

1123 2017

**EU Research &
Innovation Day
Conference**

Climate Crisis and Inclusive Innovation

Kim Myung Ja, Ph.D.

President, Korean Federation of Science & Technology Societies (KOFST)

President, Korea Business Council for Sustainable Development (KBCSD)

Visiting Distinguished Professor, KAIST (2008-16)

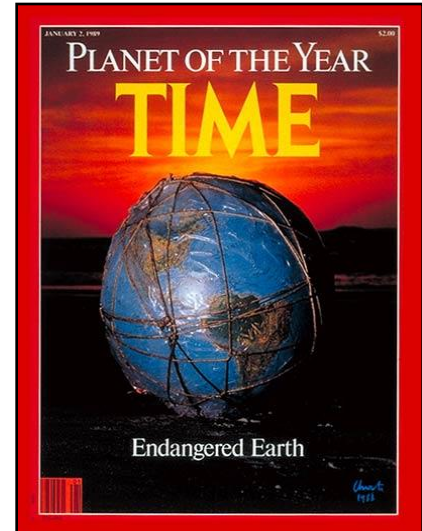
National Assembly Member (2004-2008)

Minister of Environment (1999-2003)

KOFST

What are the Key Factors of Global Trends 2025?

- Globalization & Multi-polar System
- World Population Growth & Aging Population in the Developed World
- Increase in Energy Consumption & Prices
- Resource Depletion and Rising Commodity Prices
- Climate Change & Increasing Socio-Economic Pressures
- Natural Disaster and Economic Losses
- Growing Energy, Food, & Water Constraints
- Environmental Pollution & Ecosystem Deterioration
- Resource Nationalism & Conflict over Resources
- ✓ Widening Gap between the Haves and Have-nots
- Power Shift and the Rise of Emerging Powers
- Security Threats (Terrorism, Conflict, Proliferation)
- ✓ Uncertainties from Interaction of Several Factors



How to Tackle the Global Challenges of the Multiple Crises

- Environmental Crisis - Economic Growth Crisis
- * Transition to a Paradigm of Sustainable Development :
- Future Forecasting, Successful Policy Implementation through Effective National Innovation System,
- National and International Leadership and Partnership

'Global Trends 2025 : A Transformed World', National Intelligence Council, 2008.12

World Economic Forum : Global Risks 2017

Economic, Societal Risks

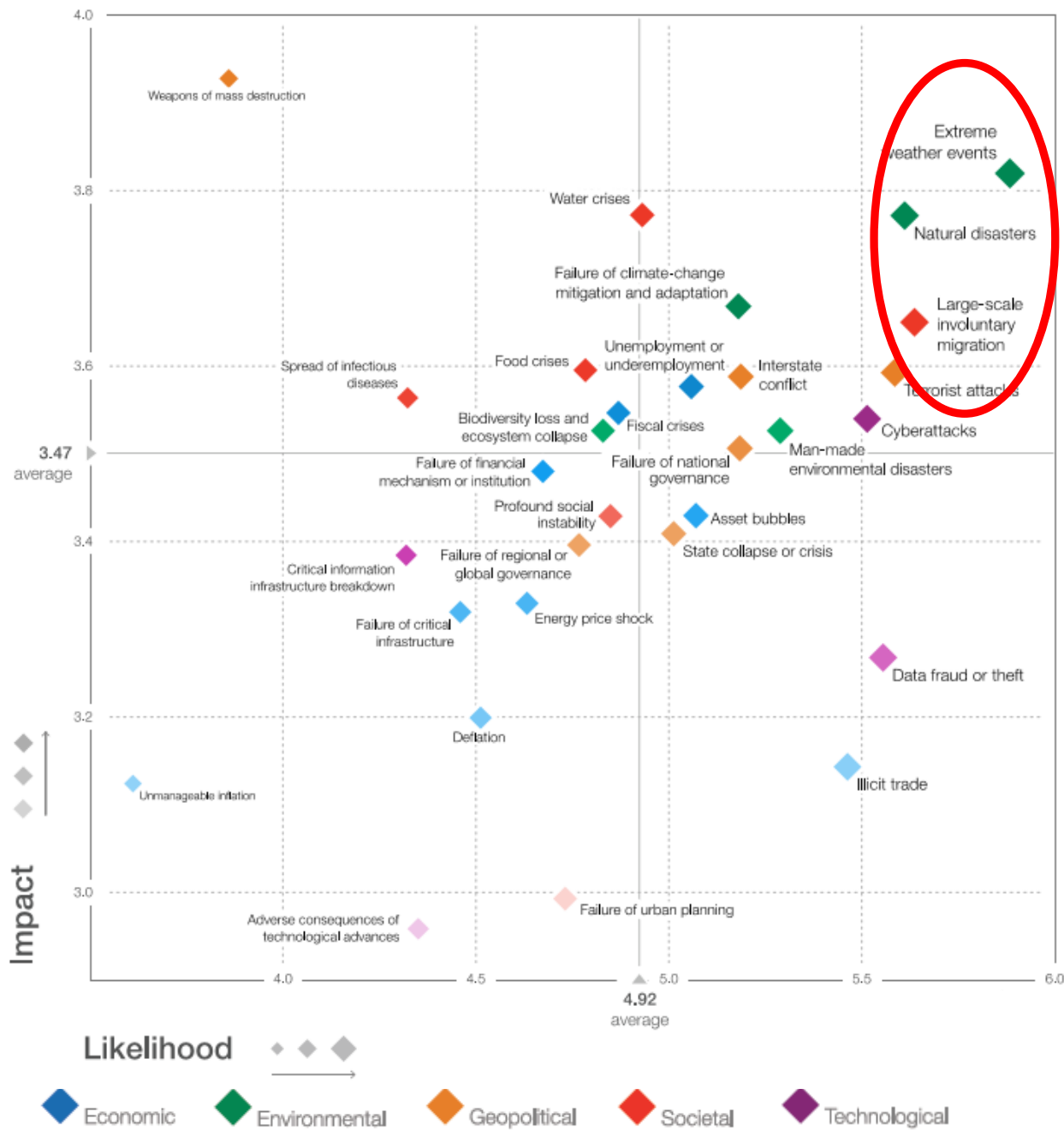
Economic Risks	<ul style="list-style-type: none">• Asset bubbles in a major economy• Deflation in a major economy• Failure of a major financial mechanism or institution• Failure/shortfall of critical infrastructure• Fiscal crises in key economies• High structural unemployment or underemployment• Illicit trade• Severe energy price shock(increase and decrease)• Unmanageable inflation
Societal Risks	<ul style="list-style-type: none">• Failure of urban planning• Food crises• Large-scale involuntary migration• Profound social instability• Rapid and massive spread of infectious diseases• Water crises

World Economic Forum : Global Risks 2017

Environmental, Geopolitical, Technological Risks

Environmental Risks	<ul style="list-style-type: none"> • Extreme weather events (e.g. floods, storms, etc)) • Failure of climate change mitigation and adaptation • Major biodiversity loss and ecosystem collapse (land and ocean) • Major natural catastrophes(e.g. earthquakes, tsunamis, volcanic eruptions, geomagnetic storms) • Man-made environmental damage and disasters (e.g. oil spills, radioactive contamination, etc.)
Geopolitical risks	<ul style="list-style-type: none"> • Failure of national governance • Failure of regional or global governance • Interstate conflict with regional consequences • Large-scale terrorist attacks • State collapse or crisis • Weapons of mass destruction
Technological Risks	<ul style="list-style-type: none"> • Adverse consequences of technological advances • Breakdown of critical information infrastructure and networks • Large-scale cyberattacks • Massive incident of data fraud/theft

The Global Risks Landscape 2017: World Economic Forum



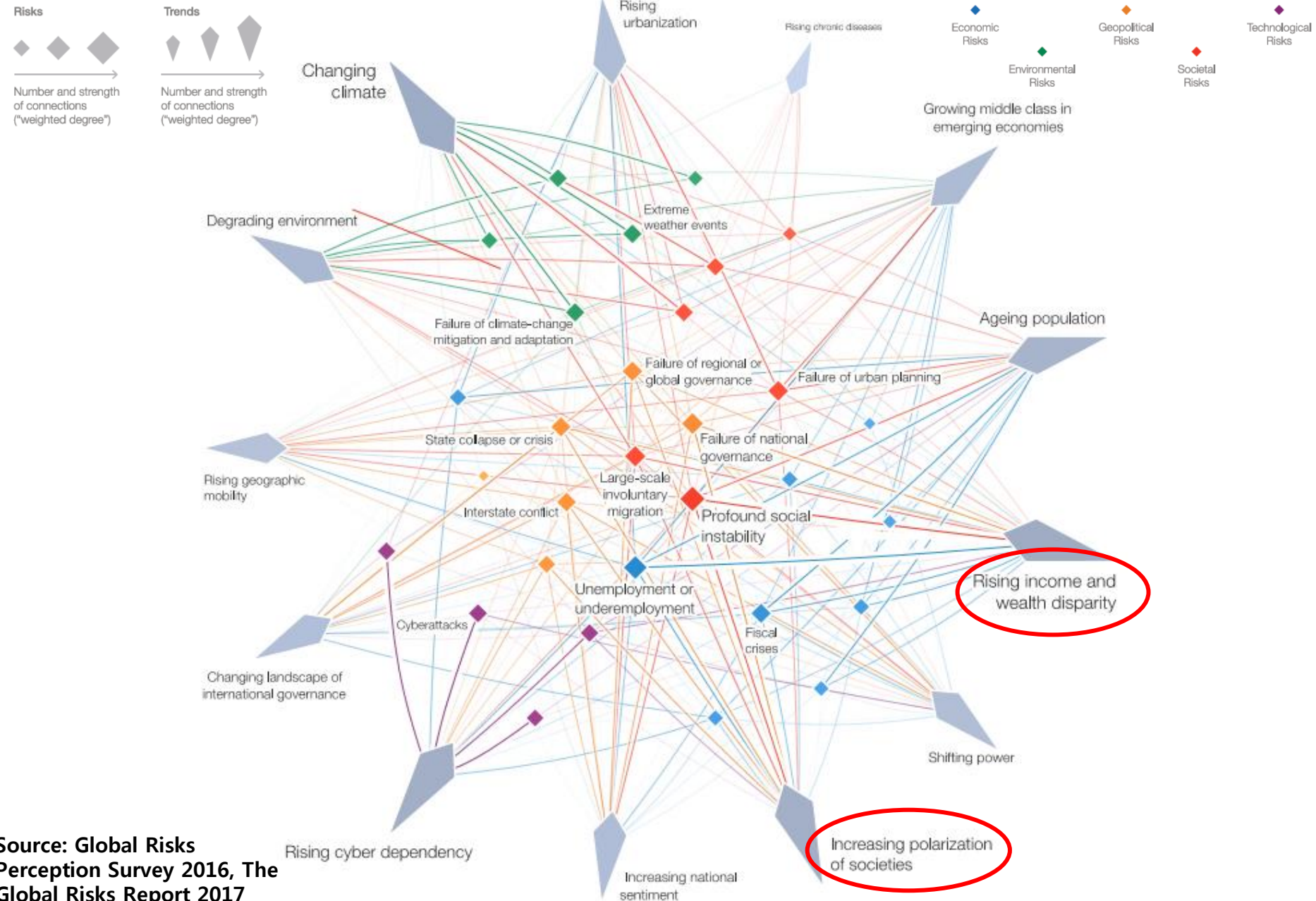
Top 10 risks in terms of
Likelihood

- 1 Extreme weather events
- 2 Large-scale involuntary migration
- 3 Natural disasters
- 4 Terrorist attacks
- 5 Data fraud or theft
- 6 Cyberattacks
- 7 Illicit trade
- 8 Man-made environmental disasters
- 9 Interstate conflict
- 10 Failure of national governance

Top 10 risks in terms of
Impact

- 1 Weapons of mass destruction
- 2 Extreme weather events
- 3 Water crises
- 4 Natural disasters
- 5 Failure of climate-change mitigation and adaptation
- 6 Large-scale involuntary migration
- 7 Food crises
- 8 Terrorist attacks
- 9 Interstate conflict
- 10 Unemployment or underemployment

The Risks-Trends Interconnections Map 2017



Source: Global Risks Perception Survey 2016, The Global Risks Report 2017

What are the Key Socio-Economic Challenges for Asia?

- **Accounting for 60 % of world population (4 billion)**

- **Adaptive capacity constrained by weak institutions and limited technologies**

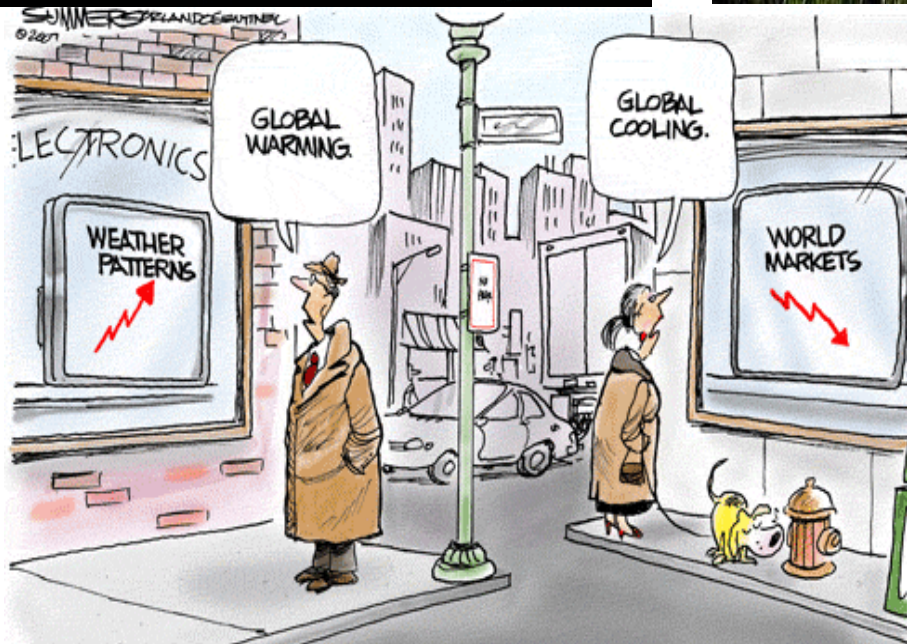
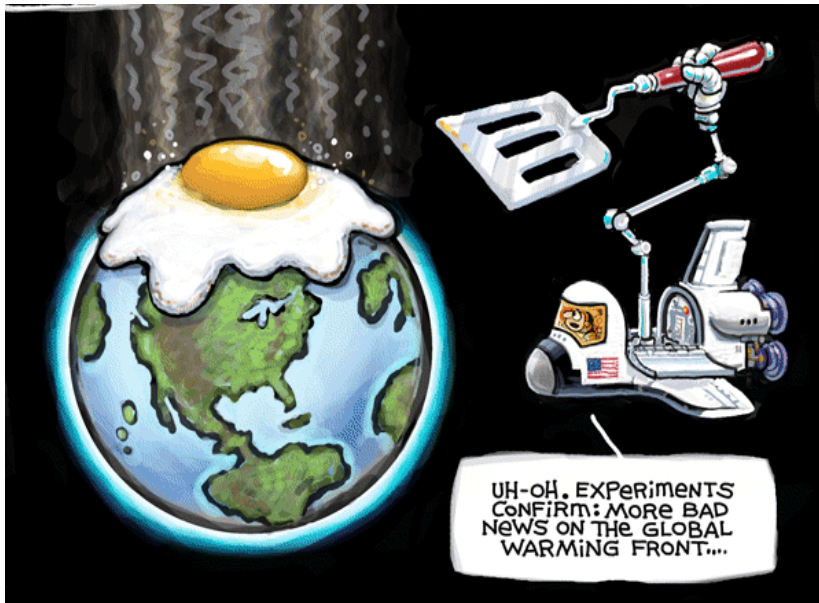
- **Rapid Industrialization and urbanization**



- **Serious widening of the rich-poor gap : the richest 20% of the population spends 16 times more than the poorest 20%**
- **Increasing demands in energy and raw materials : 1.5 billion people lack access to electricity**

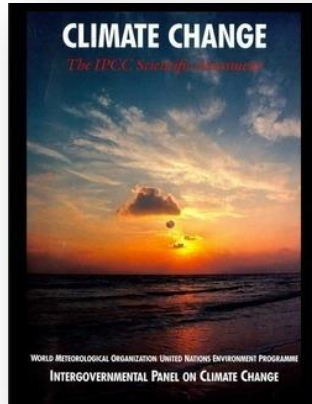


Global Mega-trend: Multiple Crises



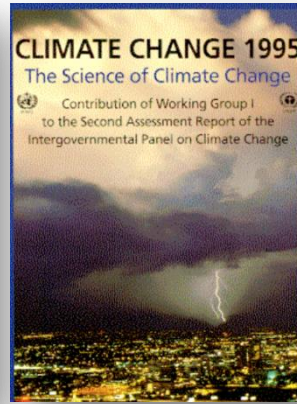
Resource Crisis
 Climate Crisis
 Economic Crisis
 Socio-Political Crisis
 Environmental Crisis

IPCC Report



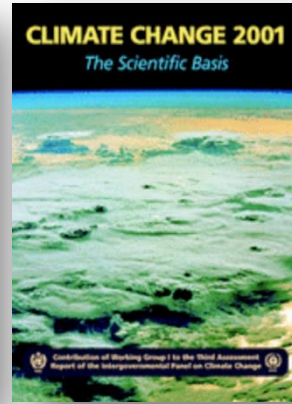
FAR 1990

Average temperature increase in 20C, 0.3- 0.6°C, Sea level rise 10~25cm



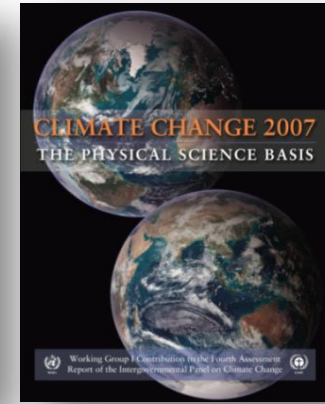
SAR 1995

Temperature increase 0.5°C, sea level rise 15~ 95cm



TAR 2001

Climate change seems man-made, extensive damage



AR4 2007

temperature increase in 21C, • 1.8- 4.0°C, Sea level rise ~100cm



AR5 2013

Human activities attributed to global warming with over 95% probability



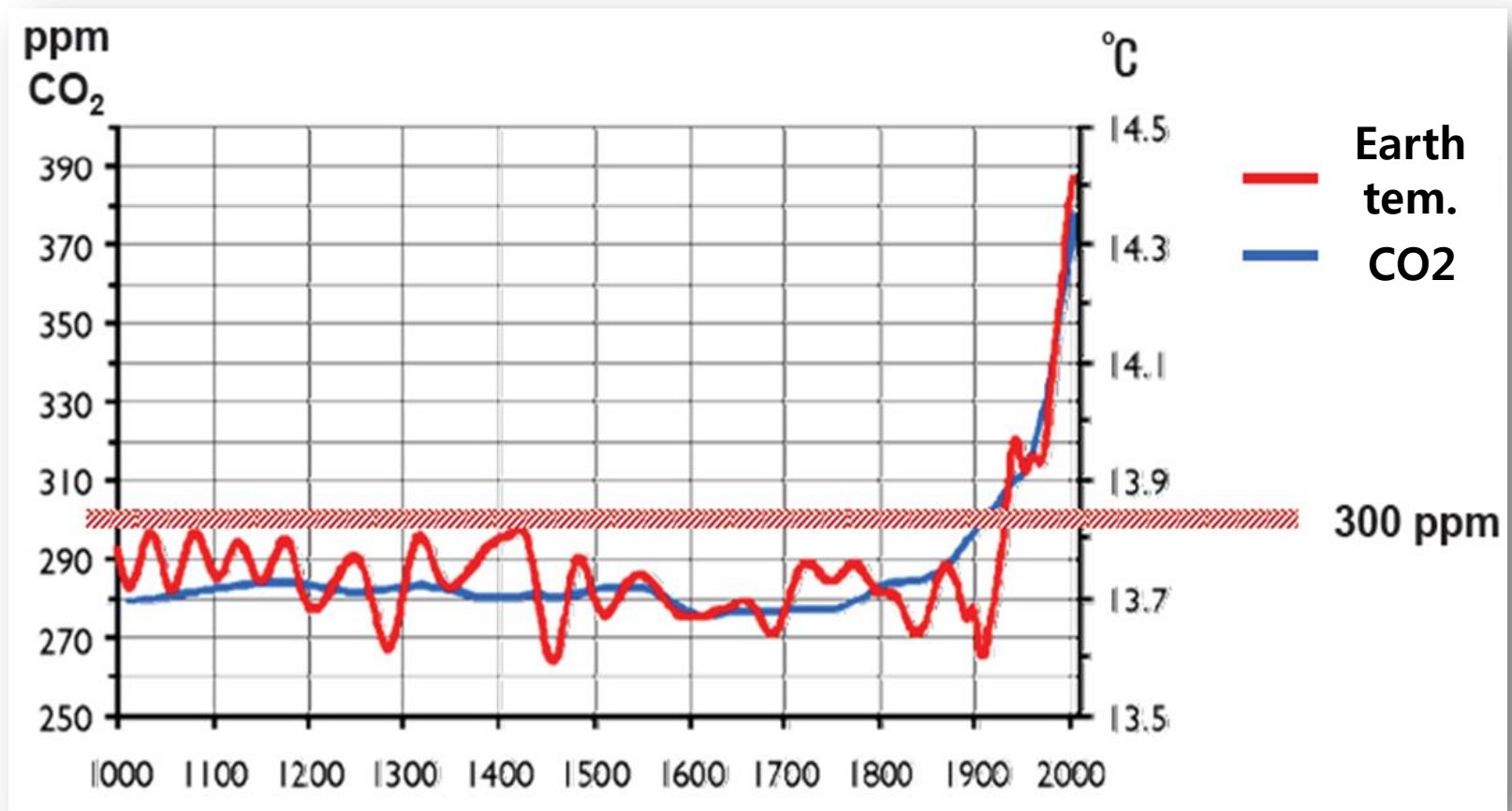
“We now have a clear roadmap for the production and delivery of AR6”

Hoesung Lee, IPCC Chair, 2015 -

Climate Change

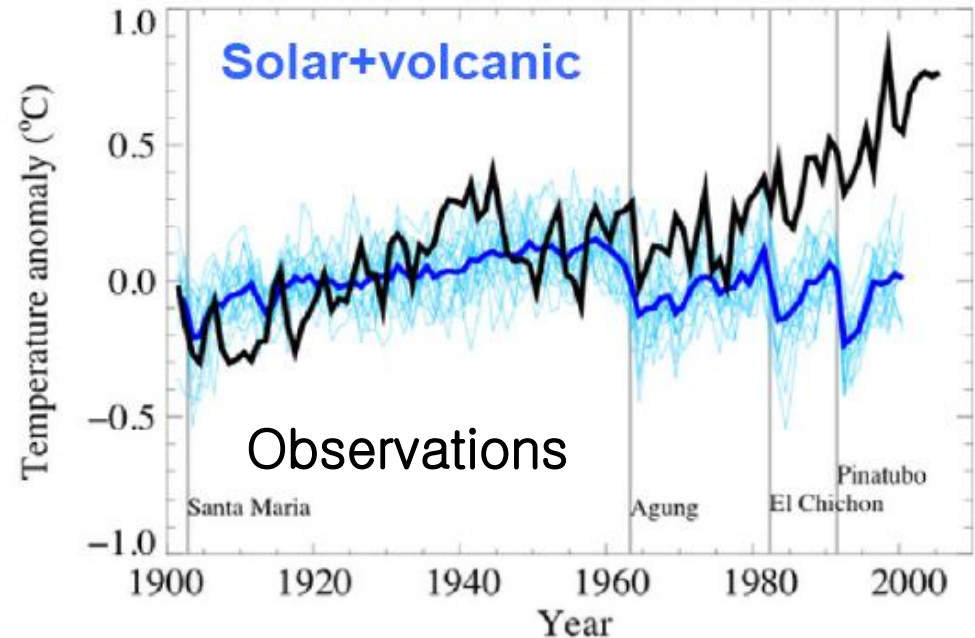
CO_2 emitted from fossil fuel is the main cause of global warming.

- ✓ Since the industrial revolution, CO_2 level has rapidly increased (280 → 380ppm).

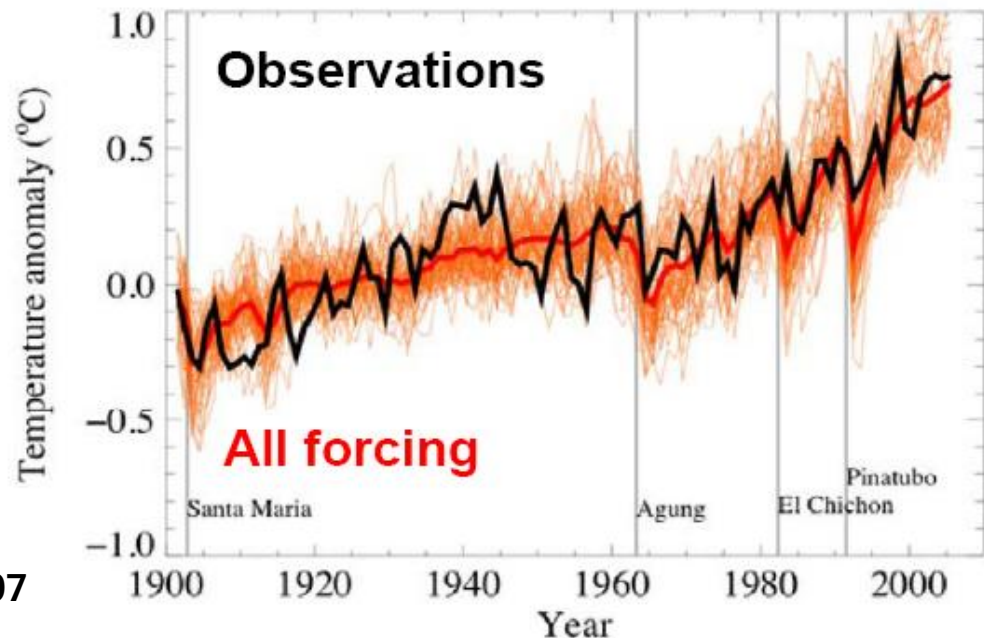


GHG Forcing Needed to Explain Observed Global Warming

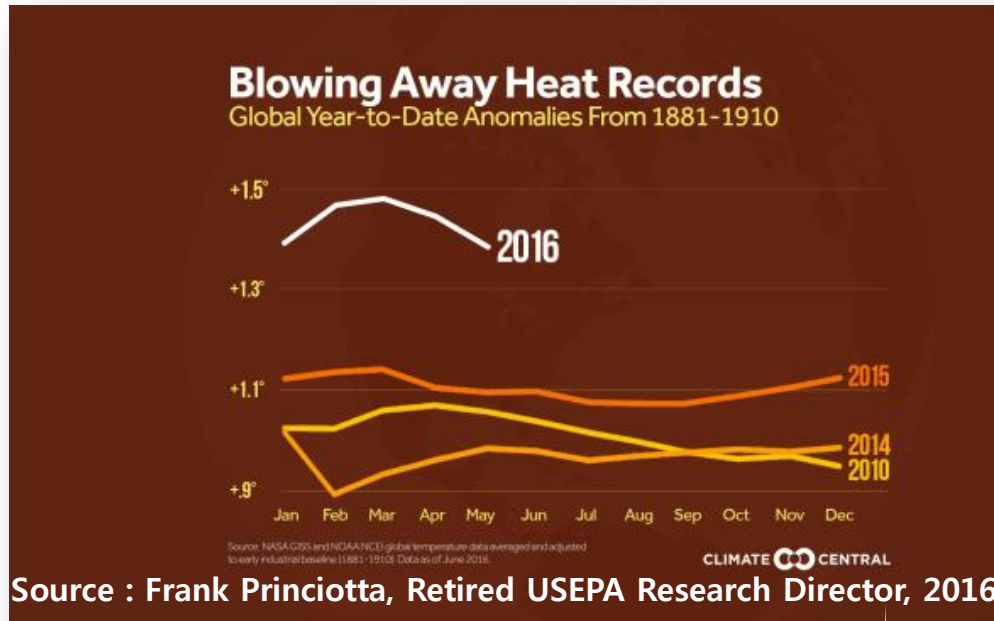
Solar + Volcanic Forcings *do not* explain **Observed Warming**



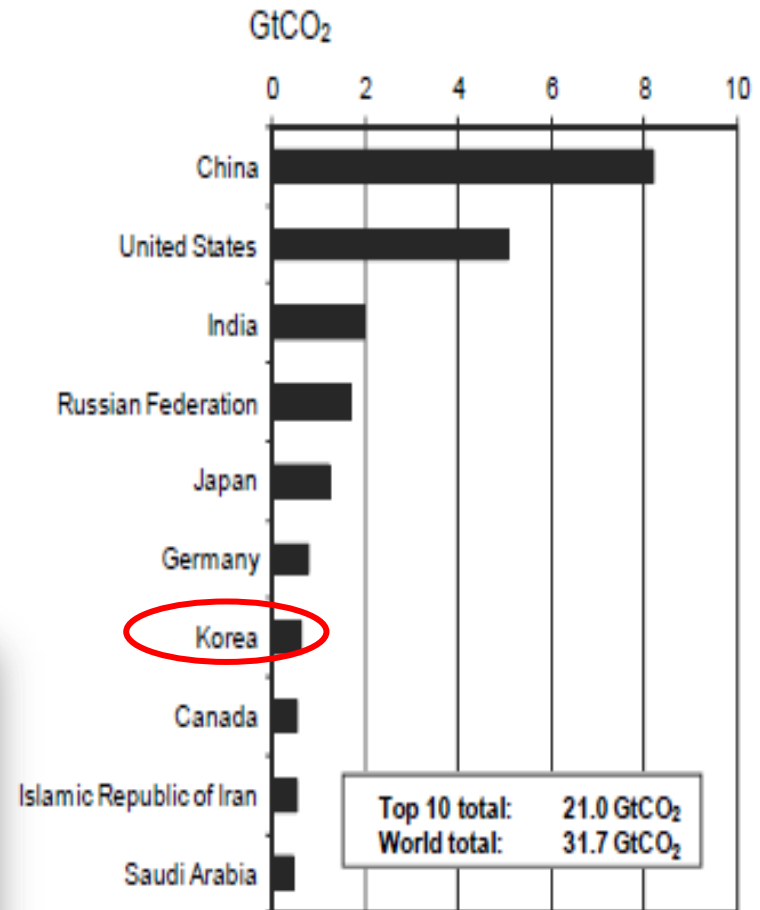
GHG + Solar + Volcanic Forcings *do* explain **Observed Warming**



As of Aug. 2016 Warmest Year by Far *Approaching 1.5° C*

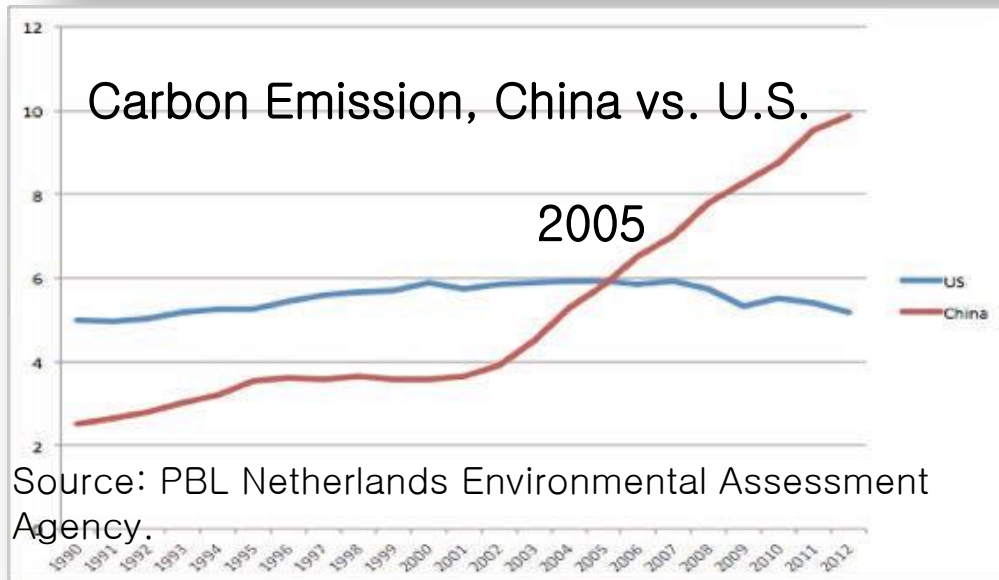


Top 10 emitting countries in 2012



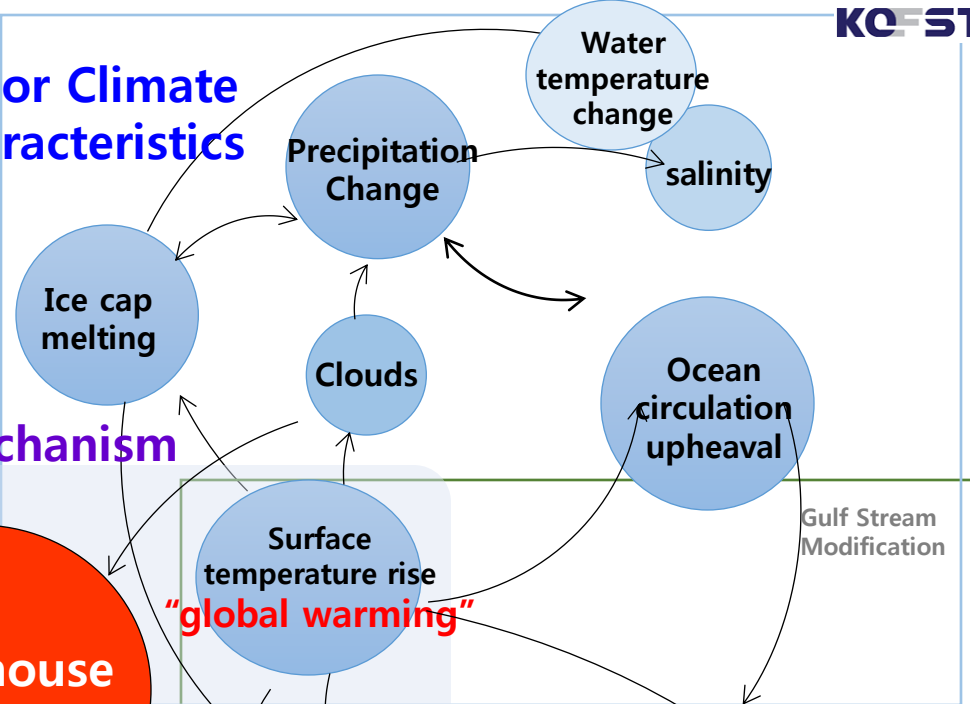
Key point: The top 10 emitting countries account for two-thirds of global CO₂ emissions.

Carbon Emission, China vs. U.S.

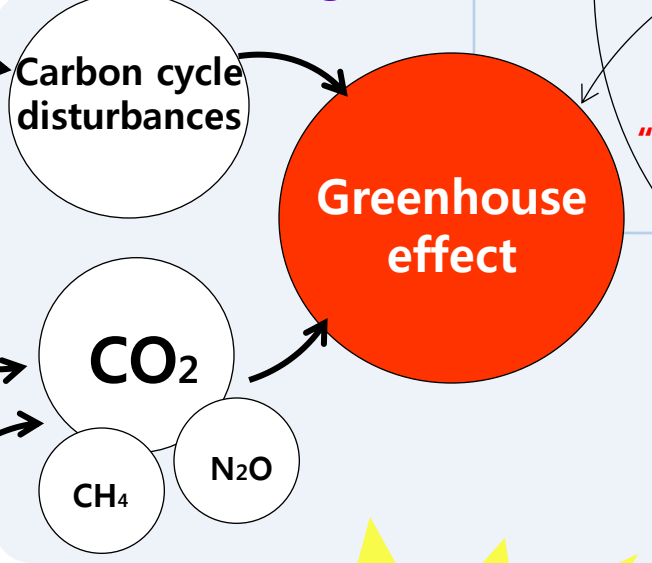


Climate Change: Mechanisms, Characteristics, and Socio-Economic Threats

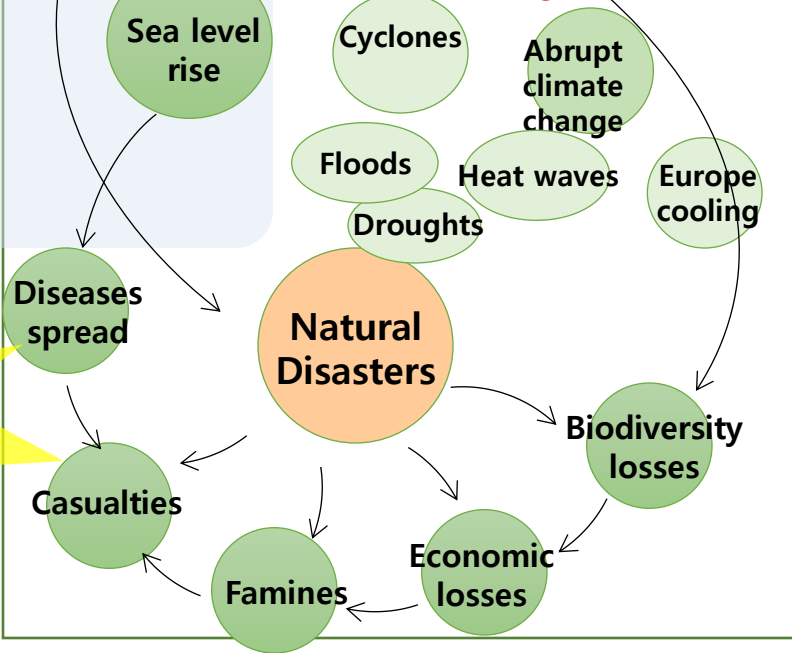
Major Climate Characteristics



Climate Change Mechanism



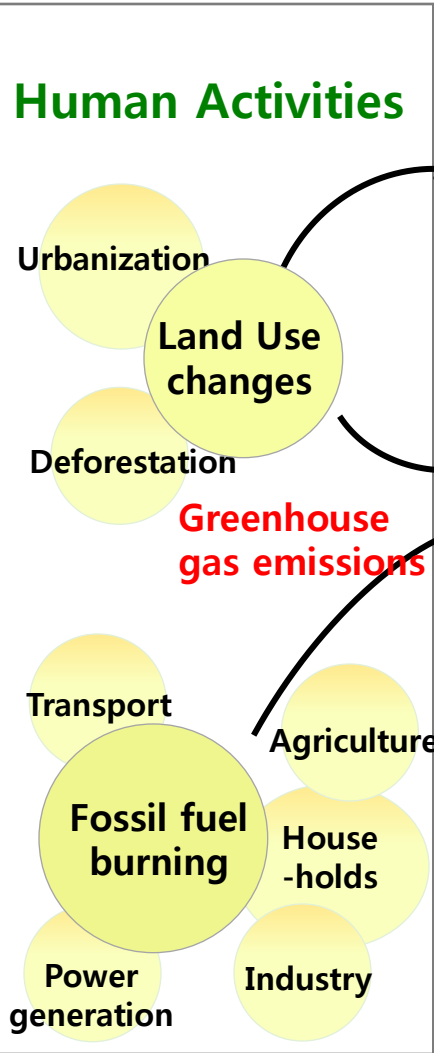
Major Threats



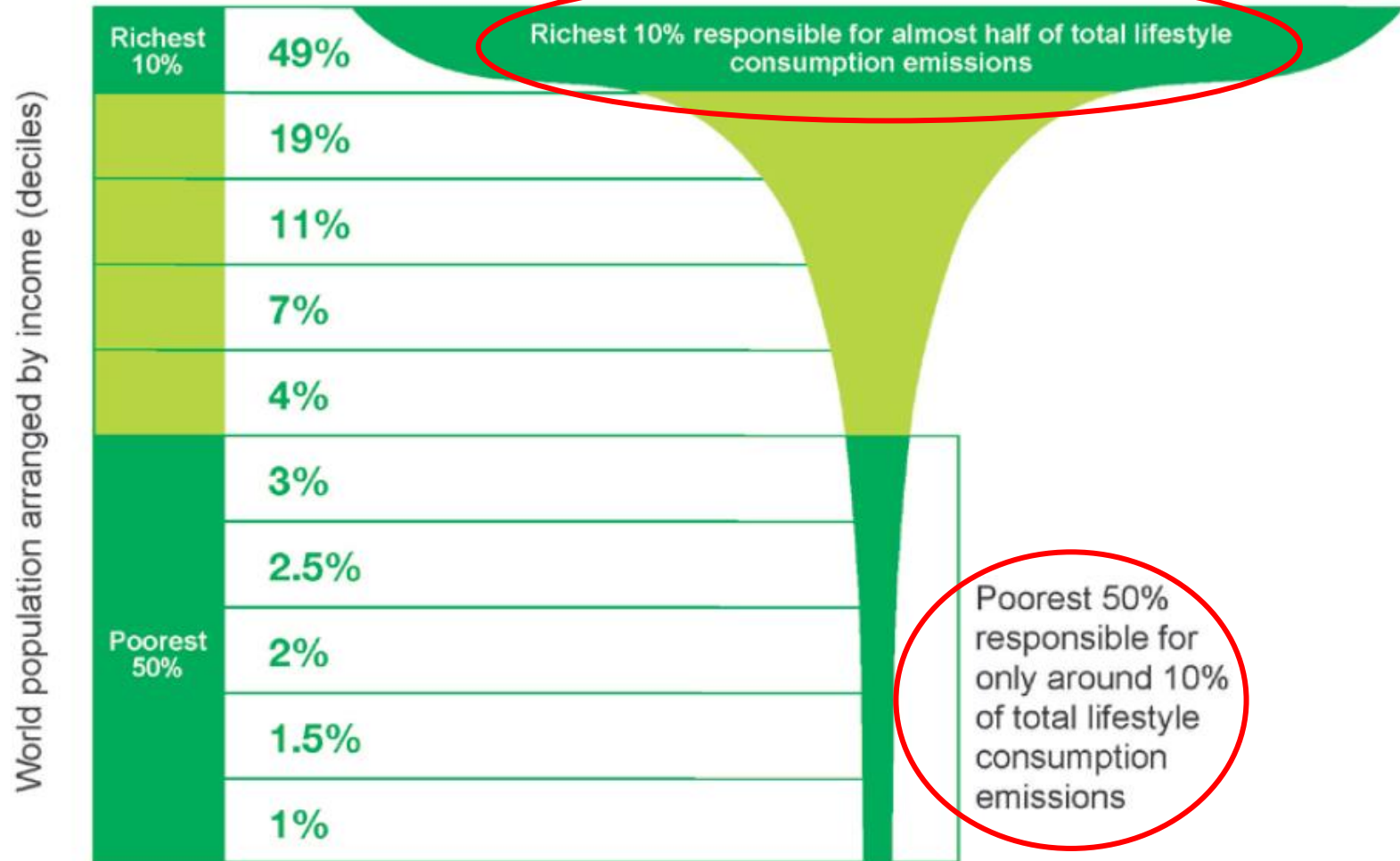
Conflict on Strategic Resources, Energy, Food, Water

Modified from UNEP/GRID-Arendal, 'Climate change: processes, characteristics and threats', designed by Philippe Rekacewicz, UNEP/GRID-Arendal Maps and Graphics Library, 2005

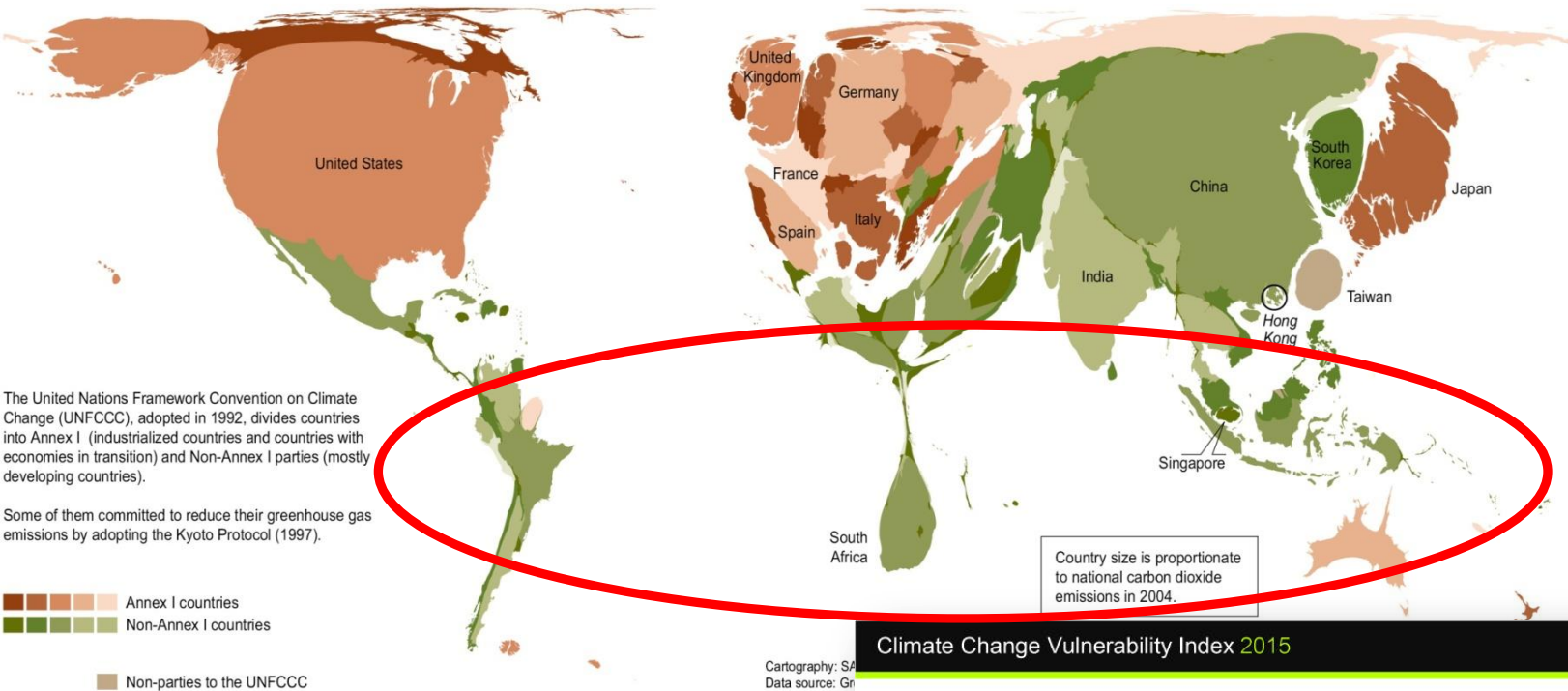
Human Activities



Percentage of CO₂ emissions by world population



Total CO₂ emissions
from fossil-fuel burning, cement production and gas flaring

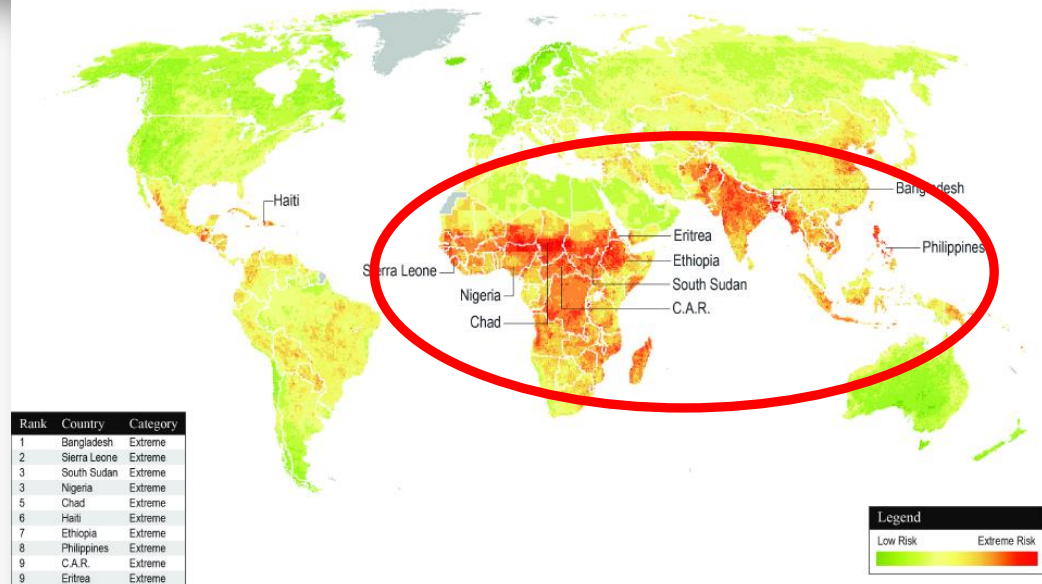


Climate Change Vulnerability Index 2015



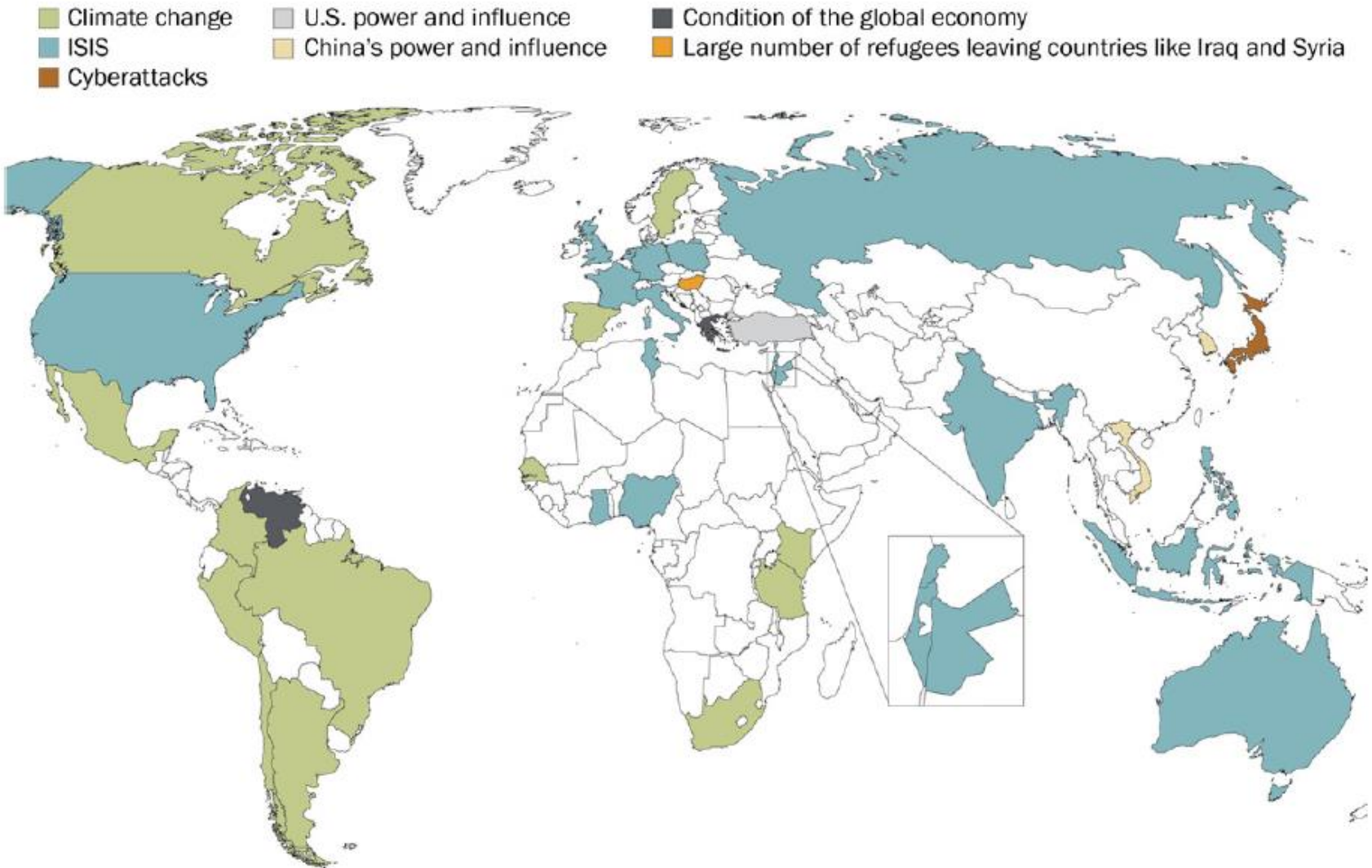
CO₂ Emission by Region/Country

Climate Change Vulnerability by Region



Global publics see ISIS and climate change as the top international threats

Top threat to (survey country)



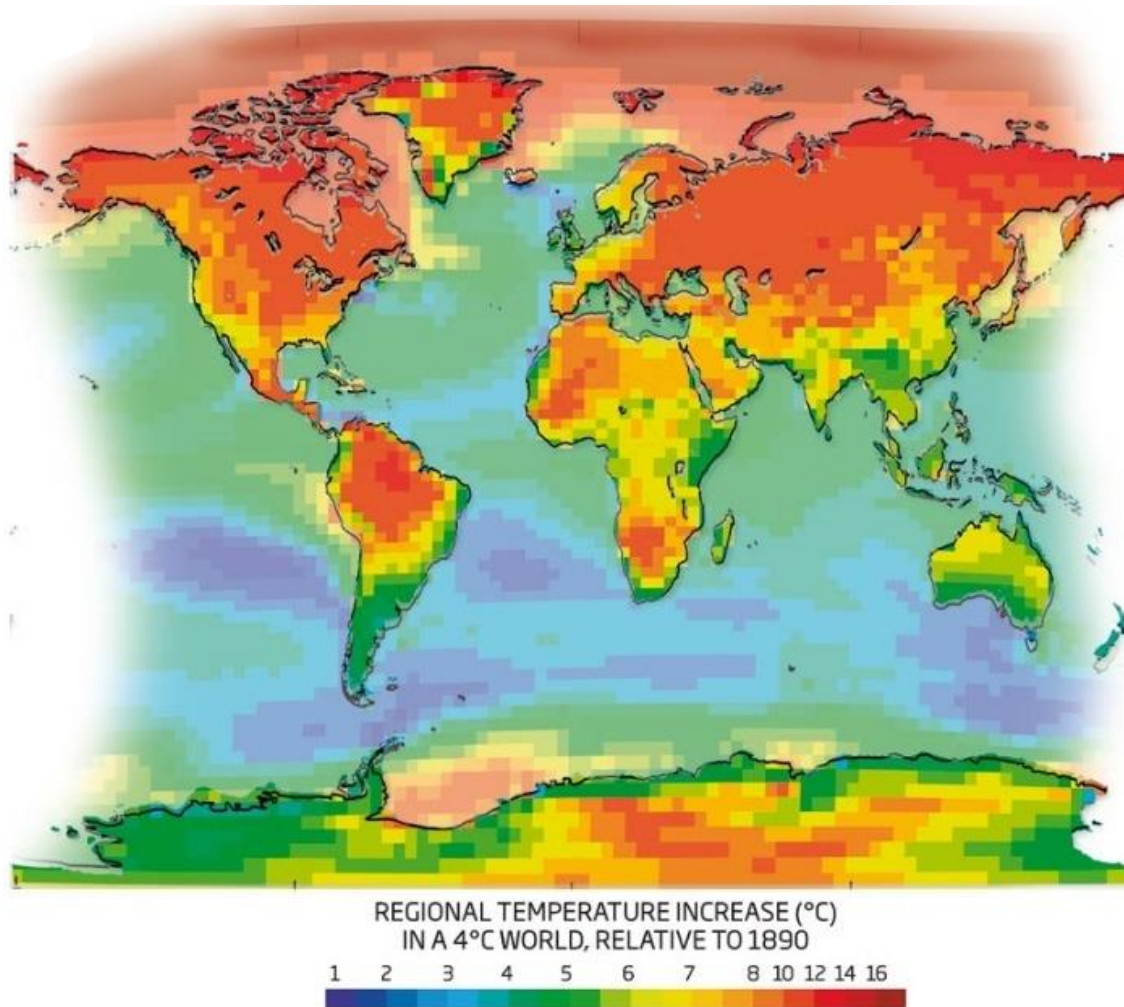
Note: U.S. power and influence not asked in the U.S., Russia's power and influence not asked in Russia, ISIS not asked in Turkey.

Source: Spring 2017 Global Attitudes Survey. Q17a-h.

PEW RESEARCH CENTER

http://assets.pewresearch.org/wp-content/uploads/sites/2/2017/07/31101043/Pew-Research-Center_2017.07.13_Global-Threats_Full-Report.pdf

Royal Society: Global Warming Map in a '4°C World'

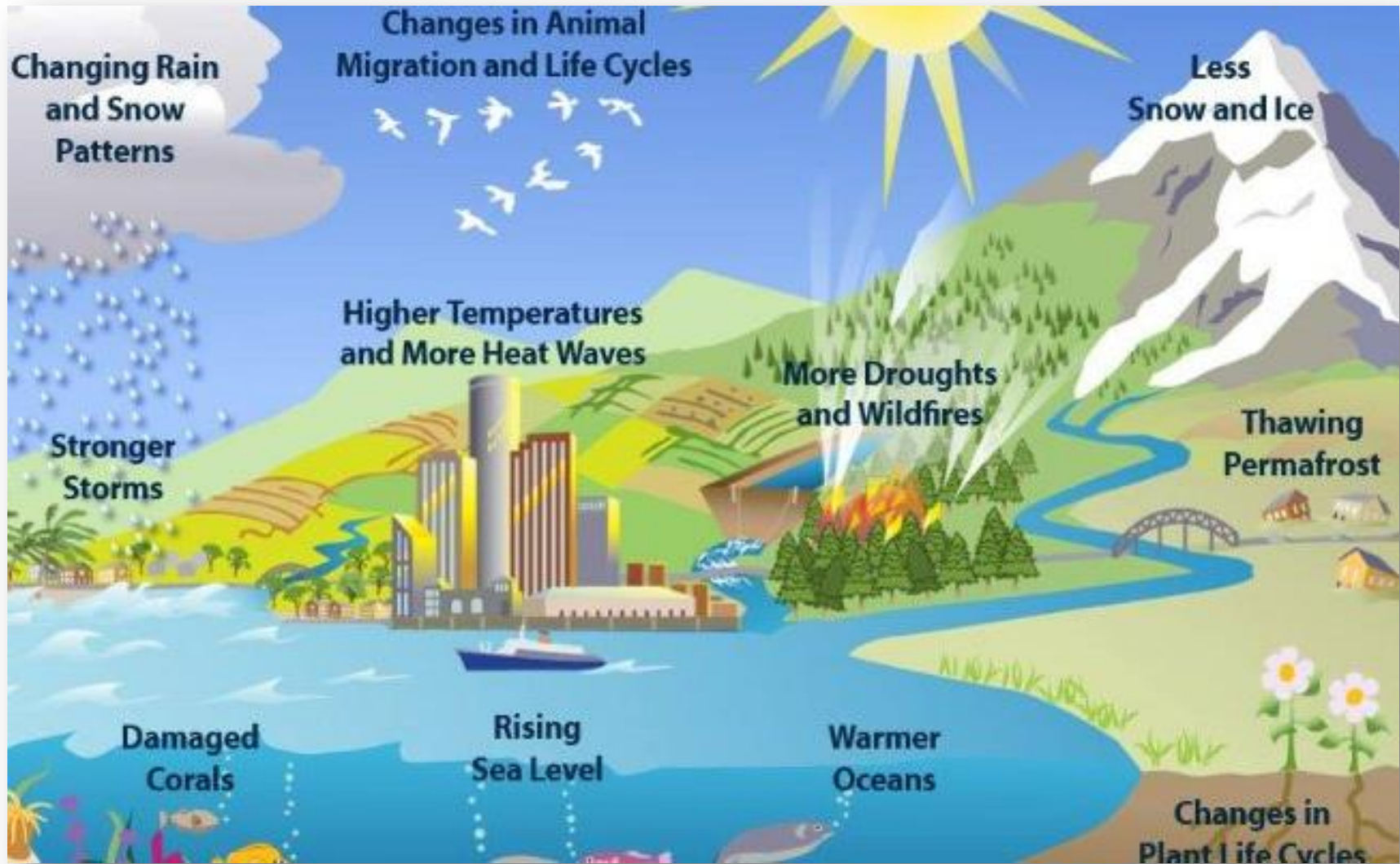


Land warming, especially at the higher latitudes is substantially higher than ocean warming and can yield radical changes in precipitation patterns.

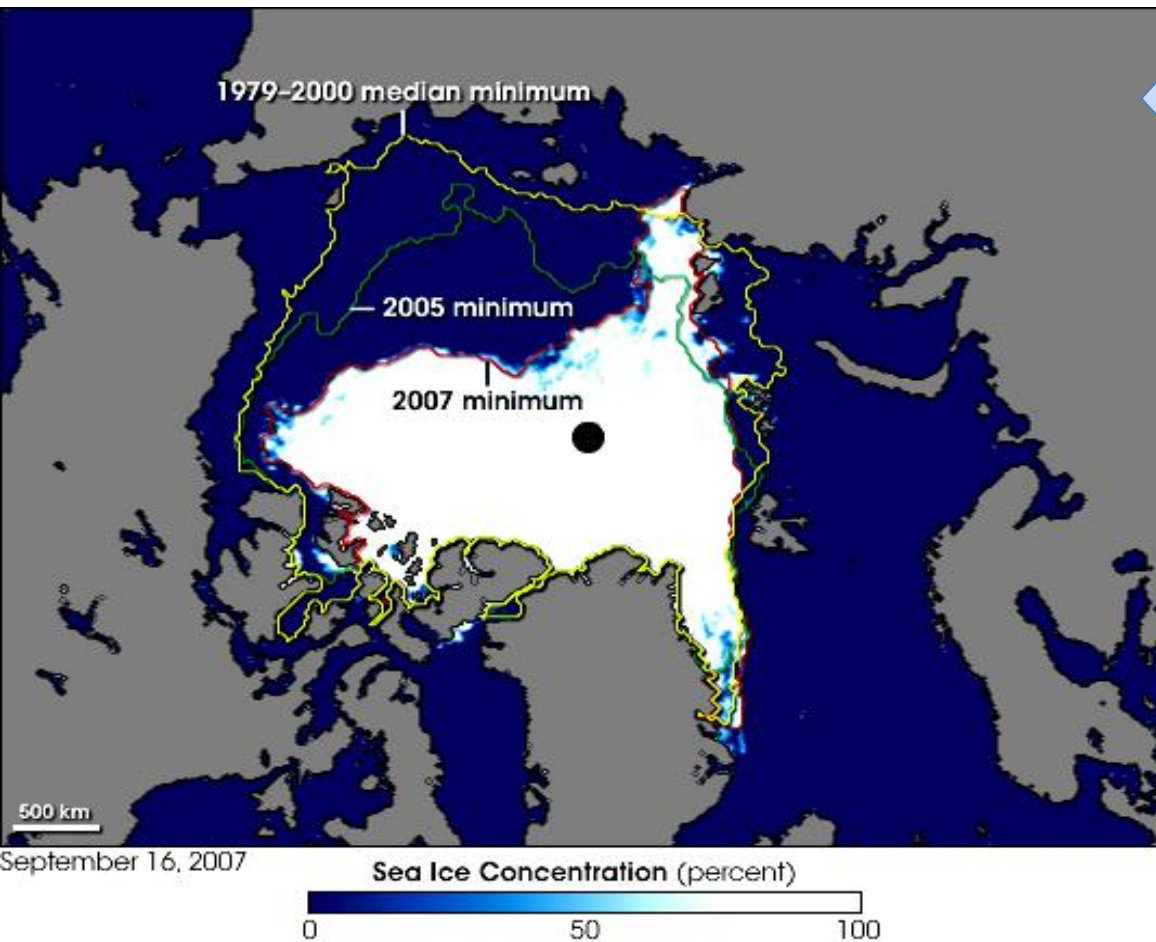
All areas will be subject to higher evaporation.

NCAR (2010) projected major increases in drought potential in much of the US, Western Europe, North Africa and Australia when average global warming is 3.5 C.

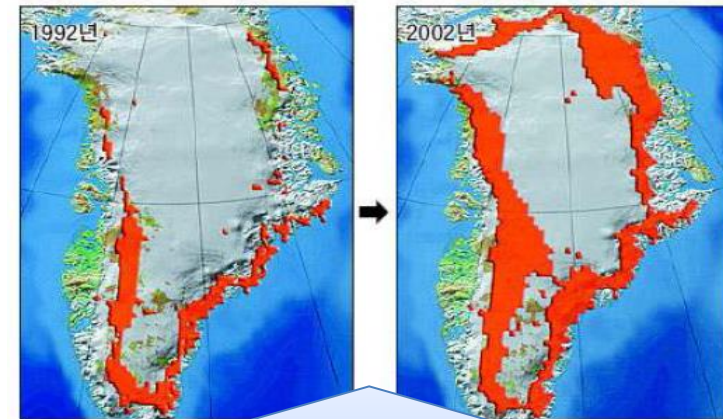
Climate Change: Mechanisms, Characteristics, Consequences and Socio-Economic Threats



Fast-Meting of Glaciers



North Pole Ice Cap Melting
: 1979 ~ 2007



Greenland Ice Melting :
1992 vs. 2002

<Source : wikipedia.org>

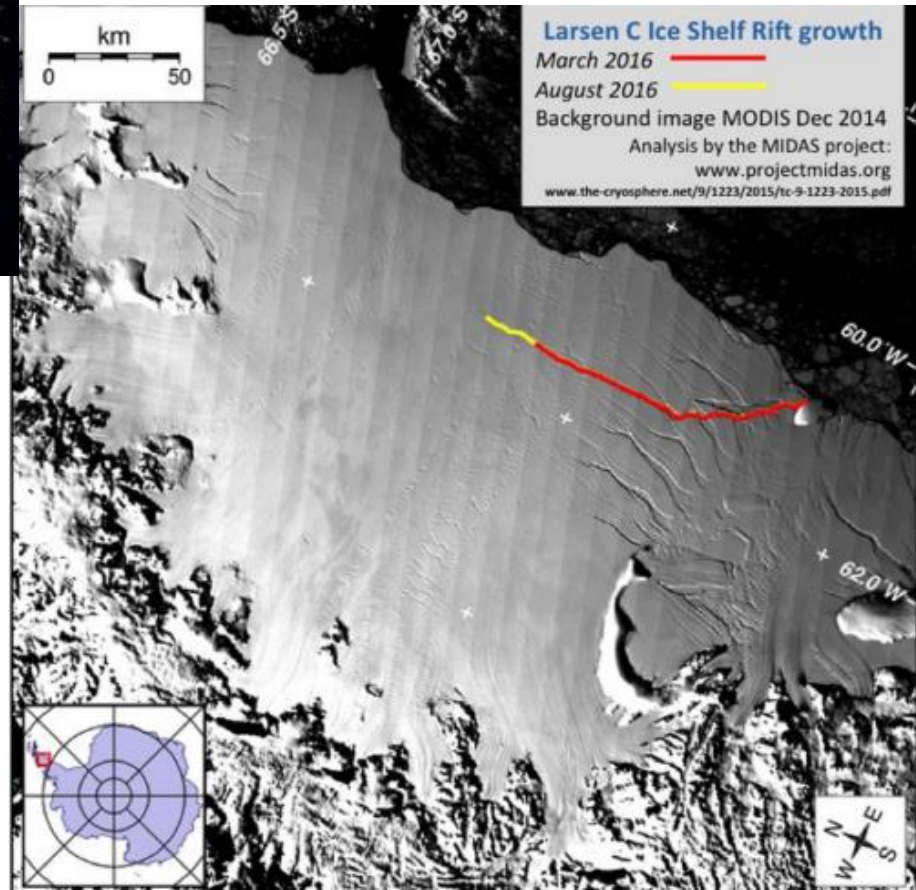
- Arctic sea ice has declined dramatically over the past thirty years, with the most extreme decline seen in the summer melt season.
- Despite some potential opportunities have gained attention such as new shipping routes and oil fields, **the risk of runaway global warming poses a serious threat.**



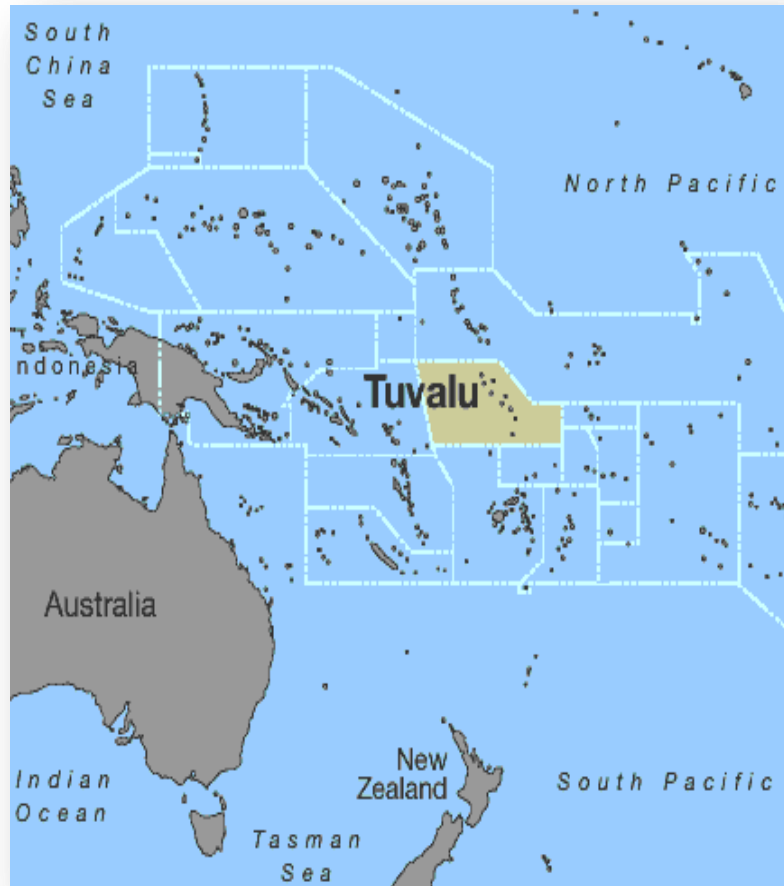
Larsen B ice shelf loss in 2002.

Credit: NASA Goddard Space Flight Centre

The rift is likely to lead to an iceberg breaking off, which will remove about 10% of the ice shelf's area ©MIDASOnIce



Sea level rise and its consequence



The Exodus of Tuvaluans



http://m.blog.daum.net/_blog/_m/articleView.do?blogid=0I89S&articleid=6124459#



On the brink of disappearing,
the Solomon Island

http://www.huffingtonpost.kr/2016/05/12/story_n_9921146.html

Ice Melting and Sea Level Rise

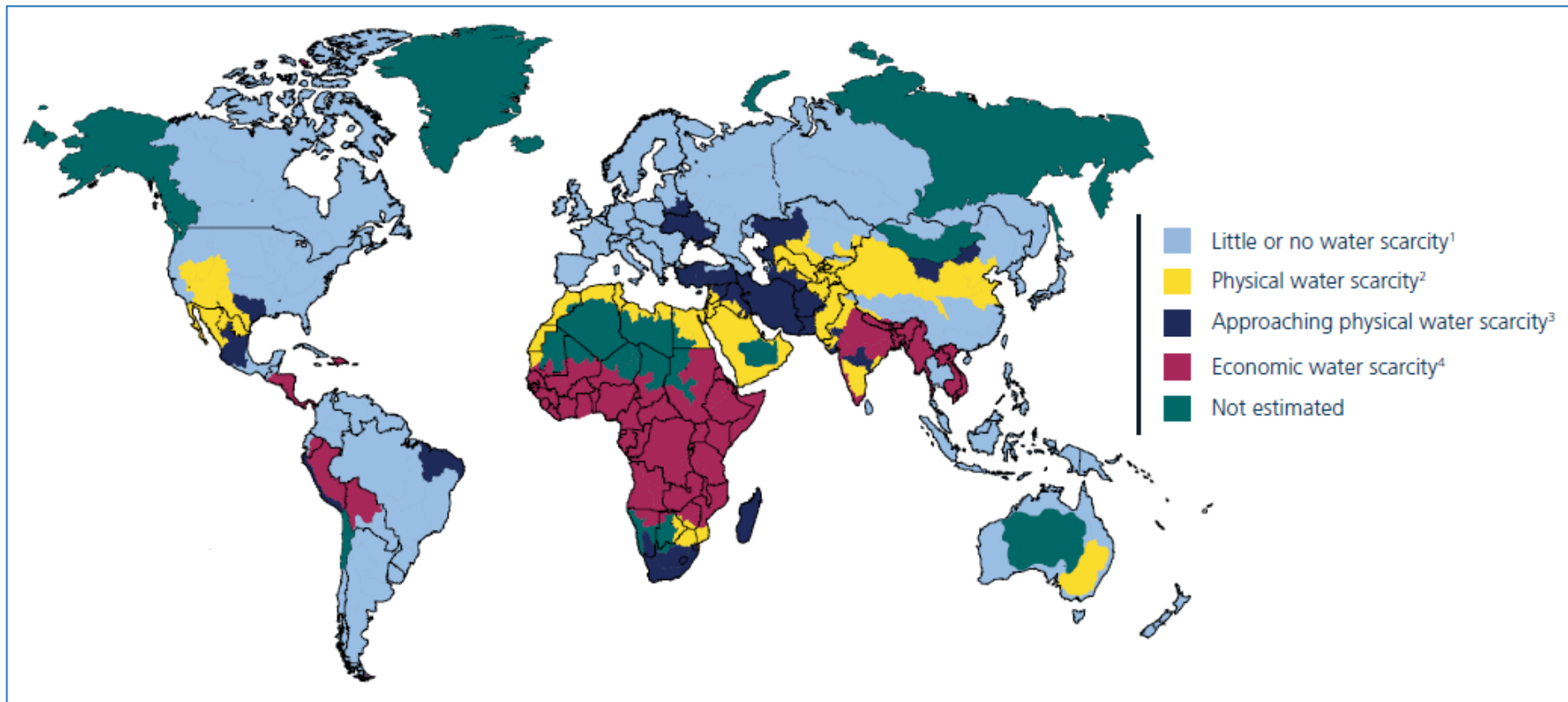
Nepal's Cabinet Meeting at Everest Base Camp, 2009.12.04



Maldives government meets underwater to Show Effects of Global Warming, Waleed Fakhroo , 2009.10.19



FIGURE 2.5 GLOBAL PHYSICAL AND ECONOMIC WATER SCARCITY



Notes:

¹ Little or no water scarcity. Abundant water resources relative to use, with less than 25% of water from rivers withdrawn for human purposes.

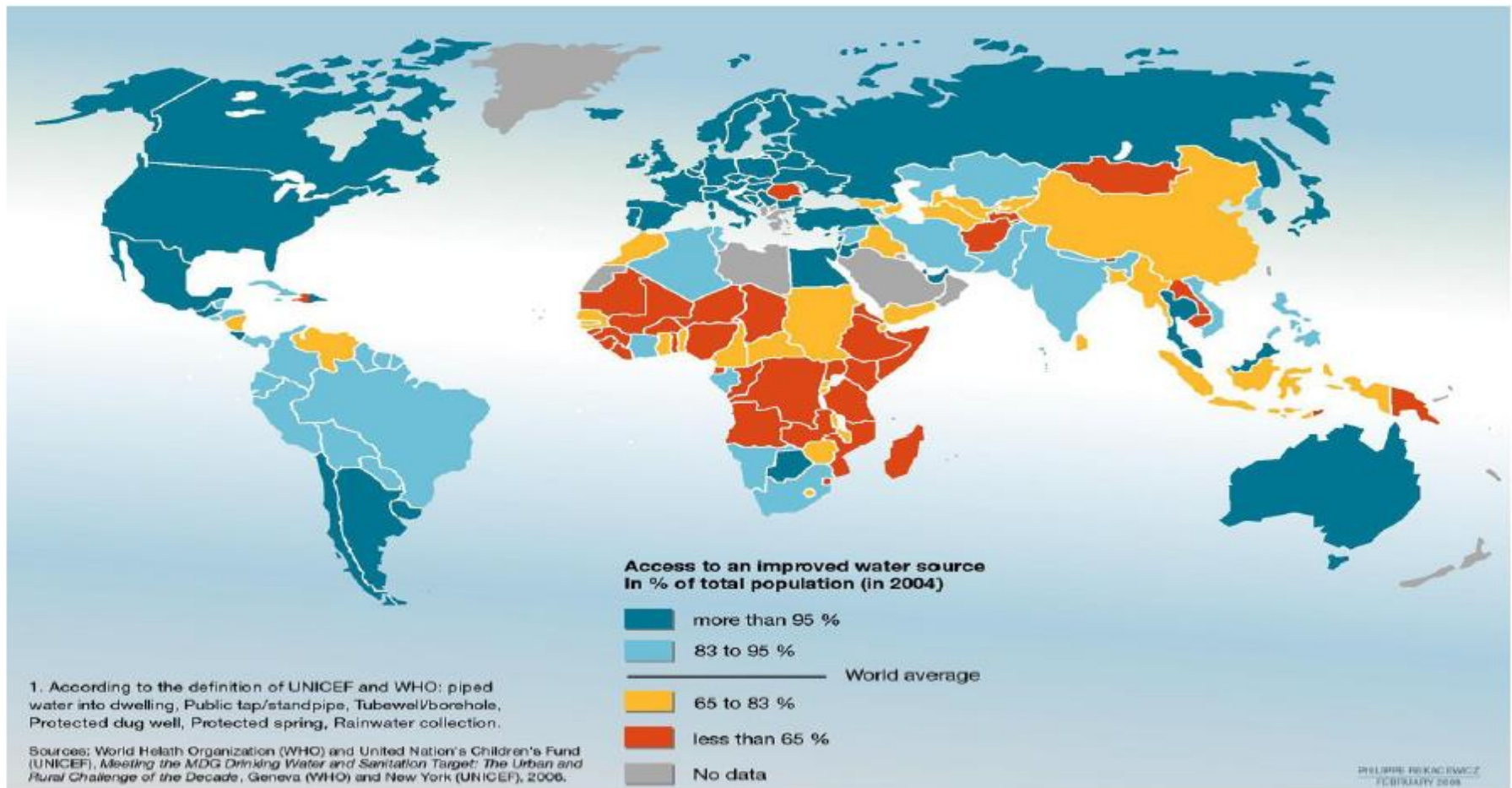
² Physical water scarcity (water resources development is approaching or has exceeded sustainable limits). More than 75% of river flows are withdrawn for agriculture, industry, and domestic purposes (accounting for recycling of return flows). This definition – relating water availability to water demand – implies that dry areas are not necessarily water scarce.

³ Approaching physical water scarcity. More than 60% of river flows are withdrawn. These basins will experience physical water scarcity in the near future.

⁴ Economic water scarcity (human, institutional, and financial capital limit access to water even though water in nature is available locally to meet human demands). Water resources are abundant relative to water use, with less than 25% of water from rivers withdrawn for human purposes, but malnutrition exists.

Source: CAWMA (2007, Map 2.1, p. 63), reproduced with permission from the International Water Management Institute (IWMI).

Access to an Improved water source



a. September 1977

b. April-June 1986

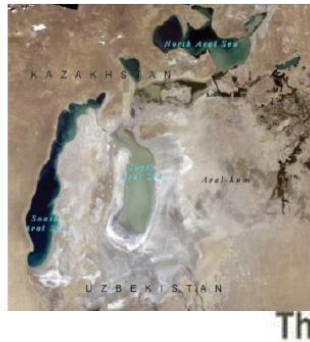
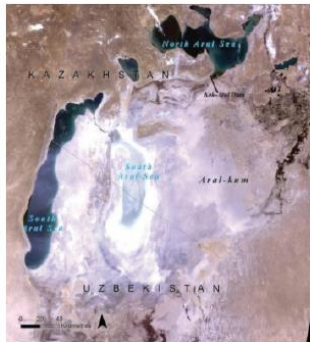
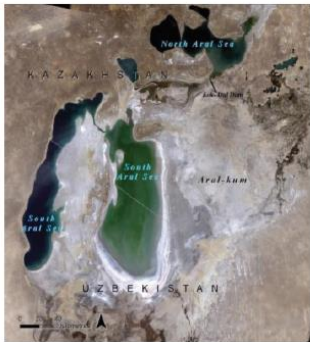
c. July-October 1999



d. July-September 2006

e. June 2009

f. June 2013



Landsat Satellite Images Showing the Constant Decline of the Aral Sea from 1977 to 2013

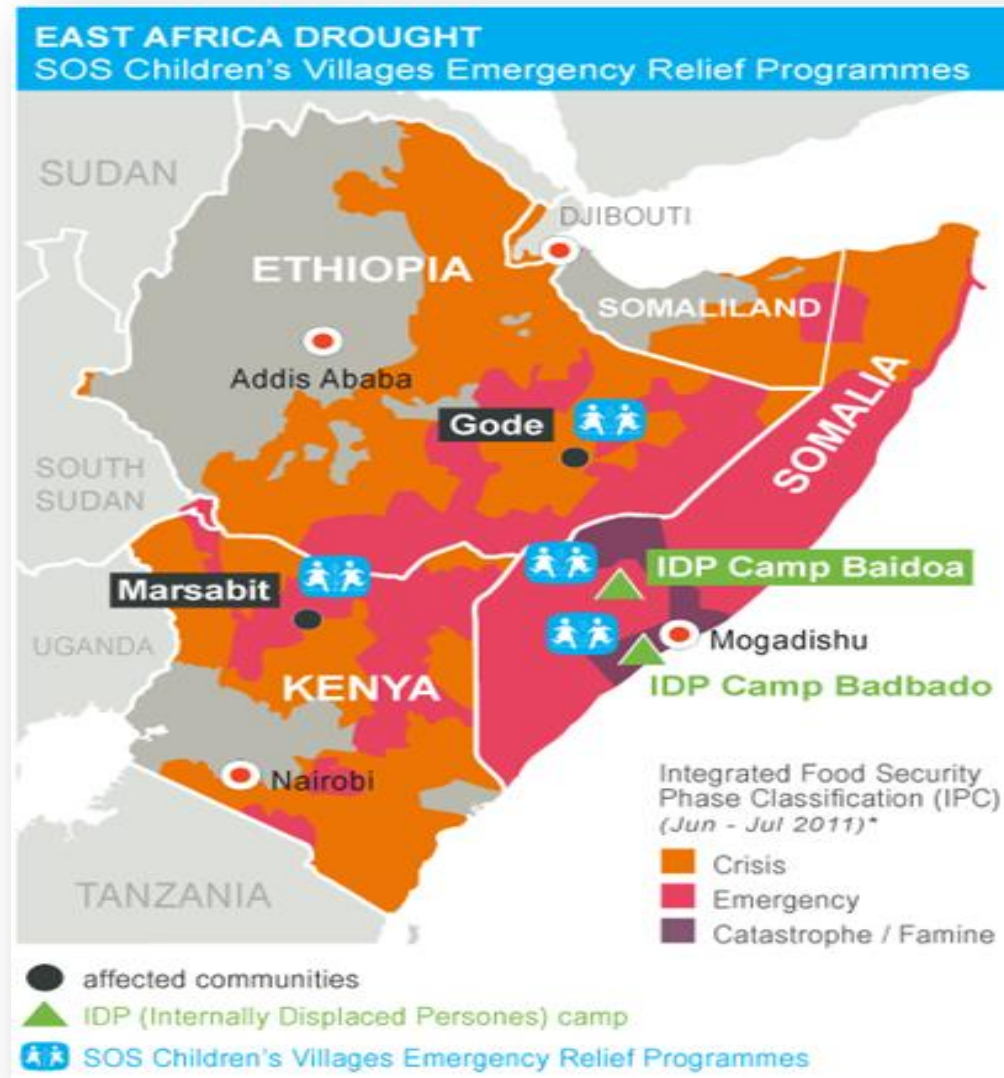
Source: UNEP Global Environmental Alert Service (2014) with data from USGS/NASA.

<https://openknowledge.worldbank.org/bitstream/handle/10986/26207/W16005.pdf?sequence=2&isAllowed=y>

The Disappearance of Lake Chad in Africa



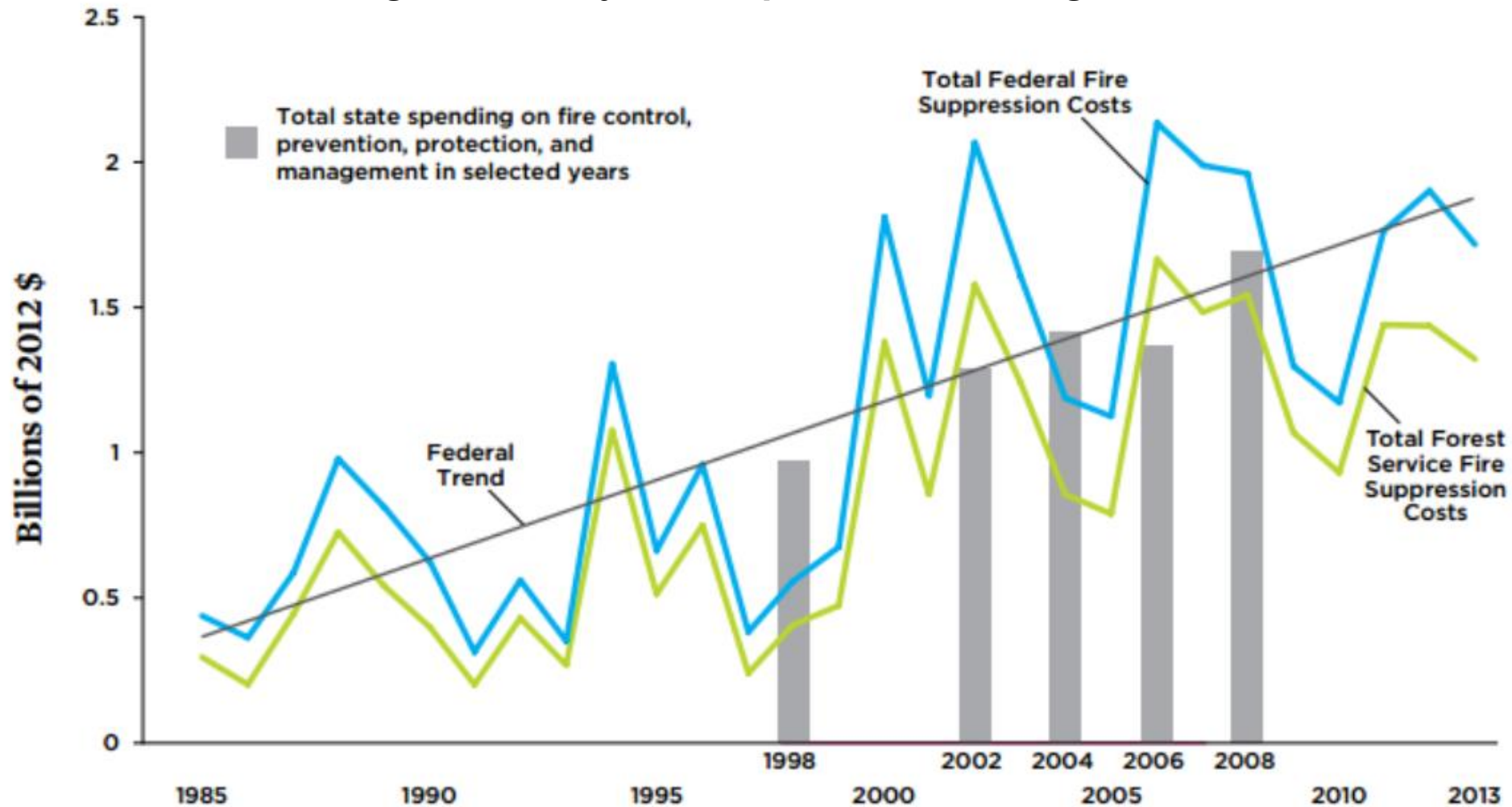
East Africa Drought due to Climate Change



장기간 계속된 가뭄에 이은 기근, 소말리아, 케냐,
에티오피아 가장 심각 - 1200만 명 기아, 75만 명 죽음의 위기

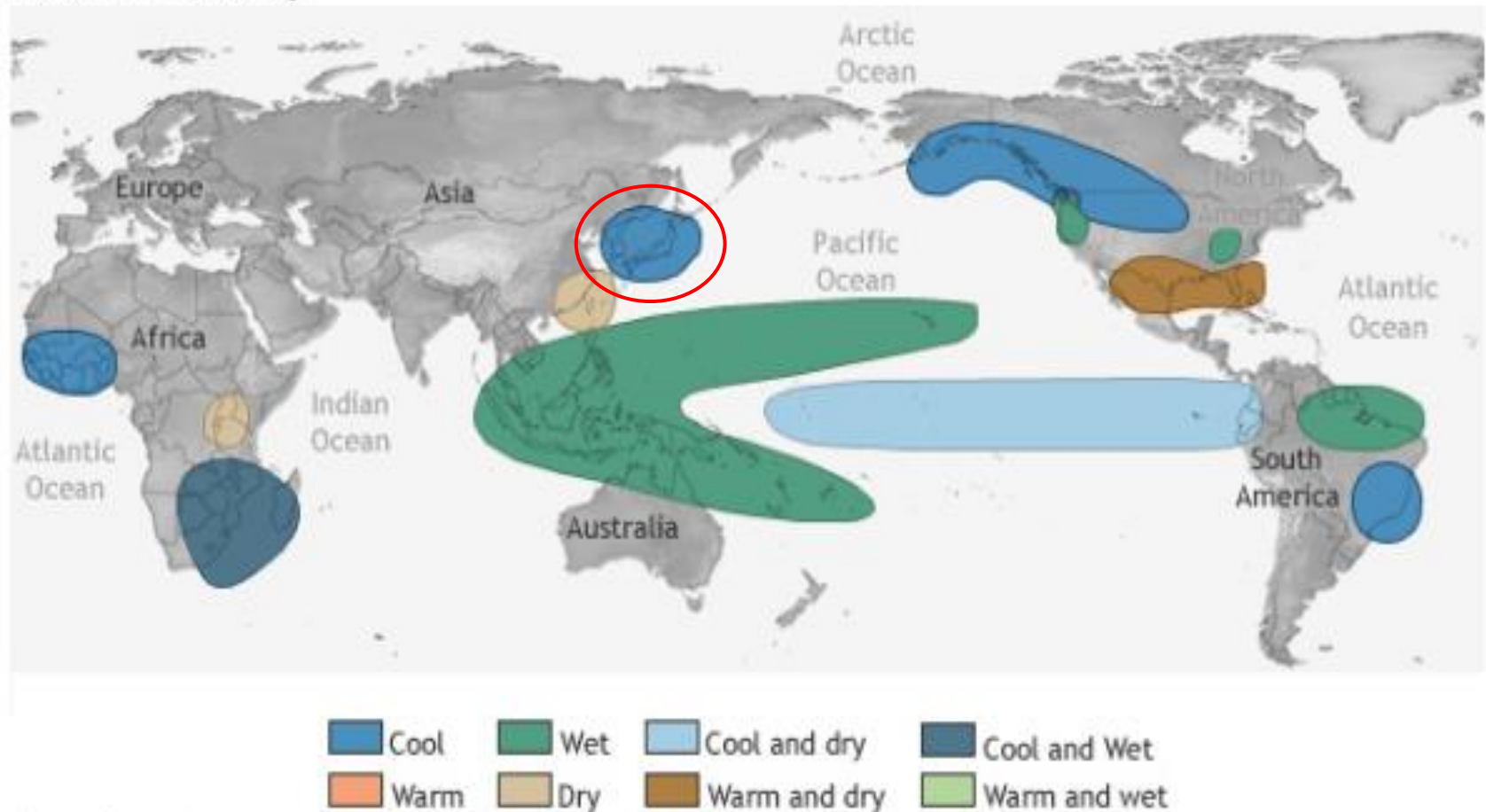
California Wildfires 2015

How Climate Change and Risky Development are raising costs of US wildfires



LA NIÑA CLIMATE IMPACTS

December-February



적도 부근 동태평양 수온 하강,
라니냐의 영향으로 북서풍이 강해지면서 중국과 몽골을 거쳐오는 바람에 미세
먼지 유입량이 대폭 늘어날 가능성 확대

<https://www.climate.gov/news-features/featured-images/global-impacts-el-ni%C3%B1o-and-la-ni%C3%B1a>

Going Hungry : Consequences of the Food Crisis

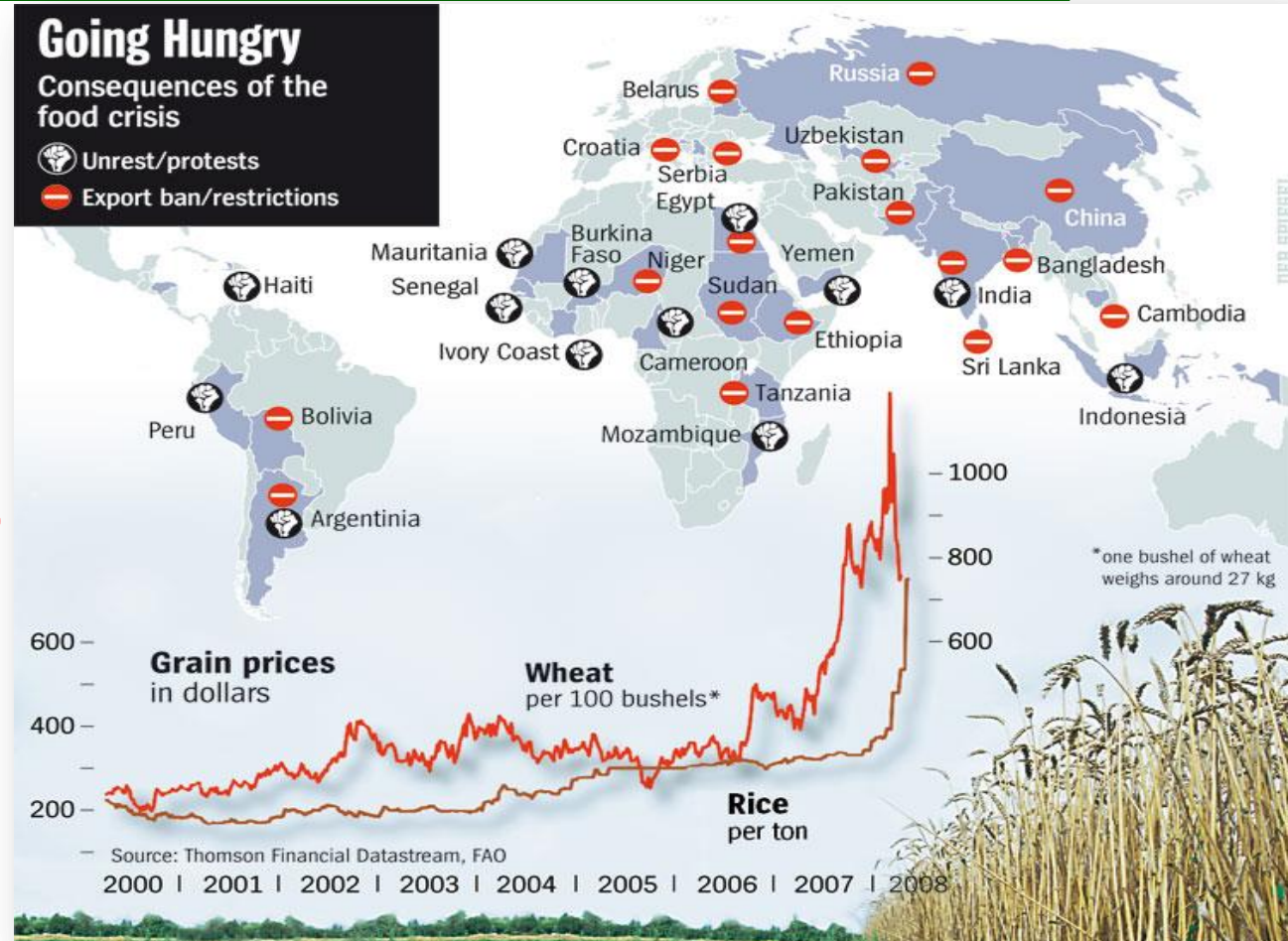
Global warming :
Increase soil evaporation
rates, Increase the
chances of droughts

Source : www.agricorner.com

The **poorest** countries would
be **hardest** hit.

Marine life and the fishing
industry
will also be severely
affected.

Source : University of Colorado



- An agricultural land loss, in particular in areas such as South East Asia
- Low lying areas such as Bangladesh, India and Vietnam will experience major loss of rice crop.

Source : http://en.wikipedia.org/wiki/Climate_change_and_agriculture

Megacities hit hard by surging sea levels even at 2C rise

Surging sea levels

2°C spike in temperature would submerge land occupied by 280 million people while a 4°C increase would affect some 600 million, new study says

Worst-affected major cities

Percentage of population at risk in temperature rise

● 4°C scenario
● 2°C scenario

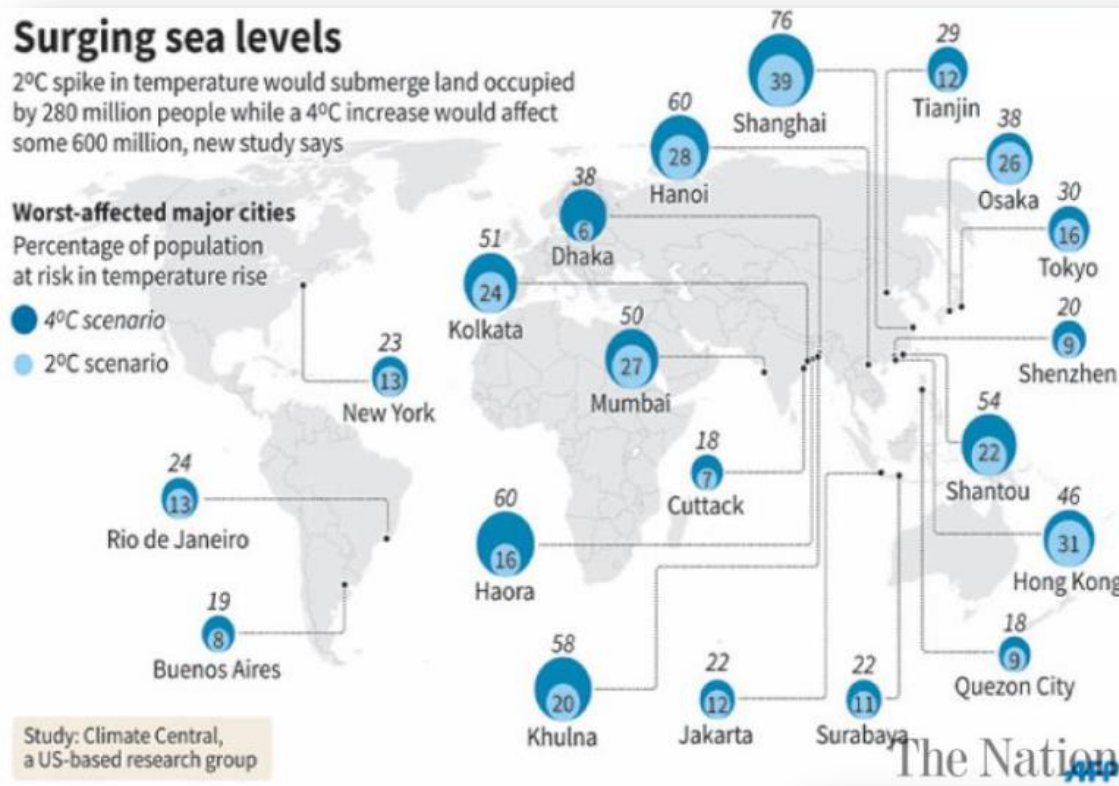
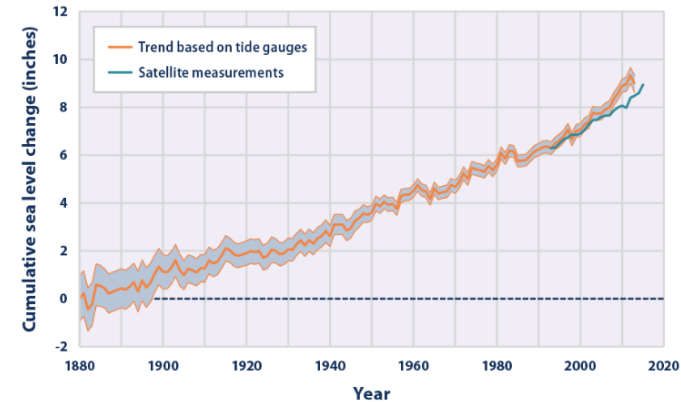


Figure 1. Global Average Absolute Sea Level Change, 1880–2015



<https://www.epa.gov/climate-indicators/climate-change-indicators-sea-level>

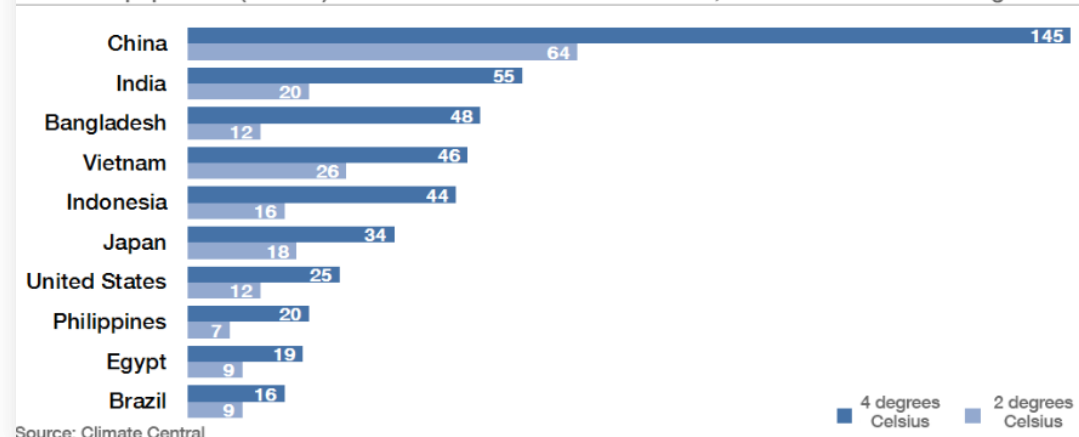
Refugees by Sea level rise

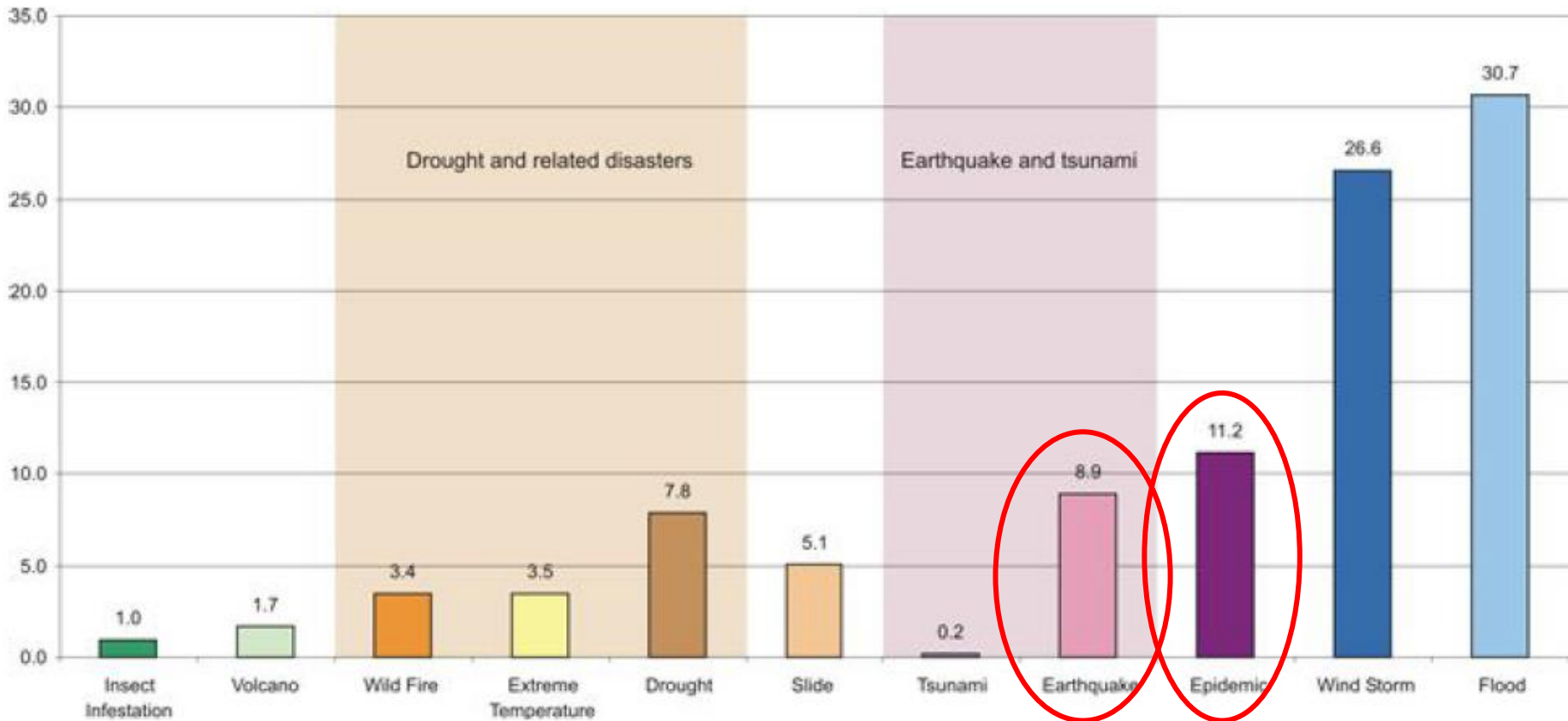
- 40% of world population live on the seashore within the range of 100km, and 0.1 billion people live at the sea level of 1m height.

<http://nation.com.pk/snippets/10-Nov-2015/megacities-hit-hard-by-surging-sea-levels-even-at-2c-rise>

Which countries are most in danger from rising sea levels?

Total 2010 population (millions) below median locked-in sea level rise, based on different warming levels





8,600

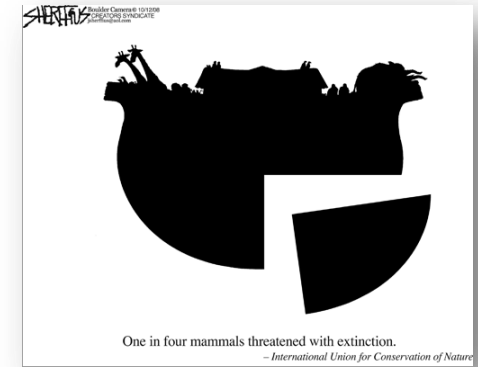
People killed by Ebola virus disease in West Africa in 2014

The impact of Ebola

The number of people killed by Ebola virus disease in West Africa eclipsed the total number of people that died due to disasters.

Increasing endangered species

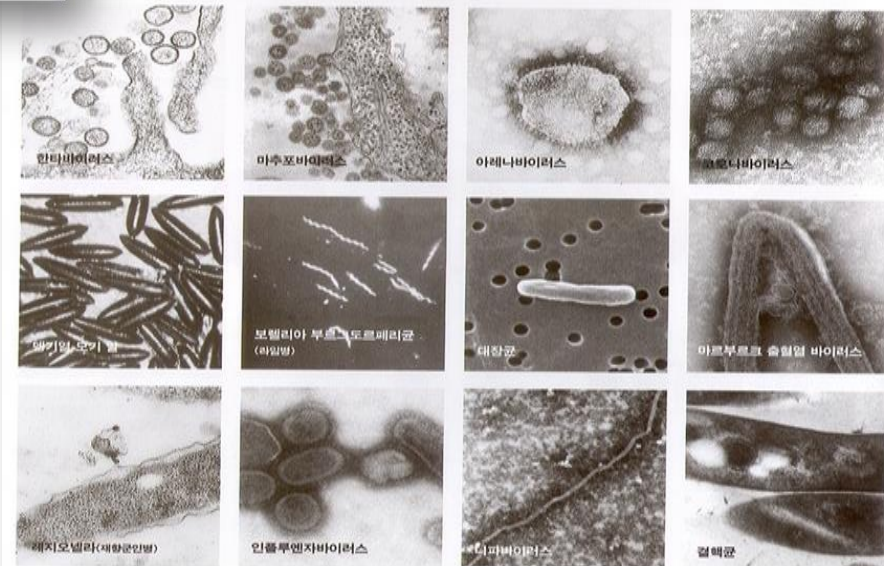
<Source : Al Gore, An Inconvenient Truth, 2006>



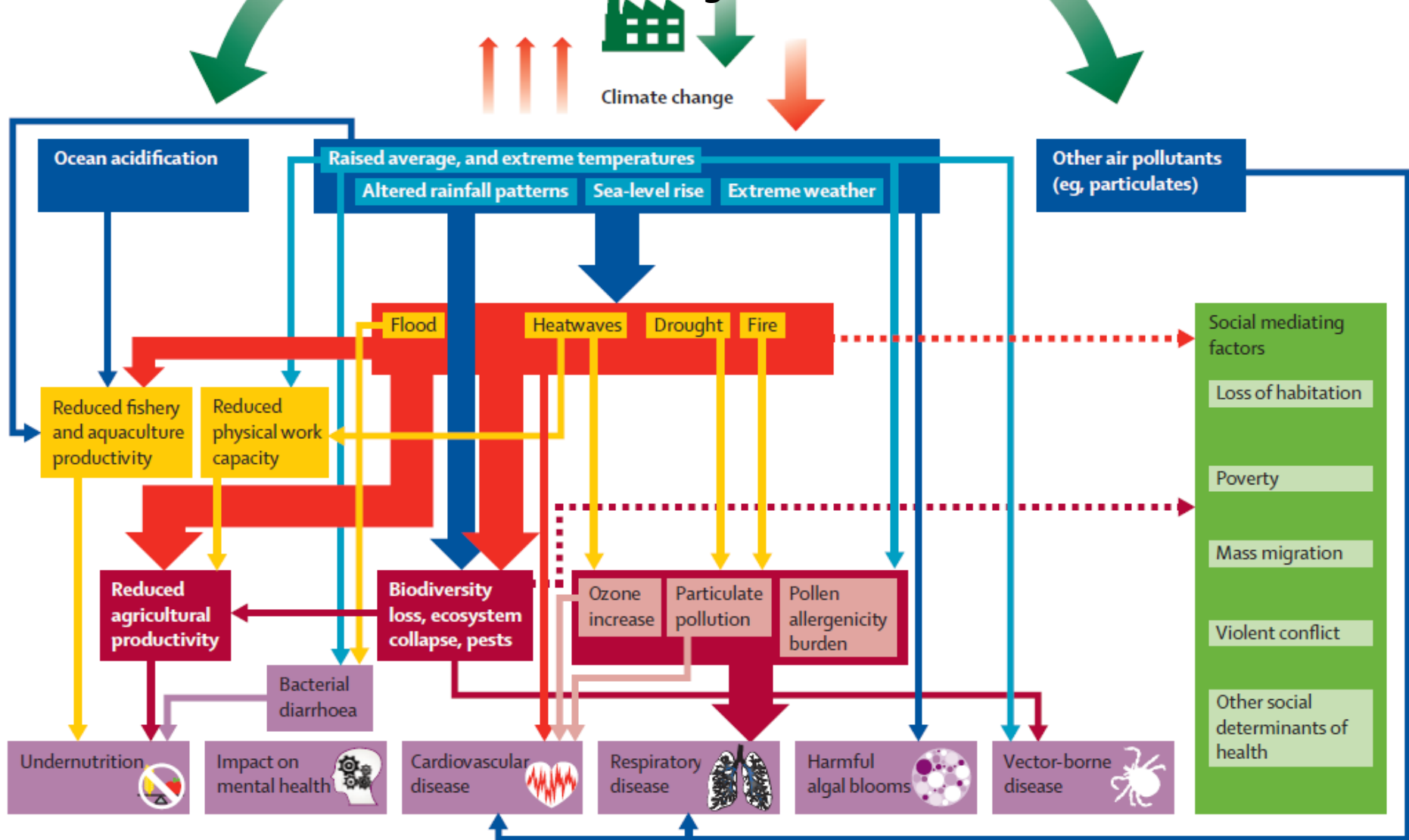
One in four mammals threatened with extinction



Spreading disease by virus



An overview of the links between greenhouse gas emissions, climate change, and health

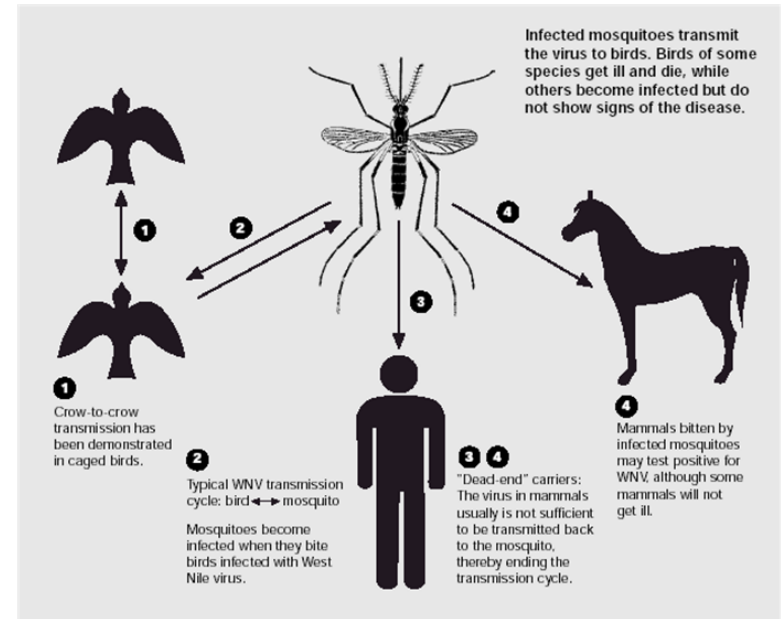


Epidemic Outbreaks

Ebola virus outbreak : 2014 CNN



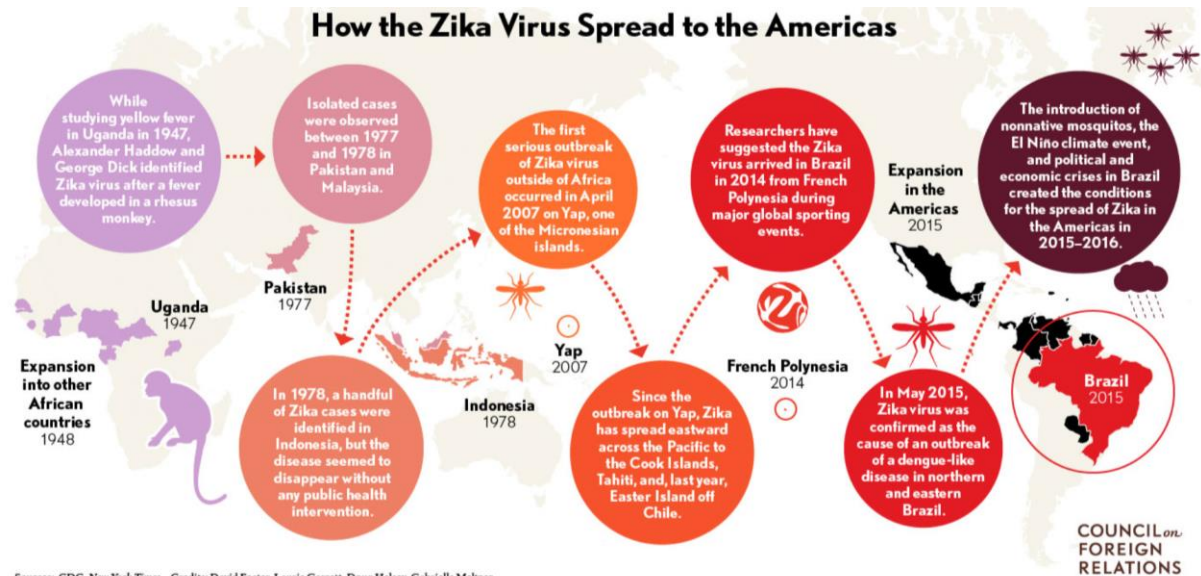
➤ West Nile Virus, First Outbreak in 1999



Medecins Sans Frontieres (MSF) : "one of the world's most deadly diseases."

"It is a highly infectious virus that can kill up to 90% of the people who catch it, causing terror among infected communities."

Zika Virus 1947 through 2016



<http://www.cfr.org/public-health-threats-and-pandemics/zika-virus/p37527>

From Jan. 2014 to Nov. 2016

Avian Influenza

has been identified in **77 countries** and **13 strains** have been detected.

Avian Influenza has **killed** both **domestic and wild birds** and has led to the **destruction of hundreds of millions of domestic birds**.

Data from WAHIS

Biggest, most damaging AI outbreak in S. Korea's history raging on, 2016

Nationwide Avian Influenza outbreak

- Areas with outbreaks
23 cities and counties in seven municipalities
- Number cases
52 (43 confirmed, 9 under assessment)



Data: Ministry of Agriculture, Food and Rural Affairs

Outbreak locations

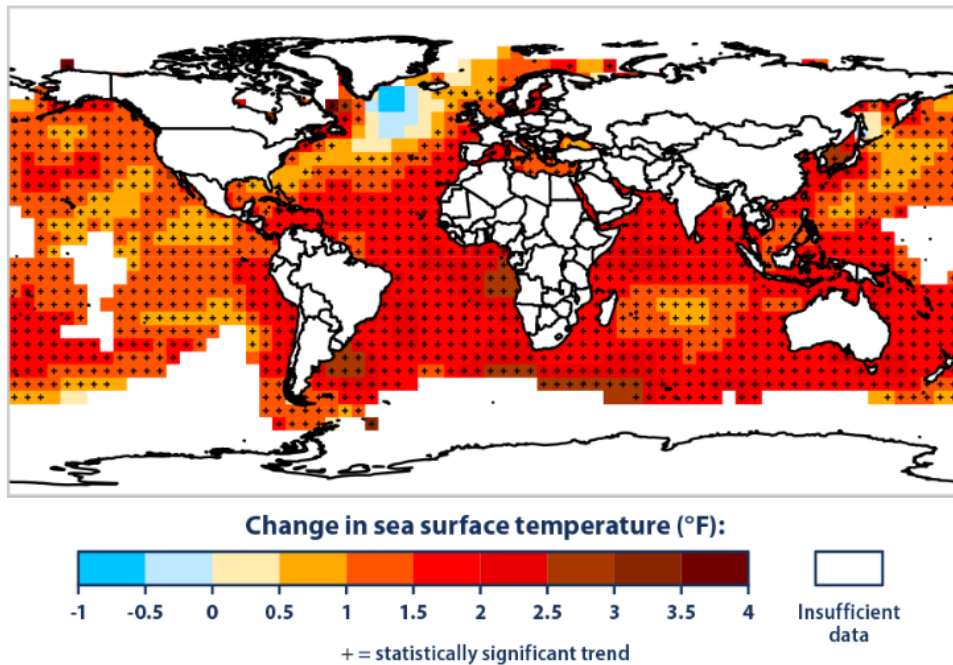
Gyeonggi	①Anseong ②Yangju ③Yangpyeong ④Yeoju ⑤Icheon ⑥Pyeongtaek ⑦Pocheon ⑧Hwaseong
Gangwon	⑨Cheolwon
Sejong	⑩Sejong
North Chungcheong	⑪Goesan ⑫Eumseong ⑬Jincheon ⑭Cheongju ⑮Chungju
South Chungcheong	⑯Asan ⑰Cheonan
North Jeolla	⑱Kimje ⑲Jeongeup
South Jeolla	⑳Naju ㉑Muan ㉒Jangseong ㉓Haenam

Comparison of AI outbreaks in 2014 and 2016

2014		2016
Jan. 16–July 29	Duration	Nov. 16 –
H5N8	Virus type	H5N6
Gochang North Jeolla	Location of first case	Haenam, South Jeolla Eumseong, North Chungcheong
212	Confirmed infections	43
13,961,000	Animals culled	8,878,000 culled 1,541,000 waiting

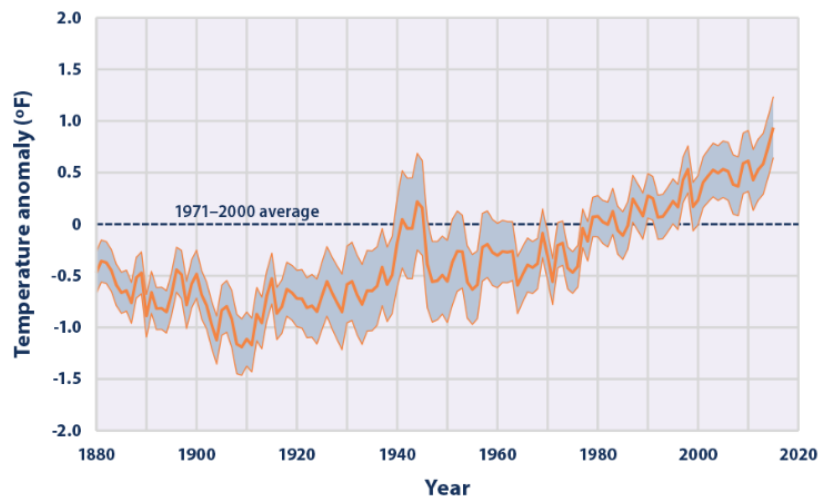
Figure 2. Change in Sea Surface Temperature, 1901–2015

Data source: IPCC, 2013⁷; NOAA, 2016⁸ Web update: August 2016

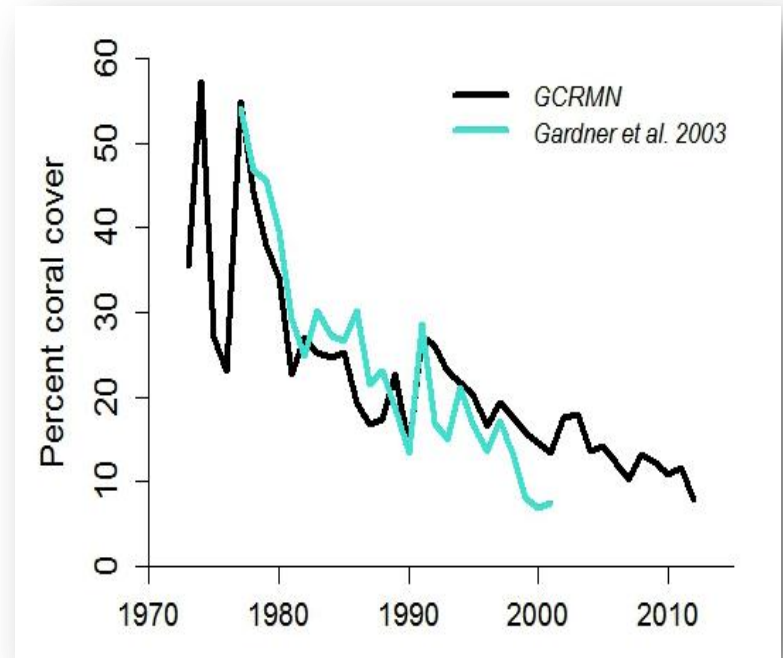


<https://www.epa.gov/climate-indicators/climate-change-indicators-sea-surface-temperature>

Figure 1. Average Global Sea Surface Temperature, 1880–2015



Data sources: Bates, 2016,⁵ González-Dávila, 2012,⁶ Dore, 2015 Web update: August 2016



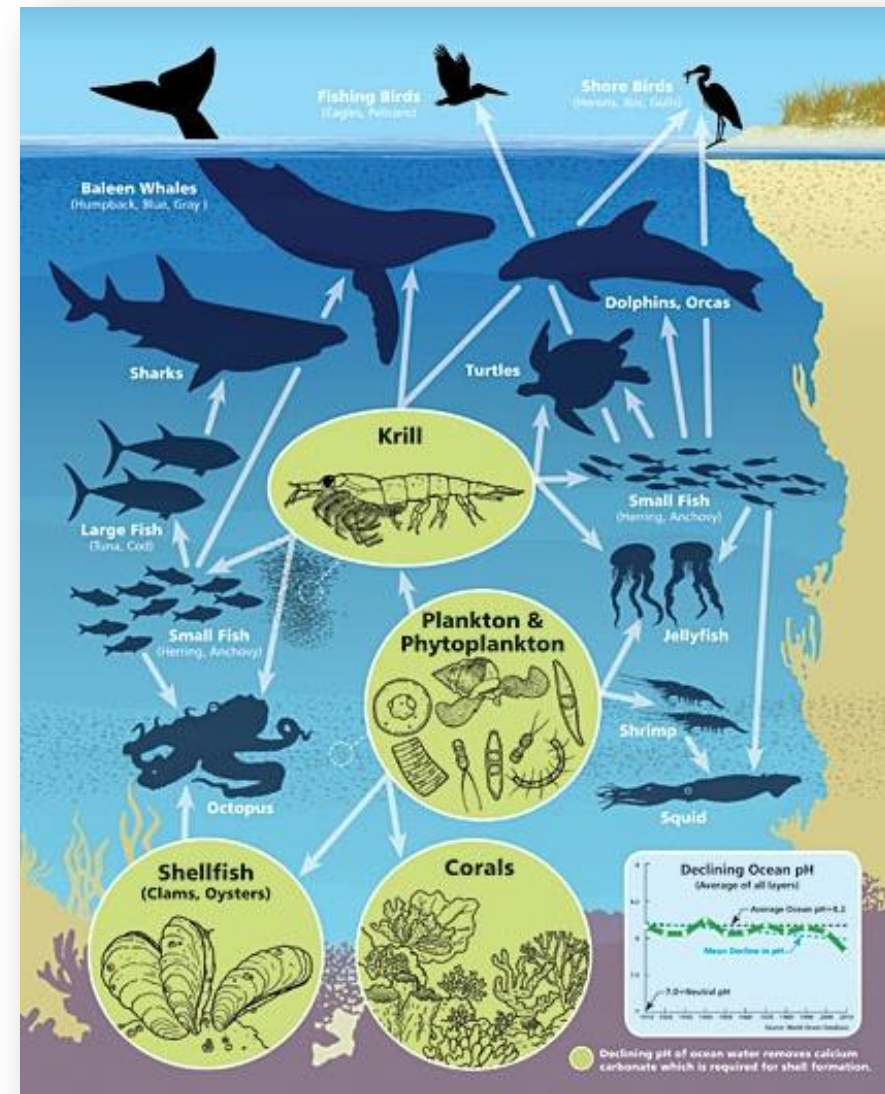
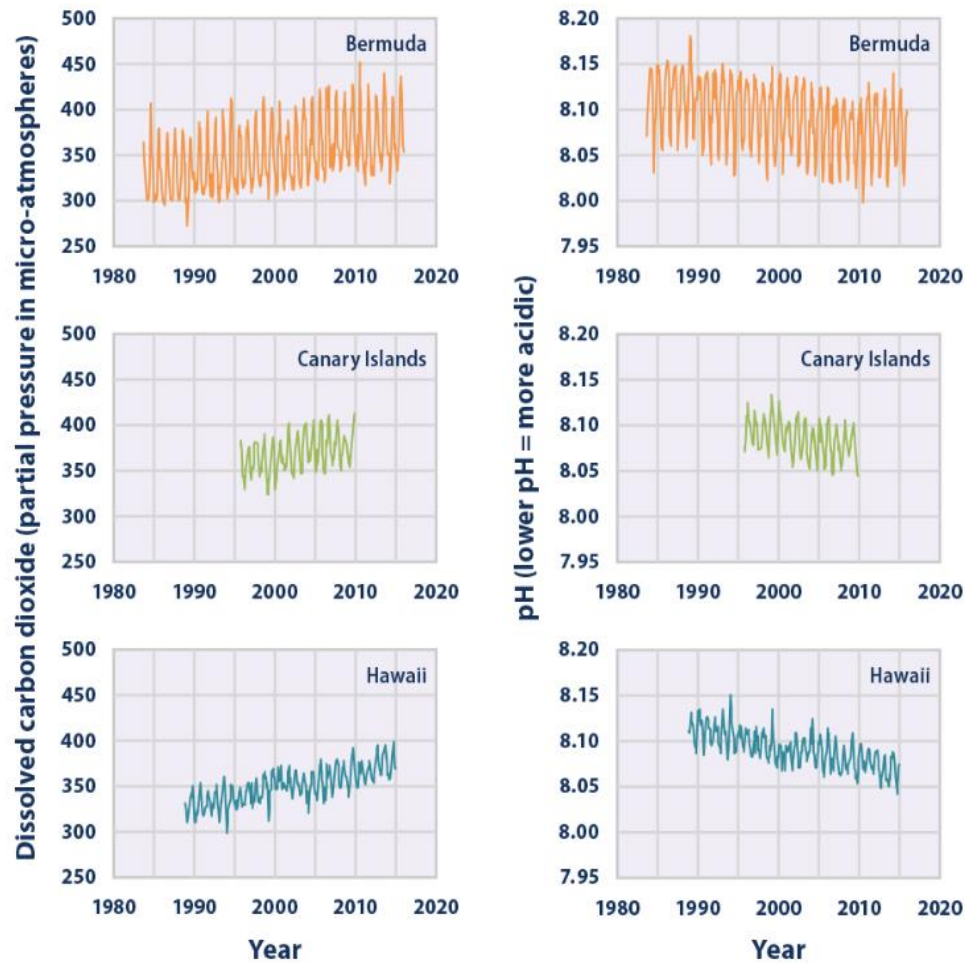
Source: guardian.co.uk, 23 February 2010

Walleye Pollack Catch on decrease due to rising sea-level in Korea



CORAL COLLAPSE Threatening Shellfish, Corals and the Entire Ocean Food Web

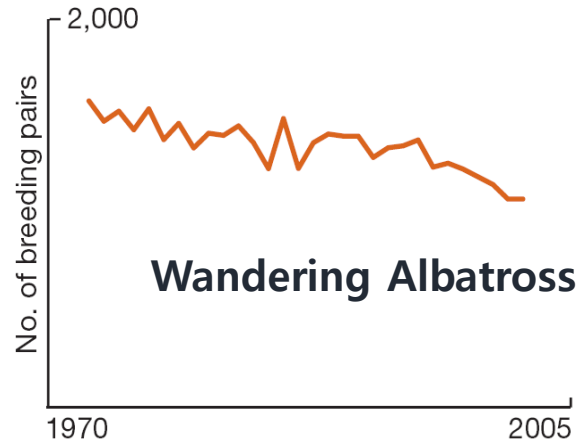
Figure 1. Ocean Carbon Dioxide Levels and Acidity, 1983–2015



<https://www.epa.gov/climate-indicators/climate-change-indicators-ocean-acidity>

Source: By Brita Belli. E - The Environmental Magazine E-Magazine © **Jerry Russell**

Biodiversity Crisis



Wandering albatross (*Diomedea exulans*), South Atlantic Ocean
(Bird Island, South Georgia)



출처: WWF Living Planet
Report 2008, www.Chrisjordan.com

Whale found dying off coast of Norway with 30 plastic bags in its stomach :



The Telegraph News, 3 Feb. 2017

<http://www.dailymail.co.uk/sciencetech/article-4622564/Cuvier-s-beaked-whale-4kg-plastic-bags-stomach.html>

The impact of the plastic had irritated and inflamed the stomach and intestinal walls, and that the 'plastic impaction was very significant and likely very sore, causing the animal to drift into shallower waters and live strand'



Rise in Natural Disasters

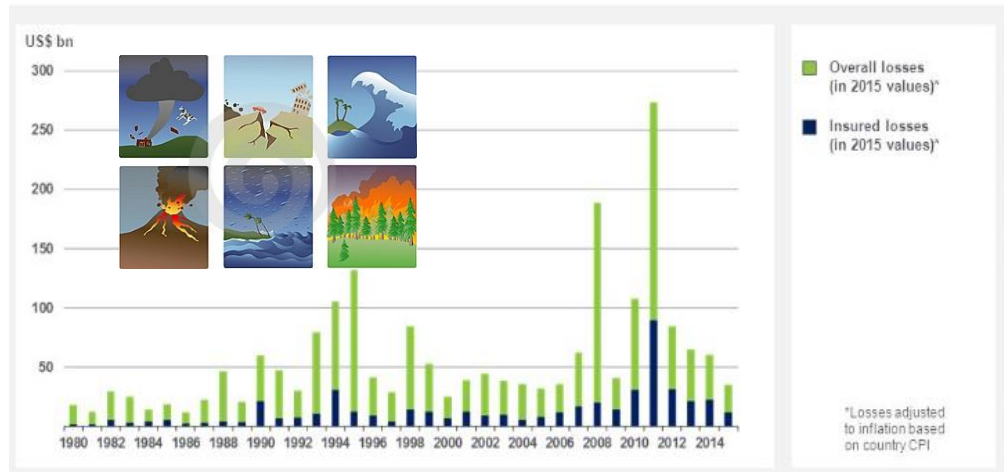
Global Natural Catastrophe Update : 1980-2015

Global Natural Catastrophe Update

Loss events worldwide 1980 – 2015

Overall and insured losses (January – June only)

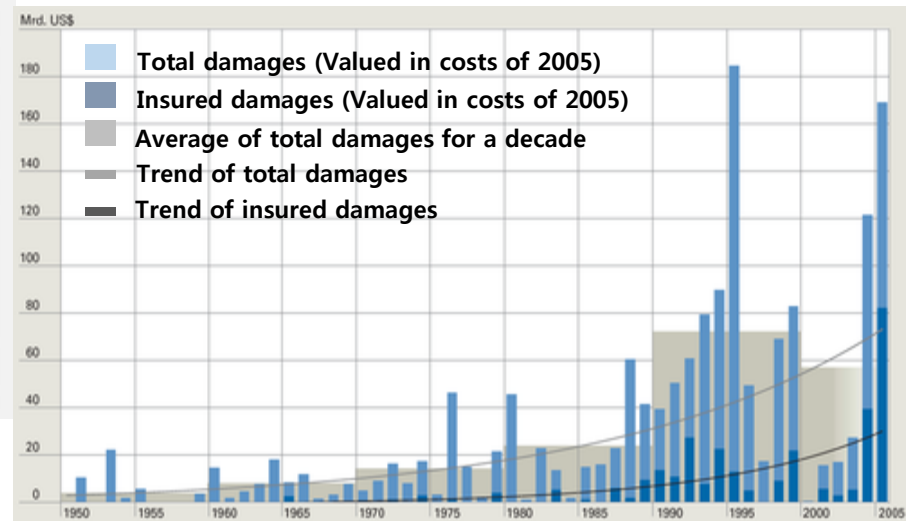
Munich RE



Source : Natural Catastrophe Year in Review, January 7 ,2015 Munich RE

- ✓ 1990년대 중반 이후 자연재해 급증 : 1970년 69건, 2000년대 매년 350건
- 1980년 ~ 2007년 가뭄, 홍수, 폭풍, 산사태, 산불 등 8천4백 건 / 200만 명 사망, 1조5 천억 달러 재산 손실
- ✓ 특히 개발도상국 피해 급증, 최근 50년간 자연 재해 경제적 손실 50배 증가,
- ✓ 재난방지 강화로 인명 피해는 10배 감소

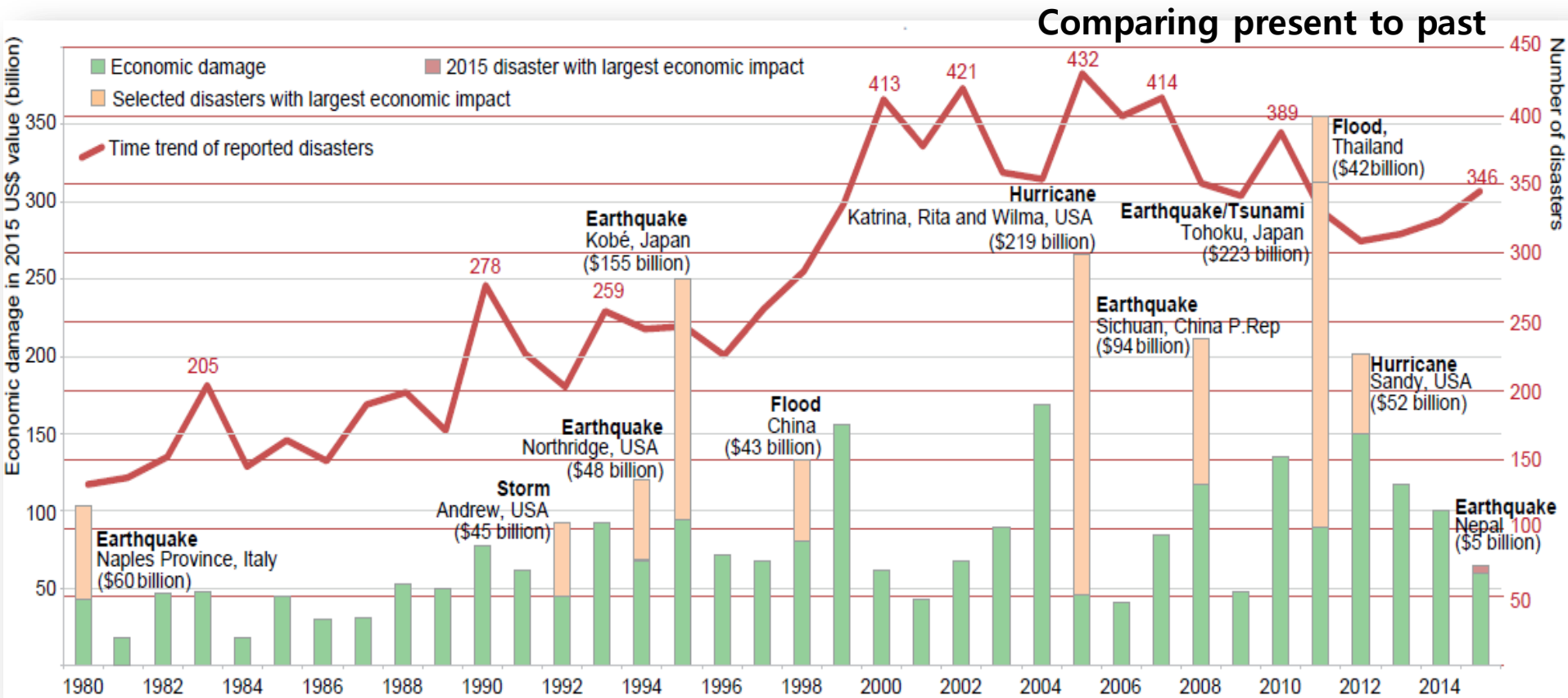
Economic Costs of Natural Disasters: 1950-2005



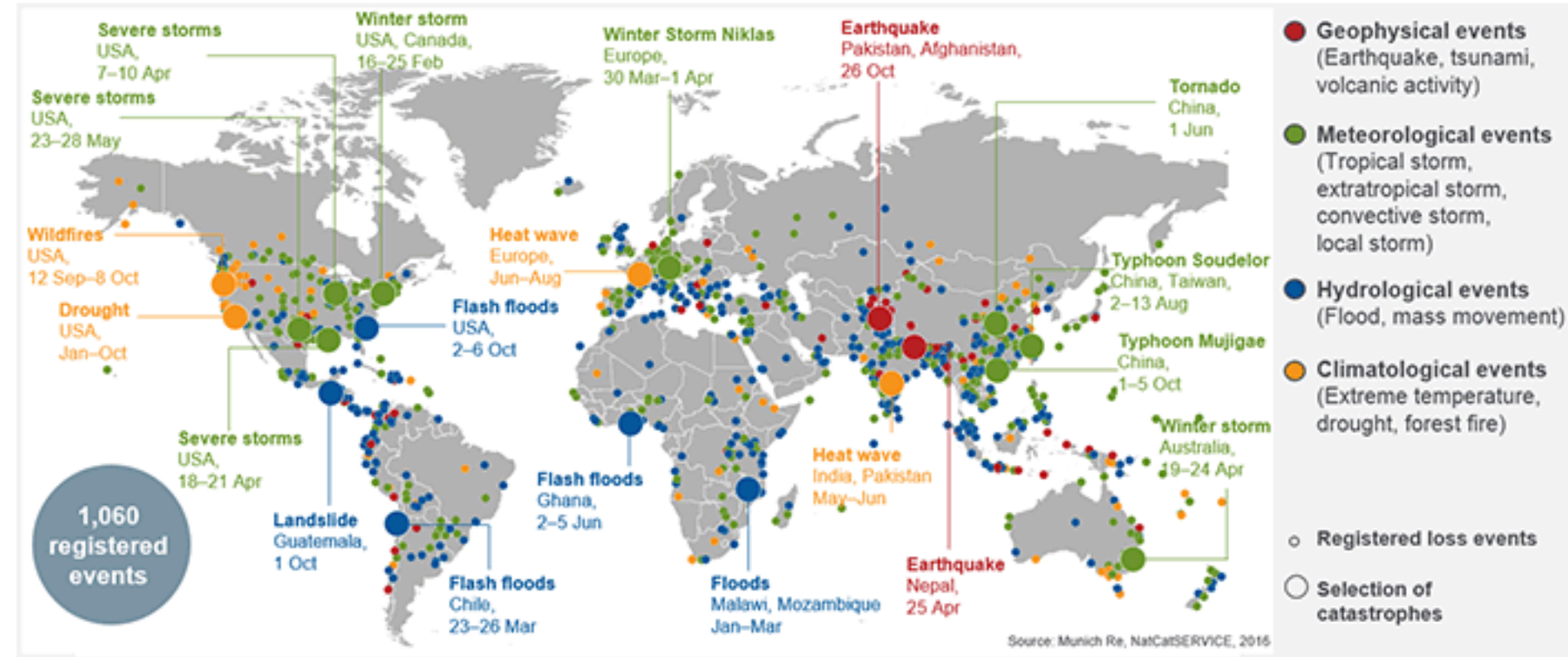
During 1990's, more than 200 million people had become the victim of natural disasters

Source : BBC news 18 Dec. 2008, UNEP

Annual reported economic damages and time trend from disasters: 1980-2015



World Natural Catastrophe Losses, 2015



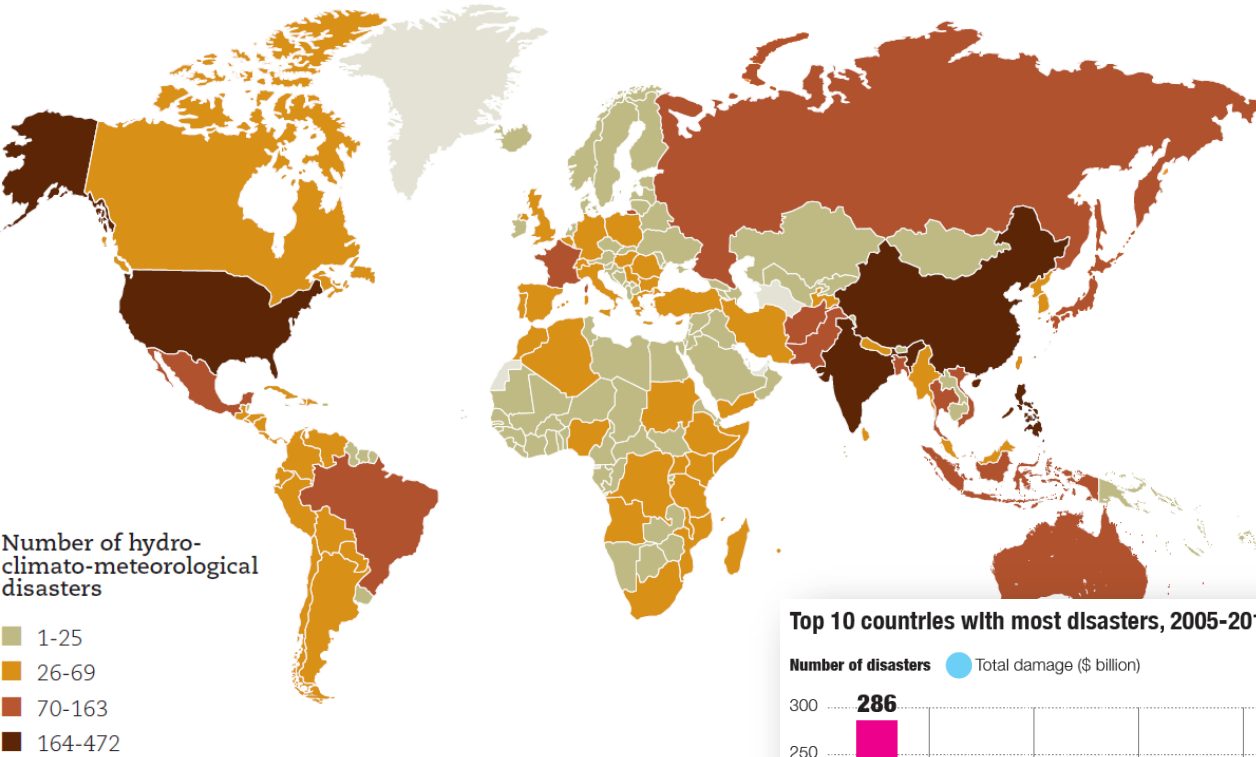
Source: © 2016 Munich Re, Geo Risks Research, NatCatSERVICE. As of March 2016.

2015 disasters in numbers

346 reported disasters
 22,773 people dead
 98.6million people affected
 US\$66.5billion economic damage

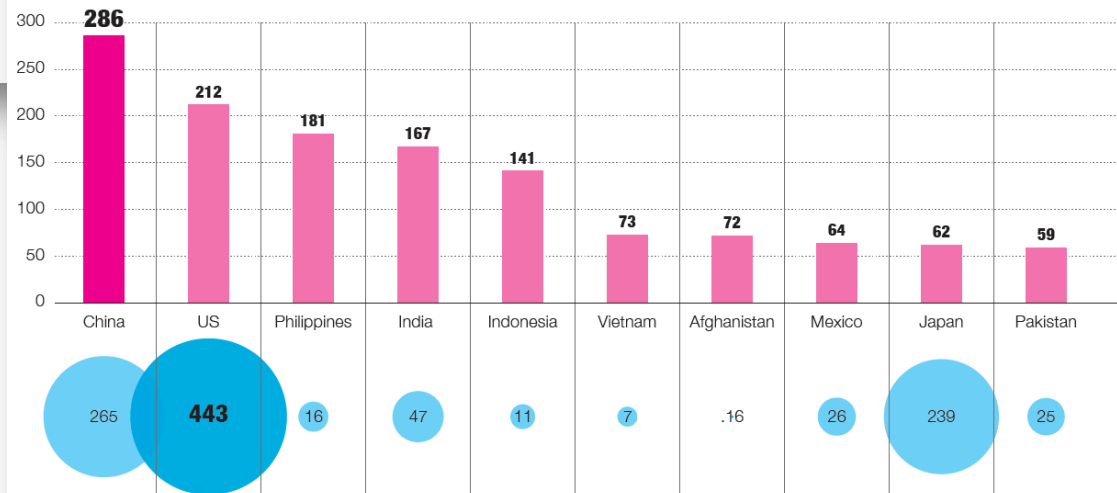
Figure 1

Number of weather-related disasters reported per country (1995-2015)



Top 10 countries with most disasters, 2005-2014

Number of disasters Total damage (\$ billion)

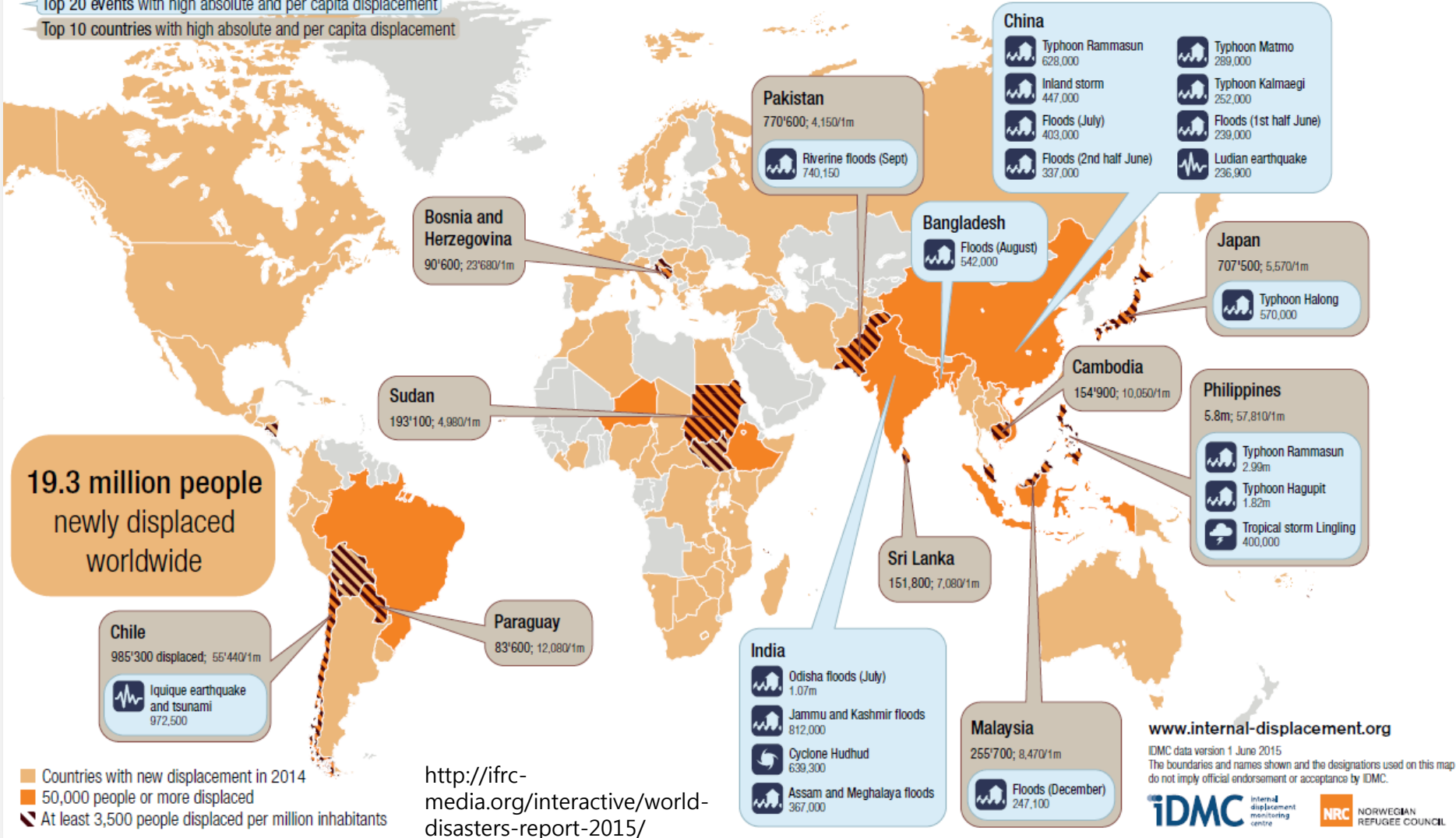


China has the most disasters from 2005-2014 but the US has incurred the most damage, and while Japan is far behind in number of disasters, its economic loss is almost as big as that of China

Displacement related to disasters worldwide in 2014

<http://www.internal-displacement.org/assets/library/Media/201507-globalEstimates-2015/world-map-global-estimates-2015-web-ready2.pdf>

- Top 20 events with high absolute and per capita displacement
- Top 10 countries with high absolute and per capita displacement



***There were 317 natural disasters reported worldwide in 2014, affecting 94 countries**

5,884
People killed by
technological disasters

8,186
Deaths caused by
disasters in 2014

58,000,000
People affected by
floods, droughts and
storms in China

107,000,000
Number of people
affected by disasters

Science 2012

Collapse of Classic Maya Civilization Related to Modest Reduction in Precipitation

Martín Medina-Elizalde and Eelco J. Rohling*

The disintegration of the Classic Maya civilization in the Yucatán Peninsula and Central America was a complex process that occurred over an approximately 200-year interval and involved a catastrophic depopulation of the region. Although it is well established that the civilization collapse coincided with widespread episodes of drought, their nature and severity remain enigmatic. We present a quantitative analysis that offers a coherent interpretation of four of the most detailed paleoclimate records of the event. We conclude that the droughts occurring during the disintegration of the Maya civilization represented up to a 40% reduction in annual precipitation, probably due to a reduction in summer season tropical storm frequency and intensity.



- 마야인 300만명이 900년경 사라져 버렸다

UNFCCC 1992-2017

UNFCCC 협약 채택 ● 1992

UNFCCC 협약 발표 ● 1994

Berlin Mandate COP1 ● 1995

Kyoto 의정서 채택 ● 1997

Kyoto 의정서 발효 ● 2005

Bali 행동계획 ● 2007

Copenhagen Accord ● 2009

Cancun Agreements ● 2010

Durban Platform ● 2011

Doha Climate Gateway ● 2012

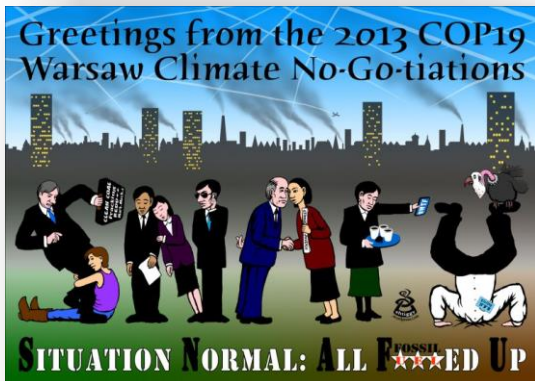
Warsaw Outcome ● 2013

Lima Call for Climate Action ● 2014

Post-2020 신기후체제 합의를 위한 Paris COP21 ● 2015

Marrakech COP22 ● 2016

Bonn COP23 ● 2017



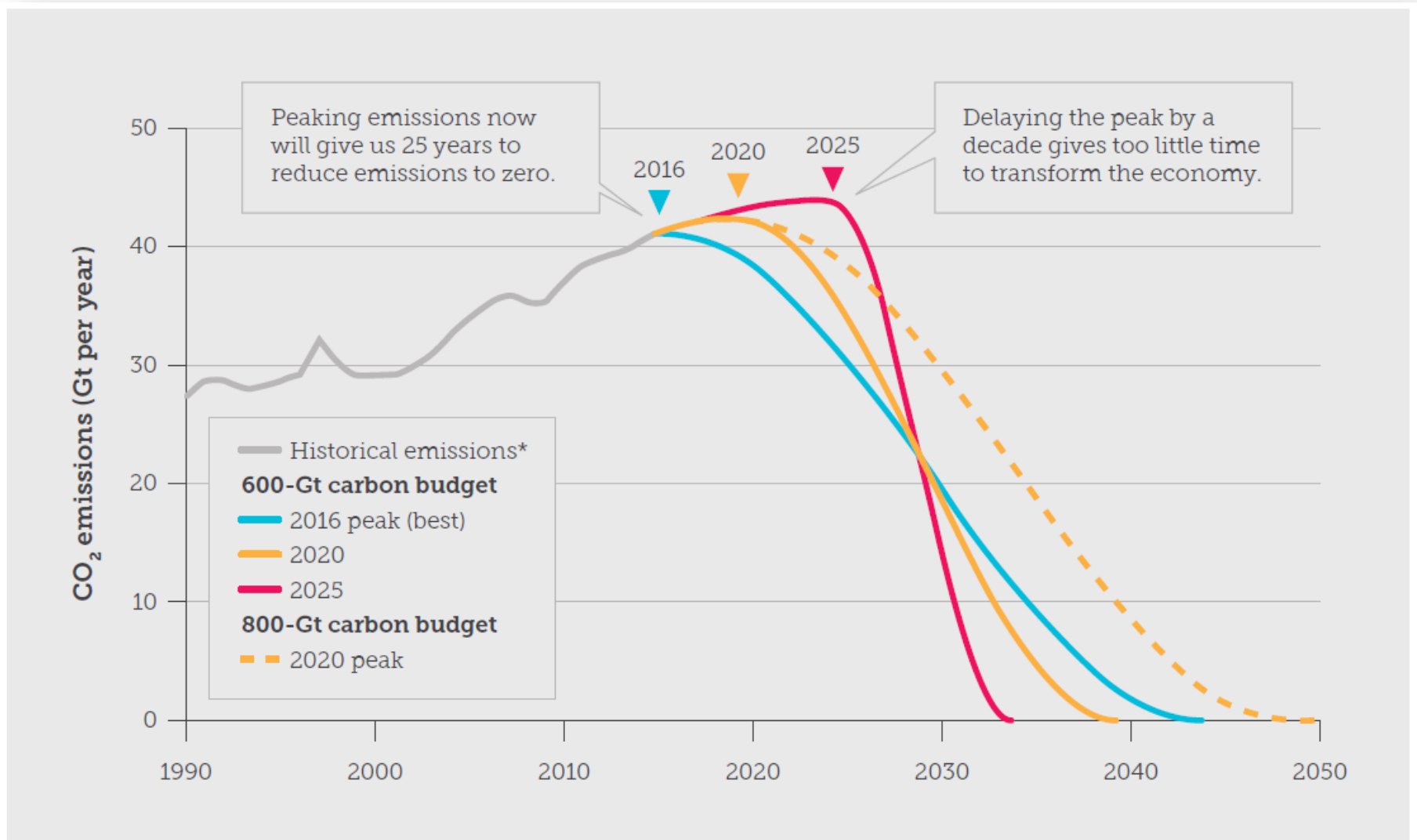
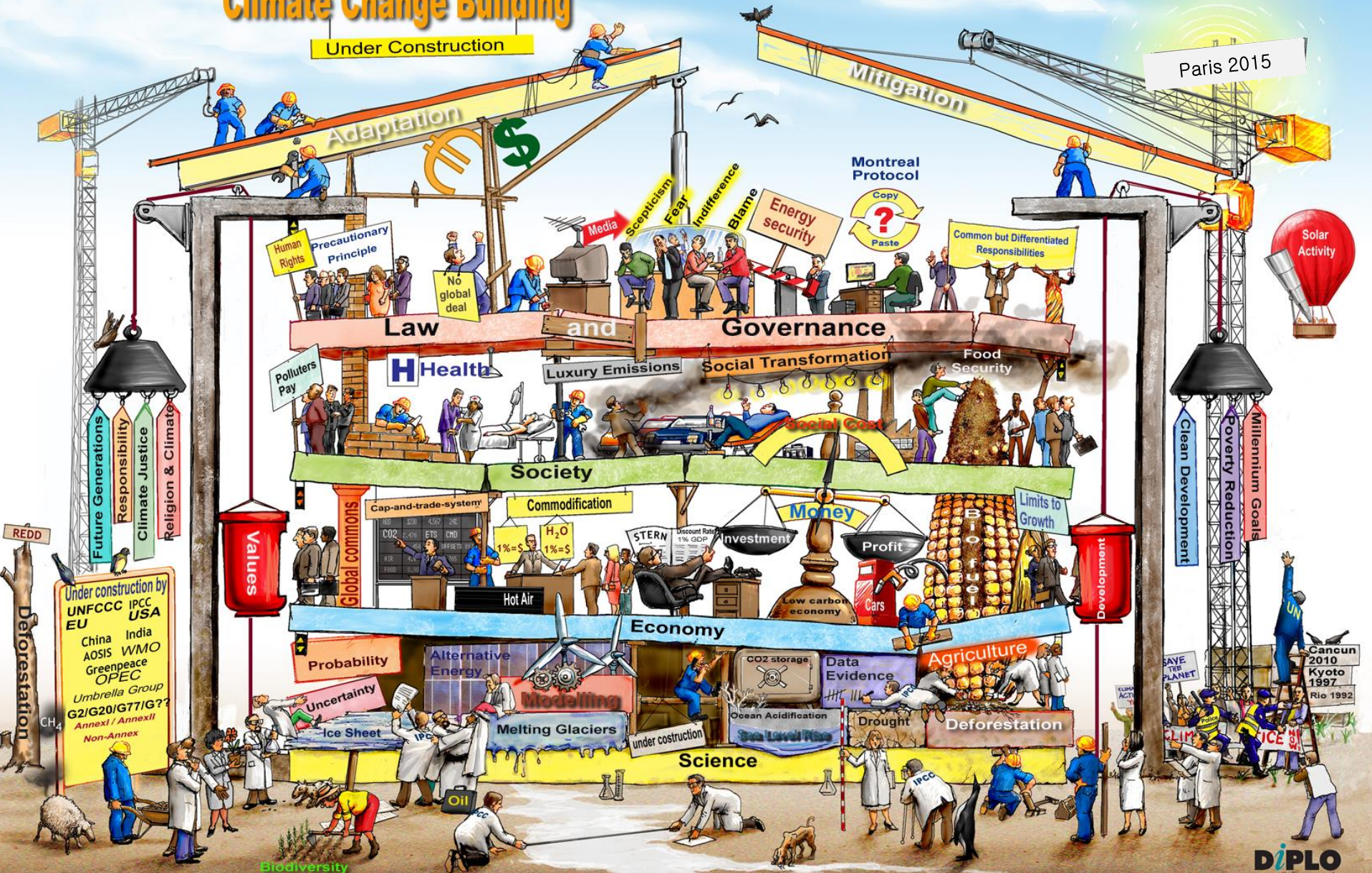


Figure 19: Emission reduction trajectories for meeting the Paris target(s). The year of peak emissions has an enormous effect on the steepness of the subsequent trajectory. Delaying peak emissions to 2025 is too late for any achievable emission reduction trajectory. **Source:** Figueres et al. 2017.

Climate Change Building

Under Construction

Paris 2015



Concept: Kurbalija Illustration: Marcetic

Creative Commons by DiploFoundation

DIPLO
www.diplomacy.edu

Source: <http://diplo.smugmug.com/ILLUSTRATIONS/Climate-Change-Diplomacy/Climate-Change-Building/i-VsmxxFZ>

Climate Technology : Sectoral Approach

- Lighting
- Effective White Goods
- Stand-by loss
- Water Heating
- Air condition
- Improved Insulation

Building

-3Gt



- Electric Motor-driveSystem
- Industrial Capture & Storage
- Smelt Reduction
- Feedstock substitution
- Energy efficiency
- Substitution of Fossil fuels

Industry

-3.4Gt



- Flooding of rice fields
- Improved animal handling
- Fertilizer shift
- Recycling
- Landfills and Waste water

Agriculture & Waste

-1.7Gt



- Fuel-efficient technologies
- Fuel-Switch
- Demand Reduction

Transport

-2.3Gt



- Carbon Capture and Storage
- CO2 efficient fossil fuel
- Renewables
- Nuclear Power
- Reduce Demand

Power

-9.8Gt



- Reduced deforestation
- Increased forestation
- Untouched forest

Forestry

-6.8Gt



Plethora of Images for 4IR



1st Industrial Revolution WATER & STEAM

Steam and water power replace human and animal power with machines.



2nd Industrial Revolution ELECTRICITY

Electricity, internal combustion engines, airplanes, telephones, cars, radio, and mass production.



3rd Industrial Revolution AUTOMATION

Electronics, the internet and IT used to further the automation of mass production.

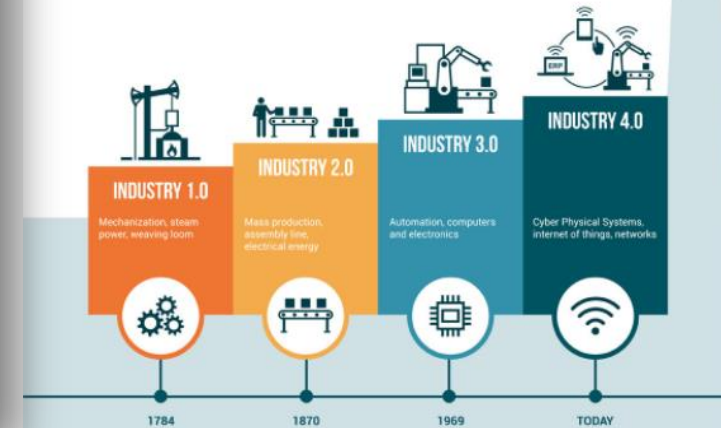


4th Industrial Revolution CYBER-PHYSICAL SYSTEMS

Driverless cars, smart robotics, materials that are lighter and tougher, and a manufacturing process built around 3D printing.

INDUSTRIAL REVOLUTION

TRANSFORMING INDUSTRIES AND INNOVATION



1st revolution



Mechanization, steam and water power

2nd revolution



Mass production and electricity

3rd revolution

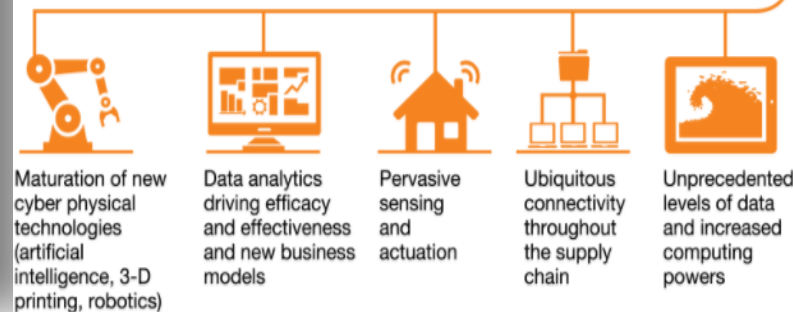
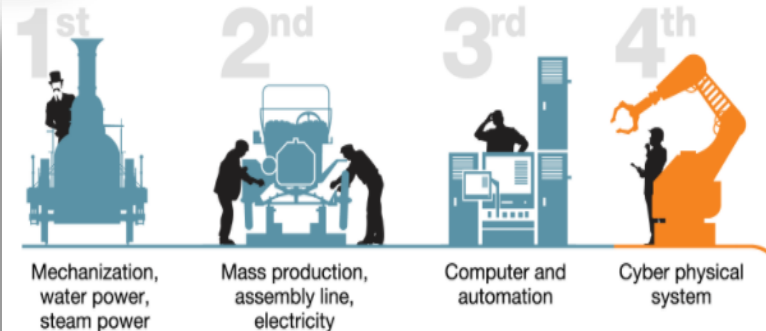


Electronic and IT systems, automation

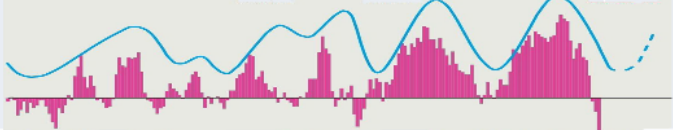
4th revolution



Cyber physical systems



Kondratieff Waves of Innovation

Waves:	1 st Wave: Industrial Revolution	2 nd Wave: Industrial Production	3 rd Wave: Scientific Revolution	4 th Wave: Scientific- Technical Revolution	5 th Wave: Information and Telecom Revolution	6 th Wave: ...
Date range:	~1780 – 1830	~1830 – 1880	~1880 - 1930	~1930 – 1970	~1970 - 2010	~2010 – 2050
Economic trend (US S&P 500)						
Key developments	Steam engine, industrialization	Railways, steel, heavy engineering	Electricity, chemistry, chemical industry	Automobile, mass production, petrochemical industry	Microcomputers, information, telecom	
Events near the peaks	War of 1812	US Civil War	World War I	Vietnam War, Six-Day War		
Events near the troughs		1873/79 Depression	1929 Depression	1974/8 Oil crisis		

26 Confidential and Copyright © SRC 2014

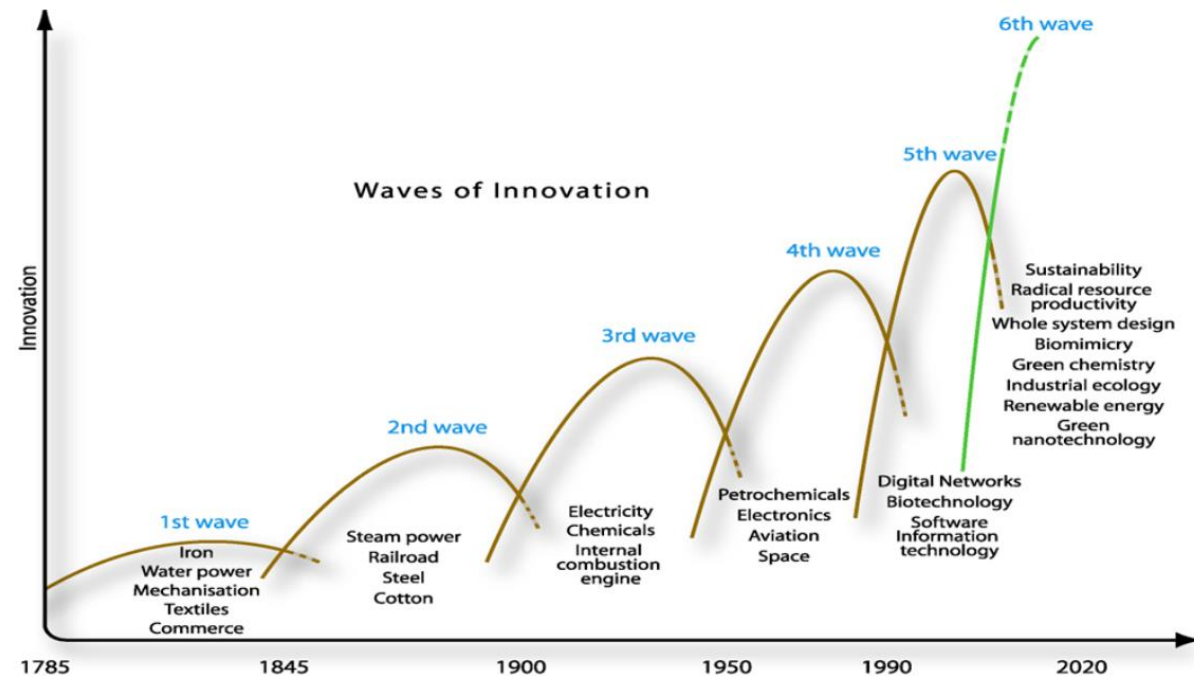
Economic trend from Wilenius and
"Surfing the Sixth Wave"

<http://www.src.sk.ca/node/377>

Waves of Innovation

Innovation is the central issue in economic prosperity.
Michael Porter, Harvard Business School

<http://aberdeeninvestment.com/riding-a-wave-of-innovation-innovation-is-the-central-issue-in-economic-prosperity-michael-porter/#.WgeIk5Jrxu1>



Source: The Natural Edge Project
The Natural Advantage of Nations (Vol.I): Business Opportunities, Innovation and Governance in the 21st Century
<http://www.naturaledgeproject.net/>

Sustainable Development Goals 17





Growth & Innovation: A Climate of Opportunity

54% of business leaders see **opportunities for growth and innovation** in addressing the climate challenge

57% believe that **investment in climate solutions** is essential to competitive advantage

Of leaders from the world's largest companies*:

70% see **opportunities for growth and innovation**

67% report a **clear business case for action**

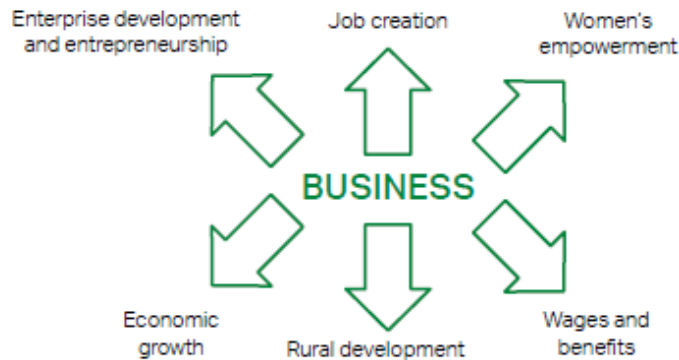
69% see **investment in climate solutions** as essential to competitive advantage

48% report a **clear business case for action on climate**

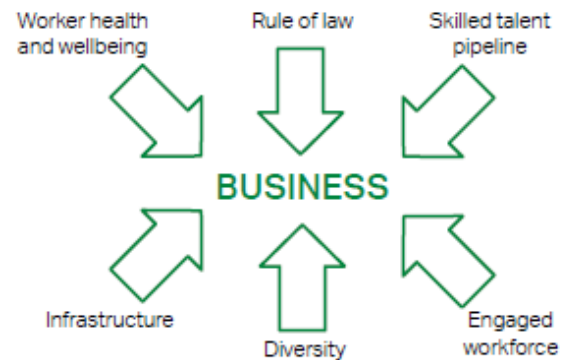


*annual revenues in excess of US\$1bn

Social Impacts

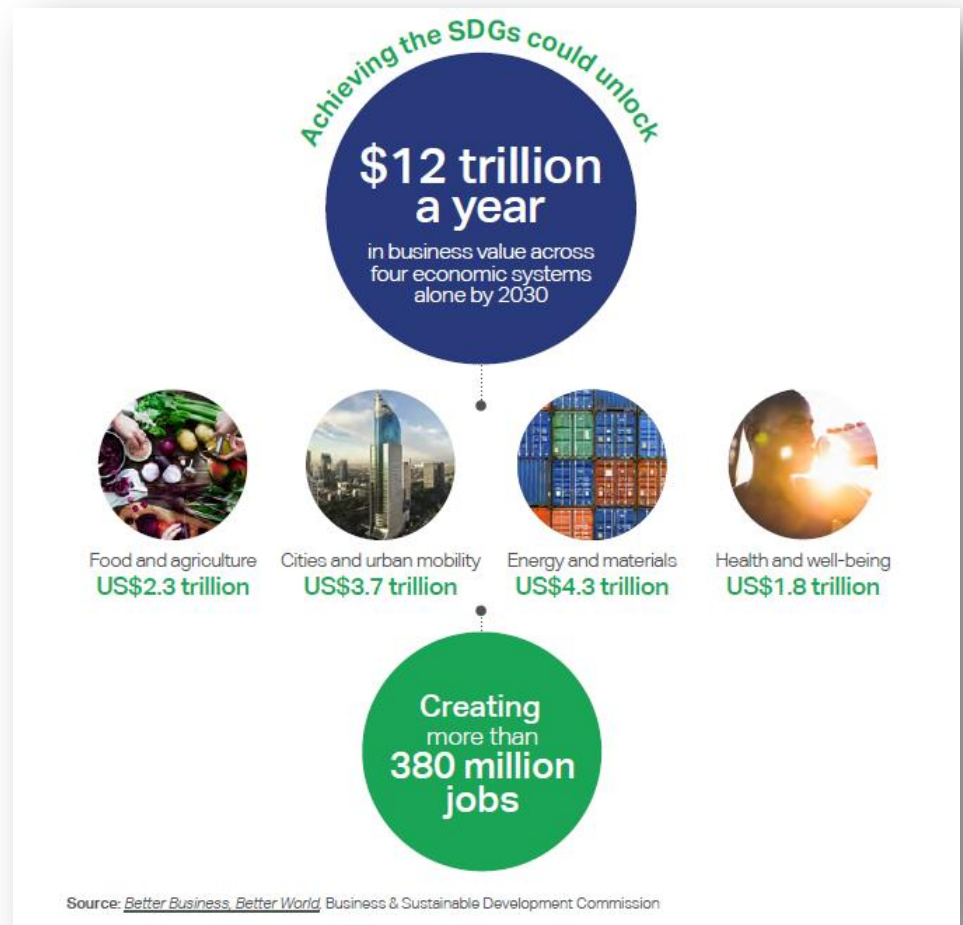


Social Dependencies



The SDGs will not be realized without business

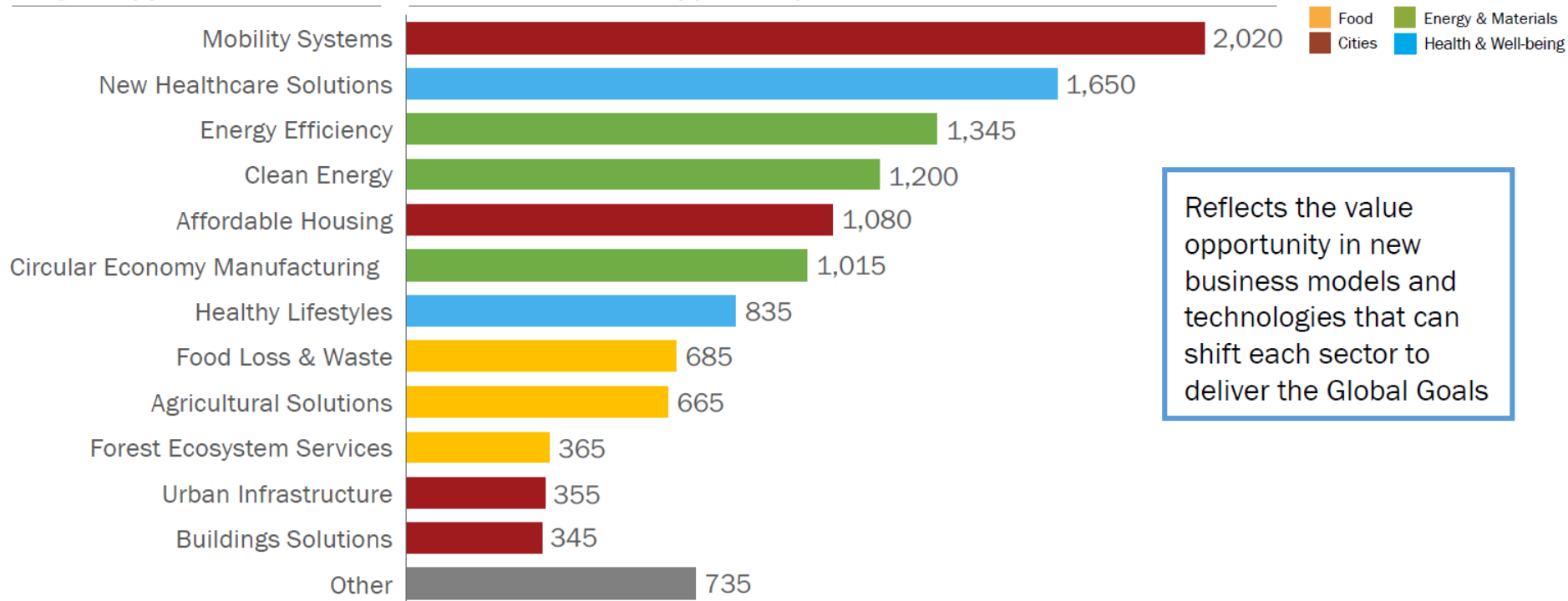
The 17 SDGs and the 169 time-bound targets underpinning them, represent a comprehensive and interconnected framework. It has resounding universal relevance for all stakeholders and nations. Its ambitions effectively transform every country into a developing country.



12 market opportunities can generate up to \$12 trillion worth of business value

Largest opportunities

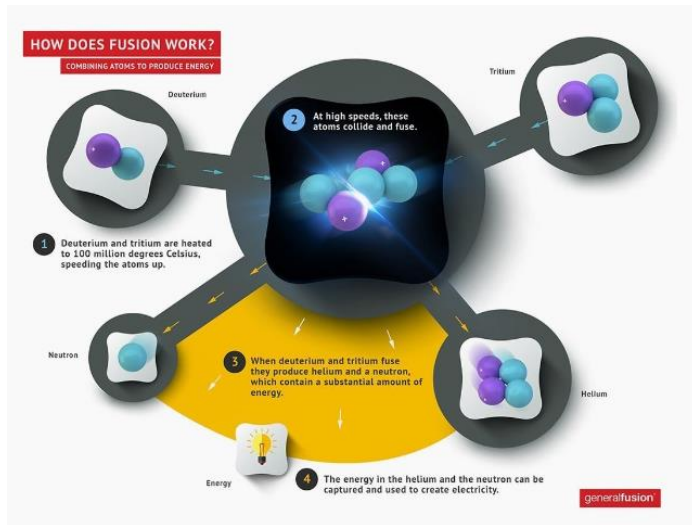
Size of incremental opportunity in 2030¹ \$ billions



Reflects the value opportunity in new business models and technologies that can shift each sector to deliver the Global Goals

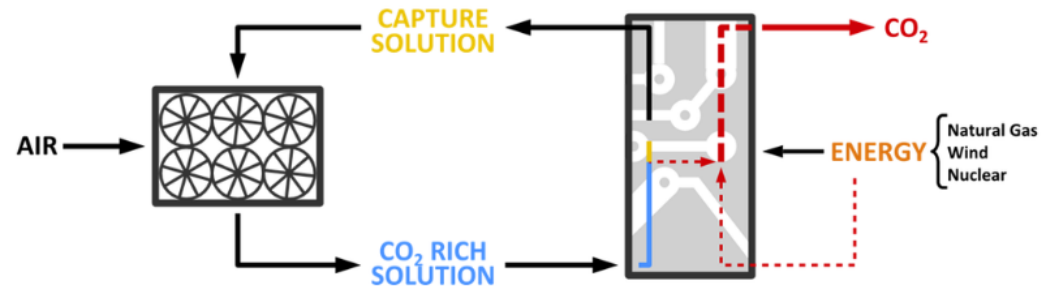
Tech innovations that could save us from climate change

Power Generation



Manufacturing

Making the things we use every day puts an enormous strain on the climate – [about 30% of emissions come from industry.](#)



Transport [Transport represents 23% of global energy-related CO2 emissions.](#) But the demand for transport is only going to increase.

Food About a quarter of all global emissions come from feeding the world's 7 billion people, and part of that comes from the consumption of meat. "There is no way to produce enough meat for 9 billion people," [said Bill Gates in a 2013 blog post.](#)

Building The greenhouse gas emissions of buildings is also significant. We need lighting, power, heating and cooling whether at home or in the office, at school or in a hospital. The combined emissions from these sources contributes [almost 20% of global emissions.](#) Part of the answer is to build smarter cities.

Energy efficiency: 3 new business models

Combining solar power and GPS technology to reflect and heighten natural light

- The Generation 2.0 Ciralight SunTracker reflects natural light in buildings using mirrors and solar tracking skylights.
- Can provide free light for up to 10+ hours a day and uses electric LED bulbs for other hours.
- System massively reduces the lighting cost of your facility while providing the incredible benefits of natural light


CIRALIGHT



Redesigning the LED lightbulb for longer lasting bulb lifespan

- Dyson's CSYS LED system uses an aluminum pipe as a heat sink to keep bulbs cooler, resulting in an extended lifespan of around 37 years per device.

dyson



Cheaper, more efficient internal combustion engines

- Achates Power has developed an internal combustion engine that has two pistons in each cylinder.
- These engines are fuel efficient, reduce greenhouse gas emission, and costs less than others of its kind.

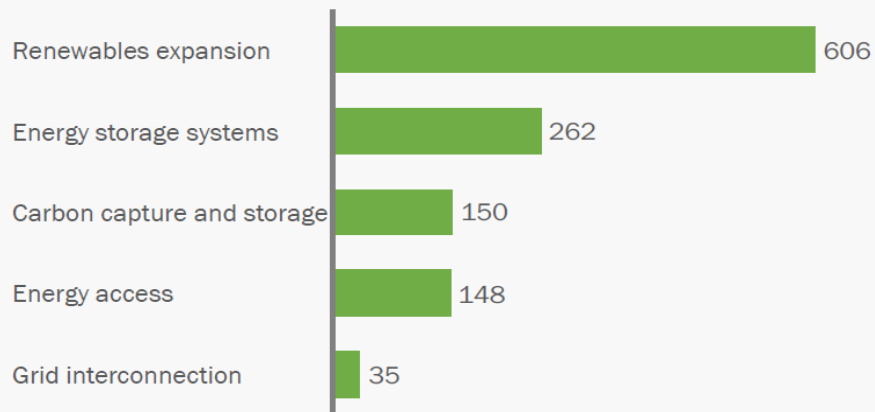
achatesPOWER
Fundamentally Better Engines®



Opportunities within clean energy

Opportunities in energy efficiency

Size of incremental opportunity in 2030¹, \$ billions



1. BASED ON ESTIMATED SAVINGS OR PROJECTED MARKET SIZINGS IN EACH AREA. ONLY THE HIGH CASE OPPORTUNITY IS SHOWN HERE
ROUNDED TO NEAREST \$5 BILLION
SOURCE: LITERATURE SEARCH ALPHABETA ANALYSIS



Renewables expansion: The International Renewable Energy Agency forecasts that renewables' share of power generation could be increased to 45% by 2030.²



Energy storage systems: An additional 150 GW of battery storage may be required by 2030 to support the increased penetration of renewables.³



Energy access: Currently an ~1.2 billion people have no access to electricity, and more than 2.7 billion still rely on solid biomass for cooking.⁴

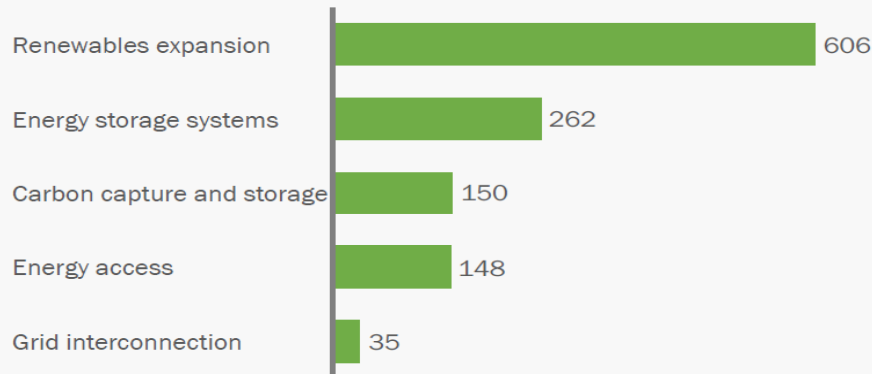


Grid interconnection: Additional interconnectors in Europe could generate annual savings of \$10 billion by reducing the need for back-up capacity in national grids to meet peak demand.⁴

Opportunities within clean energy

Opportunities in energy efficiency

Size of incremental opportunity in 2030¹, \$ billions



1. BASED ON ESTIMATED SAVINGS OR PROJECTED MARKET SIZINGS IN EACH AREA. ONLY THE HIGH CASE OPPORTUNITY IS SHOWN HERE
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Fusing solar and wind power to overcome intermittent supply

- WindStream Technologies' SolarMill, combines solar panels and windmill technology to produce sustainable energy for homes and businesses.
- It can provide power even after the sun has gone down, continuing to generate power at wind speeds as low as 4.5 mph.



Generating electricity using water-based plants

- Plant-e is using microorganisms in the roots of water plants consume organic matter, emitting electrons as a waste product which can be harvested to create electricity.
- While the system does not currently generate a lot of power, it is already being tested for powering small constructions.



Cheaper, more efficient internal combustion engines

- MiaSolé makes lightweight, flexible solar cells that can bend and twist.
- The cells can fit around curved structures, from sloping roofs to mobile devices, without breaking.



Urban infrastructure: 3 new business models

Distributed utility model to providing safe, affordable drinking water

- Piramal Sarvajal designs and deploys solutions for creating affordable access to safe drinking water in underserved areas in India.
- Their cloud-based remote monitoring technology to oversee remotely deployed purification units, allowing them to manage franchisees and remotely diagnose technical issues



Formalizing street waste pickers as self-empowered social entrepreneurs

- TriCiclos sells recycling stations in Chile that can receive and process +20 types of materials to companies, universities, or municipalities.
- Then they identify, train and permanently support street waste pickers to operate the station with a special software and traceability model.



Fully electric minicabs for an on demand urban taxi service

- Mellowcabs manufactures and operates three-wheeled, electric mini-cabs to provide low cost, eco-friendly and convenient taxi and transport services in built-up cities in South Africa.
- A mobile app connects the commuters and cabs and payment can be made by cash or card via the app.



Food loss & waste: 3 new business models

Turning food waste into energy for supermarkets

- Sainsbury's uses their trucks to collect inedible food waste from their store and deliver it to biogas plants around the country which turn it into energy to power its stores.
- Sainsbury's produces enough food waste in all their stores to power ~3,000 homes a year, or three major superstores.
- This is significantly cheaper than disposing of the food in landfills

Sainsbury's



Connecting consumers with restaurant leftovers at affordable prices

- Their app links consumers with leftover restaurant food that would otherwise be thrown away at prices from as little as £2 and a maximum of £3.80
- In the space of barely six months they've helped avoid over 200 tonnes of CO2 emissions and provided thousands of meals that would have otherwise been discarded to those in need.



Salvaging 'ugly,' unsellable fruit to make preserves

- To date Rubies in the Rubble has salvaged over 600,000 fruits and vegetables, avoiding 102 tonnes of CO2 emissions
- The jams, preserves and pickles are now sold out retailers across the UK, with each product made almost entirely from fruit and vegetables deemed unsellable.



Smart City Innovations : From Green to Smart!



Smart Energy

- Smart Metering
- Smart Grid
- District Cooling Mgt
- Gas Distribution Mgt
- Multi Energy Production
- Renewable



Smart Mobility

- EV / AV
- Road Traffic Mgt
- Parking Mgt
- Public Transport Mgt
- Smart Street Lighting
- Personal Mob. Dev.



Smart Water

- Smart Water Distribution
- Water recycling
- Urban Flooding Mgt
- Local Water recuperation



Smart Urban Services

- Video Surveillance
- Waste Mgt
- Community Mgt
- Smart Services
- Smart Safety
- Smart Security



Smart Buildings

- Automation
- iBMS/BMS/EMS
- Smart Lighting
- ACMV
- Plug Loads Mgt



Smart Living

- User engagement
- Smart Comfort
- Wellness & Productivity
- Smart Health
- Child care
- Elder Services
- Smart Public Services



Smart Data

- Connectivity
- Efficient Data Mgt
- Edge Computing
- Data Analytic
- AI
- Machine Learning
- Open Data
- Video Analytic



Smart Integration

- Smart Platform
- ICT/IOT Integ.
- ICT/FM Integ.
- Cross Domain Application
- GIS / Weather
- Asset Mgt

Smart Governance, Smart Infrastructure, Smart Security ...

Inclusive Innovation

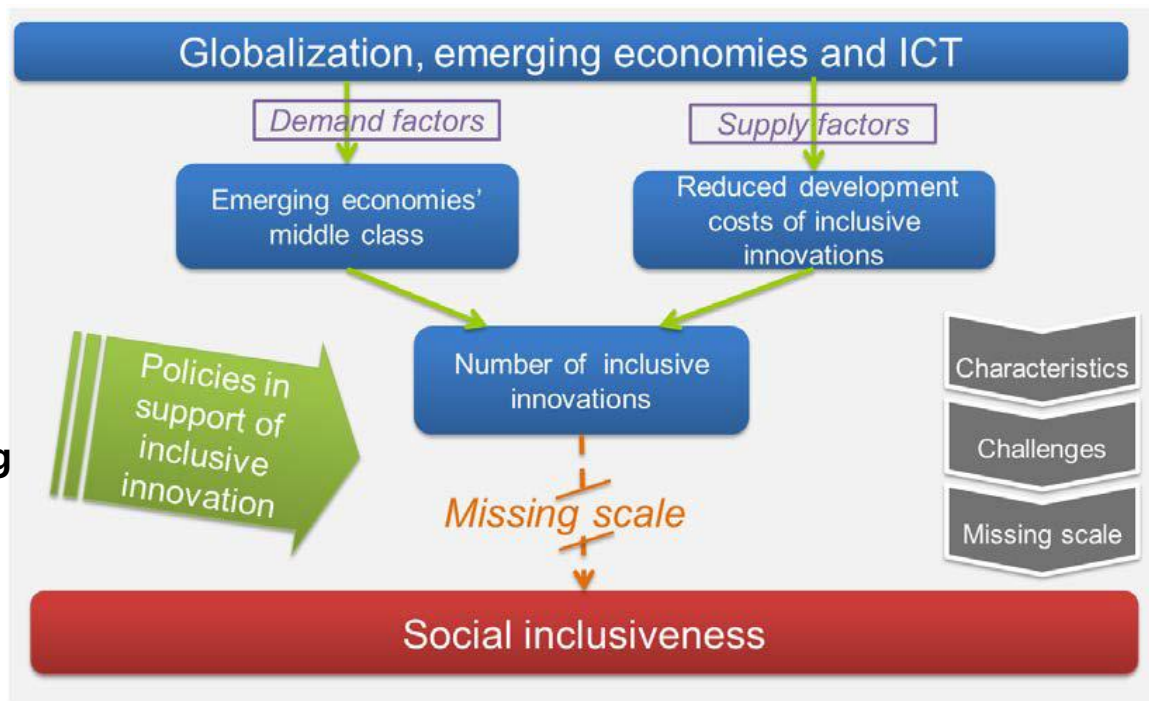
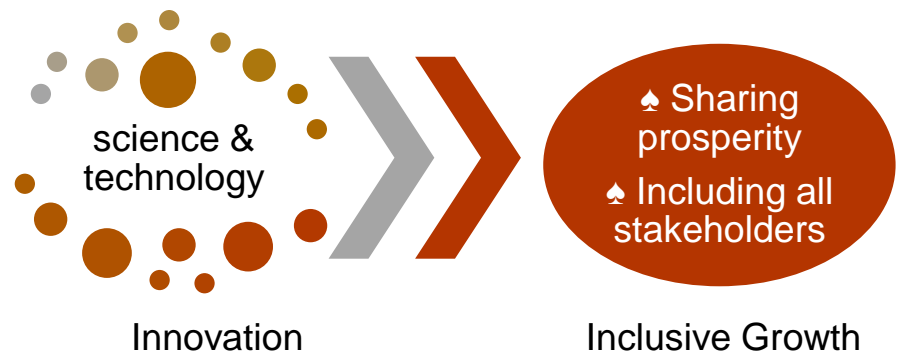
- More than appropriate technology or low tech
- S&T enabling innovation that benefits all segments of society

Inclusive innovations – innovations that directly serve the welfare of lower-income and excluded groups – can contribute to development and create work opportunities integrating marginalized groups into circuits of economic activity.

The current context is particularly favourable to inclusive innovations: ICTs and other emerging technologies offer new opportunities.

The growing importance of emerging economies also contributes by orienting business interests towards innovations that serve lower-income markets.

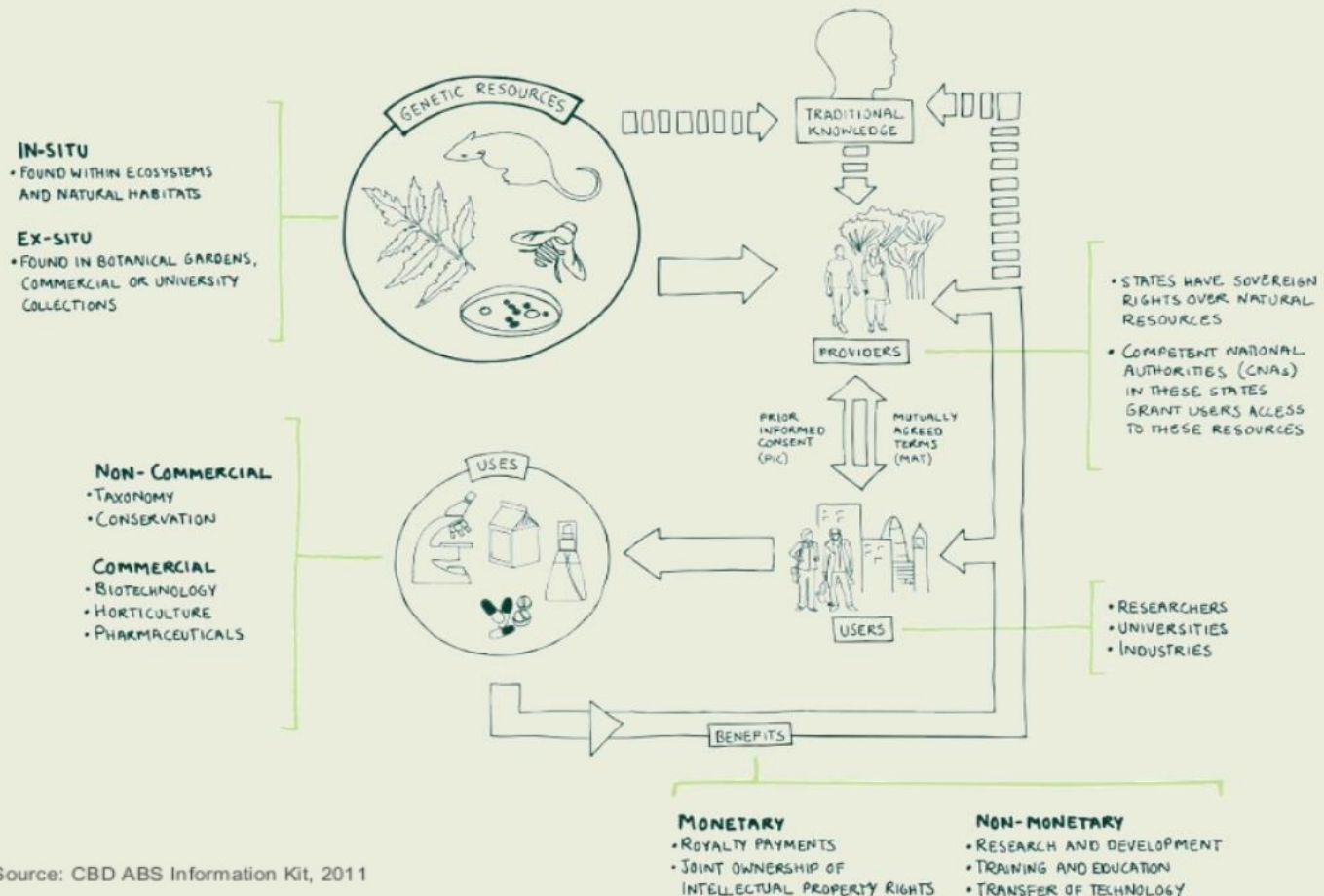
However, a variety of challenges and market failures specific to inclusive innovation hinders the scaling up of most initiatives, resulting in missing markets and calling for policy action.



IPR : Developing and Developed – Not on the same plane

Intellectual Property is extremely relevant to ABS mechanisms as most R&D based on genetic resources and associated traditional knowledge will eventually be subject to IPRs, usually through patents.

Access and Benefit-sharing (ABS)?



Four Questions for 4IR

Scaling up Human-Centered Technology

- How do we **design human-centered products and services** with ethical and moral questions on social development, value creation, privacy and ownership, and individual identity?

Leading Continuous Reinvention

- Facing an exponential speed of change in technology, how can leaders recognize **adaptive challenges to their organizations and build resilience?**

Creating Sustainable Systems

- How do we seize the opportunities afforded by **transformative technologies to create more sustainable systems** in areas such as energy, mobility, production, health, education, gender and work?

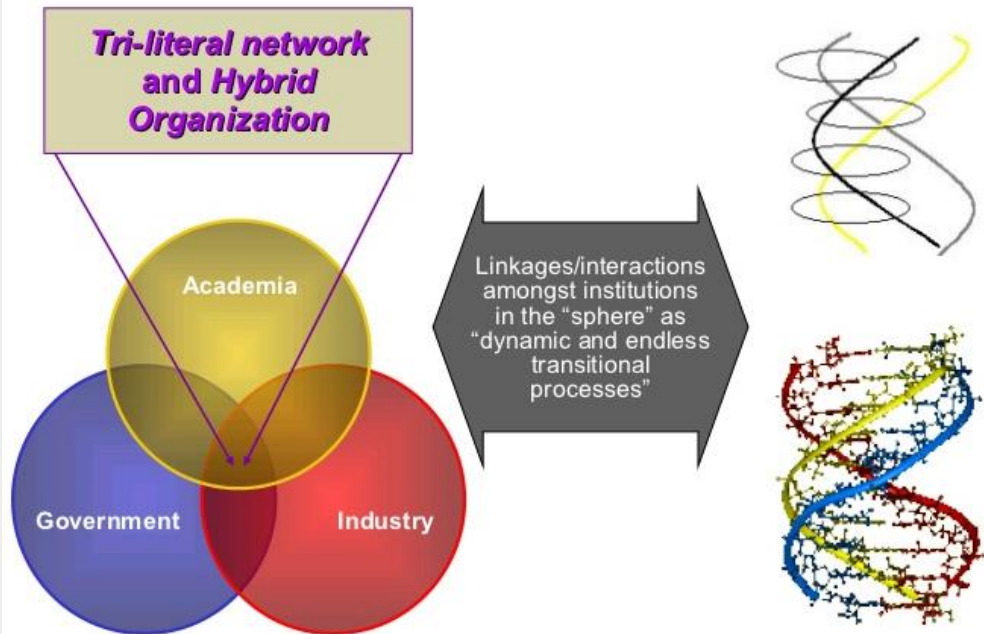
Responding to Geo-Economic Shifts

- How can communities, companies and countries **better prepare for the coming geopolitical and economic changes?**

Science, Technology and Innovation Model : Triple Helix to Quintuple Helix

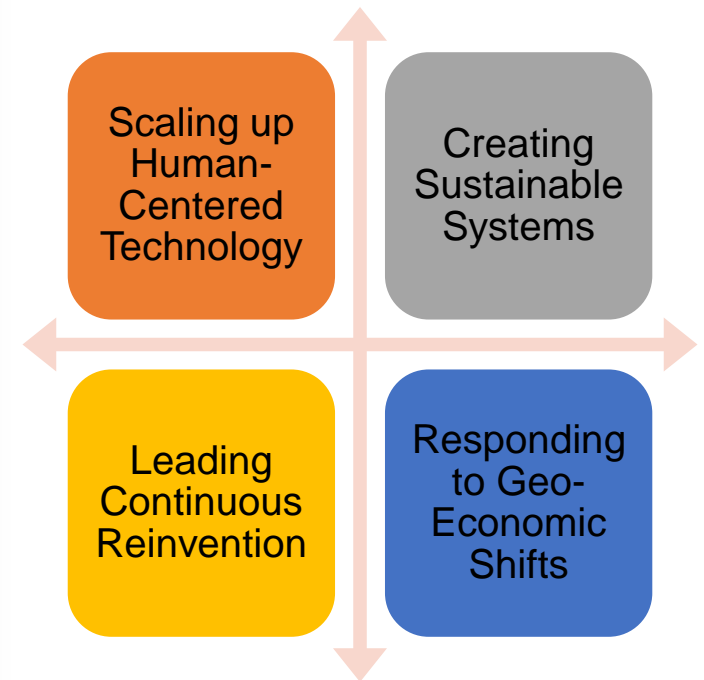
- This concept capturing the critical importance of trilateral collaboration in a national innovation system has continuously evolved with increasing theoretical and empirical sophistication.

THE TRIPLE HELIX MODEL

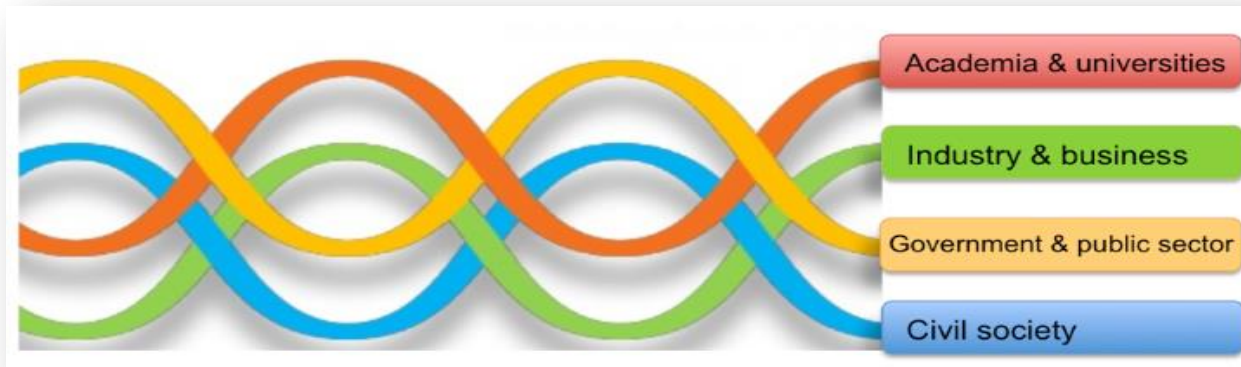


Source : Etzkowitz and Leydesdorff (2000).

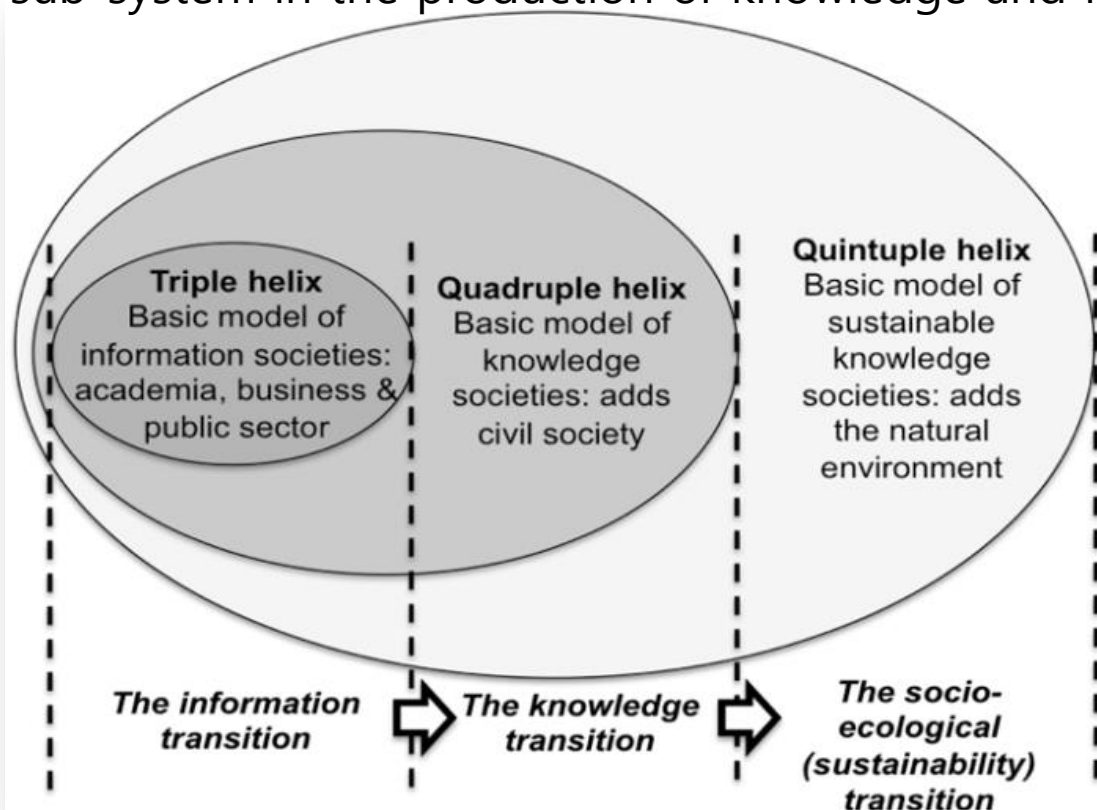
Four Basic Questions for 4IR
Pertaining to Inclusive Growth
and Innovation (WEF)



Triple Helix: Further Refinement



Quadruple helix model : Adding the fourth helix recognizing **civil society** as a sub-system in the production of knowledge and innovation



Quintuple helix model

- Aiming at a full understanding all helices in innovation for sustainability (Carayannis, et al., 2012)

<http://www.unksoc.org/index.php/handbook/4-1-transforming-societal-architectures/4-3-knowledge-and-innovation/4-3-1-creating-different-types-of-knowledge/>

프로필 : 金明子



● 학 력 : University of Virginia, Ph.D. , 서울대 문리대 화학과

● 경 력 : 1999 - 2003 환경부 장관 (헌정 최장수 여성장관, 국민의정부 최장수장관)

2004 - 2008 17대 국회의원 (국회윤리특별위원장, 국방위원회 간사)

2016 - 현재 한국과총 회장, 한국지속가능발전기업협의회(KBCSD) 회장

現 한중일30인회 위원, 사회복지공동모금회 부회장, 서울대총동창회 부회장, 아산사회복지재단 이사, 대한민국 헌정회 고문, UNSDSN 공동대표, 유민문화재단 이사, 한국여성의정 이사, 홍릉포럼 이사장, 아시아정당국제회의(ICAPP) 감사, 한국과학기술한림원 이사, 한국환경한림원 회원, 한국과학사학회 회원, KAIST 총장자문위원, 국제미래학회 자문위원, 국회 제4차산업혁명포럼 특별위원, 국회 일자리창출포럼 특별위원, 극지포럼 고문, 서울국제포럼 이사, 아시아투데이 고문, 안보경영연구원 이사, 용산센트럴생태공원시민모임 공동대표 등

前 국가과학기술자문위원, 국가과학기술위원회 민간위원, 사회통합위원, 기초기술연구회 이사, 과학기술원로정책자문위원, 과총 이사, 국민경제자문위원, KBS 객원해설위원, 동아일보 객원논설위원, 유네스코 한국위원, 중앙교육심의위원, 동북아경제중심위원, 아산정책연구원 이사, 벨기에 Ghent University Korea 이사, 기재부 KSP 수석고문, WISSET 이사장, 호스피스 국민본부 공동대표, 저탄소녹색성장 국민포럼 공동대표, 그린코리아21포럼 이사장, KAIST 총장자문위원, KAIST 초빙특훈교수, 산업부 에너지정책고위자문단, 서울대 기술경영정책대학원 CEO 초빙교수, 명지대 석좌교수, 숙명여대 교수 등

저·역서 : '과학혁명의 구조' (1981년 초판, 1999-현재, 까치글방), '사용후핵연료 딜레마' (까치글방, 2014), '인터넷바다에서 우리 아이 구하기' (까치글방, 2013), '원자력 트릴레마' (까치글방, 2013), '원자력 딜레마' (사이언스북스, 2011), '현대사회와 과학', '과학기술의 세계', '동서양의 과학전통과 환경운동', '엔트로피', '앞으로 50년', '현대인과 비타민', '여성과 사회 참여' 등

수상 : 2015 과학기술훈장 창조장, 2015년 자랑스러운 서울대인상, 2014년 자랑스러운 서울대 자연대인상, 2004년 청조근정훈장, 2002년 제1회 닦고 싶고 되고 싶은 과학기술인상, 1994년 대한민국 과학기술상 진흥상 대통령상, 1984년 한국과학저술인협회 저술상 등