PRI Principles for Responsible Investment

UNEP FINANCE INITIATIVE | United Nations Global Compact

An investor initiative in partnership with UNEP Finance Initiative and UN Global Compact

THE AMAZON

A CRITICAL CLIMATE TIPPING POINT

Supported by:

Stockholm Resilience Centre
Sustainability Science for Biosphere Stewardship
Stockholm University

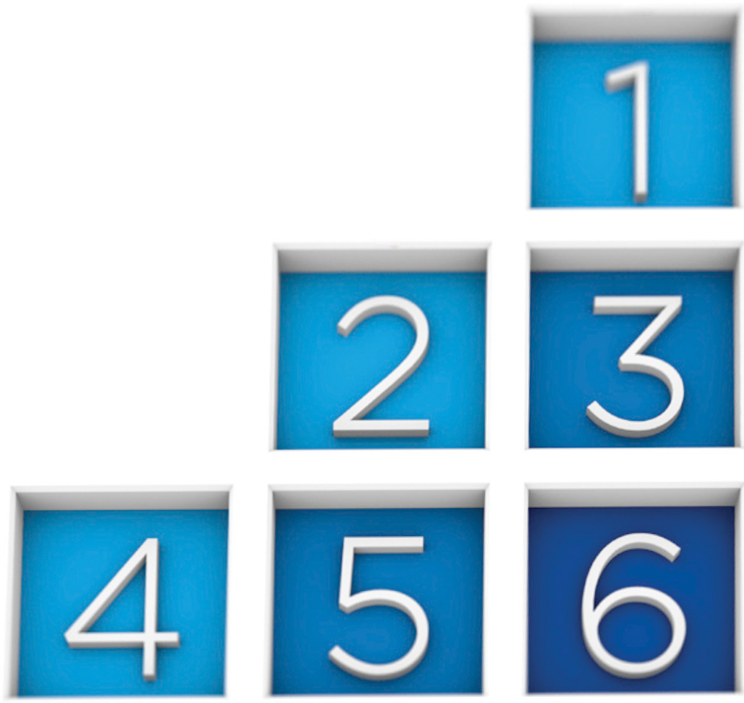
GLOBAL ECONOMIC DYNAMICS AND THE BIOSPHERE
THE ROYAL SWEDISH ACADEMY OF SCIENCES

THE SIX PRINCIPLES

PREAMBLE TO THE PRINCIPLES

As institutional investors, we have a duty to act in the best long-term interests of our beneficiaries. In this fiduciary role, we believe that environmental, social, and governance (ESG) issues can affect the performance of investment portfolios (to varying degrees across companies, sectors, regions, asset classes and through time). We also recognise that applying these Principles may better align investors with broader objectives of society. Therefore, where consistent with our fiduciary responsibilities, we commit to the following:

1. We will incorporate ESG issues into investment analysis and decision-making processes.
2. We will be active owners and incorporate ESG issues into our ownership policies and practices.
3. We will seek appropriate disclosure on ESG issues by the entities in which we invest.
4. We will promote acceptance and implementation of the Principles within the investment industry.
5. We will work together to enhance our effectiveness in implementing the Principles.
6. We will each report on our activities and progress towards implementing the Principles.



PRI's MISSION

We believe that an economically efficient, sustainable global financial system is a necessity for long-term value creation. Such a system will reward long-term, responsible investment and benefit the environment and society as a whole.

The PRI will work to achieve this sustainable global financial system by encouraging adoption of the Principles and collaboration on their implementation; by fostering good governance, integrity and accountability; and by addressing obstacles to a sustainable financial system that lie within market practices, structures and regulation.

THE REPORT

This document summarises some of the latest scientific work on the Earth's climate tipping points. It was put together by Alice Dauriach, Beatrice Crona, Victor Galaz, Owen Gaffney and Danielle Carreira, based on a presentation given by Will Steffen at a meeting co-hosted by PRI, Global Economic Dynamics and the Biosphere programme (GEDB), Future Earth and the Stockholm Resilience Centre. Figures have only been adapted from scientific publications for working draft purposes.

Please note: this is only a background working document, which has not been peer-reviewed. For more information, please refer to the following report:

DOWNLOAD THE REPORT

EARTH'S SLEEPING GIANTS

Critical thresholds in the Earth's climate system which determine how the system functions as a whole.

Once awakened (i.e. pushed past their tipping point), they may cause others to wake too, thus accelerating climate change.

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

PARIS AGREEMENT, 2015

Nations agreed to aim to keep global temperatures "well below 2°C".

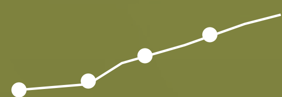
Scientific reports indicate that the risk of reaching these tipping points **rises dramatically beyond 2°C.**

A temperature rise of 4-5°C would have global catastrophic consequences.

WAKING UP

The Amazon rainforest is one of the sleeping giants likely to wake up and **could reach a tipping point if temperatures rise by 3-4°C or if deforestation reaches 40%**

Deforestation has reached almost 20% since the 1970s.



Current economic and financial models largely ignore tipping point dynamics, and as a result they most likely **grossly underestimate potential future risks and costs of climate change.**

CONCLUSION

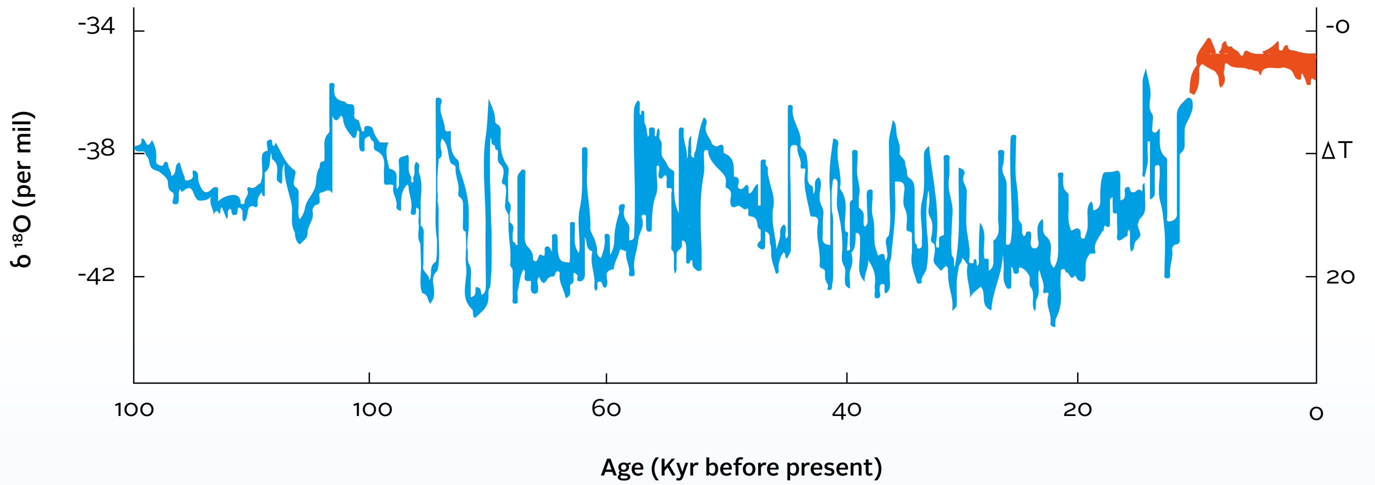
We need to meet the Paris 2°C target and stop deforestation (while increasing afforestation) to prevent the Amazon from reaching tipping point and potentially triggering effects that could destabilise global climate.

THE LATEST IN CLIMATE CHANGE AND EARTH SYSTEM SCIENCE

People shape the biosphere on a local and global level. At the same time, people fundamentally depend on the capacity of the biosphere to sustain human development. We also depend on a stable biophysical environment.

The Holocene, the geological epoch that has lasted for the past 10,000 years (highlighted in orange in Figure 1), has provided humans with a remarkably stable climate, compared to the previous 80,000 years. In the Holocene, humans invented agriculture and farming, and developed new techniques and complex societies. The Holocene's climate is the only one in which we know for certain that our current civilizations can thrive. But this stability is not a given. Are we on our way out of this stable state?

Figure 1: The last glacial cycle of 18O (an indicator of temperature). Source: Adapted from Young and Steffen (2009)



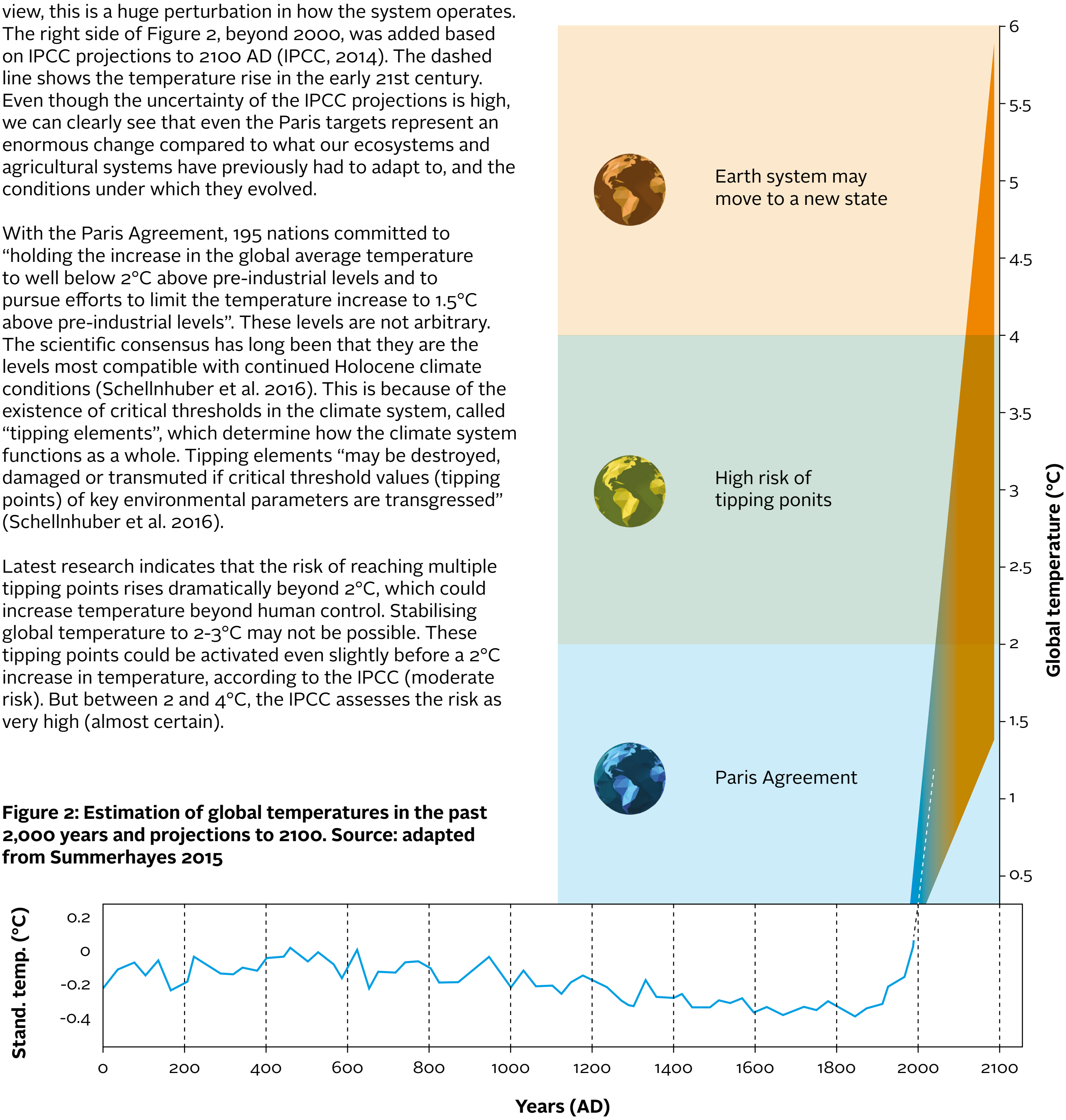
Temperatures have varied slightly over the past 2,000 years (Figure 2). The left side of the graph shows the global temperature for the last 2,000 years, represented by 30-year means. The zero on the temperature scale represents the average from 1950 to 2000. Since the 1950s, global temperatures have started rising beyond the envelope of natural variability. Temperature has been rising at 0.17°C per decade for the last four decades and is currently approximately 1.2°C above pre-industrial temperatures (Steffen et al. 2018 in press). From an Earth system point of view, this is a huge perturbation in how the system operates. The right side of Figure 2, beyond 2000, was added based on IPCC projections to 2100 AD (IPCC, 2014). The dashed line shows the temperature rise in the early 21st century. Even though the uncertainty of the IPCC projections is high, we can clearly see that even the Paris targets represent an enormous change compared to what our ecosystems and agricultural systems have previously had to adapt to, and the conditions under which they evolved.

With the Paris Agreement, 195 nations committed to "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels". These levels are not arbitrary. The scientific consensus has long been that they are the levels most compatible with continued Holocene climate conditions (Schellnhuber et al. 2016). This is because of the existence of critical thresholds in the climate system, called "tipping elements", which determine how the climate system functions as a whole. Tipping elements "may be destroyed, damaged or transmuted if critical threshold values (tipping points) of key environmental parameters are transgressed" (Schellnhuber et al. 2016).

Latest research indicates that the risk of reaching multiple tipping points rises dramatically beyond 2°C, which could increase temperature beyond human control. Stabilising global temperature to 2-3°C may not be possible. These tipping points could be activated even slightly before a 2°C increase in temperature, according to the IPCC (moderate risk). But between 2 and 4°C, the IPCC assesses the risk as very high (almost certain).

One problem is that, even if we cut all global greenhouse gas emissions to zero tomorrow, there is enough momentum in the system to take us to about 1.5°C. We are already committed to a world that will look very different from what we have evolved in. But, if we miss the Paris targets, even our highly advanced technological societies will have a difficult time dealing with the resulting changes. Reaching or missing the Paris targets may be the difference between a world we can and cannot inhabit.

Figure 2: Estimation of global temperatures in the past 2,000 years and projections to 2100. Source: adapted from Summerhayes 2015



WHAT ARE CLIMATE TIPPING POINTS AND WHAT HAPPENS IF THEY TIP?

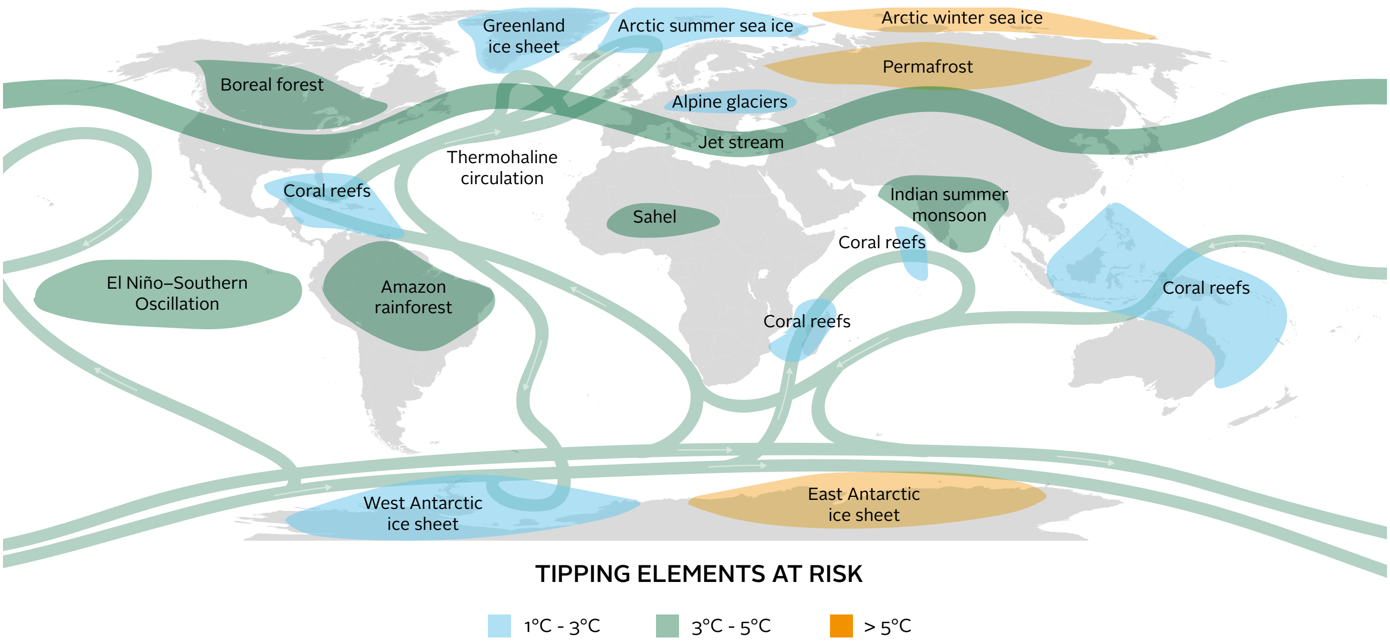
We are all familiar with tipping points and multiple stable states in real life. If you sit on a chair and start tipping it a bit, what happens? The chair returns to an upright position. If you tip it a bit more, it still returns. But if you tip just a little too much – past a critical point – that chair no longer returns upright: it invariably tips over completely, and you finish on the floor. That is a tipping point, and these kinds of tipping dynamics are surprisingly common in natural systems. In our human highly managed systems, we are used to a deterministic and linear world, where the more you push a system, the more it responds. This may be true to a certain extent, but not when the system approaches a tipping point.

Tipping points have become an important part of climate change research. Scientists, in a landmark paper (Lenton et al. 2008), define the term "tipping point" as "a critical threshold at which a tiny perturbation can qualitatively alter the state or development of a system" (Figure 3). They explored the Earth system – the complex interactions between the atmosphere, ice sheets, oceans, land, water and carbon cycles and rich diversity of life. They also introduced the term "tipping element" to describe "large-scale components of the Earth system that may pass a tipping point".

These tipping elements are also called "sleeping giants" (Steffen, 2006), which scientists have been researching in the last two decades. Globally, Arctic sea ice affects climate, as does the Amazon rainforest, boreal forests and ocean circulations. In 2017, the US Global Change Research Programme identified 12 sleeping giants (see Table 1), based on research using climate data from the deep past, Earth system models and expert elicitation. Table 1 shows the changes that each sleeping giant may undergo, the mechanisms by which this will affect the global climate, and the possible economic and social consequences.

Sleeping giants interact to keep the Earth's climate relatively stable over long periods. They may wake up if global average temperature crosses critical thresholds. The latest scientific evidence shows that different tipping elements are at risk of being triggered within different ranges of global temperature rise (see colours in Figure 3). Five sleeping giants may cross thresholds within the range of the Paris Agreement on climate: the Arctic summer sea ice, the Greenland ice sheet, the Alpine glaciers, coral reefs, and the West Antarctic ice sheet. Other tipping elements will be at risk at higher levels of rising temperature.

Figure 3: Tipping elements of the Earth system1. Source: based on an illustration by J. Lokrantz/Azote, adapted from Steffen et al. 2018.



1 Key parts of the Earth system (regions, biomes and ocean circulations) interact to keep the climate relatively stable over long periods. But as the global average temperature rises, these parts of the system could change state rapidly, potentially further raising global temperature to levels that will affect other tipping elements, creating a domino effect that may drive temperature even higher.

Table 1. Earth's sleeping giants: climate tipping elements (adapted from USGCRP Chapter 15, 2017).

CLIMATE TIPPING ELEMENT	STATE SHIFT	IMPACT PATHWAYS	ECONOMIC AND SOCIAL IMPACT
Atmosphere–ocean circulations			
Ocean circulation: Atlantic	Major reduction in strength	This has the potential to profoundly influence regional temperatures, rain and snow, in Northern Europe, for example, and affect global mean temperature and sea level.	Major adaptations required for populations.
El Niño–Southern Oscillation	Increase in amplitude	El Niño and its counterpart La Niña affect extreme weather patterns globally including rainfall and drought.	Increasingly difficult to predict regional-scale extreme weather, monsoon onset, and droughts.
Equatorial atmospheric superrotation	Initiation	Cloud cover, climate sensitivity	*Intentionally blank*
Cryosphere			
Antarctic ice sheet	Major decrease in ice volume	Sea level; albedo (heat reflected or absorbed by surfaces); ocean circulation	Rise in seal level of up to 70 metres globally over thousands of years.
Arctic sea ice	Major decrease in summertime and/or perennial area	Regional temperature and precipitation; albedo	Duration and amplification of extreme weather in Northern Hemisphere with impacts globally.
Greenland ice sheet	Major decrease in ice volume	Sea level; albedo; freshwater forcing on ocean circulation	Potentially 7 meter sea level rise over thousands of years.
Carbon cycle			
Methane hydrates	Massive release of carbon	Greenhouse gas emissions	Significantly more difficult to control greenhouse gas emissions.
Permafrost carbon	Massive release of carbon	Greenhouse gas emissions	Significantly more difficult to control greenhouse gas emissions.
Ecosystem			
Amazon rainforest	Forest die-off (death of large populations), transition to grasslands	Greenhouse gas emissions, biodiversity	Significantly more difficult to control greenhouse gas emissions.
Boreal forests	Forest die-off, transition to grasslands, range increase	Greenhouse gas emissions, albedo, biodiversity	Significantly more difficult to control greenhouse gas emissions.
Coral reefs	Coral die-off, transition to different ecological system	Biodiversity	Major economic impact on tourism, fishing, and related industries.

THE DOMINO EFFECT

In the Earth system, nothing stands in complete isolation. There are dynamics between the tipping elements, and current research focuses on understanding the possible effects that tipping elements have on each other. But even without these direct effects, one should consider that the tipping of one element will, in many cases, accelerate global warming. For example, the melting of the Arctic sea ice reduces the albedo (i.e. the fraction of light reflected by the planet), thus allowing the planet to absorb more heat from the sun. And the tipping of the Amazon rainforest to grasslands leads to the release in the atmosphere of all the carbon stored in trees, due to forest fires during the transition.

This means that reaching one tipping point increases the risks of reaching others, with the risk of triggering dangerous tipping cascades. Once the 2°C threshold is breached, risks rise so substantially that sleeping giants wake up and contribute to pulling Earth towards a +4°C rise in temperature through reinforcing feedback loops: more carbon uncontrollably enters the atmosphere from these regions, thus amplifying warming and causing forests and other biomes to emit more carbon. This scenario – the Four Degree World – is widely accepted to have catastrophic consequences for all societies (World Bank, 2012, New et al. 2011).

How catastrophic, though? The World Bank's *Turn Down the Heat* report (2012) finds that "a world 4°C warmer could be devastating, with coastal cities inundated; food security at risk, leading to higher rates of malnutrition; unprecedented heat waves in many regions, especially in the tropics; substantially exacerbated water scarcity in many regions; more intense tropical cyclones; and irreversible loss of biodiversity, including coral reef systems", with particularly grievous impacts in many of the world's poorest and most vulnerable regions. But economic impacts have not been well assessed yet. Unfortunately, the IPCC's economic estimates of the impacts of climate change largely ignore the dynamics of tipping points. Scientists argue that this omission causes economic models to grossly underestimate potential future risks and costs of climate change (Stoerk et al. 2018).

The latest research in Earth system science indicate that at +5-6°C, the Earth system may move to an entirely new state (Steffen et al. 2018 in press). It is not certain that human physiology would allow us to survive in such a world. This would pose a severe challenge to contemporary civilization, and societal collapse may not be inconceivable. This is a world we do not want to go into. The risk is simply too high.

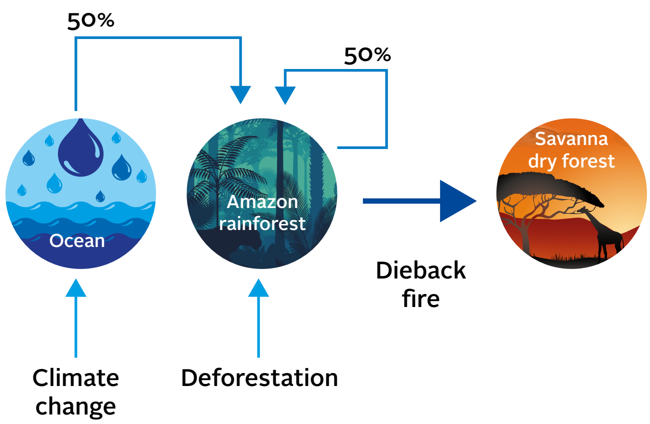
THE AMAZON – A CRITICAL "SLEEPING GIANT"

It is not just temperature rise than can awaken sleeping giants. Pollution, deforestation and habitat destruction can reduce the resilience of these sleeping giants, bringing them closer to tipping points. Resilience here means the capacity of a system to deal with change or shocks, and then recover. Of the 12 sleeping giants described in the previous section, the resilience of two of them is directly impacted by economic activities occurring in the region: the Amazon rainforest and the boreal forests. Here, we will look in more depth at the Amazon tipping element, and why it matters particularly for the global climate.

We already know that the Amazon rainforest is a vital ecosystem for the millions of people, particularly indigenous peoples, who call it their home. The Amazon rainforest has also been described as the lungs of the planet. This is a reasonable description: the forest provides 20 percent of the world's oxygen, 15 percent of the freshwater into the oceans and 10 percent of global biodiversity. Almost twice the size of India, it is a major engine in the Earth's biosphere. It pulls carbon out of the atmosphere and into its soils and trunks. Between 135 and 180 billion tonnes of carbon is stored here. For context, humans emit about 10 billion tonnes of carbon every year.

The Amazon requires sufficient amounts of rain for it to remain a tropical rainforest, which it gets from two sources. Half of it comes from evaporation in the ocean, which is transported via atmospheric circulation. The other half of the rainfall comes from the Amazon itself through evapotranspiration (trees transpire water, some of which stays over the Amazon basin and then rains down again). This is where the "tipping" dynamic comes from: if the area of rainforest decreases, the humidity rising from the rainforest will also decrease, which will curb the resulting rainfall in the Amazon, and will thus further the rainforest dieback (Figure 4).

Figure 4: The Amazon tipping element



We know that the Amazon is changing rapidly. Since the 1960s, about 20 percent of the forest has disappeared. Without the forest, rainfall in the region can shift dramatically (Coe, 2017). In the past decade, the region has been hit by record-breaking droughts (2005, 2010, 2016) and floods (2009, 2012, 2014). In the 2005 and 2010 droughts alone, 10 years of carbon storage were lost. São Paulo, the largest city in the southern hemisphere, has experienced major water crises that have been linked to deforestation elsewhere in Brazil. The oscillation between extreme states (droughts and floods) is known to be an indicator that the system may be approaching a tipping point.

The Amazon rainforest provides 20 percent of the world's oxygen, 15 percent of the freshwater into the oceans and 10 percent of global biodiversity.

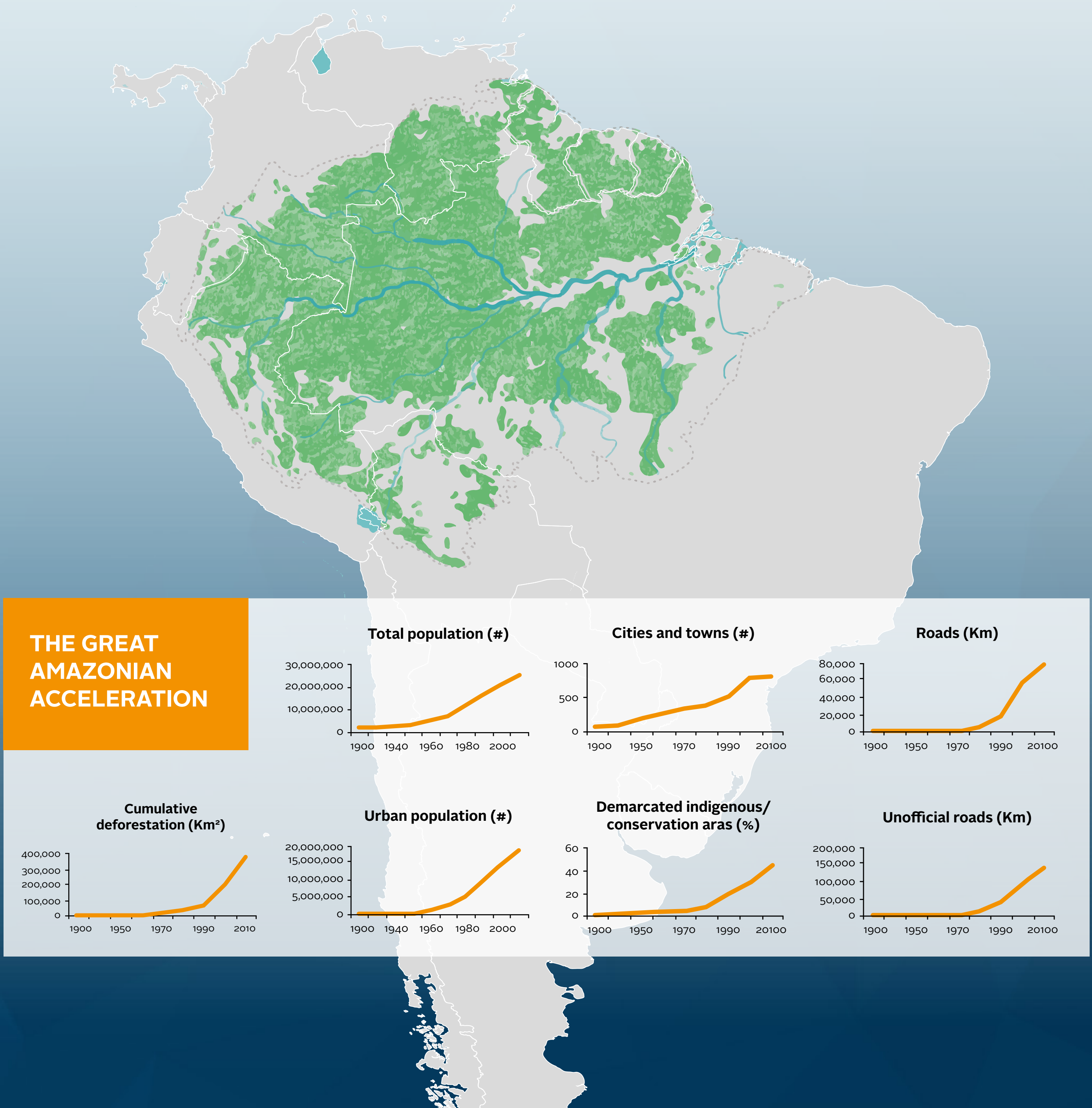
It is estimated that the Amazon rainforest could cross a tipping point where major parts of the forest die off, potentially emitting vast amounts of carbon, while huge tracts of land become savannah-like states (Figure 4). Deforestation alone (even if we have a stable climate) can tip this system. If we increase deforestation to around 40 percent, scientists are reasonably certain that the Amazon will tip. Climate change alone can also cause this to happen: a temperature rise of 3-4°C will probably tip it, without deforestation. These potential tipping points could be reached in the second half of the 21st century, and may trigger domino effects in the climate system.

However, researchers suggest that deforestation combined with warmer temperatures may bring the tipping point closer. Indeed, when taking into account climate change, the Amazon tipping point could be crossed at about 20-25 percent deforestation – i.e. slightly more than the current levels, though much uncertainty remains (Lovejoy and Nobre, 2018). This means that reaching the Paris Agreement 2°C target would reduce allowable deforestation to significantly less than 25 percent of the original cover (i.e. less than 6 percent of the remaining cover). A temperature rise of around 3°C would reduce allowable deforestation to nearly zero. Importantly, there is a lag effect in the tipping dynamic. If deforestation levels quickly reduce to zero, but temperature rises to above 2°C, the forest may look fine for another 50 years, but would eventually die off 60-70 years later.

Climate models show that deforestation in the tropics would have far-reaching consequences. The removal of tropical forests would, like the butterfly effect, lead to increased temperatures in distant regions. For example, the Western Mediterranean would become slightly cooler in winter. More worryingly, Central Asia, including densely populated areas of China, would become hotter (Snyder, 2010). This shows that we are all part of a single climate system.

In summary, we need to meet the Paris 2°C target and stop deforestation to prevent the Amazon from reaching tipping point, potentially triggering a series of effects that could destabilise the climate. In response to the rising human pressures on the Amazon biome, efforts to halt deforestation and forest degradation, preserve and regenerate remaining patches of primary forests, as well as reforestation efforts, are paramount. Forest management will increasingly play a critical role in the stability and resilience of the Amazon, as well as for the Earth's climate system as a whole.

Figure 5: The Great Amazonian Acceleration.
Co-author: Jerker Lokrantz/Azote



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The Principles for Responsible Investment (PRI)

The PRI works with its international network of signatories to put the six Principles for Responsible Investment into practice. Its goals are to understand the investment implications of environmental, social and governance (ESG) issues and to support signatories in integrating these issues into investment and ownership decisions. The PRI acts in the long-term interests of its signatories, of the financial markets and economies in which they operate and ultimately of the environment and society as a whole.

The six Principles for Responsible Investment are a voluntary and aspirational set of investment principles that offer a menu of possible actions for incorporating ESG issues into investment practice. The Principles were developed by investors, for investors. In implementing them, signatories contribute to developing a more sustainable global financial system.

More information: www.unpri.org

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The PRI is an investor initiative in partnership with UNEP Finance Initiative and the UN Global Compact.

United Nations Environment Programme Finance Initiative (UNEP FI)

UNEP FI is a unique partnership between the United Nations Environment Programme (UNEP) and the global financial sector. UNEP FI works closely with over 200 financial institutions that are signatories to the UNEP FI Statement on Sustainable Development, and a range of partner organisations, to develop and promote linkages between sustainability and financial performance. Through peer-to-peer networks, research and training, UNEP FI carries out its mission to identify, promote, and realise the adoption of best environmental and sustainability practice at all levels of financial institution operations.

More information: www.unepfi.org

UNEP FINANCE INITIATIVE

United Nations Global Compact

The United Nations Global Compact is a call to companies everywhere to align their operations and strategies with ten universally accepted principles in the areas of human rights, labour, environment and anti-corruption, and to take action in support of UN goals and issues embodied in the Sustainable Development Goals. The UN Global Compact is a leadership platform for the development, implementation and disclosure of responsible corporate practices. Launched in 2000, it is the largest corporate sustainability initiative in the world, with more than 8,800 companies and 4,000 non-business signatories based in over 160 countries, and more than 80 Local Networks.

More information: www.unglobalcompact.org

United Nations Global Compact