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Why climate change adaptation in cities needs customised and flexible climate services

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ABSTRACT

Cities are key players in climate change adaptation and mitigation due to a spatial concentration of assets, people and economic activities. They are thus contributing to and especially vulnerable to climate change. Identifying, planning, implementing and monitoring respective measures in cities is challenging and resource consuming. The paper outlines challenges for adaptation, discusses most common approaches and argues why implementation of theoretical methods has its shortcomings. Based on case studies, an innovative, practice-oriented approach has been tested to develop a climate service prototype product. It provides a general framework that allows a flexible and customised support for cities to adapt to expected impacts of a changing climate.

Practical implications Urban areas are key players with respect to climate change. They are not only contributing to climate change, they will also be affected by expected climate change impacts such as urban and river floods after heavy rain events or heat stress, which will most likely occur more frequently and with increasing intensity in the future (Jacob et al., 2014; Revi et al., 2014; Collins et al. 2013). This is why cities need to adapt to the expected changes on time to protect inhabitants, assets, and elements of critical infrastructures. Given this background several questions immediately arise from the point of view of the city: how can we respond to climate change impacts or what information is needed to choose right and reasonable strategies and measures? Further questions arise from the point of view of climate services: How can we best support cities with respect to their individual needs? These are crucial questions especially when considering, that the focus has only been on climate change mitigation for a long time.

A common approach to support adaptation in urban areas is the provision of best-practices measures, for instance via web-portals such as the Austrian Database on Climate Change Adaptation,[1] the German *KomPass-Tatenbank*[2] with best-practice examples of adaptation measures or the Climate-Adapt web portal[3] of the European Environment Agency. This approach however has its shortcomings. It might be suitable as a first step to see what has been done elsewhere but solutions that worked in one city do not necessarily work in another. There are no one-size-fits-all-solutions because cities are complex networks with very specific framework conditions in many aspects such as location, urban climate, population density, financial and human resources, and stakeholder interests. To transfer a measure or strategy that was specifically designed for a given framework to another city, much meta-information is needed. However, they are rarely provided on web-portals. Moreover, adaptation measures that result from research projects often receive funding for the development, which other cities may not have. Thus, developed measures are only rarely implemented due to limited project durations. Since limited financial resources are a major topic for many cities, a lack of funding opportunities may prevent the next city from taking action.

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[1] http://www.klimawandelanpassung.at/ms/klimawandelanpassung/de/kwadatenbank/.
[2] http://www.umweltbundesamt.de/themen/klima-energie/klimafolgen-anpassung/werkzeuge-der-anpassung/tatenbank.
[3] http://climate-adapt.eea.europa.eu/.

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Based on experiences gained from several case studies conducted in different cities in Germany, stakeholder consultation processes, interviews, literature analyses and survey evaluations it became clear that a tool is needed that addresses the whole range of actions needed for climate change adaptation. This tool needs to be flexible enough to ensure applicability in all cities, independent of their specific settings. This work refines the basic idea of an innovative tool to support cities in their adaptation process and presents an innovative climate service prototype – the *Stadtbaukasten* (adaptation toolkit for cities). It currently contains eleven module groups covering the most important fields that are relevant for planning, developing and implementing adaptation strategies or measures. While some of these module groups have been tested successfully and are ready for application, others are still under development. This development has been done in close cooperation with the cities to ensure that their needs are met.

The *Stadtbaukasten* contains some basic modules such as ''communication", which is needed to raise awareness to local problems and involve all relevant stakeholders such as representatives from different local authorities or from the private sector. It also includes more content-related modules such as the provision of local climate information that are inevitable for further adaptation actions focused on climate impacts. Officials or employees of cities can choose single modules from the *Stadtbaukasten*-portfolio or a combination according to their specific needs. The structure also allows for each of the modules, to be excluded if no longer needed. There is also the possibility to co-develop customized, new modules if required. The entire module-framework or only selected parts can also be integrated in existing decision-making process chains to reduce additional administrative efforts and thus facilitate adaptation action. This is of utmost importance since in many cases adaptation activities compete with activities in other sectors such as educational and cultural services. In conclusion, the climate service prototype enables successful adaptation by supporting the development of customised solutions according to the local situation on a case-by-case basis.

1. Introduction

Urban areas are key players when it comes to climate change. Currently, a little more than half of the world's population lives in urban areas with an expected increase of this share to approximately two thirds by 2050. This trend can also be observed in Germany with a projected increase in urban population from roughly 75% in 2014 to 83% in 2050 (United Nations, 2015). In addition, a major part of societies' assets and economic activities is placed in cities. This makes cities a contributor to climate change and, at the same time, particularly vulnerable to its impacts. To reduce both CO_2 emissions as an accelerator of climate change and the resulting vulnerability, mitigation and adaptation need to be addressed simultaneously. Even with a substantial reduction of emission rates, the stock of GHGs will continue to rise (Victor et al., 2014). Therefore, one of the main fields of work for city administrations in the future is the implementation of adaptation measures. It has to be highlighted that at the same time, climate change can also open up opportunities for cities (Groth et al., 2015; Ricardo-AEA, 2013; CDP, 2012). According to Moser and Ekstrom (2010), adaptation involves changes in social-ecological systems in response to actual and expected impacts of climate change in combination with non-climatic drivers such as demographic change or economic development.

Adaptation strategies can range from short-term to longer-term activities, which aim to meet more than climate change goals alone and may or may not succeed in moderating harm or exploiting beneficial opportunities. Furthermore, it is important to clearly define and distinguish between the terms adaptation, resilience and vulnerability, as they are strongly related. In its 5th assessment report the IPCC (IPCC, 2014) defines adaptation as ''the process of adjustment to actual or expected climate and its effects", vulnerability as the ''propensity or predisposition to be adversely affected", whereas resilience is the ''capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation". Therefore, a resilient system is less vulnerable than a non-resilient system, but this relation does not necessarily imply symmetry, and hence vulnerability is not the opposite of resilience (Gallopín, 2006).

Due to climatic and non-climatic drivers, numerous interactions between different sectors, and a high number of involved stakeholders with different interests, an integrated and holistic approach is needed to equivalently address the different mentioned dimensions. However, to date a large number of cities has neither developed comprehensive adaptation strategies, nor have they implemented respective adaptation measures in order to respond to expected climate change impacts. A large number of cities are still focusing on mitigation strategies only (e.g. Revi et al., 2014; Carter, 2011), and in other cases are starting to prioritize the development of an adaptation strategy once they have been affected by an extreme weather event. However, local councils are key actors when it comes to the development, implementation and monitoring of adaptation strategies and respective measures. In doing so, they are embedded in a complex frame that is influenced by internal and external factors (Groth and Nuzum, 2016; Umweltbundesamt, 2015; Kalafatis et al., 2015; Ricardo-AEA, 2013). This includes, but is not limited to, legislation, different (and conflicting) interests of administrative units, missing or incomplete knowledge of climate change and its impacts, limited financial and human resources, geographical location, city structure, size and density, urban-rural relationships, inhabitants, cultural habits, operational capability and individual backgrounds as well as interests of involved stakeholders. All this is equally important and needs to be taken into account (Bender et al., 2014, 2015; Cortekar et al., 2015; Dilling et al., 2015; Terenzi and Westerlind Wigström, 2014; Ricardo-AEA, 2013).

Finally, the needs of cities to adapt differ according to already established actions, different exposure, and vulnerabilities to climate change impacts. All this taken together raises the question how cities could best be supported in their efforts to adapt to climate change. The initial idea to develop a flexible and customizable consulting service is based on previous works particularly from the *KLIMZUG*-network (Biebeler et al., 2014) and an assessment of needs within the sectors agriculture and water management (Bender et al., 2012). Both activities indicated that needs and requirements of users vary broadly even within specific stakeholder groups. Therefore, novel approaches are needed to support cities in adapting to expected local and regional changes of climatic conditions and related impacts on an individual basis. The so far most common approaches were in many cases considered too rigid. This paper presents and discusses the results and conclusions of a long process starting with the simple idea to meet the needs of cities more properly, i.e. to provide a flexible framework that allows cities to choose exactly those parts relevant for their specific needs, and ending with the presentation of a climate service prototype. The whole prototyping process was focused on

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