Chapter 1
Nature-Based Solutions in Flood Risk Management

Thomas Hartmann, Lenka Slavíková and Simon McCarthy

Floods are among the most expensive natural disasters (Munich Re 2014). The Intergovernmental Panel on Climate Change (IPCC) states—with "high confidence"—that damages incurred by water-related risks continue to increase in Europe (IPCC 2014) due to changing hydro-meteorological conditions. Also landslides or avalanches are among the consequences of these developments. But not only changing environmental conditions, but also intensification of land and water use, contribute to increasing risks. In particular, cities are increasingly vulnerable to such events—as recent flash floods in Central Europe have illustrated in summer of 2016.

In recent decades, water management has been changing its approach: although technical and engineering methods and measures are still prevailing in many subfields of water management, nature-based solutions (NBS) are growing more popular. However, the frequency, variability and scale of their implementation vary throughout Europe.

Nature-based solutions are "actions which are: (1) inspired by, (2) supported by or (3) copied from nature" (European Commission 2015, p. 5). Such solutions for risk reduction and adaptation in river catchments involve, for example, Natural Water

T. Hartmann (✉)
Faculty of Environmental Sciences, Wageningen University & Research, Wageningen, The Netherlands
e-mail: thomas.hartmann@wur.nl

Faculty of Social and Economic Studies, J. E. Purkyně University in Ústí nad Labem, Usti nad Labem, Czech Republic

L. Slavíková
Faculty of Social and Economic Studies, Institute for Economic and Environmental Policy (IEEP), J. E. Purkyně University in Ústí nad Labem, Usti nad Labem, Czech Republic
e-mail: lenka.slavikova@ujep.cz

S. McCarthy
School of Science and Technology, Flood Hazard Research Centre, Middlesex University, London, UK
e-mail: S.McCarthy@mdx.ac.uk

T. Hartmann et al. (eds.), *Nature-Based Flood Risk Management on Private Land*,
https://doi.org/10.1007/978-3-030-23842-1_1

Retention Measures (NWRM), space for the rivers, or measures for resilient cities (i.e., green infrastructure in cities, green roofs, decentralized rainwater management). These solutions are also referred to as "green and blue infrastructure". Typically, such measures bring multiple benefits to people and social systems—they can, for example, not only reduce flood risks but are able to simultaneously improve the quality of life, reduce heat and dust, enrich biodiversity, etc. Nature-based solutions to water-related risks cannot entirely substitute for traditional measures such as flood pathway and receptor approaches, both structural and behavioral (e.g., flood walls, flood warnings), but their potential value for risk reduction and adaptation has been recognised (European Commission 2015).

Natural flood management (NFM) and natural water retention measures (NWRM) are also types of NBS; NFM includes measures that "alter, restore or use landscape features to manage flood risk" (Holstead et al. 2015); NWRM include (1) interception (retaining water in and on plants), (2) increased plant transpiration, (3) improved soil infiltration, (4) ponds and wetlands, and (5) reconnecting the floodplain. These measures have the potential to reduce extremes in the flow discharge and thus help to level out extremes. Positive effects can include a beneficial impact on ecological issues (i.e., nutrition retention), agriculture (irrigation) or tourism. Natural water retention measures can be combined with other aims of water management—most notably with water quality (Morris et al. 2014)—but also with agriculture, tourism or ecology (Posthumus et al. 2008; Calder 2005; Biswas 2004). But the ancillary benefits of NWRM, the compatibility of different purposes, and the cumulative effects have hardly been researched, as an initiative led by the European DG Environment on NWRM has shown (www.nwrm.eu).

Also floodplain restoration in general can be considered a nature-based solution that mitigates water-related risks (European Commission 2015, p. 12). The concept of making space for the rivers was first introduced by the Dutch Government as a reaction to the major floods in the 1990s (Greiving 2002). "Space for the rivers" summarizes a paradigm that moves from the ideology of defending against floods and "keeping the water out" to an ideology of managing floods and asking citizens to "make space for water" (Johnson and Priest 2008, p. 513). Besides preventing flood damage, space for the rivers can also have beneficial effects for the environment (Moss and Monstadt 2008). The European Commission has already affirmed in 1999 in the European Spatial Development Programme that river works and urban development in the floodplains accelerated flood risk (article 319). In addition "restoring degraded terrestrial ecosystems, such as grasslands, arable land and forests, as well as former industrial and brownfield sites by using nature-based solutions also can deliver a variety of benefits, including improved water quality, carbon sequestration, and attractive landscapes" (European Commission 2015, p. 18). At the time, policy initiatives to restore floodplains are limited to a few forerunners (Moss and Monstadt 2008, p. 64). Still today, implementation of space for the rivers is hampered by the lack of available rights in land (i.e., land use and land ownership) (Hartmann 2012).

A related concept to NBS is called "Payments for Environmental Services (PES)" (sometimes Payments for Ecosystem Services). These measures go beyond NBS. They involve "redistributive mechanisms between different social groups" (Kumar

and Muradian 2009, p. 1) that aim to take into account environmental services provided by one party for the service of others (Kumar and Muradian 2009, p. 8). Watershed developments are an application of PES schemes in developing countries, in particular in India (Kerr 2002). These projects seek "to optimize the use of natural resources for conservation, productivity, and poverty alleviation" (Kerr 2007). So, PES includes a conceptual approach.

So, there are related concepts in flood risk management (FRM), which can be summarised under the term "nature-based solutions". The current trend towards NBS has emerged as traditional ("grey") infrastructure (such as dikes and dams) has been questioned increasingly and rejected by some scholars while actual or assumed benefits of NBS have been emphasised. Grey infrastructure is usually very specialised—specifically designed to solve one particular issue (i.e., defend the centennial flood event). These measures are generally not versatile enough to address different issues; hence changing environmental conditions present a challenge to these types of solutions. In theoretical terms, grey infrastructure is often prone to technological lock-in situations (Arthur 1989; Thompson 2008). However, changing societal needs and dynamic nature (i.e., climate change) lead to a need for more multi-functional and flexible solutions. Nature-based solutions are assumed to be much more adequate for multi-purpose use than traditional grey infrastructure. Nature-based solutions cannot replace grey infrastructure but rather be integrated so that more traditional methods of management are complemented or enhanced by using nature (European Commission 2015, p. 12). Nature-based solutions are suggested by the EU as a complementary and sustainable way of addressing "a variety of environmental, social and economic challenges" (European Commission 2015, p. 5). In the current research funding landscape, NBS seem to be regarded as panacea for many environmental issues.

Nonetheless, some pitfalls and problems related to NBS need to be considered. One of the issues is the great uncertainty of the effects of many NBS. The effects are difficult to quantify, and therefore they defy traditional methods to assess and justify measures. Usually, for example, dikes are justified via a positive cost-benefit ratio, which confirms that the costs of building such structures will pay off in terms of prevented damage. But if NBS cannot be justified in this way, their realisation—in particular when it means to intervene in private property rights or to spend a lot of public money—can come into question. This becomes crucial because NBS need more land than grey infrastructure, as we will discuss below.

Nature-based solutions have two interrelated issues in common: first, basically most such measures require more land than traditional grey infrastructure. A dike against inundations, for example, is much more land thrifty than a retention area. Within retention areas, controlled retention areas are far more effective, but alluvial forests are much more valuable in terms of their ecological benefit. Although this oversimplifies the matter; as a general rule, the more nature-based a solution is, the higher its demand for land. Second, the land that NBS need is often owned by private landowners rather than public stakeholders. These measures raise conflicts over land (Van Straalen et al. 2018).

Ultimately, land is the critical factor that determines whether NBS can be implemented to deal with water-related risks. Land is an essential and inevitable ingredient for the implementation of NBS to mitigate and adapt to water-related risks. Making this land available and persuading land users to implement the measures are thus two key challenges for implementing measures to mitigate or adapt to water-related risks. Usually, flood risk management deals first with technical and hydrological issues before addressing land management. Implementation of flood risk management is often hampered by the lack of land management approaches. Land users are often regarded as mere recipients of water management, not as key stakeholders. Most existing research initiatives on water-related risks focus on technical or hydrological aspects, forecasting, disaster management, or institutional governance aspects. Approaches for collaborating with private land users to realize risk reduction and adaptation measures on private land are lacking in theory and practice. Although there are many case studies and much experience on NBS on the small scale, evidence on the effectiveness and efficiency of nature based-solutions on a large scale is lacking. "There is a clear need to compile a more comprehensive evidence base on the social, economic and environmental effectiveness of possible NBS, including a comparison with more traditional solutions" (European Commission 2015, p. 21). If land management for NBS is not properly addressed and scaled up to the level of the catchment (or aquifer), NBS for FRM remain ineffective and inefficient.

In conclusion, nature-based solutions are favoured in FRM. These measures require more—and mostly privately owned—land, and more diverse stakeholder involvement than traditional (grey) engineering approaches. This also implies that there are challenges related to different disciplines. Flood risk management with NBS is an issue not only of technical expertise, but it asks for land-use planning, economics, property rights, sociology, landscape planning, ecology, hydrology, agriculture and other disciplines to cope with the challenges of implementing them. Ultimately, nature-based FRM is an inter and transdisciplinary endeavor. This is why this volume is addressing the various disciplinary aspects of NBS in FRM on private land.

Two related research questions are therefore discussed:

1. What are the challenges of NBS from various disciplinary angles?
2. How can a inter and transdisciplinary approach to nature-based FRM help dealing with these challenges?

This requires a special format. Therefore, cases are presented that develop, demonstrate or deploy innovative systemic and yet locally attuned NBS (i.e., green and blue infrastructure and ecosystem-based management approaches, in rural and urban areas). The role of land management and spatial planning is described as well as the involvement of other stakeholders. All cases reflect on the multi-benefit of the measures, such as impacts on landscape, local communities and cultural acceptance as well as co-benefits such as biodiversity conservation/enhancement, more sustainable local livelihoods, human health and well-being, climate change mitigation, etc. Barriers related to the social and cultural acceptance and policy regulatory frameworks

will be discussed as well as a reflection on the replication of innovative investment strategies elsewhere.

A special feature of the book is that each case study is discussed from at least two different disciplinary perspectives. So, the main body of the book comprises two kinds of contributions: main contributions outline a case study of NBS. The contributions will address a description of the problem (why some action started), the relevant contextual variables (biophysical environment, socioeconomic conditions, and institutional arrangement), the main actors and their interactions (with focus on conflicts, cooperation, and social capital creation), an outline of how the action pursued/implemented (i.e., procedural aspect and governance). These main contributions are then complemented by shorter commentaries, where authors discuss the presented solutions in the case through the lens of particular disciplines. The commentaries are brief academic reflections that critically highlight which specific aspects are of significance from a certain disciplinary angle.

Acknowledgements Open access of this chapter is funded by COST Action No. CA16209 Natural flood retention on private land, LAND4FLOOD (www.land4flood.eu), supported by COST (European Cooperation in Science and Technology).

References

Arthur WB (1989) Competing technologies increasing returns and lock-in by historical events. Econ J 99:116–131

Biswas AK (2004) Integrated water resources management: a reassessment. Water Int 29(2):248–256

Calder IR (2005) Blue revolution. Integrated land and water resources management, 2nd edn. Earthscan, London

European Commission (2015) Towards an EU Research and Innovation policy agenda for Nature-Based Solutions & Re-Naturing Cities. Final report of the Horizon 2020 Expert Group on 'Nature-Based Solutions and Re-Naturing Cities'. European Commission, Brussels

Greiving S (2002) Räumliche Planung und Risiko. Gerling-Akademie Verlag, München

Hartmann T (2012) Land policy for German rivers. Making space for the rivers. In: Van Buuren A, Edelenbos J (eds) Warner JF. Making space for the river. Governance experiences with multifunctional river planning in the US and Europe. IWA Publishing, London, pp 121–133

Holstead KL et al (2015) Natural flood management from the farmer's perspective. Criteria that affect uptake. J Flood Risk Manag 10(2):205–218

IPCC (2014) Climate change 2014: impacts, adaptation, and vulnerability. IPCC WGII AR5, Part B: regional aspects, pp 1267–1327. http://www.ipcc.ch/report/ar5/wg2/. Accessed 22 July 2014

Johnson CL, Priest SJ (2008) Flood risk management in England. A changing landscape of risk responsibility. Int J Water Resour Dev 24(4):513–525

Kerr J (2002) Watershed development, environmental services, and poverty alleviation in India. World Dev 30(8):1387–1400

Kerr J (2007) Watershed management. Lessons from common property theory. Int J Commons 1(1):89–109

Kumar P, Muradian R (2009) Payment for ecosystem services. Oxford University Press, New Delhi, New York

Morris J, Beedell J, Hess T (2014) Mobilising flood risk management services from rural land: principles and practice. J Flood Risk Manag 9(1):50–68

Moss T, Monstadt J (2008) Restoring floodplains in Europe. Policy contexts and project experiences. IWA Publishing, London

Munich Re (2014) Schadenereignisse weltweit 1980–2013. 10 teuerste Überschwemmungen für die Gesamtwirtschaft. Munich Re. Available via DIALOG. https://www.munichre.com/…/Significant-Natural-Catastrophes/.pdf. Accessed 1 Aug 2014

Posthumus H et al (2008) Agricultural land use and flood risk management: engaging with stakeholders in North Yorkshire. Agric Water Manag 95(7):787–798

Thompson M (2008) Democratic governance, technological change and globalisation. Economic and Social Research Council (ESRC). Available via DIALOG. http://cultural-theory-action-research.wikispaces.com/file/view/Michael+Thompson+Lisbon+Report+Democratic+Governance+Technological+Change+and+Globalisatio+%282%29.pdf. Accessed 19 Oct 2012

Van Straalen F, Hartmann T, Sheehan J (eds) (2018) Property rights and climate change. Land-use under changing environmental conditions. Routledge, Abington

Thomas Hartmann is Associate Professor at the Landscape and Spatial Planning Group of Wageningen University. He combines in his research an engineering perspective on environmental science with a socio-political perspective on FRM and land policies. He is vice-chair of the LAND4FLOOD Cost Action, speaker of the advisory board of the German Flood Competence Centre and active member of the OECD Water Governance Initiative. He is also Vice-President of the International Academic Association on Planning, Law, and Property Rights (PLPR).

Lenka Slavíková graduated from University of Economics, Prague (public economics and policy). Currently, she serves as the Associate Professor at the Faculty of Social and Economic Studies J. E. Purkyně University in Ustí nad Labem. Her long-term interest lies in water and biodiversity governance with the focus on Central and Eastern European Countries. She investigates flood risk perception of different actors and financial instruments for flood recovery and risk reduction.

Simon McCarthy with a background in commercial social research, undertakes teaching, training and academic social research in the Flood Hazard Research Centre at Middlesex University London. His research interests focus on the role of both public and professional social contexts in decision making, communication of risk and uncertainty and approaches to participatory interaction in flood risk and water management. Simon is appointed member of the Thematic Advisory Group on flood and coastal erosion risk management research and development for England and Wales; Department of Environment, Food & Rural Affairs, Environment Agency and Natural Resources Wales.