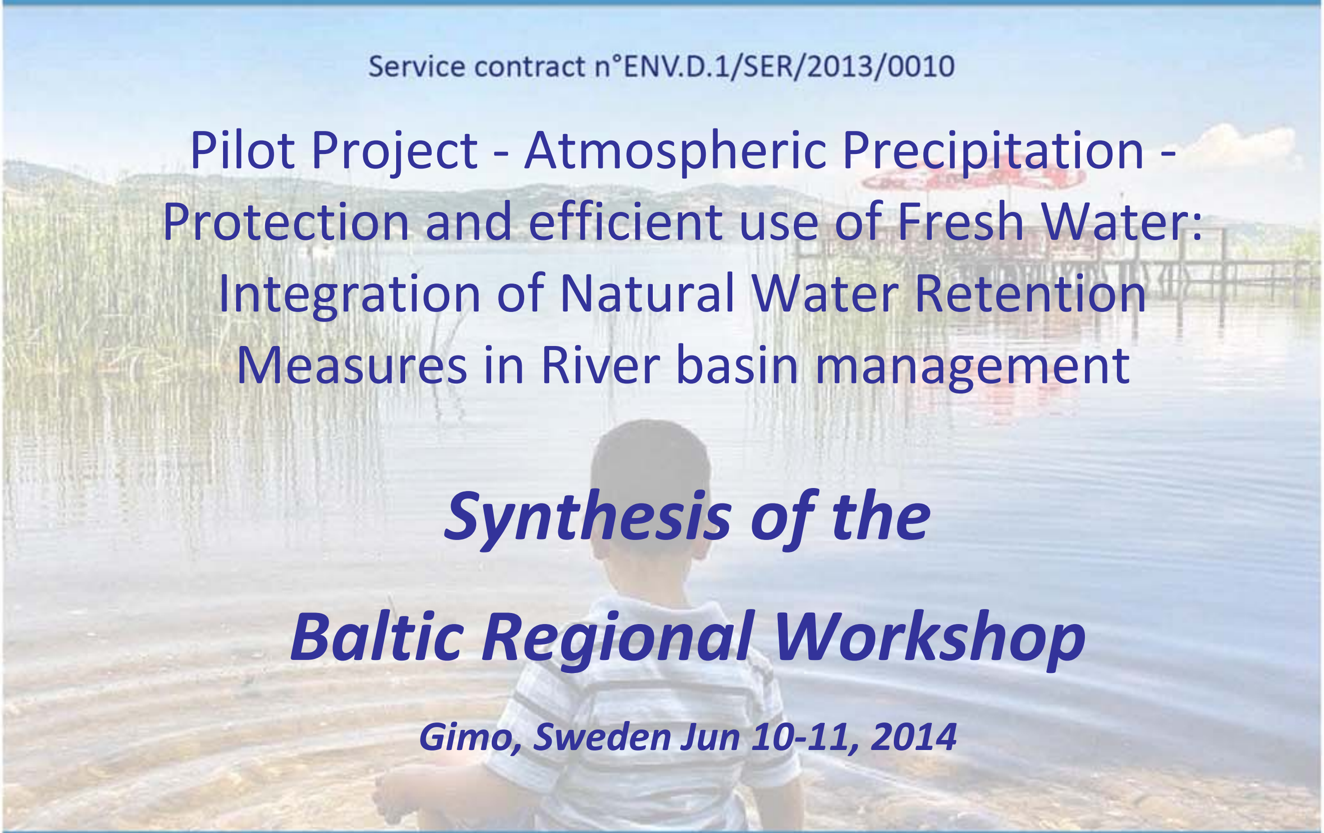
European Commission

DIRECTORATE GENERAL ENVIRONMENT
Directorate C
Unit C1

Office International de l'Eau



Service contract n°ENV.D.1/SER/2013/0010

Pilot Project - Atmospheric Precipitation - Protection and efficient use of Fresh Water: Integration of Natural Water Retention Measures in River basin management

Synthesis of the Baltic Regional Workshop

Gimo, Sweden Jun 10-11, 2014

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Note to the reader

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-attributed to A. Einstein

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J. Lewandowski

"NWRM are the decathletes of flood management – they are better all round but lack recognition"

C. M. Gómez, cited by G. Delacámara

1. The Background (Fammler, Collentine & Futter)

The NWRM initiative was launched by the EC DG Env in October 2013 to promote green infrastructure solutions for precipitation management. This pilot project is a service contract funded by DG Env with 11 partners from 8 countries, and runs from September 2013 to October 2014. The objective of the project is to develop a scientifically sound, comprehensive, web-accessible pan-European knowledge base on NWRM and a practical guide which can support the design and successful implementation of NWRM across Europe. By meeting these objectives it will contribute to the development of a European community of practice in design and implementation of NWRM. It is hoped that this community of practice will contribute to the spatial planning process for European directives including the Water Framework Directive (WFD) and Floods Directive (FD), further links between then and the Nature Directives (Birds and Habitats), nature-based approaches, the development of climate adaptation strategies and sustainable cities. The main goal of the project is to support DG Env with information collected from all 28 EU Member States (MS) plus Norway and Switzerland and to contribute to the evidence basefor WFD and FD planning and implmentation.

This project follows on from an earlier DG Env initiative "Towards Better Environmental Options for Flood Risk Management". This earlier initiative introduced a number of green infrastructure techniques using natural approaches which showed promise for local flood reduction. It also presented a number of projects devoted to restoration of flood plain ecosystems which helped with flood prevention. This earlier project showed that when used appropriately, green infrastructure including NWRM can safeguard and enhance the water storage potential of landscapes, soils and aquifers by restoring natural features and characteristics of water courses and the surrounding landscape and by using natural processes for precipitation management. NWRM can support adaptation and reduce vulnerability of water resources.

Throughout the project, there have been ongoing discussions as to what is meant by "Natural", what qualifies as an NWRM and their relevance in the water-rich Nordic Baltic region. In the Nordic Baltic states, most agricultural and forest water management is devoted to getting water off the land, not for water retention. Thus, in this region, NWRM are seen primarily but not exclusively as measures for flood or stormwater management. NWRM use natural processes and enhance or emulate functions commonly performed by nature including slowing down of water flows, soil infiltration, aquifer recharge and evapotranspiration. In the Nordic Baltic region, there have been a number of successful sectoral NWRM implementations for urban, agricultural and forest water management. While these successful implementations are an important part of the NWRM evidence base, there is a need to look further into the purpose of NWRM. Specifically:

- Who is interested in NWRM, and for what purpose?
- Are NWRM always multi-functional?
- What are the links between NWRM, the WFD and the FD?

Finding answers to these questions crystallized the focus of the Gimo workshop. In the Nordic Baltic region, the water retention function of NWRM is often seen as an ancillary benefit and the primary purpose of measures is often related to biodiversity or water quality improvement. Discussions in the FD Programmes of Measures (PoM) working group and the competent authority in Sweden suggested that the flood management process was focused too much on flood risk and flood hazard in urban areas, and did not take sufficient consideration of flood prevention or the source of water in the upstream catchment. Thus, a decision was made to focus the Gimo workshop on the role of NWRM in urban flood prevention and the connection between upstream and downstream measures.

The following key questions were addressed during the Gimo workshop:

- What are the key issues and challenges faced when implementing NWRM for flood risk management?
- What additional green infrastructure solutions could act as NWRM? From a flood risk management perspective, what features do they share?
- What knowledge should be produced by this pilot project for supporting the design and implementation of flood risk related NWRM across Europe?
- Which issues should receive specific attention in the practical guide that will be developed as an outcome of the project?
- What is the best way to mobilize stakeholders and other actors in the networks and workshops organized in the different regions?

Successful implementation of NWRM requires a conceptual framework for evaluating the cost efficiency of upstream-downstream links between NWRM in the rural landscape and urban flood prevention. The main hypothesis behind the upstream-downstream concept is that water retention in the upstream catchment can prevent downstream flooding. Water retention involves (i) either a longer residence time somewhere in the water cycle, either on the land, in soils, surface water or groundwater or (ii) more efficient return of precipitation to the atmosphere through canopy interception, evaporation or transpiration.

- NWRM are green infrastructure alternatives and complements to grey infrastructure such as embankments, dykes and dams.
- NWRM can include restoration of riparian areas, wetlands and flood plains as well as sustainable urban and rural drainage systems (SuDS)
- NWRM are multi-functional, they retain water, support biodiversity, enhance soil fertility, prevent floods and droughts and provide important recreation and amenity services

Despite the relative newness of the term “NWRM”, most of the measures themselves are not new. Wetlands, riparian buffer zones, continuous cover forestry, green roofs, swales and flood plain reconnection are tried and tested components of green infrastructure. What is new with NWRM is the clear focus on the benefits of retention. These include on-site benefits such as nutrient or drought reduction, increased biodiversity and improved recreation and amenity services; downstream benefits including flood risk reduction and water quality improvement ; and potentially upstream benefits, but the potential trade-offs must be carefully assessed.

NWRM operate at a range of spatial and temporal scales, ranging from the very small and very short term to multi-year effects across the largest river basins. Buffer zones and hedge rows can slow down overland flows at very local and short term scales, but the cumulative effect of multiple buffer zones and hedgerows can have a noticeable effect on downstream flooding. Wetlands and irrigation ponds can store rainwater and snowmelt, thereby slowing water flow through the landscape. Measures which enhance infiltration including afforestation, buffer zones, wetlands, swales and permeable pavements can all contribute to groundwater recharge, which reduces peak flows and contributes to maintenance of low flows. Water sensitive agricultural practices including reduced tillage and tile drain regulation can all contribute to enhanced water storage in soil and reductions in high flows. Flood plain reconnection can mitigate flood peaks in even the largest rivers. Given the complex range of spatial and temporal scales on which NWRM operate, some form of planning framework is clearly needed.

NWRM should be included in both WFD River Basin Management Plans (RBMP) and FD Flood Risk Management Plans (FRMP) and should be a priority for financing under the Common Agricultural Policy (CAP), Cohesion and Structural Funds. NWRM should be highlighted in the WFD planning process. The WFD addresses all the challenges faced by EU waters. The Directive recognizes that water quality and quantity are intimately related to the concept of “Good Ecological Status”, land use and management affect both water quality and quantity, and human activities can both threaten and improve ecological status. While the WFD is currently focused primarily on water quality, it is clear that water quantity issues including water scarcity, droughts, over-abstraction and floods can all negatively affect ecological status.

NWRM offer a number of benefits for FD and WFD co-implementation. They provide an opportunity for measures which both reduce flooding and contribute to WFD water quality goals and they provide an opportunity for RBMP PoM which are compatible with the FD. All of this should be good news for the FRMP. NWRM can reduce the source of some flooding and play an important role in flood prevention. Compared to grey infrastructure, NWRM are low cost, potentially cost-effective and give a possibility for both urban and rural gains. Financing for some NWRM is possible through CAP and European Structural and Investment Funds (ESIF).

There are tradeoffs associated with rural NWRM and urban flood prevention. The cost of urban flood damage mitigation is generally very high. Grey infrastructure defensive measures are expensive with high maintenance costs and high opportunity costs. The costs of NWRM in rural areas are generally low. Measures that lower urban flood risk often have low opportunity costs and little or no maintenance cost. Urban and rural benefits differ. Urban areas typically receive high benefits from reduced flood damage and some ancillary benefits related to biodiversity and recreation. Rural areas receive low but locally important benefits from reduced flood damage and significant ancillary benefits related to improved water quality, enhanced biodiversity and improved amenity services. Deciding whether to site flood risk prevention measures in urban or rural locations involves an assessment of the cost efficiencies:

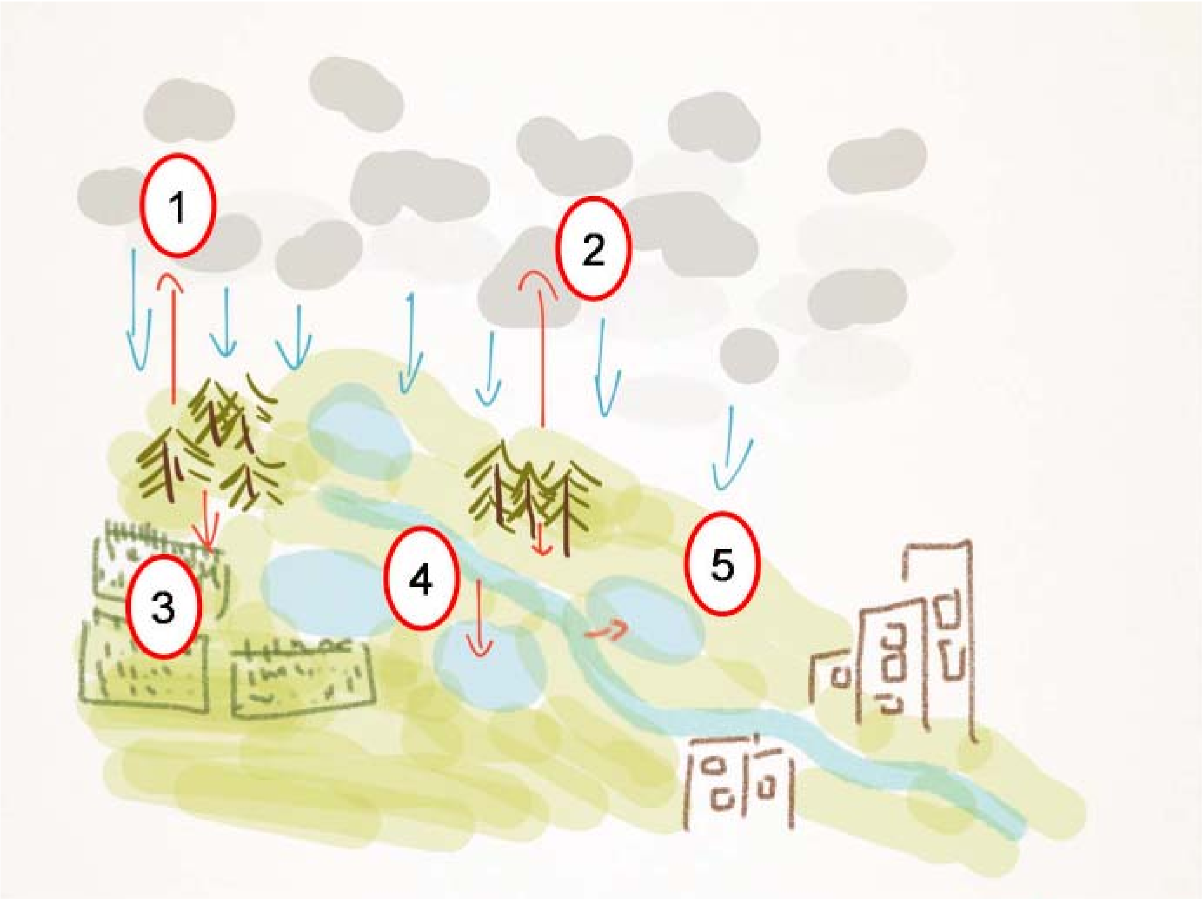
- Most cost-efficient: Urban-Rural – measures that have high (urban) benefits and low (rural) costs

- May be cost efficient: Rural-Rural – measures that have low (rural) benefits and low (rural) costs
- May be cost efficient: Urban-Urban – measures that have high (urban) costs and high (urban) benefits

NWRM can also be embedded into a framework of Sustainable Flood Management. There are three pillars to SFM: Preparation, Protection and Prevention. The FD takes good account of the first two pillars while NWRM have a role to play in the third. From a hydrological perspective, the goal of NWRM is to reduce the frequency of high-flow events.

The frequency of high flow events is often described using the easily misunderstood concept of "return periods". Return periods are estimated based on observed flows and a mathematical extrapolation. While flows with a given return period are often referred to as a "50 year flood" or a "100 year flood", this does not mean that such a flood will only occur once every 50 or 100 years. Broadly speaking, there are two ways of reducing the frequency of high flow events: making room for the river, and keeping the rain where it falls. In the context of the present workshop, making room for the river involves rural measures downstream of a city while keeping the rain where it falls involves rural measures upstream of an urban area.

Making room for the river involves re-connection of the river to its floodplain and may also involve artificial channels and floodways downstream of at-risk urban areas. When implemented correctly, measures that make room for the river are able to reduce the frequency of even the highest flow events. Many NWRM help to keep the rain where it falls. Afforestation, for example, can have multiple benefits as it leads to increased interception, more transpiration and improved infiltration. Urban measures such as permeable pavements and green roofs can serve similar functions. Unlike making room for the river, which can contribute to preventing even the largest floods; keeping rain where it falls only helps to reduce small to medium size floods .



“Keeping the rain where it falls” can involve (1) afforestation measures to improve canopy interception and return of precipitation to the atmosphere; (2) measures such as afforestation to enhance evapotranspiration; (3) agricultural and land management practices contributing to improved infiltration; (4) creation or refurbishing of ponds and wetlands and (5) reconnection of rivers to their floodplains.

Both “making room for the river” and “keeping rain where it falls” have a role to play in flood prevention in the Nordic Baltic region. Broadly speaking, there are three kinds of floods in the Nordic Baltic countries: predictable high flows associated with snowmelt every spring, less predictable summer flash floods associated with heavy rains and storm surges or high tides in areas near the sea. Each of these kinds of floods can cause significant damage and inconvenience in urban areas. While the effects of spring flooding or storm surges are often more spectacular, overloading of sewage treatment plants and localized flooding can mean that summer floods are actually more costly. Cities near the sea can be flooded by high tides or storm surges. While there is limited scope for managing sea water, “keeping the rain where it falls” may have a role to play in preventing urban flooding related to seawater intrusion by giving the storm surge more room to dissipate upstream of a flood vulnerable area.

2. Guidance for NWRM Implementation

From the discussions at the workshop, it was clear that there is a need for guidance so as to ensure the success of NWRM implementation. The guidance must include the following:

- The scientific evidence base

- Clear guidance for implementation, ideally in national languages
- Tools to evaluate potential benefits and success of NWRM

The evidence base for any guidance on NWRM implementation must be based on high-quality case studies which describe the NRM and provide a multi-functional assessment of benefits. The challenges and uncertainties of using natural features and natural processes must be clearly recognized to ensure the credibility of NWRM. It is extremely important to avoid a spurious impression of certainty. In many cases, qualitative guidance will be better and more credible to stakeholders than quantitative results which may be very site specific. Participants agreed on the importance of case studies from their countries, and on the presentation of material in national languages.

A scientific evidence base is necessary but not sufficient for successful NWRM implementation. Guidance and success stories are also needed. The scientific evidence base can demonstrate the hydrological benefits of NWRM, but insights on how to successfully negotiate the regulatory framework also needed. Information on ways to successfully engage stakeholders and secure financing for NWRM creation and maintenance are required to ensure the ongoing sustainability of the process.

Hard and soft tools are needed to evaluate the potential benefits of NWRM. “Hard” tools include hydrologic and water quality models while “soft” tools include a community of practitioners and credible, comprehensible guidance documents.

3. A Paradigm Shift (Hartmann)

NWRM are one part of a larger paradigm shift in water governance. Increasingly, it is recognized that on their own, engineering approaches to flood protection are not sufficient for a sustainable environment. Ensuring environmental sustainability will require more attention to spatial planning and risk management. There is a role for FRMP in institutionalizing this paradigm shift.

The FD states that MS shall develop flood risk management plans on the basis of flood hazard maps, and that these plans shall be coordinated at the river basin district level. Flood hazard maps shall be created which cover high, medium and extreme event scenarios. These scenarios may be linked to return times and are defined at the discretion of individual MS. The FRMP shall take into account relevant aspects including environmental objectives, soil and water management, spatial planning, land use, nature conservation, as well as navigation and port infrastructure.

Traditional engineering approaches have focused on what happens in the river channel, and how to keep the river in the channel, while spatial planning takes a whole catchment approach. FRMP fall within the remit of spatial planning as they should take a holistic whole-catchment approach to water management. This can lead to institutional challenges. Traditional engineering approaches are often embedded in a top-down “command and control” organizational structure while spatial planning involves balancing and negotiating the competing needs and demands of multiple stakeholders. In a similar manner, traditional engineering approaches make a one-dimensional evaluation of success while multipurpose solutions such as NWRM must be evaluated using multiple criteria.

In many ways, spatial planning is more difficult than engineering approaches. While this is an over-simplification, the engineering approach estimates the flow at a target return time and then builds a wall high enough to keep the water out. This grey engineering approach does have an air of certainty and physical infrastructure is often reassuring but it may not be the best way to sustainably manage water. Building a wall or dike in one location can have two undesirable consequences. First, there is a moral hazard as urban infrastructure develops behind the potentially unsustainable wall. Second, the flooding problem is not solved, merely exported further downstream. Spatial planning cannot necessarily solve these problems, but it can highlight the need to balance the competing demands of different stakeholders and to identify cost-efficient tradeoffs.

4. Flood Risk Management Plans – A Link between the Floods and Water Framework Directives (Teibe)

There are a number of opportunities for better coordination between the FD and WFD. The FD has a series of explicit and implicit requirements. It explicitly states that MS shall take appropriate steps to coordinate FD and WFD application and to focus on opportunities for improved efficiency, information exchange and achieving common synergies and benefits related to WFD environmental objectives. Specifically: flood hazard maps and flood risk maps are to be consistent with information presented according to the WFD; and FRMP and their subsequent reviews shall be coordinated with and may be integrated into the RBMP review process. There are several similarities between the two directives:

- Both Directives operate within a river basin district (although the FD does permit different units of management)
- Trans-boundary cooperation and coordination is required
- The basic implementation and review process is similar
- Both directives mandate that climate change shall be considered (Article 4.2 in FD and Guidance Document 24 for WFD)

There are possible synergies in the planning cycle, both the WFD and FD follow an iterative cycle of assessment, characterization, identification, assessment and objective setting followed by implementation and review of PoM. However, there are some key differences between the two directives:

Differences between the Water Framework Directive and the Floods Directive	
Water Framework Directive	**Floods Directive**
The main purpose: protection of surface and ground water quality with an emphasis on ecosystem function and ecological status. Contributions to mitigating effects of floods and droughts are considered.	**The main purpose:** reduction of adverse consequences associated with floods for human health, the natural and built environments, cultural heritage and economic activity
Scope: the whole river basin district as even water bodies achieving good ecological status may require measures to prevent deterioration	**Scope:** areas which have been identified where potential significant flood risks or hazard exist, or identified areas where floods might be considered likely to occur
Economic Analysis: a significant and comprehensive component of the Directive. The WFD implements the "polluter pays" principle and mandates the identification of significance of water uses, prediction of changes in drivers, as well as justification of pricing policies, exemptions and selection of measures (cost-benefit analysis)	**Economic Analysis:** Cost-benefit analysis is only explicitly required for shared river basins or sub-basins when the measures being assessed will have trans-national effects. In addition, the preliminary assessment shall include descriptions and or assessments of the adverse consequences for economic activity which were caused by past floods

	or which might be caused by future floods.
Public Participation: there is a clearly defined requirement and timelines; there must be at least 6 months for public evaluation of draft PoM and management plans, in addition, background documents shall be made available.	**Public Participation**: a requirement exists to encourage active public involvement but this falls amongst other general requirements

Creativity will be needed to successfully address the challenges of implementing both the WFD and FD. The WFD requires all countries to achieve GES in all water bodies. The meaning of GES is inter-calibrated so as to permit meaningful comparisons between the very different types of water bodies found across Europe, and to ensure that measures implemented in one country do not have adverse effects on its neighbours. Flood management measures can potentially contribute to upstream or downstream flood risks. Coordination and agreement is required, both between and within MS. In addition, flood management measures can conflict with achieving a goal of GES. As with other policy conflicts, definition of WFD or FD priorities and justification of exemptions may by quite challenging. Finally, there is a need to better consider floods and flood protection in the WFD DPSIR (Driver, Pressure, State, Impact, Response) chain. Creative solutions will be needed to address the institutional challenges of implementing the FD and WFD. While it is possible and desirable to implement FRMP into the RBMP process, there is a great deal of uncertainty surrounding how this will occur in practice. In some countries, such as Latvia, the same competent authority is responsible for both sets of plans. In other countries, the responsibility is shared between different competent authorities. The implementation is further complicated by the need for a paradigm shift from reductionist to more holistic approaches to catchment-scale water management.

5. Institutional Obstacles (Lewandowski et al.)

Sustainable Flood Management (SFM) is built on five pillars:

- Risk Prevention: reduce both the probability and consequences of floods through proactive spatial planning and allocation policies
- Flood Defence: grey and green infrastructure including dikes, dams, spillways and sand supplements
- Flood Mitigation: urban green infrastructure, catchment scale flood retention, “keeping the rain where it falls”, “making room for the river”
- Flood preparation: public education, warning systems, disaster planning and evacuation plans
- Flood recovery: rebuilding areas, relocating infrastructure and insurance systems

These five pillars can be understood in an institutional framework of rules, actors, resources and discourses. Rules include legislation, procedures, politics and culture. Actors include public and private stakeholders, individuals, coalitions, interest groups and their interactions. Resources consist of legal authorities, financial resources, knowledge and political influence while discourses include scientific paradigms, general policy objectives, programmes and concepts as well as historical metaphors.

The general features of flood risk are similar in most Nordic Baltic and north European states. There are changes in the biophysical environment related to land use change, urbanization, deforestation, rifer regulation, channelization and construction of embankments. The socio-economic systems are also changing with increasing exposure through flood plain development, and greater investment in infrastructure in flood prone areas. The DPSIR framework holds promise for understanding the complex interactions between natural and social systems and their effects on flood risk.

The recent floods in Poznań, Poland are a useful case study for understanding the institutional challenges. There have been two serious floods in Poland in recent years. The 1997 flood presented a marginal danger for Poznań while the threat from the 2010 flood was more serious. Institutional responses to the floods were dominated by a flood defence strategy which appeared to focus more on project realization and gaining EU funds than problem solving. Conflicting property rights and responsibilities greatly complicate flood risk management in Poznań. While the existing rights and responsibilities are highly efficient for financing, they are problematic during flood events. For example, the water in a river is managed by a regional water management board, however, the ground underneath the river is managed by the national water management board. The riparian areas immediately adjacent to a river are managed by local authorities, but the flood defence measures are managed by regional authorities. To further complicate matters, flows over 2 m^3/s are regulated under one framework, while smaller flows are regulated under a different framework. In this multi-institutional environment, there is a clear need for effective spatial planning. Local land use planning authorities have a fundamental role, but the multitude of responsible agencies means there is a possibility for incoherent spatial decisions and a lack of coordination between economic development and flood risk minimization.

Poland is one of the few Nordic Baltic MS to currently implement landscape scale retention measures. It was recognized that there was a lack of effective, small retention measures in Poland. To address this, a number of afforestation and forest water retention programmes have been developed. Unfortunately, these small forest retention measures are still institutionally decoupled from flood retention measures such as large storage reservoirs. A more coordinated approach to water planning which linked large and small retention features could make flood risk reduction more effective.

Poland also implements a “rain tax” where municipalities impose a fee for the losses in permeability associated with urban development. While this is an excellent idea in theory, which would promote green urban infrastructure, SUDS and NWRM, there have been some challenges with its implementation. The fee is too low to be a meaningful instrument for changing individual actions and there is a lack of political will for its implementation. There is also a perception that the fee goes into municipal general revenues, instead of being used for the promotion and development of more sustainable approaches to urban water management.

Institutional obstacles also have a spatial component. Local knowledge is often inadequately appreciated by regional or national competent authorities. This lack of consideration of local knowledge damages the credibility of national and regional competent authorities. Fortunately, there is an increasing awareness of the need for local knowledge in the spatial planning process.

6. Implementation of NWRM – who should pay ? (Delacámara)

Despite the large biophysical and institutional differences between the Nordic Baltic region and the Mediterranean region, there are some common challenges. Both areas have problems related to the wrong amount of rain falling in the wrong place at the wrong time. For example, in Spain, the hydro-ecological functioning of the landscape has been impaired by a loss of connectivity between rivers and their floodplains, disconnection of paleo-channels, colonization by alien species, a large reduction in ecological and landscape heterogeneity and a lack of awareness about actual river functioning and its consequent socio-economic effects. Grey infrastructure solutions including large underground stormwater holding tanks have been built to manage urban flooding. These grey infrastructure responses are not a solution as they merely change the nature of the problem from one of urban flooding to adverse downstream impacts on water quality. Upstream green infrastructure including returning the river to its natural channel and planting of flood-tolerant riparian forests show greater potential for a holistic solution to the urban flooding problem.

While NWRM can play an important role in sustainable flood management, there are challenges surrounding their implementation. As NWRM fall outside the traditional institutional flood defence framework, it may not be possible to convince those responsible for flood management to fund their implementation. Because of their multi-functional nature, it may be possible to fund NWRM implementation through other channels. For example, NWRM have been implemented using Life+ funds when it could be shown that they would provide habitat for Red List species. Spatial planning and appropriate definition of system boundaries can be an important aid in presenting the multi-dimensional nature and multi-functional benefits of NWRM. Some of the factors to be considered include the following:

Scale: catchment scale is of paramount importance; individual measures may have limited local effect but their cumulative benefit can be large; this argues for sound spatial planning so as to maximize the landscape-scale benefit of multiple small scale NWRM

Challenges: interventions in one place may generate benefits elsewhere; rural NWRM may be the most cost effective solution to urban flooding but there is a need to recognize the tradeoffs and choose the right system boundaries for a meaningful evaluation of cost effectiveness. Spatial planning is necessary to address these challenges and evaluation must be based on more than simple monetary criteria.

Direct and Indirect Benefits: the benefits of NWRM are multi-dimensional and may include enhanced biodiversity, improved water quality, better quality of life in urban areas as well as water retention. In the Nordic Baltic region, water retention is often an ancillary benefit of measures serving other purposes. If some benefits are overlooked, or the system boundaries are incorrectly defined, NWRM would not be seen as effective and it could be perceived that there was a lack of incentives for engagement.

Valuation: valuing benefits of NWRM is challenging but feasible; there is a significant knowledge gap as most evidence on effectiveness refers to design conditions and not actual performance.

Commitment: Building a strong, scientifically credible evidence base in key to inducing changes in policy processes and public awareness.

Honesty: There is a need to avoid self-indulgence and overblown promises. NWRM are good in themselves as they serve to restore natural hydro-ecological functioning in the landscape and the biophysical flows of ecosystem services but they are not a solution to all problems and there are uncertainties surrounding their effectiveness.

The self-evident nature of some of the advantages associated with NWRM can lead to a tendency to ignore the opportunity costs and the existence of alternatives which may serve the same purpose. In addition to their role in water retention, NWRM need to be judged against their potential contribution to other objectives stated in the WFD, FD, EU 2020 Biodiversity Strategy, Climate Change Adaptation Strategy, CAP reform, etc. Properly designed and implemented NWRM should be seen as opportunities that can be adapted to the purpose of water management. While there are multiple benefits to NWRM, transaction costs should not be overlooked. Unlike "command and control" grey infrastructure solutions to flood risk management, NWRM require greater dialog and consensus building between multiple actors with potentially competing world views.

An appropriate incentive structure can help contribute to adoption and implementation of NWRM. Prevailing incentives favour the maintenance of the status quo. A particular NWRM might be rational from an overall cost-benefit perspective but still lack appeal to those charged with its implementation. Voluntary acceptance in the land-based sector including forestry and agriculture requires properly designed economic incentives. The CAP reform (pillar 1 but also RDP) can be one example, as can ESIF partnerships, CCA, DRR and innovation funds such as LIFE or EIB. The question of who benefits from NWRM must be addressed. If NWRM benefits are not public goods (non-rival and non-excludable), there must be some discussion of how beneficiaries pay for them. This raises the cost recovery issue: if in addition to water management, NWRM serve many other purposes, there must be discussions as to how the measures are to be financed. For example, can payment for environmental services (PES) be based on public implementation and ex-post evaluation?

As well as their role in water management, NWRM provide outstanding opportunities for better coordination of different sectoral policies including land planning, rural development, agricultural and forest policy, adaptation to climate change, etc. They also provide new opportunities for collaboration between the private and public sectors since action in different areas can help to coordinate objectives and reduce compliance costs while simultaneously achieving different policy objectives.

Implementation of NWRM requires the breaking up of institutional silos at all levels (EU, national and sub-national) and a recognition that a paradigm shift is occurring in water governance. While a paradigm shift is occurring, there are still problems with institutional lock-in in water management. In many cases, the prevailing institutional framework favours traditional grey infrastructure flood protection measures instead of innovative green infrastructure NWRM. Further work is needed to identify the changes in institutional frameworks which will facilitate innovative new instruments she as PES or performance-based subsidies.

7. Working Group Discussions

Workshop participants were asked to discuss the following three questions related to sources and management of floods:

- How have measures to manage flood risk been determined?
- How can the source rather than the direct impact be included in flood risk assessment ?
- What is the potential in using NWRM in rural areas to reduce flood risk ?

Group 1 focused on addressing these questions while groups 2 and 3 used the questions as a jumping off point for their discussions.

a. Group 1

- **How have measures to manage flood risk been determined?**

The FD is quite specific on this point: there is a focus on flood protection in urban and industrialized areas and a search for possible flood prevention measures in rural areas. The risks and the occurring costs are calculated to find the highest return on investment. Since NWRM are rarely implemented at the area of flood risk, motivation for investments in marginal areas is often low.

Furthermore, flood protection can be an ancillary benefit of NWRM. Water retention is a means to a specific end in each area. Therefore, it is not possible to do a comprehensive cost-benefit analysis regarding flood protection since much of the necessary information is lacking.

- **How can the source rather than the direct impact be included in flood risk assessment?**

Flood water sources include rain water (in cities and river basins), river water (ice melting), and in some cases the sea. Flooding from rainwater in cities from the Baltic States is a legacy of post-Soviet reconstruction which led to an imbalance between infrastructure and needs. Rainwater sources within the cities must be differentiated from and managed differently than rainwater from sources. Urbanization has led to problems with water flows. There are examples of rainwater pipes used as canalization, other examples include ditch blocking due to new roads and house construction. It appears that sensible and well applied legislation and regulations about construction on private and public property can add up to the solution of rainwater in the city.

In some cases, it seems that drainage systems are in conflict with nutrient control in rivers. Rainwater and waste water should be ideally divided, but they are not and can lead to problems with waste water treatment and overflows of sewer system. Floods are a problem in southern Spain, even without much rainfall, because of sealed soils. Grey infrastructure to contain flood water often leads to bigger problems, because the capacities to clean this water are limited. Stormwater management is a critical issue that has to be addressed by urban water management systems as well.

It should be noted that extreme cases in certain cities do not necessarily speak for bigger areas. A problem might occur due to low infiltration in high precipitation areas. On the other side this problem might occur in semi-arid areas. When we think about the source, we normally think about water collecting in rivers. On intensively used agricultural areas, soil compaction can occur. This leads to higher runoff to the rivers. Here, the source lies in intensified agricultural land use.

- **What is the potential for using NWRM in rural areas to reduce flood risk?**

An informative situation can be found in Breslau, where the mountains are upstream. Nevertheless, poor urban planning has contributed to elevated flood risk. Maps from the early 20th century show large areas used as flooding polders. After the war these areas were sealed and houses were constructed. Other areas on the Odra River show the same situation. Today, micro-dams can be used on agricultural used natural slopes to retain surface run off and break runoff lines. In general, there are agricultural and forestry measures that are not revolutionary and do work. The problem is in fact human, as nature has no problem with floods at all. To restore more natural situations or conditions might help to ease the flood situation.

For the more extreme floods huge measures, i.e. polders, are needed. For the smaller, more probable floods, NWRM, measures that are more “natural”, might help to ease to the situations. For example, the winner case for Denmark: Re-meandering of a former straightened ditch, and reclaiming the flood plain. Re-meandering rivers in previously agricultural used areas, are NWRMs in rural areas that are not agricultural measure themselves.

b. Group 2

Participants noted that the institutional framework still favours grey infrastructure. EU money can be spent on NWRN but there is a lack of understanding about how the measures should be designed and implemented. This lack of a knowledge base is concerning - humans are rational, if there is evidence that new ways are better (i.e. NWRM) then the change will not be so difficult but there is a widespread belief that the necessary knowledge about NWRM technical measures, effectiveness, effects, costs etc. is lacking and that statements about NWRM are just speculation.

Participants felt that the NWRM knowledge base is not adequately communicated. There is always too little knowledge (room for improvement) and the existing knowledge about NWRM should be systemized. There was a belief that there is a lack of scientific certainty about NWRM. This lack of certainty translates into a lack of clear and effective guidance for NWRM implementation and possibly inadequate communication with key actors. For example: in Latvia, the Ministry of Environmental Protection and Regional Development carried out a survey among municipalities where they were asked about their previous experience with green infrastructure:

- 80% of respondents stated that they have no experience with NWRM, they do not understand these measures and cannot assess their value (i.e. impact of ponds is not understood)

- A lot of the respondents indicated problems with flooding (mainly local level) so they want to do something – usually build something to show to inhabitants that municipality has done something

This lack of knowledge and desire to do something highlights a need for credible technical guidelines related to NWRM implementation. However, without a valid scientific knowledge base, it is not possible to formulate credible guidelines. Quantitative technical recommendations are very difficult as there are so many different ways to give guidance on implementation as every location is unique. Participants were concerned that recommendations should only be made when there was certainty about the effectiveness of measures; there was a perception that recommendations often come before evidence is available.

NWRM must be considered in a spatial planning framework. For example, farmers and land managers are often keen to contribute to small-scale NWRM on their land where there is clear ownership and clear evidence of benefits. It is easier to talk about stakeholder involvement in small areas (everyone knows each other) but usually big floods come with big rivers and in that case it seems that stakeholder involvement is totally different and different tools have to be used, or different ways have to be found to motivate people's involvement. This led to further questions about spatial scale and how different measures are appropriate at different scales. For example, different communication strategies are needed to successfully identify the shared interests of people from different areas, often if the problem is out of sight, it is not perceived as a joint or shared responsibility. This issue is even more complicated in trans-boundary situations.

Participants recognised the strengths and weaknesses of current institutional linkages between the WFD and FD. The WFD works at river basin scale which integrates upstream and downstream areas and is relevant for flood prevention. The FD is supposed to be implemented at a river basin scale but action plans are developed for at-risk areas (In Sweden 10 cities have elaborated flood management plans, however, they do not consider at the moment the source). The FD does not exclude upstream measures but neither does it require them. Further explanation is needed, ideally in guidance documents, since people tend to go the easier way if possible. If no incentives are available, it is doubtful that upstream NWRM will be widely adopted. There will be challenges with RBMP and FRMP implementation in many MS since they are currently done separately but must be coordinated in the future. While the two processes can be integrated, it is not mandatory (i.e. Latvia will integrate, Lithuania will not, Estonia will try to integrate).

The way forward involves new thinking. At the moment, many actors take a project based rather than problem solving approach. There is too much focus on completing tasks and filing reports and not enough on system understanding and planning. Using ecological and environmental sustainability argument could lead to new thinking about NWRM and upstream-downstream linkages. However, socio-economical assessments are also needed to assess ecological effects and it should not be forgotten that we live in a financial world where money plays a big role. Furthermore, it was recognised that NWRM have to be complimentary to grey engineering measures.

Ideally, there will be further EC support for NWRM (in addition to this project which collects cases, provides guidance documents and engages with stakeholders). For example, long term test cases and pilot studies with adequate biophysical monitoring can contribute to the evidence base. This will help with good case recommendations which show that NWRM are not only ecologically better but also financially (this will be a challenge as direct comparisons are not possible, however, there are ways how to show cost-effectiveness/socio-economic benefits).

c. Group 3

In some MS, agricultural authorities are planning measures which address floods with a two-year frequency. For these small, high frequency floods, NWRM are very relevant. In the Nordic Baltic region, drainage system maintenance is an important issue for farmers; famers support those measures which help to get water as quick as possible from their lands.

Up-stream downs stream linkages should be viewed not only from the perspective of how farmers can support cities in reducing flooding in urban areas, but also how cities regulate building activity. For example, due to building on the floodplain of the Nemunas River delta, the Silute municipality experiences annual floods. Although the local municipality has offered affected households the opportunity for relocation, inhabitants prefer stay on their lands and be rescued in extreme floods. The increase of impervious surfaces in up-stream area leads to faster run-off thus impacting urban and rural areas located down-stream.

The Estonian Ministry of the Environment is starting to prepare its first flood risk management plan. Initial assessment of the situation indicates that coastal regions and cities on river mouths are most vulnerable and a prevailing flooding source is storm surges. It is foreseen that the measures shall be integrated in spatial planning by setting the conditions for land use. Additionally, the building regulations shall include the requirement to build special cellars and to elevate the first floor to be more flood safe. Moreover, the cities have and need adequate evacuation and or rescue plans.

There are a number of areas in which multi-functional nature of NWRM could be better appreciated. For example, NWRM are seen as a mechanism to reduce effects of the floods, in particular regular floods which occur in rural areas. There is also a need for greater clarity in NWRM cost benefit analysis. Participants discussed issues related to cost-estimates and cost – benefit analyses of different measures to prevent floods. However, it was noted stated that these tools are not yet used in flood risk management planning. Furthermore, the role of existing nature protection areas is not evaluated from the perspective of flood risk management. Having Natura 2000 sites is very often seen as a limitation factor for development, but what ecosystem services they provide is not assessed. The information on assessment of wetlands as flood mitigation measures is also not widely available; however, they would be potentially valuable for managing frequent floods.

8. Case Studies (Williams, Veidemane, Deutschmann and Eckert)

Four case studies were presented on three rivers: the Belford in the UK, the Lielupe in Latvia and Lithuania and the Oder (Odra) which separates Poland and Germany.

a. Lielupe (Veidemane)

The Lielupe is one of four international basin districts in Latvia and Lithuania, the catchment is shared approximately equally between the two countries with 8849 km^2 in Latvia and 8949 km^2 in Lithuania. The catchment is come to approximately 840 000 people, of which 58% live in Latvia and 42% in Lithuania. Floods are associated mainly with spring melt and ice jams. The legal framework for flood prevention includes the 2002 Law on Water Management which includes regulations on initial flood risk assessment and flood risk management planning; the 1997 Law on Protection Belts which defines and delineates floodplains, the Law on Spatial Development Planning which is a practical tool for implementing flood risk prevention measures and nature protection legislation which recognises the importance of floodplain habitat. It should be noted that the Law on Protection Belts delineates floodplains on the basis of flows with a 100-year return time.

The first round of flood risk management and prevention programmes developed between 2008 and 2015 focussed on identification of priority flood risk areas and to plan flood protection measures. One of the key conclusions of this exercise was that more detailed information and investigation of areas at risk of flooding was needed. Some of the key investments in grey infrastructure included renovation of existing dams and flood gates and dredging of river beds.

Jelgava city is in the Lielupe catchment and has a significant area (34%) which has been identified as being at risk of flooding. A combination of high groundwater levels and floodplain development contribute to this problem. The at risk area in Jelgava includes recreational areas, individual houses and nature conservation areas. A PoM to manage flood risk based solely on grey infrastructure and costing circa 10M euros will be implemented in 2014-2015 and will include renovation and construction of new urban infrastructure to reduce flood risk, renovation of flood-gates, polders and channels, dredging of river beds and building of a new protection dam.

In some ways, Jelgava in the Lielupe catchment epitomizes the old paradigm of water governance. It implements tried and tested grey infrastructure measures for flood prevention. It is not clear what opportunities for cost savings or greater efficiencies could be achieved if the spatial planning paradigm were adopted.

b. Belfort (Williams)

The Belfort is a small catchment in northeast England where NWRM have been successfully implemented to manage flood risk in the village at the bottom of the catchment. Traditional flood defences had been employed to protect the village but these were not seen as being cost effective. A series of upstream NWRM for flood prevention were implemented in partnership with local land owners at a cost of 250000 euros, which compared favourably to the estimate of 3M euros for grey infrastructure flood protection measures.

The Belfort is nearly unique for the wealth of data collected. Detailed before and after monitoring, combined with sophisticated modelling, was able to demonstrate the strengths and challenges of NWRM. One key conclusion of the exercise was that NWRM are effective as part of a network, thus spatial planning is a key part of their implementation. The monitoring also showed the multiple benefits of NWRM, as well as flow control, there were clear benefits related to sediment and nutrient retention.

Some key lessons were learned in the Belfort catchment related to effectiveness and implementation. Both monitoring and modelling were used to provide evidence of effectiveness. Effectiveness was clearly related to scale. Individual measures had small effects, but the network of measures could have large effects. It was clear that the most appropriate measure varied with location and intended purpose. It was also apparent that effectiveness was dependent on antecedent conditions. Measures were more efficient in drier conditions which gave higher water retention capacity in the landscape. It was also important to be realistic – it is impossible to prevent all flooding. Some important lessons were learned about implementation. Engaging stakeholders was key, local residents and landowners felt they had ownership of the project. It is important to recognise that timescales can be long, and implementation can be helped by collaboration with the scientific community. Finally, long-term commitments, maintenance agreements and secure funding are needed.

c. Oder / Odra (Deutschmann and Eckert)

The Oder / Odra river separates Poland and Germany and flows through the city of Frankfurt (Oder). The river has a length of 854.3 km and a basin of 124,049 km^2. The basin lies 86.4% in Poland, 5.9% in the Czech Republic and 7.7% in Germany. There are 16.4 million inhabitants, agriculture is the dominant land use and there are significant areas of forests, cities and industry as well as 7 national parks and many nature protection zones. The catchment receives 29.5% of the precipitation falling on the Baltic catchment. The river has an average flow of 580 m^3/s in the German sections.

Between 1717 and 1932 a process of channelization and straightening reduced the length of the river by approximately 22.75% from, 822 to 635 km. Since 1896, more than three-fourths of the floodplain has been lost (from 3708.9 to 859.4 km^2). Floods typically occur in the spring but can occur at any time of year. Climate change may exacerbate flooding in the future. There are approximately 500000 inhabitants at risk of flooding and the financial risk exceeds 3.3B euros.

Flood risk management planning is conducted at the transboundary, national and state level. The Federal State of Brandenburg does its own FRMP. Plans are based on hazard and risk maps and known flooding issues. The FRMP is based on a series of maps which are used to compile an inventory for analysis and development of water management objectives which were then presented to other interested parties and the public.

Flood risk management for the Brandenburg Oder includes the development of measures and existing schemes. Technical measures include reconstruction of levees, development of retention areas and the possible relocation or further protection of bridges. FRM is based primarily on "classical" grey infrastructure measures. There is some consideration of natural flood management and a small but significant role for NWRM.

Frankfurt on Oder faces a number of economic challenges. Since reunification, the city has lost almost one-third of its inhabitants. There are significant areas of ex-industrial brownfields in the Frankfurt flood plain. Due to post-war demolition and decline of heavy industry since the 1990s, many potential building sites are now available. Redevelopment of these flood prone areas could add significantly to the municipal tax base. Many of these sites are within the area of medium probability flood risk, and formal designation of floodplain status will generally prevent any further development. This contradicts the general principle for spatial planning which favours internal urban development.

A number of governance and regulatory options are available to cope with flood risk in these areas. Options include flood-adapted urban development, which could lead to continuous redevelopment and densification of the inner city despite existing flood risk. There is also the possibility to protect buildings instead of building embankments. Changing the legal restrictions on designated floodplains could aid urban redevelopment, but this must be balanced with changes to the building code to minimize vulnerability to flooding.

Urban development in Frankfurt on Oder highlights a number of areas where a paradigm shift is needed for urban flood management. Some of the key points to consider include:

- Structural measures such as the construction of dykes for flood protection are not the only solution for urban flood management
- A shift to flood-adapted urban development is needed to make the best use of floodplains
- Shifts to building related flood protection which transfer responsibility from the state to the building owner are needed
- Shifts to flood prevention measures which keep and reclaim retention space in urban and rural areas are necessary

9. Conclusions

NWRM are an important part of the emerging paradigm shift in water management. This pilot project and the Nordic Baltic region can play an important role in their implementation and acceptance. While NWRM are multi-functional, they have an important role to play in urban flood prevention. Successful incorporation of NWRM into spatial planning for urban flood prevention will require a number of shifts in thinking. There are six key areas where further thought is needed:

- Landscape vs. Lawscape
- Grey vs. Green
- City vs. Catchment
- Reductionism vs. Holism
- Winners vs. Losers
- Multi-functional vs. Flood Control

Landscape vs. lawscape contrasts the biophysical versus the social environment. We have a good, but inadequate, understanding of the hydrology of floods and NWRM but we lack understanding of the institutional and regulatory framework, or lawscape. It was clear from this workshop that the paradigm shift in water governance requires shifts in institutional activities and attitudes if it is to succeed.

There is a role for both grey and green infrastructure in sustainable flood management. NWRM cannot solve all problems but they are an important, under-appreciated and cost-effective complement to grey infrastructure solutions. More pilot scale and demonstration NWRM are needed to build the knowledge base and increase the societal acceptance of NWRM for sustainable flood management.

The FD and WFD planning cycles are liked and share many similarities. However, the FD could be even more effective if it focused on catchment scale water retention measures as well as urban flood risk management. Problems associated with floods occur mainly in cities. Flood prevention solutions can only occur in the catchment.

The change in paradigm from flood protection to water management involves a shift from reductionist to holistic thinking. Many institutions and other actors are ill-prepared to deal with this shift as it entails greater uncertainty, more decision making and balancing competing views and interests.

Implementing measures to prevent urban flooding, whether they are related to “making room for the river” or “keeping the rain where it falls” will have both winners and losers. On a simplistic level, the winners will be those urban residents who avoid flooding while the losers will be rural land owners. Adequate mechanisms must be developed to compensate losers and charge winners for catchment scale water retention services.

NWRM are the decathletes of water management. Decathletes do not get the same attention as sprinters but they can do many things extremely well. NWRM are multi-functional: they have a clear role to play in flood prevention, but they also fill many other important roles for human wellbeing and environmental sustainability.

10. Participants

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