

Flood Label for buildings – a tool for more flood-resilient cities

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Abstract. River floods are among the most expensive natural disasters in Europe. Traditional flood protection methods are not sufficient anymore. It is widely acknowledged in the scholarly debate and in practice of flood risk management that traditional flood protection measures such as dikes need to be complemented with measures to increase the resilience of cities. For cities to become flood-resilient, actions by land users (and homeowners) are required. Currently, land users insufficiently implement measures to mitigate flood-induced damages. Reasons for this include the lack of knowledge about potential measures and the benefits as well as lack of tailored information on flood risk. In this paper, a tool is discussed that addresses these two issues: the German Flood Label for buildings (Hochwasserpas). It is discussed how such a tool can create awareness by land users and how it can trigger the realization of precautionary damage mitigation measures. It will then be discussed how such a tool needs to be embedded in a strategic governance arrangement between land users, water authorities and insurance companies to ultimately achieve flood-resilient cities.

1 Introduction

Floods are among the most expensive natural disasters. € 12.900 million is the estimated damage of the summer 2013 river floods in Central Europe. In 2002, the damage was € 14.000 million in a similar area. In 2013, 37 % of all damages from natural disasters were caused by inundations. Much of the damages occur at the individual household level (Munich Re, 2014a). The Intergovernmental Panel on Climate Change (IPCC) states with “high confidence” that damages by river floods will substantially increase in Europe (IPCC, 2014). Other flood events caused by flash floods or rising groundwater levels are also expected to increase.

At the same time, the vulnerability of cities continues to increase as well (Loucks, Stedinger, Davis, & Stakhiv, 2008). Even in areas of the global North with sophisticated land-use planning and comprehensive water management, urban development still takes place in flood-prone areas, without adaptation (Hartmann, 2012; Petrow, Thielen, Kreibich, Merz, & Bahlburg, 2006).

It is widely acknowledged in scholarly debate as well as flood risk management practice, that traditional flood protection measures such as dikes need to be complemented with measures to increase the resilience of cities (Klijn, Samuels, & van Os, 2008), such as precautionary flood damage mitigation measures. The recent European Floods Directive recognizes the need to reduce vulnerabilities (Directive 2007/60/EC on the assessment and management of flood risks, 2007). But contemporary practices in flood protection are still mainly focused on technically-oriented flood defence

(Hartmann & Juepner, 2014; Jüpner, 2005). The practice of flood risk management reveals that implementing precautionary flood damage mitigation measures is quite difficult (Hartmann, 2011b) and water management agencies often focus instead on technical measures, because this is more within their control (Klijn et al., 2008).

This leads to and increases the dike paradox—sometimes called the “escalator effect” in flood policy (Saurí-Pujol, Roset-Pagès, Ribas-Palom, & Pujol-Caussa, 2001). This is when land users feel safe and protected behind dikes or other technical measures, and they accumulate (immobile) values in their houses without adapting to the flood risk (Tempels & Hartmann, 2014; Wagner, 2008). This phenomenon has also been denoted as “clumsy floodplain” (Hartmann, 2011a). But since the flood risk is a product of both probability and potential damage, both variables must be reduced in order to reduce risk (Houghton, MacCarthy, & Metz, 2001; Patt & Jüpner, 2013).

The flood-resilient city is able to absorb negative consequences of such flooding (Begum, Stive, & Hall, 2007; Bruijn, 2005; Petrow et al., 2006)—in other words, flooding leaves minimal damage (Holling, 1996). One of the advantages of a flood-resilient city is that it not only responds to river floods or coastal storm surges, but also reduces impacts from flash floods, impounding water from the sewage system, or rising groundwater levels.

Cities are not meant to be inundated. So the flood-resilient city requires adaptation. Existing approaches to resilient cities focus on public infrastructure at the city level (e.g. streets as discharge flumes, multifunctional

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areas, evacuation routes, or non-structural measures) (Berke & Campanella, 2006), whereas major damages occur foremost on buildings on private land (Osberghaus, 2015). There is a wide range of flood damage mitigation measures for individual buildings, which can reduce damages by inundations. In summary, these have the potential to make cities more flood-resilient (Brombach et al., 2013). However, most of these measures need to be implemented by homeowners (e.g. implementing valves against backwater or swales to drain water) or require land users' action (e.g. change of use of certain building levels) (Bubeck, Botzen, & Aerts, 2012).

In order to have a substantial effect on cities, these individual flood damage mitigation measures need to be realized on a city or at least the neighborhood level to avoid worsening the single individual situation (e.g. leading water to the neighbour). If land users would indeed realize such measures in a coherent area, flood risk management strategies could be developed in a much more efficient and effective way (Patt & Jüpner, 2013; Poussin, Botzen, & Aerts, 2014). (If not explicitly stated otherwise, throughout the remaining paper, 'land users' is used to refer to land users, land owners and homeowners). So, one of the key questions of resilient cities is: How can we get land users within a coherent area to realize precautionary flood damage mitigation measures on land and buildings?

2 The Flood Label

The Flood Label (*'Hochwasserpäss'*) is a tool which is designed to increase the preparation of individual households. It has been developed by the Flood Competence Centre in collaboration with the insurance industry (Scheibel & Johann, 2015). It will be conceptually elaborated in this contribution how such a Flood Label can be used for achieving the flood-resilient city. Therefore, a governance arrangement will be proposed and discussed. Methodologically, the paper mainly builds on literature studies and first-hand experiences with the Flood Label (pilot studies are pending throughout 2016/2017).

2.1 The Flood Label in two steps

The Flood Label foresees a self-check by land users. This self-check is a basic, free, web-based questionnaire written in accessible language to raise the awareness of personal flood risks. This collects general but basic information about the location and the building, such as knowledge about previous flood events in the area, distance to rivers and geographical aspects of the terrain, and constructional aspects. Based on this first self-check, automated standardized information about the possible personal risk and ideas for prevention measures are provided.

A detailed questionnaire is accessible, if more detailed information is required (e.g. getting credits or insurance). To get a proofed and "official" certificate including personal guidance, the land user can request a Flood Label in a next step. This implies that the land user

selects from a list of specially trained experts someone who will make a detailed analysis on the location and give more tailored advice on measures. It is estimated that for a normal single family house, this assessment costs between 300-900 Euro (depending on the specific building). Based on the assessment, the expert will rank the existing protection of the building— differentiated in river floods, flash floods, backwater from the sewage system, and inundation from groundwater. This will be documented in a Flood Label, indicating the preparedness of a building. In addition, the expert gives hints and advice for specific measures to reduce the vulnerability of the building. Then the land user can decide if measures should be implemented (depending on the personal risk) and go into more detailed planning. Realizing the measures will then change the assessment on the Flood Label. The label is simply an indicator of how flood-proof a building is. In some respects, the label is comparable to the well-known European energy performance certificate that depicts the energy standards of a building. It could be used as a selling-point for properties. The certificate can also be used to claim reduced insurance premiums or as a selling point on the real estate market, if the insurance industry is involved accordingly.

To use the Flood Label effectively and efficiently and achieve a flood-resilient city, three challenges need to be addressed:

- Communicate individual flood risk with land users.
- Identify tailored measures for buildings.
- Strategically apply the tool in a coherent area.

The remaining paper discusses these three challenges and derives conceptual ideas for what they mean for the development of a Flood Label for Buildings.

3 Communicating individual flood risk

The key aspect of the implementation of precautionary flood damage mitigation measures is that land users need to know the flood risk and they need to take action. Public flood risk maps are often easily accessible via respective websites. However, experience shows that the pure availability of the information somewhere is not sufficient to get land users to implement measures on their land and in their buildings or even to look for the information.

3.1 Flood Hazard Maps

Information on flood risk is not lacking. Since the European Floods Directive from 2007 prescribed Flood Hazard Maps for all member states, information on flood risk is publically available (and it was often available before as well). However, the way these maps communicate the flood risk can in fact lead to increasing vulnerabilities. These maps are design-level orientated. This means they depict scenarios of inundations (i.e. Flood Recurrence Intervals of 1:100 in large parts of Germany or 1:1.250 up to 1:10.000 in the Netherlands). This leads to misinterpretations. The residual (or remaining) risk is not properly illustrated. Instead, the

maps mostly draw sharp lines between inundation zones and remaining land. These lines are publically interpreted as boundaries where flood risk seems to end (Loucks et al., 2008). However, it is difficult to incorporate in the maps the remaining risk of overflows, cumulative disasters, or potential failures of hydraulic engineering solutions (i.e. dikes). Even if most water engineers were aware of the limits of flood hazard maps, they do not communicate the remaining risk (Patt & Jüpner, 2013). To use the information in the Flood Hazard Maps to trigger action by land users, they need to be considered as a target audience of Flood Hazard Maps.

This is one of the first challenges the *Flood Label* needs to tackle: to communicate flood risks in an understandable and accessible way to land users and build awareness for the relevance of being prepared for flood risk.

3.2 Tailored information

The information on the Flood Hazard Maps needs to be tailored to individual properties and buildings, in order to reach out to land users and increase the relevance of flood mapping.

For various reasons current Flood Hazard Maps are generalized and do not usually provide such information. This is due to potential issues of liability if the information is imprecise, but also because tailored information on precise flood risk requires precise and also dynamic models. Flood risk is not static, but rather dynamic. Flood risk can change by activities of other activities in a catchment (i.e. upstream). Climate conditions are also dynamic, and demographic or cumulative risks can influence the risk assessment at a given location. Because flood risk is so dynamic, this makes tailored information difficult to provide with traditional methods of risk communication (i.e. static flood hazard maps).

The claim for tailored information also contradicts the previously discussed aspect of remaining risk. Location-specific information on flood risk to individual land users should not necessarily be sharply drawn lines. New methods for risk communication are needed. This also involves information on other types of flooding and inundations, such as flash floods, inundation through the sewage system, or flooding by groundwater. It is to some extent an issue of modelling (i.e. detailed models for flow paths scaled down to the building level can be quite complex and therefore consume resource-). But it is also a political decision whether or not to include certain hazards in public maps. For example, groundwater flooding is not included in the Floods Directive. Nonetheless, a flood-resilient city cannot ignore these types of flooding, as they also cause damage, and there are many synergy measures to prevent or mitigate the damage. This implies that the *Flood Label* needs to incorporate smart solutions where land users can see the impact of various scenarios and assess the impact.

3.3 Risk Perception

The provision of information is not sufficient to get land users and homeowners to respond properly. Kreibich et al. found in a quantitative study that after the 2002 flood, although the preparedness of households and businesses improved, further “significant improvement in flood preparedness activities is still necessary” (Kreibich et al., 2011). This is confirmed by qualitative research conducted after the flood in 2006. After the flood in 2002 along the River Elbe, reconstructions of affected buildings were financially supported by governmental money. Landowners confirmed that the financial support was more than sufficient to rebuild their homes, and sometimes improved them. However, although damage mitigation measures and techniques are available, their implementation has been minimal (Hartmann, 2011a). So, the numerous flood events in the past two decades could not substantially change risk-ignoring behaviour of land users and homeowners (Loucks et al., 2008; Petrow et al., 2006). Even high exposure to flood risk is not a sufficient driver for households to invest in precautionary flood damage mitigation measures (Bubeck et al., 2012). This leads to the conclusion that in addition to information on the risk and measures, risk perception--the social construction of risk--needs to be addressed.

4 Tailored measures for building

For the measures that individual homeowners and land users can undertake, information on the effectiveness of the measures and its costs and benefits are necessary. In addition, it is important to identify what role public policy actors play in supporting these measures.

4.1 Precautionary damage mitigation measures

Some of the measures can be rather simple and small, such as the construction of certain swales on the individual plot to control and drain the water on the surface (i.e. away from the building), installation of valves against backwater from the drainage and sewage system, or small barriers such as sills and stop-log systems at doors, windows and basement entries. Some measures are mere maintenance, such as rain gutters. Other measures can be more fundamental structural measures such as the construction of waterproof concrete tanking around the building to protect against groundwater. Even the reallocation of technical infrastructure such as heating or electric installations from the basement to higher levels can contribute to substantially reducing the vulnerability of a building against floods. Another type of measure would be a change of certain building level use, such as having the expensive home-cinema in a higher level room instead of the basement. In addition, land users could store valuable items (not only monetary values, but also things with emotional value, or important documents) in more flood-safe (higher) locations in a building. There are also measures that take the flooding of houses into account

and prevent external damage, such as measures to prevent upswing of oil tanks. This prevents environmental damage. Most of these measures can be undertaken by land users, and others require homeowner action because they require structural changes on or in the building (Bubeck et al., 2012). A number of different measures combined would be able to reduce the flood risk and make buildings more flood-resilient.

4.2 Costs & benefits

The few studies on the effectiveness and efficiency of precautionary damage mitigation measures show that the benefits of such measures can be high (Bubeck et al., 2012). The effectiveness of precautionary damage mitigation measures depends on the characteristics of the flood hazards. For example, there is a difference between slow river inundations and flash-floods (Poussin et al., 2014). The cost-efficiency of the measures is dependent on the Flood Recurrence Intervals (FRI) of the events. The more often an area is affected, the higher the payoff of such measures (Poussin et al., 2014). In addition to the individual efficiency of measures, the macroeconomic impact needs to be taken into account. Cumulative damage on individual houses costs a significant amount of public money to pay for disaster management and other assistance. Information on the costs and benefits of precautionary flood damage mitigation measures is important to enable homeowners and land users to decide which measures to take.

Besides the actual costs and benefits, the relative costs are important: the ability to implement certain measures does not only relate to the actual costs, but also refers to costs in relation to the income and specific situation of stakeholders (Bubeck et al., 2012). Public subsidies can help in implementation. After the major flood event in Germany and in neighbouring countries in 2013, the German government-owned KfW bank (Kreditanstalt für Wiederaufbau) set up a fund of about 100 million Euro for supporting enterprises, homeowners, and municipalities in rebuilding and reconstructing their damaged houses and infrastructure with low-interest credits (1,00%). However, the reconstruction did not set conditions for precautionary measures. Such conditional credits could help realize such measures. In addition, linking certain measures to mortgages in flood-prone areas could help. However, an instrument would be needed to institutionalize and monitor these conditions. Such an instrument does currently not exist.

Apart from monetary losses, factors such as potential stress caused by damage remedies and the loss of non-tangibles (e.g. memorabilia) are an even better motivator.

4.3 Role of public policy

Numerous brochures and informational material help homeowners and land users learn what they can do to adapt to flooding. However, the mere availability of the information on websites and in brochures is not sufficient. To increase preparedness in flood-prone areas, policy action is required (Bubeck et al., 2012). “Policy

makers should ... provide advice on which measures to install” (Poussin et al., 2014, p.83–83). This is particularly important in areas where the last flood event was many years ago. But how should the information be communicated with homeowners and land users so that it leads to proper action? Besides individual land owners, other stakeholders need to be addressed. For example, some of the measures mentioned earlier are easier and more cost-efficient to realize with new buildings (i.e. waterproof concrete tanking), while others apply to existing buildings. This means that architects and also land user planners need to be able to advise on precautionary damage mitigation measures.

An additional aspect to precautionary damage mitigation measures is that they may not be at the expense of other land users. On a larger scale, this is known as the impairment principle: any building activity in a floodplain must not impact the water discharge and must respectively compensate the change in the discharge within the aquifer. This principle also applies on the lowest scale. For example, a land user may not build a wall around a piece of land to prevent it from flash floods, if this measure impairs other land users. In order to enforce this, precautionary damage mitigation measures need to be embedded and monitored by some public authority, such as a water management agency.

In addition, although it is beneficial to make individual buildings in a city more flood-resilient, only the realization of the measures on a larger scale (i.e. city or at least neighbourhood scale) can ultimately lead to a flood-resilient city. If realized on such a larger scale, flood risk management can strategically make use of more adapted areas of cities and adjust their flood protection strategy accordingly. This can then lead to more efficient and effective flood risk management (Patt & Jüpner, 2013). Experts and academics agree that precautionary adaption measures are considered to be an integral part of flood risk management strategies, next to technical flood protection measures and flood retention (i.e. via polders and retention measures) (Brombach et al., 2013; Bubeck et al., 2012; LAWA, 2003). In addition to being able to substantially reduce the impact of a flood event for individuals (Poussin et al., 2014), and to make flood risk management more efficient and effective, a further aim of precautionary damage mitigation measures is to prevent damage for the environment or downstream parties, because such measures contribute to less pollution (i.e. by oil tanks) (Brombach et al., 2013).

In sum, public policy needs to not only promote the use of the Flood Label, but also monitor its use and control the measures undertaken to avoid free-riding behaviour or externalities.

5 Strategy for the resilient city

The hitherto elaborated issues, with respect to risk communication and the precautionary flood damage mitigation measures, help enlarge the application of the Flood Label and support its use. However, to use it strategically for resilient cities means to establish a governance arrangement that engages other actors.

Thereby, the Flood Label can lean on existing approaches.

5.1 Use existing approaches

In order to make the flood label an effective and efficient tool to achieve resilient cities, two conditions need to be met: First, it needs to be used strategically for resilient cities. Second, it needs to be cost-efficient, which implies using smart technologies to standardize it. Therefore, existing governance and technological approaches can be used and built upon.

Other countries, such as Flanders and Austria, are currently exploring possibilities for certificates that document risk exposure. In France, information on various risks and technical issues, including natural hazards, is already mandatory for sellers (the 'Dossier des Diagnostics Techniques'). However, such instruments, including the Hochwasserpapier are not yet used strategically to reduce the vulnerability and increase resilience of whole neighbourhoods or cities. Rather they are mainly designed to help individual land users become aware of the risks and advice on measures.

Smart technologies for GIS-based flood damage modelling tools for cities and neighbourhoods already exist (Schinke, Neubert, & Hennersdorf, 2013). Only few link hydrological information (i.e. water depth) with accurate land use and build stock data or even important data like care centres for children or older people. Fewer reach a level of detail that allows identification of damages at the building level, such as the damage simulation model HOWAD (Neubert, Naumann, Hennersdorf, & Nikolowski, 2016). Most such models do not yet recommend measures and are not deliberately designed to trigger land user action. But most importantly, Decision Support Systems for flood risk management regard public authorities as "end users," not land users (van Ree et al., 2011). Those public authorities, however, are barely equipped and legitimized to enforce land users to implement certain measures.

To realize the resilient city, the two issues need to be merged: embed flood damage modelling tools in a governance arrangement that triggers incentives and implements it on an appropriate scale in a coherent area, and address land users instead of public authorities.

5.2 Towards a governance arrangement for resilient cities

Three different groups can be identified who have an interest in resilient cities. First are the, land users because they directly suffer the damage of a flood event, not just economic damage, but also non-financial damage, such as loss of personal items). Second, public authorities, notably water authorities and city officials, are interested in reducing the vulnerability of cities. This will help to pursue a more efficient and effective flood risk management which saves resources. B It is also in the general interest of a welfare-oriented elected body to care for the well-being of citizens. The third group are

market actors. Foremost, the insurance industry has an interest in reduced vulnerabilities and more flood resilient cities, as flood risks are among the most expensive disasters for insurers (Munich Re, 2014b). But flood resilience might also be an aspect for land markets (although this aspect might be difficult to prove). So, land users, public authorities and the financial market are key players in realizing the resilient city as described above.

With those three interest groups, the implementation of flood-resilient cities becomes a governance challenge: determining how to stipulate collaboration between civil society, state and market so that flood-resilient measures on private land are realized in a coherent urban area. Resilient cities require the type of governance where "various actors that are independent of a central power and operate at different levels of decision-making" (Klůvanková-Oravská, 2010) come together to realize collective goals (Benz, 2005; Driessen, Dieperink, Laerhoven, Runhaar, & Vermeulen, 2012). A governance arrangement is needed that nurtures the collaboration between the three groups of actors.

How such a governance arrangement could function is depicted in Figure 1. In order to realize a resilient city, or a city where buildings in a coherent area implement measures to reduce the vulnerability to inundations, the three actors must collaborate in a certain way. Land users need to be aware of the risk and implement measures. Public authorities need to facilitate and monitor the implementation within a coherent area. And the insurance industry can set financial incentives in the form of reduced premiums if certain measures are applied (Hartmann, 2011a).

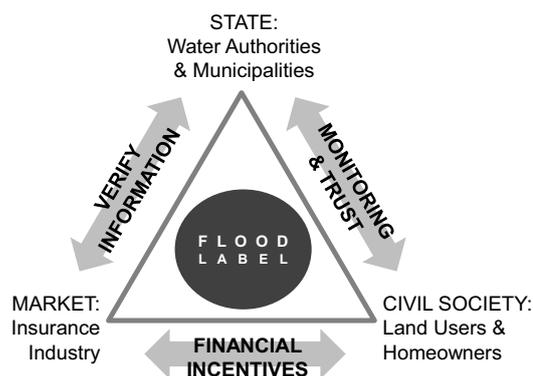


Figure 1. Governance arrangement for resilient cities.

In this government arrangement, different responsibilities and relations are assigned to the three groups of actors:

The state provides validated and reliable information on flood hazards and land use to homeowners and land users. Also, the state embeds the measures by homeowners and land users in a general strategy to pursue a flood-resilient city. This could be supported by setting up special subsidies (i.e. in Germany, the KfW bank could provide conditional credits for particular measures).

The insurance industry can, in addition to state subsidies, set incentives by granting reductions on insurance premiums if a certain assessment of the flood-certificate is achieved. The Flood Labels can be also used as a communication instrument for real estate agents to inform potential buyers about the flood risk of certain buildings (similar to the energy label).

The reliability of the Flood Label needs to be warranted by publically affiliated experts. This makes the certificate independent of market interests and ensures insurers a certain standard for the Flood Labels (on which basis they can reduce premiums or sell houses with different conditions).

In sum, this means that the Flood Label needs to be embedded in a governance arrangement between state, market and civil society actors. Setting up and institutionalizing such an arrangement sets certain requirements on the Flood Label, which require standards and cost-efficient procedures as well as transparency for all involved actors. This can only be achieved by embedding it in a planning support system with a dedicated methodology and procedure.

6 Discussion & conclusion

The Flood Label is currently being prototyped and the first pilot studies are to be conducted in various locations. This contribution cannot yet present any empirical evidence for how the Flood Label really stimulates land users to realize precautionary flood damage mitigation measures. However, this contribution shows several potentials for the Flood Label. Those lie in the following three aspects:

First, the communication of individual flood risk with land users is essential for the functioning of the Flood Label. Flood Hazard Maps are not sufficiently informing land users about their individual flood risks: tailored information on various types of flooding needs to be provided. There is a tension between the potential misinterpretation of flood scenarios and the need for precise flood risk information to make the personal impact clearly visible. Smart technologies could potentially help partially resolve this issue. Communication about flood risk should also not be regarded as absolute, but as subject to interpretation and social construction. What appears to be a high risk for one land user can be interpreted as tolerable by a second land user. Addressing and responding to this social construction of risk will be a challenge but also a potential for the Flood Label.

Second, the identification of precautionary flood damage mitigation measures needs to be tailored for buildings. This involves expertise on technical matters, but also on the costs and benefits of measures. The Flood Label can be a useful tool to communicate on the possibilities, potentials and constraints of measures, but it needs to be supported by public policy. Public policy cannot be reduced to merely promoting the measures, but

public authorities should also monitor and control the implementation of the measures. The Flood Label can provide a structured way of achieving this monitoring and control.

Third, to use the Flood Label to realize the flood-resilient by getting land users to implement certain measures, essentially means to embed it in a strategic governance arrangement. This arrangement needs to govern the measures within a coherent area, so that flood risk management can become more efficient and effective.

Finally, there is huge potential in the Flood Label. Its implementation requires a combination of hydrological and technical knowledge, communication skills in generally intelligible language, smart technologies, and governance. It requires more research and development. This is essentially an interdisciplinary task. A huge gap in flood resilient cities could be closed, namely the realization of measures on private properties, which are out of reach of traditional flood risk management. Applied in the described way, the Flood Label could ultimately contribute to more flood-resilient cities.

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