100 % flood protection is not possible – we need four pillars of sustainable flood mitigation and adaptation measures

In May and June 2013, parts of Central Europe were haunted by the second large flood in a decade. After a week of heavy rainfall due to a stationary cyclone in eastern-central Germany, Czech Republic and Austria three larger tributaries of the Elbe river peaked simultaneously and thus lead to an huge areas flooded, thousands of evacuated people and heavily destroyed infrastructure and agricultural land. The duration of the 2013 flood was almost a month and still, the returned families are faced with high groundwater levels and wet basements.

Summary – four pillars of sustainable flood prevention

(1) In the past, structural flood protection has proved insufficient to safeguard settlements (cities, villages) entirely against flooding. However, it is not possible to construct dikes sufficient to protect every single built-up area, moreover dikes can overflow or break.

(2) The call to provide rivers with more space and to decrease soil sealing in the catchments to capture more rainfall locally is important and correct. However, it will remain a challenge to recover expansive areas of alluvial plains or change land-use on a large scale in an environment characterised by dense population, commercial use and intense agricultural exploitation.

(3) In future, there is a threat of floods in built-up areas, too. Private mitigation measures as called for in the German Federal Water Act (WHG, § 5), can contribute to a minimisation in damage. Nonetheless, appeals and statutory requirements alone will not be sufficient to realise private sector prevention. Thus, the message will be: don't just demand, subsidise too.

(4) To some extent we have to live with floods and also with flood damages, as 100% safety is neither possible nor affordable. Therefore we need new venues to cope with financial losses. A mandatory insurance requirement could guarantee comprehensive relief affordable for each individual/household while maintaining incentives for private mitigation through prevention-based pricing of insurance premia.

Reasons for the flooding in 2013? – A fateful simplification of the discussion

The political discussion concerning the reasons for the 2013 flooding rose in pitch once the first houses were under water. And it runs along well-practised lines of conflict: nature conservation associations, citizens' initiatives, farmers and federal responsibilities were declared accountable for the delays in constructing technical flood protection systems, seemingly in turn. These arguments posit that individual interests are given priority to common interests, hence obstructing the rapid construction of dikes and the designation of additional floodplains. Even if an individual assessment should be conducted on whether the plan approval procedures for the construction of dikes and the designation of retention areas have delayed

effective flood protection, the premise of this argument remains questionable: It assumes that improved technical protection could have prevented flooding and that the economic damage could have been prevented. But the painful recollections of incidents in Central Europe over recent years (1997 flooding along the Oder, 2002 along the Elbe, Danube and tributaries, 2006 along the Danube and the Elbe, 2010 along the Neiße and the latest events along the Elbe and the Danube in 2013) confirm that there is no such thing as complete protection against flooding. The idea of a 'comprehensive flood protection scheme' is in itself fallacious, as this concept assumes that future damage can be reduced if exclusively planning procedures are expedited. We believe that the principle of mitigating measures must be adequately considered. The following paragraphs sketch four pillars of sustainable, mitigation flood management: (1) Technical flood protection, (2) Natural retention, (3) Private mitigation measures (4) Mandatory insurance coverage. These pillars were already mentioned by the German Committee for Disaster Reduction (DKKV) in their 'lessons learned' following the flood disaster in 2002. But progress made since then in these four fields is very different ranging from high to non-existing. In this regard, networking in flood risk management is particularly deficient.

Technical flood protection – what has been undertaken since 2002 and where are the limits?

Above all, technical flood protection involves the construction and maintenance of dikes and (mobile) flood walls as well as retention basins in the upper reaches of the rivers, aimed at holding back the water and intended to prevent the flooding of built-up areas and zones used for agricultural purposes further downstream.

Between 2002 and 2012, roughly 530 million Euro were spent on technical flood protection in the Federal State of Saxony alone; there are plans to invest a total of one billion Euro by 2020. New concrete walls and dikes now protect many cities in Saxony and other federal states.

Large swathes of the population and many municipalities associate the construction of major technical facilities with the hope of achieving enhanced or indeed even complete protection of their built-up areas in the future. In a representative survey conducted in 2005 among 404 households damaged by the flooding in 2002, over 60% of the inhabitants of three municipalities in the Mulde hinterlands agreed with the statement that dikes convey a sense of security (Steinführer and Kuhlicke 2007, 101). This is a contributing reason why in advance of the 2013 flooding, many local executives believed that dikes and the protection they promise are especially important for the population. Any local government authority admitting that, despite existing protection, a similarly destructive event such as in 2002 is possible would inflict deleterious effects on the municipality's future development potential.

As examples such as Eilenburg or Erlln (see pictures), show, many of these newly constructed dikes or technical flood protection facilities fulfilled their functions in 2013, protecting the built-up areas against flooding. But the conclusion that technical flood protection facilities are consequently a form of strategic panacea is short-sighted. After all, dikes and walls only offer protection up to a certain level, the so-called design standard. As soon as the dikes

overflow or break, the protection they offer is irretrievably gone. Indeed, the so-called dike effect may induce spiralling costs, higher even than without any protection at all: frequently, the alleged risk reduction offered by flood protection goes hand in hand with an increase in the number of buildings and hence with a rise in the damage potential within the 'protected' zone (see Seifert 2012). This is also a reason why drawing on technical protection alone is overly short-sighted.

Natural flood protection – more space for rivers?

Floodplains occupy an inevitable function in flood protection, however, they are only able to fulfil this function if the respective volumes of water can be retained in the areas as long as possible. This is the exclusive and most efficient way to cut peak flood levels, nearly in every part of a catchment. Natural floodplains with aligned land utilisation in particular have a vastly significant role to play in terms of their retention function. However, agricultural land use, settlements, commercial areas and infrastructure developments along the rivers in Germany allow only one third of the original natural floodplains to provide this retention function (BMU & BfN 2009). Indeed, only 10 to 20% of the original floodplains of the Rhine, Elbe, Danube and Oder Rivers remain in their Holocene beds.

Reactivation of natural flooding zones such as wetlands and floodplains is hence important in order to reduce peak flooding (e.g. Busch & Hammer 2006, Alexy & Faulhaber 2011). For instance, measurements conducted as part of a dike relocation in Lenzen, Germany, (420 ha) implemented in 2009 reveal that the peak flooding based on the levels in Schnackenburg during the 2011 floods were over 20 cm lower than levels ascertained during the comparable floods in 2006 before relocation of the dike (Alexy & Faulhaber 2011).

This function of floodplains to reduce flooding has risen somewhat in the public perception over recent decades and is seen as a generally accepted benefit to the ecosystem. Accordingly, numerous dike relocation projects have been planned since the start of the 1990s in the German Federal States bordering the Elbe. Over 50 dike relocation projects were counted here alone (Neuschulz & Purps, 2000). Most of the proposed areas are located in Saxony Anhalt, but various projects are in progress, planning or discussion in Saxony, Brandenburg and Lower Saxony. In the region of 23,250 ha could be reactivated if all projects were completed, accounting for an increase in current floodplains by just short of 30%.

According to the Agency for Flood Protection and Water Management (LHW) in Saxony-Anhalt, there are currently 17 dike relocation projects planned, covering an area of approximately 2600 ha along the Elbe, Untere Mulde, Schwarze Elster and Havel Rivers in Saxony-Anhalt. Additionally, there are plans for polder solutions on the Mulde, the region of Torgau / Wittenberg and the Havel valley, intended to provide targeted reduction of peak water levels during extreme incidents. Dike relocation along the Elbe has already produced approx. 700 ha. Amt Neuhaus/Lower Saxony has implemented dike relocation in a magnitude of approx. 120 ha along the Elbe since 1990 (BRV 2009). The first completed large-scale project of this kind is the dike relocation along the Roßlauer Oberluch (City of Dessau-Roßlau) in the Middle Elbe Biosphere Reserve. Following preparation lasting over 10 years, a floodplain of approximately 140 ha was created here in 2006 within the framework of a dike reconstruc-

tion project (Scholz et al. 2009). The dike relocation project in the Elbe valley floodplains near Lenzen in Brandenburg, covering some 420 ha, was completed in the summer of 2009 with the opening of the old dike (Damm 2012). The largest project of this kind is currently underway upstream of the mouth of the Saale River, conducted by the Federal Agency for Nature Conservation (BfN) under the auspices of the WWF Germany; in it, expansive, forested areas in the former floodplain (approx. 600 ha) located in Lödderitz Forest, the largest alluvial forest along the Elbe, will be reconnected with the flooding system by 2018 (Eichhorn et al. 2004).

Nevertheless, successful recovery of retention zones remains a daunting challenge given that the interests of various protagonists and land uses must be taken into account during the planning and implementation process. This is why the costs are high and the drain on resources so substantial. In some cases, the high proportion of areas used for intensive agricultural purposes in potential dike relocation zones of the former floodplains places a significant strain on finding expedited solutions.

But completed projects show that it is possible to recover retention zones. The political will and financial backing from regional, national and even international institutions in addition to active support among residents and local authorities tips the balance in terms of whether a project will succeed. Concepts and tools are on hand for implementation, but they require targeted development, pooling and financing to unleash their effects in combination with the other pillars of preventative flood management.

In general, however, the procedure of providing rivers with more space by integrating former natural floodplains represents an opportunity to operate sustainable, preventative flood management that combines conservation goals with benefits to the ecosystem and society (Scholz et al. 2012).

Private precautionary measures – not just demands, also subsidisation

Mitigation measures in the private sector represent a further pillar in flood risk management. Generally speaking, four strategies of mitigation measures in construction are conceivable (DKKV 2003, 46):

- Evade (i.e. build houses on stilts or on elevations);
- Withstand (prevent water penetrating the house, e.g. using mobile protective walls or backflooding flaps);
- Yield (tailored use and fittings, i.e. construction of buildings, e.g. through the application of water-resistant construction materials or the relocation of more valuable household items to higher storeys) or
- Secure (protection against building and environmental contamination caused by pollutants, e.g. by relocating heating systems and oil tanks to higher storeys).

Studies indicate that private precautionary measures can substantially reduce the extent of damage. For instance, the damage of the Rhine floods in 1995 was significantly lower than in the comparable Rhine flooding in 1993. Households that in the wake of 1993 had initiated

mitigation measures in their own sphere of influence in particular suffered less damage by far (Bubeck et al. 2012).

The legislator also underlines the importance of private sector mitigation measures. For instance, § 5 of the Water Management Act (General Duties of Care) reads: "Any such person as may be affected by flooding is obligated within the framework of what is possible and reasonable to undertake suitable mitigation measures in protecting against the hazards of flooding and to reduce the damage thereof, in particular to design the use of properties to consider the possible deleterious implications that flooding may have on human beings, the environment or material assets."

In terms of the public consciousness, however, obscure legal texts, appellative brochures and flyers will hardly prove adequate in order to establish private precautionary measures as a sustainable pillar in combating floods across a broader basis: research in environmental psychology plainly shows that defining standards without any additional intervention or economic incentives yields barely any noticeable effects in terms of the environment (Mosler and Gutscher 1998). In particular people in areas with high standards of technical flood protection will hardly experience any incentives to undertake measures of this nature (Bubeck et al. 2012). Massive investment in technical flood protection can lead to paradoxical effects in the long-term as they provide a sense of security which in the main goes hand in hand with an erosion in risk consciousness, a loss of practical expertise and of the willingness and indeed the ability to take action, hence undermining any private precautionary measures. At the same time the technical, protective structures reduce the expected damage and therefore the efficiency of additional, private-sector mitigation (Meyer et al. 2012, Kuhlicke et al. 2013). Further, Kreibich (et al. 2011) reveal that private precautionary measures are only effective and hence profitable for the owners if flooding is expected as a relatively frequent phenomenon. And this is not the case in precisely those areas that are already protected. It is well-documented though that in particular direct experience of a flood leads to the increased implementation of these kinds of private sector mitigation measures (Bubeck et al. 2012). Accordingly, an 'as well as' strategy, trusting in both strong technical flood protection and also in private precautionary measures in one and the same area, can only function to a limited extent. Private initiative is more effective and efficient where there is no, or only slight, protection in the form of technical flood management facilities.

But questions emerge at the same time, given that there is a reassignment of responsibility from the public sector to the citizens and companies, as it is ultimately up to the individual to make decisions on the extent to which private flood protection will be initiated: is it sufficient to get hold of a few sand sacks or should the entire house be rendered flood-proof as a kind of 'private siege fortification'? This makes citizens into managers of their own risks, whereby the 'risk profile' and hence the willingness to invest are not dependent solely on the perception of a risk and an attendant assignment of significance but also on the financial resources available in a private household. Who will be able to afford which individual degree of protection in future? And what happens to those among us who can afford no protection at all?

This is why private sector mitigation measures should also be subsidised financially. In addition to targeted state-level subsidisation in the form of low-interest loans linked to construction or refurbishment to provide flood protection, there is the option of providing incentives for private mitigation in the form of reduced insurance premiums (Bubeck et al. 2012).

We need mandatory, prevention-oriented insurance

Nevertheless, even a combination of technical, natural and private mitigation to protect against flooding will not succeed in preventing all damage – 'residual risks' remain, as will non-protected areas. The prevailing system of ad-hoc relief results in a "justice gap": While some built-up areas receive technical flood protection facilities financed by the state, others remain unprotected and can receive compensation claims only in exceptional cases, rather than on a statutory basis. Hence, some affected are forced to provide for their own insurance (if insurance is available) or are reliant on ad-hoc state assistance that does not represent a lawful right to compensation and will indeed vary substantially depending on the media echo in response to the event - the greater the catastrophe and the nearer the election, the more likely is the state support. What is needed though, is a systematic, comprehensive and planned regulation of loss and damage compensation – unencumbered by elections or media-driven ad-hoc assistance. And this brings the demand for mandatory insurance to protect against elementary damage back to the table! Mandatory insurance would, in the spirit of solidarity, reassign the costs for damages suffered and would provide an economic incentive for private-sector mitigation measures to safeguard against 'elementary damage' such as flooding, storm surge, snow pressure and heavy rainfall.

Discussions on a mandatory insurance for flood damage rose up around the 'flood of the century' in 2002 (Schwarze/Wagner 2002), but have since petered out in the back chambers of politics, albeit not entirely. For instance, the German government is considering the introduction of a mandatory insurance policy for climate damage in the face of climate change. The German adaptation strategy specifies: "In certain areas of insurance, in future the state could supplement the products offered by the financial services industry, when economic considerations make it impossible for the private sector to bear such risks. This might be due to the fact that the persons concerned cannot afford the necessary premiums or that the size of the potential losses is too great. Such supplements could be offered in different forms, for example as a compulsory elementary loss policy or a state fund solution. In any case, however, it can only be the last resource. Such approaches have repeatedly been pursued, especially in the wake of flood disasters such as the Oder floods of 1997. The Federal Government – in consultation with the Länder authorities – intends to launch a new initiative here" (BMU (2008). In this way, the topic of mandatory insurance sets the wheels in motion within the private sector insurance industry. For instance, there are studies by the German Insurance Association (GDV) in cooperation with leading academic institutions concerning the development of new insurance models for extreme weather conditions (Schwarze and Wagner 2004), education campaigns and a constant stream of new surveys as concerns the insurance density and 'uninsurable' stock of buildings. The trend is: insurance density is on the rise – to over 30% in 2012 – while the stock of 'uninsurable' buildings is falling, most recently 1.4% in areas that statistically speaking are flooded every ten years. While

1.4% of the building stock sounds negligible, it still represents over a million uninsured persons. And for those who could potentially be insured, the policies are frequently too expensive: almost 70% of households without insurance coverage are not willing or able to pay for private insurance policies because costs are up to three times higher compared to the costs of mandatory insurance. Climate change is further exacerbating the problem of affordability, as the premiums will rise in line with the increase of extreme events and 'elementary risks'. Although GDV President Rolf Dieter Hoehen recently declared at the organisation's climate conference in 2011 that "Germany remains insurable despite climate change", he did make the weighty qualification "but only at the price of higher premiums." (GDV 2011)

A solidarity model for mandatory insurance therefore appears appropriate and necessary à la longue. A carefully designed, mandatory insurance can reassign the costs for damage suffered in such a way that economic incentives to take mitigation measures against flood protection and severe rain are not dissipated. Premia could be differentiated to reflect 'risk zones' so that buildings in flood prone areas pay higher prices and depreciate in value. Moreover, insurers could honour efforts of private mitigation (e.g. water resistant constructions) by means of lower premia.

A mandatory 'elementary damage insurance' would also enable blanket coverage for rare or local events such as landslides, land subsidence, storm surges or earthquakes. Indeed, following the major flooding in East Saxony in August 2010, the Saxon Minister of the Environment Frank Kupfer went so far as to announce the introduction of a mandatory insurance for 'elementary damage' as a 'last resort' to achieve comprehensive coverage: "A solution (for 17,000 uninsured households) must be found. That is what insurance is for." (Dpad 2011) .

Four conclusions:

- Technical flood protection remains necessary, in particular the protection of larger settlement areas. Nevertheless, complete protection through technical measures is impossible.
- Whenever possible, dike relocation must come on the agenda. Thereby, it is particularly important here to foster the cooperation between flood risk management, nature conservation and farmers and to provide adequate compensation for the rededication of land. Moreover, adapting spatial planning and land-use to long-term changes and heavy rainfall in the catchment areas has to be more seriously followed as complementary measures to relocating and/or heightening dikes.
- Private precautionary measures are particularly sensible where to date there is no, or inadequate, technical flood protection. State subsidisation programmes could assist affected citizens in undertaking suitable precautionary measures.
- We believe that an easy-to-implement and practical form of a mandatory insurance is unavoidable in order to provide a framework of solidarity to live with 'residual risks'.

All these listed measures/suggestions are associated with costs. We are convinced that a debate within society is needed in response to the recent major floods in Germany/Europe: what burden of responsibility and hence cost must the state carry for flood protection and compensation and how much responsibility remains with the inhabitants of the areas at risk of flooding. Therefore, we do not need less public debate, we require more and more comprehensive debate on the trade-offs between protection, lifestyle and cost sharing in flood-prone areas in Germany and throughout Europe.

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