

Adaptive Planning - Needs and strategies for indicator based adaptive planning

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Abstract

Resilience has become a central buzzword for all activities performed by cities to handle potential disruptions and changes of social, economic as well as ecological nature. Especially the increasing consequences of climate change are challenging city governments in ensuring resilience nowadays. Understanding adaptability as a key component of resilience, a lot of cities are implementing substantive measures in order to be more adaptable to disasters. Unfortunately these measures are not able to enhance the adaptability of a city itself; rather they just adapt certain components to anticipated risks.

In this context, this paper provides a concept for adaptive planning, helping cities to establish adaptable governmental planning procedures and therefore to be more resilient towards disasters. This concept combines the approaches of adaptive management and adaptive government with the concept of indicator based decision making. Thereby resilience-oriented indicators will be monitored, controlling the need for the adaption of processes and procedures.

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1. Introduction

Cities and human agglomerations in general are in a continuously state of transition, affected by financial, social and technical changes. Especially due to the increasing climate change, cities are challenged to develop and implement strategies to handle natural disasters. In this context a new expression found its way into research as well as into city development during the last years: Resilience. Resilience of a city can be understood as its capacity to prevent, cope with and recover from all kinds of external and internal negative powers and influences such as natural disasters or manmade crises like the recent economic crisis.

Against this background, city and planning administrations as well as research projects worldwide are currently looking for answers how resilient cities or communities can be developed. For instance, cities more frequently adapt specialised geo design and modelling applications in order to foster an environment friendly urban development. Research solutions on the other side are varying from resilience self-assessment tools (e.g. LG-Sat Tool by UNISDR) engaging all relevant local stakeholders in the assessment process to a manifold of decision support systems for crisis situations. For example, the EU-FP7-Project CRISMA is modelling all crisis management activities of large scale crisis situations in order to support disaster relief. All these projects try to provide solutions for cities in order to become more resilient, providing city and planning authorities with tools and methods to adapt to emerging changes and challenges.

Further, these very important and useful research projects share a common understanding of the role of city planning authorities regarding the cities resilience: They need to plan in order to adapt the city to changes and especially to risks and hazards. Unfortunately they neglect the adaptability of planning systems and regulations themselves. Therefore, this paper will focus on this specific lack, outlining the need for adaptable planning procedures and regulations in order to increase cities resilience and to enhance the prevention of risks specifically triggered by climate change.

Methodically the paper first outlines the concept of resilience, including various perspectives on the term (section 3). By concentrating on a disaster oriented adaptation strategy of social-ecological-systems such as cities, the paper then describes the role of city planning agencies within disaster resilience (section 4). Section 5 will thereupon present the concept of procedural adaptive planning; combining the concepts of adaptive management and governance with an indicator based decision-making process. Finally,

section 6 summarizes the main insights of the paper, further providing an outlook regarding the concepts chances for implementation.

2. Resilience of Cities - Definition and current developments

Resilience has become a central buzz-word in development strategies of cities, development agencies as well as within the scientific work during the last few years. This trend can for example be observed in the pure amount of resilience related project calls announced by the European Commission for their current framework programme for research HORIZON 2020 (more than 20 calls specifically addressing resilience of certain systems).

But how can resilience be defined and to what extent is this concept relevant for city development in general and particularly for planning processes? As Aldunce et al line out, resilience is a concept adopted by a range of disciplines such as physics and mathematics, psychology, ecology and also sociology, all developing own definitions and understandings of resilience (Aldunce et al 2014). Even though all of them reflect upon a systems ability to handle external influences in a preserving manner, they are not only distinguishable by the objective of observation such as a substance, an individual or a socio-ecological system, rather they define resilience and its key components sometimes similarly but still quite differently.

Since this paper is going to argue for the relevance of adaptable planning processes, it seems to be obvious to refer herein to definition approaches which are addressing city-like systems. In this context resilience was often considered in relation to social-ecological-systems (SES), uniting all coherent systems and the respective inherent biological, social and institutional components. Therefore the SES-concept addresses specifically the perspective of humans and their living environment (Folke et al 2010). Originally formulated by Holling in 1973, resilience primarily was defined as capacity of an ecosystem to absorb perturbation and persist without changing its fundamental structure” (Aldunce et. al. 2014).

Transferring this definition to cities, perturbations can be understood as natural as well as man-made disasters, impairing the cities functionalities and structures. During the last decade research therefore concentrated on disaster oriented approaches of SES-resilience, adding a new central component to the resilience definition. While first society oriented disaster resilience approaches stated a need for anticipation and bounce-back capacities (Wildawski 1988), adaptability is considered to be the key factor of

resilient SES-systems nowadays (Adger et al 2005, Gunderson and Folke 2005). In this context adaptability is not replacing the need for adequate anticipation nor bounce-back activities; rather it improves both concepts towards more resilience:

- Anticipation of risks and threats is a key task in the preparation phase of crisis management. Nevertheless, not all risks can be anticipated, especially considering the fast changing environmental conditions cities are facing nowadays. Therefore, high adaptability can support the reaction to both anticipated and not anticipated risks.
- In the literally sense the bounce-back paradigm implies the return to an initial state after a perturbation. Therefore, a city struck by a severe disaster would reconstruct all former system structures. In this context, adaptability includes the perspectives of learning and development into the bounce-back paradigm, trying to reconstruct a city in a less vulnerable and therefore more resilient way by adapting and improving structures and processes on the basis of the gained experiences.

Concluding, resilience is not an achievable state a city can reach at any point; rather it needs to be understood as process of constant adaption in order to be able to face the constantly changing external influences challenging a city. In this context, the United Nations International Strategy for Disaster Reduction (UNISDR) defines resilience within in the Hyogo Framework for building the resilience of nations and communities to disasters as follows:

“The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organising itself to increase this capacity for learning from past disasters for better future protection and to improve risk reduction measures.”

Following this definition cities need to ask themselves, how to promote resilience in view of the rising number of natural disasters. Traditionally, cities use a certain set of crisis management activities and tools in order to prevent, prepare for, respond to or mitigate anticipated as well as unexpected risks. This includes crisis response of task forces such as the police or fire brigade, the installation of risk reducing infrastructure (e.g. flood protection systems) as well as early warning systems for anticipated risks. Nevertheless, the UNISDR identified a set of key areas to be tackled between 2005 and 2015 in order to support resilient disaster management on different governmental levels (UNISDR 2007):

- (a) “Governance: organizational, legal and policy frameworks;
- (b) Risk identification, assessment, monitoring and early warning;
- (c) Knowledge management and education;
- (d) Reducing underlying risk factors;
- (e) Preparedness for effective response and recovery.”

Cities and research institutions therefore worked on various solutions during the last years in order to close these gaps, by developing tools and methods supporting all phases of crisis management such as effective crisis response tools (EU-FP7-Project CRISMA) or cooperative reconstruction techniques (EU-FP7-Project DESTRIERO). The EU-FP7-Project DRIVER for example tries to combine and demonstrate all crisis management research efforts of the recent years by applying solutions in different local settings and crisis use cases. Therefore the adaptability of a city in crisis situations will be improved on various levels, improving its overall resilience. Among others the following aspects of disaster management are addressed:

- Training of inhabitants, volunteers and professionals for all types of anticipated disasters, helping the named groups to better adapt to both known as well as unknown upcoming disasters (work packages of sub projects 3 and 5).
- Development of crisis communication methods, including various potential threats as well as all relevant crisis communication actors (Sender, intermediaries as well as recipients of messages). The output of this specific module helps cities to adapt communication strategies to specific threats (work package 35).
- Methods and tools in order to register, include and organize volunteers within crisis management processes. Herewith cities are able to adapt within crisis situations and to directly respond to specific needs for assistance (work package 36).

In summary, most of the projects are developing solutions that help cities to be adaptable to all kinds of disasters. Therefore, all these projects make an important contribution to the resilient development of modern cities.

Nevertheless, it is necessary to acknowledge that even though most of the solutions help cities to be more adaptable, they do not address the

adaptability of the city as governmental institution and/or administrative body itself. Camacho defines these two different sets of adaption strategies as substantive and procedural strategies. While the first ones are addressing preparation, response and recovery measures, the latter ones are strengthening “the adaptability of existing processes” and help to adjust regulations in response to changes (Camacho 2009). Therefore, referring to the main areas of interest defined by the UNISDR, the first area is clearly underrepresented.

Based on this identified need for adaptive governance in order to promote city resilience, the following sections will outline a strategy for adaptive planning processes.

3. City planning and disaster resilience

When it comes to administrative or governmental processes in the context of crisis management or even resilience development, it is not possible to designate one single responsible department which is in charge for all necessary steps. Rather, all departments of a city need to contribute in order to promote overall city resilience. Various tools and methods are already taking this necessity for integrated resilience concepts into account. Exemplary, the LG-SAT tool of the UNISDR aims at assessing the resilience of local governments towards disaster risks by establishing a communication process between all relevant actors of disaster risk reduction. By cooperatively answering a set of questions all actors will be empowered to understand the dimensions of resilient development, potential gaps will be identified and the effectiveness of implemented actions to support resilience can be monitored (UNISDR 2011).

Even though projects and methods like the LG-SAT tool provide a better understanding of the status of resilience activities, they mostly do not provide specific action plans for the different city departments, offering concrete guidelines to promote resilience. Moreover it is not clear, what parts of the city administration are generally in charge of promoting resilience and to what point they are able to foster adaptability as a central part of it.

Against this background, the paper is going to reflect upon the role of city planning departments within disaster oriented resilience approaches. This choice is motivated by the traditional role of city planners in regard to crisis management activities. With the help of regulatory tools they have the ability and responsibility to prevent disasters, to allow for rescue tasks as well as to set the boundaries for (re-) construction activities, considering

anticipated risks. Analysing the basic tool set of city planners, it can be noticed again that the existing tools are static and therefore able to make cities more adaptable towards specific anticipated risks but not more adaptable themselves in order to react to changing conditions. For example, the following three traditional action fields of city planners helping cities to adapt to anticipated disasters and make them therefore more resilient:

- Land use planning - e.g. definition of protection zones (no buildings) for various disaster types such as flood protection zones or distance specifications for emergency access routes.
- Critical infrastructure planning - e.g. site selection for critical infrastructures based on anticipated threats.
- Planning of protection infrastructure - e.g. site selection, structural as well as strategic planning of protection infrastructure, including flood protection walls as well as hospitals or firehouses.

Even though these activities are crucial for a city's resilience towards disasters, their static approach seems to be not adequate in times of fast changing frame conditions. Usually plans and strategies are developed or updated periodically, adapting solutions to the currently known situation and risks. Therefore, these plans again can be understood just as substantive responses and not as procedural solutions.

For example, in Germany land-use plans need to be renewed every 20 years. The rare renewal of legally valid plans is not only bound to a set of fixed causes, rather the will to change existing regulations is usually triggered by specific events (e.g. disasters with severe damages) or interest of high significance (e.g. financial gains for a community).

Taking for example the rising sea level as well as the increasing amount of severe weather events into account, it should be critically scrutinized if this static approach is still adequate to protect a city from potential disasters. Within 20 years a lot of frame conditions can change and no one is honestly hoping for a disaster in order to be able to adapt strategies and plans to the new conditions.

Therefore this paper argues for a new planning approach, making plans and planning strategies themselves adaptable to frame conditions. The next section will outline this indicator based so-called adaptive planning approach, deriving its main strategy from the established adaptive management approach.

4. Adaptive planning for resilient cities

Based on the outlined need for procedural adaptive strategies of city governments and planning departments this section will propose a conceptual strategy for a planning system, building on the theories of adaptive management and adaptive governance, transferring main ideas on planning methods and strategies in the context of city resilience.

As noticed by Folke et al. (2005) as well as Garmestani and Harm Benson (2013) adaptive governance can play a crucial role in order to manage and develop SES, also contributing to resilience. Therefore this section first concentrates on the description of this theories and their relevance for planning strategies and processes.

Key component of this conceptual strategy will be an information based learning approach, monitoring certain indicators as controlling variables for procedural adapting measures of the planning system. Additionally, inter-agency information sharing as promoted by Camacho in the context of climate change adaption will be of major significance within the concept (Camacho 2009). With the help of such an information structure and here-with linked adaption strategies cities will be empowered to adapt themselves proactively to changing conditions and therefore to be more resilient.

Finally, these management strategies will be transferred onto planning processes. In order to provide a demonstrative solution, the paper will draw on various potential crisis scenarios derived from the EU-FP7-project DRIVER, taking a manifold of potential threats caused by the disasters types floods, tsunamis as well as ice-storms into account. By that it will be ensured that the concept addresses the general sustainability of a city as a SES rather than only the sustainability against specific risks and the respective coping strategies.

Since almost every country in the world has a different planning and regulatory system, it necessary to transfer the needs of the identified uses cases to a specific planning system in order to outline the potential adaption strategies on the planning level. Therefore the paper draws its final outcomes in form of procedural strategies in the context of the German planning and crisis management system, nevertheless allowing the transfer of the main concepts and strategies on a general level.

4.1 Adaptive management & governance

Formulated by Hollings in 1978 just a few years after his resilience concept, the concept of adaptive management was originally developed in the

context of resource management. This methodology was invented in order to test the resilience of a system while still managing its functionality. Further developed by Walters in 1986, the evaluation of the systems resilience aimed at the identification and reduction of uncertainties. Based on the output of monitoring and learning methods it was intended to adapt the resource management strategies in order to ensure resilience (Allen et al 2011).

Due to the highly complex decision systems within SES such as cities, the adaptive management approach can't be applied without changes to governmental processes. The management of such systems relies usually on a set of diverse stakeholders, operating on different levels and fields of competence. In the context of adaptive management it is therefore necessary to include all institutions and organization with certain responsibilities cooperatively into the learning and monitoring process. Folke et al formulated in this context the so-called adaptive co-management approach in 2005.

Since both approaches target the procedural adaptability of a system it is not only necessary to implement learning and monitoring activities, rather it is crucial to allow or even demand for management as well as government adjustments. In that context Dormeus lines out the necessity to combine finality and flexibility in regard to incremental decisions, which should be revisable accordingly to the observed monitoring results (Dormeus 2001). Again, SES being of higher complexity, the decision making process would require the integration of all relevant self-organized networks within those decision making processes (Folke et al 2005).

Even though Folke et al herewith argue for an approach which could help to adapt governance processes proactively, it builds on experiences of adaption processes during crisis situations and respective renewal and reorganizations phases (Folke et al 2005). This illustrates the main orientation of adaptive management and adaptive governance as well. Both concepts are trying to gain knowledge from disruptions of the usual conditions in order to revise management processes and be more adaptable as well as resilient to upcoming disruptions (Garmestani and Harm-Benson 2013). In this context, crises are even understood as windows of opportunity for change and building resilience (Olsson et al. 2004).

By combining the adaptive governance approach with indicator oriented monitoring, this paper argues for more proactive approach, not depending on critical disruptions in the first place, but nevertheless allowing a learning process that can provoke the revision of governmental processes. Furthermore, the paper will concentrate on adaptive planning processes as part of the governmental scope of duties. Therefore, it is possible to provide a possible set of specific adaptation measures with regard to different crisis

scenarios. Moreover, since the planning process depends on a wide range of relevant stakeholders too, the comparability to highly complex SES is still assured.

4.2 Indicator based decision making

All decisions to be made at a governmental level are to some point indicator based. High level politicians receive prepared sets of information from specialists in order to take or vote upon decisions. Governmental agencies are also basing their decisions, plans as well as strategies on evidence in form of underlying data sets. Therefore indicators can simply represent the status of a certain aspects (e.g. sq. of unprotected flooding area) as well as specific predefined thresholds (e.g. high water limits). Due to a widespread of available urban data during the last years, various intelligent data analysis techniques do nowadays allow for a strongly knowledge based decision making. Moreover, the data is mostly collected by sensors for example for real time water level tracking, minimizing the efforts for data collection and allowing real-time data queries (Wendt et al 2014).

As already outlined, adaptive management and governance approaches do integrate the concept of indicator based decision making as well. Both include the monitoring of certain indicators and trying to revise management structures based on the lessons learned from the collected data. In this context Camacho proposes interagency information sharing in combination with a systematic monitoring of decisions and programs in regard to climate change adaption (Camacho 2009).

Also in the traditional planning tasks indicator based decision making is no novelty. Almost all planning decisions are based on a careful consideration of different interests, requiring information and data sets for evidence based decision making. For example does already the preparation of a land-use plan obligate a planner to include a vast number of indicators such as available wastelands, land usage and demands, migration movements, infrastructure occupancy etc. Additionally, with regard to the resilience towards disasters even more indicators need to be included (e.g. capacities and operating range of task forces).

In accordance with the general development of novel urban data, planning agencies are benefiting from the new data sets and analysis methods. Several of this information can be integrated into indicator sets, allowing for an automated gathering of sensor data to keep track of critical information. For example, pollutant and traffic sensors are already quite common, helping cities traffic planners to identify critical noise and air pollution hot spots and to develop adequate coping strategies.

In this context, the following section is going to bring the approaches of adaptive governance and indicator based decision making together, offering a concept that helps planning agencies to adapt their planning processes according to specific crisis oriented indicators.

4.3 Adaptive planning approach

As outlined in the previous section, governmental procedures in general and planning processes in specific are not adaptive in a procedural manner. Since the resilience of cities towards disasters is strongly dependent to its adaptability towards disruptions, the concentration on mainly substantive adaption strategies seems to be not adequate. Moreover, the majority of solutions are strongly reactive oriented, learning from already occurred disruptions. In times of highly sophisticated technologies, allowing the constant monitoring of all kinds of possible threats with sensors, we are now able to develop strategies that enable cities to proactively adapt procedures and processes in order to be more resilient towards disasters.

This need for a concept for adaptive governmental procedures will be addressed now, specifically concentrating on planning procedures. Due to the comparability of planning processes in terms of high complexity of problems, involved range of stakeholders as well as orientation in regard to resilience and disaster management, it will be possible to transfer key outcomes to the more general governance level.

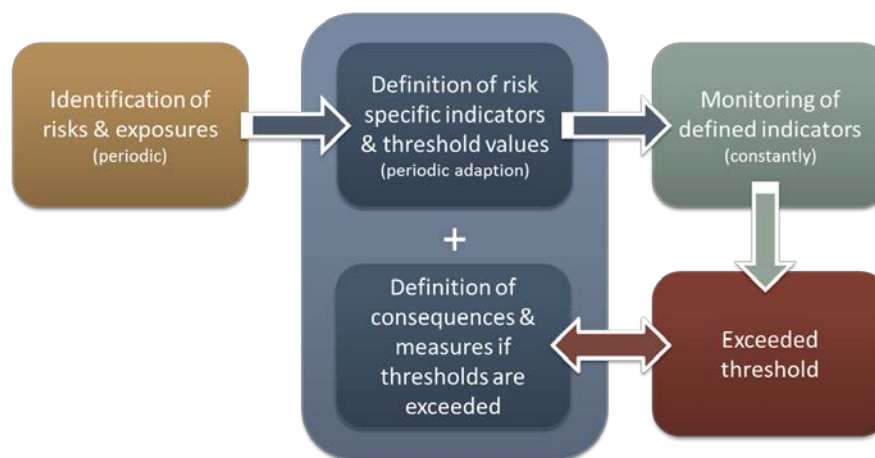
The main concept is based on the idea of monitoring specific indicators that are relevant in the context of disaster management. Therefore, in a first step all relevant risks as well as possible exposures to threats need to be identified. This step is usually performed by cities anyways as part of the disaster management activities. Subsequently, the planning department has to carry out two main tasks:

- Identification of risk specific indicators that are affecting the planning activities on different levels. Further this step includes the definition of thresholds for these indicators, stating a limit to which point currently valid plans and strategies still meet the aims in the context of resilience towards disasters.
- Secondly, the planning agency needs to define, what plans and strategies are affected if a certain threshold is exceeded. Further, it is necessary to specify what kind of adaption is necessary for the affected plans. The range of possible adaptations strategies is wide and needs to be adjusted to the specific risk and affected plan. Nevertheless, for example it is conceivable to realign whole plans and strategies such as land-use or specif-

ic building plans as well as parts of plans such as specific building regulations.

On this basis a constant monitoring of the defined indicators needs to be performed by the planning agencies. If the exceeding of a threshold value is registered the previously defined adaption measures need to be applied. The following figure 1 visualizes this main concept.

Figure 1. Steps of the adaptive planning process



As also included in this figure, all activities need to be repeated in certain intervals, ensuring the consideration of all existing threats. Moreover, a periodic adaption of indicators and threshold values is necessary due to rapidly changing technical capabilities regarding prediction, monitoring and protection technologies. Even though the monitoring process is a constant activity, the efforts to be expected are quite manageable in times of autonomously reporting and analysing sensors, especially compared to the efforts to be spend in case of a disaster destroying areas, which could have been protected with the help of the adaptive planning concept.

Furthermore, the monitoring of indicators does not rely only city planners, rather various city departments are tracking sensor data of all kinds of indicators already. For example, crisis management agencies in Germany are constantly tracking water levels of rivers, especially in times of high risk. In this context, the interagency information sharing approach proposed by Camacho is of high value.

Trying to apply this concept from a city planner's perspective, in the following the possible process steps of a responsible planner will be out-

lined. Therefore, the paper draws on three different highly diverse risk scenarios: Floods, Ice Storms and Typhoons.

For all three scenarios potential indicators to be monitored are defined. Subsequently specific recommendations for change within planning processes are pointed out. The following table 1 provides an overview over all indicators and respective adaption activities for each scenario.

Table 1. Exemplary set of risk oriented indicators and adaption activities

Risk Scenario	Potential Indicators	Adaptive planning strategy when exceed threshold
Flood	Average water level (general/ during floods); Groundwater level; Average flow velocity	Obligation to evaluate existing land-use plans with respect to potentially new flood zones and expected backwater.
Ice Storm	Number of days a year recorded as severe cold; Recorded "Ice storms" a year; Average length of recorded "Ice Storms"	Obligation to evaluate strategic/security plans of supply infrastructures (e.g. electricity, heating, food etc.)
Typhoon	Sea level; Annual severe rain/storm events; Groundwater level	Obligation to evaluate existing evacuation strategies, critical infrastructure plans and allocation plans of relief forces.

The named sets of indicators are neither complete nor final; rather they should be understood as representative examples. Nevertheless, this short list already illustrates that most of the indicators to be monitored are not particularly extravagant. In contrast, the concept can use already tracked information, only basing procedural adaptations of planning activities on the information sets.

All outlined suggested adaptive strategies at least demand for the evaluation of the concerned plans, not finally requiring a full adaption or revision. Based on this evaluation, the final decision regarding the adaption necessity of the plans and procedures will be taken. As already outlined this can lead to the full revision of whole plans (e.g. land-use plans) or just cause minor changes (e.g. specific demands on the building structure).

As a result, all plans and processes on the planning level and in a wider sense on governmental level will be constantly adapted to the current state of knowledge, making a city more resilient to disasters.

5. Conclusion and outlook

The presented paper proposes an adaptive planning concept in order to allow planning agencies to adapt procedures and processes towards enhanced disaster resilience. The two main components of this concept are:

- *Procedural adaptability* in order to allow governmental agencies to react to all kinds of anticipated as well as unanticipated risks and disasters.
- *Indicator based decision making* by basing adaption decisions for procedural change on monitoring of thresholds of predefined indicators.

The combination of these two components therefore enables city governments as well as planning agencies to counter the increasing number of threatening hazards. Concluding, the paper can be understood as a call to integrate the adaptive planning approach into governance processes.

Even though both technological as well as scientific projects will provide more and more sensors for automatic indicator monitoring and strategies to adapt to potential disasters, the success of procedural adaption strategies depends on one central aspect. Since the concepts are targeting changes of existing procedures, processes and plans, valid legal standards need to be adjusted, allowing or even demand for the revision of incremental decisions. Therefore national regulations need to allow adaptable decision making processes on local jurisdictions. In this context, it will be necessary to perform lobbying activities on all governmental levels, highlighting the benefits for the communities' resilience.

This paper is anticipated as structural basis for a doctoral dissertation on the subject of *adaptive planning*. Therefore, the author will continue with research in this field, concentrating on the development of indicator sets and respective planning adaption methods in the context of two specific crisis scenarios. Nevertheless, the aimed strategy for adapted planning will be adaptable for all types of communities, making them more resilient towards all kinds of risks.

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