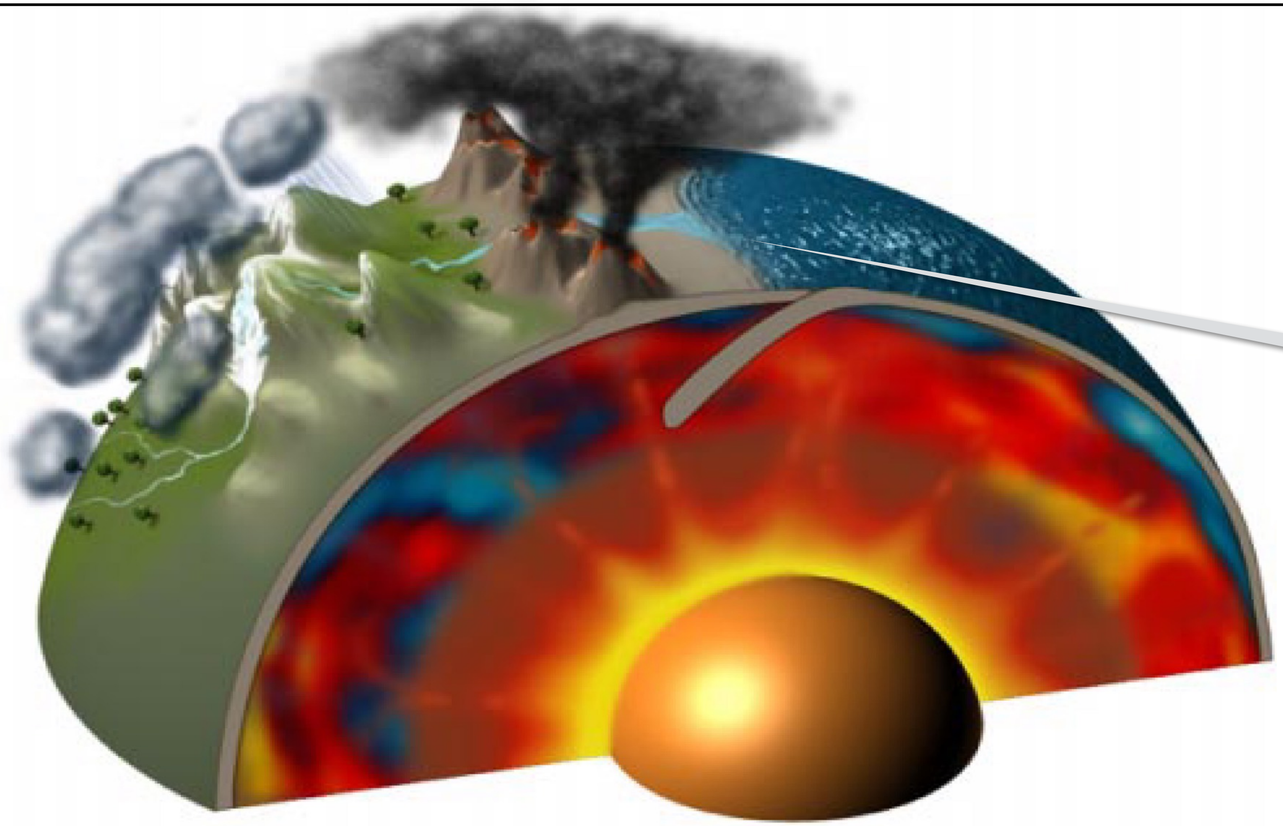

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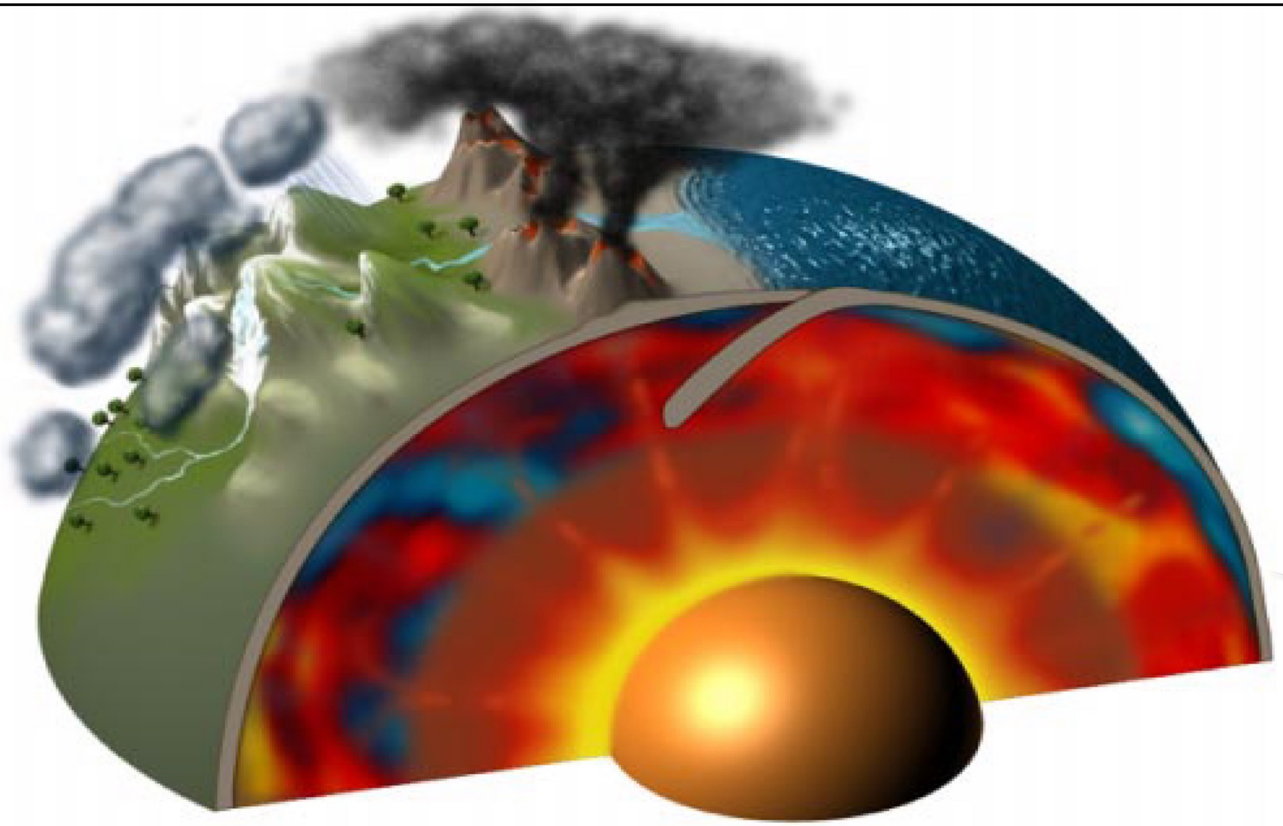

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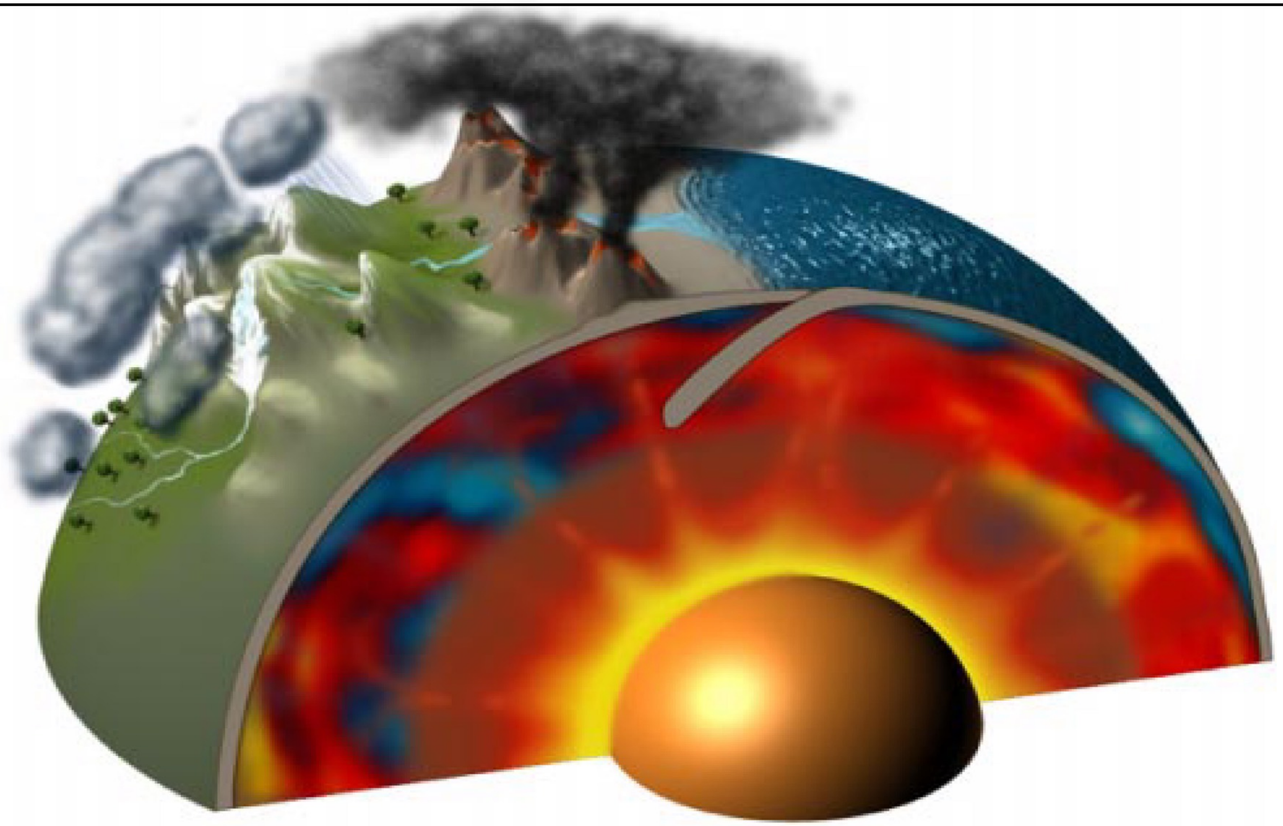

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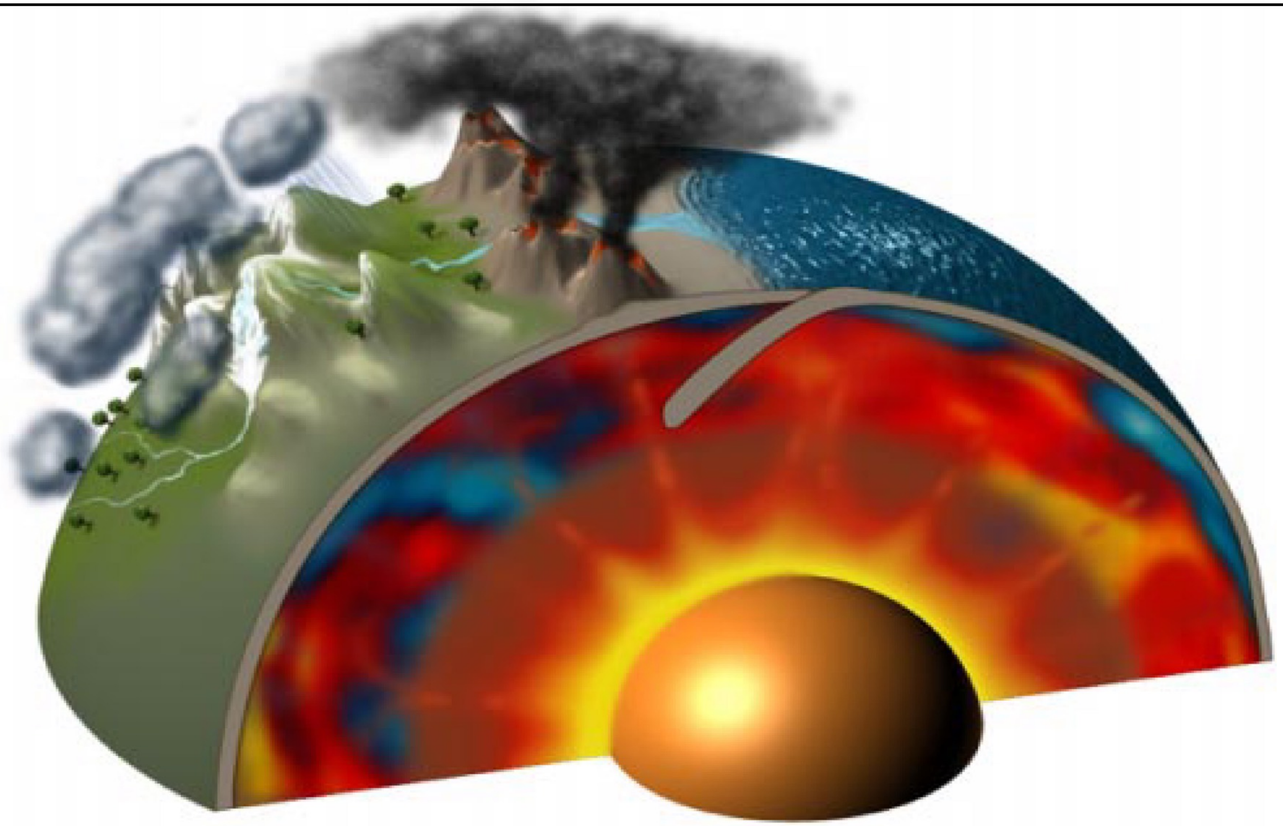

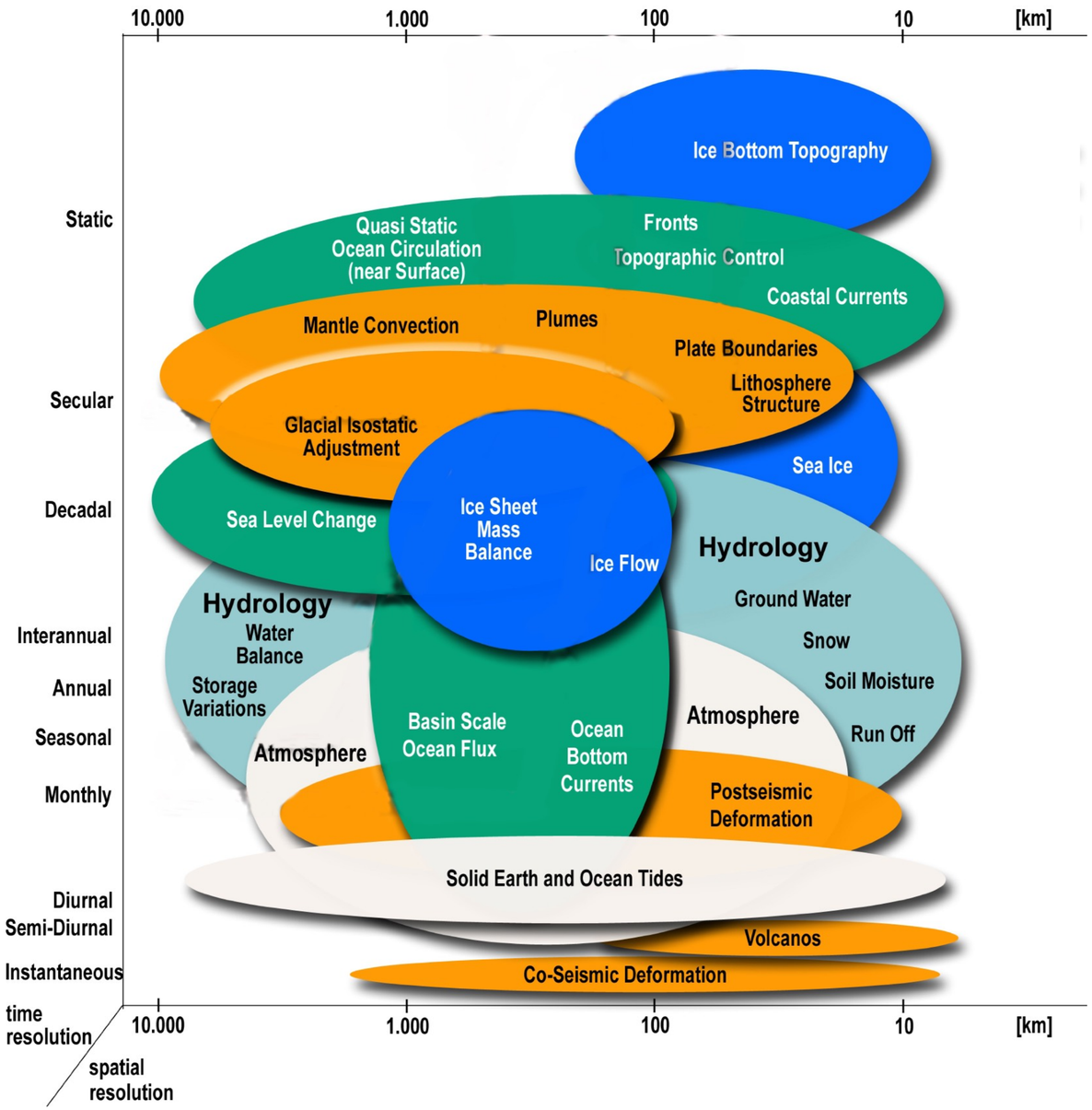

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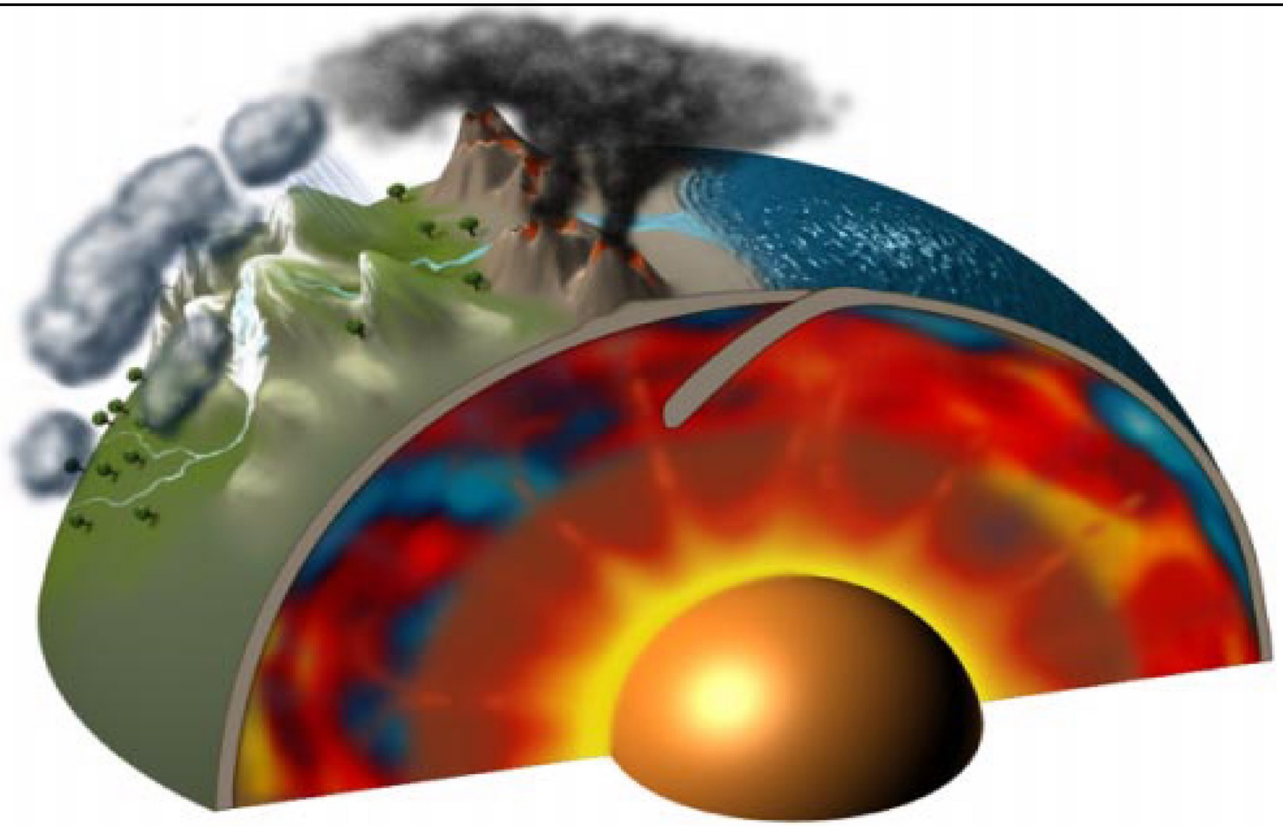

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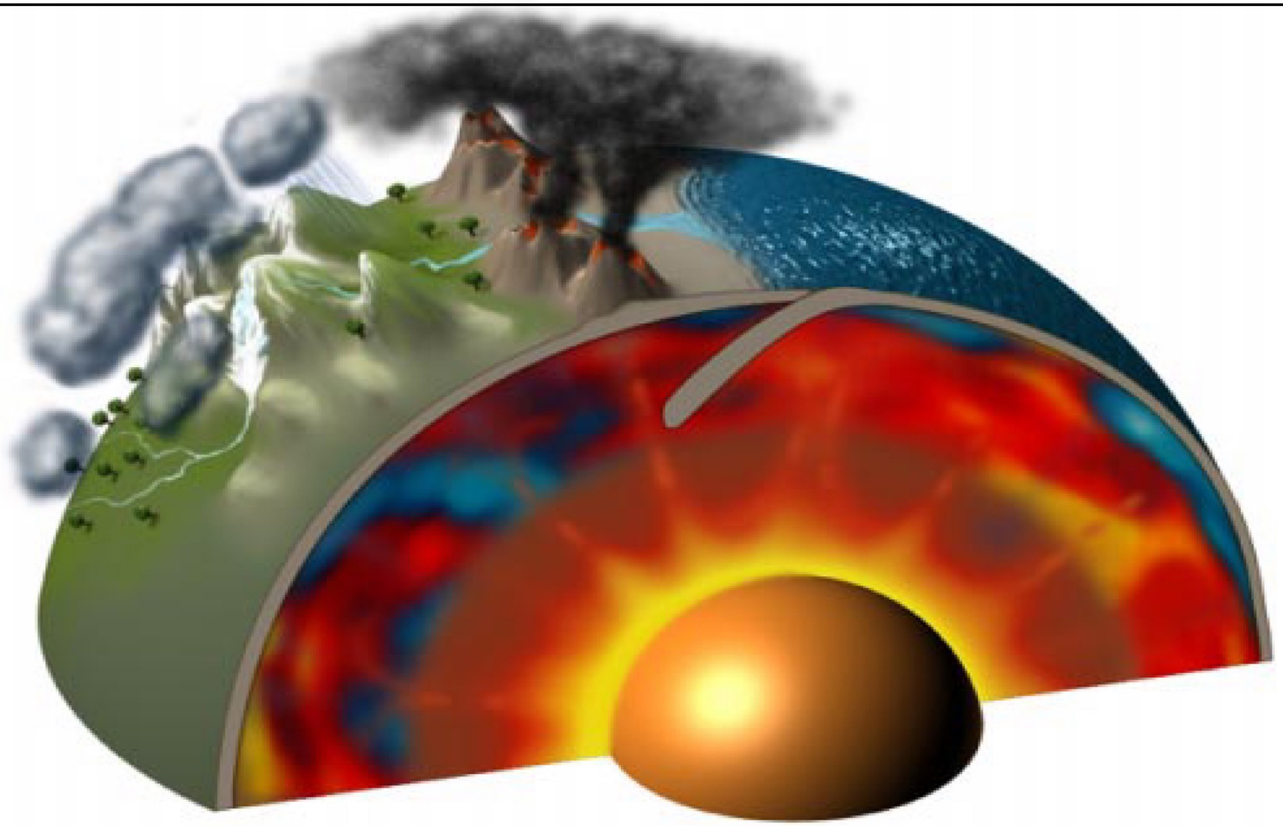

Science questions relevant for hazards:

Plate tectonics: location of and processes at plate boundaries;
Ice sheets/glaciers: ice load history, including present-day changes;
Sea level: quantification of different contributions;
Hydrological cycle: better quantification of fluxes; groundwater movements; land water storage;
Earthquakes: strain/stress accumulation and earthquakes; physical processes;
Volcanoes: location, state,

Modified from Rummel et al., 2009

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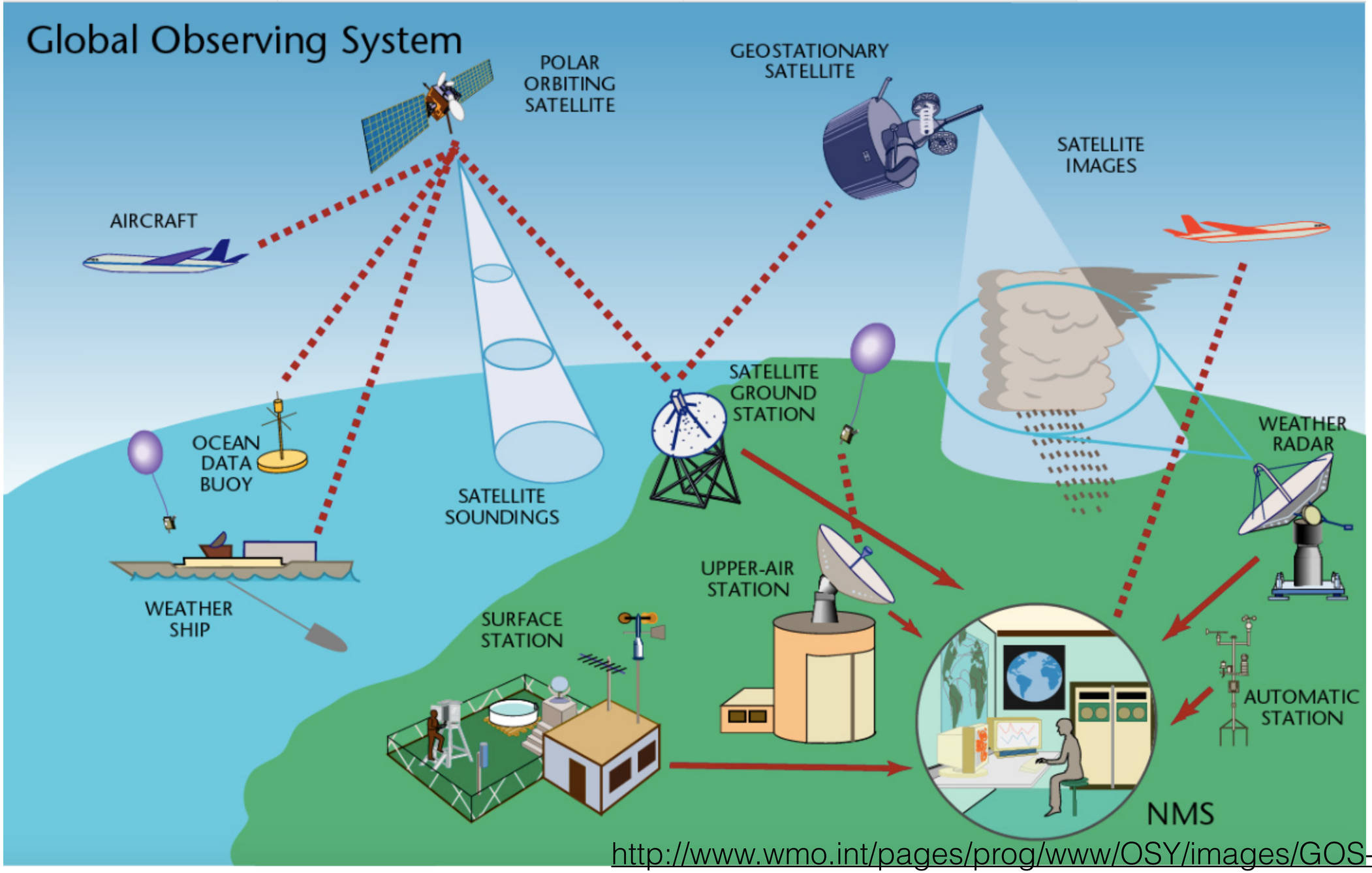
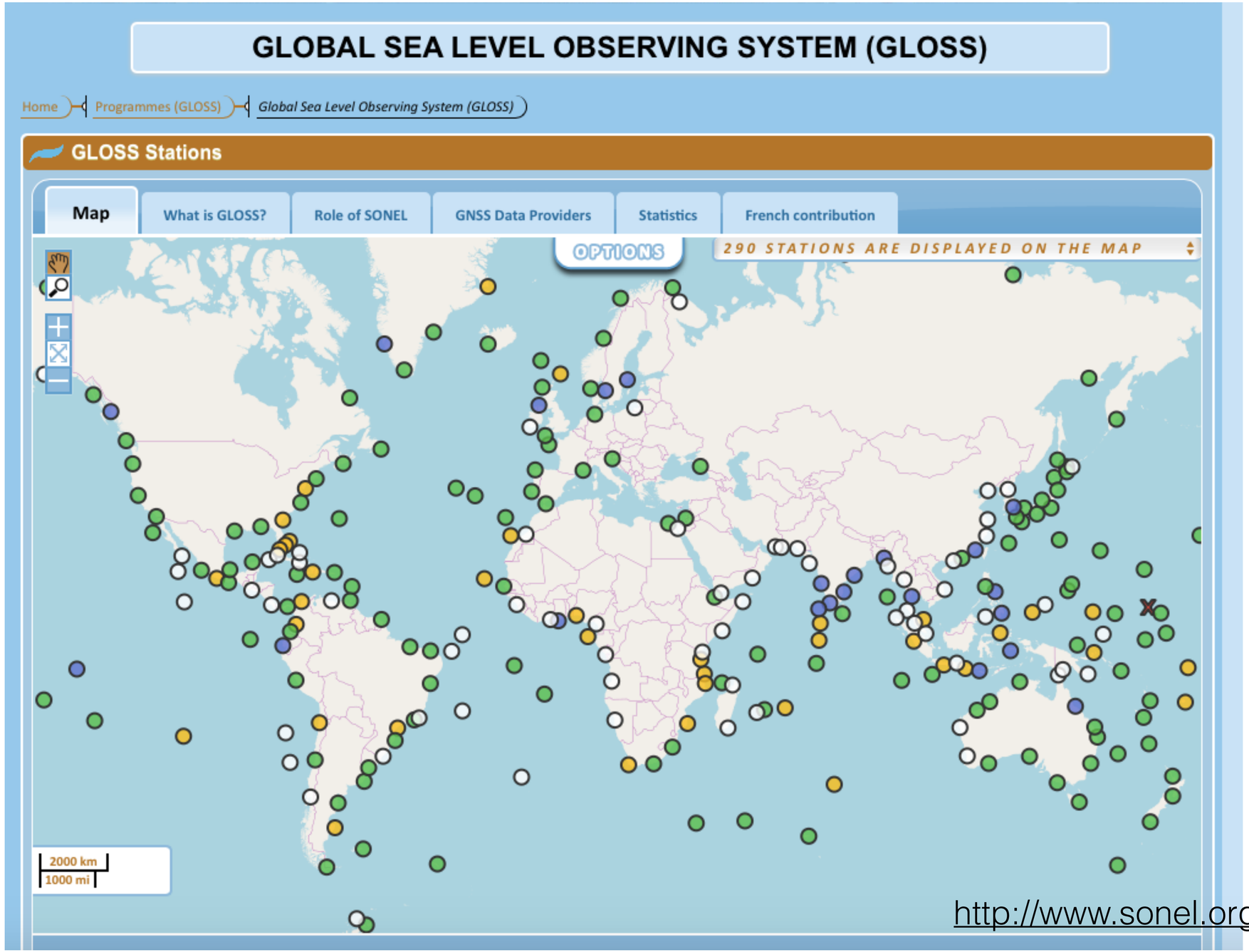
Observing Systems for a Dynamic Planet



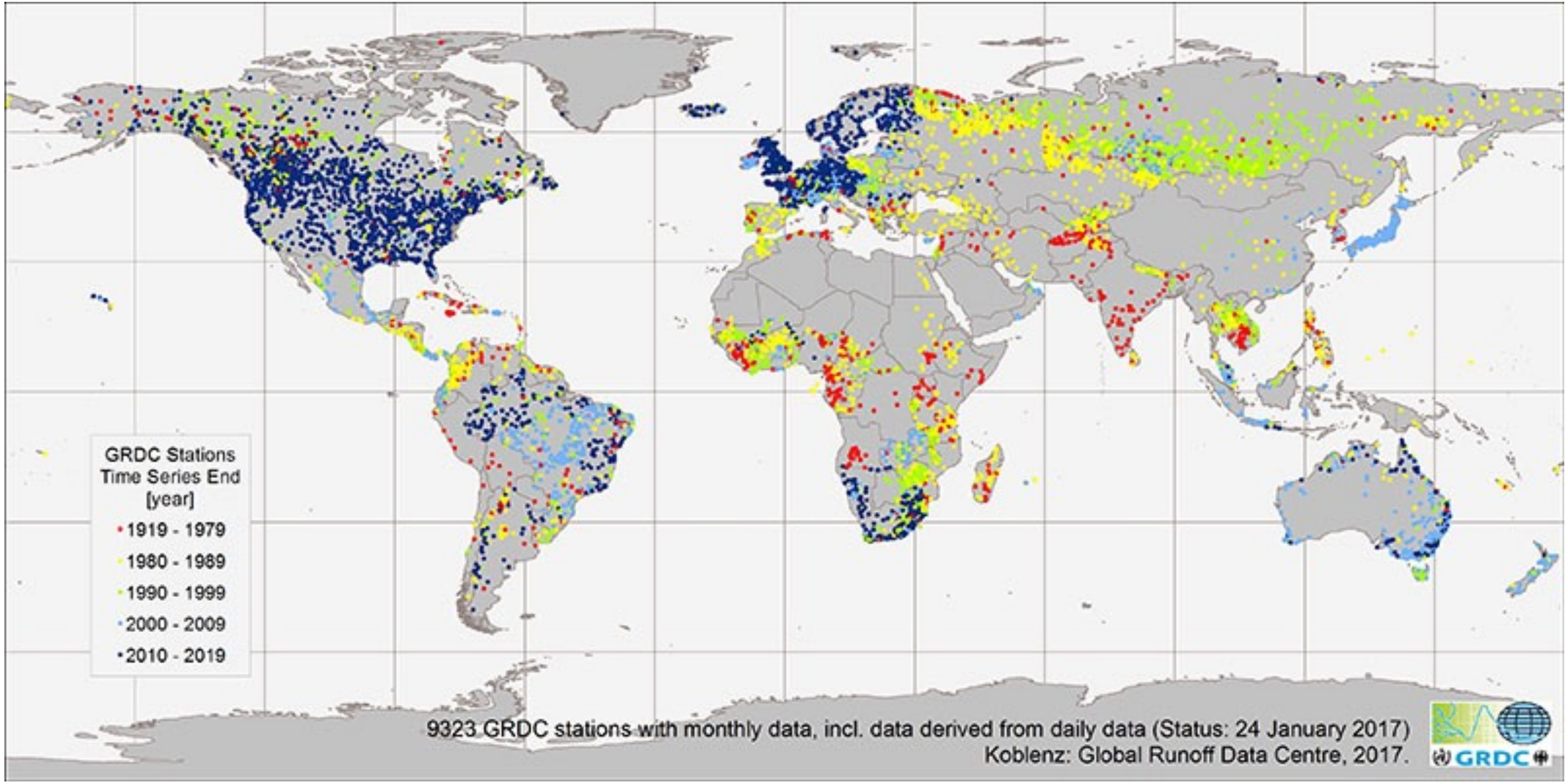
http://www.wmo.int/pages/prog/www/OSY/images/GOS-fullsize.jpg

Observing Systems for a Dynamic Planet



http://www.sonel.org/-GLOSS,81-.html

Observing Systems for a Dynamic Planet



Observing Systems for a Dynamic Planet

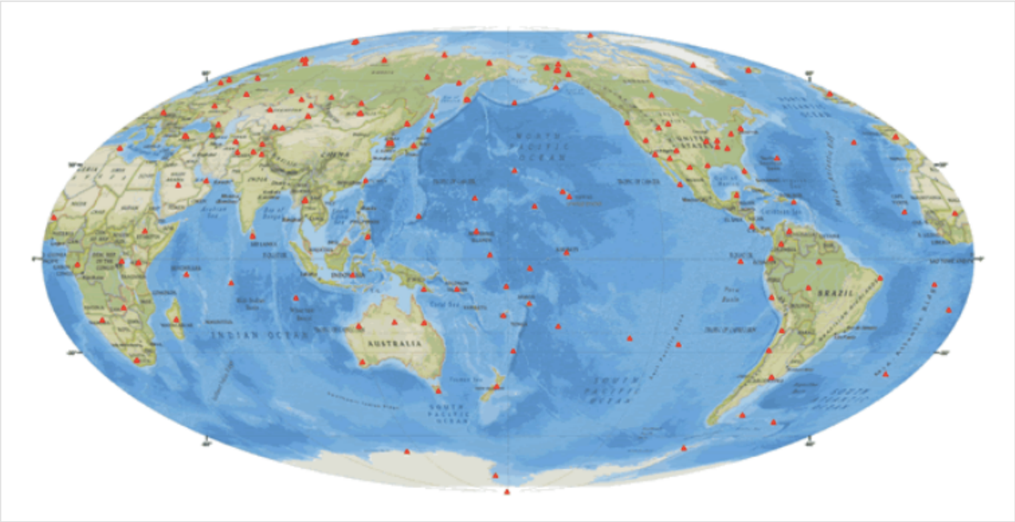
USGS
science for a changing world

Earthquake Hazards Program

← Monitoring

- National Earthquake Information Center-NEIC
- ANSS-Advanced National Seismic System
- GSN-Global Seismographic Network
- Volunteer Monitoring
- Seismogram Displays
- Earthquake Monitoring of Structures
- NSMP-National Strong Motion Project
- Crustal Deformation Monitoring

GSN – Global Seismographic Network



The Global Seismographic Network is a permanent digital network of state-of-the-art seismological and geophysical sensors connected by a telecommunications network, serving as a multi-use scientific facility and societal resource for monitoring, research, and education. Formed in partnership among the USGS, the National Science Foundation (NSF) and the Incorporated Research Institutions for Seismology (IRIS), the GSN provides near-uniform, worldwide monitoring of the Earth, with over 150 modern seismic

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USGS science for a changing world

Earthquake Hazards Progra

IRIS Incorporated Research Institutions for Seismology

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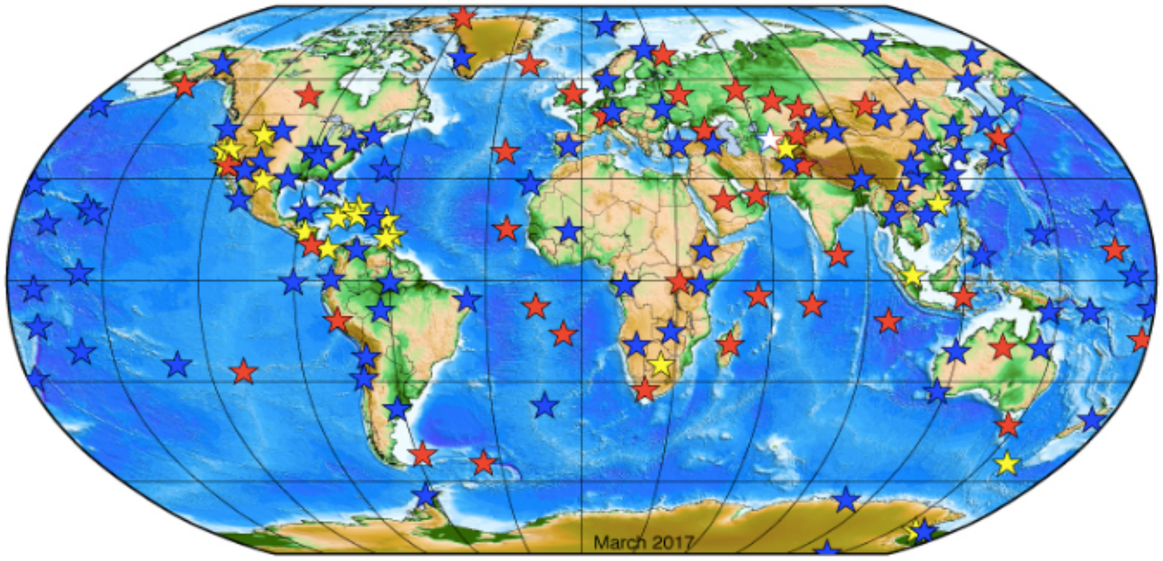
Instrumentation Services

- **Global Seismographic Network**
  - GSN Network Operators
  - GSN Maps
  - GSN Instrumentation
  - GSN Data Quality
  - GSN Data Access
  - GSN Documentation
  - GSN Review 2015
  - GSN Standing Committee
- **Portable Networks (PASSCAL)**
- **The Ocean Bottom Seismograph Instrument Pool**
- **Transportable Array**
- **Magnetotelluric Array**
- **Polar**
- **Greenland Ice Sheet Monitoring Network**
- **Global Reporting Observatories in Chile (GRO Chile)**

Global Seismographic Network



IRIS/IDA Stations | IRIS/USGS Stations | Affiliate Stations | Planned Stations

The Global Seismographic Network (GSN) is a 150+ station, globally distributed, state-of-the-art digital seismic network that provides free, realtime, open access data through the IRIS DMC. The map above shows the distribution of the current station network with respect to network operations.

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FDSN

International Federation of Digital Seismograph Networks

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About the FDSN

The International Federation of Digital Seismograph Networks (FDSN) is a global organization. Its membership is comprised of groups responsible for the installation and maintenance of seismographs either within their geographic borders or globally. Membership in the FDSN is open to all organizations that operate more than one broadband station. Members agree to coordinate station siting and provide free and open access to their data. This cooperation helps scientists all over the world to further the advancement of earth science and particularly the study of global seismic activity. The FDSN also holds commission status within IASPEI.

The FDSN goals related to station siting and instrumentation are to provide stations with good geographic distribution, recording data with 24 bits of resolution in continuous time series with at least a 20 sample per second sampling rate. The FDSN was also instrumental in development of a universal standard for distribution of broadband waveform data and related parametric information. The Standard for Exchange of Earthquake Data (SEED) format is the result of that effort.

Network Codes

Network codes are also assigned by the FDSN in order to provide uniqueness to seismological data streams. Network operators request these unique codes for both permanent and temporary networks. Network Code request forms are here.

FDSN historical information