



H  
IC  
N

Larsen B

Current  
Jan. 1  
June 2016  
August 2014  
November 2010

Shelf Front

**Larsen C  
Ice Shelf**

Rift  
extent

Larsen D

If Larsen C's shelf front retreats past this line, called the compressive arch, the shelf is likely to collapse.

## A Crack in an Antarctic Ice Shelf Grew 17 Miles in the Last Two Months

By JUGAL K. PATEL FEB. 7, 2017

A rapidly advancing crack in Antarctica's fourth-largest ice shelf has scientists concerned that it is getting close to a full break. The rift has accelerated this year in an area already vulnerable to warming temperatures. Since December, the crack has grown by the length of about five football fields each day.

# Mitigation and Adaptation Studies



# Mitigation and Adaptation Studies



## Class 7: Diagnosis (finalize), Prognosis and Therapy

### Contents:

- (The Life-Support System and Ecosystem Services)
- (Feedback Loops in the Life-Support System)
- **System Thinking**
- **Prognosis: Where is the System Heading?**

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## Class 8: Prognosis and Therapy (finalize); Extinction

### Contents:

- Prognosis: Where is the System Heading?
- Is there a Therapy? What is the Role of Conservation in that?



## Exploring Possible Futures

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- climate change:
  - extreme weather
  - global atmospheric warming
  - ocean warming
  - ocean acidification
  - sea level rise
- global disasters

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- social and technological risks
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- scenario-based modeling and simulations
  - issues: model validation, ensembles, selection of scenarios, not predictions
- risk assessments:
  - risk perception and biases, comprehensiveness

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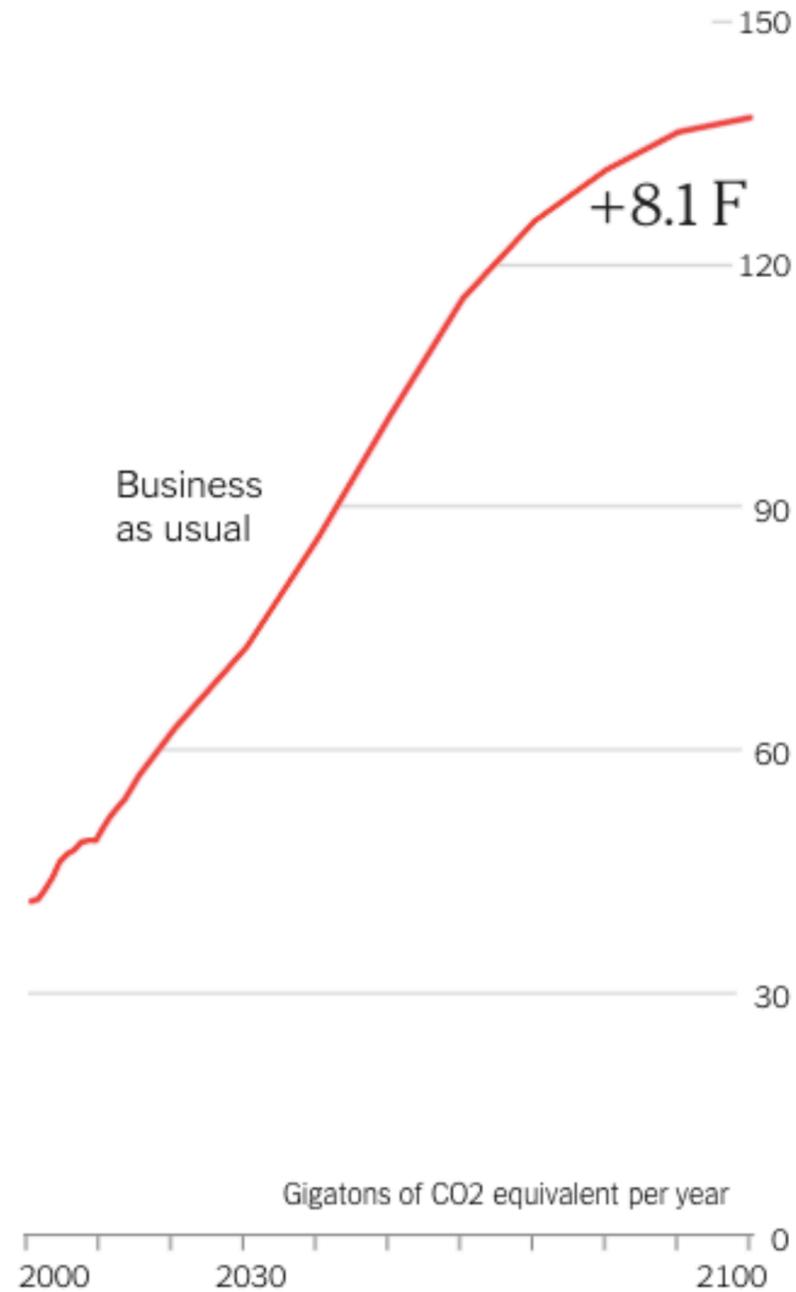
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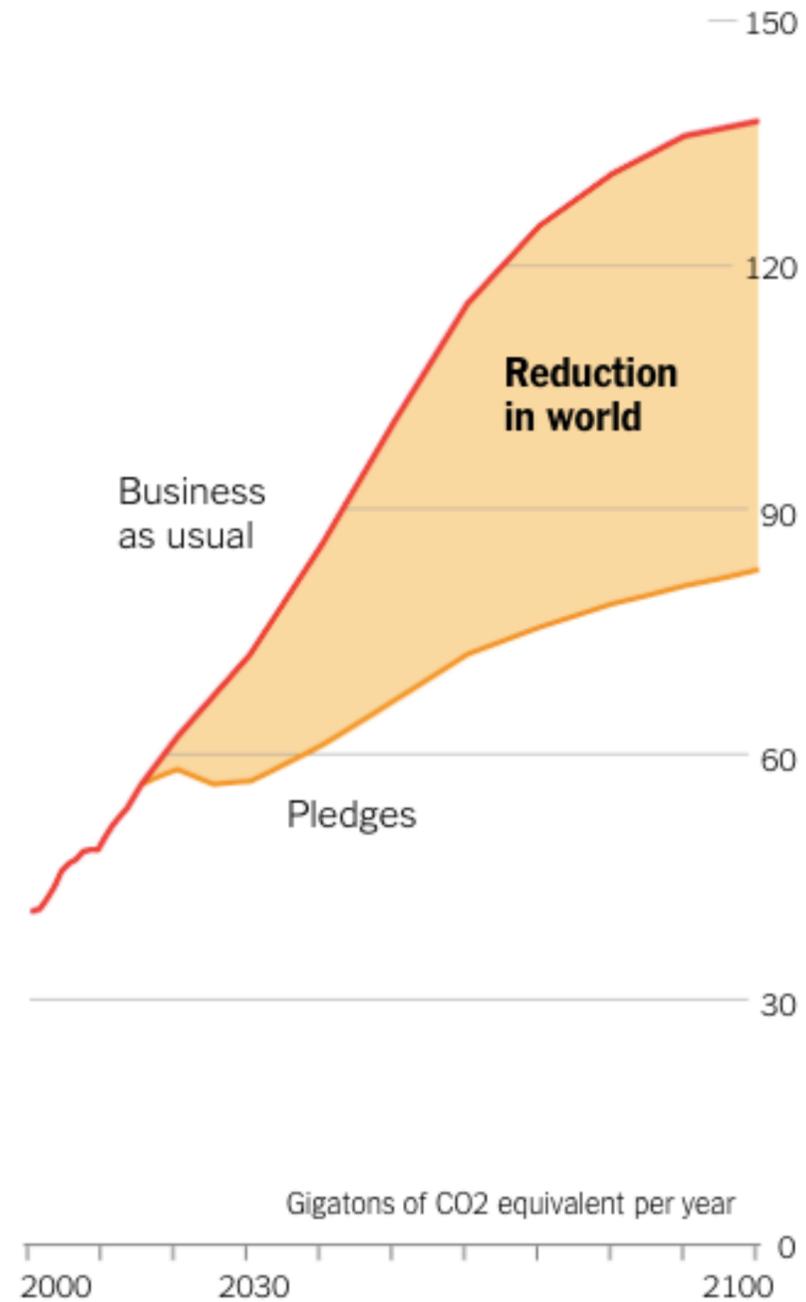
# The Climate Change Pledges Are In. Will They Fix Anything?

By HANNAH FAIRFIELD and JOSH WILLIAMS

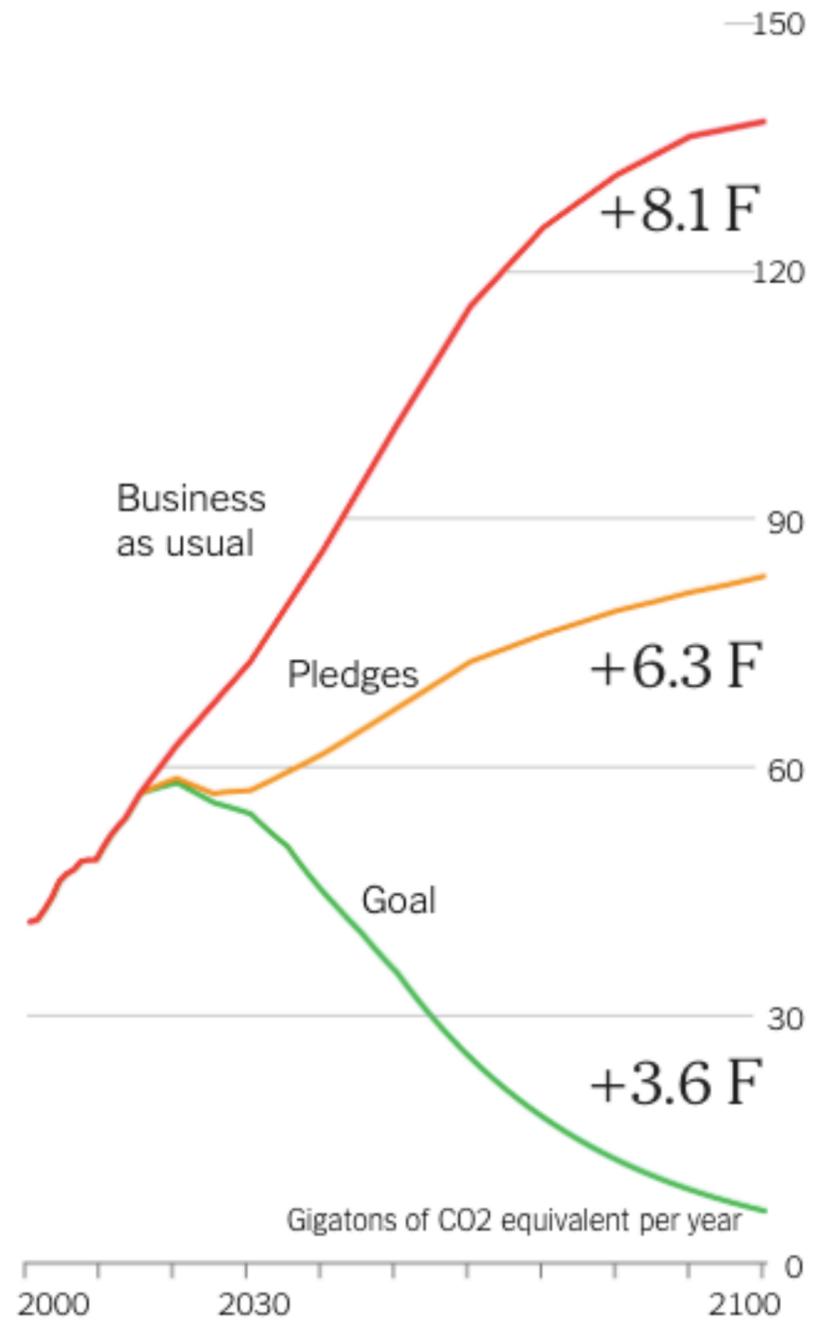
NOV. 23, 2015



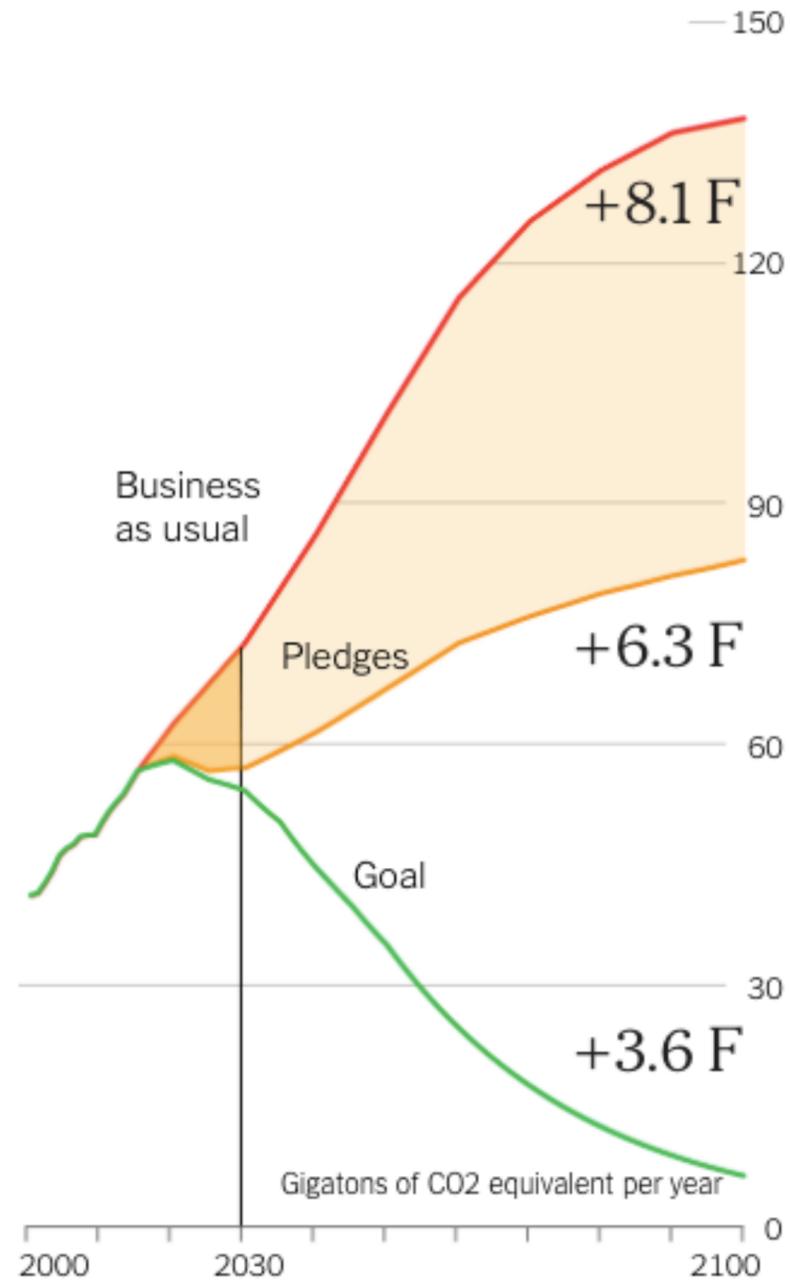
Without the pledges, **global temperatures** would likely jump more than 8°F by 2100.



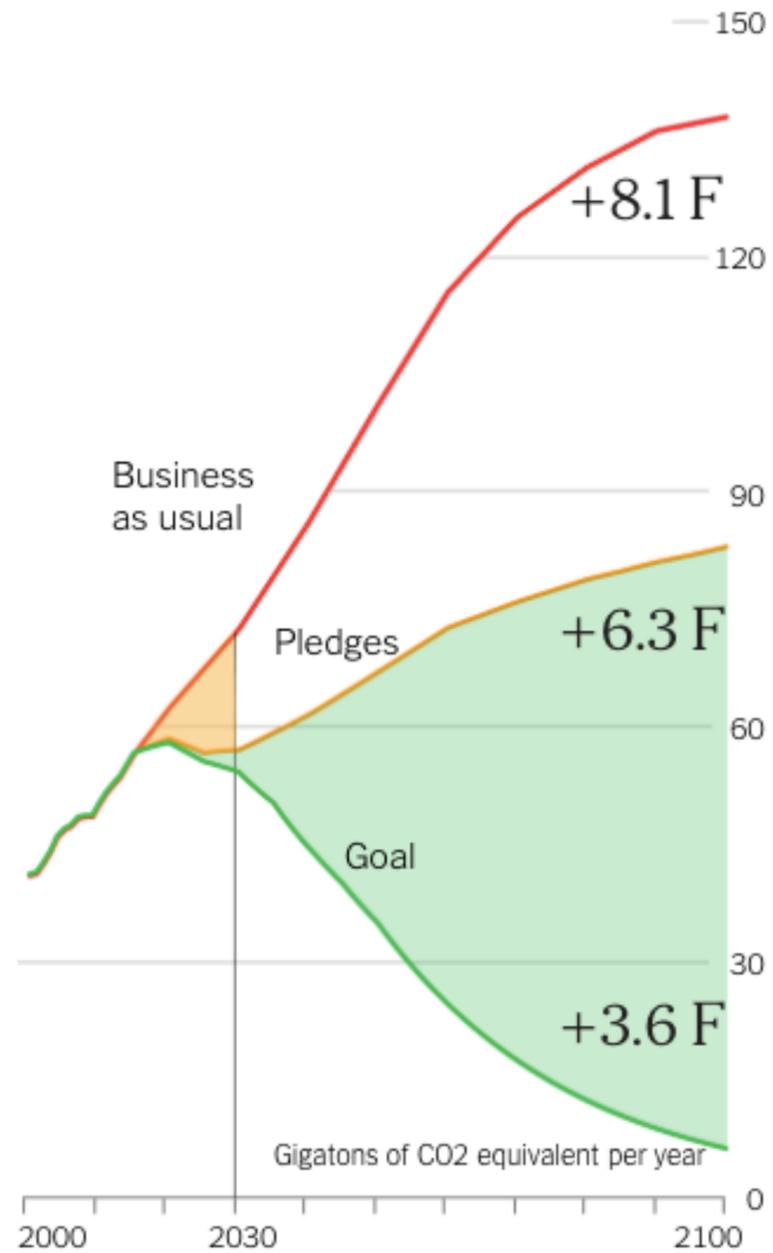
Taken together, the pledges are the **biggest cut ever achieved**, but are still not enough.



But **the goal countries agreed to** in 2010 was to limit the temperature increase to 3.6°F.



Right now, most of the pledges do not extend past 2030.



Delegates in Paris will discuss a plan for **ratcheting up national commitments** over time.

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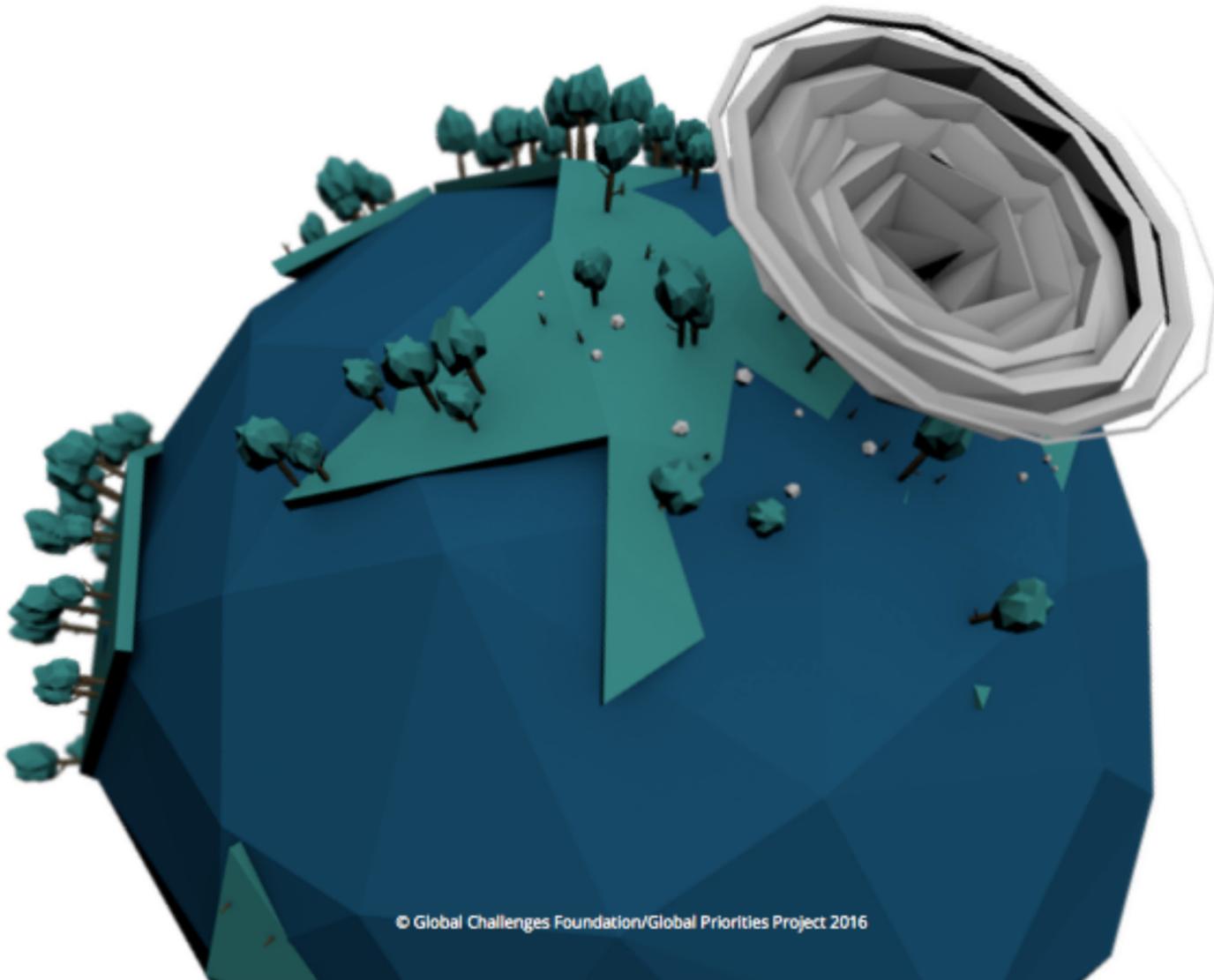
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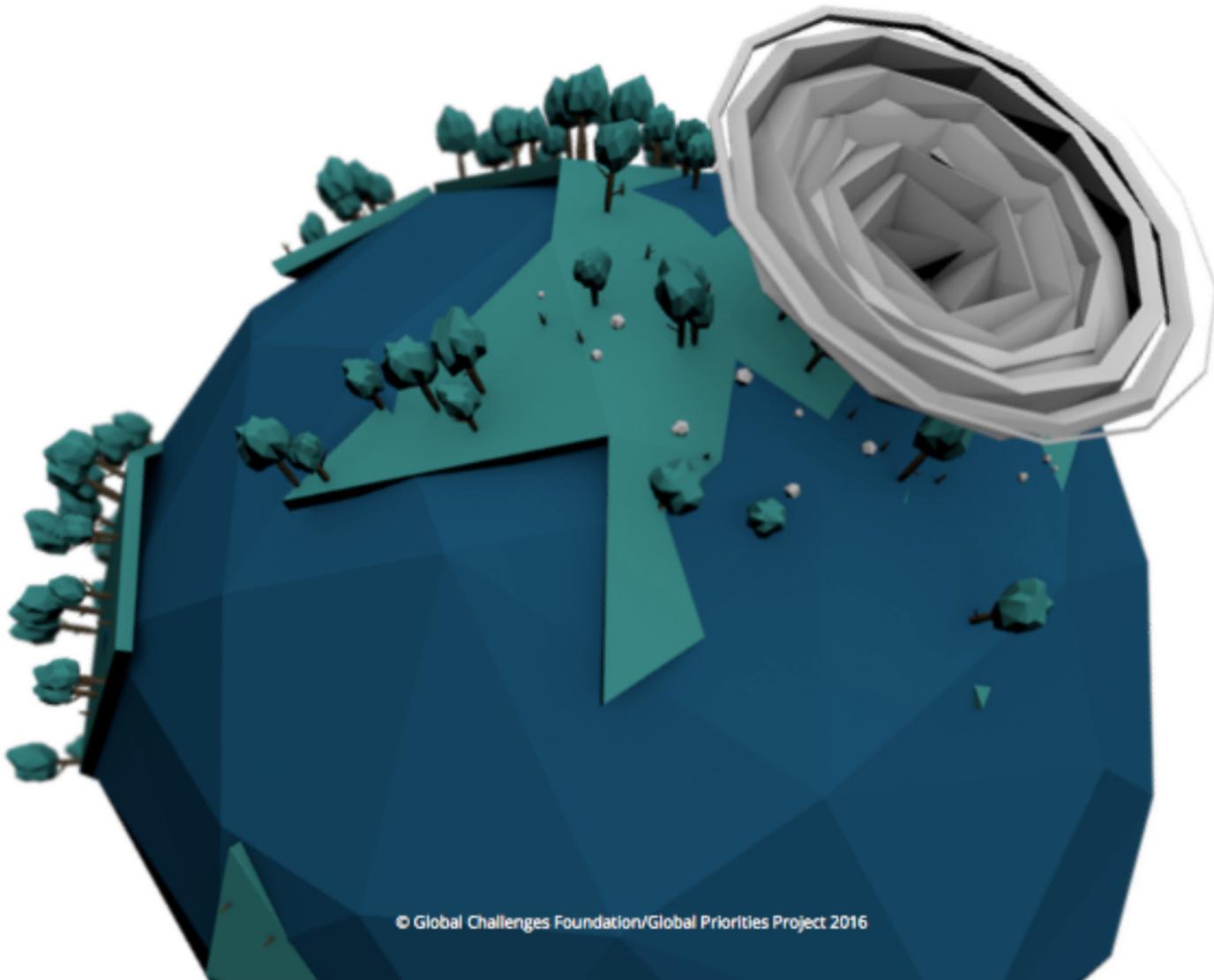
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## Global Catastrophic Risks 2016



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## Global Catastrophic Risks 2016

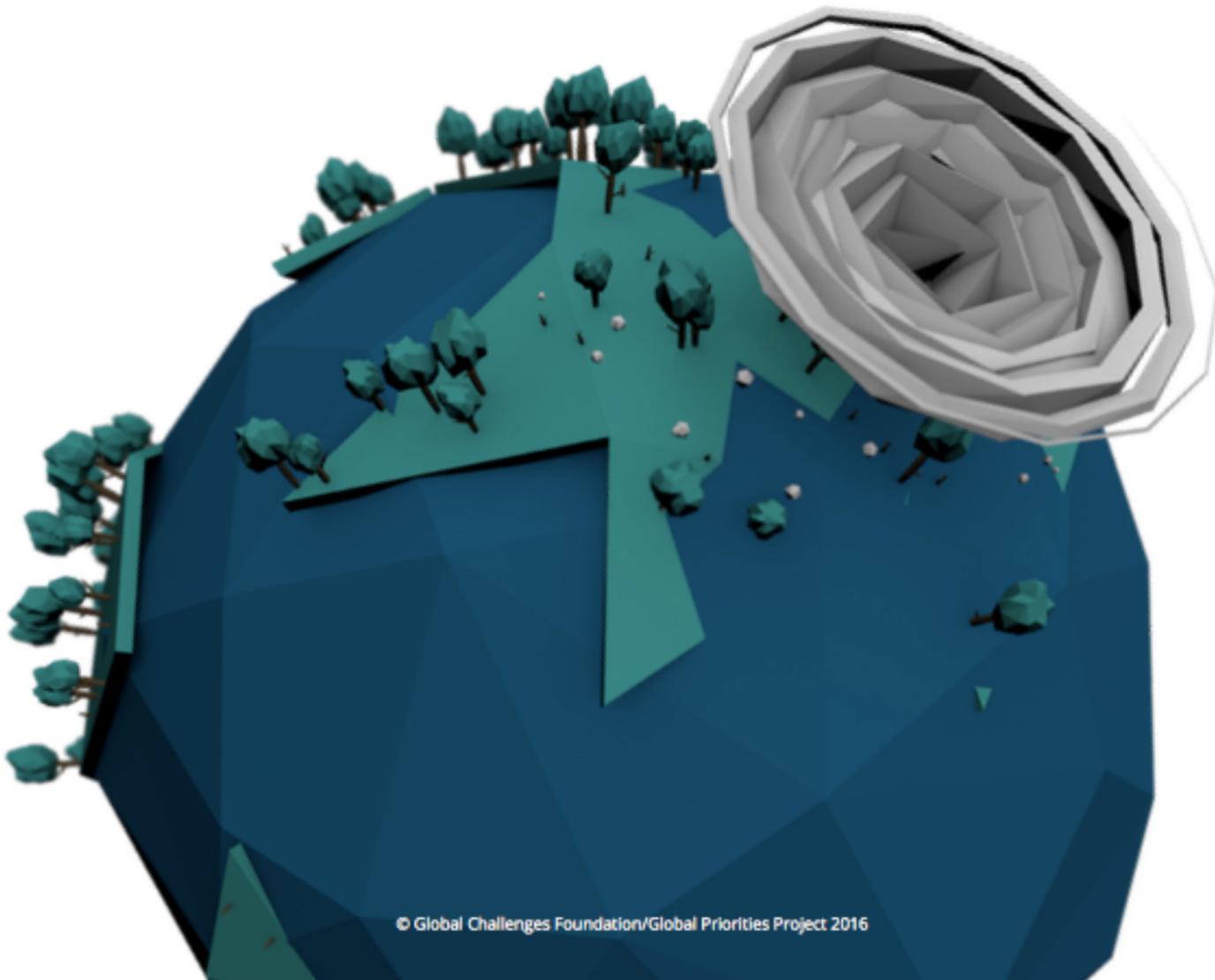


in association with



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## Global Catastrophic Risks 2016



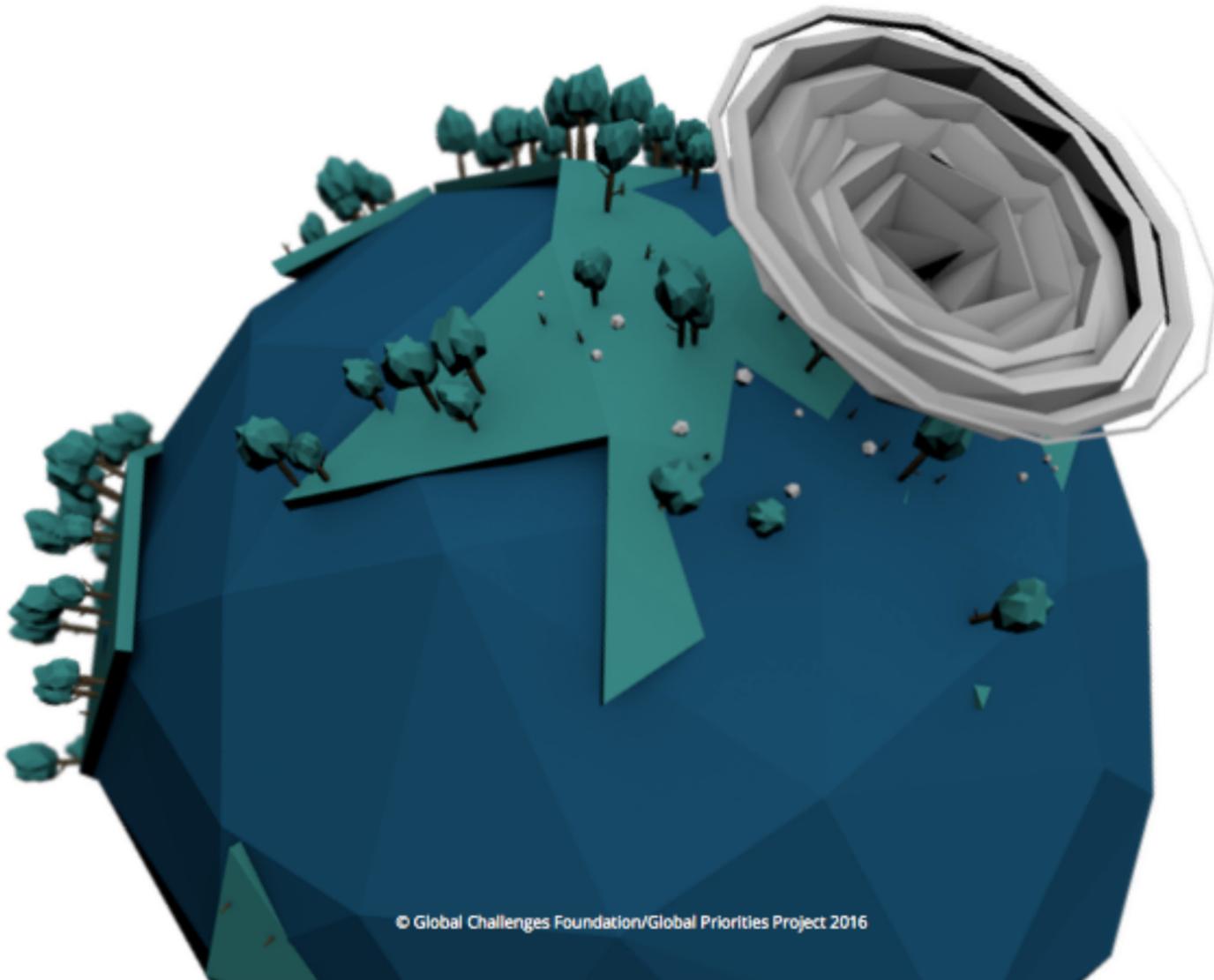
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THE GLOBAL CHALLENGES FOUNDATION works to raise awareness of the Global Catastrophic Risks. Primarily focused on climate change, other environmental degradation and politically motivated violence as well as how these threats are linked to poverty and 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.

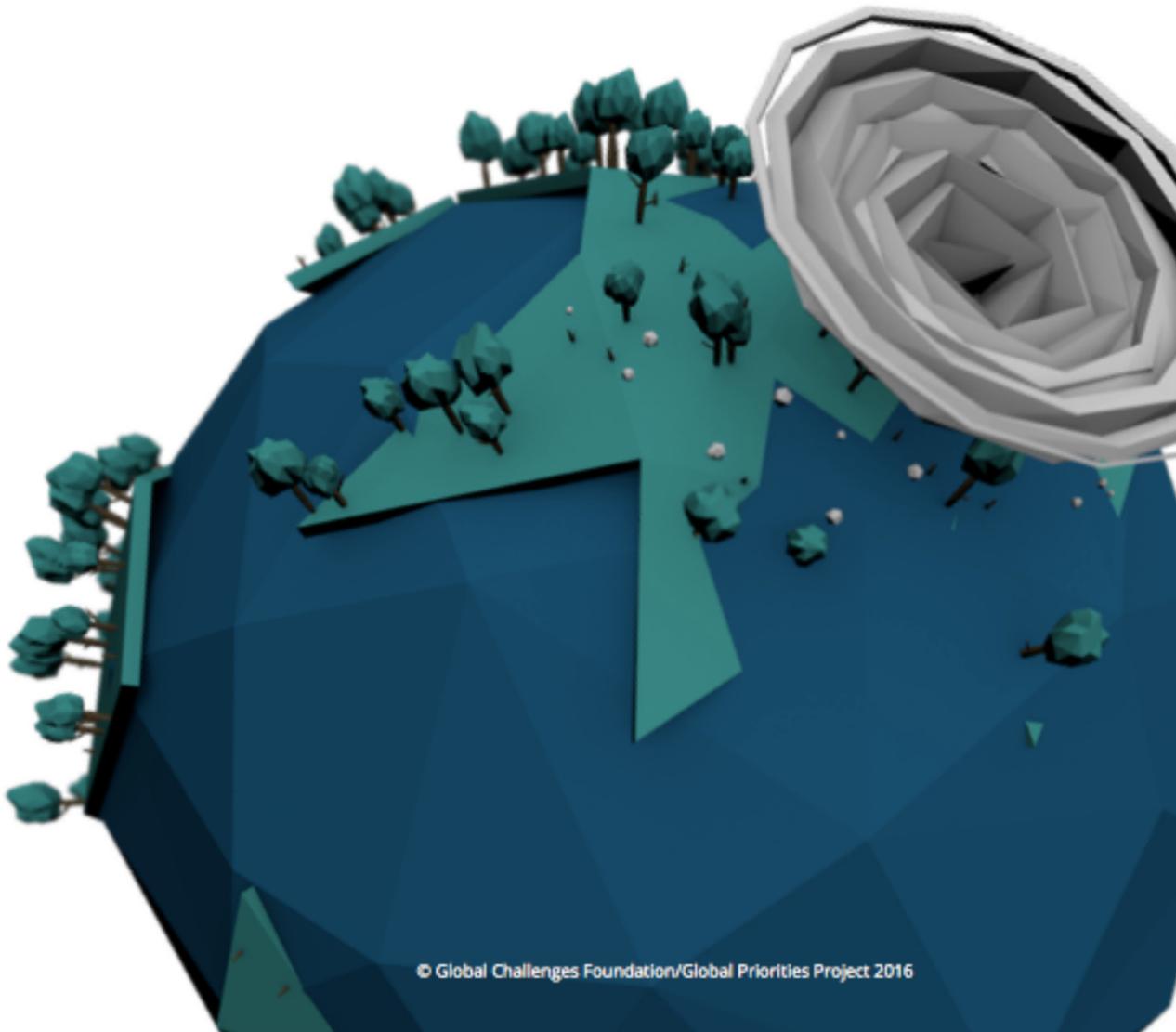
THE GLOBAL PRIORITIES PROJECT helps decision-makers effectively prioritise ways to do good. We achieve this both by advising decision-makers on programme evaluation methodology and by encouraging specific policies. We are a collaboration between the Centre for Effective Altruism and the Future of Humanity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

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## Global Catastrophic Risks 2016

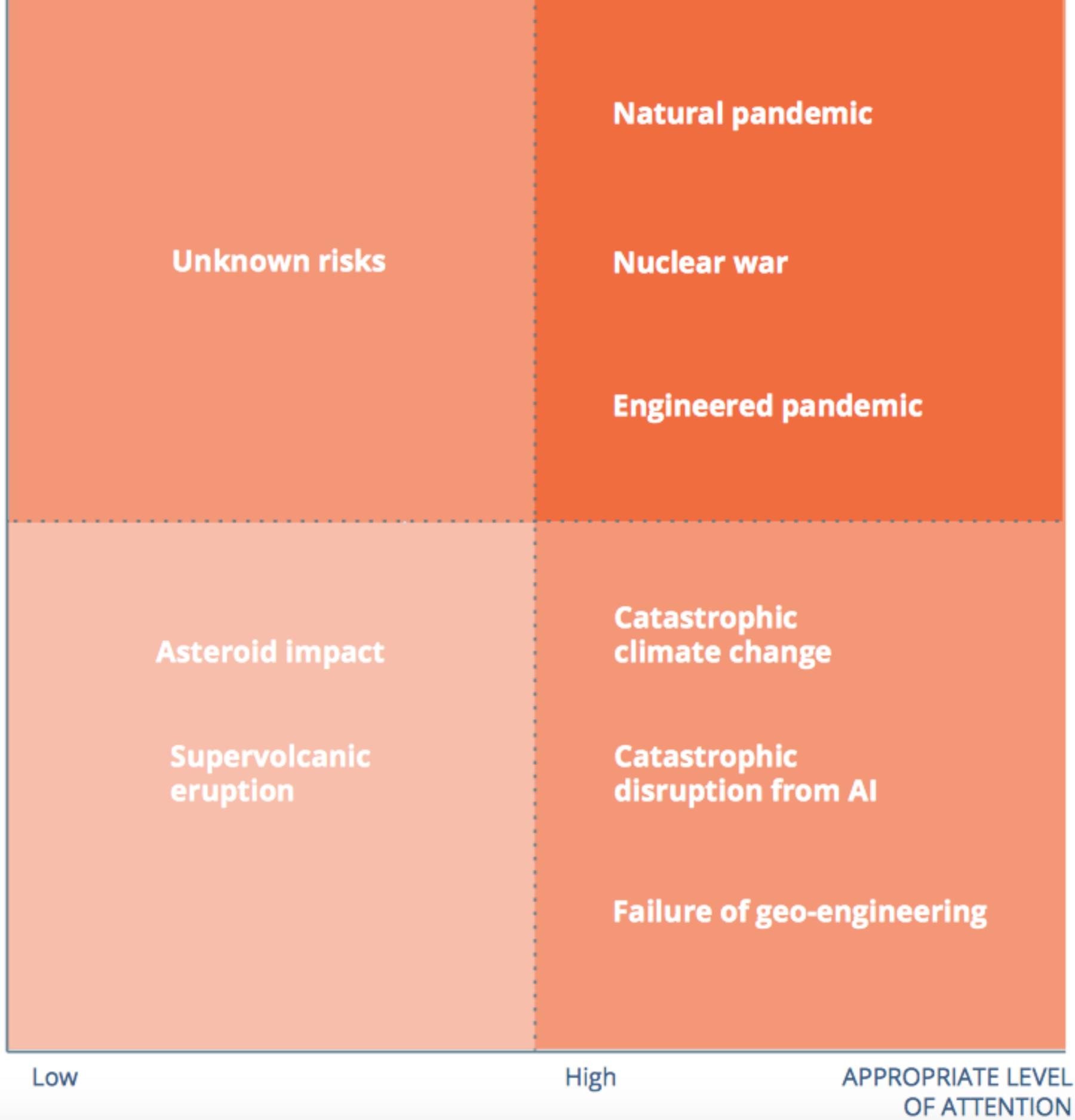


## Global Catastrophic Risks 2016

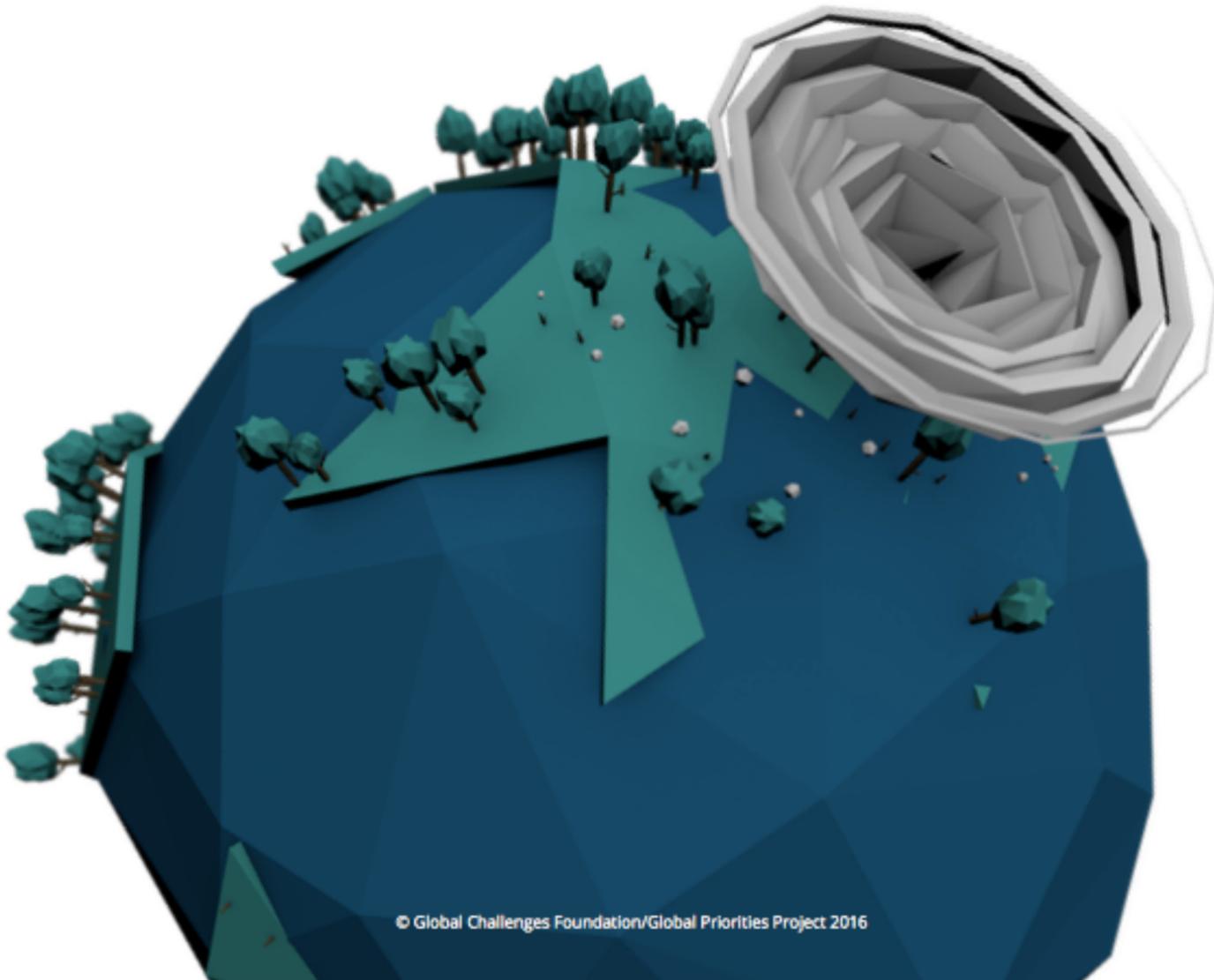


Higher likelihood  
over next 5 years

Lower likelihood  
over next 5 years



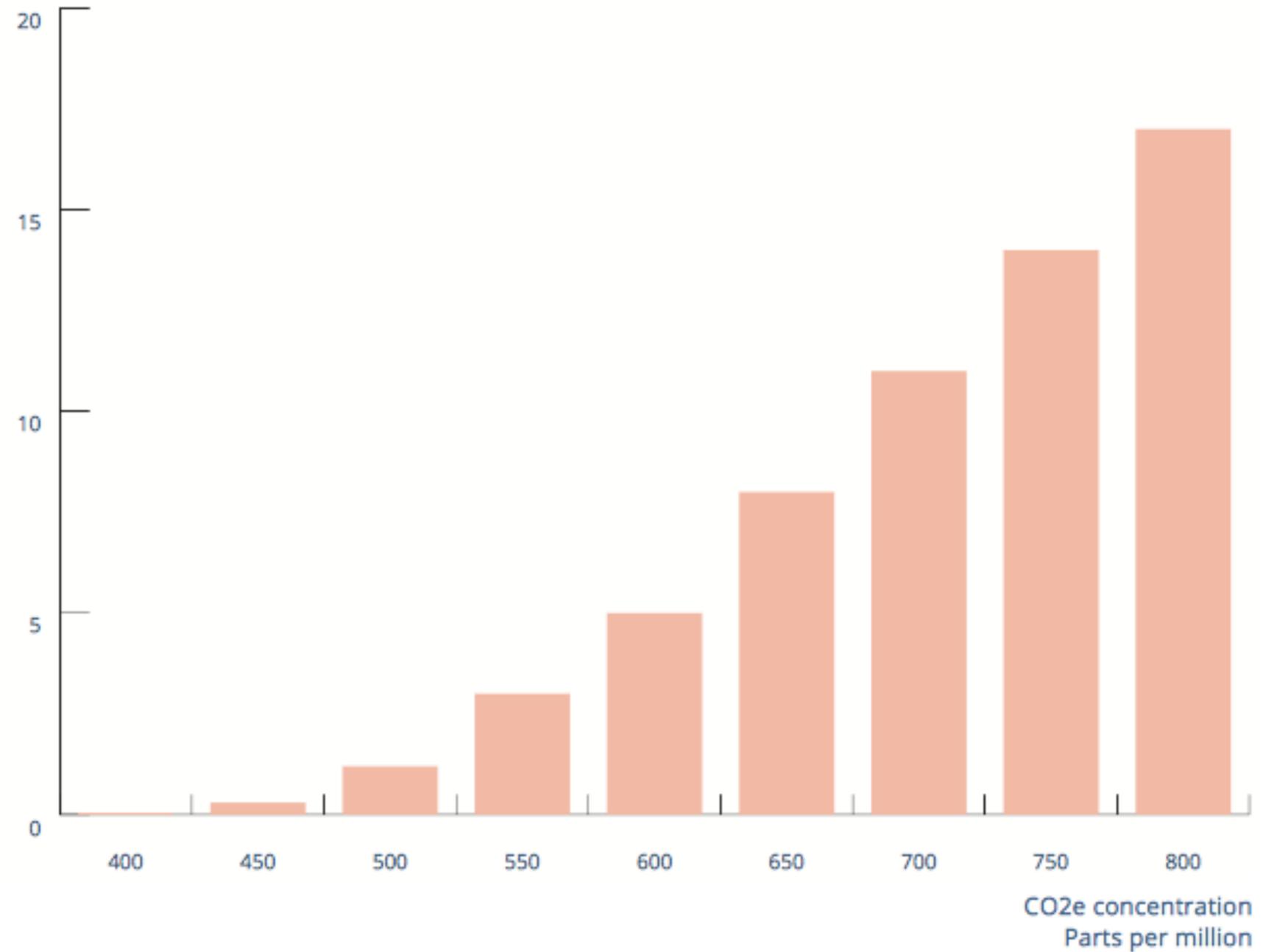
## Global Catastrophic Risks 2016



### FIGURE 2.1. THE CHANCE OF EXTREME CLIMATE CHANGE

The probability of warming of 6°C for different atmospheric concentrations of greenhouse gases.<sup>39</sup>

Probability of warming >6°C  
Percent



## Global Catastrophic Risks 2016

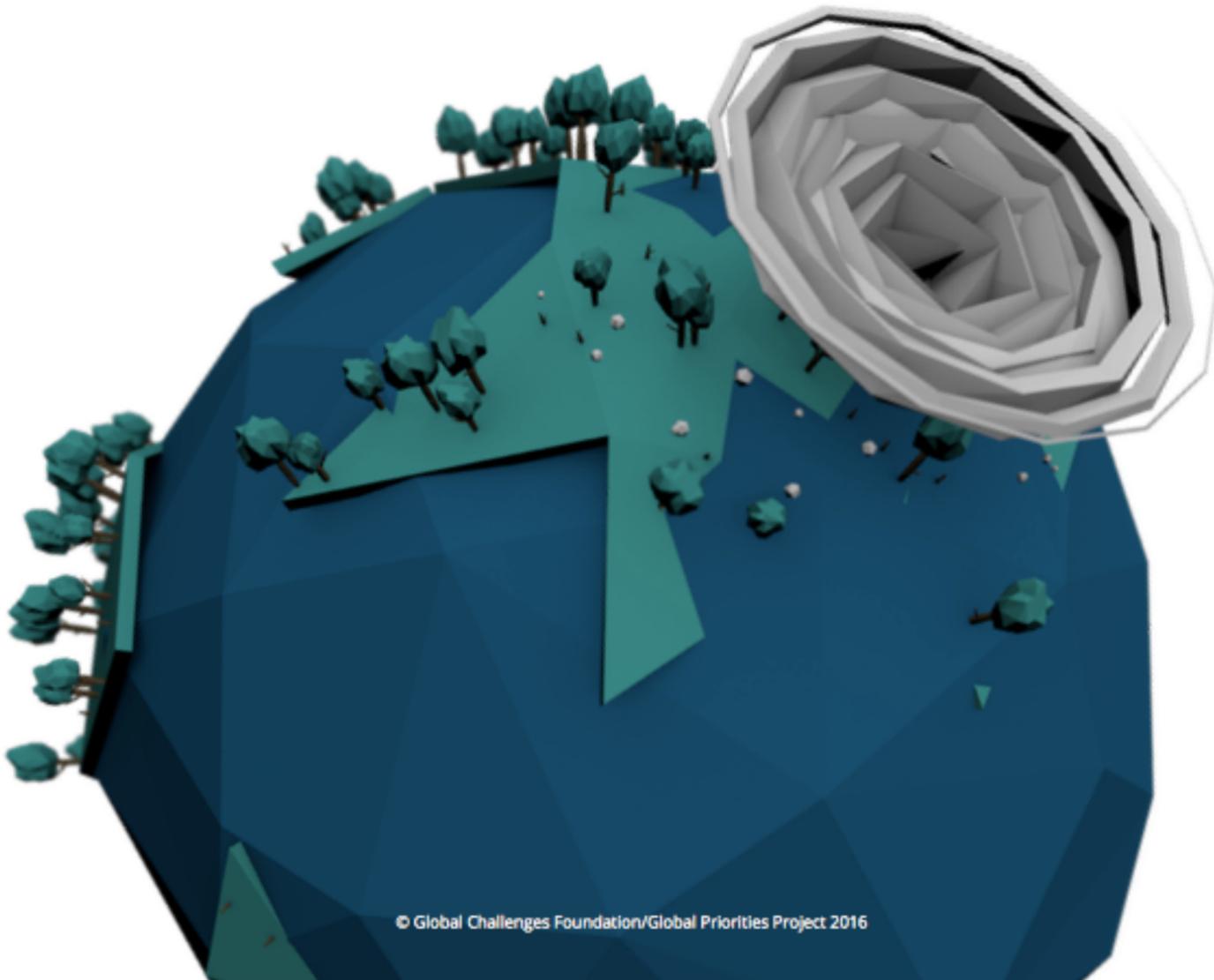
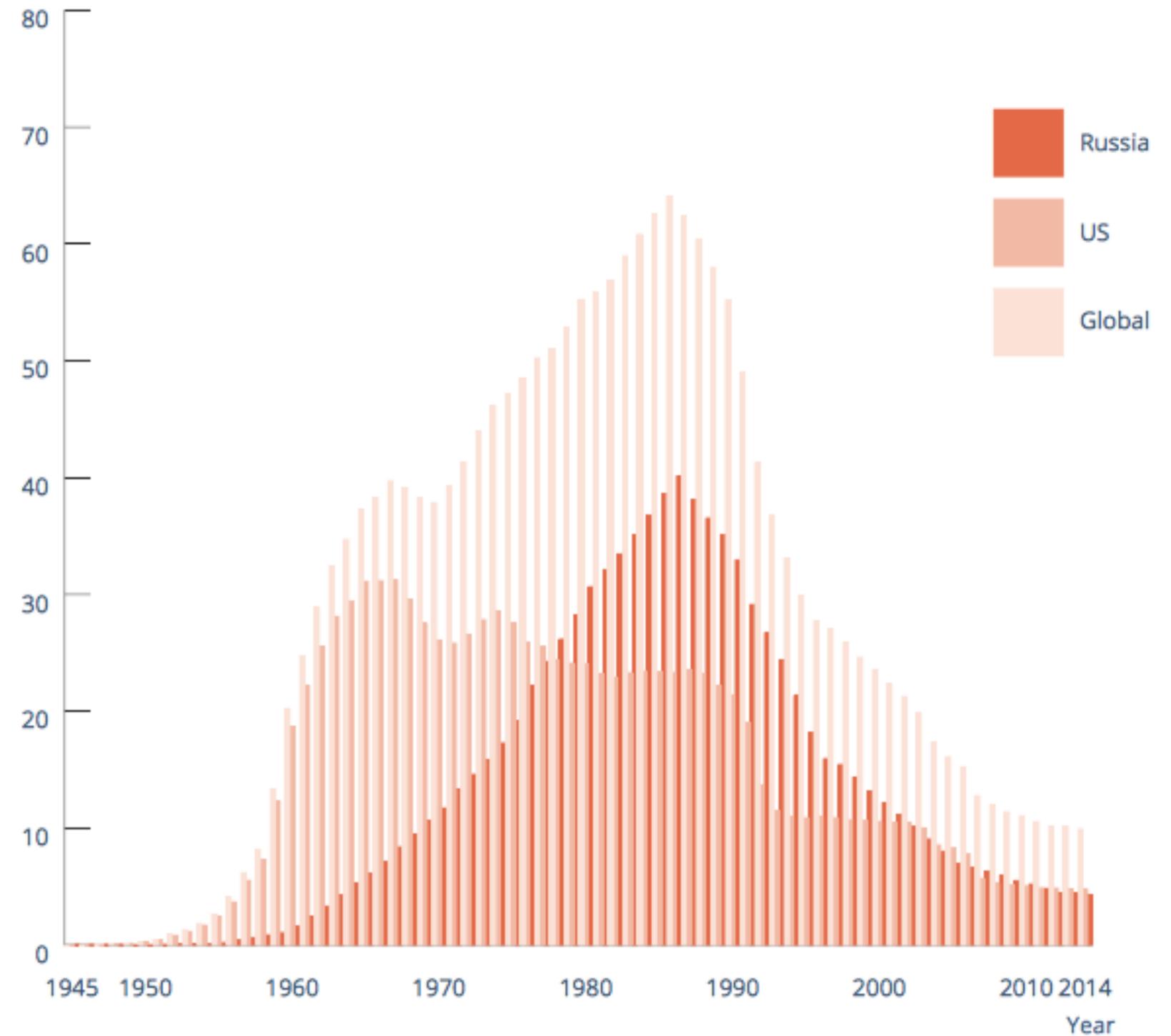
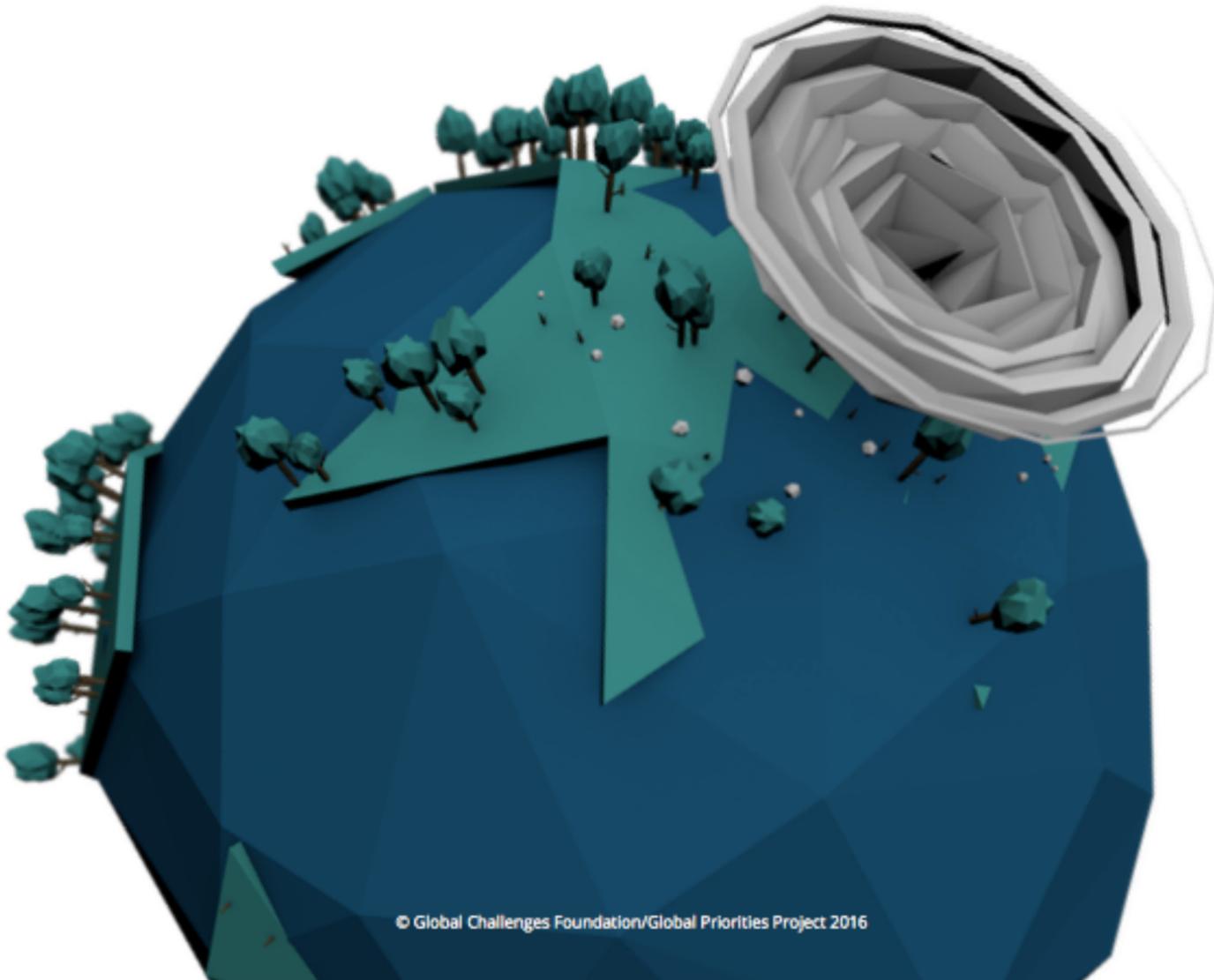


FIGURE 2.2.1. NUCLEAR ARSENALS OF THE US, RUSSIA, AND THE WORLD FROM 1945 UNTIL TODAY <sup>99</sup>

Number of nuclear warheads  
Thousands

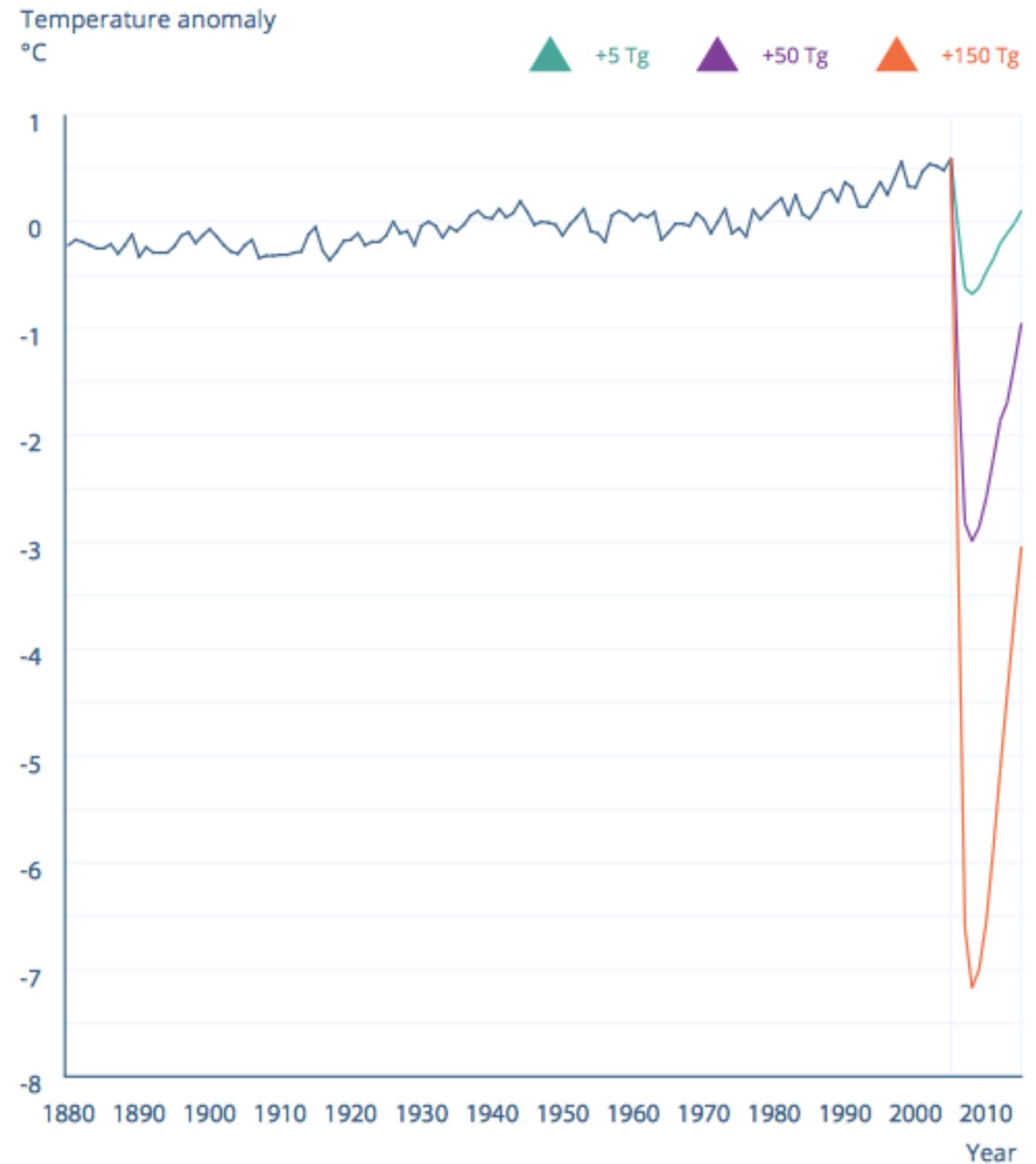


## Global Catastrophic Risks 2016

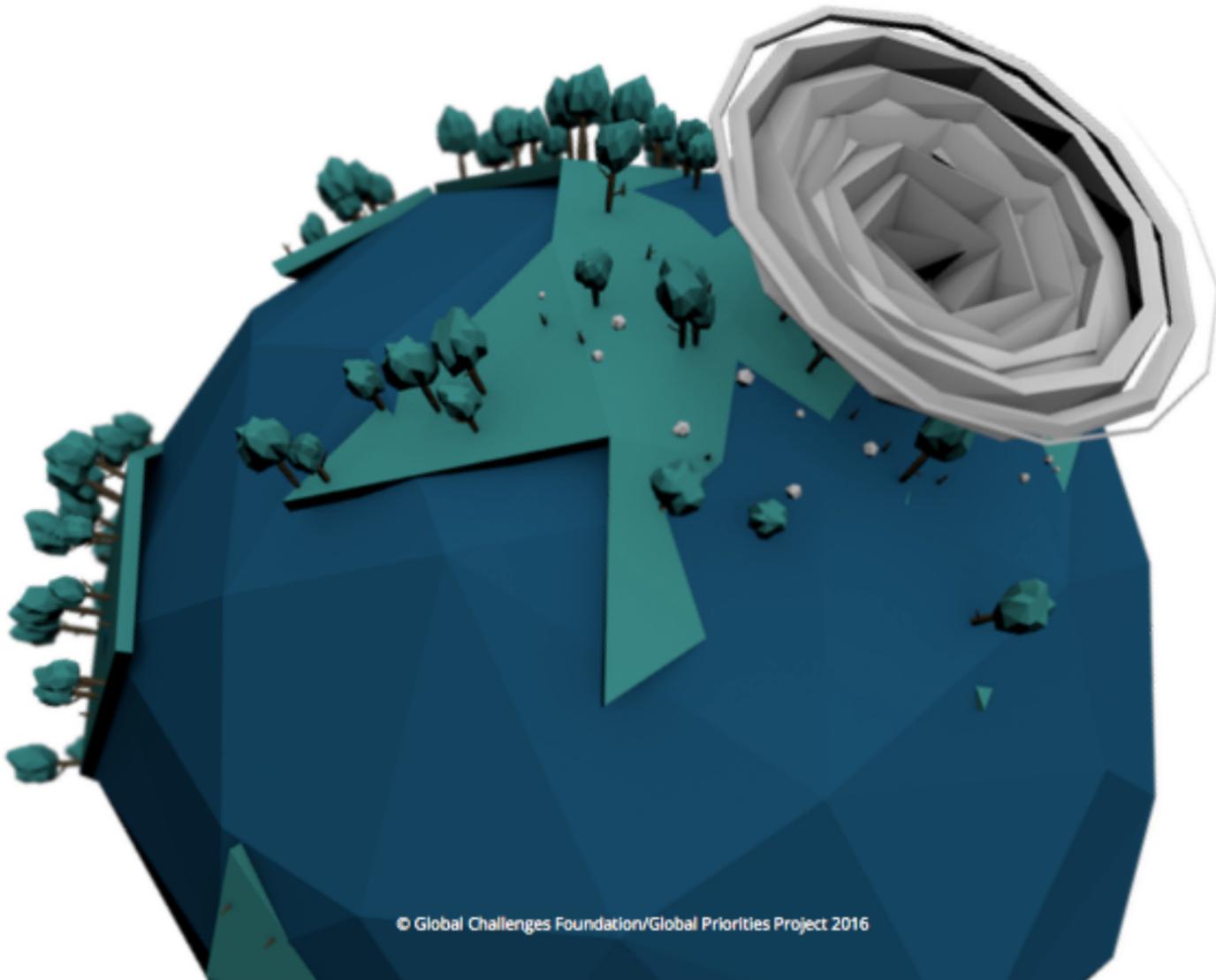


### FIGURE 2.2.2. GLOBAL TEMPERATURE ANOMALY FROM NUCLEAR WINTER

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.<sup>61</sup>

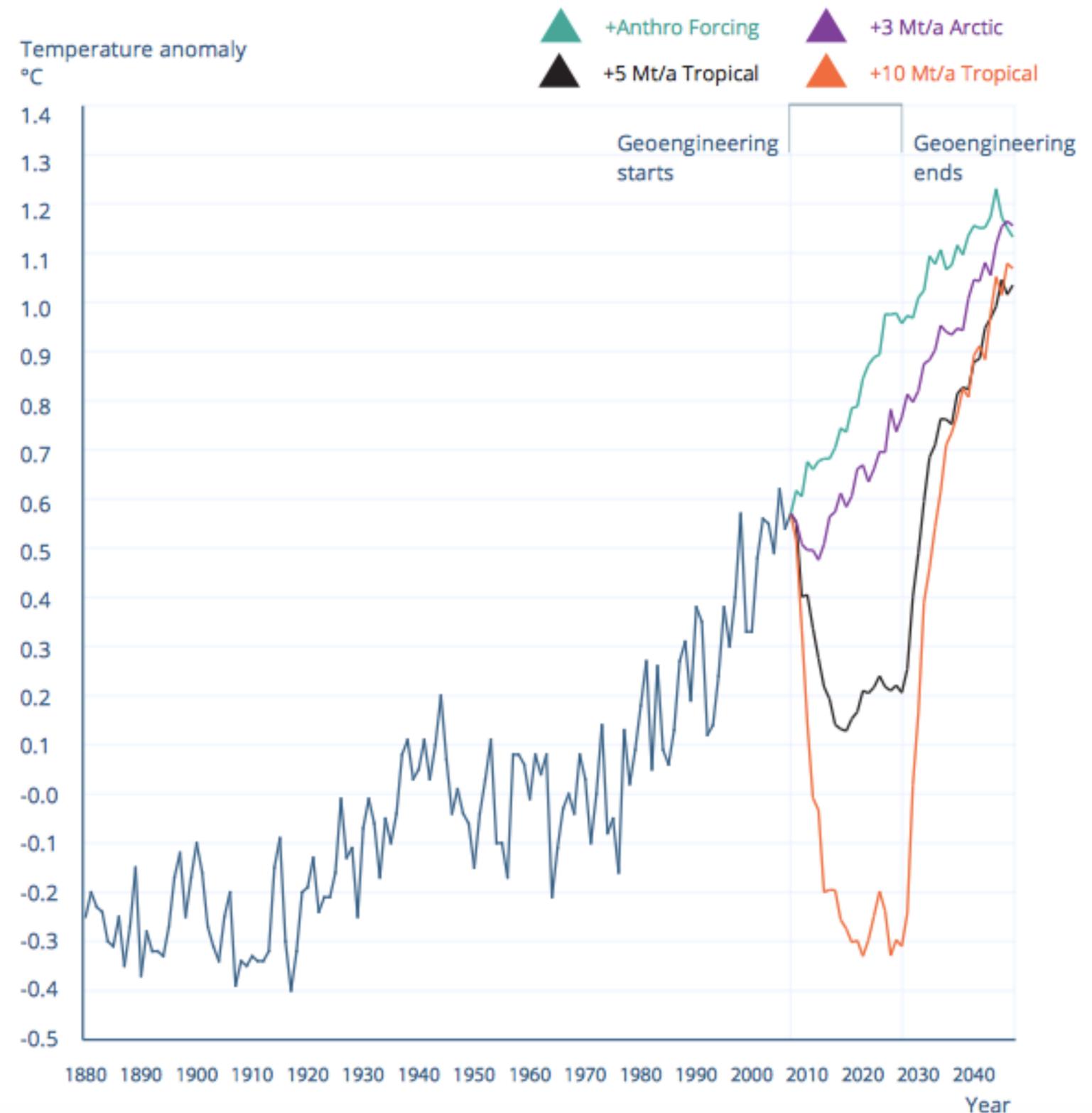


## Global Catastrophic Risks 2016



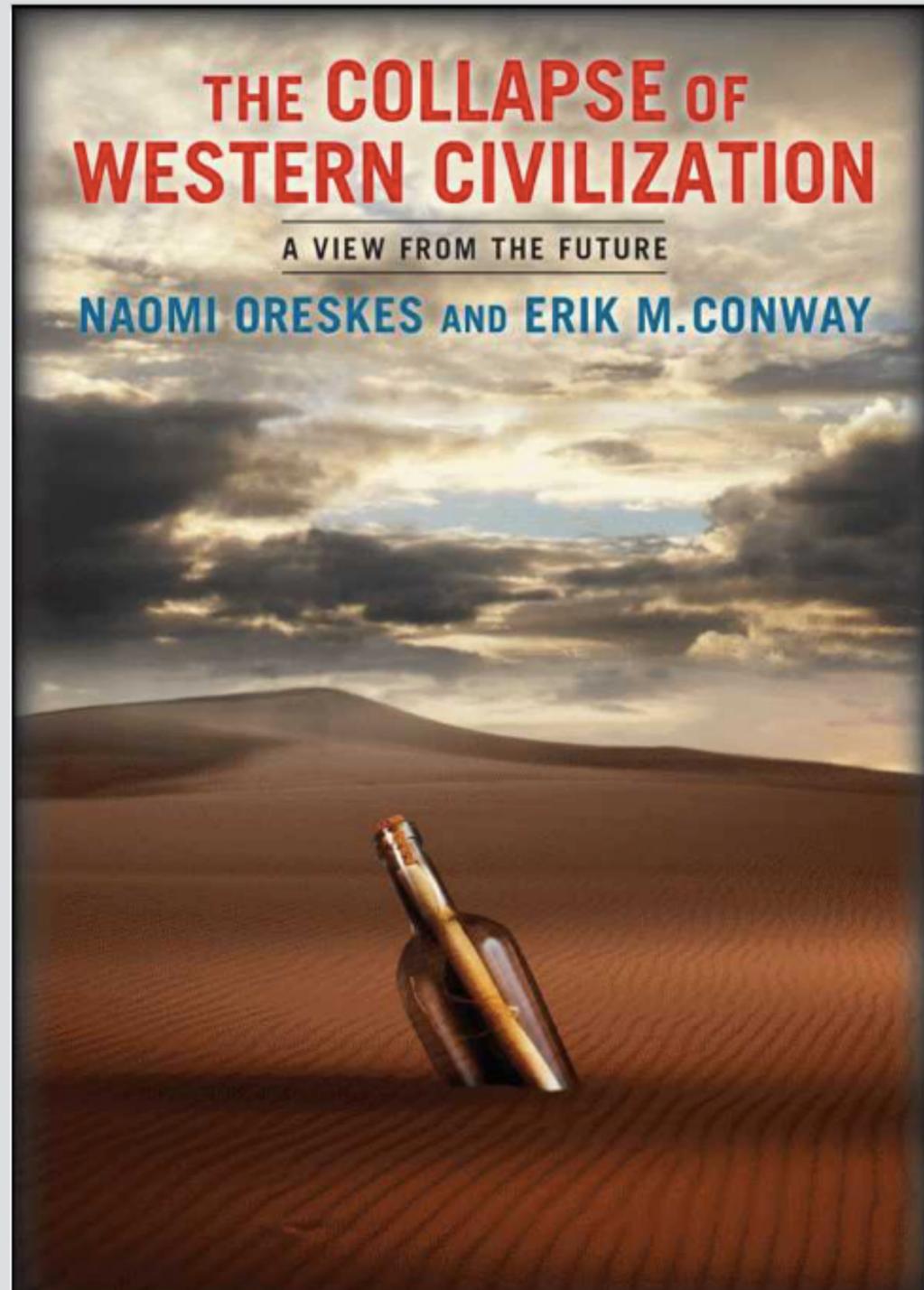
### 2.5.2. GLOBAL TEMPERATURE ANOMALY FROM GEO-ENGINEERING FOLLOWED BY TERMINATION

Global average surface air temperature change from business as usual emissions, injection of 3 megatons/annum (Mt/a) of SO<sub>2</sub> in the Arctic, 5 Mt/a of SO<sub>2</sub> in the tropics, and 10 Mt/a SO<sub>2</sub> in the tropics.<sup>130</sup>



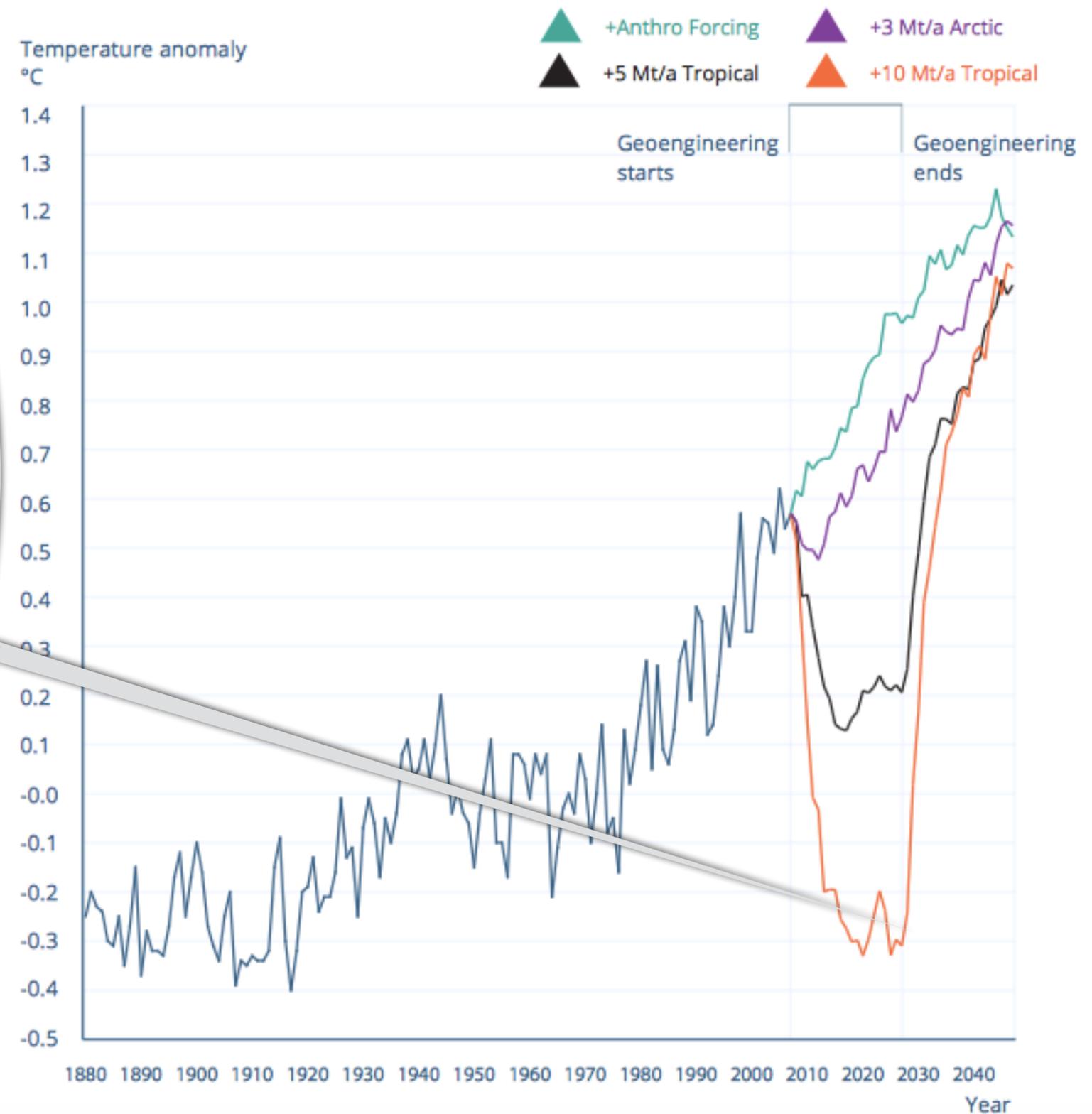
# Prognosis

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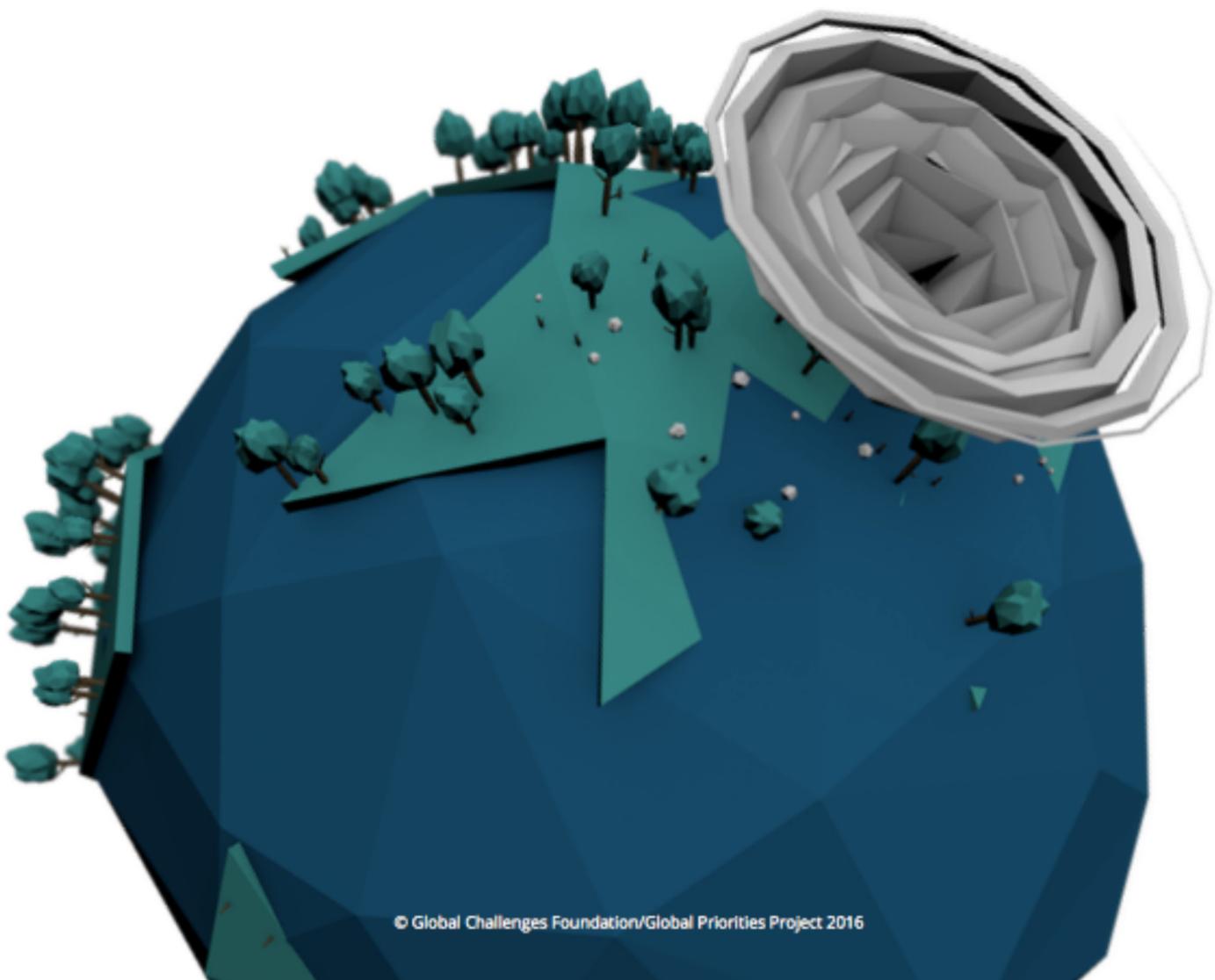
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## Global Catastrophic Risks 2016



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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. ▼▼





Insight Report

## The Global Risks Report 2017 12th Edition

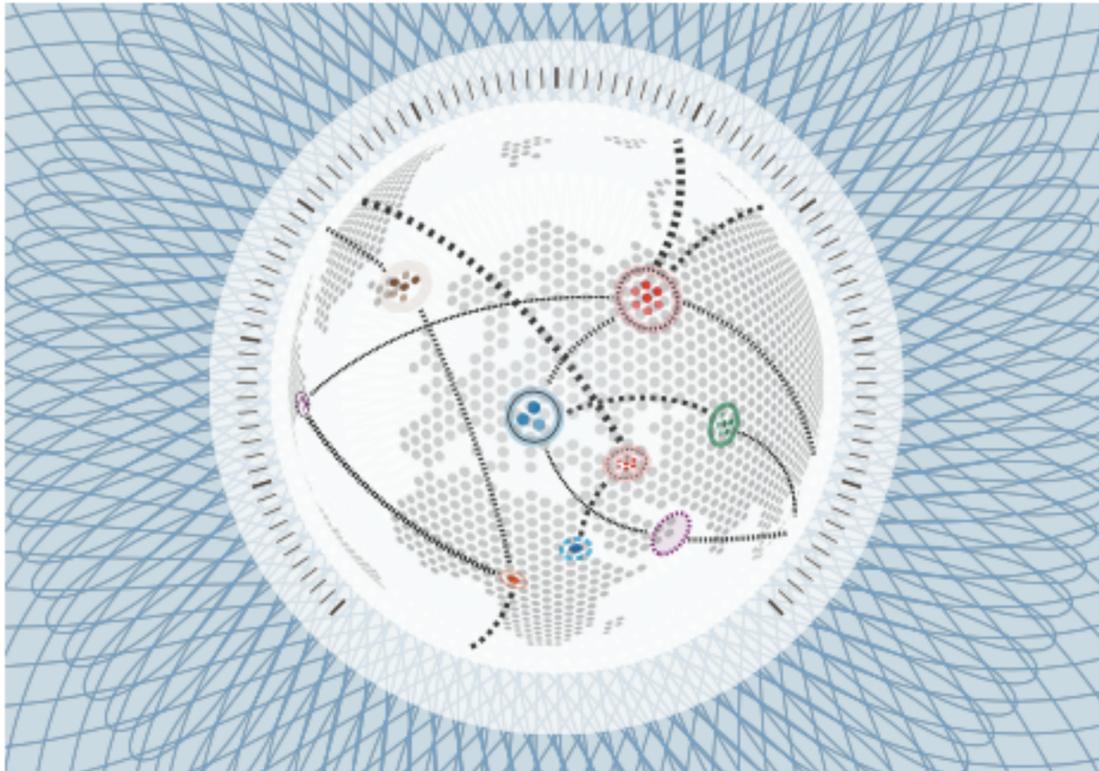
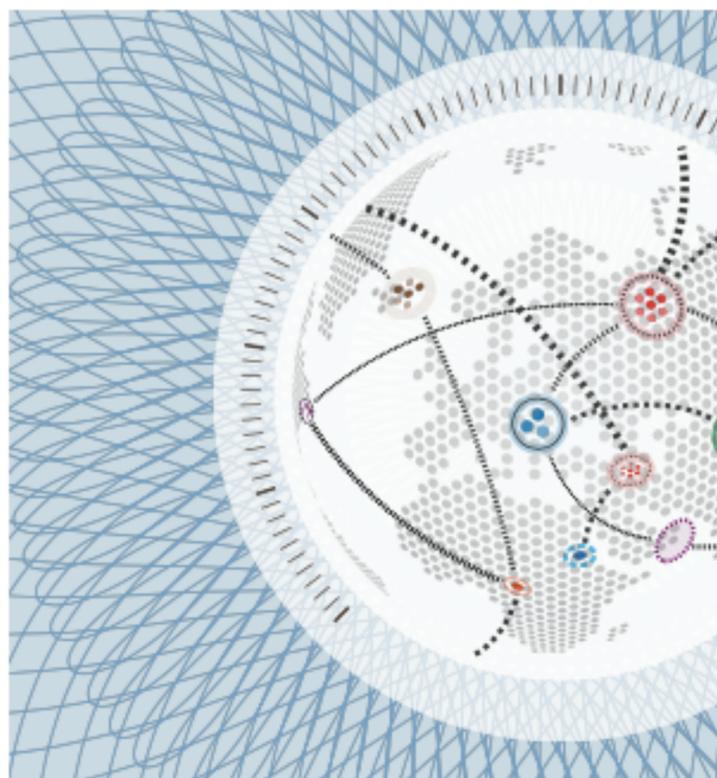


Figure 2: The Evolving Risks Landscape, 2007-2017

Insight Report

## The Global Risks Report 2017 12th Edition



### 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 shortages 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 2007-2017, Global Risks Reports

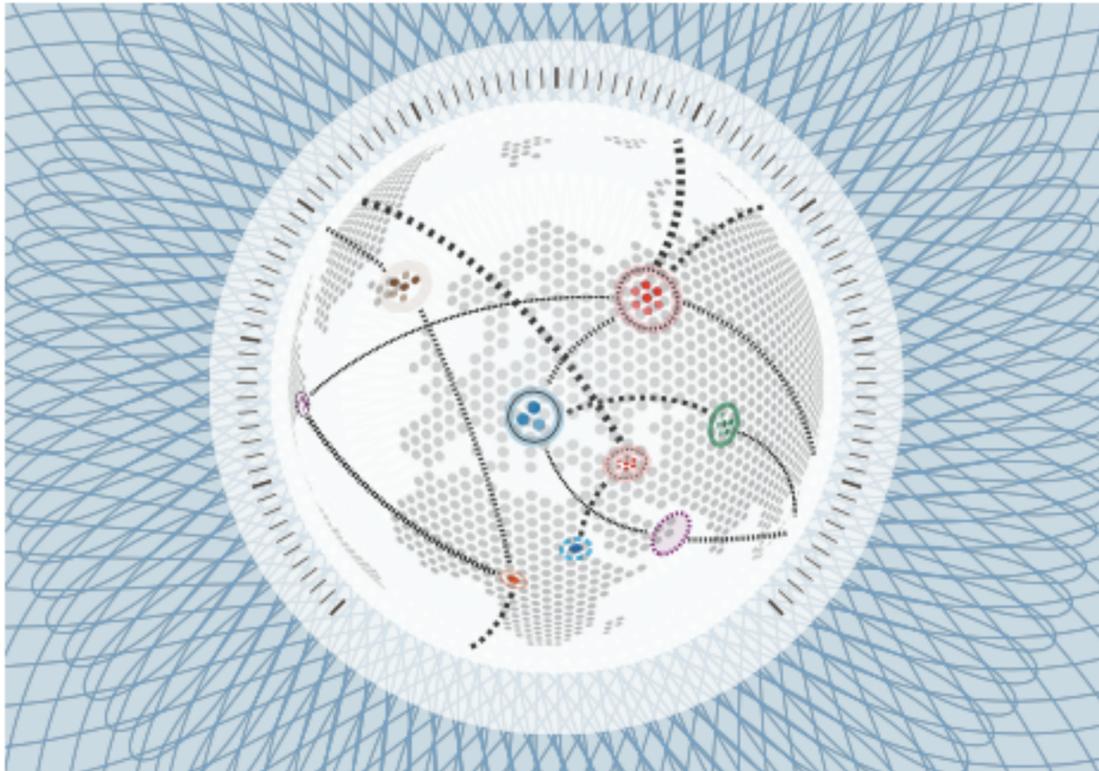
Note: Global risks may not be strictly comparable across years, as definitions and the set of global risks have evolved with new issues emerging on the 10-year horizon. For example, cyberattacks, income disparity and unemployment entered the set of global risks in 2012. Some global risks were reclassified: 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 2008 edition of the Global Risks Report did not have a risks landscape





Insight Report

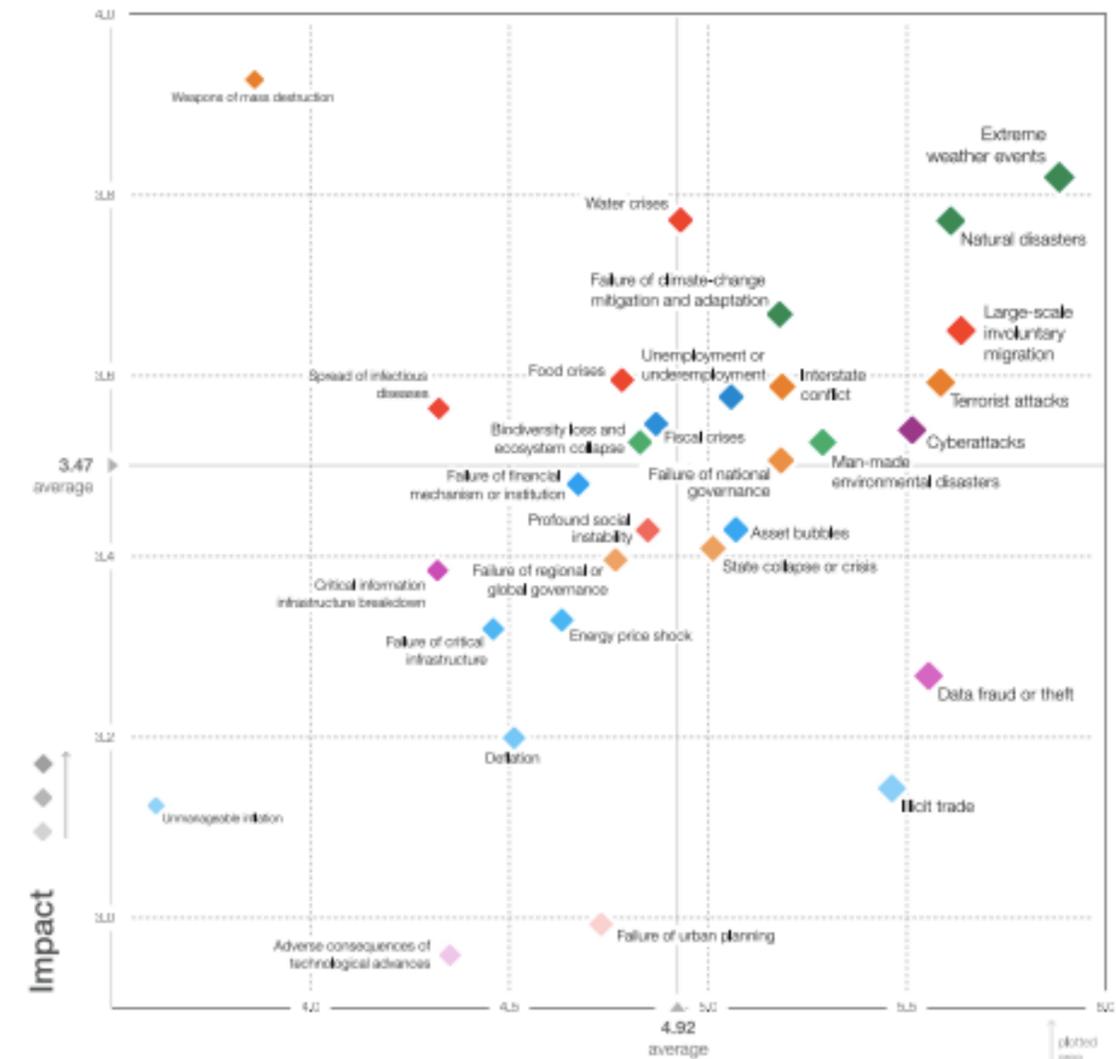
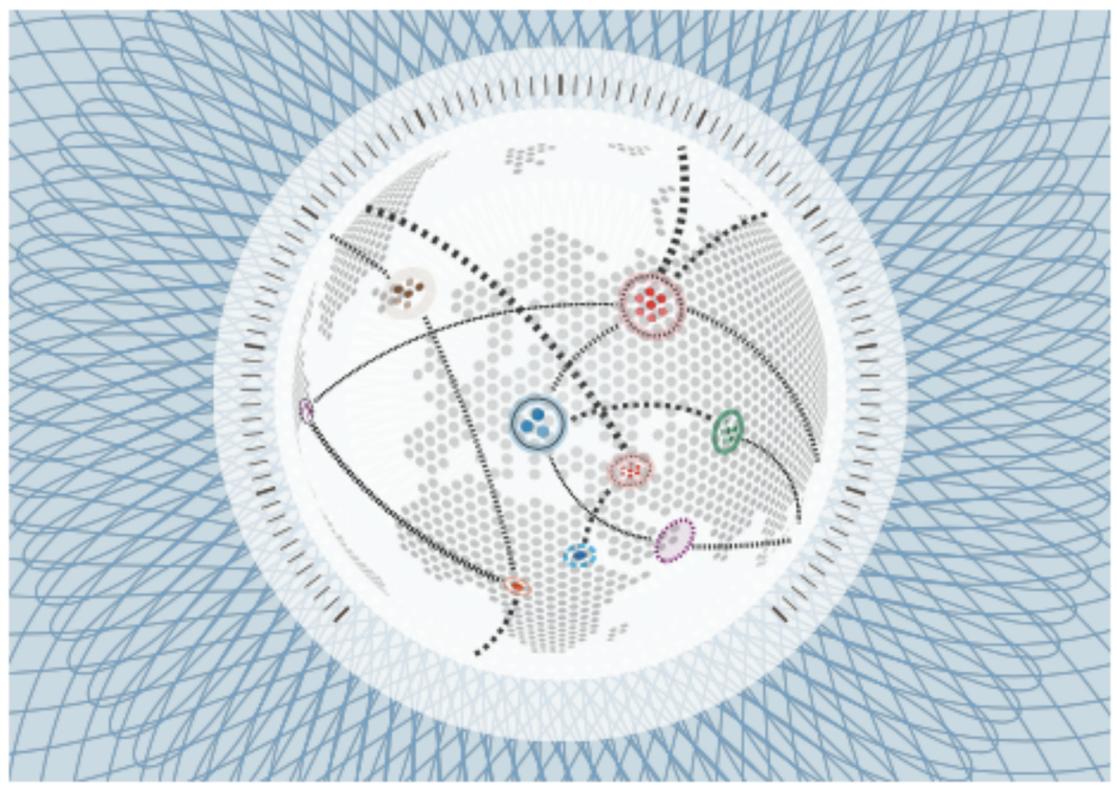
## The Global Risks Report 2017 12th Edition





Insight Report

## The Global Risks Report 2017 12th Edition



### Top 10 risks in terms of Likelihood

- ◆ Extreme weather events
- ◆ Large-scale involuntary migration
- ◆ Natural disasters
- ◆ Terrorist attacks
- ◆ Data fraud or theft
- ◆ Cyberattacks
- ◆ Illicit trade
- ◆ Man-made environmental disasters
- ◆ Interstate conflict
- ◆ Failure of national governance

### Top 10 risks in terms of Impact

- ◆ Weapons of mass destruction
- ◆ Extreme weather events
- ◆ Water crises
- ◆ Natural disasters
- ◆ Failure of climate-change mitigation and adaptation
- ◆ Large-scale involuntary migration
- ◆ Food crises
- ◆ Terrorist attacks
- ◆ Interstate conflict
- ◆ Unemployment or underemployment

### Categories

- ◆ Economic
- ◆ Environmental
- ◆ Geopolitical
- ◆ Societal
- ◆ Technological

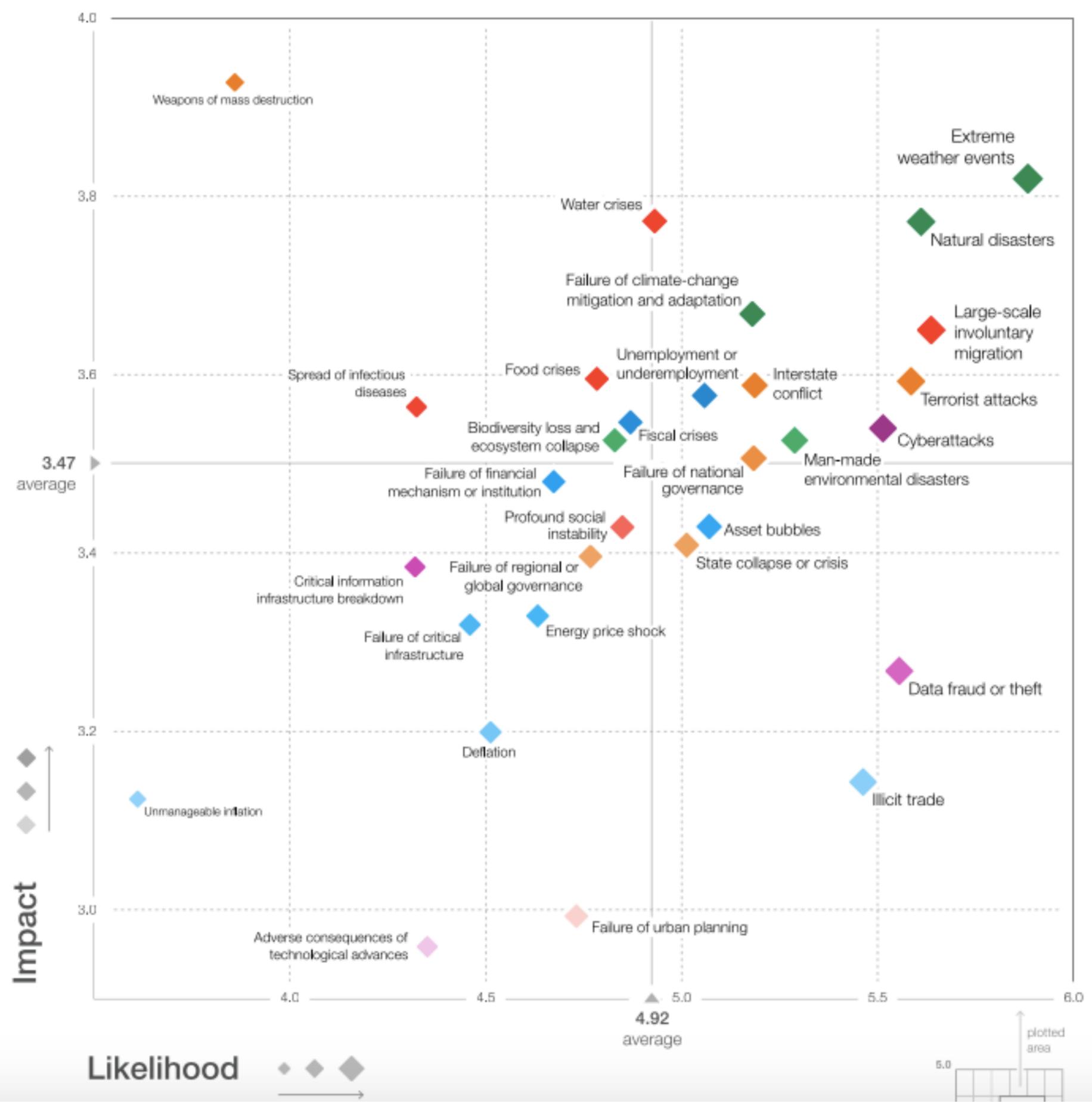
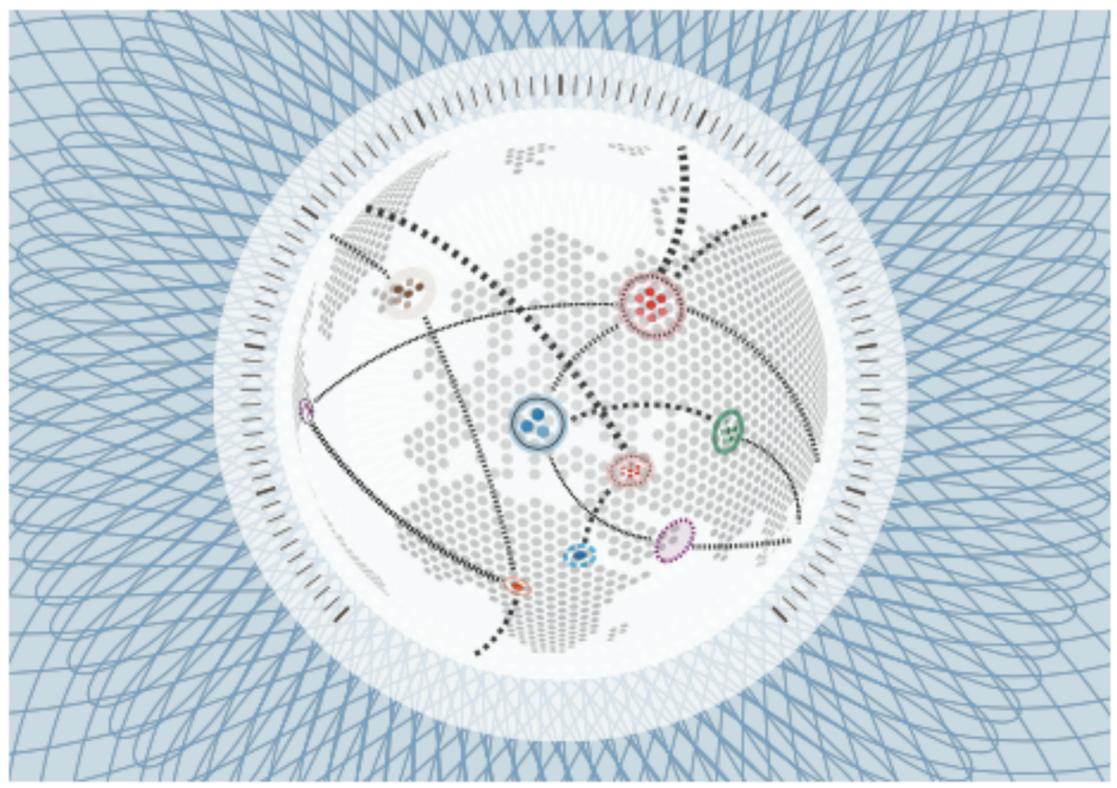
Source: World Economic Forum Global Risks Perception Survey 2016  
 Note: Survey respondents were asked to assess the likelihood of the individual global risk on a scale of 1 to 7, 1 representing a risk that is not likely to happen and 7 a risk that is very likely to occur. They also assess the impact 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.

# Prognosis



Insight Report

## The Global Risks Report 2017 12th Edition



**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

IT IS TWO AND A HALF MINUTES TO MIDNIGHT<sup>®</sup>



**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.

# The Therapy: Life Style Changes

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Role of Ethics, Moral, Social and Economic Rules

Role of Ethics, Moral, Social and Economic Rules



The current mainstream model of the global economy is based on a number of assumptions about the way the world works, what the economy is, and what the economy is for. (See Table 11– 1.) These assumptions arose in an earlier period, when the world was relatively empty of humans and their artifacts. Built capital was the limiting factor, while natural capital was abundant. It made sense not to worry too much about environmental “externalities,” since they could be assumed to be relatively small and ultimately solvable. It also made sense to focus on the growth of the market economy, as measured by gross domestic product (GDP), as a primary means to improve human welfare. And it made sense to think of the economy as only marketed goods and services and to think of the goal as increasing the amount of these that were produced and consumed.

Costanza et al., 2013

# Sustainability and Economy

The current mainstream model of the global economy is based on a number of assumptions about the way the world works, what the economy is, and what the economy is for. (See Table 11– 1.) These assumptions arose in an earlier period, when the world was relatively empty of humans and their artifacts. Built capital was the limiting factor, while natural capital was abundant. It made sense not to worry too much about environmental “externalities,” since they could be assumed to be relatively small and ultimately self-correcting. It also made sense to focus on the growth of the market economy, as measured by Gross Domestic Product (GDP), as a primary means to improve human welfare. And it made sense to focus only on marketed goods and services and to think of the goal as increasing the total value of what were produced and consumed.

Primary goal is economic growth,  
primary measure Gross Domestic  
Product (GDP)

Costanza et al., 2013

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Costanza et al., 2013

*Our economic model is at war with life on Earth. We can't change the laws of nature, but we can change our broken economy. And that's why climate change isn't just a disaster. It's also our best chance to demand—and build—a better world. Change or be changed. But make no mistake... this changes everything.*

Naomi Klein, 2013

ON THE  
**EDGE**<sup>o</sup>

## Safeguarding Our Life Support System

OVERCOMING THE “IMMUTABLE TRUTH” OF GROWTH  
BEING NECESSARY FOR A THRIVING ECONOMY

IN EARLIER COLUMNS, I MADE REFERENCE TO a new definition for sustainable development: a development that meets our needs while safeguarding the Earth's life support system on which we and all future generations depend. Safeguarding our life support system (LSS) seems logical and to be something we all should be eager and able to agree upon.



Prof. Hans-Peter Plag, PhD

Mitigation and Adaptation  
Research Institute

Old Dominion University

Norfolk, Va.

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Prof. Hans-Peter Plag, PhD

Mitigation and Adaptation  
Research Institute

Old Dominion University

Norfolk, Va.

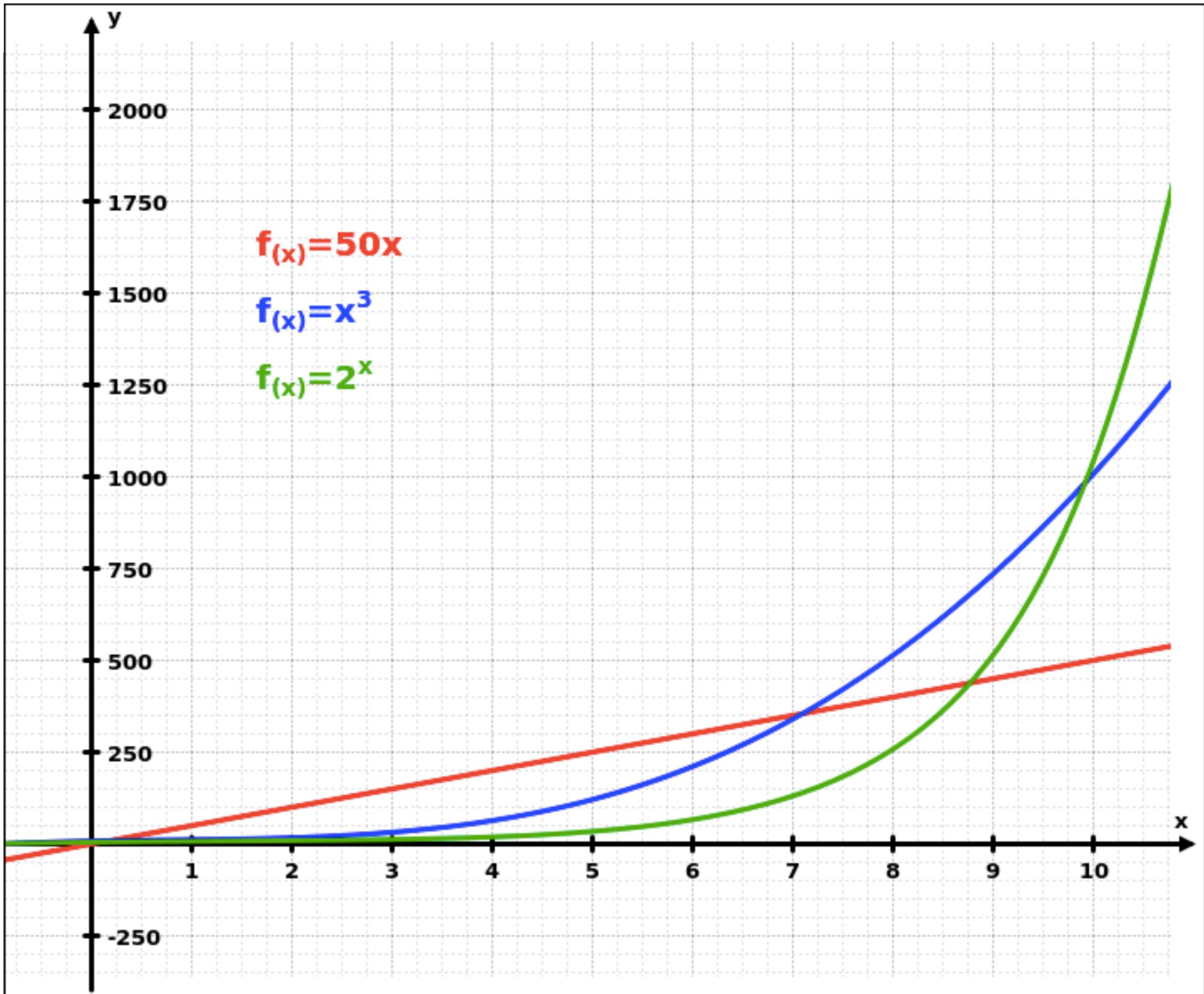
[www.mari.odu.edu](http://www.mari.odu.edu)

ON THE **EDGE**<sup>o</sup>

## Safeguarding Our Life Support System

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IN EARLIER COLUMNS, I MADE REFERENCE TO a new definition for sustainable development: a development that meets our needs while safeguarding the Earth's life support system on which we and all future generations depend. Safeguarding our life support system (LSS) seems logical and to be something we all should be eager and able to agree upon.



## Guarding Our Life Support System

“SUSTAINABLE TRUTH” OF GROWTH  
NECESSARY FOR A THRIVING ECONOMY

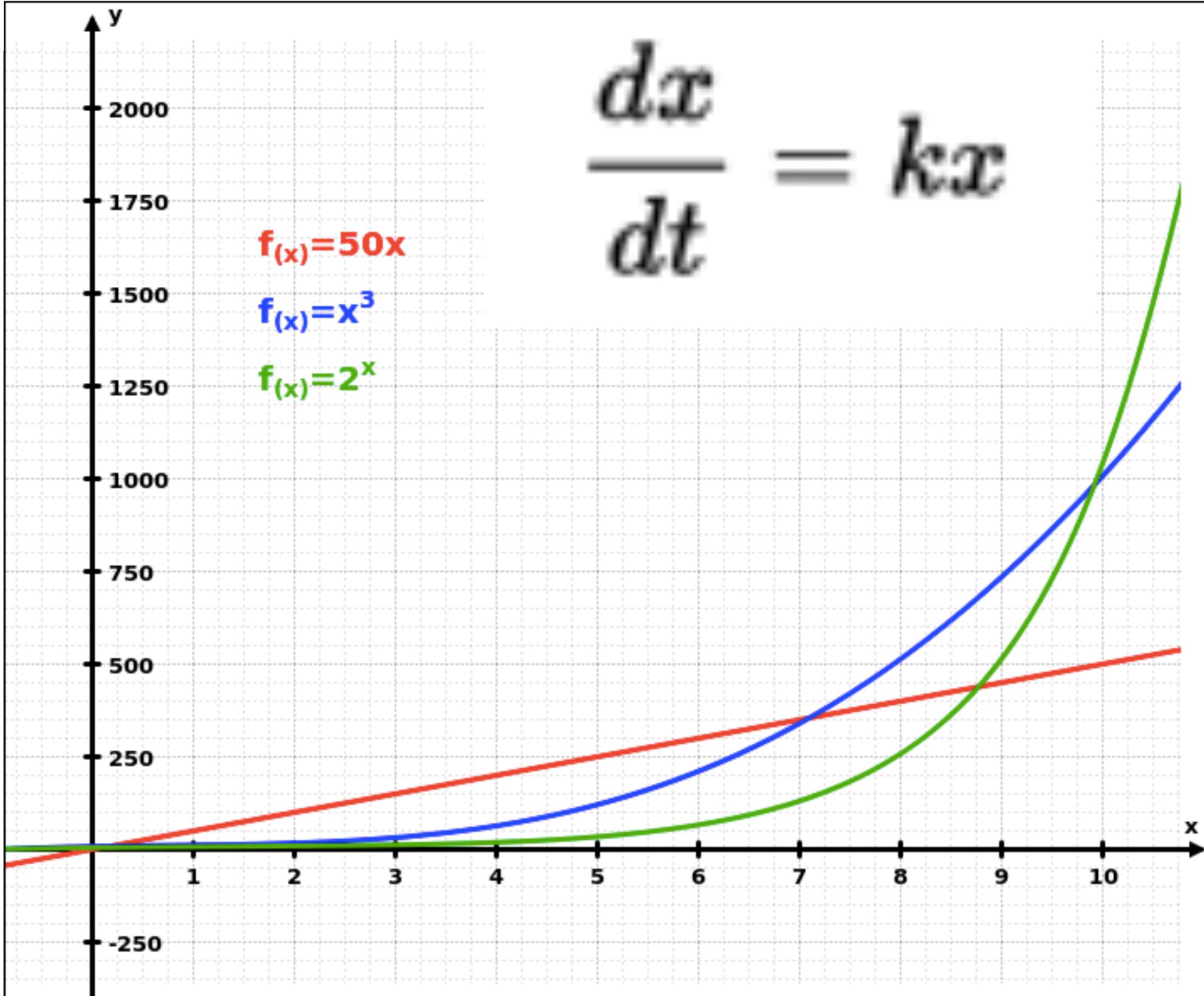
Develop a new definition for sustainable development that safeguards the Earth's life support system on the basis of the precautionary principle. Safeguarding our life support system (LSS) seems to be a goal that all nations can and should agree upon.

$$\frac{dx}{dt} = kx$$

$$f(x) = 50x$$

$$f(x) = x^3$$

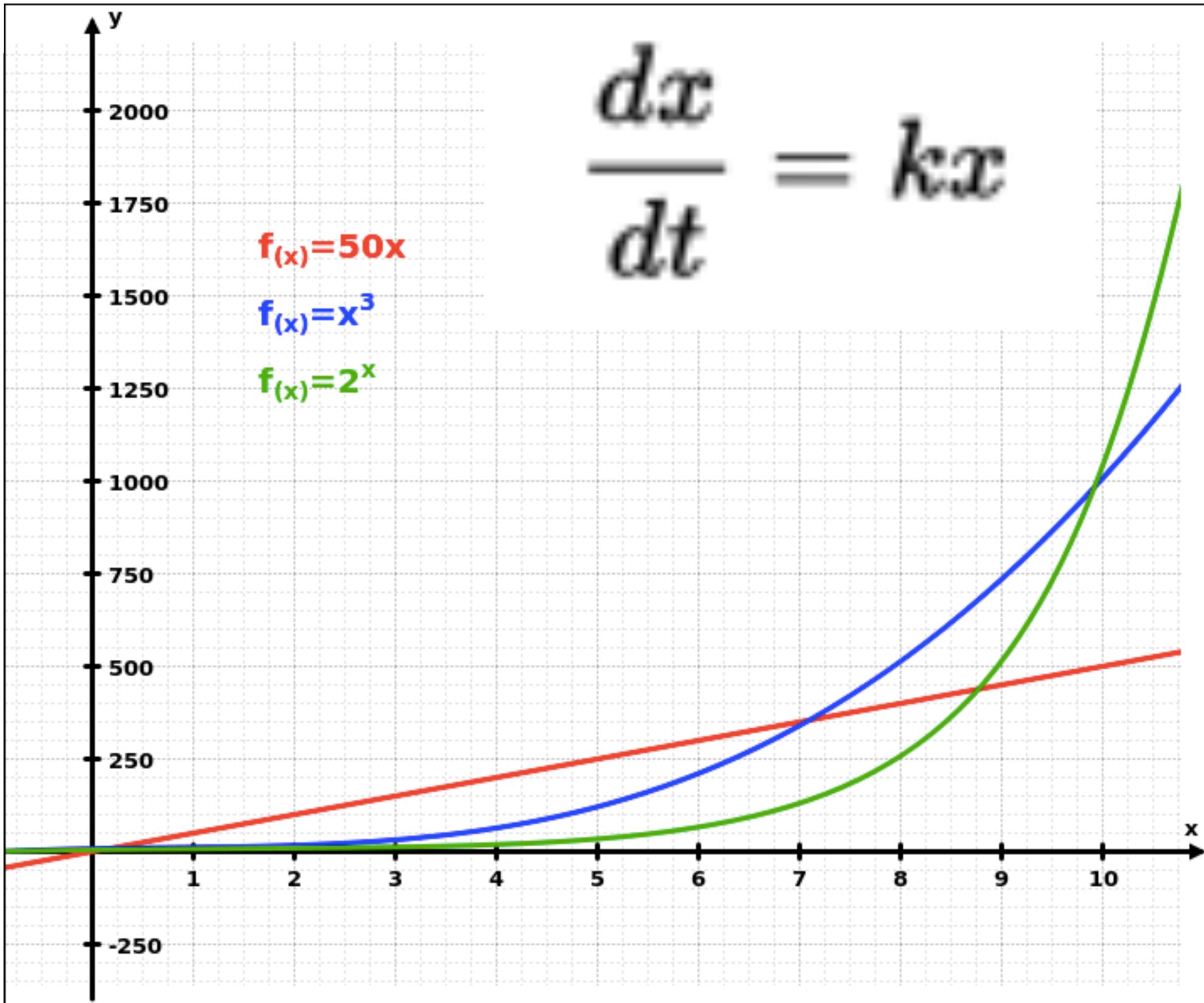
$$f(x) = 2^x$$



## Guarding Our Port System

“UNTABLE TRUTH” OF GROWTH  
FOR A THRIVING ECONOMY

And a new definition for sustainable development—safeguarding the Earth’s life support system on guarding our life support system (LSS) seems and able to agree upon.



$$\frac{dx}{dt} = kx$$

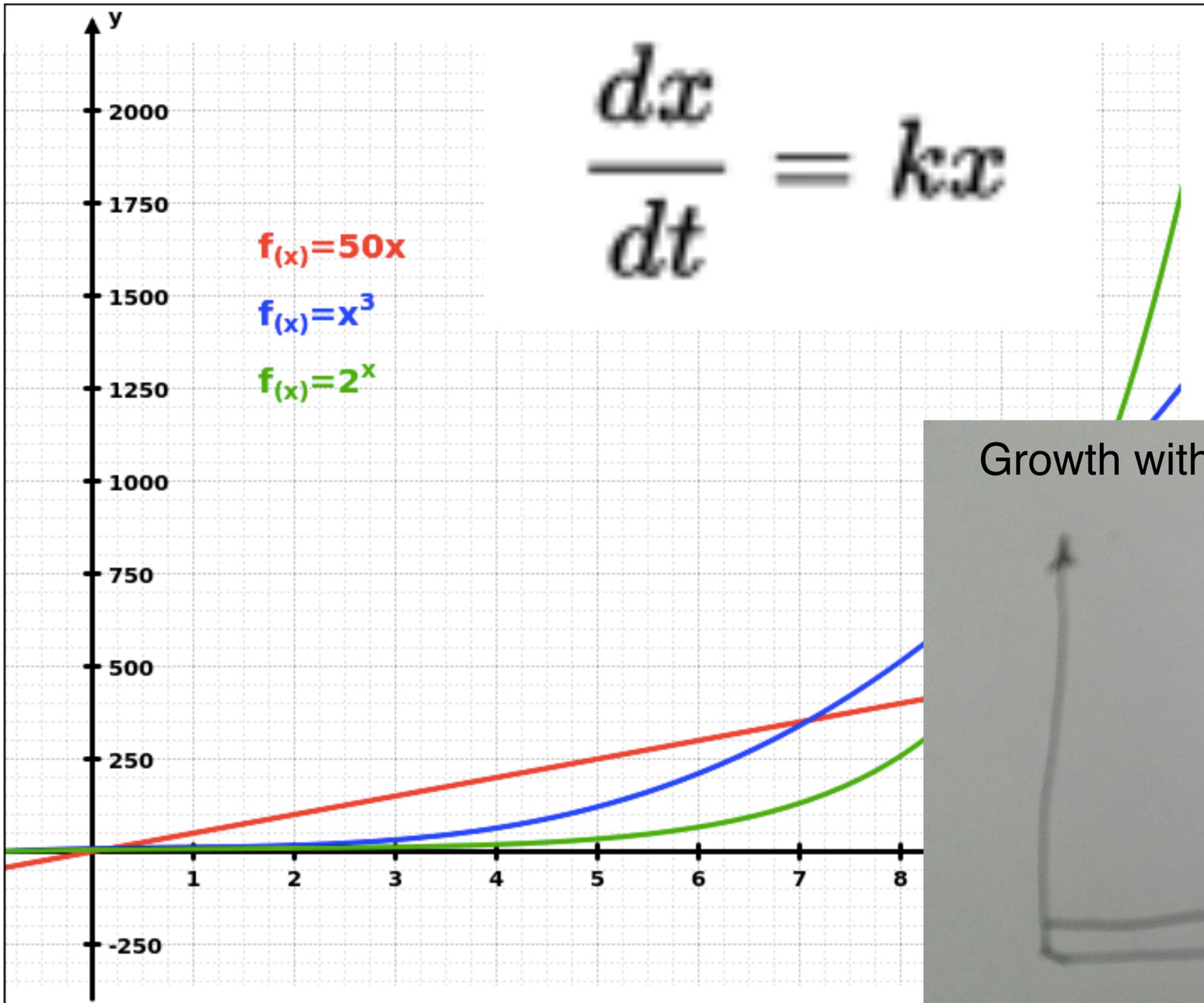
Geoffrey West:

- If  $k > 0$ , growth will eventually exceed the capacity of the system to sustain the growth.
- To change this, offsets are needed, i.e., innovation.
- Innovations have to come at increasing speed
- 

...aining our  
port System

UTABLE TRUTH" OF GROWTH  
Y FOR A THRIVING ECONOMY

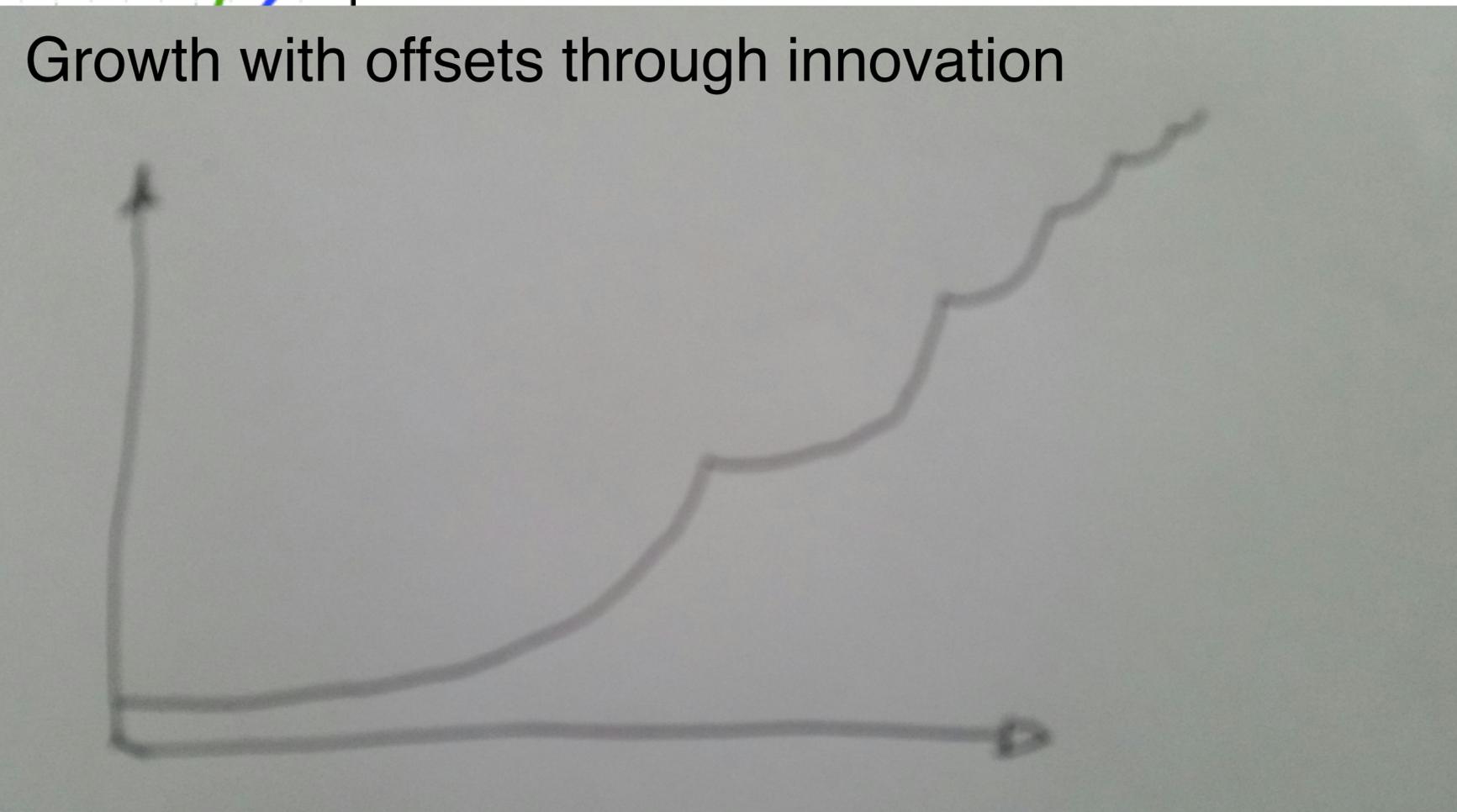
... a new definition for sustainable develop-  
... safeguarding the Earth's life support system on  
... uarding our life support system (LSS) seems  
... and able to agree upon.



$$\frac{dx}{dt} = kx$$

Geoffrey West:

- If  $k > 0$ , growth will eventually exceed the capacity of the system to sustain the growth.
- To change this, offsets are needed, i.e., innovation.
- Innovations have to come at increasing speed



ON THE  
**EDGE**<sup>o</sup>

## Safeguarding Our Life Support System

OVERCOMING THE “IMMUTABLE TRUTH” OF GROWTH  
BEING NECESSARY FOR A THRIVING ECONOMY

IN EARLIER COLUMNS, I MADE REFERENCE TO a new definition for sustainable development: a development that meets our needs while safeguarding the Earth's life support system on which we and all future generations depend. Safeguarding our life support system (LSS) seems logical and to be something we all should be eager and able to agree upon.



Prof. Hans-Peter Plag, PhD

Mitigation and Adaptation  
Research Institute

Old Dominion University

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[www.mari.odu.edu](http://www.mari.odu.edu)

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**'Business as usual is not an option.'**

Oliver James, author of *Affluenza*

## PROSPERITY WITHOUT GROWTH

Economics for a  
Finite Planet

**TIM  
JACKSON**

WITH FOREWORDS BY  
HERMAN DALY, BILL MCKIBBEN,  
MARY ROBINSON & PAVAN SUKHDEV





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## Measuring Impartial Preference for Biodiversity

Yves Meinard <sup>a,b,\*</sup>, Alice Remy <sup>c</sup>, Bernhard Schmid <sup>d</sup>



<sup>a</sup> *Université Paris Dauphine, PSL Research University, CNRS, UMR7243, Place Lattre de Tassigny, F-75016 Paris, France*

<sup>b</sup> *GERECO, 30 avenue Leclerc, F-38217 Vienne, France*

<sup>c</sup> *Faculty of Applied Ecology and Agricultural Sciences, Hedmark University College, Anne Evendstadsvei 80, NO-2480 Koppang, Norway*

<sup>d</sup> *Department of Evolutionary Biology and Environmental Studies, University of Zurich, Winterthurerstrasse 190, CH-8057 Zurich, Switzerland*

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### ABSTRACT

Biodiversity undergoes unprecedented rates of erosion despite the important services it provides. This is considered evidence that biodiversity is undervalued. Biodiversity valuation is accordingly a prominent issue in the literature. Economic valuations are, however, largely criticized. Numerous alternatives have been introduced. Most of them involve participatory protocols aimed at producing high-quality results. Being time-consuming and expensive, it is difficult to implement and reproduce them at a large scale. We produce an easily reproducible, inexpensive survey methodology to measure impartial preference for biodiversity. We implement it in Switzerland through a mail-based survey. Our result is that biodiversity should be ranked after retirement schemes and public transportation, but before relations with foreign countries, order and security, and culture and leisure in the expanses of the State. Current expenses therefore substantially underestimate the value that Swiss people grant to biodiversity. Our new method is a viable alternative to standard economic valuation. Given the impartiality achieved, at least in the Swiss political context our estimate can be used by decision makers to assess the legitimacy of conservation programs or to gauge public support. At a philosophical level, our measure is relevant for public policies because it captures the stances that people take when they participate in public decisions.



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# The Therapy: Life Style Changes

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# The Therapy: Life Style Changes

Our task: enabling a transition to an economy for humanity:  
“An economy that meets our needs while safeguarding  
Earth’s life-support system, on which the welfare of current  
and future generations depends.”



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Enabling prosperity, security:

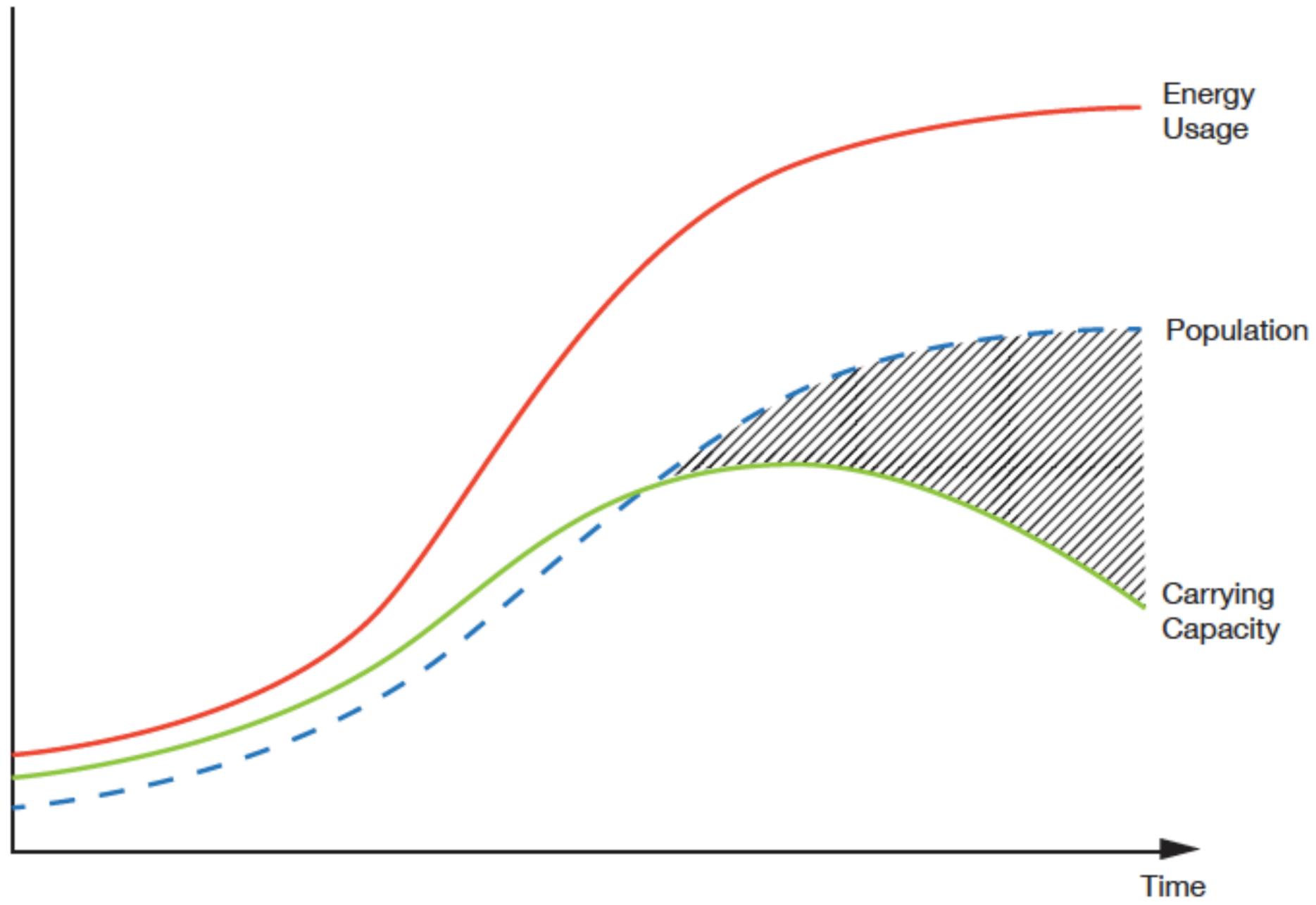
- without growth
- with more equality

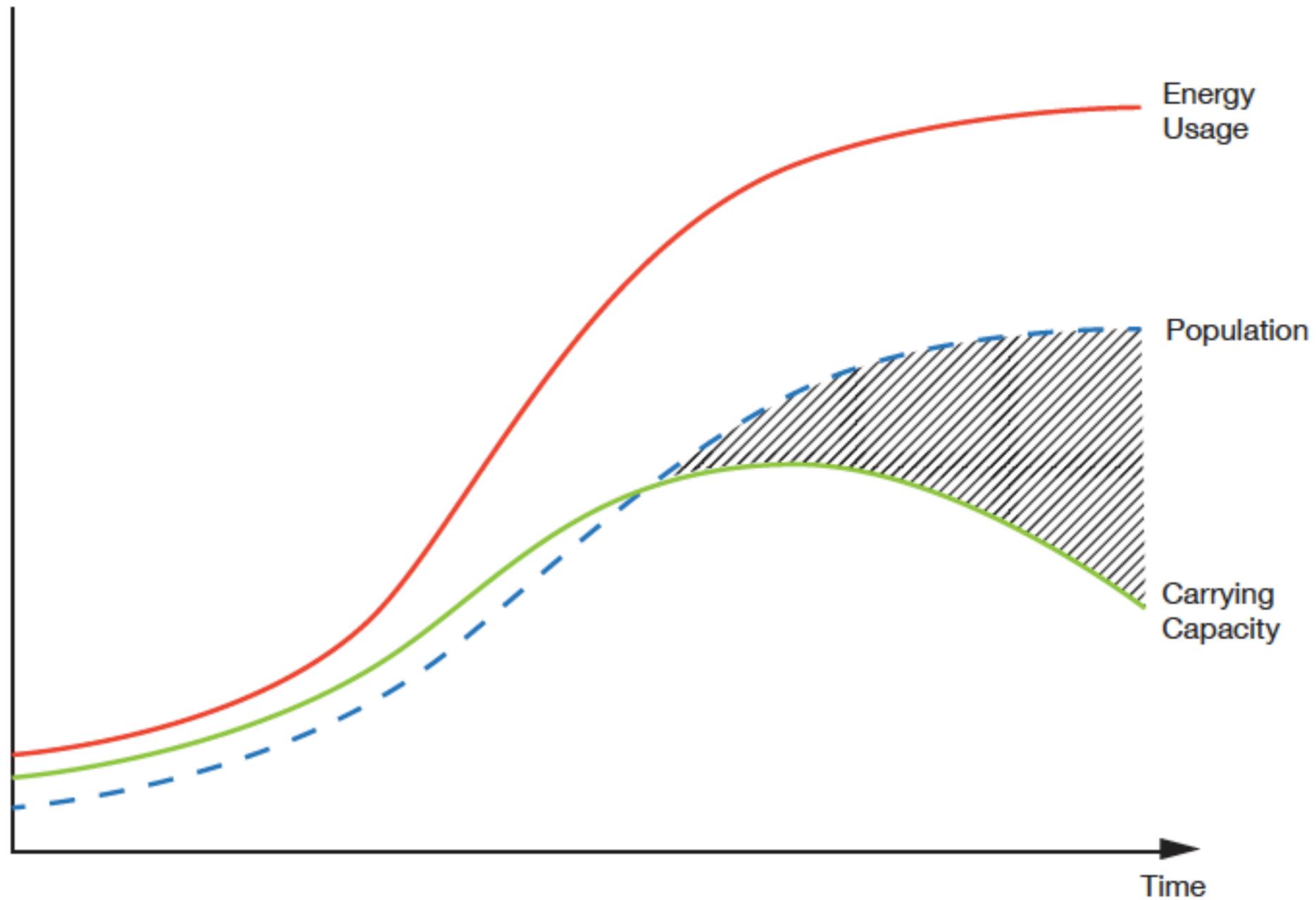


Role of Ethics, Moral, Social and Economic Rules

Role of Ethics, Moral, Social and Economic Rules

# The Therapy: Life Style Changes





Carrying Capacity = function of: Arable Land, Nitrogen, Phosphorous, Climate, Water, Biodiversity, Land Use, Energy, Degradation, Technology, ...

$$CC = f(A, N, P, C, W, B, L, E, D, T, \dots)$$

$$C = f(E, L, \dots)$$

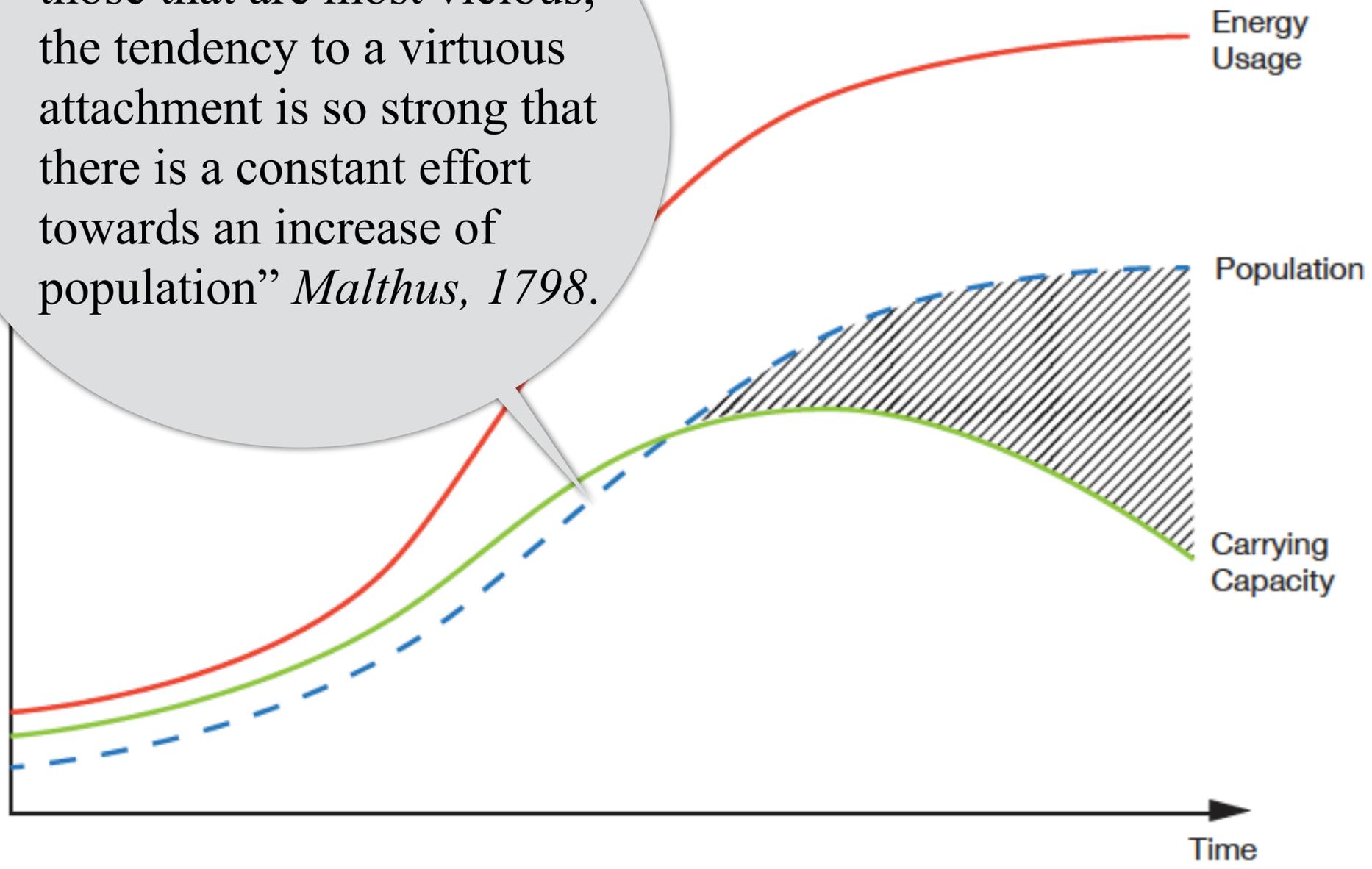
$$W = f(C, L, E, D, \dots)$$

$$N, P = f(E)$$

$$B = f(C, W, L, D, \dots)$$

# The Therapy: Life Style Changes

"Yet in all societies, even those that are most vicious, the tendency to a virtuous attachment is so strong that there is a constant effort towards an increase of population" *Malthus, 1798.*



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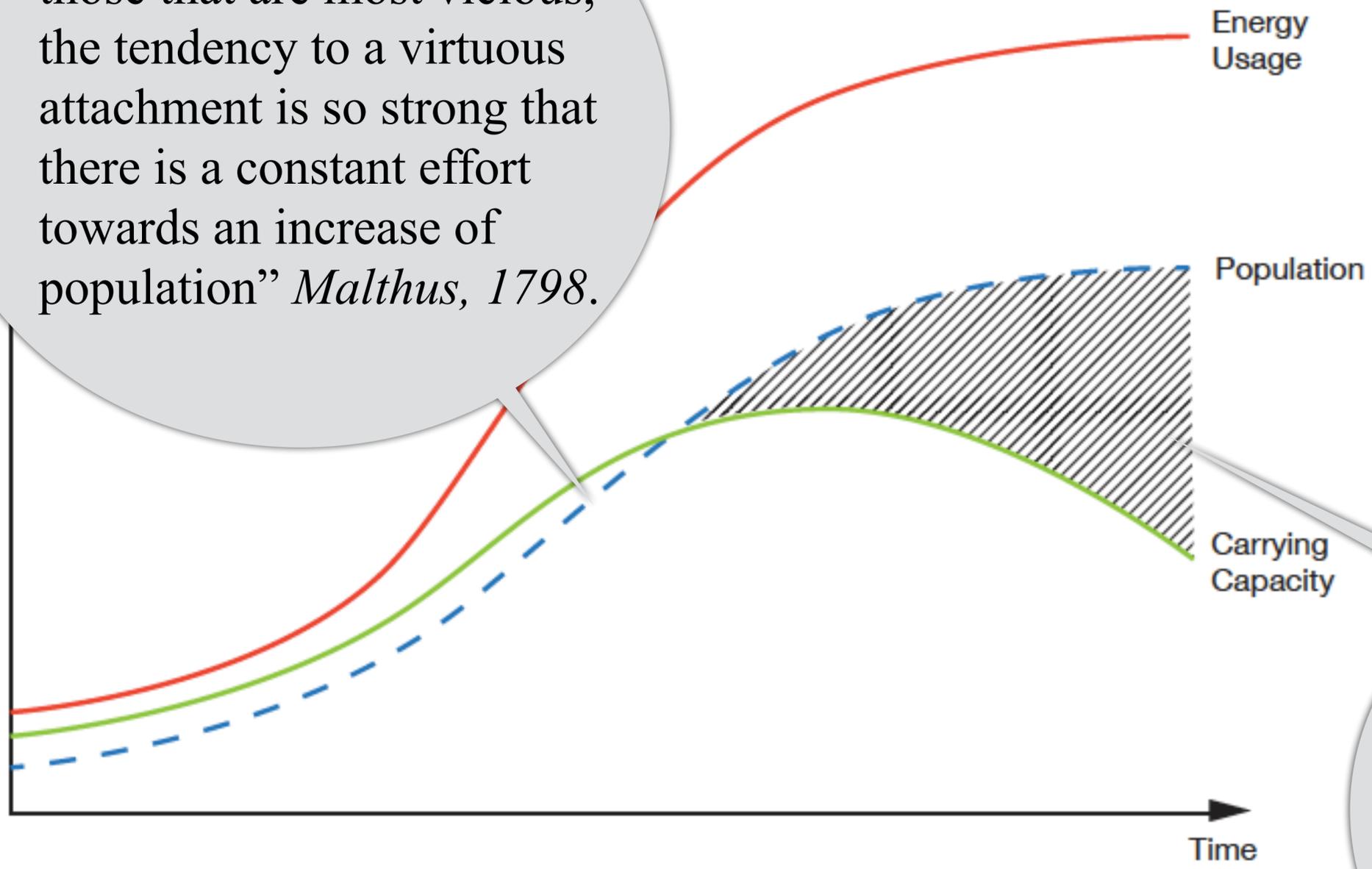
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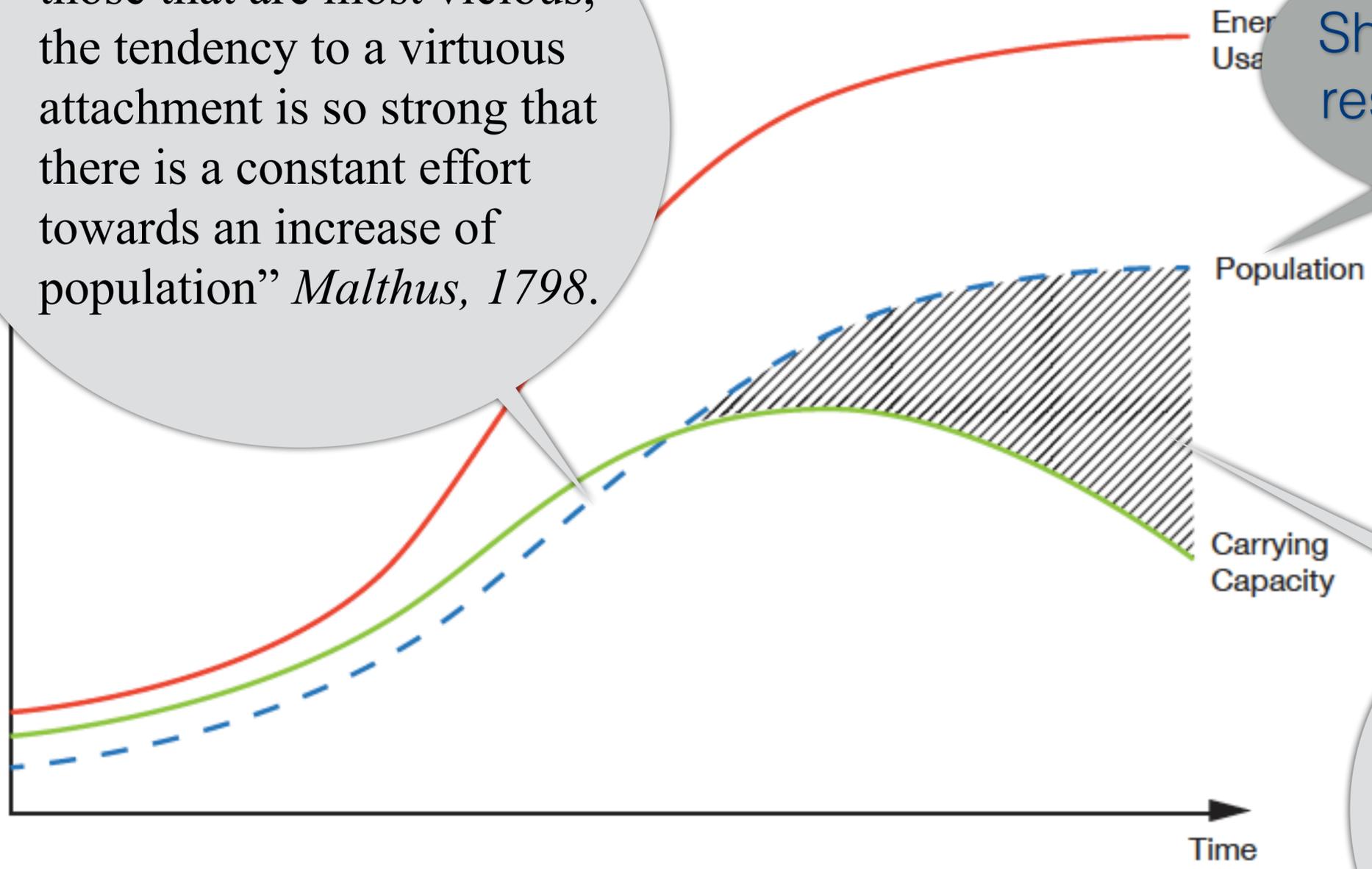
$$W = f(C, \dots)$$

"That the increase of population is necessarily limited by the means of subsistence, That population does invariably increase when the means of subsistence increase, and, That the superior power of population is repressed, and the actual population kept equal to the means of subsistence, **by misery and vice.**"

*Malthus, 1798.*

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"Yet in all societies, even those that are most vicious, the tendency to a virtuous attachment is so strong that there is a constant effort towards an increase of population" *Malthus, 1798.*



Should be multiplied by the function of: Arable resource usage per person and Use, Energy, Technology, ...

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$$C = f(E, L, \dots)$$

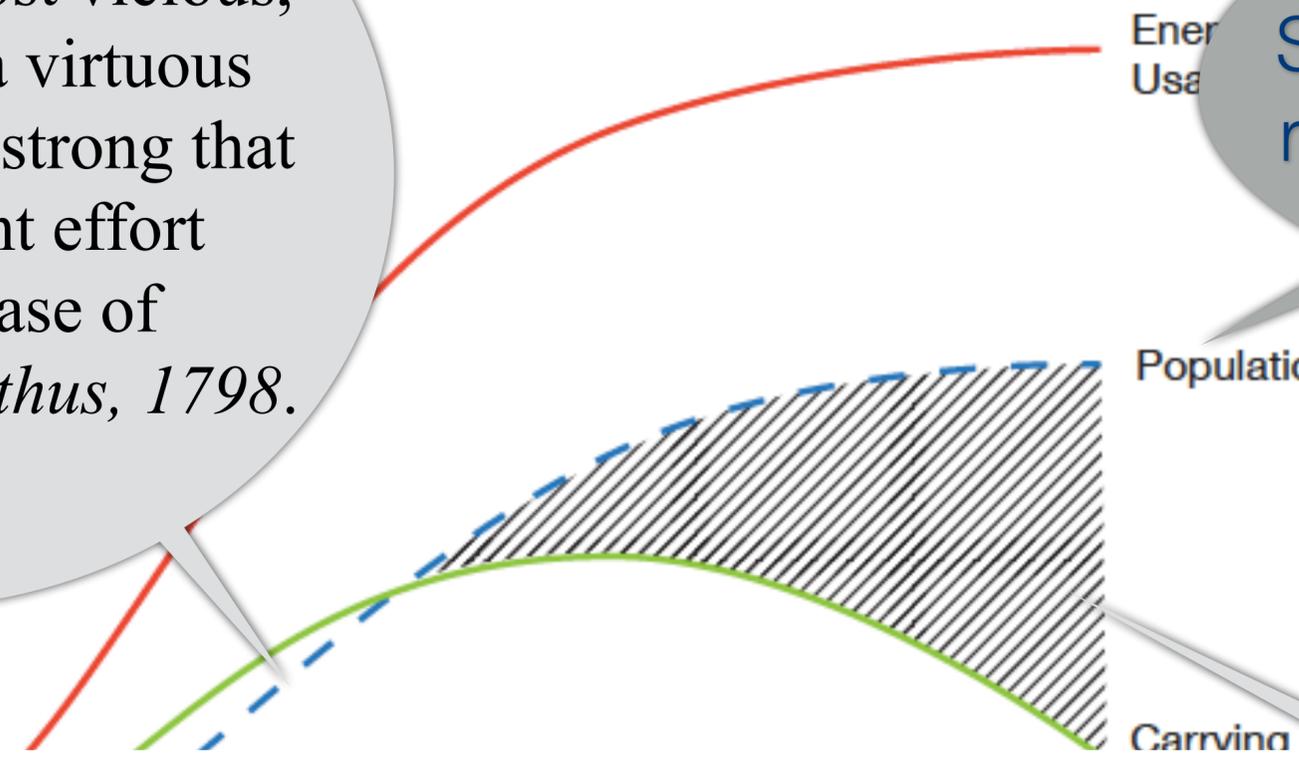
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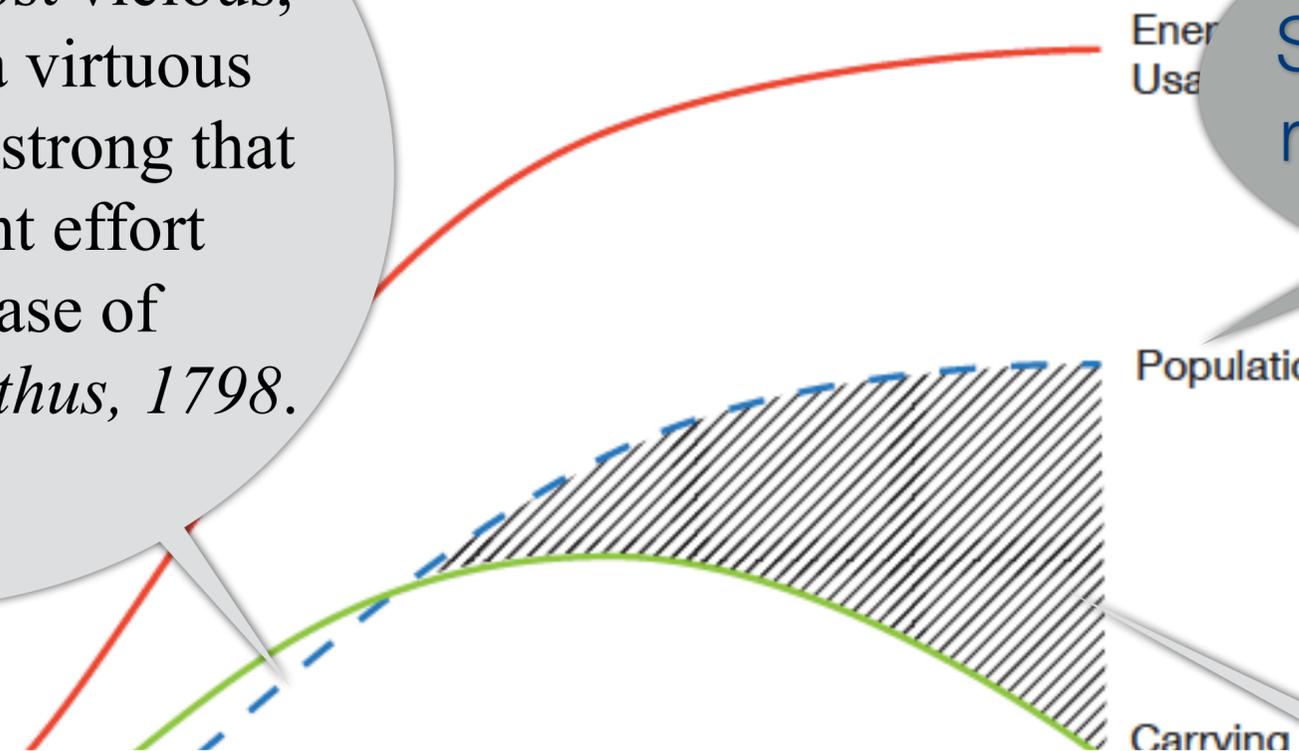
31 October 2011: The day we "celebrated" the 7-billionth baby I wrote a blog on "Crime against humanity":

$$C(t) = (N(t) - N(t_0)) * L$$

- C: crime
- t: time
- t<sub>0</sub>: arbitrary time origin
- N: number of people in the country under consideration
- L: average use of resources per person in the country

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Should be resource u

$$CC = T$$

$$C = f(L)$$

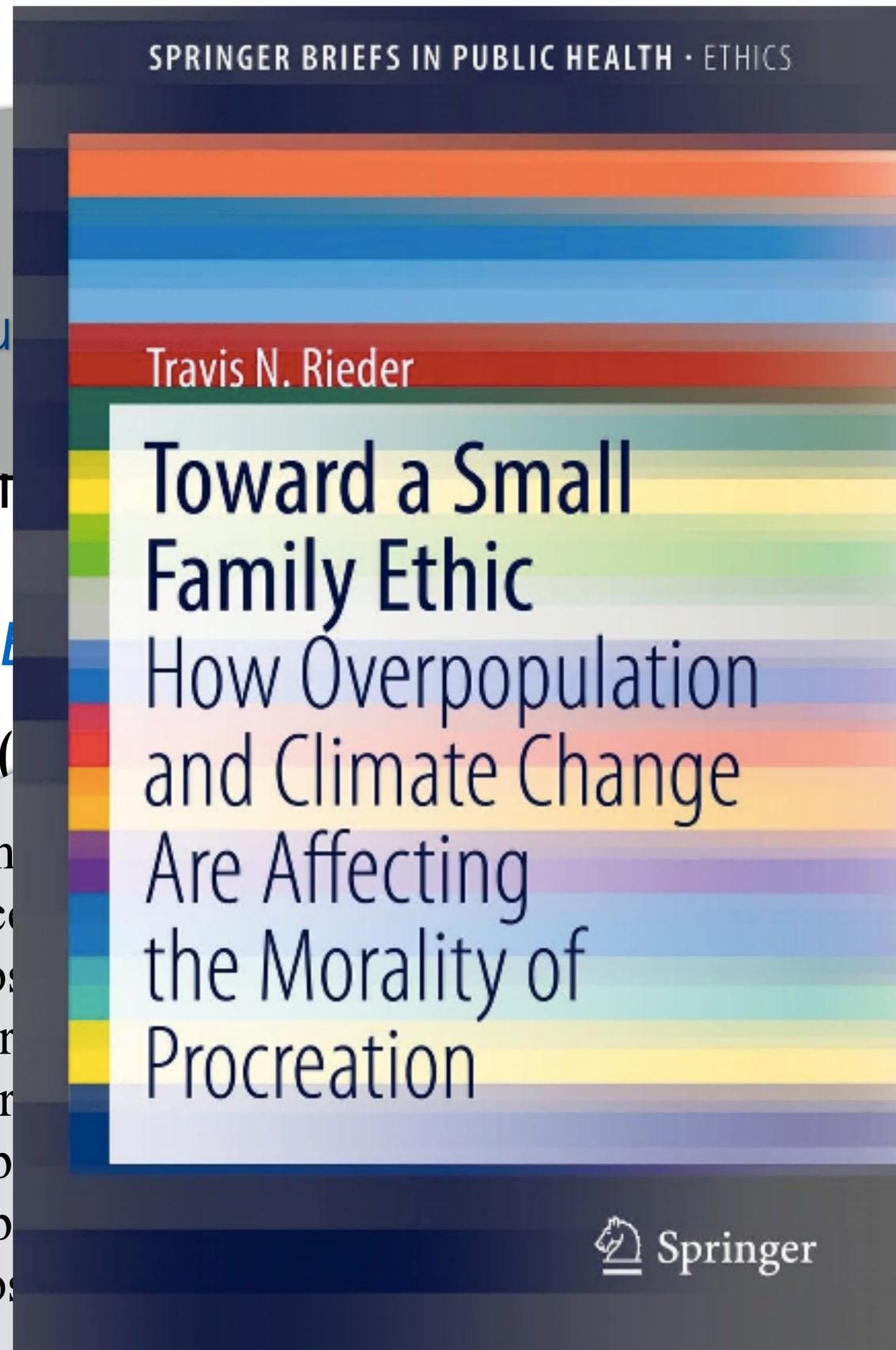
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"The  
nec  
subs  
incr  
incr  
pop  
pop  
subs



# The Therapy: Life Style Changes

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As [Pope Francis](#) puts it in his ecological teaching document, *Laudato Si'*: “To blame population growth instead of extreme and selective consumerism on the part of some, is one way of refusing to face the issues. It is an attempt to legitimise the present model of distribution, where a minority believes that it has the right to consume in a way which can never be universalised, since the planet could not even contain the waste products of such consumption.”

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## Pope Francis says destroying the environment is a sin

Pontiff says humans are turning planet into 'wasteland full of debris, desolation and filth' in call for urgent action on climate change



📷 Pope Francis welcomes the Paris accord but suggests voters might need to take additional action to ensure their governments do not backtrack on the deal. Photograph: Galazka/Sipa/Rex Shutterstock

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September 1, 2016: He called for care for the environment to be added to the seven spiritual works of mercy outlined in the Gospel that the faithful are asked to perform throughout the pope’s year of mercy in 2016.

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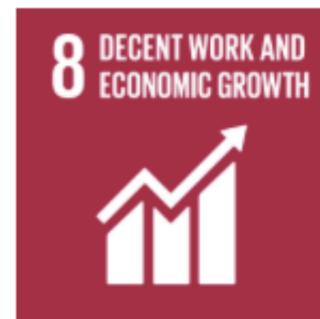
# The Therapy: Life Style Changes

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What are the governments doing?



# SUSTAINABLE DEVELOPMENT GOALS



## SUSTAINABLE DEVELOPMENT GOALS

SDGs and the Agenda 2030 are intended as our "Road to Dignity," and we are on this road together.



## SUSTAINABLE DEVELOPMENT GOALS

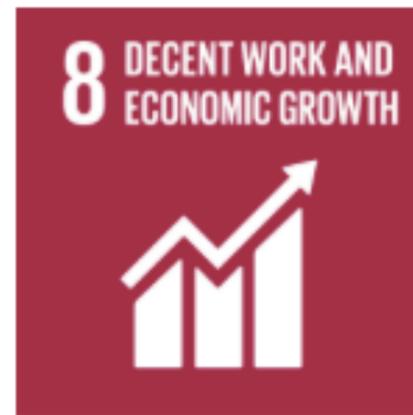
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Instead of being technology and science-driven, the Earth observation and science communities need to be problem-driven and part of the process.

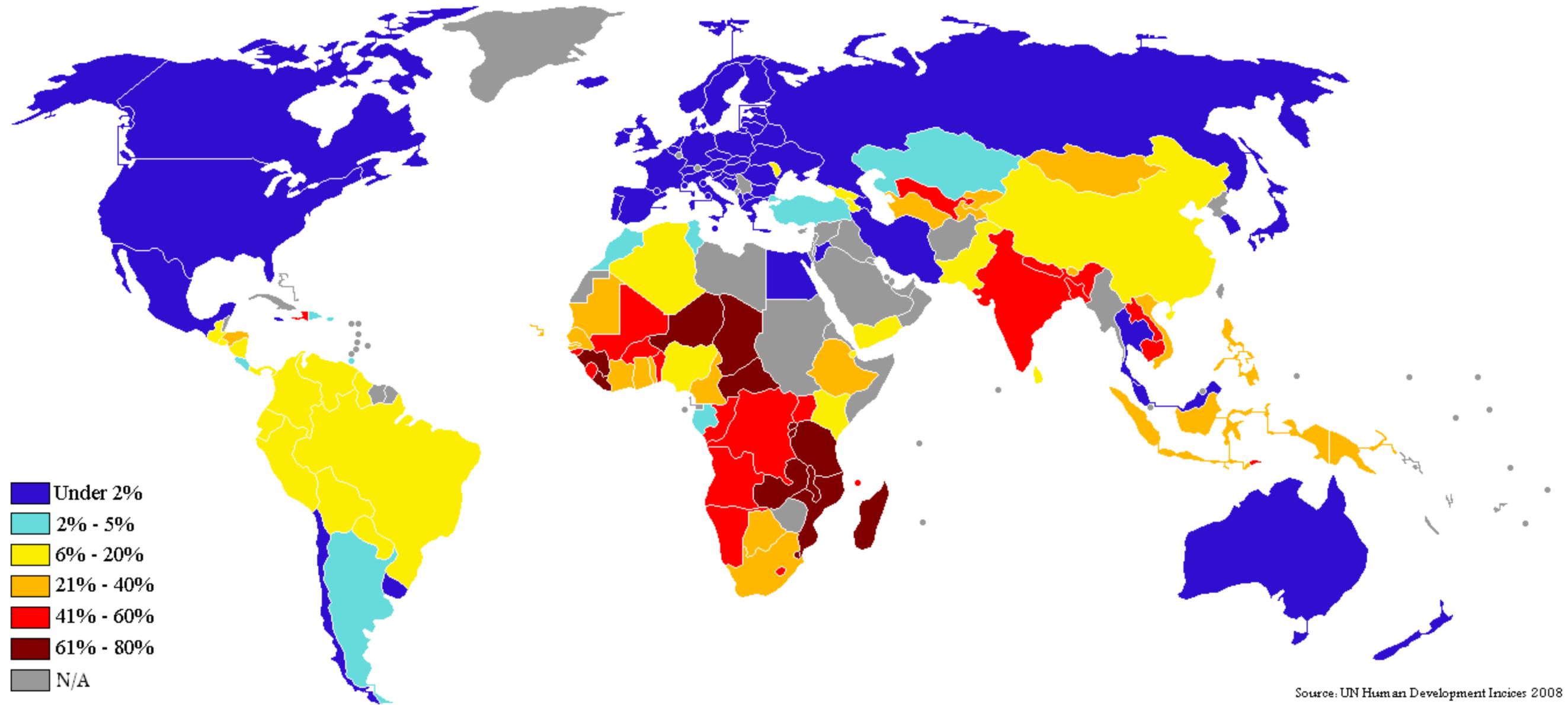


# Agenda 2030: "The Road to Dignity"





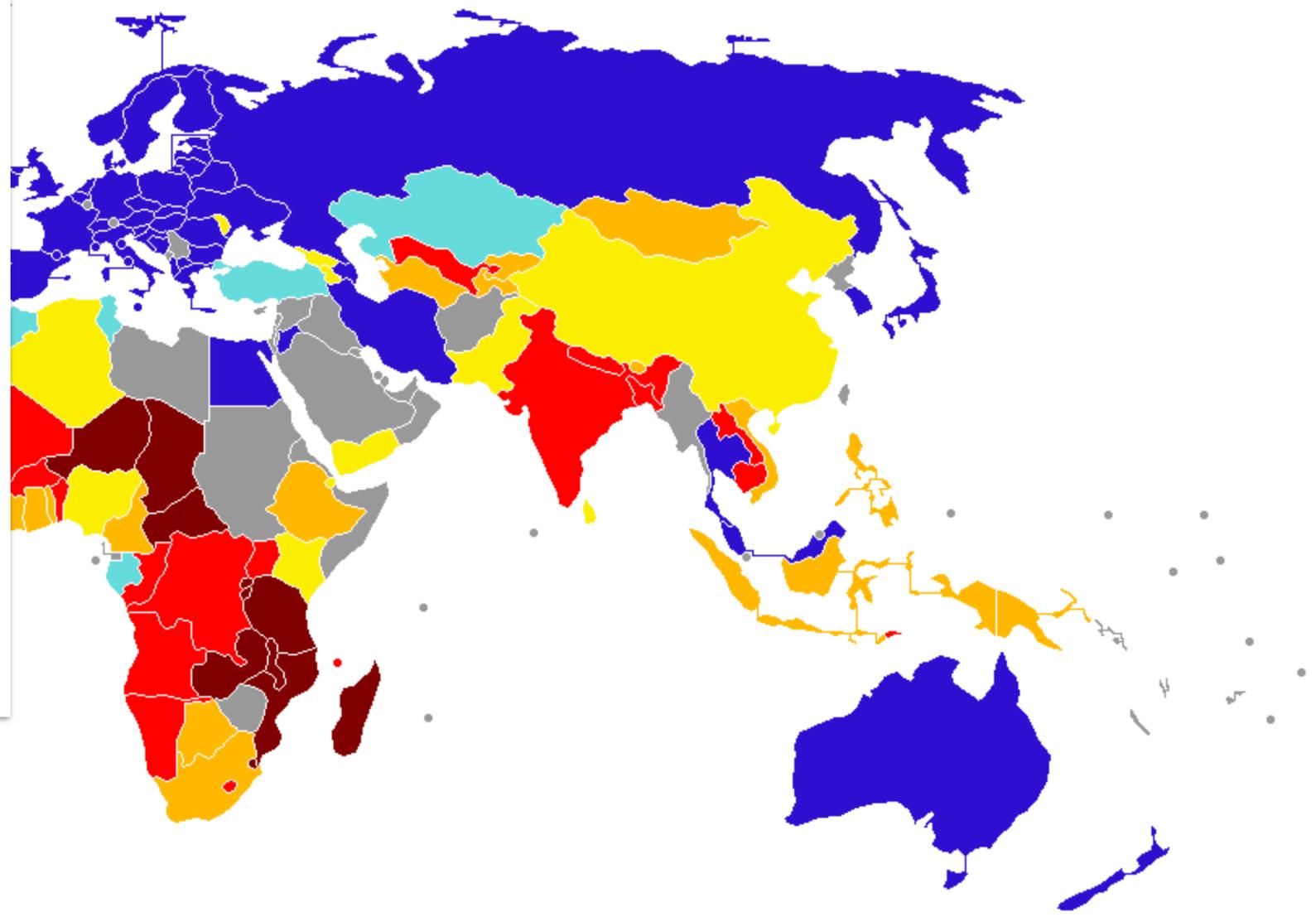
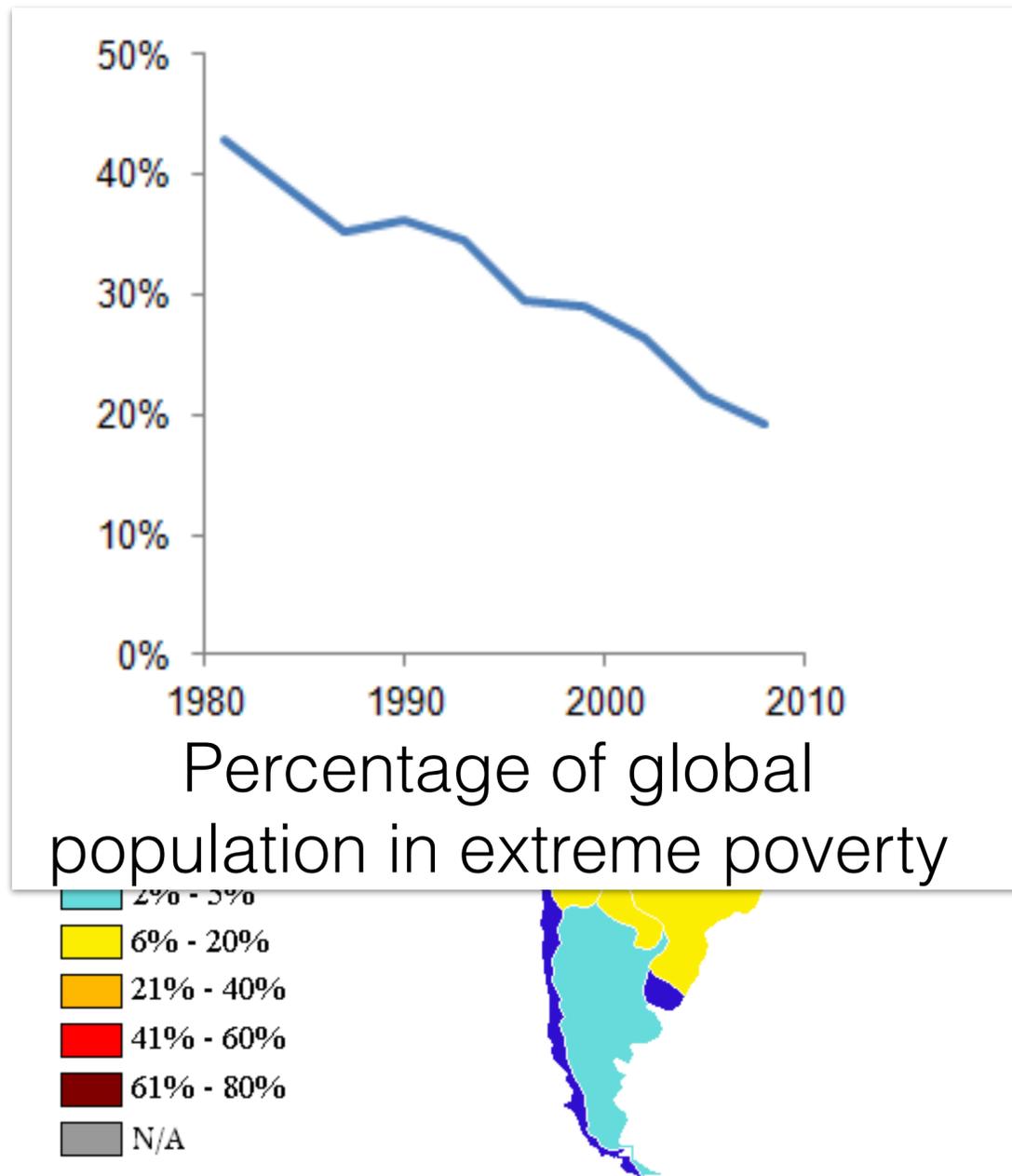
The SDGs are about real-world problems, about people suffering, ...



Percentage of population living on less than \$1 a day (2008-2009), UN Human Development Index, 2008

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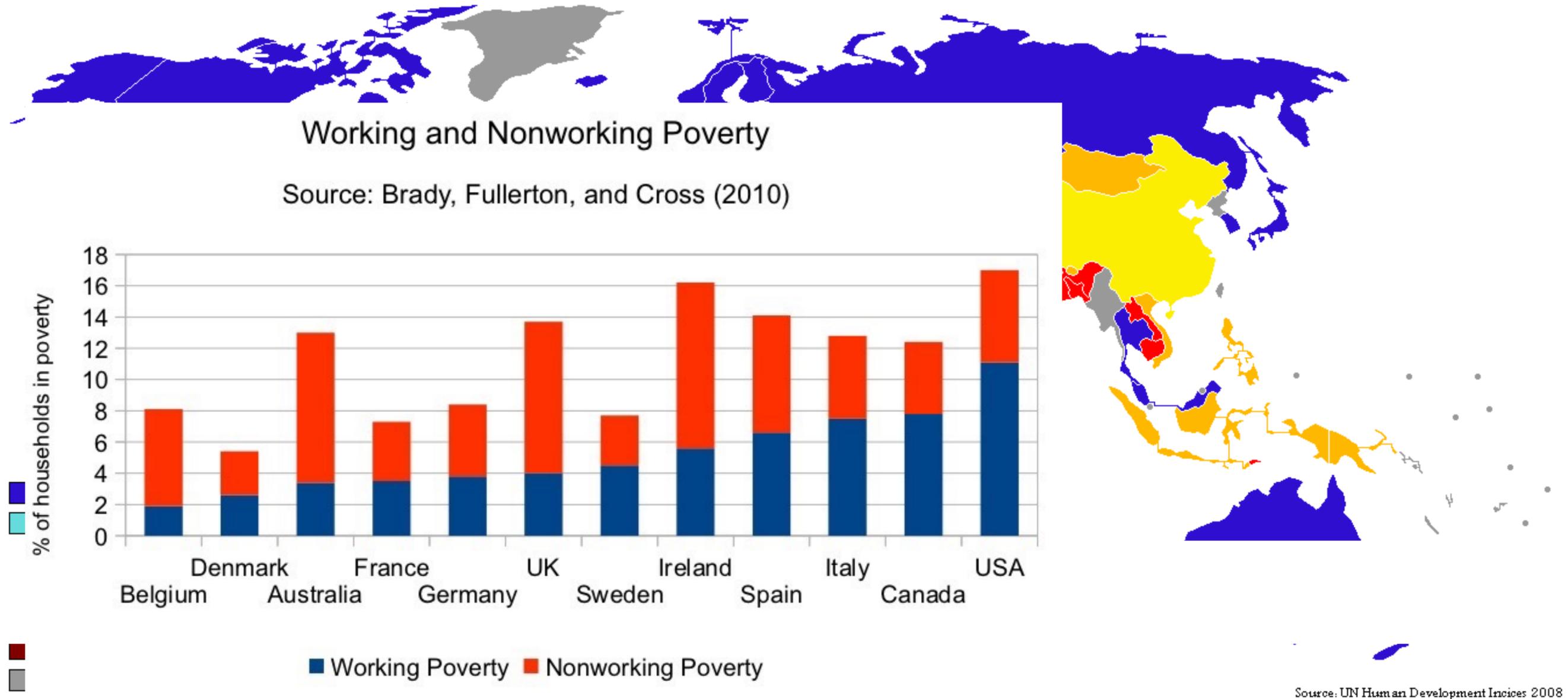


Source: UN Human Development Indices 2008

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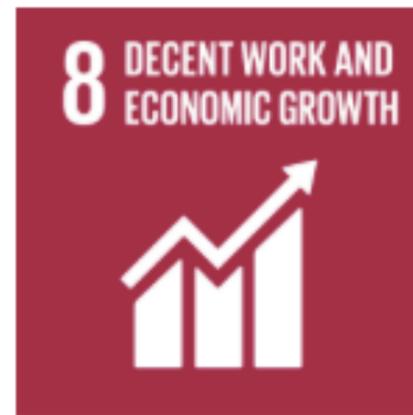
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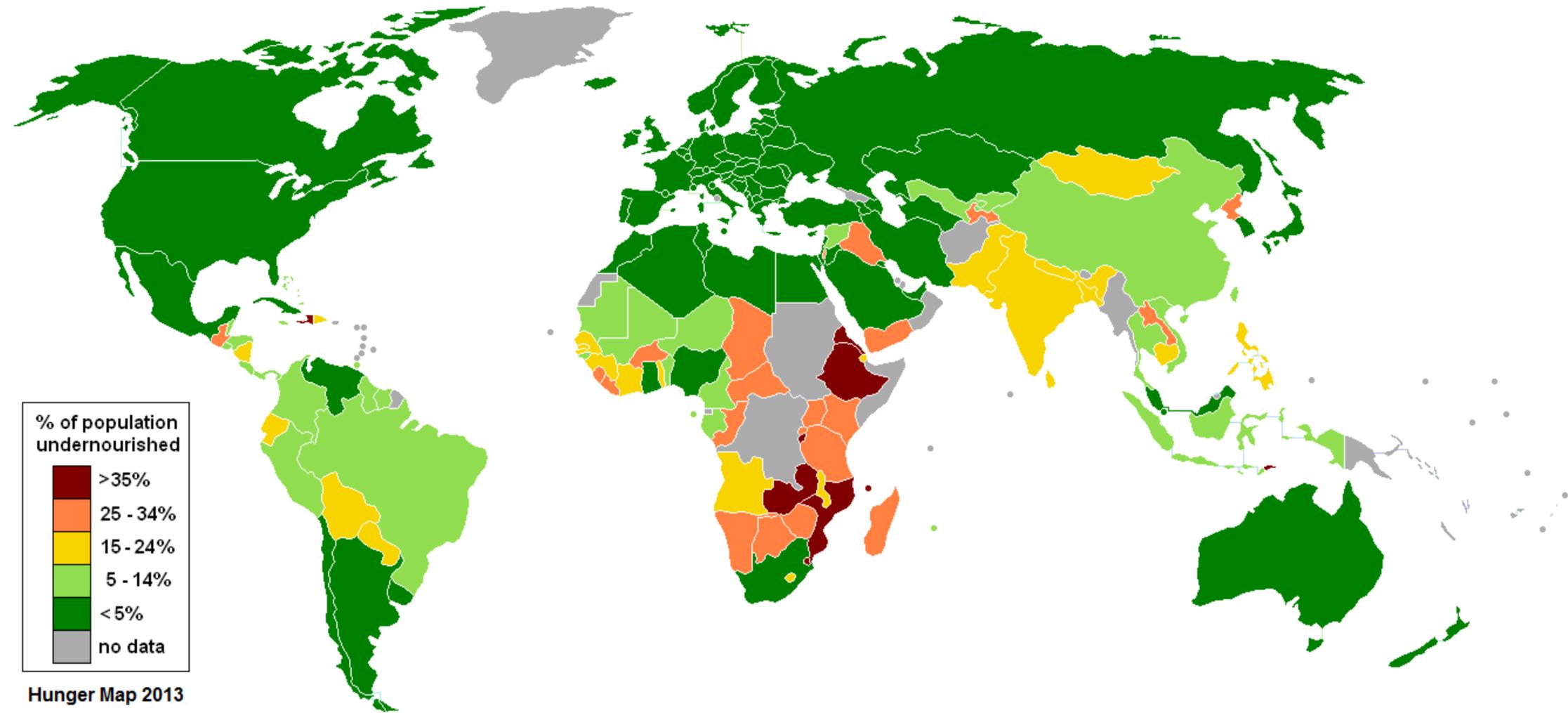
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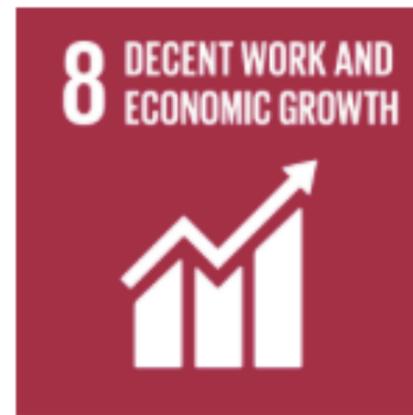




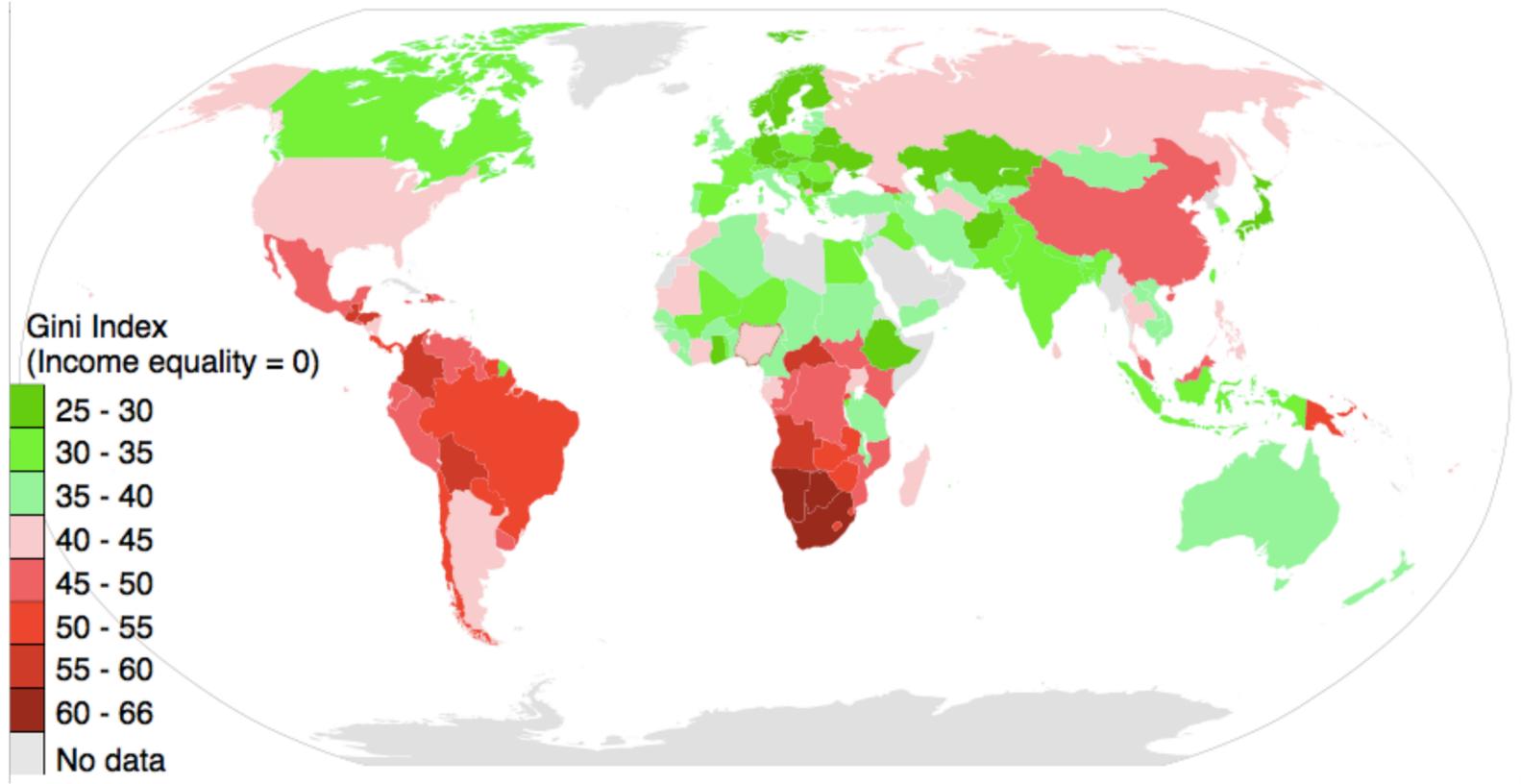
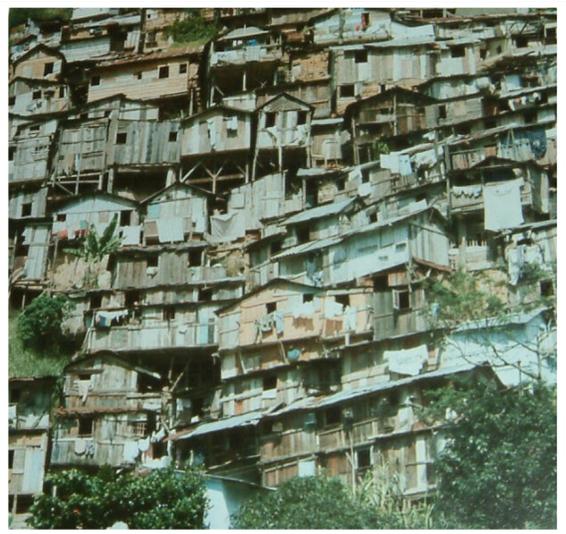
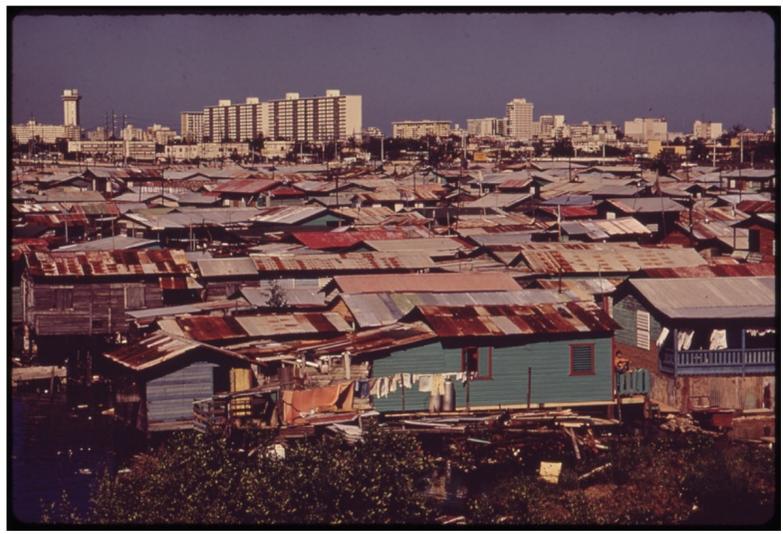
## Percentage of population undernourished



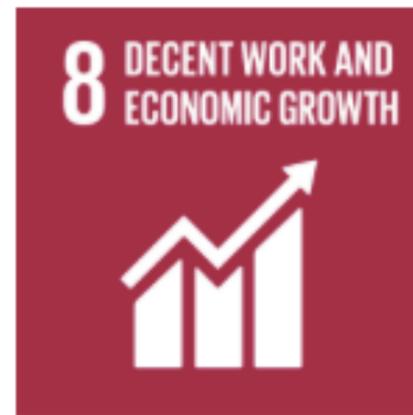
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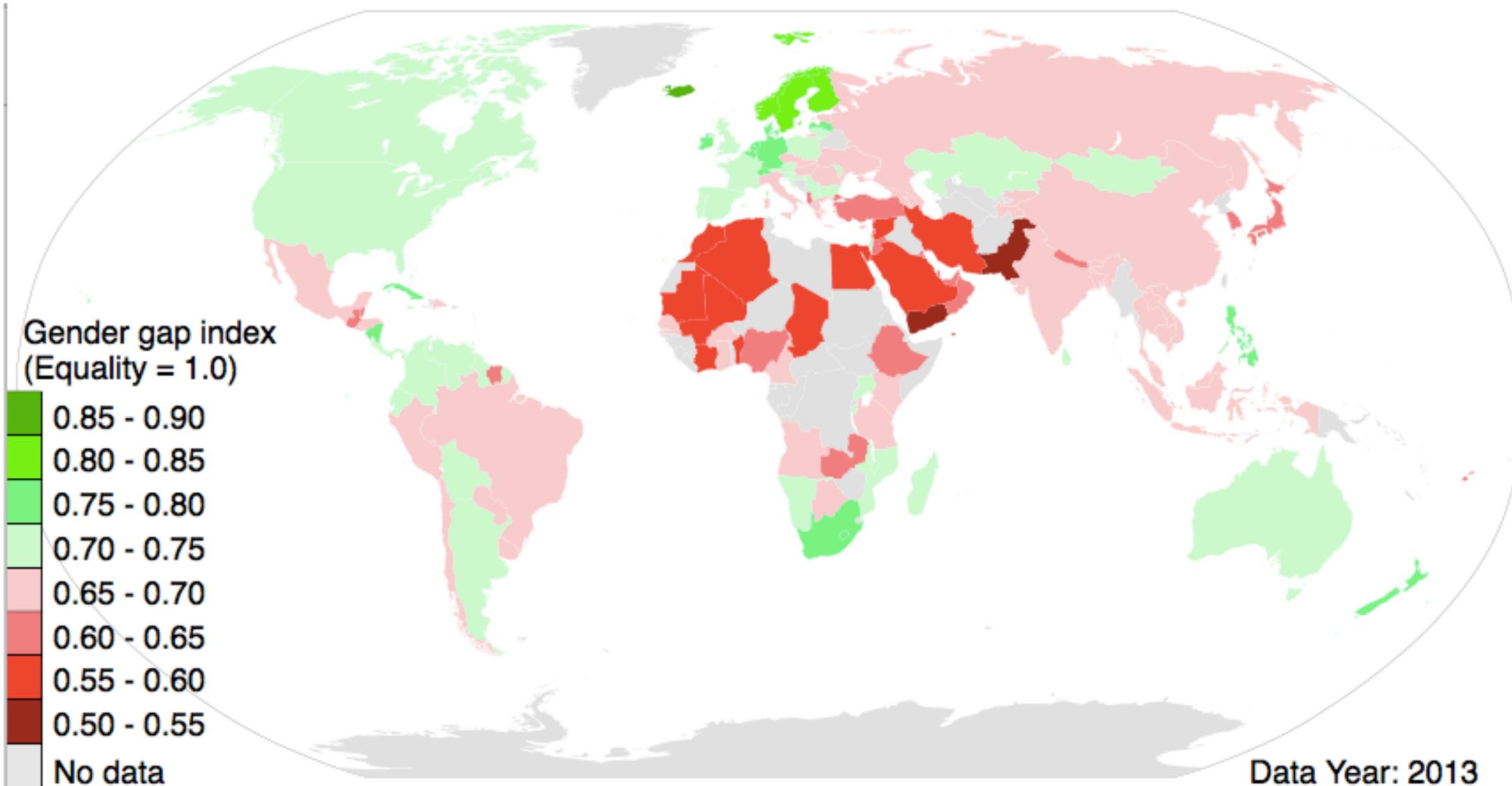


# Agenda 2030: "The Road to Dignity"





Women carry out 70% of the global work hours but they only earn 10% of the global salary



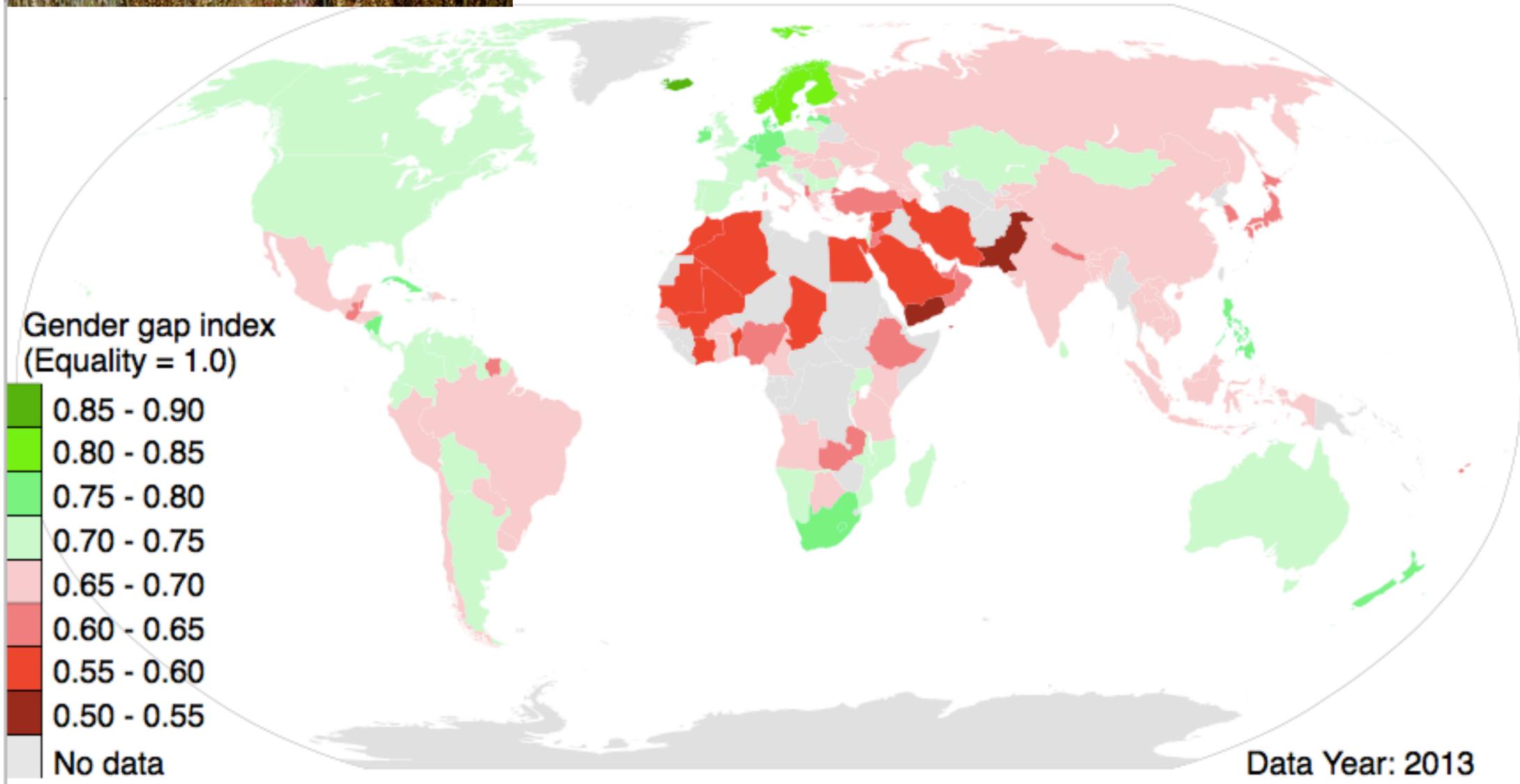
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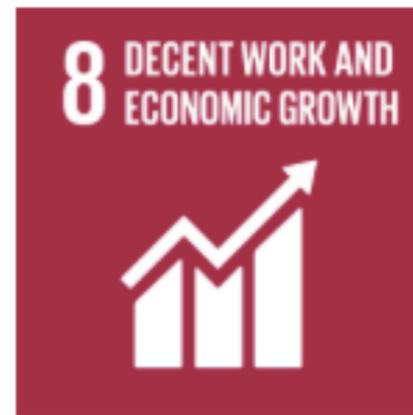
Women make major contributions to crop production. Women have the least access to the means for increasing yields and moving from subsistence crops to market-oriented production



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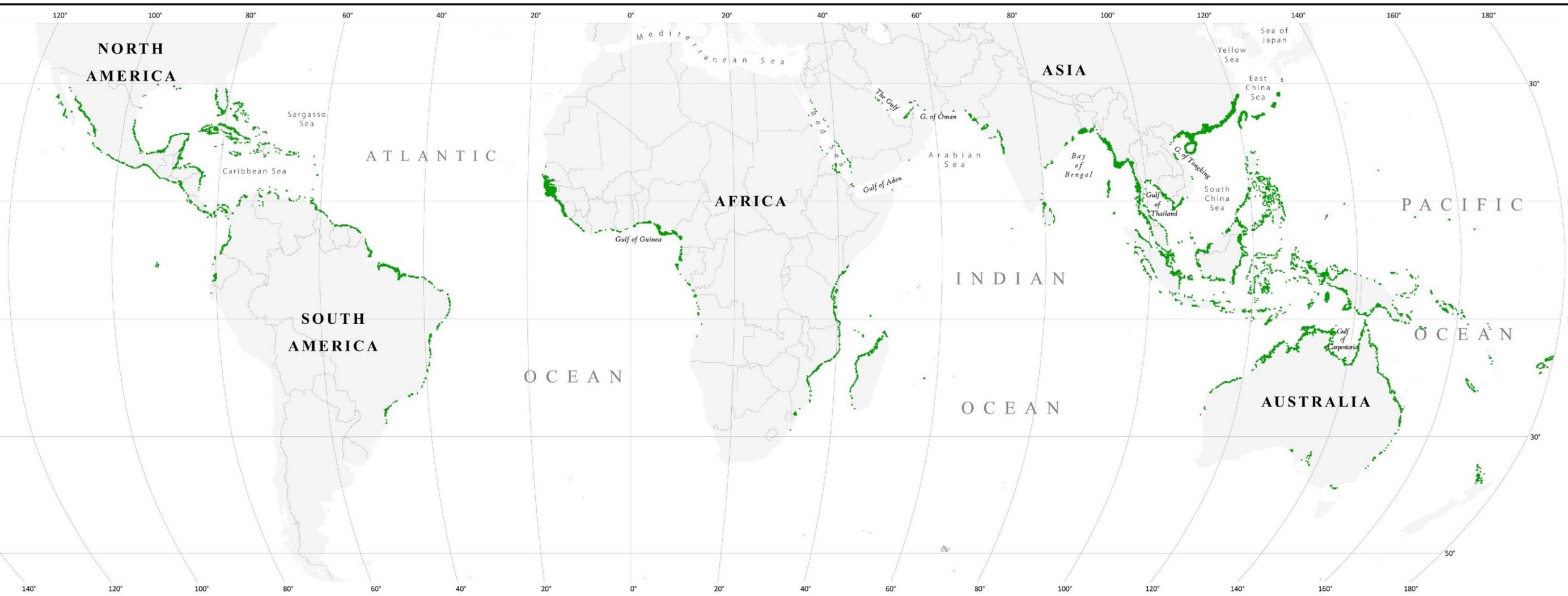
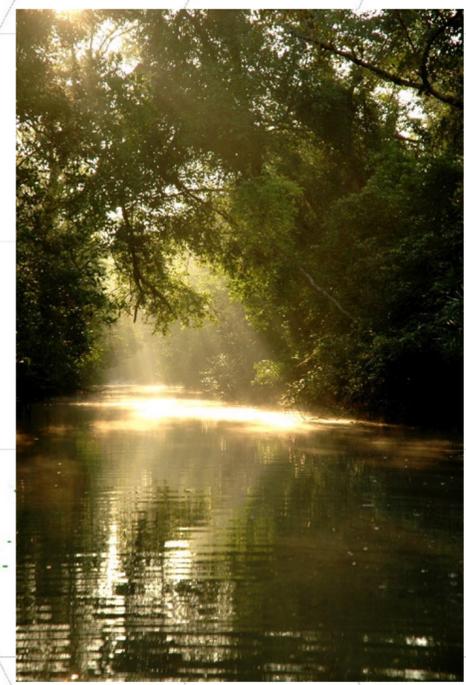


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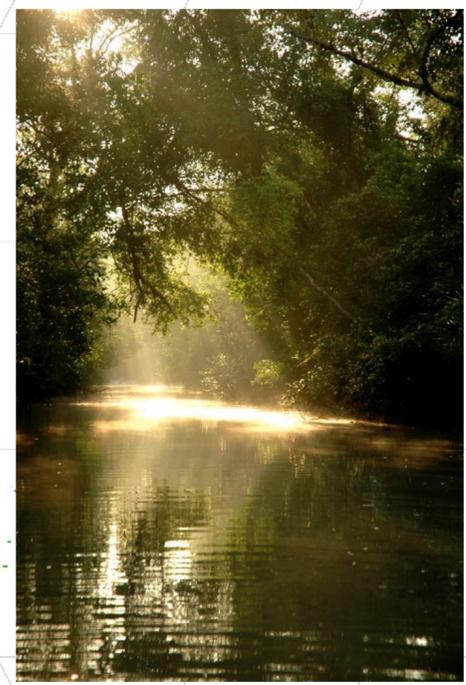
# Agenda 2030: "The Road to Dignity"

## Mangroves



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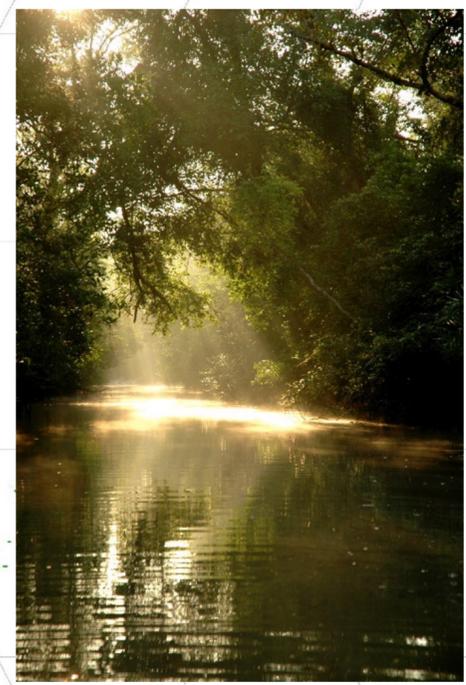
About half of mangrove loss has occurred in the last 50 years, mostly in the last two decades, due to:

- shrimp farming
- tourism
- urbanization
- agriculture expansion
- roadways
- marinas, and
- other intrusive developments.



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A Tragedy for our Oceans  
Continuing heavy loss of mangrove forests represents a real tragedy for our oceans and the extensive life-support systems mangroves engender.



# Agenda 2030: "The Road to Dignity"

Mangroves link many of the SDGs ...

