

Resilient Regions: Clyde Rebuilt

What Does Transformational Adaptation Look Like?

Literature review synthesis paper

DEL10: Possible transformative adaptation solutions for portfolio



ClimateReadyClyde

Resilient Regions: Clyde Rebuilt



Deep Demonstration

Resilient Regions
GLASGOW CITY REGION
Clyde Rebuilt



ClimateReadyClyde

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Summary

Resilient Regions: Clyde Rebuilt is a project seeking to catalyse a transformational approach to addressing the impacts of climate change in the Glasgow City Region. It is led by Climate Ready Clyde (CRC), a regional climate initiative, with support from Sniffer, Creative Carbon Scotland, Paul Watkiss Associates and EIT Climate-KIC. The project is funded by Climate Ready Clyde's fifteen members and the European Union's climate innovation hub, EIT Climate-KIC. The project is developing Glasgow City Region's Adaptation Strategy and a transformational adaptation portfolio blueprint.

An early task in the project has been to undertake a literature review to prepare the background for the study and to help define transformational adaptation. The review has explored the theoretical literature but has also tried to focus on practical aspects that can be taken forward in local implementation. This report presents a synthesis of this literature review.

Definitions

The definition of transformational adaptation from the IPCC is '*adaptation that changes the fundamental attributes of a system in response to climate and its effects*'. However, moving beyond this rather generic description, it is clear that there is no commonly agreed definition in practice, i.e. it means different things to different people and communities of practice. This finding is not new, but it is critical when setting out to design transformational change. In some studies, the definition is modest, i.e. it just involves doing something different. At the other end of the range, some literature defines it as a fundamental shift or transition to a new system or state, i.e. doing different things.

Much of the theoretical literature emphasizes that transformational adaptation involves a system

level (systemic) approach and there is often a focus on changes in governance as well as underlying causes of risk or vulnerability. In practice the discussion of transformational adaptation may relate to individual options, such as physical options, new approaches to governance and social change, as well as shifts (involving multiple and integrated actions) including in systems. Finally, definitions of transformational adaptation vary in terms of their domain. Some studies focus on climate change (adaptation) only, some include mitigation and adaptation, and some extend to wider sustainable development. What is clear from the literature is that cities/city regions will be key players in developing and implementing transformation.

Framing an approach for transformational adaptation

The literature review has found that much of the literature on transformational adaptation is very theoretical. This makes it surprisingly difficult to set out what it really looks like in practice, and therefore how cities and regions should set about approaching (and delivering) this. The review has considered different framings in the literature, to help develop practical approaches for Clyde Rebuilt. We have reviewed six areas:

1. Using criteria to set the attributes for transformational adaptation
2. Using a framing or conceptual approach for transformational adaptation
3. Drawing on existing good practice case studies on transformational adaptation
4. Producing a process for transformational adaptation
5. Setting a vision or goal for transformational adaptation
6. Considering solutions and enabling factors for transformational adaptation.

These different approaches or elements can be used to different degrees for the development of the Glasgow City Region Adaptation Strategy versus the innovation portfolio.

1) Using criteria to define transformational adaptation

There is a growing literature that defines criteria associated with transformational adaptation. These are very useful, as they allow consideration of the attributes (and success factors) associated with transformation. These could be used by the project and stakeholders to determine what [good] transformational adaptation might look like, and to use these criteria to appraise adaptation solutions. The criteria identified do vary significantly between various academic papers.

The literature review has mapped and grouped the criteria presented in the literature. These broadly fall into four areas, associated with the size/scale of the change, the characteristics of the change, the temporality of the change and the domain (and distribution) of the change. There are some common themes that are recommended for consideration in Clyde Rebuilt going forward, notably around operating at the level of the system, as well as extending to institutional and governance aspects. These can be used as criteria to assess regional adaptation options, but also as design and appraisal criteria for the innovation portfolio.

2) Key concepts or approaches for framing transformational adaptation

While interpretations vary, a number of key themes or framing concepts are commonly cited in the literature for transformational adaptation. One is centred around the identification of barriers (or limits) to adaptation, which may require a more fundamental (transformational) approach to solving them. Another is based on moving to a system level (systemic) analysis, rather than looking only at single issues or sectors. A further framing highlights an emphasis on social transformation and governance (the political economy of

how decisions are made) and there is another emerging focus on cultural and creative practices. These approaches are often presented as being mutually exclusive. However, we believe there is value in combining these spheres in Clyde Rebuilt, for the development of both the Adaptation Strategy and the innovation portfolio. The review has considered each of these areas:

- A review of the barriers and constraints to adaptation has been undertaken. This includes the (i) economic and financial; (ii) policy institutional and governance; and (iii) social, behavioural and cultural barriers to adaptation. The analysis of these can help the project, as well as CRC and the Glasgow City Region, to identify important blockages, as well as to identify where there could be limits to incremental adaptation which necessitate more transformational solutions.
- Iterative adaptation pathway approaches are often used in assessing and overcoming barriers to adaptation and can encourage transformational adaptation thinking. These have particular relevance for some climate hazards and contexts in the region, notably for the Clyde Corridor.
- The use of systems thinking is often adopted for transformational adaptation, to make sure a greater sense of scale is captured in the analysis, and to move beyond current silo thinking. This can include techniques such as social network mapping to identify organizations and governance systems as well as linkages and power dynamics. These approaches are key for a more transformational approach and are recommended for Clyde Rebuilt.
- The consideration of transformational adaptation as a social process and the acknowledgment that the political economy and power dynamics are important, can help to deliver new thinking.
- There is a growing body of research and real-world examples which explore and demonstrate the role of creative and cultural

practices in bringing about societal transformations. These can include narratives and imagination including for creative visions, as well as cultural-based methods (art, theatre). These can enhance awareness and ownership, break down traditional barriers and draw in a wider (and different) groups of people and communities. These approaches are a key part of the Clyde Rebuilt project.

3) Case studies of urban transformational adaptation

There are a number of case studies of urban transformational adaptation cited in the literature, though the number of practical examples is small. These case studies have been collated and reviewed. A number of immediate insights emerge from this review. First, the examples vary in terms of their ambition, though in truth most do not seem particularly transformational when compared to the aspirational examples provided in the theoretical literature. Second, there is a very strong bias among the case studies towards social justice and nature-based solutions (and often the combination of the two). A key finding is that there is a gap on good best practice case studies; there is an opportunity for Clyde Rebuilt to help contribute new demonstrations and examples in this area.

4) The process for transformational adaptation

Another way to develop transformational adaptation is to create a process, then to let this drive transformational outcomes. This process should be developed and agreed (with stakeholders), and then applied to explore transformational adaptation. In practice, such a process will need to define a specific method and is likely to require definitions of objectives. A critical issue identified is whether a different process is needed to deliver transformational as opposed to incremental adaptation, and thus the review has reviewed the literature on processes. The starting point is the existing 'adaptation policy cycle', which is promoted

within the EEA Climate-ADAPT platform (adaptation support tool), including for urban adaptation. A review of this framework and the supporting material concludes that these are currently focused on incremental adaptation. At the same time there are various processes and frameworks proposed in the literature for transformational adaptation. They tend to be grounded in particular perspectives (which tend to be related to the author's preferences for change). They also tend to be quite theoretical, i.e. they rarely present a clear set of concrete activities. At the same time, EIT Climate-KIC has developed a Deep Demonstration method for transformation, which has been successfully applied for mitigation. This approach is being piloted for adaptation in the Clyde Rebuilt project (along with other regions). This method captures many of the framing issues discussed above (e.g. using system thinking) and it uses an iterative approach, working through four stages: intent, frame, portfolio and intelligence. For Clyde Rebuilt, the aim is to develop an Adaptation Strategy alongside a transformational adaptation portfolio. We therefore consider some form of hybrid process would be useful. This could consider the sequence of incremental steps from the EEA adaptation cycle but expand promising areas for more transformational adaptation using the Deep Demonstrations method.

5) Vision and objectives for transformational adaptation

The next area of investigation has been to consider vision-based approaches for transformational adaptation. In such cases, the vision can be set first and then used to help determine what transformational changes are needed to bring about this goal. This approach is being used in the mitigation domain, notably for net-zero targets where there are clearly defined and quantitative goals that help frame the ambition. Similarly, there is a current focus on the use of mission-orientated approaches, which set an ambitious goal and use this to create a long-term policy landscape and identify tasks to mobilize actors for bottom-up experimentation across different sectors.

This approach is recommended in the recent European Commission RTD Mission Board for Adaptation, which includes societal transformation and draws on the EIT Climate-KIC Deep Demonstrations method. While such vision-based approaches can be used for transformational adaptation, long-term goals are more difficult to identify (for adaptation), because there are no simple common metrics. Nonetheless, this mission orientated approach is considered extremely promising for the project, as this can align to the existing vision and Theory of Change that has been developed by CRC and Clyde Rebuilt.

6) Adaptation solutions

Finally, the review has considered the literature on adaptation solutions. It has considered each of the possible barriers and looked at emerging theory and evidence on how to address these, in each of the three domains (economic and financial, policy and governance, and social, behavioural and cultural). This has identified a number of key solution opportunities for the project.

Approach proposed for the Clyde Rebuilt project

Following discussion in Clyde Rebuilt, the team is proposing to take transformational adaptation forward in the following ways:

- Given the plurality of views, we do not believe it is possible to produce a single overarching definition of transformational adaptation (or at least one that everyone will agree with). However, Clyde Rebuilt has set some conditions and characteristics that we believe are important in more transformative change. This includes the use of systems thinking, the level of change and the sustainability of the intervention, as well as having positive spill-over benefits.
- In designing a transformational Adaptation Strategy and a climate resilient innovation portfolio, Clyde Rebuilt and its stakeholders will need to define the boundaries. There is a need to make a discrete choice of whether to consider i) climate change (adaptation) only; ii) mitigation and adaptation together, which is important given the UK Government's, Scottish Government's and Glasgow's net-zero targets; or iii) all aspects of social justice and sustainable development (albeit for particular focus areas). A bolder ambition and wider boundary are likely to involve more challenges but have the potential for greater impact if achieved successfully. We highlight that as a minimum, Clyde Rebuilt should look at the transition towards net-zero alongside transformational adaptation (i.e. to be climate ready), due to the current policy landscape and the potential synergies as well as trade-offs between the two.
- We think it is unwise to attach too many aspirations to transformational adaptation, especially in terms of fixing underlying societal challenges or asking for very extensive changes in governance systems/arrangements. However, we recognize that to deliver more transformational change, there may need to be changes in governance or current thinking within the area of consideration, and potentially beyond.
- We recognize that transformational adaptation in practice is likely to be messy. It will involve a whole range of actions and will sit within a space that spans from incremental to transitional change, as well as from the risk/sector level up to an overall system. This will mean actions are unlikely to be binary, i.e. incremental or transformational, but rather part of a spectrum. In this regard, transformational adaptation is likely to involve a combination of initiatives, some of which may be incremental on their own and some which are part of a portfolio of activities.

The definitions of transformational adaptation are often value-laden, associated with particular views of current societal problems, or requiring certain elements (e.g. green, social justice, governance). However, these are not necessary preconditions. Related to this, the language and the framing used to describe transformational adaptation can strongly influence the perception of action. For example, much of the literature defines transformational adaptation through the lens of social learning. We accept that these should be activities to explore, as they could promote conditions for change, but we do not believe that all transformational adaptation has to have these attributes, i.e. we will avoid being too prescriptive.

- There are a number of approaches for exploring transformational adaptation. These need not be undertaken in isolation. Clyde Rebuilt will consider elements of the barriers to adaptation, pathways (tipping points) literature, systems thinking and social learning literature, and creative and cultural approaches, in order to develop its approach to transformational adaptation.
- It is often assumed transformational adaptation should have large positive outcomes. This is not a given. Any large-scale change is likely to have benefits for some, but disbenefits for others. Nonetheless, we think a transformational change should have scale. A set of transformational adaptation criteria will be used to assess regional adaptation options, but also as design and appraisal criteria for an innovation portfolio.
- It is possible to develop a process for transformational adaptation, centred around the EIT Climate-KIC Deep Demonstrations method, which includes varying tools and techniques. For the Glasgow City Region this includes a transformative vision, developed through a Theory of Change to guide action, the use of systems approaches and criteria-based approaches which emphasize transformation, as well as the use of cultural practices.



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Introduction

Resilient Regions: Clyde Rebuilt is a project seeking to catalyse a transformational approach to addressing the impacts of climate change in the Glasgow City Region. It is led by Climate Ready Clyde¹ (CRC), a regional climate initiative made up of stakeholders from the City Region, with technical, cultural, economic and governance expertise from Sniffer which supports CRC. It also has cultural expertise and understanding of creative arts in sustainability from charity Creative Carbon Scotland, and specialist climate change and economic expertise from research consultancy Paul Watkiss Associates. The project is funded by CRC's fifteen members and the European Union's climate innovation hub, EIT Climate-KIC.

The project recognizes that current incremental adaptation is not delivering at the scale and pace needed to address climate change. This requires a new urgency and there is a need to consider more fundamental shifts to new approaches and systems.

The project has four key aims, which are to:

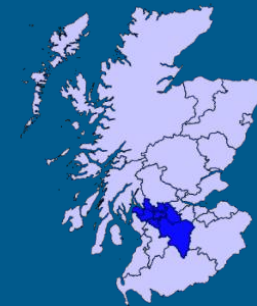
- develop a vision and Theory of Change for adaptation in the City Region
- develop Glasgow City Region's Adaptation Strategy and a transformational adaptation portfolio blueprint
- develop an adaptation solutions portfolio using an iterative approach (with learning)
- develop a portfolio of bankable projects and look to scale up with potential investors.

An early task in the project has been to undertake a literature review, to define transformational adaptation, to identify the key barriers to adaptation

¹ Climate Ready Clyde is a regional climate partnership, made up of stakeholders from the City Region. It includes eight local authorities, the Scottish Environment Protection Agency (SEPA), Transport Scotland, Strathclyde Partnership for Transport (SPT), Glasgow and Strathclyde Universities, Scottish Gas Networks (SGN) and NHS Greater Glasgow and Clyde.

Glasgow City Region and the Clyde

Glasgow City Region is home to one third of Scotland's population and its economy. It is defined by the basin of the great River Clyde and includes the commercial and cultural Glasgow city centre as well as surrounding post-industrial, suburban and rural areas.



Clyde Rebuilt is named after the City Region's remarkable history of periods of transformation built upon innovation and world-renowned quality, including industrial, cultural and commercial waves of invention and re-invention.



and to identify where more system level change may be needed. This report presents a synthesis of the literature review. A key objective of this review has been to move beyond the theoretical nature of the literature, to identify practical aspects of transformational adaptation that can be taken forward in local implementation.

What is transformational adaptation?

Definitions of transformational adaptation

The Intergovernmental Panel on Climate Change (IPCC 2014) defines adaptation as ‘the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.’

This adaptation can occur reactively, in response to experience of the climate, or it can be planned, as a result of a deliberate decision that includes consideration of future climate change. From the perspective of public policy, planned adaptation tends to be synonymous with government action, either as direct action or creating the enabling environment for others to adapt (the latter including households and the private sector). The IPCC has also defined two types of adaptation, as outlined below. The second of these is the focus of the Clyde Rebuilt project.

Incremental adaptation: Adaptation actions where the central aim is to maintain the essence and integrity of a system or process at a given scale.

Transformational adaptation: Adaptation that changes the fundamental attributes of a system in response to climate and its effects.

Some commentators have described incremental adaptation as doing things differently, while transformation involves doing different things. In this paper we use the term transformational but acknowledge that the term transformative is sometimes used in the literature (and also in the mitigation literature). Lonsdale et al. (2015) use

‘transformational adaptation’ as an umbrella term for adaptation pertaining to transformation, and ‘transformative’ to refer to actions leading, or intending to lead, to transformation. In this review we use the term transformational.

However, there are a large number of interpretations of what transformational adaptation could be. Some of the key literature and definitions are included in Box 1 on page 5.

The IPCC included the concept of transformational adaptation in the 2012 SREX report (IPCC 2012), drawing on earlier work such as Pelling (2010). This was expanded in the IPCC 5th assessment report (Field et al. 2014), which set out that transformational adaptation may involve, for example:

- the introduction of new technologies or practices
- the formation of new structures or systems of governance
- shifts in the types or locations of activities.

The IPCC (2014) widened out the conceptual aspects of transformational adaptation. It highlighted that it can be a response to adaptation limits, i.e. transformation can be defined as actions that lie beyond the limits of incremental adaptation. It also furthered the linkages between adaptation, mitigation and sustainable development, such that transformational adaptation should address underlying failures of development.

One of the widely cited reviews of the literature on transformational adaptation is Lonsdale et al. (2015). This reports on the multiple definitions of the term (building on Mustelin and Handmer 2013).

Over time, the definition and interpretation of transformational adaptation has continued to change. Recent examples from the urban and city context include:

- Transformational adaptation takes a system wide (systemic) approach and a long-term perspective to adaptation planning and implementation (EEA 2016). It can result from single initiatives or a series of rapid incremental changes in a particular direction.
- Transformational adaptation occurs when fundamentally new and innovative responses are required—typically upon realizing that historic approaches are insufficient for current or anticipated climate risks (Prairie Climate Centre 2017).
- Urban transformation builds on diverse theoretical origins, but commonly takes a systems perspective and acknowledges the need for change across social, institutional, ecological and physical dimensions (Ziervogel 2019).
- It is non-linear in scale, links adaptation and mitigation, seeks fundamental alterations, and engages with the politics of managing risk (Zografos et al. 2020).
- Transformational adaptation reorients urban climate actions around addressing entrenched equity and climate justice challenges. It focuses on systemic changes to development processes that improve people’s quality of life, enhance the social and economic vibrancy of cities, and ensure sustainable, resilient and inclusive urban futures (Chu et al. 2019).

Rather accurately, Feola (2014) notes that the term ‘transformation’ is frequently used as a metaphor. This leads to a key early conclusion for the Clyde Rebuilt project and our stakeholders.

There is no commonly agreed definition of what is transformational adaptation. It means different things to different people and communities of practice.

This finding is not new. It has been reported in early reviews (O’Brien 2012) and throughout much of the literature reviewed here, and if anything, the divergence is increasing. The theoretical literature (Box 1) has some common themes, with often an emphasis on system level (systemic) change and a focus on governance, as well as addressing underlying causes of risk or vulnerability.

However, we also note a greater use – or perhaps a misuse – of the term to describe ambitious incremental adaptation as well as more transformative change. The term is thus being adopted more generally and losing its original meaning (much as has happened with terms such as vulnerability or resilience).

Taking stock, there is now a very wide range of potential meanings. In some studies, the definition of transformation is modest, i.e. it just involves doing something different. At the other end of the range, it is defined as a fundamental shift or transition to a new system or state. There are also different forms of transformational adaptation, which can relate to individual options, whether physical options or around governance, as well as shifts (involving multiple actions) or system thinking. Finally, definitions of transformational adaptation vary in terms of their domain scope. Some studies focus on climate change (adaptation) only, some include the mitigation and adaptation, and some extend to wider sustainable development.

Box 1. Definitions and discussion of transformational adaptation in the literature

There is a growing literature on transformational adaptation, but this has led to a diverse range of definitions and interpretations. Some examples from widely cited papers are included below.

Kates et al. (2012) outline that differing from incremental adaptations, there are at least three classes of adaptations that are described as transformational:

- those that are adopted at a much larger scale or intensity
- those that are truly new to a particular region or resource system
- those that transform places and shift locations.

These include adaptations that are transformational for some scales but not others, incremental adaptations that are sustained over a long enough time that their cumulative effect is transformational, and institutional changes in adaptive thinking and adaptive capacities that improve the capacity to undertake transformational change, even if current projections of threat do not call for that decision to be made now.

The IPCC Special Report on Extremes (SREX, IPCC 2012) included a definition of transformation in the glossary as, 'altering of fundamental attributes of a system (including value systems; regulatory, legislative, or bureaucratic regimes; financial institutions; and technological or biological systems)'. It set out that actions that range from incremental steps to transformational changes are essential for reducing risk from climate extremes and that transformations, where they are required, are also facilitated through increased emphasis on adaptive management and learning. It also widened out the ambition, reporting that social, economic and environmental sustainability can be enhanced by disaster risk management and adaptation approaches. A prerequisite for sustainability in the context of climate change is addressing the underlying causes of vulnerability, including the structural inequalities that create and sustain poverty and constrain access to resources.

The IPCC (Field et al. 2014) furthered the concept that transformations in economic, social, technological and political decisions and actions can enable more transformative climate-resilient pathways. These include:

- **Practical.** Social and technical innovations, behavioural shifts or institutional changes that produce substantial shifts in outcomes.
- **Political.** Political, social, cultural and ecological decisions and actions consistent with reducing vulnerability and risk and supporting adaptation.
- **Personal.** Individual and collective assumptions, beliefs, values and worldviews influencing climate-change.

However, it also went further than this, outlining that transformation could reflect strengthened, altered or aligned paradigms, goals or values towards promoting adaptation for sustainable development, and that climate-resilient pathways are sustainable development trajectories. This is important because it shifts the boundaries – from climate change impacts – to the entire sustainable development sphere.

Pelling et al. (2015) set out that transformation as an adaptive response to climate change risk opens a range of novel policy options and positions adaptation firmly as a component of development policy and practice. Transformation describes non-linear changes. These may appear as radical shifts, directional turns or step changes in normative and technical aspects of culture, development or risk management.

The EEA (2016) distinguishes incremental from transformational adaptation as follows:

- to build on existing adaptation measures to incrementally improve them and increase their efficiency
- to establish new innovative solutions that aim to develop opportunities to transform (a city) to be resilient and sustainable (transformational adaptation).

It defines transformational adaptation as a way of using behaviour and technology to change the biophysical, social or economic components of a system fundamentally but not necessarily irreversibly. Transformational adaptation takes a systemic approach and long-term perspective to adaptation planning and implementation, avoiding lock-ins by flexibly dealing with future uncertainty. It can result from single initiatives or a series of rapid incremental changes in a particular direction. It includes planned and responsive measures using a different approach from the standard method, which includes innovation or shifting certain activities to new locations.

The Prairie Climate Centre (2017) emphasizes process, regulatory and community linkages. It reports that governance systems that emphasize transparency, integration, flexibility, monitoring, continual learning and knowledge-sharing increase the likelihood that transformational adaptation occurs at the necessary and appropriate time.

Fazey et al. (2017) highlight that transformation is a broad concept that includes social, environmental and technical domains that revolve around three key dimensions: (1) the intensity or quality of the change (depth of change); (2) the distribution of change (breadth of change); and (3) the timeframe through which a change occurs (speed of change). They highlight that social justice is important for enhancing agency and change, and enhances integrative and systemic thinking. Some of the key areas of transformational change might include changes in individuals (e.g. significant changes in their understanding of person-world relationships), institutions (e.g. taking an institution in a fundamentally new direction, with a basic change in character, configuration, structure and outcomes), procedures (e.g. major legal or regulatory reforms that have a significant bearing on society), governance (e.g. fundamentally different ways of governing), economies (e.g. alternatives to those based on assumptions of growth), or processes (e.g. the way something is brought about, such as participatory, inclusive, genuinely led by values that recognize fundamental human-environment relations).

Pal et al. (2019) identify three ways in which transformation can take place:

- from changing and improving public policies and governance
- from innovation (new technologies, new decision-making tools, new capacity-building techniques, new infrastructure solutions, new policy instruments, etc.)
- from interventions to deliver social and behavioural change.

Fedele et al. (2019) argue that transformative adaptation, which fundamentally changes systems and addresses root causes of vulnerability, usually has six characteristics: it is restructuring, innovative, path-shifting, multiscale, systemwide and persistent. Transformative adaptation may be an appropriate response to climate change when the severity of climate change impacts is expected to considerably increase, when current adaptations are reaching limits, or when radical climate-driven changes have already happened. In these cases, transformative adaptation may be planned, assisted or forced, respectively.

Filho et al. (2019) define transformational adaptation as those processes which go beyond conventional adaptation through physical changes (e.g. higher flood barriers), which at times are expensive and difficult to implement, and move towards building resilience. This means, in practice, long-term changes in the way climate impacts are handled. Transformative approaches are characterized by some key features such as:

- they help to enhance resilience
- they help to promote sustainability
- they help to reduce vulnerability
- they take into account the risks in implementation
- they pay due attention to the socio-economic contexts of a given community.

Chu et al. (2019) investigate how to unlock the transformational potential in cities and report that transformative adaptation approaches require action at all levels, from grassroots community groups and private actors to city planning departments, and regional and national agencies. In addition to linking adaptation and mitigation goals, transformative adaptation efforts can put cities on a stronger, safer path by contributing to addressing poverty, inequality and basic infrastructure deficits. They set out that this requires new types of institutions, communities, built environments and production and consumption systems that help ensure the integrity of urban and regional ecosystems. This implies such activities are a pre-requisite for transformational adaptation to occur.

David-Tàbara et al. (2018) define transformative climate science as the open-ended process of producing, structuring and applying solutions-oriented knowledge to fast-link integrated adaptation and mitigation strategies to sustainable development. This is promoted in the context of high-end climate futures. They define 12 dimensions that scientists and practitioners can use as a checklist to design transformative-oriented climate assessments.

This later point warrants further consideration. Much of the academic literature of transformational adaptation extends beyond climate risks to tackling multiple societal goals or extends to address underlying power imbalances and injustices associated with current political decision making [as perceived by authors]. In this context, transformational adaptation is required to be inclusive, equitable and just. There is also a related strong body of literature that sees transformation as requiring much deeper understanding and engagement with complex social processes. In effect, this literature (centred on social learning) defines transformational adaptation as a social process.

This expansion of adaptation from climate change only to tackling ‘other underlying problems’ increases the expectations around transformational adaptation, and it means it has rather a lot to do. It also makes it quite subjective, in that the framing of current problems (that transformational change needs to address) is determined by particular authors of any individual paper and these views will not represent all actors within a given political economy. Fazey et al. (2017) highlight that transformational adaptation is inherently subjective and relative – what is significant change to one person may not be significant to another.

Of more relevance to this project, it is highlighted that the more ambitious the definition is, i.e. as it includes system-wide thinking, integrated and longer-term perspectives, it will become more complex and challenging to deliver. This could run the risk of limiting or hindering ambition, as well as making it harder to measure success. To illustrate, a broader and more ambitious approach will require greater involvement and participation, more evidence to convince actors to change, etc. While many papers highlight the need for ‘radical change’, this involves altering the existing status quo and is likely to require a combination of institutional reforms, cultural shift and support from those invested in the current system (noting that these changes may not be in their interests).

The Clyde Rebuilt project and its stakeholders will need to define the level of ambition and the boundaries for the Adaptation Strategy and the innovation portfolio, and notably to decide whether to focus on climate change or broaden out to wider sustainable development.

The problem of adopting a definition can be addressed by using a broad definition, i.e. considering a spectrum of activities. Again, this is not a new approach (see Lonsdale et al. 2015), and it is the approach that is adopted in Clyde Rebuilt. However, it is important to distinguish this from a narrower focus only on more transformational interventions.

The problem of boundaries requires a discrete choice. This involves whether to (i) consider climate change (adaptation) only; (ii) include mitigation and adaptation together, which is important given the Scottish Government’s and Glasgow’s net-zero targets (see Box 2); or (iii) to extend to cover all aspects of sustainable development and inclusion. A bolder ambition will involve more challenges but has the potential for greater impact. We highlight that as a minimum, it would be sensible to look at the transition towards net-zero alongside transformational adaptation, as there are potential trade-offs between the two, as well as opportunities for synergies (see Box 2), especially as achieving net-zero will involve very major change across society (CCC 2019).

Finally, one message that is clear from the literature is that cities/city regions will be key players in developing and implementing transformation, because they are located at the interface of local action and national and international level climate change adaptation and mitigation commitments (Heidrich et al. 2016). They include suitable entry points and governance levels for delivering adaptation, which is primarily local in nature. This highlights the relevance of Clyde Rebuilt.

Box 2. Net-zero and the synergies and trade-offs between mitigation and adaptation

In 2019, the Scottish Government² committed to a target of net-zero emissions of all greenhouse gases (GHG) by 2045. The Scottish Government has also set out that it will adopt an ambitious new target to reduce emissions by 75 % by 2030 and has an ambitious Climate Change Adaptation Programme. Glasgow City has announced a goal to be the UK's first carbon neutral city by 2030 following a decision of the council's City Administration Committee³. This includes a large number (61) of actions⁴.

There is an existing literature on the potential synergies and trade-offs between mitigation and adaptation (Klein et al. 2007; OECD 2017), which include:

- win-win or synergistic, i.e. mitigation strategies or options that are beneficial for adaptation, or adaptation strategies or options that are beneficial for mitigation
- mitigation strategies or options that make adaptation more difficult (trade-offs)
- adaptation strategies or options that make mitigation more difficult (i.e. that increase GHGs).

Much of the literature is positive about win-wins, for example, as in the IPCC 1.5°C special report (2018). However, more recent reviews (Watkiss and Klein 2018) find that there are as many linkages that are negative or involve trade-offs, as there are positive. It also highlights that positive synergies will not happen on their own due to a number of challenges, i.e. they will require planned action.

² The Scottish Government has amended the Climate Change (Emissions Reduction Targets) (Scotland) Bill such that GHG emissions in Scotland must reach net-zero by 2045 (<https://www.gov.scot/news/scotland-to-become-a-net-zero-society/>).

³ <https://www.glasgow.gov.uk/article/25066/Council-Sets-Target-Of-Carbon-Neutral-Glasgow-by-2030>

⁴ <http://www.glasgow.gov.uk/councillorsandcommittees/submissiondocuments.asp?submissionid=94826>

Framing an approach for transformational adaptation

The literature review has found that much of the literature on transformational adaptation is very theoretical. This makes it *surprisingly difficult to articulate what transformational adaptation really looks like*. To try to address this, the review has considered different elements of the literature to help to identify more concrete concepts or actions.

The starting point is to consider the potential long-term goal of transformational adaptation. In this respect, it is useful to compare to the mitigation domain (Watkiss et al. 2015). For mitigation, the concept of transformational change is more easily understood, especially with the global targets of the Paris Agreement⁵ and the move towards 'net-zero' targets, such as Scotland's national net-zero target and Glasgow's own net-zero target (see page 9). These provide quantitative goals and can be used to consider what transformational change is needed in emitting sectors and the economy as a whole to deliver these goals. These are often framed as a set of technical options and pathways to deliver decarbonization (as in the Committee on Climate Change (CCC) net-zero report 2019). In practice, achieving net-zero targets will be an enormous challenge, and will require huge technical, policy and behavioural change (O'Brien 2016, 2018). Nonetheless, for mitigation, the goals and boundary conditions are clear, as are the metrics to measure progress (tonnes of GHG).

In contrast, for adaptation, such long-term goals are far more challenging. This is because it is not possible to set a common national or regional target for adaptation, because there are no simple

common metrics that can be measured across all risks and sectors (i.e. there is not an equivalent of a tonne of GHG emission or a quantitative quantum of success such as net-zero) (see Watkiss et al. 2015 and the UNEP adaptation gap report 2014, 2018). This makes the measurement of success harder to evaluate for the same reasons.

In theory, it might be possible to set a societal goal for adaptation to a particular risk, determined by preferences, but in practice such goals will vary with tolerance of climate change impacts, resource limitations, competing priorities and decision-making approaches (UNEP 2014). Indeed, setting an adaptation target involves a complex trade-off between the level of adaptation (and its benefits in reducing impacts, relative to its costs) and the acceptable level of residual impact after adaptation. This trade-off already exists today: Glasgow City Region (or anywhere else for that matter) has not reduced current climate risks to zero (i.e. we live with some risk) and this trade-off will continue in the future. The societal goal varies between countries and regions, across sectors and risks, and between different actors, and it involves ethical as well as economic perspectives.

Against this background, the review has investigated the literature in specific areas, to try to help progress the development of approaches and methods for cities and regions to design transformational adaptation. These include:

- using criteria to set the attributes for transformational adaptation
- using a particular framing for transformational adaptation

⁵ In 2015, the Paris Agreement agreed the goal of 'holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C' [Article 2a]. https://unfccc.int/sites/default/files/english_paris_agreement.pdf

- producing a process for transformational adaptation
- existing case studies on transformational adaptation
- setting a vision or goal for transformational adaptation.

Criteria or attributes of transformational adaptation

There are papers in the academic literature that define the attributes or criteria associated with transformational adaptation. In theory, these criteria could be very useful, as they allow consideration of the attributes (and success factors) of transformational adaptation. These could therefore be used by the project and stakeholders – to determine what [good] transformational adaptation looks like.

This review has analysed the attributes or criteria for transformational adaptation set out in the literature (Mustelin and Handmer 2013; David-Tàbara et al. 2018; Fazey et al. 2018; Fedele et al. 2019; Pal et al. 2019; Zografos et al. 2020), see Box 3.

Perhaps not surprisingly, the literature does not agree on the exact criteria, or indeed on most criteria, although there are some common and consistent elements that emerge. A mapping of these criteria is shown in Figure 1. These broadly fall into four areas, associated with the size/scale of the change, the characteristics of the change, the temporality of the change and the domain (and distribution) of the change. There are some common elements of operating at the level of the system and extending to institutional and governance aspects.

This set of criteria could be used by Clyde Rebuilt going forward, both as criteria to assess regional adaptation options, but also as design and appraisal criteria for an innovation portfolio. By discussing and agreeing criteria that are important

for CRC and the Glasgow City Region, it will be possible to set out what transformational adaptation means to our stakeholders and help shape the ambition for the portfolio process.

It is worth noting that transformational adaptation – seen in Box 3 – is portrayed almost universally in the literature as a good thing. There is very little discussion of the fact that transformative change might make things worse and could lead to maladaptation (and this is presumably a greater risk when operating at the system level and trying to deliver more radical change).

Size and scale of the change

<u>Systemic</u> comprehensive action that addresses change beyond component challenges	<u>System-wide</u> triggering systemic changes at large scale (at the level of the system)	<u>At scale</u> with an impact that extends beyond the project level	<u>Non-linear</u> at enlarged scale or intensity that reorders systems, transforms places, shifts locations
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Characteristics of the change

<u>Path-shifting</u> shifting current trajectory towards a different direction	<u>Catalytic</u> inducing and accelerating change	<u>Cascading</u> triggering indirect change and cascading effects	<u>Relational</u> with shifts in relationships between actors and institutions
<u>Re-structuring</u> altering fundamental features	<u>Cognitive</u> with significant shifts in societal beliefs, norms, values, and understandings	<u>Addressing power</u> addressing power imbalance and the causes of social injustice	
<u>Innovative</u> introducing new functions or states	<u>Structural</u> with shifts in institutional arrangements and governance processes	<u>Functional</u> with changes in the behaviour and function of the system	

Temporality of the change

<u>Persistent</u> leading to long-term change	<u>Future orientated</u> long-term change and uncertainty in the future acknowledged and built into decision-making	<u>Sustainability</u> with gains maintained over time (after intervention)
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Domain (and distribution) of the change

<u>Inclusive</u> ensuring vulnerable, poor and marginalised are included in decision-making process	<u>Synergistic</u> Linking adaptation and mitigation (win-wins)	<u>Sustainable</u> addressing the components of the SDGs, and environment, social and economic issues
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Figure 1. Mapping of the attributes (criteria) for transformational adaptation.

Box 3. Key criteria of transformational adaptation

There are a number of papers in the literature that define the attributes or criteria associated with transformational adaptation.

Mustelin and Handmer (2013) provide a table that compares many definitions of transformation from the literature and using this sets out possible criteria. Lonsdale et al. (2015) built on this paper and set out the criteria for transformational adaptation as:

- **Framing.** This frames as ‘complex’, ‘wicked’ or ‘super wicked’.
- **Learning.** Triple loop learning, sometimes known as ‘learning how to learn’.
- **Scale.** System wide change or across many systems.
- **Temporal.** Focus on future, long-term change and uncertainty in the future is acknowledged and built into decision-making.
- **Power.** Addresses power imbalance and the causes of social injustice to induce a step change/radical shift to the operation of the existing system. Outcome open ended or uncontrollable (and could be positive or negative).
- **Management.** Anticipated, planned management of change. Management of change includes questioning the effectiveness of existing systems and processes. Aim to address Type III (openness and adaptability) management problems.

Pal et al. (2019) identify five characteristics of transformational adaptation:

- **Systemic.** Delivering solutions that are comprehensive and that address change beyond just component challenges to cover also wider relational issues that pertain to the root causes of vulnerability.
- **Catalytic.** Deliberate shifts within systems are expanded to trigger indirect changes and cascading impacts within structures and systems that are beyond an initiative’s direct mandate or reach.
- **Scale.** The intervention ultimately aims to make alterations that occur at the level of ‘the system’.
- **Inclusive.** The vulnerable, poor and marginalised populations are included in the decision-making process, recognizing that marginalization and political disempowerment (owing to caste, class, gender and ethnicity, among others) magnify the vulnerability of populations and the risks they face.
- **Sustainable.** The gains for adaptation are retained over time and the initiative delivers benefits after direct implementation support ends.

Fedele et al. (2019) identify six characteristics of transformative adaptation and highlight opportunities to catalyse this in the design and implementation of responses to climate change. This is applied to nature-based solutions (Fedele et al. 2019b):

- re-structuring, altering fundamental features or interactions in ecosystems and societies
- path-shifting, shifting the current trajectory of a social-ecological system towards a different direction
- multiscale, spanning multiple spatial, jurisdictional, sectoral or trophic scales

- systemwide, triggering systemic changes at large scale
- innovative, introducing new functions or states for that location
- persistent, leading to long-term impacts, even if not necessarily irreversible.

David-Tàbara et al. (2018) set out 12 dimensions, to contrast transformational vs incremental adaptation:

- representation of agency in economic modelling
- assessment of options for change of institutional, behavioural and social-ecological systems interactions
- systems of systems approach and coordination
- assumptions about the future attainability of the existing system goals
- role of visions and normative futures
- representation of system dynamics. Role of multiple feedbacks, cumulative processes, and irreversibilities, including tipping points, phase transitions and bifurcations
- time and space scales considered at the same time
- uncertainty (assumptions and treatment)
- kind of learning required
- expected outcomes of the assessment
- assessment of equity and distributional issues
- criteria tools and methods used in the design and assessment of solutions and strategies.

A literature review (Zografos et al. 2020) identifies four core characteristics of transformational urban adaptation actions:

- They involve non-linear alterations at an enlarged scale or intensity that reorder and/or relocate systems, transform places and shift locations.
- They address underlying failures of development including increasing greenhouse gas emissions by linking adaptation and mitigation.
- They seek fundamental alterations within a city that itself produces climate change vulnerability both elsewhere and within its contours. In doing so, they seek to affect both local adaptive capacity and global mitigation.
- They confront generative causes of vulnerability to climate change by engaging with the politics of managing risk.

Fazey et al. (2018) – albeit primarily in the mitigation area for energy transitions – identify the following domains of transformational change:

- **Cognitive (values, thinking).** Significant shifts in societal beliefs, norms, values and understandings, which may manifest as radically new concepts, ways of viewing the world or notions of progress.
- **Structural (institutions and governance).** Significant shifts in institutional arrangements and governance processes for enhancing sustainability, such as major policy change, institutional reform or new feedback and accountability mechanisms.
- **Relational (interactions among actors).** Significant shifts in relationships between actors and institutions, such as moving from siloed to integrated decision-making processes, new collaborations among diverse stakeholders that enhance science-policy-practice linkages or new accountabilities between public, private and civil society actors.
- **Functional (system behaviour/outcomes).** Significant changes in the behaviour and function of a system, for example, diffusion of innovative sustainability practices or changes in technology that reshape human activities of communication, production and consumption. This may include the major technological or practical advances that disrupt the status quo and allow opportunities for more radical changes to occur and for more sustainable outcomes.

Key concepts or approaches for framing transformational adaptation

There are a number of methodological streams in the literature that are applied to transformational adaptation. The review has considered the most relevant (for Clyde Rebuilt) and summarised these below.

Barriers to adaptation and the need for transformational adaptation

There is a recognition that there are barriers or constraints that make it difficult for individuals, businesses and governments to plan and implement adaptation actions (Cimato and Mullan 2010; Moser et al. 2010; Klein et al. 2014), including in the urban context. In some cases, these may present limits to adaptation.

These various barriers can make it difficult to make decisions or take action, even when it is

clear that action is needed (Cimato et al. 2017). They can, for example, constrain the means for adaptation, increase costs, reduce incentives, etc. including for urban adaptation (Oberlack and Eisenack 2014). Addressing these challenges is therefore key for successful adaptation implementation and for the Clyde Rebuilt project.

Importantly, these barriers can sometimes be so large as to limit or *prevent adaptation*, i.e. such that incremental adaptation options cannot be implemented over a given time horizon to achieve objectives, maintain values or sustain current systems. In these cases, these barriers could act as a trigger for *transformational* adaptation, or to put it another way, only transformational adaptation can overcome these constraints (noting in extreme cases, even transformational options may come up against hard adaptation limits).

A detailed literature review has been undertaken on barriers in Clyde Rebuilt, which is summarised below. The starting point has been to identify the types of barriers or constraints to adaptation.

These can include (Adger et al. 2007) physical and ecological limits, technological limits, financial barriers, information and cognitive barriers, and social and cultural barriers. Other typologies have been developed (e.g. Klein et al. 2014). Importantly these can reflect different perspectives, and often barriers are used as a metaphor to point to the non-climate factors or conditions that negatively influence successful adaptation (Biesbroek et al. 2013).

For the Clyde Rebuilt project, we consider different perspectives and have grouped barriers and constraints into four broad areas:

- **uncertainty**
- **economic and financial**
- **policy, institutional and governance**
- **social, behavioural and cultural.**

These are discussed in Box 4. These barriers apply to incremental and transformational adaptation, as well as between context and sector. However, some barriers are greater for transformational change, notably because of the greater resistance (including psychologically) to transition shifts, as well as the challenge in visioning and delivering these transitions (and their benefits), the (typically) larger costs, and the greater level of change threatening existing power dynamics (Bierbaum et al. 2013; Kates et al. 2012; Chung Tiam Fook 2015).

It is also highlighted that while there can be synergies between mitigation and adaptation, there is also the potential for trade-offs (see Box 2). This may introduce additional problems when considering transformational adaptation alongside a net-zero transition.

Box 4. Barriers and constraints to adaptation

One of the most common barriers to adaptation is around *uncertainty* (Cimato et al. 2017). Future climate change is uncertain and thus so are the possible benefits of adaptation action. This acts to prevent action (or encourage prevarication). While uncertainty is inherent in all decisions, the deep uncertainty associated with climate change brings this constraint to the fore (Wilby and Dessai 2010). It is also clear that this uncertainty will not be reduced any time soon, as highlighted by the latest round of climate modelling. Uncertainty can act to make it harder to implement incremental and transformational adaptation. The presence of uncertainty translates through to imperfect information (a market failure, see below, HMT 2018), which acts as a barrier to the adaptation of both public authorities and the private sector (individuals and firms): when public or private actors have inaccurate, incomplete or uncertain information they are therefore unable to make the most appropriate adaptation decisions, or in some cases, any decision at all. This is an issue for regions and cities – surveys find a global survey⁶ identified that 50% of cities report they are in need of improved data to support adaptation planning (with similar findings in Europe, RAMSES 2014). It is highlighted that while this can concern climate or risk information, a more pressing issue is information on the benefits (and effectiveness) of adaptation itself.

In terms of the *economic barriers* to adaptation (HMG 2013; LSE 2016), there are a range of market failures that make adaptation challenging. These are grounded in welfare economic theory and its underlying normative principles. In this case, barriers to (efficient) adaptation broadly correspond to market failures

⁶ ICLEI and MIT Global Survey on Urban Climate Adaptation Planning. A total of 468 cities completed the 40-question survey, with the majority of respondents being from the US since this is where ICLEI has the largest membership.

(HMT 2018) or those factors that prevent the private sector from delivering socially efficient adaptation, and therefore justify government intervention. While this is a critical area, it is also recognized that considering constraints from an economic perspective only may not fully describe real-world decision-making and overlooks a range of factors affecting adaptation. There is the issue of imperfect information (see above) and lack of information or asymmetric information (Cimato and Mullan 2010).

A major economic barrier for adaptation is over public goods and externalities: many adaptation actions have public goods or non-market dimension that the private sector is unlikely to invest in (e.g. large-scale flood defences, health protection). To put another way, by acting rationally in their own interest, individuals will base their adaptation decisions on private costs and benefits, not those that are best from a societal perspective, and will not seek to generate gains for others (and may even lead to maladaptation by transferring risks to others). These issues are important and act as a constraint to adaptation. Further, there is a difference between the economic versus the financial case for action, which leads to underinvestment by the private sector. For example, ecosystem-based adaptation is very attractive from a social welfare (public) perspective, because of the large environmental benefits, but these are non-market benefits and are therefore not as important from the financial (private investor) perspective (ECONADAPT 2017).

It is the role of government – including locally – to address externalities and deliver adaptation investment with the nature of public goods. There are also potential barriers around misaligned incentives, where the costs of adaptation fall on certain individuals, while the benefits accrue to others, e.g. between property owners and tenants in building adaptation measures (Cimato et al. 2017). The market structures in place, whether these are monopoly, oligopoly or perfect competition, shape the incentives and affect the investment decisions on climate change adaptation, and may incentivise adaptation and/or lead to over- or under-adaptation due to distortions (Fankhauser et al. 1999). In terms of longer term (including transformational) adaptation, the nature of public economic appraisal acts as a further barrier, because the present value of future adaptation benefits is low due to discounting, and this makes it more difficult to justify short-term integration investment to deliver longer term change (OECD 2015). This will have relevance for any GCR business cases on transformational adaptation.

The *availability of finance* is also an obvious and important constraint to adaptation. Globally, there has been a major uplift in climate finance flows for mitigation in recent years. Data from the Climate Policy Initiative (CPI 2019) reports that global public finance flows for adaptation were US\$30 billion/year in 2017–8. Almost all of this was from the public sector (although data on private adaptation finance flows are poor). However, this can be contrasted with the potential costs of adaptation and thus adaptation financing needs (UNEP 2018), which are estimated at an order of magnitude higher even by 2030, i.e. hundreds of billions. What is also interesting is that adaptation finance flows are much lower than mitigation flows, indeed the latter are now huge (US\$537 billion annually, CPI 2019). The reasons for this relate to the issues above around economics, notably the financial return on adaptation and the challenges around the generation of revenue or income streams (as compared to mitigation), as well as the public good and non-market elements, imperfect information, etc. which constrain private investment. There are often additional opportunity or transaction costs associated with adaptation (ECONADAPT 2017), and other factors can act to constrain the financing of adaptation (e.g. the need to work with many actors, as compared to large financing projects). Surveys and reviews find that financial constraints are a big impediment to regional and local government adaptation, yet urban areas are likely to dominate adaptation investments, because of the concentration of people, assets and economic activity. Financial constraints are likely to be particularly

important during times of falling budgets or challenging budgetary choices or competing priorities. This is particularly relevant for COVID-19 but may also generate some opportunities through a green recovery: this has been considered in a separate Clyde Rebuilt policy brief (Clyde Rebuilt 2020).

There are also a set of *policy, institutional and governance barriers* to adaptation (Klein et al. 2014; Oberlack and Eisenack 2014; Brown et al. 2017) and these may be among the most frequent types of barriers encountered (Ekstrom and Moser 2014). Policy constraints may arise when regulation or policy creates a barrier to effective adaptation, noting this may be due to a constraint at the national level (in terms of mandated authority), as well as at the local level. Indeed, city adaptation planning is embedded in the legal and institutional context set by national governments and this influences the development and implementation of climate plans at the lower administrative levels (Heidrich et al. 2016; De Gregorio Hurtado et al. 2015). Policy barriers can also arise when there are conflicting or competing policy objectives – or a lack of clarity. As adaptation is a fairly new theme in policy decision-making, the existing structures and/or the regulatory policy framework are often poorly aligned to adaptation objectives. As an example, urban development objectives may not take into account the vulnerability of assets and people to climatic risks. Governance barriers occur when there is ineffective institutional decision-making and/or implementation of adaptation (HMG 2013). These can constrain action, creating challenges or slow planning and implementation.

There are often institutional barriers, for example, the lack of a clear mandate and responsibility, of coordination and resources, and low levels of inter-organisational cooperation (Lehman et al. 2012). It is noted that adaptation frequently involves cross-cutting themes and thus multiple actors and institutions with different objectives, jurisdictional authority and levels of power and resources, i.e. it is more difficult to align governance and get agreement (Watkiss et al. 2015). There is often a lack of coordination (or clear leadership or mandate, Lonsdale and Turner 2015), or sharing of responsibilities, as well as (internal) competition for resources and policy control, that can all act to make adaptation harder to deliver. In the urban area, these various institutional aspects may be compounded by the problem of competing priorities and the need to address short-term priorities (rather than long-term climate risks), inherent in political and indeed medium-term (5 year) planning cycles (EEA 2016). It is highlighted that these governance and institutional barriers are likely to be larger for transformational adaptation, because of the existing political economy, but also because of possible rent-seeking behaviours and vested interests. For example, Zografos et al. (2020) found that power politics and interests (the political economic structures) are a key barrier to adaptation in general and to transformational change in particular.

Finally, there are a set of *social, behavioural and cultural barriers* to adaptation (Adger et al. 2009). These can include psychological, cognitive, emotional, cultural and social factors that shape individual and societal norms and rules, risk perception, management and thus affect adaptation action (Klein et al. 2014). These may influence perceptions of risk (Adger et al. 2009), they may lead to 'irrational' decisions or inertia, or they may determine adaptation responses because of preferences or norms from a social context. These barriers affect decision makers as well as individuals. It is also clear that when people make choices, their current reference point matters. Past experience, rather than anticipated future climate impacts, are often a driver of adaptation (Posey et al. 2009; Amundsen et al. 2010).

There are also complexities to adaptation decisions that may affect behaviour. People generally find it more difficult to make decisions when there is ambiguity or uncertainty, and to trade-offs across time and between options with uncertain benefits (Cimato and Mullan 2010). It can also be difficult to implement

adaptation reforms and policy changes that transfer resources from one interested group to another, even if they lead to societal gains overall. Even though there is a broad consensus that the citizens and the private sector should be involved in urban climate change adaptation, alongside public authorities, they rarely are: Klein et al. (2018) reviewed adaptation activities in 400 large cities globally and found that a majority of adaptation initiatives focus exclusively on the public sector. Finally, there is also the importance of mindsets, beliefs, values and worldviews that influence how problems and solutions are perceived, approached and addressed, which may or may not favour transformational adaptation.

For Clyde Rebuilt, it would be useful to identify the most important barriers for adaptation in the Glasgow City Region. This can be taken forward through stakeholder workshops. There is also an opportunity to identify where barriers themselves might act as a tipping point for transformational adaptation, i.e. to look at the opportunities for greater system shifts.

Adaptation pathway approaches

One focus in the literature to address barriers is through *adaptation pathway* thinking (see Box 5). These show changes in conditions, barriers or constraints, often called adaptation tipping points. These include thresholds for when incremental adaptation may no longer suffice and a more transformational approach may be needed. They may also reflect cases where potential opportunities exist at scale, that will need transformational adaptation to realize.

Systems thinking

One of the common themes around definitions of transformational adaptation is that it involves changes at the system level. Reflecting this, many approaches for considering transformational use systems analysis (also often called systems thinking or systemic analysis).

Systems thinking offers a way to identify improved policy solutions for complex and multi-objective policy issues (Stewart and Ayres 2001). Such approaches can provide a better representation of a complex system and they allow decision

makers (or problem owners) to see the bigger picture and to identify underlying drivers of vulnerability or key leverage points. They therefore offer more potential to develop innovative or integrated (cross-cutting or cross-sectoral) solutions, which would be typically associated with transformational change.

In practice, systems thinking often involves: (i) bounding the system of interest; (ii) exploring and understanding its components and connections; and (iii) eliciting potentially very different stakeholder and problem owner perspectives; then (iv) exploring possible intervention points.

The bounding step is important to make the analysis manageable (otherwise the complexity becomes too great), i.e. to define where the system starts and ends. The next step is to build up an understanding of the system, including connections and inter-relations. This requires a multi-disciplinary approach, combining multiple information sources and can be facilitated with **system maps**. These can be drawn as *causal-loop diagrams* that show the feedback loops that lead to system behaviour (Eker and Ilmola-Sheppard 2020); *actor or stakeholder maps* that show the individuals and organizations which are key players in the system (Dragos Aligicia 2006) and *issue maps* that lay out the political, social or economic context (Jones and Bowes 2017). It is also possible to use more formal modelling methods, including network analysis, agent-based modelling, input-output models and computable general equilibrium models, to describe complex systems and show interactions and as well as the effects of interventions.

Box 5. Adaptation pathways, tipping points and transformation

There is a set of literature that conceptualizes transformation through ‘adaptation pathways’. This concept has been used in dynamic adaptation policy and route-maps, notably in the Netherlands (Haasnoot et al. 2013) and for the Thames Estuary 2100 project (Ranger et al. 2013). These seek to identify possible adaptation tipping points (also called turning points or thresholds), which are points beyond which a particular adaptation action (or strategy) is no longer adequate for meeting a plan’s objectives and a different adaptation option or strategy is required. These tipping points may trigger different forms of incremental adaptation, but also potentially transformational measures, see figure below.

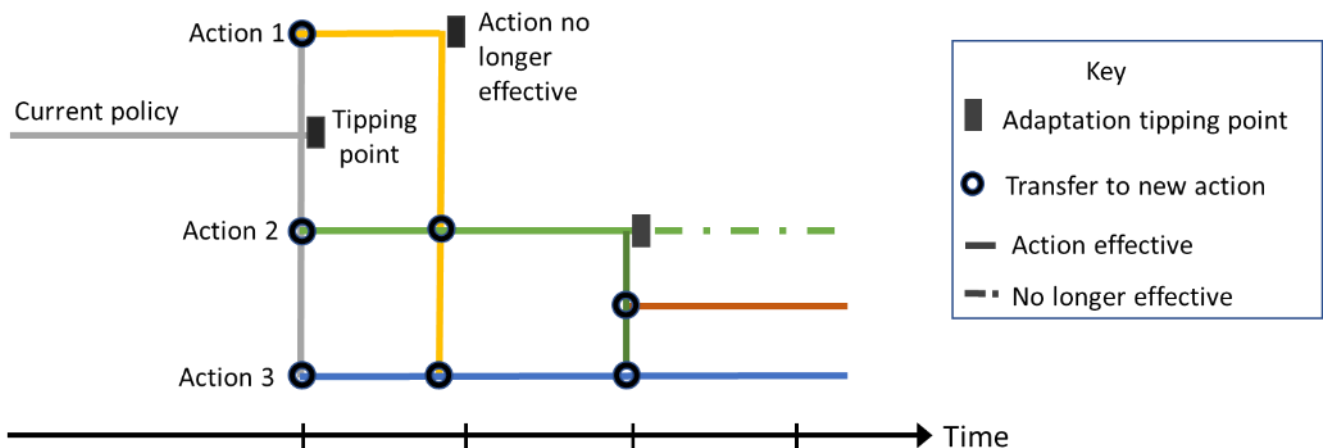


Figure 2. An adaptation pathways map.

Adapted from Haasnoot et al. 2013. The grey line shows current policy. Once a tipping point is hit, there are alternative actions (options) in different colours. Action 1 initially meets policy objectives, but hits another tipping point quickly, in which case a shift to another option is needed. Action 2 requires a shift later in time, as a different tipping point is reached. Action 3 is effective over all scenarios.

There have been extensions of the pathway approaches above to consider socio-institutional issues, with an adaptation landscapes literature that includes transformational change (Wise et al. 2014). This has a stronger focus on societal change and values/institutional/governance dimensions, noting their importance in constraining traditional pathways approaches. This literature is particularly relevant for longer term transformational adaptation (beyond incremental). An illustration of how a major barrier or constraint may lead to a transformational change is shown in Figure 3 (adapted from Wise et al. 2014). The circles represent decision points, the blue arrows represent pathways, and the dashed blue arrow represent more-or-less transformative pathways.

Adaptation pathway (incremental)

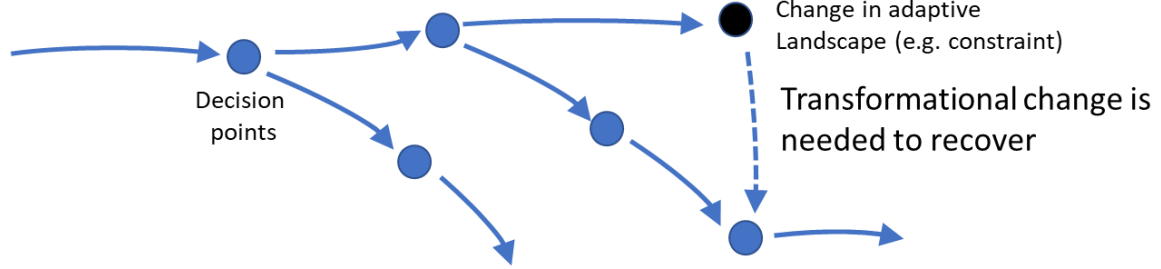


Figure 3. A decision-making actor's adaptation pathway.

There is now a large literature on adaptation pathways, though the exact definitions of adaptation pathways vary: it has been applied to several different types of approaches that involve some form of sequencing adaptation over time, normally as part of an iterative approach (adaptive management). Previous work in the Glasgow City Region has developed an indicative pathway for the Clyde (Watkiss and Hunt 2019).

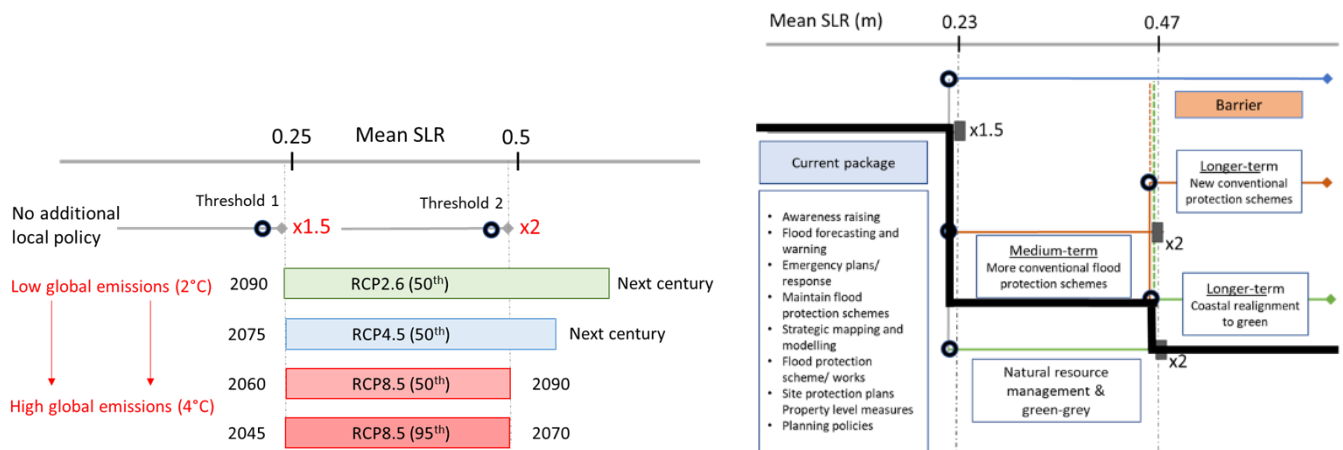


Figure 4. An illustrative adaptation pathway for the Clyde (Watkiss and Hunt 2019).

There is a related strand of literature on transformation(al) tipping points, i.e. the points which can switch a system from one state to another (Van Ginkel et al. 2020). In this case, the transformation is the shift from one state to another (preferably more desirable) state. The roots of this literature are in innovation and change theory (Rogers 1962) which studies why and how ideas and trends spread. The policy relevance of this literature is that it gives insights into how governments could formulate policies and incentives in order to achieve successful change towards societies that embrace more transformative adaptation (and mitigation) strategies.

The next step is to explore possible intervention points that can lead to systemic change in this context for transformational adaptation. This also requires understanding the perspectives of the human actors in the system and the governance arrangements around decisions. A complementary tool that is often used alongside systems thinking

for this is **Social Network Analysis (SNA)**. SNA analyses social networks and institutional actors (organizations, individuals, interest groups, etc.) and their linkages (socio-institutional relationships), mapping the influence and the exchange of information to assess adaptive capacity (Bharwani et al. 2013). It explores socio-institutional

processes and thereby identifies the context and governance around decisions.

It highlights institutional arrangements and structures, the decision framing of actors, their approach to dealing with information (confidence and uncertainty), the competence for action and the laws, regulations, values and norms that are likely to guide decisions. This can also help identify governance regimes or changes that can deliver more holistic and transformational solutions.

There are also tools and methods that can help different stakeholders consider multiple perspectives (i.e. including views or interests those that are different to their own) and can be used by groups to generate ownership through inclusive

stakeholder participation and deliberation. The key aim is to overcome barriers associated with an organization or actor's own remit or mandate (silo thinking). This includes a range of alternative governance models (see sections on societal transformation and later case studies).

An evolution of this thinking has been put forward by EIT Climate-KIC (in the Deep Demonstrations method) and focuses on the concept that creating multiple points of intervention in a system at once may offer the opportunity for greater systemic change. A key part of this has relied on the use of innovation portfolios, framed by an understanding of systems and places to intervene.

Box 6. Systems thinking and social network analysis

There are examples of the use of systems thinking and system mapping to consider climate risks for infrastructure networks (such as Pant et al. 2020 for the National Infrastructure Commission's study on resilience) or for road transport networks (Oh et al. 2020). These map these networks and can identify direct and indirect effects, and thus where the convergences of risk are. They can be used to identify the points on the system where greater resilience would be most useful to look at adaptation at the network level rather than for individual assets (or investments).

There are also examples of the use of systems approaches for transformational (green) adaptation. One example that applied stakeholder engagement using systems thinking was in Nocera Inferiore (in Italy), which implemented a three-year participatory process to co-design a nature-based solution for landslide protection that transformed the way experts traditionally manage this climate-related risk. The process worked a compromise between strongly competing perspectives by coupling expert models with stakeholder deliberation (Scolobig et al. 2014; Scolobig et al. 2016; Linnerooth-Bayer et al. 2016). A further example is transformative re-naturalization of the Isar river in Munich, where an administrative working group was formed that included not just the water and flood control agency, but also administrative departments responsible for nature conservation, urban planning, water quality, waste management, tourism and recreation, among others. The working group worked closely with highly engaged non-governmental persons and organizations. (Martin et al. 2019)

There are also examples of approaches that engage or activate communities, coupled with systems approaches and social analysis to understanding climate change and adaptation needs. Ross et al. (2015) developed a participatory approach to elicit community and stakeholder understanding of climate change adaptation needs, to connect diverse community members and officials towards potential action. This focused on social-ecological coastal systems and used 'climate roundtables', as well as influence diagrams that mapped hazards through to multi-sectoral impacts. The latter considered economic and social behaviour patterns, including how people, species and ecosystems were affected, and act, differently. They found a

participatory process was effective in building local empathy, improving the local knowledge base and empowering participants to join future climate adaptation action. Fazey et al. (2017) piloted a systems approach in the Scottish Borders Climate Resilience Communities project. This used community participation techniques and systems mapping to identify the causal loops and to better understand the causes and consequences of actions and how they can create reinforcing positive or negative responses.

This can translate through to more system-level analysis of adaptation options, using pathways or landscape approaches, which include the interlinkage between options. For example, Kingsborough et al. (2017) use generic adaptation pathways to look at options for reducing urban heat impacts for both mortality and residential building discomfort, providing a map that shows the interlinkages between options at different spatial levels.

EIT Climate-KIC have also produced a handbook for the design and implementation of participatory system mapping processes addressing system innovation (Matti et al. 2020). This includes the use of social network analysis to map the linkages between organizations. An example from the guidance is shown below.

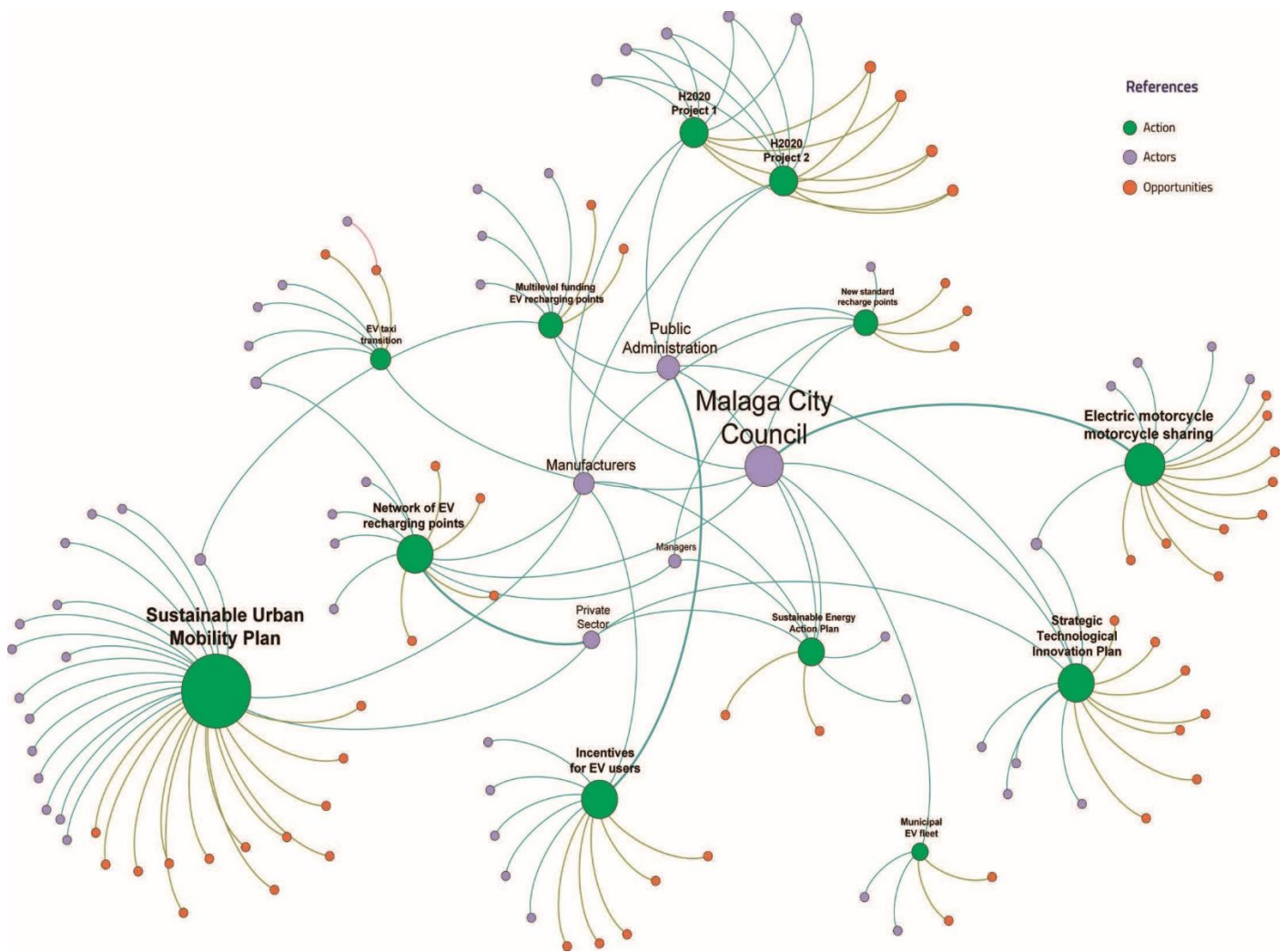


Figure 5. Network map for sustainability mobility in Malaga (Matti et al. 2020).

Social learning and social transformation

A large part of the transformation adaptation literature is centred on social transformation and draws heavily on the social learning literature. Much of this looks at mitigation and adaptation together or has a wider sustainable development perspective.

This body of literature sees transformation as requiring much deeper understanding and engagement with complex social processes, including culture, religion, ethics, values, governance and ontologies of the future and human consciousness (Fazey et al. 2017). According to this strand of literature, transformational change needs to be inclusive and driven by participatory processes aimed at enhancing the agency and empowerment of individuals. This can in turn contribute to

changing individuals' own perception from being objects to subjects or agents of change who are capable of contributing to systemic transformations (O'Brien 2018). This implies less attention to altering or manipulating people's behaviour and more on creating the conditions that promote transformational change.

This can often involve quite complex social learning approaches or concepts, such as second order learning (David-Tàbara et al. 2018) or even triple loop learning, quantum social theory (O'Brien 2016) or social justice (Fazey et al. 2017). More detail is provided in Box 7.

Box 7. Social transformation literature

O'Brien (2016) explores the significance of quantum social theory for understanding social change in the context of climate change and transformation. Quantum social theory supports or reinforces many of the understandings of relationships between social structures and human agency described by social scientists. However, it also provides a physically based, holistic perspective on conscious and intentional actions by 'entangled' individuals who can collectively influence systems and structures that appear stable or entrenched. Quantum social theory believes consciousness and free will can influence structures and systems, both of which exist in a quantum world of potentiality. One of the features of quantum theory is that the observer and observed are not separate, but part of a single system, and that people matter more than they think through an entangled, collective impact (O'Brien 2016), which can be transformational.

O'Brien (2018) argues that there are three spheres of transformation which represent both the objective and subjective dimensions of transformation processes: the practical, political and personal. The practical sphere represents specific actions, interventions, strategies and behaviours that directly contribute to a desired outcome, such as the 1.5°C target or a more resilient economy. For example, these might include investments in renewable technologies, upgrading and climate-proofing infrastructure, developing new educational tools, promoting bicycle riding, building sea walls, etc. This has been the primary focus of most climate change mitigation and adaptation research, policies and actions. The author argues that although on one hand transformations in the practical sphere can support or trigger transformations in the political and personal sphere, on the other they can also face a range of barriers associated with the political and personal spheres. The political sphere represents the systems and structures that facilitate or constrain practical responses to climate change. Finally, the personal sphere of transformation represents the subjective beliefs,

values, worldviews and paradigms that influence how people perceive, define or constitute systems and structures, as well as their behaviours and practices. This sphere represents both individual and shared understandings and assumptions about the world, which influence perceptions, interpretations and constructions of reality (O'Brien 2018). The author argues that directly recognizing and engaging people as agents of change can drastically speed up low-carbon transformation processes by shifting norms and institutions in ways that support the roadmaps and pathways consistent with the Paris Agreement (O'Brien 2018).

Fazey et al. (2017) highlight that social justice is important for enhancing agency and change, and enhances integrative and systemic thinking. Some of the key areas of transformational change might include changes in individuals (e.g. significant changes in their understanding of person-world relationships, institutions (e.g. taking an institution in a fundamentally new direction, with a basic change in character, configuration, structure and outcomes), procedures (e.g. major legal or regulatory reforms that have a significant bearing on society, governance (e.g. fundamentally different ways of governing), economies (e.g. alternatives to those based on assumptions of growth) or processes (e.g. the way something is brought about, such as participatory, inclusive, genuinely led by values that recognize fundamental human-environment relations). However, this is accompanied by acknowledgement that society is not currently very well equipped in terms of capacities, governance and processes or knowledge production methodologies to deal with, facilitate or understand transformational change. Further, many prevailing notions around change and transformation in society and in academia are underpinned by deep-rooted assumptions and challenging these assumptions is itself an essential part of transformation.

Cultural approaches and creative practices for transformational adaptation

There is a growing body of research and real-world examples which explore and demonstrate the role of creative and cultural approaches in bringing about societal transformations. The literature and examples address both mitigation and adaptation as well as transformations to sustainability.

One aspect of the literature focuses on 'transformative imagination' as a concept, which Galafassi (2018) describes as the imaginative capacity to explore the alternative futures and creative visions which are central to transformative processes. In his research, Galafassi found that art-based methods opened up spaces that went beyond rational elements and engaged participants' feelings, emotions, intuition and imagination within a visioning process. He also

highlights that instead of understanding visions as fully formed images of the future, they were found to be a process of making the future present, so that an 'embodied relation' to different futures could be formed.

In their research of creative practices in transformations to sustainability, Light et al. (2018) highlight historic examples such as Augusto Boal's 'Theatre of the Oppressed', where role play and visual techniques help to connect the audience to the performer and explore complex issues concerning oppression and social change. Audience members play the dual role of 'spec-actors' as they are invited to both observe and perform actions during the performance. In the context of the climate emergency, Galafassi suggests that artistic participatory experiences could lead to enhanced ownership and reflection on the individual's role in contributing to a more sustainable future.

Both Galafassi and Light et al.'s analyses show how creative practices can open up the imagination of participants (whether professional or community) and enable them to envision more boldly different futures and enable those involved to explore those realities.

This ability to engage communities and the wider public through creative approaches is seen as a key means by which arts-based methods can contribute to mitigation and adaptation efforts. There are a range of examples, including the HighWaterLine project in New York (2007) to Creative Approaches to Flood Awareness in Aberdeen (2018): these highlight the skills and capabilities of artists to co-design and co-produce creative, place-based responses to local climate issues which reflect communities' perspectives and concerns. With the evolution of participatory creative practices there has also been a growing recognition that arts-based methods, if used in the right way, can play a role in breaking down traditional barriers between institutions and communities. This can occur through the creation of alternative spaces and entry points for engagement and involvement of different players, including those who have been historically marginalized or excluded from decision-making processes (Municipal Artist Guide). These examples demonstrate the role of creative practices in empowering different voices in new and accessible ways, which social transformations literature recognizes as a key tenet of achieving transformational change.

As well as offering alternative means of engaging communities, creative approaches can play a role in sustainability transformations through the crafting of stories and narratives which help to prepare the ground for new changes that organizations are seeking to catalyse. Miloreit (2016) describes how stories can play a role in bridging the gap between individual and collective imagination, which can help to create a shared vision of

the future. Examples of the adoption of narrative and story-based approaches include The Viable Cities programme⁷ which employed a Chief Storyteller to help move beyond the scientific data and connect citizens on a personal level with the realities of living in a net-zero carbon world. These approaches use narrative to make concepts more accessible – and acceptable – to a wider public whilst using story to think through some of the challenges.

A further example is the Red Cross Climate Centre's experimentation with the use of humour to encapsulate complex messages. A key report has been the cartoon summary of the IPCC Special Report on the Ocean and the Cryosphere in a changing climate (RCCC 2019). As part of the Resilient Regions project, EIT Climate-KIC has worked with RCCC to develop new illustrations showcasing the challenge of adapting regions. Another key approach has been the use of embedded artists as a way of transforming individuals and groups towards more resilient states. Through the Cultural Adaptations project, Creative Carbon Scotland has been funded by Creative Europe to pilot the use of cultural approaches in the Glasgow City Region, Ghent, Dublin and Gothenburg, to support adaptation actions at community to regional scales.

Finally, at a policy level, Scottish Government's Culture Strategy (2019) sets out three key 'ambitions' including 'Ambition 2: Transformation through Culture'. This highlights a key aim of opening up the potential of culture as a transformative opportunity across society and for playing a major role in galvanizing climate action and influencing widespread behaviour change to meet net-zero targets. Although this is a more mitigation focused aim, the strategy also recognizes that culture and heritage projects are often local and place-based, offering an opportunity to engage communities across Scotland in, amongst other

⁷ The Viable Cities Programme <https://www.citylab.com/environment/2019/11/climate-change-news-solutions-per-grankvist-viable-cities/601597/>

things, visualizing and understanding the impacts of climate change and imagining the possibilities of a greener future.

Key concepts for Clyde Rebuilt

The approaches above – including barriers analysis, pathways, systems thinking, social perspective and cultural practice – can be implemented individually, i.e. one is adopted at the expense of the others. However, we believe there is value in combining these together. Specifically:

- The analysis of barriers can help the project to identify when these are particularly large, and there may be limits to incremental adaptation, thus necessitating transformational adaptation. This can include adaptation pathways analysis.
- The use of systems thinking is often adopted for transformational adaptation, to make sure a greater sense of scale is captured in the analysis and to move beyond current silo thinking. This can include techniques such as social network mapping to identify organizations and governance systems as well as linkages and power dynamics.
- The consideration of transformational adaptation as a social process and the need to ensure the political economy and power dynamics are considered, will help to deliver new thinking.
- There is a growing body of research and real-world examples which explore and demonstrate the role of creative and cultural practices in bringing about societal transformations. These can include narratives and imagination including for creative visions, as well as cultural-based methods (art, theatre). These can enhance awareness and ownership, break down traditional barriers and draw in a wider (and different) group of people and communities.

Clyde Rebuilt will consider elements of the barriers to adaptation, pathways (tipping points), systems thinking and social learning literature, and creative and cultural approaches, in order

develop its approach to transformational adaptation.

Case studies on transformational adaptation

One obvious way to consider transformational adaptation is to explore case studies that are already identified in the literature.

There is a wealth of urban adaptation case studies now available. As examples:

- **Case study publications.** The BASE Adaptation Inspiration Book: 23 European Cases of Climate Change Adaptation (Ng. et al. 2016).
- **The RAMSES common platform/city module – city navigator.** This has project results and presents the data and the results of RAMSES. It is possible to view results of the RAMSES project for over 600 European cities. The platform is regularly updated to include new findings (<http://www.pik-potsdam.de/~kriewald/ramses/>).
- **The EEA Climate-ADAPT web site** has an Urban Adaptation map viewer and illustrative case studies and relevant indicators are suggested for learning more about the climate risks to European cities (<https://climate-adapt.eea.europa.eu/knowledge/tools/urban-adaptation>).

There are also academic studies that have extensively looked at urban adaptation options in hundreds of cities (Klein 2018; Reckien et al. 2018), as well as numerous city initiatives (C40, Making cities resilient, Covenant of Mayors, 100 Resilient Cities (RC) Network, etc.). However, none of these are targeted at transformational adaptation. The review has therefore considered existing case studies of transformational adaptation cited in the literature. These are summarised in Box 8.

A number of immediate insights emerge from the case studies. First, they are diverse and vary in

terms of their ambition, though in truth most do not seem particularly transformational when compared to the aspirational examples provided earlier in the academic and theoretical literature. The Clyde Rebuilt project team undertook an exercise to evaluate each case study and decide whether it met their expectations for transformational adaptation. None of the examples were considered to be transformational by all participants: the highest 'transformational score' was attributed to the room for Dutch delta programme and the Leuven 2030 project.

Second, there is a very strong bias among the case studies towards social justice (and governance

reform) and nature-based solutions, or a combination of both of these. This indicates transformational adaptation examples could be being oriented towards certain framing and interpretations in the literature. Examples that have these attributes may be more preconditioned to be considered as good examples, even when they don't perhaps deliver transformational adaptation of the scale described in the academic literature, i.e. because they address popular concepts. This might suggest some bias that the project needs to be mindful of as interventions are explored with local stakeholders.

Box 8. Examples of transformational adaptation in the literature

Examples from Kates et al. 2012, Chu et al. 2019, Ziervogel 2019, Zografos et al. 2020, Climate-KIC 2020.

- **Relocation in Papua New Guinea.** The Carteret Islands in Papua New Guinea are cited as a case of residents migrating (to Bougainville) as a result of sea level rise. Anticipating their future evacuation, aid projects prepared islanders for their new livelihoods.
- **Ecosystem protection and management in Durban, South Africa.** The city set up a multi-stakeholder, trans-municipal partnership to examine how ecological infrastructure could safeguard water supplies and reduce natural disasters (integrated "socioecological systems approach") – this led to the Durban Metropolitan Open Space System (D'MOSS), which created a 94,000-hectare nature reserve to protect biodiversity and ecosystem services.
- **Citizen-led flood resilience building in Gorakhpur, India.** Gorakhpur has pursued ecosystem-based adaptation actions through grassroots-led efforts, using a civil society organization and a project with four interlinked goals: to develop models of climate-resilient integrated agriculture; improve income and food security; ensure the sustainability of peri-urban agricultural lands through different regulatory and incentive mechanisms; and improve the flood buffering capacity through sustainable management of agricultural ecosystems.
- **Community-based water conservation and management in Indore, India.** The city restored its 26 urban lakes, located in the peri-urban zones, to serve as an emergency water supply. Artificial floating islands were introduced to help purify the water, serve as bird habitats and improve the aesthetic quality. Local Water Conservation and Management Committees (WCMCs) were introduced, which created a community of champions promoting environmental protection.
- **Gravel platforms, Green Park informal settlement in Cape Town.** In 2015, three large gravel platforms were built in the Green Park informal settlement of Cape Town to raise the ground level above the flooded wetland area. The settlement used these to push for electricity supply, which could not be installed in flood-prone areas. The governance process has elements of a transformational approach (formal and informal and top-down and bottom-up).

- **Fostering Local Wellbeing (FLOW) programme in Piketberg, Bergvliet Municipality (South Africa).** The project took a transdisciplinary approach, where academics, practitioners, municipal officials and a group of citizens worked collaboratively to implement a range of interventions aimed at building transformative capacity for unemployed youth and local government. It includes a youth leadership development programme, the introduction of a local community currency and local government support for strengthening engagement with civil society.
- **Thames Estuary 2100 plan.** In what is considered a model of current flood adaptation, the city of London and adjacent suburbs have been protected since 1984 from flooding, high tides and storm surges on the Thames River estuary by an engineered barrier at Woolwich that can be raised or lowered. After 2060, depending on the degree of climate change, transformational options would be considered, including a new, higher barrier at a different location and relocation of development from the floodplain.
- **Management of deltas and polders in the Netherlands.** This included the “Room for River” program, widening rivers and enlarging flood plains as “de-engineering” measures to accommodate natural fluctuations, which was a major change from traditional Dutch flood control of building and raising levees and dykes. It included new measures, institutions and funding mechanisms. It also included the ‘Delta plan’.
- **Superblocks in Barcelona, Spain.** Barcelona’s superblocks (at Poblenou) incorporate elements of transformational climate adaptation, with an approach to enact transformational land use planning linked with climate adaptation efforts. The superblocks are groups of streets where traffic is reduced to close to zero, with the space formerly occupied by cars given over to pedestrians and play areas.
- **Leuven 2030 (mitigation).** This project started with roadmap (produce by the university) and then the Municipality set up Leuven 2030, a non-profit organization, to deliver commitment to carbon neutrality, governance model that could bundle all the city’s creativity and ambition together behind one vision, involving city government, citizen groups, knowledge institutions, companies and investors. To be a member, organizations had to present a binding action plan (<https://www.leuven2030.be/english>).

A process and solutions for transformational adaptation

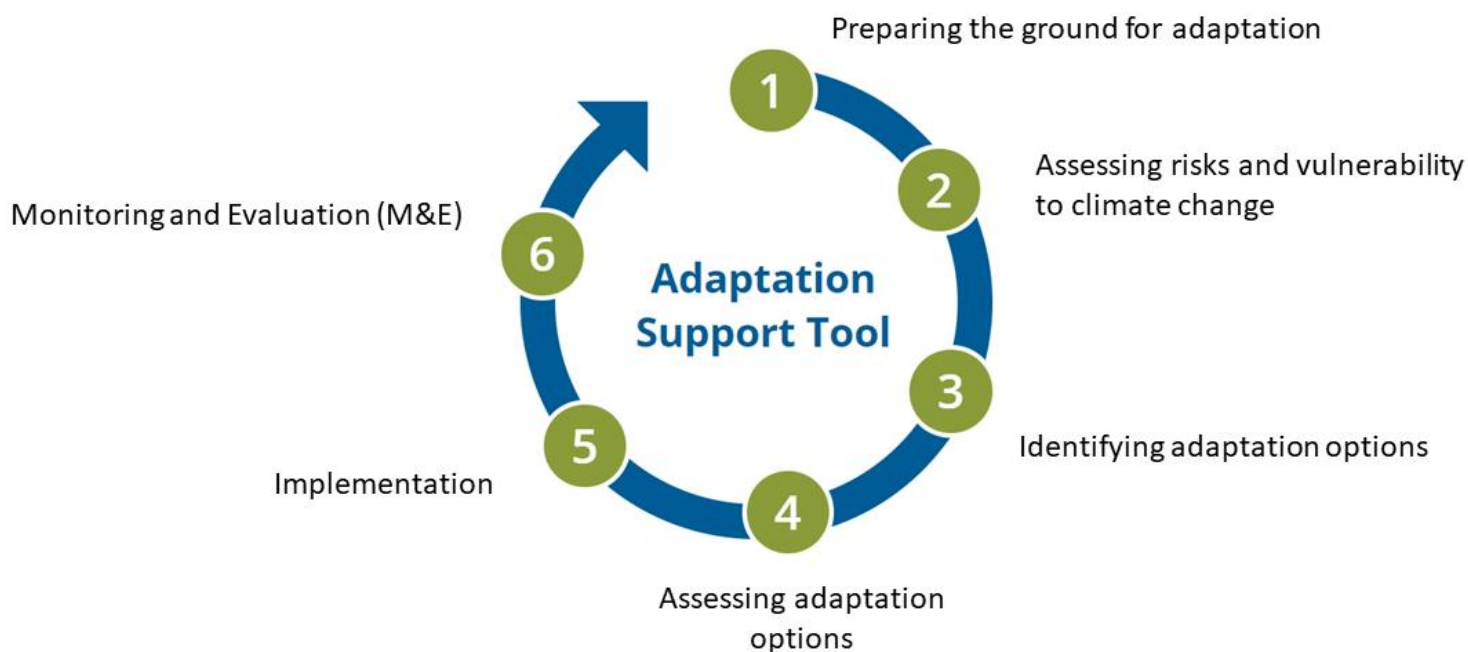


Figure 6. The adaptation policy cycle (EEA).

Towards a process for transformational adaptation

Whilst the above approaches are helpful in considering different elements in which techniques and approaches can be employed for adaptation, ultimately, their use needs to be structured around a process. This process could be developed and agreed (with stakeholders) to explore transformational adaptation and this could then be applied in a collaborative process. In practice, a process will need to define the method and is likely to require definitions of objectives, but a critical issue is whether a different process is needed to deliver transformational adaptation.

There is an existing process for adaptation, which has been promoted within the EEA Climate-ADAPT platform as the adaptation support tool.

This is based on an adaptation policy cycle and has been advanced through UKCIP (Willows and Connell 2003), the PROVIA programme (Bisaro and Hinkel 2013) and EEA in its adaptation support tool (2015). This is shown as a step cycle in Figure 6. An urban version of this adaptation policy support tool has also been developed, the Urban Adaptation Support Tool (UAST), which uses the same six step cycle⁸. An interesting question – and a very important one – is whether this cycle can (or should) be used for transformational adaptation?

A review of this framework and the supporting guidance material, concludes that at present this framework and supporting material are more focused on incremental adaptation, although there has been some work that has translated the EEA framework above to pathways thinking (such as

⁸ <https://climate-adapt.eea.europa.eu/knowledge/tools/urban-ast/step-0-0>

the RAMSES Transition Handbook and Training Package⁹). There is also recent guidance (User Guide¹⁰) from the RESIN project on implementation in cities. In theory, it would be possible to include system thinking and social network analysis in such as cycle, although this is not common practice.

At the same time, there are a large number of proposed processes for transformational adaptation in the literature. These obviously relate to the definitions and concepts that authors are using. For example, Pelling et al. (2015) set out an adaptation activity space, that provides an understanding of the origins and breadth of movement of transformation in framework that captures the diverse components of coevolving social-ecological systems. Lonsdale et al. (2015) (based on Park et al. 2012) set out a transformational adaptation cycle, which builds on change management and action-learning theory and is notable because it links an incremental adaptation cycle within a broader transformational adaptation cycle. More recently, in the urban context, Chu et al. (2019) adapted from Bazaz et al. (2018), compare the differences between incremental and transformational adaptation in what appears to be a policy cycle, but in practice is a list of characteristics (which addresses underlying inequalities, produces behaviour and lifestyle changes, requires new people-centric city planning, ensures integrity of urban and regional ecosystems, envisions new communities, institutions and economies). However, these methods or frameworks tend to be grounded in particular perspectives (related to the author's definition and preferences for change). They also tend to be highly theoretical, i.e. they do not represent a set of concrete activities that can be easily translated into an implementable step by step approach for practitioners.

A more applied example for transformational change is the EIT Climate-KIC Deep

Demonstrations Design Process (Dunlop and Belle 2019, Dunlop and Gollan 2020). While this has been focused on low carbon transitions to date, it is being piloted for transformational adaptation in the Clyde Rebuilt project. This uses an iterative approach that works through four stages: intent, frame, portfolio and intelligence. The approach includes many of the elements discussed above, i.e. with mapping of systems and social network mapping, identifying problem spaces and looking for innovative solutions, but it also translates this into a more practical context with the development of a portfolio of solutions to design and test, and based on learning to look at scaling up and leveraging.

However, this is focused on developing more transformational propositions. For Clyde Rebuilt, the aim is to develop an Adaptation Strategy alongside a transformational adaptation portfolio. We therefore think some form of hybrid might be useful. This could consider the sequence of incremental steps from the EEA adaptation cycle but expand promising areas for more transformational adaptation using the Deep Demonstrations method.

This has the added advantage of being a replicable, scalable process that could be adopted by regions across Europe, in a way which reflects resources and capacities, as well as the various entry points into adaptation.

⁹ <https://ramses-cities.eu/home/>

¹⁰ <https://resin-cities.eu/home/>

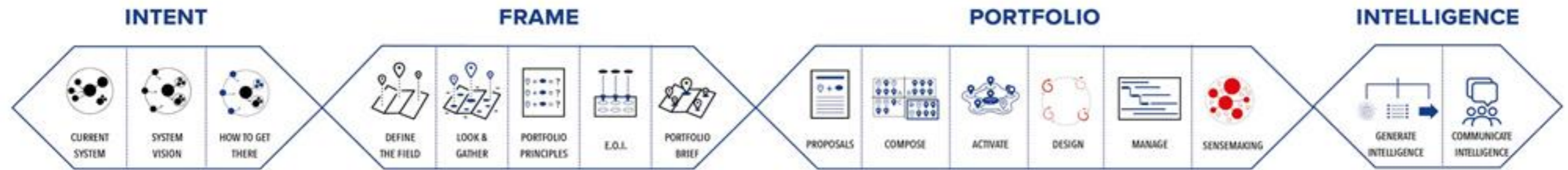


Figure 7. EIT Climate-KIC Deep Demonstrations process.

INTENT is the set-up phase of the Deep Demonstrations process.

It is designed to establish directionality, to scope needs, vision and objectives for systemic change and ultimately to agree to work together on a Deep Demonstration innovation portfolio focused on catalyzing radical transformation of systems.

It creates an opportunity to understand and embrace existing programmes and commitments and bring them within a portfolio logic.

FRAME is about defining the field for innovation action, building understanding through positioning about how innovation might achieve the vision for transformation.

This phase is made up of steps that are inherently iterative. They are designed to articulate why we want to deploy innovation, where, what to leverage and where to position ourselves to test for emerging, breakthrough possibilities as well as scaling potential.

The portfolio brief that emerges from this stage provides a frame of reference for learning and generating intelligence from innovation

PORTFOLIO is the core of the Deep Demonstrations approach. It commences with a call for proposals for solutions to catalyze change or to learn about possibilities for transformation based on the framing and positioning work done in the previous phase.

What follows is selection and activation of an initial combination of innovation initiatives, using a portfolio composition process. Subsequently the process engages partners in co-creation or co-design for effective learning and potential synergies and/or complementarities.

In this phase, innovation initiatives are supported through dynamic portfolio management and regular sense-making with the intention of accelerating the pace of learning about obstacles and barriers to innovation, potential multipliers, more or less effective leverage points, integration effects and pathways to scaling.

INTELLIGENCE is the ultimate objective of the Deep Demonstrations process. By intelligence we mean input prepared for decision makers to enable action. Intelligence is the outcome of sense-making and analytics drawing on innovation experience and learning from multiple different experiments deploying diverse leverage points.

Historic examples of transformation in Glasgow

It is also possible to look at the past for examples of transformation, including locally. A good example for Glasgow is the transformation to obtain the European Capital (City) of Culture (in 1990). The award of City of Culture and the use of the arts has been considered as a catalyst for urban regeneration and grassroots involvement from local communities in the city, as well as the role that the arts can make a difference even in socially and economically disadvantaged districts¹¹.

There is some academic analysis of the lessons from Glasgow's award (Garcia 2004a, 2004b) and on the lasting change it has achieved (Garcia 2005). These identify that the success of Glasgow's transformation since the early 1980s was down to: the development of strong public-private partnerships and city marketing strategies; medium-term appraisals establishing Glasgow's pioneering role in culture-led regeneration; long-term recollections attempting to identify the event's key legacies. This led to the city's image transformation from industrial centre to attractive creative hub, including the growth in leisure and business tourism that resulted partly from this image transformation, but highlights this used a predominantly economic rationale to justify Glasgow's success.

Vision or mission-led approach for transformational adaptation

The final area of investigation has been to explore the potential vision for the region and use this to help determine what transformational changes will be needed to deliver this goal.

As highlighted above, this approach is used extensively in the mitigation domain, but this is because

there are clearly defined and quantitative goals that help frame the ambition, i.e. net-zero targets. For adaptation, such long-term goals are far more challenging. This is because it is difficult to set a target for adaptation, as there are no simple common metrics that can be measured across all risks and sectors. To expand, should the goal for adaptation be to maintain current levels of climate related risks to the same level as today (under changing conditions of increasing risk), or to reduce to zero (which would be very expensive)? It is also much harder to set a goal that captures the wider framing used in much of the literature, i.e. to capture sustainable development and social justice.

A recent focus in the climate area, including for adaptation, is the use of mission orientated approaches (the classic example being the Apollo space programme). An example in the mitigation area is for Greater Manchester (Mazzucato 2019). Such approaches set an ambitious goal and then use this to create a long-term policy landscape, setting out tasks that mobilize actors for bottom-up experimentation across different sectors. Typically, they are or involve:

- **bold, inspirational with wide societal relevance**
- **a clear direction: targeted, measurable and time-bound**
- **ambitious but realistic research and innovation actions**
- **cross-disciplinary, cross-sectoral and cross-actor innovation**
- **multiple, bottom-up solutions.**

¹¹ <http://www.europealacarte.co.uk/blog/2010/08/20/glasgows-regeneration-glasgow-top-uk-tourist-destination/>

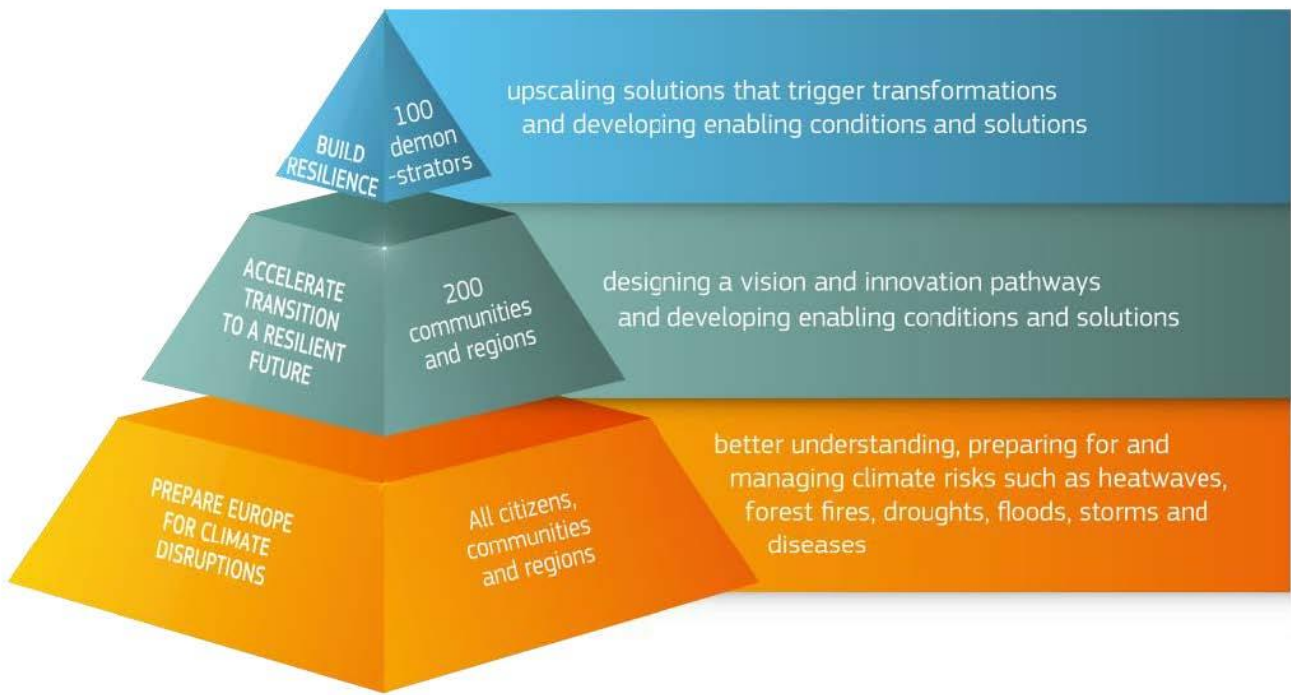


Figure 8. Objectives of the European Adaptation Mission.

This approach is adopted in the European Commission RTD Mission Board for Adaptation (EC 2020) which includes societal transformation and is adopting a similar Deep Demonstration approach to EIT Climate-KIC. This sets out the vision to make Europe more resilient, climate prepared and fair. The objectives are framed through in Figure 8.

Interestingly, the Scottish Government is already using this type of thinking with 'Clyde Mission'¹². This is a place-based approach to maximize the full potential of the Clyde. This is:

- developing a compelling investor prospectus
- identifying further opportunities for business growth and jobs
- realizing the potential of the river to help address the climate change emergency.

With respect to the latter, it will look at how to improve and open up the river for visitors, local people and communities and ensure it is climate ready – adaptable and resilient to climate change – and potentially use the river as a source of heat and energy for businesses and communities.

¹² <https://economicactionplan.mygov.scot/place/clyde-mission/>

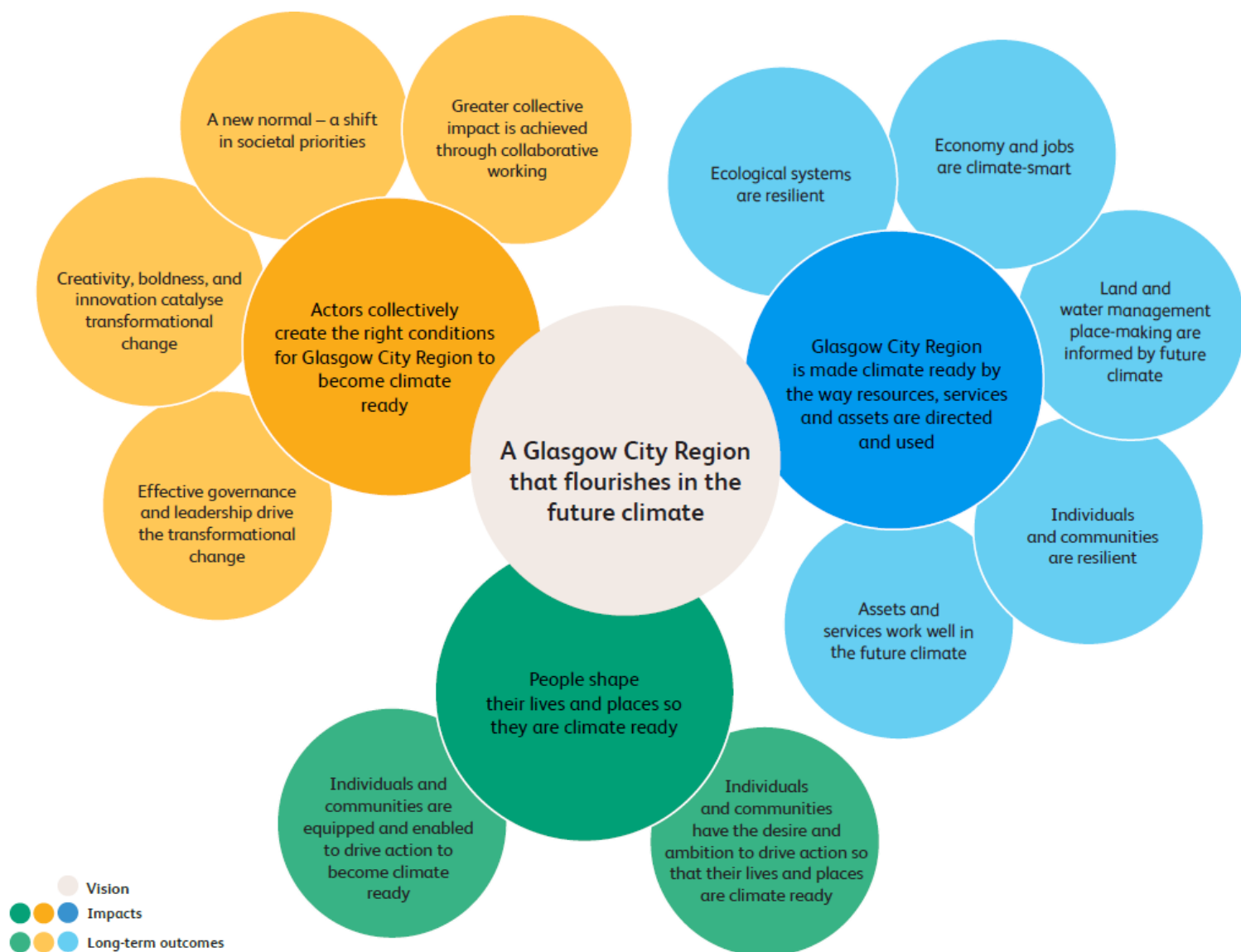


Figure 9. Theory of Change for Glasgow City Region.

The CRC and Clyde Rebuilt team have developed a Theory of Change which sets out the vision for the Glasgow City Region. This also sets out the outcomes and impacts that will deliver the vision. This is shown to the right.

This provides the necessary objectives and framing to develop a vision or mission-based approach for Clyde Rebuilt.

The Theory of Change is accompanied by a set of principles that relate to:

- intrinsic value of nature
- climate & social justice
- revolution in understanding
- more of the same won't do
- revolution in planning
- revolution in finance
- recognizing uncertainty.

Solutions and enablers to transformational adaptation

Addressing adaptation barriers

The earlier section outlined some of the barriers and constraints to adaptation. The literature review has investigated possible solutions to address these.

In terms of uncertainty and information failures, it is possible to fund more science and studies, and raise awareness, to address knowledge gaps (and tackle the failure of imperfect information). However, this is unlikely to reduce uncertainty, and thus there is a need for more information and awareness on how to make decisions under uncertainty (Watkiss et al. 2014) and frameworks that help to identify and prioritize early adaptation (Warren et al. 2018) (see also Box 5). There is a literature on the benefits of building adaptive capacity (including organizational and structure capacity, Ballard 2013) and technical assistance, including through networks which have shown to be effective in the urban context (Revi et al. 2014). However, analyzing climate information and making decisions is challenging, and there is an important role for boundary agents (also called knowledge brokers) (Hegger and Dieperink 2014). There are a growing number of research institutions (Fazey et al. 2018) and intermediary boundary organizations (such as ClimateXChange, as well as Sniffer), that have a stronger focus on climate change solutions rather than on generating knowledge directly. Cities can themselves act as facilitators, to encourage innovation, link initiatives and more (Huang-Lachmann and Lovett 2016). There is also a high potential for demonstration and pioneer projects, especially for more transformational change, to address perceptions and allow learning.

For economic and finance barriers, the focus is on addressing market failures. Many of the market failures associated with adaptation can be tackled

by government intervention, noting this can take several forms. It can be done through direct provision and support or by introducing a regulatory framework that is conducive or creating the enabling environment for the private sector to deliver adaptation (Cimato et al. 2017). It can also be advanced through provision of guidance, information and awareness to help overcome problems relating to misaligned incentives and market distortions. Financial incentives can be introduced by governments to encourage individuals or organizations to adopt certain behaviours, which includes a range of instruments that can be used to raise finance to support adaptation, e.g. taxes, fees or charges (Kamal-Chaoui and Robert 2009) or to internalize the external costs of their actions.

There are examples now of cities in Europe that have funded significant adaptation investment through local financing approaches, e.g. Copenhagen Cloudburst plan and its use of water charges (2012). There are also potential grants, loans and other forms of revenue transfers from national or regional (subnational) governments, as well as a new range of insurance and financial resilience products that could help raise finance (UNEP 2018). Innovative instruments, such as challenge funds can be used to pilot activities, or to create markets where these don't exist, such as with payment for ecosystem services (Richards and Thompson 2019). There is also a new focus on incentivizing private sector finance into adaptation (EEA 2017), sometimes using public sources to unlock this, as well as new insurance models at city and individual level. There are already examples emerging examples of what works (Power et al. 2018) from other cities. Clyde Rebuilt is investigating all these areas further as part of the resource mobilization plan.

In terms of policy and governance, there are a range of possible solutions in the literature to overcome the institutional barriers highlighted earlier. Many of these focus on the decision-making process and clarity around mandates and accountability. This can include integrated planning,

including vertical (local-national, to ensure local adaptation plans and policies are aligned with the national climate framework.) as well as horizontal (across departments, municipalities and stakeholders) coordination to help ensure decisions are not taken in silos but are part of a coherent framework. It can also include a focus on opportunities (Brown et al. 2017), i.e. critical moments when there is an opportunity to draw attention to new solutions or have policies accepted and adopted. There are examples of changes in planning to promote/disincentivize activities related to land use and development. Some literature highlights that greater effort on mainstreaming may help adaptation in cities, including for more transformative change (Chu et al. 2019), as it integrates adaptation into existing activities and processes, helping to ease planning and implementation, reducing policy and institutional barriers. There are some success factors identified in the literature for successful mainstreaming (OECD 2015, LSE 2016, WR 2018) and many of these also apply to transformation. They include:


- **The presence of a high-level national champion and/or the involvement of strong ministries or departments (such as economic and planning departments in regional or local administrations), with associated political commitment.**
- **The identification of suitable entry points in the policy process, notably in policies and programmes. There are also windows of opportunity, when these policies are being developed, when mainstreaming is most likely to succeed.**
- **There needs to be the finance available to fund the additional costs of mainstreaming.**
- **Capacity building (supported by technical assistance and knowledge brokers) is important in effectively delivering mainstreaming across regional government, especially in departments that have not historically been a major focus for climate action.**

- **Policy frameworks (and commitments) are useful to help push forward the process of mainstreaming.**
- **The presence of co-ordination mechanisms across government, that support mainstreaming goals, are important.**
- **There is a need for information and tools.**

However, it is also possible that mainstreaming may itself constrain transformational adaptation, as it will focus on current practice and systems, and incremental change, rather than allowing new governance structures and approaches (and challenging the current status quo).

There is also a need for improved engagement and interaction between the climate and adaptation community and end-users, notably through co-design and co-production (Groot et al. 2012). Co-design (cooperative design) is the participatory design of a project or programme with stakeholders (the users). The aim is to jointly develop and define questions that meet collective interests and needs: this leads on to co-production, which is the participatory development and implementation of the project with stakeholders. There are review studies that provide key success factors for co-design and co-production (Hegger and Dieperink 2014, Beier et al. 2016, COACCH 2018). Interestingly, transformational adaptation may require a different type of co-design to incremental adaptation (Harvey et al. 2017). While incremental adaptation is likely to focus on instrumental or prescriptive co-production (creating useable knowledge to inform decision-making), transformational adaptation is likely to require emergent or reflexive co-production (challenging existing thinking and narratives).

For social, behavioural and cultural barriers, there are a range of solutions, though these may take time (Oberlack and Eisenack 2014) and need to be sensitive to local contexts and social norms. Possible solutions include collaborative and participatory decision-making processes (Ziervogel



2019) including a community level (Chu et al. 2019), different regional or urban governance systems (Kamal-Chaoui and Robert 2009), as well as advocacy coalitions, which can help to build trust between actors and develop social capital. The use of cultural and creative practices (see earlier section (Galafassi 2018)) can enhance awareness and ownership, break down traditional barriers and draw in new groups of people and communities, making them active agents of the transformation process. There is also a literature on transformation tipping points and on the use of innovation and change theory, based on why and how ideas and trends spread (Van Ginkel et al. 2020).

Finally, there is some literature that discusses ways to help overcome possible barriers to transformational adaptation. David-Tabara et al. (2018) identify focusing on solutions, not problems, and on opportunities rather than impacts and costs. Complementing this, they highlight better understanding of agency, to promote the institutionalization of multiple networks working on systemic innovation and win-win solutions.

Clyde Rebuilt's approach to transformational adaptation

The literature review above identifies that definition and consideration of transformational adaptation will vary with the context and project/study. For Clyde Rebuilt, the project team is taking transformational adaptation forward in the following ways:

- Given there is a plurality of views, both within the literature and amongst practitioners, we do not believe it is possible to produce a single overarching definition of transformational adaptation (or at least one that everyone will agree to). However, we will set some conditions and characteristics that we believe are important in more transformational change. These include:
 - the level of departure, the outcome level of change
 - the degree to which it involves doing different things
 - whether it seeks to influence a system
 - the spill-over benefits (co-benefits)
 - the temporality of the intervention and the sustainability of any shift, and whether it can influence attitudes and beliefs among the public and policymakers away from just incremental change (noting for a subset of actions, it will also include the need to take risks, and even a sense of disruption).
- In designing a transformational adaptation strategy and a climate resilient innovation portfolio, the Clyde Rebuilt project and its stakeholders will need to define the boundaries. There is a need to make a discrete choice of whether to consider (i) climate change (adaptation) only; (ii) mitigation and adaptation together, which is important given the UK Government's, Scottish Government's and Glasgow's net-zero targets; or (iii) all aspects of social justice and sustainable development (albeit for particular focus areas). A bolder ambition and wider boundary is likely to involve more challenges but has the potential for greater impact if achieved successfully. We highlight that as a minimum, Clyde Rebuilt should look at the transition towards net-zero alongside transformational adaptation (i.e. to be climate ready), due to the current policy landscape and the potential synergies as well as trade-offs between the two.
- We think it is unwise to attach too many aspirations to transformational adaptation, especially in terms of fixing underlying societal challenges or asking for very extensive changes to governance systems/arrangements. However, we recognize that to deliver more transformational change, there may need to be changes in governance or current thinking within the area of consideration, and potentially beyond.
- We recognize that transformational adaptation is likely to be messy in practice. It will involve a whole range of actions and will sit within a space that spans from incremental to major transitional change, from risk/sector level up to an overall system. This will mean actions are unlikely to be binary, i.e. incremental or transformational, but rather part of a spectrum. It also means a more careful, patient approach to development will be needed, with social learning used to make sure such actions are nurtured not inaction. Transformational adaptation in practice is likely to involve a combination of initiatives, some of which may look incremental on their own, but are part of a wider set of activities to deliver more transformational change.
- The definitions of transformational adaptation (in the literature) are often value-laden, associated with particular views of current societal ills, or requiring certain elements (e.g. a

focus on ecological sustainability and/or social justice around governance and decision-making). However, these are not necessary preconditions of a shift and often the conditions attached are subjective. We will therefore avoid being too prescriptive (i.e. in predetermining whose transformation it is).

- Related to this, the language and the framing (and who is doing the framing) used to describe transformational adaptation can strongly influence the perception of the action, especially among some groups. It will also be important to tell the story of what will change (from the perspective of those it will affect).
- There is a strong cluster in the literature that defines transformational adaptation through the lens of social learning literature, highlighting it should be driven by participatory processes (i.e. involving social and community mobilization, enhancing the agency of individuals). We accept that these may be attractive activities to explore, as they could promote conditions for change, but we do not believe that all transformational adaptation has to have these attributes.
- There are a number of approaches for exploring transformational adaptation. These need not be undertaken in isolation. Clyde Rebuilt will consider elements of the barriers to adaptation, pathways (tipping points) literature, systems thinking and social learning literature, and creative and cultural approaches, in order to develop its approach to transformational adaptation.
- It is often assumed transformational adaptation should have large positive outcomes. This is not a given. Any large-scale change is likely to have benefits for some but disbenefits for others. Moreover, more major change may not work (and an important element of EIT Climate-KIC's Deep Demonstrations approach is to be allowed to fail and learn). Nonetheless, we think a transformational change should involve a large-scale intervention (or allow

replicability) and should be sustained after the initial intervention. A set of transformational adaptation criteria will be used to assess regional adaptation options, but also as design and appraisal criteria for an innovation portfolio.

- It is possible to develop a process for transformational adaptation, centred around the EIT Climate-KIC Deep Demonstrations method, which includes varying tools and techniques. For the Glasgow City Region this includes a transformative vision, developed through a Theory of Change to guide action, the use of systems approaches, criteria-based approaches which emphasize transformation, as well as the use of cultural practices.

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Resilient Regions: Clyde Rebuilt

The Resilient Regions: Clyde Rebuilt project is delivered by a consortium including Sniffer, Paul Watkiss Associates and Creative Carbon Scotland, and EIT Climate-KIC, and is funded by EIT Climate-KIC and fifteen local partners. The project has received funding from Climate KIC, supported by EIT, a body of the European Union.

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Watkiss, P. and Cimato, F. (eds) (2020). What Does Transformational Adaptation Look Like? Literature review synthesis paper. Deliverable 10 of the Resilient Regions: Clyde Rebuilt project.

Published by Clyde Rebuilt, Glasgow, Scotland

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Creative Carbon Scotland is a Scottish Charitable Incorporated Organization. Registered Scottish charity number: SC042687. Registered office: City Chambers, Room 9/50, High Street, Edinburgh, EH1 1YJ