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Chapter 5

Enhancing Resilience Towards Summer Storms from a Spatial Planning Perspective—Lessons Learned from Summer Storm Ela

Hanna Christine Schmitt and Stefan Greiving

Abstract Every year, convective extreme weather events like summer storms, hail and heavy precipitation cause enormous damages to assets, values and human lives, especially in urban areas. Although highly relevant for the field and expertise of spatial planning, so far those events are addressed rather poorly, if at all. This is mainly for two reasons: for one, convective extreme events are of ubiquitous character, meaning they have unknown probability and place of occurrence, i.e. are accompanied by great uncertainties. For another, spatial planning does not dispose of convenient concepts and instruments to address events with an intangible hazard component, as they are spatially not describable and therefore risk analyses presumably inapplicable. Ultimately, ubiquitous extreme weather events challenge urban disaster resilience and call for enhanced risk management approaches. This chapter discusses the strengths and limitations of spatial planning in dealing with ubiquitous extreme weather events, using the example of summer storm *Ela*, which devastated large parts of Western Germany in June 2014.

Keywords Spatial planning - Summer storm - Convective extreme event - Ubiquitous weather event - Risk management - Germany

5.1 Introduction

Spatial planning has the competency of deciding on if and how future land-use shall take place and is defined as comprehensive, over-sectoral planning. In order to be able to equitably weigh the consequences (chances and risks) that result from planning decisions, spatial planning has to anticipate potential *spatially relevant* and *spatial-planning relevant* hazards as well as the vulnerability of an area (Burby 1998;

Deyle et al. 1998; Greiving and Fleischhauer 2006). Together, hazard and vulnerability are the key determinants of risk, which is defined as

> the combination of the probability of an event and its negative consequences. (UNISDR 2009, 25)

Generally speaking, any extreme event poses a risk to human beings and their properties. While nature and its ecosystems have always adapted at least to natural hazards, human activities have aggravated the risk in both the hazard and vulnerability component (Greiving et al. 2017).

When discussing spatial planning's competencies and restraints in risk management, the above-mentioned terms *spatially relevant* and *spatial-planning relevant* hazard are of key interest. According to Greiving (2011), a hazard is *spatially relevant* if it is possible to differentiate hazardous from non-hazardous areas. However, not all *spatially relevant* hazards become relevant for spatial planning. *Spatial-planning relevance* either requires the need for a cross-scale and cross-sectoral handling of a *spatially relevant* hazard (e.g. if a hazard turns into a disaster), or the ability to respond to it, using land-use-related spatial planning instruments. If hazards are not *spatial-planning relevant*, coping strategies traditionally focus on emergency management and building precaution (Glade and Greiving 2011).

Within the last decade, Germany had to face numerous damage-causing events that do not fit the definitions of *spatial* and *spatial-planning relevance*. To only name three prominent examples, hail storm *Andreas/Bernd*[1] caused damage costs of more than 1.9 billion in 2013, heavy precipitation event *Quintia* led to large-scale inundations in the city of Münster in 2014 with damage costs of more than 200 million and large-scale thunderstorm *Ela* swept over large parts of Western Germany, causing damage costs of more than 650 million (GDV 2014, 2015). As the hazard components of all three events were of ubiquitous character, meaning they could have occurred more or less anywhere, these events are considered not to be *spatially relevant* and accordingly also not *spatial-planning relevant* as their hazards cannot be managed by spatial planning (Greiving 2016).

However, the damages caused by the ubiquitous events reveal patterns of second- and third-order impacts (cascading effects) on other land-uses and critical infrastructure, which eventually are of importance for and partially influenceable by spatial planning.

This chapter discusses the strengths and limitations of spatial planning in managing risks from ubiquitous extreme weather events in the light of urban resilience, using the example of recent summer storm *Ela*. In the following, the ubiquitous summer storm event is presented in its characteristics, synoptic evolution and impacts (see Sec. 5.3). Subsequently, strengths and limitations of spatial planning in managing risks from ubiquitous extreme weather events are discussed (see Sect. 5.3). Last, risk management of ubiquitous extreme events is examined in the light of urban resilience (see Sect. 5.4) and concluding remarks regarding further needs for enhancing urban resilience through spatial planning are given (see Sect. 5.5).

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[1] In Germany, cyclones and anticyclones are named by the German Meteorological Service.

5.2 Ubiquitous Summer Storm Event *Ela*

In the following, the characteristics and impacts of summer storm *Ela* are described in order to facilitate a better understanding of this challenging natural hazard. The spatial focus will be on the federal state of North Rhine-Westphalia[2] although summer storm *Ela* also affected other German federal states as well as parts of France and Belgium.

5.2.1 Differentiation Between Summer Storms and Winter Storms

Storms can generally be differentiated as storms occurring during the meteorological winter half year (winter storms; October–March) and storms occurring during the summer half year (summer storms; April–September). In Germany, winter storms are predominantly cyclones and can be characterised as storm events of great geographic extent that may last for several hours or even days. Winter storms need multiple days to evolve and are relatively precisely and easily predictable in their storm tracks (DWD 2014).

Summer storms on the other hand predominantly result from convective events and appear in the form of thunderstorms. Thunderstorms are usually of rather small geographic extent, lasting for several minutes up to a few hours. They are phenomena that are especially difficult to forecast with numeric weather forecasting (DWD 2016) as they evolve within a few hours and are hardly predictable in their storm tracks.

In the last quarter-century, several hurricane-force winter storms swept over Germany and were associated with severe damages: especially most recent winter storm *Kyrill* (Fink et al. 2007). But in June 2014, it was summer storm *Ela*, which hit large parts of Western Germany and caused considerable damages.

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[2] North Rhine-Westphalia is one of the 16 German federal states (Bundesländer) and is located in the mid-west of the country, to which the Netherlands and Belgium are adjacent to west. With about 18 million inhabitants (31.12.2015), North Rhine-Westphalia has the largest population of all German federal states. The state is home to the Ruhr Area (Ruhrgebiet), a post-industrial region in transition, which is Germany's largest agglomeration. It comprises eleven self-governed cities and four counties with smaller municipalities. About five million inhabitants of North Rhine-Westphalia live in the Ruhr Area, most of them within cities (NRW 2016).

5.2.2 Characteristics and Synoptic Evolution of Summer Storm Ela

Contrary to the above-mentioned characterisation of thunderstorms usually being of rather small geographic extent, summer storm Ela presented as a mesoscale convective complex (MCC), which basically is a large-scale thunderstorm cluster. MCCs are characterised as the strongest thunderstorm complexes possible, being the geographically most widespread and durable types of thunderstorms (DWD 2015). Although on average usual thunderstorms occur every two to three years in North Rhine-Westphalia, the federal state (*Bundesland*) had never since weather recordings[3] experienced a summer storm of Ela's geographic and enduring extent (Deutsche Rückversicherung 2015).

The days before summer storm *Ela*, North Rhine-Westphalia was meteorologically determined by large high-pressure area *Wolfgang*, extending from the western Mediterranean Sea to Middle and Eastern Europe. *Wolfgang* led to peak temperatures of more than 30 °C all over Germany and was reason for the hottest Pentecost since weather recordings. At the same time, low-pressure area *Ela* was located at the west coast of Ireland, starting to infiltrate hot, humid and unstable air masses in North Rhine-Westphalia, smoothening the way to heavy thunderstorms (DWD 2015).

On Sunday, 8 June 2014, several multi-cell thunderstorm clusters arose along *Ela's* first convergence line, which was accompanied by hail, causing the first damages of the weekend. The most severe weather developed on Pentecost Monday, 9 June 2014, above France, as the MCC formed. When the cold front of low-pressure area *Ela* approached with cloud temperatures of up to −70 °C, the hot and humid near-ground level air was elevated, arising distinct instability (lability). As a consequence of the enormous temperature difference, broad prefrontal convergence lines evolved, forming an intense bow echo of precipitation and strong wind gusts. Hurricane-force peak wind gusts of 12 Beaufort (_140 km/h) were measured at different weather stations[4] in North Rhine-Westphalia. At all stations, there had never been a summer storm of this intensity measured before (DWD 2015).

The police registered more than 5,000 weather-related operations in the night of 9 June 2014, being accompanied by an unrecorded number of fire brigade and aid agencies interventions (Deutsche Rückversicherung 2015). The state capital of North Rhine-Westphalia, the city of Düsseldorf, requested support from the German Armed Forces (*Bundeswehr*) (GDV 2015).

As *Ela* was the first MCC ever recorded in North Rhine-Westphalia, it is impossible to project possible future changes or even tendencies. Nevertheless, it has to be assumed that due to global climate change, average air temperature as well as temperature extremes (heat days, tropical nights) will increase in their number of

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[3] In North Rhine-Westphalia, the German Meteorological Service started wind measurement in 1971.

[4] Measurement stations: Düsseldorf-Flughafen, Essen-Bredeney, Aachen (DWD 2015).

occurrence. Since warmer air contains more humidity and therefore is more energised, it may be assumed that also the probability of occurrence for extreme thunderstorm complexes rises (DWD et al. 2012). In a first reflection on summer storm event Ela, the German Meteorological Service stated that the return period for a comparable event probably amounts to far more than 50 years. Nevertheless, statements on the future situations are highly uncertain as climate change might drastically increase the frequency of extreme events (DWD 2015).

5.2.3 Impacts of Summer Storm Ela

The German Insurance Association (*Gesamtverband der Deutschen Versicherungswirtschaft e.V.)* recorded 350,000 damages caused by summer storm *Ela* in Germany, in total amounting 650 million[5] (GDV 2015). Besides insured losses, *Ela* caused an undocumented number of uninsured losses and, tragically, six fatalities, 30 serious injuries and 37 slight injuries among the affected population. The estimated total damage costs for Middle Europe accounted 2.1 billion (Deutsche Rückversicherung 2015; GDV 2015).

In comparison to all previous convective storm events in Germany, damages from summer storm *Ela* predominantly resulted from hurricane-force peak wind gusts and rather subordinately from hail or heavy precipitation. Yet, *Ela's* damage types were completely different from winter storms' damages as well, as especially deciduous city trees were damaged, triggering cascading effects on land-uses and infrastructures (Deutsche Rückversicherung 2015).

5.2.3.1 First-Order Impacts

First-order impacts from summer storm *Ela* concentrated on city trees. As city trees are predominantly deciduous trees, solitarily standing along roads or in green spaces, they provide great flow resistance during the summer months as they are in full leaf. In North Rhine-Westphalia, tens of thousands of city trees were unable to withstand the hurricane-force wind gusts and in consequence were severely damaged, broken or uprooted (Deutsche Rückversicherung 2015). Additional damages were recorded in forests, where again especially deciduous trees were damaged, despite presumably better habitat conditions. The city of Essen[6], which was previously severely affected by windthrow from winter storm *Kyrill*, stated that the

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[5] Thereof 400 million were related to property insurances and 250 million to vehicle insurances (Deutsche Rückversicherung 2015).

[6] The City of Essen is located in the heart of the Ruhr Area and is accounted Germany's seventh largest city with more than 580,000 inhabitants (31.03.2017) (Essen 2017).

combined costs from forest and city tree damages from *Ela* were about four times those of *Kyrill*[7] (Stadt Essen database 2014).

Further, minor first-order impacts were untiled roofs and local inundations due to torn off leaves congesting gullies (Deutsche Rückversicherung 2015).

The first-order impacts of summer storm *Ela* illustrate the strong significance of the intensity of a storm event, i.e. its peak wind gusts, rather than its duration. As wind pressure is proportional to square of the wind speed, damages increase with increasing wind speed (DWD and GFZ 2014). *Ela's* 10-min middle-winds of 3–4 Beaufort were relatively low compared to *Kyrill's* 7–8 Beaufort, but as*Ela's* peak wind gust was just as high as *Kyrill's*, the damage intensity was similar.

5.2.3.2 Second- and Third-Order Impacts

The expression *second- and third-order impacts* embraces all subsequent impacts (cascading effects) resulting from first-order impacts rather than directly from the hazard. In the case of summer storm *Ela*, second- and third-order impacts resulted from trees falling into and onto goods and assets. Regarding both the severity of damages as well as the relevance for spatial planning, those secondary and tertiary, indirect impacts of summer storm *Ela* are of higher relevance than the above-mentioned first-order impacts, as they visualise the (systemic) criticality of infrastructure. Criticality is defined by the critical infrastructure protection strategy (CIP) as

> a relative measure of the importance of a given infrastructure in terms of the impact of its disruption or functional failure on the security of supply, i.e. providing society with important goods and services (BMI 2009, 7).

The CIP strategy differentiates between systemic and symbolic criticality. Systemic criticality describes its structural, functional and technical position within the overall system of infrastructures, symbolic criticality its cultural significance (Greiving et al. 2017).

The following descriptions exemplify second- and third-order impacts of summer storm *Ela* on transport infrastructure and the emergency response system.

Within the system of transport infrastructure, rail transport and road transport were the most affected by summer storm *Ela's* windthrow. In the central Ruhr Area, one third of the tracks were damaged by fallen trees (see Fig. 5.1) (Deutsche Rückversicherung 2015). These rather local damages had the consequence that several main train stations in the Ruhr Area could not be approached for numerous days, causing supra-regional effects like delays and redirections of trains as well as the cancellations of passenger and freight transport, resulting in economic losses. The German Rail (*Deutsche Bahn*) estimated the damage costs to 20 million due to

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[7] It is important to acknowledge the economic value of different tree species as well as their location factor; while city trees rate as city inventory and may have an economic value of more than 2,000 each, forest trees rate as timber with far less economic value. Accordingly, the city's statement does not allow to draw conclusions on the number of damaged trees.

For Fig. 5.1 see original book chapter

Fig. 5.1 Closure of rail tracks in North Rhine-Westphalia due to summer storm Ela. *Source* Deutsche Rückversicherung (2015, 23)

damages of tracks and overhead lines and additional 35 million due to loss of profits (Deutscher Bundestag 2014).

Regarding road transport, both public transport and private transport were highly restricted for several days. Public transportation, e.g. by tram or busses was impossible for several days in many cities, as trees blocked roads and damaged overhead lines and optical signalling systems. With private transport facing the same problem of federal and municipal roads being blocked, a large number of the Ruhr Area's population were unable to commute to work.

Besides the uncounted economical losses due to absenteeism, an even severer impact of summer storm *Ela* was that emergency response units were highly restricted in their operation capacity, which resulted from two circumstances: For one, the sum of tens of thousands of city trees blocked even the main emergency routes, making it difficult for the relief forces to reach their deployment sites. For another, in some cases a single fallen tree was the reason that fire brigade units or ambulances were unable to even leave their stations. Accordingly, these cases required clearing of the emergency units' properties prior to any on-site operation.

The given example illustrates only one line of cascading effects that may result from events like summer storm *Ela*. Many other were experienced by the affected cities (e.g. temporal closure of administrative and educational institutions) or are imaginable in slightly different scenarios (e.g. interruption of energy supply). Besides the illustration of cascading effects, the described impacts on transport infrastructure and emergency response capacities reveal that different land-uses and infrastructures have different levels of criticality. Moreover, as Fig. 5.1 illustrates, local damages may have systemic, large-scale effects on infrastructure systems, coming into conflict with the fact that the operational framework of a municipality ends at its administrative boarders (see Sect. 5.3). Therefore, the key question arising from the example of summer storm *Ela* is: does spatial planning have the responsibility and the ability to come into action in ubiquitous events, and if yes, how?

5.3 Strengths and Limitations of Spatial Planning in Managing Risks from Ubiquitous Extreme Weather Events

Risk management and spatial planning have a complex relationship. On the one hand, every spatial planning decision comprises decisions on the future distribution of risks, which is a form of risk prevention and therefore a part of risk management. On the other hand, both regional planning and local land-use planning tend to understanding risk management as a task beyond their jurisdiction and are likewise not perceived as risk managers by the public. A key challenge for spatial planning in managing risks seems to be that *risk* is a concept too vague, which suddenly becomes relevant in cases of imminent danger, but then it is headed by disaster relief forces rather than spatial planning, questioning spatial planning's overall responsibilities as well as abilities in managing risks (Pohl 2011).

In Germany, emergency management and consequently risk preparedness and response lie within the planning sovereignty of the municipalities and are self-government tasks within services of general interest (*Daseinsvorsorge*). Accordingly, risk prevention generally speaking is a politically and legally legitimised task of spatial planning (Pohl and Rother 2011).

More specifically, spatial planning influences the spatial distribution of risks with every land-use-related decision it takes within the frameworks of regional and land-use planning (Rumberg 2011). However, planning practice shows that so far risk management takes place rather indirectly, implicitly and sectorally, e.g. concerning flood risk protection. So far, there is a lack of an explicit statutory assignment for managing risks within spatial planning (Wernig et al. 2011), although risk assessment in regard to so-called *catastrophic risks* is required in accordance with the amendment of the EU environmental impact assessment

(EIA) Directive (2014/52/EU). However, for the addressees of this risk assessment, among others the municipalities, it remains unclear if and how second- and third-order impact that may exceed the areas covered by a plan or project could be addressed by this assessment.

In practice, planning authorities can (and should) take into account the physical component of different infrastructures and their susceptibility against various threats. Accordingly, planning authorities should protect critical infrastructure through allocation in a significant distance from hazardous areas and, vice versa, through separation of dangerous infrastructure from vulnerable land-uses (Greiving et al. 2017).

However, any risk management by spatial planning needs to be place-based within the (local) area of responsibility, which challenges especially the prevention and response towards extreme weather events in the light of systemic criticality of infrastructure systems. Systemic criticality of infrastructure is determined by its structural, functional and technical position within the overall system of infrastructure sectors. The necessity to focus on entire networks (e.g. electricity or transport network) evolves when investigating systemic risks or systemic components and potential cascading effects on other infrastructures. Thus, the systemic understanding is contrary to the areal-oriented view of land-use planning (Greiving et al. 2017).

Accordingly, a dilemma presents in the fact that a planning authority is responsible for its local area, but is rarely aware of and not entitled to deal with the network components of critical infrastructure that are located elsewhere in the region or even abroad (see Fig. 5.1). This limits the ability to deal with critical infrastructure in spatial planning to those system elements that are only of local (or regional) importance and within the municipal boundaries. Hence, there is a need for a national or even international risk assessment by those authorities which are in charge of managing a particular infrastructure network (Greiving et al. 2017).[8]

The most important international framework for disaster risk management is the Sendai Framework for Disaster Risk Reduction (UNISDR 2015). The Sendai Framework acknowledges several competencies of comprehensive, over-sectoral spatial planning in managing risks and points at the importance of the discipline for the recovery phase, although it has previously been seen as a key player only for preventive measures (see, e.g. Greiving et al. 2006).

In Priority 2 “Strengthening disaster risk governance to manage disaster risks”, the Sendai Framework promotes that:

> Clear vision, plans, competence, guidance and coordination within and across sectors as well as participation of relevant stakeholders are needed. (UNISDR 2015, 17)

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[8] A good, although sectoral example for addressing risks on a national level is the Germany-wide spatial plan on flood protection (*Bundesraumordnungsplan Hochwasserschutz*), which is currently under discussion and aims at coordinating the regional plans of the federal states (*Bundesländer*). The nationwide plan may address potential cascading effects of large flooding events with respect to the criticality of infrastructure systems.

In Priority 4 “Enhancing disaster preparedness for effective response and to ‘Build Back Better’ in recovery, rehabilitation and reconstruction”, spatial planning’s importance becomes even more apparent:

> The steady growth of disaster risk, including the increase of people and assets exposure, combined with the lessons learned from past disasters, indicates the need to further strengthen disaster preparedness for response, take action in anticipation of events, integrate disaster risk reduction in response preparedness and ensure that capacities are in place for effective response and recovery at all levels. […] Disasters have demonstrated that the recovery, rehabilitation and reconstruction phase, which needs to be prepared ahead of a disaster, is a critical opportunity to “Build Back Better”, including through integrating disaster risk reduction into development measures, making nations and communities resilient to disasters. (UNISDR 2015, 21)

More specifically spatial planning is addressed as one prerequisite for achieving Priority 4. It is important to

> promote the incorporation of disaster risk management into post-disaster recovery and rehabilitation processes, facilitate the link between relief, rehabilitation and development, use opportunities during the recovery phase to develop capacities that reduce disaster risk in the short, medium and long term, including through the development of measures such as land-use planning, structural standards improvement and the sharing of expertise, knowledge, post-disaster reviews and lessons learned and integrate post-disaster reconstruction into the economic and social sustainable development of affected areas. (UNISDR 2015, 21f.)

Another important aspect in the discussion on responsibilities and abilities of spatial planning is the understanding and handling of uncertainties. Uncertainties are risk-immanent and arise as soon as future conditions cannot be predicted with certainty. Uncertainties may, e.g. exist regarding the occurrence of an anticipated hazard (does it occur at all and if yes, when?) or its magnitude (Wernig et al. 2011). The complexity of dealing with uncertainties seems to peak in the discussion on the management of ubiquitous extreme weather events from a spatial planning perspective, as these are—per definition—indefinable in multiple characteristics. They can presumably occur anywhere at any time, i.e. are basically unpredictable in their probability, time and place of occurrence; possibly even in their precise character.

Associated with the aggravated predictability and forecasting of occurrence and magnitude of ubiquitous extreme weather events, warning management is highly restricted. Additionally, in the case of thunderstorms, peak wind gusts result from downbursts (DWD 2015), which presumably subordinates the consideration of orography and topography. And on top, there is great uncertainty on the potential future development, as extreme weather events are likely to be increased in intensity and frequency by global climate change (IPCC 2014).

For spatial planning, the uncertainty about the probability of occurrence of a certain event is one of the key challenges and often the strongest limitation to risk management actions. The question on whether an event requires (and legitimises) spatial planning actions is of normative, highly political nature and reflects the preferences and socio-political priorities of the definition of an acceptable residual risk (Greiving 2011).

Concluding, there are several strengths as well as limitations of spatial planning in managing risks, especially from ubiquitous extreme weather events. Regarding risk prevention, spatial planning proved to be responsible although the discussion showed that the awareness and execution of this responsibility are still of rather indirect nature. Due to its long-term planning horizon, the goals for sustainable development and its widely independence from political agendas, spatial planning may be regarded as one of the most important players in risk management, also beyond preventive measures (Pohl and Rother 2011).

5.4 Spatial Planning Using Risk Management for Enhancing Urban Resilience

The concept of *resilience* presents with a certain degree of vagueness, which on the one hand is beneficial for having a common objective, even from different disciplinary perspectives, but on the other hand makes it difficult to operationalise the term (Meerow et al. 2016).

In the field of spatial planning, there is a call for an understanding of urban resilience that goes beyond engineering resilience, i.e. further than the maintenance of efficiency and constancy of a system close to a single steady state (Holling 1996). Of special importance is the consideration that systems may change over time and that accordingly *bouncing-back* to a pre-disaster state may be inadequate. Instead, there is a call for preserving the potential for flexibility by considering systemic feedbacks, cross-scale dynamic interactions as well as opportunities for *institutional learning* (Bach et al. 2014).

In the understanding of socio-ecological resilience theory, a system is constantly changing in non-linear ways. This broader perspective on resilience increases the likelihood for desirable pathways under changing conditions, making it a highly relevant approach for dealing with uncertainties, e.g. from climate change, socio-economic or political changes (Walker et al. 2004; Adger et al. 2005; Boin and McConnell 2007; Tyler and Moench 2012; Rodin 2014).

In this chapter, urban resilience is understood as:

> the ability of an urban system – and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales – to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity. (Meerow et al. 2016, 45)

So how can spatial planning contribute to enhancing urban resilience through risk management?

An assignment for enhancing resilience through risk management is provided in the Sendai Framework for Disaster Risk Reduction and the amended EIA Directive.

Within Priority 4 of the Sendai Framework, resilience of critical infrastructure (i.e. their safety, effectiveness and operation during and after disasters) is stated to be a prerequisite for enhancing disaster preparedness, response, recovery and reconstruction. The enhancement of the resilience of critical infrastructure is furthermore one of the Sendai Framework's seven global targets, aiming at a substantial disaster damage reduction (UNISDR 2015).

Additionally, the amended EIA Directive is of great importance when discussing the enhancement of urban resilience through spatial planning. Article 3 § 2 in accordance with recital 14 of the amended EIA Directive states:

> In order to ensure a high level of protection of the environment, precautionary actions need to be taken for certain projects which, because of their vulnerability to major accidents, and/or natural disasters (such as flooding, sea level rise, or earthquakes) are likely to have significant adverse effects on the environment. For such projects, it is important to consider their vulnerability (exposure and resilience) to major accidents and/or disasters, the risk of those accidents and/or disasters occurring and the implications for the likelihood of significant adverse effects on the environment. (Directive 2014/52/EU)

In Germany, EIA and strategic environmental assessment (SEA) are jointly implemented in the law on environmental assessment (*Umweltverträglichkeitsprü fungsgesetz, UVPG*). The UVPG is closely interwoven with the Federal Building Code, giving the latter priority regarding the environmental assessment of spatial planning documents[9] (see §§ 16–17 UVPG). Hence, the amendment of the EIA Directive entails an amendment of the Federal Building Code.

Both Sendai Framework and EIA Directive provide an assignment to spatial planning for enhancing resilience. While the Sendai Framework explicitly identifies risk management as an adequate approach but addresses spatial planning rather implicitly, the EIA Directive identifies environmental assessment as a procedure for considering catastrophic risks in the light of susceptibility of land-uses and critical infrastructure in spatial planning.

Another angle for enhancing resilience through spatial planning can be seen in the concept of *change-proof planning*. The term comprises the demands for (a) the preservation of flexibility in planning decisions and (b) the use of governance approaches, both in order to maintain the competency for taking spatial planning decisions and actions despite uncertainties. Promoting spatial planning in a change-proof way therefore means to keep the flexibility to accommodate extremes without failure and the robustness to rebound quickly from undesired impacts (Henstra et al. 2004).

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[9] Historically, the Federal Building Code has priority over the UVPG, because land-use plans were already subject to environmental assessment procedures even before the SEA Directive was introduced by the EU. Reason for the consideration of environmental effects prior to any EU Directive was the realisation that a project's location is the key determinant for potential effects. Therefore, the decision on the location of new projects was made subject to an assessment on the level of spatial plans. By this, the German legislative secured a weighting process of potential environmental effects by considering the most suitable location for potentially hazardous projects prior to discussions on a project's realisation within EIA procedures.

The necessity for change-proof planning is exemplified by the following scenario: projections on future climate change-related effects (e.g. temperature and precipitation) bare great uncertainties, as they base on modelling of possible changes in their variables. Those future climate scenarios meet projections on other changes (land-use development, demographic changes, etc.), leading to even greater uncertainties and in sum, changing the perspective on the future situation from probabilities to just possibilities. With public decision-making not having any reliable information at hand, spatial planning actions as, e.g. restrictions of private property rights become unjustifiable.

At this point, change-proof planning needs to initiate the definition of goals and strategies in dealing with risks, i.e. needs to discuss thresholds for acceptable (residual) risks and to (normatively) gain consensus on the justification of response actions (or non-action). Basing spatial planning decisions on worst-case scenarios in accordance with the precautionary principle could be one possible option for legitimising spatial planning actions (BMVI 2017).

Moreover, *no-regret strategies* are an example for managing risks in a change-proof way. The goal of no-regret strategies is that planning decisions in the present do not restrict spatial planning's ability to act in the future, i.e. irreversibility of planning activities shall be prevented. No-regret strategies are especially useful if —as in the case of climate change-related impacts—a potential risk may take effect in the future, but its impact can presently not be assuredly predicted.

An example for a no-regret strategy, which is provided by German planning law, is temporary building lease (*Baurecht auf Zeit*). According to § 9 (2) No. 2 Federal Building Code, a designation of a certain land-use or critical infrastructure in a land-use plan stays valid only as long as certain circumstances arise. Therein, *certain circumstances* may, e.g. be defined as the occurrence of extreme events, which then may be used as an opportunity for reconstructions. However, currently temporal building lease is hardly realised in planning practice as alternatives to reconstruction on the very spot rarely exist (Zehetmair 2011).

5.5 Conclusion

Concluding, further prerequisites for enhancing urban resilience through spatial planning are compiled in the following.

First, spatial planning needs to become (more) aware of and exhaust the assignments and possibilities given. This especially requires an examination of how the amended EIA Directive and its call for considering catastrophic risks is transferred into the national planning laws. But it also requires further consideration of change-proof ways of spatial planning in order to cope with uncertainties and establish legitimacy for the management of risks. This is especially valuable for dealing with extreme weather events, where uncertainty of hazard and vulnerability is the norm. However, the requirement for a direct assignment of risk management to spatial planning in the Federal Regional Planning Act and the Federal Building

Code remains valid. And so does the discussion if *resilience* should become a guiding principle in planning law. Moreover, it needs for clear methodological guidance in order to facilitate the implementation of a risk assessment for municipalities.

Second, spatial planning needs to further elaborate its risk management tools, in order to be justifiably recognised as a key player not only in risk prevention but also in preparedness, response and recovery. In this context, an understanding of the susceptibility of different land-uses and critical infrastructure towards single (and multiple) hazards needs to be fostered. Susceptibility analyses should be designed for different hazard scenarios that reflect on the severity of impacts which can result from damages to certain buildings or infrastructures. In this context, considerations of systemic second- and third-order impacts (cascade effects) are of special importance. Additionally, tools like *pre-disaster development plans* seem to be worth formulating, so that no-regret strategies like temporal building leases may be pursued in planning practice.

Third, spatial planning needs to strengthen its key competencies in order to optimally participate in risk management. One key competency of spatial planning is its coordination and network function, which results from the comprehensive, over-sectoral perspective and its interconnectedness with other players and stakeholders involved in risk management. Using this interconnectedness, spatial planning can foster pre-event discussions of extreme scenarios (‘imagining the unimaginable’), reflections on the system’s existing response capacities, as well as post-event monitoring and evaluation activities; overall strengthening the system’s ability to learn and *bounce forward*. Another key competency of spatial planning is its long-term alignment and ability of storing knowledge from previous events, which can serve as a basis for improved responses to the next event. An insight from summer storm *Ela* that should be memorised by spatial planning is, e.g. the suitability of snow-clearing and gritting plans for the prioritisation of clearing activities, as these plans already contain a classification of all roads according to their importance for the transport infrastructure system.

In the light of ubiquitous extreme weather events, a prerequisite for the execution of the above-described approaches is a revisited discussion (and adjustment) of the definition and conditional programming of *spatially relevant* and *spatial-planning relevant* hazards. The example of summer storm *Ela* showed that despite its ubiquitous character, i.e. the disability of demarcation of hazardous areas, *spatial-planning relevance* is given as the event’s impacts display spatial patterns, oriented along the (systemic) criticality of land-uses and infrastructures. Conceivably, the second- and third-order impacts of a ubiquitous event may even reinforce the hazard component, unexpectedly providing *spatial relevance* at second glance. In the end, of course, the legitimacy and ability for spatial planning actions depend on the normative decision on the acceptability of risks (Wernig et al. 2011) as well as on the ability to consider the systemic component of criticality.

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