UKCIP

Transformational adaptation

what it is, why it matters & what is needed

UK Climate Impacts Programme (UKCIP)

UKCIP supports adaptation to the unavoidable impacts of a changing climate. It works at the boundary between scientific research, policymaking and adaptation practice, bringing together the organisations and people responsible for addressing the challenges climate change will bring. Based at the Environmental Change Institute, University of Oxford, UKCIP coordinates and influences research into adapting to climate change, and shares the outputs in ways that are useful to stakeholders.

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Foreword

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This report offers, for practitioners and researchers alike, a timely, comprehensive and insightful overview of the literature on transformational adaptation. It draws from the literature to create an ambitious skills-based framework for more effective transformative action.

The report is published at a time of unprecedented global attention on climatic hazards and societal vulnerability. There is a desire and urgent need to move from reactive, costly clean up and rebuilding to risk management and proactive action. With the approaching United Nations Climate Change Conference, due to be held in Paris, France, later this year, there is a global opportunity space for critical reflection of current practice and proactive, evidence-based dialogue and knowledge exchange between scientists, policymakers and practitioners.

Whilst there is an appetite and need for transformational adaptation at a global scale, for systemic, fundamental change in our socio-political systems, the clear message throughout this report is that progress in effecting transformational adaptation will be put in jeopardy if we do not turn our attention towards ensuring we have enough politicians, practitioners, researchers and intermediaries with the necessary transformational capacities, in particular; the capacity for systemic inquiry, the capacity to cultivate and embrace uncertainty, to lead courageously, to facilitate and effectively participate in intermediation and, crucially, collective effort to facilitate a cultural shift towards honest dialogue and learning from practice.

The broad view of how to progress transformational adaptation is helpful, allowing us to step back from the tendencies in the literature that emphasise local action and learning cycles as sites for transformation. Experience suggests these are important, perhaps necessary, but not sufficient spaces of fundamental change. It is to a conversation with national and international actors that work on transformation could now usefully turn, to find ways of facilitating transformation, acting across scales and so to avoid the trap of transformation becoming framed as a responsibility and burden for local actors as we collectively attempt to reorient development towards sustainability.

1. Why we wrote this paper

The UKCIP workshop brought together over 20 people from government and funded agencies, NGOs, practice and research with an interest in transformational adaptation. The workshop aimed to provide a conductive space to:

- identify what a practical set of actions to deliver transformative adaptation action might look like;
- consider what role researchers, policymakers and practitioners might play in delivering such actions;
- bring researchers, policymakers and practitioners together to explore opportunities for collaboration; and
- hear how others are defining and applying the concepts of transformation.

The motivation for writing this paper was to summarise the findings of a short scoping exercise we (UK Climate Impacts Programme (UKCIP)) undertook to understand transformational adaptation in more depth, compare how different people were framing it and consider what it might mean for a practice-focused organisation such as ourselves. We also saw this as an opportunity to bring together people interested in or already using the term to ask 'is this a meaningful concept?' and 'is there useful work we could do together to develop it further?'

Drawing upon recent literature on transformation and climate adaptation[1] and reflecting upon a recent Intergovernmental Panel on Climate Change (IPCC) conference (University of Oslo, 2013) and a workshop on transformational adaptation we organised in March 2015 for practitioners and academics, we consider whether transformational adaptation is simply a means of categorising the nature of our response to climate change risks, or has potential to provide practical tools for more effective adaptation. This paper is not a rigorous review but an attempt to draw out key themes from the literature, with a focus on the practice implications, as a starting point for exploring what is required to move transformation from an attractive concept to something more tangible and policy-relevant.

Mobilising information and resources to respond effectively to the challenges brought by our changing climate requires transdisciplinary approaches that address the scientific, technological and social dimensions of change, and the different ways of seeing and defining the challenge that this encompasses. As a capacity-building organisation, we are keen to identify what practical approaches might be used to enable adaptation that goes beyond incremental 'change at the margins' to build more resilient systems with capacity for transformation. This paper summarises themes from the literature and workshop discussions about the concept of transformation, how it might be applied and priorities for future research and practice.

1 *For a rigorous literature review that offers a critical perspective on transformation by mapping its conceptual and methodological diversity, see Feola (2014).*

2. Introduction

Transformational vs transformative

Throughout our review of the current transformations literature the terms 'transformational' and 'transformative' are used extensively, and sometimes interchangeably. In this report, where citing specific literature, we have used the term(s) used by the original authors. Elsewhere in the report, and after much debate, we have used 'transformational adaptation' as an umbrella term for adaptation pertaining to transformation, and 'transformative' to refer to actions leading, or intending to lead, to transformation.

Within the climate change adaptation research community there is a growing tendency to discuss adaptation using the language of transformation, reflecting a sense that the current status quo will not secure a sustainable future, especially in light of the lack of sufficient progress to mitigate the causes of anthropogenic climate change. Terms such as 'transformative' (Park *et al.*, 2012), 'transformational' (Kates *et al.*, 2012), 'transformative agency' (Westley *et al.*, 2013) and 'transition' (Tompkins *et al.*, 2010) suggest a more fundamental change within and across systems, emphasising the current adaptation deficit and seeking to move away from a perception that 'incremental is enough'. The term has also been taken up by the IPCC in their recent report on *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* (IPCC, 2012) and in their *Fifth Assessment Report* (IPCC, 2014).

This language, and the concepts which underpin it, offer hope that as a society we are capable of 'big change' in a world that increasingly demands reinvention and innovation in response to a myriad of interconnected pressures, thresholds and boundaries. However, these terms may also threaten our sense of stability; a steady change from business as usual may be far more palatable than change which may require us to question what we value and the way we live. It is a challenging, complex concept which lends itself to long-term thinking. In contrast, no regrets and win-win adaptation options are far better suited to current political timescales and appear to offer pragmatism in the face of a limited appetite for significant action to adapt to a changing climate. However, if we only focus on this low-hanging fruit, do we risk ignoring the more substantive, systemic changes which may be needed to respond to a changing climate in a rapidly changing world?

3. Understanding transformational adaptation

3.1 Defining transformational adaptation

Mustelin & Handmer (2013) observe that despite the increasing use of the term transformation in relation to adaptation, the concept is still vague and defined in different ways. As O'Brien notes (2012) it means "*different things to different people or groups, and it is not always clear what exactly needs to be transformed and why, whose interest these transformations serve, and what will be the consequences*".

Responses from participants (working in research, policy and practice) at a UKCIP workshop, March 2015 on 'What is transformational adaptation?'

- **Transformation may occur at different levels and dimensions, mediated by power relations, but usually implies a systemic or paradigm shift, possibly triggered by intolerable losses.**
- **The change is likely to be radical and challenge the current status quo, although the experience of the change and whether it is radical, incremental or transformational depends upon where you are in the system.**
- **It is likely to be painful, scary, exhausting and engage strong emotions requiring us to develop our own personal praxis. Opportunities for intermediation and shared learning also need to be developed.**
- **Effective leadership is needed for transformational change, although whether this is through strong centralised decision-making or the distribution of power to make more localised decisions was not agreed.**
- **To achieve transformational adaptation we need to pay attention to the timing of interventions. The process of transformational adaptation was described as a 'journey', a 'plan' and a 'route map' with moments (e.g. decision points) where radical change was possible but path dependency at other times, where radical change might be blocked for decades.**

Feola (2014), in his review of the literature on transformation in global environmental change, discusses the impact of using the term simply as an overarching metaphor for radical and fundamental change in a system but resisting precise definitions of the term or its underlying concepts, and attempts to define such a complex term more rigorously despite the likelihood of multiple understandings and perspectives. He suggests that without clearly defined boundaries, the potential for vagueness may constrain communication across disciplinary boundaries and inhibit meaningful action, but that attempting single definition of the concept would also be unwise. He thus recommends 'conceptual plurality' so long as the term can be characterised and articulated "in forms that can facilitate scientific dialogue, empirical testing and application of concepts and theories and, ultimately, theoretical development" (Feola, 2014). How transformational adaptation is framed affects how it is then tackled, who or what is considered relevant to making improvements, what risks are given priority, what options are considered plausible and what outcomes are seen as desirable. To understand what is actually being changed through the process of transformational adaptation, it is first necessary to locate the scale or scales of interest in relation to time and space (Mustelin & Handmer, 2013). There is some lack of clarity and difference of opinion about the spatial scale (or scales) and sectoral scope at which transformational adaptation can operate, as well as the level of control that can be exerted over the change process.

If there is a poor understanding of the dynamics of the current system, any interventions to improve the situation are not only likely to fail but may even make it worse (Cork *et al.*, 2007). The aspect of the system that is considered to be most vulnerable is likely to dictate whether the issue is framed as having only a limited, local interest or require a system-wide and transformative intervention. If vulnerability is framed as resulting from socio-political processes, then more disruptive transformational adaptation may be seen as necessary to address deeper system structures (Pelling, 2011), while in other cases incremental adaptation may be sufficient.

Table 1: Ways of interpreting transformation (building on Mustelin & Handmer, 2013)

Concept		
	Folke *et al.* (2010)	**Transformation: "The capacity to transform the stability landscape itself in order to become a different kind of system, to create a fundamentally new system when ecological, economic, or social structures make the existing system untenable".** **"Transformation or transformability in social-ecological systems is defined as the capacity to create untried beginnings from which to evolve a fundamentally new way of living when existing ecological, economic, and social conditions make the current system untenable".**
	Nelson *et al.* (2007)	**Transformation: "A fundamental alteration of the nature of a system once the current ecological social or economic conditions become untenable or are undesirable". No distinct boundary between incremental adjustments and transformation. Can be forced by systems failure or chosen in anticipation of collapse.**
	Park *et al.* (2012)	**Transformation: "A discrete process that fundamentally (but not necessarily irreversibly) results in change in the biophysical social or economic components of a system from one form function or location (state) to another thereby enhancing the capacity for desired values to be achieved given perceived or real changes in the present or future environment".**

Concept *continued...*	Thornton & Comberti (2013)	In situations where the impacts of climate change are particularly extreme or rapid, and where populations are especially exposed or vulnerable to these impacts, incremental, autonomous adaptation may be insufficient. In such cases, a more radical adaptive response, transformational adaptation, referring to fundamental changes to a social-ecological system (Olsson *et al.*, 2006), may be required (Kates *et al.*, 2012).
Purpose	Revi *et al.* (2014)	Transformative adaptation: where adaptation is recognized for its potential to address root causes of poverty and failures in sustainable development, including the need for rapid progress on mitigation.
	O'Brien (2012)	Deliberate transformation: multi-definitional concept depending on one's values and worldview; associated with changes in meaning-making processes calls for new critical approaches and challenges paradigms.
	O'Neill & Handmer (2012)	Transformative adaptation: distinct deliberate changes in practices learning through monitoring and re-evaluation.
	Olsson (2003)	Transformative capacity is the capacity to initiate social transformation that moves away from unsustainable and undesirable trajectories, towards new social-ecological trajectories that strengthen and enhance management of desired ecosystem states and associated values.
	Pelling (2011)	Adaptation as transformation: fundamental shifts in power and representation of interests and values.
	Preston *et al.* (2013)	Adaptive transformation: a fundamental alteration of "actors' perspectives on sustainability societal objectives and how they can be achieved". Main issue whether transformation is optional and voluntary or obligatory and externally mandated.
	SREX (IPCC, 2012)	Transformation presented as one of six interacting elements that make up the 'solution space' for managing risks and adapting to climate extremes.
Place	AR5, (IPCC, 2014) (quoted in Pelling *et al.* 2014)	Transformation inducing fundamental change through the scaling up of adaptation, conceived as a limited, technical intervention with transformative potential; 1. Transformation as actions or interventions opened when the limits of incremental adaptation have been reached; 2. Transformation seeking to address underlying failures of development, including increasing greenhouse gas emissions by linking adaptation, mitigation, and sustainable development.
	Kates *et al.* (2012)	Transformational adaptation: 1. Adopted at a much larger scale or intensity 2. Truly new to a particular region or resource system 3. Transform places and shift locations. Nature: both reactive and anticipatory can be collective individual organisational both autonomous and planned; spin-offs from other actions incremental or rapid.

3.2 Differentiating between incremental and transformational change

"The degree of anticipation versus reactivity to stimuli from the social environment, the time-scales, the degree of intentionality and control, and the number of actors and the intensities and forms of their connectedness in bringing about change all vary widely."

Moser & Ekstrom, 2010.

Although transformational adaptation is usually presented as distinct from incremental adaptation, the criteria used for making this distinction vary, making it hard to clearly and reliably identify what constitutes transformational change in different situations (Nelson *et al.*, 2007). Climate change adaptation only becomes 'real' in situations (Collins & Ison, 2009) where the concept can be contextualised, as both adaptation and climate resilience are 'referent' terms in that you need to understand what it is you are adapting to and who or what adapts (Smit *et al.*, 2000; Carpenter *et al.*, 2001). In most definitions, neither incremental nor transformational adaptation is described as a single strategy but more commonly as a number of interacting processes that may have been anticipated and intentional, or in reaction to significant change (and possibly unexpected). They may also occur either in response to climatic or non-climatic factors (Thornton & Manasfi, 2010; Nelson *et al.*, 2007).

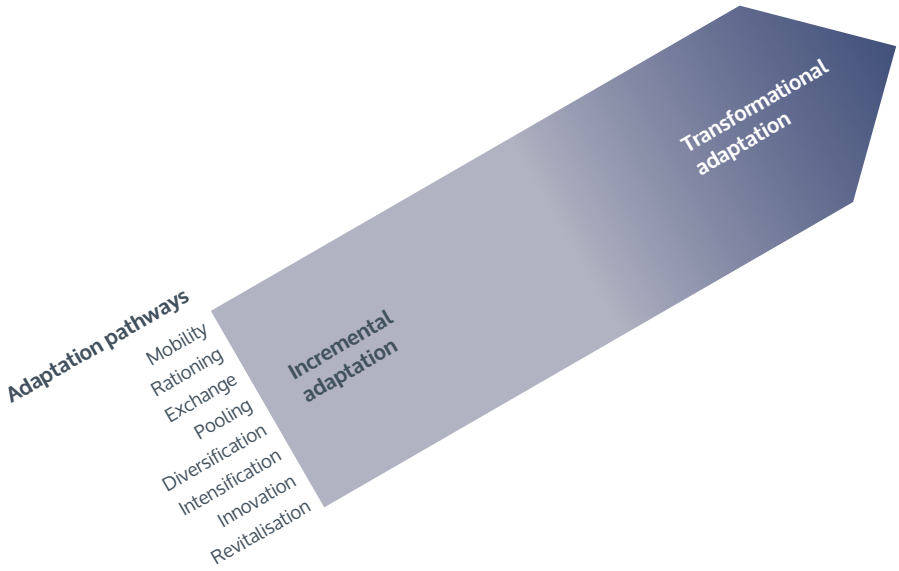
Mustelin & Handmer (2013) provide a useful table that compares many definitions of transformation from recent literature (Table 1 is an adaptation of this). Using this table it is possible to draw out criteria (given below in Table 2) they cited as enabling us to distinguish between incremental and transformational adaptation. Many of these criteria are common between definitions, but some may be disputed.

Table 2: Criteria used to distinguish incremental and transformational adaptation (adapted from Mustelin & Handmer, 2013)

	Incremental	Transformational
Framing	Framed as 'complicated'	Framed as 'complex', 'wicked' or 'super wicked'
Learning	Single and double loop learning (Agyris & Schön, 1978)	Triple loop learning
Scale	Smaller, discrete, within system changes	System wide change or across many systems
Temporal	Focus on current conditions and short-term change and future uncertainty is not acknowledged	Focus on future, long-term change and uncertainty in the future is acknowledged and built into decision-making.
Power	Generally greater control over outcome	Outcome open ended or uncontrollable (and could be positive or negative)
	Seek to operate within the status quo to maintain and/or increase efficiency of existing systems	Addresses power imbalance and the causes of social injustice to induce a step change /radical shift to the operation of the existing system
Management	Reactive management of change, focusing on current conditions	Anticipated, planned management of change
	Management of change is focused on finding ways to keep the present system in operation	Management of change includes questioning the effectiveness of existing systems and processes
	Aim to address Type I (resistance and maintenance) and Type II (change at the margins) management problems (Handmers & Dovers, 1996)	Aim to address Type III (openness and adaptability) management problems

Some researchers present incremental and transformational adaptation as operating along a spectrum. Thornton & Manasfi (2010) (Figure 1) suggest that transformational adaptation is most usefully conceptualised as the radical end of more conventional adaptation processes and capacities, while Moser & Ekstrom (2010) refer to a range "from short-term coping to longer term, deeper transformations".

Figure 1: Adaptation pathways for incremental and transformational change (redrawn from Thornton & Manasfi, 2010)



Many, however, present transformational adaptation as something quite different to incremental as it requires a 'paradigm shift' in the way the issue is framed, and because it tends to focus on larger, more profound system changes. Pérez-Català (2014) articulates the two main distinctions in the literature on transformational adaptation as 'fitting to' and 'fitting with' the environment, although others refer to this as 'adapting to' and 'adapting with' change (Pelling, 2011; Collins & Ison, 2009). In the 'adapting to' framing, the environment is external, and the focus is on how the existing system is responding to increased risk and vulnerability by developing adaptation responses that focus on increasing either the scale or intensity of existing approaches (Kates *et al.*, 2012; Rickards & Howden, 2012). In the 'adapting with' framing, socio-ecological systems are co-developing responses to change and this framing thus emphasises the need to consider the causes of vulnerability within society (Pelling, 2011; Rickards & Howden, 2012). The majority of definitions of transformational adaptation refer to how it addresses fundamental aspects of the system, often overtly including aspects of power and justice.

3.3 Models of transformational adaptation

The term 'paradigm shift' is sometimes used to describe such a fundamental system-wide alteration (Kuhn, 1962). Building on previous work, Pelling *et al.* (2014) present a model of transformational adaptation 'activity spheres' (see Figure 2). The activity spheres are conceived as co-evolving throughout history and although all are interrelated, none essentially dominate. Each sphere is capable of transforming as a result of internal processes of change as well as in response to changes in the surrounding spheres. The model prompts questions about the relative significance of each sphere in processes of transformation, and the extent to which transformational change needs to happen across all to create profound and sustainable system changes.

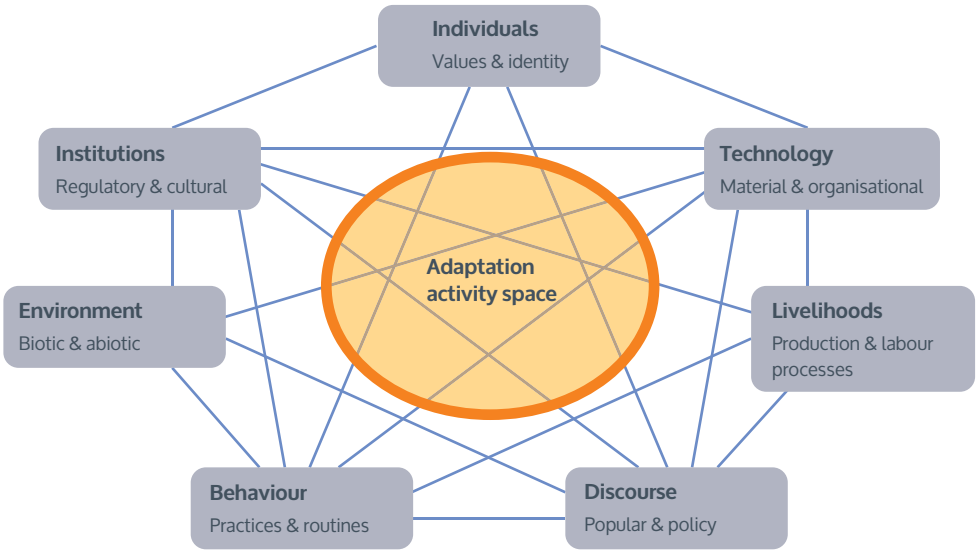
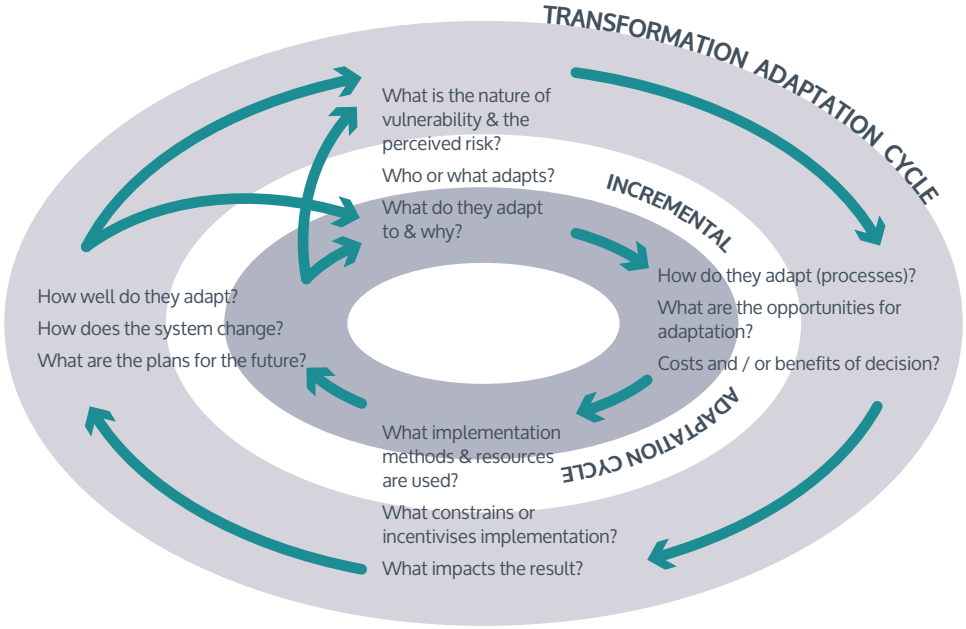


Figure 2: Adaptation activity space (redrawn from Pelling *et al.*, 2014)

Whilst there are many agreed characteristics for transformational adaptation, some remain unclear (such as the scale or durability of change) or disputed. Park *et al.* (2012) argue that transformations are so disruptive that they generally only last for a short period and settle back into a more stable state in which new infrastructure is built and change reverts to being incremental, 'change at the margins'. The adaptation action cycle model developed by Park *et al.* (2012) builds upon change management and action-learning theory to provide a model of purposeful decision-making for transformational adaptation. The cycle links an incremental adaptation cycle with a transformational adaptation cycle, identifying points where the incremental cycle might shift to the transformational cycle. Decision-making processes tend not to stay in 'transformational' mode for long periods of time as it is too disruptive. After a period of transformation, new changes are embedded in new systems, including policy and research, so Park *et al.* (2012) hypothesise that after a successful process of transformation, decision-making flips back to the incremental cycle until further transformational adaptations are considered necessary.

Figure 3: Adaptation action cycle (redrawn from Park *et al.*, 2012)



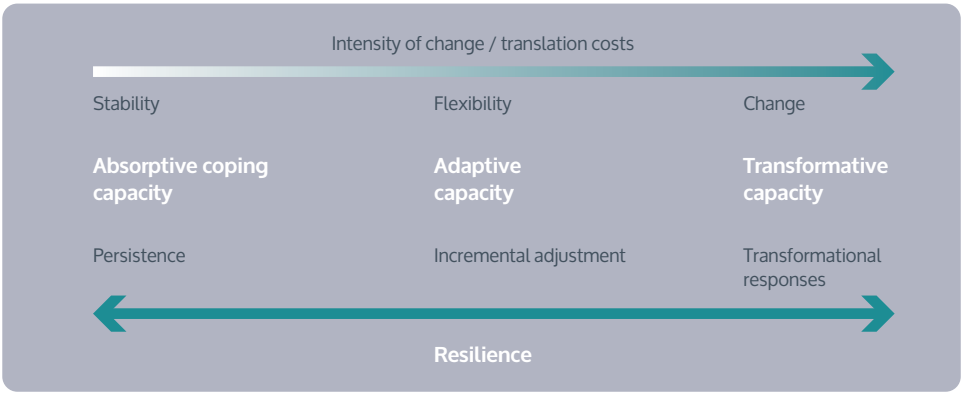
A number of authors use the metaphor of a 'window of opportunity' to describe the triggering of transformational change at particular moments, such as a rapid change or ecological crises (Folke *et al.*, 2005), or in response to social and economic shocks (Olsson *et al.*, 2006), although what actually triggers transformation is likely to be locally specific and dependent on factors such as access to assets, degree of exposure and the range of perceived options (Adger, 2006).

In this social-ecological context, a third narrative of resilience is introduced (Plummer, 2010) as:

- **Resilience**: the amount of change the system can undergo (and implicitly, therefore, the amount of extrinsic force the system can sustain) and still remain within the same domain of attraction (i.e. retain the same controls on structure and function);
- **Adaptability**: the degree to which the system is capable of self-organisation (versus lack of organisation, or organisation forced by external factors); and
- **Transformability**: the degree to which the system can build the capacity to learn and adapt (Carpenter *et al.*, 2001; Walker *et al.*, 2002; Folke 2006).

These elements are translated into capacities in other framings e.g. 3D framing (Béné *et al.*, 2012).

Figure 4: The 3D resilience framework (redrawn from Béné *et al.*, 2012)



Such transformation can be at the geological, historical and human scales (Waddell, 2011), but tends to be focused upon the last two. Clearly trying to actively influence change across a number of interlinked activity spheres or domains requires understanding of the system involved and the dynamic interrelationships and interdependencies between the key elements of the human and natural systems. It is at this interface that adaptation activity is focused, and narrow, siloed or sectoral approaches that do not appreciate this complexity are what are deemed to have led to the global ecological crisis we are now facing (Dovers & Handmer, 1992). The process for this fundamental reframing and how it leads to shifts in sense-making, power and priorities will be discussed in the next section.

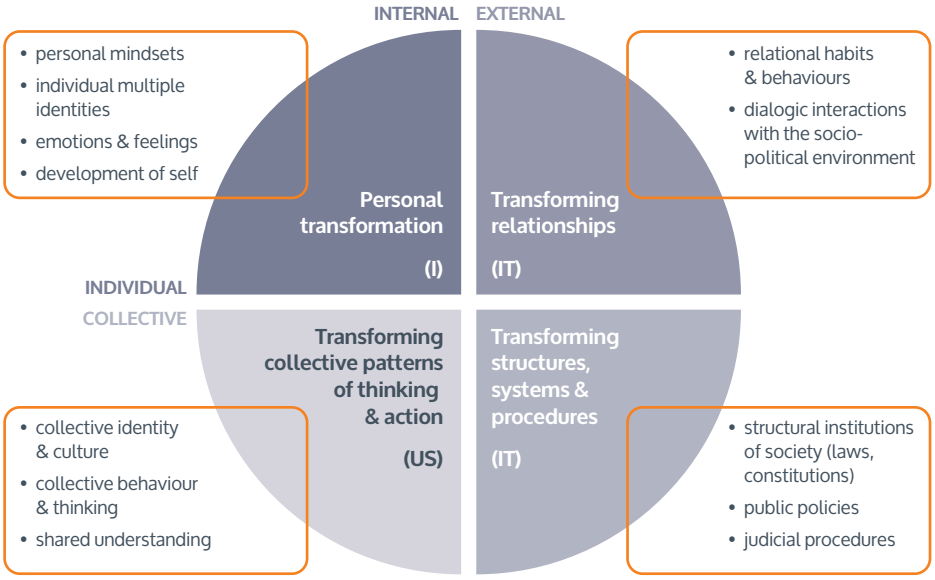
3.4 Themes arising from the literature

3.4.1 Scales of change required for transformational adaptation

The scale of change often described for transformational adaptation is at the level of governance, economic and technological systems, although many writers also suggest that to create truly sustainable transformations you need to be operating at more than one scale simultaneously. O'Brien (2011) proposes that building transformative capacity requires a combination of technological innovations, institutional reforms, behaviour shifts and cultural changes among relevant stakeholders at the international, regional, national and sub-national levels.

A number of other writers have used the frame developed by Ken Wilber (All quadrants, All levels – Wilber, 2006) to demonstrate the different areas of change required and as a tool to explore where barriers of change might exist (Ballard *et al.*, 2013; Retolaza, 2011; Ballard, Reason & Coleman, 2010). This indicates that change is required at the level of the wider system and also at an organisational, sectoral level, as well as changing perceptions, sense-making frameworks, practices and beliefs at a personal level. In Wilber's framework (2006) he differentiates between 'objective' (visible and easy to measure) and 'subjective' (important but not easily measurable) and also 'individual' and 'collective' factors to form a 2 x 2 matrix. Wilber proposes that each quadrant needs a different approach. One version of this is illustrated below:

Figure 5: Dimensions of social change (redrawn from Retolaza, 2011)



3.4.2 Timing of transformational change.

Transformational change in socio-ecological systems are is often described as a series of four distinct phases of an adaptive cycle (Holling, 2001) that exist at a number of scales in time, space and levels of organisation ('panarchies'):

Phases of an adaptive cycle:

1. **Pre-development: experimentation at is occurring at a small scale but without significant change to overall system dynamics;**
2. **Take-off: emergent innovation is sufficient to destabilise the existing 'regime' and initiate structural change in the system;**
3. **Acceleration: socio-cultural, economic, ecological and institutional changes develop further and structural transformation of the system occurs; and**
4. **Stabilisation: system in a new dynamic state of equilibrium.**

(Nelson *et al.*, 2007; Walker *et al.*, 2004; and Holling, 1973)

Many of the models of transformational change imply that systems go through periods of emergence and growth, which then lead to breakdown, reorganisation and renewal (Homer-Dixon, 2008): in some phases they are more open to fundamental change; in others they are open to incremental adjustment (Leadbeater & Mulgan, 2013). Innovation theory suggests that often the point at which you can have most influence is when a system is in transition between phases.

"A problem is recognized, a solution is available, the political climate makes the time right for change, and the constraints do not prohibit actions."

Kingdon, 1995.

Kingdon (1995) stresses the importance of timing for initiating policy changes and opening policy windows. He argues that significant changes are most likely when three independently operating 'streams' come together at critical times, i.e. problems, solutions, and politics. Rapid change and ecological crises can act to provide windows of opportunity that trigger the emergence of networks and promote new forms of governance (Folke *et al.*, 2005). Pelling & Dill (2012) argue that disaster events can create the necessary space for transformational adaptation by proving that the existing system is inadequate, and challenging established values, organisations and power. Olsson *et al.* (2006), exploring why some of these windows of opportunity generate dramatic changes of governance and others do not, suggest that leadership is critical. Good leadership for transformational change prepares the system for change by supporting the emergence of shadow networks, effectively navigating the transition, and charting a new direction for management.

3.4.3 Social justice and ecological sustainability

All adaptation decisions have ethical implications, but in transformational adaptation this is likely to be more critical. Whilst dominant adaptation approaches tend to be depoliticised and technocratic in nature, with linear causal pathways of social impacts resulting from the physical environment, the transformational approach to adaptation requires fundamental change in the systemic structures that produce vulnerability, particularly power imbalances (Schulz & Siriwardane, 2015). By aiming for 'radical change' and much more overtly addressing aspects of power, transformational adaptation seeks to reshape the existing status quo and address the root causes of current inequality. Transformation may be directly driven by dissatisfaction with the status quo (Revi *et al.*, 2014) and thus may provoke strong reaction from those invested in the current system who perceive that they have a lot to lose. Transformational change "reveals the hidden social preferences that are reproduced through adaptation choices and which can embed or challenge dominant relations of power", Pelling (2011).

By increasing the policy options for adaptation from incremental adjustments that preserve the integrity of the current system when conditions change to include measures that challenge the stability of current systems, assumptions about the rights and responsibilities of individuals, communities and wider governance, especially in relation to supporting vulnerable people and infrastructure are revealed (Adger *et al.*, 2012), as well as exposing some of the hidden structures that sustain vulnerability (Pelling, 2011). 'Adapting with' the environment rather than seeing it as something external (something that is 'adapted to'), inevitably gives humans a sense that they have influence over the economic, political and social structures that cause vulnerability (Pérez-Català, 2014; Rickards & Howden, 2012) and emphasises the dual responsibility in making fair and ecologically sustainable decisions.

Large scale social changes often require the support of influential stakeholders who benefit from the structures of the current system and are likely to object to any significant changes to it (Béné *et al.*, 2012). Handmer & Dovers (1996) describe the human desire to maintain the status quo where possible and return systems to a previous state after a disruption, rather than be open to major changes. In their typology, Type I resilience is characterised by the resistance of a system to change; Type II resilience involves marginal changes to make a system more resilient; and Type III is when there is a high degree of openness, adaptability and flexibility within the system (Dovers & Handmer, 1992). Type III resilience is capable of transformative action due to its ability to 'change the basic operating assumptions, and thus institutional structures' (ibid). It thus openly challenges unfair or ineffective power structures, and strongly advocates participatory mechanisms in order to expand the responsibility and subsequent opportunities for wider inclusion in decision-making and in expanding the choice of options. How successful and sustainable such change turns out to be depends to a large extent on the focus of interest, the extent of disruption and the reintegration between scales and sectors.

Local, regional and national level changes need to be well connected and embedded if they are to reinforce and strengthen positive changes. Positive change at the local level may be undermined by a lack of transformational adaptation at other scales or a lack of support structures embedded at the local level due to a failure to address power structures.

3.4.5 The importance of learning for transformation

"To thrive under conditions of accelerating change you have to be learning all the time."

Mary Catherine Bateson, 2004

Given the pulsed nature of change processes (Moench, 2009), continuous learning and re-evaluation become key factors for transformational planning as events reveal inefficiencies and injustices in the current structures and operations (Mustelin & Handmer, 2013). A distinction between three different systems of inquiry for learning are made by Reason & Rowan (1981):

- Learning for knowing (propositional learning or *scientia*);
- Learning for doing (practical learning or *techne*); and
- Learning for being (experiential learning or *praxis*).

"Our society and all its institutions are in a continuous state of transformation. We must learn to understand and manage these transformations. We must, in other words, become adept at learning."

Donald Schön, 1983

For transformational adaptation, this translates as: transformation of understanding; transformation of practices, and self-transformation, or the transformation of collective selves (Wals, 2009; Blackmore, 2007) which are all necessary for understanding the complexity of dynamic natural and human system interactions, and to develop the necessary resource management competence as well as the ability reflect on and learn from experience (Bawden, 2007). If what we do in this world is a reflection of how we see it (Maturana & Varela, 1987), then changing our way of seeing it and "learning our way out" (Milbraith, 1989) is an essential skill to develop. However, educational programmes that explicitly encourage students to develop their triple loop learning capacity (Agyris & Schön, 1978), and question their ways of knowing and contextualise their beliefs with others, are rare.

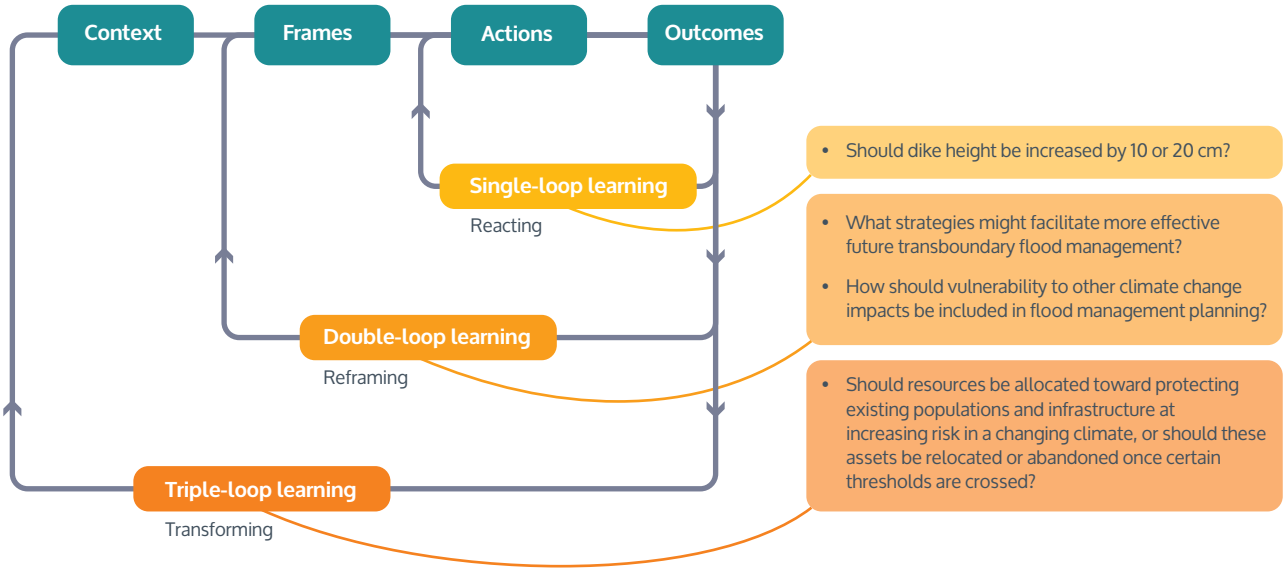


Figure 6: Image illustrating learning loops (redrawn from SREX Report IPCC, 2012)

Agyris and Schön developed a model of organisational learning which can also be used at other scales as the same dynamics apply (Wadell, 2011). In this model, single loop is associated with becoming more efficient at learning to do the same thing, and double loop when experience leads to change in how something is approached or even the goal itself. Triple loop learning occurs when the framework or context for observing and analysing is questioned (see Figure 6).

Wadell developed this further to compare single, double and triple loop learning in relation to the type of change resulting from the learning level (see Table 3). Additional factors that support transformative learning include peer-to-peer or 'conspecific' learning, as learning happens most effectively with and from others we consider to be like ourselves (distinct from social learning (see Wals *et al.*, 2009) as it does not require widespread social uptake), and the willingness to experiment and take a risk as being averse towards risk may reduce transformability (Walker *et al.*, 2004).

Table 3: Types of change and learning levels (adapted from Waddell, 2011)

Type of Change	Incremental	Reform	Transformation
Type of Learning	**Single loop**	**Double loop**	**Triple loop**
Core question	How can we do more of the same? Are we doing things right?	What rules shall we create? What should the goals be?	How do I make sense of this? What is the purpose? How do we know what is best?
Purpose	To improve performance.	To understand and change the system and its parts.	To innovate and create previously unimagined possibilities.
Power and relationships	Confirms existing rules. Preserves the established power structure and relationships among actors in the system.	Opens rules to revision. Suspends established power relationships; promotes authentic interactions; creates a space for genuine reform of the system.	Opens issue to creation of new ways of thinking and action. Promotes transformation of relationships with whole-system awareness and identity; promotes examining deep structures that sustain the system.

3.4.6 Maladaptation and barriers to transformational change

"Can we innovate rapidly enough, and with sufficient intelligence, to transform systems along pathways towards global justice, gender equity, and long-term social and ecological resilience? Can we do this in a participative manner, without resorting to fear, force or folly?"

Introduction to the Oslo Conference on Transformational Adaptation, 2012

"Humans like certainty and simplicity and are most comfortable when they feel that their future is predictable and controllable", (Cork *et al.*, 2007). We have a tendency to tune out from or oversimplify complex situations (Senge, 1994) and focus only on the part or parts that can easily be dealt with. This leads to a failure to anticipate or perceive future threats like climate change.

People respond to visible threats that are familiar and have a simple cause, especially if the threat is created by others who can be blamed. The 'story' of climate change is less simple and requires many people to engage and us all to take responsibility and change our behaviour. Opportunities to openly address the subject are rare, however, as it causes discomfort, controversy or despondency and a sense of fatalism in some ('what can I do on my own?') (Hamilton & Kassar, 2009). The urgency of need to respond may be played down by referring to uncertainty in the data and the consequences presented as some way off in the future (Marshall, 2014).

As has already been alluded to, system scale innovation is unlikely to ever be under the control of one or even just a few organisations as it involves complementary innovations at several scales. Leadbeater & Mulgan (2013) use the example that individual car ownership only became feasible after innovation in the supporting structures of garages, road markings, driving schools, oil refining and many other things. Without a detailed appreciation of the whole system (including the initial starting conditions; the history of the situation and the implicit 'framing conditions') transformative innovations may fail (Ison *et al.*, 2007) and good transformative practice at a local level can be limited by the wider system as existing structures and interests prevent the changes from diffusing (Thornton & Manasfi, 2010).

"I don't think we're yet evolved to the point where we're clever enough to handle as complex a situation as climate change. The inertia of humans is so huge that you can't really do anything meaningful."

Lovelock, 2010

Many of the skills and personal qualities required for navigating the transformational shifts thought to be necessary for sustainable adaptation responses are rare and require a high level of reflective capacity and awareness of self and others (Rooke & Torlbert, 2005; West, 2004; Belenkey *et al.*, 1986). Any significant transformation of social and institutional structures is likely to have multiple unintended side effects and there may be systems that cannot transform or would not be viable in a different configuration. We also need to understand the consequences of uneven transformation across systems, e.g. where structures are 'transformed', but the actors fail to adopt new ways of thinking and working, or where transformational change occurs at a local level but is not supported by change in infrastructure or legislation (Thornton & Manasfi, 2010). All such consequences could exacerbate rather than reduce existing inequality.

Lack of usable information is often given as a reason for lack of progress in our response to a changing climate, but it has also been shown that it is not lack of information that prevents action, and in fact more information can reinforce denial (Marshall, 2014). We need a better understanding of how to bridge the gap between knowledge about the changing climate, and the ability to link this to meaningful action and effective new opportunities without getting stuck with dysfunctional frames of reference that either inhibit action or limit it to 'change at the margins' (Handmer & Dovers, 1996).

3.4.7 Level of control over the outcomes of transformation

Some describe transformational adaptation as being inherently open ended and uncontrollable – with the implication that the outcomes could be very damaging or destructive, possibly for the most vulnerable people in society who have least capacity to respond. Others see adaptation as being fundamentally controllable with a definite, achievable end point. The term 'transition' is used by Stirling to imply a specific controllable endpoint, while transformation is inherently more open to a range of possible alternative trajectories (Stirling, 2011). He suggests that 'transitions' are more often driven by technological innovation, and managed within existing infrastructure, e.g. 'sustainable intensification' of food production using transgenic monocultures. He compares this with 'social transformations' described as "more plural, emergent and unruly political re-alignments, involving social and technological innovations driven by diversely incommensurable knowledges, challenging incumbent structures and pursuing contending (even unknown) ends".

This description fits well with 'transition management' defined as "a radical, structural change of a societal (sub)system that is the result of a coevolution of economic, cultural, technological, ecological, and institutional developments at different scale levels", (Rotmans & Loorbach, 2009). In this conception, a transition process is not set in advance, has no fixed pattern and there are large differences in the rate and scale of change and the period over which it could occur, influenced by political and social circumstances. Similar to the adaptation activity spheres (Pelling *et al.*, 2014), a transition is the result of developments in different domains (e.g. technology, the economy, institutions, behaviour, culture, ecology and belief systems) which may reinforce each other. Due to the dynamic, multi-layered and multi-dimensional nature of such change, change has to happen in several domains for a transition to occur (Martens & Rotmans, 2005). While some researchers agree that it is possible to make a deliberate choice to transform and create a positive, fairer outcome (O'Brien, 2012), others, usually those taking a resilience framing, suggest that transformation only occurs where there is no other choice, i.e. it is forced upon a system (inevitably limiting what responses are possible). Thornton & Comberti (2013) argue that using a social-ecological resilience perspective in situations where the impacts of climate change are particularly extreme or rapid, and which impact particularly exposed or vulnerable populations, radical transformational adaptation is required as this addresses fundamental changes to a social-ecological system (Olsson *et al.*, 2006; Kates *et al.*, 2012).

Perceiving transformational adaptation as inherently open ended and uncontrollable emphasises the potential for exacerbating negative effects on systems humans care about and increasing the vulnerability of sensitive groups, at least in the short-term. This raises questions about what level of short-term disruption is reasonable to achieve a future system that may or may not be fairer in the long-term. Even when well-planned and facilitated, if the scale of change is too broad and rapid for the system to maintain key functions adequately, it can lead to instability and confusion over who is responsible for new routines, practices, and their implementation (Handmer & Dovers, 2009). Large-scale rapid changes may increase system instability and may produce irreversible choices, which lead to suboptimal pathways and inflexibility, for example substituting diverse income sources for a single source of livelihood, which is more vulnerable to external pressures (O'Neill & Handmer, 2012; Handmer & Dovers, 2009).

While some present transformational adaptation as the last resort of a failing system, others speak more positively about the possibility of consciously designing a more optimistic response to institutional or climatic hazard related crises that engage actors at all levels in the process as well as developing societal pressure for change. In the transition management cycle, Loorbach & Rotmans (2010) describe four steps to achieve social transitions towards a fairer societal transitions towards sustainability. These are to:

1. Structure the problem and establish the transition arena;
2. Develop the transition agenda, the vision and identify the transition paths;
3. Undertake transition experiments and mobilise necessary transition networks; and
4. Monitor, evaluate and learn lessons from the transition experiments and adjust the vision, agenda and networks accordingly.

In this model the 'transition arena' is set up as a place to develop new ideas, agendas and visions; to support the transition process through learning and network and coalition building; and to find ways to influence the existing regimes and regime actors through activities at the level of the whole societal system, its subsystems such as financial and physical infrastructure and reflection on short-term day to day decision making that enable actors to evaluate and recreate or change system structures.

Another approach to achieving deliberate transformation at a human scale is through the holistic design framework described by Colvin & Abidi-Habib, (2013). The authors suggest the following basic principles for developing such platforms, for example:

- Valuing difference and diversity by bringing together **unlikely alliances** of individuals from different organisations, sectors or levels of governance and seek to reflect the wider system of interest, in microcosm.
- Draw on a **rigorous and holistic design framework or process** as a mechanism for transforming individuals' understandings, relationships, intentions and actions and to explore ways forward.
- **Carefully bounded or 'holding' space**, so that participants feel enough protection and safety, but also enough pressure and friction, to engage in the process and meaningfully acknowledge and negotiate the complexity of the situation.

In the next section we will look at the capacities that are needed to initiate transformational change and increase the potential for positive outcomes.

Key messages:

- There is a growing tendency to use the term transformation, reflecting a sense that greater, more significant adaptation responses will be required in the face of a global failure to mitigate the causes of anthropogenic climate change.
- Transformational adaptation is frequently contrasted with incremental adaptation and is characterised by:
  - system-wide change or changes across more than one systems;
  - a focus on the future and long-term change;
  - direct questioning of the effectiveness of existing systems, social injustices and power imbalances.
- There are several ways to conceive transformational adaptation and there is a distinct lack of clarity about the spatial scale (or scales) and sectoral scope at which transformational adaptation operates, as well as the level of control that can be exerted over the outcomes of the change process.
- There is some doubt about our ability as humans to adequately anticipate the changes likely to result from a changing climate and allow sufficient time to prepare for the scale of change required for deliberate transformation.

4. What are the transformational capacities we need to develop?

4.1 Capacity for systemic inquiry

Capacity needed: The interconnections between players in any given system are complex, and poorly designed attempts to make changes can have negative unintended consequences or introduce new failures or inequalities. Supporting transformational adaptation requires the capacity to inquire systematically. This means to inquire into a system of interest, to understand the history of that system (e.g. around sources of control, legitimacy and knowledge) and challenge the assumptions that underpin existing structures and ways of doing things. Reproducing 'solutions' without assessing what holds the current system in place may result in simply reinforcing existing failures and inequality. By developing a more detailed sense of the system as it currently exists, we can design interventions and feedback mechanisms that enable us to learn as ideas for system improvements are put into practice.

Systems and complexity approaches enable us to deal with complex issues or 'messes' (Ackoff, 1974) that have serious implications, many people involved, and different and uncertain consequences for each. The uncertainty involved in the 'mess' makes it difficult to pin down neatly (Reynolds & Howell, 2010). Systems and complexity thinking helps us to gain a bigger picture that includes the 'whole system' (however this is bounded) and appreciate the perspectives of others in this system (Chapman, 2004). By understanding the history of a situation and why it is currently dysfunctional or unfair, we can start to unpick the elements that have led to it becoming 'locked in' to the current set of limited perspectives or 'path dependency' (Ramalingham, 2013; Sydow *et al.*, 2009). The set of decisions that are available in a system at any given time is limited by previous decisions, even though past circumstances may no longer be relevant (Ison, 2010). In Phase I of the illustration below, there are many possible options that gradually reduce until the system becomes fully 'locked in' to a single path as it passes between Phase II and Phase III. By looking back at the past, the reasons one set of choices were made, and why other options were not taken, can be explored as a way to open up awareness of new possible options for the future. Such options can include those which retain flexibility and reduce the risk of lock-in in the face of uncertainties.

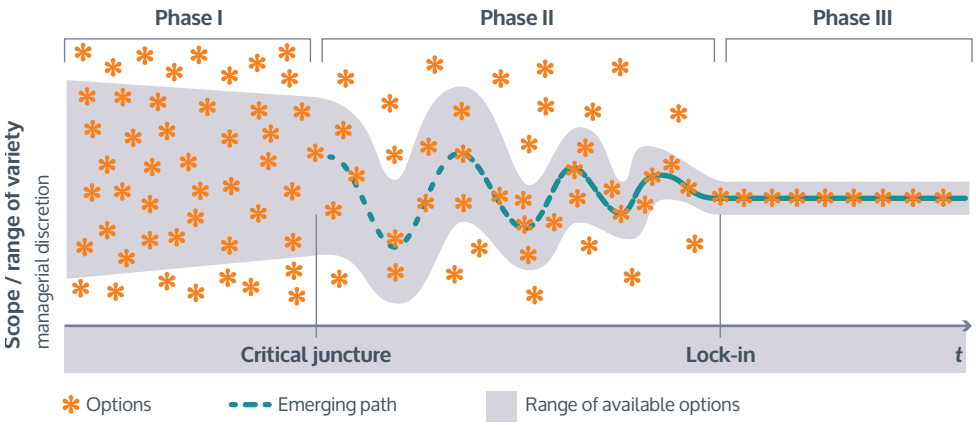


Figure 7: Illustration of path dependency (redrawn from Sydow *et al.*, 2009)

By collectively exploring the past and present of why existing systems operate as they do, improvements can be identified and trialled, and agreed upon or modified. The hope is that difficult issues that keep the system 'stuck' and ineffective may be aired, and that shared learning may generate new ways of perceiving and improving these issues. Activities to assist such an exploration have been developed in a number of social learning programmes (Wals *et al.*, 2007), e.g. through the framework developed in the Social Learning for the Integrated (Catchment) Management (SLIM) Project as illustrated in the table below (Mackay *et al.*, 2014; Blackmore *et al.*, 2010).

Table 4. Systems approaches used to enable improved collaboration in two regional Australian natural resource governance situations (Mackay *et al.*, 2014)

Key elements of the SLIM Framework	Associated activities
Context	Appreciate past causes of current understanding and practices
Institutions and policies	Develop conducive policies Develop conducive institutions
Stakeholding	Identify stakeholders Build stakeholding through joint responsibility
Facilitation	Identify facilitation needs Provide necessary facilitation (people and mechanisms)
Epistemological constraints	Co-produce knowledge in action Jointly produce what constitutes an improvement

4.2 Leadership for transformation

Capacity needed: People in positions of leadership have to make choices between investing time and resources on day-to-day maintenance activities and activities focused on coping well in the future. This requires the capacity to shift between the details of current activities while maintaining an awareness of the bigger picture, and being conscious of long-term goals when making short-term plans. The capacity to 'cultivate uncertainty'[2] about the situation of interest may also be essential to avoid too quickly making assumptions about a situation, and limiting the exploration of its complexity and the range of possible improvements that could be tried. The leader also plays an important role in articulating the issue and encouraging system-wide (or even inter-system) participation.

Thornton & Manasfi (2010) observe that leadership is one of the three key dimensions identified for transformational adaptation in the recent literature. Leaders can act to initiate and guide transformation by developing and communicating visions, encouraging followers to think differently and challenge, legitimising and giving value to new ways of thinking, behaviour and organisation, and mobilising support for such changes (Colvin & Abidi-Habib, 2013; Olsson *et al.*, 2006; Folke *et al.*, 2005). Reflecting on their own roles as leaders, Thornton & Manasfi make the point that noticing what is unfolding moment by moment and recognising the choices available at any given time is an important leadership skill: "Initially an important commonality was our understanding was that this was a moment of power and opportunity. Recognising the space that had opened up, we saw that we could do a combination of three things: act as visionaries, as change agents or merely as 'good consultants'."

Rooke & Torbert's (2005) leadership model, based on work by Crook-Geuter, examined the 'action logic' of leaders or how leaders interpret their surroundings and react when their power or safety is challenged. Moving between the seven distinct action logics in their model demonstrates the transformation process that leaders may go through when they expand their capacities and scope of influence from that of, for example, an efficient technical manager who is expert in a narrow field, to that of an 'alchemist' capable of moving between different action logics as the situation requires and catalysing social transformation. With on-going learning and personal development to cope with increasing complexity, most individuals can evolve to be able to operate at a higher level of leadership although not all can achieve the 'alchemist' action logic (only 5% or fewer leaders are thought to be able to operate at this level).

Transformational designers (Colvin & Abidi-Habib, 2013) play a leadership role in planning and facilitating processes of experimentation and fast cycles of learning. Colvin & Abidi-Habib (2013) observed that the people who are invited or offer to become such leaders are often accomplished and well-respected by their peer-group, but that wanting to maintain professional credibility may inhibit their ability to shift from an 'expert' role to that of facilitating a dynamic learning process in the face of novelty and uncertainty. Leading and managing transformational processes can feel risky and professionally 'unsafe', although for those at the higher 'action logics', as defined by Rooke & Torbert (2005), the challenge presented may be appealing.

2 *"To cultivate uncertainty means to become optimistic and to expect change to be possible..." Staemmler, F. 1997.*

Laszlo (2012) describes the 'mind-set', 'skill-set' and 'heart-set' competencies required by leaders of transformational processes. The mind-set of such a leader is grounded in a systems and evolutionary view of the world, and competencies include: practicing systems thinking; understanding the complexity and interdependencies of global dynamics; perceiving the patterns of change; considering the ethical and long-term implications of decisions; embracing a participatory and co-evolving emergence of new realities; declaring new possibilities for organisations, communities and society, and showing integrity between their world-view and actions. Skill-set competencies include: the ability to bring people together and act as a visionary guide pointing to new possibilities, and as an enabler empowering individuals and communities to make the vision a reality. Laszlo (2012) comments that the last set of competencies (the 'heart-set' competencies) are often either assumed or ignored but are core to the effectiveness of such leadership. These include: listening actively; engaging in difficult conversations and exposing those that are missing; and practicing systems thinking and systems being. Leaders also have to be comfortable with paradox, capable of paying attention to many different groups, and managing different perspectives at one time while remaining calm.

Leadbeater & Mulgan (2013) note, that as transformational processes involve so many aspects of change, they also require more than one leadership style. For example, acting to disrupt unfair structures requires a leader like a "pirate leading a crew, launching raiding parties on the status quo from the margins", while building alliances and movements requires a leader who is more like a "community organiser or the political leader of a coalition". In more open, emergent systems with many actors and where the task is to create solutions, then successful leadership is likely to be more interactive and distributed and more like "leading a community of volunteers, who cannot be instructed." (see also Westley *et al.*, 2013).

4.3 Learning from practice

Capacity needed: To be present and notice things, cultivate uncertainty and learn from experience. To create opportunities to reframe understanding based on practice and to inform the development of new approaches. To facilitate the learning process to ensure it provides sufficient challenge (through incorporating dissonant information or opposing views) and support (to encourage wide participation to include seldom heard and disparate voices).

Transformational learning is often said to be initiated by information or a dilemma that is sufficiently disorienting to force a reassessment of assumptions of 'how things are'. Identifying a new vision then leads to exploration of new roles, relationships, actions and planning a course of action that may require new knowledge and skills, testing and capacity-building before it can be implemented (Boenhert, 2009; Meizerow 2009). This process of reflection and reassessment requires individuals and organisations that are capable of creating shared visions across different disciplines, sectors, scales and other boundaries.

Reframing understanding based on practice

In *Steps to an ecology of mind* (1972), Gregory Bateson suggests that we are governed by epistemologies (ways of defining how we know what we know) that we know to be wrong as they fail to take in the full complexity of the world. To live with uncertainty and change, and nurture diversity for reorganisation and renewal, we need to be able to bring together multiple forms of knowledge for learning and creating opportunities for self-organisation (Berkes *et al.*, 2003).

Bateson describes a number of different possible levels of learning: Level 0 where there is no change (also called ignorance, denial or tokenism); Level 1 where existing systems are maintained and incremental change is accommodated; Level 2 where there is reformation and critically reflective change is possible; and the highest level, (Level 3) where transformation allows for the creative revisioning of the whole system.

Tschakert & Dietrich (2010) recommend both action-learning and action-research as useful approaches for developing capacity to learn from practice (Reason & Torbert, 2001, drawing upon Argyris & Schön 1974, 1978; Heron, 1992). Action-research approaches develop communities of inquiry where theories are built and tested in 'real life' to deepen understanding at the level of the individual, the group and the wider system. The main strength of action-research approaches comes from the active participation of people in the system in the formulation of the research questions, the collection of the information and the evaluation of what emerges. This may require bringing together multiple ways of knowing and experience to define and explore the issues in ways that make sense to the people who are part of that system and know it best, rather than 'professional' researchers from outside the system. Through critical reflection on practice, tacit assumptions can be identified and questioned, and unintended consequences acknowledged and integrated into new frames and plans. Developing the capacity for critical reflection in ourselves as individuals allows us to "act on our own values, purposes and meanings rather than on those uncritically assimilated from others." (Meizerow, 2009). Developing the capacity for transformational learning requires the capacity for reflective practice. Schön in his book, *The Reflective Practitioner* (Schön, 1983), describes the differences in approach taken by a 'reflective practitioner' as opposed to an 'expert' (see Table 5).

Table 5: Comparison of 'expert' and 'reflective practitioner' roles (Schön, 1983)

Expert	Reflective practitioner
I am presumed to know, and must claim to do so, regardless of my own uncertainty.	I am presumed to know, but I am not the only one in the situation to have relevant and important knowledge. My uncertainties may be a source of learning for me and for them.
Keep my distance from the client, and hold onto the expert's role. Give the client a sense of my expertise, but convey a feeling of warmth and sympathy as a "sweetener".	Seek out connections to the client's thoughts and feelings. Allow his respect for my knowledge to emerge from his discovery of it in the situation.
Look for deference and status in the client's response to my professional persona.	Look for the sense of freedom and of real connection to the client, as a consequence of no longer needing to maintain a professional façade.

Deliberate design for intermediation

Adaptation is frequently framed as a 'wicked' (Rittel & Webber, 1973) or 'super wicked' (Levin *et al.*, 2009; 2012) problem or a Type III problem (Handmer & Dovers, 1996) that is complex, uncertain, potentially urgent and for which both the problem description and response may be controversial or disputed. Such issues require many different groups to participate and, as there exists no best practice, only the option to 'sense' and 'probe' the system (Snowden & Boone, 2007) through experimentation in order to identify possible 'improvements' (Armson, 2011). To do this well requires the deliberate design of processes and mechanisms to bring such groups together, to articulate the issues of concern, share understanding and perspectives and collaborate to bring about improvements. Whole system approaches can be used, e.g. change labs; design labs; learning systems and innovation platforms; and systems (Colvin, 2014; Colvin & Abidi-Habib, 2013). These approaches recognise the significance of 'start conditions' and the need to understand the history of the system of interest in order to understand how to intervene.

Intermediation activities are not simply used to bridge different 'worlds' but also provide a set of functions to encourage interaction. The term 'K*' has been used to describe the functions and processes that may occur at the interfaces between knowledge, practice, and policy (Shaxon *et al.*, 2012). The K* paper (ibid) describes how these functions (with the associated capacities implied) act to improve the ways in which knowledge is shared and applied, e.g. by:

- **Informing**: creating, collecting, codifying, storing, and communicating ideas and information to make it more accessible and usable;
- **Relational**: improving relationships between the various actors around an issue; to enable co-production of knowledge and genuine dialogue, taking into account the power dynamics between all those involved; and
- **Systems**: working across a whole system to enable change (possibly working on multiple functions simultaneously) to ensure that there is a good institutional environment for sustainable innovation.

In some simple situations it may be sufficient to have access to information in order to progress, but in complex situations other roles become important, e.g. knowledge translation, brokerage or relationship building in order to co-produce knowledge or test out new approaches.

Supporting learning facilitators

In transformational processes learning must be seen as a constant activity both for the people involved and also for intermediaries shaping the on-going process (Hargreaves *et al.*, 2013). The role of intermediary people, organisations and other mechanisms (e.g. intermediary projects, networks, tasks) is necessary for bringing together the range of information needed to provide a suitable space to advocate for, and explain the range of, different perspectives and allow for the reframing of the issue, and in building confidence in the process of engagement to develop good working partnerships to enable all to participate effectively.

The key role played by 'learning facilitators' in designing, driving and supporting processes of learning in organisations is described in *The Heart of Organisational Learning* (Barefoot Collective, 2012) and includes a number of abilities that would assist learning in processes of transformational adaptation in organisations and more widely, e.g:

- Establishing and sustaining an environment and culture that is conducive to learning – ensuring different learning processes and styles are respected;
- Providing support necessary to take the risks involved in unlearning and learning;

- initiating, designing and facilitating learning processes;
- following up and holding people to account;
- drawing out learning from successes and failures in order to maintain interest, confidence and momentum and linking what emerges with real needs and changed action, attitudes or understanding;
- developing a vision that can be challenged as a source of learning;
- pushing for depth in reflection by asking incisive questions and challenging people to move beyond their comfort zones;
- providing dissonant information to encourage reassessment of current framing;
- acting as a role model through sharing reflections with others;
- keeping others in the system informed of what is going on (and asking for feedback); and
- cultivating uncertainty to allow new thinking to emerge (Staemmler, 1997).

Without support for skilled people to play such roles the depth of learning and its further impact is likely to be diminished.

Encouraging innovation, experimentation and new ways of seeing

The capacity for experimentation has long been understood as being integral for building resilience (Berkes *et al.*, 2003) or adaptive capacity (Levine *et al.*, 2011). The willingness to experiment is also a key capacity for transformations (Olsson *et al.*, 2006) needed to create radically new systems when incremental adaptation and adjustments are no longer possible or desirable. Storytelling and metaphors can be used to represent alternative versions of the current situation (Küpers, 2013; Lakoff & Johnson, 1980) allowing it to be viewed in new way and opening up new ways of seeing, new connections and new questions for further enquiry. Metaphors can "evoke and suggest new ways of doing things", (Cleary & Packard, 1992). Similarly, stories can also be used to re-shape our mental landscape and trigger new narratives or ways of operating. In this way, 'new' knowledge can be created and transferred. Of course, stories can be manipulated and many different narratives are possible, but if we are interested in creating a more positive future, constructing a coherent, convincing and compelling story might be a good place to start (Marshall, 2014). Clearly, in addition to experimenting with new ideas and piloting new approaches, there has to be a structured way to ensure that learning is fed back into the next stage of planning. Handmer & O'Brien (2012) proposed a set of new approaches to transform the way bushfire risk is managed in Victoria (Australia) by diminishing the hazard; reducing the exposure of infrastructure and buildings; reducing the vulnerability of people; and increasing the adaptive capacity of local institutions. The authors note that to avoid path-dependency maladaptation later (Barnett & O'Neill, 2010), these activities have to be 'nested' both in time (by creating pathways with continual re-evaluation and learning) and process (through incremental decision-making embedded in longer-term transformational pathways).

Learning histories rather than best practice examples

One of the conclusions of the transformation workshop was that there is a dearth of examples of transformational adaptation that enquire with sufficient depth and honesty into the real, messy practice involved in trying to transform an existing system. Learning histories, and some other action-research approaches, could be used to profoundly enquire into existing examples so that the richness and depth of that learning might be more easily shared and used elsewhere. As adaptation is a continuous learning process, this could also have the dual benefit, in these settings, of improving adaptive capacity.

A learning history or 'jointly told tale' captures the moment-by-moment reasoning of the people who took part, and describes their struggles to achieve the final outcome (Gearty, 2014). In working together to record and compare the various narrative strands that make up the learning history, participants also deepen their own understanding about what took place and which can be embedded in future plans. In more traditional case study approaches there is often a reluctance to record aspects that might be considered 'mistakes' or 'failure', although these parts are where the potential for greatest learning lies. Ensuring the necessary richness and depth of learning requires courage, honesty and profound enquiry which can seem risky and counter-cultural, especially in more technical organisations.

Key messages:

- **This section explored the capacities mentioned in the literature and from the UKCIP workshop that are needed to initiate transformational change and increase the potential for positive outcomes.**
- **Systems and complexity approaches helps us to gain a picture of the whole system, the history of the situation and why it is currently dysfunctional or unfair. By understanding this, and including the perspectives of others in this system, we can start to open up new ways of seeing the current situation and new visions for the future.**
- **As well as understanding the complexity and interdependencies of the system, leaders of transformational processes need many competencies, some of which may be quite rare. For example, they have to be comfortable with paradox and capable of paying attention to many different groups and perspectives at the same time.**
- **To make sense of complex systems in order to be able to transform requires us to develop our capacity to learn as individuals, as organisations and as systems.**
- **Action-learning and action-research approaches can be used to engage people in the system through the process of setting the questions for enquiry, collecting material, and in reviewing and evaluating what results.**
- **To aid system-wide learning there should be investment in learning facilitators and the deliberate design of intermediary processes, organisations and objects to bring people together, and open up space for sharing experience and planning future experiments and interventions.**
- **Ensuring the necessary richness and depth of learning requires courage, honesty and profound enquiry which can seem risky and counter-cultural, especially in more technical organisations.**

5. Themes for future research and practice

Building on the previous sections and contributions from participants at the transformation workshop, some themes for a future agenda are:

Applied practice

It is clear that future work has to be embedded in the real-life practice of making interventions in the systems that concern us. In order to make sense of this term, we need to ground concepts from the literature in examples, as without understanding the context we are limited to abstract conversations.

Learning focus

Learning has to be an intentional aspect of designing and progressing future work in order to obtain the level of detail and depth that we need to understand the complexity of the systems of concern we are working with. This requires honesty and profound enquiry that can seem risky and counter-cultural, as it involves a shift from 'best practice' accounts that gloss over 'failure' to real, messy practice. The roles of brokerage and intermediation are important in developing intentional learning, carrying it to other places and creating the space and enabling environment for change. Are we learning effectively from what is already happening in relation to transformational change, and could this research and practice be more effectively shared in the future? How we can develop our capacity to notice things and learn from our experiences?

A systemic approach

A systems approach is needed to understand the interdependencies between sub-systems that can make transformation difficult. What is the institutional infrastructure that will allow us to take a systemic approach? What impedes or enhances our ability to encourage transformational change? How might we fund it? How should we decide to invest our resources? The term 'pathway' implies a rational approach, whereas transformational adaptation requires something more revolutionary. What can we learn from socio-technical literature about developing new visions, utopias, alternative worlds entrepreneurs, niche experiments, 'sharp breaks', small scale initiative, learning and innovation? As well as creating new ways forward we need to simultaneously be destabilising and dismantling old ones, e.g. coastal defences as a response to sea level rise.

Such dismantling can evoke a sense of fear, especially to those with high vested interests in the existing system, but seems to be a necessary, and often overlooked, element of transformation.

The following key messages are drawn from the UKCIP transformation workshop:

1. **There is confusion over what transformational adaptation is, both as a concept and in practice. Having a well-articulated context-specific argument would help in persuading others in the system of concern to take an interest. It would also help to explain why funding such work requires new approaches to collaboration and learning.**
2. **There is a dearth of examples that enquire into the real, messy practice involved in trying to transform an existing system with sufficient depth and honesty. Learning history and other action-research approaches could be used to profoundly enquire into existing examples, e.g. Thames Estuary 2100, so that the richness and depth of that learning might be more easily shared and used elsewhere.**
3. **There is potential to enhance knowledge exchange and shared learning between those working on issues relating to transformational change. The challenge will be to acknowledge the context specific nature of work in this area while drawing out broader lessons, but without this leading to purely theoretical discussions based solely on the framing of the issue.**
4. **Transformation is not something that just happens 'out there', performed by someone else – it requires us to build our own reflexive awareness and set up opportunities to enquire into what needs changing, how to change it and learn throughout the process.**

Investing in capacity and skills for transformational action

Transformational adaptation requires leaders and others who are prepared to innovate and take calculated risks. This requires courage and a capacity to reflect on experience. This type of work can be rewarding but, potentially, demoralising. It can inspire and catalyse positive change but can also entail decisions that may be unpalatable to some, to which there may be strong resistance. It requires that someone in the system of concern needs to want to change. Other aspects that need to be understood include: where is the energy for action in the existing regime? Who has autonomy, influence, power over decisions, and the motivation and sustained energy to make necessary changes? The amount of control someone has, their pressures, targets and what they have seen and understand of the whole system, depends on their position in the system. For example, small transitions at a farmer level might be a result of more radical decisions higher up the supply chain.

To conclude, transformational adaptation ***offers*** a lot in terms of providing a framework to start to describe the types of change that could create more appropriate structures and responses to cope with the scale and rate of change resulting from a changing climate. We now need to ***deliver*** a lot if we are going to have any chance of initiating and managing such ambitious and radical change in practice. This requires applied transdisciplinary action-research approaches that are grounded in real situations and which involve those in the system as co-researchers. We see this paper as an opportunity to start developing conversations with others on how to do this.

A number of areas for future inquiry were identified by participants in our transformational adaptation workshop:

- **Clearer understanding and definition of the concept**
  Do we need a standard definition of transformational adaptation?

- **How we enact this concept in practice?**
  How do people, organisations and systems recognise the decisions that need to change?
  How do we recognise the decision or intervention points where transformational change is necessary/ possible?
  How might I develop my own praxis?
- **Learning by example**
  Are there examples of transformational adaptation that we can learn from?
- **Measuring transformational adaptation**
  Can we develop criteria for ethical and sustainable transformational adaptation processes?
- **Communicating the need for transformational change**
  How do we better articulate the need for more than incremental change?
  How can we identify and communicate the benefits of transformation?
- **Developing a vision**
  How can we articulate a positive vision of transformational change that resonates with decision-makers?
- **Funding and finance**
  What are the costs and consequences of not transforming?
- **Links beyond climate**
  Can transformational adaptation be separated from societal transformation? Will it drive change for dependent issues outside of climate?
- **Going to scale**
  How do we scale up and out from projects to system level and paradigm shifts?
- **Fairness and inclusion**
  What are the different types of support that different stakeholders in decision-making and outcomes need?

References

Ackoff, R.L. (1974). Redesigning the future: Systems approach to societal problems. 273pp. John Wiley & Sons. ISBN: 978-0-4710-0296-3

Adger, W.N. (2006). Vulnerability. *Global Environmental Change*, **16**(3): 268–281. DOI: 10.1016/j.gloenvcha.2006.02.006

Adger, W.N., Barnett, J., Brown, K., Marshall, N. & O'Brien, K. (2012). Cultural dimensions of climate change impacts and adaptation. *Nature Climate Change*, **3**: 112–117. DOI: 10.1038/nclimate1666

Argyris, C., & Schön, D. (1974). Theory in practice: increasing professional effectiveness. 264pp. Jossey Bass, San Francisco, USA. ISBN: 978-1-5554-2446-6

Argyris, C., & Schön, D. (1978). Organisational learning: a theory of action perspective. 356pp. Addison Wesley, Reading, Massachusetts, USA.

Armson, R. (2011). Growing wings on the way: systems thinking for messy situations. 344pp. Triarchy Press, Devon, UK. ISBN: 978-1-9080-0936-4

Ballard, D., Bond., C, Pyatt, N., Lonsdale, K., Whitman, G.P., Dessai, S., Evans, M., Tweed, J. & J.H. (2013). PREPARE – Barriers and enablers to organisational and sectoral adaptive capacity – qualitative study, Part of the PREPARE Programme of research on preparedness, adaptation and risk. *Final Report for project ERG1211* by Ricardo-AEA for Defra.

Ballard, D., Reason, P. & Coleman, G. (2010). Using the AQAL Framework to accelerate responses to climate change. *Journal of Integral Theory and Practice*, **5**(1): 43–60.

Barefoot Collective, (2013). The heart of organisational learning. Cape Town, South Africa.

Barnett, J. & O'Neill, S. (2010). Maladaptation. *Global Environmental Change*, **20**(2): 211–3. DOI:10.1016/j.gloenvcha.2009.11.004

Bateson, C.B. (2004). Willing to learn: passages of personal discovery. 384pp. Steerforth Press, Hanover, New Hampshire, USA. ISBN: 978-1-5864-2080-2

Bateson, G. (1972). Steps to an ecology of mind. University of Chicago Press, USA. ISBN: 978-0226039053

Bawden, R. (2007). Messy issues, world views and systemic competencies. *Social Learning Systems and Communities of Practice*, Blackmore, C. (ed). 89–101. DOI: 10.1007/978-1-84996-133-2

Belenky, M.F., Clinchy, B.M., Goldberger, N.R. & Tarule, J.M. (1986). Women's ways of knowing. 256pp. Basic Books, NY, USA. ISBN: 978-0-4650-9099-0

Béné, C., Godfrey Wood, R., Newsham, A. & Davies, M. (2012). Resilience: new utopia or new tyranny? Reflection about the potentials and limits of the concept of resilience in relation to vulnerability-reduction programmes. IDS Working Paper 405, Institute of Development Studies, UK. ISBN: 978 1-7811-8091-4

Berkes, F., Colding, J. & Folke, C. (2003). Navigating social-ecological systems: Building resilience for complexity and change. Cambridge University Press, Cambridge, UK. 393pp. ISBN: 978-0-5210-6184-1

Berkhout, F. (2013). Speed, scope and depth: what counts as a socio-transformation? Presentation at *Transformation in a changing climate conference*, 19–21 June, 2013, Oslo, Norway.

Blackmore, C. (2007). What kinds of knowledge, knowing and learning are required for addressing resource dilemmas? a theoretical overview. *Environmental Science and Policy*, **10**(6): 512–525. DOI: 10.1016/j.envsci.2007.02.007

Blackmore, C., Ison, R. & Jiggens, J. (eds). (2007). Social Learning: an alternative policy instrument for managing in the context of Europe's water. *Environmental Science & Policy*, **10**(6): 493–586. DOI: 10.1016/j.envsci.2007.04.003

Boenhert, J. (2009). Transformative learning in sustainable education. 14pp. University of Sussex, Brighton, UK.

Brown, A., Gawith, M., Lonsdale, K. & Pringle, P. (2011). Managing adaptation: linking theory and practice. UK Climate Impacts Programme, Oxford, UK.

Burton, I. (2005). Adapt and thrive: options for reducing the climate change adaptation deficit. *Policy Options*, December 2005–January 2006: 33–38.

Carpenter, S.R., Walker, B.H., Anderies, J.M & Abel. N. (2001). From metaphor to measurement: resilience of what to what? *Ecosystems*, **4**(8): 765–781. DOI: 10.1007/s10021-001-0045-9

Chapin III, F.S., Kofinas, G.P. & Folke, C. (eds). (2009). Principles of ecosystem stewardship: resilience-based natural resource management in a changing world. Springer, New York, USA. ISBN: 978-0-3877-3033-2

Chapman, J. (2002). System failure: why governments must learn to think differently. Demos, London, UK. ISBN: 978-1-8418-0123-0

Clearly, C. & Packard, T. (1992). The use of metaphors in organizational assessment and change. *Group Organization Management*, **17**(3): 229–241. DOI: 10.1177/1059601192173002

Collins, K. & Ison, R. (2009). Jumping off Arnstein's ladder: social learning as a new policy paradigm for climate change adaptation. *Environmental Policy and Governance*, **19**(6): 358–373. DOI: 10.1002/eet.523

Colvin, J. (2014). Pathways for climate adaptive water governance in South Africa: Reflections on developing transdisciplinary learning. *Challenging Organisations and Society*, **3**(2): 573–599.

Colvin, J. & Abidi-Habib, M. (2013). Learning about transformational design in Pakistan's climate compatible development space. In: *University of Oslo (2013) Proceedings of transformation in a changing climate*, 19–21 June, Oslo, Norway. pp 105–115.

Cork, S., Eckersley, R. & Walker, B. (2007). Rapid and surprising change in Australia's future: anticipating and preparing for future challenges and opportunities on the way to a sustainable Australia. Australia21, Weston, Australia.

Craig, R.K. (2010). Stationarity is dead – long live transformation: five principles for climate change adaptation law. *Harvard Environmental Law Review*, **34**(1): 9–75.

Defra (2012). UK Climate Change Risk Assessment: Government Report. Defra, London, UK.

Dovers, S.R. & Handmer, J.W. (1992). Uncertainty, sustainability and change. *Global Environmental Change*, **2**(4): 262–276. DOI:10.1016/0959-3780(92)90044-8

European Commission (2013). Climate-ADAPT website. [online] Available at http://climate-adapt.eea.europa.eu/web/guest/adaptation-support-tool/step-1

Feola, G. (2014). Societal transformation in response to global environmental change: a review of emerging concepts. *AMBIO*, **4**(5): 376–390. DOI: 10.1007/s13280-014-0582-z

Folke, C. (2006). Resilience: The emerging of a perspective for social–ecological systems analyses. *Global Environmental Change*, **16**(3): 253–67. DOI:10.1016/j.gloenvcha.2006.04.002

Folke, C., Carpenter, S., Walker, B., Scheffer, M., Chapin, T. & Rockstrom, J. (2010). Resilience thinking: integrating resilience, adaptability and transformability. *Ecology and Society*, **15**(4): 20.

Folke, C., Hahn, T., Olsson, P. & Norberg, J. (2005). Adaptive governance of social–ecological systems. *Annual Review of Environment and Resources*, **30**: 441–473. DOI: 10.1146/annurev.energy.30.050504.144511

Gearty, M. (2014). Learning history. In: Brydon-Miller, M. Coghlan, D. & Gaya, P. (eds). *Encyclopedia of Action Research*, **2**: 495. Sage Publications, New York, USA.

Geels, F., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy*, **36**(3): 399–417. DOI: 10.1016/j.respol.2007.01.003

Hamilton, C. & Kasser, T. (2009). Psychological adaptation to the threats and stresses of a four degree world. *Four degrees and beyond conference*, 28–30 September, 2009. University of Oxford, Oxford, UK.

Handmer, J.W. & Dovers, S.R. (1996). A typology of resilience: rethinking institutions for sustainable development. *Organization and Environment*, **9**(4): 482–511. DOI: 10.1177/108602669600900403

Handmer, J. & Dovers, S. (2009). A typology of resilience: rethinking institutions for sustainable development. In Schipper, E.L.F. & Burton, I. (eds). *Adaptation to climate change*, pp 187–210. Earthscan, London, UK. ISBN: 978-1-8440-7531-7

Hargreaves, T., Hielscher, S., Seyfang, G. & Smith, A. (2013). Grassroots innovations in community energy: The role of intermediaries in niche development. *Global Environmental Change*, **23**(5): 868–880. DOI:10.1016/j.gloenvcha.2013.02.008

Heron, J. (1992). Feeling and personhood: psychology in another key. 276pp. Sage, London, UK. ISBN: 978-0-8039-8729-6

Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics*, **4**: 1–23. DOI: 10.1146/annurev.es.04.110173.000245

Holling, C. S. (2001). Understanding the complexity of economic, ecological, and social systems. *Ecosystems*, **4**(5): 390–405. DOI: 10.1007/s10021-001-0101-5

Homer-Dixon, T. (2008). The upside of down: catastrophe, creativity, and the renewal of civilization. 448 pp. Island Press, Washington DC, USA. ISBN: 978-1-5972-6065-7

IPCC (2012). Managing the risks of extreme events and disasters to advance climate change adaptation. A special report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, USA.

IPCC (2014). Climate change 2014: Impacts, adaptation, and vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland.

Ison, R. (2010). Introduction and rationale: thinking and acting differently. Chapter 1 in *Systems practice: how to act in a climate-change world*. Springer, London, UK. DOI: 10.1007/978-1-84996-125-7_1 ISBN: 978-1849961257

Ison, R., Röling, N. & Watson, D. (2007). Challenges to science and society in the sustainable management and use of water: investigating the role of social learning. *Environmental Science and Policy*, **10**(6): 499–511. DOI: 10.1016/j.envsci.2007.02.008

JPI Climate, (2012). International research leaders' positions on societal transformations in the face of climate change – research priorities for the next decade. [online] Available from: www.jpi-climate.eu/search/item/10829915/Paper-Societal-transformations-in-the-face-of-climate-change-Research-priorities-for-the-next-decade

Kates, R.W., Travis, W.R. & Wilbanks, T.J. (2012). Transformational adaptation when incremental adaptations to climate change are insufficient. *Proceedings of the National Academy of Sciences*, **109**(19): 7156–7161. DOI: 10.1073/pnas.1115521109

Kingdon, J.W. (1995). Agendas, alternatives, and public policies. 254pp. Longman, New York, USA. ISBN: 978-0-2050-0086-9

Kuhn, T. (1962). The structure of scientific revolutions. 226pp. University of Chicago Press, Chicago, USA. ISBN: 978-0-2264-5808-3

Küpers, W. (2013). Embodied transformative metaphors and narratives in organisational life-worlds of change. *Journal of Organizational Change Management*, **26**(3): 494-528. DOI: 10.1108/09534811311328551

Lakoff, G. & Johnson, M. (1980). Metaphors we live by. 256pp. University of Chicago Press, Chicago, USA. ISBN: 978-0-2264-6801-3

Laszlo, K. C. (2012). From systems thinking to systems being: The embodiment of evolutionary leadership. *Journal of Organisational Transformation & Social Change*, **9**(2): 95–108. DOI: 10.1386/jots.9.2.95_1

Leadbeater, C. & Mulgan, G. (2013). Systems innovation. Discussion paper. Nesta, London.

Lenton, T. M. (2011). Early warning of climate tipping points. *Nature Climate Change*, **1**: 201–209. DOI: 10.1038/nclimate1143

Levine, S., Ludi, E. & Jones, L. (2011). Rethinking support for adaptive capacity to climate change: the role of development interventions. *Overseas Development Institute* (ODI), London, UK. ISBN: 978-1-9072-8856-2

Loorbach, D. & Rotmans, J. (2010). The practice of transition management: examples and lessons from four distinct cases. *Futures*, **42**(3): 237–246. DOI: 10.1016/j.futures.2009.11.009

Lovelock, J. (2010). Humans are too stupid to prevent climate change. The Guardian, 29 March 2010. [online] Available from: www.theguardian.com/science/2010/mar/29/james-lovelock-climate-change

Mackay, M., Allan, C., Colliver, R. & Howard, J. (2014). Systems approaches enable improved collaboration in two regional Australian natural resource governance situations. *International Journal of Systems and Society*, **1**(2): 1–21. DOI: 10.4018/ijss.2014070101

Marshall, G. (2014). Don't even think about it: why our brains are wired to ignore climate change. 272pp. Bloomsbury USA, New York, USA. ISBN: 978-1-6204-0133-0

Martens, P. & Rotmans, J.(2005). Transitions in a globalising world. *Futures*, **37**(10): 1133–1144. DOI: 10.1016/j.futures.2005.02.010

Maturana, H. & Varela, F. (1987). The Tree of Knowledge: the biological roots of human understanding. 273pp. Shambala Publications, Boston, Massachusetts, USA. ISBN: 978-0-8777-3642-4

Meadows, D. (1999). Leverage points: places to intervene in a system. *Solutions*, **1**(1): 41–49.

Meizerow, J. (2009). Transformative learning in practice: insights from community, workplace and education. Jossey-Bass Inc., San Francisco, USA. 336pp. ISBN: 978-0470257906

Merry, P. (2009). Evolutionary leadership: integral leadership for an increasingly complex world. 174pp. Integral Publishers, Pacific Grove, California, USA. ASIN: B00GLAOIU6

Milbraith, L.W. (1989). Envisioning a sustainable society: learning our way out. 403pp. SUNY Press, New York, USA. ISBN: 978-0-7914-0163-7

Moench, M. (2009). Responding to climate and other change processes in complex contexts: challenges facing development of adaptive policy frameworks in the Ganga Basin. *Technological Forecasting and Social Change*, **77**(6): 975–986. DOI: 10.1016/j.techfore.2009.11.006

Morris, E. (2007). From horse power to horsepower. *Access No. 30*, Spring 2007.

Moser, S.C. & Ekstrom, J.A. (2010). A framework to diagnose barriers to climate change adaptation. *Proceedings of the National Academy of Sciences*, **107**(51): 22026–22031. DOI: 10.1073/pnas.1007887107

Mustelin J. & Handmer, J. (2013). Triggering transformation: managing resilience or invoking real change? In: *Proceedings of transformation in a changing climate conference*, 19–21 June 2013, University of Oslo, Norway. ISBN: 978-8-2570-2001-9

Nelson, D.R., Adger, W.N. & Brown, K. (2007). Adaptation to environmental change: contributions of a resilience framework. *Annual Review of Environment and Resources*, **32**: 395–419. DOI: 10.1146/annurev.energy.32.051807.090348

North, D.C. (1990). Institutions, institutional change and economic performance. Cambridge University Press, Cambridge, UK. 159pp. ISBN: 978-0-5213-9734-6

O'Brien, K. (2013). What is transformation?' Presentation given at *Transformation in a changing climate conference*, 19–21 June 2013, University of Oslo, Norway.

O'Brien, K. (2011). Responding to environmental change: a new age for human geography? *Progress in Human Geography*, **35**: 542–549. DOI: 10.1177/0309132510377573

O'Brien, K. (2012). Global environmental change II: from adaptation to deliberate transformation. *Progress in Human Geography*, **36**(5): 667-676. DOI: 10.1177/0309132511425767

O'Neill, S.J. & Handmer, J.W. (2012). Responding to bushfire risk: the need for transformative adaptation. *Environmental Research Letters*, **7**(2012) 014018. DOI: 10.1088/1748-9326/7/1/014018

Olsson, P. (2003). Building capacity for resilience in social-ecological systems, unpublished PhD Thesis, Stockholm University, Stockholm, Sweden.

Olsson, P., Gunderson, L.H., Carpenter, S.R., Ryan, P., Lebel, L., Folke, C. & Holling, C.S. (2006). Shooting the rapids: navigating transitions to adaptive governance of social-ecological systems. *Ecology and Society*, **11**(1): 18.

Park, S.E., Marshall, N.A., Jakku, E., Dowd, A.M., Howden, S.M., Mendham, E. & Fleming, A. (2012). Informing adaptation responses to climate change through theories of transformation. *Global Environmental Change*, **22**(1): 115–126. DOI: 10.1016/j.gloenvcha.2011.10.003

Pelling, M., O'Brien, K. & Matyas, D. (2014). Adaptation and transformation, climatic change. In: *Special Issue on Advancing climate change adaptation and risk management*. Birkmann, J. & Mechler, R. (eds). DOI: 10.1007/s10584-014-1303-0

Pelling, M. (2011). Adaptation to climate change: from resilience to transformation. 224pp. Routledge, London, UK. ISBN: 978-0-4154-7751-2

Pelling, M. & Dill, K. (2010). Disaster politics: tipping points for change in the adaptation of sociopolitical regimes. *Progress in Human Geography*, **34**(1): 21–37. DOI: 10.1177/0309132509105004

Pérez-Català, A. (2014). Conceptualizing transformational adaptation. [online] Available at: http://climate-exchange.org/2014/03/02/conceptualizing-transformational-adaptation/

Plummer, R. (2010). Social-ecological resilience and environmental education: synopsis, application, implications. *Environmental Education Research*, **16**(5–6): 493–509. DOI:10.1080/13504622.2010.505423

Preston, B.L., Dow, K. & Berkhout, F. (2013). The climate adaptation frontier. *Sustainability*, **5**(3): 1011–1035. DOI: 10.3390/su5031011

Pringle, P. (2011). AdaptME: Adaptation monitoring and evaluation. UK Climate Impacts Programme, Oxford, UK. 37pp.

Ramalingham, B. (2013). Aid on the edge of chaos. 480pp. Oxford University Press, Oxford, UK. ISBN: 978-0-1995-7802-3

Reason, P. & Rowan, J. (1981). Human inquiry: a sourcebook of new paradigm research. 554pp. John Wiley & Sons, New York, USA. ISBN: 978-0-4712-7936-5

Reason, P. & Torbert, W. (2001). The action turn: toward a transformational social science. *Concepts and Transformation*, **6**(1): 1–37. DOI: 10.1075/cat.6.1.02rea

Resilience Alliance, (2010). Assessing resilience in socio-ecological systems, Workbook for practitioners, Version 2. [online] Available at: www.resalliance.org/srv/file.php/261

Retolaza, I. (2011). Theory of Change: A thinking and action approach to navigate in the complexity of social change processes. Hivos/UNDP/Democratic Dialogue.

Revi, A., Satterthwaite, D., Aragon-Durand, F., Corfee-Morlot, J., Kiunsi, R.B.R., Pelling, M., Roberts, D., Solecki, W., Gajjar, S.P. & Sverdlik, A. (2014). Towards transformative adaptation in cities: the IPCC's Fifth Assessment. *Environment and Urbanization*, **26**(1): 11–28. DOI: 10.1177/0956247814523539

Reynolds, M. & Holwell, S. (2010). Introducing systems approaches. In: Reynolds, M. & Holwell, S. (eds), *Systems approaches to managing change: a practical guide*. Springer, London. pp 1–23. ISBN: 978-1-8488-2809-4

Rickards, L. & Howden, S.M. (2012). Transformational adaptation: agriculture and climate change. *Crop & Pasture Science*, **63**(3): 240–250. DOI: org/10.1071/CP11172

Rittel, H. & Webber, M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, **4**(2): 155–169. DOI: 10.1007/BF01405730

Rockstrom, J., Steffen, W., Noone, K., Persson, A., Chapin III, F.S., Lambin, E.F., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., Nykvist, B., de Wit, C.A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P. & Foley, J.A. (2009). A safe operating space for humanity. *Nature*, **461**: 472–475. DOI: 10.1038/461472a

Rooke, D. & Torbert, W.R. (2005). Seven transformations of leadership. *Harvard Business Review*, **83**(4): 67–76. PMID: 15807040

Rotmans, J. & Loorbach, D. (2009). Complexity and transition management. *Journal of Industrial Ecology*, **13**(2): 184–196. DOI: 10.1111/j.1530-9290.2009.00116.x

Schön, D. (1983). The reflective practitioner: how professionals think in action. 384pp. Basic Books, New York, USA. ISBN: 978-0-4650-6878-4

Senge, P.M. (1994). The Fifth discipline fieldbook: Strategies and tools for building a learning organization. 608pp. New York: Currency, Doubleday, New York, USA. ISBN: 978-1-8578-8060-1

Shaxson, L. with Bielak, A.T. *et al*. (2012). Expanding our understanding of K* (KT, KE, KTT, KMb, KB, KM, etc.) A concept paper emerging from the *K* conference*, Hamilton, Ontario, Canada, April 2012.

Shove, E. (2010). Beyond the ABC: climate change policy and theories of social change. *Environment and Planning A*, **42**(6): 1273–1285. DOI: 10.1068/a42282

Smit, B., Burton, I., Klein, R.J.T. & Wandel, J. (2000). An anatomy of adaptation to climate change and variability. *Climatic Change*, **45**(1): 223–251. DOI: 10.1023/A:1005661622966

Snowden, D.J. & Boone, M. (2007). A leader's framework for decision making. *Harvard Business Review*, **85**(11): 69–76. PMID: 18159787

Spearman, M. & McGray, H. (2011). Making adaptation count; concepts and options for monitoring and evaluation of climate change adaptation. World Resources Institute.

Staemmler, F. (1997). Cultivated uncertainty: an attitude for gestalt therapists. *British Gestalt Journal*, **6**(1): 1–76.

Stafford Smith, M., Horrocks, L., Harvey, A. & Hamilton, C. (2011). Rethinking adaptation for a 4°C world. *Philosophical Transactions of the Royal Society A*, **369**:196–216. DOI: 10.1098/rsta.2010.0277

Stirling, A. (2011). Emancipating transformations: from controlling 'the transition' to culturing plural radical progress. STEPS Working Paper, IDS, University of Sussex, Brighton, UK.

Sydow, J., Schreyögg, G. & Koch, J. (2009). Organisational path dependence: opening the black box. *Academy of Management Review*, **34**(4): 689–709.

Schulz, K. & Siriwardane, R. (2015). Depoliticised and technocratic? Normativity and the politics of transformative adaptation. Earth System Governance Working Paper No. 33, 2015. Earth System Governance Project, Lund University, Amsterdam, The Netherlands.

Thornton, T. & Manasfi, N. (2010). Adaptation genuine and spurious – demystifying adaptation processes in relation to climate change. *Environment and Society: Advances in Research*, **1**(1): 132–155. DOI: 10.3167/ares.2010.010107

Thornton, T.F. & Comberti, C. (2013). Synergies and trade-offs between adaptation, mitigation and development. *Climatic Change*, 13/09/2013: 1–14. DOI: 10.1007/s10584-013-0884-3

Tompkins, E.L., Adger, W.N., Boyd, E., Nicholson-Cole, S., Weatherhead, K. & Arnell, N. (2010). Observed adaptation to climate change: UK evidence of transition to a well-adapting society. *Global Environmental Change*, **20**(4): 627–635. DOI: 10.1016/j.gloenvcha.2010.05.001

Tschakert, P., & Dietrich, K. A. (2010). Anticipatory learning for climate change adaptation and resilience. *Ecology and Society*, **15**(2): 11.

UKCIP (2010). The UKCIP Adaptation Wizard V 3.0. UKCIP, Oxford, UK. [online] Available at: www.ukcip.org.uk/wizard/

UNEP. (2005). Millennium ecosystem assessment. Ecosystems and human well-being: synthesis. Island Press, Washington, DC, USA.

University of Oslo, (2013). Proceedings of transformation in a changing climate conference, 19–21 June 2013, Oslo. University of Oslo, Oslo, Norway. ISBN: 978-8-2570-2001-9

Waddell, S. (2011). Global Action Networks: Creating our future together. Bocconi on Management Series. 256pp. Palgrave-Macmillan, Hampshire, UK. ISBN: 978-0-2302-8548-4

Walker, B., Carpenter, S., Anderies, J., Abel, N., Cumming, G.S., Janssen, M., Lebel, L., Norberg, J., Peterson, G. D. & Pritchard R. (2002). Resilience management in social-ecological systems: a working hypothesis for a participatory approach. *Conservation Ecology*, **6**(1): 14.

Walker, B., Holling, C.S., Carpenter, S.R. & Kinzig, A. (2004). Resilience, adaptability and transformability in social-ecological systems. *Ecology and Society*, **9**(2): 5.

Wals, A. Ed. (2009). Social learning towards a sustainable world: principles, perspectives, and praxis. 538pp. Wageningen Academic Publishers, Wageningen, The Netherlands. DOI: 10.3920/978-90-8686-594-9 ISBN: 978-9-0868-6031-9

West, E.J. (2004). Perry's legacy: models of epistemological development. *Journal of Adult Development*, **11**(2): 61–70. DOI: 10.1023/B:JADE.0000024540.12150.69

Westley, F.R., Tjornbo, O., Schultz, L., Olsson, P., Folke,C., Crona, B. & Bodin, Ö. (2013). A theory of transformative agency in linked social-ecological systems. *Ecology and Society*, **18**(3): 27. DOI: 10.5751/ES-05072-180327

Westley, F., Olsson,P., Folke, C., Homer-Dixon, T., Vredenburg, H., Loorbach, D., Thompson, J., Nilsson, M., Lambin, E., Sendzimir, J., Banerjee, B., Galaz,, V. & van der Leeuw, S. (2011). Tipping toward sustainability: emerging pathways of transformation. AMBIO, **40**(7): 762–780. PMID: 22338714

White, R. & Stirling, A. (2013). Sustaining trajectories towards sustainability: dynamics and diversity in UK communal growing activities. *Global Environmental Change*, **23**(5): 838–846. DOI: 10.1016/j.gloenvcha.2013.06.004

Wilber, K. (2006). Introduction to integral theory and practice: IOS Basic and the AQAL Map. *AQAL: Journal of Integral Theory and Practice*, **1**(1): 1–40.