State of the Art Report (1)
Resilience, Adaptation and Disaster Risk Reduction
concepts, definitions and application

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<td>Hypatia Nassopoulos, Maxime Ehret, Marc Vuillet, Jean Marie Cariollet, Morgane Colombert, Youssef Diab</td>
</tr>
<tr>
<td>Co-author(s)</td>
<td></td>
</tr>
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**CONTACT:**

Email: resin@tno.nl  
Website: www.resin-cities.eu
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List of acronyms

ACC: Adaptation to Climate Change
DRR: Disaster Risk Reduction
GHG: Green House Gases
CC: Climate Change
SD: Sustainable Development
Executive Summary

In 2050, 66% of world’s population will live in urban areas. Given that currently cities have the highest socioeconomic activities concentration, CC becomes an extra challenge to be handled through adaptation strategies development and resilience strengthening. Here, you will find a review of climate change adaptation (ACC), resilience and disaster risk reduction (DRR) definitions, to identify the most appropriate ones within the frame of the RESIN project.

Following our review, risk, a major issue of concern since its beginning, can be defined following the 5th IPCC report, as the potential for consequences, where something of value is at stake and where the outcome is uncertain. ACC, an issue of concern notably since the Rio conference in 1992, can be defined as a process that comprises implementation of actions to withstand CC impacts and ensure the same level of performance for infrastructures. DRR research communities, since the Yokohama report1 in 1994, have focused upon reducing risks through systematic efforts to reduce the causal factors that result in disasters. Reducing exposure to hazards, lessening vulnerability of people and property, wise management of land and the environment, and improving preparedness and early warning for adverse events are all examples of disaster risk reduction. Last, resilience is a much vaguer concept and its definition has evolved – and is still evolving – over the years. Resilience thinking has gained momentum since the Katrina disaster in 2005 (Johnson, 2006). According to the DRR Huogo Protocol in 2005 and the UN conference on DRR, resilience can be defined as the ability to function, survive and thrive to any stress. It should also include the ability to maintain critical infrastructures’ operations/ functions in the face of crises, to skillfully prepare for, respond to, and manage a crisis or disruption. Finally, it should include the ability to return to and/or reconstitute quickly normal operations and possibly bounce back to better ones.

This review understands ACC and DRR as a set of actions and recommendations. Resilience, on the other hand, is recognized as a paradigm concept. A glossary is provided in Section 7 with suggested definitions for the RESIN project.

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1 The report was realized following the World Conference on Natural Disaster Reduction. The Conference was held in May 1994 in Yokohama, Japan. Within this report we can find: guidelines on prevention, preparedness and mitigation of natural disasters, as well as guidelines on the principles of action plans. Last, this report includes information on debates held during the Conference, decisions adopted and actions taken, leading to the adoption of the report.
1. Cities and Climate Change (CC)

By 2050, due to the expected increasing levels of urbanization, 66% of world’s population will live in urban areas (WHO, 2014). The trend towards densification has resulted in more cities as well as an increasing number of megacities (United Nations, 2015). Given that cities concentrate people, economic activities, built environments and other assets (The World Bank, 2011), climate change (CC) poses significant issues in terms of the way that the specificities of urban environments may exacerbate the effects of climate change; the urban heat island is an oft-cited example. CC thus becomes an extra challenge against that cities will have to address.

There is a consensus that the global climate is changing and will continue to change (IPCC, 2014), mainly due to the concentration of greenhouse gases (GHG), leading to serious socioeconomic and ecological impacts such as ice reduction, sea level rise, alteration of hydrological systems and decreasing agricultural production (EEA, 2012). Climate change will affect regions and sectors differently. For example, impacts over Europe will be modest until 2050. These impacts will accentuate after 2100 with more frequent and intense extreme events. Such weather and climate hazards are dealt in a separate report for the RESIN project (Carter 2015). Climate change will have significant consequences on sectors such as health and water (Smith, 1997; Staub et al., 2012). Adaptation becomes increasingly important and could be initiated through a range of diverse approaches (e.g. centralized/non centralized, on-site/offsite, top-down/bottom-up, soft/hard, demand side/supply-side). Critical infrastructures, such as the energy sector, will need to undergo significant structural transformations until 2100 in order to adapt to CC (Aaheim et al., 2013). This implies, among others, two challenges: a) a gradual transition to a low carbon energy system in the midterm, with possibly a greater reliance on fossil fuels that the long term and b) a high degree of climate variability in the long term including both intensity and frequency of changes.

In Europe, the European Commission (EC) (2015) has adopted the ‘European Adaptation Strategy’ with an obligation to all Member States to adopt national plans to cope with the inevitable CC impacts by 2017. Many EU members have already developed national strategies (e.g. Denmark, Finland, Spain and the UK.) (Swart et al., 2013; Biesbroek et al., 2010). Additionally, in 2012, the EC presented ‘The EU Approach to Resilience: Learning from food crises’, which provided policy principles for action to help vulnerable communities in crises-prone areas. In 2013, the ‘Action Plan for Resilience in Crisis Prone Countries 2013-2020’ laid the foundations for more effective EU collaborative actions on building resilience. Countries, such as the UK, developed separate national resilience plans, but others, such as Denmark, resilience is included in their national adaptation strategies.

The IPCC’s Fifth Assessment Report (AR5) suggests that mainstreaming mitigation, adaptation and resilience policies within sustainable development is an emerging issue. Indeed, the IPCC highlights the importance of climate-resilient pathways and development trajectories, combining adaptation and mitigation, to achieve sustainable development (SD) goals. Adaptation and mitigation can either assist or impede SD, which in turn can assist or impede CC responses. These links emphasize that SD and CC strategies are highly
interactive. Thus, climate-resilient pathways can assist SD within a CC context, possibly requiring important transformations. These transformations can be realized through necessary steps to reduce CC vulnerability, to build capacity to increase available options, to cope with unexpected threats and to revisit risk reduction responses based on continuous learning (IPCC, 2014, p. 1104, 1109). The IPCC also states that CC responses can indeed contribute to climate-resilient development pathways, yet since some key resilience elements lie within SD implementation, resilience can be more or less achievable.
2. Method

The aim of this report is to focus on the definitions of these key terms: Adaptation to Climate Change, Resilience and Disaster Risk Reduction. To do that, our work was organized in the following way.

- First we have undertaken an extensive literature analysis of scientific and non-scientific documents, in order to identify the generic definitions, not only of the key terms of this report (ACC, Resilience, DRR) but also definitions of the associated concepts often used to consolidate and refine the definitions of the key terms and characterize them.

- In addition, another objective of our review was to identify efforts made within the frame of various disciplines (social sciences, economics, engineering etc.) and sectors (energy, infrastructures, health, tourism etc.), to define ACC, Resilience and DRR. Definitions formulated within disciplines and sectors are also exposed in this report. It can be highlighted that these last definitions related to disciplines and sectors can be seen more as focuses or application examples found in various sectors and disciplines.

From our review it was clear that for many authors and documents, IPCC still constitutes the key reference source.

Thus, our idea was to first start with an overview of concepts often related to the key terms (exposure, risk etc.) of ACC, resilience and DRR, and notably their definitions provided by IPCC as well as other identified sources throughout our review (4.1). Then, ACC, Resilience and DRR definitions were presented following not only IPCC but also the remaining literature identified. For that:

- Starting with ACC:
  - First generic definitions were described (4.2.1)
  - Then, associated to ACC definitions were presented (4.2.2)
  - Followed by sectorial attempts to define ACC (4.2.3).
- Concerning DRR, as it will be developed latter on (4.3), definitions were mainly generic.
- Similarly to ACC, for resilience:
  - Generic definitions were first presented (4.4.1)
  - Then, associated definitions to resilience were provided (4.4.2)
  - Followed by sectorial definitions of resilience (4.4.3)

Moreover, thanks not only to the scientific literature but also to the non-scientific one, among the main issues associated to the key terms, we have focused on convergences and divergences identified in the definitions of ACC, resilience and DRR (5.1), as well as on the synergies and contrasts (5.2) among the terms. In addition, the ongoing debates have been identified related primarily to ACC and resilience (5.3), as well as cities that are carrying out leading actions in these fields (5.4).
Concerning the literature found and analyzed, our aim was to identify as broadly as possible documents, from scientific and non-scientific fields, that deal with the key terms. Nine categories of documents were identified. The first concerns IPCC reports published through the years, followed by publications made within the frame of 21 EU projects. The third category consists of 20 French and International PhD theses dedicated on the key terms while the forth of 64 scientific papers published in peer reviewed journals. In the fifth category we can find documents that are related to 3 identified leading cities in terms of actions related to ACC, resilience and DRR while in the sixth, documents published by eight international organisms identified. The seventh category includes documents published by five international investment banks. The eighth category includes 3 city networks while the ninth and last category documents published by five private enterprises.
3. Definitions

This section collects the results of the literature review on the definitions of ACC, resilience, DRR and associated terms, following the IPCC reports and notably the 5th one and the other identified sources throughout our literature review (4.1, 4.2, 4.3, 4.4, 4.5). As it will be stated also latter on in this report, each of the three key terms, ACC, resilience and DRR has evolved from different beginnings. These key terms have different terminologies even if they have some common characteristics. We can mention for example the fact that both ACC and DRR focus on reducing vulnerability. Yet, despite these terminology differences, as stated in the Resin project bid, there is a need to have the key terms converging. Indeed, in order to increase cities resilience, ACC options need to be mainstreamed into the strategies of all concerned public and private cities’ stakeholders and a coherent and equitable disaster risk management approach needs to be formulated. Furthermore, as stated below, exposure and vulnerability definitions have been modified by the IPCC as it can be seen while comparing the terms used in IPCC AR4 and AR5 reports, in order to align the adaptation community to the DRR community. Initially, exposure was considered by IPCC as part of vulnerability, while lately, exposure was separated from vulnerability, putting forward a risk-based framework. Indeed, in the last IPCC report a more generic definition was provided for vulnerability in order to harmonize ACC approaches with DRM approaches. This is further developed in an accompanying RESIN report on vulnerability assessments (Connelly et al., 2015).

3.1 ACC, Resilience, DRR key related concepts

Figure 1: Key concepts to ACC, Resilience and DRR. Source IPCC 2014.
Figure 1 illustrates terms often used to define ACC, resilience and DRR. This IPCC framework will be used in the Resin project.

We have reviewed all the IPCC reports published through time to assess whether the definitions have changed over time. As mentioned in the introduction of section 4, definitions of the terms exposure and vulnerability have notably changed. Next, we present the definitions provided in the AR5 (IPCC, 2014). Where relevant, we also state definitions from other sources.

Exposure expresses the presence of people, livelihoods, species or ecosystems, environmental functions, services and resources, infrastructure or economic, social or cultural assets in places and settings, that could be adversely affected by a hazard (p.12 Birkmann et al 2014).

Sensitivity represents the degree to which a system or species is affected, directly or indirectly, adversely or beneficially, by climate variability or change (p. 24 Birkmann et al, 2014).

The third term, hazard, is the potential occurrence of a natural or human-induced physical event that may cause loss of life, injury or other health impacts, as well as damage or loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources (p. 15 Birkmann et al, 2014).

Exposure is also defined as people and goods in a place that could be affected by a hazard, hazard being a sudden event or gradual change leading to impacts on them (Denig et al., 2013), or an unavoidable natural phenomenon causing damages (UNISDR, 2009; Jasper et al., 2013). These authors consider also disaster, socially constructed and avoidable, corresponding to a disruption of the functioning of a community causing damages.

Impacts correspond to the effects on natural and human systems of extreme weather and climate events related to CC. The term adaptive capacity is the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences (Birkmann et al, 2014, p. 16). As seen in (Giordano et al., 2010), impacts can be, potential (may occur without adaptation) or residual (occur after adaptation). Another important concept is the adaptive capacity i.e. the ability to, modify exposure, absorb and recover from CC impacts and exploit its benefits (Carter et al., 2015; Adger et al., 2005; Wilson et al., 2011, Smit et al., 2001). This definition highlights notably the importance of the capabilities related to earning and flexibility, in order to consolidate the adaptive capacity (Walker, 2004; Kurzbach et al., 2014).

These terms lead us to the vulnerability term. Vulnerability expresses the degree to which a system is susceptible to, or unable to cope with adverse CC effects, both variability and extremes. We can state that until the special IPCC report on vulnerability, published in 2012,
the 2001 IPCC definition was indeed used; highlighting also that vulnerability depends on the character, magnitude, and climate variation rate in addition to the sensitivity and adaptive capacity of the exposed system. Following that, the 2012 special report as well as the 5th report defines vulnerability in a more generic way as the ‘propensity or predisposition to be adversely affected’, which corresponds more to an internal characteristic of the affected component.

Vulnerability is also a major term which, as highlighted by Sharifi et al. (2014), corresponds to any characteristics or features that make a system susceptible to suffer from damages/disturbances. Following Denig et al. (2013), it represents the propensity for a hazard to affect features. Vulnerability is also defined as the condition of a household/community or the characteristic of a person/group (Blaikie et al., 1994; TERI, 2007), which determine their ability or inability to cope, recover and adapt to CC effects (Kelly et al., 2000; Giordano et al., 2010).

The IPCC now defines risk as ‘the probability of the occurrence of hazardous events/trends multiplied by the impacts, if these events/trends occur’ (Birkmann et al., 2014, p. 23). It expresses the potential for consequences where something of value is at stake and where the outcome is uncertain. We can mention that various associated definitions related to risks are suggested in the 5th IPCC report. First, risk can be also defined from a social perspective, as the disruption of a social equilibrium (Lavell et al., 2012, p. 45). Disaster risk is defined as the likelihood over a time period of severe alterations in the normal functioning of a community/society, due to hazardous physical events interacting with vulnerable social conditions, leading to adverse effects that require immediate emergency response to satisfy critical human needs with possible external support for recovery (Birkmann et al., 2014, p. 9). Particularly in disaster risk, internal characteristics refer to persons/groups’ features and situation affecting their anticipation, coping, resistance, recovery capacity.

The systemic risk is also identified as the risk due to extreme weather events leading to breakdown of infrastructure networks and critical services (Oppenheimer et al., 2014, p. 1044). The 5th IPCC report includes also the term residual/unmitigated risk to define risks that are remain after disaster risk reduction processes. In addition, risk transfer is defined as the process of formally or informally shifting the financial consequences of particular risks from one party to another where, one party will obtain resources from the other party after disaster occurrence in exchange for ongoing or compensatory social or financial benefits. Risk reduction aims to reduce exposure and vulnerability, and the probability of occurrence of some events. The IPCC defines also the term of disaster risk continuum where risk is seen to evolve and change constantly, requiring different modalities of intervention over time.

The IPCC distinguishes between ‘key’ and ‘emergent’ risks. Key risks are potentially severe adverse consequences for humans and social-ecological systems from the interaction of climate-related hazards with vulnerabilities of societies/systems exposed. They are ‘key’ due to either high hazard or high vulnerability, or both. Emergent risk is defined as the risk that arises from the interaction of phenomena in a complex system over time, such as (i.e. risks related to an increase of vulnerability or exposure in a particular region due to climate change migratory dynamics. Furthermore, the AR5 (IPCC, 2014) introduces the notion of ‘associated risk’, which refers to the indirect impacts which may take place either near or far from the original climate impact’s location. This notion could be considered close to the ‘cascading
effects’ one. Indeed, taking into account the inter-linkages between different infrastructures, the climate impact that has occurred at an initial location (infrastructure) can be propagated to interlinked locations (infrastructures).

Furthermore, the AR5 (IPCC 2014) refers to ‘compound risk’ and ‘newly assessed’ risks. The former refers to a region where climate-change induced impacts in one sector affects other sectors in the same region or a region where CC impacts in different sectors are compounded, leading to extreme or high-risk consequences. The latter, refers to the risks which, based on progress made in the scientific literature has recently provide evidence sufficient enough to permit assessment. Newly assessed risks have at least the potential to become crucial.

Several other definitions of risk can be found in the literature. According to Beck,(1992), risks are predicable types of events which can be recognized, compensated, avoided. This definition is close to the AR5 (IPCC, 2014) definition which highlights that risk expresses the potential for consequences where something of human value is at stake. Alternatively, ISO 31000 defines risk as the effect of uncertainty on objectives and the level of risk as the magnitude of a risk or combination of risks expressed as the combination of consequences and their likelihood. (UNISDR, 2009; Jasper et al., 2013) define also the term disaster risk as the potential disaster losses. Brooks (2003) defines the term of event risk as the risk of occurrence of any particular hazard or extreme event, as well as the term of outcome risk as the risk of a particular outcome, thus integrating both the characteristics of a system and the chance of the occurrence of an event.

Last, while examining the AR5 (Oppenheimer et al., 2014), risks are classified into the following categories: undetectable, moderate, high, and very high. A risk is considered as undetectable if no associated impacts are detectable and attributable to CC. A risk is considered as moderate if the associated impacts are both detectable and attributable to CC with confidence, which is at least medium and considering also specific criteria to the key risk notion. The high risk category refers to severe and widespread impacts in addition to the specific criteria of the key risk notion. Last, into the high risk category we can find risk for which the entire key risk notion’s specific criteria indicate indeed a high risk. The following figure illustrates how this risk classification is used. This figure illustrates the relationship between mitigation scenario categories and global temperature rise outcomes in 2100, as well as level of risk associated with Reasons for Concern (RCFs).
Risk categorization systems have also been suggested by other authors. We can mention the example of Zhang (2008), who categorized risks into ‘simple’, if they have a clear cause-and-effect connection, ‘complex’, if there is a difficulty to identify and quantify causal links between a wide variety of causal agents and observed effects, ‘uncertain’, if the available knowledge is incomplete and ‘ambiguous’ if there is a problem in agreeing on the appropriate values, priorities, boundaries for the determination of possible outcomes.

In the following sections, we present generic definitions of the key terms (4.2.1, 4.3, 4.4.1), definitions of their associated terms (4.2.2, 4.4.2) and efforts made by disciplines and sectors to refine key terms definitions (4.2.2, 4.4.3).
3.2 ACC

We will first present the generic definitions given to ACC, the associated terms and the attempts to refine ACC, and last the disciplinary/sectorial definitions. As highlighted in the 'Method' section, the disciplinary/sectorial definitions must be considered more as application examples/fociuses made by the identified disciplines/sectors and not like attempts of these disciplines/sectors to formulate unique, standalone definitions to be considered by these disciplines/sectors.

3.2.1. ACC generic definitions

According to IPCC, ACC can be defined as the adjustment process to actual or expected CCs and its effects to moderate, harm or exploit opportunities (McCarthy et al., 2001). This definition is broadly used (e.g. Miller et al., 2015; Locatelli, 2013; Pelling, 2011; Bosch et al., 2014, etc.). Adaptation describes a response to a perceived risk or opportunity (Smithers et al., 1997) and notably for CC, the efforts to reduce its negative effects (Hansen et al., 2010; 2013, Biagini et al., 2011) by managing to avoid probable costly post-disaster recovery and rehabilitation (Adhar et al., 2010). Blanco et al. (2009) consider that adapting to CC’s spatially dispersed and systemic impacts is somewhat similar to mitigating natural, localized, episodic hazards. Thus, ACC corresponds to the preparation for the inevitable CC’s impacts (anticipation) to face a disaster situation and make conditions more suitable (Chappin, 2014; Kress, 2007; SUEZ, 2009).

But, how could ACC be materialized? ACC is often seen as an adjustment that can reduce vulnerability or help taking advantage of opportunities (Bicknell et al., 2009; Kvamas, 2012; Piekle, 1998; Smit et al., 2000), that must be continually updated until a stable climate regime is achieved (Larsson, 2003). Smith (2004) strengthens also that ACC denotes long-term adjustments that extend cultural practices in new directions.

ACC can be seen also as a process through which an actor is able to reflect and enact change in practices and institutions generating risk’ causes and framing coping capacity (Pelling,2014). It is also an iterative and ongoing process of recognizing, assessing and responding to risks and vulnerabilities (Smit et al., 2006; de Pryck et al., 2014; UNDP, 2005; GERES, 2011). Taylor (2014) go a step further by adding that options are selected and implemented, outcomes evaluated to possibly reveal benefits (UKCIP, 2003; Harley et al., 2008) and risks re-assessed.

3.2.2. ACC associated definitions

In this section we will present the terms closely related to ACC. IPCC reports, for instance the 5th one, define terms associated to ACC such as adaptation strategies which seek to reduce
exposure or sensitivity, or enhance adaptive capacity. Indeed, as highlighted by other sources, countries, cities, sectors, regions, etc. need an adaptation strategy i.e. a general plan of actions (mix of policies and measures) to address CC impacts and reduce vulnerability (Pramova et al., 2012; Niang-Diop et al., 2005; Biesbrock et al., 2010). These plans consider also implementation i.e. transformation of the adaptive capacity into action. In our review, mainstreaming ACC was also mentioned, defined as the integration of policies and measures to address CC into ongoing planning and decision-making, in order to sustainably ensure investment sensitivity reduction to current and future climatic conditions (Klein et al., 2005; Rayner et al., 2012). Moreover, the review revealed the adaptation space term defined as the set of options from the universe of existing ones potentially available to an organization to deal with CC (Arnell et al., 2006; Peter, 2009; Berkhout et al., 2004).

Figure 3 - Characterization of adaptation. Source Authors.

ACC generic definition can be refined in various ways, as it can be seen in the figure above. Following IPCC reports, first, ACC can be autonomous (spontaneous), i.e. not a conscious response to climatic stimuli, but triggered by ecological or welfare changes (McCarthy et al., 2001). This can provide important support to planned ACC (Bosello et al., 2013) i.e. the result of a deliberate policy decision and awareness that conditions have changed thus action is required to achieve a desired state. ACC can be also characterized as incremental (efficiency improvement within existing technological, governance etc. systems) or transformational (alterations of fundamental attributes) (Edenhofer et al., IPCC 2011). Third, ACC can be anticipatory (or proactive) if it takes place before CC impacts are observed, contrary to reactive.

In addition, we can mention the definition of reformist adaptation which occupies a middle ground between adjustment and transformative adaptation, giving emphasis to social and political dimensions of vulnerability (Basset et Fogelman 2013; Lorentz et al., 2014; Pelling,
2011). Furthermore, according to Park et al. (2012), proactive adaptation will require responses that continually cycle between incremental and transformative actions, thus formulating the Adaptation Action Cycle with four clusters (strategic, tactical, operational, reflexive). We can also mention the adaptive policy making which corresponds to further developed policy analysis into a planned approach to adaptation (Haasnoot et al., 2013; Timmermans et al., 2015; Walker et al., 2013, 2001), embedded in assumption based planning. (Haasnoot et al., 2013; Walker et al., 2013) define also Adaptation Pathways as the sequences of possible actions after a tipping point in the form of adaptation trees.

Table 1 provides definitions that were identified in other sources as characterizing ACC, based on criteria presented in the first column. With this table our aim was to gather all the attempts to refine ACC generic definitions. Our review revealed that these attempts are done based on the criteria of the importance of the investment, the generated costs and benefits, the person or institution initiating an ACC action, the timing and the degree of consciousness of the responses. From the table below it can be seen that notably for the timing criterion, attention is put on whether we act during or after a stress, or we act beforehand in order to consolidate our capacity to adapt; this difference is either reflected by the used terms backward vs. forward, or reactive vs. anticipatory.

3.2.1. Disciplinary and Sectoral Differences in Climate Change Adaptation

The aim of this section is to move from generic to specific definitions, through definitions suggested within the frame of several disciplines and sectors. As highlighted in the introduction of the adaptation to CC section, these definitions must be considered more as focuses made within the frame of various examples of application of the disciplines/sectors that we have identified with our review.

The following table presents the emphasis that different disciplines and sectors have when considering climate change adaptation in order to identify operational dimensions for particular sectors, at particular spatial scales, and for particular risks. Our review brings out that indeed various sectors have tried to address the issue of ACC. Among the first ones, we can mention the fields of social sciences and engineering notably concerning buildings and infrastructures adaptation. As stated below, this table includes examples of focuses made within the frame of the identified disciplines/sectors, that we have identified during our review. Overall, we can see from the identified examples that the terms that are often used are related to community issues, cost and benefits aspects, living conditions, viability, performance level/reliability maintenance, impact reduction.
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<th>Criteria</th>
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| **Investment**<br>(Dumollard et al., 2011; Trinks et al., 2012) | Soft:  
- Low investments, institutional, regulatory measures. Short-term planning.  
Hard:  
- Technical measures.  
- Heavy investments.  
- Long-term planning. |
| **Costs & Benefits**<br>(Mansanet-Bataller, 2010; Berry et al., 2008) | Flow:  
- Both increase over a single time period.  
Stock:  
- Benefits accrue after costs. |
| **Instigator**<br>(Mendelsohn, 2000, Hallegatte et al., 2011) | No-regret:  
- Net social, economic benefits.  
- Implementation not CC related.  
Mal-adaptation:  
- Harmful ACC, unintended consequences.  
- Undermine resilience. |
| **Timing**<br>(Palmer et al., 2008, Beermann, 2011) | Private:  
- Private interests.  
- Decision-maker the only beneficiary.  
- Spontaneous.  
Public:  
- Public interests like government. |
| **Response Consciousness**<br>(Berry et al., 2013 Trinks et al., 2012) | Backward:  
- Cope during moments of stress  
Forward:  
- Theoretical components of adaptive capacity. |
|  | Reactive:  
- Response after extreme events occurrence.  
- Damage mitigation to stem future degradation.  
Anticipatory:  
- Before CC occurrence.  
- Deliberate decisions. Pro-active, increase resilience. |
|  | Autonomous:  
- Spontaneous.  
- Behavioral changes.  
Planned Adaptation:  
- Conscious intervention.  
- Deliberate policy decision. |

Table 1 – Type of adaptation to CC following cost, benefit, investment and responsibility criteria.  
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<th>ACC</th>
<th>Focus</th>
<th>Source</th>
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<tbody>
<tr>
<td>Social sciences</td>
<td>Community cohesion, human livelihoods, adjustments.</td>
<td>(Sovacool et al., 2012), (Smit et al., 1999)</td>
</tr>
<tr>
<td>Engineering</td>
<td>Strategies risks/costs/benefits estimation, sustainable development pathways contribution.</td>
<td>(Stewart et al., 2014), (Eriksen et al., 2011)</td>
</tr>
<tr>
<td>Building</td>
<td>Comfortable living conditions, damage minimization, use restoration, design/construction/operation/use changes process, buildings environment link optimization.</td>
<td>(Thompson et al., 2015), Bouygues Immobilier (2013)</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Performance level maintenance, 'hardware' implementation.</td>
<td>(Canadian Standards Association, 2006); (Lapointe, 2015)</td>
</tr>
<tr>
<td>Corporate</td>
<td>Profits maximization, risk management process, constraints/ opportunities anticipation.</td>
<td>(Mendelsohn, 2012), (Zilberman et al., 2012)</td>
</tr>
<tr>
<td>Transport</td>
<td>Anticipatory, designing standards renewal, accessibility satisfaction, delays reduction, evacuation during crises.</td>
<td>(Eisenack et al., 2012), (Chinowsky et al., 2012)</td>
</tr>
<tr>
<td>Energy</td>
<td>Higher demand coping, real-time re-routing, production/consumption equilibrium, power outages risk decrease, return to normal operations rapidly.</td>
<td>(Byrne et al., 2014), (Vine, 2011)</td>
</tr>
<tr>
<td>Water</td>
<td>Safe reliable access, resistance to uncertain multi-decadal CC, lower supply/ higher demand coping, efficiency increase, conveyance losses decrease.</td>
<td>(Schaeffer et al. 2013), (ADB 2012)</td>
</tr>
<tr>
<td>Health</td>
<td>Exposure/adverse impacts reduction, resilience enhancement.</td>
<td>(Ebi, 2009), (Frumkin et al., 2008)</td>
</tr>
<tr>
<td>Tourism</td>
<td>Behavioral change, benefits generation continuity, Pull-factor driven (same experience), push/pull-factor driven (experience delocalization).</td>
<td>(Scott et al. 2009), (UNWTO 2009)</td>
</tr>
<tr>
<td>Ecosystem</td>
<td>Interactions learning ability, performance improvement, rule discovery.</td>
<td>(Holland, 2006), (Heinimann, 2010)</td>
</tr>
<tr>
<td>Agriculture</td>
<td>Production risk failure decrease, adaptive capacity enhancement.</td>
<td>(Easterling et al., 2007), (Bryant et al., 2000)</td>
</tr>
</tbody>
</table>
In terms of spatial scales, the review discovered that defining ACC at various spatial scales is not an objective per se, it is rather an element of the context of case studies where definitions to ACC is provided. Overall, attempts to define ACC are found at various spatial scales, going from the continental, down to the infrastructure scale, which are presented in figure 4. Indeed, our review helped us identify examples of definitions at the continental, national, regional, departmental, district and infrastructure scales. Indeed, it must be highlighted that the figure below includes examples of case studies identified within our review. These identified case studies which present application examples, have formulated ACC definitions following the context of their respective studies. Thus, the figure below illustrates some examples of spatial scales and definitions found. We can also mention that in the figure below the ‘local’ term is used to define a finer spatial scale category, finer notably while comparing to the district scale, which can include various examples like for instance the critical infrastructure example.

![Figure 4 - Spatial scales & adaptation. Source Authors](image-url)
3.3 DRR

This section is focused on DRR generic and associated terms’ definitions. As stated below, resilience is characterized by a lack of definition conciseness which may not be seen as negative as it encourages a diversity of ideas like accommodating a broad range of context’s including individual, community, ecological and organizational resilience. In addition, resilience usefulness is identified in the fact that it helps mitigating the limits of the traditional risk management approach. DRR, which is presented here, can be seen more as an action framework.

IPCC reports have also focused on the definition of DRR (Pachauri et al., 2014; Arctic Council, 2013). DRR denotes both a policy goal/objective and the strategic and instrumental measures employed for anticipating future disaster risk, reducing existing exposure/hazard/vulnerability and improving resilience.

According to Weaver (2009) and Higbee (2007), DRR is a conceptual framework aiming to avoid (prevention) or limit (mitigation, preparedness) the adverse impacts of hazards, and anticipate them, in order to minimize vulnerabilities and disaster risks throughout the society, within a broader sustainable development context. Definitions highlight the longer term aspect that characterizes efforts to provide emergency responses and recovery services (Stromberg, 2007; Bankoff et al., 2004; Solecki et al., 2011). DRR can also be defined as a framework to analyze and manage the causal factors of disaster by reducing exposure and lessening vulnerability with a better resources management and preparedness (UNISDR, 2009; Setiyadi et al., 2010; Prabhakar et al., 2015; ISDR, 2005; Sendai, 2015; UNISDR, 1994).

Through our review, we noticed that DRR has the same goal as ACC: to reduce the impacts of both extreme environmental and human hazards (Higbee, 2007) and increase urban resilience to disasters, particularly of vulnerable populations (Solecki et al., 2011). The main DRR steps are presented in figure 5 (Manuel-Navarrete et al., 2007; Pelling et al., 2004;
Wisner et al., 2004; Brooks et al., 2003; Vale et al., 2005; World Bank, 2006; Solecki et al., 2011; Verdon-Kidd et al., 2010; de Sherbinin et al., 2009).

Within the frame of our review, concerning sectoral views, we were able to identify definitions associated to the built environment, to critical infrastructures, governance, and urban planning defining DRR as the aim to make facilities more disaster resistant and less ‘risky’, and the communities benefiting from the facilities more resilient and less susceptible to disasters.

3.4 Resilience

In this section generic definitions and associated terms will be followed by definitions related to specific disciplines/sectors.

3.4.1. Resilience generic definitions

Resilience is a much vaguer concept and its definition, has evolved and is still evolving – over years. At the very beginning, resilience was introduced by the field of materials’ resistance notably by Charpy’s tests at the beginning of the XX century and used latter on in psychology in the sixties. The resilience concept, as currently considered and further developed latter on, was first used by Odum (1971) and Holling (1973). Since then, the concept evolved to match different sectorial needs.

IPCC reports have also focused on the definition of resilience (Pachauri et al., 2014; Arctic Council, 2013). Resilience is defined as the capacity of systems to cope with a hazardous event/trend/disturbance, responding or reorganizing in a way that allows maintaining their essential function, identity and structure, and the capacity for adaptation, learning, and transformation.

Following the Resilience Alliance (2007), the components of resilience are outlined in Figure 6. However, there is little agreement in the literature over how these are to be refined.

---

**Resilience**

| Amount of change a system can undergo and retain its function/structure | Degree to which the system is capable of self-organization | Ability to build/increase the capacity for learning and adaptation |

Figure 6 - Resilience definition adapted from Carpenter et al., 2001 and used e.g. by Jerneck et al., 2008; Berkes et al., 2003; Hart et al., 2013.
First, it must be highlighted that resilience is strongly linked to the concept of system. Resilience typically defines a system which has the ability to maintain its core purpose in the face of unanticipated dangers thanks to agility, adaptation and flexibility (Chapin et al., 2009; Zolli et al., 2012). The ability to bounce-back can be also added when impacts cannot be avoided (Tomkins et al., 2004; Wilder et al., 2012; Lhomme et al., 2012; Martin-Breen et al., 2011; Sutcliffe et al., 2003; Wildasky, 1991). Some authors add also the ability to detect and prevent disruptive challenges (UKCP 2010; Kallaos et al., 2014), or, more globally, the capacity to prepare, respond, recover in the face of hazards and adjust to continual changes (Denig et al., 2013).

Other definitions explain mainly how a change can be faced. Usually, it is the ability to resist, absorb and recover to normal operation (Lhomme et al., 2013; Ouyang et al., 2012; Walker et al., 2006; Pierce et al., 2011; Anh et al., 2013; Pettengell, 2010). Resilience (Günther et al., 2007) can also be defined by resistance (precautionary measures), short-term adaptation (return to a starting point), and innovation (opportunities due to discontinuities). Definitions highlight also the capacity of a system to increase its learning capability (UNISDR, 2004), to integrate a disturbance in its functioning (Leygonie, 2000), or to learn to live with the spectrum of continuous changes while maintaining an acceptable stability (Denig et al., 2013).

The question of maintenance and recovery of a system is often underlined. Authors insist either on reaction aspects (Samuels et al., 2008), quick and easy recovery (Scottish Government, 2007; Anh et al., 2013), or on regeneration (Leygonie, 2000; Magnan et al., 2009). Other definitions (UK Government) add also the adaptation criterion before and after crises while others (Rebotier, 2007) insist on the maintenance ability through a disturbed period.

Last, resilience is also seen as a process of being vitally prepared for adversity without knowing what one will be called to act upon (Wildavsky, 1991; Vogues et al., 2007), thanks to human ingenuity to mitigate vulnerabilities (O'Brien, 2008). Resilience can also be defined as the transition from one equilibrium state to another (Magnan et al., 2005) by system's qualities improvement (Kurzbach et al., 2014). Finally, resilience is also associated to vulnerability, the former being the opposite of the latter (Gallopin, 2006).

Francis et al. (2014) identify convergence between all these definitions towards the ability to cope and recover from a reaction to short-term perturbations (recoverability), re-organize into a possible adaptation after a reaction to long-term perturbations (adaptive capacity), withstand perturbations (resistance/absorptive capacity), and maintain its structure/functions (identity retention).

Last, as highlighted by (Davoudi et al., 2013), resilience, beyond recovery from shocks, should also cultivate preparedness and transformative opportunities. In their paper, authors gather three broad conceptualizations of resilience: a) engineering (return to an equilibrium state-bounce back); b) ecological (absorb changes and still persist- bounce forth) and c) socio-ecological (challenging that stability domain remains fixed over time; ‘people and
nature as interdependent systems’). Thus moving towards an evolutionary understanding of resilience, with a continuous alteration as the system adapts and changes and a broadening of the idea of conserving ‘what you have and recovering to what you were’, various elements are incorporated. The dynamic interplay between persistence and preparedness is notably added. In addition, the adaptability, the transformability across multiple scales and time frames, the flexibility and the resourcefulness, are incorporated.

3.4.2. Resilience associated definitions

Next to resilience definitions some associated terms are also identified. The first is sustainability, an ‘umbrella’ term (Sharifi et al., 2014) including resilience as one central component. The other ones are downward and upward resilience. The former depicts macro level directions/solutions in order to prepare for resilience, whereas the latter defines micro level decisions to ensure safety in the face of goal conflicts (Tjørhom, 2010). Last, definitions concerning critical infrastructure (CI) can be mentioned which vary across states. Australian Government (2010) defines it as the physical facilities, supply chains, information technologies (IT) and communication networks which, if destroyed or degraded for an extended period, would have significant impacts. Canada’s government defines it as the physical and IT facilities, networks, etc. which, if disrupted or destroyed, would have serious impacts on health, safety, security or well-being or governments’ effective functioning. In Germany, CI refers to organizations and facilities of major importance whose impairment would cause supplies’ sustained shortage, public order disruptions or other dramatic consequences. The key topic of critical infrastructures is covered in SOTA report 1.

3.4.3. Sectoral Views

As done for ACC, our aim for resilience was to first identify generic definitions, then do efforts to specify those for instance per sector, spatial scale or risk. Our review revealed that resilience definitions seem to be mainly formulated by broad fields like ecosystems, economics, or social sciences. Much less efforts were identified to define resilience per sector like energy, water, transport etc. Results of our analysis are summarized in the following table.
As for ACC, definitions are found at various spatial scales. As noted for ACC, defining resilience at various spatial scales does not seem to be an objective per se, rather an element of context of case studies. The figure below illustrates the spatial scales identified through the resilience definitions that we have identified in our literature review; these scales move from the territorial down to the infrastructure level. As it can be seen from the figures 4 and 7, the spatial scale terms that are used for adaptation and resilience are not necessarily the same. Indeed, even if we can find some terms in common, the objects of studies are defined in a different way according to the initially asked questions respectively related to adaptation and resilience. As for the figure on adaptation, it must be highlighted that the figure below includes examples of case studies identified within our review that are focused on resilience topics. These application examples have formulated definitions following the context and focus of their respective studies. Thus, below some examples of spatial scales and definitions can be found. It is interesting to notice, beside the spatial scale terms issue discussed above that are used related to ACC and resilience, that some notions are used by ACC and resilience definition examples at different spatial scales. For instance the 'adaptive capacity' notion is used in an ACC definition at the national scale and in a resilience definition at the community scale.
Our review, brought several times the ‘resilient city’ term, defined as the city able to function, survive and thrive to any stress (ARUP, 2014). Grosvenor (2014) defines resilience under CC. Following the author, cities’ resilience corresponds to the cities’ capability to thrive as clusters by achieve the sustainability policies’ objectives established under these new climatic conditions. ICLEI (2011) refers to urban resilience as the composition of the following factors:

- to withstand stresses levels with flexible and substitutable systems
- to avoid single pressure point,
- to timely restore functionality,
- to design systems that safely fail,
- to identify problems,
- to build capacity to deal with them.

Last, at the finer CI scale, CI resilience (CIR) is defined as the ability to maintain critical functions under crisis (robustness), prepare for a crisis (resourcefulness) and return to normal operations quickly and efficiently (rapid recovery) (Birkmann et al., 2012; Vugrin et al., 2010). Muller (2012) and Liomme (2013) describe CIR as the ability to resume normal function at a performance level equal to the one before a disruptive event. This definition can be seen as conservative. Indeed, as stated by McEvoy (2013), resilience, and the focus on strengthening local communities, is considered to have more positive connotations than a focus on CC impacts and vulnerability.
Yet, challenges remain to be addressed i.e. the ‘bouncing back’ aspect after a perturbation is not always to recommended; returning back to normal functioning can be inadequate as in the case of the insurance industry which restores properties back to their pre-flood state rather than making them more resilient (O’Hare et al 2015). In addition, in light of coupled socio-ecological systems and existing multilevel and multi-actor relationships means that there is no agreed consensus over what resilience actually is or means in practice (White and O’Hare 2014).

Furthermore, authors acknowledge that resilience should not be considered as a single pathway but rather a generic set of principles and attributes (Denton et al, 2014). Also, as stressed by authors, a return to the normal functioning of a system, or part thereof after an extreme event, may be an inadequate adaptation response or, in some cases, may actually constitute maladaptation (Klein et al., 2003; MacGray et al., 2007; Barnett &O’Neill, 2010; O’Hare et al. 2015).

Lastly, resilience definitions focus on precise climate risks. For instance, flood resilience can be defined as the capacity to ‘live with’ a flood event and with the river (Beucher, 2008), to absorb flood waves and reorganize (de Graaf, 2009; Gersonius et al., 2010). Such definitions reveal the importance of the temporal horizon issue. Indeed, it can be noticed that if we focus on very short term events, we refer more to disaster resilience, while if we focus on a more mid/long term horizon we refer to climate changes, while resilience encloses both time horizons.
4. Key topics and issues

Through our literature review, we were able to identify some main issues related to the key topics studied in this report. Indeed, we were able to see, while analyzing ACC, Resilience and DRR definitions that some commonalities/interactions exist in those (5.1). In addition, per pairs i.e. ACC and DRR, and DRR and ACC, some synergies and contrasts/conflicts were identified (5.2). Following that, through our review, ongoing debates on the key topics of this report were identified (5.3). Last, our aim was also to identify and present three leading cities in terms of commitment and actions carried out related to ACC, resilience and DRR (5.4).

4.1 Definitions

While looking ACC, resilience and DRR definitions, points in common were found. In the following table, the common terms found in both ACC and resilience definitions are presented (part A.). Next, we present definitions that consider first (part B.) resilience as part of ACC and DRR definitions and second (mainly) ACC as part of resilience definition (part C of table above).

4.2 Synergies & contrasts

Following the previous section on definitions, this section will be focused on synergies and contrasts between ACC and resilience and DRR and ACC (Table 6). As highlighted by Few et al., 2006 and Rivera, 2014, and seen notably by the synergies and contrasts presented above, mainstreaming ACC into DRR and resilience reveals to be important in order to take actions to reduce the impact of extreme events.

Regarding synergies, both resilience adaptation aim at managing climate risks (Carter et al. 2015) in order to withstand a shock (Carter et al. 2015). Yet, we must highlight that resilience is not only focusing on climate risks but all types of risks. Furthermore, when describing adaptation strategies, it can be seen that their contribution aims either to reduce vulnerability to changing conditions or to increase resilience (Dessai et al., 2005; Luers et al. 2006; Schneider et al. 2001; Smit al. 2000; Smithers et al. 1997, Bedsworth et al. 2010). Kuhlicke et al. (2009) and Birkmann et al. (2012) even state that resilience strategies facilitate the exploration of adaptation strategies through, for instance, the capacity consolidation to modify behavior in order to adapt to changing environmental conditions at large (Smit et al. 2006, Caputo et al. 2015). Last, they both face the same obstacle, which is the ‘invisibility’, in other words uncertainties (Jerneck et al. 2008), meaning that they don’t know exactly what impact they will face, thus to what they need to resist.

Regarding contrasts, resilience still seems to be for the time being a more attractive objective for city leaders and investors than adaptation (Brugmann 2011), since it is mainly linked to the idea that we build and invest on cities to secure for instance their economic utility. Resilience attractiveness is also related to the fact that resilience focuses both on the short
### A. Common Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>ACC</th>
<th>Resilience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robustness, flexibility.</td>
<td>(Tol, 2008)</td>
<td>(Wardekker et al., 2010)</td>
</tr>
</tbody>
</table>

### B. Resilience in adaptation and DRR definitions

<table>
<thead>
<tr>
<th>Definition</th>
<th>ACC</th>
<th>DRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme events' impacts reduction &amp; resilience increase (resilience a concept for ACC &amp; DRR).</td>
<td>(Solecki et al., 2011)</td>
<td>(Pelling, 2011)</td>
</tr>
<tr>
<td>Impact on resilience for vulnerability reduction.</td>
<td>ACC, DRR</td>
<td></td>
</tr>
<tr>
<td>Maintaining/restoring ecosystem resilience.</td>
<td>ACC</td>
<td>CLIMSAVE (2013)</td>
</tr>
<tr>
<td>Resilience first stage of adaptive capacity.</td>
<td>ACC</td>
<td>(Pelling, 2011)</td>
</tr>
</tbody>
</table>

### C. Adaptation & DRR in resilience definitions

<table>
<thead>
<tr>
<th>Definition</th>
<th>Resilience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptation necessary to learn and better respond the next time.</td>
<td>(Magis, 2010)</td>
</tr>
<tr>
<td>Short-term adaptation, resilience component.</td>
<td>(Günther et al., 2007)</td>
</tr>
<tr>
<td>Flexibility, resilience core characteristic, depending on adaptation ability.</td>
<td>(Rockefeller Foundation, 2013)</td>
</tr>
<tr>
<td>Reorganization into a possible adaptation [in a more generic way, not only related to CC], a resilience component.</td>
<td>(Francis et al., 2014)</td>
</tr>
</tbody>
</table>

Table 4 - Definitions. Source Authors.
and long term, while ACC focuses only on the long term. Overall, various elements in addition to the ones stated below (CC uncertainties, priority attributed to CC mitigation etc.) can lead to the fact that, for the time being, resilience can be seen as more attractive. Moreover, adaptation focuses on mitigating specific risk factors without a clear connection to the overall performance of the relevant areas as a unique functioning urban unit, whereas resilience aims to create a performance and investment premium for an urban area (Brugmann 2011). Last, resilience has as an aim to maintain or return to the previous order of a system with changing conditions (Davoudi et al. 2013, Pizzo 2015). We do not find the same aim for adaptation.

Synergies were also found between DRR and adaptation (Solecki et al. 2011). First, they both aim at reducing the CC effects, by building resilience. In addition, they have common stakeholders and they both consider activities and measures for addressing climate-related disasters at a household or community level (Wamsler 2014, Rivera 2014). The strategies of both CCA and DRR rely on analysis of the underlying causes of exposure and vulnerability, seeking to integrate these findings into planning, management and action. Moreover, they both support capacity building among potentially impacted individuals and institutions (Solecki et al. 2011). Overall, mainstreaming CCA into DRR reveals to be important in order to take actions to reduce the impact of extreme events (Few et al. 2006, Rivera 2014). Differences and points in common are further presented in Table 5.

4.3 Debates

Our review revealed some gaps in the understanding notably of adaptation. For resilience gaps may seem less numerous since it started to be studied a long time ago (Cutter et al., 2008). This is mainly related to the fact that resilience is seen as a more fashionable concept yet its conceptual underpinnings and the empirical evidence are far from agreed issues. Gaps are presented in the Table 6.
<table>
<thead>
<tr>
<th>Differences between DRR and ACC</th>
<th>Points in common between DRR and ACC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stakeholders</strong></td>
<td></td>
</tr>
<tr>
<td>DRR N/A</td>
<td>ACC N/A</td>
</tr>
<tr>
<td>Household, community, city administrations, public &amp; private operators</td>
<td></td>
</tr>
<tr>
<td><strong>Objectives</strong></td>
<td></td>
</tr>
<tr>
<td>DRR N/A</td>
<td>ACC N/A</td>
</tr>
<tr>
<td>Capacity building</td>
<td></td>
</tr>
<tr>
<td><strong>Hazard types</strong></td>
<td></td>
</tr>
<tr>
<td>DRR all</td>
<td>ACC Climate-related</td>
</tr>
<tr>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Origins and ‘culture’</strong></td>
<td></td>
</tr>
<tr>
<td>DRR Humanitarian assistance after disaster events</td>
<td>ACC Scientific theory</td>
</tr>
<tr>
<td>ACC specialists from various sectors, including DRR</td>
<td></td>
</tr>
<tr>
<td><strong>Risks timeframe</strong></td>
<td></td>
</tr>
<tr>
<td>DRR Present</td>
<td>ACC Future</td>
</tr>
<tr>
<td>DRR increasingly forward looking; Present, entry point for ACC</td>
<td></td>
</tr>
<tr>
<td><strong>Perspective</strong></td>
<td></td>
</tr>
<tr>
<td>DRR Historical</td>
<td>ACC Future</td>
</tr>
<tr>
<td>As above</td>
<td></td>
</tr>
<tr>
<td><strong>‘Initial’ focus</strong></td>
<td></td>
</tr>
<tr>
<td>DRR Vulnerability reduction</td>
<td>ACC Physical exposure, vulnerability</td>
</tr>
<tr>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td><strong>Community-based process origins</strong></td>
<td></td>
</tr>
<tr>
<td>DRR Experience</td>
<td>ACC Policy agenda</td>
</tr>
<tr>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td><strong>Application</strong></td>
<td></td>
</tr>
<tr>
<td>DRR Practical, at local level</td>
<td>ACC Theoretical, at local level</td>
</tr>
<tr>
<td>Increasing recognition of ACC tools need</td>
<td></td>
</tr>
<tr>
<td><strong>Tools</strong></td>
<td></td>
</tr>
<tr>
<td>DRR Full range (established)</td>
<td>ACC Limited range (under development)</td>
</tr>
<tr>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td><strong>Implementation</strong></td>
<td></td>
</tr>
<tr>
<td>DRR Incremental development</td>
<td>ACC New, emerging</td>
</tr>
<tr>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td><strong>Funding streams</strong></td>
<td></td>
</tr>
<tr>
<td>DRR Ad hoc, insufficient</td>
<td>ACC Sizeable, increasing</td>
</tr>
<tr>
<td>DRR community in ACC funding mechanisms</td>
<td></td>
</tr>
</tbody>
</table>

Table 5 - Differences and points in common between DRR and ACC. Source: Authors (after Tearfund, 2008; Mercer, 2010; Wamsler, 2014; Rivera, 2014; Solecki et al., 2011; Few et al., 2006).
Table 6 - Gaps on ACC & Resilience. Source: Authors.

### Adaptation Gaps

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ACC and growth initiatives conflicts (Bowen et al., 2012; Barnett et al., 2010; Lele et al., 2013)</td>
<td>Available knowledge- policymaker’s knowledge needs gaps, barrier to best policy choice, maladaptation.</td>
</tr>
<tr>
<td>Justice dilemmas (Parry et al., 1998, King 2004)</td>
<td>Not clearly established CC responsibilities, significant investments for minor contributors (northwest European storms: not an established link between ACC and hazard).</td>
</tr>
<tr>
<td>Cultural norms change (Lazrus, 2009)</td>
<td>Norms extension (ACC long-term adjustments), norms threatening (short-term adjustments); joint thinking with mitigation &amp; energy transition.</td>
</tr>
</tbody>
</table>

### Resilience Gaps

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Various interpretations (Klein et al., 2003)</td>
<td>Operationalization slowdown.</td>
</tr>
<tr>
<td>On-going questioning (Beucher, 2008)</td>
<td>What should be resilient? To what? What will allow re-organization?</td>
</tr>
<tr>
<td>Spatial scale (Beucher, 2008)</td>
<td>Resilient cities, yet vulnerable people.</td>
</tr>
</tbody>
</table>

4.4 Leading cities

Cities represent a pertinent spatial scale to deal with the CC challenge. Various efforts are identified at the worldwide level (Broto et al., 2012). Here, we focus on the cases of:

- Melbourne, considered being a pioneer,
- New York, and its significant investments to be protected against changes already experienced in the past and
- Copenhagen and its objective to remain a pleasant place to be across time.

These cities have been chosen for several reasons., Firstly we wanted to focus on cities that are not among the four cities studied within the frame of Resin project (Manchester, Paris, Bilbao, Bratislava), since these cities will be analyzed in an extensive way within the project. Secondly, we wanted to have a certain geographical diversity. In order to do so, we have chosen one north American, one Australian and one European city. In addition, regarding the
choice of the cities within these continents, we were inspired by the C40 website (http://www.c40.org/press_releases/press-release-c40-and-siemens-honor-cities-for-leadership-in-tackling-climate-change) were the ten reward cities by C40 and Siemens were listed, amongst which Melbourne and New York City. While looking for a European city, we were mainly inspired by the 100 Resilient Cities website where the 10 leading cities against CC were listed (http://www.100resilientcities.org/blog/entry/ten-cities-that-are-leading-on-climate-change). In Table 7, we present framework documents issued by the cities’ local authorities and notably ACC, Resilience and DRR definitions provided by these documents.

Table 7- The case of 3 leading cities; Melbourne, New York and Copenhagen. Source: Authors

<table>
<thead>
<tr>
<th>Melbourne</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACC Strategy (2007)</td>
</tr>
<tr>
<td>ACC = set of measures for local systems CC vulnerability reduction</td>
</tr>
<tr>
<td>through resilience increase.</td>
</tr>
<tr>
<td>Council of Government’s Senior Officer (2009); Government (2010)</td>
</tr>
<tr>
<td>CIR = coordinated planning across sectors/ networks with responsive,</td>
</tr>
<tr>
<td>flexible, timely recovery measures; organizational culture development</td>
</tr>
<tr>
<td>to provide a minimum service level and return to full operation.</td>
</tr>
<tr>
<td>Urban Landscapes Adaptation Program (2010)</td>
</tr>
<tr>
<td>Heat and drought response; actions implementation (green roofs,</td>
</tr>
<tr>
<td>permeable pavements etc.); City Climate Leadership Award (C40 &amp; Siemens).</td>
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<table>
<thead>
<tr>
<th>New York</th>
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<tr>
<td>(Rosenzweig et al., 2011)</td>
</tr>
<tr>
<td>ACC = set of actions to respond to changing climate and create opportunities.</td>
</tr>
<tr>
<td>(Rosenzweig et al., 2011)</td>
</tr>
<tr>
<td>Adaptive capacity enhancement = CC understanding, vulnerabilities</td>
</tr>
<tr>
<td>identification, risk levels assessment, ACC strategies prioritization;</td>
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<tr>
<td>Adaptation Assessment Guidebook.</td>
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<tr>
<td>PlaNYC, 2013</td>
</tr>
<tr>
<td>Resilient city = protected by effective defenses, adapted to mitigate</td>
</tr>
<tr>
<td>climate impacts, bounce back quickly, swing back to original state.</td>
</tr>
<tr>
<td>PlaNYC, 2013</td>
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<tr>
<td>Post Sandy, 2012 hurricane; 250 adaptation measures.</td>
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<th>Copenhagen</th>
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<tr>
<td>Adaptation plan (2011)</td>
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<tr>
<td>ACC = provision of clear information on how CC will affect the city, how</td>
</tr>
<tr>
<td>challenges will be tackled to maintain secure status.</td>
</tr>
<tr>
<td>Adaptation plan (2011)</td>
</tr>
<tr>
<td>Climate adaptation planning incorporation into all planning forms;</td>
</tr>
<tr>
<td>climate adaptation project framework on current &amp; future initiatives</td>
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<tr>
<td>status; citizens’ involvement.</td>
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5. Resin project issues and connections

Following the above, we can define risk as the probability of occurrence of a disturbance (Giordano et al., 2010) which results from the combination of hazard, exposure and vulnerability (see figure 8). (Denig et al., 2013).

![Risk Composition Diagram]

Thanks to ACC and DRR, exposure is reduced and risks are recognized and assessed, and then resilience is built to compensate or avoid them (ADB, 2010, Schneider et al., 2007). Within RESIN, ACC depicts actions implementation in order to withstand CC impacts and ensure the same infrastructures’ performance level (Hughes et al., 2010). This should allow critical infrastructures to continue to function during a disturbance or quickly get back and provide its original services, increasing infrastructures and all interrelated city components’ resilience (CI, buildings, public spaces etc.). DRR should be also considered, this concept being closely linked to ACC, yet keeping in mind the difference between them i.e. the fact that DRR focuses on current disasters while ACC on future CC impacts on hazards including both disasters and mean changes. Indeed, DRR hazard timeframe is present and existing hazards while ACC timeframe is future ones, still with an increasingly forward looking that can be noticed for the former and the recognition of the present as an entry point for the latter. Moreover, resilience should be connected to ACC and DRR as the ability to function, survive and thrive after stresses and to prepare, respond and manage resulting crisis and return quickly to normal operations (NIAC, 2009).
4. Suggested definitions for the Resin project

Following this review, ACC can be seen as the processes that comprise the implementation of actions in order to withstand CC impacts and take advantage of opportunities and to ensure the same level of performance of infrastructures, such as guaranteeing the energy and water supply during and after an extreme weather event (Hughes et al., 2010). DRR is the concept and practice of reducing disaster risks through systematic efforts to analyze and reduce the causal factors of disasters. It can be highlighted that DRR follows an all-hazard approach with notably a focus on near-term hazards. Reducing exposure to hazards, lessening vulnerability of people and property, wise management of land and the environment, and improving preparedness and early warning for adverse events are all examples of disaster risk reduction (Yokohama, 1994) and also ACC.

Resilience, on the other hand, should be defined as the ability to function, survive and thrive, no matter what stresses or shocks happened. It should also include the ability to maintain critical operations of infrastructures in the face of crises, to skillfully prepare for, respond to, and manage a crisis or disruption as it unfolds and to return to and/or reconstitute normal operations, as quickly as possible, after a disruption (NIAC, 2009).

All of these definitions can be seen as the most adequate to the RESIN Project ensuring that all partners will work with the same knowledge and the same awareness of the signification of these terms. Lastly, the key diagram suggested is the one suggested by the 5th IPCC report and presented in section 4.1 of this report.
5. Conclusion

In this report, we have reviewed ACC, DRR and Resilience definitions to find the most appropriate for the RESIN project. Even if there is a reference source (i.e. IPCC), definitions can be refined following for instance the sector or spatial scale (i.e. focuses-application examples as highlighted above). The review done in this report can be helpful for all the packages in Resin project, notably the ones related to tools development (WP2-vulnerability, WP3-adaptation, WP6- decision support) and the spatial (whole city, selected sectors, vital infrastructures etc.) and temporal (season, month, year etc.) scales to be considered in order to develop these tools.

This report presented some commonalities that exist between key terms as well as differences that still exist between them. ACC is related to the maintenance of the same level of performance of infrastructures (Hughes et al., 2010). Attention must be put to the fact that ACC corresponds to a set of actions often strongly linked to mitigation and energy transition (Cop Rio, Kyoto, Copenhagen and Paris). DRR is defined as the concept and practice of reducing disaster risks through systematic efforts to analyze and reduce the causal factors of disasters. Reducing exposure to hazards, lessening vulnerability of people and property, wise management of land and the environment, and improving preparedness and early warning for adverse events are all examples of disaster risk reduction (Yokohama 1994). Indeed, DRR corresponds to a framework of actions (Yokohama, 1994; Hyogo, 2005; Sendai, 2015). Resilience can be defined as what enables to survive, adapt and thrive in the face of acute or chronic stresses (Rockefeller Foundation, 2013). Resilience can be seen as a new and vaguer concept that breaks with the traditional risk approach, offering a new reflection frame to think jointly ACC and DRR. To sum up, we can say that DRR and ACC are closer, with the only differences being for example the timescale of the disruption (further examples are provided above; the timescale is an example); ACC on future hazards, DRR on present hazards (Tearfund, 2008). In the review, we found many ACC definitions including resilience or using the definition of resilience (Tol, 2008). Thus, it is concluded that, in order to adapt for instance to climate threat, the global aim of an action to implement is to increase resilience, i.e. system’s ability to function no matter what stresses happen, maintain its critical functions in the face of crises, prepare for a crisis, and return quickly to an equilibrium. Thus, there is an effort towards DRR and ACC harmonization while resilience is common to both.

To successfully develop ACC strategies, one of the key recommendations would be to actively involve stakeholders (inhabitants, policy makers, etc.) on the CC effects and their consequences’ management, through notably providing to them a common terminology. Indeed, with this report our aim was to contribute to the definition of a common terminology which will assist the implication of the various stakeholders who are related to the key terms of ACC, DRR and resilience. Attention must be given to the ACC measures’ effectiveness assessment, a ‘poor sibling’ until now (Higbee, 2007).
6. Key resources

1) Book, M. Pelling ‘Adaptation to climate change: From resilience to transformation’ (2011):
   - ACC and resilience definitions
   - Possible choices related to resilience, transition and transformation
   - Case study on urban settlement
   - ACC contexts diversity description
   - ACC history, costs, limits presentation

   - Discussion on the introduction of resilience into planning.
   - Focus on events requiring resilience, nuances in definitions, theoretical/operational urban related problems.

   - Resilience indicators development strategy presentation.
   - CI and CIR definitions.
   - Case studies on CI in different sectors and communities.

   - A toolkit explaining how to build resilience in the city.
   - A case study of NYC Electrical Grid.
   - City and infrastructure resilience definitions.

   - DRR and ACC differences/similarities presentation.
   - DRR and ACC definitions.
   - Case study on Papua New Guinea DRRs and wider development policies.
7. Glossary

Exposure (IPCC 2014): The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.

Vulnerability (IPCC 2014): The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

Impacts (IPCC 2014): (Consequences, Outcomes) Effects on natural and human systems. The term impact is used primarily to refer to the effects on natural and human systems of extreme weather and climate events and of climate change.

Hazard (IPCC 2014): The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources.

Risk (IPCC 2014): The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values; represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur.

ACC (Hughes et al., 2010): The process that comprises the implementation of actions in order to withstand CC impacts and to ensure the same level of performance of infrastructures, like guaranteeing the energy and water supply.

Adaptive capacity (IPCC 2014): the ability of a system to adjust to CC, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Critical infrastructure Australian Government (2010): It refers to every infrastructure whose disruption or destruction would cause catastrophic and far-reaching damage.

Resilience (NIAC, 2009): the ability to function, survive and thrive no matter what stresses happen and to skillfully prepare for, respond to, and manage a crisis. Finally, it should include the ability to return to normal operations as quickly as possible after a disruption.

Sensitivity (IPCC 2014): represents the degree to which a system is affected, directly or indirectly, adversely or beneficially, by CC.

Autonomous adaptation (spontaneous) (IPCC 2014): adaptation that does not constitute a conscious response to climatic stimuli, but is triggered by ecological changes in natural systems and by market or welfare changes in human systems.

Planned adaptation (IPCC 2014): the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.
Anticipatory (or proactive) adaptation (IPCC 2014): adaptation that takes place before impacts of CC are observed.

Reactive adaptation (IPCC 2014): adaptation that occurs when CC impacts are observed.

DRR (Yokohama, 1994): is the concept and practice of reducing disaster risks through systematic efforts to analyze and reduce the causal factors of disasters. Reducing exposure to hazards, lessening vulnerability of people and property, wise management of land and the environment, and improving preparedness and early warning for adverse events are all examples of disaster risk reduction.

Adaptation strategies (IPCC 2014): they include a mix of policies and measures with the overarching objective of reducing vulnerability. Depending on the circumstances, the strategy can be set at a national level, addressing adaptation across sectors, regions and vulnerable populations, or it can be more limited, focusing on just one or two sectors or regions.
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