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Source: Kreibich, H., Bubeck, P., Van Vliet, M. & De Moel, H. (2015). A review of damage-reducing measures to manage fluvial flood risks in a changing climate. *Mitig Adapt Strateg Glob Change*, 20(6), pp.967-989. DOI: 10.1007/s11027-014-9629-5

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1. Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32007L0060

2. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0060

European Commission

Science for Environment Policy

Review of damage-reducing measures for floods

Climate change is likely to increase the frequency and severity of flooding. This study reviewed damage mitigating measures at local, regional and national scales, and suggests that approaches including both spatial planning and private precautionary measures (such as building adaptations) are important for integrated risk management.

Floods and the resulting damage are increasing in Europe. For instance, the Danube and Elbe rivers experienced major flooding in 2002 and 2013, causing severe damage and costs of over €6 billion in Germany alone. Damage due to flooding is expected to be exacerbated by climate change and exposure growth, as more at-risk areas become habited.

Hazard and risk mapping are used to categorise hazardous areas of floods ('zoning'). Maps of this kind are the basis for spatial planning policy to reduce flood risk; almost all European countries have flood hazard and risk maps, as it is required by the European Flood Directive[1].

Alongside spatial planning, private damage-reducing measures, which include flood adapted buildings and mobile flood barriers, can also be an important part of flood risk management. There has been an almost universal shift towards a more integrated risk management approach to connect structural (e.g. dykes, retention basins) and non-structural (e.g. land use planning) measures. The Flood Directive requires management plans to be developed for areas at significant risk, which are integrated with the river basin management plans of the Water Framework Directive[2] to form catchment-scale integrated water management. Individual Member States have also begun to implement more integrated management strategies.

However, academic knowledge of land-use planning and private damage reduction is fragmented, and often specific to different regions. Furthermore, although spatial planning methods are part of risk management in many countries, their contribution to the mitigation of risk tends to be low.

To improve understanding, this study reviewed a large body of literature on different damage reducing measures and considered their implementation and effects.

In terms of spatial planning, the authors found hazard maps that are too detailed can cause delays in implementing policy. Additionally, they warn against the politicisation of hazard map creation, as local communities may have an interest in underestimating hazards. Updating maps should be a priority, as demonstrated by Hurricane Sandy in 2012 where a significant increase in flood-prone areas was shown afterwards, compared to maps developed 25 years prior.

They also evaluated the use of zoning regulations in different countries, which affect land use and implementation of building regulations. Zoning policies limit exposure of people and assets to flooding and therefore limit fatalities and economic losses. Yet development pressures on floodplains continue to grow, and short-term interests, such as job creation and building houses, can dominate over longer term flood risk management interests. The authors recommend clear penalties for non-compliance and say financial compensation could be given to communities that struggle to grow as a result of flood risk.

Spatial planning can also limit flood hazard. In Belgium, France, the Netherlands and the UK, spatial planning is used to increase storage space or through flow of a river, using measures such as relocating dykes or floodplain interventions.

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Review of damage-reducing measures for floods *(continued)*

In terms of private precautionary measures, the authors looked at two main types: wet flood proofing (adapting the building use and interiors to avoid or resist flood damage) and dry proofing (adapting the building structure, such as implementing elevation or using non-permeable concrete).

Very few studies have quantified the damage-reducing effect of these measures, likely due to a lack of data. One study estimated that wet proofing reduces damage in private households by 30–48%, while dry proofing reduced damage by up to 85%. Yet the authors note it is difficult to make generalisations about these measures, or their economic benefits, as they depend on local conditions and the intensity of the flood event.

Many at-risk households and companies still do not use private damage reduction measures. This may be due to difficulties in estimating the long-term benefits of these up-front investments alongside behavioural factors, such as 'wishful thinking'. The authors say financial incentives from insurance contracts or government schemes can help individuals to invest in self-protection.

Integrated flood risk management strategies have great potential, and will become more important as flood risk increases. To improve implementation, the authors say efforts must be made to increase cooperation between stakeholders (such as the public, local and national governments, and insurance companies), better communication of risk, financial incentives, and more stringent national regulations.