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## CASE STUDY

# Financial instruments for nature-based solutions to reduce risks of flooding and drought

Anna Ternell<sup>1</sup>, Peter Stigson<sup>1</sup>, Bodil Elmqvist<sup>1</sup>, Johanna Alkan Ohlson<sup>2</sup>, Helena Hansson<sup>2</sup> and Anders M. Nilsson<sup>3</sup>

<sup>1</sup>PE Teknik & Arkitektur, <sup>2</sup>Lund University, <sup>3</sup>Västra Götalandsregionen/Västarvet

**Abstract** – Today's expansion and densification of cities, where more space is being impermeably surfaced by grey infrastructure, means an increased risk of flooding. An urban space with reduced green areas is less resilient to increased temperatures. In dealing with this, research has pointed to the complementarity of Nature-based Solutions (NBS) in contributing to more resilient and cost-efficient flood management. NBS do not only serve to reduce risk for flooding and drought, they also provide additional sustainability values, such as strengthening ecosystem services through increased biodiversity and recreation opportunities. In many circumstances, combining this NBS with traditional grey infrastructure can provide next generation solutions that enhance system performance and better protect communities. The study has focussed on subjects argued as central to provide a business value for upstream landowners to perform NBS measures. Results of the Workshop on Nature Based Solutions for flood and drought prevention organized in May 2019 in Gothenburg substantially contributed this study. The main objective of the study is to propose developments that can lead to business models and financial instruments that support the adoption of upstream water retention through Nature-based Solutions based primarily on research from the Västra Götaland region of Sweden.

**Keywords** – grey infrastructure, upstream water retention, climate change, flood management, ecosystem services, nature-based solutions (NBS), Water Framework Directive, Floods Directive, Environmental Quality Standards

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## 1. Introduction

The need to minimise the risks of flooding through increased capacity to retain water in the landscape and the need for water access during drought is increasingly emphasized in policy and by regions. These water-related risks can be handled through two main paths: grey infrastructure such as concrete walls, elevated quaysides, and water dikes; or, nature-based solutions (NBS) such as ponds, wetlands, and other blue-green measures. Most commonly, measures to address flooding focus on grey infrastructure. More resilient climate adaptation solutions through a policy and institutional development that create a business case in adopting NBS for flood and drought management should be encouraged. This is analysed in a multi-stakeholder setting and highlights new ways of cooperation between private, public and civil stakeholders. The results provide a business model based on downstream landowners (beneficiaries) reimbursing or in other ways compensating upstream landowners (providers) to

increase the water retention potential through NBS. The suggestion is a public policy instrument that stimulate financial instruments as a basis for agreements between different landowners – both municipal and private. This is aimed to complement other financial contributions, such as restoring wetlands funded by local water measures (LOVA)<sup>1</sup> granted by the County Administrative Boards.

Challenges to a successful implementation and increased cooperation for NBS are in particular those related to the difficulties in implementing common intermunicipal interventions due to different conditions and priorities of municipalities (Grimes and McKenna, 2019). Legal barriers can also challenge the viability financial instruments due to the diversity of laws governing water and water activities that in turn give rise to a multitude of legal problems and dilemmas. A strong input and driver for this financial instrument is derived from The European Landscape Convention (Council of Europe, 2000) and the Directive on

<sup>1</sup> LOVA is part of the Swedish Government's marine environment grant, stands for Local Water Management Project. The purpose is to support local measures that contribute to achieving the

environmental quality goals and thereby improve the aquatic environment.

the assessment and management of flood risks (EU Parliament and the Council of Europe, 2007). The Convention aims to encourage public authorities to adopt policies and measures at local, regional, national and international level for protecting, managing and planning landscapes throughout Europe. It further proposes legal and financial measures, aimed at shaping "landscape policies" and promoting interaction between local and central authorities as well as cooperation in protecting landscapes. The Directive requires member states to develop flood risk management plans that include measures to reduce the probability of flooding and its potential consequences. It addresses all phases of the flood risk management cycle including prevention (i.e. preventing damage caused by floods by avoiding construction of houses and industries in present and future flood-prone areas), and protection by taking measures to reduce the likelihood of floods and/or the impact of floods in a specific location (e.g. restoring flood plains and wetlands). However, NBS is today not implemented on the scale identified as beneficial by relevant stakeholders and in literature. This, arguably, decreases the effectiveness and efficiency of public climate adaptation policies. The workshops and analyses identify that this is caused by information asymmetries, policy uncertainties as well as cost barriers. The latter highlights the financial systems and a system for monetary transactions from the downstream beneficiary to the upstream provider.

### 1.1. The scope of the study

The aforementioned problems indicated the necessity of a new policy initiative, aimed to stimulate awareness about, and adoption of NBS. The subjects, which are central to provide a business value for upstream landowners to perform NBS measures include:

- The benefits and values of water retention both upstream and downstream (to motivate providers and beneficiaries)
- An analysis of policy instruments that can provide a formal basis for financial instruments (as input to the model set-up)
- Legal conditions and recommendations (for implementational requirements and political support).
- Case projects, challenges and recommendations (as inspiration and input to the business model)

The NBS concept is closely related to other concepts including sustainability, resilience, ecosystem services, coupled human and environment, and blue-green infrastructure. The study has decided to use the term Nature-based solutions (NBS) as these solutions aim to solve societal challenges in a cost-effective way and simultaneously provide environmental, social and economic benefits. The European Commission is further actively engaged in NBS as a driver in developing ecosystem services-based approaches throughout Europe and the world. This study has focussed on

the upstream areas of cities and their effects on downstream areas, and not retention of water in cities, such as storm water ponds, green roofs and parks. For more information on NBS in cities, we refer to the EU project Naturvation,<sup>2</sup> that for example has developed an Atlas with 1,000 examples of NBS from across 100 European cities. The respective location of municipalities and landowners along a catchment area creates dependencies that can be referred to upstream – downstream relations. Inter-municipal and public – private cooperation, and coordination of planning activities based on a catchment approach, is central to adopting NBS to alleviate flood risks and drought. The business model developed in this study only looks at how downstream beneficiaries can compensate upstream providers when implementing NBS measures that reduce floods and drought. In contrast, the reverse model would be that upstream areas compensate downstream areas for measures that increase costs related to flooding. That is by intensifying land-use in the form of technical structural measures of flood control (e.g. dikes, levees) or soil sealing (e.g. exploitation of housing), which could increase peak charges to downstream areas. This, however, has not been part of the study.

Table 1. Definitions of concepts

Concept	Definition and description
Nature-based solutions	An umbrella term referring to actions that protect, manage, and restore natural capital in ways that address societal challenges effectively and adaptively. These include structural and non-structural actions, ranging from ecosystem restoration to integrated resource management, green infrastructure, and more.
Policy instrument	A policy instrument is, predominately, a public tool to achieve a certain objective, which can be to reach a goal or to overcome an identified obstacle or failure
Financial instrument	A financial instrument is a monetary contract between parties that can be created, traded, or modified.
Business model	A business model is a company's core strategy for making a profit. It defines the product or service it will sell, the target market, and the costs.
Business Model Canvas	Business Model Canvas is a strategic management and lean start-up template for developing new or documenting existing business models. It is a visual chart with elements describing a firm's or product's value proposition, infrastructure, customers, and finances.

<sup>2</sup> The Naturvation (NATure-based URban innoVATION) Project is a 4-year project, funded by the European Commission and involving

14 institutions across Europe in the fields of urban development, geography, innovation studies and economics <https://naturvation.eu/>

## 1.2. Climate benefits of nature-based solutions

Within water resource management, disaster risk reduction, and climate change adaptation, NBS is gaining attention internationally as a complement to grey infrastructure. The benefits achieved by NBS can be decreased flooding risks and related biophysical impacts, i.e. the mechanisms of water

quantification and estimates of groundwater recharge are of high importance for sustainable water resources management, which is particularly relevant in regions where an increase in the duration and frequency of drought events can be expected due to future climate change (Freyberg et al. 2015). As such, NBS in terms of blue-green solutions holds a clear potential to support climate adaptation. It can also, however, support



Figure 1. Benefits of increasing water holding capacity in the landscape through Nature-Based Solutions (NBS)

retention (Fig. 1), which is slowing and reducing runoff. This improves the water bodies' status and control flood risks. NBS can also have other benefits in the landscape where the measures are implemented, such as increased biodiversity and recreation opportunities. Table 2. lists both these types of benefits with short explanations. Like flood risks, climate change increases the risk for drought. Rising temperatures increase evaporation and water needs and thus dry out soils and vegetation (Némethy and Molnár, 2014). A negative effect of this is also increased risk for fires. Furthermore, drought negatively impacts groundwater recharge and stable water provision, which implies many challenges for the agricultural sector (Pavelic et al. 2012). Therefore, a reliable

climate mitigation through reducing the need for concrete to construct storm drains and other different grey flooding infrastructures, which cause pollution and discharge of greenhouse gases during their manufacturing processes (Müller et al. 2013). However, due to already existing structures and economic factors hybrid, integrative solutions might be necessary (Depietri and McPhearson, 2017). The County Administration of Västra Götaland has listed several measures to reduce risks of flooding related to the possibilities in relation to different sectors. For the forestry sector it can, for example, be of importance to increase or keep forests in the catchment area to increase evapotranspiration and reduce runoff. In the agricultural



sector, measures include, for example, catch crops and no-plough farming. Table 2. lists areas of measures to reach benefits of restoring water in the landscape.

Table 2. Nature-based measures, categorized by sector, to reduce flooding<sup>3</sup>

Area of measures	Benefits
<b>Agriculture</b>	
Spring ploughing	More organic material in the soil
Catch crop	Increase biodiversity
No-plough farming	Reduced runoff
Permanent tracks for vehicles	Increased groundwater recharge
Structure liming	Reduced sediment and nutrients in watercourses, lakes, and sea
Low/no-till agriculture	
<b>Unused zones</b>	
Protections zones	Slow high flows
Edge zones	Reduced erosion
Buffer strips and hedges	Increased infiltration of water in the soil
Forest-riparian buffers	Increased organic material content
Integrated protection zones	Increased biodiversity
	Increased evapotranspiration
	Less sediment and nutrients in watercourses, lakes, and sea
<b>Forest and trees</b>	
Increase or keep forest in catchment areas	Delayed snowmelt
No clear-cut forest	Increased evapotranspiration
Land-use conversion	Slower water flows
Plant trees and shrubs in water-bearing slopes	Increased ground water recharge
Meadows and pasture	Reduced runoff
	Reduced erosion
	Increased biodiversity
<b>Measures in ditches</b>	
Avoid driving damage in forests	Increased infiltration in the ground
Open culverts	Slower water flows
No cleaning of ditches	Increased water-holding capacity
Two-stage trenches	Increased biodiversity
Re-meandering	Less sediment and nutrients in water courses, lakes, and sea

<b>Ponds and dams</b>	
Wetlands	Increased infiltration
Create detention basins and ponds	Increased evaporation
Let road banks curb high flows	Reduced runoff
Phosphor dams	Increased ground water recharge
	Reduced sediment and nutrients in water courses, lakes and sea
	Sediment can be used for arable land as fertilizer
	Less erosion
	Increased biodiversity
	Store water
	Maintain water cycle
<b>Large measures</b>	
Restoration of lakes	Slow water flows
Flood plane restoration	Store water
	Increased infiltration
	Increased ground water recharge
	Increased biodiversity
	Reduced sediment and nutrients in water courses, lakes, and sea

### 1.3. The financial model

There are two primary set of solutions to the known problem of flood and drought management: upstream and downstream measures; as well as nature-based and grey infrastructure solutions. While this setting is known, the primary solution today is downstream grey infrastructures. This constitutes a market failure seeing that upstream and NBS can increase cost-efficiency and effectiveness in climate adaptation. The conclusion of a market failure is emphasised by argued information asymmetries on the possibility and value of NBS by key stakeholders. This failure has persisted despite upstream and NBS solutions being pointed-out in national and EU policies to improve flood and drought management and not reaching policy goals of implementing such solutions.

To alleviate this failure, we argue that a public policy instrument is needed to scale-up NBS and comply with these policy objectives. The policy framework should thus provide a basis for up- and downstream stakeholders to collaborate on implementing NBS, which includes providing a credible setting for the financial instruments and transactions that this entails, and thus that upstream landowners may see NBS as a business case. An evaluation of this business case can help landowners to decide if they want to include NBS in their

<sup>3</sup> Source: Naturbaserade lösningar mot översämning, en praktisk handbok, 2019. Länsstyrelsen, Västra Götalands Län

<https://www.lansstyrelsen.se/download/18.2c30d6f167c5e8e7c0d584/1546947630948/2018-13-broschyr.pdf>

business model. In other words, not all potential business cases are adopted into the business model, which can be due to various reasons, such as competence and tradition. The potential to adopt the business case into a business model has been tested in this study. A credible setting needs to provide information on measuring, reporting and verification of the performed measures, for contracts to be robust. It should also provide metrics of values for downstream benefits. Depending on various NBS that can be applied, there may be several types of financial instruments. This setting aims to turn the landscape into a resource for landowners/municipalities in a novel way, whereby the landowner can sell water-holding services and by that decrease the risk for future flooding. A strong input and driver for this financial model is derived from the Flood Directive.<sup>4</sup>

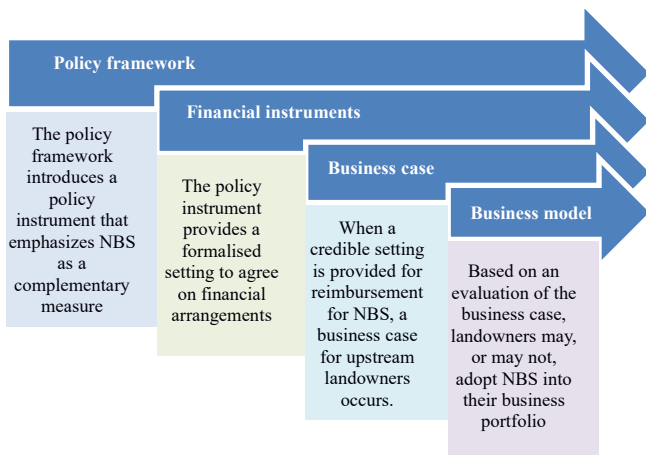


Figure 2. From policy to business case – a policy framework to compensate NBS

To reduce flood risks in downstream municipalities, the water upstream needs to be stored or managed until there is room for water flows that do not exceed a level that causes unacceptable damages. A key factor for such solutions, and arguably even more so for blue-green water storage measures, the municipality and landowner need to agree on how to value the municipality's benefits to avoid flooding, and how any costs for landowners to retain water should be valued.

Downstream beneficiaries contribute to expenses for increased water holding capacity measures made by upstream providers in order to reduce risks for flooding and drought. Compensation for flood storage requires mechanisms that link those who provide flood retention services and those who benefit from them. The proposed policy framework and resulting business case has the potential to be scaled up as a general model and be applied in other parts of Europe bearing in mind that compensation schemes are sensitive to the specific needs of the actors involved and local/regional conditions. Compensation for flood storage is complex and

the financial compensation requires negotiations among beneficiaries and providers. Transparent cost-benefit evaluations can contribute to protection measures and compensation levels. Moreover, the local context is important and compensation schemes need to be sensitive to the specific needs of the actors involved and local/regional conditions, such as the distribution of risks and land uses.



Figure 3. Financial model – vulnerable downstream areas benefit from upstream flood retention services.<sup>5</sup>

#### 1.4. The study area

The study is based on a regional pre-study carried out in Västra Götaland Region, Sweden, in spring 2018 (Business

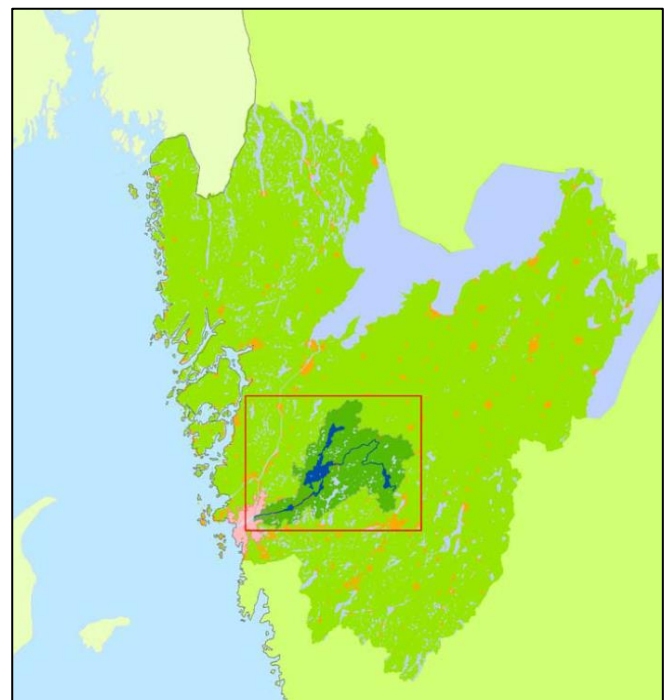


Figure 3. Region Västra Götaland and the Sävåån river and its hydrographic catchment area. Settlements are marked with orange colour while the city of Gothenburg is pink.<sup>6</sup>

<sup>4</sup> EU Commission, 2007; <https://eur-lex.europa.eu/legalcontent/EN/TXT/?uri=CELEX:32007L0060>

<sup>5</sup> Source: Business model for blue-green compensation to reduce risks for urban flooding. Ideation study, EIT Climate – KIC 2018

<sup>6</sup> Source: Sävååns landskap. Rapport. Västarvet 2008. ISBN 978-91-7686-201-8



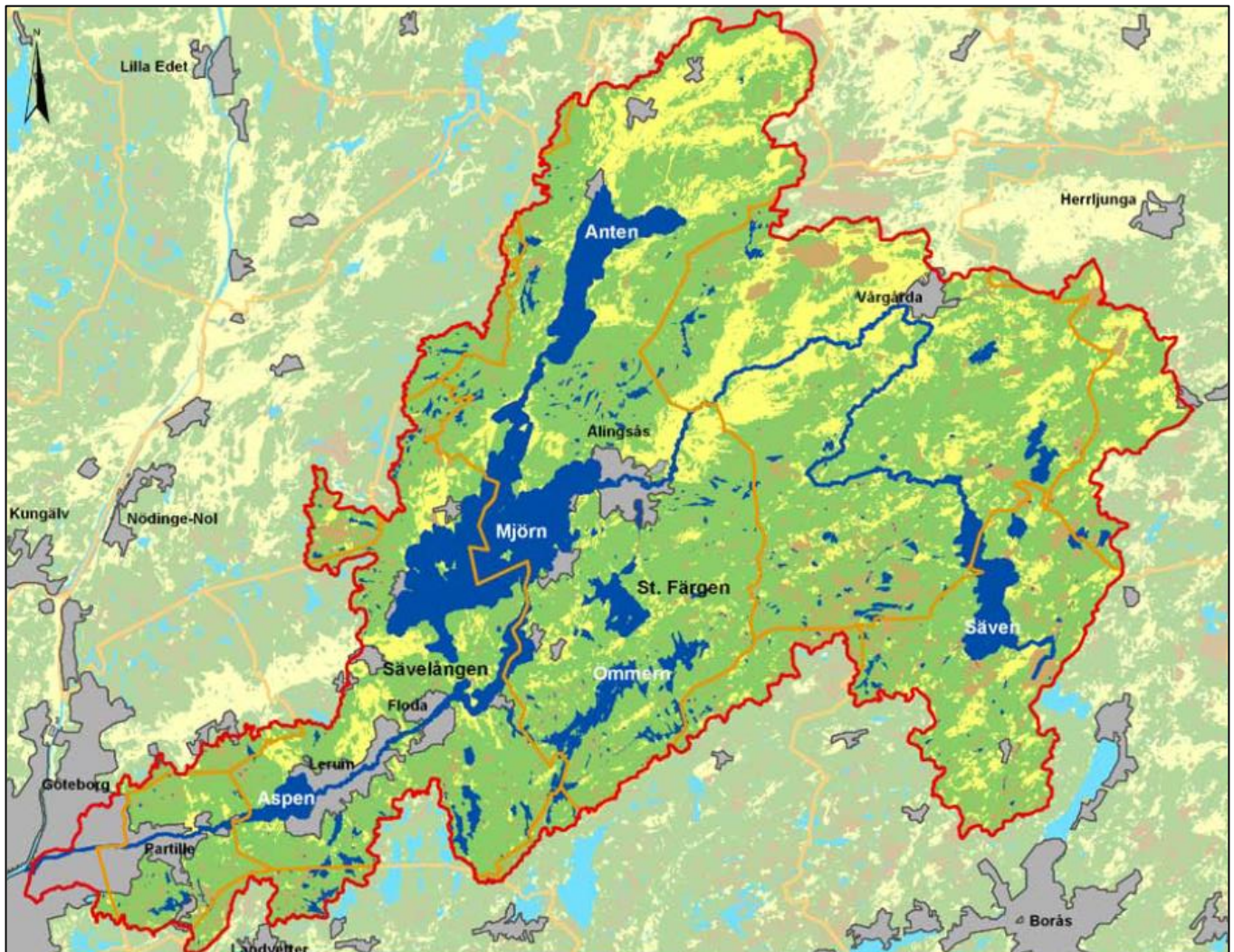


Figure 4. The hydrographic catchment area of Sävå river including municipalities and settlements within the area

— border of the hydrographic catchment area  
 — borders of municipalities    settlements

model for blue-green compensation to reduce risks for urban flooding, EIT Climate-KIC, 2018). Included in this area is the low-lying City of Gothenburg (approx. 1.000.000 inhabitants in the larger city area) that have major challenges with flooding and predominantly look at grey infrastructure solutions to solve them. The study looked specifically at the Sävå river catchment area (Figures. 4, 5 and 6), which leads into the larger river Göta Älv and through four municipalities.

In recent years, the region experienced a succession of large flood events (e.g. 2006, 2014, and 2016) including severe floods in the areas of southwestern Sweden. The study area included the City of Gothenburg and adjacent municipalities and the outcomes of the study were discussed and tested with private, public and civil stakeholders in this area. Flooding along lakes, rivers and streams is the most common type of flood in Sweden and is in most cases caused by heavy rain or snowmelt. MSB with the support of the County Administrative Board, has made an inventory on flooding in Sweden, which shows that 70% of the significant floods in Sweden occurred along lakes and rivers during the last century.

In the case of the City of Gothenburg, the area is extra sensitive to flooding due to its location downstream and next to the sea. As the city is located on low-land area along the coast, coastal flooding occurs when sea surface rises, for example, as a result of strong winds or when the sea surface rises more permanently with respect to climate change. The effects from sea level rise is hard to avoid, while a reduction in upstream water flows from streams and rivers can be addressed through NBS.

The annual rainfall in Region Västra Götaland was 795 mm during the period 1961-1990. Most precipitation falls along the coast. Over the past 23 years, precipitation has increased slightly, mainly in the southwestern part of the region. The analysis further shows that precipitation is expected to increase, with between 12% and 25% to the end of the century. Similarly, the same analysis shows an increase in the annual run-off. From 1961 to 1990, the run-off increased with 5-15% in the area. This is estimated to continue towards the end of the century (Fig. 7).





Figure 5. The Säveå river near Hedefors, municipality of Lerum. Photo: Anders Nilsson



Figure 6. Säveå river at Knavra bridge, Stenkullen, municipality of Lerum. Photo: Anders Nilsson



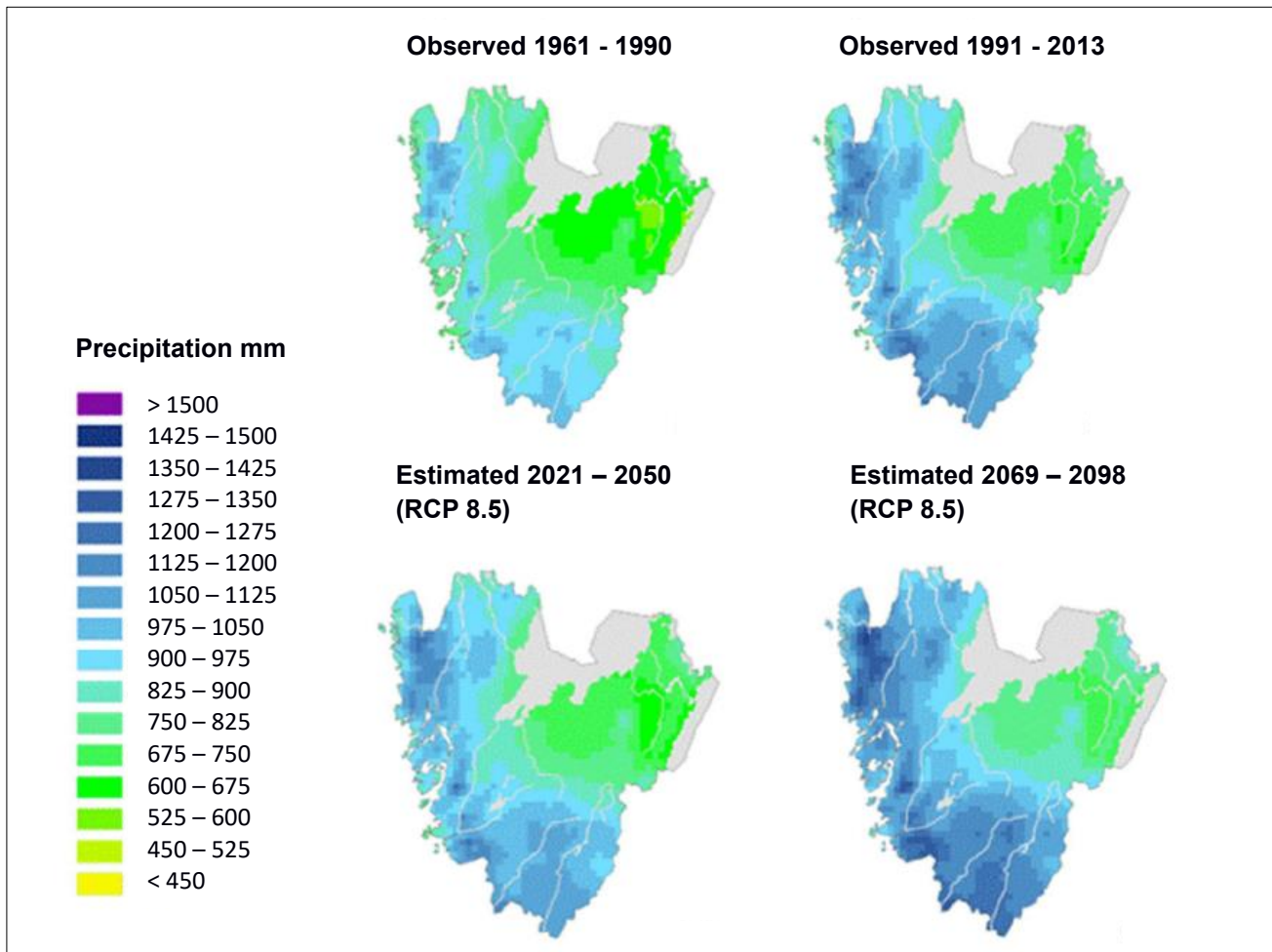


Figure 7. The development of precipitation from 1961 and estimated rainfall up to 2098 in Region Västra Götaland made by the Swedish Meteorological and Hydrological Institute (SMHI). Source: SMHI, 2015, Framtidsklimat i Västra Götalands län, KLIMATOLOGI Nr 24, 2015. RCP 8.5 = Representative Concentration Pathway scenario 8.5 (IPCC)

**1.5. Stakeholders**

Table 3. Stakeholder benefits in the proposed financial model

Groups	Actors	Benefits
<b>Providers</b>	Landowners (private, public, farmers, forest and landowners)	Benefit from hazard and risk reduction locally, compensated for blue-green interventions, receive indirect benefits such as increased biodiversity, health and other income generated effects.
<b>Beneficiaries</b>	Landowners (all)	Benefit from options for land development
	Municipalities (land and property owners, developers responsible for flooding investments)	Benefit from options for land development and reduced investments for flood damage control, pay compensation based on land value appreciation and cost savings.
	Private homeowners, businesses etc.	Benefit from hazard and risk reduction, pay compensation based on averted flood damage (flood risk)
<b>Intermediaries</b>	Civil engineers/entrepreneurs	Provide technical expertise, assessment of (direct and indirect) costs and benefits
	Public authorities	Represent public interests (e.g. flood risk reduction and keeping public expenditures low), coordinate interests and negotiate compensation scheme. They have an important role in the land use planning and decision making.
	Academia	Provide knowledge and research results on costs and benefits of NBS and flooding.



Stakeholders can influence and be influenced by the implementation of NBS in different ways. Three main groups of stakeholders are identified within the study: providers (e.g. landowners), beneficiaries (municipalities), and intermediate stakeholders (e.g. organisations with different mandates in regional and local water management). Table 3 illustrates the involved stakeholders and their respective roles and responsibilities in implementing NBS.

## 2. Societal values

Both grey infrastructure and green infrastructure can play an important role in water management. Grey infrastructure refers to the human-engineered infrastructure such as concrete walls, elevated quaysides and water dikes. Green infrastructure is the “strategic use of networks of natural lands, working landscapes, and other open spaces to conserve ecosystem values and functions and provide associated benefits to human populations” (Allen, 2013). Blue-green infrastructure is also a term used interchangeably with green infrastructure to describe measures such as rain gardens or wetlands. It is important to understand the differences and challenges these alternatives bring from economic, environmental, and social perspectives.

### 2.1. Green and grey infrastructure

Green infrastructure can be cost-effective and deliver wide-ranging co-benefits valuable to society. The financial case for considering green infrastructure has been well-documented in areas such as reducing the cost of water-related service provision but varies depending on local conditions. Service providers and their partners should therefore conduct site-based assessments on a case-by-case basis to evaluate financial impacts. Savings generated by natural systems can be large, for example, New York City saved 22 percent, or \$1.5 billion, by combining green and grey infrastructure instead of pursuing a grey-only strategy to secure water supply for the city (Bloomberg and Holloway, 2018).

Compared to green infrastructure, grey infrastructure currently has a clearer asset life, depreciation, and return on investment. Challenges surrounding grey infrastructure include funding and public investment, maintenance, and increased urbanization. Urbanization presents a water management challenge because the introduction of more hard surfaces, like concrete or asphalt, contributes to higher volumes of stormwater runoff due to a reduction of infiltration. Due to its relative size, construction requirements, and finite life, grey infrastructure can also be inflexible. Green infrastructure presents challenges in terms of measuring return on investment, risk management, and effectiveness in urban areas. Current regulation—or absence of regulation—at the national or local levels also presents obstacles, as many green infrastructure projects don’t fit traditional standards or building/urban codes to govern how

the projects should be implemented.<sup>7</sup> As a largely untested concept, green infrastructure also faces socio-political uncertainty/acceptance, and decision-making uncertainty.

### 2.2. Values of Nature Based Solutions

Identifying and valuing the benefits of blue-green solutions are important for the financial model. While NBS provides general benefits to society, these may not be known and needs to be articulated. There is also a need to translate the benefits to specific values in order to be monetarised. Finally, the societal values will affect stakeholders differently and thus needs to be specified in terms of perceived values for different stakeholders (Fig. 8). This value-chain needs to be elaborated to provide an understanding of which values of NBS that are not realised (market failures) as well as which willingness to pay that exists among stakeholders for which benefits.

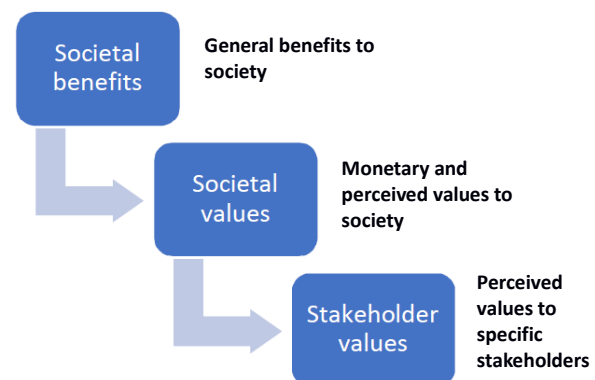


Figure 8. Benefits and values of green infrastructure from society to stakeholders

Measuring the effectiveness of green infrastructure has resulted in the development of new frameworks, and adaptation of existing frameworks, in the context of water management (Table 4). Values of NBS are related to the benefits as explained above and imply direct and indirect costs savings (Bockarjova & Botzen, 2017). The most direct cost saving is reducing costs from flooding and drought. Costs related to flooding is enormous where, for example, the estimated damage of the 2013 river floods in Central Europe was €12.9 billion.<sup>8</sup> Flood storage also encounter costs. Storing water demands large areas of open land (mostly farmland) and usually infringes on existing property and land-use rights. In the event of flooding, these areas are purposely flooded to alleviate downstream flood risk. Landowners can bear direct costs if, for example, crop yields are reduced, or the drainage systems are damaged or indirect costs if land value falls or there is foreclosure of development option. Droughts also incur large costs, of which some are direct related to fire and others loss of income. The 1992 drought in Sweden resulted in €280 millions in loss of income for farmers alone. Other direct cost-related benefits of NBS are avoided costs for water purification, eutrophication and avoided damage to drainage systems.<sup>9</sup>

<sup>7</sup> <http://www.medspring.eu/sites/default/files/Green-infrastructure-Guide-UNEP.pdf>

<sup>8</sup> IWRA, 2019; <https://www.iwra.org/wp-content/uploads/2019/02/PB-N-April-web-1.pdf>

<sup>9</sup> LRF, 2019; <https://www.lrf.se/politikochpaverkan/aganderatt-och-miljo/torka/torkan-kostar-miljarder-for-sveriges-bonder/>

Table 4. General and economic tools for Nature Based Solutions. Measuring the effectiveness of green infrastructure has resulted in the development of new frameworks, and adaptation of existing frameworks, in the context of water management.

Tool	Objective	Link
Green versus Grey Analysis (GGA)	The U.S. Centre for Sustainable Economy and other partners developed the Green vs. Grey Analysis (GGA) which extends conventional public infrastructure analysis models to evaluate the cost effectiveness of technological solutions. This is done by looking at the unique role of how wetlands, forests, riparian zones, and other green infrastructure elements play in enhancing water quality and flow or achieving other environmental objectives. GGA is used to determine whether investing in these green infrastructure options is a more cost-effective approach than grey infrastructure.	<a href="https://sustainable-economy.org/wp-content/uploads/2015/05/Ashland-Green-Gray-Analysis.pdf">https://sustainable-economy.org/wp-content/uploads/2015/05/Ashland-Green-Gray-Analysis.pdf</a>
Green Infrastructure Valuation Toolkit	The Natural Economy Northwest programme (U.K.) and partners developed this framework for assessing the potential economic and wider returns from investment in green infrastructure and environmental improvements.	<a href="https://www.merseyforest.org.uk/services/gi-val/">https://www.merseyforest.org.uk/services/gi-val/</a>
Green Value Calculator	A calculator by The Centre for Neighbourhood Technology (CNT) in the U.S. that compares performance, costs, and benefits of green infrastructure and low impact development solutions for stormwater management.	<a href="http://greenvalues.cnt.org/calculator/calculator.php">http://greenvalues.cnt.org/calculator/calculator.php</a>
Aqueduct Global Flood Analyzer	An open-access online platform to quantify and monetize river flood risks worldwide. The tool estimates current and potential future effects on GDP, the affected population, and urban damage from river floods for every state, country, and major river basin in the world.	<a href="https://www.wri.org/resources/maps/aqueduct-global-flood-analyzer">https://www.wri.org/resources/maps/aqueduct-global-flood-analyzer</a>
Aqueduct Water Risk Atlas	A tool for drought management. It is a global water risk mapping tool that helps companies, investors, governments, and other users understand where and how water risks and opportunities are emerging worldwide. it uses the best available data to create high-resolution, customizable global maps of water risk but does not evaluate options for green infrastructure.	<a href="https://www.wri.org/resources/maps/aqueduct-water-risk-atlas">https://www.wri.org/resources/maps/aqueduct-water-risk-atlas</a>
Global Forest Watch–Water	This combines global data on water stress with near real time, high-resolution data on tree cover change, enabling users to view where ecosystem change may be having adverse impact on water resources. It helps users identify which of their sites are exposed to water risks because of loss and degradation of natural infrastructure	<a href="http://water.globalforestwatch.org/">http://water.globalforestwatch.org/</a>
Coastal Resilience	An approach and web-based mapping tool designed to help communities understand their vulnerability to coastal hazards, reduce their risk, and determine the value of green infrastructure. The tool's apps enable planners and decision-makers to visualize current and future risk and then identify a suite of infrastructure solutions that reduce social and economic risks, while maximizing the benefits and services provided by nature.	<a href="https://coastalresilience.org/approach/identify/">https://coastalresilience.org/approach/identify/</a>



Nilsson and Johansson (2015) illustrate how beneficial values can be divided into three categories:

1. *Qualitative value*

- Identifying ecosystem services and their values.
- Suitable for ecosystem services that are difficult to value such as recreation.

This is the method that requires least detail knowledge about the ecosystem service and can be done for all known ecosystem services. This kind of valuation requires that the ecosystem service is identified and the connection between ecosystem service and human well-being are described. This type of valuation is especially useful for ecosystem services that are difficult to put numbers on, for example, the potential of recreation.

2. *Quantitative value*

- Purifying of amount of m<sup>3</sup> water, number of visitors to the national park, etc.
- E.g. how many m<sup>3</sup> water is retained and purified

This type of valuation quantifies the values and describes e.g. how many m<sup>3</sup> of water is purified by a process. To make it possible, it requires a relatively good knowledge of how ecosystem service works.

3. *Monetary value*

- Market value of e.g. increased food production avoided costs for water purification or willingness to pay for an open landscape.
- Higher value of production (i.e. rapeseed production goes up with more pollination)
- Implies several challenges to set a price on ecosystem services.

Monetary valuation requires that the ecosystem function is well described. It can, for example, be market value for increased raw material production arising from e.g. pollination, or increased land value when new development opportunities arise.

Both monetary and quantitative values can be relevant for downstream beneficiaries. Simulation of water flows needs to be carried out based on for example 100 years rain. Valuing the reduced costs for grey infrastructure could also be possible but it might be difficult to select what measures to value. In the case of Austria,<sup>10</sup> the project decided to base the compensation value on a percentage of the increased value of land. The funds go to actual water retention measures upstream and to compensation to landowners for loss of values, for example loss of crops.

Below lists examples of criteria, indicators and valuation that can be used when selecting possible values to use in a compensation model (Table 5).

Providers of risk management measures need to be compensated for possible costs. These can be based on loss of production values, land values, investments or knowledge building. Table 6 illustrates the costs and their indicators.

Table 5. Selection of criteria, indicators and valuation for nature-based solutions. Source: Camino Liqueste et.al. (2016)

Criteria	Indicators	Valuation
Reduced flood risk	Peak flow reduction Reduction of flooding downstream	Quantitative valuation
Improve water quality	Load reduction of dissolved organic carbon Load reduction of nitrogen	Quantitative valuation
Improve recreation and health	No. of visitors/users Frequency of visits	Qualitative valuation
Support wildlife	Expert judgement about biodiversity Landscape diversity	Qualitative valuation
Produce market goods	Value of crop production	Monetary valuation
Reduce public costs	Total construction costs Total maintenance costs	Monetary valuation
Increased land value	Land value increase after potential exploitation	Monetary valuation
Reduced insurance costs	Insurance cost saving	Monetary valuation

Table 6. Possible costs for upstream providers based on the stakeholder workshop in May 2019.

Costs	Criteria	Indicator
Loss of land and damage to land	Production failure Change of crops	Loss of income from crop prod. Loss of income from biomass Costs for new crops
Land value decrease	Missing potentials of exploitation	Reduced value of land
Investment & maintenance costs	Establishment of blue – green solutions e.g. wetlands	Costs for construction maintenance and administration
Lost production values		Lost value of crop production
Knowledge and capacity building	Learning process	Time

3. **Financial instruments**

Public policy initiatives, primarily economic policy instruments, can overcome what we argue as a market failure of NBS not being implemented on the potential scale identified as beneficial by relevant stakeholders and in

<sup>10</sup> IWRA 2019

literature. The rationale to focus on public policy is to provide a formal and credible system. We identify that the market failure is caused by both information asymmetries, policy uncertainties as well as cost barriers. The latter lies within the financial systems and a system for monetary transactions from the downstream beneficiary to the upstream provider.

### 3.1. A formalised system

The reason to formalise the system is to provide credibility and safety in the transaction. A key aspect for the credibility is measuring, reporting and verification (MRV) of the measures carried out by the performer. Simply put, the beneficiary needs to be asserted that the measures will provide the benefits that has been agreed. The system can be formalised through different means where the most obvious is a public economic policy instrument.

An important aspect of economic policy instruments is that they can handle market failures either in providing financing to reduce capital expenses (CAPEX) or provide incentives through reducing operational expenses (OPEX).

Hence, the choice of economic policy instrument needs to include an analysis of the implementors' perceptions on CAPEX and OPEX as barriers to perform retention measures. In this study, as is shown below, both provide barriers to implement NBS.

The system could also be formalised outside of the formal public policy framework through bilateral agreements, such as through a broker. To reiterate, however, we argue that an institutionalised setting is likely needed to promote such bilateral agreements, seeing the low level of NBS implementation to date. This is also supported by the workshop, where participants identified a public agenda and policy instruments as the most important factors to promote NBS.

This scope does not neglect the potential for non-economic policy instruments as part of a broader policy framework. Administrative policies could force the implementation of retention measures of which NBS could be a part and under which the economic policy instruments could specifically promote actions towards NBS. Similarly, informative policy instruments could provide attention of NBS and alleviate information asymmetries. An example could be a labelling scheme for buildings that offset their climate adaptation impact by upstream solutions.

It should be noted that in most, if not all instances, there will be policy instruments that will support various aspects of measures along the NBS value-chain. The focus here, however, is on policy instruments to specifically establish a financial system between beneficiaries and providers with the aim to increase the implementation of NBS for flooding and drought management. This is needed despite policies of different sub-aspects of that system in order to be effective.

### 3.2. A monetary system

The system should be monetary as a financial transaction is the target of the project.<sup>11</sup> The transaction should ideally be a direct transaction between the beneficiary and performer, possibly with a broker as a middleman. As an example, a system where a policy instrument is introduced that leverages a tax on downstream landowners that construct houses in a flood risk area, and then allocate parts of the fiscal budget to a subvention system for upstream water-holding measures, is not included, because it does not constitute a financial instrument such as defined within the study. Furthermore, the system should be as simple as possible, in order to reduce administrative costs and complexity. This is emphasised by NBS being relatively novel, and thus that promoting them should be associated with low barriers. Hence, it also includes that the system should be easily understood by beneficiaries (e.g. public servants) and performers (e.g. landowners) that may not be accustomed to such transactions and systems.

### 3.3. Stakeholder perspectives

This section describes barriers and values from the workshop<sup>12</sup> in a policy perspective, as to facilitate a discussion on policy instruments that can be recommended to overcome said barriers and build on values as opportunities.

#### *Perceived barriers as market failures*

The workshop revealed an array of perceived barriers to increase the water retention capacity in upstream areas. These can be broken down into the following policy implications:

#### 1. Administrative

- Conflicting legislation
- Mandate to establish and sign contracts that regulate measures and economic compensation
- Conflicting interests between different stakeholders and organisations not being dealt with by the County Board
- Contracts needing long time-horizons

#### 2. Administrative/economic

- Liabilities if the retention capacity does not have stated effects e.g. could be argued as contributing to flooding.

#### 3. Economic

- Uncertainties in valuing benefits (value creation) and costs
- Economic effects due to impact on other activities by the provider

#### 4. Information

- Lack of experiences and thus rooting in business-as-usual practices

#### 5. Other

- Cultural implications in changing traditional land-use practices

<sup>11</sup> However, different trading on goods and services could theoretically also be applicable.

<sup>12</sup> Workshop on Nature Based Solutions for flood and drought prevention, May 2019, City of Gothenburg



- History of conflicts and differences in opinions between relevant stakeholders

Seeing that most barriers thus lie within administrative policy aspects, dealing with these are fundamental for the effectiveness of establishing and operating a financial system to promote NBS. The economic implications mainly relate to uncertainties in valuing costs and benefits for the performer and beneficiary as well as the contracts that establish liabilities. Looking at the former, the key costs for providers, as highlighted in the workshop, are:

- Loss of production (e.g. produce and available land for use)
- Investment and maintenance
- Permits (costs and time to apply for permits, e.g. shoreland protection)
- Change in production systems, which have been optimised for current practices (e.g. machinery, buildings, infrastructure)

Apart from the last point, these do not pose apparently significant barriers from a policy perspective, seeing that they point to a need to support costs of performing an activity. Importantly, the costs lie both within CAPEX and OPEX, meaning that a financial system should ideally support both. This means that a formalised financial system likely needs to include more than one policy instrument, as economic policy instruments typically either provide financing – supporting CAPEX – or incentives – supporting OPEX. There are however instruments that can provide both, such as negotiated agreements. This instrument is also interesting from the point of being a favourable instrument in complex and novel situations, where policy uncertainty may otherwise impede investments (Dinica, 2006; Helby et al., 1999; Ramesohl and Kristof, 2001; Rietbergen et al., 2002).

The last point on change in production systems is however potentially more fundamental, as it may provide a more fundamental and cultural change as well as risks of stranded assets due to the change in business model (i.e. using the land for an income by retaining water). This barrier is however alleviated, in part, by the statements by representatives from the Federation of Swedish Farmers (LRF) at the workshop, that the farmers are in the business of using their land and that this can be accomplished by new models such as NBS. This should however not neglect culture and traditions, highlighting a need for information to land-owners by a source that they find credible in order to effectively promote NBS. On the other side, the costs for beneficiaries are more straightforward:

- Costs of compensation
- Uncertainties of the benefits

There are ample policy examples of policy instruments that are adopted to support specific goals. This includes, for example, green certificates to support renewable energy and white certificates to support energy efficiency. Seeing the sheer magnitude of cost estimates for climate adaptation in the case study area, it would be reasonable to assume a political willingness to enforce a compensation system for organisations and projects that contribute to flood risks. This

could be a system that forces construction projects, such as houses or infrastructure, to support complementary flooding measures. A question is, however, in the scope of this study, whether there are legal possibilities to enforce that this should be NBS solutions and if it can stipulate upstream measures that are potentially in another municipality.

The uncertainties of benefits support our notion that an MRV (Monitoring, Reporting, Verification) system is fundamental to the effectiveness of the financial system. This includes both data as well as institutionalising the MRV system within an existing or new organisation. An existing organisation is favourable if possible, seeing that NBS is relatively new and that a transition to increasing such measures should be associated with as low administrative changes and thus barriers as possible. This, however, hinges on whether such an organisation exists, its mandate and its perceived credibility by the performers and beneficiaries. Further investigations should target which level of certainty that is perceived as needed by different beneficiaries. As such, while no key barriers are identified at the workshop which strictly points out informative policy aspects, such aspects exist, and information appears important to support the implementation of NBS overall as well as the effectiveness of specific policies.

#### *Perceived values as market opportunities*

While the perceived barriers point to a need of policy intervention, the opportunities also provide input to policy aspects. The input that opportunities provide to this, as is discussed below, are metrics that can be used to define what and how providers can be rewarded, and for which benefits to the beneficiaries. The aforementioned workshop provided these policy implications:

#### *Administrative – N/A*

#### *Economic*

- Reduced costs for downstream investments in flood management and water retention
- Reduced risks for costs as associated with reduced vulnerability and improved resilience in flood management

#### *Information – N/A*

#### *Other*

- Improved access to groundwater for services, such as drinking water, irrigation, extinguishing water, improved balance in water flows
- Reduced emissions of greenhouse gases associated with construction of grey infrastructure
- Improved biodiversity
- Multifunctionality (e.g. ice-skating during winter)
- Strengthening other values, such as nature reserves, recreation, outdoor activities, hunting, and fishing
- Improved business models for landowners

In terms of economic aspects, the costs can be evaluated based on previous research and hydrological modelling and are associated with relatively clear benefits. The more diverse set of other aspects is another matter. While research and

guidelines on benefits of NBS exists, they are less commonly operationalised in policy frameworks, which is also true in the Swedish case. This, again, strengthens the conclusion that a transition towards a framework for NBS solutions in this scope poses a novel context both regarding both policies and collaboration. Moving towards new land-use practices can be viewed as a risk for the landowners (Milman et al. 2017). However, it is interesting to note comments by representatives from the Federation of Swedish Farmers (LRF) that they see their business and making a profit out of using their land and that this could just as well be to manage water. Again, this means novelty in terms of the business model, but it also points to an openness and potential willingness to include NBS for flood and drought management in their businesses.

#### *Comparing up- and downstream failures and opportunities*

From a policy perspective, a key conclusion is that barriers can be more easily associated with specific costs and stakeholders, while the opportunities predominately lie in general societal benefits. In other words, the former are concrete while the latter are more discrete and less likely to be acknowledged without a framework that point out and describe how these and how they affect a diverse of policy aims that they support. It is also interesting to note that some opportunities are shared by providers and beneficiaries, mainly including improved biodiversity, groundwater services and water for extinguishing. This poses the question of willingness to pay for shared services and how such benefits should or could be allocated between providers and beneficiaries. Moreover, the study generally assumes that the upstream provider is in another municipality than the downstream beneficiary. This is likely to be the case in most instances, but the setting could be different. Hence, the question arises of whether a policy initiative that would work between municipalities, would work within a municipality. As such there needs to be an understanding of the broader value creations to avoid a disconnect between perceived value up and down stream, risking a market failure.

## **4. Legal barriers and possibilities to implement NBS**

### **4.1. General considerations**

The barriers and possibilities of implementing solutions depends on how, where and by whom they are implemented. This influence in turn which laws that become relevant. The diversity of laws governing water and water activities give rise to a multitude of legal problems and dilemmas. There may be gaps in the legal system (a particular issue may be unregulated), overlaps (one issue may be regulated in multiple statutes) which make selection of perspectives unclear or regulations may be in conflict with each other. The major reason for the diversity of regulations related to water activities is that laws regulating water and land use have evolved over time and have different purposes.

For many years, drainage was the focus, except when it concerned hydropower. Consequently, laws related to water handle many different interests, such as energy, hydropower, water quality, agriculture and forest production, climate adaptation and municipal interests for urban development etc. The focus of this chapter is to study which legal rooms that may be activated in relation to different types of monetary transfers between down-stream actors and upstream actors. When studying these rooms, we are interested in assessing the barriers and possibilities of different types of compensation for regulating services focusing on two types of compensation: community-based compensation (indirect payment) and beneficiary-based compensation (direct payment). We separate between legal rooms relevant for the organisation and agreements in relation to compensation, respectively legal rooms activated in relation to the construction and management of the solution.

To assess the barriers and possibilities related to the legal rooms activated when implementing different types of NBS to support climate adaptation, a stepwise and iterative process were used. This mixed method approach was chosen due to the complex structure of regulations related to water activities, and the fact that the implementation of NBS may need an expansion or reinterpretation of the existing legal frameworks. This need has been recognised in the European Union, since the EU Research and Innovation policy agenda on Nature-Based Solutions and the Re-Naturing Cities programme have been launched to position the EU as leader in 'Innovating with nature' for enhancement of resilience and sustainability of societies.<sup>13</sup>

### **4.2. Relevant legal acts and laws**

Since Sweden became a member of the European Union, EU directives have been implemented in the Swedish legislation. This has caused several challenges related to older national legislation but also in relation to the organisation of national water management, which is separated between different national agencies.

#### *EU directives*

There is a wide range of EU directives governing water management including the Water Framework Directive (2000/60/EC) and the Floods Directive (2007/60/EC). In Sweden, various authorities are responsible for developing policy documents and plans related to the different directives. See Appendix 1 for a summary of the most essential Directives.

#### *Swedish acts and laws*

There are several legal Acts that are needed to consider when establishing upstream water retention NBS, including several chapters of the Swedish Environmental Code (1998:808)<sup>14</sup>,

<sup>13</sup> <https://ec.europa.eu/research/environment/index.cfm?pg=nbs>

<sup>14</sup> [https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/miljobalk-1998808\\_sfs-1998-808](https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/miljobalk-1998808_sfs-1998-808)



the Joint Facilities Act (1973:1179)<sup>15</sup>, the Land Code (1970:994)<sup>16</sup> and the Planning and Building Act (2010:900)<sup>17</sup>.

### 4.3. Theoretical paths for establishing upstream water retention

This study explores the possibilities of creating upstream NBS to increase the water-holding capacity, and to reduce downstream flooding. Based on the Floods Directive the basis for such facilities should be the regional flood plan. Västra Götaland has been identified as an exposed area (one of 18 in Sweden) in accordance with the EU Floods Directive (2007/60/EC) and the national regulations that were drawn up for its implementation MSBFS 2013:1.<sup>18</sup> The regional plan includes a description of the coordination of the work in accordance with the regulation (2004:660) on the management of the quality of the aquatic environment (MSBFS 2013: 1 4§ 3). A special report on the implementation of the EU Floods Directive in Sweden mentions that there are many deficiencies in the implementation of flood prevention measures due to insufficient funding (MSBFS 2013:1 4§ 3).<sup>19</sup> The report also mentions that flood damage insurance and spatial planning must to a greater extent be part of the management of flood risks.

Which legal issues that are relevant in relation to a solution will depend on the land ownership (private/ public) and the involved actors who is providing, respectively receiving the benefits (private landowners, citizens buying shares in a water retention facility, co-operations, trusts, private companies, municipal companies). We see four different paths:

#### Path 1.

Purchase of private land in the same or another municipality and the development of a wetland, pond or similar water retention facility.

- A. Buy land in detailed planned area (water = storm water)
- B. Buy land outside planned area (water = water activity)

#### Path 2.

Purchase of the water retention service (for example cubic meters of water, similar to CO<sub>2</sub> emission offsets)

#### Path 3.

Development of land-use agreement for water retention

- A. lease land in detailed planned area (water = storm water)
- B. lease land outside planned area (water = water activity)

#### Path 4.

Different types of subsidies targeting environmental impacts of land use (EU Common agriculture policies, local measures for better sea and water environments)

These paths should not be perceived as separate, but could, depending on the implemented NBS, be combined. All paths have a potential to trigger several different regulatory areas, and in the text below we only provide references to the most important laws and regulations. For example, the planned NBS could affect the water quality status (Environmental Code, Chapter 5), be in or close to protected areas (Environmental Code, Chapter 7), be considered as a hazardous activity (Environmental Code, Chapter 9) or a water operation (Environmental code, Chapter 11).

#### *Path 1. Buying land (organisational factors)*

The legal barriers and possibilities related to this theoretical path depends on whether the NBS is located on detailed planned municipal land, or not (solution placed on detailed planned land need to align to regulations in the Planning and Building Act, as well as regulation related to storm-water management). Additionally, this path depends on the land market, i.e. the availability and cost of land, as well as the willingness of landowners to sell land to different types of actors. Barriers for implementations are related to for example be resistance to sell land to private and/or municipal companies depending on price, availability and but also to historical events such as the current and historic relation between private landowners and municipalities.

#### *Path 2. Purchase of water retention services (organisational factors)*

Purchase of water retention services; a form of 'payment for ecosystem services' (PES) (Engel et al., 2008) is not something that is commonly used in Sweden today, even though it has been tested in some cases. For example, Lysekil, a small municipality in Wester Sweden, tested to pay for water treatment by mussel banks. The first major attempt began in 2005 when Lysekil's municipality chose to replace the nitrogen treatment in the municipal water treatment plant with the ecosystem service provided by mussels. Nordic Shell, a company with Norwegian owners, built mussel cultivars that would absorb more nutrition than the most efficient water treatment plant could offer. Due to lack of knowledge of environmental laws related to coastal protection and food production, as well as broken agreements between the company and the municipality, the attempt was not successful.

Several Swedish municipalities are also working on the development of different types of carbon storage pools for

<sup>15</sup> [https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/anlaggningslag-19731149\\_sfs-1973-1149](https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/anlaggningslag-19731149_sfs-1973-1149)

<sup>16</sup> [https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/jordabalk-1970994\\_sfs-1970-994](https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/jordabalk-1970994_sfs-1970-994)

<sup>17</sup> [https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/plan--och-bygglag-2010900\\_sfs-2010-900](https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/plan--och-bygglag-2010900_sfs-2010-900)

<sup>18</sup> MSBFS 2013:1 Myndigheten för samhällsskydd och beredskaps föreskrifter om länsstyrelsens planer för hantering av översvämningrisker (riskhanteringsplaner)

<sup>19</sup> Särskild rapport nr 25/2018: Översvämningdirektivet: framsteg har gjorts vad gäller riskbedömningar, men planeringen och genomförandet måste förbättras

example in Lund Municipality. However, there are still very few examples of payment for ecosystem services. There are potential areas where PES systems could be implemented. For example, in Sweden, the water facility fee paid by the households is based on how much water that are released to the system. In the case of PES for water retention, the system would need to be the reversed, so that the one that could store the water at the source would receive the payment. The legal issues related to the land-use context for the NBS construction are same as for Path 1 and will need some kind of purchase agreement. Then knowledge about environmental regulations are important by both seller and buyers of PES to avoid the situation as in Lysekil with the mussel banks. To implement Path 2, there also need to be a market for PES and maybe a broker to facilitate transactions. The success of the implementation will also depend on how you define water retention services, as different laws have different definitions.

### *Path 3. Development of land use agreement (organisational factors)*

This Path would include some type of legal agreement, which agreement depend on which actors that are involved. Possible actors are private persons, private and public companies, municipalities and NGOs. Agreement law is very complex. In many cases, the agreement is following the private or juridical person, i.e. the owner of the land. This may have implications for the establishment of long term NBS, as access use agreements are dissolved when the land is sold. Access use agreements cannot be longer than 50 years in Sweden (Land Code, Chapter 7).

If the solution is developed within the frame of the Joint Facility Act the solutions is tied to the property. However, the Joint Facility Act is referring to, for example, cables and pipes and a central question is if when and how an NBS could be considered as such a utility (see section 6.6 on cases below). The main issue using this law is how you interpret whom can be part of a joint facility. According to §5 of the Joint Facility Act, a property “has to have a part in the facility”. As the services delivered by climate adaptation solutions are mainly targeting downstream actor, a question is if the legal room on what is a part of a joint facility can be reinterpreted to include a broader landscape or watershed perspective, some kind of reversed ditching enterprise. Such perceptions on water facilities are much more developed in the Netherland who since long have been deeply dependent on such structures to avoid inundation on downstream land. This path could also include upstream co-benefits, such as biodiversity and recreation as a part of the transaction of services.

### *Path 4. Subsidies for provision of ecosystem services*

In Sweden, there are several subsidies supporting the reduction of environmental problems related to land use. One

subsidy is LOVA (Regulation 2009:381)<sup>20</sup>, which is a support for water measures to improve the water quality (reduce nutrient leakage and improve nutrient uptake i.e. improve eutrophication levels). LOVA funding can only be used by municipalities and civil society organizations. But LOVA projects could include cooperation between municipalities and private landowner. Since 2018, the beneficiaries can apply for 90% or the costs. There is a similar type of subsidy for measures targeting nature protection initiatives (LONA) (regulation, 2003:598)<sup>21</sup>.

The 2013 EU common Agricultural Policy (CAP) reform, initiated a payment scheme for a compulsory set of ‘greening measures’, consisting of 30% of the direct income support to farmers. These measures intend to assist farmers to provide public goods more efficiently and ensure the long-term sustainability of EU agriculture. The CAP could potentially provide a ground for climate adaptation measures. However, NBS would need to be efficiently localized at the landscape level and be in line with the ambitions of both the Water Framework Directive and the Flooding Directive. The rationale behind these subsidies is the landowners right to what is produced on their land given to them through sector regulations (agriculture and forestry). Lack of knowledge of municipalities and property owners has been identified as a major barrier related to water and the role of water in the landscape and for different types of subsidies to be efficient. Moreover, effort to develop more wetlands in Sweden has to be able to handle existing ditching enterprises. Under the realm of the work done in relation to wetland subsidies the Swedish protection agency initiated the development of a case database, but the work could not be finalised due to a drastically reduced budget to the Agency in 2019.<sup>22</sup>

### **4.4. Examples of organisational structures for the establishment of NBS**

#### *Creation of wetland for the achievement of good water status*

In Skåne, especially since the establishment of the Water framework Directive, but even before, several ponds and wetlands have been constructed to increase the water quality in lakes, watercourses, the sea and coastal zones. We believe that the ‘Skåne case’ is important to better understand the potential as well as difficulties in relation to NBS. The ‘Skåne case’ is an example of Path 3 and 4. In the city of Helsingborg for example, there has been an active work to create and rebuild wetlands for more than 20 years. The main purpose has been to get cleaner water in the watercourses and reduce the amount of nutrition that is carried by the rivers to the sea. Between 1991 and 2015, the city of Helsingborg constructed approximately 70 hectares of wetlands. Success factors have been a long-term municipal involvement and a good dialogue with different landowners. Most of the constructed wetlands

<sup>20</sup> <https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/forordning-2009381-om-statligt-stod-till-sfs-2009-381>

<sup>21</sup> <https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/forordning-2003598-om-statliga-bidragtill-sfs-2003-598>

<sup>22</sup> Naturvårdsverket 2019, Återrapportering för skydd av värdefull natur 2016-2018, Rapport 6876, page 54.

are situated on private arable land and have been constructed in close cooperation with the landowners. The wetlands have mainly been financed by the city together with external funds. External funding comes from the EU Rural Program and the Swedish government in terms of LOVA funding. In parallel with the construction of wetlands in the arable landscape, the city has created storm-water ponds for water retention and purification.

#### *Ecological compensation and the balancing principle*

When an exploitation is causing damage in a protected area ecological compensation may be necessary (the Environmental code, Chapter 7). In many cases, ecological compensation is made in relation to Path 3, with its adjacent dilemmas. Many Swedish municipalities also work with compensation measures to reduce the loss of green space, biodiversity, ecosystem services when the damage is not covered by the regulations in the Environmental Code. This concerns exploitation of new urban areas. In some municipalities, the compensation is based on political decisions, in others it is just a negotiation principle used by civil servants when developing land purchase, and exploitation agreements. The structures for such compensation are at the moment very diverse and the structures for its implementation is complex which may raise several legal dilemmas related to rights and duties. However, the current experimentation around compensation is creating an important knowledge base, but there are also several pitfalls, such as lack of knowledge of environmental laws, as well as stable organizational structures around the compensation.<sup>23</sup>

#### **4.5. Regulation and NBS implementation in court cases**

In this section, we summarize barriers and possibilities of how different legal regulations can affect the implementation of NBS; using extraction from Swedish court cases. A general search was made on creation of retention dams and wetlands.

##### *Barriers*

- There are many cases where businesses argue against not being granted emission permissions to water. If new dams are constructed it may influence the effects of previous emission permissions as the water level including ground water tables may be affected (MÖD 2007:21).<sup>24</sup>
- Not surprisingly a majority of the identified court cases concerning hydropower dams and how they destroy the environment and production possibilities in its surrounding. Depending on the retention structure to be built some of these court cases could be influential on the

implementation of NBS, if its implementation goes to court.

- Depending on how the court defines the responsibility “strikt ansvar” (no-fault liability) to handle the risk for example dam rupture, the possibilities to get compensation for potential downstream hazards will differ (NJA 1997 s 684)<sup>25</sup>. Consequently, the quality of the underlying information supporting an environmental impact assessment that support the decision concerning a dam will be essential.
- Important to have clear information to landowners and authorities about when a permission for a dam is necessary (MÖD 2014:29).

##### *Possibilities*

- The possibility to get tax reduction when constructing a dam on your property (Case nr. 3151-15)

## **5. Case projects, challenges and recommendations**

### **5.1. Case projects**

There are few examples found on similar financial models related to water holding capacity and compensation in Europe. Two projects in Austria deals with compensation for controlled flood storage. Two other projects were found in southern Sweden, one with inter-municipal cooperation and land compensation and the other utility fee reduction. Outside Europe, the New York project shows extraordinarily high savings in green infrastructure. The conclusion and lessons learnt from these projects are summarised below.

#### *Determination of compensation payments in Austria*

Flood retention services are compensated differently in the two municipalities. In the first municipality property owners in 100-year flooding areas were included in a water cooperative. Contributions to the cooperative were defined based on their individual benefit from protection measures due to damage reduction. Together with provincial and federal funds the beneficiary contributions finance the construction and maintenance costs of the flood storage project. Upstream landowners are compensated for both direct costs such as flood damage and indirect costs such as land depreciation.

In the second municipality, agricultural landowners are compensated from public funds as well as from revenues from zoning building land in flood-protected areas (indirect benefits). Homeowners who are direct beneficiaries from damage reduction do not contribute to flood storage compensation.<sup>26</sup>

<sup>23</sup> Informant interviews with municipal employees at; Lomma, Gothenborg and Helsingborg municipality, ekologigruppen and Enefjärn Natur (Eco gain)

<sup>24</sup> MÖD = Mark och Miljööverdomstolen vid Svea Hovrätt = Land and Environmental Court of Appeal at the Svea Supreme Court

<sup>25</sup> New Legal Archive, NJA, is a Swedish periodical where, among other things, references to judgments from the Supreme Court are published.

<sup>26</sup> Source: IWRA (2019); <https://www.iwra.org/wp-content/uploads/2019/03/PB-N-3-feb-2019-OK.pdf>



*Water protection strategies designed for water quality benefits reducing capital costs in the form of bypassed water treatment processes and avoided costs in New York City.*

New York City's protective management of the Catskill-Delaware watershed enabled the city to "replace" the upfront capital costs of building an expensive treatment plant estimated near \$8.0 billion with the comparatively cheaper green infrastructure strategy that has only cost a little over \$1.5 billion since the 1990s (Gartner et al. 2013). Additionally, projects upstream of dams reduce reservoir sedimentation, extending the life of facilities and reducing dredging and maintenance costs.<sup>27</sup>

#### *The Høje River Compensation Project*

The Højeå project<sup>28</sup> was launched in Southern Sweden in the early 1990s. The project was a collaboration between different municipalities in the river basin with the goals to reduce eutrophication levels and increase biodiversity and recreational opportunities in the area. The goals would mainly be achieved through the construction of ponds and wetlands in the landscape. When wetlands are built by Høje River Water Council, a land compensation is often paid to the landowner. This compensation does not constitute full cost coverage for the market value of the land but can be regarded as a compensation for the revenue that the land would have given in another land use. When it comes to financing the wetlands, the municipalities contribute with an annual funding, together with government funding, including money from the Common Agricultural Policy Rural Development Program's environmental investment support. The CAP rules changed in 2015, with the consequences that the Water Councils are not permitted to pay land compensation, in addition to the land compensation paid within the Rural Development Program. Therefore, they are looking for alternative ways to compensate the landowners for the full costs when implementing water conservation measures.

#### *Together we make room for water*

The water utility company in Malmö VA Syd has recently introduced a pilot project "Together we make room for water"<sup>29</sup> where property owners receive a reduction in the water utility fee, if they disconnect their rainwater pipes from the municipal storm- water management system. The investment started in 2017, is financed by Malmö's water tariff, and will last for five years. It is a cutting-edge project that aim to develop and test new working methods and collaborations in the work with climate adaptation in Malmö, where property owners are payed to take actions to reduce the amount of water emitted to the sewage water system by installing water collecting tanks, or disconnect the drain-pipes from the drainage system. The current project is mainly targeting smaller property owners but could be developed to target larger property owners which has space for, in this case, lager rainwater gardens.

## **5.2. Challenges and possible solutions**

Several challenges with implementing compensation models for water retention have been identified from above case studies. Possible solutions to the challenges are addressed where possible.

#### *Finding incentives to free land for NBS*

Flood storage is land intensive and often infringes on private land use rights. Private landowners, regardless of legal status, may have less incentive to establish NBS, such as wetlands. To remove this impediment, actions are needed to provide, for example reduced operational costs, increased property value or financial benefits from providing ("selling") water holding capacities. It can also be promoted simply through better knowledge about the long-term benefits of such actions, which are today not accounted for. Moreover, looking at collaborations for action, it should be acknowledged that relationships between landowners and municipalities may be strained due to past conflicts. The challenge is also to consider multifunctional land uses, which enable temporary flood retention and water storage on land without restricting the provision of other ecosystem services.

#### *Reconciliation of flood risk management and land management.*

Since NBS need to be implemented on private and to some extent public land, multiple aspects need to include: economic issues (e.g. how to compensate for or incentivize flood retention services); property rights issues (e.g. how to allow temporary flood storage on private land); issues of public participation (e.g. how to ensure the involvement of private landowners) as well as issues of public subsidies (e.g. how to integrate/mainstream flood retention in agricultural subsidies).

#### *Meet the national priority need for housing and hard surfaces with freeing land for NBS.*

Some of the municipalities in the area own large land areas. The land is often intended for future exploitation and thus income to the municipality. The pressure of housing projects is high, and municipalities get governmental construction bonus for building new houses. Further, housing developments near water is increasing. This has negative effect as hard surfaces reduce the soil's ability to hold water, causing increased risk for flooding. In Gothenburg, peri-urban areas have been treated as reserve land for future exploitation, and few investments are made to strengthen ecosystem services. The potential for the City is, however, that through its vast land holding, they can control how the land area is used. Municipalities also have the possibility under existing law to demand building permits for hardening surfaces. Moreover, they could engage in information campaigns related to "de-paving" cities. Placement of houses could be made in a more water retention friendly way.

<sup>27</sup><https://drive.google.com/drive/folders/1wmZUJ3A9R42usUh9rdvYRtAbjB8cyMMj>

<sup>28</sup> <http://www.hojea.se/Hoje-aa.htm>

<sup>29</sup> Source: VA Syd, 2019, <https://platsforvattnet.vasyd.se/>

*Promote legal change to planning practises of disaster prevention.*

River floods do not stop at administrative borders, but municipal planning and decision making do. Difficulties in common intermunicipal planning and decision making is a challenge when implementing cross-border measures. This means that municipalities are limited to measures within their municipality to avoid flooding risks from upstream areas. To alleviate flooding, coordinated planning activities based on a catchment approach is needed. Interviews suggest that water solutions related to e.g. flooding should even be lifted to a higher level, e.g. regional or national level, so that the best solutions – and a combination of technical and NBS – can be planned for to the benefit for all partners. Legislation can affect the implementation of NBS.

*Promote common priorities for NBS.*

Municipalities within the same catchment area many times experience large differences in challenges and priorities. Additionally, factors such as size, number of inhabitants, economy and land use differ, and all factors imply that municipalities in the same catchment may priority differently. A policy system promoting common priorities and legal requirements are needed managed by a dedicated authority.

*Meet the challenges with willingness to pay and financial models.*

The Austrian cases suggest that willingness to pay may be a problem for some actors and negotiation of flood storage compensation takes time, but transparent cost-benefit evaluations can contribute to improving local ownership of protection measures and increase awareness of the benefits.

### 5.3. Recommendations

Lessons learnt from case projects presented in this study, workshops and literature, list the following major recommendations.<sup>30</sup>

*Ecological*

- NBS are not designed for extreme flood events, but they can have substantial effects on local smaller and medium floods.
- Knowledge of the hydraulic effects of decentralized retention is still limited and the effects are very location specific. This requires a careful case- by-case investigation of each context.

*Organisational/stakeholders*

- Organisational frameworks facilitate landowner involvement: cooperatives, associations and other organisational frameworks are powerful tools to engage affected landowners and provide a legal basis for structuring compensation processes.
- Local actors play a leading role in promoting and implementing nature-based solutions. Technical capacity

building is critical to enable them to promote the approach.

- Service providers, policymakers, financial institutions, researchers, civil society, regulators, and communities must cooperate to put green infrastructure to work. Partnerships among these actors in developing countries, in collaboration with and support from development partners, can spark the urgently needed transition to next generation infrastructure by integrating the consideration and assessment of natural systems throughout the project cycle.
- Stakeholders should prioritize social support for green infrastructure and build long-term coalitions.
- Service providers need to invest resources in developing new areas of expertise related to stakeholder engagement and community interactions.

*Economic*

- Compensation for flood storage is complex: the negotiation of flood storage compensation takes time, but transparent cost-benefit evaluations can contribute to improving local ownership of protection measures and fostering risk awareness.
- Service providers should take advantage of green infrastructure's characteristics to sell innovative financing approaches. In addition to standard financing instruments for built engineering systems, service providers should increasingly tap emerging funding sources from governments, development agencies, and the private sector.
- Scale and context matter: there are no one-fits-all solutions; compensation schemes need to be sensitive to the specific needs of the actors involved and local/regional conditions, such as the distribution of risks and land uses.

*Political*

- Improved scientific knowledge and effective communication on nature-based solutions has the potential to strengthen decision-making and mobilise resources for implementation.
- All stakeholders must work with and encourage policymakers to promote green-grey approaches through policies, laws, and regulations. Once there is policy commitment at multiple levels, then governments can create the enabling conditions by adjusting laws and regulations to allow service providers to proactively develop green infrastructure.
- National and local government agencies should routinely consider opportunities to integrate green infrastructure approaches in regional and master planning, as well as land-use planning processes, such as river basin or urban development plans. This will encourage water service and other providers to assess if and how green infrastructure components might be incorporated into their infrastructure projects.

<sup>30</sup> Workshop May 2019, World Bank, 2019, IWRA, 2019a

**6. Business model**

River floods do not stop at administrative borders. The respective location of municipalities and landowners along a river creates different dependencies that can be referred to upstream-downstream relations. It is important to acknowledge both upstream and downstream stakeholders in the business model. This strengthens the multi-stakeholder approach targeted in this study, seeing that it supports a dialogue about relevant impacts for different stakeholders affected by the choice of solutions, both in terms of action or inaction in this field of climate adaptation. Balancing upstream-downstream interests thus mark a decisive factor in catchment-oriented flood risk management and explicitly demands cross-sectoral, trans-boundary, and regional flood management solutions (Seher and Löschner, (2016). As such, it moves from a technologically centred silo approach to a nature-based systems approach.

**6.1. Business model canvas**

The study has defined that NBS has a potential business case that landowners may include as a business model. This can be done in different ways and stakeholders can learn from each

other how this can be accomplished. This section will further elaborate on a potential business model as well as discuss some major challenges. As stated in the Business Model Catalogue, created by EU-project Naturvation, a combination of different models increases the funding capacity.<sup>31</sup>

There are different ways to realize flood retention on agricultural land. Public authorities can opt to make the land available for flood retention by means of legal expropriation, buyouts or land swaps. Or they may compensate the flood-related infringement in land use and property rights. Beneficiary compensation is when those benefiting from retention services compensate for investments and providers costs. The provision of land for water retention may only be realised if landowners are compensated. This is best accomplished through a public policy framework as to provide a robust and credible basis for financial contracts. Cooperatives, associations and other organisational frameworks are other powerful tools to engage affected landowners and provide a basis for structuring compensation processes. In realising retention measures, several stakeholders are affected. In principle two types of compensation approaches can be distinguished:

Table 7. The key segments of business model Canvas applied for NBS

Key partner	Key activities	Value propositions	Customer relationships	Customer segment
Landowners, private or public, that can provide water holding capacity on their land	Connect the potential landowners with interested municipalities	Reduce costs for (technical) measures to prevent flooding	Good results spread on the website, workshops, and network interaction. Personal relationships between landowners and customers who are connected through the system.	Downstream municipalities struggling with short-term expensive technical solutions preventing flooding.
Key partners are landowners and municipalities. Other important partners are e.g. private companies, consultants, water management organisations, insurance companies, and NGOs.	Set the price that meets the demands from both the consumers and landowners	Reduce risks for damages with flooding		
	Develop a network website	Build sustainable long-term systems	<b>Channels</b>	
	Marketing activities		The service is provided in the form of new water-holding measures, e.g. ponds and wetlands in upstream areas.	
<b>Key resources</b>				
	Sales consultant or broker system that can work on commission. Stakeholders with experiences from creating wetlands and other nature-based solutions for water holding systems.			
<b>Cost structure</b>		<b>Revenue streams</b>		
Investment costs, allowance costs, application costs, and potential lost production costs		Price is based on customer demand and will be a balance between costs for the landowner as well as the customer interest to pay. Value of water-holding capacity will be calculated. The basic package will be sold on long-term basis or a subscription that can only be cancelled before the next renewal. The system will charge a percentage for connecting the landowner and the customer as making sure that the money transactions work as supposed to. Other revenues can be related to recreational activities and increased production.		

<sup>31</sup> Toxopeus, 2019: <file:///C:/Users/User/Downloads/Covenant%20of%20Mayors%20Webinar%20-%20Business%20model%20for%20NBS%20-ppt.pdf>



### *I. Community-based compensation*

In line with the community-pays-principle the compensation costs are allotted to the general public. Those providing land for water retention services are compensated by public authorities, such as municipalities or state governments.

### *II. Beneficiary-based compensation*

In line with the beneficiary-pays-principle, those benefiting directly or indirectly from flood retention services pay (at least part of) the compensation costs to those providing land for flood storage.

The proposed business model suggests that both types of compensation should complement each other. Beneficiary-compensation alone may be difficult to cover all costs for needed measures, and public funds are available for implementing e.g. wetlands. In the case of community-based compensation, public authorities determine or negotiate with landowners which costs, direct or indirect, of providing land for flood storage are to be compensated. Based on (cost-benefit) assessments by civil engineers and other technical experts, the public authorities offer compensation or develop a compensation agreement. This may consist of:

- a. One-time or yearly payments to compensate for the provision of flood storage and/or
- b. Payments in the event of flooding to compensate for flood-related losses

In the case of beneficiary-based compensation public authorities also must negotiate with the beneficiaries of flood storage to determine how much each is to contribute to the compensation scheme. This sub-section explains the business model using the Business Model Canvas (BMC) based on the 'Strategyzer' approach<sup>32</sup>. The BMC is a tool to help understand a business model in a straightforward, structured way. Using this canvas can lead to insights about the customers served, what value propositions are offered through what channels, and how to make money. The BMC model has won acceptance as de facto standard in both industry and academia as an approach to communicate customer value and business model design. The business model is seen from a partner selling water-holding capacity to downstream beneficiaries. The key segments in the model are explained in Table 7.

### **6.2. Outcomes of validation**

Validation was carried out among key stakeholders in the study area. Below is a summary of the outcome of the validation.

- Most of the stakeholders we have been in contact with during the study are very positive about implementing water holding measures at the landscape level. They see that NBS are important to prevent flooding and droughts.
- Among the stakeholders we conducted validation with, no one has been hesitant to build these business models

to solve the financial difficulties of coping with floods and drought. They see this as a support in the idea of finding new solutions.

- However, there is a relatively great concern about how the legislation can be an obstacle or create difficulties in practical implementation. Several stakeholders believe that there may be reason to change some legislation to be able to work with NBS to a greater extent.
- There is also some concern about how pricing should be done and how much the willingness to pay is among those who will benefit from measures high up in a river basin.
- There is a clear consensus among all these actors that it is an absolute must to work together for water management at a landscape level.

### **7. Conclusions**

The key conclusion is the complexity and novelty of the NBS value-chain and the range of potential measures as well as costs and values. While the results in terms of barriers point to aspects that can be harboured within specific policy instruments, it is unlikely that such a policy will be effective in lack of a strongly improved learning and collaboration among the stakeholders along the value-chain.

As the cross-municipal setting of NBS requires a mandate for an organisation to work in such cross-border capacity, meaning that it is however not necessarily municipalities that are those best suited to be responsible for the negotiation process. Hence, an organisation should ideally be appointed to handle the multi-stakeholder perspectives in order to provide a clear mandate. This could be water councils, which was identified as an important stakeholder in the workshop. A barrier is that lack of funds and staff at these councils which could be handled through them receiving remuneration for each process in order allow them to build the capacity to handle this part in the policy implementation.

The study identifies that the financial model should be operationalised by a policy, as part of a climate adaptation policy framework (or another framework that encompass the range of aspects of NBS). If not, there will be an impediment, similar to a lack of mandate to promote a dialogue about potential solutions, and to use financial instruments. In other words, the efficacy of financial instruments is intrinsically linked to the policy framework. The relevance of policy instruments depends on whether the policies support learning to overcome the novel and complex policy system. NBS will in many cases, by the very nature of catchment areas, include cross county and municipal borders. Hence, limiting the support to activities within the beneficiary's administrative borders would be in stark contrast to the potential for NBS. It is also argued that the policy efficacy is dependent on learning and participatory elements due to the novelty and complexity of the policy setting. Few policy instruments exist, which literature has pointed to as contributing to this situation.

<sup>32</sup> <https://www.strategyzer.com/>

Consequently, the study argues that this should be further investigated in terms of how a framework for negotiating and implementing such agreements can be set up.

The workshop provided relatively distinct information on stakeholder perspectives and costs to adopt NBS for flooding and drought management, but less so on benefits. Consequently, examples for policy instruments to deal with the costs can be suggested. The difficulty, however, is which stakeholder or stakeholders that should bear the costs through a policy framework or bilateral agreements. The results suggest that the municipalities need to manage this as the societal benefits and beneficiaries are diverse. A suitable policy framework could thus include that municipalities identify benefits for different societal stakeholder groups and within a policy framework impose that they contribute to the costs of the provider.

The efficacy of the policy is furthermore dependent on the extent of which it encompasses the key costs and benefits identified by the providers and beneficiaries. Hence, such information needs to be provided as a basis for the development of financial models. As a stakeholder-based result, the situation will differ from place to place. The results point to the need to further investigate specific details and differences in the perceptions of providers on CAPEX and OPEX. This feeds in to whether they are more interested in a single one-off financial support for their measures or a more regular support, where both costs for investment and maintenance is highlighted in the workshop.

Moreover, the willingness of performers to invest in NBS measures will be partly, and possibly strongly, determined by aspects within the financial sector, such as insurances and loans. Using their land for retention measures will mostly be a new business that could mean that banks and insurance companies will re-evaluate the conditions for the performer. This supports the notion of a public system to deter risk perceptions by those institutions.

It is interesting to note potentially critical benefits, such as water for fire extinguishing and, of course, reduced risks for flooding during critical conditions. This raises the question of how policies can support benefits that may be realised very intermittently but be potential critical in those instances. This also relates to the question of insurances and reliability of those benefits, or services, in that asserting that these are available when needed and which responsibility that the provider has to this end. This poses a difficulty in the policy analysis, which needs to be investigated further.

To ensure long term provisioning of climate change adaptation, under the current legal situation, Path 1 is the most legally solid solution, as the rights and duties are clearly defined through the landownership. Path 2 is an area under development at the international arena<sup>31</sup>. To implement Path 2 in Sweden, there need to be a market for PES and a broker able to facilitate agreements between buyers and sellers of services. The trust in such a system will depend on how water retention services is defined, the reliability of rainfall and

flood data to ensure consistent flood risk assessment, and the control mechanism to ensure the capacity and continued performance of the solutions.

Path 3 do already exist, where NBS are built with the aim to reduce eutrophication. Several key stakeholders claimed that there is an important learning curve in relation to the design of the wetlands and agreements with landowners. However, there seems to be no evaluation of the long-term efficiency of the solutions except for the evaluation made by the Swedish Natural Protection Agency. In addition, no land-use agreements can be longer than 50 years, which is a risk factor, especially in the context of climate adaptation. Path 4 is an established path for NBS construction, and both national authorities and the CAP provides substantial funding. However, the CAP mainly provides yearly subsidies, which is not efficient for long-term climate adaptation. One problem of subsidies for wetland production may also be an uneven geographical uptake due to different levels of application capacity in different parts of the country, or even within regions, which may become a distributional issue.

To develop an NBS for climate adaptation system there is a need to ensure that data is reliable and that there is a long-term existence of the solutions. Otherwise, if not providing efficient flood protection services, these structures can endanger the security of the society in just one generation. In addition, there must be organizational structures in place that in an adaptive way are able to handle different uncertainties and risks imposed by the solutions but also evaluation structures to ensure that the developed solutions continue to provide the necessary services. Such an organization has to include insurance companies that can provide an economic stability to the system. At the same time handling over responsibilities to the actors as an insurance policy would include maintenance duties. Important things to consider is the different types of insurances needed by upstream and downstream communities (service providers and service users).

An important dilemma is the fact that regulation related to water retention are to some extent conflicting. This is practically visible in the current quest to delete smaller waterpower plants to increase the natural habitats of water streams forwarded by the Water Framework Directive, whereas the need to increase upstream storage facilities has increased due to the sister directive, the Flood Directive.

During a very long time in Swedish history, ditching enterprises was a way to develop more fertile land and this possibility was used by Kings to gain power and create allies in Sweden. In this perspective the right to dry land has become both the legal and social norm, where the ditching enterprise is made for the own benefit. The court case where a landowner tried to get a tax-reduction for a rewetting could be a step in the other direction, however it was still made for the landowners' own benefits (storing water in dry seasons).

Another important dilemma to consider when developing NBS systems is the potential trade-offs between increased

land and or wood prices due to drainage activities, and the need for more water storage in the landscape.

All upstream-downstream transaction of regulation services may impose a risk for upstream societies in the long-term perspective, as it will reduce availability of land for future activities and development. Such future needs must be considered on a national level, as it could even be land grabbing by downstream richer communities to continue business as usual. This perspective must be considered if we aim to develop a just climate adaptation system.

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