



United Nations
Climate Change



**Defining and understanding
transformational adaptation at different
spatial scales and sectors, and assessing
progress in planning and implementing
transformational adaptation approaches
at the global level**

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United Nations Framework Convention on Climate Change, the Kyoto Protocol and the Paris Agreement

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Abstract

This summary document explores how transformational adaptation is defined and understood across different spatial scales and sectors. It emphasizes the urgent need for adaptation measures that go beyond small adjustments and instead changes the core features of natural and human systems in response to climate change and its wide-ranging impacts. It summarizes the current understanding of transformational adaptation, key dimensions, potential pathways, and the risks of maladaptation. The summary discusses the current definitions and dimensions to develop a common understanding of transformational adaptation in the face of climate change. It presents key aspects and practical features of transformational adaptation and shows the important elements needed to build a shared understanding. The summary reviews the evidence of the implementation of transformational adaptation, drawing on existing literature. Furthermore, it examines the progress made in planning and implementing transformational adaptation approaches at a global level. It emphasizes the need for a context-specific approach that includes different perspectives and knowledge systems to build strong frameworks for adapting to climate impacts.



Executive summary

1 Transformational Adaptation (TA)

Transformational adaptation changes the foundations of a social-ecological system in response to climate change and its effects. This results in significant changes in the structure or function of the system, going beyond adjusting existing practices and leading to new strategies or resource systems. It involves transforming places and triggering deep and long-term societal changes, including through changes in values and world views.

2 Why is TA being explored?

Incremental adaptation, which maintains the essence of existing systems, may not always be sufficient to address the increasing risks and vulnerabilities from climate change.

Transformation is being explored to limit or overcome vulnerabilities and risks that cannot be addressed by incremental adjustments. It is increasingly necessary as adaptation limits are approached or breached. Transformation is seen as necessary to meet the SDGs. It can create pathways to strengthen climate resilience while fostering sustainable development.

3 Dimensions of TA

Different aspects used to assess the nature and extent of TA:

- Depth of deliberate change;
- Scope/scale of deliberate change;
- Speed of change;
- Limits of change;
- Adaptive sustainability;
- Relevance.

4 Implementation and evaluation

Successfully carrying out transformational adaptation relies on supportive conditions, such as learning, aligning goals with priorities, strong bottom-up governance, long-term backing, and funding. Evaluating it requires understanding its complex, multi-dimensional nature. The dimensions of transformational adaptation offer a framework to track progress and evaluate adaptation efforts using clear indicators.

5 Path forward

- **Systematic documentation and dissemination of knowledge:** Sharing efforts, successes, and insights.
- **Regionalized horizon scanning exercises:** Identifying region-specific challenges and opportunities.
- **Contextualized adaptation pathways:** Tailoring approaches to specific targets, sectors, and regions.
- **Utilizing indicators:** Formulating meaningful indicators specific to TA.
- **Enhanced collaboration and collective thinking:** Engaging diverse stakeholders.
- **Integration of overlooked elements:** Identifying and including previously missed sectors and considerations.
- **Connecting adaptation to specific objectives:** Establishing clearer linkages between adaptation discourse and targets.
- **Leveraging existing knowledge bases:** Utilizing findings from the IPCC and reports from Parties.

6 Attributes of TA

The characteristics or qualities of natural and human systems that are changed as part of TA:

- Dynamically altered goals and values;
- Ambitious actions;
- Generates positive outcomes;
- Provides a clear vision of the future;
- Transformation in both how and what changes;
- Can cause disruption;
- Long-term and lasting change;
- Actionable at all scales;
- Overcomes limits;
- Manages trade-offs;
- Comprehensive, systems thinking approach;
- Multi-stakeholder inclusion;
- Justice.

7 Types of constraints

Factors that limit or hinder the planning and implementation of TA:

- Social/cultural;
- Governance, institutions, and policy;
- Financial;
- Information/awareness/technology;
- Physical;
- Biological.

8 Case Example

Regenerative agriculture for climate-resilient food production is an example of transformational adaptation. Conventional agriculture, which often relies on monocultures and chemical inputs, is highly susceptible to the adverse impacts of climate change. In contrast, regenerative agriculture utilizes farming methods that aim to enhance soil health and biodiversity by working with natural processes. This transition signifies a deep change in the approach to food production, moving beyond simply adjusting existing practices to changing the underlying system to achieve climate resilience.

Abbreviations and acronyms

AR	Assessment Report of the Intergovernmental Panel on Climate Change
BTR	Biennial Transparency Report
CIF	Climate Investment Funds
CMA	Conference of the Parties serving as the meeting of the Parties to the Paris Agreement
GHG	greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
NAP	national adaptation plan
NBS	nature-based solution(s)
NDC	Nationally Determined Contributions
PESTEL	political, economic, social, technological, environmental and legal (analysis)
SDG	Sustainable Development Goal
SIDS	Small Island Developing States
UNFCCC	United Nations Framework Convention on Climate Change

A

Background and Conceptualization

A.1 Mandate and scope

CMA 5 requested the UNFCCC secretariat (hereafter referred to as ‘the secretariat’) to examine how transformational adaptation is defined and understood across various scales and sectors, and how to assess progress in its planning and implementation at the global level, for consideration at CMA 6¹. Furthermore, CMA 5 decided that the United Arab Emirates Framework for Global Climate Resilience should guide adaptation efforts, including both long-term transformational and incremental adaptation, to reduce vulnerability and enhance adaptive capacity and resilience, in the context of the temperature goal referred to in Article 2 of the Paris Agreement².

The secretariat prepared and published a technical paper, FCCC/TP/2024/8³, at CMA 6, with a view to informing further discussions on transformational adaptation, drawing inter-agency discussions, relevant literature, including from the IPCC, as well as inputs from the regional collaboration centres.

After the publication of the technical paper, a mandate for a reader-friendly summary of the technical paper on transformational adaptation, available in all six official languages of the United Nations was directed in paragraph 42 of decision 3/CMA.6. This report is intended to fulfil this mandate to provide a reader-friendly summary that reflects

the key insights explained in further detail in FCCC/TP/2024/8. Examples of case studies and success stories of transformational adaptation to climate change are provided in the annex.

A.2 Background; incremental adaptation to transformation

The Paris Agreement has driven global climate action, yet *incremental adaptation* alone may not always be enough to address escalating climate risks, leading to *residual risks* and the breaching of *adaptation limits*. Global warming exceeding 1.5 °C will result in limited freshwater resources, significantly impacting SIDS and regions dependent on glacier and snow melt. Moreover, several crucial ecosystems, including warm-water coral reefs, coastal wetlands, rainforests, and polar and mountain ecosystems, will reach a point where adaptation efforts become ineffective. This underscores the critical urgency of evaluating the potential of *transformation* to limit or overcome vulnerabilities and risks that result from climate change.

To build climate resilience while supporting sustainable development and poverty eradication, governments need to support transformations that integrate climate resilience and low

Definitions

Incremental adaptation: Adaptation actions that maintain the essence and integrity of a system or process.

Residual risk: The risk related to climate change impacts that remains following adaptation and mitigation efforts.

Adaptation limits: The point at which an actor's objectives (or system needs) cannot be secured from intolerable climate change risks.

Transformation: A change in the fundamental attributes of natural and human systems, potentially strengthening or realigning global paradigms and narratives to promote adaptation for sustainable development, including poverty reduction.

Transformational adaptation: adaptation that changes the fundamental attributes of a system in anticipation of climate change and its impacts.

Adaptation: The process of adjustment to actual or expected climate and its effects, seeking to moderate or avoid harm or utilize beneficial opportunities in human systems, potentially facilitated by human intervention in some natural systems.

'Soft' adaptation limits: a point where options exist to adapt and avoid risks from climate change, but current barriers prevent their implementation.

Values and beliefs: Fundamental attitudes about what is important, good and right; and strongly held principles or qualities that are intrinsically valuable or desirable and are often preserved in laws, traditions and religions.

Climate-resilient development: Trajectories that strengthen development to promote planetary health and human well-being, including through efforts to eradicate poverty, and reduce inequalities while promoting fair adaptation to and resilience in a changing climate.

Solution space: the biophysical, cultural, socioeconomic, and political-institutional factors that shape who takes action to reduce climate risks, as well as how, when, and why they act. These factors include both 'hard' and 'soft' limits.

Deliberate transformation: A major shift toward sustainability, planned and driven by certain groups in society, supported by changes in people's shared values, behaviours, and power structures.

'Hard' adaptation limits: a point where no adaptive actions can prevent intolerable risks from climate change.

GHG into different sectors. The IPCC highlights that these transformations are essential to achieving the SDGs and may involve changing systems, governance, and economic models. Although these changes can create new opportunities, they can also be disruptive⁴. This makes proactive planning, inclusive governance, and fair transitions essential to avoid negative impacts. Without urgent action, climate risks will outpace *adaptation* efforts, threatening vulnerable populations and ecosystems.

Transformational adaptation, involving larger system-wide change, may increasingly be necessary for coping with climate change. In this context, transformational approaches to adaptation will generate pathways for adapting to the impacts and risks of climate change. Key outcomes of transformational adaptation can include:

- Enhancing resilience through fundamental changes to natural and human systems in response to climate change, moving beyond incremental adaptation;
- Supporting sustainable development, ensuring both planetary health and human well-being, while addressing social equity;
- Challenging, expanding or overcoming '*soft*' limits to adaptation;
- Triggering deep, long-term societal changes, influencing *values, beliefs*, and power structures towards greater climate resilience;
- Harmonizing adaptation and mitigation efforts to improve climate resilience while reducing greenhouse gas emissions, ensuring a coordinated approach to *climate-resilient development* pathways.

Transformational adaptation changes the fundamental attributes of a system in anticipation of climate change and its impacts. It represents adaptation at a large scope or scale that occurs once '*soft*' limits have been breached.

As Figure 1 displays, adaptation actions can either work within the existing system's *solution space* through incremental adaptation or expand it through *deliberate transformational adaptation*, which might become necessary if 'hard' adaptation *limits* are exceeded. Characteristically, transformational adaptation has the potential to challenge and expand 'soft' adaptation limits. However, as the impacts of climate change worsen, both incremental and transformational adaptation options may become constrained and less effective. This may lead to ecosystems reaching or surpassing 'hard' adaptation limits, rendering adaptation efforts ineffective and leading to increased risks.

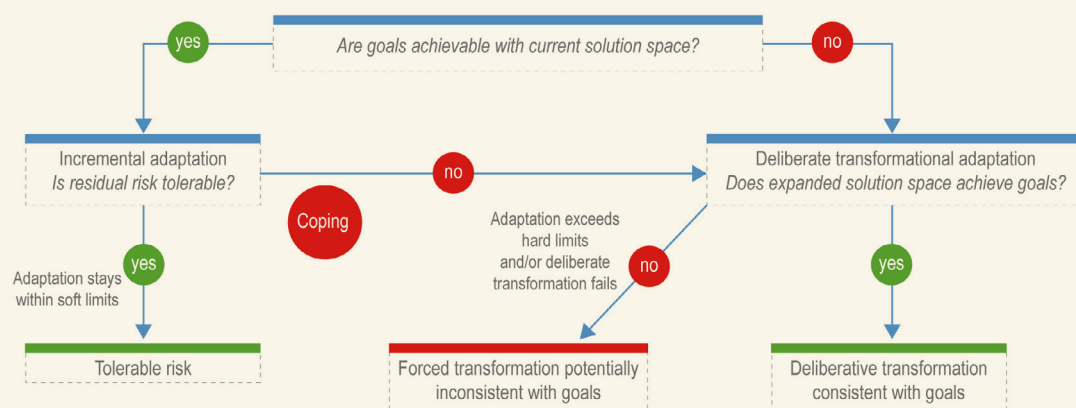
Forced transformation may occur if 'hard' adaptation limits are exceeded,

resulting in intolerable risks that cannot otherwise be avoided, such as through forced relocation due to sea level rise. Such situations often reveal significant inequities, with tolerable risks for powerful groups and intolerable ones for marginalized groups.

Examples of transformational adaptation include using Indigenous knowledge to enable profound change, reshaping cities for resilience and others as exemplified in Box 1. History has demonstrated that not only is transformation possible, but it shows examples of large-scale transformations, such as the rapid industrial and technological advancements over the past 200 years, which fundamentally reshaped societies, economies, and political systems.

Figure 1
How adaptation pathways connect with limits within the solution space

Alternative Pathways to Transformation



Story line for figure:

This figure aims to connect the concepts of transformation, solution space, adaptation gap, limits to adaptation, and residual risk. Achieving policy goals may require expanding the solution space and pursuing a transformation towards a desired future. If such a transformation is not pursued or is not successful, we may be forced to undergo a transformation to a less desirable future.

Example Box 1

Example of transformational adaptation⁶ Regenerative agriculture for climate-resilient food production

Conventional agriculture is highly vulnerable to climate change. Transformational adaptation in this context involves changing entire farming systems to regenerative agricultural practices that improve the health of ecosystems, mitigate climate change and enhance the resilience of food production systems.

Structural change: The entire farming system is restructured from monoculture, chemical-intensive practices to a polyculture, ecosystem-based approach. This changes not only the crops grown but also the land-use patterns, soil management and water-use strategies of farms.

Functional impact: Instead of focusing solely on maximizing short-term yields, regenerative agriculture prioritizes long-term sustainability, soil fertility and climate resilience. This transforms the function of the farms to a regenerative part of the local ecosystem, restoring natural processes such as water infiltration, carbon sequestration and biodiversity support.

Role and knowledge of farmers: Farmers shift from acting as 'input managers' (applying chemicals to increase yields) to becoming land stewards who work in harmony with the environment. They depend more on local knowledge and agroecological practices.

More examples and case studies of transformational adaptation can be found in Annex I and Annex II.



Definitions

Transformational adaptation changes the fundamental attributes of a social-ecological system in response to climate change and its effects. This results in significant changes in the structure or function of the system, going beyond adjusting existing practices and leading to new strategies or resource systems. It involves transforming places and triggering deep and long-term societal changes, including through changes in values and world views.

The terms relating to ‘transformational’ and ‘transformative’ change are often used interchangeably, but they can imply different things based on the context.

Transformational change refers to large-scale, systemic changes that fundamentally alter existing structures, systems or paradigms. It involves a complete shift from one state to another and often requires overhauling deep-rooted patterns.

Transformation refers to a change in the fundamental attributes of natural and human systems.

Transformative change often entails catalysing significant change from within systems, making them more adaptive, resilient or innovative. The respective change requires more than technological change by considering social and economic factors.

Transition refers to the process of changing from one state or condition to another in a given period of time.

A.3 Defining and contextualizing transformational adaptation

The concept of transformational adaptation was first introduced in the IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation in 2012. Although transformational adaptation has been explored through different initiatives, including in AR5 and AR6, its definition has since remained virtually unchanged, despite being used interchangeably with similar terminology at times, as can be distinguished in the definition box below.

Transformational adaptation can function as a ‘boundary concept’, since the concept can be shared among different communities while maintaining their unique interpretations of it. This flexibility in defining transformational adaptation raises important questions about its criteria. Notably, some initiatives have been implementing transformational adaptation without explicit labelling, likely due to the relatively new nature of the concept. Emphasizing context specificity and integrating the experiences and perspectives of diverse adaptation practitioners can support effective implementation, as formal definitions may not fully capture the needs of real-world application. Furthermore, a comprehensive understanding of transformational adaptation would require challenging and questioning dominant views that might be skewed towards developed-world knowledge, potentially overlooking valuable diverse knowledge systems.

Practical Elements

B.1 Dimensions of transformation

The term “transformational” in the context of climate change adaptation involves several interconnected factors and brings together different aspects of how climate change impacts people and the environment. In this context, dimensions are characteristics or aspects that are used to help define, understand and implement the adaptation measures and assess evidence of transformational adaptation. Dimensions provide a framework for assessing whether an adaptation is merely an incremental adjustment or transformational. FCCC/TP/2024/8 proposes the following dimensions to support monitoring, evaluation and implementation of transformational adaptation:

- A. Depth of Deliberate Change:** This indicates a shift away from current practices by changing the core structures, values, logic, and assumptions of systems. It may involve major changes in how things are done, rethinking basic values, and a collective shift in mindsets;
- B. Scope and Scale of Deliberate Change:** This dimension examines how far-reaching and integrated adaptation is across geographic or institutional levels. A small scope refers to localized initiatives, while a broad scope encompasses large-scale, system-wide changes;
- C. Speed of Change:** This considers the timeframe within which

changes occur. It ranges from slow, incremental adjustments to sudden shifts in views and perceptions;

- D. Limits of Change:** This refers to evidence that ‘soft’ adaptation limits are being challenged or overcome.
- E. Adaptive Sustainability:** This highlights that transformational change must be impactful, flexible, and long-lasting. Populations, systems, and change processes need to respond to changing conditions of social, economic, and environmental factors;
- F. Relevance:** This shows the continued connection between goals, context, and opportunities. At the system level, change can be assessed by how well it aligns with important societal goals and processes.

While there are strong interactions between the different dimensions, the dimensions relating to **depth of deliberate change** and **limits to change** are core to transformational adaptation. The other dimensions, relating to scope/scale and speed of deliberate change, can be viewed as complementary. This is because an adaptation measure could be implemented at high speed but may not lead to the deep changes required by transformational adaptation.

AR5 assessed the transformational potential for depth, scope, speed and limits as key dimensions, as well as for all dimensions taken together (“overall”). The transformational potential shown for low, medium and high transformational adaptation potential in Table 1 below, showing different components of adaptation.

Table 1
Transformational potential of different dimensions of adaptation

<i>Dimensions</i>	<i>Transformational potential of adaptation</i>		
	Low	Medium	High
Overall	Small adjustments, 'business as usual'; sporadic and fragmented efforts	Expanding and coordinated adaptation; wider implementation	Widespread implementation at full (or near its full) potential across multiple dimensions
Depth	Expansions of existing practices; minimal change in values	Shift away from existing practices, norms, or structures	Entirely new practices; deep structural reform (mindset change)
Scope/scale	Localized and fragmented adaptations	Affects wider areas, multiple sectors; mainstreamed and coordinated	Widespread across many or all sectors, governance levels and actors
Speed	Implemented slowly (results seen in >5 years)	Implemented moderately quickly (results in 3-5 years)	Rapid change (results in 1-3 years)
Limits	Approaches but doesn't challenge 'soft' limits, meaning that while some adjustments are made, they don't push the boundaries of what is currently feasible	Overcomes some 'soft' limits but doesn't approach 'hard' limits, indicating a more significant shift, where some barriers are overcome, but other constraints remain untouched	Exceeds many 'soft' limits and approaches/challenges 'hard' limits, signifying a profound change, where adaptation measures push the boundaries of what is considered possible

Source: Adapted from the contribution of Working Group II to the AR6, chap. 16, table 16.1, p.2435. For details on the methodology used for assessing evidence of transformational adaptation, see the contribution of Working Group II to the AR6, supplementary material, chap. 16.1, table 16.6, p.16SM-14.

B.2 Attributes of transformation

Given its complexity, key practical attributes can be used to distinguish transformational adaptation from other forms of climate change adaptation or societal changes, including incremental adaptation, as depicted in Figure 2. **Attributes refer to qualities of the natural and human systems that undergo change as part of the transformation.** These are the qualities of the system itself that are being altered.

The technical paper identified the following practical attributes that can help differentiate transformational adaptation from other forms of adaptation when present:

- A. Dynamically altered goals and values:** Transformation involves changing the core features of a social-ecological system. This includes adjusting societal goals or values through a flexible process that is reviewed regularly, since key indicators for each area can shift over time;
- B. Ambitious actions:** Transformational adaptation usually involves more ambitious actions. This ambition can be understood as a spectrum ranging from securing basic survival, to managing climate change impacts, to meeting and maintaining the SDGs, and ultimately moving towards transformational resilience and sustainability;
- C. Generates positive outcomes:** Assessing whether a transformation is "good" involves evaluating the

extent to which the transformation has achieved its intended goals and generated positive outcomes, such as long-term sustainability, equity and social justice;

- D. Provides a clear vision of the future:** An essential starting point of transformational adaptation involves envisioning the characteristics of a transformed future which is aspirational and desirable by society;
- E. Transformation in both how and what changes:** Transformation applies to both the process, including fundamental changes in such systems, and the outcome, referring to the resulting changes, of transformational adaptation of social-ecological systems. For example, the adaptation planning process itself (i.e. the development of NAPs) can be conceptualized as transformational, as it includes a mindset shift around incorporating climate risks in planning;
- F. Causes disruption:** Disruption is considered to be an attribute of transformational adaptation, going beyond current political and economic 'business as usual' scenarios. Disruption can involve drastic changes in attitudes and mindsets and can help to advance towards a deeper level of transformation;
- G. Long-term perspective and lasting change:** Taking a long-term perspective means planning ahead with the expectation that deep changes will be persistent over time;
- H. Actionable at all scales:** Transformational adaptation can take place at local, national, and global levels, with different characteristics at each scale, and requires careful consideration of potential trade-offs between these levels.
- I. Overcoming limits:** Transformation involves actively identifying and overcoming 'soft' limits to adaptation;
- J. Managing trade-offs:** As adaptation becomes more transformative and

scaled up, the trade-offs across different areas, timeframes, and sectors become more complex and need careful management. For example, achieving transboundary benefits may require some countries to sacrifice individual national benefits for larger collective gains. Long-term interventions can reduce societal vulnerability to trade-offs;

- K. Comprehensive, systems thinking⁵ approach:** The complexities of transformational adaptation require a comprehensive approach that integrates interconnected dimensions such as socioeconomic, cultural and governance dimensions. In some cases, however, transformational adaptation can be a simple solution;
- L. Stakeholder inclusion:** Successful transformational adaptation requires involving a wide range of stakeholders and all levels of governance in planning and decision-making, with a strong focus on empowering marginalized communities;
- M. Justice:** Central to transformational adaptation are principles of justice that ensure a fair allocation of resources, inclusive decision-making processes and respect for diverse values and perspectives. Applying the principles of justice and ensuring a just transition are essential to prevent situations where losses incurred in the transition towards the aspirational future do not outweigh the benefits of that future..

The AR6 highlights that the post-AR5 focus on transformational adaptation and resilience present in the literature suggests that institutions that enable system transitions towards climate-resilient development are secure enough to facilitate a wide range of voices. These voices can help adjust goals or processes over time without weakening effectiveness. At the community level, transformational adaptation can involve empowering

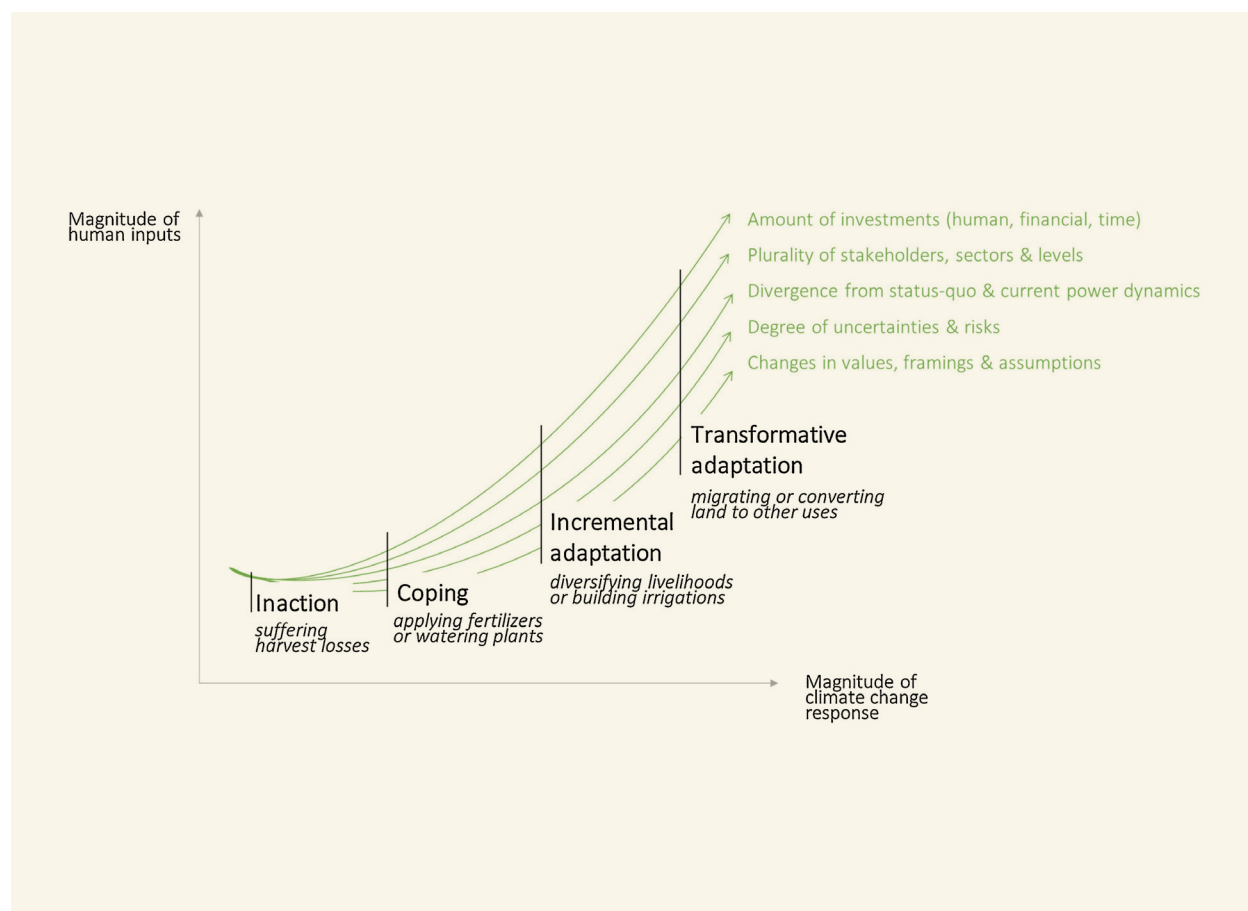
local communities, municipal planning, national policies that prioritize community needs, regional approaches to address vulnerability and build resilience, NAPs and NDCs. At the global level, it requires mobilizing resources and involving relevant actors in decision-making processes. How this finding applies to transformational adaptation may require further reflection as the concept develops and is better understood.

The IPCC reports emphasize that transformational adaptation requires not only the implementation of changes but also a proactive state of preparedness

for those changes. This entails that societies, institutions, and individuals must exhibit a willingness to adapt their lifestyles, energy consumption patterns, and approaches to nature interaction, as is demonstrated in the example in Box 2.

A shared understanding of the principles behind transformational adaptation, such as equity and justice, both within and across generations, is key to success. It helps ensure a just transition where benefits are distributed fairly, especially among vulnerable populations. These principles can potentially be operationalized through a multilateral development bank process.

Figure 2
Different climate-change strategies in a social-ecological system and the magnitude of social-ecological responses.



Source: Fedele G, Donatti CI, Harvey CA, et al. 2019. Transformative adaptation to climate change for sustainable social-ecological systems. *Environmental Science & Policy*. 101: pp.117. Available at <https://www.sciencedirect.com/science/article/pii/S1462901119305337>.

Box 2**Promoting Decentralized Rainwater Harvesting in Cities**

In urban areas facing significant water scarcity exacerbated by droughts, overpopulation, and climate change (e.g., Cape Town, Bangalore, São Paulo), a shift from traditional centralized water infrastructure (dams, reservoirs) to decentralized rainwater harvesting is being explored as a form of transformational adaptation.

This entails a structural change where the water supply shifts from a top-down, city-managed system to a distributed, community-based system. Individual buildings (homes, offices, schools) are equipped with rainwater collection systems for local storage, significantly reducing reliance on the central water supply grid.

The functional impact is a change in how water needs are met. Households and communities become more self-sufficient, utilizing stored rainwater for non-potable uses (gardening, washing) and potentially for drinking after purification. This alleviates pressure on overstressed centralized infrastructure and diversifies water sources.

From a governance and management perspective, the system evolves from a purely city-managed approach to one where individual citizens and local communities play a direct role in water collection, conservation, and distribution. This necessitates new regulations, incentives, and infrastructure investments.

This example shows how people and communities can adapt by choosing to change their lifestyles and manage water locally. Simultaneously, institutions adjust their governance structures to support and regulate the new decentralized systems.



Box 3

Case Example: Water in Circular Economy and Resilience in Chennai, India⁶

A case study from Chennai, India, illustrates how transformational adaptation can be driven by the need to address specific climate vulnerabilities and achieve resilience targets. Prompted by drought and flooding events, which indicated the reaching of 'soft' adaptation limits, the city undertook a large-scale reconfiguration of its urban water cycle.

The measures put in place, such as policy support at multiple levels for water reuse and integrated actions across domestic, wastewater, and industrial supply, aimed to diversify water sources and reduce dependence on overused infrastructure. In addition, strong stakeholder involvement and changes in tariffs to encourage sustainable water use show a focused effort to shift behaviour and make the new water system effective over the long term.

While the case study may not explicitly state numerical targets, the transformational changes were clearly directed at achieving the goals of greater water security and reduced vulnerability to the identified climate impacts of drought and flooding on a long-term scale. The move towards a more circular and resilient water economy in Chennai serves as an example of how recognizing specific vulnerabilities can drive transformational changes aimed at achieving clear, if not always precisely quantified, resilience targets.

B.3

Connecting transformational adaptation with specific targets

Linking transformational adaptation to specific, well-defined targets⁷ such as the ones illustrated in Figure 3 is crucial for enabling countries and relevant agencies to create actionable measures for transformation. This approach helps bring transformational thinking into the design of NAPs, making sure adaptation efforts match broader development goals and can be monitored over time. It also clarifies where concepts like loss and damage may overlap. In addition, it connects the conceptual ideas of transformational adaptation with practical, indicator-based actions, as suggested through the identified targets from the United Arab Emirates–Belém work programme.

Indicators should capture both the practical steps and the clear results of transformational adaptation efforts. Indicators can be used to;

- A.** Evaluate the depth, scope, speed and limits of adaptation actions to effectively measure their transformational potential (e.g. low, medium, high);
- B.** Measure the extent to which diverse stakeholder groups, including marginalized populations, are involved in the decision-making process and assess the role of Indigenous knowledge in transformational adaptation⁸;
- C.** Explore the need for capacity-building for transformational adaptation and the type of learning required, from first order change ('business as usual') to second order change (transformational);
- D.** Track actions that help create supportive conditions for

- transformational adaptation. This includes new or updated policies, the extent of coordination between agencies, and the establishment of monitoring and evaluation systems;
- E.** Identify how equity and distributional concerns are addressed in decisions, alongside visioning for future transformations within or across a system.

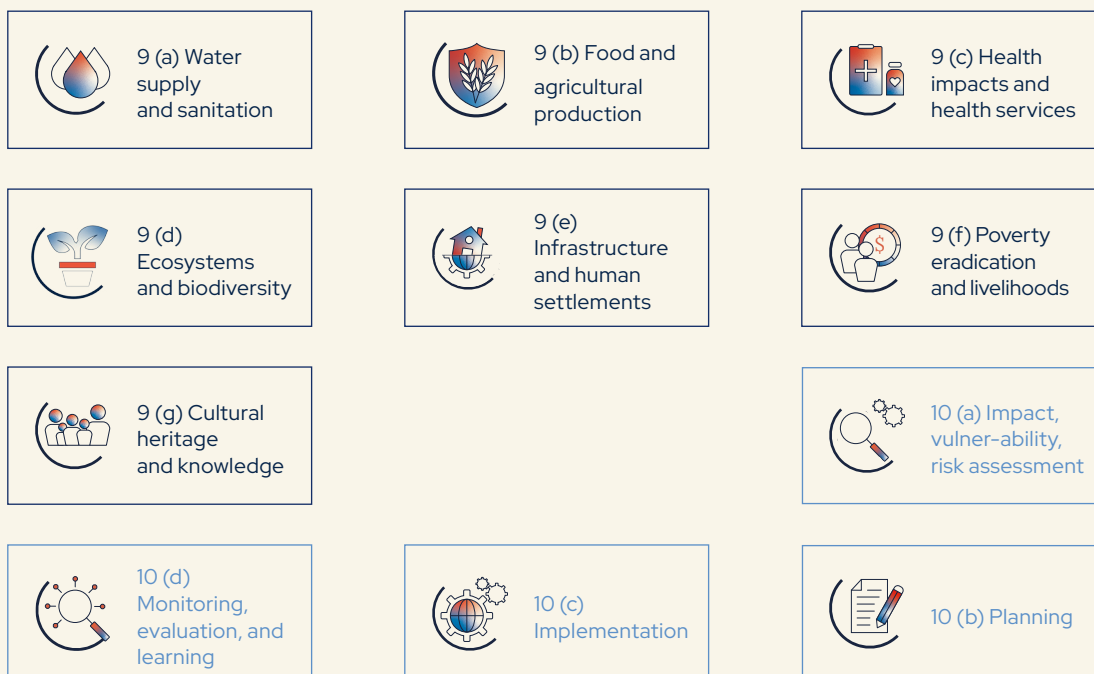
It is important to consider indicators that can provide advance warning of potential resistance or challenges to transformational adaptation efforts. Monitoring these indicators enables proactive identification of potential

challenges and the development of strategies to mitigate them, as is illustrated in the case study in Box 3. Depending on the context and objectives of assessing transformational adaptation, a weighting system can be used to prioritize indicators.

The dimensions of transformational adaptation can be assessed using both inductive and deductive methods. This involves combining practical feedback from those implementing adaptation measures with indicators derived from research. Using both methods ensures the understanding of transformational adaptation remains theoretically sound and applicable in real-world settings.

Figure 3
Targets under the UAE Framework for Global Climate Resilience

2/CMA.5, paragraph 9 (a)–(g): Thematic targets



2/CMA.5, paragraph 10 (a)–(d): Dimensional targets

Source: 2/CMA.5 Global Goal on Adaptation, Paragraph 10



Transformation Action and Evaluation

C.1

Current and future adaptation trends

The IPCC has observed progress in adaptation planning and implementation across various sectors and regions and suggests that this progress is unevenly distributed. Many actions tend to prioritize immediate and near-term climate risk reduction, which can inadvertently limit the scope for more fundamental, transformational adaptation.

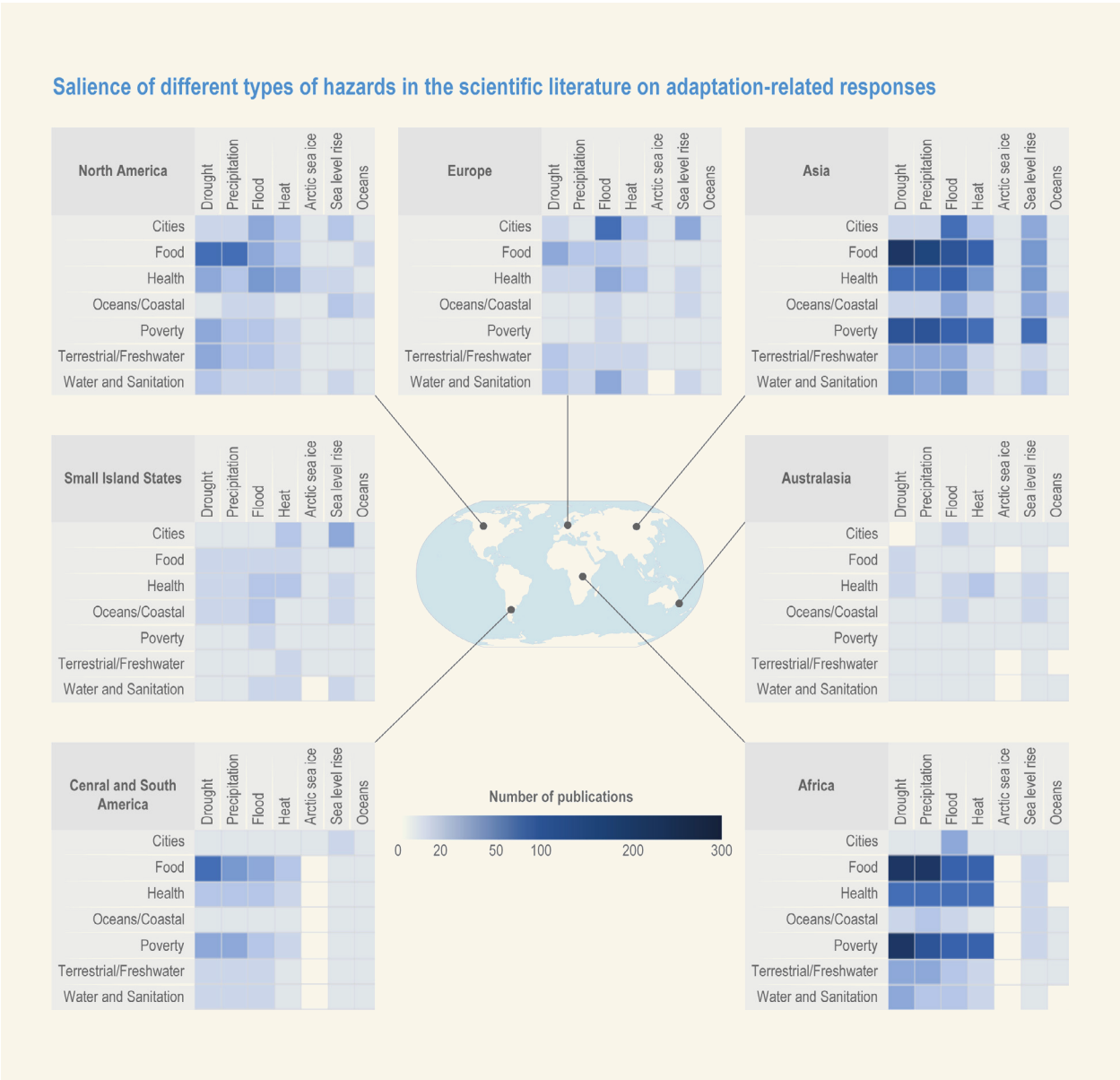
The Global Adaptation Mapping Initiative, which reviewed scientific literature on adaptation actions from 2013 to 2019, provides insights into the documented evidence of transformational adaptation. The findings, summarized in Figure 4, indicate that the overall transformational nature of adaptation across most regions and sectors is currently low. Documented adaptations often involve minor modifications to existing practices and few responses demonstrate transformational characteristics. This can be further observed in Box 4, which

summarizes information from reports submitted by Parties during the first global stocktake on transformational adaptation efforts.

It is important to question the extent to which global systems can be transformed to enable a desired and positive vision of the future in the context of the climate crisis. While FCCC/TP/2024/8 provides a preliminary assessment of the potential for transformation, further work is needed.

‘Horizon scanning’ exercises conducted by the secretariat and supported by artificial intelligence, using an analysis of PESTEL factors, are outlined below in Table 2, assessing future trends of adaptation efforts. This analysis highlights emerging trends like the integration of Indigenous knowledge, increased interest in regenerative agriculture, and the emphasis on urban green infrastructure. While the ‘horizon scanning’ exercise was conducted at the global level, it would also be beneficial to conduct such an exercise at regional levels.

Figure 4
Evidence of transformational adaptation by sector and region



Source: The contribution of Working Group II to the AR6, figure 16.6, p.2436.

Note: "Cities" relates to cities, settlements and key infrastructure; "Food" relates to food, fibre and other ecosystem products; "Health" relates to health, well-being and the changing structure of communities; "Oceans/Coastal" relates to oceans and coastal ecosystems and their services; "Poverty" relates to poverty, livelihoods and sustainable development; "Terrestrial/Freshwater" relates to terrestrial and freshwater ecosystems; and "Water and Sanitation" relates to water, including sanitation.

Box 4**Summary of an analysis on how Parties are considering or implementing transformational adaptation**

An analysis of reports submitted by Parties (such as NAPs or BTRs) during the first global stocktake under the Paris Agreement revealed that less than one-third of Parties currently provide information on their transformational adaptation efforts.

Specifically, the analysis found that:

- A total of 28 per cent of Parties described their planned transformational adaptation measures in key sectors such as agriculture, fisheries, forestry, terrestrial ecosystems, disaster risk management, and urban areas.
- 22 per cent of Parties are aiming to strengthen transformational adaptation planning and implementation or enhance the transformational capacity of social and economic systems.
- 11 per cent of Parties acknowledged that implementing transformational adaptation requires a combination of technological innovations, institutional reforms, diverse funding sources, and behavioural and cultural shifts within the multilevel governance system.
- 10 per cent of Parties emphasized the importance of fostering gender-sensitive and gender-inclusive approaches, as well as increasing gender equality in planning for transformational adaptation.

5 per cent of Parties highlighted the need for a deeper understanding of fairness and just transitions in planning and implementing transformational adaptation, with some noting a lack of sufficient international support necessary for the just transformation of adaptation priority sectors.

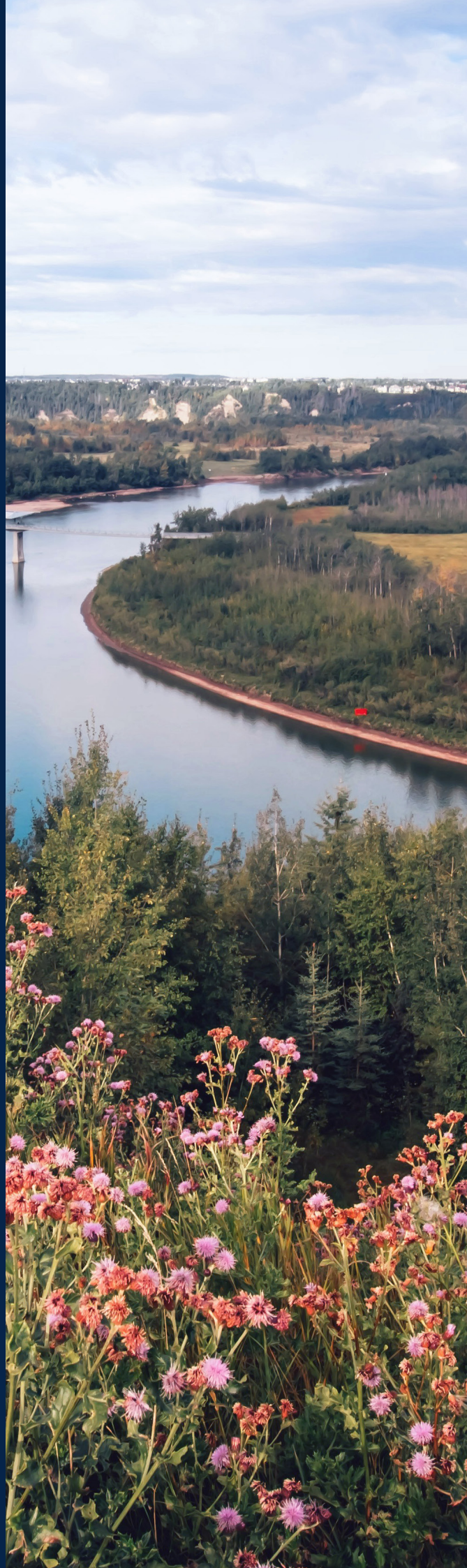


Table 2

Key findings from the secretariat's 'horizon scanning' exercise on the future trends of adaptation

<i>PESTEL Factors</i>	<i>Key Opportunities</i>	<i>Key Uncertainties and Challenges</i>
Political	International agreements will continue to shape adaptation efforts.	Political instability and changes in leadership may undermine adaptation and funding.
Economic	New markets and innovations will facilitate economic possibilities.	Economic feasibility of large-scale adaptations is uncertain. The degree to which climate change will disrupt traditional economic systems is uncertain. Increased insurance premiums.
Social	Enhanced public awareness of climate change risks, influencing social acceptance. More sustainable lifestyle changes will occur.	Social willingness and capacity to adapt to required changes. Potential for social unrest due to climate inequities.
Technological	Emerging technologies will support adaptation and enhance capacities. Big data and forecasting will have an increased role in decision-making.	More research is needed on the role of technology and innovation in transformational adaptation.
Environmental	NBS can be a key part of transformational adaptation.	More frequent and intense climate impacts on biodiversity and ecosystems.
Legal	National legislation and international treaties will lead adaptation. New projects will incorporate compliance with environmental regulations.	Potential for legal disputes over adaptation obligations. Developing and enforcing effective legal frameworks.

Note: More information on the PESTEL analysis and the future trends of adaptation options can be found in Annex III.



C.2

Implementation of transformational adaptation

While the concept of transformational adaptation is increasingly discussed in theory and planning, its actual implementation is only beginning to gain traction. Actions to support the implementation of transformational adaptation can be grouped by its key dimensions as seen in Table 3.

Table 3

The dimensions and related actions to support the implementation of transformational adaptation

<i>Dimension</i>	<i>Actions to support transformational adaptation implementation</i>
Depth of change	• Re-evaluating current assumptions on dominant values, rules and practices to promote new adaptation options. • Facilitating multi-loop learning⁹ approaches that question current mind-sets and create opportunities for alternative adaptation. • Utilizing sudden changes for transformation. Sudden changes can include extreme climate hazards, political reform and new technologies to redirect development pathways. • Identifying leaders and key agents to promote deep social changes that lead to transformational adaptation, as well as power dynamics that might prevent its implementation.
Adaptive sustainability (robustness, resilience and adaptiveness of change):	• Investing in research and experimentation on new adaptation options, including transformational adaptation. • Learning through long-term monitoring and evaluation to avoid ineffective adaptation. • Securing political and funding support for long-term actions.
Scale of change relating to levels, policies, people, geography, levels of understanding and the public-private Continuum:	• Shifting governance dynamics to connect multiple spatial and jurisdictional scales by: – Scaling up action from the individual household, community or subsector level over time as decisions, practices or technologies become widespread; – Scaling down action from the national level, for example through large-scale nationally determined contributions to the regional and local level and through investments in change.
Speed of change:	• Accelerating impacts to achieve the appropriate speed of change while ensuring a just transition. This usually depends on how well broader system changes, scaling efforts, and shifts in related social, economic, and environmental systems align.

C.3

Evaluating transformation

Transformational adaptation and its multidimensional complexity can be assessed and evaluated through its attributes. It should be noted that transformational adaptation does not automatically guarantee adequacy or effectiveness. A low level of transformation may suffice for certain climate risks, while a high level of transformation may not be adequate for others.

Different initiatives have attempted to assess, quantify and measure evidence of transformation through different means to track its implementation and support its understanding. Table 4 summarizes how existing sources have evaluated transformational adaptation.

Table 4
Examples of evaluating the potential for transformational adaptation

<i>Initiative</i>	<i>How transformation was evaluated</i>	<i>Explanation</i>
AR6	Dimensions used: Depth of change, scope/scale of change, speed of change, and limits of change.	Assesses evidence of transformational adaptation based on adaptation responses reported in scientific literature. Operational descriptors are provided for low, medium, and high transformational adaptation potential for each dimension ¹⁰ .
Literature Review ¹¹	Characteristics used: Restructuring, path-shifting, innovative, multiscale, system-wide, and persistent characteristics ¹² .	This review of 80 conceptual papers identifies six common characteristics of transformational adaptation in ecological, social, and social-ecological systems. It found that restructuring and path-shifting were the most frequently mentioned dimensions.
Framework ¹³ used by the IPCC ¹⁴	Aspects used to assess the scope of transformation (incremental to transformational): Change within or across the system, agency (single or heterogeneous), role of visioning, type of learning required, and extent to which equity and distributional issues are explicit.	Used to assess the potential for transformation of adaptation options. Actions are categorized as resulting in no, small, moderate, and broad system change.
CIF Framework	Dimensions used: relevance to context and beneficiaries, potential for systemic change, speed of change acceleration, scalability along dimensions, and sustainability.	Evaluates the operationalization for transformational adaptation in a country-driven manner, supporting countries in developing investment plans and adaptation plans, such as NAPs. It uses qualitative categories to evaluate transformational change, except for speed of change.

D Further Considerations and Pathways

D.1 Potential for transformational adaptation and risks of maladaptation

Even when well-intended, adaptation actions, including transformational adaptation, may come with risks of maladaptation¹⁵, meaning that some transformational actions might unintentionally worsen or create new vulnerabilities as shown in the example in Box 5.

Risks of maladaptation vary according to different contexts. AR6¹⁶ suggested that for low-lying coastal areas, the

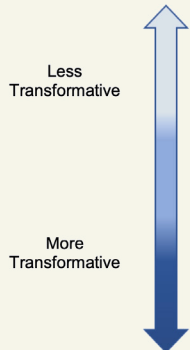
transformational option of strategic coastal retreat has a low risk of maladaptation, whereas options like building more coastal infrastructure have a moderate to high risk. In food security, changing diets and cutting food waste offer strong potential for effective adaptation with very low risk of maladaptation. Experts assessed the transformational potential of various adaptation options by focusing on actions that aim to create positive system-wide change, rather than on managing specific risks which may no longer be effective. These options include both specific actions, like diversifying livelihoods, and broader processes that support rethinking and reshaping systems.



Box 5 Adaptation Options in the Health Sector:

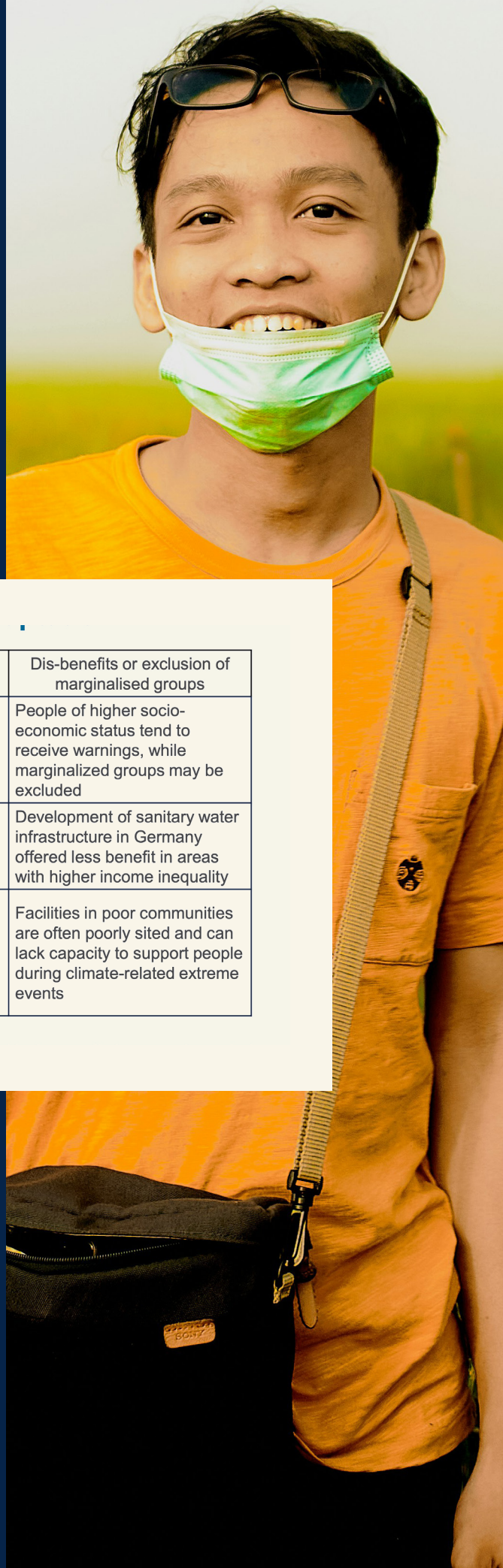
Different adaptation options in the health sector vary in their potential for transformational adaptation and their benefits or disadvantages for marginalized groups. Early warning systems tend to be more incremental, enabling people to maintain existing systems they live in. Figure 5 shows the potential for transformation of different adaptation options in the health sector, however none of these options were seen to be consistently beneficial for vulnerable groups.

Figure 5
Potential for transformation and maladaptation risks of several adaptation options in the health sector



Adaptation	Benefits to marginalized groups	Dis-benefits or exclusion of marginalised groups
Early-warning systems (<i>high confidence</i>)	Help with planning and pre-emptive identification of vulnerable groups	People of higher socio-economic status tend to receive warnings, while marginalized groups may be excluded
Infrastructure for health (<i>high confidence</i>)	Improvements to water infrastructure reduce displacement and improve mental health outcomes	Development of sanitary water infrastructure in Germany offered less benefit in areas with higher income inequality
Climate-resilient health care systems (<i>medium confidence</i>)	Universal health coverage can be highly beneficial, especially to lower income people when needed for climate-related health outcomes	Facilities in poor communities are often poorly sited and can lack capacity to support people during climate-related extreme events

Source: IPCC presentation at the fifth workshop under the Glasgow–Sharm el-Sheikh work programme on the global goal on adaptation. Available at: <https://unfccc.int/documents/627408>



D.2 Constraints to transformation

Transformational adaptation faces constraints and barriers that can limit planning and effective implementation. These challenges span economic, social, cultural, institutional, and informational dimensions and can include the following:

- Economic constraints: existing livelihoods, economic structures and economic mobility, including economic lock-ins. The economic feasibility of large-scale adaptations, and the degree to which climate change will disrupt traditional economic systems, can also be key uncertainties;
- Social/cultural constraints: social norms and practices, cultures, identity, place attachment, beliefs, world views, values, awareness, education, social justice and social support. Social willingness and capacity to adapt to the changes required to combat climate change and the potential for social unrest owing to climate inequities are also uncertainties;
- Human capacity constraints: individual, organizational and societal capabilities to set and achieve adaptation objectives over time, including training, education and skills development;
- Governance, institutions and policy constraints: existing laws, regulations, procedural requirements, governance scope, effectiveness, institutional arrangements, adaptive capacity, absorption capacity, a lack of broad ownership and institutional path dependency;
- Financial constraints: lack of financial resources;
- Information/awareness/technology constraints: lack of awareness or access to information or technology;
- Physical constraints: the presence of environmental, or structural limitations such as the availability of suitable land for community relocation or the

existing coastal geography affecting wetland restoration;

- Biological constraints: temperature, precipitation, ocean salinity, acidity and intensity and frequency of extreme events, including storms, droughts and wind.

To move past these barriers and constraints, transformational adaptation must manage trade-offs and apply a range of values and principles. These include intrinsic, instrumental, and relational values linked to nature-based solutions, along with the use of 'systems thinking' to understand connections and support sustainable development.

D.3 Possible ways forward

The concept and practice of transformational adaptation form a developing field that calls for ongoing learning and deeper understanding. Given that the concept of transformational adaptation is complex and evolving, it should not become a requirement for providing adaptation finance to developing countries, which are struggling to implement incremental adaptation measures and have significant capacity constraints. The concept may be more useful when applied from a backward-looking perspective by assessing what worked and was considered transformational in a given project.

By using existing knowledge and current initiatives, it is possible to explore new ways to better integrate transformational adaptation into climate strategies, decision-making, and actions. Some possible ways forward include:

- A. Systematic Documentation and Dissemination of Knowledge:** Systematic documentation and sharing of ongoing efforts, success

stories, and experiential insights relating to transformational adaptation across diverse regional and sectoral contexts. This exchange of knowledge will help enhance understanding and support implementation;

- B. Regionalized Horizon Scanning Exercises:** Given that climate change impacts and adaptation needs vary by context, tools like 'horizon scanning' can help identify region-specific challenges, opportunities, and options for transformational adaptation;
- C. Contextualized Adaptation Pathways:** To support concrete action, it is helpful to define transformational adaptation approaches for each target under the United Arab Emirates Framework for Global Climate Resilience, tailored to specific goals, sectors, and regional contexts;
- D. Utilizing indicators:** Using the work on indicators under the United Arab Emirates–Belém work programme can be an opportunity to formulate meaningful indicators specific to transformational adaptation;
- E. Enhanced Collaboration and Collective thinking:** Addressing the complex nature of transformational adaptation calls for strong collaboration and collective thinking. This includes involving a wide range of stakeholders in developing adaptation indicators;
- F. Integration of Overlooked Elements:** A comprehensive approach to transformational adaptation requires the identification and integration of sectors and considerations that may

have been previously overlooked. Further research is also needed to understand the role of technology and innovation in catalysing transformational adaptation;

- G. Connecting Adaptation to Specific Objectives:** Establishing clearer linkages between adaptation visioning and discourse with specific targets can help ensure that adaptation efforts are purposeful and impactful;
- H. Leveraging Existing Knowledge Bases:** The findings of the IPCC, in particular regarding the evidence and potential for transformational adaptation should serve as a guiding framework for prioritizing areas of focus and informing future work. Furthermore, reports submitted by Parties offer valuable insights.
- I. Harmonizing Adaptation and Mitigation Strategies:** It is essential to acknowledge the intrinsic interconnectedness between adaptation and mitigation strategies to support climate resilience while simultaneously reducing greenhouse gas emissions. Harmonizing the understanding and practical application of transformational adaptation across efforts, including reporting mechanisms, is essential.

Transformational adaptation demands a deep shift beyond small, gradual changes toward bold, ambitious actions. It involves questioning current beliefs and practices, encouraging innovation, and focusing on equity and justice during the transition to a climate-resilient future.



E

Annex



Annex I: Examples of transformational adaptation

Building climate-resilient health systems through green urban design

In response to the rising health impacts of climate change such as heat waves, vector-borne diseases, air pollution and flooding, some cities are adopting green urban planning and infrastructure to mitigate health risks, rather than simply expanding hospitals or clinics to handle rising patient loads.

Structural change: This approach transforms the structure of the health system from being a centralized, hospital-based response system to one that is embedded into the urban environment. Health resilience is no

longer just about medical treatment but about how cities are designed, how people live and how community systems are organized.

Functional impact: The health system shifts from simply responding to illnesses (like treating heatstroke in emergency rooms) to actively preventing them through urban planning that reduces climate risks. This includes steps like lowering heat-related deaths with greener, cooler city designs and preventing disease outbreaks by improving water and sanitation management.

Collaboration across sectors: Health resilience becomes a shared responsibility across sectors, involving urban planners, environmental scientists and public health officials working together to design cities that protect human health from climate impacts.



Photo by Filippo Cesarini on Unsplash • Source: <https://www.weforum.org/stories/2020/09/cities-sustainability-innovation-global-goals/>

Assisting migration of species to new habitats

The American pika, a small mammal native to mountainous regions of North America, is highly vulnerable to rising temperatures. As a warming climate shrinks its alpine habitat, researchers have considered relocating pikas to higher elevations or cooler regions, beyond their traditional range, to ensure their survival.

Structural change: The entire approach to species conservation changes. Instead of maintaining species within their historical ranges through habitat restoration or protection, this method restructures the geographic boundaries of ecosystems. Introducing species to new areas changes the makeup of both the original and new ecosystems.

Functional impact: The function of conservation shifts from preserving ecosystems in their current form to actively intervening in natural processes to anticipate future changes. This calls for a more adaptable and flexible view of ecosystems as constantly changing systems, rather than fixed ones that must stay the same.

Ecosystem interaction: Relocating species creates new interspecies relationships, altering predator–prey dynamics, competition and resource use in both the ecosystems the species leave and the ones they enter. This could lead to a change in entire food webs, creating a fundamental change in ecosystem functioning.



“American pika” by GlacierNPS is marked with Public Domain Mark 1.0.
Source: <https://rockies.audubon.org/blog/naturalist/monitoring-pikas>

Restoring coastal wetlands for storm protection

Structural change: Large-scale restoration of coastal wetlands (e.g. salt marshes) to replace or supplement traditional engineered defences (e.g. sea walls).

Functional impact: Wetlands act as natural buffers, absorbing storm surges and reducing flooding. This can improve coastal resilience by enhancing the ability of an ecosystem to protect human populations while also providing habitats for biodiversity. Wetlands change the natural coastline structure and shift its function from being a natural habitat only to also serving as a critical climate adaptation solution.



Coastal wetland in Bair Island, Redwood City, California.

Photo by Div Manickam on [Unsplash](https://www.pewtrusts.org/en/research-and-analysis/white-papers/2022/08/wetlands-restoration-boosted-greenhouse-gas-captured-by-san-francisco-bay-estuary). • Source: <https://www.pewtrusts.org/en/research-and-analysis/white-papers/2022/08/wetlands-restoration-boosted-greenhouse-gas-captured-by-san-francisco-bay-estuary>

Relocating a coastal community

A coastal town facing severe risks from rising sea levels and increased storm surges might engage in transformational adaptation by relocating the entire community to a safer inland location. This is a more radical shift compared with traditional adaptation measures such as building higher sea walls or improving flood defences, which are aimed at maintaining the community in its current location.

Structural change: The community's geographic location changes, which alters the layout of homes, infrastructure and public services.

Functional impact: The economic activities of the town may shift as industries tied to the coast (e.g. fishing or tourism) may need to be replaced by new livelihoods more suitable to an inland setting.

Community identity: Moving a whole town fundamentally reshapes its cultural and social connections, changing the way the community interacts with its environment.

Promoting land-tenure reform to address climate vulnerability and inequality

In many parts of the world, marginalized communities, including Indigenous Peoples and smallholder farmers, often lack secure rights to the land they live on and cultivate. This lack of security leaves them vulnerable to climate change, as they have little control over land-use decisions, face frequent displacement from 'land grabs,' and cannot invest in long-term, climate-resilient farming practices.

Transformational adaptation through land-tenure reform involves creating and enforcing policies that give these communities legal ownership or secure access to their land.

Structural change: Land-tenure reform changes the fundamental structure of who owns and controls natural resources, shifting it from governments,

corporations or other powerful groups to local, marginalized communities. This restructuring is crucial for long-term climate adaptation, as communities can now manage and protect their lands with climate resilience in mind.

Functional impact: The function of land use and governance is transformed from being top-down and extractive to being community-driven and sustainable. The focus shifts from short-term profit-making through resource exploitation to long-term environmental stewardship and climate resilience.

Power shift: This policy reform results in a significant shift in power dynamics, giving control over resources to communities that have been historically marginalized. It also allows them to participate more actively in national and global discussions on climate adaptation, reducing inequality and increasing their influence in policymaking.



Reintroducing cultural fire practices to manage wildfire risk

To address the growing threat of wildfires, some regions in Australia have abandoned conventional wildfire suppression practices and instead embraced traditional Aboriginal fire management. This involves setting small, controlled fires in cooler seasons, which reduces fuel loads and minimizes the intensity of wildfires later in the dry season.

Structural change: The entire land management approach shifts from a reactive firefighting strategy to a proactive, cyclical practice of landscape management. This changes

the relationship between people, the environment and fire.

Functional impact: The role of fire is redefined from a hazard to a tool for ecological balance, drawing on thousands of years of Indigenous knowledge. Fire is no longer merely something to be suppressed but is understood as part of the land's natural rhythm.

Governance and knowledge systems: Indigenous leaders take on a key role in managing fire practices, requiring the integration of local knowledge into regional and national fire management policies. This represents a shift in power dynamics, where Indigenous communities are central to decision-making processes.



Controlled burn of woodlands for wildfire control near Faro, Portugal.

Photo by OB OA on Unsplash. • Source: <https://www.nature.org/en-us/about-us/where-we-work/asia-pacific/australia/stories-in-australia/bringing-indigenous-fire-back-to-northern-australia/>

Annex II: Examples of case studies of transformational adaptation

Transformational adaptation to climate change is a relatively new concept, and there are ongoing efforts to understand and implement it. While there may not be a wide range of well-documented success stories specifically focused on transformational adaptation, there are examples in the literature that highlight the potential and effectiveness of transformational approaches, including:

- A.** *The role of adaptive capacity in incremental and transformative adaptation in three large U.S. urban water systems.*¹⁷ Urban water systems must meet the needs of growing populations in a changing climate. Studying systems that face extreme events like drought can help clarify what adaptive capacity looks like and whether it supports either incremental or transformational adaptation. Researchers conducted case studies of three large U.S. metropolitan water systems to examine how drought-related actions influenced adaptive capacity and whether those actions created the conditions needed for transformational adaptation;
- B.** *Adapting to Climate Change – Three Success Stories.*¹⁸ This study highlights various examples from around the world where communities, households and governments have taken measures to reduce their exposure and vulnerability to weather shocks and climate change. It emphasizes that investing in successful adaptation strategies can help to reduce the economic costs of climate change;
- C.** *Transformational adaptation to climate change for sustainable*

*social-ecological systems.*¹⁹ This article acknowledges that certain coping or incremental adaptation strategies may not be sufficient or sustainable in the long term to address climate change. It emphasizes the need for fundamental changes in social-ecological systems to address the root causes of vulnerability. While the article does not provide specific success stories, it highlights the characteristics of transformational adaptation and the importance of addressing vulnerability;

- D.** *Towards more sustainable responses to natural hazards and climate change challenges via transformative adaptation.*²⁰ This paper reviews the literature on transformational climate change adaptation and refers to a unique set of cases from 20 countries, predominantly in the Global South. While the paper does not provide detailed success stories, it suggests measures to implement transformational adaptation to tackle climate challenges;
- E.** *Adapting cities for transformative climate resilience: lessons from the field.*²¹ This editorial highlights the need for cities to move beyond protecting the status quo towards social transformation²² in the face of climate change. It emphasizes the importance of rethinking resilience planning and policy and provides insights into how different stakeholders and their networks can engage in transformational resilience at the urban level;
- F.** *Characteristics of Transformational Adaptation in Climate–Land–Society Interactions.*²³ This paper examines the features of transformational adaptation and development in the context of major changes in land use and climate. It contains four case studies: managing storm water run-off related to the conversion of rural land to urban land in Indonesia; using a basket of interventions



Ecosystem based adaptation for resilience in Freetown, Sierra Leone.

Photo by [Random Institute](#) on [Unsplash](#) • Source: <https://www.unep.org/zh-hans/node/24215>

to manage the social impacts of flooding in Nepal; combining a national glacier protection law with water rights management in Argentina; and community-based relocation in response to permafrost thaw and coastal erosion in Alaska, United States;

- G.** *Lessons learned from several case studies conducted by UNEP, such as on Xalapa, Mexico,²⁴ which identifies the key elements for setting up a transformational financing scheme, including how the depth and scale of transformation depend on political influence over its pace; and policy briefs on lessons learned from Lesotho,²⁵ Madagascar²⁶ and the United Republic of Tanzania²⁷ that offer insights into potential examples of transformation, including in terms of sustainability and replicability, and on gender inclusivity as an enabler of transformation in the Gambia;²⁸*
- H.** *The NAP task force Policy brief on progress, good practices and lessons learned: challenges and opportunities in the application of traditional knowledge, knowledge of Indigenous Peoples and local knowledge systems in adaptation,²⁹*

which highlights the importance of traditional and Indigenous Peoples' knowledge and local knowledge systems in providing insights into and solutions for transformational adaptation measures. The shift towards long-term transformational adaptation, systems change and holistic approaches can facilitate the integration of scientific and technological innovations with traditional and Indigenous knowledge. This includes the application of alternative value systems such as the rights of nature and which recognise the deep relationships between humanity and the natural environment.

These examples demonstrate the potential for transformational adaptation to address the challenges posed by climate change. However, it is important to note that transformational adaptation is context-specific and requires interdisciplinary approaches, stakeholder engagement and long-term planning. Further research and case studies are needed to better understand and document successful transformational adaptation efforts.

Annex III:

Future trends for adaptation options

<i>Options</i>	<i>Impact</i>	<i>Likelihood</i>	<i>Time frame</i>	<i>Maturity</i>	<i>Priority</i>
Community-driven climate-resilience planning	High	Likely	2023–2030	Emerging	High
Green infrastructure in urban areas	Very high	Very likely	2023–2034	Emerging	Very high
Adaptive water resource management	High	Likely	2023–2030	Emerging	High
Climate-proofing infrastructure	Very high	Likely	2023–2037	Maturing	Very high
Migration as an adaptation strategy	High	Likely	2023–2034	Emerging	High
Disaster-resilient agriculture	High	Likely	2023–2030	Emerging	High
Investment in climate-resilience metrics	High	Likely	2023–2030	Emerging	High
Nature-based coastal defence strategies	High	Likely	2023–2030	Emerging	High
Climate-induced innovation in insurance	High	Likely	2023–2030	Emerging	High
Urban heat island mitigation measures	High	Likely	2023–2030	Emerging	High
Cross-sectoral climate education programmes	High	Likely	2023–2030	Emerging	High

Note: The information in this table is based on the PESTEL analysis carried out by the secretariat

Endnotes

- 1 Decision 2/CMA.5, para. 46.
- 2 Decision 2/CMA.5, para. 8.
- 3 See [FCCC/TP/2024/8](#)
- 4 See document [FCCC/SB/2023/9](#), paras. 3 and 6.
- 5 Systems thinking refers to a holistic approach that emphasizes the interconnectedness and dynamic interactions within and between the different elements and relationships of a system.
- 6 Water in Circular Economy and Resilience (WICER): The Case of Chennai, India. Available at <https://documents.worldbank.org/pt/publication/documents-reports/documentdetail/737251622708324921/Water-in-Circular-Economy-and-Resilience-WICER-The-Case-of-Chennai-India>.
- 7 See suggested targets referred to in paragraphs 9–10 of decision 2/CMA.5.
- 8 See the summary of the fifth workshop under the Glasgow–Sharm el-Sheikh work programme on the global goal on adaptation (with the theme of the workshop selected in accordance with decision 3/CMA.4, para. 20(e) and (g)), available at <https://unfccc.int/documents/627908>.
- 9 Multi-loop learning in this context can be defined as an approach that for understanding how individuals and organizations learn and adapt.
- 10 Refer to Section 4.
- 11 Fedele G, Donatti CI, Harvey CA, et al. 2019. Transformative adaptation to climate change for sustainable social-ecological systems. *Environmental Science & Policy*. 101: pp.116–125. Available at <https://www.sciencedirect.com/science/article/pii/S1462901119305337>.
- 12 This can refer to either the ecological structure of ecosystems (e.g. species diversity), the social structure of communities (e.g. power dynamics) or the structure of social-ecological interactions (e.g. land uses).
- 13 David Tàbara J, Jäger J, Mangalagiu D, et al. 2019. Defining transformative climate science to address high-end climate change. *Regional Environmental Change*. 19(3): pp.807–818. Available at <https://doi.org/10.1007/s10113-018-1288-8>.
- 14 See the contribution of Working Group II to the AR6, table 17.3, p.2559.
- 15 Maladaptation refers to changes in natural or human systems that inadvertently increase vulnerability to climatic stimuli.
- 16 See the contribution of Working Group II to the AR6, figure 17.11., p.2604.
- 17 Dilling L, Daly ME, Travis WR, et al. 2023. The role of adaptive capacity in incremental and transformative adaptation in three large U.S. urban water systems. *Global Environmental Change*. 79: pp.102649. Available at <https://www.sciencedirect.com/science/article/pii/S0959378023000158>.
- 18 Pugacheva E and Mrkaic M. 2018. *Adapting to Climate Change—Three Success Stories*. Available at <https://www.imf.org/en/Blogs/Articles/2018/03/20/adapting-to-climate-change-three-success-stories>.
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- 21 Danieri A and Archer D. 2023. Editorial: Adapting cities for transformative climate resilience: lessons from the field. *Frontiers in Sustainable Cities*. 5. Available at <https://www.frontiersin.org/journals/sustainable-cities/articles/10.3389/frsc.2023.1211125/full>.
- 22 Social transformation refers to a change in the fundamental attributes of human systems advanced by societal actors.
- 23 Warner K, Zommers Z, Wreford A, et al. 2019. Characteristics of Transformational Adaptation in Climate–Land–Society Interactions. *Sustainability*. 11(2): pp.356. Available at <https://www.mdpi.com/2071-1050/11/2/356>.
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- 28 UNEP. 2024. *A Decade of Ecosystem-based Adaptation: Lessons from the United Nations Environment Programme*. UNEP. Available at <https://www.unep.org/resources/policy-and-strategy/decade-ecosystem-based-adaptation-lessons-united-nations-environment>.
- 29 Available at: <https://unfccc.int/documents/640913>.



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