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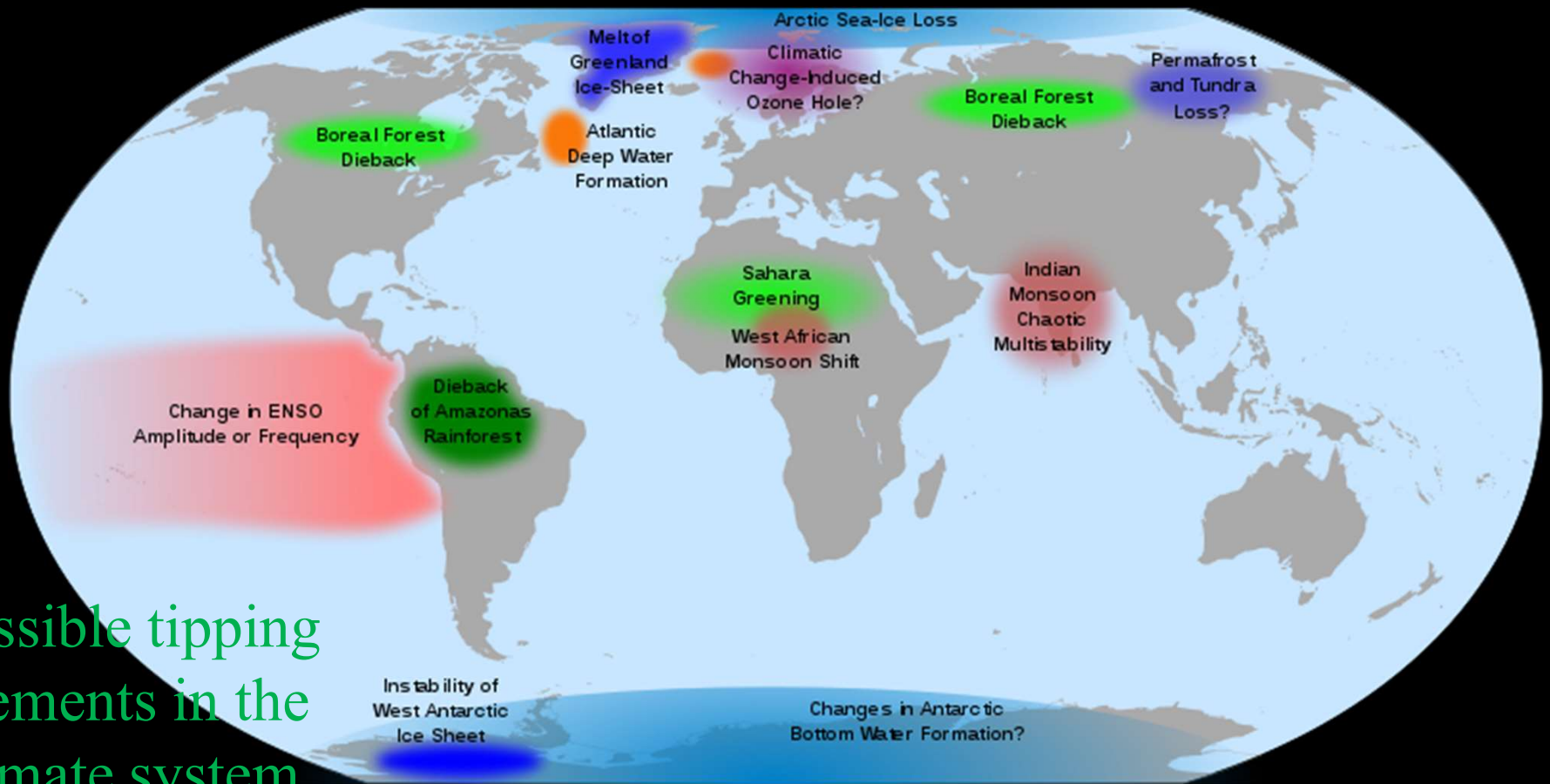
Global Catastrophic risks  
&  
Unexpected Climate Changes

16<sup>th</sup> September, 2022

# Tipping points in climate system

Climate change may be triggering events that would dramatically alter Earth as we know it.

A tipping point in the climate system is a threshold that, when exceeded, can lead to large changes in the state of the system such as mass extinction of species, dramatic sea level rise, extensive droughts and the transformation of forests into vast grasslands



Possible tipping elements in the climate system.

# The top six climate events scientists worry about today

## 1. The Arctic sea ice melts

The melting of the Arctic summer ice is considered to be the single greatest threat, and some scientists think we've already passed the tipping point. As sea ice melts and the Arctic warms, dark ocean water is exposed that absorbs more sunlight, thus reinforcing the warming

## 2. Greenland becomes ice-free

The warming of the Arctic may also render Greenland largely ice-free. While Greenland's ice loss will likely reach the point of no return within this century, the full transition will take at least a few hundred years.

The impacts of the Greenland ice melt is expected to raise sea levels by up to 20 feet.

Half of the 10 largest cities in the world, including New York City, and one-third of the world's 30 largest cities are already threatened by this sea level rise. .

### 3. The West Antarctic ice sheet disintegrates

Scientists expect the West Antarctic ice sheet to “tip” this century, and there is evidence that it already began happening in 2014.

However, the entire collapse of the glacier, which would raise sea level by 16 feet, could take a few hundred years.

### 4. El Niño becomes a more permanent climate fixture

The oceans absorb about 90 % of the extra heat that is being trapped in the Earth system by greenhouse gases. This could affect the ocean dynamics that control El Niño events. That would cause extensive drought conditions in Southeast Asia



## 5. The Amazon rain forest dies back

Rainfall in the Amazon is threatened by deforestation, a longer dry season, and rising summer temperatures.

Half of the Amazon rainforest could turn into savannah and grassland, which - once triggered - could happen over just a few decades. Lead to a considerable loss in biodiversity

However, the reduction of the Amazon ultimately depends on what happens with El Niño, along with future land-use changes from human activities.

## 6. Boreal forests are cut in half

Increased water and heat stress are taking a toll on the large forests in Canada, Russia and other parts of the uppermost Northern Hemisphere. So are forest disease and fires.

This could lead to a 50% reduction of the boreal forests, would gradually transition into open woodlands or grasslands over several decades.

This would have a huge impact on the world's carbon balance because forests can absorb much more carbon than grasslands..

# Global catastrophic risk

A hypothetical future event which could damage human well-being on a global scale

An event that could cause human extinction

## Existential risk

suggested a 19% chance of human extinction by the year 2100



Artist's impression of a major asteroid impact

## Anthropogenic

Artificial intelligence

Biotechnology

Cyber attack

Environmental disaster

Experimental technology accident

Global warming

Mineral resource exhaustion

Nanotechnology

World population and agricultural crisis

Warfare and mass destruction

## Non-anthropogenic

Asteroid impact

Cosmic threats

Extraterrestrial invasion

Global pandemic

Natural climate change

Volcanism

# Black swan Theory

Describe the impact of events that come as a surprise in societal aspects (Nassim Nicholas Taleb)

Combination of mathematical and philosophical reasoning to explain and describe the randomness of uncertainty

History!!!

The theory has three properties:

- 1) Rarity: The event is a surprise
- 2) Extreme impact: The event has major impact
- 3) Retrospective predictability : Looking back, the event could have been expected to take place



Examples black swan events : the rise of the Internet, the personal computer, World War I, the dissolution of the Soviet Union and the September 11, 2001 terrorist attacks.

Solution: our time would be better spent preparing for the impact of negative black swans that occur, rather than attempting to predict the unpredictable

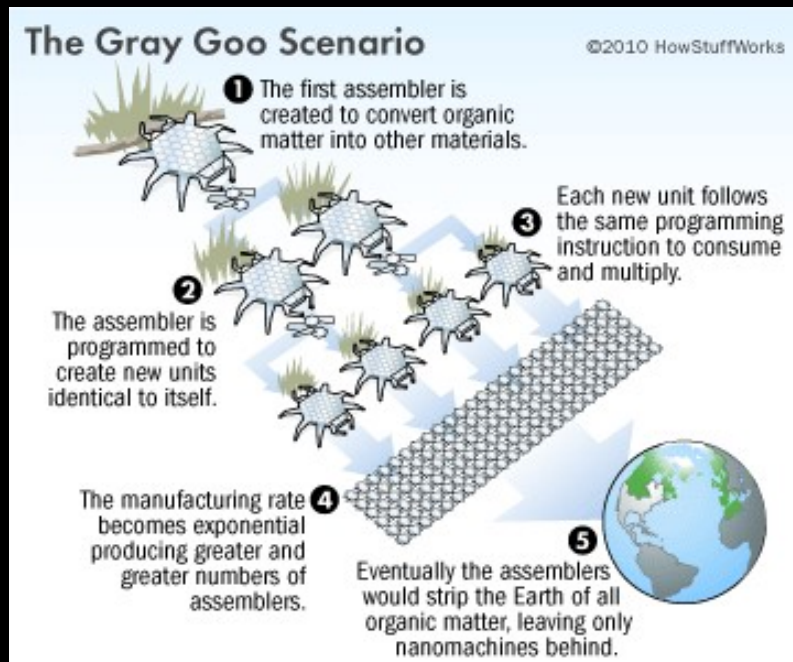


# Gray goo

Term was first used by molecular nanotechnology pioneer Eric Drexler.

Drexler envisioned a future in which tiny machines called assemblers could build materials molecule-by-molecule.

Gray goo refers to a hypothetical end-of-the-world scenario involving molecular nanotechnology in which out-of-control self-replicating robots consume all biomass on Earth while building more of themselves



For this scenario to come true, the nanomachines would have to be able to survive in a variety of harsh environments.

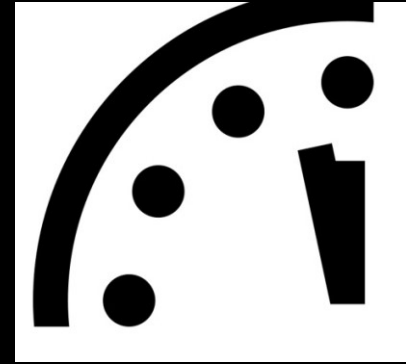
They'd also need the ability to consume any and all organic matter.

And we'd have to be defenseless against the nanomachines.



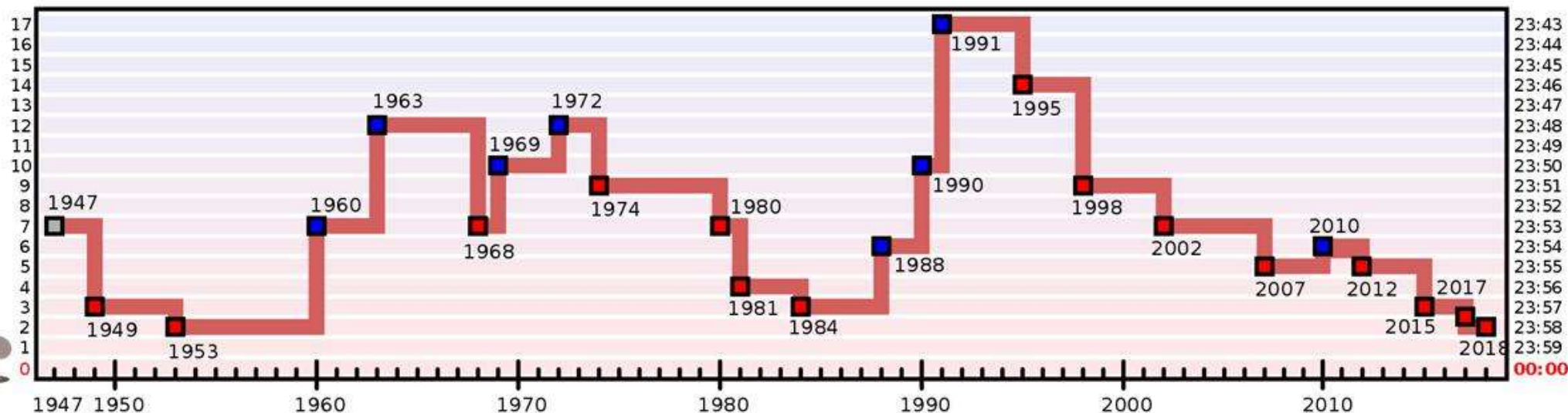
# The Doomsday Clock

A symbol which represents the likelihood of a man-made global catastrophe. Maintained since 1947 by the members of the Bulletin of the Atomic Scientists.



The Clock is a metaphor for threats to humanity from unchecked scientific and technical advances. The Clock represents the hypothetical global catastrophe as "midnight" and the Bulletin's opinion on how close the world is to a global catastrophe as a number of "minutes" to midnight

Doomsday clock: minutes to midnight, 1947-2018



*Doomsday Clock graph, 1947–2018. The lower points on the graph represent a higher probability of technologically or environmentally-induced catastrophe, and the higher points represent a lower probability.*

The factors influencing the Clock are nuclear risk and climate change. The Clock's original setting in 1947 was seven minutes to midnight. It has been set backward and forward 23 times since then, the smallest-ever number of minutes to midnight being two (in 1953 and 2018) and the largest seventeen (in 1991).

### Doomsday clock extremes



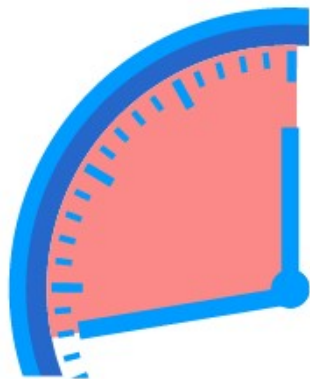
**2018**

Fears grow worldwide about a U.S.-North Korean conflict.



**2017**

President Trump threatens North Korea over its nuclear missile tests.



**1991**

The Cold War ends. U.S. and Russia reduce nuclear arsenals.



**1953**

The U.S. tests its first hydrogen bomb in November 1952.

SOURCE Bulletin of Atomic Scientists

The most recent officially announced setting—2 minutes to midnight—was made in January 2018, which was left unchanged in 2019 due to the twin threats of nuclear weapons and climate change putting the future of civilization in extraordinary danger

## How the minutes to doomsday have changed

(from the UK Guardian)

**2015**

Climate change and nuclear weapons



**2012**

Climate change



**2007**

North Korea conducts nuclear test



**2002**

Fears of nuclear terrorist attack



**1998**

India and Pakistan test nuclear weapons



**1991**

Cold war over



**1990**

Soviet Union collapses



**1989**

Berlin wall falls



**1981**

Soviets invade Afghanistan



**1974**

India tests its first nuclear device



**1972**

Arms treaty signed



**1969**

World's nations sign nuclear treaty



**1963**

Partial test ban treaty signed



**1953**

US tests first hydrogen bomb



**1949**

Soviet's first nuclear test



**1947**

Doomsday clock first appears



# Global Terrestrial Stilling

GTS is the decrease of wind speed near the Earth's surface (~10-meter height) over the last three decades, originally termed "stilling".

Mainly affected mid-latitude regions of both hemispheres, with a global average reduction of  $-0.140 \text{ m s}^{-1} \text{ dec}^{-1}$  and with high-latitude ( $> 75^\circ$  from the equator) showing increases in both hemispheres.

In contrast to the observed weakening of winds over continental surfaces, winds have tended to strengthen over ocean regions.

In the last few years, a break in this terrestrial decrease of wind speed has been detected suggesting a recovery at global scales since 2013.

The exact cause(s) of the global terrestrial stilling are uncertain and has been mainly attributed to two major drivers: (i) changes in large scale atmospheric circulation, and (ii) an increase of surface roughness due to e.g. forest growth, land use changes, and urbanization.

Given climate change, changes in wind speed are currently a potential concern for society, due to their impacts on a wide array of spheres, such as wind power generation, ecohydrological implications for agriculture and hydrology,

# Hypercane

A hypothetical class of extreme tropical cyclone that could form if ocean temperatures reached approximately 50 °C

Such an increase could be caused by a large asteroid or comet impact, a large supervolcanic eruption, or extensive global warming.

Difference between a hypercane and present-day hurricanes is that a hypercane would extend into the upper stratosphere, whereas present-day hurricanes extend into only the lower stratosphere.

Such an intense storm would also damage the Earth's ozone layer, potentially having devastating consequences for life on Earth

Water molecules in the stratosphere would react with ozone to accelerate decay into O<sub>2</sub> and reduce absorption of ultraviolet light.



# Unexpected Climate Changes

## **1. Volcanic eruptions will become more frequent**

*Since the glaciers begin to melt, the amount of water in the oceans increases and the global sea level rises, the weight distribution of the earth's crust is displaced from land to sea.*

*This shift may result in the fact that volcanoes will erupt become more frequently. This conclusion is confirmed by the recently discovered rock deposits, showing that in some periods of the history of the Earth frequent volcanic eruptions coincided with periods of glacier melting. People of the 21<sup>st</sup> century, probably, will not perceive these changes, as the effect would be noticeable in about 2500 years from now.*



## 2. Oceans will darken

*Climate change will lead to an increase in rainfall in some regions of the globe, making the rivers more affluent. Big rivers will carry the flow of silt and debris, which eventually will get into the ocean. Thus, the ocean will become less transparent.*

*In the coastal regions of Norway's sea the water has already become darker due to increased rainfall and heavy snowmelt in the last decade. Some researchers believe that the turbidity in the water is the cause of the changes in some ecosystems, for example, in recent years the population of jellyfish has increased.*

### 3. Sunlight will reach the seabed at the North Pole

*As the sea ice melt, water in the shallow coastal areas near both poles will become noticeably lighter, in particular, the light can reach the seabed at the North Pole. Deep-water worms, sponges and other invertebrates that are accustomed to living in complete darkness will have to live and suffer the effects of sunlight.*

*Recent studies have shown that climate changes can significantly alter the way of life of these colonies: in particular, algae and other marine plants will penetrate in the depth, which will reduce the population of invertebrates. This has already been observed in the bays of the Atlantic and the Antarctic coasts, so that biodiversity in the Polar Regions may be significantly reduced.*

## 4. The invasion of ants will slow down

*Pheidole megacephala*, also known as big-headed ants are one of the most dangerous invasive species on Earth. There are colonies of these insects in South America, Australia and Africa, which multiply rapidly and spread to new areas. As an invasive species, ants enter the habitat and capture food resources of other animals. As far as it is known, the ants prey even on chicks of small birds.

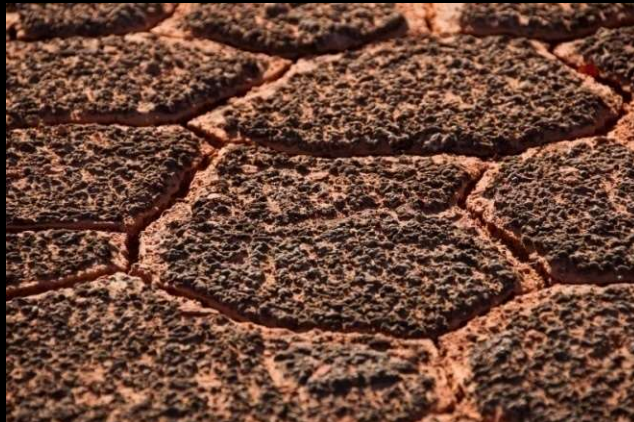
But since the Earth's temperature is increasing, these cold-blooded animals will spread more slowly and their natural habitat will be significantly reduced. Studies show that the percentage of territories occupied by these species will decrease by 2080 by about one fifth.



## 5. Decline of desert bacteria

*The soil in the desert may seem uninhabitable, but in fact it is teeming with bacteria: bacterial colonies spread all over the place there so that they form a solid layer that protects the soil from erosion.*

*Studies of this soil in the United States has shown that different types of desert bacteria live and thrive under different temperature circumstances. Some prefer the exhausting heat of Arizona and New Mexico, and the other live in cool climate of Oregon and Utah. As the temperature due to climate change has become more volatile, the desert bacteria have to adapt to it, and desert soil will become more susceptible to erosion as a result of their decline.*



## 6. Disappearing Beaches

*As the sea level rises, it makes sense that beaches are the first to go. Already, 70 to 90 percent of beaches are being wiped away by this rising waters, exacerbated by major storms.*

*Many governments trying to preserve their beaches have been importing fresh sand or dredging it up from the sea floor. While this is already a temporary solution (the sand just washes away again), it's about to get more difficult. There's currently a sand shortage, thanks to demand from the fracking, glass and cement industries.*



# Carteret Islands

*The people of the Carteret Islands of Papa New Guinea became the first ever climate change refugees after they were displaced due to rising sea levels (as well as a shift in tectonic plates).*

*The people of Carteret lived their lives mostly free of automobiles and only used only minimal electricity. Their collective carbon footprint was practically nonexistent.*



*This was a population that lived off of the crops they grew, and were forced to relocate to the island of Bougainville after years of salt water inundated their crops and infiltrated the fresh water wells. While the people of Carteret may have found safety on a new island, scientists believe their native islands will be uninhabitable by 2015 and all islands will be completely submerged by 2020.*



## 7. Faster-Growing Trees

*Over the past 50 years, trees in Europe have been growing faster. Researchers from the Technische Universitaet Muenchen in Germany found that in some cases, tree growth has increased by as much as 70 percent. (Trees in rainforests are expected to follow suit, but haven't yet, according to recent research.)*

*While there are multiple hypotheses to explain this phenomenon, researchers think higher levels of carbon dioxide and nitrogen in the atmosphere may contribute to tree growth. Those higher levels are thanks to climate change. "It's also a bit warmer than it was (up to 1 degree Celsius on average), and this means the period of growth is extended in spring and autumn," says John Grace, from the University of Edinburgh.*

*At least bigger trees absorb more carbon dioxide*

## 8. More Lightning

*Lightning strikes will increase thanks to global warming, according to researchers from University of California, Berkeley.*

*Lightning occurs when electrical charges build up within the water vapor of a cloud. Warmer temperatures mean there will be more water vapor trapped in the atmosphere, leading to more lightning.*

*Scientists expect lightning strikes to increase by about 12 percent for every degree Celsius gained.*

## 9. Deteriorating Mummies



*The world's oldest man-made mummies aren't Egyptian—they're Chinchorro, a fishing people that lived along the coast of present-day Chile and Peru. For upwards of 7,000 years these mummies—prepared via de-fleshing the bodies and stuffing them with plant fibers—remained well-preserved in the bone-dry Atacama Desert, but that's coming to an end.*

*In the last decade, the mummies have begun to rapidly deteriorate, with some even turning into black ooze. Rising humidity levels, possibly caused by climate change, may be to blame—the humid air facilitates the growth of mummy-chomping bacteria.*

*Climate change may put other historical artifacts under siege too, from outdoor marble statues to the ancient frozen tombs of Siberia.*

## 10. Hot (Human) Tempers

*Could rising temperatures also bring rising tempers? Recent research suggests they might. According to the analysis of 56 research papers on the subject, increased temperatures and fluctuating precipitation patterns are likely to cause an increase in both individual clashes, like fistfights, and larger brawls, like wars.*

*"Heat changes the way people feel and think, increasing anger and making thoughts of aggression increase," Richard Larrick, who studied the effects of heat on aggressive acts by baseball players, told the Washington Post.*

# Cricket and Climate change

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Climate Change Is Affecting Cricket, Football And Golf Games

cricket authorities to introduce "heat rules" including postponing games in response to climate change

calls for extra care around youth players and for manufacturers to develop equipment that enhances air flow, as extreme heat becomes more common

It notes youth matches in Australia have been disrupted due to heat, while dire water shortages have hit a tour of South Africa and flooding has delayed cricket in England.

authors say they have combined climate science with heat physiology to show how batsmen and wicketkeepers are becoming increasingly susceptible to poorer performances due to the conditions.



They argue "safety-related heat stress guidelines" are now needed, and that more games may need to be postponed or rearranged to cooler times of the day

"Above 35 degrees (Celsius) the body runs out of options to cool itself,"

"For batsman and wicketkeepers even sweating has limited impact as the heavy protective cladding creates a highly humid microclimate next to their bodies."

In fact the ICC Men's Cricket World Cup (2019) was officially the wettest tournament of all time. It was the first real exhibition of the effects of climate change on cricket's ecosystem (and economy).

In 2016, 13 IPL matches in Maharashtra were relocated due to the severe drought.

Then in 2017, Sri Lankan cricketers wore face masks to protect themselves from Delhi smog.

<https://www.youtube.com/watch?v=mpyiyEazodM>

<https://www.youtube.com/watch?v=2o2AapO6rK8>

<https://www.youtube.com/watch?v=0XDHMgqlcEU>

<https://www.skymetweather.com/content/climate-change/cclimate-change-and-its-impact-on-sports/>