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CITIES, ENERGY AND BUILT ENVIRONMENT

Vol.8 n.2 August 2015

print ISSN 1970-9889 e-ISSN 1970-9870
University of Naples Federico II

TeMA Journal of
Land Use, Mobility and Environment

CITIES, ENERGY AND BUILT ENVIRONMENT

2 (2015)

Published by
Laboratory of Land Use Mobility and Environment
DICEA - Department of Civil, Architectural and Environmental Engineering
University of Naples "Federico II"

TeMA is realized by CAB - Center for Libraries at “Federico II” University of Naples using Open Journal System

Editor-in-chief: Rocco Papa
print ISSN 1970-9889 | on line ISSN 1970-9870
Lycence: Cancelleria del Tribunale di Napoli, n° 6 of 29/01/2008

Editorial correspondence
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Cover image: The ZCB Zero Carbon Building, designed by Ronald Lu & Partners, conceived to promote a low carbon emission lifestyle and to be a showcase of technologies to initiate a cultural change.

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TeMA Journal of
Land Use, Mobility and Environment

CITIES, ENERGY AND BUILT ENVIRONMENT 2 (2015)

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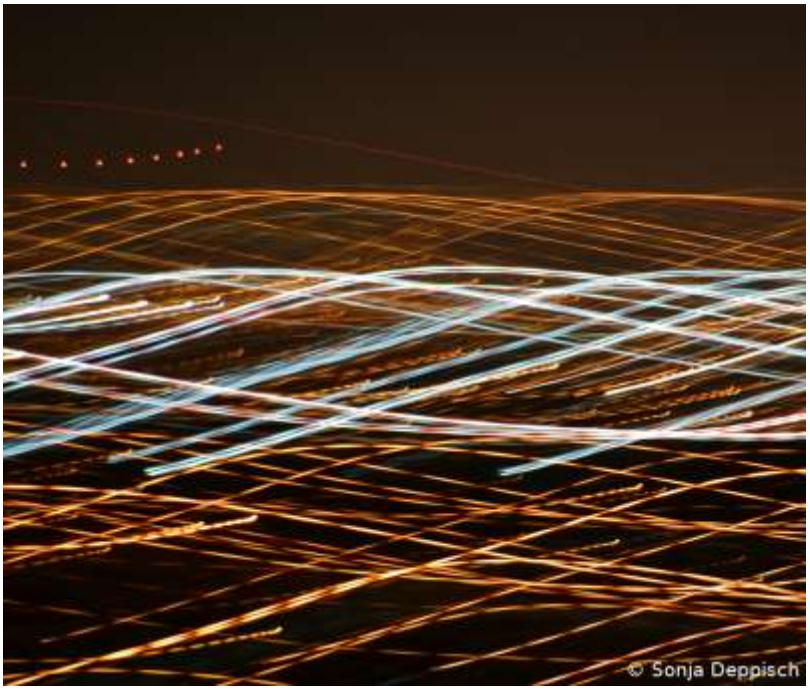
TeMA Journal of Land Use, Mobility and Environment

TeMA 2 (2015) 131-144
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/2982

review paper received 31 March 2015, accepted 27 July 2015

www.tema.unina.it

How to cite item in APA format:
Deppish, S., Dittmer, D. (2015). Urban Planning Dealing with Change and Infrastructure. *Tema. Journal of Land Use, Mobility and Environment*, 8(2), 129-142. doi: http://dx.doi.org/10.6092/1970-9870/2982



URBAN PLANNING DEALING WITH CHANGE AND INFRASTRUCTURE

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ABSTRACT

This paper deals with urban planning and change processes potentially impacting local infrastructure. The overarching theoretical frame is social-ecological resilience thinking and its potential application to as well as implications for urban land-use development. The paper draws its main attention on if this concept can be of use for urban planners dealing with change and urban infrastructure and if a readiness towards its application can be identified. This endeavor is informed by two explorative studies in Germany. One study gains its material from a scenario process with planning practitioners and further urban stakeholders of a medium-sized city. Main topic was how to deal with the challenges of climate change impacts in urban planning and development. The second explorative study reflects research results on the readiness to apply the resilience concept to urban planning dealing with change and local infrastructure in a small community. The scenario process showed that applying social-ecological resilience thinking to urban planning helps to critically reflect so far taken paths in local built infrastructure, to take on an integrated perspective and to develop new and innovative strategies for further land-use development. Nevertheless, such a process requires additional financial as well as human resources and translation exercises. Also, the given path dependency as well as financial constraints are hindering to perceive any leeway in infrastructure development at the political level, so that concrete implementation at the moment seems to be out of sight, which is also caused by multi-level dependencies.

KEYWORDS:
urban resilience, urban planning, social-ecological resilience thinking, infrastructure

TeMA
有关土地使用、交通和环境的杂志

TeMA 2 (2015) 131-144
print ISSN 1970-9889, e- ISSN 1970-9870
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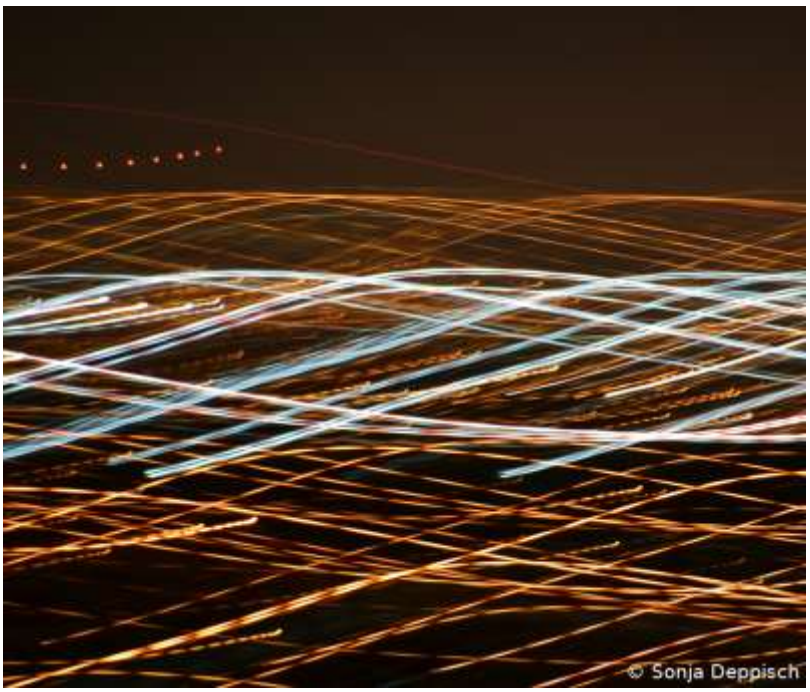

应对变化和基础设施的城市规划

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摘要

本文论述 了城市规划 和变化过程 对当地基础可能造成的影响。总体理论框架是思考社会生态的恢复能力及其在城市土地利用和发展中的潜在应用及影响。本文重点关注此概念是否可以被城市规划者用来应对变化和建造城市基础设施，以及其应用是否可以就绪。此工作由德国的两项探索研究完成。一项研究从规划从业人员的方案和一座中等城市的利益相关者中获得材料。主题是如何在城市规划和发展中应对气候变化的影响。第二项探索性研究反映了恢复力的概念在小型社区应对挑战和当地基础设施时的准备成果。该方案过程表明，运用社会生态恢复力来思考城市规划有助于进行批判性反思，以及在基础社会的建设中获取捷径，采取综合角度为土地的利用与开发制定进一步创新战略。然而，这样的过程需要额外的资金、人力资源以及翻译操作。此外，对给定捷径的依赖以及金融制约也在政治层面阻碍着基础设施的开发，因此任何真正的实施要淡出人们的视线也是多层次的依赖所造成的。

关键词
城市规划，当地技术基础设施，
社会生态复原, 变化

1 URBAN RESILIENCE MEANDERING BETWEEN BUZZWORD AND COMPLEX CONCEPT

There is a growing discussion on the resilience concept and its relevance to different fields of science. Accordingly, there are seemingly almost as many resilience definitions as authors who write about the concept, even within the same discipline. This paper draws on the discussion of social-ecological resilience and discusses its potentials for being applied to urban planning and urban administration dealing with local technical infrastructure. The main question tackled here is if and how this complex and abstract concept can be of use for urban planners and related colleagues of urban administration dealing with local infrastructure, and if there can be detected a readiness to apply resilience thinking.

Especially with reference to cities and urban development resilience received a growing attention and use as catchword of importance not only within the scientific discussion (e.g. Galderisi and Ferrara, 2012, for an overview and grouping into "families" of bodies of literature see Colucci, 2012), but also in practice. The latter is for instance manifested in the 2013 Rockefeller's Foundation competition "100 Resilient Cities" (Rockefeller Foundation, 2014) with several hundreds of international applications from cities and also in the annual practice-oriented conference on Resilient Cities of the international cities association "Local Governments for Sustainability".

The growing use of the catchword resilience risks rendering the term to a fashionable buzzword loosing conceptual depth and meandering between very different definitions (Bahadur et al., 2010; Mazzeo, 2014; Papa et al., 2015). Also, as Papa et al. (2015) state, out there are not many concrete definitions of what is meant by urban resilience, but the ones provided share the common line of focusing on safety and the uphold of urban functions in case of crisis and further external forces. While as not that many explicit definitions exist, the term resilient city is often used. For further clarification, therefore, in this section, it will be explained what is meant by using resilience. It is referred to a specific body of literature, namely to the social-ecological resilience concept.

This conceptual understanding of resilience is considered as helpful looking at cities dealing with change, as it offers a perspective different to the common perspective used in practice. It highlights change as immanent component of a system instead of perceiving it as an external factor only. The interdependence of ecosystems and society is a crucial element of this concept, based on the understanding of inseparable social-ecological systems which develop dynamically and in a non-linear way. Their dynamics are described with so-called adaptive cycles and are illustrated with the figure of a "lying" number eight (Holling and Gunderson, 2002). This "lying eight" symbolizes the systems moving continually between four different phases. Walker and Salt (2006) highlight that the systems can also show different dynamics as these theoretically described ideal phases. Within this context, social-ecological resilience is understood as the capacity of social-ecological systems to persist continually and eventually to reorganise themselves. This happens through maintaining essential functions and structures of the whole system and further developing through incorporating change (Berkes et al., 2003; Walker et al., 2004). To reach resilience in this understanding, Berkes et al. (2003) propose as essential system abilities to learn to live with change and uncertainty, to support diversity, to combine different forms of knowledge and to provide for self-organization. An additional essential component of the social-ecological systems concept is the understanding of "panarchy" (Holling and Gunderson, 2002). Panarchy describes, that the considered system influences and is influenced mutually by systems on different levels which also go through adaptive cycles. In consequence, also dynamics on smaller or bigger scales can evoke disturbance or even shocks for the considered system.

As this understanding of social-ecological systems and of resilience roots in systems ecology, it still undergoes strong discussions being applied to social dominated systems (see e.g. Swanstrom, 2008). Adger (2008) highlights as an answer to these critics that the concept is mainly to be understood as an analytical

tool and that it does not provide normative judgments. Nevertheless, even if it is understood as an analytical tool only, the highly abstract as well as multi-dimensional concept renders it difficult to bring it to further and concrete use in practice, especially in human dominated systems. While there is a multitude of very different approaches to operationalize the social-ecological resilience concept, these are mainly developed in non-urban research contexts or are very broad if it is dealt with urban complexes. But research and literature on urban resilience is fast growing, also within the social-ecological resilience concept it got increased attention during the last years. Especially the complexity of urban systems and the difficulty to define their confines due to the matter of fact that they are decoupled from the resources they use, render analyses of their system dynamics or their social-ecological interdependencies very demanding (Alberti, 2008; Colding, 2007).

With regard to the question we deal with here, the reference to social-ecological resilience is helpful, because it allows us to understand cities or, even broader, urban regions as complex adaptive systems. They are characterized by a variety and multitude of interactions and interdependencies between humans and the environment on different spatial and temporal scales. Additionally, they are undergoing uncertain or even surprising non-linear conditions of social, political, technological, economic or environmental change. Approaching urban planning and administration with this concept can mean to scrutinize dominant linear and complexity-reducing thinking in planning practice as well as the sectoral split within urban governance and administration (Deppisch et al., 2014). Referring to social-ecological resilience in practical spatial planning would mean in consequence to emphasize complexity and here especially non-linearity, emergence, uncertainty and potential states of not-knowing, relevant other temporal or spatial scales (panarchy) as well as social-ecological interdependencies.

In bringing these ideas and concepts closer to planning practice, the main attention is drawn on if and how this complex theoretical concept can be of use for urban planners dealing with change and local infrastructure and if there can be detected a readiness towards its application.

2 EXPLORATIVE RESEARCH SETTING AND CONTEXT

This endeavor is informed by two explorative studies in Northern Germany. One study gains its material from a transdisciplinary scenario planning process in a medium-sized Northern German city located at the Baltic Sea coast. This process used a translated resilience perspective as the conceptual point of reference. It was undertaken in a period within two years (2011 to 2012), prepared and conceptualized by a core-group consisting of practitioners from urban and regional planning and administration as well as of scientists with different disciplinary backgrounds. The idea to emphasize the characteristics of a translated resilience perspective was brought in by these scientists. The process consisted of three main scenario workshops with up to 40 participants from different fields relevant to urban development, ranging from planning practitioners to urban politicians, economic actors and further urban stakeholders. Main topic of this process was how climate change as well as other factors will impact future land-use development of the urban region and how urban and spatial planning can deal with the challenges of these change processes (for details see Hagemeier-Klose et al., 2013). For the intention of this paper, it will be looked especially at the interim as well as the final outcomes of this process with reference to the topic of the current state of the urban infrastructure and its further development. As empirical material it is referred to protocols of the scenario planning workshops (plan B:altic, 2011a-b, 2012) as well as the finally developed climate change adaptation concept adopted by the City Parliament (Hansestadt Rostock, 2013). For further contextualization of the urban planning and infrastructure situation, it is referred to the preparatory land-use plan (Hansestadt Rostock, 2009) and further documents of the city. With reference to infrastructure development, Rostock provides several characteristics. So it has an important sea harbor for cargo and for passenger handling, and further enlargement of the harbor is not only discussed but also foreseen within the preparatory land-use

plan (ibid.). Such an enlargement could also require additional traffic structures or improvements of given structures with a general municipal road system which can be considered as sufficient and in a good state as it was improved after German Reunification. Public transport is ascribed an important role by urban planning (ibid.) and next to the upgrading which already took place during the last decades, further upgradings and improvements are planned, especially to strengthen public transport against road traffic (ibid.).

Further information comes from a second explorative study. This study reflects research results on the applicability of the social-ecological resilience concept to urban administration and planning in dealing with change and local technical infrastructure in a small Northern German town, based more inland. The research material in this explorative study was gained through semi-structured interviews with practitioners from urban and regional planning, urban administration and from the service provider for energy. Additionally, documents of relevant local political committee meetings were analyzed (Gemeinde Seevetal, 2013a-c, 2014a-c). With identified key persons of urban planning the material gained was also re-discussed and it was analyzed if there is to be found a readiness to apply a resilience perspective in dealing with local infrastructure in preparatory land-use planning at the community level.

As can be judged already from the material, we here deal with two explorative studies and do not pretend to have performed an all-encompassing broad study. Nevertheless, we think that this material is worth to be published to give further – and practically tested – information and insights on the discussion on urban resilience.

3 RESULTS

3.1 OUTCOMES OF A TRANSDISCIPLINARY SCENARIO PLANNING PROCESS HIGHLIGHTING UNCERTAINTY AND COMPLEXITY

Starting with the first explorative case study, we look at Rostock, a medium-sized city at the German Baltic Sea coast with around 200 thousand inhabitants. It is an old hanseatic town and spreads basically from its old medieval center along the river which is mouthing in the Baltic Sea.

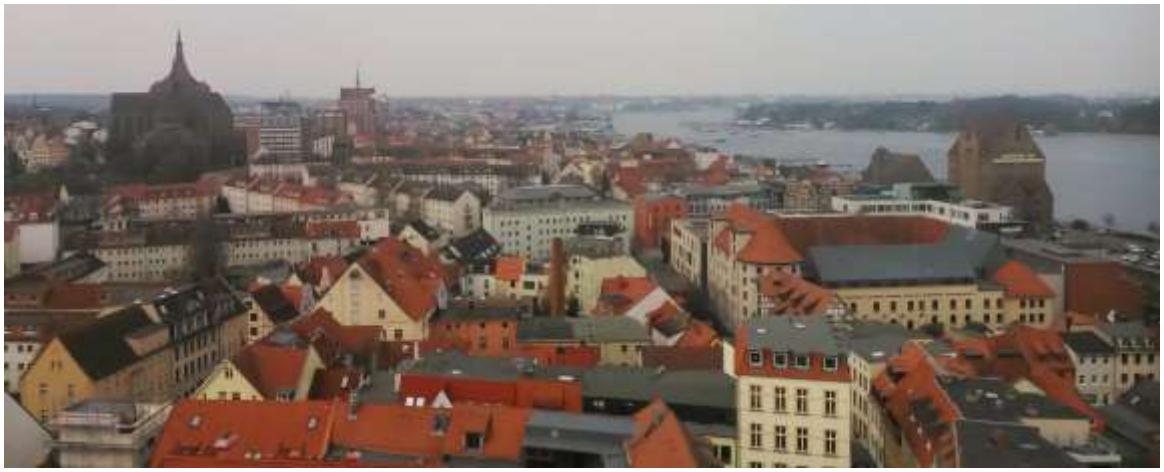

Fig. 1 Rostock, the old hanseatic center and the river Warnow mouthing in the Baltic Sea

This city, which is not belonging to an administrative district due to its size, and its surrounding suburban area started together with a research team in 2011 a process on dealing with climate change impacts on future land-use development and here especially with related complexity and uncertainty. Before, it was not dealt purposely with climate change impacts with regard to the land-use development in the urban region, neither in the urban nor in the regional land-use plan. Potential climate change impacts to be expected within the city are storm floods with an increase in intensity as well as frequency, more and more severe

flooding events due to sea-level-rise and an increase in frequency and intensity of extreme events such as heavy precipitation events or droughts. Also the already existing urban heat island is expected to rise due to rising temperatures. Nonetheless there can be identified some strategies within the preparatory land-use plan of 2009, which can also serve as adaptation strategies. The intention to create a strcuture with multiple centers for energy production is such an example to distribute to diverse territorial parts of the town diferent functions of the grid (Hanstestadt Rostock, 2009, 62), which then can, due to this diversification, better react to extreme weather events. But at the same time there are also other strategies, which can run contrary to adaptation purposes, as climate change adaptation was not a topic during developing and adopting this preparatory land-use plan in 2009. Examples are planned new settlements as well as tourist infrastructure close to the river or the sea-side (ibid, 99ff.), which can be threathened due to extreme floodings or storm surges.

For the purpose of this paper, we focus here on aspects of energy and further local infrastructure and their discussion within the general land-use development as well as urban planning context. As method to deal with the potential future of land-use and influencing factors, a scenario-process was performed. This process showed that while dealing with climate change impacts and the related complexity and uncertainty issues in the land-use development of the core city and its hinterland, the most prominent infrastructure topics were energy and transport. But also, water drainage, further built infrastructure as well as drinking water supply were discussed.

Energy supply and related infrastructure was already a prominent topic within the city since a first framework concept on climate change mitigation was developed in 2005, long before the scenario process started. It was aimed at mitigating further climate change and at sustaining the future local and regional energy supply through renewable sources. Here, also an explicit reference to an energy optimized urban as well as infrastructural development was made (Energiebündnis Rostock, 2011). In consequence, it was also a very prominent topic within the scenario-process which had a focus on how to deal with climate change impacts (plan B:altic, 2011a-b, 2012). The participating stakeholders and practitioners from civil society, politics, economics as well as urban and regional planning and administration highlighted the importance of an energy transition with reference to both sides of the coin climate change.

What exactly was considered as important to be dealt with referring to the energy supply? The energy transition to a mainly renewables-based energy generation got a high attention throughout the whole scenario-process. It is seen as a potentially benefiting factor for the further economic development of the core city and the urban region through saving current high costs for fossil energy and replacing them with locally produced renewable energy. The boosting effect for the local economy is not only seen in the energy production and supply itself, but also in further related economic fields such as rendering the urban region to a focal point of related technology development and transfer. Still, it was also taken into account that an energy transition of this kind would depend on funding mechanisms supporting renewable energy as otherwise the so produced energy would be too expensive for the inhabitants in comparison to conventionally produced energy. Also it was critically judged if full support for such a transition by the inhabitants could be expected as they were not as familiar with potential changes, related complexity and uncertainty as the actors who were participating in the scenario planning process. Also, climate change was considered to be a negatively biased topic in the public sphere so that it cannot be expected to foster the willingness to transform the energy supply and to accept the consequences, such as higher prices for locally produced energy. The latter as well as the transition as such were also discussed in dependence from the global market, such as the price development for coal or oil. Not to forget, it was mentioned that there will be an increase in future energy demand due to needed cooling purposes which are expected to be necessary due to future climate change impacts such as extreme heat events or increased urban heat island effects.

Setting these points in relation to urban and regional planning as well as spatial development, it became obvious, that aiming at this energy transition, there are further areas as well as further infrastructure developments needed for implementation. Additionally, the risk was seen to focus on renewables only in a way of "mono-culture". With reference to land-use development, the need for additional areas to plant biomass for bio-energy purposes which are now used for other purposes such as crop production or the need for new solar or wind energy production sites was seen very critical. These needs also conflict with other measures developed within the process to deal with potential climate change impacts, such as the strategy to hold as many areas as possible free from use to mitigate the urban heat island and to still have options to deal with unforeseen events or to focus on urban and regional agricultural food production. Here it was also seen as necessary to develop further strategies to re-use already sealed areas or to think on multi-use strategies. Such a potential for a multi-use strategy was for instance seen within the harbor area of the town, where the potential for solar or wind energy production was identified (Albers and Davidse, 2011). Such a development would then require further infrastructure to distribute the generated energy. Potential disturbances for the – then already transitioned – energy supply were also seen by climate change impacts such as an increase in intensity and frequency of storms leading to damage of the related energy infrastructure like aerial lines.

During discussing potential unexpected events, off-shore wind energy sites were considered as potential reason for unexpected disturbances of the sea-based traffic. This traffic is important for the city as its harbor is an already established important economic factor for the urban as well as the regional scale. Looking at further transport infrastructure, an important measure of dealing with climate change impacts was discussed, namely to intentionally use specific roads as areas to be flooded, especially in case of future heavy precipitation events (Richter and Davidse, 2012). The use of these roads as flooding zones would in consequence require providing better connected and combined transport modes throughout the urban territory. While this was discussed during the workshops as a long-term implementable non-conventional measure of flood-protection, the participants also ended up with a completely opposite idea they prioritized finally. The proposed important as well as short-term implementable adaptation measure was to raise the main roads which then would also function as protective dykes in case of floods within the city (plan B:altic, Hagemeier-Klose et al., 2012).

With regard to surface water drainage it was highlighted as important to create new drainage axles on the surface within the city to prevent devastating flooding events. Also it was considered necessary to adapt the sewage system technically to potential water volumes of heavy precipitation events. But this was then denied as over-dimensioned sewage systems would cause severe problems in case of periods without increased precipitation or even with droughts. Further infrastructure-related potential adaptation strategies which were developed, were to apply amphibious infrastructure solutions in the spheres of transport (especially for the harbor area), tourism and housing as well as general infrastructure purposes. But their potential usability was only seen in a limited way as the participants also expected problems with this kind of innovative infrastructure if extreme events such as storm surges or major flooding events would occur.

As far as general infrastructure planning was discussed, it was seen as a short-term need to take potential climate change impacts into account in ongoing planning and land-use decisions about long-lasting infrastructure and to use a more generalistic approach within urban development looking at infrastructure development. It was emphasized to respect the need in further plans to think in different plausible futures which might also have very opposite consequences such as a drought or a heavy precipitation event as well as to try to create more flexibility and diversity. These points are also concretely reflected within the urban framework concept (Hansestadt Rostock, 2013, 13), where a future critical assessment of the urban infrastructure (transport, energy, etc.) is envisaged. As main criteria to be used for this assessment were laid down the functioning of all supplies even if some parts fail, to reduce vulnerability of the infrastructure against extreme events and to guarantee the main functions and infrastructure services. Also, a mid-term

reflection of the municipal urban planning and environmental department on the need to retreat from certain already built areas found its way in this framework concept on climate change adaptation (ibid., 21).
A difficult and therefore only cursory discussed point was the further population development of the core city as well as the sub-urban communities. Both, the further ongoing trend of re-urbanization but also a return of sub-urbanization processes were seen as possible, the latter for instance could be caused by increased urban heat islands effects or heat extremes. Especially the latter would have an effect on further infrastructure needs.
Overall, the participants highlighted as a very fruitful additional outcome of the process to have established a wide spanned network crossing sectors within urban administration as well as going beyond administrative actors and crossing the city boundaries, too. This crossing was seen as essential to get a comprehensive impression of social-ecological-technical interdependencies and to be able to discuss a wide array of potential future land-use developments and respective consequences in the urban region.

3.2 OUTCOMES OF A STUDY ON READINESS TO APPLY THE SOCIAL – ECOLOGICAL RESILIENCE THINKING IN URBAN PLANNING

The second study was performed between 2014 and 2015 on the main topic if at all and if yes how a comprehensive approach within urban planning dealing with local technical infrastructure can be fruitful, which is based on social-ecological resilience. The focus was on a holistic perspective including complexity and change as a system-immanent component of the local system. In contrast to the first case, here, a transdisciplinary process to implement a perspective of social ecological resilience within land-use development was not performed. Instead, it was focused on the current readiness of urban planning to implement social-ecological resilience from a pure scientific perspective. Also, barriers to practically implement such thinking were of concern. The case is based in a Northern German local community of around 40 000 inhabitants, located inland. In difference to the above mentioned case, this is a smaller local community which belongs to an administrative district. It does not have an old center but provides a polycentric structure as it originates in 19 different local communities being organized into one in 1972. It provides some central functions to its neighboring more rural communities. As a consequence of the former structure of 19 single and autonomous local communities, the now united community provides a quilt-like picture of a big energy and water supply as well as sewage network.
While there are only some smaller private energy production sites (solar, wind and water power), the very main part of the energy supply comes from external sources. As far as water supply and sewage is concerned, these are also externally steered at the administrative district level. But there can be found relevant productive infrastructure within our considered community, which serves for both, for itself as well as for the district. Especially the sewage plant is of relevance for the whole administrative district. Within the process of compiling a new preparatory land-use plan for the whole territory of the local community, this infrastructure was of special relevance as its state urgently needs to be renovated in some parts. It was emphasized to seek for synergy measures concerning the built infrastructure. Decentralizing infrastructure within the community with the aim of rendering it less dependent from upper administrative and political scales was not a topic at all. The main questions of supply and sewage are now strategically prepared at the district-level. This tributes to the fact that local single action is nearly possible given the already built infrastructure networks and related dependencies, at least at the community level.
Urban planning is having difficulties in dealing strategically on the land-use development of the whole local territory; also its position was weakened substantially in giving up the idea of establishing a new formal preparatory land-use plan. This plan was intended to revise strategically the so far ongoing land-use and the related future land-use development concepts. Instead, local politics decided upon an informal concept which is also to be respected in the binding land-use plans but which does not provide a coherent land-use strategy for the whole municipal territory. A formal preparatory land-use plan would have encompassed

decisions or at least contents regarding local infrastructure for the whole territory, which are now lacking in the informal concept. The latter mainly contains single areas for further development and related prioritized measures.

An astonishing result was that urban planning uses different (old) plans of local infrastructure, especially in the field of water supply and sewage, while as in the same building their colleagues from the local civil engineering department are using different and new plans. So urban planning in this case is not up to date as far as the state of the local technical infrastructure is concerned. Additionally, both departments are also working with different concrete data, not only with different plans. The supply and sewage structures are not an explicit topic within the established informal concept concerning land-use, a general strategy with reference to urban development is lacking.

These infrastructures are only discussed with reference to certain potential areas for further development and the current state of infrastructure and the link from these areas to the infrastructures are discussed. In case these considerations led to the potential need to change infrastructure networks, the respective areas were not considered for further development due to the then necessary high development costs. The dominant thinking is oriented on a stable state equilibrium and does not provide an overarching strategy. Questioning the future-fitness of the local infrastructure system would have been possible within a cross-cutting and all-encompassing preparatory land-use plan which was not pursued anymore, but instead an informal and punctual concept. Ideas on implementing local renewable energy were raised, but not implemented.

Generally, questions of change, uncertainty and resilience are not at all discussed at the local level, neither in general urban planning nor in urban planning dealing with infrastructure related questions. Instead, the term of sustainable development is of relevance to German urban planning, so also in this case, as it is part in the German national land-use and building law. But this is only of a theoretical nature as it does not play any prominent role in concrete urban planning of our case. The interviewees were mentioning that a general strategic concept on sustainable development of their community is lacking to guide land-use planning. Additionally the dominant priority in financial spending of the community is focused on efficiency. The application of this principle does not allow for leeway or to develop buffering capacities as they are considered as financially inefficient.

A good example for this way of thinking is the already occurred problem with surface water running over the run-off sites and leading to flooding and potentially also threatening buildings. Even if this problem occurs from time to time and can be expected to increase due to climate change, it was politically decided not to act upon this to prevent further surface water runoff problems but to prevent financial investments. This decision was taken in spite of several problem analyses of different administration departments. A general discussion on resilience thinking and related aspects with the planning department had as an outcome that urban planning in this case is dominated by single projects and by higher-level planning. A critical reflection of eventually implicitly applied planning strategies is nearly undertaken, but would be essential to identify capacities or willingness to implement resilience.

4 DISCUSSION

Both studies show that resilience can more be understood as a process (Folke, 2006) than a property of cities or local communities. Nevertheless, it does not provide for a concrete end or aim of the process, but it indicates so far blind spots not considered within practical urban planning. Dealing with change is explicitly challenging looking at built or yet to be built technical infrastructure. Roggema et al. (2012) distinguish three different types of dealing with change in land-use planning and refer to them as incremental change (the weakest version of changing the existing), transition as a further version of change and transformation as the strongest version changing fundamentally the existing (Roggema et al., 2012, 2525). Even if the first

case started explicitly with a complexity and uncertainty perspective, it did not end with a transformative notion in this understanding. But it already provided a very comprehensive discussion of manifold interdependencies and led to in this sense transition-oriented strategies and measures. Also, the participants of the process found many new interdependencies or cascades of interrelations and consequences of new strategies they considered beforehand more in a one-way perspective in thier daily working routine. During the process, the willingness to deal with these issues and to adopt such a resilience-based perspective was growing as it showed advantages. Also, a certain share of these ideas and strategies already found its way in the politically adopted municipal framework concept on climate change adaptation (Hansestadt Rostock, 2013). The second study, however, showed the barriers towards such a readiness within the daily practice of urban planning, especially in smaller local communities.

In practice it is nearly possible to analyze all interdependencies or complex states of the urban system and its non-linear dynamics. This was not only shown by the very sectoral planning approach even the so-called cross-cutting urban planning in the second case showed. Also the first case could just get a superficial impression in many interdependencies and cascades of consequences of socio-technical decisions, even if there was applied a complexity perspective. One has also to consider that this process was externally funded and supported by a research team. The practitioners were convinced that a repetition of a process like that would not be possible without this extra funding and support due to lacking additional man power to cover new tasks next to the regular duties. Additionally, it is difficult to gather all available and current information as well as knowledge needed due to the sectoral divide within urban administration and the different responsibilities. This serves as a barrier to apply the resilience concept and its holistic approach, too. This became also obvious in the second case, where urban planning behaved more than a single sectoral task instead than a cross-cutting one, which would encompass everything relevant to further land-use development. Here, local infrastructure seems to be not of a business of urban planning. But also the first case shows that the integrative and all-encompassing approach of social-ecological resilience is very challenging as it meets a practice which is segmented in sectors. And as the second case demonstrated, these sectors are not forceably using the same updated plans even if they are working on the same municipal territory.

With regard to the panarchy concept, the cities are dependent on developments on other levels or outside of politics and administration, especially in the field of water or energy leading networks. The smaller city shows this dependence even more, as some responsibilities of public administration are decided upon at the administrative district level. And if we look especially at local technical infrastructure, main decisions are taken at other relevant levels than the one of the city or local community. One aspect illustrating this is the essential legal basis for financing renewable energy infrastructure which is taken at the national level. This law regulates who is allowed to supply with current at which charges. Also it is decided on upper levels which form of energy production is supported by financial funds and further supporting schemes.

Even if these dependencies as well as interdependencies are given, it is possible to reflect them critically and discuss opportunities of self-organization, as the first study showed. Here it was discussed already before the resilience-oriented scenario process started to change the given path of the mainly external fossil-energy supply. Was this at the beginning mainly triggered by financial incentives, it was discussed comprehensively within the scenario process, reflecting also potential land-use conflicts. The second study, in contrast, showed the opposite as here even the opportunity of looking strategically at taken paths within infrastructure development of the whole territory was not seized through following up with a new preparatory land-use plan. Instead, this endeavor was given up and in consequence, the strategic decisions were left open and delegated to the district level.

In both cases – in the first above all at the beginning of the process, in the second during the first contacts with practitioners – there were lacking boundary points to identify potential contacts between the theoretical concept of social-ecological resilience and the daily planning practice and concepts it uses. Here, within the

small second study, it was only possible to talk about these ideas and their potential use in planning through using a reference to sustainability. If a reference to resilience is made, then it is – if we follow here the differentiation of Folke (2006) – the engineering type of understanding resilience which emphasizes a stable and constant equilibrium and the time of reaction as well as the efficiency of returning to this equilibrium. This is in close connection to the reductive perspective on infrastructure on its technical functioning; measures related to infrastructure are then maintaining the status-quo technically. The idea of other possible states outside of the path taken so far is hard to be found. The first case shows thinking which goes beyond the current state, but doubts its practical transition-oriented implementation at the end. This is also related to the high costs related to infrastructure development and the difficulty to change the paths taken so far. The latter would require huge changes correlated with huge financial investments. The bounce back oriented thinking ("engineering resilience", Folke, 2006) is even more prominent in the second case as the example of surface water shows as well as the decision to waive a new general land-use strategy. The latter might have offered also a future-oriented strategy in dealing with local technical infrastructure. This is a clear identified barrier to implement resilience, which depends on local politics and not on urban planning alone. And it supports the point of Papa et al. (2015, 29), who emphasize that it is important to consider both, the so-called hard as well as soft components of an urban system to built up or improve its resilience. This was reflected in the first case more comprehensively.

A relevant point to add and emphasize is the path dependency of the so far existing infrastructure which does not surprise while dealing with built infrastructure. This path is oriented on a stable state equilibrium and in case it works it does re-strengthen itself through many different feed-backs (Gößling-Reisemann, 2008). But if we look at discussed changes such as the change of the energy supply system to foster energy transition, also the transport of energy is of relevance. Such a transition would not only require a change in main energy sources, but also a change of the centralized supply network.

A decentralized system with many polycentric networks allowing a diversity of current injections would be necessary requiring an additional change in infrastructure (Gößling-Reisemann, 2008). The local communities in Germany have the autonomous power to take the necessary decisions by themselves. But a real change not only in the energy generation infrastructure but also in the supply networks and related feedbacks would require too many financial resources, especially for local communities with tight financial backgrounds or already problematic financial states, which are leading already to weakened investments and shortages even within municipal compulsory tasks (Deutscher Städtetag, 2014). This renders the path dependency even higher, due to the long-lasting permanence of built infrastructure as well as their high building-investment costs and also necessary destruction works and consecutive costs. But nevertheless, as the scenario process in case one showed, it is possible also within tight municipal financial constrains to think on diverse, redundant as well as multiple-use strategies and to leave given paths of infrastructure location as well as abilities.

5 CONCLUSION

Returning to the main question we raised at the beginning we can sum up the following answers. First, it was shown that the concept of social-ecological resilience thinking can be of use for urban planning and related administration to deal with change and local infrastructure. Introducing social-ecological resilience and the related thinking to urban and regional land-use development initialized new discussions and catalyzed the confronted practitioners to reflect certain topics within land-use development and local infrastructure development in a different way. Also new strategies such us multiple uses of transport infrastructure or local polycentric infrastructure networks were identified. Also the application of this thinking can be of use if it is brought to a concrete territory and applied there as this can reveal: (a) so far blind spots not considered within practical urban planning as it highlights socio-technological and ecological

interdependencies, related complexity, uncertainty and change as ever-present system-immanent features cities have to deal with; and (b) severe conflicts between different land-uses, even if they appear per se as general positive contribution to a sustainable urban land-use and infrastructure development.

Considering the established technical infrastructure, it appears more as an outcome or interplay of contingencies leading to current path dependencies, and less as a planned strategy. This does not contradict resilience thinking but it puts into question if a comprehensive and strategic approach at community level on applying and especially implementing social-ecological resilience thinking is realistic, even in a mid- or long-term perspective. This is especially questionable if local financial constraints are tight and if urban planning does not have a strategic role or even a role of importance attributed by local politics to generate innovative strategies with reference to land-use and immanent change, over spanning spatial as well as temporal scales.

At least and refering with that to the second part of the initial question how the concept can be of use, reflecting critically so far taken paths is possible and supported by an integrated resilience perspective which also brings to the light further interdependencies and consequences, also in relation to future change processes and their spatial consequences. Also it is helpful to develop manifold options for further actions as well as integrated strategies, which can also deal with potential surprises and further uncertain or unexpected not yet known change processes and events. This would be an alternative to the predominant bounce-back understanding of resilience.

Finally with reference to the third aspect of our question, if there can be detected a readiness towards applying social-ecological resilience thinking in urban planning already now, it still remains questionnable, if these developped diverse options or multi-use strategies will also be implemented. This depends on the political will, which seems to be dominated by the (financial) efficiency paradigm, while as implementing social-ecological resilience thinking would require sumptuous strategies and measures leading to many different as well as decentralized ways of maintaining energy as well as water supply and sewage. Such a readiness to apply this thinking on the whole urban territory and all its socio-technical-ecologocial interdependencies is also depending on available personal as well as financial resources to start all-encompassing analyses and the identification of cross-sectoral strategies and measures. It is easier for well equipped bigger cities or, as the first case showed, additionally supported cities, to test an application of this thinking than for smaller communities staffed with less human and financial resources. For the latter, also upper administrative levels can be attributed the role of initiating resilience-oriented processes. Additionally the actors available as well as filling the relevant positions within a place and their respective cross-scale networks and openness play a role, so that within the explorative cases shown, this can play an additive role next to the available resources and size of the city (see also Pike et al., 2010). Still, tackling urban complexity as well as a holistic social-ecological resilience approach are the most challenging aspects, especially in an administration divided by sectors, even within cross-cutting land-use planning.

In these respects it does not suffice to discuss the social-ecological resilience concept with experts of urban planning and infrastructure, but to bring it up to broader political discussions. Here one could also raise the further research question on the usefulness of respectively changed laws to force local communities as well as administrative districts to deal explicitly with the characteristics of social-ecological resilience and the meaning for their current as well as further land-use and infrastructure development.

ACKNOWLEDGMENTS

Parts of this research were supported by a research grant awarded by the German Federal Ministry of Education and Research (FKZ 01UU0909). The authors would like to thank for this support.

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IMAGE SOURCES

Cover Image: by first author (Sonja Deppisch); Fig. 1: by first author (Sonja Deppisch)

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