WP 8: Stimulating European urban strategies for transition

D8.1:
Factors of transition and their dynamics

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**Short Description:**  
The aim of this deliverable is to present the identified factors which influence transition dynamics. These factors are related to availability of financial and other resources, legal and regulatory frameworks, cross-scale socio-economic interactions (due to, for example, institutional architecture, investments of private companies, provision of basic services, etc.), technology availability, cultural and consumption behaviour patterns, among others.

**Authors and co-authors:** Maddalen Mendizabal, Beñat Abajo, José Antonio Martínez, Laura Gutiérrez, Gemma García, Jorge Paz, Efren Feliu  
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Internal Reviewers:

*Gerardo Sanchez Martinez (WHO)*

*Annemie Wyckmans (NTNU)*
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List of Abbreviations

CBA Community-Based Adaptation
IAD Institutional Analysis and Development
IPCC Intergovernmental Panel on Climate Change
MLP Multi-Level Perspective
RAMSES Reconciling Adaptation, Mitigation and Sustainable Development for citiES
STT Socio-Technical Transition
SD Stakeholder Dialogue
TM Transition Management
UHI Urban Heat Island
UTL Urban Transition Lab
1. Executive Summary

This report introduces an approach to stimulate the European urban strategies for transition towards sustainable urban development and more resilient cities. A selection of the best approaches for the transition to be applied in European urban environments has been done and theories, frameworks, approaches, methods and tools behind these concepts have been identified and compared. For this selection two main communities’ approaches to this topic have been analysed: the transition community and the climate adaptation community. Therefore, the present work focuses upon transitions, which are long-term non-linear processes (25-50 years) that result in structural changes in the way a society or a subsystem of society operate. Moreover, a literature review that characterises barriers and opportunities has been completed to explore the reasons for the limited conversion of assessments, agendas and plans into transition practice.

As a result of the literature review, an integrated conceptual framework for transition has been defined. The objective of the framework is to serve as a basis in the RAMSES project to develop a systems-based approach that considers trade-offs, synergies and interlinkages with social and environmental issues. Moreover, the present approach will capture ‘top-down’ drivers of change but also provide the ‘bottom-up’ local context. This framework will enable the design of adaptation strategies that consider the triggers of change and consist of:

- A system map, in which the impacts on the urban system are analysed and the key problems are detected and the normative scenarios are created - also called desirable futures, visions, or future visions. In this phase sciences meets policy in order to build a vision aligned with local knowledge and governance;
- Selecting adaptation options, where the pre-identified adaptation options that act against the detected problems are characterized, assessed and prioritized. This phase must be conducted by methods and tools proposed by experts and contrasted with local stakeholders (selection of prioritisation method, selection of criteria, weighting and scoring);
- Planning and implementing, where “how”, “when” and by “whom” is defined through an adaptation pathway approach, the identification of the triggers of change for the transition, and the definition of the monitoring.
Unfortunately, the ingredients of, and barriers to, action on climate change at the local level are poorly understood phenomena that deeply influence the likelihood of successful adaptation strategies. In order to study in depth the detection of enablers and triggers of change found in the literature, an empirical approach has been designed. The approach consisted of two Stakeholder Dialogue exercises covering different steps of the adaptation framework (impact analysis and hot spot detection in order to create a future vision and do the backcasting in which triggers of change have been detected). In the first Stakeholder Dialogue a list of triggers for change was pre-identified. In the second Stakeholder Dialogue this list was reviewed, ranked and metrics for their quantification were identified.

These exercises aim at encouraging diverse stakeholders to work together in the framework of adaptive management and answer the following questions:

- Is it helpful for cities to create specific visions?
- Is it possible for cities to introduce triggers of changes in their work on adaptation? Or is it too abstract?
- Can the researchers be more precise in the detection of triggers of change?
- Can the researches define some metrics to evaluate these triggers of change?
2. How European urban strategies for transition can be stimulated?

Scholars from urban studies have defined several approaches and conceptual models to study the transition towards sustainable urban development and more resilient cities. The aim of this section is to summarize the two main communities’ approaches to this topic: the transition community and the climate adaptation community. A literature review of the approaches for the transition will be done. The main goal of this chapter is to identify major research fields in transitions in order to name the theories, frameworks, approaches, methods and tools behind these concepts.

A keyword search was performed in the search engine Scholar Google, Science Direct and the Web Of Science tools using the English keywords “Socio-techn* AND transition”, “transition AND climat*chang*”, “climat*chang* AND adaptat* AND pathway”, “adaptation AND concept”, “adaptation AND barriers OR obstacles OR opportunit*”, “climat* adaptation AND barriers OR obstacles OR opportunit*”. WOK and Science Direct were selected as they are the most powerful, current, comprehensive, and widely used search engines available for analysis of interdisciplinary, peer-reviewed literature. Scholar Google was selected as it includes most peer-reviewed online journals of Europe and America’s largest scholarly publishers, plus scholarly books and other non-peer reviewed journals.

In total, we selected 105 papers, sections of books, conference paper and Reports. 65 of the papers and documents include the word transition and 89 of the works include the adaptation word. Therefore, some of the reviewed papers and documents address adaptation and transition issues.

2.1. The transition community

There is a growing international community of scholars in the field of transition studies. The issue of how to promote and govern a transition toward sustainability, i.e., a fundamental transformation towards more sustainable modes of production and consumption, has received increasing attention both in the policy arena and in social
science research (Markard et al., 2012). In theoretical terms, several frameworks so far have achieved quite some prominence in transition studies in the urban context. The major concepts related to the transition community will be discussed in the following sub-sections: the analysed system, the description of the process, different approaches, and the method and tools that support the transition studies.

### 2.1.1. Systems theory

This community analyses the socio-technical system. This perspective examines how societal system and technical systems co-evolve over time (Smith and Stirling, 2008). It focuses upon transitions, which are long-term non-linear processes (25-50 years) that result in structural changes in the way a society or a subsystem of society operate. Governance to establish transition is often referred to as transition management (TM) or transition governance (Nevens et al., 2013; Rijke et al., 2013; Romero-Lankao P. and Gnatz D.M., 2013). Socio-technical transitions differ from technological transitions in that they include changes in user practices and institutional (e.g., regulatory and cultural) structures, in addition to the technological dimension (Markard et al., 2012).

Transition management (Loorbach, 2010; Nevens et al., 2013; Park et al., 2012) is a governance approach based on insights from governance and complex systems theory as much as upon practical experiment and experience. It is characterized by long-term thinking, considers multiple domains and different actors, focuses on learning and on system innovation while maintaining a wide playing field. In the transition management framework, four different types of governance activities (alternatively called “spheres”) are identified that are relevant for societal transitions: strategic (the transition arena), tactical (the transition agenda), operational (experiments), and reflexive (monitoring and evaluation). Initially, the TM approach was mainly deployed in research and empirical experience at national levels and manly sectoral policy transformations (e.g. energy, water, mobility, building and living, material use) (Figure 1).
Furthermore, Transition Management should be seen as a reflexive governance approach aiming at exploring, initiating and facilitating sustainability transitions, while taking into account system thinking, complexity and uncertainty (Loorbach, 2010). Many authors believe that transformative processes take a long period (over 25 years) to materialize (Frantzeskaki and de Haan, 2009; Grin et al., 2010; Markard et al., 2012; Quist et al., 2013). Research on sustainability transitions receives increasing attention in the literature (Markard et al., 2012). And last but not least, the Urban Transition Management is the adapted approach to city-specific challenges and context that adheres to the same principles and guidelines as Transition Management (Drift, 2011).

2.1.2. The process

The stages
The socio-technical perspectives follow a process of subsequent stages and activities. These include (a) pre-development, where system dynamics do not change visibly, but experimentation is occurring at the individual level; (b) take-off, where the process of structural change starts to build up momentum, due to the emergence of innovation and destabilization of the existing regime; (c) acceleration, where structural transformation occurs as a result of the accumulation and implementation of socio-cultural, economic, ecological and institutional changes, and (d) stabilization, where the system reaches a new dynamic state of equilibrium. Therefore, for this perspective multi-level governance is crucial (Nevens et al., 2013; Park et al., 2012; Rijke et al., 2013) (Figure 2).
Figure 2: Transitions to sustainable development: A logical combination of reinforcing steps and associated activities (Nevens et al., 2013).

The steps

TM process methodology includes a combination of a number of mutually reinforcing steps and associated activities (Nevens et al., 2013; Roorda et al., 2014):

- Analysing a system: determining the relevant players and their interrelations, the key system functions, institutions, etc. consisting of quantitative data and qualitative information;
- Envisioning: creating an appealing and inspiring vision: entails images and a narrative of desirable systems based on shared principles of sustainable development;
- Exploring pathways: consisting of a backcasting exercise resulting in different strategic transition pathways that include the actions that will progressively build-up in pursuing the desired vision;
- Experimenting: transition experiments are real-life developments of drastically alternative ways of working and/or thinking, fitting into envisaged new system approaches;
- Assessing: instruments that are designed for an effective follow-up of actions that are undertaken. Products, processes and technologies can be the subjects of monitoring and assessment;
• Translating: the lessons learnt from experiments, backcasting or envisioning efforts result in an effective dynamic process of change.

2.1.3. Transition approaches

Tree approaches will be presented: the socio-technical transition theory (STT), the Institutional Analysis and Development (IAD) framework and the Urban Political Ecology.

The STT focuses on transformative change at national level, on long-term, multi-dimensional, and fundamental transformation processes through which established socio-ecological and technical system shift to different modes of resource use and new relationships with their environment (Romero-Lankao P. and Gnatz D.M., 2013). Therefore, socio-technical transitions are structural changes, both physical and administrative, to the way society organizes itself. Following structuration theory, institutions constitute a range of formal (legislation, regulation) and informal rules (norms, values) which provide actors with different forms of agency to change these rules. Therefore, understanding the institutional context and the agency of actors offers a way to address the knowledge needs of transition management (Bettini et al., 2015).

The IAD framework and the Institutional Work Theory, both provide a conceptualization of the institutional context. This frameworks offers a model of an action situation, analogous with the transition arena, with which the space where actors interact and act can be visualized (Bettini et al., 2014). The unit of analysis is the rules-in-use that consist of various laws and social conventions that guide and shape the way actors (individuals, networks, organizations) act and interact. These formal (documented) and informal (tacit) rules constitute the institutional setting (Bettini et al., 2013). While the IAD Framework provides a structural understanding of the institutional context, sociological institutional theories recognize that these structures are altered through the interpretation and reinterpretation of the rules-in-use by actors. Through the day-to-day practices and interactions of practitioners, cognitive and normative underpinnings of formal institutions are questioned and altered (Bettini et al., 2015).

The Urban Political Ecology considers cities as a continuum with nature through metabolic processes of social and environmental change and evolution that can be captured through ecological and metabolic approaches. They conceives cities as networks of intertwined metabolic processes that are simultaneously physical, human, cultural and material and act as hybrids embedded in the social construction and transformation of
ecosystems’ structure, function and services. Using a combination of elements from socio-technical transition theory and political ecology, Romero-Lankao and Gnatz (2013) suggested a framework for the analysis of urban transitions (Error! No se encuentra el origen de la referencia.). Within a city’s network intertwined metabolic processes, infrastructures, built environments, and institutions, which exists through and for the social construction and transformation of their physical and climatic conditions. A major goal is to take advantage of the immediate ecosystem’s function and services or to move to these services from other areas. This framework incorporates elements from both STT and political ecology as it relates to niches (innovations: niche-level experiments, governmental or grassroots initiatives conducted by urban communities) and relates to landscapes (exogenous drivers and triggers, such as disasters, socioeconomic and demographic growth and changes in risk tolerance).

2.1.4. Methods and Tools

Several methods and tools are used in transition studies. They will be presented in the following lines.

**Multi Level Perspective**

Associated with the socio-technical approach there is the concept Multi-Level Perspective (MLP) that is a core STT-component explaining transition (Figure 3). The MLP understands transition as a result of interactions between three levels of analytical concepts: niche-innovation at a micro-level (niche-innovations build up internal momentum, through learning processes, price/performance improvements, and support from powerful groups), socio-technical regimes at a meso-level (destabilisation of the regime creates windows of opportunity for niche-innovations) and socio-technical landscapes at macro-level (changes at the landscape level create pressure on the regime) (Geels F.W. and Kemp R., 2000; Geels F.W. and Schot J., 2007, 2007; Naess P. (último) and Vogel, N., 2012; Porter N. et al., 2014; Rijke et al., 2013; Romero-Lankao P. and Gnatz D.M., 2013) (Figure 4). Naess and Vogel (2012) see the MLP perspective as a fruitful descriptive framework and a device for structuring narratives about transition processes. However, the MLP needs to be adapted when we talk about urban transition, in order to address the high complexity and context dependency of the urban system (Naess and Vogel, 2012).
Figure 3: The multi-level perspective (Geels & Kemp, 2000; Porter et al., 2014).

Figure 4: Multi-level perspective on transitions (Geels and Schot, 2007).

Moreover, when it comes to urban spatial structure and mobility patterns, we are dealing with multi-segmented regimes that could be viewed as compromises between different
“technologies” in order to deal with processes within different arenas of society where one regime is replaced with a new one. Therefore, in transition theory research, more attention should be directed toward the landscape level and the need for changes at this level in order to enable sustainable urban transition. Landscape-level analysis should also include critical analyses of political-economic structures and mechanisms (Naess and Vogel, 2012).

**Backcasting**

Backcasting is defined as "generating a desirable future, and then looking backwards from that future to the present in order to strategize and to plan how it could be achieved (Vergragt and Quist, 2011). Backcasting is forming the construction of future scenarios and analyzing the conditions and processes for their realization. Therefore, it can be used for concretizing the current situation. Coupling backcasting studies together with socio-technical studies may envisage scenarios and pathways and what kind of resulting urban structure this would entail. Several types of backcasting can be distinguished (Quist et al., 2013):

- **Target-oriented backcasting**, which focuses on developing and analysing target-fulfilling images in which the target is usually expressed in a quantitative manner. The development of a future vision is more elaborate than the specific pathways of how to get there;

- **Pathway-oriented backcasting** in which setting strict goals is considered less important. The focus is on how change can take place and which measures can support the changes like policies, taxes, or behavioural changes;

- **Action-oriented backcasting** in which the main objective is to develop an action agenda, strategy or action plan. The focus is on who could bring about the changes and realising buy-in and commitment among stakeholders;

- **Participation-oriented backcasting** in which backcasting is used as a creative workshop tool. Key elements of participatory backcasting are (1) stakeholder involvement and dialogue, (2) participatory generation of desirable future visions, and (3) stakeholder learning through involvement, interaction, vision development and vision assessment.

- **Combinations of the above.**

**Urban Transition Labs**

The Urban Transition Lab (UTL) is inspired by the "living lab" concept, which is considered as a user-centred, open-innovation ecosystem. Nevens et al. (2013) consider an Urban Transition Lab as the locus within a city where (global) persistent problems are translated
to the specific characteristics of the city and where multiple transitions interact across domains, shift scales of operation and impact multiple domains simultaneously (e.g. energy, mobility, built environment, food, ecosystems). It is a hybrid, flexible and transdisciplinary platform that provides space and time for learning, reflection and development of alternative solutions that are not self-evident in a regime context. The platform brings together innovative ‘regime’ actors and frontrunners from ‘niche’ contexts. The authors translated the essential elements of TM in the context of cities which are: setting the stage (preparation and organization); problem structuring and envisioning; exploring pathways and building an agenda; experimenting and implementing; monitoring and evaluation. Therefore, the UTL approach can be considered as a city governance niche or experiment.

The UTL covers better conceptual and application challenges regarding urban transition than the MLP perspective (Nevens et al., 2013):

- The multi-scale challenge: dynamics of urban sustainability transitions need to be investigated in multiple scales in order to understand the embeddedness of transformation processes in space. The UTL can be adapted to investigate multi-scalar dynamics;
- The innovation scaling-up challenge: needs to recognise, empower and scale-up social, economic, technological and ecological innovations that emerge at an urban context beyond ‘juxtaposing’ or ‘devising’ technological diffusion patterns. Therefore, the UTL would apply strategic niche management or transition management for empowerment of sustainable innovations at the urban context;
- The cross-scale and time-scale challenge: requires a translation of successful practices from national level to urban context and the consolidation of visions without losing the inspiration these imaginaries bring forward.

**Transition pathways**

Geels and Schot (2007) present in their work a typology of transition pathways. The typology is based on variations of timing and nature of multi-level interactions. Using combinations of these two criteria, the authors developed four transition pathways:

- Transformation path. In this pathway moderate landscape changes create pressure on the regime, leading reorientations by regime actors. Thereby new regimes grow out of old regimes through cumulative adjustments and reorientations;
- De-alignment and re-alignment path. In this transition pathway the regime comes rapidly under much landscape pressure (changes in deep structures create strong pressure on regime). The regime experiences major internal problems, collapses,
erodes and de-aligns. The lack of stable rules leads to the exploration of multiple directions and innovation trajectories. And eventually, one niche-innovation gains momentum and becomes dominant, followed by re-alignment and re-institutionalisation in a new sociotechnical regime;

- Technological substitution. If there is much landscape pressure (Figure 4, ‘specific shock’) at a moment when niche innovations have developed sufficiently, the latter will break through and replace the existing regime. This pathway assumes that radical innovations have developed in niches, but remain stuck because the regime is stable and entrenched.

- Reconfiguration pathway. Symbiotic innovations, which developed in niches, are initially adopted in the regime to solve local problems. They subsequently trigger further adjustments in the basic architecture of the regime. In the reconfiguration pathway the new regime grows out of the old regime (similar to transformation path with the difference that the reconfiguration path experiences substantial changes in the regime’s basic architecture).

Transition theories that provide an already integrated perspective, such as the multi-level perspective, usually have the form of heuristics that do not readily translate into the formal descriptions needed for models, but require additional assumptions to make them operational for modelling. A way to promote a further maturation of models of transition is to develop a shared understanding and toolbox of elements and processes operating on lower levels of abstraction. The identification of a set of important lower level mechanisms and their relation to higher level structures and processes would also be a contribution to theory development in the transition field (Holtz et al., 2015).

2.2. The climate adaptation community

The climate adaptation community focuses research on: quantifying climate change and the biophysical, social and economic consequences of climate hazards developing and applying methods for assessing the vulnerability of communities and ecosystems, providing general principles and broad strategies for adaptation, and identifying opportunities for and barriers to adaptation (Wise et al., 2014).

Adaptation is a process that can take the most diverse forms depending on where and when it occurs and on whom is adapting to what (Bosello et al., 2012). Climate change adaptation can thus be effected by altering exposure, by reducing sensitivity of the
system to climate change impacts, and by increasing the adaptive capacity of the system (Begum et al., 2014).

2.2.1. System Theory

The Climate Adaptation community analyses the socio-ecological system, in which social systems interact with ecosystems and the concept of resilience emerged. Based on the socio-ecological perspective and the resilience, the concept of adaptive governance came out as a way of governing by anticipating long-term change, responding to immediate shock events and recovering from such events. Adaptive governance focuses on the ability to maintain system functions under changing conditions (Rijke et al., 2013). Changes in socio-ecological systems are described in terms of a series of distinct phases, collectively described as the adaptive cycle (Holling, 2001; Park et al., 2012). Adaptation materialises in changes in ecological, social and/or economic systems. These changes can be the result of natural responses and in this case they usually involve organisms or species, or of socio-economic or institutional reactions in which case they are undertaken by individual or collective actors, private or public agents (Bosello et al., 2012; Pelling, 2011).

Adaptive governance is a process of creating adaptability and transformability in socio-ecological systems. This concept has emerged from the intersection of two areas of inquiry (Gunderson and Light, 2006): the application of ecological systems theory to natural resource management, catalyzed by the work of Buzz Holling and continued by the Resilience Alliance (Gunderson and Holling, 2002), and the study of self-governing institutions led by Elinor Ostrom (Ostrom et al., 1992).

Adaptive management (Holling, 2001; Pelling, 2011; Timmermans et al., 2015; Westley, 2002; Willows et al., 2003) is based on systems perspective, the interaction between social and natural dynamics. Adaptive management is an option for linked ecological/social/economic systems, slow variables, multistable behaviors, and stochasticity. It focusses on adaptation through learning to increase the resilience of socio-ecological systems and is more analytic and substantial as compared to transition management (that has a strong process orientation with a focus on sustainability). Adaptive management can be described in terms of a set-up or planning phase during which some essential elements are put in place, and an iterative phase in which the elements are linked together in a sequential decision process (Figure 5):
2.2.2. The process

Stages
Holling (2001) represented the adaptive cycle though four ecosystem functions: growth or exploitation (r); conservation (K); collapse or release (omega); and reorganization (alpha) (Figure 6) (Fath et al., 2015).

The arrows show the speed of the flow in the cycle. Short, closely spaced arrows indicate slowly changing situation; long arrows indicate a rapidly changing situation.
An adaptive cycle that alternates between long periods of aggregation and transformation of resources and shorter periods that create opportunities for innovation is proposed as a fundamental unit for understanding complex systems from cells to ecosystems to societies.

**Steps**

Park et al. (2012) defined 4 steps in the Adaptation Action Cycle (Figure 7) which refers to common steps of a rational decision-making process (also mentioned by other authors like Moser and Ekstrom, 2010):

- Problem structuring and establishing the adaptation arena: the objective of this step is to define the nature of the vulnerability, who or what adapt and why do they adapt to vulnerability of what and vulnerability to what;
- Developing the adaptation agenda, vision and pathway: the objective of this step is to define the processes (how do they adapt), the opportunities for adaptation and cost and/or benefits of decisions;
- Implementing adaptation actions: the objective is to define the methods for the implementation and resources needed, the constraints and incentives linked with the implementation, and the impacts of the results;
- Evaluating, monitoring and learning: the objective is to define how well the recipients are adapted, how the systems are changed, and based on the above plans for the future are planned.

*Figure 7: The Adaptation Cycle through space and time (Park et al., 2012).*
The process

In addition to the above, there are two general approaches of the process observed in adaptation planning and implementation to date: top-down and bottom-up. Top-down approaches are scenario-driven and consist of localizing climate projections, impact and vulnerability assessments, and formulation of strategies and options. National governments often take this approach. National adaptation strategies are increasingly integrated with other policies, such as disaster risk management. These tendencies lead to adaptation mainstreaming, although there are various institutional barriers to this process. As the consideration of the social dimensions of climate change adaptation has attracted more attention, there has been an increased emphasis on addressing the needs of the groups most vulnerable to climate change, such as children, the elderly, disabled, and poor. Bottom-up approaches are needs driven and include approaches such as community-based adaptation (CBA). Where a combination of top-down and bottom-up activities has been undertaken, the links between adaptation planning and implementation have been strengthened. In either approach, participation by a broad spectrum of stakeholders and close collaboration between research and management have been emphasized as important (Dessai and Hulme, 2004; Mimura et al., 2014).

Reeder and Ranger (2010) described a different way to explain the process:

- Science first: the process begins with the generation/interpretation of climate projections, follows with an analysis of their impacts, and ends with the design and assessment of adaptation options (this also will be a top-down approach).
- Context first: the process begins at the level of the adaptation problem itself rather than with climate change projections, specifying objectives and constraints, identifying appropriate adaptation strategies and only then appraising their desirability against a detailed set of projections and other inputs. Understanding the vulnerability of the system is the first step and core of the adaptation analysis. The series of steps for context first approach will be structuring the problem, appraise solutions and implementation.
2.2.3. Adaptation approaches

The streams of thinking on adaptation can be clustered as follows: adaptation drawn from the ecological system (cybernetics and coevolution), adaptive management, and coping mechanisms.

Cybernetics is the reductive, opening scope for mathematical modelling of behaviour but not able to incorporate the significance of competing values and power asymmetries in shaping action. Coevolution orients adaptation less towards the search for ways in which to manage risk and change, and is more interested in adaptation as a process, a state of living with uncertainty. Adaptive management acknowledges the role of difference in access to information and decision-making capacity in shaping adaptive processes and outcomes, but does not have power as a focus of analysis. Cybernetics focuses on technical aspects but in this case with a view to informing policy learning. Last but not least, coping is the outlier in offering a legacy for adaptation that is grounded not in systems theory but in development studies (Pelling, 2011).

But, three concepts underpin the adaptation approaches: the adjustment or incremental adaptation, the transformative adaptation, and the reformist adaptation or transition.

Adjustment [incremental] adaptation views climate impacts as the major source of vulnerability (Bassett and Fogelman, 2013; Lorenz et al., 2014; Wise et al., 2014). It draws attention to responses to climate change rather than to the social causes of vulnerability. The purpose of adaptation is to adjust to these new conditions through climate risk management, the aim of which is to “return” society to some desirable equilibrium state. Therefore, the central aim of the actions is to maintain the essence and integrity of an incumbent system or process at a given scale (Park et al., 2012). The proposed solutions come from the risk management.

Transformative adaptation is defined most notably within resilience theory. Transformation is a discrete process that fundamentally (but not necessarily irreversibly) results in change in the biophysical, social, or economic components of a system from one form, function or location (state) to another, thereby enhancing the capacity for desired values to be achieved given perceived or real changes in the present or future environment. Transformative adaptation emphasizes the importance of understanding the causal structure of vulnerability in different political–economic and environmental contexts as the basis of adaptation planning. Transformation adaptation strategies involve
purposeful decision-making. The proposed solutions are related to the “political regime shift” that will change the existing system altogether (Bassett and Fogelman, 2013; Kates R.W. et al., 2012; Lorenz et al., 2014; Park et al., 2012).

Reformist adaptation [transition] occupies a middle ground between the adjustment and transformative adaptation approaches. The papers in this grouping place more emphasis on the social and political dimensions of vulnerability. Reformist adaptation seeks to reduce social vulnerability by addressing “vulnerability drivers” and “response capacity” through “development“. The key distinction for the reformist approach is that proposed adaptation alters rules and decision-making processes, but did not significantly alter the norms and principles that governed the rules: co-production of knowledge for climate adaptation, the influence of social identity in risk perception, and the behavioral dimensions of adaptive actions. The proposed solutions are related to the alteration of the rules and regulations that give rise to vulnerability within the boundaries of the existing system (Bassett and Fogelman, 2013; Lorenz et al., 2014; Pelling, 2011).

Both incremental and transformational responses are considered merely to be two subsets within the broader suite of available adaptation strategies, which may additionally include the active decision to not take action. The key difference between incremental and transformational change thereby lies in the extent of change, in practice manifesting in either in the maintenance of an incumbent system or process, or in the creation of a fundamentally new system or process (Park et al., 2012).

Since the IPCC Fourth Assessment Report (AR4), the adaptation and resilience literature has suggested that climate change or other factors may drive actors toward the deliberate pursuit of transformational adaptation as a mechanism for managing the discontinuities associated with experiencing an adaptation limit. In addition, some studies have discussed the interactions between incremental and transformational adaptation and the pathways by which actors can transition from one to the other (Klein et al., 2014; Park et al., 2012; Pelling, 2011).

Proactive preparation for the future will require responses that continually cycle between incremental and transformative actions (Figure 8). To this Park et al. (2012) developed the Adaptation Action Cycles (adapted from the Transition Management Framework). The authors suggest the processes of incremental and transformative change through the same four activity clusters (strategic, tactical, operational and reflexive) and are subject to
the same key questions as the basis for social learning and the provision of information and policy development.

![Schematic representation of the Adaptation Action Cycles](image)

*Figure 8: Schematic representation of the Adaptation Action Cycles, depicting two concentric, but linked, action learning cycles operating at different scales (Park et al., 2012).*

Cities need to focus on enabling decision makers to make difficult and urgent choices between a range of alternative policy and management options in interconnected social and natural systems. Therefore, adaptation plans need to be linked to the implementation (Wise et al., 2014).

### 2.2.4. Methods and Tools

Tree methods used in adaptation studies will be presented in the following paragraphs: the Adaptive Policy Making, Adaptation Pathways and the Dynamic Adaptive Policy Pathways.

Adaptive Policy Making consists of policy analysis into a planned approach to adaptation (Haasnoot et al., 2013; Timmermans et al., 2015; Walker et al., 2013, 2001). Adaptive Policy Making is a generic structured approach for designing dynamic robust plans. Conceptually, it is rooted in Assumption-Based Planning (it was developed at the RAND Corporation for improving the adaptability and robustness of existing plans, Walker et al.,
2013). It is structured through the following steps that allow design of a dynamic adaptive plan:

- Setting the stage: the existing conditions of a system are analyzed and the objectives for future development are specified;
- Assembling the basic plan: the way in which these objectives are to be achieved is specified by assembling a basic plan;
- Increasing the robustness of the basic plan: the basic plan is made more robust through four types of actions: mitigating, hedging, seizing and shaping actions;
- Setting up the monitoring system: to monitor the plan’s performance and to take action if necessary;
- Preparing the trigger responses (critical values of signpost variables or triggers beyond which additional actions should be implemented are specified) (Figure 9).

There are four different types of actions that can be triggered by a signpost:

- Defensive actions: actions taken to clarify the basic plan, preserve its benefits, or meet outside challenges in response to specific triggers that leave the basic plan unchanged;
- Corrective actions: adjustments to the basic plan;
- Capitalizing actions: actions to take advantage of opportunities that can improve the performance of the basic plan;
- A reassessment of the plan: initiated when the analysis and assumptions critical to the plan’s success have clearly lost validity.
Adaptation Pathways (Haasnoot et al., 2013; Walker et al., 2013): The Adaptation Pathways approach presents a sequence of possible actions after a tipping point in the form of adaptation trees (e.g. like a decision tree or a roadmap) (Figure 10).
Recent efforts have been made to construct the concept of “pathway” or “route map” which focus more on the processes of decision making rather than the outcome, emphasizing the adaptive nature of the decision process itself in the face of high uncertainty and inter-temporal complexity. There is, however, the need to improve understanding the “when”, “where” and “how”. In this context pathways are definitions of the alternative trajectories for knowledge, intervention and change. A key strength of this approach for adaptation is that explicitly considers the interdependencies between the uncertain timing and magnitude of climate-change impacts and the characteristics of responses in terms of their costs, lead and lag times, reversibility, etc. The tool emphasizes the need for flexibility and iterative management on immediate decisions, informed by a strategic vision of the future and a framework to inform future actions based on decision triggers and monitoring (Wise et al., 2014).

Adaptation Pathways provides insight into the sequencing of actions over time, taking into account a large ensemble of transient scenarios. The pathways map provides information to the decision maker, but gives no guidance on how the decision maker can translate this into an actual plan. Adaptive Policymaking supports the decision maker in a different way. It specifies a stepwise approach to designing a plan. However questions such as how one can identify vulnerabilities, how the actions should be sequenced, or how one decides whether to hedge against vulnerability, are not explicitly addressed (Haasnoot et al., 2013).
The Dynamic Adaptive Policy Pathways method (Haasnoot et al., 2013) is the combination of Adaptive Policymaking and Adaptation Pathways. This approach assists in designing dynamic adaptive plans, and is built upon the best features of two existing adaptation methods. This integrated approach includes: transient scenarios representing a variety of relevant uncertainties and their development over time; different types of actions to handle vulnerabilities and opportunities; Adaptation Pathways describing sequences of promising actions; and a monitoring system with related contingency actions to keep the plan on track of a preferred pathway. The steps in the approach are presented in Figure 11:

![Image of Figure 11: The Dynamic Adaptive Policy Pathways approach (Haasnoot et al., 2013).](image)

The fifth step is the assembly of pathways using the information generated in the previous steps. In this approach a pathway is considered as a chain of actions, where a new action is activated once its predecessor is no longer able to meet the definition of success. Each of these routes can then be evaluated on its performance. In addition, fundamental criteria, such as the urgency of actions, the severity of the impacts, the
uncertainty involved, and the desire to keep options open, could be used to develop a set of promising pathways. The result is an adaptation map (Figure 12), which summarizes all logical potential pathways in which ‘success’ (the desired outcomes in terms of indicators and targets that evaluate the performance of actions and pathways) is achieved. The next step (6) consists on the preferred pathways, which are pathways that fit well within a specified perspective. This consists not only in the identification of physically robust pathways, but also ‘socially robust’ pathways (Offermans, 2012). The preferred pathways will form the basic structure of a dynamic adaptive plan (like the basic plan in the Adaptive Policymaking framework) (Haasnoot et al., 2013).

![Figure 12: Adaptation Pathways map (left) and a scorecard presenting the costs and benefits of the 9 possible pathways presented in the map. Actions A and D should be able to achieve the targets for the next 100 years in all climate scenarios. If Action B is chosen after the first four years, a tipping point is reached within about five years; a shift to one of the other three actions will then be needed to achieve the targets (follow the orange lines). If Action C is chosen after the first four years, a shift to Action A, B, or D will be needed in the case of Scenario X (follow the solid green lines). In all other scenarios, the targets will be achieved for the next 100 years (the dashed green line). The colors in the scorecard refer the actions A (red), B (orange), C (green), and D (blue) (Haasnoot et al., 2013).](image)

The seventh step is to improve the robustness of the preferred pathways through contingency planning -in other words, to define actions to get and keep each of the pathways on track for success. Haasnoot et al. (2013) distinguish three types of contingency actions from Adaptive Policymaking: corrective, defensive, and capitalizing actions, which are associated with a monitoring system and trigger values. The monitoring system specifies what to monitor, and the triggers specify when a contingency action should be activated.

The eighth step is to translate the results from all of the previous steps into a dynamic adaptive plan. The plan summarizes the results from the previous steps. The challenge is
to draft a plan that keeps the preferred pathways open for as long as possible. Thus, the plan specifies actions to be taken immediately.

Finally, the actions to be taken immediately are implemented and the monitoring system is established. Then, time starts running, signpost information related to the triggers is collected, and actions are started, altered, stopped, or expanded in response to this information. After implementation of the initial actions, activation of other actions is suspended until a trigger event occurs.

The Adaptive Policymaking, Adaptation Pathways, and Dynamic Adaptive Policy Pathways approaches produce dynamic robust plans (covering anticipatory, concurrent, and reactive adaptation), while Robust Decision Making produces a static robust plan (focusing on anticipatory adaptation) (Figure 13) (Walker et al., 2013). What the urban system needs under the climate change uncertainty is to develop a dynamic robust plan.

Figure 13: A map of the approaches for developing adaptive policies according to their dynamics and level of uncertainty (Walker et al., 2013).
Some remarks related to the Adaptation approaches

Wise et al. (2014) argue that there is a growing shift in climate adaptation science from a problem-orientated to a decision-orientated focus, which at the end aims to assist decision-makers to assess and implement alternative policy options within highly uncertain, dynamic and complex socio-ecological system. Attention now needs to turn from incremental actions on proximate causes, to more challenging and long-lead time transformative aspects. If we are thinking of a proactive preparation for the future, this will require responses that continually cycle between incremental and transformative actions. This process requires the social participation, institutions and organisations, skills and capabilities necessary to guide, facilitate, and manage the “when”, “where” and “how” of adaptation. All these are needed for building the resilience and sustainability of desirable system functions and for transforming values, decision-making processes and governance arrangements. Moreover, city systems need dynamic adaptive plans and not static robust plans. This requires a new framing of adaptation as part of pathways of change and response.

An adaptation pathway approach fosters an iterative and adaptive governance process for designing and implementing collective action (Butler et al., 2014). Moreover, the pathway approach could provide a heuristic and necessary guidance for the policy processes. The pathway provide a powerful and flexible analytical approach for decision makers in relatively closed, high-reliability systems that are amenable to technical solutions (e.g., the Thames barrier) (Reeder and Ranger, 2010). A key strength of this approach for adaptation is that it explicitly considers the interdependencies between the uncertain timing and magnitude of climate-change impacts and the characteristics of responses in terms of their costs, lead and lag times, and reversibility. In this regard, the tool emphasises the need for flexibility and iterative management of immediate decisions, informed by a strategic vision of the future and a framework to inform future actions based on decision triggers and monitoring (Haasnoot et al., 2013).

2.3. Transforming barriers into enablers: conditions for change

Literature that characterises barriers and opportunities also explores the reasons for the limited conversion of assessments, agendas and plans into transition. How barriers are transformed into enablers will be analysed in the following section. Therefore, the
conditions for change will be identified in both communities (transition and climate adaptation). The aim of this section is to detect the condition for change into the literature and use this review as a baseline for the later discussion of which triggers of change are needed to promote transition (4.4 Conclusions).

**Transition community**

When designing long-term policies, policy makers need to be aware of what drives the transitional development of the system. Frantzeskaki and de Haan (2009) distinguishes three main conditions for change, all based on the idea of functional mismatch. If the regime is considered to represent the dominant function in a societal system then mismatches can occur either with the surrounding systems internally to the regime, or with other subsystems.

These conditions-for-change are:
- Tension: these are the mismatches with the landscape.
- Stress: the internal mismatches within the regime.
- Pressure: the mismatches with emerging new societal functioning in niche-regimes. This is seen when a certain new societal functioning scales up to the point where it becomes an alternative for the regime functioning. Similar resources and infrastructures are then used even if it does not imply direct competition it is a condition for change.

Even the conditions for change are necessary to drive societal system to change must be accompanied with forces. A force is defined as a descriptive variable of the system state during a transition. Forces can be stimulating or inhibiting. Two key characteristics of the forces have been investigated by the authors: direction and origin. The first step is that the forces that drive transitional change are identified by spotting the direction of change. Specifically, when change is driven from above (top-down) the societal system is said to experience tensions. When change is driven from below (bottom-up), the societal system experiences pressure. When change is driven from within (internal), the societal system experiences stress.
Furthermore, the forces influencing transitions are:

- **Formation forces:** related to the potential for societal innovation. They are: presence of a niche, presence of new demand, presence of a new functioning.
- **Support forces:** strengthen or weaken present transitional trends. Some of them are: standardization of practices/routines, provision of resources, exercise of power.
- **Triggers or triggering forces:** perturb or shock the system. They are: systemic failures, crises, exogenous events (natural disaster and accidents).

The next step will be finding the origin of the forces. The forces of change can be investigated in three conceptual blocks that correspond to the components of a societal system:

- Environment and the science and technology;
- Civil society;
- The institutions (and more specifically the formal institutions).

The system experiences tension, stress or pressure due to the presence or absence of forces. A brief presentation of the patterns of change and the present forces linked to the present conditions is given in Table 1:

<table>
<thead>
<tr>
<th>Present condition</th>
<th>Patterns of change</th>
<th>Present forces</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tension</strong></td>
<td>Niche-regimes are supported and reinforced</td>
<td>Provision of resources, exercise of power, standardization of practices</td>
</tr>
<tr>
<td></td>
<td>Regime incorporates niche functioning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Societal support for niche functioning grows</td>
<td></td>
</tr>
<tr>
<td><strong>Stress</strong></td>
<td>Niche-regimes grow and expand autonomously</td>
<td>Self-regulation</td>
</tr>
<tr>
<td></td>
<td>Growing niches can become empowered</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Regime incorporates niche functioning</td>
<td></td>
</tr>
<tr>
<td><strong>Pressure</strong></td>
<td>Regime adapts towards alternative functioning</td>
<td>Presence of new functioning, presence of a niche, presence of new demand</td>
</tr>
</tbody>
</table>

*Table 1: Patterns of change and present indicative forces (Frantzeskaki and de Haan, 2009).*

In addition to the above, Moore (2012) describes some key enablers/supports of behaviour change. The author has identified the enablers from behavioural economics, community based social marketing and other approaches. Even these enablers refers to the areas of energy efficiency, travel behaviour and social acceptance of energy.
infrastructure give as some ideas for the detection of triggers of change for urban transition.

Some of the key enablers for behaviour change in the short to medium term are listed below (Moore, 2012):

- **Remove Barriers: Make it Available, Affordable and Accessible.**
  - Information and education play an important but not sufficient role in changing behaviour. In terms of information, this should be kept simple and clear.
  - Raising environmental awareness on specific behaviour areas (e.g. energy-efficient consumer choices) can be effective.
  - Credible information should be available at points of decision for the society.
  - One useful approach is the 4 Es approach which includes: enable (e.g. remove barriers to motivation and action, give information and best practice, provide capacity); engage (use networks, encourage community participation); encourage (adjust tax system, offer grants, and impose penalties); and exemplify (lead by example, achieving consistency in policy). Critics point to the need for regulatory and infrastructural changes too (i.e. enforce).
  - Building capacity is valuable.

- **Social Norms are Key**
  - The social context and social system are important to consider, not just individual behaviour change. Engaging people as members of a community is an important strategy for changing behaviour.
  - Feedback plays a key role in behaviour change -compares use with that of peers, neighbours, social networks. It works well when combined with focused goals and commitments to act. People are influenced by what others are doing so behaviour change can often be group-led.
  - Encouraging group participation to develop social norms can be effective.
  - It can be useful to fit the new behaviour/practice into everyday rules, practices and habits as more likely to gain traction.

- **Make it Attractive**
  - Incentives are useful in supporting behaviour change, particularly when they are immediate. People often have a tendency to ‘discount the future’ -in other words, they may prefer a smaller reward today over a larger reward in the future.
Incentives do not have to be financial to have an impact. They can also include adding value or status to a new practice or adding technological appeal (e.g. new apps for smart phones).

**Climate adaptation community**

The approach from the IPCC to address triggers factors or enablers consists of the analysis of the adaptation opportunities. In this sense, the adaptation opportunities are representing the enabling factors. According to the IPCC, the opportunities for adaptation vary from increasing awareness of climate change consequences and the costs and benefits of adaptation to the implementation of policies that will create conditions which allows adaptation. The opportunities that facilitate adaptation are summarized in Table 2. The actions that enhance the awareness of actors and stakeholders help overcome constraints. The development and application of tools to support assessment, planning, and implementation can aid actors in weighing different options and their costs and benefits. Policies, whether formal policies of government institutions, initiatives of informal actors, or corporate policies and standards, can direct resources to adaptation and/or reduce vulnerability to current and future climate. Finally, the ability for humans to learn from experience and to develop new practices and technologies through innovation can significantly expand adaptive capacity in the future (Klein et al., 2014).
Table 2: Key adaptation opportunities and examples with supporting references (Klein et al., 2014).

Apart from the identification of adaption opportunities the detection of obstacles that need to be overcome is a key issue in order to have an effective and efficient action plan:

- Regulatory issues or enablers include:
  - The policy tools that the municipality has at its disposal (such as its Official Community Plan, system of bylaws, legality and procedural feasibility) (Burch, 2010; Moser and Ekstrom, 2010) as well as interactions between multiple levels of government (Kenny et al., 2014). Schipper and Pelling (2006) suggest that a supportive institutional and policy environment at the state and international level can enable local adaptation.
  - Regulatory programs should employ prioritisation tools foster creativity in achieving solutions, match the scale of the ecosystem and spillover effects they are meant to govern, and must have comprehensive, adaptive, and incentive based regulatory design (Burch, 2010; Moser and Ekstrom, 2010).

- However, the normative issues of whose values count, the prevalence of externalities and the changing preferences over time for well-being and risk avoidance need to be made explicit (Adger et al., 2009).

- Structural or operational issues or enablers:
  - Climate change policy scholars have argued that adaptation is likely to be implemented only if it is consistent with programs designed to cope with non-climatic stresses and this claim has been echoed on the mitigation
side (Burch, 2010; Lehmann et al., 2015). That why it is important also to consider the barriers hindering institutional feasibility. They arise from rigid or weak institutions, blocked by existing policies and internal operating procedures (Matasci et al., 2014).

- The success of mainstreaming efforts depends on the capacity of responsible organizations to plan and implement respective measures. This capacity is affected by the continuity of institutional processes. Institutional memory and inter-institutional coordination are important factors in allowing adaptive measures to be adopted both in project design and approval (Sietz et al., 2011).

- Behavioural and cognitive issues or enablers are especially critical to local action. Adaptation plans often seem to lack the links to implementation due to a diversity of limitations and barriers relating to human behaviour and governance (O’Brien and Wolf, 2010; Wise et al., 2014).

- They generally incorporate both the personalities and leadership capabilities of individuals in critical positions within the municipality (Anguelovski et al., 2014; Kenny et al., 2014; Moser and Ekstrom, 2010), and the institutional cultures of various groups within the institution and municipal departments. Strong leadership can help motivate and advance adaptation in some cases (the efforts of London, New York City, and the Southeast Florida Regional Climate Change Compact are leading examples) while hindering broad ownership of the challenges and responsibilities to plan and implement adaptation can help in others (Moser et al., 2012).

- Contemporary changes in policy and behaviour of societal sectors are often induced by coercion, voluntary agreements, societal pressure, financial stimuli, and market stimuli but although these forces have been found to stimulate changes, it is not clear that, without facilitation, the altered behaviour will be sustained or become the dominant mode of action (Burch, 2010). Barriers hindering social acceptability also occur from the first phase of understanding the adaptation problem and also play a crucial role in the planning and management phase of the adaptation. Social acceptability is often strictly linked to intrapersonal, interpersonal and decision making factors that are, at their root, psychological (Matasci et al., 2014).

- Moreover, cultural barriers to adaptation can only be understood in context, which requires that the scale and agency of decision making is
defined. This is generally much less problematic at the micro-scale, where the range of agents, contexts and interests are less diffuse (Nielsen and Reenberg, 2010). At the policy level, adaptation policies, like many other areas of public policy, are constrained by inertia, cultures of risk denial and other phenomena well known in policy sciences (Adger et al., 2009; Kenny et al., 2014).

- Two concepts related to the context and locations are very important: place and occupational attachments. Attachment to place is a concept that describes the level of connection that people have with their physical community or ‘place’. And attachment to occupation describes the identity that is created as a result of working in a particular occupation. People with high levels of place or occupational attachments may be less likely to be willing to contemplate or undertake change that involves moving or changing occupation. They are potentially important influences that need to be considered before successful transformation strategies can be planned (Adger et al., 2009; Marshall et al., 2012). Marshall et al. (2012) identifies negative correlation between transformational capacity and both place attachment and occupational attachment, suggesting that whilst these factors may be important positive influences on the capacity to adapt to incremental change, they may act as barriers to transformational change.

- Awareness:
  - The uncertainties associated with climate scenarios have made it difficult in some cases to design robust adaptation strategies (Adger et al., 2009; Hammill and Tanner, 2011; O’Brien and Wolf, 2010). (Pelling, 2011) also name the barriers to take up and adds that the high costs of information gathering and monitoring and associated difficulties in acquiring funding have also inhibited the implementation of adaptive management approaches (Deressa et al., 2009; Moser and Ekstrom, 2010). Moreover, there is a need to develop more dedicated tools which have an explicit focus on screening for climate change risks and for facilitating adaptation (Hammill and Tanner, 2011).
  - Moreover, the availability and proper management of climate data and information is paramount for planning and implementing adaptation measures (Lehmann et al., 2015; Moser and Ekstrom, 2010; Sietz et al., 2011).
Resources. The remaining category of barriers to local action includes the context within which the municipality is functioning.

- Barriers hindering economic feasibility come into play towards the end of the adaptation process, after stakeholders decided to act and are in the planning or the managing phase. These barriers typically take the form of insufficient funding or an unfavorable cost-benefit ratio of planned measures (Abel et al., 2011; Bryan, 2015; Deressa et al., 2009; Matasci et al., 2014).

- Barriers hindering technological feasibility also intervene in the adaptation process during the planning and managing phase. Stakeholders may lack know-how about, for instance, protecting areas from natural hazards or building infrastructure on unstable soil (Matasci et al., 2014).

Moser and Ekstrom (2010) defines the process of adaptation (understanding the problem, planning adaptation actions, and managing the implementation of the selected option(s)) which provides the foundation for identifying and organizing the barrier. The barriers may impede progress from one stage to another or result in problems or unintended consequences later. The author identifies barriers in the stages of the understanding, planning and managing and also names some crosscutting issues. The authors linked the barriers with the phases and sub processes throughout the adaptation process: understanding, planning and managing (Figure 14).

![Phases and sub processes throughout the adaptation process](image-url)
3. Conceptual Framework for RAMSES

There are several approaches related to transition in the literature, some come from the transition community and others from the adaptation community. Moreover, these communities define approaches using specific concepts, methods and tools.

The first conclusions we get from the literature review of both communities (transition and climate adaptation) are summarized in the Table 3:

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>TRANSITION</th>
<th>CLIMATE ADAPTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Socio-technical <em>(society and technical system co-evolve)</em></td>
<td>Socio-ecological <em>(resilience)</em></td>
</tr>
<tr>
<td>GOVERNANCE</td>
<td>Transition management <em>(governance)</em></td>
<td>Adaptive management <em>(governance)</em></td>
</tr>
<tr>
<td>STAGES</td>
<td>Pre-development, take-off, acceleration, stabilisation</td>
<td>Re-organization, growth, conservation and collapse <em>(adaptive cycle)</em></td>
</tr>
<tr>
<td>STEPS</td>
<td>Analyse a system, envisioning, exploring pathway, experimenting, assessing, translating</td>
<td>Problem structuring and establishing the adaptation arena; develop an agenda, vision and pathway; implementing adaptation actions; evaluating, monitoring and learning</td>
</tr>
<tr>
<td>APPROACH</td>
<td>1. Socio-technical transition theory</td>
<td>1. Adjustment [incremental] adaptation</td>
</tr>
<tr>
<td></td>
<td>2. Institutional Analysis and Development</td>
<td>2. Transformative</td>
</tr>
<tr>
<td>METHODS/TOOLS</td>
<td>• Multi-Level Perspective <em>(niche-innovation, regimes and landscape)</em></td>
<td>• Adaptive Policy Making <em>(APM)</em> <em>(design dynamic robust plans)</em></td>
</tr>
<tr>
<td></td>
<td>• Backcasting</td>
<td>• Adaptation Pathway <em>(AP)</em> <em>(focus on the processes of decision making)</em></td>
</tr>
<tr>
<td></td>
<td>• Urban Transition Labs <em>(living lab)</em></td>
<td>• Dynamic Adaptive Policy Pathways <em>(the combination of APM and AP)</em></td>
</tr>
<tr>
<td></td>
<td>• Transition pathway <em>(multi-level interaction)</em></td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Comparison of the transition concepts described in two scientific communities (Transition and Climate Adaptation).

Smith and Stirling (2010) compares the analysis and governance of socio-ecological and socio-technical systems. On one hand, research into social-ecological systems recognises technology as an important influence on resilience, but rarely considers the dynamics of technological change in any detail. On the other hand, the transition management
toward more sustainable socio-technical systems does consider technology dynamics in depth (Figure 15). Anyway, both systems consider the same elements and the differences are into the elements highlighted.

The core issue when we want to move a city to a sustainable and resilient stage is in the adaptation approach we choose: incremental, transformative or transition. In this regards, there are two opposites and one in the middle ground (transition). In thinking about where incremental adaptation ends, and more fundamental transformation adaptation begins, it becomes necessary to identify the points of difference between the two response strategies (Park et al., 2012). The main conclusion is that proactive preparation for the future will require responses that continually cycle between incremental and transformative actions (Park et al., 2012) through transition.

Regarding top-down and bottom up approaches, the literature suggests a combination of both approaches as the best option. Incremental approaches follow on from top-down and transformative adaptation can exhibit both. It should however be highlighted that participation by a broad spectrum of stakeholders and close collaboration between research and management has been emphasized as important (Mimura et al., 2014).
Lastly, the debate is focused on the governance (transition management or adaptive governance) and the methods and tools we choose to help cities gaining sustainability and resilience.

Transition Management (TM) is an alternative model of governance which seeks to guide the gradual, continuous process of transformation of socio-political landscapes, socio-technical practices and “the structural character of society” from one equilibrium to another (Rotmans et al., 2001). This governance model focuses mainly on the society and the technology. The sequence of events undertaken in practice in TM has offered a limited range of opportunities to validate the concept. On the other hand, Adaptive Governance is a process of creating adaptability and transformability in socio-ecological systems (Gunderson and Light, 2006). Adaptive management focuses mainly on the interaction between social and natural dynamics. It also focuses on adaptation through learning to increase the resilience of socio-ecological systems and is more analytic and substantial as compared to transition management (that has a strong process orientation with a focus on sustainability) (Timmermans et al., 2015).

Regarding the methods used in the studies of socio-ecological systems, the Adaptive Policymaking, Adaptation Pathways, and Dynamic Adaptive Policy Pathways approaches produce dynamic robust plans (covering anticipatory, concurrent, and reactive adaptation). Nevertheless, the Dynamic Adaptive Policy Pathways approach is built upon the best features of two existing adaptation methods.

In the RAMSES project the objective is to develop a systems-based approach that considers trade-offs, synergies and interlinkages with social and environmental issues. Moreover, the RAMSES approach will capture ‘top-down’ drivers of change but also provide the ‘bottom-up’ local context. RAMSES will also consider social effects of climate change by addressing human related impacts to enable the design of adaptation strategies that consider these broader system interactions (Dawson, 2011).

In this context, regarding the objectives of the RAMSES project and the literature review done in the previous section, we defined the integrated conceptual framework for transition to be used into RAMSES project (Figure 16).
This integrated approach includes the following steps:

- A system map: where the impacts on the urban system are analysed and the key problems are detected and the normative scenario is created - also called desirable futures, visions, or future visions;
  - Step 1: Impact analysis. Imply the use of climate scenarios and modelling of impacts. RAMSES will analyse the impacts related to flood and heat in transport and urban (built environment) sectors.
  - Step 3: Vision creation. Taking as a basis all this analysis, a vision is created (an appealing and inspiring vision): this entails images and a narrative of desirable systems based on shared principles of sustainable development (Nevens et al., 2013).
  - Step 4: Backcasting to identify adaptation options. It consists looking backwards from that future to the present in order to identify the adaptation options that allow achieving this future (Vergragt and Quist, 2011).

- Selecting adaptation options: where the pre-identified adaptation options that act against the detected problems are characterised, assessed, and prioritised (Moser and Ekstrom, 2010);
  - Step 5: Adaptation options characterisation. It consists of a general description of the adaptation options, indicating objective(s), scale (e.g., international, regional, national, subnational, or local), timing and responsibilities for implementation and financing. This description would address the technical feasibility of options, barriers to their implementation (e.g., cultural, social), the capacity to implement and sustain the measure, and the cultural acceptability of the technology involved (Niang-Diop et al., 2004).
  - Step 6: Assess the effectiveness and the cost-efficiency. The effectiveness is the ability to be successful and produce the intended results (in this case focused on the hazard and vulnerability). Cost-efficiency considers not only the benefits (economic and non-economic) gained from adaptation options, but also the costs (the direct and external costs) and the co-benefits of the measure (that can be related to the multi-functionality and/or the ecosystem services provided).
Step 7: Prioritisation of the adaptation options. It consists on the selection of the most “appropriate” adaptation option or options, among all potential available options. This selection implies the definition of criteria that will allow their prioritisation and the selection of the prioritisation method (Cost-Benefit Analysis, Cost-Effectiveness Analysis, Multi-Criteria Analysis, Robust Decision Making, etc.).

- Planning and implementing: where “how”, “when” and by “whom” is defined through adaptation pathway approach, the identification of the triggers of change or enablers for the transition and the definition of monitoring (Moser and Ekstrom, 2010).

Step 8: Pathway definition and selection. The pathway is considered as a chain of actions, where a new action is activated once its predecessor is no longer able to meet the definition of success. Each of these routes can then be evaluated on its performance, urgency of actions, severity of the impacts, uncertainty, and the desire to keep options open. The next step consists of preferred pathways, which fit well within a specified perspective. This consists not only of identification of physically robust pathways, but also ‘socially robust’ pathways (Haasnoot et al., 2013; Offermans, 2012).

Step 9: Detection of triggers of change. It consists of detecting the main conditions for changes and the trigger factors as well as defining the adaptation opportunities and detecting the barriers or obstacles. The adaptation opportunities represent the enabling factors that enhance the potential for actors to plan and implement actions to achieve the adaptation objectives or facilitate the adaptive responses by natural systems (Klein et al., 2014). The detection of obstacles that need to be overcome is a key issue in order to have an effective and efficient action plan (Burch, 2010).

Step 10: Define and implement a Dynamic Adaptive Plan or Strategy. The plan summarises the results from previous steps, such as targets, problems, and potential and preferred pathways. The challenge is to draft a plan that keeps the preferred pathways open for as long as possible. Thus, the plan specifies actions to be taken immediately to keep open future adaptations (Haasnoot et al., 2013).

Step 11: Define the monitoring system (that allow defining contingency actions) and evaluate the plan.
The circular representation of the above defined conceptual framework will be the Dynamic Adaptive Cycle (which is based on the Dynamic Adaptive Policy Pathways approach defined by Haasnoot et al., 2013) (Figure 17).
Figure 17: The Dynamic Adaptive Cycle for transition (to be used in WP8 of the RAMSES project).
4. Exercises

4.1. Introduction

While climate change action plans are becoming more common, it is still unclear whether communities have the capacity, tools, and targets in place to trigger the transformative levels of change required to build fundamentally adapted, resilient, healthy communities. Evidence increasingly supports the finding that this transformation is not triggered by climate policy alone, but rather is shaped by a broad array of decisions and practices that are rooted in underlying patterns of development (Burch et al., 2014). The barriers and enablers of climate change at the local level, however, are poorly understood and deeply influence the likelihood of successful mitigation and adaptation strategies (Burch, 2010).

To further understand enablers and triggers of change found in the literature, an empirical approach has been designed. This has resulted in two stakeholder dialogue (SD) exercises wherein the following methodology is applied. These exercises aim at encouraging diverse stakeholders to work together in the framework of adaptive management (Stringer et al., 2006) and answer the following questions:

- Is it helpful for cities to create specific visions?
- Is it possible for cities to introduce transition factors in their work adaptation? Or is it too abstract?
- Can the researchers be more precise in the detection of transition factors?
- Can the researchers define some metrics to evaluate these transition factors?
- Will it be more useful for the cities to talk about pathways that consider complimentary, temporary, and progressive adaptation measures (instead of transition factors)?

Before starting with the exercises, some concepts are clarified with the stakeholders to have a common understanding:

- What do we mean by transition strategies?

The field of transitions research aims to understand patterns and processes of transformative change towards sustainable goals. Its main focus can be the socio-technical systems (in case of the transition governance) or socio-ecological systems (in case of the adaptive governance). The transition strategy aims to address questions such
as how can we enable transformative capacity in the institutions, communities, technology, and infrastructure of our system? (Markard et al., 2012; Wise et al., 2014)

- How can this be introduced in practice?

First we need to consider the complexity, scale and context-dependency of cities. Cities can vary much in population size, composition of trades, affluence, hierarchies, and access to national or international transport infrastructure as well as in climate and land use. Second, the complexity of cities implies that an assessment must be based on indicators with a goal to maintain sustainability (Naess and Vogel, 2012). Third, backcasting can be done in the form of normative, sustainable, appropriate conditions for the detection of the triggers of change (Naess and Vogel, 2012).

- How can this be useful for cities in supporting their work on adaptation?

The transition strategy allows creating an integrated approach of socio-technical and socio-ecological systems development towards more sustainable cities. These socio-technical and socio-ecological systems are the main recipients of the adaptation measures and plans.

- Is it helpful for cities to work within a specific vision or is too abstract?

The assessment has to ensure sustainability and practicality of ‘best practices’ and ‘niche technologies’ (Naess and Vogel, 2012).

The main objective of the exercises is to detect the triggers for change in the transition of the city (step 9 of the conceptual framework, Figure 17) through the following stages (Figure 18):

1. **SYSTEM ANALYSIS.** Includes a review of the impact analysis (step 1 of the conceptual framework), identification of major problems and hot spot detection through the vulnerability assessment (step 2).
2. **VISION CONSTRUCTION.** It consist on the positive part of the challenges (step 3)
3. and a BACKCASTING exercise to detect the triggers of change (step 9)
The first Stakeholder Dialogue (SD) took place in Brussels on the 11th of October 2013. The dialogue brought together around 25 participants from different European countries, including city representatives and regional actors, research and European institutions, international organisations and adaptation stakeholders from the private sector (Terenzi and Westerlind, 2014). The topic addressed into the first SD was “How to create urban strategies for transition”. The aim of the first SD was validate the system analysis, create a vision and define the triggers of change.

The 2nd RAMSES Stakeholder Dialogue took place in Copenhagen on the 11th of May 2015. The Dialogue brought together around 20 participants from different European countries, including city representatives and regional actors, research and European institutions, international organisations and adaptation stakeholders from the private sector. The topic addressed into the second SD was “Detecting triggers of change for transition in cities” (Terenzi, 2015). The aim of the second SD was validate the triggers of change detected in the previous SD, to prioritise them and to identify metrics to quantify the transition factors.
4.2. Methodology

The exercises were divided into the 3 work packages defined in the general methodology: (1) System analysis; (2) Vision construction; and (3) Backcasting. Prior to the SD, a desktop study was also carried out to prepare information for the participants.

The participants were further divided in two groups, each group representing a city typology defined by the desktop study. Each group would then apply the 3 work packages to their chosen city typology.

4.2.1. System analysis

Before holding the SD exercise a desktop study was carried out by the researchers to generate a city grouping (depending on climate change regions) and vulnerability characterisation.

According to the cities attending the SD, each participating city has been associated to the typologies of climate change regions (Table 9 (Annex I): Different types of regions characterised by climate change based on cluster analysis (European Environment Agency, 2012a). The participating cities were located into 4 climate change regions: northern-eastern Europe (4 cities), northern-central Europe (1 city), southern-central Europe (2 cities), and Mediterranean region (3 cities). Due to the proximity of one of the cities (located into northern-central Europe) to southern-central Europe, this was merged with the last mentioned climate change region (Table 4). Of these, two city groups were selected to work with during the SD exercises. Within the first SD the Mediterranean region and the Southern-Central Europe region were selected by the participants.

<table>
<thead>
<tr>
<th>City</th>
<th>CC regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antwerp</td>
<td>Northern-Western Europe</td>
</tr>
<tr>
<td>Rotterdam</td>
<td>Northern-Central Europe</td>
</tr>
<tr>
<td>London</td>
<td>Southern-Central Europe</td>
</tr>
<tr>
<td>Amsterdam</td>
<td>Mediterranean region</td>
</tr>
<tr>
<td>Dresden</td>
<td>Mediterranean region</td>
</tr>
<tr>
<td>Bratislava</td>
<td>Mediterranean region</td>
</tr>
<tr>
<td>Sfantu Gheorghe</td>
<td>Mediterranean region</td>
</tr>
<tr>
<td>Burgas</td>
<td>Mediterranean region</td>
</tr>
<tr>
<td>Barcelona</td>
<td>Mediterranean region</td>
</tr>
</tbody>
</table>
The methods used for the vulnerability assessment consisted of ESPON CLIMATE initiative (ESPON and IRPUD, 2011) and EEA initiatives for urban adaptation, climate change impact and vulnerability (European Environment Agency, 2012a, 2012b, 2012c) that were based on the indicator-based approach. To get the data for the cities analysis several databases and maps were consulted (from Urban Audit, ClimateAdapt, ETC CCA, etc.). A spreadsheet was created including exposure, sensitivity and adaptive capacity indicators for each city. The data was subsequently classified and standardized. The extended version of this work can be found on Annex I: Typologies of climate change regions and system analysis for the first SD.

Indicator-based vulnerability assessments relied on the identification of a number of factors shaping the exposure and vulnerability (sensitivity and adaptive capacity) to climate change threats within the specific domains of the urban systems that are being analysed (e.g. areas, social groups, built environment, and infrastructure (Birkmann, 2006; Birkmann et al., 2013; Burton, 2012; Carter et al., 2014; Guillaumont and Simonet, 2011; Villagrán-De-Leon, 2006).

1. Exposure

For the exposure, the analysis consisted of 8 climate indices plus 2 triggered climatic effects: change in annual mean temperature; decrease in winter temperature; change in number of hot days/warm nights; change in mean winter precipitation; change in mean summer precipitation; change in number of heavy rainfall days; summer water stress (WEI, EcF); change in number of days with snow cover; and triggered climate effects (change in river extreme discharge and change in exposure to coastal flooding).

The following information was analysed:

- Ensemble mean of several Regional Climate Models (RCM), simulations run under the IPCC A1B climate scenario, two periods (2021-2050, 2071-2100) http://discomap.eea.europa.eu/arcgis/rest/services/ClimateAdapt:
  - annual \( T^\circ \) change, summer \( T^\circ \) change, winter \( T^\circ \) change, \( n^\circ \) of hot days warm night, annual...

---

\(^1\) The data presented in this document are only indicative and cannot be accepted as absolute truth. The main aim of this information was to serve as a basis for drawing the current situation of the cities together with the stakeholder’s attending the SD.
pp change, n° days with extreme pp, summer pp change, winter pp change extreme river discharge, urbanised area potentially flooded;


Description of the 3 climate change regions in relation to the exposure indicators can be found on Annex I.

2. Sensitivity

Five sensitivity dimensions were identified (Table 11 Annex I) in the ESPON Climate Project: cultural, economic, environmental, physical and social sensitivity.

Unfortunately, this regional information did not provide enough accuracy to evaluate the city vulnerability. In this case, urban vulnerability indicators are considered more accurate (Swart et al., 2012) (Table 12 Annex I).

Some indicators considered of importance were:

- Population density: this indicator provides a reasonable initial estimate for Urban Heat Island (UHI) at the city level (Steeneveld et al., 2011). It can be used as a proxy for the density of the built environment. Anthropogenic heat production is also related to population density. Therefore, population density may serve as a biophysical sensitivity indicator for the potential UHI of a city (Swart et al., 2012);

- Low-income households: this indicator may be more sensitive to heat-related mortality (Fisher et al., 1994; Harlan et al., 2014; Klein Rosenthal et al., 2014; Mee et al., 2014; Reid et al., 2009; Schauser et al., 2010). In this case, these cities are more sensitive to heatwaves and to the UHI effects;

- Green urban areas: they play an important role in the local climate (temperature and humidity control) and in the runoff control. A low percentage of these areas make the cities more sensitive to CC effects, such as heatwaves and heavy rains (Bosch P., 2014; Voskamp and Van de Ven, 2014).

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3. Adaptive capacity

The assessment of the response capacity to climate change was also analysed taking into account the urban vulnerability indicators described in the European Topic Centre on Climate Change Impacts, Vulnerability and Adaptation study (Swart et al., 2012). For the present study only a few indicators were selected, depending on the data availability (present in Urban Audit database) (Table 13 Annex I).

Some remarks related to the adaptive capacity indicators:

- In general, locations with higher levels of stores of human knowledge are considered to have greater adaptive capacity than those with lesser levels of knowledge and education (Smit and Pilifosova, 2003);

- According to the IPCC, the economic condition of locations, whether expressed as the economic assets, capital resources, financial means, wealth, or poverty (in this case GDP), clearly is a determinant of adaptive capacity. It is widely accepted that wealthy nations are better prepared to bear the costs of adaptation to climate change hazards and risks than poorer nations (Smit and Pilifosova, 2003). This could be extended to cities: the wealthier cities may have higher ability to mobilise financial resources in the case of emergency. Also, the wealthy residents require less state/city support than the poorer ones (Swart et al., 2012). Moreover, if wealthy cities have a higher municipal authority expenditure per resident, they have more response capacity;

- In addition, the lack of amenities can be used as a proxy for the general state of the buildings within the city, which may affect how they can cope with extreme weather events (Swart et al., 2012);

- The number of hospital beds reflects the ability of the city to cope during and after extreme weather events associated with climate change. Thus, having a buffer in the number of hospital beds available makes cities better prepared for extreme weather (Swart et al., 2012);

- Finally, the unemployment rate indicates the economic circumstances of the population and it is also an indicator of response capacity (Swart et al., 2012).

All this desktop information was used in the SD Exercise for the group facilitation to describe the case cities. The information provided by the desktop study was validated with the SD participants and the main vulnerabilities of the case cities were detected and described.
Facilitation was carried out to help participants detect and describe vulnerabilities: some examples of limiting factors for change or constraints were presented to inspire the identification of changes needed:

- Demography: elder and young people vulnerability, demographic dependency;
- Urban architecture: population density, spatial urban structure;
- Land use: green areas, soil sealing proportion;
- Social aspects: unemployment rate, dwellings lacking basic amenities, health infrastructures;
- Economy (GDP, low income households, expenditure of the Municipal Authority per resident);
- Environment: adaptation to the climate change effects (heatwaves, floods, droughts ...), consumption of water;
- Education: proportion of students in higher level;
- Transport system: kilometres of public transport (connections between neighbourhoods), cost of public transport;
- Energy system, ...

The information generated by the SD formed a representation of the vulnerable system. After this first SD exercise, an “impact chain” was developed for each city case. To do so, the researcher detected the explanatory factors of the detected problems and compared with the literature. The literature provided a number of inventories of explanatory factors that potentially increase or alleviate the impacts of climate change within any of the complex socio-environmental components that define complex urban systems (Cutter et al., 2010; Jacobs et al., 2012; Schauser et al., 2010). These explanatory factors were organised in different categories and represented in a series of schematic figures summarising the causal structure of vulnerability and risk within each impact chain. Such representations of the vulnerable systems were inspired by Downing’s ‘causal chain of hazard development’ (Dowing and Patwardhan, 2005) and Wisner and Blaikie’s ‘Pressure and Release model’ (Wisner et al., 1994). These inputs were used as a reference framework for developing the ‘impact chains’ for each city typology (Figure 19).
4.2.2. Vision construction

After vulnerabilities had been identified for a particular city, the next step consisted of converting the previous hotspots/challenges of the impact chain into positive statements (combining elements inspired in the different generic visions). Then these were translated into a vision.

Three classes of scenario or future can be distinguished from the literature: what will happen (trend extrapolations; business as usual scenarios); what could happen (forecasting, strategic scenarios) and what should happen (normative scenarios like those used in backcasting). Normative scenarios are also called desirable futures, visions, or future visions (Börjeson et al., 2006; Vergragt and Quist, 2011). In scenario construction, this requires the use of qualitative knowledge about natural mechanisms, social contexts, causal complexes, and links between the different processes that together account for the trajectory of each scenario. Regarding to the SD exercises two classes of scenarios were used:

- What could happen: at the present time the most influential forward-looking scenarios are the IPCC scenarios. These scenarios were used in the step 1 of the exercises to detect the major vulnerabilities and hotspots;
- What should happen: normative scenarios including backcasting scenarios. These scenarios were used in the vision construction. A desktop study was carried out in...
order to pre-identify three generic visions for the cities based on a literature review (Frantzesskaki et al., 2012; Roorda et al., 2014, 2012; Schäpke and Rauschmayer, 2011; Wittmayer et al., 2011). These were presented during the first SD as a baseline to build a vision for each city typology.

The three generic visions and their elements which served to inspire the stakeholders were:

- A future city that focuses on the environmental improvement. The city with good environmental quality will have:
  
  o Green areas with a minimum of biodiversity;
  o Connections between natural spaces;
  o A good air and water quality;
  o More resilient environment that can better face up climate related risks: healthy ecosystems;
  o Balanced population density depending on the city resources, balanced urban metabolism;
  o Balanced and efficient water management (consumption and water resource) depending to the water availability (water pricing, incentives, industrial regulation, if there is water scarcity problems: use of reservoir capacity management, desalination ...);
  o A sustainable transport system;
  o Efficient energy system based on renewable sources;

- A future city with a more efficient land use and urban planning. A future city with efficient land use and urban planning will have:
  
  o An efficient transport system;
  o Multifunctional spaces;
  o Land uses depending on its ecosystem services and natural, social and economic capital;
  o Adaption to climate change effects: urban design and urban architecture that reduce UHI, heatwaves and heavy rains effects;
  o Urban comfort design: infrastructure, building (materials, forms ...) and urban form characteristics (ventilation pattern);
  o Green infrastructure design and distribution (which increase permeability and better climate regulation);
  o Resilient infrastructures: prepared transport system to face up to a flood event;
o Adapted flood risk areas: building flood barriers, defences, storage;
o Balanced services distribution across the city: neighbourhoods with economic growth, job creation, education services, tourism;
o The safe location of critical infrastructures which are coherent with the spatial management of the territory (airport, energy plant, hospitals, etc.);

• A future city with better governance and social lifestyles. A future city with efficient governance and social lifestyles will have:
  o An efficient communication platform within the society: use of social networks;
  o The social groups will be present and active in governmental decisions related to the development of the city (participation);
  o Strong inter- and intra-institutional relationships: depending on sectors and scales;
  o All dwellings have all basic amenities: solid masonry, appropriately insulated and good quality housing;
  o Strengthened social services: hospitals (number of beds ...), fire-fighters, good emergency mechanisms;
  o Strengthened education systems: higher levels of stores of human knowledge;
  o A strong economy based on the common welfare principle;

• Combinations of the above options.

4.2.3. Backcasting to detect the triggers of change

The previous points helped identify the most relevant guiding principles or elements of the future vision. From this list of principles the next step after the first SD exercise was to identify the factors that allow achieving the vision. For this purpose a backcasting tool was selected to help the identification of the triggers of changes (Giddens, 2009; Vergragt and Quist, 2011). Giddens (2009) suggested backcasting as a sustainable alternative to traditional planning and considers the use of a tool for moving toward alternative futures when dealing with climate change.

A desktop study was carried out prior to the first SD to pre-identify a set of triggers of change based on the literature review. These were presented during the first SD as a baseline to build a list of triggers of change for each city typology.
The pre-identified triggers of change were classified under categories:

- Governance and institutional framework
- Urban planning: spatial urban structure/architecture
- Land use
- Transport system / mobility
- Water management
- Energy system
- Social lifestyle

The first desktop approach to the detection of actual challenges, future vision definition and triggers of change had been described and presented during the SD exercise to inspire the stakeholders (Figure 20). The output of the first SD exercise was a list of triggers of change.

<table>
<thead>
<tr>
<th>Actual challenges</th>
<th>Triggers of changes</th>
<th>Future situation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Demography: elder and young people vulnerability</td>
<td>• Exploitation of social networks, • Investments in health and security</td>
<td>1. An efficient communication platform; strengthened social services</td>
</tr>
<tr>
<td>2. Urban architecture: population density, spatial urban structure.</td>
<td>• Density constraints, urban growth bounds, • New design of urban structure &amp; define architecture rules: balance the population distribution and CI location across the city.</td>
<td>2. Balanced population density; balanced services distribution across the city; or the location of critical infrastructures is safe and coherent</td>
</tr>
<tr>
<td>3. Land use: lack of green areas, soil sealing proportion.</td>
<td>• Safeguarding high value ecosystems, recovery of brownfields, promoting green belts</td>
<td>3. Green areas with a minimum of biodiversity and connected; multifunctional spaces, based on ES</td>
</tr>
<tr>
<td>4. Social aspects: unemployment rate, dwellings lacking basic amenities, health infrastructures.</td>
<td>• Assign budget for rehabilitation of homes</td>
<td>4. All dwellings have all basic amenities; strengthened social services; a strong economy</td>
</tr>
<tr>
<td>5. Economy (GDP); low income households, expenditure of the Municipal Authority per resident.</td>
<td>• Approval of strengthened social services and optimal placement of this CI</td>
<td>5. Strengthened economy based on common welfare</td>
</tr>
<tr>
<td>6. Environment: adaptation to the CC effects (heatwaves, floods, droughts, ...), consumption of water</td>
<td>• Approval of public subsidies and grants to support local entrepreneurs.</td>
<td>6. urban comfort; GI; resilient infrastructure; adapted flood risk areas; efficient water management</td>
</tr>
<tr>
<td>7. Education: proportion of students in higher level</td>
<td>• New design of urban structure &amp; define architecture and infrastructure materials that improve city ventilation and reduce UHI.</td>
<td>7. strengthened education systems</td>
</tr>
<tr>
<td>8. Impacted transport system</td>
<td>• Promote the space for the river policy: ban the settlements across the floodplain of 100 RP (with CC)</td>
<td>8. Sustainable and adapted transport system</td>
</tr>
<tr>
<td>9. Impacted energy system</td>
<td>• Define alternatives for affected transport infrastructures</td>
<td>9. Efficient and adapted energy system</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Urban planning</th>
<th>Governance</th>
<th>Land use</th>
<th>Transport system</th>
<th>Energy system</th>
<th>Social lifestyle</th>
</tr>
</thead>
</table>

Figure 20: A first approach of the detection of actual challenges, future vision definition and triggers of change.

This list defined in the first SD was presented into the second SD to validate, reformulate (e.g. add new ones, remove or change) and rate. For that purpose, participants were given green, yellow, red dots that correspond to highly relevant, somewhat relevant, and
irrelevant. After they had assigned the dots, the facilitator asked them to add new ones and reflect on them. Once the most relevant factors were rated/added, participants were asked to suggest specific indicators-metrics for measuring those triggers of change identified based on the specific city case (the Mediterranean region and the Southern-Central region). After indicators had been identified, participants discussed under which conditions these would become effective and their applicability.
4.3. **Results**

4.3.1. **System analysis**

The main drivers detected during the SD exercise for the Mediterranean cities were the expected increment on $T^0$ and the reduction of precipitation, together with a potential sea level rise. These drivers may have the following impacts on Mediterranean cities: heatwaves, droughts, floods, air pollution and loss of biodiversity. This in turn may affect the health sector (decreasing human comfort and security, increasing health problems and the morbidity and mortality rates). This may not guarantee the universal access of services of general interest and can cause more expensive maintenance and reduced functionality of infrastructures (e.g. transport, mobility, energy security) (Figure 21).

For the Southern-Central cities, the main drivers detected were the expected increase of temperature and winter precipitation, and the decrease of summer precipitation. This could lead to an increase in flood, drought and thermal impacts (heatwaves) with consequences such as: increasing energy use that in turn increases the pressure on resources (not only in energy demand, but also in water availability and quality among others); more expensive maintenance and reduced functionality of infrastructures (transport and mobility, energy security, etc.). These main impacts may possibly cause economy turndown (related to the industrial activities, food supply, tourism, etc.) as well as social conflict and effects on public order (Figure 22).
Figure 21: An impact model for the Mediterranean cities representing the causal structure of vulnerability and risk under climate change.

Figure 22: An impact model for the Southern-Central cities representing the causal structure of vulnerability and risk under climate change.
4.3.2. Vision Construction

In order to transform the previously identified hotspots into positive statements about the future resilient city, a vision was created for each city typology in the SD exercise. Inspired by the three generic visions presented by the facilitator, the stakeholders created a vision for the Mediterranean cities consisted of:

- Biodiversity and ecosystem services optimisation: improve existing biodiversity (re-introduction of species, removing invasive species);
- Resource efficiency;
- Efficient/sustainable water management;
- Efficient energy systems based on renewables;
- Low carbon, green and bio-economy;
- Social equity;
- Early warning systems, monitoring and communication with society;
- Reduced dependency (self-sufficiency);
- Multilevel and community based governance.

For the Southern-Central cities, the created vision consisted of:

- A future city with a more efficient land use and urban planning:
  - Land-use depending on its ecosystem services,
  - Multifunctional spaces,
  - Compact city in an ecological network.
- Protection of critical infrastructures (waste, water, renewable energy, transport, etc.);
- Reduced dependency: mix of central & decentralise solutions;
- Resource efficiency: energy system based on renewables, space, water;
- Strengthened social services;
- Early warning systems (financial resources);
- Multi-level and community based governance. Efficient communication platform with society.

4.3.3. Triggers of change

The triggers of change detected during the first SD exercise were presented in the second SD. The stakeholders confirmed the validity of the triggers of change, added nuances on them, added new ones and even removed one of the them (Table 5, Table 6).
<table>
<thead>
<tr>
<th>M</th>
<th>First SD</th>
<th>Second SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Public decision and political leadership for disruptive innovations and change</td>
<td>Public decision and political leadership for disruptive innovations and change. The leadership must be a long-term commitment.</td>
</tr>
<tr>
<td>2</td>
<td>New regulation and codes, accountability, pricing, taxation, penalties and incentives framework.</td>
<td>Regulation and codes, accountability, pricing, taxation, penalties and incentives framework. It is necessary to transform or update the existing regulation and codes and they need to be implemented incrementally according to proper designed trajectories. In that way the cities will have regulation and codes that take into account the climate change issue and have coherence with and a proper design and implementation.</td>
</tr>
<tr>
<td>3</td>
<td>Education and awareness.</td>
<td>Education and awareness. It is necessary to have transparency and data-information accessibility (open data).</td>
</tr>
<tr>
<td>4</td>
<td>Co-responsibility, increased public-private interface, social participation and new consumption patterns</td>
<td>Co-responsibility, increased public-private interface, social participation and new consumption patterns. These factors need long-term commitment.</td>
</tr>
<tr>
<td>5</td>
<td>Informed, inclusive and adaptive multilevel governance.</td>
<td>Informed, inclusive and adaptive multilevel governance: vertical and cross-sector or horizontal too.</td>
</tr>
<tr>
<td>6</td>
<td>Integrated and adaptive planning and management.</td>
<td>Integrated and adaptive planning and management. This needs a monitoring and evaluation mechanism in place to do a post-evaluation of the decisions that helps in a learning process.</td>
</tr>
<tr>
<td>7</td>
<td>-</td>
<td>Living lab approach for innovation. The central idea is that innovation and business emerges from the experiments. The successful pilot experiments can be scaled up and replicated in other places. Nevertheless there are some doubts related to the methods used, more developments and/or standard approaches are needed.</td>
</tr>
<tr>
<td>8</td>
<td>-</td>
<td>The new factor detected by the stakeholders is the learning from previous disasters. The probability of a transition depends on factors like flood, storm or heat wave frequency or duration. Therefore, the transition factor will be defined by the number of events occurred and the severity.</td>
</tr>
</tbody>
</table>

Table 5: triggers of change identified in the first SD and reviewed in the second SD. Mediterranean region.
regulations

2 Climate proofing, improve resilience

Climate proofing, improve resilience. This is a goal more than a trigger of change. Therefore this factor was removed from the list.

3 Better exploit benefits, promote services and green jobs

Better exploit benefits, promote services and green jobs. Accepted as valid.

4 New regulation and codes, pricing, taxation and incentives framework: assign a price to the ecosystem services

New regulation and codes, pricing, taxation and incentives framework: assign a price to the ecosystem services. More than create new ones, the stakeholders proposed to adapt the existing ones.

5 Co-responsibility, increased public-private interface, social participation

Co-responsibility, increased public-private interface, social participation. These were accepted as valid.

6 Adaptive multilevel governance

Adaptive multilevel governance: the stakeholders detected the need to learn working with uncertainty (cost-benefit tools, among other) and long-term vision.
- Horizontal and vertical governance, need to improve relationships.

7 Change the working culture within the administration (through workshops, training) to include daily commitment to the resilience and climate change concepts in urban planning and promoting transversality (instead of a pyramidal culture).

8 Increase the motivation: administration, companies ...

Table 6: triggers of change identified in the first SD and reviewed in the second SD. Southern-Central Europe.

The stakeholders highlighted some important key factors to be considered in the transition process: leadership (it is important to have public consent and political leadership in order to have disruptive innovations and change), education and awareness (going beyond the efficient communication platform), increased public-private interface and social participation, and last but not least adaptive multilevel governance (going beyond adaptive planning).

In Table 7, the rankings of the triggers of change are presented. The triggers of change with the highest scoring were pooled into 3 groups depending on their relevance (in decreasing order).
## Table 7: Triggers of change identified in the first SD and reviewed in the second SD. Southern-Central Europe.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mediterranean region</th>
<th>Southern-Central Europe</th>
</tr>
</thead>
</table>
| 1     | Public decision and political leadership; regulation and codes, accountability, pricing, taxation, penalties and incentives framework; and learning from disasters | Adaptive multilevel governance: learn to work with uncertainty (cost-benefit tools) and long-term vision.  
- Horizontal and vertical (improved relationships) governance. |
| 2     | Education and awareness; co-responsibility, increased public-private interface, social participation and new consumption patterns; and living lab approach for innovation | Change the culture within the administration (through workshops, training). Included in the cities day to day work the resilience and climate change concepts in urban planning, and promote the transversality (differ from the pyramidal structure) |
| 3     | Informed, inclusive and adaptive multilevel governance; integrated and adaptive planning and management | Treat climate change holistically. |

The metrics proposed and discussed in the SD are showed in the following figures (Figure 23 and Figure 24).

**Drivers and factors**
- Public decision and political leadership for disruptive innovations and change
- Regulation and codes, accountability, pricing, taxation, penalties and incentives framework.
- Education and awareness.
- Co-responsibility, increased public-private interface, social participation and new consumption patterns
- Informed, inclusive and adaptive multilevel governance.
- Integrated and adaptive planning and management.
- Living lab approach for innovation.
- Learning from disasters

**Metrics / Indicators:**
- Yes/no: creation of a central administration body officially in charge of adaptation policy making; Statements of leadership; Written vision/strategy including CC
- Budget allocated (incentives) to promote investments in risk prevention
- Yes/no: municipal requirements to implement green/blue infrastructures in new buildings or regenerated areas; developed guidelines
- Creation of a resilient building certification / set directives
- Set revisions of regulations
- Yes/no: Adaptation relevant data and information is available (e.g. through a dedicated website or other comparable means).
- Nº of: Capacity building activities take place; Nº of education and training materials on CC adaptation concepts created
- Creation of the Science-policy interfaces; Nº of workshops, consultation Forum; Nº of citizens engaged in
- Yes/no: Horizontal (i.e. sectoral) coordination mechanisms exist within the governance system, with division of responsibilities
- Yes/no: Vertical (i.e. across levels of administration) coordination mechanisms exist. Participation/membership
- Yes/no or Nº: of plans that include CC;
- Monitoring & evaluation mechanisms in place
- Yes/no: Key land use and resource management planning policies take into account the impacts of climate change
- Nº of Demonstration projects promoted at local level that include risk & vulnerability assessment CC, identification of adaptation options + implementation, monitoring & evaluation
- “Stress test”, based on previous events

*Figure 23: Proposed metrics and indicators for the triggers of change of the Mediterranean region.*
In order to apply these triggers of change in practice the stakeholders listed the following issues as key for the applicability and success of the concepts previously defined:

**Long-term vision.** It is necessary to have a clear idea of the purpose of the measure (of the transition factors) in order to find the real applicability and use of the results.

**Effective benchmarking.** It is important to define comparable transition factors. The task of measuring transition factors is challenging in particular for outcome-based indicators or metrics. Having universal metrics for adaptation like in mitigation is challenging from different points of view as it is reflected in the Table 8.
Economic view

Ex-ante identification of promising projects; ex-post monitoring (Noble, 2008), ex-post corrections/adjustment (Hinkel, 2008), and potentially for allocation of funds (Butzengeiger-Geyer et al., 2011)

Measurement of indicators is uncertain (Hinkel, 2008; Hallegatte et al., 2011), important metrics are qualitative.

Table 8: Opportunities and challenges of having universal metrics in transition field (adapted from Stadelmann et al., 2014)

As argued in the text above, developing common units for transition factors seems to be needed in order to be able to compare between cities. Nevertheless, it is not only a question of the metrics, but also the processes used for acquiring these transition metrics. Consequently it is important to not only define the metric or indicator, but also to develop a common unit and define a common process for the measurement.

Acquiring skilled expertise. The people involved in the climate change adaptation issues in cities need knowledge and expertise in the field. It is possible to train the staff but the most important thing to have is a common understanding of the transition concept, approach and the available methods and tools to support the study.

Maximising synergies with existing monitoring. The need for city follow-up and monitoring is clear. Therefore, it is important to take into account the existing monitoring efforts to date and maximise synergies in order to avoid having a fragmented monitoring system.
4.4. Conclusions

In this section, the SD outputs will be discussed in context with statements from various authors in the literature. Additionally, pertinent information from the literature related to the key issues mentioned by the stakeholders will be presented.

The stakeholders detected the need for a long-term vision as a key issue during the SD. Even when drafting short-term plans cities need to have a long-term vision. Cities need to plan according to principles that define their development, and these include long-term targets. In order to ensure that the long and the short-term targets are complimentary, regulations should be incrementally upgraded to factor in adaptation and resilience priorities. For this, cities should strive to make long-term commitments even in the face of volatile short-term political coalitions. In order to achieve this, cities can stipulate long-term partnerships with different actors and initiatives (Haasnoot et al., 2013; Klein et al., 2014; Shaw et al., 2014; Smit and Pilifosova, 2003).

Transition is a very broad concept and this makes it difficult to define precise transition factors. In the present deliverable we identified some transition factors, but it is advisable to develop the case studies further in order to identify context specific transition factors (the RAMSES project-task 8.3) and to further the development of the transition conceptual framework (task 8.2).

In summary, some of the transition factors identified in this work and their metrics are presented in the following paragraphs:

As we saw in the result section, there is not a unique transition factor for a city. What the cities need is to push to a resilient and staged adaptation considering all the phases and sub-processes (understanding, planning and managing). One key issue to consider is that effective and efficient action in response to climate change at the local level is facing many obstacles, despite increasing levels of awareness of the causes and potential impacts of this complex and uncertain phenomenon. Many of these obstacles are institutional in origin, and include regulatory, structural, behavioural, cultural, and contextual factors (Burch, 2010). Moser and Ekstrom (2010) identify potential barriers in each phase throughout the adaptation process (which are very much in line with the once identified by Burch, 2010). The triggers of change or transition factors should be aligned with the obstacles detected for each phase of the adaptation process. That will
allow the success of effective and efficient actions and will help move the socio-ecological and socio-technical system to a resilient and adapted stage.

The triggers of change that enable overcoming barriers, allow success of implemented action and help move the socio-ecological and socio-technical system to a resilient and adapted stage can be presented in three main groups prioritised by the stakeholders:

**Group 1:**
- **Authority and political leadership** for disruptive innovations and change. This must be a long-term commitment (Burch et al., 2014). This is a common barrier and can be critical at any stage in the adaptation process but maybe most important in initiating the process and sustaining momentum over time. When there is no mandate, law, job description, or public demand for adaptation planning, leaders are required to initiate the process. Leaders vary in the quality of guidance, motivation, and vision they provide. Those who demonstrate high skill levels (e.g., in communication, facilitation, and elicitation) and strong qualities of integrity (e.g., dedication and openness to the issue, the process and the solution options, self-reflexivity, humility, creativity, transparency, honesty) tend to be trusted more by participants and perceived as legitimate (Moser and Ekstrom, 2010). As an example, many communities in British Columbia have demonstrated leadership on climate change (Shaw et al., 2014).
- **Regulation and codes, accountability, pricing, taxation, penalties and incentives framework.** Accountability, legality and procedural feasibility are common barriers throughout the stages of the Managing phase (i.e. implementing options and sub processes). The implementation of an option must be legal and feasible within existing policies, laws, rules, regulations, programs, and mandates unless the selected strategy is to change a law or process (Kenny et al., 2014; Moser and Ekstrom, 2010)
- **Learning from disasters.** There is the issue of deeply held values and beliefs that influence how people perceive, interpret, and think about risks and their management, what information and knowledge they value, what concerns have standing and so on. Individuals look at new problems, tasks, and solutions through the lens of their pre-existing values, preferences, beliefs, norms, and experiences (Moser and Ekstrom, 2010)
Group 2:

- **Education and awareness**: availability, accessibility and ability to use data. These are common barriers in the stages of the Understanding and Planning phases of the adaptation process (i.e. gathers information and assesses options and sub processes). A growing body of literature highlights the importance of effective communication of climate change information to increase awareness and understanding, provide continuity, and constructively engage policy-makers, stakeholders, and the public. Information-related barriers have to do with whether, which, and how information is created, how it is communicated, and who delivers and receives it. Misunderstood information, unintended interpretation of conveyed information, complete lack or insufficient frequency or content of communication can severely interrupt or derail social interactions among those involved in the adaptation process (Kenny et al., 2014; Moser and Ekstrom, 2010);

- **Co-responsibility, increased public-private interface, social participation** (Burch et al., 2014; Kenny et al., 2014). These are common barriers throughout the stages of the Managing phase (implement options and sub processes) (Moser and Ekstrom, 2010). Behavioural barriers are especially critical to local action. Contemporary changes in policy and behaviour of societal sectors are often induced by coercion, voluntary agreements, societal pressure, financial stimuli, and market stimuli but although these forces have been found to stimulate changes, it is not clear that, without facilitation, the altered behaviour will be sustained or become the dominant mode of action. The ability to overcome the challenges of inertia need to be promoted and the importance of providing opportunities for iterative, collaborative partnerships between municipal practitioners and climate change response experts need to be revealed. For change to occur that addresses a highly complex and pervasive issue like climate change, it “must be recognized as necessary, feasible, and advantageous to consider a broader range of actors and institutions” than are involved in traditional decision-making (Burch, 2010; Kenny et al., 2014). Participatory processes are an important means by which these claims of feasibility and advantageousness may be established, with the goal of overcoming or adapting to a path dependent on social and institutional processes.

- **Living lab approach for innovation**. The availability of technology as a social tool and to increase the adaptive capacity of the cities can be a common barrier. The successful pilot experiments can be scaled up and replicated in other places.
Group 3:

- **Informed, inclusive and adaptive multilevel governance.** The implementation of actions is influenced in important ways by the governance and larger social context, in part through its impact on the actor’s perception, freedom, and capacity to do so (Moser and Ekstrom, 2010). Municipalities are often not empowered to implement critical climate change strategies, and must instead wait for key pieces of legislation to pass at higher levels of government (Burch, 2010). Adaptive multilevel governance can help overcoming these barriers.

- **Integrated and adaptive planning and management** (Burch et al., 2014). Adaptation is likely to be implemented only if it is consistent with programs designed to cope with non-climatic stresses. Effective mitigation actions are likely to be those that are fully integrated into general policy strategies. Therefore, isolating climate change responses in an organizational or policy sense is unlikely to yield the depth or scale of transformation required to produce truly resilient, carbon neutral communities. This integration, however, is not just a matter of encouraging the emergence of champions throughout the organization. Instead, climate change action must eventually become more independent of personality and political will that may render it fragile in the long run (Burch, 2010). A sustainability approach may provide a level of integration with existing policies, plans and priorities (Shaw et al., 2014). Moreover, the existence of a monitoring plan is a common barrier in the stages of the Managing phase (monitor outcomes and environment sub processes). For adaptive management, mechanisms have to be put in place to allow monitoring and periodic evaluation of the changing environment and the outcomes of the implemented option. A range of barriers have arisen in the past in various adaptive management experiments. Lack of agreement on indicators, relevant data, methods, and expertise can undermine assessing outcomes and success as well as involve varying degrees of reception by decision-makers and their constituents (Moser and Ekstrom, 2010). The cities of Vancouver, Surrey, Victoria, and others have implemented systems of monitoring and verification, of varying levels of rigour and breadth (Burch et al., 2014).

The exercises undertaken allowed the collection of stakeholders’ first impressions and opinions regarding the usefulness of these concepts:

- The models and the science can explain part of the reality related to climate drivers and impacts, but this information must be verified and validated with stakeholders. The stakeholders consider their development of an impact chain a positive exercise.
• The stakeholders identify as crucial the vision creation which must be aligned with the local governance and in the same time with the climate issue.
• The stakeholders remarked the importance of facilitating the implementation of adaptation actions and the need to push the adaptation process.
• For triggers of change to be accurate, definitions of enablers and barriers should be clear.
5. General Conclusions

Currently the adaptation plans have no clear link with implementation. This is due to a diversity of limitations and barriers relating to human behaviour and governance. The city needs to focus on enabling decision makers to make the difficult and urgent choices between a range of alternative policy and management options in interconnected social and natural systems. And for that they need a clear definition of the adaptation process in which the development of each phase of the process must be facilitated.

The present work has detected the main barriers and obstacles that must be overcome in order to push the city to resilience and climate adaptation. The involvement of the city stakeholders in climate change adaptation planning is essential for further implementation.

The data gathered in this research, combined with the literature review in transition and climate adaptation communities has allowed the definition of an integrated conceptual framework for transition which can serve to the cities to meet the transition goal:

- System map: where the impacts on the urban system are analysed and the key problems are detected and the normative scenario is created- also called desirable futures, visions, or future visions. In this phase sciences meets the policy in order to build a vision aligned with the local knowledge and governance;
- Selecting adaptation options: where the pre-identified adaptation options that act against the detected problems are characterised, assessed and prioritised. This phase must be conducted by methods and tools proposed by experts and validated by local stakeholders (selection of prioritisation method, selection of criteria, weighting and scoring).
- Planning and implementing: where “how”, “when” and by “whom” is defined through an adaptation pathway approach, the identification of the triggers of change or enablers for the transition and the definition of the monitoring. This phase is of great importance for the stakeholders

Regardless which adaptation approach is selected (incremental, transition or transformative), the cities need to be involved into the adaptation process (system map, planning and managing) depending on the current state of the city.
Moreover, the cities must decide on the purpose of adaptation. In this sense, three options might be possible: to adjust the system to the new conditions (incremental); to reduce the social and political vulnerability altering the rules and decision-making processes (but keeping the norms and principles that governed the rules) (transition); or to reduce the vulnerability through a political regime shift that will change the existing system altogether (transformation). The scientific community suggests interactions between incremental and transformational adaptation and have discussed the pathways by which actors can transition from one to the other. At the end, the key difference between adaptation approaches thereby lies in the extent of change and that must be a city decision or commitment.

The city’s commitment needs to be linked with a long-term vision (even when drafting short-term plans) and must have public approval and political leadership (with high skill levels and strong qualities of integrity). In order to align long- and the short-term visions, actions should be planned and implemented with mainstreaming into actual policies. In order to achieve this, cities can stipulate long-term partnerships with different actors and initiatives. Moreover, the implementation of the adaptation options must be legal and feasible within the existing policy context.

There is however the issue of deeply held values and beliefs that influence how people perceive, interpret, and think about risks and their management. Therefore, it is crucial to work with enablers for behaviour change. There a several enablers that have impact in the behaviour that the adaptation process must take into consideration (remove barriers, make it available, affordable and accessible; consider the social norms and engage people; and make it attractive through incentives among others).

The society is therefore part of the transition processes and must be considered as such, not only a passive receptor of measures but also as an active part of the adaptation process. For example, the use of technology as a social tool to gather information from citizens and to trigger innovative and co-creational thinking can represent an opportunity for accelerating transitions.

In addition, a successful transition towards resilience must be cross-sectoral and cut across vertical levels of government. Metropolitan and regional authorities should be involved in the transition process. As mentioned before, this must be done together with a cultural change in how hierarchies are understood and competencies divided. Leveraging a transition by integrating patterns with different levels of government can
build momentum for the creation of a vision in cities and foster innovative cooperation patterns.

All these remarks make the difference between a successful transition and a failed process. The next question therefore will be detecting the barriers linked to each phase of the adaptation process and facilitating the translation of existing capacity into action. And last but not least city transitions call for innovative ways of measuring progress. Transitions cannot be measured by usual quantitative indicators. Cities should therefore define process indicators that they deem suitable to evaluate transitional journeys starting from their guiding principles. These indicators can give an appreciation of how integrated, flexible and adaptive the city transition process is.

A sustainability approach opens up the possibility of framing climate change in a way that resonates with local political priorities, ensuring traction with the public and potentially more effective collaboration on a diverse and inter-disciplinary set of issues.
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Annex I: Typologies of climate change regions and system analysis for the first SD

Typologies of climate change regions (European Environment Agency, 2012a)

The analysis of European patterns of climate change has led to a typology of climate change regions derived from a cluster analysis. Based on the exposure indicators 5 different types of regions according to their climate change profile have been identified.

The most prominent climate change characteristics in each of these regions are summarised in Table 9. This table shows on the one hand that every chosen stimulus is important for describing the main characteristics of a least one type of region.

<table>
<thead>
<tr>
<th>Cluster/stimuli</th>
<th>Northern-central Europe</th>
<th>Northern-western Europe</th>
<th>Northern Europe</th>
<th>Southern-central Europe</th>
<th>Mediterranean Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in annual mean temperature</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Decrease in number of frost days</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Change in annual mean number of summer days</td>
<td>+</td>
<td>+</td>
<td>0</td>
<td>++</td>
<td>--</td>
</tr>
<tr>
<td>Relative change in annual mean precipitation in winter months</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>0</td>
<td>--</td>
</tr>
<tr>
<td>Relative change in annual mean precipitation in summer months</td>
<td>--</td>
<td>--</td>
<td>0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Change in annual mean number of days with heavy rainfall</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>0</td>
<td>--</td>
</tr>
<tr>
<td>Relative change in annual mean evaporation</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>--</td>
</tr>
<tr>
<td>Change in annual mean number of days with snow cover CDSC</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Key:
++ Strong increase
+ Increase
o insignificant stimulus for the characterisation of the cluster
- Decrease
-- Strong decrease

Table 9 (Annex I): Different types of regions characterised by climate change based on cluster analysis

A strong increase in annual mean temperature is observable for three clusters, namely ‘Northern Europe’, ‘Southern central Europe’ and ‘Mediterranean region’. Strong decreases in number of frost days predominantly characterise the clusters of ‘Northern central Europe’, ‘Northern Europe’ and ‘Southern central Europe’ whereas strong increases in annual mean number of summer days is projected for the clusters of
‘Southern central Europe’ and ‘Mediterranean region’. Concerning change in precipitation in winter months the ‘Northern Europe’ cluster shows particularly strong increases while for summer months most significant changes in terms of strong decrease can be observed in ‘Southern central Europe’ and ‘Mediterranean region’ clusters. The variables heavy rainfall and evaporation do not show very strong changes for any of the clusters while days snow cover are projected to decrease strongly in the ‘Northern central Europe’ cluster.

The results seem plausible as main topographic characteristics are well covered (such as Alps, Carpathians, Balkan, Pyrenees, Apennines) and underline the validity of the derived typology at least from a pan-European perspective. On the regional level the case studies conducted within this research project will contribute further to local variations of climate change providing more insights to the validity of the developed typology (Figure 25).

It has to be emphasised that these clusters do not constitute ‘climate clusters’, but ‘climate change clusters’, i.e. each cluster consists of regions that are similar in regard to the changes of the climatic stimuli as presented in the previous pages. Furthermore, the names of these clusters only serve the heuristic purpose of providing easy to understand and easily distinguishable labels. As such they should not be considered as completely accurate in a geographical sense (European Environment Agency, 2012a).
System analysis

EXPOSURE

Description of the 3 climate change regions in relation to the exposure indicators (Table 10):

1. Northern-Western Europe (Antwerp, Rotterdam, London and Amsterdam). On the one hand this region is characterised by rainy winters, expected increase in heavy rains and extreme discharge and increase in exposure to coastal flooding...
(except London) that led to a situation where the flood risks are expected to increase. On the other, it is expected a drier summer and a higher water stress.

2. Southern-Central Europe (Dresden, Bratislava and Sfântu Gheorghe). This region is characterised by rainy winters with a slight decrease of heavy rains together with an increase on number of days with snow cover. For 2 of the cities it is expected an increase on river discharge except for Sfântu Gheorghe that expect a decrease. On the other, this region expects warmer temperatures and increase of heatwaves together with a drier summer.

3. Mediterranean region (Burgas, Barcelona and Gibraltar). This region is characterised by warmer climate, heatwave episodes and strong decrease on summer precipitation. On the other, the sea level rise can influence the cities of this region.
Table 10 (Annex I): Exposure to climate change. Note: the data presented has a regional scale (25km resolution), so the data for the cities are provided for guidance only. $T^\circ=$temperature, $pp=$precipitation.

<table>
<thead>
<tr>
<th>City</th>
<th>Change in annual mean $T^\circ$ $(2071-2100)$ (K)</th>
<th>Decrease in winter $T^\circ$ $(2071-2100)$ (K)</th>
<th>Change in nº of hot days/ warm nights</th>
<th>Change in mean winter pp $(2071-2100)$ (%)</th>
<th>Change in nº of heavy rainfall days</th>
<th>Summer water stress (WEI) (for 2050, EcF)</th>
<th>Chang e in nº of days with snow cover</th>
<th>Change in river extreme discharge (%)</th>
<th>Change in exposure to coastal flooding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antwerp</td>
<td>0.9</td>
<td>1.4</td>
<td>2</td>
<td>+35</td>
<td>-30</td>
<td>1.1/5 Medium</td>
<td>10-1</td>
<td>+10</td>
<td>Medium (3mm/Year)</td>
</tr>
<tr>
<td>Rotterdam</td>
<td>0.9</td>
<td>1.8</td>
<td>2</td>
<td>+40</td>
<td>-25</td>
<td>1.1/5 Low</td>
<td>0</td>
<td>+40</td>
<td>Highest (3mm/Year)</td>
</tr>
<tr>
<td>London</td>
<td>0.9</td>
<td>1.4</td>
<td>NoDat</td>
<td>+35</td>
<td>-30</td>
<td>1.1/5 Severe</td>
<td>10-1</td>
<td>+20</td>
<td>No</td>
</tr>
<tr>
<td>Amsterdam</td>
<td>0.9</td>
<td>1.8</td>
<td>NoDat</td>
<td>+40</td>
<td>-25</td>
<td>1.1/5 Severe</td>
<td>0</td>
<td>+10</td>
<td>Highest (3.5 mm/year)</td>
</tr>
<tr>
<td>Dresden</td>
<td>3</td>
<td>2.8</td>
<td>2</td>
<td>+20</td>
<td>-15</td>
<td>-0.9/1 Medium</td>
<td>10-20</td>
<td>+20</td>
<td>No</td>
</tr>
<tr>
<td>Bratislava</td>
<td>3</td>
<td>1.8</td>
<td>22-26</td>
<td>+45</td>
<td>-20</td>
<td>-0.9/1 Low</td>
<td>10-20</td>
<td>+10</td>
<td>No</td>
</tr>
<tr>
<td>Sfantu Gheorghe</td>
<td>3</td>
<td>1.8</td>
<td>22</td>
<td>+45</td>
<td>-30</td>
<td>-0.9/1 Medium</td>
<td>20-40</td>
<td>-10/-20</td>
<td>No</td>
</tr>
<tr>
<td>Burgas</td>
<td>3</td>
<td>1.8</td>
<td>50</td>
<td>+15</td>
<td>-45</td>
<td>-0.9/1 Low</td>
<td>10-1</td>
<td>+5/+10</td>
<td>Marginal (2.5mm/year)</td>
</tr>
<tr>
<td>Barcelona</td>
<td>3</td>
<td>1.4</td>
<td>50</td>
<td>+15</td>
<td>-40</td>
<td>-4.9/-1 Medium</td>
<td>0</td>
<td>-10</td>
<td>Marginal (2mm/year)</td>
</tr>
<tr>
<td>Gibraltar</td>
<td>2</td>
<td>1</td>
<td>42</td>
<td>-15</td>
<td>-30</td>
<td>-4.9/-1 Low</td>
<td>0</td>
<td>Marginal (2mm/year)</td>
<td></td>
</tr>
</tbody>
</table>

Table 10 (Annex I): Exposure to climate change. Note: the data presented has a regional scale (25km resolution), so the data for the cities are provided for guidance only. $T^\circ=$temperature, $pp=$precipitation.

SENSITIVITY

Five sensitivity dimensions were identified (Table 11) in the ESPON Climate Project: cultural, economic, environmental, physical and social sensitivity. In the following table the regions that belongs the cities are presented through the 5 dimensions.

<table>
<thead>
<tr>
<th>Cultural</th>
<th>Economic</th>
<th>Environmental</th>
<th>Physical</th>
<th>Social</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern-Antwerp</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
<td>Very</td>
</tr>
</tbody>
</table>

5 [http://discomap.eea.europa.eu/arcgis/rest/services/ClimateAdapt](http://discomap.eea.europa.eu/arcgis/rest/services/ClimateAdapt)
Table 11 (Annex I): Sensitivity to Climate Change. Note: the data presented has a regional scale (25km resolution), so the data for the cities are provided for guidance only.

The cities that belong to the CC region Northern-western Europe presents more sensitivity comparing to the rest of regions (except for the region of London). The Mediterranean region, presents economic, environmental and social sensitivity. Finally, for the Southern-central Europe the most sensible dimension is the Environmental one.

Unfortunately, this regional information does not provide enough accuracy to evaluate the city vulnerability.

In this sense, it will consider the urban vulnerability indicators to have a better diagnosis (Jacobs et al., 2012) (Table 12).

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7 ESPON Climate Project
Table 12 (Annex I): Sensitivity to climate change, according to the variables listed in Jacobs et al. (2012). The data have been consulted in Urban Audit database.

The cities that belong to the **Northern-Western Europe** present an elevated sensitivity due to a high population density, a considerable percentage of low-income households and not very high percentage of green urban areas. A brief comment on the Antwerp city, it presents the highest ratio related to the demographic dependency and with highest percentages of vulnerable population: more than 40% of the population with more than 65 years and more than 25% with less than 14 years old. People over 65 years old and less than 14 years old are more sensitive to natural risks, such as the heatwaves, pluvial floods, fluvial floods, coastal floods, etc. Two of the cities have high water use per capita (Antwerp and Amsterdam), this makes them more sensitive in a water stress condition.

The cities that belong to the **Southern-Central Europe** has less sensitivity than the rest of the regions in relation to the share of green urban areas, with more than a half of the area covered with green elements, making the cities less sensitive to heatwaves and rainy winters. Nevertheless, it will be important to know the distribution of these green areas.

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8 http://eea.maps.arcgis.com/home/webmap/viewer.html?webmap=d4124af689f14c8d82bb815ae81d76&extent= -10.5451,34.4066,34.8944,58.4419#
9 Data from 2001
since the most important is to have a mosaic land with spatially distributed patches, or at least these areas must be located in areas with runoff and heat problems.

These cities have not population density problems but they may have a demographic dependency, with a relative high percentage of elder, being this part of populations more sensitive to CC effects, such as heatwaves and flood events.

A brief comment on Bratislava city, it has a quite high water use per capita and this do the city more sensitive to expected drier summers.

Finally, the cities that belong to the Mediterranean region are sensitive to heatwaves due to a low percentage of green areas (for both cities) and high population density (in case of Barcelona), which makes the city more susceptible to have UHI problems. Moreover, Barcelona has sensitivity problems in relation with heatwaves and sea level rise due to its high percentage of elder.

The high water use per capita of Burgas makes this city more sensitive to the expected drier summers.

**RESPONSE CAPACITY:**

The assessment of the response capacity to climate change is also analysed taking into account the urban vulnerability indicators describes into the ETC CCA work (Jacobs et al., 2012). For this study only a few set of indicators has been selected depending the data availability (present in Urban Audit database) (Table 13).
Table 13 (Annex I): Response capacity to climate change, according to the variables listed in Jacobs et al. (2012). The data have been consulted in Urban Audit database\footnote{http://www.urbanaudit.org/DataAccessed.aspx}. ISCED level 3-4: upper and further education.

<table>
<thead>
<tr>
<th>region</th>
<th>Barcelona</th>
<th>Gibraltar</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>31.04</td>
<td>NoData</td>
</tr>
<tr>
<td></td>
<td>27905.8</td>
<td>NoData</td>
</tr>
<tr>
<td></td>
<td>981.68</td>
<td>NoData</td>
</tr>
<tr>
<td></td>
<td>0.2</td>
<td>NoData</td>
</tr>
<tr>
<td></td>
<td>5.46</td>
<td>NoData</td>
</tr>
<tr>
<td></td>
<td>10.85</td>
<td>NoData</td>
</tr>
</tbody>
</table>

The cities that belong to the **Northern-Western Europe** present a high response capacity due to the GDP per head and due to the annual expenditure of the municipal authority per resident. But, these cities need to strengthen the proportion of the population with higher education, the dwellings lacking basic amenities (especially on London) and the number of hospital beds to be prepared for extreme events.

In case of cities that belong to the **Southern-Central Europe**, they have a greater adaptive capacity due to the higher levels of stores of human knowledge and due to an higher number of hospital beds in case of Dresden, but they have work to do in relation to: increasing the GDP of Bratislava and the annual expenditure of the municipal authority per resident, even decreasing the unemployment rate of Dresden.

Finally, the cities that belong to the **Mediterranean** region, presents different realities. Whereas Barcelona has a quite good rate of GDP per head and low proportion of dwellings lacking basic amenities, it has to strengthen the percentage of students with higher level, increase the annual expenditure of the municipal authority per resident and decrease the unemployment rate. While Burgas has high levels of stores of human knowledge, it has to work on strengthen the GDP per head of the population and decrease the proportion of dwellings lacking basic amenities.