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Understanding Transformational Adaptation

A shared vision across EU Horizon projects

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- TransformAr – GA 101036683
- P2R – GA 101093942
- IMPETUS – GA 101037084
- REGILIENCE – GA 101036560
- DesirMED – GA 101112972
- CARDIMED – GA 101112731
- TRANSCEND – GA 101084110
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1. WHY TRANSFORMATIONAL ADAPTATION?

The EU's Mission on Adaptation to Climate Change has a concrete objective: to support at least 150 European regions and communities in becoming climate resilient by 2030. The Mission on Adaptation contributes to the EU's 2021 Adaptation Strategy. Due to the scale, speed, and complexity of the challenges that climate change presents, both the Mission and the EU Adaptation Strategy require us to adapt faster, in a smarter and more systemic way. A far-reaching, transformational response is therefore needed that includes, but also goes beyond traditional, incremental adaptation strategies. A far-reaching transformational response may be more effective in achieving the EU Mission's objective, providing better solutions than conventional, incremental adaptation strategies.

The summer of 2024 was the hottest ever for Europe, while 2023 saw one of the most severe wildfire seasons in Europe's history. In recent decades, Europe has faced increasingly frequent and intense weather-related natural disasters, including floods, storms, heatwaves, droughts, and wildfires. Climate change is expected to even further exacerbate the intensity and frequency of these events.[1] Incremental adaptation efforts no longer suffice to withstand the effects of these recent extreme weather events, highlighting the need for a transformational approach to climate adaptation.

In comparison to climate mitigation and the related climate neutrality goals (i.e. net zero greenhouse gas emissions), Europe is lagging behind on climate change adaptation. As the EU remains vulnerable to climate impacts, the Mission on Adaptation to Climate Change calls for solutions that move beyond current methods, technologies, and practices to induce fundamental and system-level change. The goal of transformational adaptation is to create societal and economic systems that are resilient and flexible enough to adapt to future uncertainties by addressing what makes the EU particularly vulnerable to current and future climate impacts. By adopting proactive strategies that adapt to future conditions, transformational adaptation ensures long-term sustainability and reduces future risks. Considering the urgency to adapt to the consequences of climate change, it is important to accelerate and upscale adaptation action in these ways.

This policy brief is developed under the Working Group on Transformational Adaptation of MIP4Adapt. MIP4Adapt is the EU Mission on Adaptation to Climate Change's Implementation Platform. The working group is composed of representatives of the following EU Horizon projects: TransformAr, Pathways2Resilience (P2R), IMPETUS, REGILIENCE, DesirMED, CARDIMED, RECREATE, and TRANSCEND. This policy brief is targeting actors involved in the implementation of transformational adaptation, at local and regional level in Europe, including authorities at EU, local and regional level.

[1] See more from the European Environment Agency (EEA): https://www.eea.europa.eu/en/topics/in-depth/extreme-weather-floods-droughts-and-heatwaves

2. TRANSFORMATIONAL ADAPTATION CONCEPT

Transformational adaptation is defined by the Intergovernmental Panel on Climate Change (IPCC) in their 6th assessment report (AR6) as "actions aiming at adapting to climate change resulting in significant changes in structure or function that go beyond adjusting existing practices." Adapting to climate change refers to responding to actual or expected climate change and its effects, including under uncertainty, thereby aiming to reduce harm to people, socio-economic systems, and natural systems.

In essence, transformational adaptation is a strategic approach focused on addressing the underlying causes of vulnerability to climate change by steering systems away from unsustainable or unfavourable paths (Fedele et al., 2019, O'Brien, 2012; Olsson et al., 2014). While the concept and importance of transformational adaptation has been acknowledged in literature for more than 10 years, in practice it is not (yet) widely applied. This policy brief describes the concept of transformational adaptation, while also describing the first steps to implementation. In the context of the EU Mission on Adaptation, the terms 'transformational' and 'transformative' climate change adaptation are used interchangeably.

Climate resilience[2], often considered the final goal of climate change adaptation, is built by means of climate adaptation actions. A broad range of climate adaptation actions exist ranging from local, stand-alone actions (e.g. placing sandbags, or diverting water to react to a flood), cooperative social innovation initiatives to prepare for climate impacts, to a large-scale programme (i.e. a portfolio of actions fitting in a broader strategy) that aims to transform the economy, governance system, and landscape (e.g. Room for the River programmes[3]).

Depending on their scope, depth, impact, timing, and inclusivity, adaptation actions can be considered a coping response (reacting to extreme weather), incremental adaptation (short-term reactions to current climate risks, with, often isolated benefits) or transformational adaptation (systemic, long-term approach). All three of these approaches can lead to unintended negative outcomes or shifts in vulnerability, known as maladaptation. Because incremental adaptation focuses on current needs, it may become maladaptive when novel challenges arise. Transformational adaptation, with its increased complexity, also has the potential of becoming maladaptive. An assessment of potential maladaptation, from the start, is therefore important to avoid adverse consequences.

While the differences between terms are not always clear-cut, in practice, quick wins and other short-term incremental adaptation and coping responses remain essential to make progress. Yet, damages, hardship, and unnecessary repair and investments are likely to be reduced if the actions undertaken fit in a broader vision for transformational change. A transformational approach typically involves a bold and decisive leap and represents a major shift from the past.

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[2] Climate resilience is defined as the capacity of social and ecological systems to absorb, adapt, and recover from climate-related disturbances while maintaining their essential functions and structures.

[3] See more on the Room for the River approach on Climate ADAPT: https://climate-adapt.eea.europa.eu/en/metadata/case-studies/room-for-the-river-regge-netherlands-2013-restoring-dynamics

As shown in Figure 1, both incremental and transformational adaptation involve adaptation actions (represented in Fig. 1 by blue squares). Incremental adaptation typically consists of short-term responses to current climate risks. While these actions may benefit some groups, they often fail to address the needs of the most vulnerable, such as the elderly, people in high-risk areas, or from disadvantaged socio-economic backgrounds. These groups are most affected by climate change but have the least capacity to adapt, often being excluded from adaptation benefits, which reinforces existing inequalities.

Climate resilience is defined as the capacity of social and ecological systems to absorb, adapt, and recover from climate-related disturbances while maintaining their essential functions and structures. It is vital to include vulnerable groups in efforts to build resilience, as they are typically the most affected by climate impacts, but are less likely to be able to manage these impacts.

Transformational adaptation, which also involves adaptation actions (represented by the blue squares in Figure 1), takes a more comprehensive, long-term approach to achieving climate resilience. By focusing on equity, participation, and structural change, transformational adaptation ensures that marginalised and at-risk groups are not left behind. It moves beyond short-term, incremental measures, aiming to transform systems to reduce vulnerability and build climate resilience for all.

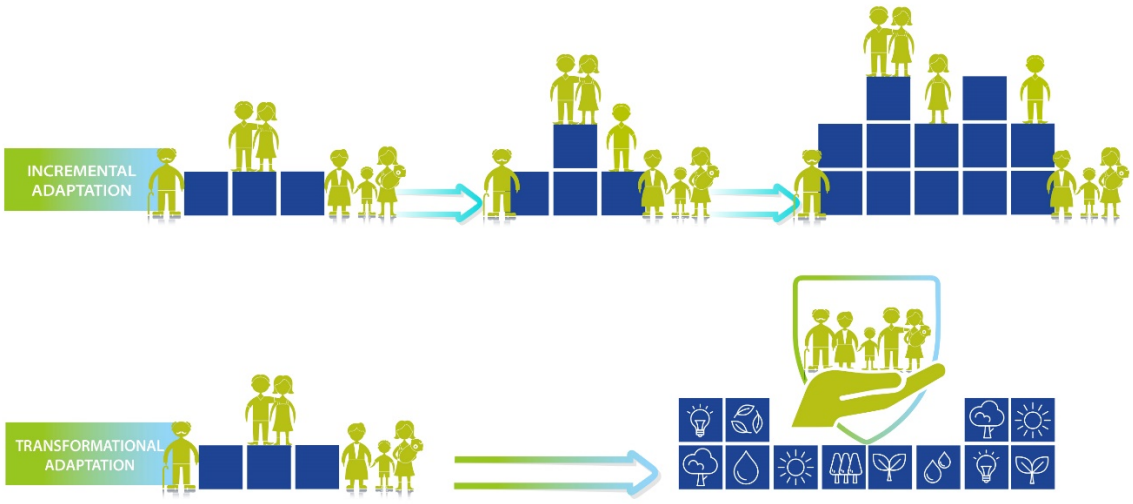

Figure 1:Incremental versus transformational adaptation

Achieving transformational adaptation typically requires a systemic approach, often driven by innovation . Systemic here refers to a cross-sectoral or a whole-of-society approach, in which co-creation and multi-actor engagement is important. Moreover, it may involve the mainstreaming of climate resilience in other policy fields, i.e. the climate-proofing of otherwise non-climate related investments (e.g. road infrastructure). Enhanced cooperation and coordination between actors across sectors, and climate-proof investments ensure that communities, economies, and ecosystems can survive and thrive in a changing world. Transformational adaptation is typically driven by governmental policies. Yet, bottom-up social innovation initiatives have demonstrated

their efficacy in triggering transformational adaptation. Regardless of scale, co-creation and inclusivity are important characteristics of transformational adaptation, as will be elaborated below (see section 4). To go further, various key enabling conditions are required, including data-driven and digital technologies, better knowledge sharing, improved governance, financial tools, and business models.

In addition to reducing vulnerability, transformational adaptation has benefits for the economy, society, and environment. Transformational adaptation has a reciprocal relationship with innovation, both being enabled by and driving new industries, jobs, and opportunities in areas like renewable energy, sustainable agriculture and resilient infrastructure. Socially, it can lead to more inclusive and equitable societies, empowering communities to make decisions about their futures in the face of climate change. From an environmental perspective, transformational adaptation can help restore or conserve ecosystems in ways that address various drivers of ecosystem degradation, such as land and sea use changes, overexploitation of resources, climate change, and pollution. This in turn will also support biodiversity and the ecosystem services essential for human well-being. Nature-based solutions are a key component for this transformational approach. Circular economy initiatives can also support transformational adaptation by reducing environmental pressures, conserving resources, and enhancing ecosystem resilience.

Whether a solution, or a portfolio of solutions, is considered transformational is relative, depending on both context and scale. For example, small water retention areas become transformational if they are upscaled and connected to a network, whereas individual water retention areas are likely to have a minor, local impact. Thus, the potential for a solution to become transformational depends significantly on its diffusion potential (how, why, and at what rate new ideas and technology spread) through geographical scaling (scaling out) (Balmann, 1997). This is closely connected to its ability to change beliefs across individuals and communities (scaling deep) and impact laws, policies and institutions (scaling up) (Moore et al., 2015). The Room for the River approach in the Netherlands and Belgium is currently common practice, but is also the result of a transformative process. Extensions or improvements of the current Room for the River programmes in the Netherlands and Belgium would now be considered incremental adaptation, while in many other countries it would disrupt the current approach of flood risk management, and thus offer a transformational approach.

It is important to note that climate change adaptation actions can generate winners and losers, and benefits are not guaranteed for everyone (Suckall et al., 2019; van der Plank, 2024). For instance, although relocation away from flood-prone areas is often presented as reducing community vulnerability, it may lead to new exposures to different hazards or fail to sufficiently improve livelihoods and access to resources (Nalau and Handmer, 2018; van der Plank, 2024). Transformational adaptation can also lead to inequalities through processes such as “creative destruction,” which refers to new innovations which disrupt and replace existing industries or technologies (Ulgen, 2020). When designing a transformational adaptation approach, it is important to identify potential trade-offs, and winners and losers, and as a result foresee complementary measures to mitigate negative consequences and compensate losses generated by the transition process.

3. BARRIERS TO TRANSFORMATIONAL ADAPTATION

Transformational adaptation does not happen without its challenges. This section outlines common barriers that often impede the willingness to engage in transformational adaptation or that can affect the overall success of the process.

Incentives, politics and power

Transformational adaptation requires the involvement of various actors (stakeholders, sectors, governance levels, etc.) with different interests which may be difficult to reconcile with one another (Fedele et al. 2019). It may prove challenging to platform different priorities at once e.g. economic growth versus nature preservation and scaling down economic activities. This leads to a need for awareness-raising approaches which combine the different visions and interests of stakeholders and allow for a shared narrative. Powerful actors who benefit from the status quo have the potential to prohibit drastic change due to inequalities between the involved players (ibid.). Along this line of thinking, an underestimated barrier is institutional organisation or complexity: the procedures to steer and implement transformational adaptation can be heavy and unclear. This phenomenon can be seen playing out in the implementation of nature-based solutions by multiple organisations, a process which may require unprecedented pooling of financial resources. Creating space for these nature-based solutions may require legal steps relating to land ownership and tenure or may give rise to social conflicts, slowing down the implementation process (Vojinovic, 2020, De Stefano & Hernández-Mora, 2018).

Transitional costs

A transformational change requires substantial investments in terms of human capital, financial resources, and time (Fedele et al. 2019, Kates et al. 2012). While in the short term, a transformational approach is expected to lead to substantial transitional costs, e.g. for cooperation, coordination and planning, it is expected that a transformational approach is more cost-effective in the long run, due to reduced vulnerability, damages and losses are avoided, while resources can also be pooled across sectors, from private and public resources, to achieve common goals. An example is the Adaptation Fund developed in Guadeloupe under the TransformAr project. In the Adaptation Fund, financial resources from various French agencies and a private investor are pooled to invest in climate adaptation on the French archipelago of Guadeloupe.[4] Even so, vulnerable communities are likely to have high barriers to support or initiate transformational change from their own resources (Matyas and Pelling 2015). It cannot be ignored that transformational changes bear some risks and can potentially result in unintended consequences. Transformational adaptation may jeopardise the stability of economies, ecosystems, or societies. Proper monitoring and risk management is therefore needed.

Uncertainty and long-term vision

Individuals and decision-makers are uncertainty- and risk-averse, and as such will often prefer solutions with a more certain but possibly lower payoff (incremental), to those with a more uncertain but possibly higher payoff (transformational). Incremental adaptation does not

[4] More information on the TransformAr Adaptation Fund available here: https://transformar.eu/storage/2023/06/Quel-financement-pour-lAAC-en-Guadeloupe_Ademe_Acterra.pdf

challenge the status quo and requires the future to be predictable and controllable, while transformational adaptation requires a far-reaching vision in an unpredictable world. Building evidence on uncertainty ranges, identifying the potential unintended consequences of incremental responses to climate change, and developing tools to manage such uncertainties are essential for enabling transformational adaptation. (Kosavac & Davidson, 2020). Moreover, people typically respond to visible risks while climate impacts tend to be less visible (Fedele et al. 2019, Lonsdale et al. 2015). Additionally, there is a gap between climate change knowledge and meaningful action, which may be addressed by fit-for-purpose climate services (*actionable* science). A knowledge gap may also arise from disciplinary bias. Engineers typically propose engineering-based solutions to flood risk, for example, while a nature-based approach might be more effective at improving resilience. Non-trivial barriers, such as risk aversion (Kahneman & Tversky, 2013), status quo bias (Samuelson & Zeckhauser, 1988), groupthink (Janis, 2008), bounded rationality (Simon, 1955) or misinformation (Lewandowsky et al., 2012), need to be overcome. Treatment of these barriers may call for debiasing exercises (Cook et al., 2018).

4. CHARACTERISTICS OF TRANSFORMATIONAL ADAPTATION

In order to describe the extent to which an adaptation action or a change programme is 'transformational', the following criteria (characteristics) are proposed. Building on literature, including the IPCC's AR6 characteristics, we suggest the following categorisation of characteristics under five umbrella terms: depth, scope, impacts, temporality, and inclusivity. Each of the characteristics can be broken down in sub-characteristics as shown in Figure 2.

Depth

A transformational climate action is expected to be more in-depth compared to an incremental action. The depth of an adaptation or change programme is described by the three conditions proposed by Fedele et al (2019): path-shifting, restructuring, innovative, and addressing root causes of vulnerability. A change is **path-shifting** if the system's current trajectory is altered towards a new direction. This may involve an economic reorientation. For example, the Métabief ski resort (France) is turning towards alternative tourist activities as a result of reduced snowfall due to climate change (*see Box 1*). An adaptation is **restructuring** when existing structures, processes, or relationships (the way things are done) are fundamentally altered, e.g. a shift from resource-intensive to regenerative agriculture. As mentioned earlier, a change is considered **innovative** if the system changes to a state which previously did not exist in that area, without necessarily requiring entirely new means or actions. Innovation can be achieve in various aspects ranging from new technology, a changed mindset or organisational approach. An additional characteristic here is the **addressing of root causes**. The Eco-city Augustenborg project near Malmö (Sweden), for example, addressed the root cause of flood vulnerability in the area: insufficient water drainage. This was solved by building a sustainable drainage system, separating stormwater from the sewer system, building canals, and installing green roofs on all new buildings (and retrofitting some older buildings) (Climate-Adapt, 2017). The Room for the River (the Netherlands) project scores well on all characteristics of an 'in-depth' change. Room for the River initiatives mark a shift from relying on engineered dykes and levees to prevent flooding, to adopting natural water management approaches, allowing rivers to overflow and shape their courses naturally, much like they did in pre-modern times (Rijke et al, 2012).

Box 1: Beyond Snow – Transformational adaptation of the Métabief ski resort (FR)

The Métabief ski resort, nestled in the Jura mountains of France (Doubs) at an altitude between 890 and 1,420 metres, is increasingly facing reduced snowfall due to climate change. Local studies have indicated that the viability of alpine skiing could end as early as 2030-2035. Beyond this period, snowfall will become too sparse, and the cost of artificial snow production will make skiing an unsustainable economic activity in the area.

In September 2024, the Doubs Department Council unanimously acknowledged the urgent need to accelerate the transition of the Métabief ski resort starting in 2025, particularly by closing one-third of its skiable area. Local stakeholders have endorsed a reimagining of the resort's economic model, emphasising the importance of moving away from a "snow-only" economy and accelerating its transformation into a four-season mountain tourism destination.

Rather than continuing to invest heavily in alpine skiing and risking stranded assets, the resort is opting for a more pragmatic approach by maintaining existing ski lifts without renewing them—a choice deemed economically unviable in the long run.

Métabief is now turning to alternative tourist activities such as mountain biking, trail running, and Nordic walking to offset the decline in snow. At the same time, it is highlighting its natural and cultural heritage, seeking to diversify its tourist offerings and make the destination appealing year-round, regardless of snow conditions. This strategy helps reduce the severe effects of climate change on the local economy by creating a tourism model that is less dependent on alpine skiing and more resilient to new snow conditions.

Moreover, the resort's local management initiated forward-looking studies to guide future public investments and attract private stakeholders, thereby encouraging sustainable transformation. This approach, which includes concrete and educational actions, serves as a model for other French and European resorts facing similar climate change risks.[5]

Scope

The scope refers to the extent and/or range of influence of the adaptation programme. Transformational adaptation typically is cross-sectoral (e.g. connecting nature to water or agriculture), engages multiple organisational levels (e.g. municipal and national authority) and goes beyond the pilot scale. Small-scale, non-replicated, actions would be considered incremental adaptation. Yet, transformational changes could also be implemented within a particular sector (e.g. if the whole value chain is considered). A value chain approach can be considered transformational because of it multi-scale and scalability characteristics.

Scope is defined by the sub-characteristics system-wide, multi-scale and scalability. Adaptation actions are **system-wide** when they affect an entire system (Fedele et al., 2019; Kates et al., 2012; Scolobig et al., 2023). Considering the complexity of societal and economic systems, it is

[5] For more information, see: "C'est le début de la fin du ski" : Métabief ferme Piquemiette, le département du Doubs acte une décision inévitable

not straightforward to set boundaries on the system. For practical application purposes, a system for transformational adaptation can e.g. be a geographical area (a river basin or city for example), an ecosystem or a community. The characteristic **multi-scale** requires the change to have an impact across multiple scales or multiple beneficiaries. For example, conversion of farmland to forests often increases biodiversity, enhances erosion control and benefits the surrounding inhabitants through improved water quality (Fedele et al., 2019). Such a conversion requires systemic changes across governance levels regarding, for example, agricultural policies. In order to assess the transformational potential of a change, **scalability** is an important characteristic. Scalability refers to the potential to replicate the adaptation, either to a larger geographical area, or replication elsewhere.

Impacts

The societal impacts of transformational change is expected to be larger than that of incremental adaptation. Societal impacts of adaptation change are defined by the governance approach, co-production and change in mindsets or beliefs. A change in **governance,** for example, could be a substitution of top-down decision-making with the involvement and interaction between various stakeholders with different views (Scolobig et al., 2023; Garrick, 2015). **Co-production** refers to the collaboration between actors, ideally following a whole-of-society approach. An example where broad societal and economic impacts are achieved is the reconversion of the former coal mining area in Germany (see *Box 2*). The reconversion, driven by other factors than climate change (economic reconversion) led to better resilience. Transformational programmes do need to be driven by large government-led reconversions. An example from the city of Leuven (Belgium) shows the potential of bottom-up initiatives. Through the non-profit organisation "Leuven 2030", more than 600 partners (governments, knowledge institutions, companies, organisations, citizens) collaborate on a climate transition strategy and its implementation in the city of Leuven (Belgium) (Korneeva & Dienhart, 2024). A change in institutions or the adoption of alternative policy instruments often requires significant time and resources (Garrick, 2015). Transformational adaptation also requires a change in mindsets or **beliefs**, among the public and policymakers towards accepting risks and undergoing disruptions of the status quo (Watkiss and Cimato, 2020).

Temporality

Temporality implies that an adaptation programme leads to **persistent change** (with long-term impacts, no intention to return to the prior state) and **acknowledges future uncertainties** in both climate impacts and the potential implications of the change. The change should generate **benefits over time**, rather than only targeting current needs (Fedele et al., 2019). Furthermore, transformational adaptation may also be a **dynamic process**, implying flexibility to adapt to evolving climate risks (Termeer et al., 2017) and to learn from past experiences.

Inclusivity

A transformational change programme should benefit all groups of the population, and thus follow the "leave no one behind" principle (**equitable**) (Scolobig et al., 2023) and preferably address other Sustainable Development Goals in addition to climate action (**SDG-aligned**). The case of "creative destruction" and stranded assets (i.e. the replacement of old, polluting, infrastructure with new infrastructure), for example, is only truly equitable when the livelihoods of people

depending on the old infrastructure are considered and addressed as part of the programme. Transformational change is also considered to be **synergetic**, i.e. delivering other benefits than adaptation. A typical synergy on climate action contributes to both climate adaptation and mitigation. Adaptation can contribute to climate mitigation in various ways, e.g. through energy savings projects, technologies that make use of renewable energy sources, and through the restoration of blue and green carbon ecosystems. For example, in the Vipava Valley (Slovenia), an irrigation decision support system was developed to help farmers optimise water usage during dry periods, based on real-time soil-water monitoring (Climate-ADAPT, 2023). As a result, energy consumption and CO_2 emissions were also reduced.

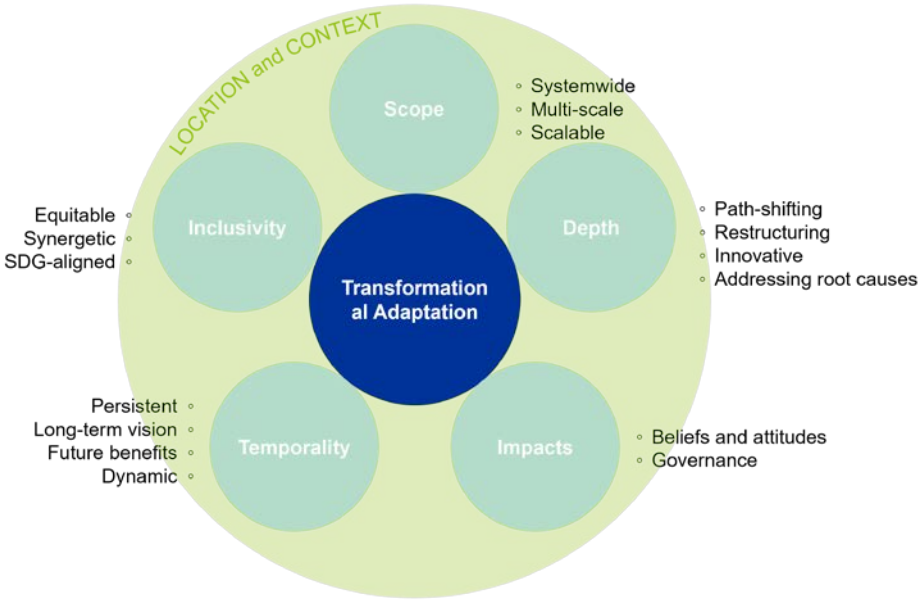

Figure 2: Five categories of characteristics which determine transformational adaptation

Additionally, it is important to stress location and context dependency. What is transformational in one place is not necessarily transformational in another. An important condition for transformational change is thus “the level of departure versus the outcome level of change”. For example, to what extent did the characteristics of the societal and economic system change after the climate action (e.g. governance change, change in mindsets) (Watkiss & Cimato, 2020). Transformational adaptation is therefore a relative concept. Each of the characteristics mentioned above should be assessed in the context of the adaptation programme. None of the abovementioned characteristics are hard criteria. Whether or not a criterion is met is best assessed by the stakeholders themselves, who are most likely to be familiar with the situation prior to and after the adaptation programme has taken place.

Box 2: Transformational change of the former coal-mining Ruhr area (DE)

Transformational change can be necessary not only for adaptation to climate change, but also, for instance, to address regional de-industrialisation processes. In the 1950s, the coal and steel-based economy in the Ruhr area came under threat. This was originally addressed with incremental policies, e.g. based on subsidies and some isolated attempts to introduce new industries to maintain national coal production. Only in the 1980s did more transformational approaches start prevailing. These jointly addressed industrial change, restructuring of the labour market, education, ecology, and regional identity. A series of specific factors enabled this new and more transformational policy course towards structural change: time gained, inter alia, with coal subsidies postponing the closure of mines, sufficient resources, a strong social security system, and a strong position of trade unions (*Montanmitbestimmung*) supporting a conservative governance. The latter produced a socially more acceptable process, attempting to mitigate the social impacts of de-industrialisation.

An important measure of this transformational process was the International Building Exhibition Ruhr (IBA) which aimed at the catalytic function of transformations of landscape and architecture. The exhibition generated more than 100 projects in 17 cities for landscape design, ecology, and the re-use of derelict sites and buildings, creating a new sense of identity and replacing the past image of decline and decay.

5. ADAPTATION DOMAINS

Transformational adaptation can manifest in various forms, driven by different factors and contexts. System transformation, which often involves several interventions, can occur either simultaneously or consecutively, often as a result of cascading effects triggered by changes in specific segments of the system. In what follows, we describe different domain examples of change.

Economic or sectoral transformation

Economic reconversions across Europe have resulted in transformational change. A number of existing long-term successes of economic reconversions, however, were not driven by climate change, but nevertheless resulted in improved climate resilience. For example, Bilbao's economic transformation has revitalised its urban landscape, shifting from an industrial base to a service-oriented economy. The regeneration of the Zorrotzaurre area of Bilbao exemplifies this change, turning a former industrial site into a sustainable residential neighbourhood with social, cultural, and commercial spaces. While not directly driven by climate change, the project incorporates adaptation strategies to enhance resilience against increased flood risks, showcasing a holistic approach to urban planning that benefits both the economy and the environment (Climate-ADAPT[6]). The reconversion of the German Ruhr area was also driven by economic necessity (see *Box 2*).

[6] https://climate-adapt.eea.europa.eu/en/metadata/case-studies/public-private-partnership-for-a-new-flood-proof-district-in-bilbao

An example of sectoral transformation induced by climate change is the increasing wine production in northern European regions which were previously unsuitable for viticulture. Similarly, the extreme heat and droughts in the Mediterranean shifted the peak season from July and August to spring and autumn, whereas more Norther destinations receive more tourists in summer. The reconversion of the Métabief ski resort (France) in *Box 1* also describes an example of sectoral transformation due to changing snowfall.

Technological transformation

Technology can be a game changer in becoming climate resilient. Examples from the TransformAr project include the smart gate and associated sensors installed on the Marceddi lagoon in Sardinia, Italy to regulate flows, in order to reduce both inland and coastal flood risk while also managing water quality and ecosystem health of the lagoon[7]. Internet of Things (IoT) sensors and intertidal modelling on mussel rafts, from TransformAr, in the coastal zone of Galicia, Spain give real-time conditions on mussel health and generate warnings on upcoming environment-related damages. Within the CARDIMED project, nature-based solutions in combination with bio-infiltration units for water treatment in Greece ensure the quality of infiltrated water. A similar urban bio-infiltration from TransformAr is in operation in the city of Lappeenranta, Finland to capture polluted rainfall runoff from entering Lake Saimaa. Real-time water quality sensors capture the pollution from stormwater runoff.

Community-wide social transformation

Bottom-up social innovations change how communities and societies organise themselves. In Brussels (Belgium) for example, district contracts have existed for 30 years[8]. Through district contracts, citizen-led initiatives have been realised with financial support from the Brussels city and regional authorities. Citizen organisations agree on 4-year district contracts with the main aim to improve liveability and urban development for vulnerable communities. While the district contracts do not have climate adaptation as a main focus, climate action has been realised, e.g. in the development of urban parks and social infrastructures (Romańczyk, 2015). In Germany, volunteers offered aid during the 2021 flood in Germany, thereby co-organising emergency support (Bier et al., 2023). The relocation of residents in Papua New Guinea is an example from Small Island Developing States (SIDS), threatened by disappearance as a consequence of sea level rise. The citizens from the Carteret Islands migrated with the support of aid projects that helped them adapt to new livelihoods in the city of Bougainville. This case demonstrates how a community, guided by collective action and external support, can undergo significant behavioural and social transformations to adapt to a changing environment

Institutional transformation focuses on reshaping institutions and governance frameworks to better address climate change impacts and adaptation needs (Termeer et al., 2016). Changes in policies, regulations, and governance structures to support climate-resilient practices are ensured. For example, Dorset, UK has introduced planning regulations that require financial contributions from planning applications, funding measures to reduce fire risks and protect the region's heathland (Attwell, 2024). Another example of institutional transformation is the Thames

[7] https://climate-adapt.eea.europa.eu/en/mission/solutions/mission-stories/coastal-contract-story7
[8] https://www.brussels.be/brochure-district-contracts-celebrate-their-30th-anniversary

Estuary 2100 plan where climate uncertainty is considered in Thames River estuary adaptation planning to avoid adaptation options being implemented too early or too late (Watkiss & Cimato, 2020).

Behavioural transformation involves shifts in social norms, values, and practices to adapt to new environmental conditions or opportunities. These transformations can be nonlinear and abrupt, depending on the incentives in place, governance structures, and mental processes driving behaviour. Regret, loss aversion, and availability bias can influence how individuals respond to extreme events. For instance, transformations can lead to beneficial societal outcomes like nature-based water retention measures, or to maladaptive responses like illegal water abstraction for irrigation in times of drought-related irrigation bans. Changes in individual or community behaviours are also needed in response to climate change. Individuals have increasingly started to adjust their daily routines to minimise exposure to high temperatures. For instance, outdoor workers may shift their schedules to earlier in the morning or later in the evening when temperatures are lower, while citizens seek shade during peak heat hours. Another example is the long-term effect on water consumption of a drought in 2007-2008 in Barcelona, during and after which communities reduced their water use (Bernardo et al., 2015).

Environmental/landscape transformation involves large-scale ecosystem rehabilitation or urban transformation interventions that result in significant land use changes, alterations in ecosystem functioning, and shifts in the landscape. The above-mentioned Room for the River approach is intended to restore natural river dynamics. The transformational potential lies in its ability to not only enhance flood protection but also to restore ecological integrity, increase biodiversity, and create more resilient, adaptive landscapes that can better withstand the impacts of climate change. Another example comes from the IMPETUS project, where a large dune is being restored along the Catalan coast (Spain) to deal with sea-level rise and coastal erosion (IMPETUS). This involved a naturalisation of previously urban beaches used for tourism purposes. The project is transformational in that it requires an entirely new way of thinking about coastal management and relies on a change in the public's behaviour.

6. PUTTING TRANSFORMATIONAL ADAPTATION INTO PRACTICE: TOOLS & RECOMMENDATIONS

The EU's Adaptation Mission on Adaptation increases focus on transformational adaptation and urges the EU's regions and communities to advance on transformational adaptation. Yet, both in research and practice, the term 'transformational adaptation' remains conceptually unclear (Kuhl et al., 2021). This policy brief has elaborated on the concept, objectives, and characteristics of transformational adaptation, while also providing real-life examples. This policy brief presents a shared vision of key experts in ongoing EU Horizon projects that support the EU's Mission on Adaptation. In this final section, we conclude with a snapshot of tools and recommendations on how to assess and implement transformational adaptation which could be further elaborated in a forthcoming guidance document. The recommendations are provided primarily to the European administrators and the regional and local authorities, including mission charter signatories, that are engaged in the implementation of the EU Adaptation Mission.

Towards a more transformational Regional Adaptation Support Tool (RAST)

The Regional Adaptation Support Tool (RAST) is promoted by Climate-ADAPT as the tool designed to help local and regional authorities with climate change adaptation strategies and plans. RAST consists of 6 steps: 1) preparing the ground for adaptation, 2) assessing climate risks and vulnerabilities, 3) identifying adaptation options, 4) assessing and selecting adaptation options, 5) implementation adaptation policies and actions and 6) monitoring, evaluation and learning (MEL). For cities, a similar Urban Adaptation Support Tool (UAST) exists. RAST, and also UAST, provides a further breakdown in sub-steps, and provides examples of the application of a specific step. Both tools are a good starting point to develop adaptation planning. An adaptation plan, however, does not automatically result in a transformational approach, e.g. when the plan is composed of unconnected incremental adaptation actions or does not aim to leave the status quo. While the RAST and UAST highlights challenges that need to be overcome for effective climate adaptation policies and actions, the importance of a transformational approach is insufficiently stressed. The latter include the challenges related to the assessment of adaptation actions, including the associated selection of evaluation criteria and decision-making process, the importance of multi-level coordination and stakeholder engagement, the integration of adaptation policies and action plans into other plans (e.g. on water, agriculture, infrastructure) and the securing of funding or financing of the plan. A database of tools developed in ongoing Horizon projects, in support of the EU Mission on Adaptation is available on the Mission Portal. Tools relevant for transformational adaptation are highlighted below.

Practical guidance and lessons learned on adaptation pathways

Adaptation pathways can be described as a series of actions that can gradually be carried out based on future developments and risks. An adaptation pathway is referred to in RAST (step 4.2) as a tool make low-risk investments today while keeping future flexibility in mind amid climate uncertainty. A key point with adaptation pathways is that they seek to tackle a significant challenge for decision makers regarding climate change: uncertainty. The goal is to evaluate various solutions, assess their feasibility (including under uncertainty), and identify critical decision points or tipping points that determine which path to take. Adaptation pathways can therefore include different strategies to reach a specific goal or desired outcome. The development of adaptation pathways can help to devise a transformational approach and thus be used to upgrade adaptation plans. Several projects developed and applied a approach to develop adaptation pathways. The TransformAr Playbook is one tool to develop and envision transformational adaptation pathways for a wide variety of stakeholders and community systems. The Regional Resilience Journey is proposed by the Pathways2Resilience (P2R) project as step-by-step guidance for regions to produce their first climate resilience plans and intervention portfolios or to improve the existing ones by applying a systemic approach, just transition principles and by harnessing transformative innovation. In addition, the TRANSCEND modelling suite aims at expanding widely used stakeholder models to account for uncertainties across interconnected systems, understand key vulnerabilities, and inform the adoption of resilient solutions. In order to support regions in choosing their way forward, a lessons learned paper is being developed, as a joint effort between projects, in which the various approaches to develop adaptation pathways are analysed and compared.

Standardised self-assessment : transformational adaptation & maladaptation

The assessment of adaptation options is a crucial aspect of adaptation planning (see steps 3 and 4 of RAST). Yet, in absence of jointly selected criteria on how to assess (or score) incremental or transformational adaptation, the assessment steps is typically challenging. In order to get more clarity on the transformational potential of adaptation actions or programmes, the TransformAr project is working on a transformational adaptation scorecard (expected 2025). The scorecard will be a simple self-assessment checklist. The transformational adaptation scorecard will be based on the characteristics of transformational adaptation, shown in Fig. 2 and elaborated in section 4.

Also the REGILIENCE tool for maladaptation, aims for self-assessment by regional and local authorities. The maladaptation tool guides users through a checklist of 17 questions, focusing on the risk factors for maladaptation. Considering the complexity of ttransformational adaptation, an assessment of potential maladaptation, from the start, is important to avoid adverse consequences. With increasing financial resources dedicated to climate adaptation, so too does the risk of maladaptation.

Towards more transformational climate proofing

Transformational adaptation is imposed by the impacts of climate change, but the required action should not be driven by climate change objectives alone. Planned infrastructure e.g. needs to consider the future impacts of climate change, and are to be designed in line with the Paris Agreement. The climate proofing of infrastructure is a legal requirement to become eligible for EU funding for infrastructure. The climate proofing process integrates the two climate pillars (mitigation and adaptation) into the development of infrastructure projects. The method to follow for climate proofing is elaborated in the EC Technical Guidance document on Climate Proofing of Infrastructure. Principles followed are ‘energy efficiency first’ for climate mitigation and ‘do not significant harm’ for climate adaptation. The basis for identifying, appraising and implementing climate change adaptation measures are a climate vulnerability and risk assessment. An example of climate proofing is the assessment of the future flood risk of new urban project development and consequent identification of compensation measures such as sustainable urban drainage and/or nature-based solution. Adding a climate proofing component to urban development, accelerates progress on climate resilience, with minor additional resources. It must be noted that climate proofing targets only one aspect of transformational adaptation, namely how to design new infrastructure. In a more holistic approach, the integration of nature-based solutions and social innovations must be considered, while also updating organisational processes towards climate resilience. In the updating of the EC Guidance document by 2027, the transformational component of adaptation is to be better developed.

A role for transformational adaptation in the European Water Resilience Strategy

The European Water Resilience Strategy is a priority in the Political Guidelines of the 2024-2029 European Commission. The Strategy is to ensure that water sources are properly managed, scarcity is addressed, and that the competitive innovative edge of the European water industry is enhanced while taking a circular economy approach. The European Commission will lead efforts to help mitigate and prevent acute water stress in Europe and across the world. In a effort to work on climate resilience and preparedness, a European Climate Adaptation Plan will be developed.

We recommend to explicitly include a transformational approach to ensuring water security in the upcoming European Water Resilience Strategy.

Promote transformational adaptation into practice

The overall importance to address the climate crisis with a transformation of our social and economic system is to be promoted. This policy brief is providing first argumentation. In essence, transformational adaptation is urgent because of the scale of the challenge: the impacts of climate change are becoming increasingly significant and require radical responses. Incremental measures remain essential in the short term, but are no longer sufficient to meet emerging or future risks. Transformational adaptation offers the opportunity to build a more sustainable, desirable, and equitable future. Furthermore, more concrete examples, and concrete guidance is needed to bring to bring transformational adaptation into practice. Examples and methods can be further developed and tested by e.g. Horizon Europe projects with direct cooperation with adaptation mission signatories. Promoting transformational adaptation can be partly by the ongoing projects that wrote this policy brief. However, more concrete considerations on transformational adaptation could be add to forthcoming horizon calls.

7. KEY GUIDANCE DOCUMENTS

Transformational adaptation is an emerging concept in climate science and policy. Here is an overview of key guidance documents that define and offer strategies for implementing transformational adaptation, for further reading.

- The **IPCC Sixth Assessment Report (2021)** builds on earlier assessments, offering updated insights into climate science and the urgent need for transformational adaptation. It discusses current and future climate impacts and provides recommendations for incorporating these profound changes into national and international strategies.
- The **UNFCCC Adaptation Committee** provides various guidance documents for incorporating transformational adaptation into national and local adaptation plans. This guidance assists countries in developing comprehensive strategies that address climate risks and vulnerabilities through systemic changes.
- The **Global Centre on Adaptation's "Adapt Now" report (2019)** offers a framework for advancing adaptation strategies, including transformational approaches, across different sectors and regions. It calls on leaders to prioritize and implement strategies that promote resilience and address systemic changes needed for effective climate adaptation.
- **OECD work on Climate adaptation and resilience** supports governments as they face the challenging task of taking action today to reduce vulnerability and exposure to future climate impacts whose exact occurrence and intensity are uncertain.
- The **Centre for International Forestry Research (CIFOR)** offers guidelines on implementing transformational changes in forest and landscape management. These guidelines focus on achieving systemic change to address environmental and climate challenges in forested and rural landscapes.
- The **Paris Agreement** emphasizes the importance of transformational adaptation as part of its broader climate goals. The adaptation communication guidelines encourage countries to develop and communicate strategies that include transformational approaches to achieve long-term climate resilience.

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