Operationalising urban resilience: insights from the science-policy interface in the European Union

Aliaksandra Baravikova [1]*, Alessandro Coppola [2], Alberto Terenzi [3]

[1] Social Sciences Department, Gran Sasso Science Institute, via Michele Iacobucci 2, 67100 L'Aquila (Italy), e-mail: aliaksandra.baravikova@gssi.it

[2] Department of Architecture and Urban Studies, Politecnico di Milano, e-mail: alessandro.coppola@polimi.it

[3] Independent researcher, e-mail: alb.terenzi@gmail.com

* Corresponding author

Abstract By examining three policy-oriented research projects funded by the European Union (RAMSES, RESIN, SMR) the paper critically discusses operationalisation efforts of urban resilience as they are designed and produced at the interface between science and policy. By analysing the documents and conducting interviews with the projects' coordinators and participants, three main research questions were addressed concerning how urban resilience is defined across the projects and the actors involved, the role of the tools produced by them in their difficult task to reconcile wider applicability and local specificity and finally how stakeholder engagement and co-creation were framed and implemented. Based on the evidence collected, the authors argue that conceptualisations of urban resilience within operationalisation efforts being produced at the science policy-interface are still quite plural and open, that such openness is largely confirmed by the flexibility of the tools produced by the projects and that while becoming increasingly relevant stakeholder engagement and co-creation strategy are yet to be fully framed and theorised. Finally, they present further research pathways aimed at strengthening our knowledge of operationalisation efforts, the role of practitioners and of urban resilience implementation in discreet scientific and political environments.

Keywords: urban resilience, science-policy interface, EU, co-creation, operationalisation

1 Introduction

During the last decade, urban resilience has sprawled across policy frameworks and discourses from the local to the global scales, becoming a defining term for many debates around urban issues. It has been seen as an appealing and intuitively graspable concept which can serve as a bridge between different disciplines and policy areas. The actual operationalisation of the concept, however, remains a largely unresolved issue, despite growing efforts of scholars and international practitioners to define, measure, evaluate and test it by identifying both qualitative dimensions and quantitative measures to analyse the performance of specific urban systems (Allen et al., 2018; Bahadur & Tanner, 2014; Kirbyshire et al., 2017; Quinlan et al., 2016; Sharifi & Yamagata, 2016).

The way urban resilience is conceptualised and operationalised determines whether it is integrated into urban planning and policy-making processes, through which specific measures, who benefits from them and who does not (Chelleri et al., 2015; Meerow & Newell, 2016). The lack of operationalisation is argued to hinder the actual use of the concept on the ground, and therefore concerns have been raised regarding the risk for it to become an "empty signifier" (Weichselgartner & Kelman, 2015, p. 1) or "nothing more than a rhetorical device" (Davidson et al., 2016, p. 27).Calls for more

1

conceptual clarity and better operationalisation of urban resilience date back to almost two decades ago (Carpenter et al., 2001) and have been restated also in the recent publications (Coaffee et al., 2018). While it seems there is no consensus over the exact meaning of the concept yet, resilience features in increasingly numerous policies and projects around the world. This pushes scholars to ask key critical questions: what visions of urban resilience emerge in its rapidly developing policy domain? How — if at all — the challenge of operationalisation has been approached in policy-making arenas and processes?

These questions are at the heart of our research. We examine them in the context of the European Union (hereafter EU). EU policy-making realms and tools are of great relevance for this discussion, as urban resilience is now prominent in many of its programs and initiatives related to urban governance and adaptation to climate change in cities (Section 2.2). So far, however, little research has been conducted into the actual conceptualisation and operationalisation of this concept in the EU policies and projects (with some notable exceptions, e.g,. a study on the EU FP7 TURAS project by Collier et al. (2016) or Coaffee & Davis (2015) on HARMONISED.)

To address this gap, it is critical to look at boundary spaces at the interface of science and policy (Wessenlink et al., 2013) where research is conducted with the aim of producing operationalisation frames and tools for policy design and implementation. Such an approach allows intercepting operationalisation efforts in their actual production before they hit policy-making situations. In this perspective, the paper aims to contribute to the filling of the void by examining the rationals, functionings and results of three EU-funded research and innovation projects pursuing the design of operationalisation models of urban resilience - RAMSES, RESIN and SMR - proposed by different project networks of scientific institutions, local governments and businesses.

Critical analysis of these cases allows us to make a meaningful contribution to the operationalisation debates, bringing much-needed empirical evidence in theoretical discussions. We believe these insights will help to better understand the gaps between urban resilience theories and practices, as well as about mainstreaming the concept at the EU level.

The paper is structured as follows. We start by taking stock of the current debates on the operationalisation of urban resilience, highlighting key challenges and existing approaches to it. Then we trace the emergence of urban resilience in the EU policy landscape, which allows us to contextualise the projects we examine (Section 2). These projects are introduced, alongside with our research methods, in Section 3. We proceed by discussing the definitions of urban resilience and the strategies of its operationalisation employed by the projects examined. In particular, we investigate the potential tension between wider applicability and local specificity, as well as the impact of stakeholder engagement and co-creation. These questions are examined in detail in Section 4 (Results), while Section 5 (Discussion) provides a more synthetic perspective and links the results to the previous insights from the literature on urban resilience in Europe and other contexts. We conclude by critically discussing how RAMSES, RESIN and SMR contribute to our understanding of operationalisation of urban resilience and its challenges.

2. On operationalising urban resilience and its development in the EU

2.1 Unpacking the problem

While flexibility and potential for metaphorical uses may make resilience an inspiring 'boundary

object' (Meerow et al., 2016), they also imply the term is interpreted differently across disciplines and policy communities. Broadly speaking, two major approaches to resilience are distinguished: engineering (or 'bouncing back') and evolutionary (or transformative, dynamic resilience, ''bouncing forward'). A comprehensive comparison between them and a discussion on resilience across different disciplines can be found elsewhere (Bahadur and Tanner, 2014; Chelleri & Olazabal, 2012). This subsection reflects on the current state of operationalisation efforts.

In recent years, within academic and policy literatures, a shift from the engineering approach that focuses on "what can be done now and what can be achieved within the existing governance context" (Tanner et al., 2017, p. 8) to the evolutionary one, which embraces uncertainty and transformation - has become increasingly evident (Biermann et al., 2015; Coaffee & Lee, 2016). The key merits of the evolutionary (transformational) view of resilience include its emphasis to look across sectors and consider cascading impacts (Chelleri et al., 2015) as well as interdependencies between human behaviour and infrastructures (Doorn, 2017) and, more at large, between socio-ecological and socio-technical systems. Transformational resilience is also seen as a way to address the drawback of an engineering, "bouncing back" approach, which disguises or inadequately addresses political dimensions. Transformational resilience, by contrast, entails challenging the status quo and the existing neoliberal order, asking the question "resilience for whom and to what?". It scrutinises the role of local constraints and unbalances emerging from sociodemographic factors, socio-spatial inequalities and power relations in real-life contexts. These constraints and unbalances may have a significant effect on which planning choices and investments are prioritised, and thus we cannot successfully operationalise resilience without understanding the political and decision-making context (Davoudi, 2018; Matin et al., 2018; Meerow & Mitchell, 2017; Romero-Lankao et al., 2016; Ziervogel et al., 2017).

This shift to the evolutionary approach, however, is not linear and unproblematic. Some recent research has demonstrated that, while the idea of transformation has been widely accepted at the discursive level, many characteristics of engineering perspective still prevail among academics and practitioners (Chelleri & Baravikova, forthcoming). The challenge is that aligning 'bouncing back' and 'bouncing forward' visions on resilience implies inevitable trade-offs across spatial and temporal scales. Chelleri & Olazabal (2012) illustrate this argument showing that when the goal is building resilience to short-term disruptions, the objective is system persistence, whereas a long-term perspective would necessitate some degree of transition or transformation. Potential tensions exist "between maximising specified resilience to existing threats and general capacity to adapt to unanticipated disruptions" (Meerow & Newell, 2016, p. 16). It is also unclear whether resilience should be understood - and therefore operationalised - as a final desirable state to be achieved (as an engineering approach suggests), as a process with multiple equilibria or as a quality necessary to achieve sustainability (Elmqvist, 2017; Redman, 2014).

But even if we consider transformational resilience alone, its operationalisation is still difficult. First, challenging the status quo and the existing neoliberal order is not an easy undertaking; second, it involves more uncertainty, and since "targets, strategies and goals are continuously adjusted across scales, sectors, and multiple potential arenas of action", transformational approaches to resilience are more difficult to translate into implementation than engineering approaches (Tanner et al., 2017, p. 8). Moreover, while dealing with interconnections is inherent to resilience theory (Yamagata & Shar-

ifi, 2018), how to frame and understand these interdependencies remains a great challenges for operationalisation (Kirbyshire et al., 2017; Doorn, 2017).

Besides the problems arising from different definitions of resilience, there are issues with the operationalisation attempts themselves. First, "many of the existing frameworks for measuring resilience are too data-demanding, too academic or too time-sensitive to meet practitioners' needs for rigorous monitoring and evaluating of resilience interventions" (Kirbyshire et al., 2017, p. 37). Secondly, existing operationalisation approaches are usually context-specific and have limited replication value (Ghimire et al, in Yamagata & Sharifi 2018). Therefore, there is a potential tension between local specificity and wider applicability. Furthermore, they often serve not as a tool to elaborate a strategy through specific actions but as a mechanism to diagnose issues (Tanner et al., 2017).

Engaging stakeholders is increasingly seen as a way to address the challenges outlined above. It allows to include different stakeholders' perspectives (Meerow & Mitchell, 2017), make the knowledge more relevant and accessible for them, as well as to deal with siloed thinking by stepping away from sector-based planning and recognising interconnectedness (Yamagata & Sharifi, 2018). Bottom-up negotiation not only allows to clarify the meaning of resilience and its characteristics, but also addresses the questions of "for whom, to what, where, when and why"and may serve as a source for innovation (Crowe et al., 2015). Theoretically, this approach is underpinned by seeing resilience as a process, a negotiation which inevitably entails contestation and considers the likelihood of inherent trade-offs (Harris et al, 2017). In practice, it is realised through the mobilisation of a wide array of stakeholder involvement technologies such as participative processes, collaboration, co-design, co-creation and urban laboratories (Wardekker et al. (2010); Coppola (2016), Chelleri (2018)).

To sum up, the underlying factors that impede operationalisation are related to different rationales of engineering and evolutionary approaches to resilience, complex nature of interdependencies, local political constraints and power imbalances, as well as limited applicability of general frameworks across different contexts.

2.2 The rise and spread of urban resilience in the EU policy-making.

The spread of urban resilience in Europe is to be understood in the context of the wider development of urban resilience-focused projects, partnerships and networks at the global level and, more in general, of the broadening role of cities in sustainability and climate change governance (Bulkeley & Betsill, 2013). More specifically, and differently from the US and Asia (Coaffee, 2013; Coaffee & Lee, 2016), the mobilisation of the concept in the realm of EU policy-making mostly developed not in relation to disaster risk reduction and security concerns but, instead, in the context of climate change adaptation (ibid), which in turn emerged from broader environmental and sustainability concerns.

A series of milestones punctuated the process leading to the adoption of the EU adaptation strategy (EC, 2013), such as the 2009 white paper 'Adapting to climate change: towards a European framework for action' (EC, 2009) where resilience was mentioned in relation to health and infrastructure, the launch of the EU Cities Adapt Project (2011-2012), the opening of the Climate-ADAPT platform (2012) and the launch of the Mayors Adapt Initiative set up by the European Commission (EC) in 2014 and then merged into the Global Covenant of Mayors for Climate and Energy in 2017 (Haupt and Coppola, 2019; Kemmerzell, 2018).

The launch of the Adaptation strategy coincided with the rise of nature-based solutions (NbS), which are now considered as the best practice in adapting territories to climate change due to the many co-benefits it entails (Maes & Jacobs, 2017). Thanks to the efforts of DG Research and Innovation, together with the European Investment Bank (EIB) which promotes natural capital financing and consultancy for cities, NbS have become a key policy line and a strong agenda within the resilience discourse in Europe (Faivre et al., 2017).

Moving closer to the science-policy interface, the reports produced by the European Environmental Agency (EEA) inform policies and calls for applications and financing projects within specific frameworks such as FP7, Horizon 2020 and Life .

3. Methods

3.1 Research design

Previous research on operationalisation has focused on developing typologies and principles of urban resilience (e.g., six principles by Wardekker et al., 2010, or three ideal types by Davidson et al., 2016). This study, in contrast, does not suggest new ways of operationalisation: instead, it examines existing efforts in the EU policies and research projects.

It is guided by an overarching question: How is urban resilience being operationalised in the science-policy interfaces of the EU?

This overarching question is addressed through three sub-questions:

1. How is urban resilience defined?

We examined whether and how urban resilience is defined across the projects, looking into whether any shared understanding emerges, what are the eventual differences and whether it is framed as "bouncing back", "forwards" or both.

2. How were the tools designed and tested during the projects used by cities within and beyond their duration, and what were the challenges and limitations in such a process?

We investigated the role of tools in operationalising urban resilience and looked at the strategies to reconcile wider applicability and local specificity. We also discussed whether the tools continue to be used after the project is over.

3. What is the role of co-creation and stakeholder engagement in operationalising urban resilience?

We looked into the kind of actors involved, based on which principles and through which practices. This subquestion was underpinned by theoretical assumptions that stakeholder engagement might play an important role in operationalising urban resilience.

3.2 Data sources and analysis

We started by examining the relevant EU policies that were selected based on the field overview presented in Section 2.2. In total, 13 documents were consulted, including strategic policy papers and policy reports in the field of climate adaptation (see the list of documents in Appendix). In our analysis we marked down the definitions of urban resilience (or lack of); the context in which they appear; the mentioning of stakeholder engagement and co-creation and interventions suggested to enhance resilience.

In the second stage, to enable a more focused examination, we chose three prominent EU-funded

research projects which aimed at creating knowledge and tools for supporting cities' decision-making on resilience: SMR, RAMSES and RESIN (see projects profiles below). We thoroughly analysed the materials related to the projects (dissemination materials, funding calls, handbooks for tools and peer-reviewed articles). Finally, we conducted seven interviews with the project coordinators and managers in the selected project partner cities: Antwerp (RAMSES), Bratislava (RESIN), Donostia and Rome (SMR). Interviews were conducted by Skype, their average duration was 40 minutes. They were subsequently transcribed and analysed using a combination of inductive and deductive coding (Saldaña, 2009). (The respondents are anonymised here using numerical codes from 1 to 7, e.g., R1.)

3.3 Case introduction

The choice of these particular projects was motivated by their explicit focus on urban resilience operationalisation and their high visibility on the EU policy-making arena. Of course, they do not represent an exhaustive picture of urban climate resilience development in the EU context, but a close examination of specific initiatives and linking them with higher policy levels – funding calls and strategic policy documents – allows to identify some tendencies and patterns as well as outline avenues for further investigation.

The first project was *RAMSES* — Reconciling Adaptation, Mitigation and Sustainable Development for Cities (2011-2017), funded under the 7th Framework Research Programme. Its main goal was to assess how much information is needed to build climate change models. It provided "quantified evidence of the impacts of climate change and the costs and benefits of a wide range of adaptation measures"[1], allowing to compare top-down (simplified) and bottom-up (more detailed) approaches.

The second project was *RESIN* — Climate resilient cities and infrastructures (2015-2018), funded under Horizon 2020 programme (hereafter H2020), aimed to develop "standardised approaches to increase the resilience of Europe's cities and urban areas to extreme weather and climate change"[2]. Its particular focus was ensuring a better integration of critical infrastructure and providing infrastructure managers with operational tools.

The third project was *SMR* — Smart Mature Resilience (2015-2018), also funded under H2020. Its major goal was to develop the European Resilience Management Guidelines. Beyond this, SMR aimed to create a network of resilient cities and provide operational tools to them.

All three projects consortiums included partners from various cities, representing both academics (research institutes, universities) and practitioners (city authorities, consultancies, industry etc). The details about funding and focal cities are presented in Table 1.

Table 1. Key information about the projects

Project name	Focal cities	Funding
RAMSES	London, Bilbao, **Antwerp**	Call: **FP7**-ENVIRONMENT **topic:** ENV.2012.6.1-3 - Strategies, costs and impacts of adaptation to climate change

---

[1] http://www.ramses-cities.eu/home/
[2] https://cordis.europa.eu/project/rcn/196890/en

RESIN	Bilbao, **Bratislava**, Manchester, Paris	**Calls:** H2020-EU.3.5. - Societal Challenges **topic:** DRS-09-2014 - Disaster Resilience & Climate Change topic 1: Science and innovation for adaptation to climate change: from assessing costs, risks and opportunities to demonstration of options and practices
SMR	Glasgow, **Donostia**, Kristiansand (tier-2: Riga, **Rome**, Bristol, Vejle)	**Call:** H2020-EU.3.7. - Secure Societies **topic:** DRS-07-2014 - Crisis management topic 7: Crises and disaster resilience – operationalising resilience concepts

Before joining the projects, cities had different degrees of familiarity with resilience. Some were already working with the concept (e.g., in Rome the 100 Resilient Cities initiative ran almost simultaneously with SMR); others were concerned about the issues related to resilience but weren't using the concept.

4. Results

4.1 Definitions and characteristics

In the high-profile policy documents and project calls, resilience was usually not defined. If it was, then the definition revolved around a more engineering perspective ("… maintaining the current form and function of that area" — Adaptation Strategies for European Cities, 2013). Similarly, an ability to resist, absorb, accommodate to and recover from the effects of a hazard constituted a definition of resilience in the call under which SMR was funded. While the report 'Urban adaptation to climate change in Europe (2016) elaborated on transformative approaches to adaptation, the basic definition of resilience provided was in 'bouncing back terms': "the ability of cities to withstand crisis" (p. 32).

In the same vein, there was no coherency of definitions neither between the projects nor within them. Notwithstanding the basic definition adopted in SMR was the same as in the project call (engineering vision), the project coordinator emphasised they took a holistic perspective on resilience which encompasses both 'bouncing back' and 'bouncing forward': "otherwise this is not resilience, this is something partial… even if [these perspectives] are contradictory, resilience is about integrating them." In RESIN, the definition given in the glossary was taken from IPCC (2014) and included transformation ("… maintaining the capacity for adaptation, learning, and transformation.") In the course of the project, however, the concept of adaptation was mostly used; in the words of our respondent, resilience "is far wider concept than the one we actually used" and comprised not only risk management perspective and climate-induced disasters, but also social resilience and other natural events [R2]. The focus areas of RAMSES were adaptation and mitigation, but the term resilience was mentioned in the project description ("need to strengthen urban resilience") and featured in some of

7

its tools and materials, where the ability of a system to reorganise and multi-equilibrium understanding of resilience were brought forwards[3]. But, similar to RESIN, in the course of the project they used the term adaptation and not resilience.

Is the task of operationalising and defining urban resilience perceived as a relevant issue in the EU policy and science-policy domains at all? It is not discussed in the strategic policy papers, was explicitly mentioned only in SMR and its funding call ("…survey worldwide approaches how to define, develop, implement and evaluate resilience concepts", p. 20). Similarly, in the interviews the task of operationalisation was brought up only by the participants and coordinator of the SMR project. One of them emphasised resilience "is still a developing science, there is not yet a clear framework of knowledge… while the resilience of critical infrastructure is well-known and clear, it gets more complicated at the city level, where different sorts of social problems appear" [R7]. Two other projects mentioned the challenges in its operationalisation only briefly.

Table 2. Methodological frameworks used in the projects.

project	methodological frameworks	characteristics
RAMSES	**Transition Model** grounded in the adaptation pathway approach	Methodology is cyclical, suggesting an incremental and iterative pathway for city planning
RESIN	**RESIN Decision Framework**, embedded into an online platform ('E-Guide')	Methodology moves from identification of risks to development of an implementation plan; composed of four steps with a series of reiterated sub-steps
SMR	**Resilience Maturity Model**, understood as both a methodological framework and a self-assessment tool for cities	five stages describing the maturity of a city with regard to resilience: Starting, Mature, Advanced, Robust, Vertebrate

All three projects put emphasis not so much on resilience or adaptation as an outcome but on the incremental process supposedly leading to them. The methodological frameworks they have produced (see Table 2) defined a pathway for cities to incrementally build capacity and ways of functioning able to ensure resilience of the urban system as a whole. Thus, resilience was framed as a process here. Also, the need to see resilience in a holistic way - and therefore also including social dynamics - was posited by the respondents even if in the course of their project they did not use the term explicitly or the definition was associated with the engineering approach. To reiterate, in many instances resilience was not explicitly defined and/or used interchangeably with other terms, such as adaptation.

---

[3] For examples, see Kallaos et al. (2014) and the video with Adriana Galdersi in the tool 'On urban resilience': http://on-urban-resilience.eu/

4.2 Tools to strengthen urban resilience

4.2.1 Local specificity vs wider applicability

Although the tools differed given the scope of the projects (see an overview in Table 3), some patterns in how they dealt with local specificity / wider applicability tension can be distinguished. All the projects started with an assessment phase and identification of risks which later informed strategy development. Therefore, contrary to some criticism raised in the literature, they not suggested 'ready-made' tools for diagnosis of risks and indicators to be fulfilled (Leitner et al., 2018) but assisted in developing the actionable tools and strategies. Because each city faces different challenges, making single case studies would be too time and resource-demanding. Therefore the projects aimed to create tools "not hard-wired but which could be connected by way of user consultations, local expert involvements of doing the steps" [R1].

We may deduct three strategies employed by the projects, often in a complementary way. Firstly, they attempted to bring more standardisation in the processes, tools and information. For instance, RESIN in collaboration with the Standardisation Institute of the Netherlands conducted an inventory of the standards in the fields of climate change adaptation/resilience and initiated standardisation activities themselves. Secondly, they left enough room for stakeholder engagement. As the project coordinators put it: "models can never explain everything… Even the climate models are very simple in comparison with what happens in the atmosphere in reality" [R2]; "you don't need to know everything in order to act" (see more in Subsection 4.3). The third strategy was to create communication tools and repositories which included practical adaptation policy examples form European cities and could be consulted by other cities.

Interestingly, all three projects' coordinators acknowledged that reconciling wider applicability and local specificity was a challenging task. According to one of them, "you have to think of something like a generic European city, which is nothing in fact" [R1]. The cities' representatives, by contrast, did not perceive this tension as a problem. Instead, they talked more about how using the packages and cases developed in other cities exceeded their expectations. As one of the respondents pointed out, the issue of applicability was not only about geography but also different themes: "if it can be used in my city in other thematic issues, then I can imagine that it can be easily transferred to other cities" [R4].

4.2.2 Who uses them?

Some cities continued to use the tools after the end of their participation, either directly or indirectly. Several city representatives discussed how the project outcomes were applied in the design of adaptation strategy and how local emergency plans were created by the stakeholders who took part in their workshops. Two other cities, however, used the tools only to a limited degree.

Several factors impeded the use of project results. First, local politics precluded form putting them into practice. The respondents described how they found themselves in a "political vacuum in between two political cycles" [R6] and the reluctance of political administration to use the insights from such projects that are technically clear and discussed together with representatives of all the sectors of the society... It is not very easy to let them [politicians] understand, because you know how politics functions." [R7]

Second, language was an important, albeit rarely discussed issue in policy diffusion. This point was brought up by several city representatives. When no equivalent existed in the local language (as it happened for the term 'resilience'), the new word required additional explanation and discussion. But

this task was much less problematic than the need to translate the tools: as not everyone was comfortable using English, translating the tools slowed down the process.

Several city participants highlighted that while the tools were useful and facilitated the discussion, learning how to use them and the actual implementation of the results ("digesting the learning" [R5]) took time beyond the project span. Often you can measure the project's impact only after its completion, one of the respondents pointed out. Both city representatives and coordinators felt there should be more follow-up monitoring of projects' success, otherwise "there is a risk that it [research] ends at the end of the project and it's not brought further" [R1]. Some of the projects' goals listed implications for the EU policy-making, but overall there was a lack of understanding the subsequent use of the developed tools. It should be underlined, though, that despite these limitations both project coordinators and city representatives expressed fairly high levels of appreciation concerning the overall effectiveness while sharing positive impressions about the projects.

Table 3. Key tools produced by the projects

project	tools
RAMSES	*Transition Handbook and Training Package:* provides a methodology for developing a climate resilience strategy
	Communication tools: audio-visual guidance "On urban resilience" *Ramses Slidedeck*: presents the main scientific findings of the project.
RESIN	*E-Guide*: online platform that embeds project tools into a step-by-step methodology ('RESIN Decision Framework')
	Climate Risk Typology: allows cities to compare their risks with those of other cities, visualise and assess them spatially
	Impact and Vulnerability Analysis of Vital Infrastructures and built-up Areas (IVAVIA): illustrates cause-effect relationships of climate change hazards and enables the identification of geographical hotspots of vulnerability
	RESIN Adaptation Options Library (draws together ca. 300 relevant papers and 700 scenario cases related to climate change adaptation
SMR	*Risk Sistemicity Questionnaire*: a qualitative risk assessment tool based on a group interaction
	City Resilience Dynamics: allows simulating the adoption of different resilience policies
	Resilience Building Policies tool: a collection of case studies as a reference for cities
	*Resilience Information Porta*l: a communication tool for cities.

4.3 The role of co-creation and stakeholder engagement

4.3.1 General perceptions about stakeholder engagement

While stakeholder engagement and co-creation were not specifically discussed in the EU strategic papers, all three projects involved a significant amount of stakeholder engagement (SE) that was generally understood as a central component in the design and testing of the solutions that the projects intended to deliver. Co-creation was only briefly mentioned in the footnote on the call for RESIN (p. 19), but the interviewees said co-creation *was* used in the course of the project (more on this below). To include SE as a methodological element, all three projects have conducted activities first-hand to develop resources and trained cities on how to map and involve stakeholders locally through a set of workshops and webinars. The core of stakeholders was formed by the representatives of the relevant departments in the participant cities (mostly environmental, climate-related and urban planning of-fices). They, in turn, sometimes invited people from other departments, representatives of NGOs and other civil society actors.

The degree of SE was ultimately stipulated by the conditions of the project calls and funding pro-grams. RAMSES was launched before co-creation became popular on the policy scene, and it was realised within FP7 which envisaged fewer opportunities for SE comparing to the H2020 projects (SMR and RESIN). This tendency could be observed in the documents and was corroborated by the interviewees. Unlike RAMSES, where "you could be a user without doing anything, just giving them data, if you don't have a real interest in the results " [R4], in the H2020 projects the tools themselves were designed in a participatory way: "they advise you to invite your stakeholders, establish work-shops, consult them, use whatever method of participation" [R6]. One of the respondents explained this shift by the fact that "now when everybody has an impact study.... the necessity to work and co-create with other different partners is much higher". [R4] According to the interviewees, the key element of co-creation was that scientists and stakeholders should develop the ideas and questions from the very beginning together, and that all the steps were done in cooperation with end-users rather than supervised by scientists. This not only enhanced communication between scientists and policy-makers (also among different departments), but allowed to overcome siloed thinking and ensured the participants' interest in the project outcomes.

None of the city representatives felt communication with scientists or understanding the scientific results was difficult. Many of them had scientific background themselves and appreciated they could bring a meaningful contribution, not only in terms of data but also in framing the questions, giving practical recommendations and developing user case scenarios — participating in "a dialogue, not Q&A" [R6]. As one of the respondents summed it up, "now they understood in H2020 that we are not dummies." [R4]

4.3.2 Co-creation as a pathway to operationalisation: examples

Below are some examples of how increased SE and co-creation might be influencing framing and operationalisation of urban resilience. Firstly, by bringing together engineering and social perspec-tives on it. Stakeholders' meetings became the venues for collaboration, enabling a dialogue between public and private entities and between different departments. As was put by a city representative, "an engineer working on electrical grid knows very little about social problems in the city" [R7]. Mutual learning allowed to create new knowledge and more comprehensive and clear understanding of risks.

Co-creation was explicitly used to understand resilience in both SMR focal cities, Donostia and

Rome. As the Donostia representative explained, different stakeholders had diverging perspectives on the concept, but eventually they overcame this challenge with the help of discussions. In Rome, one of the challenges in defining resilience was the spatial understanding of the city, because of the peculiarity of its very broad administrative boundaries. So during the meetings the stakeholders had to come up with a new definition, which was then put in the operational guidance to the project.

Secondly, as discussed in the previous subsection, while the tools aimed to improve standardisation, they were also supposed to be "not hard-wired". It means the users themselves could have an impact on how resilience was framed, for instance by deciding what types of risk and interdependencies to include into the model. In RESIN, IVAVIA and the tools behind it were based on a step-wise approach, allowing practitioners who execute vulnerability assessments to put in local knowledge and decide, for example, whether or not to include cascading effects.

The respondent from SMR described how during the stakeholder meetings they worked on three types of risks related to climate change, social dynamics (e.g., elderly population) and critical infrastructure: first independently and then tried to integrate them. To assure a balanced perspective, they attempted to have representatives of all three types of risks as well as participants with more strategic knowledge and more complete overview of the city problems (e.g., chief resilience officer, if possible.) These examples illustrate how stakeholders can have an impact on the meaning of resilience by deciding on terms' definitions and considering which risks and interdependencies to include.

4.3.3 Limitations and challenges to co-creation in practice

There were, however, some challenges and limitations in applying co-creation in practice. While all three coordinators emphasised strong cooperation with and between the cities within their projects, some of them admitted co-creation had been realised only to a certain extent. Mostly because of the novelty of the term, both for cities and researchers: it took time "to get into a real mode of co-creating" [R1]. In the words of one of them, "we were using the metaphor of building a ship and using it at the same time. (….) We didn't have the tools in the beginning, so the end-users need some patience." [R2].

This novelty contributed to the occasional mismatch between the project's aims and stakeholders' expectations, mentioned both by coordinators and city representatives. This is how a city representative described the first meeting with their stakeholders: "I am not saying they were disappointed but they were expecting nice pages with nice solutions, saying what you have to do. And it wasn't like that. We were saying to them: no-no, first of all we want to understand which is our situation, and then we want to build up with you, together, the possible solutions" [R5]. At the same time, one of the project coordinators emphasised, researchers should acknowledge they have to provide some practical value to the end-users, "you cannot only work only on very philosophical or academic issues" [R2]. Co-creation, therefore, requires efforts and behavioural change from both sides. It also necessitates good time planning and being specific about the intended contribution of stakeholders, as there is a difference between just informing the participants about this concept ("which is already an asset") and their actual involvement in the development of models and planning approaches [R2].

5. Discussion: the conceptual openness of urban resilience in Europe

Similar to previous research (Coaffee & Davis, 2015), this study argues there is no shared understanding of urban resilience in Europe, as its current conceptualisations are highly specific to discreet

institutional contexts. In the strategic policy documents, reports and funding calls the notion of resilience, albeit increasingly present, is usually not elaborated and defined, and we may find differences in how resilience is defined or described between or sometimes even within the projects. In some cases the idea of the transformative capacity of resilience is embraced, elsewhere an engineering perspective is promoted. Based on the interviews, we can assume a tendency among practitioners to adopt a more holistic view on urban resilience which comprises both 'bouncing back' and 'bouncing forward' perspectives, as well as to underline the social dimension. The projects have explicitly addressed some of the key challenges to the operationalisation of urban resilience, such as interdependencies of risks, the need to overcome siloed practices and improve the applicability of the frameworks and tools across the contexts.

However, this has not led to a unified, single understanding of the term nor to an overarching operationalisation model. Instead, it appears there is a sort of pluralisation and broadening of conceptualisations of resilience. This may partly be underpinned by the scope of the funding calls: the concept seems to be defined and used contextually and situationally within particular projects and policy papers, sometimes interchangeably with other concepts (e.g., climate adaptation). While SMR, RAMSES and RESIN have conducted impressive work to improve the standardisation of certain aspects that are relevant for urban climate resilience, the overall understanding of the term remains open and malleable. This conceptual openness is supported by seeing resilience as a process rather than an outcome, which is in line with the critical scholarship on urban resilience (Harris et al., 2017), as well as by the openness and flexibility of the produced tools: while introducing some standards and guidelines, the projects aimed for the tools to be appropriated and employed discretionary by other potential users, therefore they left enough space for stakeholder engagement and co-creation. Thus, the solutions produced by the projects are less codified than assessment schemes like 100RC and ARUPP. They are negotiated and adapted to a particular context and seem to suggest a procedure or a pathway for planning rather than a rounded model for action.

While the extent of SE and co-creation varied between the projects and had some limitations due to the novelty of co-creation they were seen as valuable instruments to address siloed thinking, improve collaboration, clarify and develop new ideas. Examples in subsection 4.3 have confirmed theoretical assumptions about the role of co-creation practices in operationalising urban resilience. However, we have not found pronounced evidence of co-creation challenging the status quo, asking 'resilience for whom' and explicitly addressing contestations and trade-offs. This may be explained by the

the relative lack of innovation in the strategies of identifying stakeholders, which have seldom gone beyond fairly established public governance, business and civil society arenas and actors, as well as the weak presence of social sciences in the projects' coalitions.

6. Conclusion and further research

The main goal of this study was to provide insights about the actual functioning of urban resilience in the EU science-policy interface and thereby to contribute to the scholarship of concept's operationalisation. Up to now, very little research has examined how urban resilience is used in policies and by practitioners (Oulahen et al., 2019), focusing instead on theoretical debates around its meaning and genealogy. By investigating the differences in how urban resilience is understood and operationalised in the EU policy documents and three joint knowledge production projects, this paper addressed an existing void in the literature. It has demonstrated that the definition of urban resilience continues to be very open and discreetly adapted to particular contexts, and how this openness is

supported and reproduced by the tools created within the projects examined.

But to what extent this lack of a single definition and the persisting openness of the concept is a problem? On a slightly provocative note and contrary to the existing scholarship, we suggest it may be not so problematic.

Our study has illustrated that multiple understandings of resilience exist in various contexts and within various projects; such plurality and lack of a strict definition do not seem to pose particular problems or feed particular conflicts within projects that, by working at the interface between science and policy, are supposed to design the frameworks for proper policy implementation. In the context of such projects, the concept of resilience seems to act as a facilitator of a variety of operations binding different actors that are not particularly interested in establishing clear-cut and definitive theoretical understandings of what they are doing. Furthermore, based on the interviews and insights from existing literature (Stigt et al., 2015), we might argue that practitioners do not perceive this apparent lack of a clear definition as the most challenging issue; instead, navigating in the tools and abundance of information might be a much harder and relevant task. As the EU Climate partnership action plan suggests, "there are many decision support tools already in existence, and the H2020 research projects keep on producing new ones. For cities often, the problem is not the absence of knowledge, but too much information to choose from, and effectively not being able to 'see the wood for the trees. What is needed is the evaluation of the existing tools and decision frameworks, with the engagement of cities, and their prioritisation - what is the most useful? Which tools are the most appropriate to which types of cities?" (Urban Agenda for the EU, 2018, p. 75). In this context, what emerges is the complex and challenging position - and therefore positionality - of practitioners who have to both actively participate to the production of knowledge at the interface between science and policy and access and use the growing abundance and plurality of its results.

In this perspective, it seems relevant to inquire into the key factors and conditions - i.e. the role of funding calls on spreading the concepts and pushing actors to include specific approaches - that influence resilience operationalisation efforts in particular contexts. To get a more in-depth understanding of the power dynamics within projects, further research might engage with a more extensive use of ethnographic methods: as Corson et al. (2014, p. 21) note in their study of global environmental governance, "political decisions are made by "people in a room" across diverse forms of government." We suggest that closer attention to what happens in a room might yield new insights also about the production of knowledge and politics in boundary spaces at the interface of science and policy (Wesselink et al., 2013). For instance, besides the questions that were already addressed in this paper, scholars should also enquire more in depth into cities' motivation to join the projects in the first place, as well as what are the scientific communities that are involved in the projects and how the relations between them - e.g., hard and soft sciences - are actually shaped. And how the mundane and often overlooked circumstances of projects functioning - i.e. the need to agree a common lexicon made of continuous translations of foundational concepts and taxonomies - affect their deployment and the implementation of their results.

As we have demonstrated above, addressing the political dimension remains a challenging aspect of operationalisation. Future analysis should also address how the projects fit - or not - into the local political context. This is crucial, because, as previous research has argued, challenges in shifting tra-

ditional governance approaches lie at the heart of the implementation gap, because "resilience implementation in public administrations is, in most cases, in conflict with bureaucratic values such as efficiency and procedural rationality, which are difficult to balance with adaptability, redundancy, and innovation" (Coaffee et al., 2018, p. 405). We believe addressing these issues might help to narrow the gap between theory and practice.

References

Allen, C. R., Birge, H. E., Angeler, D. G., Tony Arnold, C. A., Chaffin, B. C., Decaro, D. A., … Gunderson, L. (2018). Quantifying uncertainty and trade-offs in resilience assessments. *Ecology and Society*, *23*(1). https://doi.org/10.5751/ES-09920-230103

Bahadur, A., & Tanner, T. (2014). Transformational resilience thinking : putting people, power and politics at the heart of urban climate resilience. *Environment and Urbanisation*, *26*(4), 1–15. Biermann, M., Hillmer-Pegram, K., Knapp, C. N., & Hum, R. E. (2015). Approaching a critical turn? A content analysis of the politics of resilience in key bodies of resilience literature. *Resilience*, *3293*(October), 1–20.

Bulkeley, H., & Betsill, M. M. (2013). Revisiting the urban politics of climate change. *Environmental Politics*, *22*(1), 136–154. https://doi.org/10.1080/09644016.2013.755797

Carpenter, S., Walker, B., Anderies, J. M., & Abel, N. (2001). From metaphor to measurement: resilience of what to what? *Ecosystems*, *4*(8).

Chelleri, L., & Olazabal, M. (2012). *Multidisciplinary perspectives on urban resilience: A workshop report. Basque Centre for Climate Change*.

Chelleri, L. (2018). Barcelona Experience in Resilience: An Integrated Governance Model for Operationalising Urban Resilience. In Y. Yamagata & A. Sharifi (Eds.), *Resilience-Oriented Urban Planning* (pp. 11–128). Springer.

Chelleri, L., Waters, J. J., Olazabal, M., & Minucci, G. (2015). Resilience trade-offs: addressing multiple scales and temporal aspects of urban resilience. *Environment and Urbanisation*, *27*(4), 181–198. https://doi.org/10.1177/0956247814550780

Coaffee, J. (2013). Towards Next-Generation Urban Resilience in Planning Practice: From Securitisation to Integrated Place Making. *Planning Practice & Research*, *28*(3), 323–339. Coaffee, J., & Davis, P. (2015). A HARMONISE'd approach to building security-driven urban resilience: a call to arms. *Journal of Financial Management of Property and Construction*, 2–21.

Coaffee, J., & Lee, P. (2016). *Urban resilience: Planning for risk, crisis and uncertainty*. Macmillan International Higher Education.

Coaffee, J., Therrien, M.-C., Chelleri, L., Henstra, D., Aldrich, D. P., Mitchell, C. L., … Rigaud, É.

(2018). Urban resilience implementation: A policy challenge and research agenda for the 21st century. *Journal of Contingencies and Crisis Management*, *26*(3), 403–410.

Collier, M. J., Connop, S., Foley, K., Nedović-Budić, Z., Newport, D., Corcoran, A., … Vandergert, P. (2016). Urban transformation with TURAS open innovations; opportunities for transitioning through transdisciplinarity. *Current Opinion in Environmental Sustainability*, *22*, 57–62. https://doi.org/10.1016/j.cosust.2017.04.005

Coppola, A. (2016). Cambiamento climatico, resilienza e politiche urbane. *Italianieuropei*, *2*(9).

Corson, C., Campbell, L. M., & MacDonald, K. I. (2014). Capturing the Personal in Politics: Ethnographies of Global Environmental Governance. *Global Environmental Politics*, *14*(2), 82–101. https://doi.org/10.1162/GLEP

Crowe, P. R., Foley, K., & Collier, M. J. (2015). Operationalising urban resilience through a framework for adaptive co-management and design: Five experiments in urban planning practice and policy. *Environmental Science and Policy*, *62*, 112–119. https://doi.org/10.1016/j.envsci.2016.04.007

Davidson, J. L., Jacobson, C., Lyth, A., Dedekorkut-howes, A., Baldwin, C. L., Ellison, J. C., … Smith, T. F. (2016). Interrogating resilience: toward a typology to improve its operationalisation. *Ecology and Society*, *21*(2).

Davoudi, S. (2018). Just Resilience. *City & Community*, *17*(1), 3–7. https://doi.org/10.1111/cico.12281

Doorn, N. (2017). Resilience indicators: opportunities for including distributive justice concerns in disaster management. *Journal of Risk Research*, *20*(6), 711–731. https://doi.org/10.1080/13669877.2015.1100662

Elmqvist, T. (2017). Sustainability and resilience differ. *Nature*, *546*.

Faivre, N., Fritz, M., Freitas, T., De Boissezon, B., & Vandewoestijne, S. (2017). Nature-Based Solutions in the EU: Innovating with nature to address social, economic and environmental challenges *Environmental Research*, *159*(December 2016), 509–518. https://doi.org/10.1016/j.envres.2017.08.032

Harris, L. M., Chu, E. K., & Ziervogel, G. (2017). Negotiated resilience. *Resilience*, *3293*(July), 1–19. https://doi.org/10.1080/21693293.2017.1353196

Haupt, W., & Coppola, A. (2019). Climate governance in transnational municipal networks: advancing a potential agenda for analysis and typology. *International Journal of Urban Sustainable Development*, *11*(2), 123–140. https://doi.org/https://doi.org/10.1080/19463138.2019.1583235

Kallaos, J., Mainguy, G., & Wyckmans, A. (2014). Considering Resilience; Steps Towards an Assessment Framework. *TeMa. Journal of Land Use, Mobility and Environment*, *7*(1), 5–28.

Kemmerzell, J. (2018). Innovations in European climate governance and their impact on local climate policy: An analysis of German major cities. In S. Hughes, E. K. Chu, & S. G. Mason (Eds.), *Climate*

change in cities. Innovations in multi-level governance. (pp. 39–58). Springer.

Kirbyshire, A., Lovell, E., Nadin, R., Roberts, E., Tanner, T., & Weingärtner, L. (2017). *Resilience Scan April-June 2017: A review of literature, debates and blogs on resilience.*

Maes, J., & Jacobs, S. (2017). Nature-Based Solutions for Europe's Sustainable Development. *Conservation Letters*, *10*(1), 121–124. https://doi.org/10.1111/conl.12216

Matin, N., Forrester, J., & Ensor, J. (2018). What is equitable resilience? *World Development*, *109*, 197–205. https://doi.org/https://doi.org/10.1016/j.worlddev.2018.04.020

Meerow, S, & Newell, J. (2016). Urban resilience for whom, what, when, where, and why? *Urban Geography*, (July). https://doi.org/10.1080/02723638.2016.1206395

Meerow, Sara, & Mitchell, C. L. (2017). Weathering the storm: The politics of urban climate change adaptation planning. *Environment and Planning A*, *49*(11), 2619–2627.

Meerow, Sara, Newell, J. P., & Stults, M. (2016). Defining urban resilience: A review. *Landscape and Urban Planning*, *147*, 38–49. https://doi.org/10.1016/j.landurbplan.2015.11.011

Quinlan, A. E., Berbés-Blázquez, M., Haider, L. J., & Peterson, G. D. (2016). Measuring and assessing resilience: broadening understanding through multiple disciplinary perspectives. *Journal of Applied Ecology*, *53*(3), 677–687.

Redman, C. L. (2014). Should sustainability and resilience be combined or remain distinct pursuits? *Ecology and Society*, *19*(2). https://doi.org/10.5751/ES-06390-190237

Romero-Lankao, P., Gnatz, D. M., Wilhelmi, O., & Hayden, M. (2016). Urban sustainability and resilience: From theory to practice. *Sustainability (Switzerland)*, *8*(12), 1–19.

Saldaña, J. (2009). *The Coding Manual for Qualitative Researchers*. Sage.

Sharifi, A., & Yamagata, Y. (2016). Urban Resilience Assessment: Multiple Dimensions, Criteria, and Indicators. In A. Sharifi & Y. Yamagata (Eds.), *Urban resilience: a transformative approach* (pp. 259–276). Springer. Stigt, R. van, Driessen, P. P. J., & Spit, T. J. M. (2015). A user perspective on the gap between science and decision-making. Local administrators' views on expert knowledge in urban planning. *Environmental Science & Policy*, *47*, 167–176. https://doi.org/https://doi.org/10.1016/j.envsci.2014.12.002

Tanner, T., Bahadur, A., & Moench, M. (2017). *Challenges for resilience policy and practice*. London.

Urban Agenda for the EU. (2018). *Climate Adaptation Partnership: Action Plan*. Retrieved from https://ec.europa.eu/futurium/en/system/files/ged/final_action_plan_last_version.pdf

Wardekker, J. A., de Jong, A., Knoop, J. M., & van der Sluijs, J. P. (2010). Operationalising a resilience approach to adapting an urban delta to uncertain climate changes. *Technological Forecasting and Social Change*, *77*(6), 987–998. https://doi.org/10.1016/j.techfore.2009.11.005

Weichselgartner, J., & Kelman, I. (2015). Geographies of resilience: Challenges and opportunities of

a descriptive concept. *Progress in Human Geography*, *39*(3), 1–19. https://doi.org/10.1177/0309132513518834

Wesselink, A., Buchanan, K. S., Georgiadou, Y., & Turnhout, E. (2013). Technical knowledge, discursive spaces and politics at the science-policy interface. *Environmental Science & Policy*, *1*(9), 1–9.

Yamagata, Y., & Sharifi, A. (Eds.). (2018). *Resilience-Oriented Urban Planning*. Springer. https://doi.org/https://doi.org/10.1007/978-3-319-75798-8

Ziervogel, G., Pelling, M., Cartwright, A., Chu, E., Deshpande, T., Harris, L., … Zweig, P. (2017). Inserting rights and justice into urban resilience: a focus on everyday risk. *Environment and Urbanisation*, *29*(1), 123–138. https://doi.org/10.1177/0956247816686905

Appendix. Policy documents reviewed

1. European Commission (2009) White paper: adapting to climate change: towards a European framework for action. COM(2009) 147 final. Brussels: Commission of the European Communities. http://eur-lex.europa.eu/legal-content/EN/TXT/? uri=CELEX:52009DC0147
2. European Commission (2013) Adaptation Strategies for European Cities: Final Report
3. European Commission (2013) An EU strategy on adaptation to climate change. COM(2013) 216 final. Brussels: The European Commission. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52013DC0216.
4. European Commission (2013) Appendix 12: A toolkit for cities (Adaptation Strategies for European Cities: Final Report)
5. European Commission (2013) Climate change, environmental degradation, and migration (Commission staff working document accompanying the document 'Communication from the commission to the European Parliament, the council, the European economic and social committee and the committee of the regions. An EU Strategy on adaptation to climate change')
6. European Commission: Directorate-General for Research and Innovation (2015) Towards an EU Research and Innovation policy agenda for Nature-Based Solutions & Re-Naturing Cities. Retrieved from
7. European Environmental Agency (2012) Urban adaptation to climate change in Europe - Challenges and opportunities for cities together with supportive national and European policies. Retrieved from https://www.eea.europa.eu/publications/urban-adaptation-to-climate-change
8. European Environmental Agency (2016) Urban adaptation to climate change in Europe — Transforming cities in a changing climate. Retrieved from https://www.eea.europa.eu/publications/urban-adaptation-2016
9. European Union (2011) Climate-friendly cities. A handbook on the tasks and possibilities of European Cities in Relation to Climate Change.
10. European Union (2013) Decision No 1386/2013/EU of the European Parliament and of the Council of 20 November 2013 on a General Union Environment Action Programme to 2020 'Living well, within the limits of our planet' (7th Environment Action Programme)

11. FP7 Cooperation Work Programme 2012: Environment (including climate change).
12. Horizon 2020 Work program 2014-2015. Climate action, environment, resource efficiency and raw materials (European Commission Decision C (2015)7154 of 23 October 2015)
13. Horizon 2020 Work program 2014-2015. Secure societies – Protecting freedom and security of Europe and its citizens (Consolidated version following (European Commission Decision C (2015)2453 of 17 April 2015)