Advanced Transition Management Methodology

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Preface

IMPRESSIONS Workpackage (WP) 4 aims to develop time- and scale-dependent adaptation, mitigation and transformation pathways and to identify synergies and trade-offs between pathways and sectors that build resilience and promote sustainability in the context of high-end climate change scenarios. The development of such pathways builds on the transition management approach as an overarching framework to consider how long-term, transformative change towards a sustainable and (climate) resilient future can be enabled. This report outlines the advanced transition management approach, placing a special emphasis on these new potential climate futures. The approach has been advanced conceptually and methodologically in order to integrate possibly extreme social-ecological disturbances and critical societal tipping points, which can shift the system onto new pathways.

The pathways will include short-, medium- and long-term strategies that progressively build up resilience and promote sustainability. They also include strategic objectives and specific bundles of innovative solutions which aim to increase the adaptive, mitigative, transformative and orchestrating capacities of societal systems. These will lessen the negative impacts associated with high-end climate scenarios and provide the enabling conditions for shifts towards new development pathways. The methodology also supports the analysis of the developed pathways to cross-check whether the pathways might achieve their desired end points (i.e. the visionary objectives).

Summary

The aim of this document is to provide the conceptual and methodological framework for the transition management process that will be used to generate time- and scale-dependent adaptation, mitigation and transformation pathways in the context of high-end climate scenarios. Addressing high-end climate change poses new questions and challenges for science, policy and public engagement, which need to be reflected in the transition management framework.

Transition management is a theoretical and methodological framework that offers operational guidance on how to set up dialectic/engagement processes for change-oriented interventions in complex adaptive societal (sub-)systems. It starts from the proposition that only a fundamental destabilisation and reconfiguration of an incumbent regime will help escape lock-ins into unsustainable pathways. Sustainability transitions are non-linear, long-term, fundamental and multi-dimensional change processes towards sustainability. We conducted a systematic review of applications of transition management in the peer-reviewed literature. The literature review showed that the transition management approach is suitable for application across multiple sectors and different geo-political contexts and that it can be applied in a flexible way (as theoretical, heuristic and operational applications of the framework have been reported). Over the years, transition management has also been criticised, stimulating a fruitful dialogue between researchers. We have identified two major points for future directions for development of transition management: (a) consideration of issues of conflict, politics, power, and democratic legitimacy; and (b) consideration of the role of agency and the role of individuals in transition processes and in agenda realisation. In the context of IMPRESSIONS, we take these insights on board by linking transition management to concepts from social-ecological systems, resilience and climate change literatures to integrate radical changes, thresholds and deep uncertainty into the framework. This positions the framework in the context of high-end scenarios.

Section 4 outlines the conceptual framework of agency's capacities for climate governance that addresses the gap in the transition management literature and applications concerning the actors and agency processes underlying the inner workings of transition processes. The framework combines understandings of actors and agency in transition processes in the context of high-end climate change by building on transitions, resilience, climate change and meta-governance literatures. It proposes a nested perspective on governance interventions to safeguard against expected disturbances and pressures (i.e. to adapt), to minimise the occurrence of disturbances and pressures (i.e. to mitigate), to create radical innovations (i.e. to transform) as well as to create synergies between interventions (i.e. to orchestrate). We identify four corresponding governance capacities – adaptive, mitigative, transformative and orchestrating capacities – that are produced by agency processes. The framework will be used to support the analytical activities in the transition management methodology by enabling IMPRESSIONS to: (a) assess existing strategies and actions as well as the implied strategies in the input scenarios (RCPxSSP combinations); (b) identify the institutional conditions required for the proposed strategies and pathways; (c) identify the prospective governance capacities to be established by the pathways; and (d) assist with the reflection on synergies and trade-offs between different transition pathways across sectors, scales and time.

1. Introduction

The aim of this document is to provide the conceptual and methodological framework for the advanced transition management methodology that will be applied in the IMPRESSIONS workshops and wider project activities to develop the integrated adaptation and mitigation pathways which build resilience and promote sustainability under high-end climate scenarios. Addressing high-end climate change poses new questions and challenges for science, policy and public engagement which need to be reflected in the transition management framework.

High-end scenarios describe climate change levels at the upper end of the range of possible futures. In IMPRESSIONS they are considered as those beyond the EU and UNFCCC target to limit climate change to 2°C above pre-industrial levels, and the new climate target after Paris 2015 that also includes 1.5°C. It is increasingly plausible that global increases in mean temperatures will surpass the 2°C threshold (IPCC 2014; Smith et al. 2011). This could lead to detrimental environmental and social consequences, and the emergence of critical thresholds that tip current social-ecological systems into another (probably less socially desirable) state with largely unknown consequences. The IMPRESSIONS high-end scenarios include Representative Concentration Pathways (RCPs) beyond the 2°C threshold, that are combined with Shared Socioeconomic Pathways (SSPs) that are consistent but independent from the RCPs. The IMPRESSIONS high-end scenarios describe a range of socio-economic challenges to mitigation and adaptation combined with RCPs as well as the ability of society to cope with the impacts of climate change (Tinch et al. 2015).

High-end scenarios involve a considerable likelihood of extreme risks, surprises, threshold effects and fast and radical system changes. Drivers of such scenarios are rooted in structures, cultures and practices that are deeply entrenched in human societies (Meadowcroft 2009b; Smith et al. 2011). Addressing climate change under high-end scenarios requires new approaches that can deal with non-linearity and deep uncertainty, link climate resilience to broader considerations of sustainability and social desirability, and foster more fundamental changes to overcome underlying path dependencies and lock-ins (Shaw et al. 2014). Appropriate climate governance will involve some balance of mitigation, adaptation, transformation and residual damages (Tinch et al. 2015). Within the IMPRESSIONS project, the aim is to look at responses to high-end climate change that foster stronger action on mitigation and adaptation, seek co-benefits between different strategies and actions across scales and catalyse transitions towards resilient and sustainable societies.

Using high-end climate and socio-economic scenarios at multiple scales, scale- and time-dependent adaptation and mitigation pathways will be developed in WP4 and synergies and trade-offs between pathways and sectors will be identified. The pathways will include short-, medium- and long-term strategies that progressively build up resilience and promote sustainability. They also include strategic objectives which aim to increase the adaptive, mitigative, transformative and orchestrating capacities of societal systems so as to lessen the negative impacts associated with high-end scenarios and enable shifts towards new development pathways.

A complex adaptive system perspective that considers societal systems as interconnected social, ecological and technological wholes, that are highly complex and with the ability to adapt their behaviour and respond over time to exogenous stimuli (Holland 1990) is needed to address the profound challenges posed by climate change. With this conceptualisation of societies as complex adaptive systems, we aim in IMPRESSIONS to examine what are the existing and required strategies and governance capacities for current societal systems (our societies) to mitigate, cope with, adapt to and prepare for change in anticipation of extreme climate change. To do so, we build on theory and empirically grounded governance frameworks (e.g. Transition Management) that take the governance of complex adaptive systems as a starting point to conceptualise a guiding methodology

for co-creating strategic pathways which simultaneously navigate societal complexity and climatic uncertainty.

This methodology for developing pathways that build resilience and promote sustainability under high-end scenarios needs:

- To stimulate thinking about a normative approach (e.g. sustainability) for identifying pathways that address climate change drivers and impacts (mitigation and adaptation) across scales and time.
- To build on current knowledge and effective climate policy measures to identify scalable actions and innovative solutions which can be replicated across different locations and across different policy sectors, extended in time, extended in resources, and transferred to different administrative scales/levels.
- To stimulate thinking on transformative action by creating multiple high-uncertainty contexts and wild-uncertainty events that might indicate the need for fundamentally different strategies to address drivers and impacts of climate change.
- To incorporate knowledge from a variety of actors and sources. Systemic knowledge holders, change knowledge holders, knowledge brokers and future-knowledge visionaires are those who provide insights and co-create the pathways for action[1]. Not only academics and policy-makers fit into these profiles, but also actors from civil society.
- To incorporate practical insights and knowledge from civil society (citizen science) on removing obstacles to action for transformation and on foreseeing feasible and achievable action in the short, medium and long-term.

[1] In the WP5 Milestone (MS19) on "Integrated Climate Governance Framework for Synthesis (February 2015)", it was highlighted that the selection of actors should not be based on their stakes: "… we will base the selection of stakeholders not on their 'stakes' but on their knowledge, institutional practices, capacities and social ties". Systemic knowledge holders are those actors that have an overview of how different sub-systems and processes within and between those sub-systems act in concert. Knowledge brokers are those actors that channel information and knowledge between existing networks of actors. Future-knowledge visionaires are those actors that are aware of knowledge about forthcoming or planned scientific, technological or industrial breakthroughs/innovations/developments that will influence how current societal systems are organised and operate.

2. Transition management: Looking back and ways forward

The transition management methodology has been introduced as a new approach to deal with the persistent unsustainability problems that societies face today (Rotmans et al. 2001; Loorbach 2007; 2010; Frantzeskaki et al. 2012). In this section we take stock of the transition management methodology, its background and guiding principles as well as past transition management applications and lessons learnt, and outline the ways forward for advancing the transition management approach to address high-end scenarios.

2.1. Transition management background and principles

Transition management is a theoretical and methodological framework that offers operational guidance on how to set up strategic co-creation processes for change-oriented interventions in complex adaptive societal (sub-)systems (Rotmans et al. 2001; Loorbach 2010; Frantzeskaki et al. 2012; Nevens et al. 2013). It builds upon the Integrated Sustainability Assessment framework (Jaeger et al. 2008) but is differentiated from it by taking on board a consistent focus on transformations and strategic development for transformative change. With a focus on the persistent structural and cultural constraints hindering shifts towards more sustainable lifestyles, it highlights the need for long-term fundamental change in existing socio-technical systems and provides a tool for understanding how governance, cultural systems, infrastructures and social practices co-evolve creating lock-ins or radical changes (Kemp et al. 2007).

More specifically, transition management starts from the proposition that only a fundamental destabilisation and reconfiguration of an incumbent regime helps escape lock-ins into unsustainable pathways. In essence, transition management studies complex adaptive systems (e.g. societal sectors, cities) “that go through fundamental non-linear changes in cultures (for example, attitudes, perceptions, and routines), structures (for example, institutions, ways of organising, hierarchical orderings), and practices (for example, behaviour, implementation procedures, and daily routines)” (Loorbach et al. 2015: 12). These changes result from co-evolving processes in economy, society, ecology and technology (Rotmans et al. 2001; Frantzeskaki and de Haan 2009; Loorbach 2010). Sustainability transitions are non-linear, long-term, fundamental and multi-dimensional change processes towards sustainability (Grin et al. 2010; Markard et al. 2012). Unlike what its name would suggest, transition management does not intend to plan or actually ‘manage’ such transitions. Rather, it is characterised by long-term thinking, the consideration of multiple domains and a large diversity of actors, and a focus on learning and system innovation while maintaining a wide playing field (Nevens et al. 2013). The methodology highlights guiding principles for governing sustainability transitions in complex adaptive systems, which by definition occur in a chaotic and non-linear way, through the creation of spaces for searching, learning and experimenting (Loorbach et al. 2011). It includes specific steps such as systems analysis, envisioning, pathways development and experimenting (Loorbach 2010; Frantzeskaki et al. 2012).

Over the past 15 years, transition management has been applied to a diverse range of sustainability questions, policy contexts and geographical scales (Loorbach et al. 2015; Frantzeskaki et al. 2014a; Frantzeskaki et al. forthcoming) and has become one of the most prevalent approaches currently used in parts of Europe to scientifically ground the governance of sustainability transitions (Rauschmayer et al. 2015). The applications have shown that the approach is able to support governance of, and for, sustainability transitions (Nevens and Roorda 2013; Frantzeskaki et al. 2014b; forthcoming Loorbach et al. 2015). It provides a portfolio of tools with a common objective to enable change in practices and structures (institutions) directed towards sustainable development targets. In response to criticism, a fruitful dialogue has started to advance the approach.

Transition management has been developed against the background of public policy processes in the Netherlands. The methodology's underlying argument is that persistent problems are firmly rooted in the very structure of societal systems; addressing them requires radical changes in the way society is organised (e.g. physical and economic infrastructures, institutions), values services and amenities (e.g. dominant values and norms) and operates (e.g. production routines, behaviour at the individual level) (Rotmans et al. 2001; Frantzeskaki and Loorbach 2010). Transition management seeks to influence, support and accelerate transitions by playing into existing dynamics and embracing complexity and uncertainty as opportunities for change towards sustainability rather than as something to ignore or control. Through bringing together change-inclined actors to develop a common understanding of the transitional dynamics and opportunities for systemic change, they will be (better) able to influence the speed and direction of a particular transition.

Transition management is based on action research (Loorbach et al. 2011), as well as on research approaches closely linked to Integrated Assessment (Rotmans 1999), post-normal science (Ravetz 1999) and Sustainability Science (Kates et al. 2001). Research on past and on-going transitions reveals that such processes involve continuous interactions between multiple actors (Grin 2012; Farla et al 2012), employing different strategies and processes of engagement, as well as spreading both conceptual and technical innovations (Smith and Kern 2012; Brown et al 2013). These unroll by replacing contemporary practices (Geels and Schot, 2007), or hybridising between new and old practices, eventually dismantling previously dominant structures and means of operation. Specific sustainability objectives and outcomes are not *a priori* defined but rather the result of negotiation, co-creation, debate, competition and experiment (Loorbach 2007). Transition management puts forth a number of prescriptive tenets for navigating societal sustainability transitions of complex adaptive systems (Loorbach 2007; Rotmans and Loorbach 2009; Frantzeskaki et al. 2012). While these tenets are not meant to be an exhaustive and immobile set of rules, they nevertheless offer guidance for the governance of complex and adaptive societal systems (Loorbach 2010):

- *System insight*: The dynamics of the system create feasible and unfeasible means of steering. This implies that content and process are inseparable. Process management on its own is not sufficient; insight into how the system works is an essential precondition for effective management.
- *Long-term thinking*: Long-term thinking (of at least 25 years) is preferably used as a framework for shaping short-term policy in the context of persistent societal problems. This means reflection and foresight: setting short-term goals based on long-term goals and reflecting on future developments through the use of scenarios (Wiek et al. 2006) and other visioning techniques (Eames and Egmose 2011; Köves et al. 2013).
- *Flexible objectives*: Objectives should be flexible and adjustable at the system level. The complexity of the system is at odds with the desire to formulate specific objectives and blueprint plans. While being steered, the structure and order of the system are continuously changing, and so the selected objectives should also change.
- *Timing*: Crises offer possibilities for immediate and effective interventions, as they can help to overcome system inertia. At the same time, alternatives can be developed slowly and wait for windows of opportunity.
- *(Dis)equilibrium are both useful*: Managing a complex, adaptive system means using disequilibria as well as equilibria. Relatively short periods of non-equilibrium therefore offer opportunities to direct the system in a desirable direction (toward a new attractor).
- *Creating niches*: Creating space for actors to build up alternative regimes is crucial for innovation. Actors at a certain distance from the regime can effectively create a new regime in a protected environment to permit the investment of sufficient time, energy and resources.

- *There is no 'outside the system'*: Steering from "outside" a societal system is not possible. Structures, actors and practices adapt and anticipate in such a manner that these should also be directed from "inside."
- *Learning*: A focus on (social) learning about different actor perspectives and a variety of options (which requires a wide playing field) is a necessary precondition for change.
- *Participation*: Participation from, and interaction between, stakeholders is a necessary basis for developing support for policies and to engage actors in reframing problems and solutions through social learning.

2.2. Taking stock of 15 years of transition management

In view of the proposed application of transition management for climate governance in the context of high-end climate change in the IMPRESSIONS project, we conducted a systematic literature review on the documented (in journal papers) applications of transition management in order to identify: (a) whether the framework is suitable for studying cross-sectoral and different geo-political contexts; (b) whether researchers who have applied the framework suggest adaptations or further developments; and (c) limitations and methodological pitfalls. This section reports on our findings from a systematic and extensive literature review that identified more than 400 papers and which through consistent screening reviewed a total of 89 papers (until 31.12.2014). Table 1 presents an overview of the literature review.

The literature review showed that the transition management approach is suitable for application across multiple sectors and different geo-political contexts. It has been applied in a great variety of sectors, and in different countries across Europe and outside Europe in a flexible way (theoretical, heuristic and operational applications of the framework have been reported).

Since its inception, transition management has been practiced in a variety of policy fields, sectors and at different geographical scales in the Netherlands and beyond (Loorbach et al. 2015; Frantzeskaki et al. 2014a; Frantzeskaki et al. forthcoming; Frantzeskaki and Shiroyama forthcoming). Initially, the transition (management) approach was mainly deployed in research and empirical experience at national levels and mainly for sectoral policy transformations (e.g. energy, water, mobility, building and living, material use) (Avelino et al. 2012; Loorbach and Rotmans 2010; Verbong and Loorbach 2012). Later, the approach was increasingly applied to regional and local scales within Europe (Roorda et al. 2014; Roorda and Wittmayer 2014; Nevens et al. 2013; Nevens and Roorda 2013; Wittmayer et al. 2011; 2014; Frantzeskaki et al. 2010) and to a few cases outside Europe (Frantzeskaki et al. forthcoming; Silvestri and Frantzeskaki forthcoming). However, applications have still largely focused empirically on Western affluent societies (Frantzeskaki and Shiroyama forthcoming).

The transition management framework has shown analytical robustness in different types of applications: *theoretical* applications position and advocate transition management as a new governance framework for transformative change; *operational* applications adopt transition management process tools (e.g. the transition arena, transition experiments) in setting up and realising participatory processes for scenario development and strategy formulation; and *heuristic* applications employ transition management as a descriptive and/or diagnostic lens to understand and explain the dynamics of on-going governance processes (Frantzeskaki et al. 2014b).

Theoretical and heuristic applications of transition management analyse and examine past or contemporary transition dynamics in an interpretative way. As such they contribute to the understanding of the governance *of* sustainability transitions (Frantzeskaki and Shiroyama forthcoming). Governance of sustainability transitions refer to issues that are relevant to debate

about types of interventions and how they play out in changing the direction and the pace of sustainability transitions. The operational applications of transition management provide knowledge for explaining the 'successes' or fitness of transition management as a process method that is instrumental to the governance *for* sustainability transitions. Governance for sustainability transitions is the prescriptive dimension: the methods, instruments and frameworks that are promoting, enabling or triggering sustainability transitions. Despite its contribution to governance for and of sustainability transitions, empirical cases open up many new questions including the role of cultural diversity, actor roles and learning processes (ibid).

Reviewing transition management applications in developed (Western) European contexts, Loorbach et al. (2015) find the underlying guiding principles and methodological ingredients provide a basic set to develop context-sensitive implementations. The approach was shown to add value by triggering explorations of more fundamental change processes and empowering social innovations. This underlines the need for departing from blueprint planning or standard recipes. The authors also acknowledge, however, that transition management is "so far not achieving the aspired large scale systemic changes (Loorbach 2014)" (ibid: 25). They identify several challenges in relation to governance interventions in transitions and transition management, including the question of inclusivity (of e.g. marginalised perspectives), facilitation techniques for social learning and capacity building, and regime persistence. This points to current research directions for transition management, such as explorations of institutional change, top-down strategies, new forms of power, the role of scale and the psychology of transitions.

Over the years, transition management has also been criticised, stimulating a fruitful dialogue between researchers. It invoked a fundamental debate around the question to what extent transitions can actually be managed (Walker and Shove 2007). It is also criticised for simplifying agency dynamics and neglecting issues of conflict, politics, democratic legitimacy and power (Voß et al. 2009; Shove and Walker 2007; 2008; Smith and Kern 2009; Smith and Stirling 2008; Hendriks 2007; Meadowcroft 2007). As a governance framework for transitions that builds on complexity theory (Rotmans et al. 2001; Rotmans and Loorbach 2009), transition management is also often debated as serving a new 'dogma' for incrementalism (Shove and Walker 2007; Frantzeskaki et al. 2012b; Paredis 2013), while also being at risk of tautological entrapment in 'explaining complexity' and 'enabling complexity' rather than navigating societal complexity by creating knowledge for interventions that can trigger transitions to sustainability (Vasileiadou and Safarzyńska 2010). Duineveld et al. (2007) are concerned by the 'double role' of researchers in transition management processes. Against the background of these and other criticisms a productive scientific dialogue has emerged addressing these challenges to the methodology (Jhagroe and Loorbach 2015; Avelino 2011; van Steenbergen and Wittmayer 2012; Jhagroe and Frantzeskaki 2012; Wittmayer et al. 2014; Wittmayer and Schäpke 2014; Eshuis et al. 2012).

On a more conceptual level, transition management lacks a deeper understanding of individuals and their agency. There is insufficient knowledge on the individuals engaging, for example, in transition experiments and what drives them; on different types of roles needed in transition processes; and on changes occurring at the level of the participating individual in transition management processes (Rauschmayer et al. 2015; Farla et al. 2012; Scholz 2011).

Table 1: Applications of transitions management (TM) identified by a literature review (Frantzeskaki et al. 2014a).

	Scientific papers
Theoretical applications	
Focus: Position and advocate it as a new governance approach for transformative change **Contribution** *Informing a new conceptualisation of governance:* *Theoretical contributions *Questions of politics and agency *Thematic focus on innovation and technology *Multiple sectors, multiple scale applications	Avelino 2009, Beers et al. 2010, de Bruijne et al. 2010, de Graaf and van der Brugge 2010, Eames and Egmose 2011, Elzen et al. 2004, Elzen and Wieczorek 2005, Foxon et al. 2009, 2010, Frantzeskaki and Loorbach 2010, Frantzeskaki et al. 2012, Genus and Coles 2008, Gössling et al. 2012, Grin 2012, Heiskanen et al. 2009, Hendriks and Grin 2007, Hendriks 2009, Holtz et al. 2008, Huétink 2010, Hurlbert et al. 2011, Kemp et al. 2005, 2007a, 2007b, Kemp and Rotmans 2009, Lachman 2013, Loorbach 2010, Loorbach and Frantzeskaki 2012, Loorbach and Rotmans 2010, Loorbach et al. 2010, 2011, Meadowcroft 2009a, Nill and Kemp 2009, Raven et al. 2010, Rotmans et al. 2010, Rotmans and Loorbach 2009, Nevens et al. 2013, Park et al. 2012, Shove and Walker 2007, Smith et al. 2005, Smith and Stirling 2010, Sondeijker et al. 2006, Späth and Rohracher 2010, Stephens and Graham 2010, Tukker and Butter 2007, van der Brugge et al. 2007, Vergragt 2011, Vollenbroek 2002, Voß and Bornemann 2011, Voß et al. 2009, Walker and Shove 2007, Westley et al. 2011, Wiek et al. 2006
Operational applications	
Focus: Adopt TM process tools (e.g. the transition arena) in setting up participatory processes for scenario development and strategy formulation **Contribution:** *Setting up processes of co-imagining, co-creating and co-mobilising transformative change for sustainability:* *Process adoption for scenarios and strategy development *Sectoral focus on water, energy and mobility *Lessons to improve process methodology and context fitness are lacking	Alkemade et al. 2009, Beers et al. 2010, Bos et al. 2013, Cramer 2013, de Bruijne et al. 2013, Eames and Egmose 2011, Frantzeskaki and Loorbach 2010, Frantzeskaki et al. 2012, Foxon et al. 2010, Gössling et al. 2012, Grin 2012, Hendriks and Grin 2007, Huétink 2010, Loorbach and Rotmans 2010, Loorbach et al. 2010, Kemp et al. 2005, 2007a, Kemp and Rotmans 2009, Kern and Smith 2008, Köves et al. 2013, Lopes et al. 2012, Luiten and Sandick 2007, Nevens et al. 2013, Raven et al. 2010, Rotmans and Loorbach 2009, Park et al. 2012, Sondeijker et al. 2006, van der Brugge et al. 2005, van de Kerkhof and Wieczorek 2005, van der Voorn et al. 2012, Vreugdenhil et al. 2012, Wiek et al. 2006
Heuristic applications	
Focus: Employ it as a descriptive and/or diagnostic lens to understand and explain dynamics of on-going governance processes **Contribution:** *Analysing and rethinking on-going or past governance processes:* *Critical turn on TM *Strong focus on critical infrastructure (including health sector) *National scale preference	Avelino 2009, Beers et al. 2010, Bos et al. 2013, Caron-Flinterman et al. 20107, Cramer 2013, de Bruijne et al. 2013, de Graaf and van der Brugge 2010, Eames and Egmose 2011, Elzen et al. 2004, Foxon et al. 2010, Frantzeskaki and Loorbach 2010, Gössling et al. 2012, Grin 2012, Heiskanen et al. 2009, Hekkert et al. 2007, Hendriks and Grin 2007, Huétink 2010, Hurlbert et al. 2011, Kemp et al. 2005, 2007a, 2007b, Kemp and Rotmans 2009, Kern and Howlett 2009, Kern and Smith 2008, Loorbach and Frantzeskaki 2012, Loorbach and Rotmans 2010, Loorbach et al. 2010, 2011, Luiten and van Sandick 2007, Meadowcroft 2009a, Monaghan 2009, Nevens et al. 2013, Noteboom 2007, park et al. 2012, Rotmans et al. 2001, Scarse and Smith 2009, Smith and Stirling 2010, Späth and Rohracher 2010, Stephens and Graham 2010, Tukker and Butter 2007, van der Brugge et al. 2005, van der Brugge and van Raak 2007, Vollenbroek 2002, Voß amd Bornemann 2011, Vreugdenhil et al. 2012, Walker and Shove 2007, Westley et al. 2011

To summarise, two major points are made by researchers who have applied transition management for the future directions for development: (a) consideration of issues of conflict, politics, power, democratic legitimacy; and (b) consideration of the role of agency and the role of individuals in transition processes and in agenda realisation.

Finally, the review found that generally there is no feedback loop that questions the fundamental assumptions underlying transition management despite a rich discourse and criticism due to underdeveloped methodological guidelines for the operational applications of transition management (Frantzeskaki et al. 2014a). New concepts are only introduced to a limited extent. Similarly, the promises of transition management are not rigorously evaluated by drawing on empirical examples. One reason for this is the still limited empirical application of transition management thus far. Another is that the approach is still used in an exploratory manner. It is suggested that transition management would greatly benefit by linking it to debates within other theories that are concerned with governance for sustainability, such as institutional theories, policy studies (Howlett et al. 2009), adaptive management and resilience research fields (Olsson et al. 2014).

2.3. Approach to advancing transition management in IMPRESSIONS

We take on board these criticisms and challenges for advancing the transition management methodology while considering the scientific objectives of IMPRESSIONS. In particular, we seek to develop new concepts by linking transition management to concepts from social-ecological systems, resilience and climate change literatures to integrate radical changes, thresholds and deep uncertainty into the framework. Resilience and climate change literatures help to position the framework in the context of high-end scenarios by conceptualising (radical) change in social-ecological systems, considering impacts of change and the ability of systems to respond to such. Our objective is to support decision-making processes to build resilience against (possibly detrimental) impacts of climate change and other social, economic and environmental pressures, deal with uncertainty and surprise, and shifts towards sustainable development trajectories. This is achieved by developing alternative future visions that depict starting points for subsequently thinking about long-term, mid-term and short-term strategies and innovative solutions.

Based on our extensive experience with applying transition management in various contexts (e.g. including the MUSIC project – Nevens et al. 2013; Frantzeskaki and Tefrati 2015; Frantzeskaki and Shiroyama 2015; the Melbourne and Port Vila projects – Ferguson et al. 2013a,b; Poustie et al. forthcoming; and many more applications), we have fully developed an advanced process methodology architecture that we present in Chapter 3. There, we first present all the steps in the transition management cycle (the process architecture itself) and second the operationalisation of the process architecture for the IMPRESSIONS' research objectives.

There are two distinct issues that need consideration in the proposed advanced transition management approach compared to other applications of transition management. First, the system analysis is not part of the process steps and takes a different form, given that the development of pathways is realised in reference to future high-end scenarios. With IMPRESSIONS we aim to use the input scenarios (combinations of RCPs and SSPs) as contexts in which transition pathways are generated in participatory settings to achieve the Vision objectives. As such, we attempt to learn from linking the input scenarios to policy relevant knowledge in the form of transition pathways. In this way, we aim to move a step closer in learning how to incorporate the RCPxSSP scenarios into policy-making (cf. Burch and Harris 2014, p.201). Second, the actors selected for participating in the co-creating process are not necessarily frontrunners (in terms of pioneering innovative and in some

cases transformative actions), but diverse knowledge holders. The advanced transition management process aims to inspire and stimulate transformative thinking in a variety of stakeholders.

We propose two specific methodological advancements. First, the advanced methodology includes a process for introducing additional non-linearities in the co-creation process by the introduction of wildcards in transition management approach. This step is inspired by resilience thinking. The wildcards are used to test the robustness of the pathways against additional extreme events that put the coping capacity of the system under pressure. These advancements are depicted in the steps that we describe in Chapter 3 and included in the Transition Management Cycle – the co-creation cycle of the process (Figure 1).

Next, we developed a new analytical framework – the governance capacities' framework (Hölscher et al. 2015) – to further analyse and hence include knowledge on agency dynamics in the transition management process. The governance capacities framework will be used to: (a) assess existing strategies and actions as well as the implied strategies in the input scenarios (RCPxSSP combinations); (b) identify the institutional conditions required for the proposed strategies and pathways; (c) identify the prospective governance capacities to be established by the pathways; and (d) assist with the reflection on synergies and trade-offs between different transition pathways across sectors, scales and time. In the IMPRESSIONS project activities, the governance capacities' framework is positioned in the Knowledge Translation Cycle where all the analytical activities are structured and take place. The Capacities Framework is presented in detail in Chapter 4 in this document.

3. Advanced transition management in IMPRESSIONS

In this section, we outline the individual process steps of the advanced transition management methodology. The transition management methodology unfolds across three nested activity cycles of the IMPRESSIONS project (Figure 1). On an operational level, the advanced Transition Management Cycle includes co-creation activities performed with stakeholders. This cycle encompasses four phases: orienting, agenda setting, activating and reflecting. These phases also organise the activities on the analytical and synthesising level. On an analytical level, the Knowledge Translation Cycle involves analytical activities performed by IMPRESSIONS experts. These pertain to analyses of inputs and outputs of the operational phases. Finally, at a synthesising level, the Knowledge Consolidation Cycle refers to synthesis activities that are performed both with stakeholders and by IMPRESSIONS' experts.

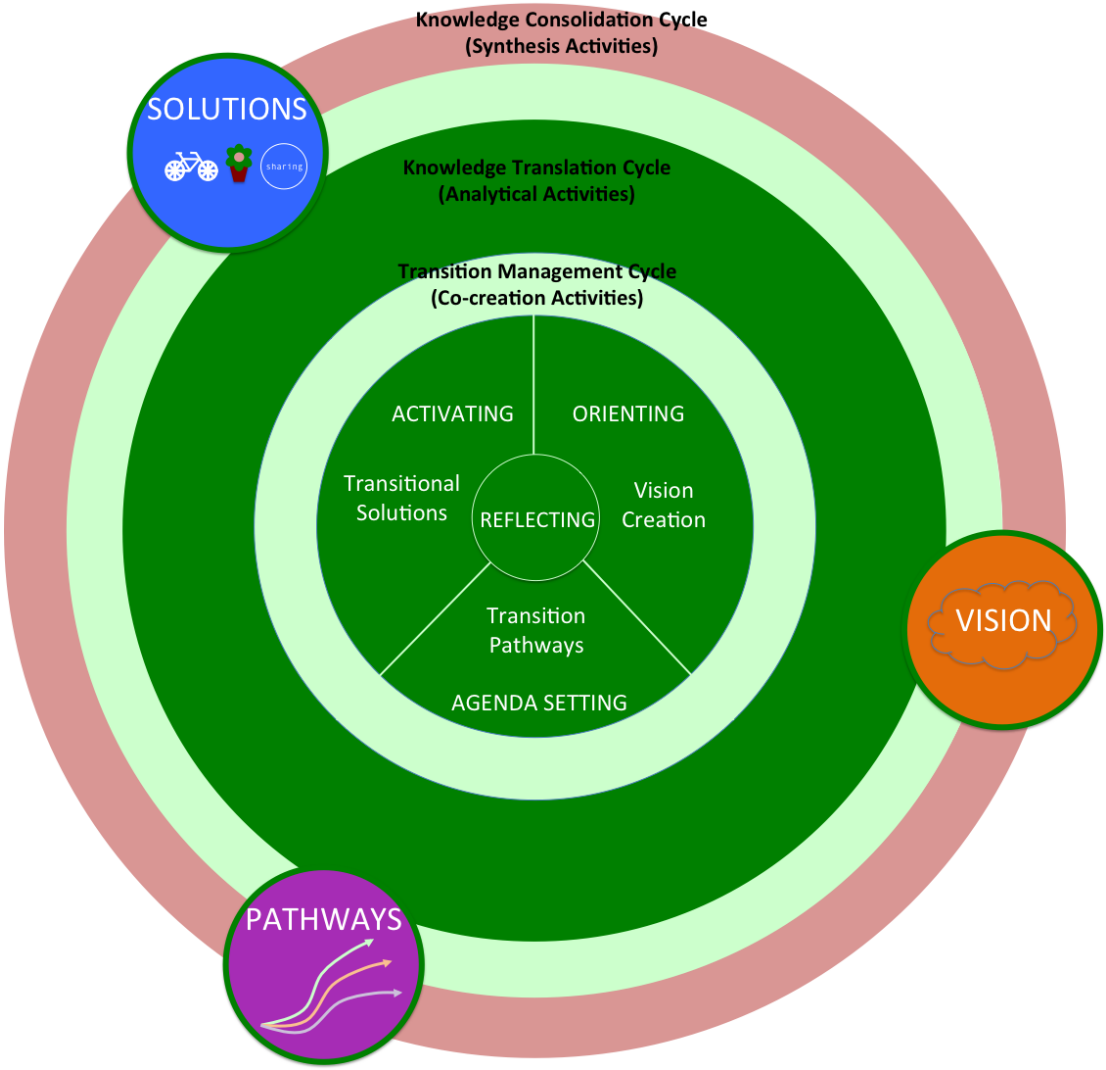


Figure 1: The three activity cycles of the IMPRESSIONS project: the advanced Transition Management cycle (co-creation activities performed with stakeholders), the Knowledge Translation cycle (with analytical activities performed by IMPRESSIONS' experts) and the Knowledge Consolidation cycle (with synthesis activities performed both with stakeholders and by IMPRESSIONS' experts).

Figure 2 specifies the operational and analytical activities by cycle phase that work together to create distinct outputs. The orienting phase serves to create a Vision. This builds on analytical level activities that provide insights on the current situation and on consolidation of the insights. The agenda setting phase serves to develop transition pathways that identify adaptation, mitigation and transformation strategies. Analytical level input includes insights on current good climate governance practices and strategies that are integral to the SSPs. The activating phase serves to identify innovative solutions for adaptation, mitigation and transformation. This activity is supported by an analysis of the conditions needed for the implementation of pathways and the identification of wildcards that serve to stress-test the pathways. The Reflecting phase includes the through-process evaluating and monitoring activities to ensure maximised fitness of the process design and process outcomes to the context dynamics and in this way ensure a quick take-up of the knowledge co-created for policy and society.

In the following, we describe the process architecture and operationalisation for IMPRESSIONS of each phase.

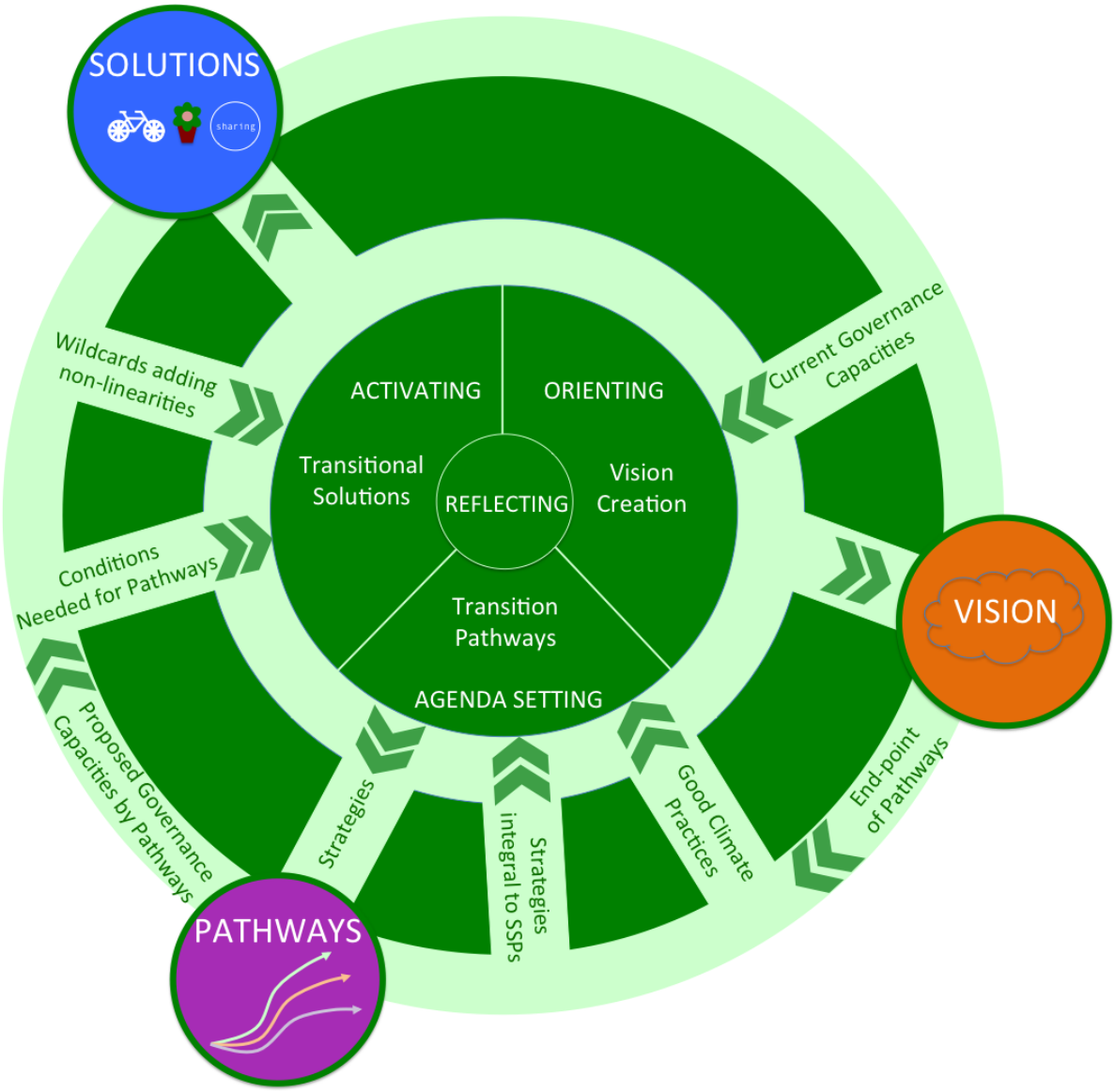


Figure 2: The Transition Management Cycle (co-creation cycle) along with the inputs and outputs through the Knowledge Translation Cycle activities.

3.1. Orienting phase: Co-creating a transformative vision

In the first phase of transition management, the orienting phase, the process steps lead to co-creating a transformative vision. These steps include: (a) formulating guiding principles; (b) narrating the Vision or creating vision narratives; and (c) linking the Vision to indicators to enable the assessment of the performance of proposed strategies and actions that constitute the transition pathways.

For each of these steps we will elaborate on the three design elements (process, content, context) based on scholarly work from foresight science, scenario development and operational research (Bishop et al. 2007; O'Brien and Meadows 2013; Ringland 2010; Robinson 2011).

3.1.1. The process architecture

Formulating guiding principles

The objective of this step is to formulate a suite of principles that represent desired system outcomes for the long-term horizon. In this step of the process, core values of the participants are uncovered and negotiated in order to formulate principles that work in synergy for guiding future developments (Schultz et al. 2007; Rogers and Bazerman 2008). This step aims to stimulate thinking about long-term aspirations rather than quick and incremental fixes of the system pathologies (formulated as underlying challenges).

The expected outcome of this step is a list of guiding principles that forms the basis of the broader vision and that will trigger the vision building process. Guiding principles are descriptive statements of the desired future system, its desirable operations and the services it will/may deliver.

The way that the guiding principles are presented to the participants can differ based on whether the information sharing between the participants and non-participants is open or closed. An overview of the negotiated guiding principles along with a short description of their meaning can suffice to bring the envisioning process forward. However, careful presentation is needed if the guiding principles are to be communicated or shared with non-participants or in forums and processes outside the current process (Pichert and Katsikopoulos 2008).

In order to take context dynamics into account in the process design, it is suggested to: (a) search, acknowledge and present existing visioning work especially when there are participants in the envisioning process that are aware of, or have participated in, past or on-going parallel envisioning processes; (b) take into consideration recent developments including pilot projects, emerging initiatives from communities or partnerships as well as existing (sustainability) agendas or planning programs; and (c) provide the choice to the participants to either build on existing work or start with a new perspective to build principles.

Creating a Vision

The objective of this step is to create descriptions and/or images of the envisioned future system which express the agreed desires and wishes of a future society and planet in 2100. The Vision comprises of vision statements that are specific narrative constructs that depict explicit desires, assumptions, beliefs and paradigms that underlie a desired future.

Creating a vision can facilitate effective strategic process (or strategy planning processes) for identifying transformative action in the face of high uncertainty contexts (Miller et al. 2015). Miller

et al. (2015, p.65) note that "narrative is particularly salient in the development and application of futures approaches for tackling the problem of governing complex systems change". Miller and Iwaniec (2014) argue that visions are important in sustainability science since they provide "a key reference point" for developing transition pathways.

A successful vision captures the imagination of both participants and a broader audience and can create symbolic value in a system or organisation (Shipley 2000; Shipley and Newkirk 1999; O'Brien and Meadows 2013). For a vision to create social value or symbolic value in its context, it has to transcend from the group that created it and become relevant for the communities that constitute 'the context' (Hughes 2013). Communication of the vision from the group or group representatives to a broader audience or targeted audience is a side step that may enable value creation and mobilisation of networks and resources for realisation of the vision (Hudges 2013; Tompkins et al. 2008; Frantzeskaki et al. 2014; Frantzeskaki and Tefrati 2015; Volkery et al. 2009).

The expected outcome from this process step is a comprehensive description of a vision that outlines and synthesises different images or representations of the desired future. The overall vision can be presented as having different themes or different images. The vision can be presented in the form of storylines, artistic impressions and/or expressions (e.g. images or videos or sculptures), newspaper headlines or front pages.

On tailoring the process to the context dynamics, scholarly work on envisioning and creative scenario building offers a great variety of empirical examples but limited knowledge on operational guides for tailoring. Among the limited and fragmented 'good practices' on contextualisation of envisioning processes are to: (a) consider existing narratives around change and trigger them by designed 'crises' scenarios/contexts within the vision (Sondeijker et al. 2006; Wiek et al. 2006); (b) consider emerging 'narratives' or debates within the operating institutional context and relate them to the envisioning process of symbolic meaning creation to substantiate partially the emerging narratives. In this way, new meaning and new content is created for emerging concepts that already seek, or are under, policy attention (Cairns et al. 2013; Volkery and Ribeiro 2009); (c) allow for open confrontation and open searching of commonly shared values and future desires by engaging with a variety of actors, or simply allow for not-like-minded people to envision together for a successful vision (Helling 1998; Van der Helm 2009); and (d) include different knowledge representatives in the envisioning for co-creation and learning (Sheppard et al. 2011; Gidley et al. 2009).

Linking the vision to strategic objectives

The objective of this step is to generate strategic objectives that relate to, and are, operational translations of the guiding principles. The role of the strategic objectives is to enable assessment of the actions, i.e. do the actions taken bring the system closer to the Vision. They enable assessment of whether a vision is achieved. With this comes the reflection that creating a vision is not a goal in itself. At the same time, having a suite of strategic objectives provides the means to better design short-term actions to open the route for more daring and transformative steps in the medium and long-term.

A suite of strategic objectives need to be formulated which are focused on the values represented in the guiding principles and the vision description (Keeney 1996a; 1996b; Frantzeskaki and Walker 2013). Taking context dynamics into account for operationalising the Vision, implies that existing indicator schemes may be incorporated or partially adapted if they fit to the overall vision content.

3.1.2. Operationalisation: IMPRESSIONS' vision co-creation

The purpose of the visions in IMPRESSIONS is an ENDPOINT against which we can measure (mostly qualitatively, but perhaps against selected quantitative results) the "success" of pathways. It is important to use the Vision as an endpoint in order to ensure that the participatory process in developing the transition pathways is effective and is set to connect process with outcomes (cf. Helling 2007).

Within the IMPRESSIONS project, we have agreed that we need a transformative vision for each case study area in order to have an "endpoint" for the development of adaptation / mitigation / transformation pathways. We need visions that are customised to the case study and reflect the challenges of high-end scenarios. The (broad) vision is used as a target for the development of actions and strategies within the context of an integrated input scenario (RCPxSSP). The language in the final vision should include some statements that can be linked to definite outcomes, to support an assessment of whether elements of a vision are achieved or not. What distinguishes the vision from the pathways and scenarios is their level of operationalisation. The time horizon for the IMPRESSIONS visions is the year 2100. The focus of the transformative vision is explicitly set to '**where we want to be**' and not to 'where we are heading now' or 'how to go there'.

Step 1: Reviewing past visions

The preparatory phase of the vision creation involved IMPRESSIONS' experts. Firstly, a review of global sustainability visions was undertaken, including the VISION RD4SD, Planet 2050, GEO 5, POLFREE Vision and The Great Transition. Core elements of these visions were then identified as shown in Box 1. This material will be used during the stakeholder workshops in each case study to stimulate stakeholders in generating their vision. At the cross-scale workshop (across case studies) towards the end of the project, the visions of the different case studies can be compared to reveal common key messages about stakeholders' visions for the future.

Box 1: Outputs from reviewing visions: The starting IMPRESSIONS' Vision Elements.

A useful illustration of the different elements that commonly make up a vision is the "doughnut" developed by Kate Raworth[2]. As Kate herself writes: "[the doughnut brings] social and environmental concerns together in one single image and approach. It also sets a vision for an equitable and sustainable future, but is silent on the possible pathways for getting there, and so the doughnut acts as a convening space for debating alternative pathways forward." As such, the doughnut provides a useful starting ground for exploring the vision elements and formulating prompting vision statements.

The "doughnut", along with a synthesis of the GEO-5 and the Great Transition visions, was used to generate a generic set of vision statements that can serve as 'prompts' for engaging with stakeholders in the case study workshops:

[2] http://www.kateraworth.com/doughnut/

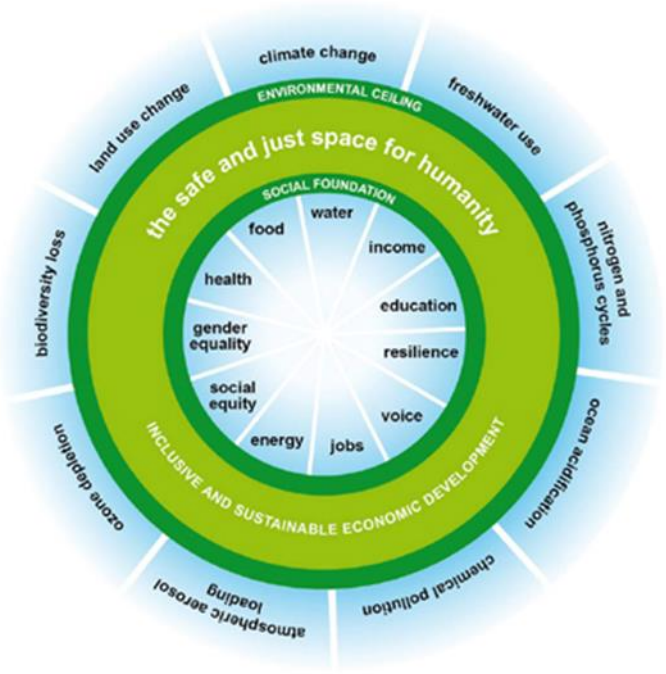


Figure 3: The Integrated Image of Social and Planetary Boundaries delineating the Safe and Just Operating Space for Humanity. Figure developed by Kate Raworth[3].

Planetary Boundaries

- Global warming is abating as greenhouse gas emissions return to pre-industrial levels.
- Ecosystems are restored and endangered species are returning, although scars remain as reminders of past heedlessness.
- Population stabilisation, low-meat diets and compact settlements reduce the human footprint, sparing land for nature.

Food, water and energy

- Organic farming makes use of high inputs of knowledge, and low inputs of chemicals to keep yields high and sustainable.
- Basic drinking water and sanitation needs of even the poorest have been met.
- We live in a solar economy. Solar cells, wind, modern biomass and flowing water generate power and heat buildings and direct electricity for transportation.

Health and well-being

- More humans enjoy a higher quality of life for longer than ever before, without denying future generations the same possibility. The pursuit of the well-lived life turns to the quality of existence and human relationships and a harmonious relationship with nature.
- More humans have access to health than ever before, and access to health care is equally distributed across and within countries.

Income, education and jobs

- A minimum guaranteed income provides a comfortable but very basic standard of living. Community spirit is reinforced by heavy reliance on locally produced products, indigenous natural resources and environmental pride.
- A consensus is in place at the global level with the aim to foster and sustain prosperity rather than continued economic growth at all costs, a commitment to redirect investments to green entrepreneurship and innovation.
- All humans have free and equal access to education. Education focuses on the development of 21st century skills.

Resilience

- Learning and mimicking nature's resilience has helped restore ecological function in areas once considered irretrievably lost.
- Knowledge of nature, species and ecosystems is used as a measure and model for humanity's greatest challenges. Most of the world's citizens are actively engaged with humanity's goal of living within planetary limits.

Voice, social equity and gender equality

- Global communication networks connect the four corners of the world, and translation devices ease language barriers. A global culture of peace and mutual respect anchors social harmony.
- A civilization with unprecedented freedom, tolerance and decency exists. The pursuit of meaningful and fulfilling lives is a universal right, the bonds of human solidarity have never been stronger and an ecological sensibility infuses human values.
- The fabric of global society is woven with diverse communities. A new way of living is galvanized by the search for a deeper basis for human happiness and fulfillment. This has been expressed through diverse cultural traditions.

The final IMPRESSIONS' vision(s) should be developed in the following steps that include involvement of stakeholders and experts/analysts:

Step 2: Collect stakeholder inputs for the vision prior to stakeholder workshop #2

Prior to the second workshop (WS2)[3], each case study will survey the stakeholders who will participate in the workshop and ask them to send their inputs (statements) about their vision for the case study region in 2100. They should express their ideas freely and without restrictions.

Step 3: Analysis of stakeholder inputs for the vision

These stakeholder contributions will be analysed before the second workshop to: (a) identify commonalities and differences, leading to a basic vision; and (b) match these with element categories of pre-existing visions (such as GEO-5, The Great Transition, etc).

Step 4: Adapt and expand towards a co-created transformative vision

Workshop 2 will start with a short presentation on the vision statements that IMPRESSIONS' experts have compiled from the stakeholder survey. Participants then have the chance to adapt and expand the vision elements in order to arrive at an agreed basic vision for the rest of the process for the case study. In this way, the developed vision will be co-created by the participants in WS2. We should foresee that the group of stakeholders may not agree on all aspects for a vision. If this occurs, the process will continue with those vision elements upon which there is agreement, noting the non-agreed other parts.

Step 5: Using elements of the vision to evaluate pathways

The vision represents the stakeholders' desired endpoint for the pathways that will be developed by the stakeholders during the workshop process. As such it is necessary to assess qualitatively and/or

[3] In the Scottish case study this process is slightly modified. Collecting the elements of the vision took place during the mini-Workshop in September 2015.

quantitatively to what extent the pathways' actions and strategies contribute to achieving the Vision. Depending on the vision element and case study, this assessment of whether the proposed pathways lead to positive or negative, high or low changes may be done by expert judgement or from a comparison of appropriate modelling output indicators with qualified vision elements.

3.2. Agenda setting phase: Co-creating transition pathways

Pathways are cross-sectoral progressive courses of action that connect short-term to long-term actions. More specifically, pathways consist of a bundle of strategies that progressively build up from short-term actions to long-term actions into broader transformations. Pathways are not random collections of actions but purposive courses of actions, meaning that they are target-seeking. As such, pathways (i) build, (re-)create and break down resilience as well as reduce vulnerability through mitigation, adaptation and transformation actions that address drivers and impacts of system change, and (ii) build the system's capacities that also establish the conditions for the trajectories. This phase of the advanced transitions management methodology explores different elements of pathways focusing on pathways which (i) are multi-sectoral, cross-scale and time-dependent; (ii) include short-term, medium-term and long-term strategies; and (iii) include strategies and solutions which can foster synergies between adaptation, mitigation and transformation actions.

The pathways will be generated within the IMPRESSIONS stakeholder workshops that provide the initial input that will subsequently be processed by the IMPRESSIONS expert team. Each pathway represents a course of actions that progressively builds towards achieving the Vision, along with a set of mechanisms and conditions which enable synergies across different pathways to be developed. In addition, the generated pathways will take into account: (a) who is accountable for realising the solutions or actions in the short-term; and (b) what are the perspective governance capacities that need to be established by the proposed pathways. In this way, the IMPRESSIONS suite of pathways will not only consider high uncertainty and social complexity, but also agency and social structures that are largely overlooked by climate governance studies (see Wangel 2011).

3.2.1. The process architecture

Backcasting

Participatory backcasting will be used as the main approach for generating the transition pathways. The three design elements (process, content, context) for the backcasting approach are based on scholarly work from foresight science and scenario development (O'Brien and Meadows 2013; Ringland 2010; Robinson et al. 2011). The objective of the backcasting is to identify sets of strategies that are likely to achieve the defined vision. It aims to stimulate the creative capacity and innovative thinking of participants for generating future alternatives that were not thought of before in order to come up with unconventional, yet tangible, means to achieve future desires while ensuring protection of values (complying with the guiding principles) (Ringland 2010; Kok et al. 2011; Robinson et al. 2011; Phdungsilp 2011).

Backcasting is a normative approach in which the starting point is a desirable objective, target or vision that is used to trigger thinking on 'which actions can enable us to achieve this vision, by reversing time?' In this process the generation of actions relates first to the long-term time horizon (e.g. near 2100 in the case of IMPRESSIONS) and it progresses 'backwards' in time from the vision to actions for the short-term. It is frequently the case that the short-term actions generated by backcasting condition the viability/applicability of medium-term and long-term actions.

Backcasting has been used to enable vision-led action and innovation with the aim of creating path-breaking developments as a counter-method to forecasting (Kok et al. 2011; Quist et al. 2011; van Vliet and Kok 2015). In this way, backcasting is employed as a method that can help to avoid thinking of actions based only on feasibility and viability in reference to current situations and historical paths. One of the major benefits of the backcasting method is that it allows for multiple pathways to be generated to progress from the current situation to the future vision (Gordon 2015). As such, it is a suitable method for contexts of high complexity and high uncertainty in which there is no optimal pathway but a plethora of pathways and actions (van den Voorn et al. 2012).

It is also important to trigger participants to think about the build-up effect of actions: short-term proposed actions will create new ground and remove obstacles in order for medium-term proposed actions to pave the way to achieve future visions, while long-term actions build on the impacts and work of medium-term actions but can be more daring and radical. In this way, pathways are created that progressively build up transformative change to realise the Vision. The output of this step is a set of pathways that bring about transformative change by connecting short, medium and long-term actions into a strategy continuum that paves the ground to realise the desired future Vision (O'Brien and Meadows 2013).

It is important to consider the context dynamics in terms of which conditions already exist that create an enabling or inhibiting institutional context to new pathways (Ferguson et al. 2013). At the same time, consideration of context dynamics can be realised by identifying which pathways relate to on-going policy programs and how they relate, or may relate, to them (Godet 2000), as well as by examining whether some pathways have been proposed before and failed (contextual grounds of stalling of past proposals that may relate to suggested pathways).

Testing robustness of transition pathways

When co-creating transition pathways, the medium and long-term future are considered complex and uncertain, however, there needs to be a methodological choice in order to incorporate the future uncertainties and complexities in further strengthening the plausibility of the proposed pathways. In this stage, we propose to incorporate a step for testing the robustness of transition pathways in the face of a shock, stress or disturbance as a way to incorporate non-linearities from social, ecological and technological sub-systems or global developments.

3.2.2. Operationalisation: IMPRESSIONS' pathways co-creation

Backcasting approach in IMPRESSIONS

In the IMPRESSIONS stakeholder workshops, we will employ backcasting in order to identify strategies and actions to achieve the Visions in view of existing policies, the input scenarios (RCPsxSSPs) and the Vision. The steps in the backcasting process are described below:

Step 1: Identify and analyse the adaptation and mitigation implied in the input scenario (RCPxSSP combinations) and first identification of strategies within the input scenario.

Socio-economic developments within the SSP scenarios cannot be viewed separately from potential actions and changes in policies that might be part of the pathways. This is particularly the case for high-end and long-term climate change and particularly in worlds such as SSP1 (which is likely to be closest to the stakeholder vision). Hence, adaptation/mitigation that is inherently happening in the input scenario (RCPxSSP combination) will first be identified. This will result in a table indicating key adaptation and mitigation strategies that build mitigative and adaptive capacities across different

policy areas per input scenario. This table will be introduced at the second stakeholder workshop. The backcasting will then aim to identify additional strategies which are needed to reach the Vision on top of the level of adaptation/mitigation already present in the input scenario rather than current practice.

In addition, examples of good practice related to climate change adaptation and mitigation will be identified from a review of literature and websites and introduced to stakeholders at the workshop to inspire the further generation of strategies (and possibly actions). This will be complemented by information on the stress-testing of current policies being undertaken by WP5. Within the workshop, stakeholders will discuss how these existing strategies and policies are affected by the climate and socio-economic changes in each input scenario which could show which strategies currently in place should be continued or expanded. All this information will stimulate a first discussion on "what do we need to do, if we are to achieve our Vision for 2100".

Step 2: What are the additional strategies needed in this input scenario to achieve the Vision?

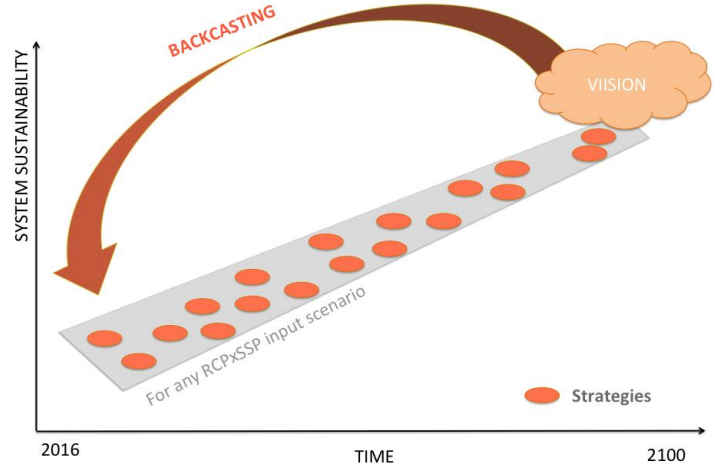
In the second step, participants at the stakeholder workshops will backcast from the Vision to the RCPxSSP combination input scenario. This will involve identifying for each of the strategies proposed in the first step the time-slice they believe that the strategy has to begin (2020-2050/2050-2070/2070-2100). Participants then identify, for each strategy, with which other strategies it relates in different time-slices. In this way we create time-dependent strategies (i.e. the first formation of a proto-pathway). Here, we start from the first time-stamped strategy e.g. a strategy with a time-stamp of 2017 and follow the linked strategies across the different time slices. This activity is used to cross-check with participants whether additional strategies need to be added besides those already identified as well as further identifying the related actions that contribute to this 'pathway'.

Following the formation of the proto-pathway, stakeholders will be asked to brainstorm and generate additional strategies with no time-stamp. After the brainstorming they will identify when these strategies have to begin and how they relate to the strategies already in the time-slice. After strategies have been put in the time-slices and connected with other strategies across time, we ask 'how would each strategy be realised?' Here, we aim to identify specific actions and actors for each strategy, as well as the sectors involved. This is an operationalisation activity from strategies to actions. It is important to note that strategies are cross-sectoral and actions are more specific, more operational and sector-specific. The outputs from this second step are a first rough set of transition pathways with identified strategies in each time-slice and a set of actions identified per strategy.

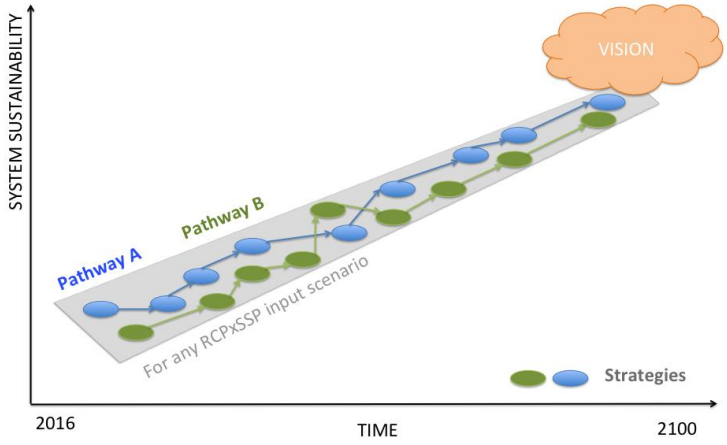
The final activity in step two is to identify synergies and coordination between strategies. This activity will be performed by the WP4 team after the first set of pathways has been generated. This will be based on the governance capacities framework that is presented in Chapter 4.

Figure 5 shows how the 'backcasting' and forecasting in Step 2 will unfold.

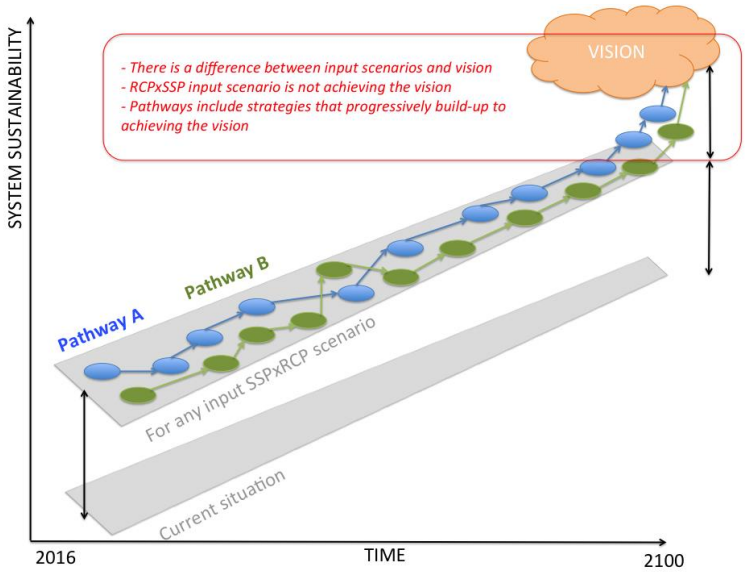
Backcasting from the Vision to the RCPxSSP combination input scenario:



Forecasting from the first identified strategy to the Vision to create pathways. The figure shows an example of two pathways:



For most of the input RCPxSSP scenarios, the input scenarios are not 'leading' to the Vision. Therefore, the pathways need to extend system's capacities and build on strategies that achieve the Vision.



Identification of synergies and coordination between strategies. The figure shows an example of two pathways and synergies between strategies that are also synergies between pathways:

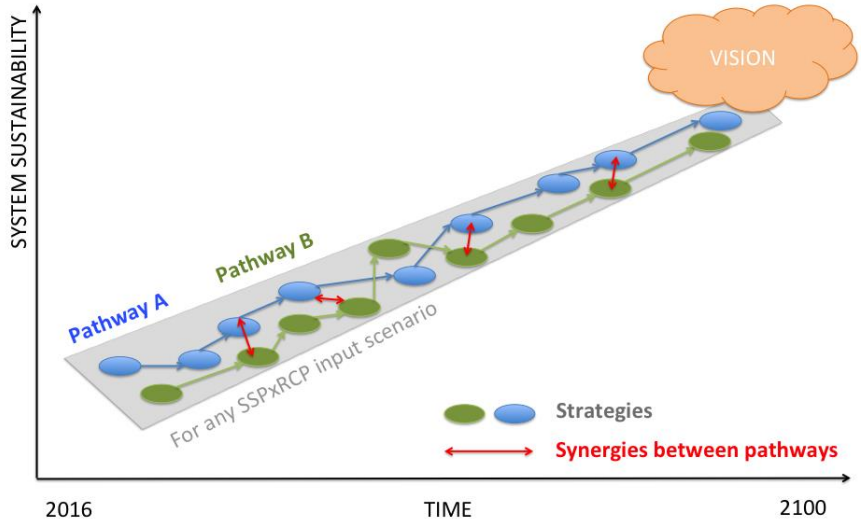


Illustration of four pathways in two input RCPXSSP scenarios and how the different pathways connect in order to achieve the Vision. In this figure we only show how synergies between the pathways are mapped. In Task 4.3 we will also examine the synergies across pathways across input scenarios:

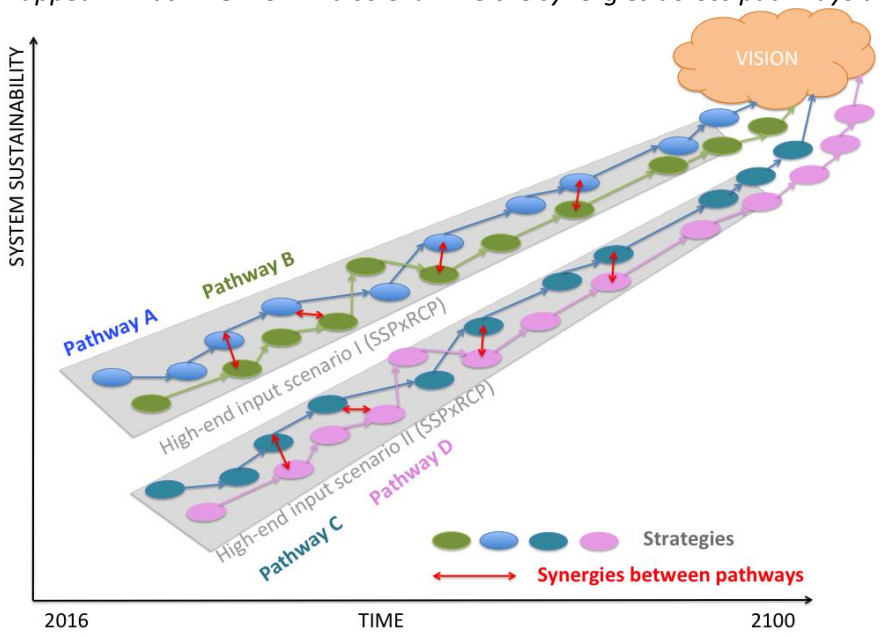


Figure 5: Illustration of IMPRESSIONS' backcasting steps'.

Step 3: Identify the conditions needed for putting in place the pathways

This is an analysis step that includes identifying three sets of conditions that will complement the pathways:

(a) Institutional conditions that will enable the realisation of strategies in a pathway. The institutional conditions will be identified with the capacities frameworks (using the governance capacities dimensions, see the Tables in Chapter 4).

(b) Resource conditions that will enable the viability of strategies in a pathway. The resource conditions will be identified by the capitals framework (developed within WP5 in IMPRESSIONS).
(c) Relational conditions that concern the synergies and trade-offs between different strategies across pathways, across sectors and across time (guided by Task 4.3 and assisted by the governance capacities framework).

The aim of identifying synergies and trade-offs is to:

- Compare what is being done now (existing actions) with the adaptation and mitigation actions/strategies proposed within the pathways (which will be operating at multiple scales; and addressing vision-related issues within multiple sectors).
- Identify policy or societal mechanisms by which some adaptation and mitigation strategies and actions within pathways can be aligned to achieve co-benefits and avoid unintended consequences (either cross-sectoral or adaptation/mitigation conflicts).

In this step we will map the strategies and actions within the transition pathways across the sectors, scales and SSPs in which they should deliver adaptation and/or mitigation 'benefits'; and identify where there are synergies and conflicts (Figure 6). We will focus on those Strategies with 'opportunity-value'. For example:

- Strategy A has synergies at multiple scales for forestry (i.e. identified within EU, national and municipality pathways). The question becomes then – what mechanisms can deliver A across scales?
- Strategy A has synergies for forestry across multiple SSPs, i.e. identified in pathways for multiple SSPs (but not business-as-usual (BAU), i.e. current policy - strategies). The question becomes then - how to harmonise BAU strategies/policies with A?
- Strategy B has synergies across multiple sectors in Scotland (positive for urban, health, forestry and biodiversity; but negative for agriculture and water). The question becomes then – how to minimise the negative effects?

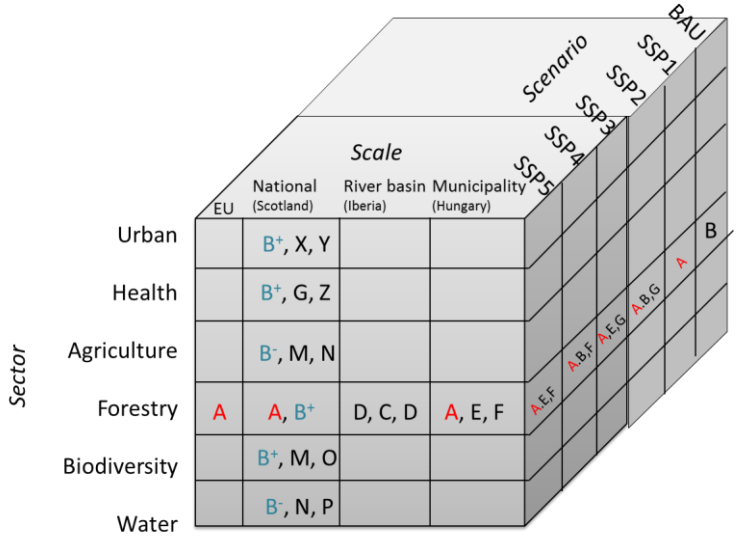


Figure 6: Showing how synergies between strategies across scales, across sectors and across scenarios can be mapped.

Testing robustness of transition pathways in IMPRESSIONS: Wildcards

Wildcards will be used to introduce additional non-linearities and trigger discussions about the robustness of the Vision and pathways. This will stimulate additional transformative thinking and identification of additional strategies that might be needed to recover from the aftermath of an extreme event. The complementary strategies will further enrich the pathways and strengthen their robustness to additional non-linearities.

Before presenting and elaborating on the process to generate wildcards, we first explain what is a wildcard and why we are using them in IMPRESSIONS.

Wildcards are events with very high impact and very low probability. They can be linked to early signals, they can be positive (creating windows of opportunity for a desired transformation) or negative (leading to a forced/undesired transformation), and they can be both irreversible and reversible (Saritas and Smith 2011; Wardekker et al. 2010).

> "*Wild Cards are **surprising** and **unexpected events** with **low 'perceived probability' of occurrence** but with **very high impact** (e.g. 2001 attack to the World Trade Centre on 9/11, major disasters in environmental or technological systems, etc.). Serendipity or the faculty of making scientific discoveries by accident is another important source of wildcards, which can be included into the unexpected surprises of human actions category. Some typical examples are the discovery of the penicillin (by Fleming), LSD (by Hofmann), dynamite (by Nobel), America (by Columbus) and Viagra (by Osterloh), to name a few*." (Popper 2011)

We employ wildcards to test the robustness of pathways. The wildcards will introduce additional non-linearities that originate in social, economic, technological and infrastructural developments and will affect the capacities of agency to mobilise capital in achieving the desirable sustainability vision. At the same time, introducing wildcards in a participatory setting (within the third set of IMPRESSIONS stakeholder workshops) aims to stimulate transformative thinking which will help the identification of recovering strategies which are able to deal with the aftermath of an extreme event and which are complementary to the strategies already positioned in the pathways.

The importance of looking at the way social capital may be affected by extreme events is important in the context of high-end climate change due to the historical evidence that societal collapses have occurred when environmental changes were combined with, and made more severe by, inappropriate institutional responses (Tainter 1990; Pelling 2011) in appropriating resources (money, infrastructure, technology, knowledge, time) and in preparing and responding to drivers and pressures of environmental change.

The process of generating wildcards in IMPRESSIONS is described below.

Step 1: Reviewing existing wildcards' databases

An existing database of wildcards created from the FP7 project iKnow and grey literature of international organisations' reports on extreme events were reviewed. The iKnow database included 440 wildcards (www.iknowfutures.eu) and our literature review from international reports resulted in 20 additional wildcards. The total of 460 wildcards were screened and 39 wildcards were selected based on the following criteria:

- Wildness: the wildcard is an extreme event and/or extreme impact, i.e. it has the potential to tilt or tip the system.

- Cross-sectoral impact: more than one sector will be affected through the occurrence of the wildcard. The sectors that we consider include: food, water, biodiversity and/or health.
- Exposure: wildcards that have an acute impact or unfolding impact are equally selected.
- Impact array: wildcards with local and global impacts are selected. Wildcards with very specific local impact are not selected.

What we excluded:

- Extreme trends: scenario-like extremes are not wildcards.
- Extremes that have already occurred multiple times are not considered to be a wildcard (even if it was included in the iKnow database).

Step 2: Screening of selected wildcards by IMPRESSIONS' experts

In an expert workshop in Rotterdam (October 2014) we further screened the basket of 39 wildcards. The expert participants also contributed to the descriptions of the wildcards and added new wildcards. The screening criteria that were used during the expert workshop include the following:

- Wildcards are extremes that *differ from the SSPs* (additional non-linearity);
- Wildcards are extremes that *can relate to more than one case study* (universality);
- Wildcards that present a *fatalistic future are excluded* (e.g. nuclear world-war) because they are not serving the objective of using the wildcards in the IMPRESSIONS transdisciplinary research work.

At the end of the expert workshop, 17 wildcards were selected. These 17 wildcards were then analysed and prepared after the workshop by adding the inputs from the experts' workshop in the description of the wildcards and their impacts. This information was presented separately and checked in the literature.

Step 3: Screening of selected wildcards by IMPRESSIONS' experts against their impact

A second expert workshop took place in January 2015 to further screen the basket of 17 wildcards to identify those that are compatible with the context and dynamics of the IMPRESSIONS case studies. The screening criteria proposed and used by the experts in this workshop included:

- Extremes that can have an *extreme impact* in the *case study's context* (extreme impact AND extreme local impact);
- Extremes that *can have a leakage effect due to cross sectoral impacts* (extreme local impact AND cross-sectoral impact) (escalating impact);
- Extremes that *can have a melting down impact*: extremes with global impact via cross-sectoral linkages have also extreme local impact (extreme global impact AND cross-sectoral impact) (downstream impact).

At the end of the expert workshop, a basket of 10 wildcards was selected.

Step 4: Grounding the selected wildcards in the literature

The ten selected wildcards have been further analysed and their impacts reviewed in the literature. More specifically, the descriptions of the impacts of the wildcards have resulted from a literature review (grey literature and academic literature) about these extreme events. From the literature review we conclude that the impacts that are mentioned, including any suggestions of their severity and damages, are 'foreseen' with reference to the current global situation. As such, the impacts are

not indicative for the high-end scenarios that we will use in IMPRESSIONS. Hence, the impacts as suggested in the literature will be used to support the choice of these wildcards as events of 'high impact' and 'low probability'. However, the impacts will not be presented to participants in the IMPRESSIONS stakeholder workshops nor to experts participating in the Delphi method (see Step 6 below). The ten selected wildcards have been also compared with wildcards generated from international organisations, such as the wildcards presented in the 'Global Risks 2014' report published by the World Economic Forum. Here, we found that six of our wildcards are very similar to the high-impact global risks for 2014 identified in the insights' report of the World Economic Forum as presented in Figure 7.

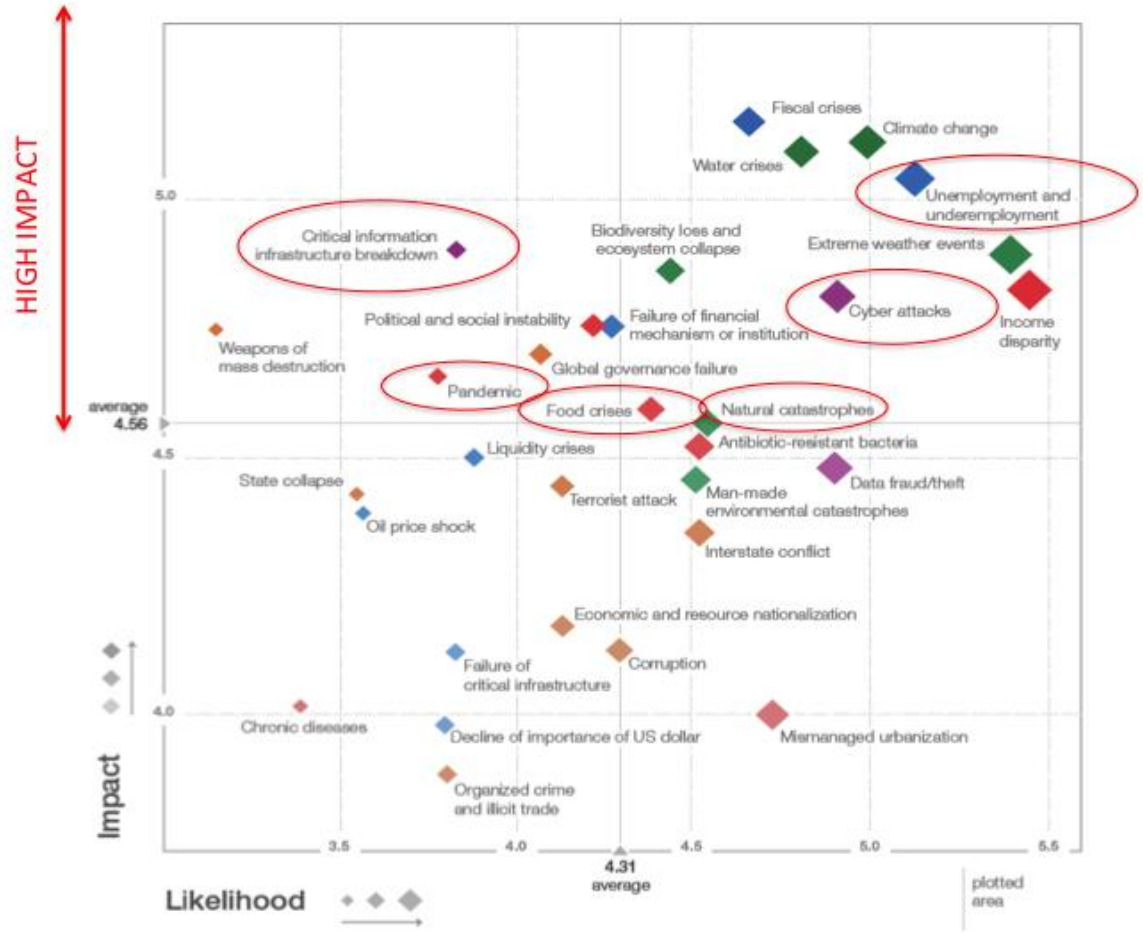


Figure 7: Comparison between the IMPRESSIONS' wildcards and the high-impact global risks' map of the World Economic Forum. IMPRESSIONS' wildcards are circled in red (Source: Global Risks 2014, Ninth Edition is published by the World Economic Forum; Editing of the picture by authors).

Step 5: Screening the selected wildcards based on compatibility, applicability and redundancy across the SSPs

The ten selected wildcards have been contrasted with the SSP input scenarios so as to check their compatibility (i.e. is the wildcard 'wild-enough' in the scenario?) and redundancy (i.e. does the wildcard occur already in the scenario?). The results of this assessment by the IMPRESSIONS WP2 team are shown in Table 2.

Table 2: Contrasting the wildcards with the IMPRESSIONS' input scenarios to assess compatibility, applicability and redundancy.

	IMPRESSIONS Input Scenarios			
WILDCARD	**SSP1**	**SSP3**	**SSP4**	**SSP5**
(1) Pandemic outbreak				
(2) Worldwide vegetarianism				
(3) Secular Stagnation				
(4) New energy source discovered in EU				
(5) Breakdown of trade routes				
(6) Nuclear accident				
(7) Artificial Food Production				
(8) End of aging				
(9) Collapse of the Internet				
(10) Major Volcanic Eruption				

	Wildcard applicable in this input scenario
	Wildcard incompatible with this input scenario (not wild-enough for this scenario)
	Wildcard redundant in this input scenario (already occurs in this scenario)
	Wildcard not relevant for this input scenario (technology or social conditions have changed so much that its occurrence is phased out)

The final set of wildcards will be used in the third set of stakeholder workshops. Therefore, the wildcards need to be applicable across all the SSP scenarios: SSP1, SSP3, SSP4 and SSP5. Based on Table 2, we conclude that six wildcards fulfill this criterion and should be further validated by external experts:

(1) Pandemic Outbreak
(2) Worldwide vegetarianism
(3) Artificial food production
(4) End of aging
(5) Collapse of the Internet
(6) Major volcanic eruption

To this set of six, a climatic wildcard has been added after feedback from IMPRESSIONS' experts. The climatic wildcard is: "West Antarctic ice shelf collapses".

Step 6: Wildcards description and contextualisation of possible impacts by external experts' elicitation

The Delphi method (Box 2) is being used to elicit expert opinion in order to validate and further advance the description of the wildcards, while also considering contextual elements of their impacts and nature. A medium scale Delphi is being performed supported by a webinar for the experts whose inputs are conflicting.

Box 2: The Delphi Method.

The Delphi method is a technique designed to produce an elaborated and specified examination of a topic or a problem and to promote their discussion among a group of experts participating in the panel (Ulschak 1983; Turoff and Hiltz 1996; Ludwig 1997). The Delphi method originates from the 1950s when it was developed by Olaf Helmer and Norman Dalkey of the Rand Corporation in Santa Monica, California, with the aim of addressing a specific military problem (Dalkey and Helmer 1963).

In the literature, the Delphi method is considered as a widely used technique for consensus-building and it uses a series of questionnaires to collect data and information from a group of experts (Dalkey and Helmer 1963; Dalkey 1969; Linstone and Turoff 1975; Lindeman 1981; Martino 1983; Young and Jamieson 2001). The method collects information about a specific topic or problem through the collection of ideas, knowledge and expertise from a group of panelists with the final aim of guiding the group of experts toward a consensus.

In accordance with Fowles (Fowles 1978), the Delphi method is characterised by anonymity, controlled feedback, and statistical response. In fact the interaction between experts is completely anonymous and every comment or observation is presented without declaring any identification. The method is based on the use of a series of questionnaires that are sent by mail or by other computerised systems to selected experts.

The following are the steps of the Delphi method as described by Fowles (Fowles 1978):

1. Creation of a Delphi team to undertake and monitor the project.
2. Identification and selection of one or more panels to participate in the technique (exercise). The participants in the panel should be experts in related fields.
3. Development of the first round of the Delphi questionnaire where experts have to answer anonymously.
4. Testing the questionnaire for proper wording (e.g. ambiguities, vagueness).
5. Transmission of the first questionnaires to the panel experts.
6. Analysis of the first round responses.
7. Preparation of the second round questionnaires (and possible testing).
8. Transmission of the second round questionnaires to the experts.
9. Analysis of the second round responses (Step 7 to 9 may be repeated to reach a consensus among the panelists or if necessary to achieve stability in the results).
10. Preparation of a report by the analysis team presenting the results of the process.

4. Towards an agency's governance capacities framework

In this section, we introduce a conceptual framework of agency's capacities for climate governance. The framework addresses the gap in transition management literature and applications concerning the inner workings of transition processes, and particularly the interplay between actors at different levels of government and different policy domains (Bettini and Frantzeskaki forthcoming). To develop a framework that combines understandings of actors and agency in transition processes in the context of high-end climate change, it builds on an integration of transitions, resilience and climate change literatures. It therefore proposes an integrated perspective on governance interventions to adapt against expected disturbances and pressures, mitigate the occurrence of disturbances and pressures, and transform as well as create synergies between interventions.

The framework is consistent with the overall approach in IMPRESSIONS and current scientific discussions to explore the question 'who is the solution' and the role of agency by taking a systems perspective (Tàbara et al. 2015). The purpose of the agency's governance capacities framework in IMPRESSIONS is to support the transition management process analytically. The capacities framework will also contribute to the analysis of the pathways in terms of the established governance capacities for implementing the pathways.

More specifically, we have developed a new analytical framework – the governance capacities' framework (Hölscher et al. 2015) – to further analyse and hence include knowledge on agency dynamics in the transition management process. The governance capacities framework will be used to: (a) assess existing strategies and actions as well as the implied strategies in the input scenarios (RCPxSSP combinations); (b) identify the institutional conditions required for the proposed strategies and pathways; (c) identify the prospective governance capacities to be established by the pathways; and (d) assist with the reflection on synergies and trade-offs between different transition pathways across sectors, scales and time. In the IMPRESSIONS project activities, the governance capacities' framework is positioned in the Knowledge Translation Cycle where all the analytical activities are structured and take place.

In the following, before identifying and specifying the capacities for climate governance, we clarify our conceptual approach to governance capacities that builds on a nested understanding of how actors engage in interdependent processes to produce agency. Finally we indicate how the capacities framework will be used in IMPRESSIONS.

4.1. Defining actors, agency and agency (governance) capacities

Governance has become a means of encapsulating the complex decision-making and deliberation processes in which a multitude of public and private actors interact to achieve common objectives (Jessop 1998; Stoker 1998; Scharpf 1994; Kooiman 1993). Sustainability scientists have since taken up the term in recognition of the fundamental changes needed in multi-level decision- and rule-making to enable inclusive and sustainable management of natural resources while achieving equitable development (Plummer 2013). A focus on such governance raises questions about who are the different actors involved in governance and how they collectively engage in solution-seeking endeavours to address societal sustainability challenges (ibid, Hermans 2010; Westley et al. 2013). In this line, the capacities for governance build on the reciprocal processes through which actors deliberate between contested and tested sustainability-contributing solutions rather than promoting individual actor interests (Frantzeskaki et al. 2015; Adger and Jordan 2009) as well as navigate their structural contexts (Kooiman and Jentoft 2009). We therefore build on a nested understanding of actors, agency and agency's capacities to conceptualise agency's governance capacities for transformative climate governance that builds resilience and promotes sustainability (Table 3).

Table 3: Actor, agency and agency's capacities.

Actor	Social entity, i.e. a person or organisation, or a collective of persons and organisations, that is able to act.
Agency	The interactive, deliberative and temporally constructed active engagement by actors to intervene in a contemporary situation or event.
Agency's capacities	The abilities of actors to mobilise resources within a system to intervene in a contemporary situation or event (i.e. to exercise agency).

Sustainability will not emerge or "just happen in a natural or pre-ordained way" (Adger and Jordan 2009: 7). Solution-seeking endeavours to address climate change and promote sustainability are based on multi-level and multi-phase processes, involving a variety of actors that are interdependent (Farla et al. 2012; Adger and Jordan 2009; Westley et al. 2013; Hermans 2010). An 'actor' can be conceived of as any social entity that is able to act (Hermans 2010; McLaughlin and Dietz 2008). We can distinguish between actors at different levels of aggregation – individual actors (e.g. policy-makers, consumers, entrepreneurs) and organisational actors (e.g. public agencies, NGOs, community organisations) – that can be broadly associated with different societal sectors (state, market, community and third sector) (Avelino and Wittmayer 2015).

Actors are constrained and enabled in their actions by the structural frameworks in which they operate (Giddens 1984; Kooiman and Jentoft 2009). The research field of institutional entrepreneurship solves this puzzle of 'embedded agency' by conceptualising agency as being "distributed within the structures that actors themselves have created" (Garud et al. 2007: 961). According to this view, agency presupposes an interactive response; agency is "the temporally constructed engagement by actors of different structural environments — the temporal-relational contexts of action — which, through the interplay of habit, imagination, and judgment, both reproduces and transforms those structures in interactive response to the problems posed by changing historical situations" (Emirbayer and Miche 1998: 970). Following this line, we can argue that addressing climate change and promoting sustainability through governance requires interactive responses of a variety of actors that exercise agency.

As efforts at finding solutions to climate change and sustainability challenges will not go uncontested, the exercise of agency requires skilled actors (Garud et al. 2007; Westley et al. 2013). They need to be able to seize opportunities and mobilise resources to narrate and theorise change in ways that give other social groups reasons to cooperate. When actors are able to create system-level change, they exercise certain system-level capacities. In this sense, the capacity notion provides a lens to study the agency processes underlying system change dynamics (Bettini and Frantzeskaki forthcoming). It alludes to the interplay between the institutional-bound conditions and multiple actors' behaviours, i.e. the processes by which actors are able to mobilise resources and implement change (exercise agency).

We translate this understanding of agency's capacities to conceptualise how governance is produced by the practices of actors. Agency's capacities for governance hence manifest in the processes through which actors create, mobilise and mediate resources to achieve certain goals (Kooiman 1993; Plummer and Armitage 2010). In other words, agency's governance capacities can be defined as *actors' abilities to engage actively in searching, establishing and/or mobilising resources for implementing strategies that work towards achieving a desirable goal.*

This definition positions resources as part of the structural preconditions of agency's capacities that must be activated to effect desirable system change. Resource accessibility is hence mediated through agency, while recognising that also structural conditions determine resource availability and accessibility.

4.2. Agency's governance capacities for transformative climate governance

In this section we identify the agency's governance capacities that make up climate governance. This builds upon our positioning of system change in a high-uncertainty context. In particular, the conceptualisation of agency's capacities for climate governance links the goals to build system resilience and promote sustainability. In scientific and policy communities there is an increasing shift towards searching for holistic approaches that consider multiple sectors and functions in a system to create co-benefits for resilience and sustainability (Frantzeskaki and Tillie 2014; Frantzeskaki and Kabisch forthcoming). Addressing climate change in this way acknowledges that, especially in high-end scenarios, climate impacts jeopardise societal wellbeing and welfare, aggravate injustice and compromise ecosystem services (IPCC 2014). At the same time, tackling the drivers of climate change that are deeply entrenched in social structures and practices provides opportunities to shift system development trajectories towards sustainability (Meadowcroft 2009b). Holistic approaches promote integrated solutions to addressing drivers and impacts to build resilience and promote sustainability (Berry et al. 2015, Burch et al. 2014, Shaw et al. 2014). This requires concerted action from diverse actors at different scales and from multiple sectors to produce synergies and avoid trade-offs.

Holistic and integrated climate governance requires different types of interventions. In essence, each of these interventions follows different goals with effects at different levels of a system (Figure 8). At the level of *system impacts,* interventions result in immediate effects on the system in terms of improved resilience to anticipated and on-going disturbances (i.e. adaptation to impacts of system-level change) and minimised or avoided negative externalities and disturbances (i.e. mitigation of drivers of undesirable system-level change). In our understanding, the level of *system outcomes* refers to a different quality of effects. While having repercussions on the system-level impacts, interventions at this level primarily target governance processes in themselves. Transforming interventions are directed towards enabling radical changes of current system configurations. As such, while at the level of system impacts they achieve a more safeguarded and/or less negatively forcing system, they transcend existing system boundaries. Orchestrating interventions coordinate between different types of governance interventions across scales, sectors and time to produce synergies and avoid, reduce or compensate trade-offs.

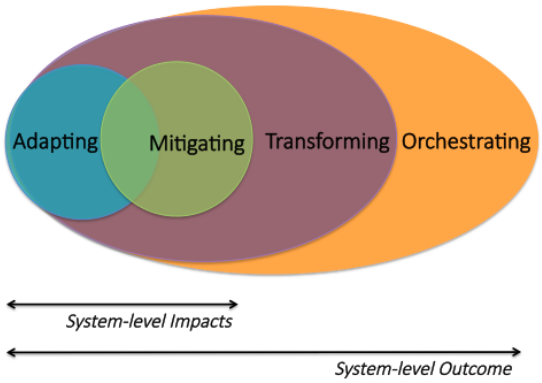


Figure 8: Governance interventions producing change at levels of system impacts and system outcomes.

Following from this distinction of governance interventions at different system levels, we identify four corresponding agency's capacities: adaptive, mitigative, transformative and orchestrating capacities (Figure 9). In this conceptualisation, agency's governance capacities condition the feasibility of interventions through agency processes; these interventions result in system-level impacts and outcomes. In the following, we review how these capacities are treated in the

resilience, transition and climate change literatures, to identify the agency processes by which the capacities are manifested.

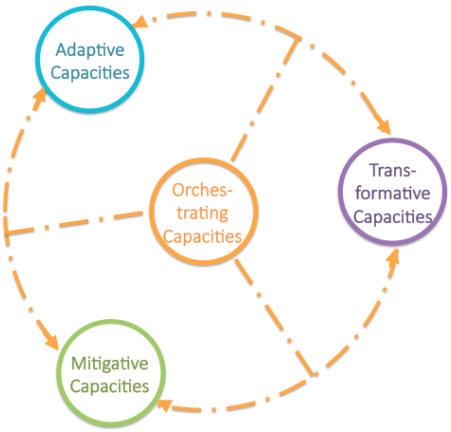


Figure 9: Agency's capacities for climate governance

4.2.1. Adaptive capacity

Adaptive capacity is a prominent notion in diverse literatures that are concerned with global environmental change to encapsulate the abilities of societies to respond to existing and anticipated environmental changes and stresses, in particular to climate change, while exploiting beneficial opportunities (Adger et al. 2004; Fankhauser 1998; Ensor and Berger 2009; Brown and Westaway 2011; Smit and Wandel 2006; Hill and Engle 2013). The concept originates from social-ecological systems and resilience literatures on the management of ecosystem dynamics (Holling 1978). In resilience and climate change adaptation literatures, adaptive capacity allows resilience to be built and maintained against disturbances, enables a system to recover from shocks, and promotes learning and flexibility in the face of uncertain change (Quay 2010; Folke and Berkes 2002; Chapin et al. 2010; Ensor and Berger 2009; IPCC 2014). It is often defined as encompassing the abilities to adapt, learn and self-organise (Nelson et al. 2007; Lebel et al. 2006). Resilience and climate scholars predominantly explore adaptive capacities of local communities, but also of individuals and households (Lockwood et al. 2015; Marshall et al. 2012; Nelson et al. 2007; Park et al. 2012; Brown and Westaway 2011). In the transitions research field the concept of adaptive capacity is not explicitly considered, because of the school's focus on transformative change. Transition scholars comprehend the notion traditionally as implied in the actions that work to optimise, reproduce and reinforce existing system logics and operation procedures in response to external landscape and innovative niche pressures so as to resist change (de Haan and Rotmans 2011; Pesch 2015).

We define adaptive capacity as the *ability to safeguard and restore system functions against disturbances to build, maintain and regenerate a system's resilience* – in contrast to scholars who apply adaptive capacity to also denote a system's ability to transform (Nelson et al. 2007; Revi et al. 2014). As such, adaptive capacity is limited by the existing system logic, i.e. underlying assumptions of system functions are not questioned (Pahl-Wostl et al. 2013; Burch et al. 2010; Hordijk et al. 2014). It is a *reactive* ability, as it is mobilised in response to anticipated or experienced disturbances and pressures. It differs from coping capacity in that the ability to cope with disturbances and changes is influenced by the implementation of adaptation that has taken place (Tinch et al. 2015).

Notably, scholars more often than not focus on the structural conditions determining adaptive capacity, including availability of (in)tangible assets and resources (Brown and Westaway 2011; Bettini et al. 2015; Smith and Wandel 2006). Table 4 provides an overview of the agency processes

that manifest in adaptive capacity that have been derived from the literature on adaptive capacity. Firstly, adaptive capacity builds on processes that *recognise feedback loops*. Knowledge about system dynamics that is based on diverse knowledge sources and understanding of how the system responds to change and disturbances is mentioned in all literatures as a critical precondition for adaptation (Walker et al. 2009; Folke et al. 2003; Tàbara et al. 2011; Fankhauser et al. 1999; de Haan and Rotmans 2011). Secondly, in order to safeguard and regenerate system functions, adaptive capacity manifests in processes that *fit structures to system dynamics*, such as fitting institutions to social and ecological contexts (Lebel et al. 2006; Gupta et al. 2010), establishing highly connected social networks with key leaders, building trust and promoting collective learning (Wilson et al. 2013; Folke et al. 2005; Berkes et al. 2003; Adger and Vincent 2005; Lebel et al. 2006; Gupta et al. 2010; Kates et al. 2012). Finally, adaptive capacity is manifested by processes that *incorporate monitoring for continuous learning*. This encompasses iterative evaluation of how a system responds to disturbances and the effects of management as well as systematically revisiting underlying assumptions and objectives (Walker et al. 2009; Chapin et al. 2010; Gupta et al. 2010; Frantzeskaki et al. 2012; Loorbach et al. 2011; Burch et al. 2014).

Table 4: Agency processes that manifest in adaptive capacity.

Capacity dimension	Agency processes and respective supporting sources
Recognising feedback loops	• Developing models of feedback mechanisms and how systems respond to change and disturbances (Walker et al. 2009; Lebel et al. 2006; Carpenter et al. 2001; Bettini et al. 2015; Loorbach 2010; Fankhauser et al. 1999; Chapin et al. 2010; Olsson et al. 2010; Folke et al. 2003; Tàbara et al. 2011) • Combining and integrating different forms/sources of knowledge and understanding (Lebel et al. 2006; Berkes and Folke 1998; Berkes 1999; Chapin et al. 2010; Folke et al. 2003; 2005; Gunderson et al. 2006; Loorbach et al. 2011; Kates et al. 2012) • Continuous access to data (Gupta et al. 2010; Folke et al. 2005) • Embracing uncertainty/coping with informational uncertainty (Lebel et al. 2006; 2010; Folke et al. 2003; 2005; Kates et al. 2012)
Fitting structures to system dynamics	• Fitting institutions to social and ecological contexts (Lebel et al. 2006; Olsson and Galaz 2012; Gupta et al. 2010) • Establishing/formalising social networks that are locally based with high connectivity and key leaders (Wilson et al. 2013; Sandstrom and Rova 2010; Folke et al. 2005; Berkes et al. 2003; Chapin et al. 2010; Aylett 2015; Adger and Vincent 2005) • Building trust (Folke et al. 2005; Chapin et al. 2010; Gupta et al. 2010) • Accumulating experience through collective learning and build a collective memory of experience for linking past experiences with present and future, improving routines (Folke et al. 2005; Walker et al. 2009; Gupta et al. 2010; Pelling et al. 2008) • Creating opportunity for self-organisation: empowering stakeholders to adapt, fostering social capital, supportive social contexts, team self-assembly mechanisms (Folke et al. 2003; 2005; Lebel et al. 2006; Gupta et al. 2010; Armitage 2005; Kates et al. 2012)
Incorporating monitoring for continual learning	• Iteratively evaluating how the system responds to disturbances and the effects of management (Walker et al. 2009; Chapin et al. 2010; Folke et al. 2005; Gupta et al. 2010; Kates et al. 2012; Loorbach et al. 2011; Burch et al. 2014) • Systematically revisit and question underlying assumptions and objectives (Walker et al. 2009; Kates et al. 2012; Lebel et al. 2006)

4.2.2. Mitigative capacity

Mitigative capacity is the least addressed in the scientific literature. As a term central to climate change research, the IPCC defines mitigative capacity as the ability to recognise and act upon the need for reducing anthropogenic forcing on the climate system through mitigation (IPCC 2001). Climate mitigation includes interventions that reduce greenhouse gas (GHG) emission sources and enhance GHG sinks (Berry et al. 2015; Winkler et al. 2007; Perry et al. 2015). Both mitigation and mitigative capacities are however also more broadly applied to strategies that reduce all anthropogenic pressures on environments and ecosystems (IPCC 2014). It is also linked to sustainability, demanding that mitigative actions should be more socially acceptable than existing alternatives, as well as structurally, socially, politically and culturally feasible (IPCC 2001; Shaw et al. 2014). Mitigative capacity as such is not explicitly addressed in resilience and transitions literatures. While resilience scholars largely focus on responding to disturbances rather than addressing its drivers (Redman 2014), some also stress the likelihood of adverse side effects and risk redistribution that need to be recognised and acted upon (Lebel et al. 2009a; 2010; Chapin et al. 2010). Transitions thinking highlights historical and present drivers of unsustainable production and consumption patterns that need to be broken down (Rotmans and Loorbach 2010). It therefore presents a perspective on "disrupting, destabilising and dismantling existing regimes" (Loorbach 2014: 62) that (re-)produce persistent unsustainability problems.

We define mitigative capacity as *the ability to minimise or avoid socially undesirable pressures on system structures and functions*. As such, it is generally meant to target the origins and drivers of undesirable and detrimental side-effects of anthropogenic forcing and reduce the occurrence or magnitudes of disturbances. It therefore represents an *anticipatory* ability that serves to recognise drivers and undesirable system change and that mobilises to prevent the consequences "that arise in response to almost every policy on current complex and interactive systems" (Tàbara and Pahl-Wostl 2007).

Generally, work on mitigative capacity focuses on nation states' structural conditions that enable them to engage in climate mitigation (e.g. national GDP, institutional frameworks, technological options, cultural contexts) (Yohe 2001; Winkler et al. 2007; Betsill and Bulkeley 2006; Schreurs 2008; Burch and Robinson 2007). Table 5 summarises the agency processes that manifest in mitigative capacity. Firstly, following from its anticipatory approach towards system change, processes that *recognise and anticipate (the drivers of) socially undesirable side-effects*, negative externalities and system failures – while being sensitive to social economies and injustices – establish mitigative capacity (Bulkeley et al. 2010; Burch and Robinson 2007; Chapin et al. 2010; Lebel et al. 2010; Schuitmaker 2012; Revi et al. 2014; Burch et al. 2014; Shaw et al. 2014). Furthermore, mitigative capacity builds on processes that *phase-out recognised drivers of undesired side-effects*, negative externalities and risks to avoid stresses and disturbances. This includes leadership to establish support and break-down lacking political willingness for phase-out (Winkler et al. 2007; Burch and Robinson 2007; Burch 2010), processes that establish clear responsibilities for drivers and risks (Howlett 2014; Shaw et al. 2014), developing networks that form counter-movements (Loorbach 2014; Winkler et al. 2007; Parson 2003; cf. Chapin et al. 2010) as well as undermining and dismantling structures and practices that drive undesirable side-effects and create risks (Loorbach 2014; Walker et al. 2009; Bettini et al. 2015; Avelino 2011: 72). Lastly, processes that *enhance sinks to absorb drivers of undesirable side-effects* build mitigative capacity, such as reducing social-ecological sensitivities and sustaining the capacity of systems to provide multiple services and absorb shocks, especially of vulnerable segments of society (Chapin et al. 2010).

Table 5: Agency processes that manifest in mitigative capacity.

Capacity dimension	Agency processes and respective supporting sources
Recognising (drivers of) undesirable side-effects and emergent risks and vulnerabilities	• Identifying sources and sinks for undesirable side-effects, (market, political etc.) failures and maladaptation, monitoring trends in stressors and impacts (Bulkeley 2010; Burch and Robinson 2007; Yohe 2001; Chapin et al. 2010; Lebel et al. 2010; Schuitmaker 2012; Turner 2003) • Vulnerability analyses to identify the stresses that are most likely to cause harm and the segments of society that are particularly vulnerable (Turner 2003) • Detecting current and probable risks, identifying areas with higher/increasing risks and how changes affect different needs and interests (Marshall et al. 2012; Revi et al. 2014) • Linking undesirable side-effects to basic system needs and sustainability (Burch et al. 2014; Shaw et al. 2014; Bulkeley 2010)
Phasing-out drivers of undesirable side-effects, risks and vulnerabilities	• Leadership to put mitigation on the political agenda and build political willingness and public awareness (Winkler et al. 2007; Burch and Robinson 2007; Burch 2010; Betsill and Bulkeley 2006; Winkler et al. 2007) • Clarify responsibilities for drivers and risks (Howlett 2014; Shaw et al. 2014) • Provoking mismatch, undermining, destablising and dismantling existing regimes and resistance against systemic change, creating (dis)incentives and regulations, strategic divestment (Loorbach 2014; Walker et al. 2009; Bettini et al. 2015; Avelino 2011; Dolata 2009) • Developing (political) networks that form counter-movements against regimes (Loorbach 2014; Winkler et al. 2007; Parson 2003)
Enhancing sinks to absorb drivers	• Improving ability to absorb stressors and risks (Chapin et al. 2010; Berry et al. 2015) • Sustaining the capacity of ecosystems to provide multiple services, sustain and enhance crucial components of well-being, particularly of vulnerable segments of society (Chapin et al. 2010)

4.2.3. Transformative capacity

There is growing attention to transformative capacity in diverse literature strands resulting from an acknowledgement of necessary radical changes to move towards sustainability and avoid possibly disastrous consequences of human systems (Wolfram et al. 2015). Lonsdale et al. (2015) provide a comprehensive overview of approaches to transformational adaptation including transformational capacities that include leadership, learning, reframing and experimentation (Howlett 2014, Revi et al. 2014, Bulkeley and Castán Broto 2013). Resilience scholars similarly highlight leadership, shadow networks as well as vision building and innovation (Olsson et al. 2006, 2014, Folke et al. 2010, Westley et al. 2013). Though to a large extent not explicitly labelled as transformative capacity, one of transitions research's prime areas of interests is on how innovation can lead to radical system change. Traditionally this entails a focus on how niche actors – sustainability pioneers – who are aware of a complex persistent problem take the lead in the change process, create new visions and implement experiments to structurally transform the regime (Frantezskaki et al. 2012; Elzen et al. 2011; van Buuren and Loorbach 2009; Sengers and Raven 2015).

Transformative capacity enables the *fundamental innovation of system structures, functions and feedback processes*. Hence, it produces more radical changes in the functioning of the system and therefore moves beyond the existing operation logic (Pahl-Wostl et al. 2013). Although the system-level impact still results in a more safeguarded and/or less negatively forcing system, on the system outcome level the system itself has changed. This distinction is critical since transformative capacities unfold on a meta-level of governance activities; they enable processes in which system innovations relating to adaptive and/or mitigative system-level outputs are developed, aligned to

local contexts and embedded and strengthened. There are still debates on what transformations contain, in terms of what elements of the system change and to what extent the concept can be applied to social systems (Brand 2014; Olsson et al. 2015). Conceptually, this concerns the elements of a system (in terms of stocks and flows) and the feedback loops between them that overall result in an altered identity (Göpel 2014; Olsson et al. 2014). These can include cultural values, practices, technologies and ecosystem dynamics (Rotmans and Loorbach 2010; Walker et al. 2006).

Table 6 summarises the agency processes that establish transformative capacities. Firstly, transformative capacity manifests in processes that *enable the creation or establishment of novelty*. Processes involve experimentation and piloting (Marshall et al. 2012; Olsson et al. 2006; Gupta et al. 2010; van Buuren and Loorbach 2009), leadership and setting up shadow networks and protected spaces for innovation (Smith and Raven 2012; Schot and Geels 2008; Frantzeskaki et al. 2008; 2012). Secondly, processes that *align novelty with on-going dynamics* establish transformative capacity, through anticipating and recognising opportunities for change (Olsson et al. 2006; Walker et al. 2009; Rotmans and Loorbach 2010), reaching out to broader networks and stimulating social learning to reframe or change the perspectives of actors (Folke et al. 2005; Berkes 2009; Seyfang and Smith 2007) and promoting shared future visions (Loorbach and Rotmans 2010; Nevens et al. 2013; Pahl-Wostl et al. 2013). Thirdly, transformative capacity is represented by processes that *enable novelty to gain ground*. Processes encompass leadership to mobilise for support (Olsson et al. 2006; Frantzeskaki et al. 2012; Loorbach and Rotmans 2010; Gupta et al. 2010; Westley et al. 2013), forging alliances that ease the road to achieve broad acceptance of innovation (Moore and Westley 2011; Olsson et al. 2006; 2010) and aligning institutional processes and structures to new vision and actions (Frantzeskaki et al. 2008; Rijke et al. 2013; Pahl-Wostl et al. 2013; Bos and Brown 2013; Burch et al. 2014).

Table 6: Agency processes that manifest in transformative capacity.

Capacity dimension	Agency processes and respective supporting sources
Enabling the creation or establishment of novelty	• Testing and experimenting with options (van der Brugge and van Raak 2007; Folke et al. 2005; Westley et al. 2013; Loorbach 2010; Frantzeskaki et al. 2012; Bos et al. 2013a,b) • Leadership by example (Marshall et al. 2012; Olsson et al. 2006; Gupta et al. 2010; Farrelly and Brown 2011; van der Brugge and van Raak 2007; Bos and Brown 2013; van Buuren and Loorbach 2009; Folke et al. 2005; Westley et al. 2013; Burch et al. 2014) • Provision of protected spaces where an innovation can safely develop (Smith and Raven 2012; Raven et al. 2015; Schot and Geels 2008; Loorbach 2010; Frantzeskaki et al. 2008; 2012; Frantzeskaki and de Haan 2009) • Informal and heterogeneous (shadow) networks that develop and test innovation and experiments (Olsson et al. 2006; Westley et al. 2011; 2013; Folke et al. 2005; Rotmans and Loorbach 2010; Loorbach 2010; Frantzeskaki et al. 2008 2010; Österblom and Folke 2013)
Aligning novelty with on-going dynamics	• Anticipating and recognising opportunities for change and crises (Olsson et al. 2006; Walker et al. 2009; Rotmans and Loorbach 2010) • Stimulating social learning to reframe or change the perspectives of actors (Folke et al. 2005; Berkes 2009; Cumming et al. 2012; Seyfang and Smith 2007; Armitage et al. 2008) • Shared future visions to provide guidance and inspiration (Loorbach and Rotmans 2010; Nevens et al. 2013; Pahl-Wostl et al. 2013) • Aligning institutional processes and structures to new vision and actions to increase implementation of novelty (Frantezskaki et al. 2008; Rijke et al. 2013; Pahl-Wostl et al. 2013; Bettini et al. 2015; Bos and Brown 2013; Burch et al. 2014) • Aligning short-term actions to long-term thinking and visions (Nevens et al. 2013; Frantzeskaki et al. 2009; Gupta et al. 2010)

Capacity dimension	Agency processes and respective supporting sources
Enabling novelty to gain ground	• Leadership and frontrunners who inspire and direct change and mobilise for support (Olsson et al. 2006; Frantzeskaki et al. 2012; Loorbach and Rotmans 2010; Frantzeskaki et al. 2009; Gupta et al. 2010; Westley et al. 2013) • Heterogeneous networks with cross-scale and cross-sector connections create support for novelty (Wilson et al. 2013; Loorbach 2007) • Forging alliances and advocacy networks to create broad acceptance of innovations (Moore and Westley 2011; Moore et al. 2011; Olsson et al. 2006; 2010)

4.2.4. Orchestrating capacity

Climate governance that seeks holistic solutions in a complex governance landscape requires coordination of multi-scale, multi-sector and multi-actor processes (Bulkeley and Betsill 2003; Burch et al. 2010; Shaw et al. 2014). There have been calls to more explicitly discuss the (social) trade-offs involved in building resilience, take implications of existing power relationships and politics into consideration and generate mutual benefits with development policies (Adger et al. 2004; Bahadur and Tanner 2014). Some transitions scholars explicitly link to the need for meta-governance to coordinate and mediate between diverse sub-processes, activities, instruments and actors and discuss competing priorities (Frantzeskaki et al. 2014; Loorbach 2014; Hodson and Marvin 2010). Resilience scholars follow similar lines of thought in discussing resilience governance and the navigation of societal sustainability transformations. Sustainability transformations require the coordination of collaboration and alignment across scales, demanding research to move away from the role of individual leaders to interacting key individuals and how, possibly antagonistic, strategies for change play out in multi-level and multi-phase contexts (Olsson et al. 2014; Biggs et al. 2010; Westley et al. 2013).

We introduce orchestrating capacity to allude to processes of *coordination and collaboration to establish synergies and avoid trade-offs across scales and sectors*, particularly pertaining to strategies for adaptation, mitigation and transformation. Orchestrating capacity operates upon a meta-level of governance processes. We denote as 'orchestrating' the activities undertaken to facilitate and foster processes of collaborative governance and coordination while setting the scene for self-organisation and emergence of solutions and innovation (Frantzeskaki et al. 2014). This helps to ensure that the plurality of actors and networks puts forth concerted efforts to create synergies for building resilience and promoting sustainability. We derive this notion from meta-governance literature that employs the term meta-governance or orchestration to describe a way of "enhancing coordinated governance in a fragmented political system on a high degree of autonomy for plurality of self-governing networks and institutions" (Sørensen 2006: 100). Literature on meta-governance developed against the background of theoretical deliberations and empirical analyses on the need for coordinating self-organised governance networks. The starting point is the distribution and interaction of governance activities of a diversity of actors at local to global scales (Kooiman and Jentoft 2009). The different approaches to meta-governance recognise a need for indirect steering of the actions and interactions of these self-organised governance networks to ensure coherence and integration without impeding on their autonomy and self-regulation (Sørensen 2006; Jessop 2011; Beisheim und Simon 2015; Sørensen und Torfing 2007). Meta-Governance can in principle be performed by all kinds of public and private actors (Kooiman and Jentoft 2009; Steurer 2013; Jessop 2009), though much attention focuses on the (new) role of state actors (Capano et al. 2015; Meuleman 2008). It raises questions on how values, norms and principles underpin governance systems and governing approaches (Kooiman and Jentoft 2009).

Table 7 outlines the agency processes that manifest in orchestrating capacity and that build on indirect steering instruments to promote and facilitate collaboration and coordination (Sørensen 2006; Vabo and Røiseland 2012; Bevir 2009). These include the strategic alignment through the elaboration of meanings and identities, formulation of political goals and visioning (Sørensen 2006; 2014; Zonneveld und Spans 2014). A common strategic alignment is critical to reconcile the different goals and needs of the actors involved in governance and to set up reference points for concerted actions (Bevir 2011; Abott et al. 2015; Scourfield 2015). The need for processes that promote shared perspectives and commitment across scales and sectors is also resonated in the other reviewed literatures (Gupta et al. 2010; Folke et al. 2005; Armitage 2008; Hodson and Marvin 2010; Fankhauser 1998). Another instrument of orchestration is the mediation of knowledge, experiences and goals across diverse self-organised actors and networks to ensure coherent action and common understanding, build trust, solve tensions and conflicts and (re-)distribute resources (Klijn and Edelenbos 2007; Steurer 2013; Beisheim and Simon 2015; Jessop 2011). This can also include the setting up of connection nodes for knowledge brokerage, connecting actors with each other and providing resources (Scourfield 2015). Such knowledge sharing and translation across scales and sectors as well as the need for conflict resolution and promotion of mutual respect and trust can also be discerned from the other literatures (Olsson et al. 2006; Rauschmayer et al. 2015; Moore and Westley 2011; Shaw et al. 2014; Wittmayer et al. 2014; Frantzeskaki et al. 2014; Folke et al. 2005). Finally, orchestration sets the political, financial and organisational context in which self-organised governance networks act. Such framework conditions provide incentives for certain options for action, including e.g. regulations, institutional designs and game structures that create win-win situations (Jessop 2011; Sørensen 2006; 2014; Steurer 2013). Examples are financing agreements for specified targets, cooperation agreements and setting time limits (Scourfield 2015; Aagaard Thuesen 2013; Zonneveld and Spaans 2014). The other reviewed literatures similarly point to the need to encourage and support integrated action (Hodson and Marvin 2010; Shaw et al. 2014; Burch 2010).

Table 7: Agency processes that manifest in orchestrating capacity.

Capacity dimension	Agency Processes and respective supporting sources
Strategic Alignment	• Defining a shared and integrative strategic direction and reference points for governance (shared goals, vision, narrative) (Sørensen 2006; 2014; Zonneveld and Spans 2014; Bevir 2011; Abott et al. 2015; Wittmayer et al. 2014b; Gupta et al. 2010; Folke et al. 2005; Armitage 2008; Pahl-Wostl 2009; Sørensen 2006; 2014; Westley et al. 2013; Hodson and Marvin 2010) • Setting priorities based on comprehensive system knowledge (Scourfield 2015) • Creating ownership over the strategic direction (Scourfield 2015)
Mediating across scales and sectors	• Recognising, brokerage and integration of information, knowledge and goals (Vabo and Røiseland 2012; Bache et al. 2015; Steurer 2013; Beisheim and Simon 2015; Frantzeskaki et al. 2014; Olsson et al. 2006; Fankhauser et al. 1999; Moore and Westley 2011; Hodson and Marvin 2010) • Building trust, conflict management (Klijn and Edelenbos 2007; Scourfield 2015; Sørensen and Torfing 2009; Jessop 2011; Rauschmayer et al. 2015; Wittmayer et al. 2014b; Frantzeskaki et al. 2014; Folke et al. 2005; Olsson et al. 2004; Armitage 2005; Pahl-Wostl et al. 2007; Gupta et al. 2010; Moore and Westley 2011; Shaw et al. 2014) • Setting up connection nodes to mediate knowledge and resources (Sørensen 2006; 2014; Beisheim and Simon 2015; Scourfield 2015; Hodson and Marvin 2010; Frantzeskaki et al. 2014; Folke et al. 2003; Berkes et al. 2003; Chapin et al. 2010) • Adapting network structures to optimise interactions between self-organised actors and networks (Jessop 2011; Derkx and Glasbergen 2014) • Bridging organisations and individuals that participate in formal and informal processes (Pahl-Wostl et al. 2013; Moore et al. 2013)

Capacity dimension	**Agency Processes and respective supporting sources**
Creating opportunity contexts	• Defining political goals of governance networks, financial incentives, regulations, institutional designs and gaming structures (Sørensen 2006; 2014; Jessop 2011; Vabo and Røiseland 2012; Zonneveld and Spaans 2014; Beisheim and Simon 2015; Derkx and Glasbergen 2014; Frantzeskaki et al. 2009) • Threats and negative incentives (Steurer 2013; Vabo and Røiseland 2012) • Determining (normative) action mandates and possibilities of governance actors (Jessop 2011; Kooiman 2003; Kooiman and Jentoft 2009) • Establishing and incorporating long-term and multi-scale thinking into decision-making and implementation processes (Nevens et al. 2013; Gupta et al. 2010; Frantzeskaki et al. 2009; 2014; Loorbach et al. 2011; Chapin et al. 2010; Folke et al. 2010; Lebel et al. 2006) • Understanding opportunity context and timing to create links between actors, strategies and resources, identify (new) resource opportunities (Westley et al. 2013; Fankhauser et al. 1999; Luers and Sklar 2013; Gupta et al. 2010; Frantzeskaki et al. 2014) • Supporting those actors that will loose from trade-offs (Walker et al. 2009; Chapin et al. 2010; Adger et al. 2004)

5. Conclusions

The presented advanced transition management co-creation approach will guide the development of transformative visions, pathways and solutions in the IMPRESSIONS' case studies. The operationalisation of the advanced transition management methodology for the IMPRESSIONS' research objectives shows not only the conceptual effort and detailed workplans of the research team but also that process methodologies can create theoretical and methodological bridges between qualitative and quantitative inputs as well as between expert and tacit knowledge. For bringing all these inputs and knowledge together, a well organised and well-structured process outline is essential. In IMPRESSIONS we have such a triple-cycle process outline (Figure 1) that is detailed also in Figure 10. The development of the pathways has been shown to build on the transition management approach as an overarching framework, and will enable stakeholders to consider how long-term, transformative change in each of the IMPRESSIONS case study areas can contribute towards a sustainable and (climate) resilient future for Europe.

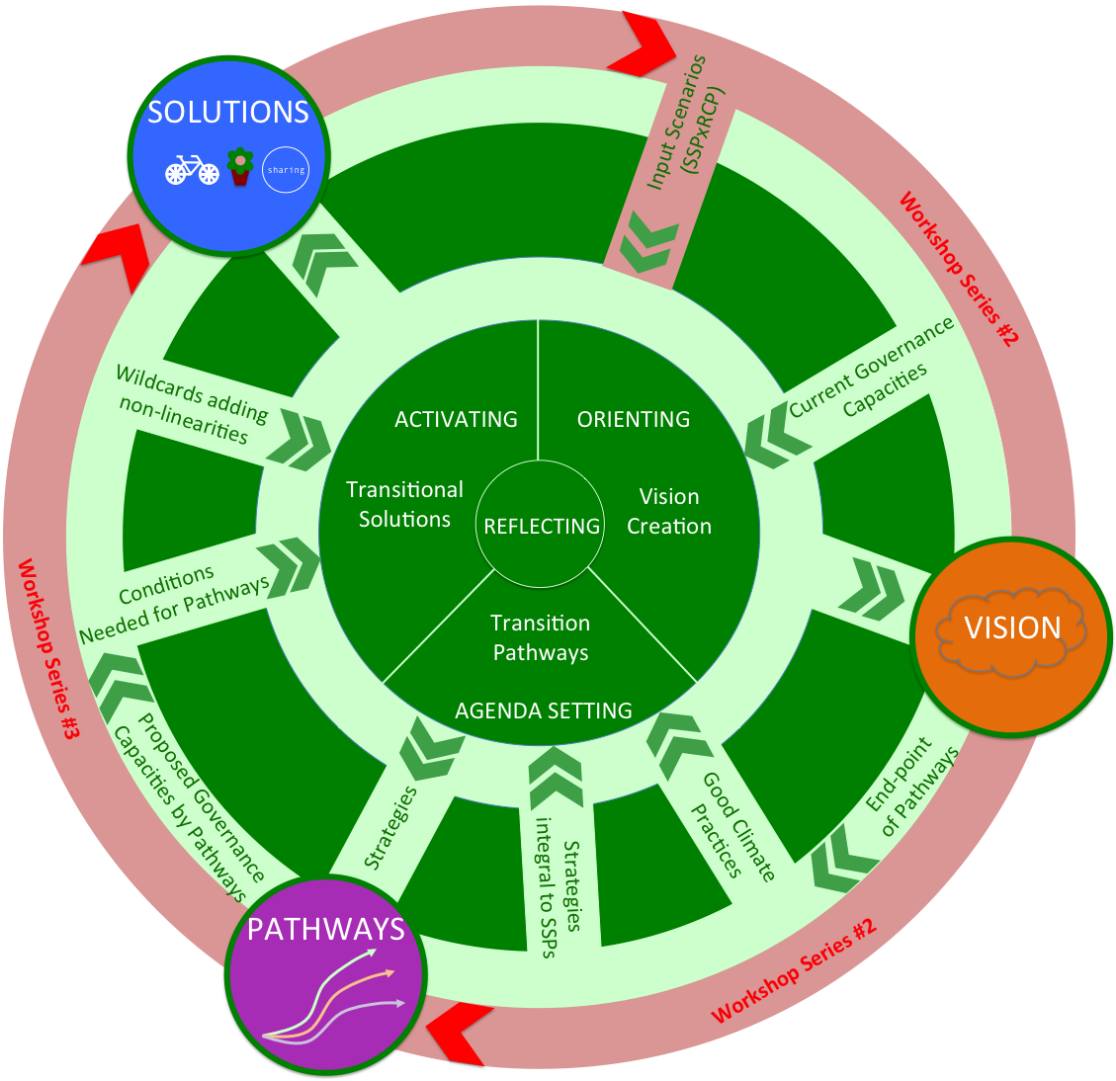


Figure 10: Outline of the triple-cycle process in IMPRESSIONS of connecting knowledge co-creation (with Transition Management cycle), knowledge translation (including all the analytical activities by multiple frameworks and models including the governance capacities framework) and knowledge consolidation towards transformative visions, pathways and solutions. The process is realised in three consecutive workshop series.

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- Frantzeskaki, N., and Tefrati, N., (2016-Forthcoming), A transformative vision unlocks the innovative potential of Aberdeen City, UK, Springer: Theory and practice of governance of urban sustainability transitions BOOK
- Frantzeskaki, N., and Shiroyama, H., (2016-Forthcoming), Sketching future research directions for transition management applications in cities, UK, Springer: Theory and practice of governance of urban sustainability transitions BOOK
- Frantzeskaki, N., Bach, M., Holscher, K., and Avelino, F., (2016 -Forthcoming), Co-creating sustainable urban futures – lessons from applications of transition management in cities, Springer: USA (Edited book).

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