GLOBAL TIPPING POINTS REPORT 2025 SUMMARY

GLOBAL TIPPING POINTS

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FOREWORD

The Global Tipping Points Report 2025 comes at a time of urgency — but also of possibility. As the world prepares to gather in Belém for COP30, science warns us of ecosystems approaching dangerous thresholds. Yet this same science also shows us the extraordinary potential of positive tipping points: self-reinforcing shifts in policies, technologies, finance, and behaviours that can drive change at unprecedented speed and scale.

Brazil's vision for COP30 is to transform the narrative of tipping points from fear to hope. We must prevent irreversible harm but equally **trigger positive tipping points** that can propel societies towards low-carbon, resilient development and inclusive prosperity. This requires collective effort — a *Global Mutirão* — where all nations and communities act together, by choice, to build a future not imposed by catastrophe, but designed through cooperation.

The COP30 **Action Agenda** embodies this approach. Its *Granary of Solutions* is conceived as a reservoir of concrete tools and initiatives — scalable, replicable, and aligned with the Paris Agreement — that connect ambition with implementation. By mobilising actors and resources across six axes - from forests and food systems to energy, cities, finance, and technology, the Action Agenda has been conceived as a platform for channeling global cooperation for triggering positive tipping points of transformation leveraging solutions that already exist.

The Global South is central to this endeavour. Across Africa, Asia, and Latin America and the Caribbean, communities are pioneering regenerative agriculture, restoring mangroves and forests, developing new bioeconomy value chains, and advancing innovative financial instruments for just transitions. These are not peripheral experiments: they are **seeds of systemic change**, able to cascade into global impact if nurtured with solidarity, resources, and political will.

Every tipping point of danger can be mirrored by a tipping point of opportunity. If coral reefs are dying back, restoration of coastal ecosystems can still drive resilience and livelihoods. If forests are at risk, their regeneration can unlock carbon removal, biodiversity recovery, and sustainable prosperity. If energy systems remain carbon-intensive, the exponential uptake of renewables and electrification — already led by many countries of the South — can define a new development model that cascades into positive change across other sectors.

Our three objectives for COP30 are clear:

1. **Reinforce multilateralism** — because only united can we safeguard the climate regime and make it deliver.
2. **Connect climate action to people's lives** — because climate action must begin and end with people.
3. **Accelerate the implementation of the Paris Agreement** — inclusively, and beyond negotiation rooms, by mobilising every sector, every international institution and every community.

This report is therefore not only a warning but a guide: it maps where dangers converge, but also where opportunities to tip systems positively are within reach. COP30 in Belém must be remembered as the moment when we chose to **scale up solutions from all parts of the world — especially the South — into a global wave of renewal.**

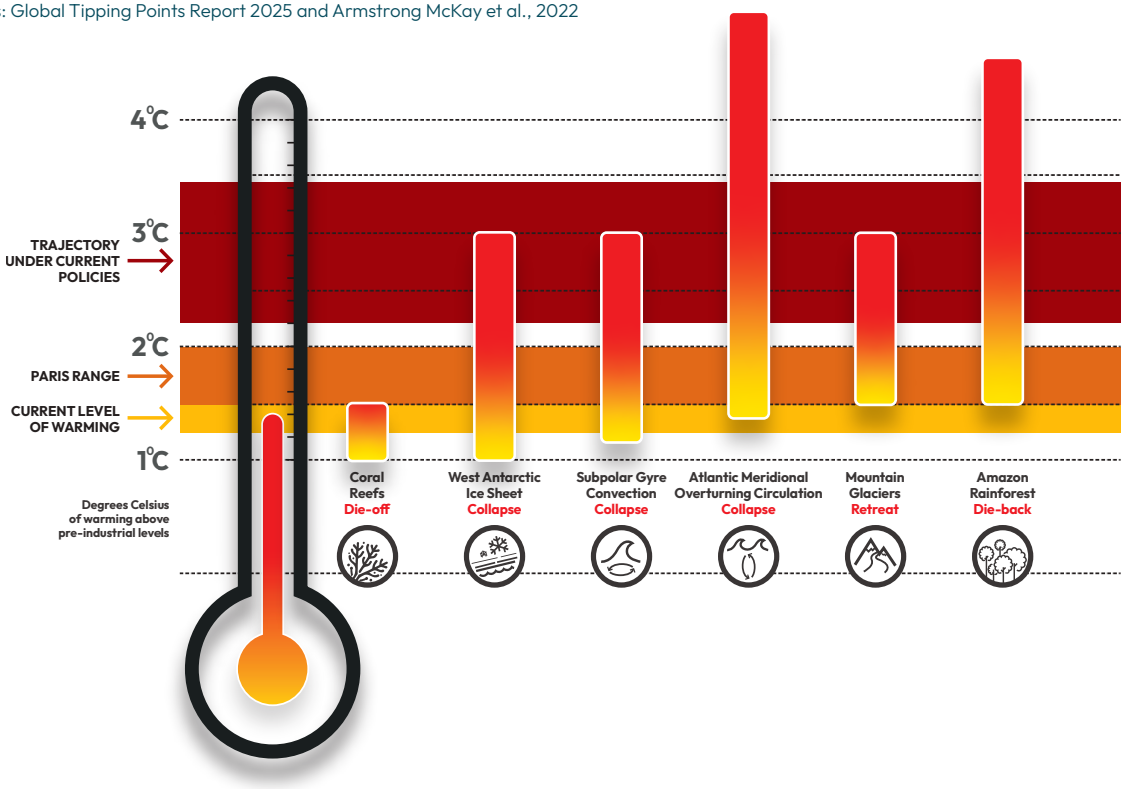
The time to act is now. United, we can reverse the dangerous trend towards a sequence of systems collapses in domino effect. Let us build on and support each other to prevent a potentially devastating chain-reaction. Let us trigger instead a "chain of action," for exponential low-carbon and climate-resilient solutions worldwide. Let us change by choice, together.

André Aranha Correa do Lago

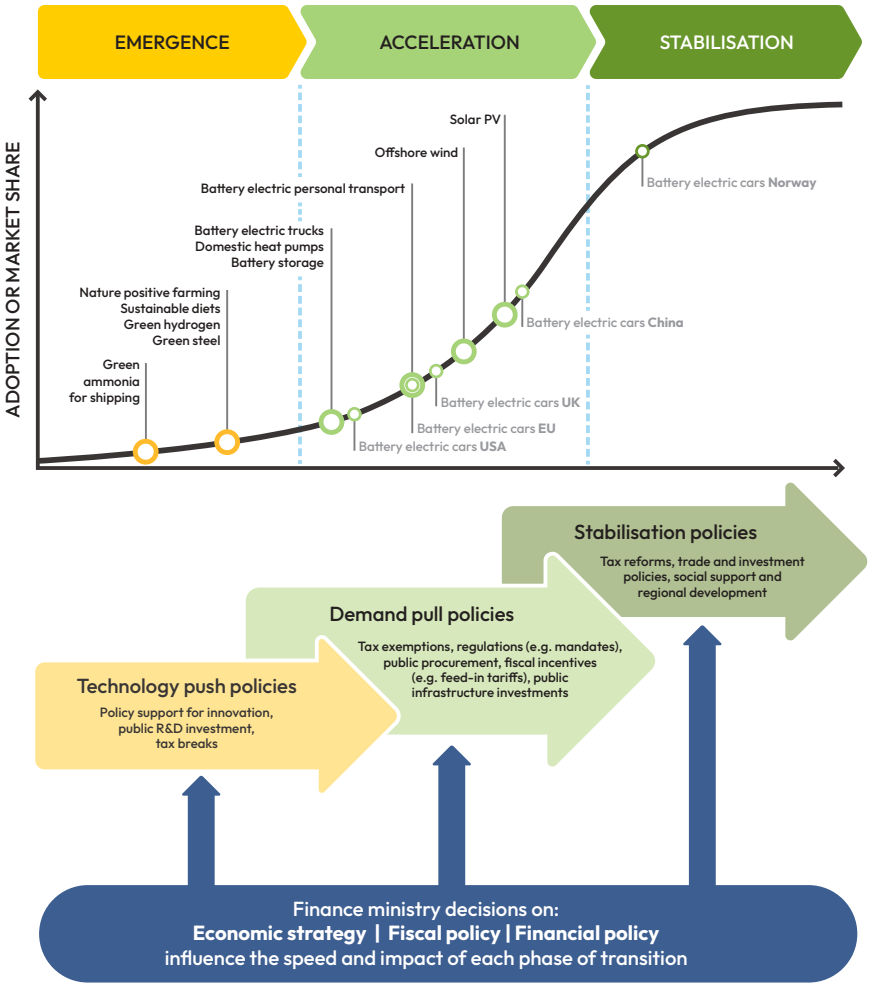
COP30 President Designate

Risks of Earth system tipping points increase with global warming

Sources: Global Tipping Points Report 2025 and Armstrong McKay et al., 2022



Policies to support positive tipping and the transition status of different technologies and markets



SUMMARY

The world has entered a new reality. Global warming will soon exceed 1.5°C. This puts humanity in the danger zone where multiple climate tipping points pose catastrophic risks to billions of people. Already warm-water coral reefs are crossing their thermal tipping point and experiencing unprecedented dieback, threatening the livelihoods of hundreds of millions who depend on them. Polar ice sheets are approaching tipping points, committing the world to several metres of irreversible sea-level rise that will affect hundreds of millions.

Every fraction of additional warming increases the risk of triggering further damaging tipping points. These include a collapse of the Atlantic Meridional Overturning Circulation (AMOC) that would radically undermine global food and water security and plunge northwest Europe into prolonged severe winters. Together, climate change and deforestation put the Amazon rainforest at risk of widespread dieback below 2°C global warming, threatening incalculable damage to biodiversity and impacting over 100 million people who depend on the forest.

These climate tipping point risks are interconnected and most of the interactions between them are destabilising, meaning tipping one system makes tipping another more likely. The resulting impacts would cascade through the ecological and social systems we depend upon, creating escalating damages. Humanity faces a potentially catastrophic, irreversible outcome. The Inter-American Court of Human Rights recognises the right of humans to a safe climate, hence preventing irreversible harm to the climate system is a legal imperative.

How hot we let it get and for how long really matters in preventing climate tipping points. The magnitude and duration of global temperature overshoot above 1.5°C has to be minimised. To achieve that, global anthropogenic greenhouse gas emissions must be halved by 2030 (compared to 2010 levels) and then reach net zero by 2050. This requires an unprecedented acceleration in decarbonisation, rapid mitigation of methane emissions and other short-lived climate pollutants and fast scaling of sustainable carbon removal from the atmosphere.

If we wait to cross tipping points before we act, it will be too late. The only credible risk management strategy is to act in advance. But the window for preventing damaging tipping points is rapidly closing. Current Nationally Determined Contributions (NDCs) and binding long-term or net zero targets are not enough. They still commit the world to ongoing global warming that will likely exceed 2°C before 2100. This demands immediate, unprecedented action from leaders at COP30 and policymakers worldwide.

To achieve such a radical acceleration of action requires triggering positive tipping points that generate self-amplifying change in technologies and behaviours, towards zero emissions. In the two years since the first Global Tipping Points Report was published, there has been a radical acceleration in the uptake of solar power and electric vehicles worldwide. However, there has also been a recent spate of backsliding on commitments in some nations and sectors, including finance.

Nevertheless, a minority can still tip the majority when they have self-amplifying feedback on their side. This is clearly evident in clean technology adoption. Solar PV panels have dropped in price by a quarter for each doubling of their installed capacity. Batteries have improved in quality and plummeted in price the more that are deployed. This encourages further adoption. The spread of climate litigation cases and nature positive initiatives is also self-amplifying. The more people undertaking them the more they influence others to act.

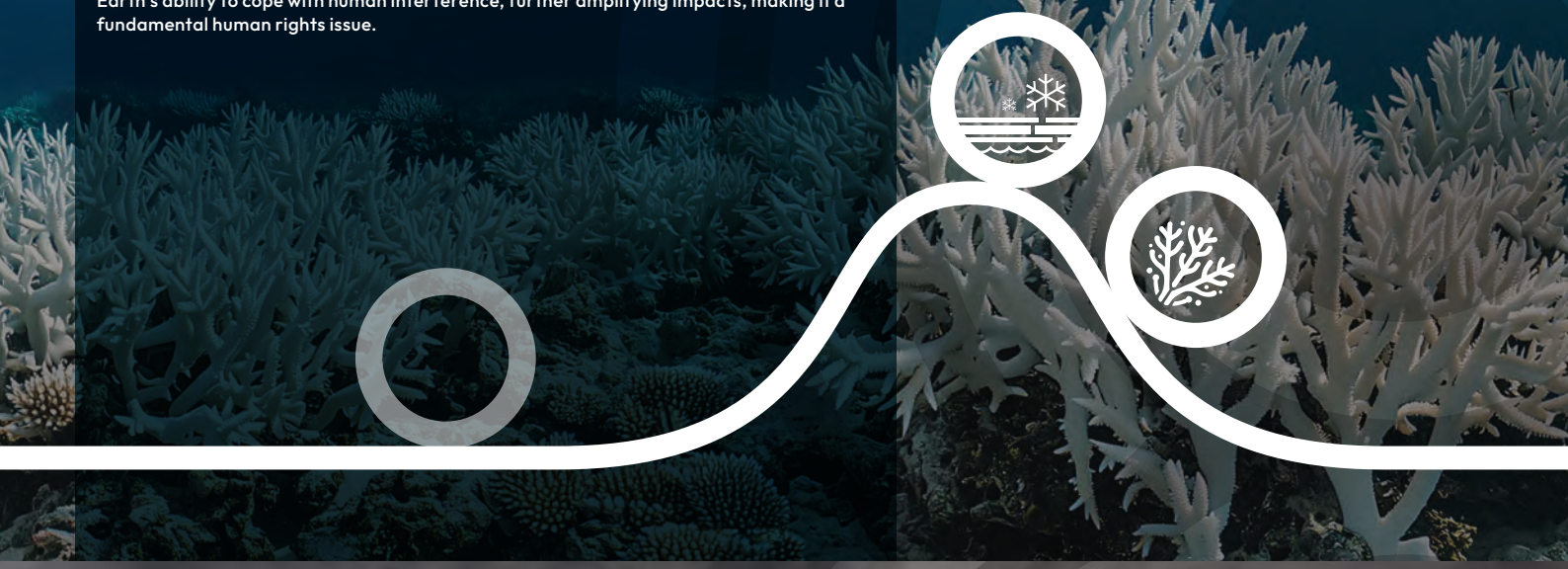
Positive tipping points are also starting to interact and reinforce one another. Policies targeting super-leverage points of interaction can help trigger this cascading positive change. Reinforcing feedback between civil society and policymakers is also critical to amplifying positive change. Hence the Global Mutirão, by catalysing collective action from civil society, could be key to triggering positive tipping points.

Only with a combination of decisive policy and civil society action can the world turn from facing existential climate tipping point risks to seizing positive tipping point opportunities.

01. NEW REALITY

Earth's climate and nature are already passing tipping points as global warming approaches 1.5°C.

Since the first Global Tipping Points Report in 2023, understanding of tipping point risks has increased. Already at 1.4°C of global warming, warm water coral reefs are crossing their thermal tipping point and experiencing unprecedented dieback, impairing the livelihoods of hundreds of millions who depend on them. Parts of the polar ice sheets may also have crossed tipping points that would eventually commit the world to several metres of irreversible sea-level rise affecting hundreds of millions. Crossing tipping points reduces Earth's ability to cope with human interference, further amplifying impacts, making it a fundamental human rights issue.



02. ESCALATING RISK

Overshooting 1.5°C puts the world in a danger zone where further tipping points pose catastrophic risks.

Global warming is projected to overshoot 1.5°C within a few years, placing humanity at even greater risk. Climate change and deforestation together put the Amazon rainforest at risk of widespread dieback below 2°C, threatening incalculable damage to biodiversity and impacting over a hundred million who depend on the forest. The Atlantic Meridional Overturning Circulation (AMOC) is also at risk of collapse below 2°C, which would radically undermine global food and water security and plunge northwest Europe into severe winters. Preventing climate tipping points should be a legal imperative.

03. PREVENT TIPPING

Minimising overshoot of 1.5°C is essential to prevent climate tipping points.

Every fraction of a degree and every year over 1.5°C matters for preventing climate tipping points. To minimise the magnitude and duration of global temperature overshoot above 1.5°C, global anthropogenic greenhouse gas emissions need to be halved by 2030 (compared to 2010 levels), reach net zero by 2050, and then net greenhouse gas removal needs to occur. This requires unprecedented acceleration in decarbonisation, rapid mitigation of short-lived climate pollutants – especially methane emissions, and rapid scaling of sustainable and equitable carbon removal from the atmosphere.

04. ACT NOW

Leaders at COP30 must act now to prevent damaging tipping points.

The window for preventing some damaging, irreversible tipping points is rapidly closing. If we wait for certainty that tipping points have been crossed before we act, it will be too late. Current Nationally Determined Contributions (NDCs) and binding long-term or net zero targets are not enough to prevent damaging tipping points. They commit the world to global warming that will likely exceed 2°C before 2100. Hence unprecedented action is needed from leaders at COP30 and policymakers worldwide to prevent damaging tipping points.

05. ACT LOCALLY

Tackling non-climate drivers can help avoid biosphere tipping points.

For warm-water coral reefs, the Amazon rainforest and other ecosystems at risk of tipping, reducing non-climate stressors can help increase their resilience to tipping. For coral reefs, this includes reducing overfishing and nutrient loading. For the Amazon rainforest, reducing deforestation and forest degradation are key. These local actions can give communities some agency over the fate of their ecosystems. Ultimately, however, global warming will need to be reduced below 1.5°C towards 1°C to prevent the permanent loss of coral reefs.

06. RECENT PROGRESS

Climate progress has accelerated in the last 2 years despite recent backsliding.

Since 2023, there has been a radical acceleration in the uptake of clean technologies worldwide, notably solar PV power and electric vehicles. There has also been contagious spread of climate litigation cases, nature regeneration initiatives, together with the emergence of more sustainable patterns of consumption and production in food and fibre supply chains. Despite recent backsliding on commitments in some nations and sectors, a minority can still positively tip the majority, generating self-amplifying change in societies, economies and technologies. The more people who act, the more they influence others to act.

07. TRANSITION AWAY

Policy mandates are needed to accelerate the transition away from fossil fuels.

The most effective policies to trigger positive tipping points in the energy system are generally policy mandates to phase in clean technologies and transition away from fossil fuelled ones. These include bans on the future sale of petrol/diesel cars, diesel trucks and gas boilers in key markets. They can make clean alternatives better and cheaper for everyone, helping eliminate the 75% of greenhouse gas emissions linked to the energy system, and transition away from fossil fuels in a just, orderly and equitable manner.

08. ENABLE FINANCE

Reducing the cost of capital enables positive tipping points especially in the Global South.

All sources of public and private finance can be engaged to reduce the cost of capital for low-carbon technologies and resilient infrastructure, particularly for the benefit of Global South countries. The costs of climate finance must also take into account the long-term economic and health benefits of climate action and the far greater costs of inaction or delay. The Baku-to-Belem Roadmap offers a transformational opportunity for climate finance.

09. PROMOTE JUSTICE

Positive tipping points can simultaneously combat poverty, hunger and inequality.

Positive tipping points are already reducing energy prices worldwide, accelerating access to cheap electricity for those that lack it, and benefitting the economies of net fossil fuel importing countries where three-quarters of people live. Engaging communities in rapid transition can help ensure that decarbonisation also achieves social developmental goals of combatting hunger, poverty and inequality. Digital public infrastructure can support fairness and shared prosperity by delivering essential financial, health, educational, and other social and economic services, particularly in low- and middle income countries.

10. TIP FOOD

Sustainable production and consumption can positively tip the food system.

Policy changes are needed worldwide to help eliminate the 25% of greenhouse gas emissions linked to food, farming, and deforestation and in so doing, help reverse global biodiversity loss. Domestic legal frameworks and governance, shifts to sustainable production supported by public and private finance, changes in consumption and sustainable international trade policies are critical to avoid damaging tipping points in nature. This includes avoiding dieback of the Amazon rainforest. These changes are necessary to liberate land for regenerating nature.

11. REGENERATE NATURE

Positive tipping points of nature regeneration can scale sustainable carbon removal.

Nature regeneration can be positively tipped, and social tipping points are already spreading nature positive initiatives, including marine protected areas. Action to protect indigenous rights, support community-led conservation initiatives, ensure fair and transparent valuing of nature and establish rights of nature, can help trigger further positive tipping points for nature. This will help achieve the Kunming-Montreal Global Biodiversity Framework targets and is essential to scale up sustainable removal of CO_2 from the atmosphere and limit overshoot of 1.5°C.

12. CASCADE CHANGE

Civil society and governance can catalyse each other to cascade positive change.

Positive tipping points can cascade between different parts of society and the economy. Catalysing collective action from civil society - through the Global Mutirão - is key to helping trigger positive tipping points and giving policymakers a mandate to act. Policy action should target super-leverage points that can trigger cascading positive change across sectors. Only with a combination of decisive policy and civil society action can the world tip its trajectory from facing existential climate tipping point risks to seizing positive tipping point opportunities.

SECTION 1

GOVERNANCE OF EARTH SYSTEM TIPPING POINTS

Section lead authors:
Manjana Milkoreit, Simon Willcock

Earth system tipping points pose distinct and urgent governance needs

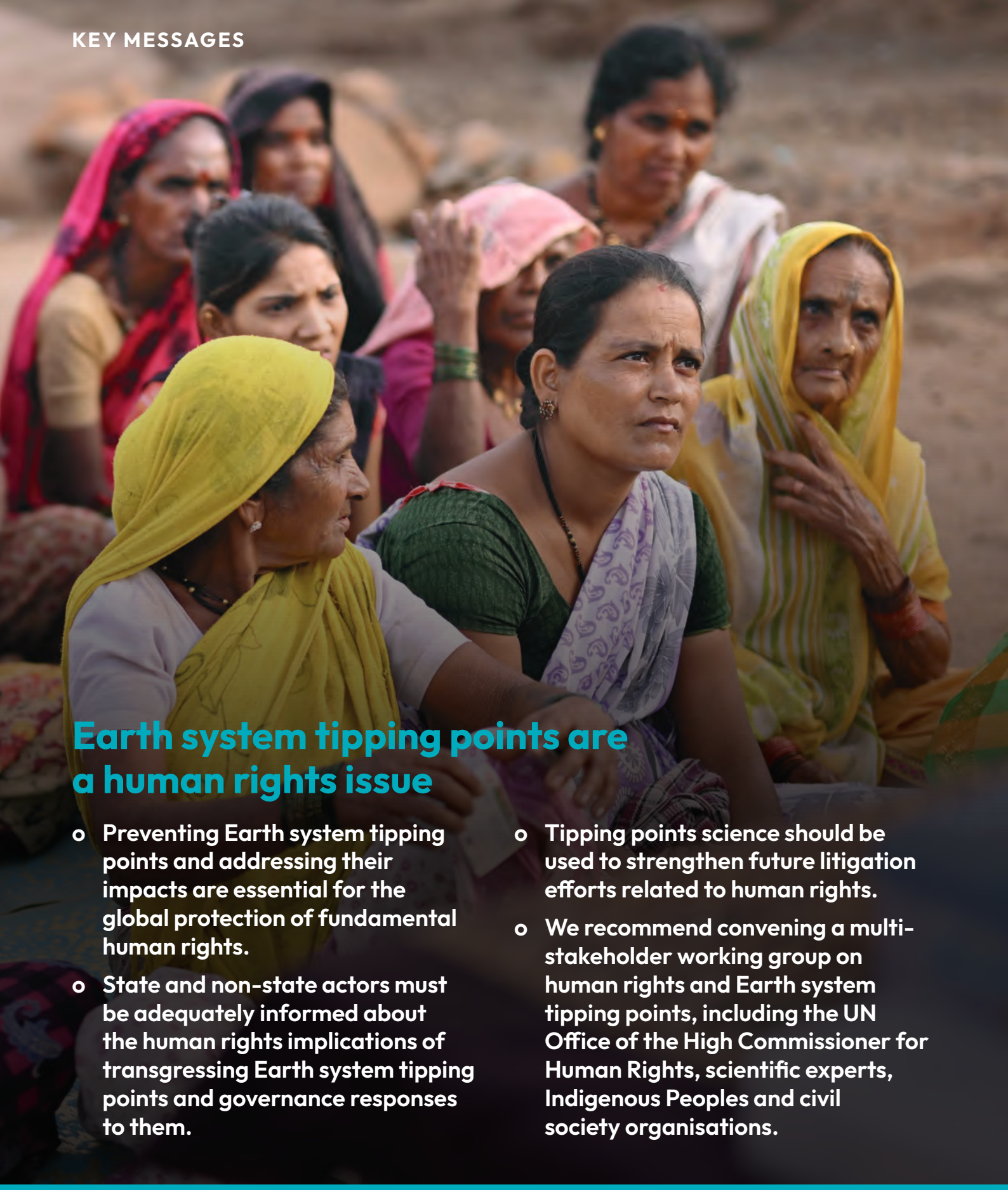
- With global warming soon overshooting 1.5°C, developing and implementing effective governance strategies to prevent Earth system tipping points is increasingly urgent and important.
- Tipping points present distinct governance challenges compared to other aspects of climate change or environmental decline, requiring both governance innovations and reforms of existing institutions.
- Precaution, anticipatory governance and systemic risk governance are key approaches for addressing Earth system tipping points.
- Amid deepening geopolitical fragmentation and the weakening of multilateralism, governance responses to Earth system tipping points must focus on fostering a flexible, multi-scale agenda capable of advancing under challenging political conditions.

Preventing Earth system tipping points requires a change in strategy

- The risk of activating Earth system tipping processes exists at current levels of global warming and increases with every 0.1°C and every year of overshooting the globally agreed goal of 1.5°C.
- Current climate mitigation measures are not sufficient to prevent tipping events; they need to be accelerated and coupled with measures addressing non-climate drivers, such as deforestation of the Amazon rainforest.
- Preventing tipping points requires 'frontloaded' mitigation pathways that minimise peak global temperature, the duration of the overshoot period above 1.5°C and the return time below 1.5°C with immediate, comprehensive transition away from fossil fuels.
- Sustainable carbon dioxide removal approaches need to be rapidly scaled up to help return the global mean temperature to and then below 1.5°C.

The impacts of Earth system tipping points demand governance action

- Societies need governance efforts that anticipate and prepare for the specific impacts of Earth system tipping points before tipping points are crossed – these impacts differ from the observed and expected impacts of other aspects of climate change.
- Governance should assess and reduce vulnerability to tipping point impacts, build resilience and include tipping point impacts in climate adaptation policy and planning and related policy domains.
- Governments, intergovernmental organisations, economic and financial actors should integrate Earth system tipping points in risk assessments across scales.
- Justice – intragenerational, intergenerational and interspecies – must be at the centre of Earth system tipping point impact governance.



Earth system tipping points are a human rights issue

- Preventing Earth system tipping points and addressing their impacts are essential for the global protection of fundamental human rights.
- State and non-state actors must be adequately informed about the human rights implications of transgressing Earth system tipping points and governance responses to them.
- Tipping points science should be used to strengthen future litigation efforts related to human rights.
- We recommend convening a multi-stakeholder working group on human rights and Earth system tipping points, including the UN Office of the High Commissioner for Human Rights, scientific experts, Indigenous Peoples and civil society organisations.

Multiple actors are needed to govern Earth system tipping point risks

- Earth system tipping points require engagement not only from national governments and international bodies, but also municipal, regional, corporate and community actors, each of whom have particular responsibilities, capacities and opportunities to influence outcomes.
- Diverse strategies are needed to address Earth system tipping points—ranging from law and policymaking to advocacy, institutional reform and storytelling—drawing on the varied capacities, mandates and influence of actors operating across multiple scales and domains.
- In this early agenda-setting phase of Earth system tipping point governance, actors such as international organisations, science communicators and advocacy groups have a critical role to play in raising awareness, shaping narratives and mobilising political will.
- Addressing Earth system tipping points requires building trust and fostering cooperation and coordination among state and non-state actors across multiple levels of governance.

SECTION 2

EARTH SYSTEM TIPPING POINTS AND RISKS

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Jesse Abrams, David Armstrong McKay, Joshua E. Buxton, Sina Loriani, Nico Wunderling

Earth system tipping points pose profound risks

- Tipping points threaten the stability of the Earth system, which our society and economy fundamentally rely on. Societal development, wellbeing, prosperity and economic health are threatened by Earth system tipping points.
- Earth system tipping points create diverse and interconnected risks that are different to other climate impacts, often characterized by irreversibility, deep uncertainty and potential for cascading failures across natural and human systems.

New risk assessment approaches are needed for tipping points

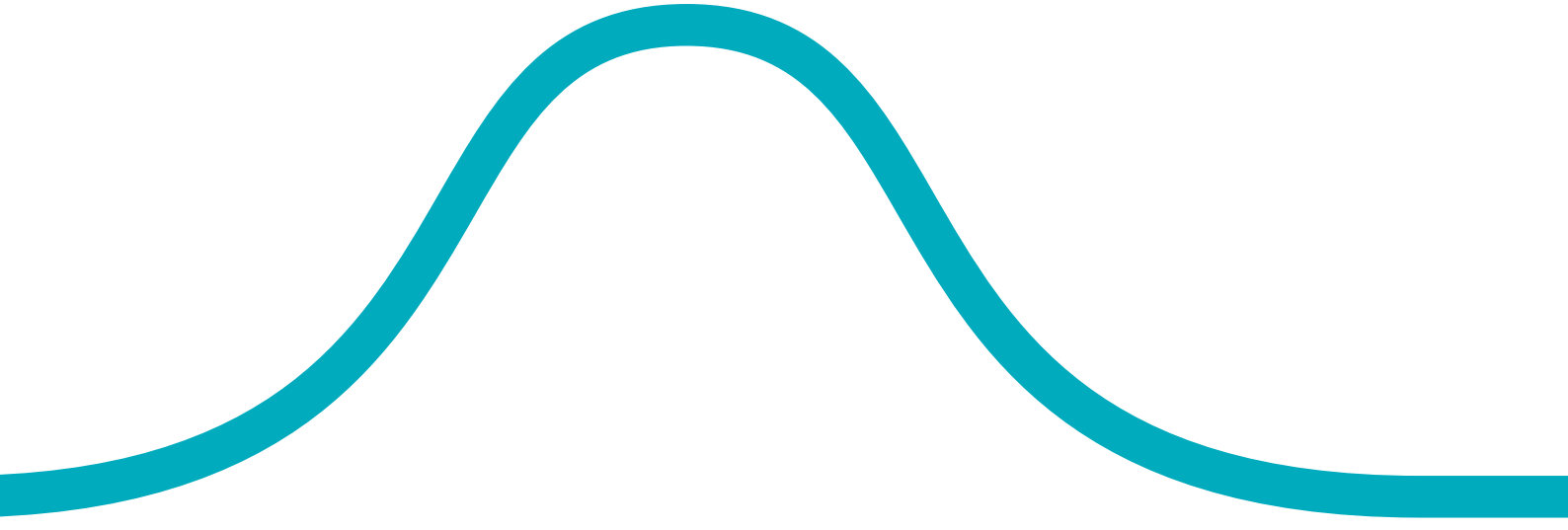
- Traditional risk assessment fails for Earth system tipping points: Conventional impact-probability matrices capturing individual climate impacts are inappropriate for tipping point risk analysis, due to uncertainty, nonlinear dynamics and the systemic scale and scope of interactions between impacts and their cascading effects.
- Assessing tipping point risks can benefit from specialized approaches including risk registers that translate Earth system changes into policy-relevant "risk currencies" while capturing cascading effects and system interactions.

Cryosphere tipping points may already have been crossed

- We have high confidence that ice sheets - from Greenland to West Antarctica - have warming tipping points leading to irreversible collapse, locking in long-term multi-metre sea level rise and have been at risk since at least 1°C of global warming.
- While Arctic summer sea ice is unlikely to reach tipping points, Antarctic sea ice may have a tipping point that could already be underway, although highly uncertain.
- We have medium confidence in potential regional tipping points in permafrost and glaciers, which would respectively amplify emissions and commit some regions to total deglaciation.

Biosphere tipping points are approaching faster than we thought

- Warm-water coral reefs have experienced the worst bleaching event on record over 2023-25 and the central estimate of their thermal tipping point of 1.2°C global warming has been crossed.
- The Amazon rainforest has faced two years of intense El Niño-induced drought and the combined effects of deforestation and climate change put it at risk below 2°C of global warming.
- We now recognise river deltas and peat bogs as potential tipping systems, identify the potential for localised mangrove tipping with high confidence and the potential for local-scale temperate forest tipping with low confidence.



Ocean and atmosphere circulation are already at risk of tipping points

- Recent modelling supports the Atlantic Meridional Overturning Circulation (AMOC) and Sub-Polar Gyre (SPG) deep convection having tipping points, which cannot be ruled out at current warming levels, but limited models and observations means their likelihood of tipping remains uncertain.
- In the Southern Ocean, dense shelf water formation may be declining and could reach a tipping point, but understanding of its interactions with ice remains limited.
- Recent modelling supports the Indian summer monsoon having tipping dynamics, although evidence remains limited, whereas evidence against tipping dynamics in the 'jet stream' has strengthened.

Interactions between tipping systems tend to increase risk

- Out of 20 climate tipping system interactions assessed, most are destabilising, but a few may have a stabilising effect.
- The AMOC is the key global mediator of tipping point interactions, featuring in 45% of all assessed tipping point interactions.
- A vicious cycle may form where permafrost thaw could lead to amplified Arctic sea ice retreat, which may lead to enhanced inland permafrost degradation and so on.

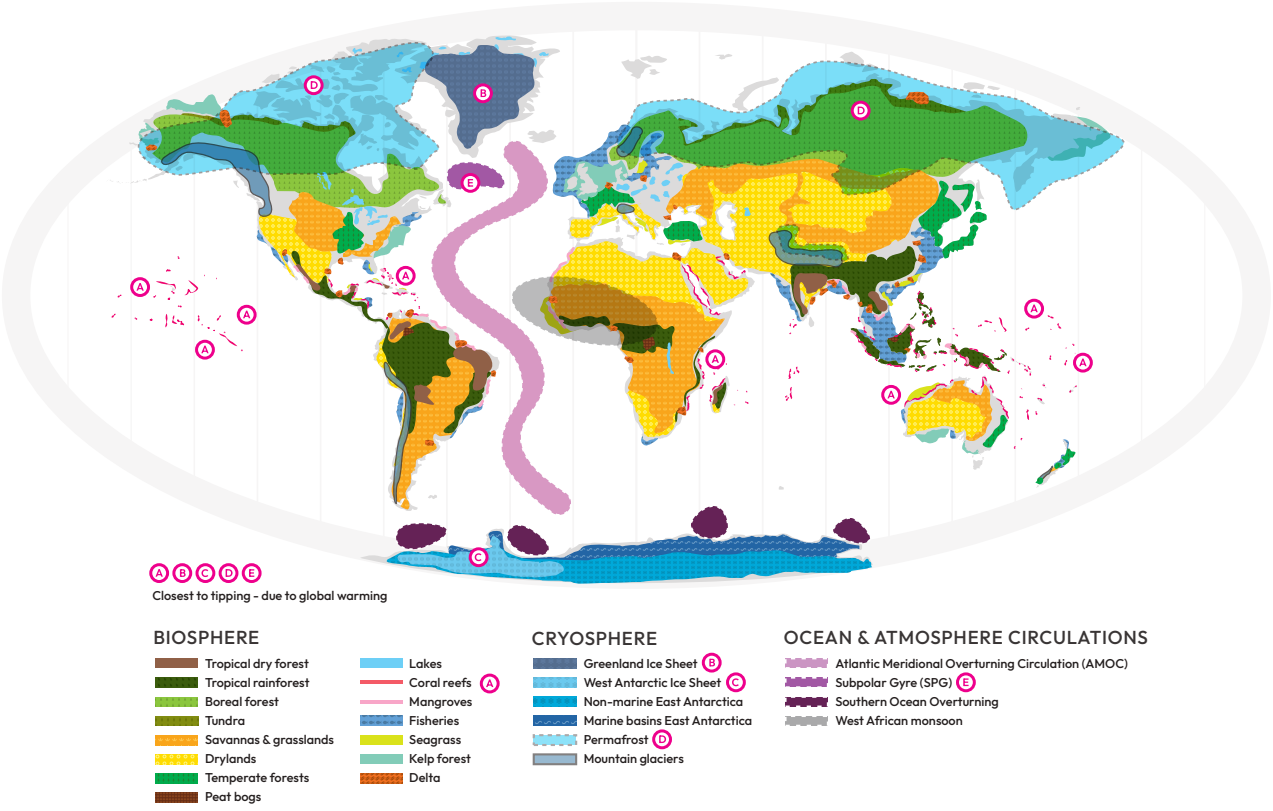
Overshooting 1.5°C increases the risk of crossing multiple climate tipping points

- Several systems (land permafrost, Greenland ice sheet, West Antarctic ice sheet and sub-polar gyre) likely have a tipping point around 1.5°C global warming.
- Several more systems (mountain glaciers, boreal forests and AMOC) likely have a tipping point around 2.0°C global warming.
- Crossing these tipping points becomes more likely for each 0.1°C of global warming.

Peak warming and time above 1.5°C must be minimised to limit tipping risks

- Limiting tipping risks requires minimising peak global warming and overshoot duration above 1.5°C and ultimately stabilising global warming below 1.5°C before 2100 and below 1.0°C on longer timescales.
- Fast tipping systems are vulnerable to even short-lived overshoots of their tipping points and therefore they constrain the allowable peak global warming.
- Slow systems can tolerate temporary overshoots of their tipping points but constrain the allowable duration of overshoot and the eventual temperature stabilisation level.

Parts of the Earth system identified in this report as featuring tipping points



Warming feedbacks and other anthropogenic stressors increase tipping risks

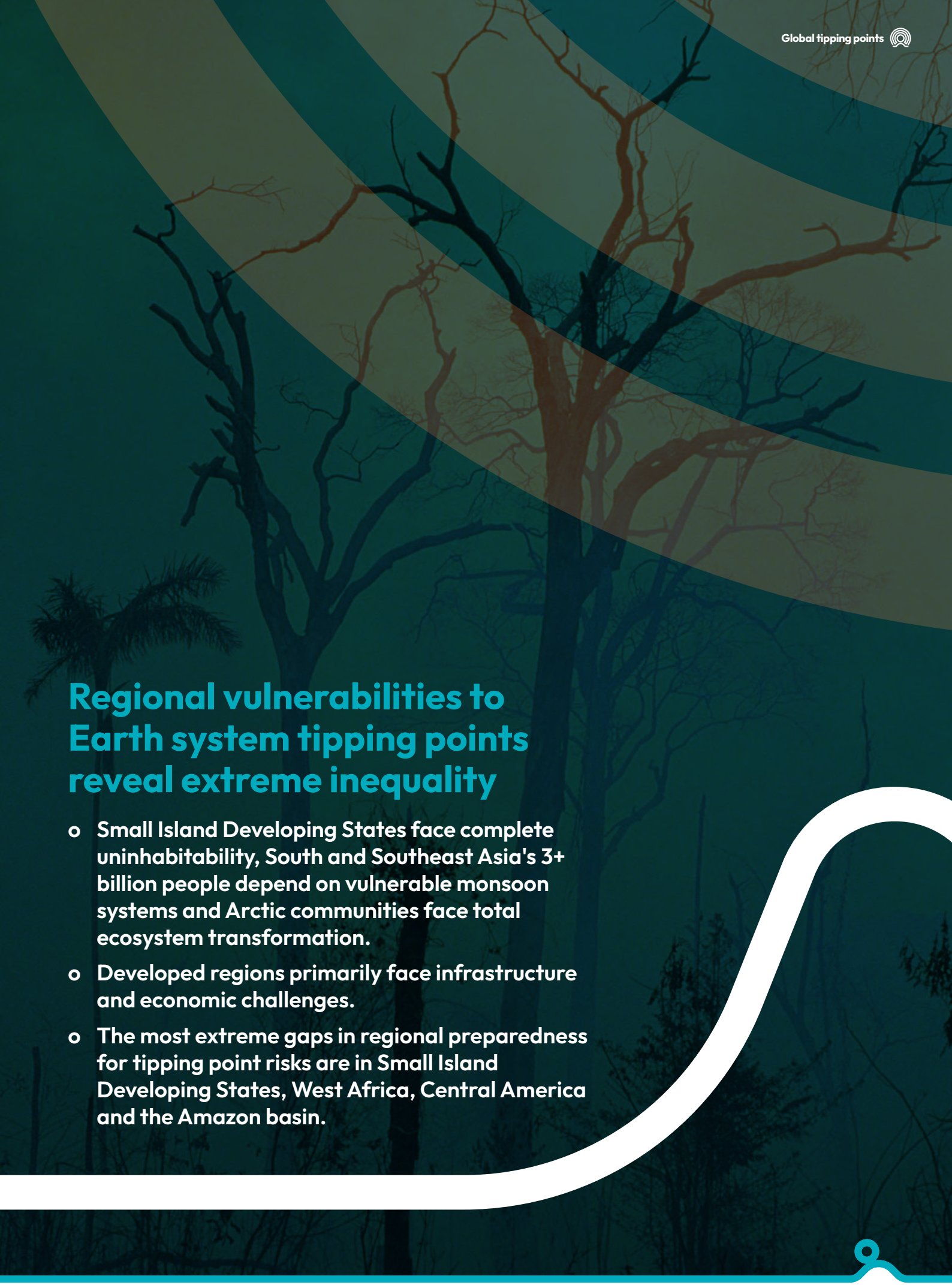
- Most tipping systems are expected to amplify global warming if tipped, making it more difficult to return to lower global warming levels in an overshoot period.
- Additional pressures, such as other anthropogenic stressors, interacting tipping systems and destabilising Earth system feedbacks, can amplify tipping risks further.
- Decreasing direct anthropogenic stressors can reduce the likelihood of climate-induced tipping for some systems (e.g. halting Amazon deforestation).

Earth system tipping points have huge impacts that demand further research

- There is an urgent need for dedicated research on the impacts of crossing Earth system tipping points especially their systemic, cascading impacts through societies.
- We provide an initial analysis of these impacts relying heavily on inferences from general climate impact literature applied to anticipated tipping point changes.
- Our assessment suggests that crossing Earth system tipping points will cause profound risks across nine critical domains, including food security, energy infrastructure, economic stability and social cohesion, affecting billions globally.
- Earth system tipping points are also a national security issue as food, water and heat stresses will impact populations. If climate change is unchecked then mass mortality, forced displacement and severe economic losses become likely.

All regions and billions of people face major impacts from Earth system tipping points

- Critical tipping point risks exist for small islands and East Asia from ice sheet loss, for South Asia, Southeast Asia and Central America from monsoon disruption, for West Africa from AMOC collapse and monsoon disruption and for North Asia from permafrost thaw and boreal forest tipping.
- Major tipping point risks exist for Northeast America from AMOC collapse and ice sheet loss, for Northwest Europe from AMOC collapse and for the Amazon region from rainforest dieback.
- The greatest population is ultimately at risk from monsoon disruption, followed by ice sheet loss, AMOC collapse and the degradation of warm-water coral reefs.

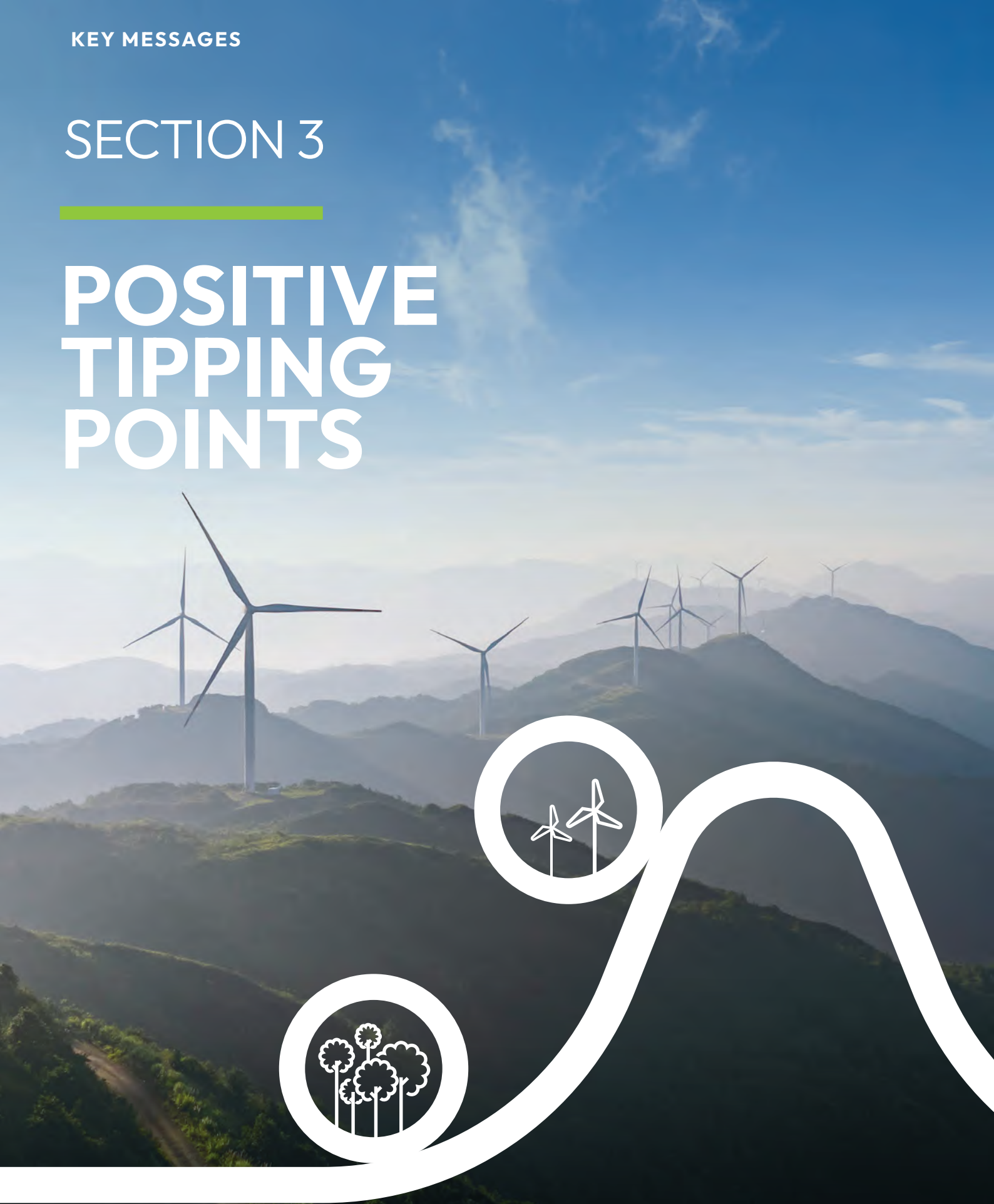


Regional vulnerabilities to Earth system tipping points reveal extreme inequality

- Small Island Developing States face complete uninhabitability, South and Southeast Asia's 3+ billion people depend on vulnerable monsoon systems and Arctic communities face total ecosystem transformation.
- Developed regions primarily face infrastructure and economic challenges.
- The most extreme gaps in regional preparedness for tipping point risks are in Small Island Developing States, West Africa, Central America and the Amazon basin.

SECTION 3

POSITIVE TIPPING POINTS



Section lead authors:
Floor Alkemade, Sara M. Constantino, Tom Powell, Steven R. Smith

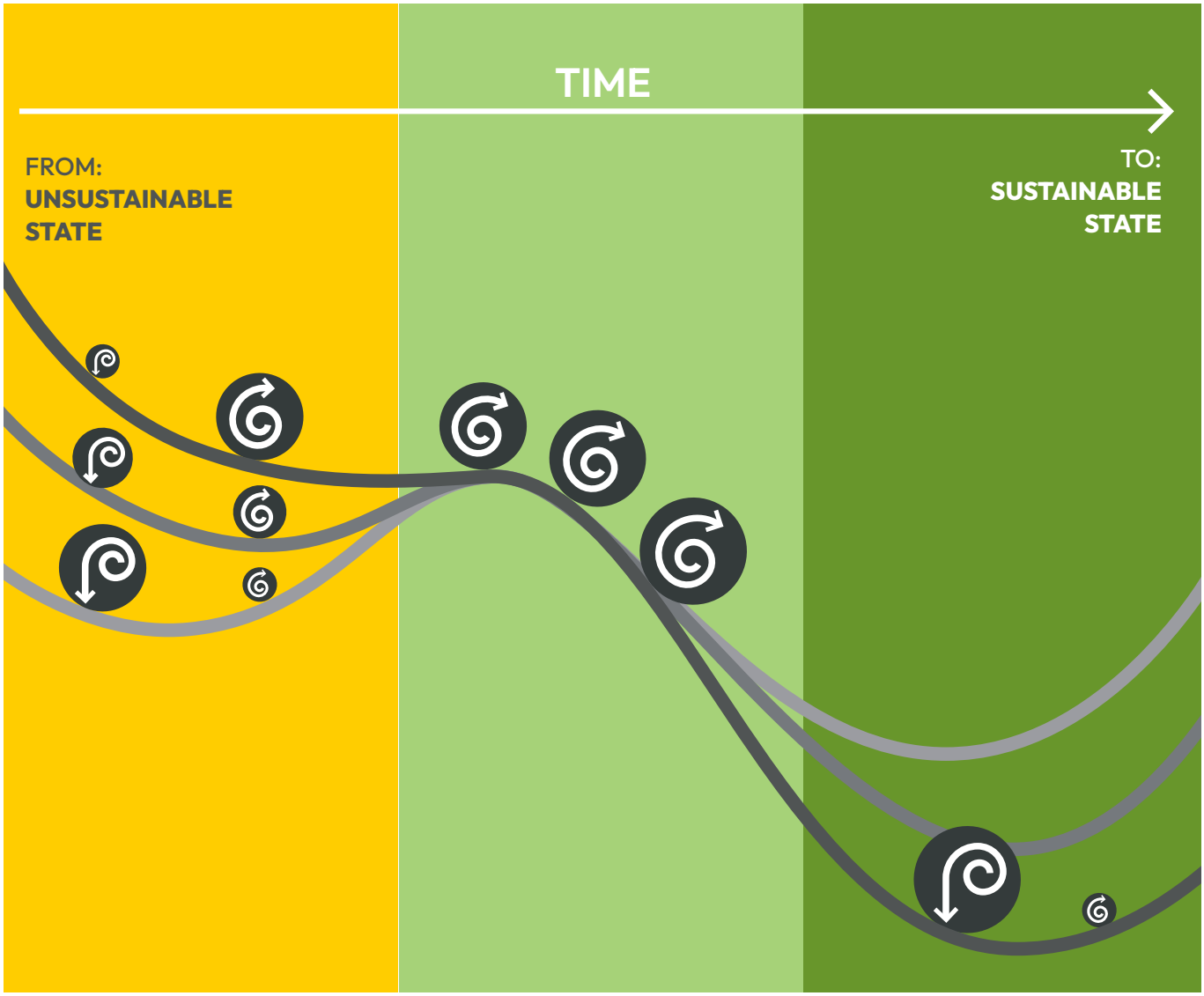
Positive tipping points must be identified and triggered to accelerate to net zero

- Positive tipping points occur when reinforcing feedbacks in a system overwhelm balancing feedbacks, triggering self-propelling change towards a more sustainable state.
- Policymakers can accelerate decarbonisation by prioritising technologies and behaviours that have the potential to positively tip.
- Easily imitatable behaviours in which social influence plays a strong role (e.g. active travel) and highly modular, mass producible technologies (e.g. solar panels), have greatest potential to be positively tipped.
- Deliberate actions can enable positive tipping by neutralising balancing feedback, promoting reinforcing feedback and helping make a desired change the most affordable, accessible and/or attractive option.

Progress towards positive tipping points can be sensed and acted upon

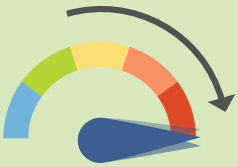
- Positive tipping points have already been crossed in the adoption of solar PV and wind power globally, in the adoption of electric vehicles, battery storage and heat pumps in leading markets and there is potential for them in various applications of green hydrogen, green ammonia and alternative protein foods.
- Early opportunity signals can reveal a loss of resilience of an incumbent system and a window of opportunity for positive tipping, but better indicators are needed to understand tipping potential and proximities to tipping points.
- System interactions can create opportunities for positive tipping cascades whereby tipping in one sector (e.g., battery technology) can increase the likelihood of tipping in another (e.g., renewable energy).

The fundamental processes behind positive tipping points

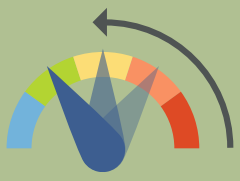


NET FEEDBACK EFFECT

1 - Balancing feedbacks resist change and lock in the status quo, but strengthening reinforcing feedbacks can weaken this resilience and create the conditions for tipping.



2 - Reinforcing feedbacks tip the system towards a new state.



3 - Feedbacks rebalance in a new stable state.

DRIVING/REINFORCING THE CHANGE

RESISTING/BALANCING

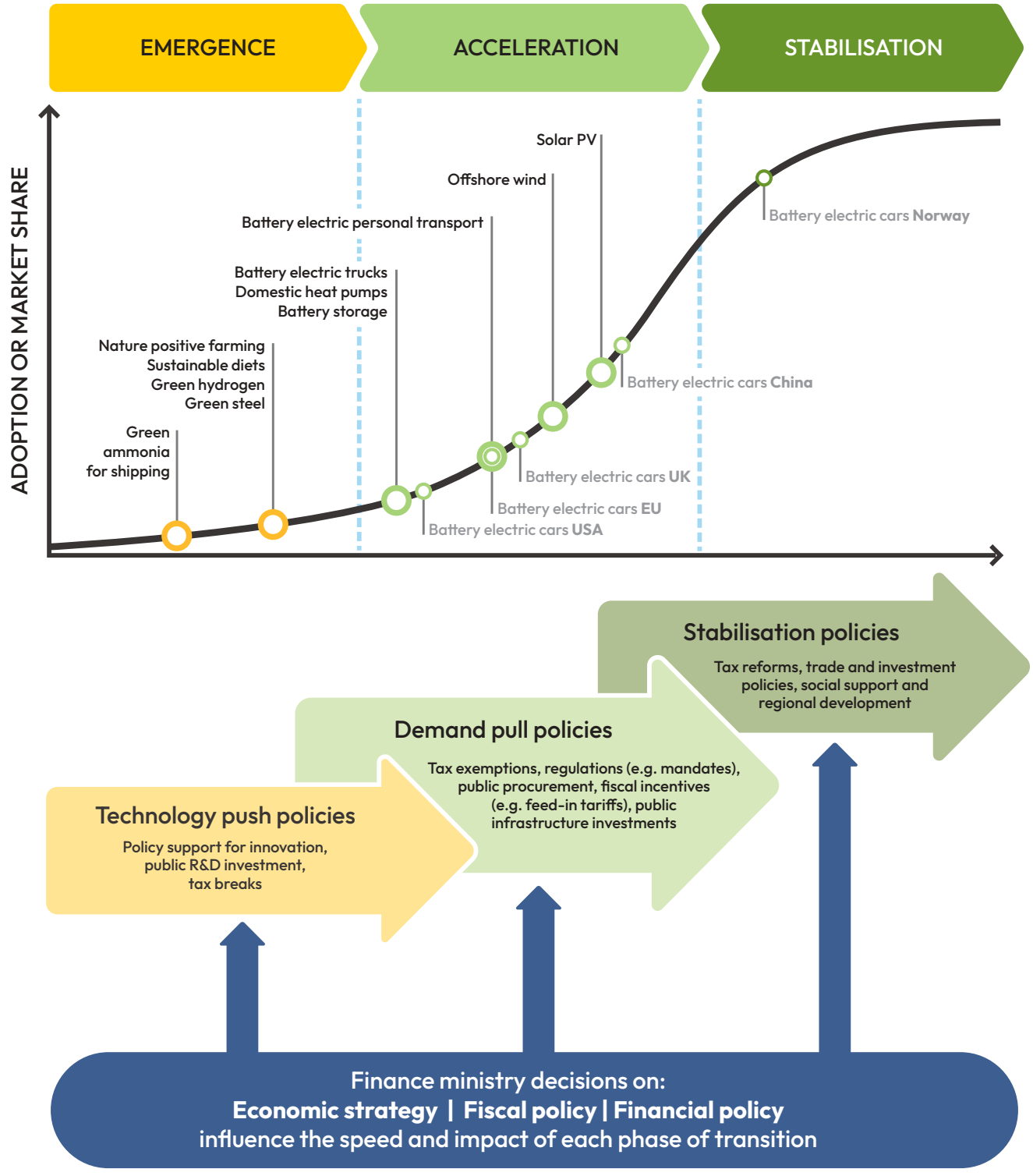
Cross-cutting factors can support positive tipping points

- Patterns of capital allocation that enable sustained financial flows into emerging low-carbon technologies and sectors can help overcome lock-ins, reduce perceived risk and build market confidence, particularly in underinvested regions and markets.
- Digitalisation and AI have the potential to accelerate positive tipping points by managing complex systems from renewable energy smart grids and transportation systems to social deliberation processes.
- Climate communications in the format of film, journalism, performance art and other media can be instrumental in generating the political momentum for positive change, particularly when connected to targeted policy advocacy and trusted messengers.

Coordination and coalitions can catalyse positive tipping points

- Coordinated cross-sectoral action at 'super-leverage points' can unleash positive tipping cascades. Coordinated mandates across interacting sectors (e.g. power, transport and heating) can bring forward tipping in all.
- Coherent, committed, ambitious coalitions can challenge incumbencies and catalyse positive tipping towards majority adoption of social and technological innovations.

Policies to support positive tipping and the transition status of different technologies and markets



Policy design needs to match the phase of a positive tipping process

- Effective sequencing of interventions is important to activate positive tipping points. Different opportunities exist to overcome barriers and enable scaling at different phases of an S-curve of adoption. Effective policy design needs to match the system's tipping phase.
- Policy mixes need to be appropriate to the scale, context, sector, actor and phase of transition, to effectively catalyse and facilitate positive tipping dynamics.

Positive tipping points need to be well governed to ensure a rapid and just transition

- Governance can create the enabling conditions for positive tipping, including easing access to finance, providing the necessary infrastructure to support rapid deployment and cultivating sufficient stakeholder engagement and public support for policies to be approved and implemented.
- Rapid transition benefits from governance that is collaborative, localised and tailored to what communities say they want through participatory methods.
- Governments need to be aware of the potential for unintended consequences from positive tipping points including financial and political instability, stranded assets (including human assets) and perceived (in)justice of the transition.

Transformation is underway in the power and mobility sectors but can be accelerated

- Renewable energy is scaling rapidly but unevenly. Solar PV is doubling capacity every 2-3 years and growth of wind power is also strong. Reducing planning delays, providing grid infrastructure and finance can accelerate change.
- Battery prices have plummeted by 84% in the last decade and capacity is growing exponentially, underpinning mobility and power sector transitions.
- Electric vehicle adoption is accelerating in leading markets. China has become the dominant manufacturer. Norway has near total adoption. Price parity, battery performance and charging availability are key determinants of mass adoption.

Policy action can bring forward positive tipping points in other key sectors

- Policy mandates and coordinated finance and investment are essential for bringing forward positive tipping points in the energy system.
- Heat pumps are a critical lever for decarbonising buildings, but face high upfront costs and other barriers including a shortage of skilled installers. Improved policy incentives, financing (e.g. cheap loans) and consumer trust are vital.
- Affordable green hydrogen could unlock hard-to-abate sectors such as those requiring industrial heat (eg steel and cement). Current costs are 2-3 times higher than grey hydrogen but learning curves could lead to price parity.
- Clear policy supported by financial incentives can enable farmers to switch to more sustainable production methods and build resilience to extreme weather events.

High public support for stronger action on climate change is threatened by polarisation and disinformation

- Widespread support for rapid decarbonisation can be strengthened by ensuring that the benefits are evenly distributed, e.g. through lower bills, better health outcomes and improved quality of life.
- Supportive policy and public procurement can help to normalise and spread sustainable behaviours, e.g. through promoting active transport, sustainable eating.

Electrification presents key positive tipping point opportunities

- Electrification is a decarbonisation multiplier: electrifying heating, transport and industry both reduces emission and stimulates investment in new renewables. It increases overall efficiency and flexibility of the energy system.
- Integration can accelerate the self-propelling growth of renewable electricity generation, but requires urgent grid upgrades, energy storage and demand flexibility.
- New digital technologies that can optimise energy balancing and storage between commercial and domestic energy providers need to be accelerated.

Targeted policies can accelerate electrification

- Decoupling renewable electricity pricing from fossil fuel-linked marginal pricing could significantly benefit consumers and accelerate change.
- Co-adoption strategies can trigger positive tipping: bundling complementary technologies increases value, reduces risk and speeds clean technology diffusion.
- Policy should target households during key renovation and purchasing moments.

Positive tipping points in food and fibre supply chains can end deforestation and ecosystem conversion

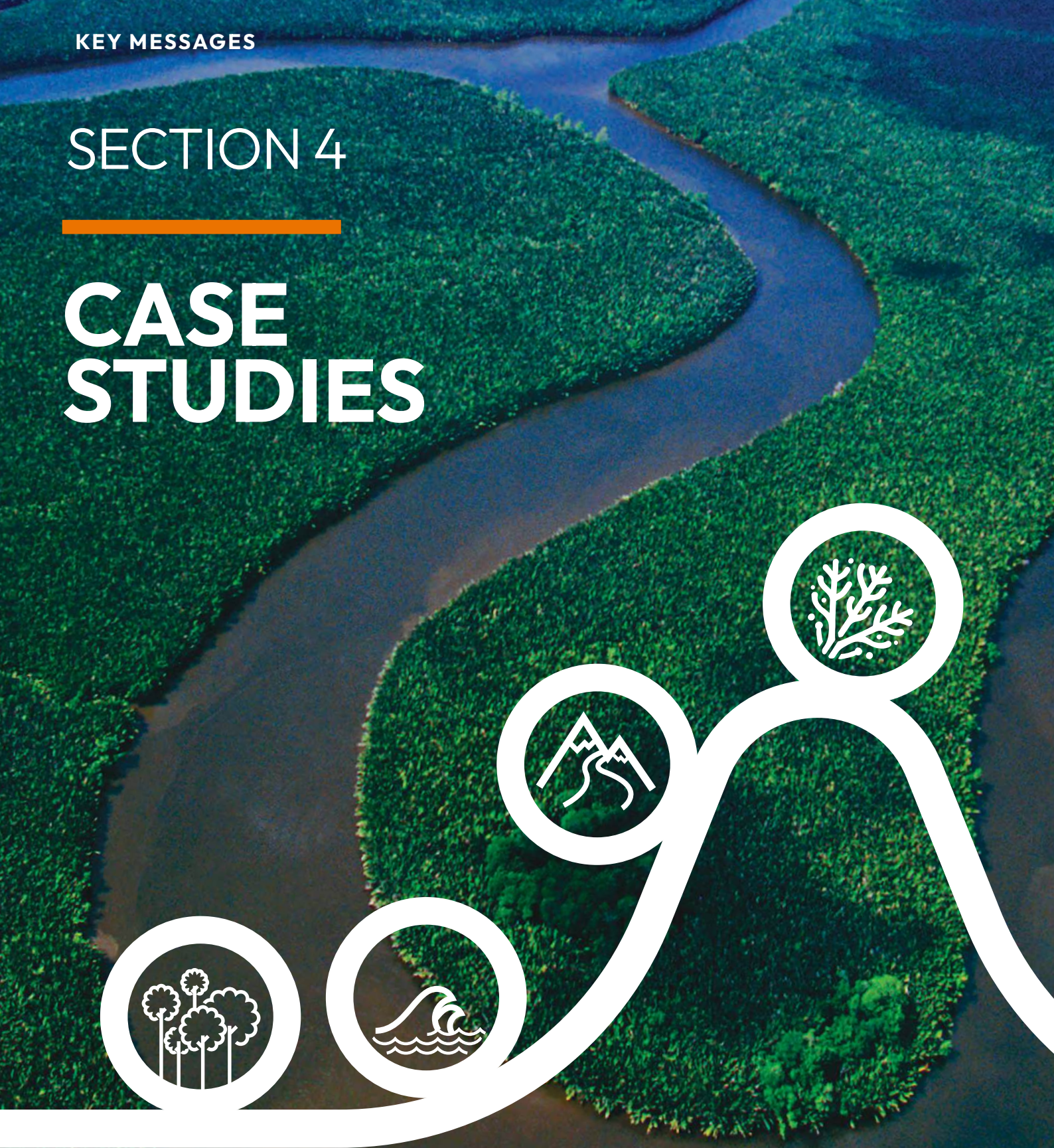
- Triggering positive tipping points in the sustainable production and consumption of agricultural commodities requires mutually reinforcing actions in three areas: Clear policy signals and enforcement; coordination across supply chains and between key markets; and finance to support transitions in production.
- Legal protections for tropical forests and their inhabitants need to be established and enforced.
- Standards for sustainable commodity production (e.g. soy, beef, cocoa, cotton, palm oil) and trade need to be developed and enforced. Successful moratoria (e.g. Amazon Soy) show that regulation and monitoring are essential for compliance and that sustainable alternative options must be available for producers (and financially viable).
- Demand-side interventions in import markets must align with domestic policy in major producing countries to ensure success and should support producers in meeting new standards through provision of transition finance.
- Policy and market structures currently incentivise harmful practices. Subsidies and procurement should change towards sustainable production and consumption, thereby supporting sustainably productive landscapes that include standing forests.

Positive tipping points can rapidly restore nature and biodiversity

- Ecosystem restoration can positively tip degraded systems back to health, through interventions like keystone species reintroduction, nutrient reduction and clumped planting that activate natural reinforcing feedbacks.
- Recovery of food and water resources can be positively tipped through promoting community governance of common pool resources including groundwater, forests, fish stocks and the creation of marine protected areas.
- Scaling nature-positive initiatives depends on local benefits and governance. Community management, equitable benefit-sharing and leveraging ecological feedbacks enable rapid spread. Combining local agency with supportive policy increases durability.

SECTION 4

CASE STUDIES



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THE AMAZON RAINFOREST

Risk assessment

- The Amazon is approaching ecological tipping points due to interacting climate and land-use feedbacks that threaten to trigger large-scale forest degradation and regime shifts in the range 1.5-2 °C global warming.
- These changes risk transforming forested areas into altered ecosystems, weakening global climate regulation, altering regional climate and accelerating biodiversity loss.
- Negative social tipping points, including displacement, health impacts and cultural erosion are unfolding alongside ecological forest transitions, especially among Indigenous and traditional populations.
- These impacts and risks remain significantly under-addressed in climate policy and are intensified where governance fails to secure land rights, or enforce protections, or support adaptation.
- Indigenous Territories and Protected Areas exhibit strong climate mitigation potential, underscoring their vital role in maintaining carbon stocks and resisting ecosystem collapse.
- In contrast, undesignated Public Forests account for the majority of carbon losses from degradation, reflecting the consequences of weak governance and land tenure insecurity.
- Without immediate action, cascading risks could result in irreversible losses to both ecosystems and communities, undermining regional and global sustainability.

Recommendations

- The Amazon forest holds global significance as a biocultural and climate-regulating system; safeguarding it requires urgent, justice-centered strategies that integrate understanding of ecological thresholds, social vulnerability and climate adaptation.
- Positive social tipping points can be catalyzed by inclusive and polycentric governance, recognition of traditional knowledge systems and targeted financial investments in forest conservation, restoration and supporting Indigenous People and Communities Territories and their livelihoods.
- These interventions have the potential to reverse degradation feedbacks and ensure socio-ecological resilience across the Amazon.

ATLANTIC OCEAN CIRCULATION

Risk assessment

- The Atlantic Meridional Overturning Circulation (AMOC) and Subpolar Gyre (SPG) have different tipping points and timescales of transition but are strongly coupled via influencing stratification of the northern North Atlantic ocean.
- Crossing either tipping point has numerous impacts, including much harsher northwestern European winters, disruption of the West African Monsoon, decreased agricultural yield and marine ecosystem shifts.
- The conditions under which SPG and AMOC can tip remain uncertain, due to a limited observational record and biases in climate models, but we cannot exclude that an AMOC tipping point may already have been passed.
- Deep winter mixing in both the SPG and Greenland-Iceland-Norwegian Seas is projected to collapse in the North Atlantic before 2050 in many CMIP6 models causing AMOC to decline to weak states without a deep circulation.
- The likelihood of tipping for both systems increases with global temperature.

Recommendations

- Current observational arrays in the Atlantic Ocean should be maintained and Earth System Model bias should be reduced as both are crucial for the science of AMOC or SPG tipping and future early warning systems.
- Continuous monitoring of SPG and AMOC risks and nation-specific complex risk-assessments of the impacts of AMOC or SPG tipping should be made for European countries to inform prevention and adaptation policies.
- Preventing the crossing of AMOC or SPG tipping points should be a primary governance target.
- The potential proximity of SPG collapse demands that European governments and the EU revisit and update national and European climate adaptation and preparedness plans, policies and institutions to account for the expected impacts of this tipping process.
- Global climate mitigation efforts should be accelerated to minimize temperature overshoot of 1.5°C to minimize the risk of SPG or AMOC tipping. This requires shortening net-zero timelines and immediate investment in the development and scaling of sustainable carbon removal technologies.
- The potential benefits and risks of solar radiation management (SRM) should be explored during a moratorium on SRM implementation and large-scale experiments.

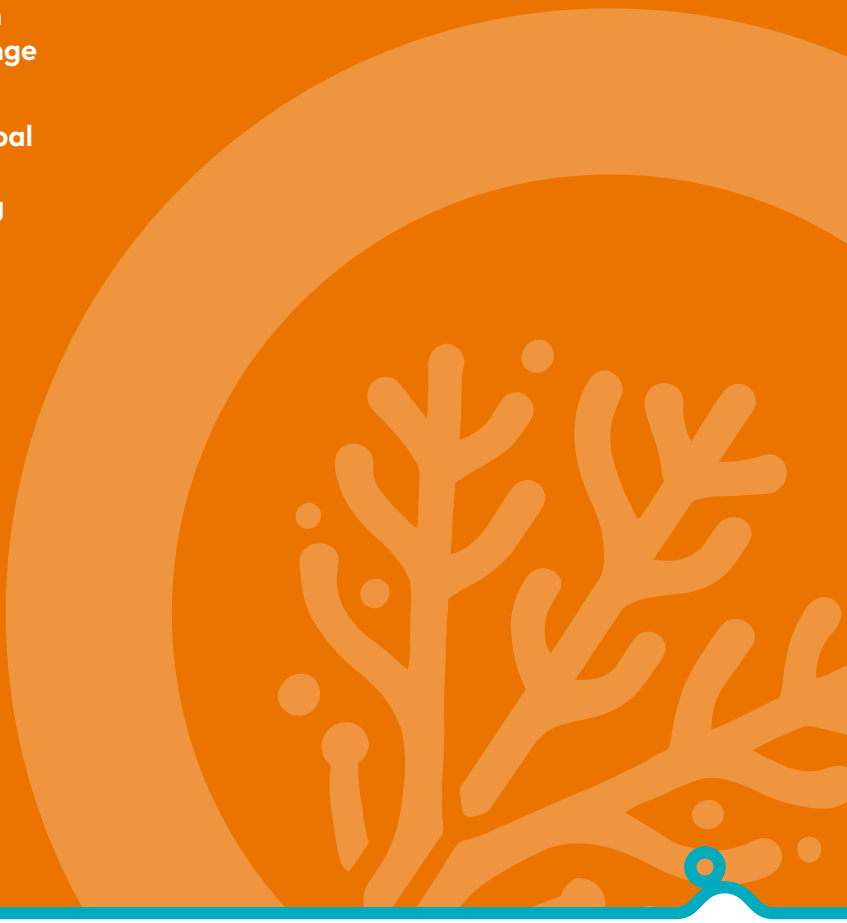
WARM-WATER CORAL REEFS

Risk assessment

- Warm-water coral reefs are vital to the wellbeing of up to a billion people and almost a million species.
- Globally, coral reefs are experiencing unprecedented mortality under repeated mass bleaching events, highlighting the impact that global warming (interacting with other, predominantly human-driven environmental stressors) is already having.
- The central estimate of the thermal tipping point for warm-water coral reefs of 1.2°C global warming above pre-industrial is already exceeded and without stringent climate mitigation their upper thermal threshold of 1.5°C may be reached within the next 10 years, compromising reef functioning and provision of ecosystem services to millions of people.
- Even under the most optimistic emission scenarios of stabilising warming at 1.5°C without any overshoot, it is considered that warm-water coral reefs are virtually certain (>99% probability) to tip, given the upper range of their thermal tipping point is 1.5°C.
- The goal of the Paris Agreement to limit global warming "well below 2°C" or 1.5°C will not prevent coral reefs from irreversibly passing their thermal tipping point.

Recommendations

- Returning global mean warming below 1.2°C with a minimal overshoot period and eventually returning to 1°C above preindustrial is essential for retaining functional warm-water coral reefs at meaningful scale, beyond a relatively few isolated refuge areas.
- Minimising non-climatic stressors, particularly improved reef management, can give reefs the best chance of surviving under what must be a minimal exceedance of their thermal tipping point.
- Risk assessments and urgent policy responses are needed to address the ecosystem and livelihood impacts of degraded or non-functional reefs.



MOUNTAIN GLACIERS (ÁAK'W T'ÁAK SÍT', JUNEAU ICEFIELD, ALASKA)

Risk assessment

- Mountain glacier tipping behaviour depends on a complex interplay between topography and climate, with mountain glaciers that experience similar external forcing having the potential to respond differently depending on local conditions.
- Áak'w T'áak Sít' and other outlet glaciers of the Juneau icefield, Alaska, have been suggested as a potential mountain glacier tipping system, with ice segregation and the bedrock hypsometry leading to nonlinear mass loss and glacier retreat.
- Rapid deglaciation of Áak'w T'áak Sít and other glaciers disrupts the relationship between Indigenous communities, glaciers and glacial landscapes, depriving future generations of this component of their identity and history, which are inseparable from the land.
- The retreat of Áak'w T'áak Sít''s tributary glaciers has led to annual outburst floods in Juneau, the future occurrence of which will depend on rates of ice retreat, the pattern of retreat and the formation of future glacier separations.
- Rapid mass loss of Áak'w T'áak Sít' could negatively impact tourism in Juneau as the glacier retreats from the Mendenhall Glacier Visitor Center viewshed, where an average of every third visitor to the state of Alaska visits.
- The economic consequences of tipping on fishing and salmon stocks are less clear, giving the complex interplay between water temperature, air temperature and riverbed scouring, all of which impact aquatic ecosystems.

Recommendations

- Anticipatory governance considerations at the local level regarding glacier loss must involve multiple partners and rights holders , including Indigenous community governments, federal and state agencies and local government, as well as community members, particularly in the context of resource management and the opening of navigable U.S.-Canada border crossings, following ice retreat.

To access full report

https://global-tipping-points.org