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PERSPECTIVE

What is needed to make climate resilient development pathways planning actionable in cities?

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Abstract

Climate Resilient Development Pathways (CRDP) is a promising concept for cities to integrate climate change mitigation and adaptation to achieve sustainable development for all. Although CRDP aims to leverage synergies and co-benefits while limiting trade-offs between a city's many objectives, there is no framework or approach for planning and implementing CRDP. A structured approach is needed to move from theory to practice. In this perspective paper, we outline three functional elements, or building blocks, for a CRDP planning framework. The building blocks are (1) identifying and evaluating interactions between adaptation, mitigation and sustainable development, (2) addressing time and uncertainty in planning, and (3) delivering specialized information for CRDP. These building blocks are informed by practice, drawing lessons from literature on recent efforts to integrate climate adaptation and mitigation in European cities, and from our experiences with adaptive pathways planning and climate services development. As cities and scholars are turning their attention to CRDP planning, the building blocks can help focus priority areas for development, informed by practice.

1. Introduction

Cities are widely recognized for their vulnerability to climate hazards and their central role in achieving climate ambitions and sustainable development goals (Hsu *et al* 2019, Adelekan *et al* 2022). Constraints on space and resources in the urban environment can cause conflicts between a city's many planning objectives. Decision makers increasingly face the need to prioritize and make trade-offs between adapting to climate change, achieving development goals and reducing emissions, among other priorities (Bai 2023). Integrated approaches to planning aim to maximize benefits by leveraging synergies and co-benefits, while minimizing trade-offs (Dovie *et al* 2020, Suckall and Tompkins 2020, Boyd *et al* 2022, Malekpour *et al* 2023). The concept of Climate Resilient Development offers cities a framework for aligning their many objectives on climate and development.

Climate Resilient Development (CRD) is the integration of climate change mitigation and adaptation to achieve sustainable development for all. **Climate Resilient Development Pathways** (CRDP) are the trajectories *over time* that integrate these objectives (Schipper *et al* 2022). CRD(P) aim to consolidate synergies and co-benefits between mitigation, adaptation and sustainable development, while identifying and limiting potential conflicts and trade-offs. For cities, sustainable development is a broad ambition, encompassing many sectors, from utilities and public health, to ecosystems, livelihoods, and transportation, among others (United Nations 2015). CRDP also requires that SDG goals, such as justice, are inseparable from traditionally concrete policies and actions, like reducing flood risk or the energy transition. In this context, CRDP offers positive and potentially transformational development trajectories for cities tackling a multitude of challenges and interests (Eriksen *et al* 2024).

While the concept of CRDP is gaining traction, it is not yet operational for planners (Singh and Chudasama 2021, Werners *et al* 2021). Recent work on CRDP in cities suggests a range of ideas and approaches are emerging (e.g. Simpson *et al* 2023, Creutzig *et al* 2024). Meanwhile, several concepts related to CRDP have also been used in cities, such as Climate Compatible Design (Mitchell and Maxwell 2010, Robinson *et al* 2022), Climate Smart Development (Akbar 2014), the Water-Energy-Food Nexus (Gondhalekar and Ramsauer 2017) and 'Adaptigation' (Langlaise 2009, Göpfert *et al* 2019). None of these approaches, however, integrate mitigation, adaptation and development planning over time, as required by CRDP. There is also limited evidence of CRDP plans when looking at other planning domains and across regions (Taylor *et al* 2023). Instead, recent examples elaborate, for instance, adaptation pathways in a development context (Gajjar *et al* 2019, Pandey *et al* 2021, Butler *et al* 2022), pathways to resilience (Kareem *et al* 2020), or pathways to sustainability (Butler *et al* 2016, Pearson and Dare 2021).

The overarching concept of pathways planning has a longer history than CRDP and has been applied widely in the field of adaptation, as well as in mitigation, resilience, and sustainable development (Werners *et al* 2021, Sparkes *et al* 2023, Haasnoot *et al* 2024). In the urban context, pathways planning has been used to adapt to sea level rise, heat stress and flooding, for example (Kingsborough *et al* 2016, 2017, de Ruig *et al* 2019, Hall *et al* 2019). Different conceptualizations and practices are found in pathways planning, but it has not yet been elaborated to integrate CRD measures over time, or to evaluate their performance, especially against multiple policy objectives (Taylor *et al* 2023). Nevertheless, the rich theory and practical experience with pathways planning approaches, and the supporting tools that have been developed, could contribute to a CRDP approach.

CRDP still requires important theoretical work, and at the same time, it must also be operationalized more practically to inform decision making and planning (Werners *et al* 2021). Establishing a framework or approach can offer guidance to decision makers and practitioners facing uncertainty and an unclear path toward new challenges like CRDP planning. A defined framework can also serve as a valuable yardstick from which further developments and innovations can be referenced and understood. Additionally, a recognizable framework can generate a community of practice and shared learning through findable published work, conference sessions and practitioner groups, among others.

In response to the current calls to make CRDP actionable, we offer a practical perspective on the fundamental components that would be required by a CRDP planning framework or approach. We call these components 'building blocks', because we see them as the basic functional elements from which a framework or approach for CRDP can be formed and built upon. The building blocks are grounded in planning practice. First, through a synopsis of literature on joint adaptation and mitigation planning in European cities, to understand the barriers and enablers experienced in recent attempts to integrate climate action. Second, by drawing lessons for CRDP from working with cities in adaptation planning and specifically, our decade of experience developing and using adaptive pathways planning and climate services. Taking these insights along with the CRDP principles laid out by the IPCC and others, we identify three functional elements, or building blocks, for operationalizing CRDP planning: (1) identifying and evaluating interactions between adaptation, mitigation and sustainable development, (2) addressing time and uncertainty in planning, and (3) delivering specialized information for CRDP.

With this perspective, we offer a pragmatic and practice-oriented starting point to making CRDP more actionable in planning. We believe that a planning framework or approach will support decision makers move toward CRDP. Identifying the functional elements, or building blocks, of such a framework is the first step. In the following section we summarize current literature on integrating climate adaptation and mitigation in European cities to understand some of the needs for a CRDP planning approach. We then propose and explain the three building blocks for a CRDP planning framework. Finally, we suggest next steps for developing CRDP planning in practice.

2. Learning from current climate action in European cities

Most climate action in European cities has been characterized by separate plans for mitigation and adaptation, with mitigation outpacing adaptation efforts . However, there is a growing focus on adaptation and accelerating its implementation (Bednar-Friedl *et al* 2022). Attention to interactions between adaptation and mitigation measures has gained traction in the last decades (Sebestyén *et al* 2023). This is especially important in cities, where measures must often be taken in the same locations and draw from the same limited resources. The Covenant of Mayors, for instance, stimulate their signatories to develop Sustainable Energy and Climate Action Plans (SECAPs) that integrate mitigation with adaptation in the context of a just transition (Pasimeni *et al* 2019, D'Onofrio *et al* 2023).

Nevertheless, **joint climate action** plans, which consider both adaptation and mitigation, exist in less than a quarter of European cities (Reckien *et al* 2018, Göpfert *et al* 2019) and the level of integration in these plans is not

high (Grafakos *et al* 2020). While joint climate action plans aim to bring together or integrate adaptation and mitigation, they are not CRDP, as they do not explicitly integrate the sustainable and just development objective of CRD, or the time dimension of pathways. Still, joint climate action planning can provide insights into where interactions between adaptation and mitigation are already recognized, and the enablers and challenges cities experience when integrating these policy objectives. We, therefore, take joint climate action planning as an imperfect but helpful proxy to harvest lessons for CRDP in cities. In this section, we synthesize experiences with joint climate action planning and summarize key enablers and barriers. We then draw lessons for what is needed to make the concept of CRDP planning in cities actionable for decision makers.

2.1. Joint climate action planning in European cities

In European cities, joint climate action is most evident in urban greening and green infrastructure (Pasimeni *et al* 2019, Sebestyén *et al* 2023), where the greatest potential for synergies and co-benefits is also found (Sharifi 2021). Other sectors with documented joint climate action planning are construction (materials and building practices), and energy efficient buildings (retrofitting and new buildings), and low-carbon transportation, such as low-emission public transit and active mobility like walking and cycling (Landauer *et al* 2015, Sharifi 2020, 2021, Sebestyén *et al* 2023). Spatial planning and land use, water management (closely linked with greening), and education and awareness are also recognized as areas with joint climate actions (Sebestyén *et al* 2023). Current joint climate action is characterized by having generally broad support and being considered low regret. This implies that cities are still prioritizing win-win solutions and avoiding tradeoffs.

Cities are more likely to recognize synergies and co-benefits in plans (Caparros-Midwood *et al* 2019), and there is more research on the 'positive' interactions between measures, compared to conflicts and trade-offs (Grafakos *et al* 2019). However, there is limited quantified knowledge of the interactions between adaptation, mitigation and development measures (Sharifi 2020, 2021). Further, when co-benefits are recognized in plans, they are rarely substantiated or quantified (Grafakos *et al* 2019, 2020). For instance, urban greening projects aimed at attenuating hazards like flooding and heat, may suggest broad co-benefits for ecosystems and wellbeing for instance, without substantiating evidence or analysis. Furthermore, trade-offs may be overlooked or omitted, such as the use of limited space and tendency for urban greening to gentrify areas and price out low-income populations (Geneletti and Zardo 2016, Chapple *et al* 2022, Rocha *et al* 2024), contravening CRDP justice principles.

Despite the growth of joint climate action plans, there is still limited evidence of cities setting out to design or to take an integrated planning approach to achieve multiple benefits. Instead, synergies and co-benefits seem to be opportunistic rather than designed outcomes. For example, co-benefits of a particular measure are recognized, and the measure then becomes the preferred option, or co-benefits are sought to bolster an already preferred measure (Grafakos *et al* 2019, Erlwein *et al* 2023).

While literature suggests that cities' climate action plans remain largely siloed, this may not be the full picture. From our experience working with European cities, we see that they often link adaptation with the energy transition and aspects of spatial planning, justice and sustainable development over time, at least at the ambition or vision level. For example, Malmö's Comprehensive Plan sets forth a long-term vision for social, economic and environmental sustainability, integrating topics from climate change to migration (Malmö stad 2018). Meanwhile, Cork's Climate Action Plan offers an ambitious vision for achieving SDGs and net-zero emissions while adapting to increasing risks from climate change (Cork City Council 2024). Milan approved an ambitious climate action plan in 2019 (Milan Air and Climate Plan 2019), which was quickly linked to the COVID-19 response in 2020 (Comuno di Milano 2020). However, we also see that these visions are hard to translate into action and can overlook trade-offs and lock-ins. Unfortunately, there is little reported in literature on these integrated visions or on cities' experiences translating them into action.

The specifics of joint climate action are unique to each city; however, literature suggests that several enablers and barriers have emerged across European cities. The enablers are clear guidance, participation in international networks and participatory planning practices. The barriers stem from inadequate knowledge and tools, funding and financing, and several institutional and administrative conditions. These enablers and barriers are elaborated below.

2.1.1. Enablers of joint climate action in European cities

Clear guidance mobilizes cities' resources and motivates integrated climate action. In European countries, the presence of national legislation has been found to significantly increase the number of cities with joint climate action plans (Reckien *et al* 2018) and to increase the level of integration of those plans (Grafakos *et al* 2020). Policies that prescribe integration, such as regeneration, building codes, private sector regulation, joint guidance, and incentives for behavior change can stimulate synergistic measures (Landauer *et al* 2015).

A city's participation in international networks for exchange, capacity building and mobilizing action is another enabler for integrated action (Reckien *et al* 2015, Erlwein *et al* 2023, Salvia *et al* 2023) and leads to more advanced plans (Heikkinen *et al* 2020). International networks, such as the EU Covenant of Mayors for Climate and Energy, are particularly valuable where national legislation is lacking or in smaller cities with less resources and capacity (Reckien *et al* 2018). Participation in networks has also been the strongest factor in cities applying for the European Cities Mission and participating in international (EU) projects, which stimulate innovation (Heikkinen *et al* 2020, Salvia *et al* 2023). Shared institutional settings, such as joint departments with dedicated and capacitated personnel generate more integrated climate action (Landauer *et al* 2019, Göpfert *et al* 2020, Grafakos *et al* 2020). Meanwhile, public participation has been found to lead to more transformative adaptation and more ambitious mitigation planning (Cattino and Reckien 2021), and structured collaborative processes are reported to promote more transdisciplinary outcomes (Erlwein *et al* 2023).

2.1.2. Barriers to joint climate action in European cities

Inadequate knowledge and tools to evaluate joint climate action is a barrier to their creation and implementation (Grafakos *et al* 2020). This barrier has two components. First, the limited understanding of the synergies, co-benefits, conflicts, and trade-offs between actions (Sharifi 2020, 2021), and sec.ond, the limited capacity to quantify the costs and benefits so that plans can be compared by decision makers (Grafakos *et al* 2020). This challenge is exacerbated in the case of urban greening and nature-based solutions, where integrated climate action is most prevalent and promising . The emergent character of nature makes it difficult to quantify the performance of greening measures for objectives like flood attenuation, but even more so for potential (co-) benefits like public health impacts or ecosystem services (Geneletti and Zardo 2016, Kabisch *et al* 2016).

Funding and financing pose additional challenges for cities attempting joint climate action. There is no clear or consistent approach for cities to finance plans that fall outside traditional funding streams for adaptation, mitigation and development, and narrow tendering rules (Landauer *et al* 2015, Grafakos *et al* 2019). Traditional financing leads to siloed investments that can be inefficient and fail to account for trade-offs or achieve synergies and co-benefits (Gondhalekar and Ramsauer 2017). A lack of joint funding programs limits cities' ability to implement integrated actions (Landauer *et al* 2019).

Some institutional and administrative conditions are also recognized as barriers to integrated planning and CRDP. Capacity, in terms of having sufficient personnel, their competencies and political support is a key challenge (Bednar-Friedl *et al* 2022, Gersonius *et al* 2016. Administrative structures and unclear authority and responsibility for domains that become integrated under joint climate action is a further barrier (Landauer *et al* 2015, McEvoy *et al* 2020). Finally, awareness, communication and coordination across domains and departments is a recognized challenge for integrated planning and action (Gersonius *et al* 2016).

2.2. Lessons for climate resilient development pathways from joint climate action

In most European cities, the practice of joint climate action planning is still in an early stage. However, active monitoring has provided insights and lessons that can inform CRDP planning. Financial and institutional systems, as well as planning procedures, will require clever restructuring to support integrated CRDP and overcome current barriers. City networks, like RCN, C40, ICLEI and the Covenant of Mayors, may be able to motivate and guide cities in CRDP planning and contribute to capacity building, learning and exchange between cities. Legislation and policies setting a CRDP approach can further catalyze action. However, guidance on *how* to plan CRDP can help cities take integrated action when they lack know-how or capacity. Further, providing information tailored to CRDP can help cities better identify and evaluate trade-offs and realize co-benefits and synergies. Finally, it strikes us by omission that current joint climate action planning does not appear to address the long-term nature of these plans and the uncertainty decision-makers face when balancing unclear future needs with near-term priorities. Time and uncertainty will need to be addressed explicitly in developing pathways for climate resilient development.

The hard work of understanding and creating the institutional, societal and financial conditions conducive to CRDP planning is beginning (Cartwright *et al* 2023, Simpson *et al* 2023, Taylor *et al* 2023). In the remainder of this paper, we focus on three functional components, or building blocks, that will be required for an actionable CRDP planning framework or approach for cities.

3. Building blocks for an actionable approach to climate resilient development pathways planning in cities

Drawing on the lessons from joint climate action planning in section 2 and a rich experience with adaptive pathways planning and climate services development, we propose a set of building blocks for a CRDP planning approach (figure 1). Building blocks are essential *functional* elements of a planning approach or framework.

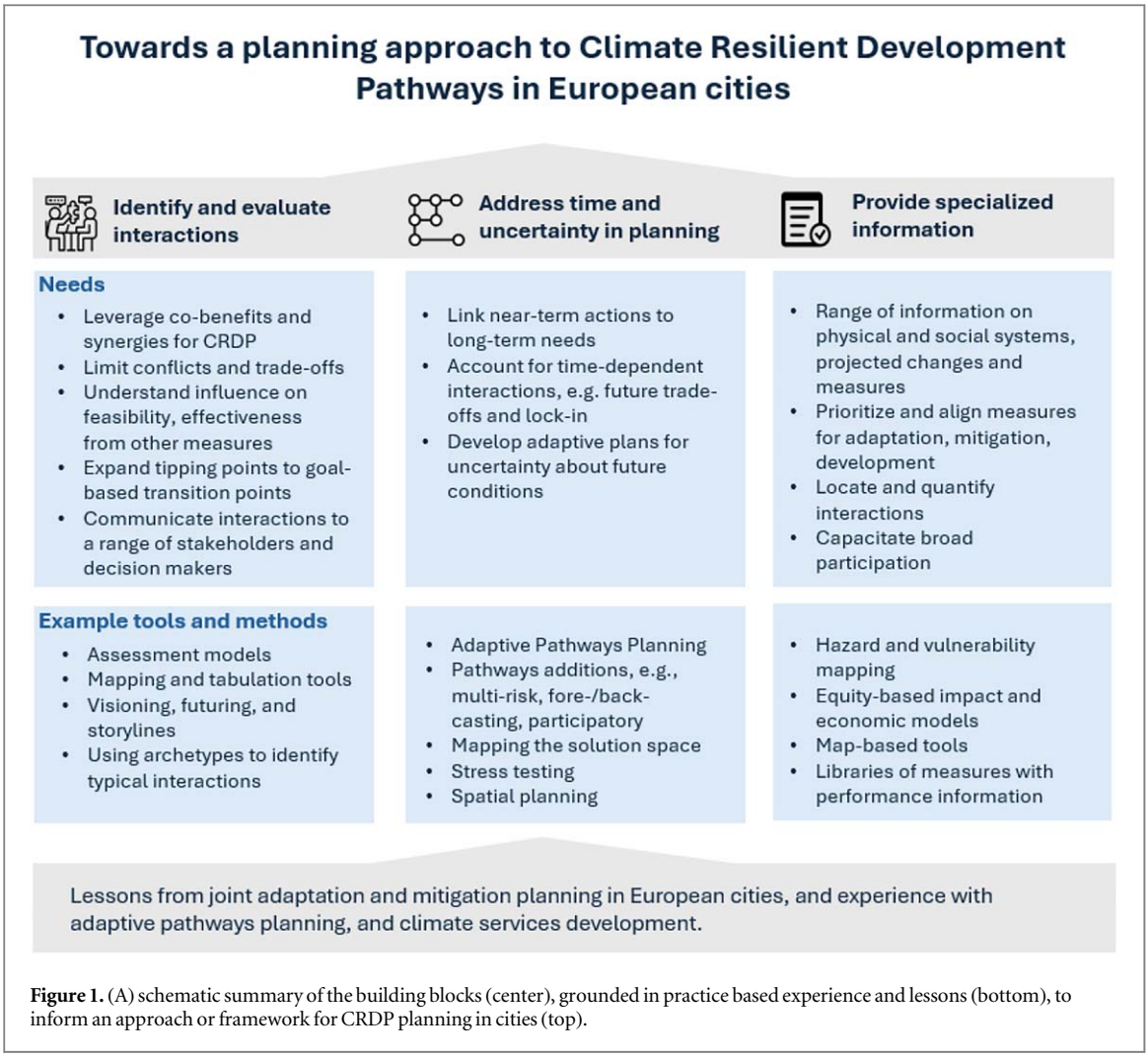

Figure 1. (A) schematic summary of the building blocks (center), grounded in practice based experience and lessons (bottom), to inform an approach or framework for CRDP planning in cities (top).

They must still be developed and structured into actionable support for CRDP planning in cities. In this section we describe and elaborate the three building blocks:(1) identifying and evaluating interactions between adaptation, mitigation and sustainable development, (2) addressing time and uncertainty in planning, and (3) delivering specialized information for CRDP.

3.1. CRDP requires identifying and evaluating interactions

Recognizing and accounting for the interactions between adaptation, mitigation and sustainable development is central to CRDP planning. A key building block to operational CRDP is identifying and evaluating interactions to leverage synergies and co-benefits and to avoid or limit tradeoffs and conflicts. These interactions also need to be communicable and decision relevant. Different approaches can be taken to assessing interactions. For example, causal loop diagrams and system-dynamics have long been used to assess interactions in complex and multistakeholder contexts (Forrester 1994), integrated assessment modeling is used to quantify a variety of impacts from changes in social and physical systems (Fisher-Vanden and Weyant 2020), tabulations are often used in IPCC reports to systematically map interactions and side effects (e.g. Bezner Kerr *et al* 2022), and stakeholder activities can capture diverse knowledge and experiences and to overcome limits to modeling approaches (Butler *et al* 2016).

Exploring interactions between actions with different objectives and for different stakeholders quickly becomes complex. This requires methods to manage and communicate complexity in ways that highlight decision relevant interactions and information, without becoming lost in details (Hadjimichael *et al* 2024). For example, in disaster risk management, Schlumberger *et al* (2022) developed a staged approach for designing pathways for multiple hazards and actors. This approach builds up layers of complexity and surfaces trade-offs and synergies between sectors and hazards in a digestible way. In adaptation pathways planning, visioning approaches like forecasting and back-casting have also been used to connect near-term decisions and priorities to longer-term futures (Mendizabal *et al* 2021, Bergeret and Lavorel 2022, van Alphen *et al* 2022). Where tabulations or causal loop diagrams may quickly become hard to follow and risk obscuring the 'big picture' of

CRDP and transformational change, visioning can broaden ideas about the possible solution space (Campos *et al* 2016, Harcourt *et al* 2021). Future visioning approaches could help create compelling narratives for stakeholders and decision makers, inspire more expansive views during ambition setting and catalyze transformative action (Nalau and Cobb 2022). However, analytical methods will still be needed to ensure that visions are grounded in systematic and comprehensive evaluations of interactions. This can limit biases and blind-spots, and the interactions in narratives are substantiated and quantified where possible. Approaches like storylines can help create meaningful narratives from complex information and provide opportunities to explore cascading impacts (van den Hurk *et al* 2023).

It is also critical to understand how actions taken for one policy objective, like adaptation, influence the feasibility or effectiveness of other actions (i.e. adaptation, mitigation or development), over time. In adaptive pathways planning, tipping points are used to indicate when a performance threshold is reached, and additional or new actions are needed (Haasnoot *et al* 2024). CRDP will need to address a broader range of transition points, when critical decision moments occur for adaptation, mitigation and sustainable development objectives. The concept of tipping points will need to be elaborated to account for mitigation and sustainable development objectives, which are typically framed in terms of goals and (moving) targets, rather than the performance thresholds used in adaptation. Archetype pathways can be useful for indicating transition points for different kinds of actions and cities (Haasnoot *et al* 2019).

Evaluating the interactions between measures or policies requires a deep and broad understanding of the effects and effectiveness of individual measures. This is an existing knowledge gap highlighted in section 2. In some cases, this gap may be addressed through research, while in other cases, climate services could be tailored to provide CRDP information needs (see section 3.3), and expert elicitation and stakeholder evaluations can also be used.

3.2. CRDP requires addressing time and uncertainty in planning

CRDP demands a long-term perspective. While decision makers are tackling current challenges and priorities, near-term actions should be linked to long-term needs to ensure sustainability and the ability to adapt to future climate change. Adaptation, mitigation and sustainable development are each dynamic processes with emergent properties and the interactions between them change over time. For example, developing affordable, energy efficient homes in a central, waterfront area may support a city's development and mitigation ambitions for the coming decade, with no tradeoffs for adaptation. However, if flood risk increases over time, the new development may have created a situation in which more people and assets are exposed to flooding and greater levels of adaptation are required. Meanwhile, the development has foreclosed effective adaptation options like natural flood plains. In adaptive pathways planning, mapping the solution space (Haasnoot *et al* 2020) helps to identify 'no regret' and 'least regret' actions, as well as decisions that could lead to 'lock-out' and 'lock-in' over time.

The dynamic nature of interactions between adaptation, mitigation and sustainable development also creates conditions of deep uncertainty for decision makers and requires adaptive plans that are robust and flexible for changing conditions. Approaches, like Dynamic Adaptive Policy Pathways (DAPP) support decision making under deep uncertainty (Walker and Bloemen 2019). Traditional DAPP planning, however, was developed for adaptation and does not account for multiple policy objectives and their interactions. Nevertheless, DAPP could be taken as a starting point and elaborated for the needs and complexity of CRDP. DAPP has been adapted to many different contexts and policy questions, it offers a systematic approach for planning under deep uncertainty and comes with a wealth of experience and tools from research and practice (Haasnoot *et al* 2024) that can be tailored to CRDP needs.

3.3. CRDP requires providing specialized information

Actionable CRDP planning creates a range of information needs. These include projections for different future conditions and the uncertainty ranges over time (e.g. increasingly stressed water supply and potential population growth). Additionally, policy objectives (e.g. adaptation needs, mitigation targets and development goals) must be made concrete. The effectiveness of different measures, their interactions, and under what conditions transition points occur is needed for anticipatory action. Distributional impacts of different measures for different populations, or for nature versus people, and different stakeholder needs and values are important in achieving more just and sustainable plans. Many climate services have been developed to help European cities understand their climate risks and plan adaptation. In particular, many of these climate services focus on areas where integrated climate action is already recognized, namely urban greening, spatial planning and land use, and water management. Many are also designed to improve participation in planning or facilitate awareness and education. These climate services can be tailored to offer some of the specialized information needed for CRDP planning. In particular, we identify four areas where climate services can support CRDP: prioritizing climate action, linking development priorities to climate action, identifying and evaluating interactions, and supporting stakeholder participation in planning.

Climate services can help prioritize and align climate action by identifying where and when adaptation and mitigation is needed. Existing climate services that map vulnerability and risk to climate change under different scenarios can form the basis for identifying urgency and hotspots for adaptation. Mitigation priorities are more often defined by sectors (e.g. transportation, utilities, etc) and building type (e.g. private, public ownership) and already have clearer targets for near and mid-term horizons. Climate services could map place-based sector and building mitigation targets and the actions to achieve them with adaptation hotspots and measures in a city.

Climate services can also link development priorities to climate action by identifying where and when opportunities and needs occur for adaptation and mitigation, related to other urban development targets. Some climate services now include development aspects, such as social vulnerability data (e.g. Fitton *et al* 2021), or actions like securing strategic land for future adaptation needs, but more is needed in this area. Further, climate services can support sustainable and just development by providing indicators related to co-benefits and the distribution of benefits (Juhola *et al* 2022, McCullagh *et al* 2024). While other tools capacitate individuals in participatory planning through the provision of accessible information and evidence-based evaluations of measures (McEvoy *et al* 2018). Examples of existing tools and capacities that can be tailored to better support CRDP include overlaying maps of climate hazards, social vulnerability, and critical infrastructure to define hotspots for action; overlaying adaptation, mitigation and development timelines to identify potential for synergistic action, conflicts and critical decision moments; using economic tools that evaluate the distributional equity of alternative strategies (e.g. FloodAdapt) or value of nature; and spatial planning tools for neighborhood design that capture the effectiveness of measures and co-benefits (e.g. Climate Resilient Cities Toolbox).

Climate services can be tailored to identify and evaluate interactions between adaptation, mitigation and development actions, and how these interactions change over time. For example, many searchable libraries exist for adaptation actions (e.g. climatescan.nl, resin-aol.tecnalia.com, adaptationactions.greenbook.co.za, climateapp.nl) and some already attempt to provide indications of co-benefits and trade-offs for mitigation or more broadly (e.g. Climate Resilient Cities Toolbox, C40 Adaptation and Mitigation Interaction Assessment Tool, and the SDG Climate Action Nexus Tool). Such tools could be elaborated to include measures for mitigation and development, or provide systematic information or evaluation of interactions for mitigation and development. Additionally, for measures already recognized for their CRDP potential (section 2.1), opportunity mapping could help identify locations or archetype locations in the urban landscape where conditions are most favorable for implementation (e.g. flat roofs for water retention and solar panels, areas suitable for greening or recreation). By identifying and evaluating the performance of actions, tailored climate services could play a role in defining transition points and quantifying the effectiveness of actions over time, also under different levels of climate change.

Finally, some climate services are designed to facilitate or enrich stakeholder participation in planning by underpinning dialogue with information or by structuring the participatory process to ensure procedural justice. Such tools can help ensure diverse stakeholders, knowledges and experiences are included in CRDP planning. Services and tools for CRDP can also collect local information and data through community engagement, support future visioning processes, participatory planning and co-design, and elicit stakeholder values and indigenous knowledge, among others. In adaptation planning, interactive dashboards, apps, online platforms and collaborative modeling activities have all been used to support both the process and content of participatory planning (McEvoy *et al* 2018). Creative approaches, such as theater have also been used (Bubeck *et al* 2024). Similar services could be tailored to support CRDP design.

4. Next steps for operationalizing CRDP planning in cities

In this perspective, we have proposed three building blocks for an operational framework or approach to CRDP planning for cities. The building blocks are (1) identifying and evaluating interactions between adaptation, mitigation, and development, (2) addressing time and uncertainty in planning, and (3) providing specialized information for CRDP. These building blocks are based on lessons from joint climate action planning in European cities and our experience with pathways planning and climate services. The building blocks are essential functional components that can be further developed into a structured approach or framework, with tools and climate services to support CRDP plans and decision making. Established approaches for adaptation, like dynamic adaptive policy pathways (DAPP), can provide a useful starting point to be elaborated for CRDP. Building on an established approach also offers a wealth of experience and tools that can be tailored to CRDP needs.

Further research is needed to support and inform CRDP planning and elaborate the building blocks. For instance, more and better information on the performance of adaptation, mitigation and development actions to better understand their interactions over time. Additionally, approaches for monitoring CRDP progress and transition points will be vital for developing and implementing adaptive plans as new information comes to light (Sparkes *et al* 2023). Methods are also needed for assessing aspects of justice and ensuring equitable outcomes

over time (Reckien *et al* 2017, Juhola *et al* 2022). A robust exchange of experiences and approaches to CRDP via documented case studies and systematic assessments will be essential for creating shared learning. Exchanging early and often will allow progress to be monitored and contribute to accelerating the transition from siloed planning to CRDP. A defined framework or approach would support this learning by fostering a community of findable practitioners, scholars and cases, and serve as a benchmark for innovations.

Of course realizing transformational CRDP requires more than the kind of practical decision support suggested by these building blocks. Institutionalization and financing CRDP plans remain significant challenges for implementation. Also, how to meet a range of stakeholders where they are and engage them in a complex transformational process (Colloff *et al* 2021). Further, we recognize that our building blocks are informed by experiences in European cities and may not fully reflect the contexts and needs of cities in other parts of the world, or in other planning domains. However, it is our view that these building blocks are sufficiently fundamental to the concept of CRDP that they may contribute to all CRDP planning. Developing a set of CRDP archetypes as guidance for different types of cities and contexts could be one way to leverage the common conditions between cities and build more generic support for CRDP planning.

European cities are already planning climate adaptation, mitigation and (sustainable) development. There are also some efforts to bridge the silos between these areas and CRDP offers a promising concept to achieve synergies and co-benefits, while limiting trade-offs between these objectives. However, CRDP remains a nebulous concept that must still be operationalized in a way that manages the inherent complexity for planners and decision makers to better align actions. With many scholars and practitioners turning their attention to CRDP, we hope these building blocks help focus and prioritize developments and ensure that the lessons and experiences from joint climate action and pathways planning are taken along.

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