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NAIAD

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From Bankability to Suitability report: value capture and business models to catalyse implementation of NAIAD demo’s NAS strategies

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Tableau 1 : Versions

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Executive Summary

Under the frame of NAIAD's WP7, a tool called Natural Assurance Schemes (NAS) canvas has been developed to analyse the process of value generation linked to nature based solutions when providing climate adaptation services. It also identified the elements required to capture that value and generate business models around the NBSs that can catalyse the economic resources required for their implementation, while driving possible service or economic transactions around the provision of (ecosystem or nature based) climate adaptation services. This deliverable presents the NAS canvas framework and how it can be applied to identify business models for NBS strategies while providing an eye-shot summary of critical information to attract funding. A linearized process through a flow of steps is also proposed to facilitate the application of the framework. In a second part, the framework is applied in NAIAD demos. Each demo applies the framework to describe in detail the value generation in each of their NBS strategies, as well as to identify all the elements required to build a successful business model for the strategy, which are then summarized into the canvas format. As a result, the deliverable presents a set of business canvases for the 9 NAIAD demos describing the most feasible business models, and showcasing the most advanced results up to the deliverable's submission date of the value and impacts of the NBS strategies designed within NAIAD. In a third section, a reflective analysis is developed addressing common factors, success conditions, and barriers perceived or found by the demos to bring these business models to actual implementation.

Some insights that can be drawn as common factors across demos.

First, regarding the role of legislation, EU legislation (particularly the WFD and FD) is found as a strong driver and support for the implementation of NBS in most of the demos. Another highly mentioned set of rules include the land use and rural/urban development agendas that push for innovation for sustainable development. These pieces of legislation provide the enabling frame favouring the introduction of NBS with the investment and intervention programmes, as their comparative environmental benefits usually align with their overall strategic objectives. However, legislation is also identified as a potential barrier or required key for success, as often the formulation or application of national and local legislation and procedures (e.g. procurement and licensing) need to be adapted to include new types of interventions.

Second, a common highlight is the critical role of EU funding to enable the design and promotion of these interventions. Thanks to NAIAD and some complementary projects, some of the demo strategies have reached the implementation phase, and thus are able to generate evidence of performance to inspire and catalyse the replication or emulation. NAIAD has also been instrumental to design a strategy for Lower Danube, Glinsica, Lez and Brague, and to push forward the interest among the relevant stakeholders.



Third, it is really important but also difficult to engage indirect beneficiaries within the pool of payers and funders, whereas in all cases it is the whole of the society who gets benefitted. In this line, insurance companies are mentioned in most of the strategies as indirect beneficiaries and potential contributors to the funding. Therefore, the efforts made in the project to make the sector aware of the NBS case are a big step forward. Other important funding sources from indirect beneficiaries identified include crowdfunding from citizens/water users, fees to tourists (an unexploited sector with great potential), specific taxes, payment for co-benefits mechanisms, and other benefitted private companies.



1 Introduction

Extreme weather events and water challenges have ranked within the top 3 greatest risks to the global economy for the last 5 years, according to the World Economic Forum annual assessments (WEF, 2019a). Around 70-90% of the economic losses caused by floods across Europe between now and 2050 can be attributed to the increase in the value of assets in floodplain areas, with the rest attributed to climate change (EEA, 2016). Conventional infrastructural measures are expensive - the investment needed in water infrastructure over the next 15 years has been estimated in 22 trillion dollars, which is more than half of the total expected infrastructure investment demand (USD 41 trillion) (WEF, 2019b). A current of new approaches to focus on soft and nature based solutions (NBS) as an alternative or complement to conventional grey solutions to create resilience and response capacity against water related hazards is gaining strength, with examples such as water funds springing up around the world. However, NBS are still at a pilot stage and facing a number of specific barriers for scaling up and mainstreaming implementation. One of the main barriers is the difficulty to access funding and financing resources that reduce the investment burden from public entities holding water risk management responsibilities, which should involve a strong business case that attracts private and impact investors. Such lack of a business case is partly due to the limited data and evidence on the actual range of benefits provided by these nature based solutions, and thus of the value they offer, as well as how this value can be captured and turned into a business that provides climate adaptation services to a range of beneficiaries, which constitute a potential pool of clients and actors capable to mobilize the required economic resources.

In this context, under the frame of NAIAD's WP7, a tool called Natural Assurance Schemes (NAS) canvas has been developed to analyse the process of value generation linked to nature based solutions when providing climate adaptation services. It also identified the elements required to capture that value and generate business models around the NBSs that can catalyse the economic resources required for their implementation, while driving possible service or economic transactions around the provision of (ecosystem or nature based) climate adaptation services. The NAS canvas is an adaptation of the traditional business model canvas developed by Osterwalder and Pigneur (Osterwalder and Pigneur, 2010), which is designed to help an organization identify and structure the value proposition and the elements required to develop a strong and feasible business model. This framework has been revisited and adapted to the specificities of Nature Based Solutions and their implementation context, spanning from the inclusion of contextual legislation and governance issues through to the identification and



valuation of the multiple co-benefits provided by these measures beyond their main target value within a context of disaster risk reduction. As a result, the NAS canvas displays the whole set of elements required along the climate adaptation service provision process, including actors involved, as well as the whole set of offered values with a quantitative or qualitative estimation that can build the business case for investment and emergence of business models for economically self-standing NBS.

This deliverable presents the NAS canvas framework and how it can be applied to identify business models for NBS strategies while providing an eye-shot summary of critical information to attract funding. A linearized process through a flow of steps is also proposed to facilitate the application of the framework. In a second part, the framework is applied in NAIAD demos. Each demo applies the framework to describe in detail the value generation in each of their NBS strategies, as well as to identify all the elements required to build a successful business model for the strategy, which are then summarized into the canvas format. The resulting canvas is validated with the demo stakeholders in the 3rd demo workshop or through alternative consultations to critical stakeholders, to finally obtain a validated business model for each of the demo's NAS strategies. As a result, the deliverable presents a set of business canvases for the 9 NAIAD demos describing the most feasible business models, and showcasing the most advanced results up to the deliverable's submission date of the value and impacts of the NBS strategies designed within NAIAD. In a third section, a reflective analysis is developed addressing common factors, success conditions, and barriers perceived or found by the demos to bring these business models to actual implementation.

2 The NAS canvas framework: a method to capture and describe value capture of nature-based climate adaptation services

2.1 The NAS canvas framework

The Natural Assurance Schemes canvas (NAS canvas) framework is aimed to sequentially identify and describe three aspects: i) the process and elements involved in the provision of climate adaptation (including natural risk reduction) services by an NBS or set of measures (NBS + soft/hybrid/grey measures), from both the supply and the demand side; ii) the actors involved and their potential roles; and iii) how the value of these services can be translated into revenues or funding resources required for the execution and maintenance of the measures. Hence, the



NAS canvas can be used for the identification of potential business models and the required elements for NBS implementation, but also serves as a fairly comprehensive framework to describe the features of an NBS implementation initiative. It also helps diagnose the type of information required and available to report the results in a way that is useful for engaging and convincing investors and attract interest on this type of initiatives.

The NAS canvas framework is an adaptation of the traditional business model canvas tailored to the specificities of Nature Based Solutions and their contextual framework. We understand business model as a description of the rationale of how an organization creates, delivers, and captures value, in economic, social, cultural or other contexts (adapted from (Osterwalder, Pigneur, & Clark, 2010). It defines the way by which an organization offers value to customers, entices customers to pay for value, and converts those payments to benefits. In the context of NAIAD, due to the often hybrid nature of services (public and private), we will consider how a different organization - be it public, private e.g. an enterprise, an NGO, or a community of citizens - can deliver value to end users. Thus, it also considers the social value (see WP4 for discussion on benefits – private and public and co-benefits).

The business model canvas is traditionally used to support companies and businesses to identify and structure their value proposition and the elements required to develop a strong and feasible business model for the delivery of a product or service to the market. The most acknowledged business canvas is the one proposed by Osterwalder and Pigneur (2010); available at <https://strategyzer.com/canvas>. The NAS canvas builds on this traditional business canvas model, and is expanded and tailored to account for the specificities of climate adaptation services and nature based solutions. In order to do so, a review of existing canvases and approaches developed and applied to nature based solutions and ecosystem services has been carried out to identify the state of the art advances in this field. After careful analysis, the so called 'PPP canvas' for ecosystem services developed by the Inclusive Business Hub (IBAN, 2018) was considered the most applicable and aligned with our purpose, and it inspired the introduction of three new elements into the traditional canvas. Finally, the canvas was also expanded to incorporate the essence and elements of NAIAD's economic framework developed by WP4 (D4.2: Graveline et al., 2017). This process resulted in our NAIAD NAS canvas, which allows capturing the extended array of co-values, actors and contextual settings inherent to NBS that will ultimately determine and condition the structure and feasibility of a NAS business model.



The NAS canvas developed for NAIAD is presented in figure 1, where the colour code of the different elements indicates the source where it originates, namely traditional business canvas, 'PPP canvas', or NAIAD's economic framework.



Cluster C. SUPPLY		Cluster A. FLOW OF ES SERVICES		Cluster E. DEMAND		
STEP 4. WHO IMPLEMENTS <i>(who takes the responsibility)</i>		STEP 1. PROBLEM TO BE ADDRESSED		STEP 9.WHO OWNS THE PROBLEM <i>(who is affected)</i>		
STEP 5. KEY ACTIVITIES <i>(Measures composing the strategy to address the problem)</i>		STEP 2. VALUE PROPOSITION <i>(Main service provided)</i> <i>(Damage costs/avoided costs + value of co-benefits)</i>		STEP 10. CUSTOMER SEGMENTS		
STEP 6. KEY RESOURCES <i>needed to implement measure e.g. knowledge, people and capacity, legal frame, political support, other, ...</i>		2A. Primary service and value <i>(Main service and risk function- risk reduction and prevention)</i>	2B. Secondary service and value <i>(co-benefits and associated values)</i>	10A. Direct Beneficiaries <i>of primary value (damage costs/avoided damages)</i>	10B. Clients <i>the ones who pay for the service</i>	10C. Extended Beneficiaries <i>(real and potential) of main value and co-benefits</i>
STEP 7. KEY PARTNERS <i>key stakeholders you need to engage with to obtain the resources</i>		Cluster B. Regulatory context		Cluster F. REVENUE STREAMS		
		STEP 3. REGULATION		STEP 11. REVENUE STREAM <i>(Income streams associated with services/value generated, including private sector and private investments)</i>		
Cluster D. COST STRUCTURE		Cluster E. Supply-demand interactions		STEP 12. FUNDING COMING FROM		
STEP 8A. Life Cycle Costs <i>Costs of implementing the NBS measure</i> <i>Including capital, operation and maintenance</i>		STEP 13. CUSTOMER RELATIONSHIPS <i>(type of communication between service provider and clients)</i>		12A. Tariffs		
STEP 8B. Opportunity costs <i>Avoided benefits from implementation of alternatives.</i>		STEP 14. CHANNELS <i>(means of communication between service provider and clients)</i>		12B. Taxes		
				12C. Transfers		
				12D. Private		
CLUSTER H. IMPACT						
STEP 15. IMPACT THROUGH KPIS						

Colour legend: **Red:** Traditional business Canvas; **Purple:** PPP business canvas; **Green:** NAIAD project framework

Figure 1. NAS canvas

2.2 A linear flow process to facilitate NAS canvas understanding and application

The canvas format is a quick visual way to compile the key information in a one eye-shot format. However, it can be difficult to follow and fall short of space and blurry when more detailed descriptions with further information need to be reported. Therefore, we have turned the canvas into a linear flow of steps that can be reported in a table. The steps are structured in a linear sequence of blocks that cluster the different components describing how value flows from the supply to the demand side, and the different elements required in this process.

The flow diagram in figure 2 shows the linearization and clustering of NAS canvas components and the sequential process proposed to facilitate the understanding, identification and description of those components when applied to particular NAS strategies.

The description and definition of the different clusters and components is described here below.

CLUSTER A: FLOW OF ECOSYSTEMIC SERVICES

This cluster defines the main problem to be addressed and the value proposition provided by the particular NAS to address this challenge.

STEP 1: Problem to be addressed. Main problem to be addressed by the NAS initiative.

STEP 2: Service provided and value proposition. In the traditional canvas the Value Proposition is the reason why customers turn to one company over another. It solves a customer problem or satisfies a customer need. The main service and value of the NAS strategy under the NAIAD focus will be the capacity to solve the problem (risk reduction function) plus the additional secondary services or co-benefits it provides (secondary values) which are not provided by other grey alternatives. Therefore, the value proposition is composed of the *primary service and value* generated by the main function (risk reduction measured through avoided damage costs) and the *secondary service and value* (co-benefits and their associated value). The total value can be estimated as the sum of steps 2A+2B, and it will reflect the comparative advantage with other alternatives.

2A. Primary service and value value: in the NAIAD framework, the main service and value is reduction of impacts from extreme water related climate events expressed as economic losses (risk function - avoided costs or damage costs) through risk reduction and prevention. The approach to estimate the avoided costs or damage costs can be found in NAIAD deliverable D6.3 (Le Coen et al., 2019a).

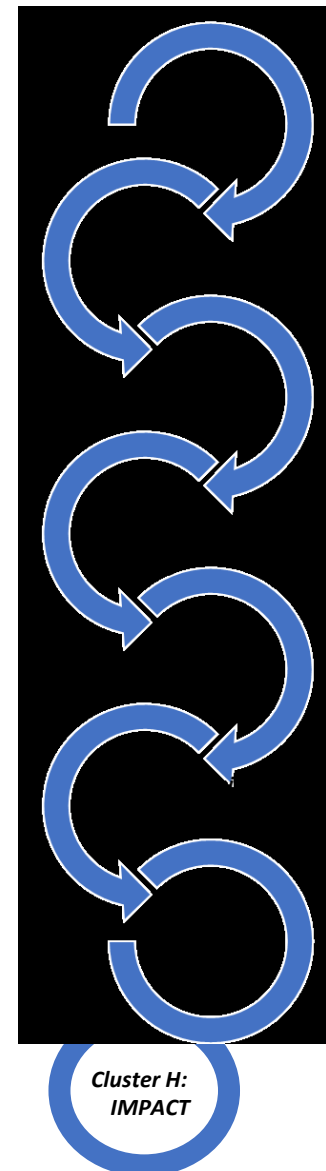


Figure 2. NAS Canvas Flow Process



2B. Secondary service and value value: secondary services are all the additional services or co-benefits generated by the strategy that are not obtained with grey infrastructure and entail a competitive advantage. The values generated by these co-benefits are difficult to express and make explicit. Within NAIAD's WP4, several co-benefit valuation methods have been explored and proposed to undertake this co-benefit valuation, as defined in deliverable D4.4 (Le Coen et al., 2019b). These span quantitative approaches for monetary valuation - such as contingency use values, travel costs, etc. -, and qualitative valuation through qualitative indicators or ranked preferences that gather public or stakeholder perceptions.

CLUSTER B: REGULATORY CONTEXT

STEP 3: Regulation. Regulation impacting or articulating the target problem management and the specific areas or disciplines involved by the solution, i.e. land use management, water management, soil and agricultural management, etc., or lack of such required regulation.

CLUSTER C: MAPPING THE SUPPLY

STEP 4: Who implements. Identification of the main agent/s responsible for implementing the strategy. For NAS strategies involving multiple measures, these can be specified by measure.

STEP 5: Key activities. List of activities required for the implementation of the measures composing the NAS strategy (NBS/Hybrid/grey/soft). This includes the set of measures applied and a breakdown of specific activities within each measure when information is available.

STEP 6. Key resources. Resources needed to implement the strategy (existing and non-existing at present-non-monetary) e.g. knowledge, people and capacity, legal frame, political support, etc.

STEP 7. Key partners. Partners required to implement the solutions and provide the service, i.e. technology centers, regional public administrations, developers, operators, funding partners,...

CLUSTER D: MAPPING THE COSTS OF THE SERVICE

STEP 8. Cost structure. Different type of costs associated to the implementation of the strategy, following NAIAD's economic framework reflected in NAIAD deliverable D4.2 (Graveline et al., 2017).

8A. Lifecycle costs: includes capital costs and operation and maintenance costs.

8B. Opportunity costs: the benefit, profit, or value that would have been generated by implementing other alternatives.

CLUSTER E: MAPPING THE DEMAND

STEP 9: who owns the problem. Who is directly affected by the problem or suffers the problem that the NAS is addressing (flood damages, water shortage...).

STEP 10: Customer segments. The demand side of the service provision can be segmented into different groups based on needs, behaviors and other traits that they share. A customer segment for NAS may be defined through spending behaviour (customers, clients), interests, and motivations.



10A. Direct beneficiaries of primary value: agents that benefit from the solution through damage costs/avoided damages.

10B. Clients: the ones who are actually paying for the service. They may - or may not - own the problem, being directly responsible for it.

10C. Indirect beneficiaries: the extended beneficiaries of real and potential benefits and co-benefits who are currently not paying for the service but may be potentially interested to pay for the co-benefits generated when fully aware of their value.

CLUSTER F: MAPPING THE ABILITY/WILLINGNESS TO PAY

STEP 11: Revenue streams. This component relates to the cash a company generates from each Customer Segment. In the NAS canvas framework, it identifies the possible income streams generated as a result of the service provision/value generated (including both private streams and public goods) for which each customer segment is willing to pay, and which can provide an economic return.

STEP 12: Funding. Funding is the money required to implement the measures, that can be obtained from a single source upfront, or from the customer segments. Some of the revenue streams identified in the previous step may need to be devoted to cover the lifecycle costs of the measure through the economic instruments explained below. Funding sources can include a mixture of the following instruments:

12A. Tariffs: charges paid by the users of the product or service as a “price” (i.e. water tariff,...)

12B. Taxes: charges paid by the users of the product or service as a fix percentage of the value (i.e. VAT) or local taxes perceive by Municipalities for sectoral policies that may be used to fund NAS.

12C. Transfers: money provided by external actors such as primarily official development assistance, philanthropic donations, grants, governmental/institutional funds, etc.

12D. Private funds or investment: money invested by the private sector or private investors.

CLUSTER G. MAPPING THE SUPPLY-DEMAND INTERACTIONS

STEP 13: Customer relationship. Type of relationship between customer and service provider or implementor. The possible types of relationships are personal assistance (human interaction), dedicated personal assistance (dedicating a customer representative to an individual client), self-service (no direct relationship with customer), transactional (through a transaction that can be economic, contractual, etc.), automated (self-service with automated processes), communities (creation of a community of users that communicates through a representative), co-creation (both customer and implementer/service provider generate value). In terms of the duration of the relationship, it can be transactional, long-term, and purpose.

STEP 14: Channels. In the traditional canvas, the communication, distribution, and sales channels comprise a company's interface with customers. Channels are customer touch points that play an important role in the customer experience. In the NAS canvas, channels are the vehicles by which the



implementing and beneficiary stakeholders communicate, such as periodical meetings, public participation initiatives, email, social media, formal letters etc.

CLUSTER H: IMPACT

STEP 15: Impact KPIs. List of tangible impacts achieved by the implementation of the measure described through KPIs or key performance indicators that should be used to track the performance and efficiency of the strategy.

The process includes two more additional steps in order to identify the keys for success and barriers faced in building the bridge from design to implementation.

STEP 16. Success conditions: what determined the success for implemented examples?

STEP 17. Existing or potential barriers: elements or factors that could constrain the feasibility or success in the implementation of the NAS strategy.

3 Application of the NAS canvas framework to NAIAD demos

3.1 Application to NAIAD demos NAS strategies

The application of the NAS canvas framework to NAIAD demos' NAS strategies was done in several phases, following the sequence described in figure 3.

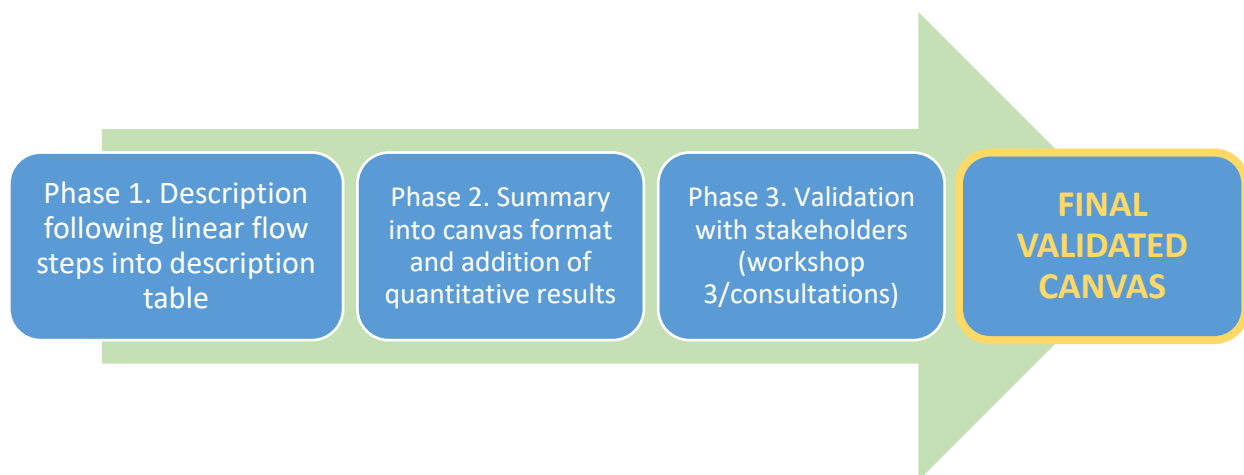


Figure 3: Sequence of NAS canvas framework application to demos.

PHASE 1- During Phase 1, each demo applied the framework to describe in detail the value generation in each of their NBS strategies, as well as to identify all the elements required to build a successful business model for the strategy. These descriptive tables of value capture in all demos' NAS strategies are provided in annex 1. The application was done following the framework steps and instructions above presented,



summarized in a guidelines document circulated by the deliverable leaders, and supported by them. The description ought to include the results from the economic analysis under the steps 2A (Primary service and value through avoided damage costs), 2B (co-benefits and results from the valuation), 8 (Cost structure), and from the analysis of impact indicators in step 15 (Impact through KPIs).

Notes and considerations from implementation of phase 1: It should be noted that, during the course of the NAIAD project, it was found that not all demos would be able to apply the full economic analysis, as further explained in D6.3. Therefore, those demos that could not carry out the economic estimation, or only partially, provided a qualitative estimation of the magnitude based on the demo team perception cross-checked with critical stakeholders (i.e. RBA technicians). In the particular case of step 2B – Secondary service and values, different methods were selected by the demos to carry out the co-benefits valuation (when possible), as reported in D6.3. As a result, the values provided for the co-benefits are expressed through different indicators, units and approaches, some quantitative and some qualitative, and are thus not comparable between them. The specific method used for the co-benefit valuation is made explicit in the reporting of step 2B in all the descriptive tables, and indicated with a code in the canvas, as displayed below in table 1.

PHASE 2- During the second phase, the detailed description was revised by the deliverable leaders and summarized into the canvas format. Several iterations were done with the demo leaders to discuss how to address demo specificities, what information to have included and how.

PHASE 3- The third phase consisted in validating the resulting canvas with the demo stakeholders in the 3rd demo workshop or through alternative consultations to critical stakeholders, to finally obtain a validated business model for each of the demo's NAS strategies. A validation exercise was designed by the deliverable leaders and included within the workshop 3 protocol, in order to guide the demo leaders in conducting the validation. This exercise entailed splitting the workshop participants into as many groups as strategies to be validated, ensuring the presence in each group of a varied representation of stakeholders that are most related to the given strategy. An A1 printout of the strategy's canvas was shown and they were lead step by step, validating and completing the information (see figure 4). In some cases, they were asked to rank the most probable element within the group (i.e. the most probable agent to pay for the service). As a result, validated canvases including stakeholders' perceptions were obtained.

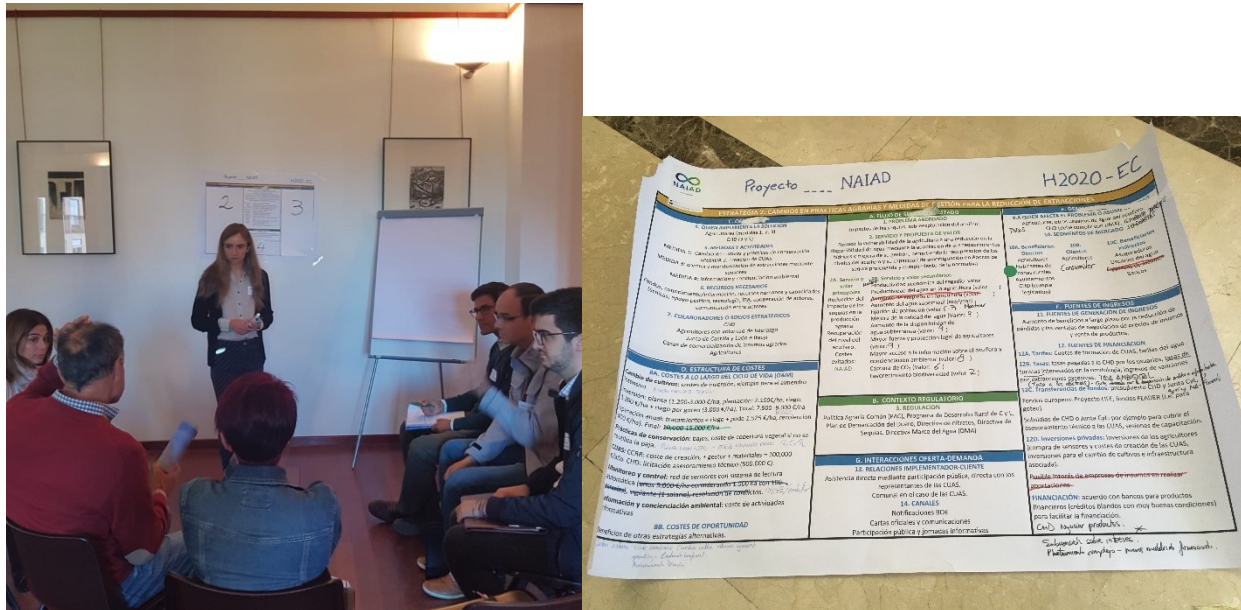


Figure 4. Canvas validation in Medina Demo's 3rd workshop

Notes and considerations from implementation of phase 3: some demos could not validate the canvas during their third workshop before the preparation of this deliverable for different reasons, but mostly due to the need to postpone the workshop in order to have the whole set of final results to be presented to stakeholders (Lower Danube, Rotterdam, Lodz, Glinica) or for other reasons (Copenhagen, Thames). As a result, some demos opted for alternative validation strategies, including one-to-one consultations with key stakeholders (Lodz and Thames). In the case of Rotterdam, Lower Danube, Copenhagen and Glinica, the validation workshop will take place after the submission of this deliverable. Therefore, the canvases for these demos do not include the final stakeholder perception and may lack some information. An updated version of this deliverable will be uploaded to NAIAD website in February including the final validated results for these three demos and missing information that could not be included in time. The validation method used by the demos is specified in table 1.

3.2 NAIAD demos NAS canvases

In order to present the canvases in a systematized way and facilitate the posterior analysis, NAIAD demos have been clustered into three categories according to the scale and span of the NAS strategy interventions:

- Large scale demos with interventions spread across a basin or water body.
- Medium scale demos with focalized interventions on or around the riverbed.
- Small scale demos with interventions at the urban scale in a city.

Table 1 presents the list of NAS strategies clustered into three categories, as well as some important descriptive data.



DEMO	NAS STRATEGY NAME	Risk	Country	Co-benefit Valuation	Canvas validation
NAS strategies in Large scale demos					
MEDINA	S1: Managed Aquifer recharge and groundwater management	Droughts, aquifer depletion	Spain	Qualitative SH perception	Workshop 3
MEDINA	S2: Change in agricultural practices and groundwater management	Droughts, aquifer depletion	Spain	Qualitative valuation SH	Workshop 3
THAMES	S1: Leaky dams	Floods	UK	Qualitative description	Consultations
THAMES	S2: Conservation agriculture	Floods	UK	Qualitative description	Consultations
THAMES	S3: Retention ponds	Floods	UK	Qualitative description	Consultations
LOWER DANUBE	S1: Flood plain restoration in the Lower Danube	Floods	Romania		Upcoming workshop 3
NAS strategies focusing at the river scale					
GLINŠČICA	S1: Glinščica restoration scenario	Floods and nature recovery	Slovenia	Qualitative description	Upcoming Workshop 3
LEZ	S1: Development of Green Infrastructure in the Lez Basin	Floods	France	Itree Eco model (Nowak <i>et al.</i> , 2008)	Workshop 3
BRAGUE	S1: High ambition: "Open a corridor to the Brague River"	Floods	France	Co-benefits transfer method (Arfaoui <i>et al.</i> , 2019)	Workshop 3
NAS strategies in urban demos					
LODZ	S1: A display of green infrastructure in the city of Lodz	Floods	Poland	Qualitative description	Consultations
COPENHAGEN	S1: Urban river restoration in the city of Copenhagen	Floods	Denmark	Qualitative description	Consultations
ROTTERDAM	S1: Urban water buffer, Spangen, Rotterdam (implemented measure in hybrid NBS strategy)	Floods	Netherlands	Measurements + literature data	Upcoming Workshop 3

Table 1: List of NAS strategies by demos and categories.

The following pages present the NAS canvases for NAIAD demos' NAS strategies following the order displayed in table 1.



MEDINA DEMO NAS STRATEGY S1: MANAGED AQUIFER RECHARGE AND GROUNDWATER MANAGEMENT MEASURES

CLUSTER C. SUPPLY	CLUSTER A. FLOW OF ES SERVICES	CLUSTER E. DEMAND
4. WHO IMPLEMENTS Confederación Hidrográfica del Duero (RBA) (Measures 1,3,4) Farmers (Measures 2 and 3(meters)) Regional government: awareness raising and planning (2,3,4)	1. PROBLEM TO BE ADDRESSED Impacts from droughts, groundwater overexploitation and degradation of surface ecosystems	9.WHO OWNS THE PROBLEM All water users, especially farmers CHD (compliance with European regulation) Ecosystems
5. KEY ACTIVITIES 1 (NBS): MAR in the Zapardiel river area 2 (Soft): WUAS formation, 3 (Soft): Abstractions control through meters and surveillance 4 (Soft): environmental awareness and information	2. SERVICE PROVISION AND VALUE PROPOSITION NBS: increased infiltration and restoration of surface riverine vegetation and wetland ecosystems along the Zapardiel river. Soft: Improved groundwater levels recovery providing a back-up resource in case of drought	10. CUSTOMER SEGMENTS
6. KEY RESOURCES Funds, knowledge/information, technical skills and human resources (CHD), political support, technological support, environmental approval (EIA), political will and cooperation of farmers, smooth communication, R&D	2A. Primary service and value Improvement of wetlands and riverine vegetation (surface recovered) Improvement in piezometric levels: (0 as to -10m in BAU) Avoided damages: 0 €	11A. Direct Beneficiaries Farmers Citizens from local municipalities Ecosystems RBA Auxiliary services
7. KEY PARTNERS CHD Farmer leaders Junta de Castilla y León (Regional government) Sociedad Pública de Infraestructuras de medio ambiente CyL Diputaciones de Ávila and Valladolid (provincial government) Municipalities Construction companies and environmental consultancies Farmer associations	2B. Secondary services and value Better surface water availability (v: 7.5) Population fixation (v: 8.1) Improved water quality (v: 7.4) Sustainable groundwater availability (GW exploitation index=1) Farmer empowerment and legal protection (v: 6) Improved capacity to negotiate prices (v: 4.8) Attraction of rural green tourism (v: 5.4)	11B. Clients Agricultural sector Users (through taxes)
		11C. Extended Beneficiaries Insurance sector Tourists Government (more taxes collection)
CLUSTER D. COST STRUCTURE	CLUSTER B. REGULATORY CONTEXT	CLUSTER F. REVENUE STREAMS
8A. Life Cycle Costs MAR: 110,000 € (pipe construction costs), O&M neglectable WUAS: for farmers: cost of creation + manager + materials + technician + protocol information = 100,000 €/year. For CHD: 500,000 € for a 3 years tender to provide free technical advice for newly founded WUAS. Monitoring: for farmers: cost of meter purchase (400 €/meter) Environmental awareness: cost of workshops (5,000 € each)	3. REGULATION Drought/flood directive, Water Framework Directive (WFD), National river basin planning, Duero River Basin Planning, Common Agricultural Policy (CAP), Habitat Directive, Local Development Plans, Agriculture related directives (Nitrates, etc.)	11. REVENUE STREAMS Fees paid by tourists to visit the recovered wetlands and for bird watching Increased agricultural turn overs thanks to greater water security and crop planning
8B. Opportunity costs Avoided benefits from other NAS strategies (to be estimated)	CLUSTER G. SUPPLY-DEMAND INTERACTIONS	12. FUNDING 12A. Tariffs: Quotas paid by farmers to form WUAS 12B. Taxes tax paid to CHD by users, pre-agreed with users, ex-post Taxes paid by tourists Money collected from fines and sanctions for excess water abstraction 12C. Transfers CHD budget, European funds: LIFE Project Subsidies from CHD or Junta CyL to cover technical advice for WUA formation and capacity building sessions, possible support for acquisition of meters. PAC subsidies. 12D. Private: Funds invested by farmers (purchase of meters, costs of WUA formation). Crowd funding, land banks, land surveillance.
	13. CUSTOMER RELATIONSHIPS Direct assessment through public participation, personal with representatives from irrigation communities. Community in the case of WUAs.	
	14. CHANNELS BOE Notifications Official letters and communications Public participation and information workshops	
	CLUSTER H. IMPACT	
15. KPIS (by 2050) - Groundwater exploitation index (EI = 0.8-1) - Ratio of aquifer surface complying with nitrate and arsenic concentration standards (<50 mg/L, <10µg/L)(target 100%)	- Trend of piezometric levels (0m reduction compared to -10m in BAU)	- Percentage of farmers that are part of a WUA (100%) - % of farmers installing meters (100%) - % of farmer having access to better information (100%)



MEDINA DEMO NAS STRATEGY S2: CHANGE IN AGRICULTURAL PRACTICES AND GROUNDWATER MANAGEMENT

CLUSTER C. SUPPLY	CLUSTER A. FLOW OF ES SERVICES	CLUSTER D. DEMAND
4. WHO IMPLEMENTS Farmers (crop change, conservation practices, WUAs and meters) CHD (GW monitoring and farmer awareness raising) Regional government: awareness raising and planning (2,3,4) 5. KEY ACTIVITIES Measure 1 (NBS): Crop change + water conservation practices (crop rotation and mulching) Measure 2 (Soft): creation of WUAs, Measure 3 (Soft): Abstractions control through meters and surveillance Measure 4 (Soft): environmental awareness 6. KEY RESOURCES Funds, knowledge/information, technical skills and human resources (CHD), political support, technological support, cooperation of farmers, smooth communication, new agricultural inputs (seeds) and machinery 7. KEY PARTNERS CHD Junta de Castilla y León (Regional government) Itacyl (training courses and feasibility studies) Agricultural input retailers Farmer leaders and farmers	1. PROBLEM TO BE ADDRESSED Impacts from droughts, groundwater overexploitation 2. VALUE PROPOSITION Reduce vulnerability of agriculture against droughts by reducing farm water requirements while recovering the aquifer piezometric levels thus providing an increased offset capacity in case of extremely severe or prolonged droughts. 2A. Primary service and value Coping capacity to drought impacts Avoided cost: 11.9-12.09 M€ Improvement in piezometric levels: (0 as to -10m in BAU) 2B. Secondary service and value Maintain economic productivity of agriculture (v: 9), Higher water productivity of agriculture (v: 9), population fixation (v: 6.7) Improvement of water quality (v: 9) Higher groundwater availability (v: 9) Higher organisation, empowerment and legal protection of farmers (v: 9), Higher access to information and environmental awareness (v: 8) CO ₂ capture (v: 8) Biodiversity improvement (v: 7)	9.WHO OWNS THE PROBLEM Farmers, Indirectly all groundwater users CHD (compliance with European regulation) 10. CUSTOMER SEGMENTS 10A. Direct Beneficiaries Farmers CHD (will comply with legislation) 10B. Clients Farmers 10C. Extended Beneficiaries Insurance sector All water users Tourists Government (more taxes collection) Ecosystems
CLUSTER F. COST STRUCTURE	CLUSTER B. REGULATORY CONTEXT	CLUSTER G. REVENUE STREAMS
8A. Life cycle costs Crop change: upfront investment costs, technical assistance e.g. almond: plant (1.200-3.000 €/ha, planting: 2.100€/ha, irrigation: 1.200 €/ha + drip system (3.000 €/ha). Total: 7.500 -9.000 €/ha O&M: treatments + irrigation + pruning + harvesting= 1.925 €/ha year) Conservation agriculture: low, if not reused, purchase of mulching material. In trees: cover crops + spring prune: 50 €/ha/year WUAS: for farmers: cost of creation + manager + materials + technician + protocol information = 100,000 €/year. For CHD: 500.000 € to provide technical advice (3 years tender) Monitoring: for farmers: cost of meter purchase (400 €/meter) Environmental awareness: cost of workshops (5,000 € each) 8B. Opportunity costs Avoided benefits from other NAS strategies (to be estimated)	3. REGULATION Common Agricultural Policy (CAP), Programa de Desarrollo Rural de Castilla y León, Duero River Basin Planning, Nitrates Directive, Drought directive, Water Framework Directive (WFD)	11. REVENUE STREAMS Fees paid by tourists to visit the recovered wetlands and for bird watching Increased agricultural turn overs thanks to greater water security and crop planning 12. FUNDING 12A. Tariffs: Quotas paid by farmers to form WUAs Water tariff 12B. Taxes tax paid to CHD by users, pre-agreed with users, ex-post Taxes paid by tourists Money collected from fines and sanctions for excess water abstraction 12C. Transfers CHD and Junta CyL budget, European funds: LIFE Project, FEADER funds (i.e. for drip) Subsidies from CHD or Junta CyL to cover technical advice for WUA formation and capacity building sessions, possible support for acquisition of meters. 12D. Private: Funds invested by farmers (purchase of meters, costs of WUA formation, part of upfront investment) -Farmers that are part of a WUA (target 100%)
CLUSTER E. SUPPLY-DEMAND INTERACTIONS	CLUSTER H . IMPACT INDICATORS	
13. CUSTOMER RELATIONSHIPS Direct assistance through public participation, personal with representatives from irrigation communities, direct technical advice. Community in the case of WUAs. 14. CHANNELS BOE Notifications, Official letters and communications Public participation and information workshops Direct meetings with WUA presidents	15. KPIS by 2050	



- Groundwater exploitation index (EI = 1)
- Ratio of aquifer surface complying with nitrate and arsenic concentration standards (<50 mg/L, <10µg/L)(target 100%)

Employments in agriculture (+0.03 jobs/ha)
Economic profitability per employment (+5,000 €/employment)
-Trend of piezometric levels (0m reduction compared to -10 in BAU)

-Farmers installing meters (100%)
-Farmers with access to better information (100%)
-Minimum area to grant a salary (10.58ha;BAU:18.7 ha)

THAMES DEMO NAS STRATEGY S1: LEAKY WOODY DBRIS DAMS

CLUSTER C. SUPPLY	CLUSTER A. FLOW OF ES SERVICES	CLUSTER E. DEMAND			
4. WHO IMPLEMENTS Environment Agency; Lead Local Flood Authorities; LLFAs lead in managing local flood risks; District and Borough Councils; Internal Drainage Boards (IDBs); RMAs not currently implementing leaky dams: Coast protection authorities; Water and sewerage companies; Highways authorities 5. KEY ACTIVITIES RMA Identifies areas at risk of flooding (from Flood Map for Planning) , identify rivers causing flood (usually ordinary watercourses only suitable for woody dams); locate suitable spot for leaky dam with capacity for flood storage and enhancement of floodplain reconnection, contact land owners, compile risk assessment, assess impact on protected areas, habitats, archaeological sites, obtain permissions, 6. KEY RESOURCES Knowledge on whether the leaky dam will actually work which would come from academia/consultant/literature. Funding - currently there is governmental backing (DEFRA £15million total funding until 2021) 7. KEY PARTNERS Government - funding and political will Contractors/staff/volunteers to build dams Landowners - permission	1. PROBLEM TO BE ADDRESSED Flooding 2. SERVICE PROVISION AND VALUE PROPOSITION Leaky dams reduce river flow by slowing the rate of flow, reducing flood peaks and holding back water or encouraging out of bank flow in designated flood storage areas in rural floodplains above urban areas during flood events 2A. Primary service and value Flood reduction. Avoided damages: expected to be rather low as there is only a very localized impact on flood reduction. Mainly through government savings on aid and insurance companies savings on compensations. 2B. Secondary services and value £0/ no co-benefits.	9.WHO OWNS THE PROBLEM Residents and businesses in the Flood Zone (impact) Government - DEFRA -(responsibility) STEP 10. CUSTOMER SEGMENTS <table> <tr> <td>10A. Direct Beneficiaries downstream residents and businesses</td><td>10B. Clients Government (indirectly through taxpayers nationally)</td><td>10C. Extended Beneficiaries society as a whole, government insurance companies</td></tr> </table>	10A. Direct Beneficiaries downstream residents and businesses	10B. Clients Government (indirectly through taxpayers nationally)	10C. Extended Beneficiaries society as a whole, government insurance companies
10A. Direct Beneficiaries downstream residents and businesses	10B. Clients Government (indirectly through taxpayers nationally)	10C. Extended Beneficiaries society as a whole, government insurance companies			
CLUSTER D. COST STRUCTURE	CLUSTER B. REGULATORY CONTEXT	Cluster F. REVENUE STREAMS			
8A. Life Cycle Costs Initial cost of £100 - £3000; median £175 - £500 Limited lifespan (10 years) Maintenance: UNK; need to be inspected frequently for soil accumulation and wood debris so maintenance is mostly manual labour (approx £50/hour but could be free if volunteers are checking) 8B. Opportunity costs None in regards to other uses of the land. During period of out of bank flood storage the land will be impassable.	3. REGULATION The strategic overview for managing and reducing flood risk is the responsibility of the Department of Food and Rural Affairs (DEFRA) through the Environment Agency (Flood and Water Management Act 2010). This is delivered by Risk Assessment Management Authorities (RMAs - see next section). Note that this act requires RMAs to aim to contribute towards the achievement of sustainable development when exercising their flood and coastal erosion risk management functions. Other relevant policies are prepared with the Treasury, the Cabinet Office (for emergency response planning), the Department for Communities and Local Government (for land-use and planning policy)	11. REVENUE STREAM Government money as a donation 12. FUNDING 12A. Tariffs: No 12B. Taxes Indirectly through general income tax paid to the government 12C. Transfers Government funds 12D. Private: No			
CLUSTER G. SUPPLY-DEMAND INTERACTIONS	CLUSTER H. IMPACT				
13. CUSTOMER RELATIONSHIPS Transactional. No direct involvement between government and NGOs/citizens. 14. CHANNELS Formal bids and reporting - the groups bid for the funding and if successful have to complete reports.					



15. KPIS		
Amount of water held back by the intervention	Reduction in flood peak downstream	Length of time it slowed the flow
THAMES DEMO NAS STRATEGY S2: CONSERVATION AGRICULTURE		
CLUSTER C. SUPPLY 4. WHO IMPLEMENTS Land owner (farmer) ultimately implements (perhaps through agent who manages the estate) 5. KEY ACTIVITIES Conservation agriculture practices: 1. Minimum mechanical soil disturbance: no-tillage and direct seeding. 2. Permanent soil organic cover (ground cover crops) 3. Species diversification (rotation). 6. KEY RESOURCES Knowledge/advice of conservation agriculture methods awareness raising parametric subsidy for environmental services from the government to the landowner for the services provided by the land 7. KEY PARTNERS Groundswell organisers and partners Land owners Government (i.e through parametric subsidy)	CLUSTER A. FLOW OF ES SERVICES 1. PROBLEM TO BE ADDRESSED Downstream flooding 2. SERVICE PROVISION AND VALUE PROPOSITION Higher soil bulk density and organic matter; improved infiltration and drainage which makes it better able to hold water; lower costs of because of less fuel, machinery and effort. Downside: lower yield. Notable impact on flood reduction. 2A. Primary service and value Flood reduction. Avoided damages: reducing peak flow on tributaries of the Thames by 15% (for an investment of less than £250,000 per tributary) 2B. Secondary services and value soil carbon sequestration when soil is not disturbed; soil biodiversity; water resources - improved infiltration; reduced agricultural contamination; sediment retention due to reduced runoff; reduced inputs of labour; machinery (diesel) and pesticides.	CLUSTER E. DEMAND 9.WHO OWNS THE PROBLEM Residents and businesses in the Flood Zone (impact) Government - DEFRA -(responsibility) 10. CUSTOMER SEGMENTS 10A. Direct Beneficiaries farmers, downstream residents and businesses 10B. Clients farmers 10C. Extended Beneficiaries Wider society government (less flood emergency)
CLUSTER D. COST STRUCTURE 8A. Life Cycle Costs Reduced/zero tillage management practices: Investment cost is £0. Maintenance costs is estimated as £50/ha for reduced tillage and for zero tillage as £67/ha.	CLUSTER B. REGULATORY CONTEXT 3. REGULATION The strategic overview for managing and reducing flood risk is the joint responsibility of the Department of Food and Rural Affairs (DEFRA) through the Environment Agency the national government i.e. Environment Agency (EA) (Flood and Water Management Act 2010). This is delivered by Risk Assessment Management Authorities (RMAs - see next section). Other relevant policies are prepared with the Treasury, the Cabinet Office (for emergency response planning), the Department for Communities and Local Government (for land-use and planning policy)	CLUSTER F. REVENUE STREAMS 11. Revenue stream: Private 12. FUNDING 12A. Tariffs: No 12B. Taxes No 12C. Transfers No 12D. Private: Investment by farmers
		CLUSTER H. IMPACT 15. KPIS - soil moisture (%) - soil bulk density (g/cm³)



8B. Opportunity costs Reduction in productivity (i.e. crop production) estimated to be £32/ha for cereal crops.	CLUSTER G. SUPPLY-DEMAND INTERACTIONS 13. CUSTOMER RELATIONSHIPS Currently no relationship. Farmer/land owner decides to practice conservation agriculture. Currently no government incentives but this may change in the planned 25 Year Environment Plan. 14. CHANNELS Annual conference at Groundswell Internet farming forums e.g. thefarmingforum.co.uk Outcomes of farm trials are presented by innovativefarmers.org	• organic matter (%) • infiltration • drainage • water storage (m3)
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THAMES DEMO NAS STRATEGY S3: RETENTION PONDS		
CLUSTER C. SUPPLY 4. WHO IMPLEMENTS Land owner 5. KEY ACTIVITIES Build retention pond: adaptation of flood plain with a containment bund, inlet, outlet and spillway 6. KEY RESOURCES Methods/guidance on construction of retention ponds E.g. Operational Flood Storage Areas, financial resources, staff 7. KEY PARTNERS Engineering company	CLUSTER A. FLOW OF ES SERVICES 1. PROBLEM TO BE ADDRESSED Flooding 2. SERVICE PROVISION AND VALUE PROPOSITION Water storage and retention, for later release of flood waters in a controlled manner. They provide temporary flood storage which can reduce peak flow. The extent of their flood risk effect depends on the number of storage areas provided throughout a catchment and their total storage volume. 2A. Primary service and value Localized impact on flood reduction. Extent of performance not possible to estimate 2B. Secondary services and value Water storage for user supply: e.g. Beam Washlands was created wetland habitat and can store 450,000 m3 floodwater. biodiversity, recreation and aesthetics. The amenity value of Beam Parklands, based on a projected 3% uplift to property values, was found to be £26 million over 99 years (eftec, 2015).	CLUSTER E. DEMAND 9.WHO OWNS THE PROBLEM Residents and businesses in the Flood Zone (impact) Government - DEFRA -(responsibility) 10. CUSTOMER SEGMENTS 10A. Direct Beneficiaries Landowner, downstream residents and businesses 10B. Clients Landowner 10C. Extended Beneficiaries Wider society government (less flood emergency) CLUSTER F. REVENUE STREAMS 11. Revenue stream: Private



Maintenance costs associated with dredging range from £0.1 - 1 per m3 of water stored 8B. Opportunity costs Storage ponds on agricultural land have an opportunity cost of loss of production. For a wheat crop, the opportunity cost is approx £100/yr	CLUSTER B. REGULATORY CONTEXT 3. REGULATION Department for Environment, Food and Rural Affairs (Defra) is the policy lead in England. These national policies are then delivered by Risk Assessment Management Authorities (RMAs): 1)Environment Agency; 2) Lead Local Flood Authorities; 3) District and Borough Councils; 4) Internal Drainage Boards (IDBs). In July 2017 DEFRA granted £15 million funding for 60 “natural flood management schemes” to the EA, LLFAs and Councils, some of which incorporated retention ponds that are built by engineers.	12. FUNDING 12A. Tariffs: No 12B. Taxes No 12C. Transfers No 12D. Private: Private funds from landowners																																							
	CLUSTER G. SUPPLY-DEMAND INTERACTIONS 13. CUSTOMER RELATIONSHIPS No current relationship with indirect beneficiaries 14. CHANNELS No current communication with indirect beneficiaries																																								
	CLUSTER H. IMPACT 15. KPIS Volume of water held back by the intervention (m3)																																								
LOWER DANUBE DEMO NAS STRATEGY: FLOOD PLAIN RESTORATION																																									
CLUSTER C. SUPPLY 4. WHO IMPLEMENTS Ministry of Waters & Forests and Ministry of Agriculture and Rural Development, local authorities, ANAR 5. KEY ACTIVITIES Restore the former pond Potelu: use drainage channels, install an underground screen to increase water level. Floodplain restoration Bistret-Rast area: method to be evaluated during the Danube Floodplain project 6. KEY RESOURCES Data: soil, water, cadastre, ownership, topography, etc Governance: Public-Public cooperation protocol Private -Public Partnership legislation Political willingness (ASD to revise the leasing contracts) Legislation: Revise legislation about land use category change and land expropriation for public interest Funding: EU Funds, National Funds 7. KEY PARTNERS	CLUSTER A. FLOW OF ES SERVICES 1. PROBLEM TO BE ADDRESSED Floods, Desertification, Erosion 2. VALUE PROPOSITION <table><tr><td>2A. Primary service and value</td><td>2B. Secondary service and value</td></tr><tr><td>Flood risk reduction</td><td></td></tr><tr><td>Drought/desertification process reduction</td><td>local businesses</td></tr><tr><td>Avoided damage costs:</td><td>diversification and development.</td></tr><tr><td>Reference 2006 flood:</td><td>Increase in local biodiversity.</td></tr><tr><td>11470 evacuated people</td><td>Decrease in soil erosion.</td></tr><tr><td>642 houses destroyed</td><td>Reduction of population migration from rural areas.</td></tr><tr><td>3200 affected households</td><td></td></tr><tr><td>36807 ha farmland</td><td></td></tr><tr><td>24 social-economic objectives</td><td></td></tr><tr><td>62,3 km roads</td><td></td></tr><tr><td>20 bridges and footbridges</td><td></td></tr></table> CLUSTER B. REGULATORY CONTEXT	2A. Primary service and value	2B. Secondary service and value	Flood risk reduction		Drought/desertification process reduction	local businesses	Avoided damage costs:	diversification and development.	Reference 2006 flood:	Increase in local biodiversity.	11470 evacuated people	Decrease in soil erosion.	642 houses destroyed	Reduction of population migration from rural areas.	3200 affected households		36807 ha farmland		24 social-economic objectives		62,3 km roads		20 bridges and footbridges		CLUSTER E. DEMAND 9.WHO OWNS THE PROBLEM Municipalities, local residents, farmers 10. CUSTOMER SEGMENTS <table><tr><td>10A. Direct Beneficiaries</td><td>10B. Clients</td><td>10C. Extended Beneficiaries</td></tr><tr><td>Local population - villages along the Danube</td><td>Customers for fishing permits</td><td>Local businesses (protection and sustainability)</td></tr><tr><td>Local authorities</td><td>Local businesses</td><td>Local authorities (through taxes)</td></tr><tr><td>Government</td><td>Local tourism</td><td>Local biodiversity/ Ministry of Environment</td></tr><tr><td></td><td>Tourists for services provided by local authority or private companies from the area</td><td></td></tr></table> CLUSTER F. REVENUE STREAMS 11. REVENUE STREAM	10A. Direct Beneficiaries	10B. Clients	10C. Extended Beneficiaries	Local population - villages along the Danube	Customers for fishing permits	Local businesses (protection and sustainability)	Local authorities	Local businesses	Local authorities (through taxes)	Government	Local tourism	Local biodiversity/ Ministry of Environment		Tourists for services provided by local authority or private companies from the area	
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Local authorities County Councils National Administration Romanian Waters Ministry of Waters and Forests Ministry of Agriculture and Rural Development The Agency for the State Domains (ADS) Ministry of Environment	3. REGULATION Private -Public Partnership legislation; Expropriation legislation; Land use change legislation; Cadastre / unclear land ownership; European: FD and WFD; Strategy for drought prevention and management	Fishing permits Fees for renting land/for providing various services Tourism fees, revenues from accommodation and food tourists/ birdwatchers/ fisherman Local handicraft/local food products
CLUSTER D. COST STRUCTURE	CLUSTER G. SUPPLY-DEMAND INTERACTIONS	12. FUNDING
8A. Life Cycle Costs Data acquisition Hydraulic modelling /Establish wetland restorability Payments for land lost Construction costs/Materials costs Monitoring Administration and Maintenance 8B. Opportunity costs Land cost for the land occupied by green infrastructure that cannot be used for other more profitable use.	13. CUSTOMER RELATIONSHIPS Local authority/Local Council – direct, Local farmers/ Local Authority -PPP: direct, automated, co-development (if they are involved in the design) 14. CHANNELS Direct meetings private & public stakeholders Promotion at local/county/national level	12A. Tariffs: tariffs charged for raw water consumption and wastewater discharge by ANAR 12B. Taxes: Taxes for fishing permits and local tourism 12C. Transfers ANAR budget, national budget and/or loans/or EU funds for works needed in each basin for flood protection 12D. Private: Private owners through investment in water retention and infiltration measures to meet the municipal standards.
	CLUSTER H. IMPACT	
	15. KPIS Development of local businesses Number of permanent inhabitants Increasing number of tourists	Increased biodiversity (number of birds, fish population, number of plants/habitats) Groundwater quantity and quality

GLINŠČICA DEMO NAS STRATEGY: RESTORATION SCENARIO EXTENDED		
CLUSTER C. SUPPLY	CLUSTER A. FLOW OF ES SERVICES	CLUSTER E. DEMAND
4. WHO IMPLEMENTS none, NGOs winning EU funding, City Municipality of Ljubljana, Slovenian Water Agency 5. KEY ACTIVITIES NBS measures: Retention areas effectiveness, River renaturation with re-meandering, Wetlands restoration Required activities: Physical risk assessment, Infrastructure maintenance, Search for funding opportunities for infrastructure, Territory control, Community involvement, Institutional cooperation, Training, Insurance policy effectiveness, Physical risk assessment infrastructure maintenance, Monitoring and warning system effectiveness 6. KEY RESOURCES river restoration and ecology experts, public participation, engineering, geology, awareness/education/perception among locals, specialised labour and administrative bodies	1. PROBLEM TO BE ADDRESSED Deterioration of natural areas and flooding 2. VALUE PROPOSITION 2A. Primary service and value Flood risk reduction Biodiversity and ecosystems state enhancement 2B. Secondary services and values - Social value of ecosystems enhancement: increase in green spaces and provision of urban ecosystem services - Recreational values -Emotional, educational, cultural, visual values attracting tourism, -Pollination, - Ground water quantity and quality, - Biodiversity, - Drought mitigation, - Surface water purification and quantity, - Temperature mitigation, - Air pollution mitigation	9.WHO OWNS THE PROBLEM Ministry for Environment and Spatial Planning, Slovenian Water Agency, Municipality of Ljubljana, residents of Ljubljana, 10. CUSTOMER SEGMENTS 10A. Direct Beneficiaries nature, residents, City Municipality of Ljubljana, Ministry of Environment and Spatial Planning, Insurance companies 10B. Clients residents, City Municipality of Ljubljana, Ministry of Environment and Spatial Planning, tourists 10C. Extended Beneficiaries All actors: nature, local people, citizens of Slovenia, tourists, Government, experts,...



7. KEY PARTNERS local government, local people, Slovenian Water Agency, NGOs, environmental engineering companies, software companies	CLUSTER B. REGULATORY CONTEXT	CLUSTER F. REVENUE STREAMS
CLUSTER D. COST STRUCTURE	3. REGULATION Water Framework Directive and National Water Management Plan, Floods Directive and National Flood Reduction Plan, Law on Waters, Urban Agenda for the EU, Slovenian Development Strategy 2030, Sustainable Urban Strategy of MOL, MOL Spatial Plan	11. REVENUE STREAMS Fees paid by tourists and residents to use the green spaces.
8A. LIFE CYCLE COSTS Costs of implementing the NBS measure Including capital, operation and maintenance	CLUSTER G. SUPPLY-DEMAND INTERACTIONS	12. FUNDING
8B. OPPORTUNITY COSTS Avoided benefits from implementation of alternatives.	13. CUSTOMER RELATIONSHIPS If implementor is NGO: indirect If implementor is Municipality or Slovenian Water Agency: indirect, or automated (via websites-communication) or co-development (if they involve the community to co-develop the actions) 14. CHANNELS Websites, communications, public participation, formal letters	12A. Tariffs: No 12B. Taxes: Possible tax paid by residents for green spaces 12C. Transfers: Funds allocation from national or local government; external funding from EU or other donors 12D. Private investment: Possible external funds from private banks or investors, possible investment from insurance companies
CLUSTER H. IMPACT		
15. KPIS Biophysical: Runoff coefficient in relation to precipitation quantities (mm/%), Flood peak reduction (e.g. Qmax,0/Qmax,1) Increased storm water retention (volume), Species richness and composition, Increased biodiversity, Water flow speed (in relation to natural), Flood peak reduction (e.g. Qmax,0/Qmax,1) and increase in time to peak, Extent of urbanized floodplain areas, Social: Distribution of public green space – total surface or per capita, Improved human health and wellbeing, Urban green: index of biodiversity, provision and demand of ecosystem services, Number and extent (number of people affected) of intervention events		

LEZ DEMO NAS STRATEGY: DEVELOPMENT OF GREEN INFRASTRUCTURE IN THE LEZ BASIN		
CLUSTER C. SUPPLY	CLUSTER A. FLOW OF ES SERVICES	CLUSTER E. DEMAND
4. WHO IMPLEMENTS Municipalities, private and public developers, private owners 5. KEY ACTIVITIES Bioswales Green roofs Open Vegetated Retention Basins Parking with permeable pavement Rain gardens 6. KEY RESOURCES -Funding: The Montpellier Municipality perceives a tax of 3 million euros yearly for the prevention of flooding. Need for better information on flooding risk and on co-benefits Department/Region/Europe/Water basin agencies can be involved in NBS funding	1. PROBLEM TO BE ADDRESSED Serious and recurring flood risks mainly caused by runoff, air pollution, heat island effects 2. VALUE PROPOSITION (from 2020 to 2040) 2A. Primary service and value Protection against runoff risk Avoided damage costs: 1.30-1.86 M€/yr; Aggregated value 2020-2040: 29M€ 2B. Secondary service and value Air pollution reduction: value: 1.8-2.2M€ Carbon sequestration: value: 0.2 unit Overall estimation of co-benefits evaluated through stated preference survey for 2020-2040: 605M€	9.WHO OWNS THE PROBLEM Municipality, residents, farmers, businesses, insurance companies (indirectly) 10. CUSTOMER SEGMENTS 10A. Direct Beneficiaries Residents of the Lez Basin, Farmers, Businesses 10B. Clients Tax payers, municipalities 10C. Extended Beneficiaries Insurance sector: Insurers are mainly interested in the reduction of flood damages.
	CLUSTER B. REGULATORY CONTEXT	CLUSTER F. REVENUE STREAMS



-**Capacity development:** training of public workers, awareness
-**Operation:** green infrastructure specialist, engineering companies, gardeners, plants and green biomass, strategic spatial locations...

7. KEY PARTNERS

-**Private developers**
-**Municipality and State** (impose the rules on urban runoff management and develop green infrastructure projects)
- **Local residents:** lobby to support implementation.
-**Specialized engineering and bio-architecture companies** who can technically implement these solutions

CLUSTER D. COST STRUCTURE

8A. LIFE CYCLE COSTS

Construction and maintenance costs for green infrastructures

Actualized cost (2020-2040) without opportunity cost: 92-148M€

8B. OPPORTUNITY COSTS

Land cost for the land occupied by green infrastructure that cannot be used for other more profitable use.

Actualized cost (2020-2040): 239-396M€

STEP 3. REGULATION

Since January 2018, the protection of water ecosystems and the prevention of flooding (GEMAPI) is under the responsibility of Municipalities (runoff risk management, flood zone definition).

CLUSTER E. SUPPLY-DEMAND INTERACTIONS

13. CUSTOMER RELATIONSHIPS

If implementors are the public sector: automated via website communications, or co-development via public participation.

If implementors are private entities: direct through contract with payers, community if the solution is implemented by a community (i.e. of neighbours).

14. CHANNELS

Municipality website, formal letters, public participation, community meetings, information sessions/workshops,...

11. REVENUE STREAMS

Co-benefits generated,, which are mainly public good should leverage investment from municipalities/state

12. FUNDING

12A. Tariffs Water tariffs paid by consumers indirectly fund deproofing actions implemented by Water Agencies.

12B. Taxes The GEMAPI tax in addition to local tax

12C. Transfers The Barnier Fund (financed by a 1.4% contribution from all insurance policies), other funds

12D. Private investment: Private owners through investment in water retention and infiltration measures to meet the municipal standards.

The insurance sector recently considered voluntary contributions

CLUSTER H. IMPACT

15. KPIS

Surface of green infrastructure implemented in the basin (m²)

Reduction of hazard in terms of damage avoided (€/yr) and number of people exposed (Number of people in flooding areas)

Reduction of air pollutant for NO₂, PPM₁₀, PPM_{2.5}, SO₂ and O₃ (T/yr)

Health impact in terms of reduced mortality and morbidity (Number of death avoided/yr, Number Carbon sequestration (T of C/Yr)

BRAGUE DEMO NAS STRATEGY: HIGH AMBITION: AN OPEN A CORRIDOR TO THE BRAGUE RIVER

CLUSTER C. SUPPLY

4. WHO IMPLEMENTS

SMIAGE: multi-basin agency (broad management)

CASA: group of municipalities from two river basins including the Brague (local management of the basin scale project)

5. KEY ACTIVITIES

Small natural retention areas, cumulated area ≈ 200ha

CLUSTER A. FLOW OF ES SERVICES

1. PROBLEM TO BE ADDRESSED

Reduce risks related to flash floods

2. VALUE PROPOSITION

2B. Secondary service and value

CLUSTER E. DEMAND

9.WHO OWNS THE PROBLEM

Inhabitants of the flood plain, workers in the floodplain, people circulating on roads and paths in the floodplain, tourists passing by the floodplain, highway managers

10. CUSTOMER SEGMENTS



Widening of the Brague river bed(≈ 10-40m) Wetland restoration (11 ha) Riparian forest restoration (13 ha) 3 Large wood traps 3 Bridge widening 50-70 acquisitions and demolitions of houses 8 km of pedestrian and cycle tracks 6. KEY RESOURCES -Funding -Political support for acquisitions and demolitions of houses -Adaptation of the Fond Barnier management rules to make house acquisition and demolition more flexible -Technical and economic skills 7. KEY PARTNERS - Conservatoire du littoral (state agency in charge of nature protection, would acquire land to restore wetlands) - DDTM 06 (regional authority responsible in risk management, works and restauration in rivers and finally allowing protection strategies to be implemented or not). - Agence de l'eau RMC (Water agency) - Citizens: Public support	2A. Primary service and value Risk reduction and improved river corridor quality Avoided damage costs: 0.5 M€/yr, 14 M€ over 50 yr Better safety for people in areas at risks: decrease in water depth (m) and flooding frequency (yr-1) in residential areas Decrease of number of people frequenting risk areas (number varies with event return period) Aggregated estimated cost of co-benefits through cost-transfer method: 4.3 M€/yr; 122 M€ over 50 yr Continuity and access of cycling and pedestrian paths. Length: 8km Improved riparian forest quality: surface of forest: 13 ha Improved water quality: qualitative value Improved environmental status of the Brague River (MQI index became Very Good)	10A. Direct Beneficiaries Inhabitants of the flood plain Workers in the floodplain People circulating on roads and paths in the floodplain, tourists passing by the floodplain, highway managers 10B. Clients Inhabitants of the basin 10C. Extended Beneficiaries workers in the floodplain, people circulating on roads and paths in the floodplain, tourists passing by the floodplain, highway managers, insurance companies?
CLUSTER D. COST STRUCTURE 8A. LIFE CYCLE COSTS Real-estate acquisition: 33 M€ (25-58 M€) Capital expenditure: 24 M€ (17-35 M€) Operating and minor maintenance expenditure: 4 M€ (3-5 M€) 8B. OPPORTUNITY COSTS Change in economic activities in the floodplain because river corridor will be wider than currently. Opportunity costs estimated based on expropriation values of buildings (residential and commercial): 19 M€ (14-35 M€)	CLUSTER B. REGULATORY CONTEXT 3. REGULATION Flood Directive, Water Framework Directive, Fond Barnier management rules, GEMAPI law (Gestion des Milieux Aquatiques et Protection contre les Inondation: integrated management of river and wetland management and flood protection), vegetation management plan of the basin agency CLUSTER G. SUPPLY-DEMAND INTERACTIONS 13. CUSTOMER RELATIONSHIPS Personal assistance: citizens of the basin elect politicians who are part of the decision board in the SMIAGE and CASA. 14. CHANNELS Public and information workshops, official letters and communications, social media	CLUSTER F. REVENUE STREAMS 11. REVENUE STREAMS Local taxes (residential and companies), national taxes (residential and companies) 12. FUNDING 12A. Tariffs None 12B. Taxes GEMAPI tax (legal maximum of 40€ max /house/year, yet to implement but range of 30-90€/house/year validated by survey on 405 interviewees within NAIAD Fond Barnier (12% tax on all insurance policies of houses and cars in France) 12C. Transfers Eventual regional authority funding 12D. Private investors None so far
	CLUSTER H. IMPACT 15. KPIS Decrease in flooding area for given peak discharge (m² flooded) Decrease in damages for given peak discharge (m² flooded) Decrease in blocking of bridges by large wood (number of bridges clogged for given flood time return)	

LODZ NAS STRATEGY: A DISPLAY OF GREEN INFRASTRUCTURE IS THE CITY OF LODZ

CLUSTER C. SUPPLY	CLUSTER A. FLOW OF ES SERVICES	CLUSTER E. DEMAND
4. WHO IMPLEMENTS Municipality, Marshal Office, City companies, private investors (4, 5), Housing cooperatives (group of people inhabiting a building and taking care of the	1. PROBLEM TO BE ADDRESSED Pluvial flooding and drought related to unsustainable management of rain water and decline of ecosystem services 2. VALUE PROPOSITION	9.WHO OWNS THE PROBLEM Citizens, particularly poor people, elderly people Municipality (as owner of some assets that get flooded). 10. CUSTOMER SEGMENTS



management), State cooperatives (composed of boards of inhabitants)		2A. Primary service and value		2B. Secondary service and value		11A. Direct Beneficiaries		11B. Clients		11C. Extended Beneficiaries			
5. KEY ACTIVITIES		1. Blue-green network; 2. Green ring around the city; 3. Woonerfs; 4. Pocket parks; 5. Green backyards; 6. River rehabilitation; 7. Reservoirs and biofilters in the city		Pluvial flooding reduction (Damage costs: lower expenditure in healthcare, especially for elderly people, cost savings in grey solutions) Groundwater recharge (Avoided costs: lower O&M for Green Ring) Climate regulation (Avoided costs: reduced health care costs due to humidity increase).		Reduced water logging in water treatment plant (Value: avoidance of paying the fee for releasing low quality water); Groundwater recharge; Climate regulation; Aesthetics; Recreational places; Health benefits; Reduction of heatwaves; Availability of habitat for species; Educational values (related to water harvesting and biodiversity); Air cleaning; Noise reduction		All citizens, neighbourhoods nearby the NBS Risk prone building owners Departments which maintain infrastructure		Municipality, city companies and Marshal office Indirectly by citizens through taxes		Municipality (because of the increased natural value of the city, i.e. expohorticulture)	
6. KEY RESOURCES		Funds, human labour (academics, civil workers), new skills, enabling legal environment, awareness, commitment (at the political and civil society levels)											
7. KEY PARTNERS		Experts (engineers, environmentalists, sociologists, facilitators to engage society,...), academics, people involved in education, companies providing Polish knowhow, NGOs, Housing and State cooperatives											
CLUSTER D. COST STRUCTURE				CLUSTER B. REGULATORY CONTEXT								CLUSTER F. REVENUE STREAMS	
8a. Life cycle costs		1.Blue-green network (only maintenance cost of preserving nature) 2.Green ring around the city (only O&M of preserving nature and connecting the ring) 3.Woonerfs 4.Pocket parks 5.Green backyards 6.River rehabilitation 7.Reservoirs and biofilters in the city		3. REGULATION		National level: WFD, City climate adaptation plans, Polish Water Law City level: Integrated Development Strategy of Lodz Metropolitan Area 2020+(2017); Integrated Development Strategy of Lodz 2020+ (2012) (not very strong executing power); The Study of Determinants and Directions of Spatial Development.						11. REVENUE STREAM	
8b. Opportunity costs		Not available										Expenditures by visitors to nature related expositions Attraction of more funding for implementation based on achieved impact	
				CLUSTER G. SUPPLY-DEMAND INTERACTIONS								12. FUNDING COMING FROM	
				13. CUSTOMER RELATIONSHIPS		Personal assistance (in projects developed by citizens) Transactional (small grants given by the Municipality to the citizens). Community (through State and Housing cooperatives) Co-development (through workshops with citizens for rehabilitation). Legal or economic obligation to investors						12A. Tariffs: Tariff for the release of rainwater to the system paid to Polish Waters company that will be used to fund NBS. Tariff for reduced infiltration capacity in large scale projects or interventions with impermeable grey infrastructures reinvested in NBS	
				14. CHANNELS		Workshops with citizens; Legal obligations; Media (mostly newspapers and radio); Letters and official communications; Tenders for grants						12B. Taxes: Taxes paid by citizens, wastewater tax and stormwater tax	
												12C. Transfers Transfers from the municipality: to citizens and NGOs through the Civilian budget for projects developed by citizens, and for direct implementation by the Municipality. EU funds: the city will not invest in anything that has less than 50% funding from the EU. Structural funds, LIFE+ funds, RIAs (i.e. NAIAD)	
												12D. Private investors: Citizens investing in their own property	



Motorway ramp (Bispeeng) removal, urban planning activities for created space including urban river restoration 6. KEY RESOURCES -Monetary resources: municipalities and state + revenue from selling real-estate space and building rights + taxes. -Political agreement and legislation. -Knowledge and capacities 7. KEY PARTNERS -Municipalities of Copenhagen and Frederiksberg -State (transfer of Bispeeng motorway ramp to municipalities) -Water utilities for Copenhagen (HOFOR) and Frederiksberg (Frederiksberg Forsyning) -Consultants	2A. Primary service and value Mitigation of urban flooding effects Avoided damage costs: 3 million euros¹ Avoided water treatment costs: estimation upcoming¹	2B. Secondary service and value¹ NBS green infrastructure value. City attractiveness. Improved public health. Less pollution. Branding of Copenhagen as green city and knowledge export. Green jobs.	10A. Direct Beneficiaries Copenhagen Municipality, Frederiksberg, water utility companies, citizens	10B. Clients State, municipality of Copenhagen and Frederiksberg, real-estate companies and citizens who buy / rent houses / apartments and pay taxes	10C. Extended Beneficiaries Citizens in general, businesses in more attractive area, tourists (branding value of city) Insurance companies	
	CLUSTER B. REGULATORY CONTEXT			CLUSTER F. REVENUE STREAMS		
	3. REGULATION Climate Adaptation Plan; Cloudburst Management Plan; Water Framework Directive; Floods Directive			11. REVENUE STREAM Income generated by green jobs and revenues from branding the city and exporting NBS solutions;		
	CLUSTER D. COST STRUCTURE	CLUSTER G. SUPPLY-DEMAND INTERACTIONS			12. FUNDING COMING FROM	
STEP 8A. LIFE CYCLE COSTS¹ NBS (NAIAD demo): Costs of restoring (reopening) the urban river plus possibly tributaries further upstream Costs to maintain ecologic flow, drainage to river, pumping Costs of side accompanying measures: removal of Bispeengbuen motorway ramp + establishing traffic parts + construction + associated analyses by consultants and municipalities + maintenance costs STEP 8B. OPPORTUNITY COSTS: Under consideration	13. CUSTOMER RELATIONSHIPS Automated relationship between the Municipality and the citizens, businesses, etc., who would be informed of the NBS implementation via official communications or automatic vehicles 14. CHANNELS Meetings at all levels between the responsible municipalities and stakeholders			12A. Tariffs: N/A. Once the urban river NBS is established there are no tariffs involved for use of the NBS 12B. Taxes: Indirect via real estate taxes which contributes to financing the urban river NBS 12C. Transfers Funds contributed by the Municipality and the State. 12D. Private investors		
CLUSTER H. IMPACT						
15. KPIS Improved biodiversity (urban river and connected green infrastructure) Improved air quality Urban flooding mitigation in Bispeeng area Improved water quality Improved green space management						
ROTTERDAM NAS STRATEGY: URBAN WATER BUFFER, SPANGEN, ROTTERDAM (IMPLEMENTED MEASURE IN HYBRID NBS STRATEGY)						
CLUSTER C. SUPPLY	CLUSTER A. FLOW OF ES SERVICES			CLUSTER E. DEMAND		
4. WHO IMPLEMENTS Municipality of Rotterdam & Hoogheemraadschap Delfland (Waterboard) 5. KEY ACTIVITIES Design & Engineering. Construction of retention tanks, biofilter and infiltration and recovery wells. Monitoring	1. PROBLEM TO BE ADDRESSED Local pluvial flooding, use of potable water for stadium irrigation, need for green space in neighbourhood. 2. VALUE PROPOSITION Reduce flood risk, whilst adding green space and providing high quality water supply using biofiltration and aquifer storage and recovery (ASR).			9.WHO OWNS THE PROBLEM Inhabitants, Local Businesses, Sparta Football Club 10. CUSTOMER SEGMENTS 10A. Direct Beneficiaries 10B. Clients 10C. Extended Beneficiaries		

¹ The results are preliminary and will be refined and completed during workshop 3 that will take place in January 2020. The results will be updated with the workshop outcomes.



of water quality to gain infiltration permit. Operation & maintenance. 6. KEY RESOURCES Stakeholder engagement; Suitable geohydrological conditions; technical knowledge/support on water management, water treatment, ASR systems; permits; political support. 7. KEY PARTNERS Design, Engineering & Supply: Field Factors, KWR, Codema BE-deLier; Contractors: Van Gelder, Schijf Bronbemaling; Operators: Field Factors, KWR/Codema, Evides Water Utility; End-users: Sparta Stadium; Regulator: Delfland	2A. Primary service and value 1400 m³ of retention to reduce local flood risk = €700,000³ Alternative local water source, supplying 15,000 m³ of filtered rainwater per year to Sparta football stadium = €682,000⁷		2B Secondary service and value Reduced pumping requirements: €75,000⁴ Energy savings from reduced water production: €44,000² Emissions savings: €8,000⁵. Increased greenery and improved aesthetics resulting in higher property values: €561,000⁶ Increased water awareness		Local residents, Local Businesses, EVIDES Water Utility Municipality of Rotterdam, Hoogheemraadschap Delfland Waterboard Sparta stadium
	CLUSTER B. REGULATORY CONTEXT 3. REGULATION Broader context - Municipal water Plan (2011); Municipal Water Plan (revised, 2012), Rotterdamse Adaptatiestrategie (2013); Resilient Rotterdam and Water Sensitive Rotterdam Programs Specific relevant regulations - Groundwater legislation (see STOWA rapport 35A, 2015 – <i>Ondergrondse Waterberging</i> or <i>Infiltratiebesluit bodembescherming</i> 2009)		CLUSTER F. REVENUE STREAMS 11. REVENUE STREAMS Sparta Stadium - payments for water supply Residents - increased tax revenue from higher property values Evides - In kind contributions: operational responsibility in exchange for exploitation of the water well 12. FUNDING 12A. Tariffs - Water tariff of €0.91/m³ to cover operational costs 12B. Taxes – Indirect funding through water taxes 12C. Transfers - Innovation fund (case specific) 12D. Private		
	CLUSTER G. SUPPLY-DEMAND INTERACTIONS 13. CUSTOMER RELATIONSHIPS Long term partnerships, Consortium Agreements, Operation & Maintenance contracts 14. CHANNELS Direct communication, stakeholder meetings, documentation and reporting on system performance.		CLUSTER H. IMPACT 15. KPIS Number of separated sewer overflows / year → Target: < 2 per year Amount of infiltrated/stored water → Target: 30,000 m³/year Amount of water supplied → Target: 15,000 m³/year Quality of water after treatment → Target: Ongoing compliance with legislation on water quality for infiltration and reuse.		

1. Estimates from site data 2. Value over 50 years, energy use of avoided water production = 0.35 kWh/m³ (Vewin 2017), electricity = €0.17/kWh 3. Value of retention = €500/m³ (Gemeente Rotterdam, 2019) 4. Value over 50 years, avoided pumping costs = €0.05/m³ (Arcadis, 2019) 5. Value over 50 years, electricity = 569g CO₂/kWh (Moro et al., 2018), carbon price of €54/ton (High Level Commission on Carbon Prices, 2017) 6. 4% increase on 100 households nearest to UWB (Bervaes, 2004), average property WOZ value in Spangen = €140,233 (Gemeente Rotterdam, 2019) 7. Value over 50 years, water tariff = €0.91/m³

4 Lessons learned: common factors, keys for success and barriers from developing business models to catalyse implementation of NBS in NAIAD demos

The process of identification and design of business models for NAIAD demos provided a range of insights on existing (for demos already in or close to the implementation phase) or potential (for demos in the design phase) keys for success and barriers for implementation.

Meanwhile, a closer analysis of the canvas elements across demos was done.

The **main value of the demo strategies** under the NAIAD lenses is the disaster risk reduction capacity, valued through the avoided damages or assurance value. All demo strategies are focused towards flood risk reduction, with the exception of Medina demo which focuses on addressing drought risk. However, in some demos there was an additional environmental objective for the selected measures that was prioritized by stakeholders, sometimes even higher than the risk reduction itself. This was the case of the aquifer stabilisation and wetland recovery in Medina del Campo demo, or the recovery of natural areas in Glinsica demo. Therefore, these objectives had to be included as primary value and main selling points that naturally stirred the interest of potential implementors. This highlights the importance of the multi-value or multi-functionality nature of NBS, which constitutes one of the strongest comparative advantages as compared to grey solutions. Among the **secondary values** or co-benefits, something remarkable when looking across demos is that all of them include environmental, social and economic co-benefits regardless of the type of strategy. This means that, besides the environmental benefits, the creation of jobs, the emergence of additional economic activities through new businesses, or the attraction of tourism are common features that need to be valued and turned into revenues in order to support the implementation and especially maintenance of the strategy, especially in urban interventions where these benefits are more localized. However, the quantification of these values ex-ante is extremely complex. In the case of the Rotterdam demo, which has already been implemented, these values could be measured ex-post with very positive results (an increase in property values figure of €561,000⁶).

The range of **activities** implemented included a mix of pure NBS (Lower Danube, Glinsica, Brague, Lez, Lodz), a mixture of hybrid and NBS measures (Thames, Copenhagen, Rotterdam) and a mix of NBS and soft or management measures (Medina). In the case of mixed activities, such as in Medina S2, this combination showed to become especially powerful by allowing to align the achievement of the environmental goals (management measures to reduce water abstractions) with the risk reduction and economic sustainability goals facilitated by the NBS. The range of **resources** required for the implementation of the activities pivot around four main types: funding, knowledge and capacities, stakeholders engagement, political will, and an enabling regulatory environment. Accordingly, the main **partners** to be involved include representatives from all the stakeholder groups in most cases, from citizens, farmers or service users (i.e. water users), through to governmental and management institutions.

Following with the analysis, the possibility to infer some common factors or elements by clusters that could point at possible patterns to inspire similar types of interventions was explored for the remaining components: 1) who implements, 2) who benefits, 3) funding strategies and 4) legislation (see table 2), as these are highlighted as the four building stones to build the business model around the value proposition.

Table 2 presents a compilation of the keys for success, barriers and critical components and highlights common factors by clusters.

NAS strategy	KEYS FOR SUCCESS	BARRIERS	BM COMMON FACTORS
NAS STRATEGIES IN LARGE SCALE DEMOS			
MEDINA-S1	Obtaining of EU funding Alignment with river basin management plan Negotiations with farmers and cooperation	Uncertainty about the extent of impact on groundwater level recovery Inertia and reluctance among farmers Need for internal governance – lack of mutual trust Human resources limitations in CHD Possible political changes blocking the measures Possible social opposition	Who implements: Public environmental/water administrations Farmers/landowners Public-private!! Who benefits: Whose society in the area or downstream Insurance companies Public authority (less need for intervention) Everybody!! Funding: EC projects Public funds Private funds (farmers/landowners) Tariffs and taxes from water users Indirect beneficiaries??
MEDINA-S2	Obtaining of EU funding Alignment with river basin management plan Negotiations with farmers and cooperation	Uncertainty on new crops' profitability Upfront investment for crop change and difficulty to engage landowners Need for internal governance – lack of mutual trust Human resources limitations in CHD Possible political changes blocking the measures Blockage by intermediates in the value chain Lack of awareness of future water limitations Inertia and reluctance among farmers Lack of communication and coherence between water and agricultural policies and institutions	Funding: EC projects Public funds Private funds (farmers/landowners) Tariffs and taxes from water users Indirect beneficiaries??
THAMES-S1	Proven performance in reducing flood risk. SmartRiver sensors and stations developed by NAIAD could help overcome barrier 1	Need for systematic monitoring across geographies Question of liability in case installed on privately owned land and flooding occurs.	Legislation: European legislation (Floods Directives, WFD) + local land use-rural development legislation. Drivers/barriers!!
THAMES-S2	Proven performance in reducing flood risk	Lack of compensation/benefit to farmers/landowners for the flood risk reduction and co-benefits to downstream users. Reduction of pesticides has negative impacts on yields.	
THAMES-S3	Proven performance in reducing flood risk. SmartRiver sensors and stations developed by NAIAD could help overcome barrier 1	Need for systematic monitoring across geographies Question of liability in case installed on privately owned land and flooding occurs.	
LOWER DANUBE-S1	Local community drive available funding /financing options, Local, regional and national stakeholders cooperation	Opposition of the local large agricultural farms (lobby) and of the Agency for State Domains. Local farmers opposition (lobby)	
NAS STRATEGIES FOCUSING AT THE RIVER SCALE			
GLINSICA-S1	Those that allowed to overcome the barriers	Funding ; avoiding responsibility (political will); lack of awareness, capacity and experience to plan and implement NBS - distrust for NBS; strong lobby for further urbanization of flood plains; inadequate transfer of new policy into practice	Who implements: Groups of municipalities Water agencies Public!! Who benefits: Residents and businesses in riverine municipalities Public authority (less need for intervention) Insurance companies, tourists Everybody!! Funding: Tax mechanisms National funds (Barnier) Possible external funds (EU, private)
LEZ-S1	Political will Capacity to integrate the value of co-benefits in funding decisions Possible use of GEMAPI funds for runoff reduction Strong regulation to promote NBS	Need for more collaboration among administrative services in charge of the different issues associated with NBS co-benefits. Cultural barriers that go against NBS (private housing ideal...), Environmental issues are not priorities in the political agenda , Limited effectiveness of NBS on large flooding events, Cost of public space modification is very high.	
BRAGUE-S1	Stakeholder cooperation: Acceptance of house	Insufficient funding (existing) Unwillingness of inhabitants to leave their houses (potential)	

	acquisitions to widen the river corridor		Indirect beneficiaries, i.e. insurance?? Legislation: European legislation (Floods Directive, WFD) + local flood/development agendas Drivers/barriers!!
NAS STRATEGIES IN URBAN DEMOS			
LODZ-S1	Having European Funding Enabling political environment Evidence on performance: promotion through showcasing and demonstration cases attracting private investors	Regulatory gaps for some of the measures Use of investment as a political weapon to gain voters	Who implements: Municipality Some private initiatives Public!! Who benefits: Residents in the nearby areas, local businesses Everybody!!
Copenhagen-S1	Political agreement Available funding	Future political agreement and/or budget constraints The restoration of the urban river is constrained by the political process to transfer competencies on the different actions between administrative levels, and the need for negotiation of budget allocation.	Funding: Indirect taxes, external funding (EU, innovation funds) Indirect beneficiaries, i.e. insurance, stadium?
Rotterdam-S1	Political will Commitment and pioneering of initiators Successful private-public partnership Funding (innovation fund) Social drive (demand by inhabitants)	"Business as usual dies hard" : strong preference for well-known water management caused; uncertainty about effectiveness and lifetime of the system; multiple stakeholders to be involved ; limited interest in alternative water sources, as drinking water is currently still readily and cheaply available in Netherlands; Integral approach required funding out of different single-purpose budgets . Different standpoints and views over the problem	Legislation: Municipal water and flood/climate related strategies and Agendas Drivers/barriers!!

Table 2. Keys for success, barriers and common elements for business models in NAIAD demos.

Regarding common factors across critical supply-demand components of the business models - namely **who implements, who benefits and the funding sources** -, the analysis in table 2 builds the comparison between demo strategies by clusters, in order to consider similar scales and somehow similar types of interventions. Large scale demos with spatially distributed interventions show a mix between public and private driven implementation and funding, with larger/common use infrastructure being promoted by public institutions (mainly water and land use management agencies), and smaller spatially-spread and individual use/application based measures being implemented and funded by landowners or farmers. Funding relies partly on landowner investment capacities and partly on public budgets, having the latter more facilities to access external support from EU or other international funds as a complement. As a result, one of the perceived barriers is lack of cooperation/coordination or reluctance from individual private implementors whose perception of benefits from implementation (or incentives) is not so clear. Therefore, providing more support or clear incentives for individual private implementors through different mechanisms may help push implementation, including compensation/payment for the co-benefits generated. Worldwide, these incentives have included subsidies from cities or regional governments to support the investments, support with maintenance expenses and abatement of surface water charges/fees, among others (Ossa Moreno et al., 2017). In the case of farmers, Payments for Environmental Services have been widely used to support farmers to adopt pro-environmental practices, although payments to reduced flooding risk have not been widely developed so far.

At a smaller scale, demos focused on the riverbed and surroundings within a smaller area of influence (i.e. part of a catchment) report groups of municipalities and water management institutions as the main implementing agents, and thus a stronger public role. Hence, funding is mainly focused on public sources through specific (and innovative) taxing mechanisms such as the GEMAPI tax² in France, government funds (including national funds), and external funding from international organisms (e.g. EU funding). In the particular case of Glinsica, external funding and perceived interest are considered as the critical drivers to determine the type of agent finally taking the initiative to implement the strategy (either NGO, government or private entity).

At the urban or city scale, most initiatives identify the Municipalities as main promoters along with some private investments by neighbour communities or businesses. Funding strategies include indirect funding through citizen taxes, external funds from international organisms (e.g. EU grants), or community private investments. It is interesting how in the case of Lodz, some public funds have been derived as 'civilian budgets' to citizen organisations, such as 'Housing cooperatives', to undertake some of the interventions benefiting collectives within a certain part of the city. This kind of public-private partnerships have been very important to engage the citizens and speed up the implementation of NBS in buildings in the city.

The analysis of the **keys for success** shows a series of factors that appear reiteratively in two or more strategies and demos. These include funding availability (from EU or other sources) to start or continue the intervention, cooperation of stakeholders at different scales, proven performance of the efficacy of the measures (critical in those demos where the solutions have been already applied, i.e. Thames, Lodz, Rotterdam), and political will or enabling environment.

Among the **barriers to reach implementation**, the most recurrent ones are uncertainty about or lack of funding for implementation and later maintenance; uncertainty about or lack of performance; inertia, reluctance, or lack of cooperation of stakeholders; possible political changes/unwillingness blocking implementation; need for systematic monitoring; lobby and opposition from some collectives; and regulatory gaps.

Zooming out, some insights that can be drawn as common factors across all the demos.

First, regarding the role of **legislation**, EU legislation (particularly the WFD and FD) is found to be a strong driver and support for the implementation of NBS in most of the demos. Another highly mentioned set of rules include the land use and rural/urban development agendas that push for innovation towards sustainable development. These pieces of legislation provide the enabling frame favouring the introduction of NBS within the investment and intervention programmes, as their comparative environmental benefits usually align with their overall strategic objectives. However, legislation is also identified as a potential barrier or required key for success, as often the formulation or application of national and local legislation and procedures (e.g. procurement and licensing) need to be adapted to include new types of interventions.

Second, a common highlight is the critical role of EU funding to enable the design and promotion of these interventions. Thanks to NAIAD and some complementary projects, some of the demo strategies (such as Rotterdam, Thames or Medina in the near future) have reached the implementation phase, and thus are

² The GEMAPI tax is a recent tax levied at the municipal level to fund activities aiming at the prevention of floods and the management of aquatic ecosystems. This tax was created to support the transfer of this competence from the State to Municipalities, undertaken in the framework of the decentralization process.



able to generate evidence of performance to inspire and catalyse replication or emulation. NAIAD has also been instrumental to design a strategy for Lower Danube, Glinsica, Lez and Brague, and to push forward the interest among the relevant stakeholders.

Third, it is really important but also difficulty to engage indirect beneficiaries within the pool of payers and funders, whereas in all cases it is the whole of the society who gets benefitted. In this line, insurance companies are mentioned in most of the strategies as indirect beneficiaries and potential contributors to the funding. Therefore, the efforts made in the project to make the sector aware of the NBS case are a big step forward. An interesting and pioneering example of implication of the insurance sector in funding NBS due to the perceived benefits is the Barnier fund in France, reported as an important potential source of funding for both the Lez and the Brague strategies. Other important funding sources from indirect beneficiaries identified include crowdfunding from citizens/water users (proposed as interesting by e.g. Medina demo stakeholders), fees to tourists (an unexploited sector with great potential), specific taxes, payment mechanisms for co-benefits (mainly ecosystem services), and contributions from other benefitted private companies (such as water or energy utilities).

Overall, the application of the NAS canvas to NAIAD demos enabled to reflect the value and build the map of actors and actions required to pave the way towards implementation of NAIAD NAS strategies. This one-eye-shot compilation of expected value, resources required, actors and roles, possible funding streams, regulatory framework and battery of indicators to measure performance, provides with a strong tool to showcase the feasibility and impact of an NBS intervention, providing a solid scientific or evidence founded base to identify and attract the interest of potential investors or implementers.

5 References

- Arcadis. (2019). MKBA Klimaatbestendige Inrichting Pilotwijken: Pilot Spangen (Rotterdam) en Mariahoeve (Den Haag).
- Arfaoui, N., & Gnonlonfin, A. (2019). The economic value of NBS restoration measures and their benefits in a river basin context: A meta-analysis regression. FAERE Working Paper 09.
- Bervaes, J. (2004). *De invloed van groen en water op de transactieprijzen van woningen, Altera-Rapport 959*. Wageningen.
- EEA (2016) Floodplain management: reducing flood risks and restoring healthy ecosystems. Available at <http://www.eea.europa.eu/highlights/floodplain-management-reducing-flood-risks>
- Eftc (2015) Development of 'look-up' environmental values for initial appraisal within cost-benefit analysis, Final report for Defra BE0111
<http://sciencesearch.defra.gov.uk/Default.aspx?Module=More&Location=None&ProjectID=19514>
- FAO (2019) Conservation agriculture. Available at: <http://www.fao.org/conservation-agriculture/overview/principles-of-ca/en/>
- Graveline, N., Joyce, J., Calatrava, J., Douai, A., Arfaoui, N., Moncoulon, D., Manez, M., De Ryke H., Zdravko K. (2017) DELIVERABLE 4.1 : General Framework for the economic assessment of Nature Based Solutions and their insurance value. EU Horizon 2020 NAIAD Project, Grant Agreement N°730497
- High-Level Commission on Carbon Prices. (2017). *Report of the High-Level Commission on Carbon Prices*. Washington DC.
- IBAN (2018) PPPCanvas: a simple tool to tackle complex business models of Public-Private Partnerships. Available at: <https://www.inclusivebusiness.net/ib-voices/pppcanvas-simple-tool-tackle-complex-business-models-public-private-partnerships>
- Levkovich, O., Rouwendal, J., & Brugman, L. (2018). Spatial planning and segmentation of the land market: The case of the Netherlands. *Land Economics*, 94(1), 137–154.
- Moro, A., & Lonza, L. (2018). Electricity carbon intensity in European Member States: Impacts on GHG emissions of electric vehicles. *Transportation Research Part D: Transport and Environment*, 64(July 2017), 5–14.
- Nowak, D.J., Hirabayashi, S., Doyle, M., McGovern, M., Pasher, J. (2018) Air pollution removal by urban forests in Canada and its effect on air quality and human health. *Urban For. Urban Green.*, 29, pp. 40-48, [10.1016/j.ufug.2017.10.019](https://doi.org/10.1016/j.ufug.2017.10.019)
- Ossa-Moreno, J. Smith, K.M., & Mijic, A. (2017) Economic analysis of wider benefits to facilitate SuDS uptake in London, UK. *Sustainable Cities and Society* 28 (2017) 411–419.
- Osterwalder, A. and Pigneur, Y (2010) *Business Model Generation*. Wiley & Sons, Canada.
- Vewin. (2017). *Dutch Drinking Water Statistics 2017: From source to tap*, available at: <https://www.vewin.nl/SiteCollectionDocuments/Publicaties/Cijfers/Drinkwaterstatistieken-2017-EN.pdf>
- WEF (2019a) World Economic Forum: Global Risks Report, 2019.
- WEF (2019b) Water crises are a top global risk. Available at: <https://www.weforum.org/agenda/2015/01/why-world-water-crises-are-a-top-global-risk/>

6 Annexes

6.1 Annex 1. Extended linear NAS canvas description of NAIAD demos' NAS strategies

NAS strategies in large scale demos

MEDINA DEMO NAS STRATEGY 1: MANAGED AQUIFER RECHARGE (MAR) AND GROUNDWATER MANAGEMENT	
CLUSTER A: FLOW OF SERVICES	
STEP1. PROBLEM TO BE ADDRESSED	Impacts from droughts, groundwater overexploitation and degradation of surface riverine ecosystems along the Zapardiel river
STEP2. Value proposition	Improved groundwater levels recovery providing a back-up resource in case of drought, restoration of surface riverine vegetation and wetland ecosystems along the Zapardiel river.
2A. Primary service and value	increased groundwater availability (piezometric levels) to offset impacts in case of droughts. Avoided cost: 0. The recharge would have no effects on the deep aquifer and thus would not increase groundwater availability for irrigation. The limitation of extractions to permitted levels would reduce water availability for some farmers, thus reducing the average rent of agriculture. However, the slow recovery of the aquifer and higher flexibility through the WUAS' management mechanisms would allow to offset the impacts of severe droughts by distributing the water along the crops. Improvement of wetlands and aquatic ecosystems (surface of wetland recovered)
2B. Secondary services and value	The method applied to value the co-benefits was a qualitative valuation based on stakeholders' perceptions. The perceptions were gathered through 2 participatory workshops where representatives of all stakeholder groups (farmers and farmer associations, RBA, local government, NGOs and academia). The co-benefits were identified and ranked by expected impact by stakeholders and completed by the Medina demo team in the first workshop. Then, during a second workshops the highest ranked co-benefits were valued by the stakeholders, by giving a value in a scale from 1 to 10, being 10 the highest possible impact achieved and 1 the lowest possible impact achieved. The final value was calculated as an average of the individual values provided by the participants in the group. Better surface water availability (v: 7.5) Population fixation (v: 8.1) Improved water quality (v: 7.4) Sustainable groundwater availability (GW exploitation index=0.8) Farmer empowerment and legal protection (v: 6) Improved capacity to negotiate prices (v: 4.8) Attraction of rural green tourism (v: 5.4)
CLUSTER B: REGULATORY CONTEXT	
STEP 3. REGULATION	Drought/flood directive, Water Framework Directive (WFD) National river basin planning Duero River Basin Planning Common Agricultural Policy (CAP) Habitat Directive
CLUSTER C: MAPPING THE SUPPLY	
STEP 4: WHO IMPLEMENTS	Confederación Hidrográfica del Duero (MAR, GW monitoring and Farmer awareness raising and information) Farmers (WUAs and meters)



STEP 5. KEY ACTIVITIES

-MAR at Zapardiel river: Use of the existing pipeline infrastructures of the “Río Adaja” irrigation system. The recharge is planned to be carried out mainly through the riverbed of the river Zapardiel. Selection of Magazos^o pond as the infrastructure to develop the recharge. Installation of a 500 mm diameter and 7 m long PVC pipe that will connect the irrigation pond of Magazos with the receiving watercourses, the streams Valtodano and Zanja de las Aloberas, tributaries of the river Zapardiel, in the municipality of Langa.

Activities: trench excavation; trench filling and excavation material; Construction of concrete well; installation of PVC pipe; Site board; Health and safety measures; operation and maintenance.

Soft measures:

- Creation of Water User Associations for internal control of GW abstractions
- Application of meters for groundwater control and monitoring.
- Environmental awareness and information increase among farmers

STEP 6. KEY RESOURCES

Funds, knowledge/information, technical skills and human resources (CHD), political support, technological support, environmental approval (EIA), political will and cooperation of farmers, smooth communication,

STEP 7. KEY PARTNERS

CHD
Junta de Castilla y León (Regional government)
Sociedad Pública de Infraestructuras de medio ambiente de Castilla y León.
Diputaciones de Ávila and Valladolid (provincial government) and municipalities
Construction companies
Environmental consultancy
Farmer leaders

CLUSTER D: MAPPING THE COSTS OF THE SERVICE

STEP 8. COST STRUCTURE

MAR: Drafting of project
Construction works. Cost of infrastructure. Management cost. Maintenance and operation cost.
WUAS: cost of creation, + technical advice + manager + materials
Monitoring: Meter cost, surveillance: a person to carry out surveillance, meter reading (or related or telecontrol and reading system), conflict solving.
Environmental awareness: cost of workshops

8A. Lifecycle costs

MAR: 110,000 € (pipe construction costs), O&M costs are neglectable since the main infrastructure is owned and maintained by the Adaja Irrigation Community.
WUAS: for farmers: cost of creation + manager + materials + technician + protocol information = 100,000 €/year.
For CHD: 500,000 € for a 3 years tender to provide free technical advice for newly founded WUAS.
Monitoring: for farmers: cost of meter purchase (400 €/meter)
Environmental awareness: cost of workshops (5,000 € each)

8B. Opportunity costs

Avoided benefits from other NAS strategies (to be estimated)

CLUSTER E: MAPPING THE DEMAND

STEP 9: WHO OWNS THE PROBLEM

All water users, especially farmers
CHD (they have to achieve good water status to comply with European regulation)
Ecosystems

STEP 10: CUSTOMER SEGMENTS

10A. Direct beneficiaries

Farmers
Citizens from local municipalities
Ecosystems

10B. Clients

Farmers
Users

10C. Indirect beneficiaries

Insurance sector
Tourists
Government (more taxes collection)
Ecosystems

CLUSTER F: MAPPING THE ABILITY/WILLINGNESS TO PAY	
STEP 11. REVENUE STREAMS	Fees paid by tourists to visit the recovered wetlands and for bird watching Increased agricultural turn overs thanks to greater water security and crop planning
STEP 12: FUNDING	
12A. Tariffs	Quotas paid by farmers to form WUAs
12B. Taxes	tax paid to CHD by users, pre-agreed with users, ex-post Taxes paid by tourists Money collected from fines and sanctions for excess water abstraction
12C. Transfers	CHD budget, European funds: LIFE Project Subsidies from CHD or Junta CyL to cover technical advice for WUA formation and capacity building sessions, possible support for acquisition of meters. PAC subsidies.
12D. Private funds or investment	Funds invested by farmers (purchase of meters, costs of WUA formation). Crowd funding, land banks, land surveillance.
CLUSTER G. MAPPING THE SUPPLY-DEMAND INTERACTIONS	
STEP 13: CUSTOMER RELATIONSHIP	Direct assessment through public participation, personal with representatives from irrigation communities. Community in the case of WUAs.
STEP 14: CHANNELS	BOE Notifications Official letters and communications Public participation and information workshops
CLUSTER H: IMPACT	
STEP 15: IMPACT through KPIs (simulated to 2050)	- Groundwater exploitation index (maximum goal EI=0.8, middle goal EI=1) - Ratio of aquifer surface with nitrate concentration complying with water quality standards (below 50 mg/L): Goal close to 100 % - Ratio of aquifer surface with arsenic concentrations complying with water quality standards (below 10 micrograms/L): goal close to 100 %) -Trend of piezometric levels: by 2050 with EI 0.8 no reduction in piezometric levels as compared to 10m reduction under business as usual (EI=1.65). (see simulated values in table A1) -Minimum area to grant an average salary: 11.88 ha compared to 18.76 ha in BAU -Social profitability of water: 15.75 jobs/Mm³ compared to 11.60 jobs/Mm³ in BAU -Average water value: 0.45 €/m³ compared to 0.32 €/m³ in BAU -Employments in agriculture: 0.089 jobs/ha compared to 0.05 jobs/ha in BAU -Percentage of farmers that are part of a WUA: goal 100% -Percentage of farmers installing meters: goal 100% -Percentage of farmer having access to information about the groundwater status: goal 100%
ADDITIONAL STEPS	
STEP 16. Success conditions	Obtaining of EU funding within the LIFE IP Duero project; Alignment with river basin management plan Negotiations with farmers to go the 'soft path' to create WUAs instead of via legislative mandate.
STEP 17. Existing or potential barriers	Uncertainty about the extent of impact on groundwater level recovery Reluctancy among farmers to accept some of the measures Need for internal governance – lack of mutual trust between farmers Human resources limitations in CHD Role of landowners who rent the land and may not be interested in undertaking investments



	Possible political changes constraining the implementation of the measures Possible social opposition
SOURCE	NAIAD MEDINA DEMO, D6.3, assessment by Beatriz Mayor (Icatalist), with support of Javier Calatrava (UPTC), Marisol Manzano (UPTC), Alejandra Marín (Icatalist). LIFE IP Duero proposal Medina Stakeholder interviews and stakeholder workshop reports

MEDINA DEMO NAS STRATEGY 2: CHANGE IN AGRICULTURAL PRACTICES AND GROUNDWATER MANAGEMENT

CLUSTER A. FLOW OF SERVICES

STEP1. PROBLEM TO BE ADDRESSED	Impacts from droughts and groundwater overexploitation
STEP2. VALUE PROPOSITION	Reduce vulnerability of agriculture against droughts by reducing water demand and dependency of agriculture while recovering the aquifer piezometric levels thus providing an increased offset capacity in case of extremely severe or prolonged droughts.
2A. Primary service and value	Drought coping capacity: increased farm margin as compared to agricultural margins when the crop change measure has not been applied. Insurance value: 11.90-12.09 M€. The insurance value has been estimated comparing the NAS strategy with a BAU + control of abstractions scenario as explained in D6.3. This allows to estimate the direct effect of the crop change and crop rotation measures as compared to the non application of the measure once the control of abstractions (legal objective) has been applied.
2B. Secondary services and value	The method applied to value the co-benefits was a qualitative valuation based on stakeholders' perceptions. The perceptions were gathered through 2 participatory workshops where representatives of all stakeholder groups (farmers and farmer associations, RBA, local government, NGOs and academia). The co-benefits were identified and ranked by expected impact by stakeholders and completed by the Medina demo team in the first workshop. Then, during a second workshop the highest ranked co-benefits were valued by the stakeholders, by giving a consensual value in a scale from 1 to 10, being 10 the highest possible impact achieved and 1 the lowest possible impact achieved. Maintain economic productivity of agriculture (v: 9), Higher water productivity of agriculture (v: 9), population fixation (v: 6.7) Improvement of water quality (v: 9) Higher groundwater availability (v: 9) Higher organisation, empowerment and legal protection of farmers (v: 9), Higher access to information and environmental awareness (v: 8) CO ₂ capture (v: 8) Biodiversity improvement (v: 7)

CLUSTER B: REGULATORY CONTEXT

STEP 3. REGULATION	Common Agricultural Policy (CAP) Programa de Desarrollo Rural de Castilla y León Duero River Basin Planning Directive 91/676/CEE concerning the <i>protection</i> of waters against pollution caused by <i>nitrates</i> from agricultural sources. Drought directive Water Framework Directive (WFD)
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CLUSTER C: MAPPING THE SUPPLY

STEP 4: WHO IMPLEMENTS	Farmers (crop change, conservation practices, WUAs and meters) Confederación Hidrográfica del Duero (GW monitoring and farmer awareness raising and information)
STEP 5. KEY ACTIVITIES	-Crop change: feasibility study of different crop species at the farm level, selection of most suitable crops and design of cropping pattern, purchasing/renting specific machinery, purchasing of seeds and inputs, land preparation and work, establishment of any required



	additional infrastructure (adapted irrigation system, supporting structures,...), annual post harvest maintenance of trees. -Soil water conservation measures: training course on selection and application of soil water conservation measures, design of crop rotation pattern, purchase/acquisition of mulching material, application of practice. Soft measures: -Creation of Water User Associations for internal control of GW abstractions: -Application of meters for groundwater control and monitoring: purchase and installation of meters, lecture recording and submission, surveillance of compliance. -Environmental awareness and information increase among farmers: design of information materials, scheduling and provision of awareness raising workshops/materials.
STEP 6. KEY RESOURCES	Funds, knowledge/information, technical skills and human resources (CHD), political support, technological support, cooperation of farmers, smooth communication, new agricultural inputs (seeds) and machinery
STEP 7. KEY PARTNERS	CHD Junta de Castilla y León (Regional government) Itacyl (training courses and feasibility studies) Agricultural input retailers Farmer leaders Farmers
CLUSTER D: MAPPING THE COSTS OF THE SERVICE	
STEP 8. COST STRUCTURE	Crop change: Investment + operation and maintenance Monitoring: purchase and installation of meters, surveillance, maintenance. WUAS: cost of creation, + technical advice + manager Environmental awareness: cost of organizing information workshops and sessions
8A. Lifecycle costs	Crop change: upfront investment costs, technical assistance e.g. almond: plant (1.200-3.000 €/ha, planting: 2.100€/ha, irrigation: 1.200 €/ha + drip system (3.000 €/ha). Total: 7.500 -9.000 €/ha Annual O&M: treatments + irrigation + pruning 1.525 €/ha, harvesting 400 €/ha). Conservation agriculture: low, if not reused, purchase of mulching material. In trees: cover crops + spring prune: 50 €/ha/year WUAS: for farmers: cost of creation + manager + materials + technician + protocol information = 100,000 €/year. For CHD: 500.000 € to provide technical advise (3 years tender) Monitoring: for farmers: cost of meter purchase (400 €/meter) Environmental awareness: cost of workshops (5,000 € each)
8B. Opportunity costs:	Avoided benefits from alternative strategy
CLUSTER E: MAPPING THE DEMAND	
STEP 9: WHO OWNS THE PROBLEM	Farmers Indirectly all groundwater users CHD (they have to achieve good water status to comply with European regulation)
STEP 10: CUSTOMER SEGMENTS	
10A. Direct beneficiaries	Farmers CHD (will comply with legislation)
10B. Clients	Farmers
10C. Indirect beneficiaries	Insurance sector All water users depending on the aquifer Tourists Government (more taxes collection) Ecosystems
CLUSTER F: MAPPING THE ABILITY/WILLINGNESS TO PAY	



STEP 11. REVENUE STREAMS	Fees paid by tourists for bird watching Increased agricultural turn overs thanks to greater water security and crop planning
STEP 12: FUNDING	
12A. Tariffs.	Quotas paid by farmers to form WUAS Water tariff
12B. Taxes	tax paid to CHD by farmers Taxes paid by tourists Money collected from fines and sanctions for excess water abstraction
12C. Transfers	CHD and Junta CyL budget, European funds: LIFE Project, FEADER funds (i.e. for drip) Subsidies from CHD or Junta CyL to cover technical advice for WUA formation and capacity building sessions, possible support for acquisition of meters.
12D. Private funds or investment	Funds invested by farmers (purchase of meters, costs of WUA formation, part of upfront investment)
CLUSTER G. MAPPING THE SUPPLY-DEMAND INTERACTIONS	
STEP 13: CUSTOMER RELATIONSHIP	Direct assistance through public participation, personal with representatives from irrigation communities, direct technical advice. Community in the case of WUAs.
STEP 14: CHANNELS	BOE Notifications Official letters and communications Public participation and information workshops Direct meetings with WUA presidents
CLUSTER H: IMPACT	
STEP 15: IMPACT through KPIs	- Groundwater exploitation index (maximum goal EI=0.8, middle goal EI=1) - Ratio of aquifer surface with nitrate concentration complying with water quality standards (below 50 mg/L) (Objective: close to 100 %) - Ratio of aquifer surface with arsenic concentrations complying with water quality standards (below 10 micrograms/L)(Objective: close to 100 %) -Trend of piezometric levels: by 2050 with EI 0.8 no reduction in piezometric levels as compared to 10m reduction under business as usual (EI=1.65). (see simulated values in table A1) -Minimum area to grant an average salary: 10.58 ha compared to 18.76 ha in BAU -Social profitability of water: 16.20 jobs/Mm³ compared to 11.60 jobs/Mm³ in BAU -Average water value: 0.53 €/m³ compared to 0.32 €/m³ in BAU -Employments in agriculture: 0.086 jobs/ha compared to 0.058 jobs/ha in BAU -Percentage of farmers that are part of a WUA (goal 100%) -Percentage of farmers installing meters (goal 100%) -Percentage of farmer having access to information about the groundwater status (goal 100%) -Irrigation efficiency (5,200 m³/ha) -Employments in agriculture (0.089-0.090 employments/ha) -Economic profitability per employment (32,110 – 32,232 EUR/employment)
ADDITIONAL STEPS	
STEP 16. Success conditions	Obtaining of EU funding within the LIFE IP Duero project; Alignment with river basin management plan Negotiations with farmers to go the 'soft path' to create WUAs instead of via legislative mandate.
STEP 17. Existing or potential barriers	Lack of evidence on the profitability of the proposed crops Reluctancy among farmers to accept crop change due to the investment, uncertainty Need for internal governance – lack of mutual trust between farmers Human resources limitations in CHD Role of landowners who rent the land and may not be interested in undertaking investments Possible political changes constraining the implementation of the measures

	Possible social opposition Intermediates in the value chain are very powerful and sometimes disincentive farmer associations (they only sign contracts with individuals to keep more control over them). Lack of perception of future water limitations due to the false feeling of security of groundwater as an unlimited source Inertia among old farmers Lack of communication and coherence between water and agricultural policies and institutions; crossed effects and objectives between the CAP greening measures and the water measures.
SOURCE	NAIAD MEDINA DEMO, assessment by Beatriz Mayor (Icatalist), with support of Javier Calatrava (UPTC), Marisol Manzano (UPTC), Alejandra Marín (Icatalist). D6.3, LIFE IP Duero, Medina Stakeholder interviews and stakeholder workshop reports

Table A1. Modelled piezometric changes between 2018 and 2050 and 2350 (total change in m; rate in m/yr) under three groundwater management scenarios (0: EI = business as usual; 1: EI= 0.85 by 2050; 2: EI= 0.8 by 2050) and three precipitation scenarios (a: no changes in precipitation; b: precipitation increases 3% by 2050; c: precipitation decreases 8% by 2050). Source: regional groundwater flow modelling; UPCT.

Precipitation scenarios	Exploitation Index (EI) scenarios and piezometric changes					
	0- BAU (EI = 1.65)		1- EI = 0.85 by 2050 and beyond		2- EI = 0.8 by 2050 and beyond	
	Total change (m)	Rate (m/yr)	Total change (m)	Rate (m/yr)	Total change (m)	Rate (m/yr)
a. No changes in precipitation (current values)	By 2050: -10 m	-0.333 NA	By 2050: -1 m By 2350: +4 m	-0.033 0.012	By 2050: 0 m By 2350: +6 m	0.0000 0.018
b. Precipitation increases up to 3% by 2050 (NAIAD, 2019)	By 2050: -10 m	-0.333 NA	By 2050: -1 m By 2350: +5 m	-0.033 0.015	By 2050: 0 m By 2350: +7 m	0.000 0.021
c. Precipitation decreases up to 8% by 2050 (CEDEX, 2017)	By 2050: -10 m	-0.333 NA	By 2050: -1 m By 2350: +2 m	-0.033 0.006	By 2050: 0 m By 2350: +4 m	0.000 0.012

Brief explanation: groundwater management (through reducing the EI) has a much larger impact on piezometric recovering than climate change (through modified recharge to the regional aquifer). In the short term (year 2050), the piezometric level in the centre of the DEMO area would be as in year 2018 (no changes) with EI=0.8 and 1 m lower (-1 m) with EI=0.85, for whatever climate scenario. By year 2350, the recovery of the piezometric level would be 2 m higher with EI=0.8 than with EI=0.85 for whatever climate scenario. For EI=0.8, the piezometric recovering rate between years 2018 and 2350 would be 0.012 m/yr if the precipitation decreases 8%; 0.021 m/yr if the precipitation increases 3% and 0.018 m/yr if there were no changes in precipitation.



THAMES DEMO NAS STRATEGY 1: LEAKY WOODY DEBRIS DAMS

CLUSTER A. FLOW OF SERVICES

STEP1. PROBLEM TO BE ADDRESSED	Flooding
STEP2. Value proposition	Leaky dams reduce river flow by slowing the rate of flow, reducing flood peaks and holding back water or encouraging out of bank flow in designated flood storage areas in rural floodplains above urban areas during flood events
2A. Primary service and value	No monetary service value available. Value is thought to be low as there is only a very localised impact on flow reduction. Dams are effective once water levels reach the bottom of the dam - there is a gap at the bottom of the dam (20-30cm) to allow normal flows through and aquatic life to move up and downstream freely. Intervention needs to be very close to the assets at risk and there needs to be a large number in order to be effective.
2B. Secondary services and value	£0/ no co-benefits. Possible disbenefits include risk of dam failure during large events causing culvert blockage downstream. To reduce this risk the dams are made with long logs relative to stream width but there is significant risk that small pieces can detach and move downstream out of the designated flood storage area

CLUSTER B: REGULATORY CONTEXT

STEP 3. REGULATION	The strategic overview for managing and reducing flood risk is the responsibility of the Department of Food and Rural Affairs (DEFRA) through the Environment Agency (Flood and Water Management Act 2010). This is delivered by Risk Assessment Management Authorities (RMAs - see next section). Note that this act requires RMAs to aim to contribute towards the achievement of sustainable development when exercising their flood and coastal erosion risk management functions. Other relevant policies are prepared with the Treasury, the Cabinet Office (for emergency response planning), the Department for Communities and Local Government (for land-use and planning policy)
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CLUSTER C: MAPPING THE SUPPLY

STEP 4: WHO IMPLEMENTS	Managing and reducing flood risk is the joint responsibility of a number of bodies. The Department for Environment, Food and Rural Affairs (Defra) is the policy lead in England. These national policies are then delivered by Risk Assessment Management Authorities (RMAs) which are: • Environment Agency - which has a strategic overview of all flooding. The EA deliver projects to manage flood risks from <i>main</i> rivers • Lead Local Flood Authorities - which are county councils and unitary authorities. LLFAs lead in managing local flood risks (i.e. risks of flooding from surface water, ground water and <i>ordinary</i> (smaller) watercourses). • District and Borough Councils - which have the power for works in relation to <i>ordinary</i> (smaller) watercourses outside of IDB areas) • Internal Drainage Boards (IDBs) supervise land drainage and flood defence works on <i>ordinary</i> (smaller) watercourses RMAs not currently implementing leaky dams: • Coast protection authorities (not applicable for leaky dams) • Water and sewerage companies - manage the risk of flooding to water supply and sewerage facilities • Highways authorities - manage highway drainage and roadside ditches In July 2017 DEFRA granted £15 million funding for 60 "natural flood management schemes" to the EA, LLFAs and Councils, many of which incorporated leaky wooden debris dams. According to funding limits, these were built by engineering companies and by local volunteer conservation groups such as Thames21. Land owners within approved areas can also apply for grant of £764.42 per dam via the Countryside Stewardship Scheme.
STEP 5. KEY ACTIVITIES	RMA Identifies areas at risk of flooding (from Flood Map for Planning) , identify rivers causing flood (usually ordinary watercourses only suitable for woody dams); locate suitable spot for leaky dam with capacity for flood storage and enhancement of floodplain reconnection,



	contact land owners, compile risk assessment, assess impact on protected areas, habitats, archaeological sites, obtain permissions.
STEP 6. KEY RESOURCES	Knowledge on whether the leaky dam will actually work which would come from academia/consultant/literature. Funding - currently there is governmental backing (DEFRA £15million total funding until 2021)
STEP 7. KEY PARTNERS	Government - funding and political will Contractors/staff/volunteers to build dams Landowners - permission
CLUSTER D: MAPPING THE COSTS OF THE SERVICE	
STEP 8. COST STRUCTURE	Initial Costs: grant Maintenance costs covered by the owner/manager - could be an employee but could be a volunteer
8A. Lifecycle costs	Initial cost of £100 - £3000; median £175 - £500 Limited lifespan (10 years) Maintenance: UNK; need to be inspected frequently for soil accumulation and wood debris so maintenance is mostly manual labour (approx £50/hour but could be free if volunteers are checking)
8B. Opportunity costs	None in regards to other uses of the land. During period of out of bank flood storage the land will be impassable. Limited evidence base for leaky dams so choosing this NBS is taking a risk, but all NBS have a limited evidence base so there isn't much of an opportunity cost really
CLUSTER E: MAPPING THE DEMAND	
STEP 9: WHO OWNS THE PROBLEM	Residents and businesses in the Flood Zone (impact) Government - DEFRA -(responsibility)
STEP 10: CUSTOMER SEGMENTS	
10A. Direct beneficiaries	Downstream residents and businesses
10B. Clients	Government (indirectly through taxpayers nationally)
10C. Indirect beneficiaries	Society as a whole - less government money spent on aid and less money paid by insurance companies which should keep premiums lower
CLUSTER F: MAPPING THE ABILITY/WILLINGNESS TO PAY	
STEP 11. REVENUE STREAMS	Government money as a donation
STEP 12: FUNDING	
12A. Tariffs	No
12B. Taxes	Indirectly through general income tax paid to the government
12C. Transfers	Government through public budget
12D. Private funds or investment	No
CLUSTER G. MAPPING THE SUPPLY-DEMAND INTERACTIONS	
STEP 13: CUSTOMER RELATIONSHIP	Transactional. No direct involvement between government and NGOs/citizens. NGOs or citizen groups bid for funding from the government and then were given funding with reporting obligations attached. A key requirement of the DEFRA funding is that the projects are monitored according to EA guidelines and report to what extent these projects: 1. reduce flood risk to homes 2. improve habitats and increased biodiversity 3. support and develop partnership working with and between communities 4. contribute to research and development.



STEP 14: CHANNELS	Formal bids and reporting - the groups bid for the funding and if successful have to complete reports.
CLUSTER H: IMPACT	
STEP 15: IMPACT through KPIs	- amount of water held back by the intervention - the reduction in flood peak downstream - the length of time it slowed the flow
ADDITIONAL STEPS	
STEP 16. Success conditions	does the intervention actually reduce flood risk where assets are at risk
STEP 17. Existing or potential barriers	Systematic monitoring across geographies - //SmartRiver sensors and stations developed as part of this project are a major contribution to this deficit. Question of liability in case installed on privately owned land and flooding occurs.
SOURCE	<i>NAIAD THAMES DEMO, assessment by Caitlin Douglas with support of Sophia Burke, Mark Hülligan,...</i>



THAMES DEMO NAS STRATEGY 2: CONSERVATION AGRICULTURE

CLUSTER A. FLOW OF SERVICES

STEP1. PROBLEM TO BE ADDRESSED	Downstream flooding
STEP2. Value proposition	Conservation agriculture practices no/low tillage. The value of conservation agriculture for managing flood risk is that the soil has a lower bulk density and higher soil organic matter, improved infiltration and drainage which makes it better able to hold water. Although the crop yields can be lower than traditional agriculture, the costs of conservation agriculture are lower because it requires less fuel, machinery and effort. This type of NBS can be applied over a wide area and thus have a notable impact on flood reduction.
2A. Primary service and value	No monetary service value available, but conservation agriculture is capable of reducing peak flow on tributaries of the Thames by 15% (for an investment of less than £250,000 per tributary) (D2.5).
2B. Secondary services and value	No monetary value specifically for Thames available, although many global economic assessments of CA e.g. FAO have placed high values on co-benefits of CA. Co benefits include: soil carbon sequestration when soil is not disturbed, soil biodiversity, water resources - improved infiltration, reduced agricultural contamination, sediment retention due to reduced runoff. Reduced inputs of labour, machinery (diesel) and pesticides.

CLUSTER B: REGULATORY CONTEXT

STEP 3. REGULATION	The strategic overview for managing and reducing flood risk is the joint responsibility of the Department of Food and Rural Affairs (DEFRA) through the Environment Agency the national government i.e. Environment Agency (EA) (Flood and Water Management Act 2010). This is delivered by Risk Assessment Management Authorities (RMAs - see next section). Note that this act requires RMAs to aim to contribute towards the achievement of sustainable development when exercising their flood and coastal erosion risk management functions. Other relevant policies are prepared with the Treasury, the Cabinet Office (for emergency response planning), the Department for Communities and Local Government (for land-use and planning policy)
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CLUSTER C: MAPPING THE SUPPLY

STEP 4: WHO IMPLEMENTS	Land owner (farmer) ultimately implements (perhaps through agent who manages the estate)
STEP 5. KEY ACTIVITIES	Change land management techniques and ethos. Conservation Agriculture is based on three main principles adapted to reflect local conditions and needs (from FAO): • Minimum mechanical soil disturbance: no-tillage and direct seeding. • Permanent soil organic cover (ground cover crops) • Species diversification (rotation).
STEP 6. KEY RESOURCES	Knowledge/advice of conservation agriculture methods Events such as Groundswell, to help raise awareness Perhaps parametric subsidy for environmental services from the government to the landowner for the services provided by the land
STEP 7. KEY PARTNERS	Groundswell organisers and partners Land owners Government (i.e through parametric subsidy)

CLUSTER D: MAPPING THE COSTS OF THE SERVICE

STEP 8. COST STRUCTURE	All costs covered by farmer/land owner
8A. Lifecycle costs	Investment cost of reduced/zero tillage management practices is £0. Maintenance costs for reduced tillage estimated as £50/ha and for zero tillage as £67/ha.
8B. Opportunity costs	Reduction in productivity (i.e. crop production) estimated to be £32/ha for cereal crops.



CLUSTER E: MAPPING THE DEMAND

STEP 9: WHO OWNS THE PROBLEM	Residents and businesses (impact) Government (responsibility)
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STEP 10: CUSTOMER SEGMENTS

10A. Direct beneficiaries	Farmers, downstream residents and businesses
10B. Clients	Farmers
10C. Indirect beneficiaries	Wider society by the reduction government spending for emergency costs resulting from flooding, insurance companies (lower compensations for floods)

CLUSTER F: MAPPING THE ABILITY/WILLINGNESS TO PAY

STEP 11. REVENUE STREAMS	Private
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STEP 12: FUNDING

12A. Tariffs	No
12B. Taxes	No
12C. Transfers	No
12D. Private funds or investment	Investment by farmers

CLUSTER G. MAPPING THE SUPPLY-DEMAND INTERACTIONS

STEP 13: CUSTOMER RELATIONSHIP	Currently no relationship. Farmer/land owner decides to practice conservation agriculture. Currently no government incentives but this may change in the planned 25 Year Environment Plan.
STEP 14: CHANNELS	Annual conference at Groundswell Internet farming forums eg thefarmingforum.co.uk Outcomes of farm trials are presented by innovativefarmers.org

CLUSTER H: IMPACT

STEP 15: IMPACT through KPIs	soil moisture (%) (measurement) soil bulk density (g/cm3) (measurement) organic matter (%) infiltration (calculation) drainage (calculation) water storage (m3) (calculation)
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ADDITIONAL STEPS

STEP 16. Success conditions	does the intervention actually reduce flood risk
STEP 17. Existing or potential barriers	Farmers/land owners receive no benefit from reducing flood risk to downstream users or for the other environmental services provided by their choice of land management. Reduction of pesticides is potentially high risk for yields.
SOURCE	NAIAD THAMES DEMO, assessment by Caitlin Douglas with support of Sophia Burke, Mark Hülligan,...



THAMES DEMO NAS STRATEGY 3: Retention ponds

CLUSTER A. FLOW OF SERVICES

STEP1. PROBLEM TO BE ADDRESSED	Flooding
STEP2. Value proposition	Retention ponds store water so can reduce flooding downstream by holding back water. These are areas of floodplain which have been adapted (with a containment bund, inlet, outlet and spillway) to store and then release flood waters in a controlled manner. They provide temporary flood storage which can reduce peak flow. The extent of their flood risk effect depends on the number of storage areas provided throughout a catchment and their total storage volume. The water held within the pond can benefit the land owner/user by providing a source of water and/or for the pond's co-benefits. Examples within Thames include the Beam Washlands which has created wetland habitat and can store 450,000 m3 floodwater.
2A. Primary service and value	Monetary value unknown. Localised impact on flow reduction. Intervention needs to be close to the assets at risk.
2B. Secondary services and value	Monetary value unknown. Co-benefits include biodiversity, recreation and aesthetics. The amenity value of Beam Parklands, based on a projected 3% uplift to property values, was found to be £26 million over 99 years (Eftec, 2015). Disbenefits include the limited evidence of how these measures perform during extreme flood events. A great deal of caution is needed when designing them to ensure that any associated infrastructure are robustly designed and do not impact public safety.

CLUSTER B: REGULATORY CONTEXT

STEP 3. REGULATION	Managing and reducing flood risk is the joint responsibility of a number of bodies. The Department for Environment, Food and Rural Affairs (Defra) is the policy lead in England. These national policies are then delivered by Risk Assessment Management Authorities (RMAs) which are: • Environment Agency - which has a strategic overview of all flooding. The EA deliver projects to manage flood risks from <i>main</i> rivers • Lead Local Flood Authorities - which are county councils and unitary authorities. LLFAs lead in managing local flood risks (i.e. risks of flooding from surface water, ground water and <i>ordinary</i> (smaller) watercourses). • District and Borough Councils - which have the power for works in relation to <i>ordinary</i> (smaller) watercourses outside of IDB areas) • Internal Drainage Boards (IDBs) supervise land drainage and flood defence works on <i>ordinary</i> (smaller) watercourses RMAs not currently implementing retention ponds: • Coast protection authorities (not applicable for leaky dams) • Water and sewerage companies - manage the risk of flooding to water supply and sewerage facilities • Highways authorities - manage highway drainage and roadside ditches In July 2017 DEFRA granted £15 million funding for 60 "natural flood management schemes" to the EA, LLFAs and Councils, some of which incorporated retention ponds that are built by engineers.
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CLUSTER C: MAPPING THE SUPPLY

STEP 4: WHO IMPLEMENTS	Landowner
STEP 5. KEY ACTIVITIES	Build retention pond
STEP 6. KEY RESOURCES	Methods/guidance on construction of retention ponds eg Operational Flood Storage Areas
STEP 7. KEY PARTNERS	Construction companies, environmental advisors/consultants.



CLUSTER D: MAPPING THE COSTS OF THE SERVICE

STEP 8. COST STRUCTURE	Initial capital to build the pond plus maintenance costs
8A. Lifecycle costs	Retention ponds installed in an urban environment (i.e. part of SuDs) cost £15-50 per m3 of water stored. On farmland retention ponds are cheaper with a cost of £2.3 - 4 per m3. Maintenance costs associated with dredging range from £0.1 - 1 per m3 of water stored
8B. Opportunity costs	Storage ponds on agricultural land have an opportunity cost of loss of production. For a wheat crop, the opportunity cost is approx £100/yr

CLUSTER E: MAPPING THE DEMAND

STEP 9: WHO OWNS THE PROBLEM	Residents and businesses (impact) Government (responsibility)
STEP 10: CUSTOMER SEGMENTS	
10A. Direct beneficiaries	Landowner Downstream residents and businesses
10B. Clients	Owner
10C. Indirect beneficiaries	Society as a whole - government money not spent on aid and less money paid by insurance companies which should help to keep premiums more affordable

CLUSTER F: MAPPING THE ABILITY/WILLINGNESS TO PAY

STEP 11. REVENUE STREAMS	Private
STEP 12: FUNDING	
12A. Tariffs	No
12B. Taxes	No
12C. Transfers	No
12D. Private funds or investment	Yes, private funds only from landowners

CLUSTER G. MAPPING THE SUPPLY-DEMAND INTERACTIONS

STEP 13: CUSTOMER RELATIONSHIP	Currently no relationship. Farmer/land owner decides to practice conservation agriculture. Currently no government incentives but this may change in the planned 25 Year Environment Plan.
STEP 14: CHANNELS	Annual conference at Groundswell Internet farming forums eg thefarmingforum.co.uk Outcomes of farm trials are presented by innovativefarmers.org

CLUSTER H: IMPACT

STEP 15: IMPACT through KPIs	Volume of water held back by the intervention (m3)
ADDITIONAL STEPS	
STEP 16. Success conditions	Proofs of the extent to which the intervention actually reduces flood risk
STEP 17. Existing or potential barriers	Systematic monitoring across geographies - //SmartRiver sensors and stations developed as part of this project are a major contribution to this deficit
SOURCE	NAIAD THAMES DEMO, assessment by Caitlin Douglas with support of Sophia Burke, Mark Hülligan,...



LOWER DANUBE DEMO NAS STRATEGY 1: DANUBE FLOOD PLAIN RESTORATION

CLUSTER A. FLOW OF SERVICES

STEP1. PROBLEM TO BE ADDRESSED

Floods, Desertification, Erosion

STEP2. Value proposition

2A. Primary service and value

Flood risk reduction
Drought/desertification process reduction
Avoided damage costs:
Reference 2006 flood:
11470 evacuated people
642 houses destroyed
3200 affected households
36807 ha farmland
24 social-economic objectives
62,3 km roads
20 bridges and footbridges

2B. Secondary service and value

Estimation of specific values is in progress. Therefore, only qualitative identification is provided.
Economic:
Local businesses diversification and development
Environmental:
Increase in local biodiversity
Decrease in soil erosion.
Social:
Reduction of population migration from rural areas.

CLUSTER B: REGULATORY CONTEXT

STEP 3. REGULATION

Private -Public Partnership legislation
Expropriation legislation
Land use change legislation
Cadastre / unclear land ownership
European: Flood Directive and Water Framework Directive; Strategy for drought prevention and management

CLUSTER C: MAPPING THE SUPPLY

STEP 4. WHO IMPLEMENTS

Ministry of Waters & Forests (Flood Directive and Water Framework Directive) and Ministry of Agriculture and Rural Development (Strategy for drought prevention and management)
Local authorities that should implement the flood/drought protection measure
ANAR

STEP 5. KEY ACTIVITIES

Restore the former pond Potelu (use the existing drainage channels, install an underground screen to increase water level, etc)

Floodplain restoration Bistret-Rast area (the most feasible way to do it to be further evaluated during the Danube Floodplain project)

STEP 6. KEY RESOURCES.

Data: soil, water, cadastre, ownership, topography, etc
Public-Public cooperation protocol
Private -Public Partnership legislation
Political willingness (ASD to revise the leasing contracts)
Revise legislation about land use category change and land expropriation for public interest
Funding: EU Funds, National Funds

STEP 7. KEY PARTNERS:

Local authorities
County Councils
National Administration Romanian Waters (ANAR)
Ministry of Waters and Forests



Ministry of Agriculture and Rural Development (MARD)
The Agency for the State Domains (ADS)
Ministry of Environment
Engineering companies
NGOs for support and maintenance

CLUSTER D: MAPPING THE COSTS OF THE SERVICE

STEP 8. COST STRUCTURE

8A. Lifecycle costs	Data acquisition Hydraulic modelling /Establish wetland restorability Payments for land lost Construction costs/Materials costs Monitoring Administration and Maintenance
8B. Opportunity costs	Benefits from implementing the business as usual strategy or cost of land devoted to implement the measures or cost of implementing alternative strategies

CLUSTER E: MAPPING THE DEMAND

STEP 9: WHO OWNS THE PROBLEM	Municipalities, local residents, farmers (due to soil erosion problems)
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STEP 10: CUSTOMER SEGMENTS:

10A. Direct beneficiaries	Local population - villages along the Danube Local authorities The government
10B. Clients	Clients for fishing permits Local businesses and local tourism Tourists for services provided by local authority or private companies from the area
10C. Indirect beneficiaries	Local businesses (protection and sustainability) Local authorities (more taxes collected) Local biodiversity/ Ministry of Environment (Birds Directive and Ramsar Convention)

CLUSTER F: MAPPING THE ABILITY/WILLINGNESS TO PAY

STEP 11. REVENUE STREAMS	Fishing permits Fees for renting land/for providing various services Tourism fees, revenues from accommodation and food tourists/ birdwatchers/ fisherman Local handicraft/local food products
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STEP 12: FUNDING

12A. Tariffs	ANAR has its own budget from the tariffs charged for raw water consumption and wastewater discharge.
12B. Taxes	Taxes for fishing permits Taxes for local tourism
12C. Transfers	ANAR budget, national budget and/or loans/or EU funds for works needed in each basin for flood protection
12D. Private investment	No

CLUSTER G. MAPPING THE SUPPLY-DEMAND INTERACTIONS

STEP 13. CUSTOMER RELATIONSHIP	Local authority/Local Council – direct, Local farmers/ Local Authority -PPP: direct, automated, co-development (if they are involved in the design)
STEP 14. CHANNELS	Direct meetings private & public stakeholders Promotion at local/county/national level

CLUSTER H: IMPACT



**STEP 16: IMPACT
through KPIs:**

Development of local businesses
Increasing number of tourists
Number of permanent inhabitants
Increased biodiversity (number of birds, fishes population, number of plants/habitats)
Groundwater quantity and quality

ADDITIONAL STEPS

**STEP 17. Success
conditions**

Local community drive and available funding /financing options, Local , regional and national stakeholders cooperation - authorities, companies and citizens

**STEP 18. Existing or
potential barriers**

Opposition of the local large agricultural farms and of the Agency for State Domains, Local farmers opposition

SOURCE/S

-NAIAD Lower Danube Demo. Assessment by Ioana Groza, Florentina Nanu, BDG; Albert Scrieu, Geoecomar.
-<http://apepaduri.gov.ro/ministerul-apelor-si-padurilor-a-receptionat-in-acest-an-96-de-obiective-in-domeniul-gospodarii-apelor-comparativ-cu-37-in-2017-valoarea-totala-a-investitiilor-fiind-de-560-012-970-lei-respecti/>
Focus group Grojdibodu, December 4th, 2018, workshop 2 RBA Jiu, December 5th, 2018 and desk research,

NAS strategies in medium scale river focused demos

GLINSICA DEMO NAS STRATEGY 1: RESTORATION SCENARIO EXTENDED	
CLUSTER A. FLOW OF SERVICES	
STEP1. PROBLEM TO BE ADDRESSED	Deterioration of natural areas and flooding
STEP2. VALUE PROPOSITION	
2A. Primary service and value	Flood risk reduction: estimation is in progress. Reduction in human casualties n° or ratio, Value of damages on public infrastructure, Value of damages to buildings Enhanced natural areas
2B. Secondary service and value	Qualitative identification of co-benefits. Further estimations are in progress and couldn't be finalised before the submission of the deliverable. - Biodiversity and ecosystems state enhancement: - Community safety improvement: - Social value of ecosystems enhancement: increase in green spaces and provision of urban ecosystem services - Recreational values - Emotional, educational, cultural, visual values attracting tourism, - Pollination, - Ground water quantity and quality, - Biodiversity, - Drought mitigation, - Surface water purification and quantity, - Temperature mitigation, - Air pollution mitigation
CLUSTER B. REGULATORY CONTEXT	
STEP 3. REGULATION	Water Framework Directive and National Water Management Plan, Floods Directive and National Flood Reduction Plan, The Law on Waters, The Urban Agenda for the EU, The Slovenian Development Strategy 2030, Sustainable Urban Strategy of MOL, MOL Spatial Plan
CLUSTER C. MAPPING THE SUPPLY	
STEP 4: WHO IMPLEMENTS	In order of probability from highest to lowest: none, NGOs winning EU funding, City Municipality of Ljubljana, Slovenian Water Agency
STEP 5. KEY ACTIVITIES	NBS measures: - Improve retention areas effectiveness, - River renaturation with re-meandering, - Wetlands restoration, Activities involved: Physical risk assessment, Infrastructure maintenance, Search for funding opportunities for infrastructure, Territory control, Community involvement, Institutional cooperation, Training, Insurance policy effectiveness, Physical risk assessment infrastructure maintenance, Monitoring and warning system effectiveness
STEP 6. KEY RESOURCES	Expertise on river restoration, ecology, public participation, engineering, geology, awareness/education/perception among locals, experts and administrative bodies
STEP 7. KEY PARTNERS	local government, local people, Slovenian Water Agency, NGOs, environmental engineering companies, software companies (for monitoring software)
CLUSTER D. MAPPING THE COSTS OF THE SERVICE	



STEP 8. COST STRUCTURE:

8A. Lifecycle costs:	Estimation in progress
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8B. Opportunity costs	Estimation in progress
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CLUSTER E. MAPPING THE DEMAND

STEP 9: WHO OWNS THE PROBLEM	Ministry for Environment and Spatial Planning, Slovenian Water Agency Municipality of Ljubljana, residents of Ljubljana
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STEP 10: CUSTOMER SEGMENTS

10A. Direct beneficiaries	nature, residents, City Municipality of Ljubljana, Ministry of Environment and Spatial Planning, Insurance companies
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10B. Clients	residents, City Municipality of Ljubljana, Ministry of Environment and Spatial Planning, tourists
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10C. Indirect beneficiaries	everybody: nature, local people, citizens of Slovenia, tourists, Government, experts,...
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CLUSTER F. MAPPING THE ABILITY/WILLINGNESS TO PAY

STEP 11. REVENUE STREAMS	Fees paid by tourists and residents to use the green spaces.
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STEP 12: FUNDING

12A. Tariffs	No
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12B. Taxes	Possible tax paid by local residents for green spaces
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12C. Transfers	Funds provided by the City Municipality of Ljubljana, Ministry of Environment and Spatial Planning -Possible external funding from EU for implementation -Possible external funding from other donors
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12D. Private funds or investment	Possible external funds from private banks or actors Possible external investment from insurance companies
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CLUSTER G. MAPPING THE SUPPLY-DEMAND INTERACTIONS

STEP 13: CUSTOMER RELATIONSHIP	If implementor is NGO: indirect If implementor is Municipality or Slovenian Water Agency: indirect, or automated (via websites-communication) or co-development (if they involve the community to co-develop the actions) Resident installing a green roof: self-service
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STEP 14: CHANNELS	Websites, communications, public participation, formal letters, workshops, meetings, ...
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CLUSTER H. IMPACT

STEP 15: IMPACT through KPIs	- Biophysical: Runoff coefficient in relation to precipitation quantities (mm/%), Flood peak reduction (e.g. $Q_{max,0}/Q_{max,1}$) and increase in time to peak, Increased storm water retention (volume) - Biodiversity and ecosystems state enhancement: Species richness and composition, Increased biodiversity, Water flow speed (in relation to natural) Flood peak reduction (e.g. $Q_{max,0}/Q_{max,1}$) and increase in time to peak, Extent of urbanized floodplain areas, - Social: Distribution of public green space – total surface or per capita, Improved human health and wellbeing, Urban green: index of biodiversity, provision and demand of ecosystem services, Number and extent (number of people affected) of intervention events
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ADDITIONAL STEPS



STEP 16. SUCCESS CONDITIONS	Not applicable since not yet implemented
STEP 17. EXISTING OR POTENTIAL BARRIERS	funding; avoiding responsibility; lack of awareness, capacity and experience to plan and implement NBS - distrust for NBS; strong lobby for further urbanization of flood plains; inadequate transfer of new policy into practice
SOURCE/S	<i>NAIAD Glinsica Demo assessment by Polona Pengal.</i>



LEZ DEMO NAS STRATEGY 1: DEVELOPMENT OF GREEN INFRASTRUCTURE IN THE LEZ BASIN

CLUSTER A. FLOW OF SERVICES

STEP1. PROBLEM TO BE ADDRESSED:	Serious and recurring flood risks mainly caused by runoff. In 2014 only, there was more than 60 million euros of flooding damage or an event of a 30 year return period. 78% of this damage was due to runoff risk. The frequency of these extreme events is expected to increase in the near future)
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STEP2. VALUE PROPOSITION

2A. Primary service and value	Protection against runoff risk. The value of this protection effect is estimated at avoided damage costs of 1.30-1.86 M€/yr, with an aggregated value 2020- 2040: 29M€ ³
2B. Secondary services and value	Co-benefits have been estimated with different methods, which are described in D6.3. Air pollution and carbon sequestration co-benefits are estimated using the Itree Eco model (Nowak <i>et al.</i> , 2008). Air pollution reduction: value: 1.8-2.2 M€ Carbon sequestration: value: 0.2M€ Overall estimation of co-benefits evaluated through stated preference survey for 2020-2040: 605M€.

CLUSTER B: REGULATORY CONTEXT

STEP 3. Regulation	Since January 2018, the protection of water ecosystems and the prevention of flooding (GEMAPI) is under the responsibility of Municipalities (GEMAPI). The municipalities are also responsible for the management of runoff risk especially through the preparation of runoff zoning maps. Water basin agency request municipalities to compensate 150% of new impervious areas due to urbanization.
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CLUSTER C: MAPPING THE SUPPLY

STEP 4: WHO IMPLEMENTS	Municipalities, private and public developers, private owners
STEP 5. KEY ACTIVITIES	Bioswales Green roofs Open Vegetated Retention Basins Parking with permeable pavement
STEP 6. KEY RESOURCES	Funding: The Montpellier Municipality perceives a tax of 3 million euros yearly for the prevention of flooding. Investment require a better understanding of the impact of NBS on the reduction of flooding risk and on co-benefits. The use of this tax for the subsidy of runoff flooding protection is subject to debates. Development plans at the municipality level to develop NBS should be designed to facilitate the blending of funds aimed at different policy objectives: department level, region/European funds. Capacity development: training of public workers (especially the ones dealing with flood management and road infrastructure, engineering companies, urbanists on new solutions Raising awareness of elected people at the municipality level on the performance of NBS so that NBS are included in urban planning strategies. Insurance/reinsurance sector can support technical studies for the assessment of NBS Operation: green infrastructure specialist, engineering companies, gardeners, plants and green biomass, strategic spatial locations...
STEP 7. KEY PARTNERS	-Private developers are key for the implementation of green infrastructure in newly built urban areas. -Municipality and State impose the rules for the management of urban runoffs that drive the development of green infrastructure by private developers. The Municipality develops

³ Costs and benefits are actualized for the 2020-2040 period



green infrastructures for the requalification of existing neighbourhoods and the implementation of NBS in public spaces.

- Department/Region/Europe/Water basin agencies can be involved in NBS funding.

-Local residents value the co-benefits and lobby for their development.

-Specialized engineering and bio-architecture companies who can technically implement these solutions

CLUSTER D: MAPPING THE COSTS OF THE SERVICE

STEP 8. COST STRUCTURE:

8A. Lifecycle costs	Construction and maintenance costs for green infrastructures are estimated from 92 to 148 M€
8B. Opportunity costs	Land cost for the land occupied by green infrastructure that cannot be used for other more profitable use are estimated at 239 to 396 M€ based on land costs for construction.

CLUSTER E: MAPPING THE DEMAND

STEP 9: WHO OWNS THE PROBLEM:	The municipalities of the Lez basin, the residents who get their properties flooded, farmers, businesses, indirectly the insurance companies who compensate for damages.
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STEP 10: CUSTOMER SEGMENTS

10A. Direct beneficiaries	Residents of the Lez Basin, Farmers, Businesses
10B. Clients	Tax payers, municipalities
10C. Indirect beneficiaries	Insurance sector: Insurers are mainly interested in the reduction of flood damages. Impact of greening on the increase of property value for resident owners Tourism sector could indirectly benefit from the increased attractiveness of the city due to greening. This benefit is nevertheless difficult to estimate and therefore be considered as a potential source of revenue.

CLUSTER F: MAPPING THE ABILITY/WILLINGNESS TO PAY

STEP 11. REVENUE STREAMS	Benefits and co-benefits generate a value that can be evaluated monetarily. The Barnier Fund is one stream of revenues directly taken from policy insurance on houses and cars that can contribute to the funding of prevention measures such as NBS.
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STEP 12: FUNDING

12A. Tariffs	The water tariffs paid by residential water consumers and farmers is used to fund the water basin agencies. Water agencies fund actions aiming at deproofing cities, which can be used to fund deproofing.
12B. Taxes	The GEMAPI tax paid by local taxpayers in addition to local tax can be used to fund flood protection measures (runoff flooding is sometimes excluded however)
12C. Transfers	The Barnier Fund which is financed by a 1.4% contribution from all insurance policies for private homes and cars can be used to fund NBS but again runoff flooding is often excluded.
12D. Private funds or investment	State and municipalities impose through regulations that private owners achieve results in terms of water retention and infiltration. This generates private investments. NBS are however not necessarily imposed. Insurance sector are now considering voluntary contributions for the implementation of flood protection measures including NBS.

CLUSTER G. MAPPING THE SUPPLY-DEMAND INTERACTIONS

STEP 13: IMPLEMENTOR-	If implementors are the public sector, the relationship with residents could be automated via website communications, or co-development if there is public participation involved in the co-design of the solutions.
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CUSTOMER RELATIONSHIP	If implementors are private entities, the relationship can be direct if there is a direct contract with payers, community if the solution is implemented by a community (i.e. of neighbours or farmers).
STEP 14: CHANNELS	Municipality website, formal letters, public participation, community meetings, information sessions/workshops,...
CLUSTER H: IMPACT	
STEP 15: IMPACT through KPIs:	Surface of green infrastructure implemented in the basin (m ²) Reduction of hazard in terms of damage avoided (€/yr) and number of people exposed (Number of people in flooding areas) Reduction of air pollutant for NO ₂ , PPM ₁₀ , PPM _{2.5} , SO ₂ and O ₃ (T/yr) Health impact in terms of reduced mortality and morbidity (Number of death avoided/yr, Number Carbon sequestration (T of C/Yr)
ADDITIONAL STEPS	
STEP 16. Success conditions	Political will Capacity to integrate the value of co-benefits in funding decisions Clearer possibility to use GEMAPI funds for runoff reduction Need for strong regulation to promote NBS use and not only water retention.
STEP 17. Existing or potential barriers	Need for more collaboration among administrative services in charge of the different issues associated with NBS co-benefits. Cultural barriers that go against NBS (private housing ideal...), environmental issues are not priorities in the political agenda, limited effectiveness of NBS on large flooding events, Cost of public space modification is very high
SOURCE/S	NAIAD Lez Demo. Assessment by Philippe Le Coent, BRGM.



BRAGUE DEMO NAS STRATEGY 1: HIGH AMBITION: "OPEN A CORRIDOR TO THE BRAGUE RIVER"

CLUSTER A. FLOW OF SERVICES

STEP1. PROBLEM TO BE ADDRESSED	Reduce risks related to flash floods
STEP2. VALUE PROPOSITION	Risk reduction and improved river corridor quality
2A. Primary service and value	Avoided damages related to flash floods (€): lower bound of the mean annual avoided damage estimated to 0.5 M€ (0.2-0.7M€), better safety for people in areas at risks (decrease in water depth (m) and flooding frequency (yr ⁻¹)) and decrease of number of peoples living, travelling or working in areas at risks (number) The cumulative avoided damages for a 50 years period are estimated in 14 M€ (0.7 – 47.3 M€)
2B. Secondary service and value	Co-benefits were identified though stakeholder workshops and valued using the transfer of co-benefit valuations method as described by Afaoui and Gnonlongin, (2019). Aggregated annual monetary value of co-benefits: 4.7 M€ (0.7(5% quartile)- 47.3 (95% quartile)), with an cumulative value for a 50 years period of 122 M€. Improved continuity of paths and cycle track for pedestrian and cycle mobility and improved access to river corridor (length of tracks), Improved landscape quality (qualitative indicator), Improved forest riparian quality (surface of forest (m ²), Management practice (qualitative), Improved water quality (qualitative), Improved environmental status of the Brague River (MQI)

CLUSTER B: REGULATORY CONTEXT

STEP 3. REGULATION	Flood Directive, Water Framework Directive, Fond Barnier management rules (fund for protection measures building), GEMAPI law (GEstion des Milieux Aquatiques et Protection contre les Inondation: integrated management of river and wetland management and flood protection) , vegetation management plan of the basin agency
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CLUSTER C: MAPPING THE SUPPLY

STEP 4. WHO IMPLEMENTS	SMIAGE: multi-basin agency (broad management, deals with a very wide area, eventually raises taxes according the GEMAPI law) CASA: grouping of municipalities on two river basins including the Brague (local management of the basin scale project)
STEP 5. KEY ACTIVITIES	Small natural retention areas, cumulated area ≈ 200ha Widening of the Brague river bed(≈ 10-40m) Wetland restoration (11 ha) Riparian forest restoration (13 ha) 3 Large wood traps 3 Bridge widening 50-70 acquisitions and demolitions of houses 8 km of pedestrian and cycle tracks
STEP 6. KEY RESOURCES	Funding Political support, specifically for acquisitions and demolitions of houses Adaptation of the Fond Barnier management rules to make more flexible the eligibility of houses to be acquired and demolished (really strict at the moment and limiting acquisition possibility) Technical and economic skills (hydrologists, bio-engineers, economists) Awareness and understanding of NBS and grey solutions efficacy and limitations
STEP 7. KEY PARTNERS	DDTM 06 (regional authority responsible in risk management, works and restauration in rivers and finally allowing protection strategies to be implemented or not). Agence de l'eau RMC (Water agency, funder for restoration and NBS projects) Conservatoire du littoral (state agency in charge of nature protection, would acquire a large extend of the floodplain to restore wetlands) Public support by citizen association



CLUSTER D: MAPPING THE COSTS OF THE SERVICE

STEP 8. COST STRUCTURE	Best estimate (range of uncertainty) : 80 M€ (59-132 M€)
8A. Lifecycle costs	Real-estate acquisition: 33 M€ (25-58 M€) Capital expenditure: 24 M€ (17-35 M€) Operating and minor maintenance expenditure: 4 M€ (3-5 M€)
9B. Opportunity costs	Change in economic activities in the floodplain because river corridor will be wider than currently. Opportunity costs estimated based on expropriation values of buildings (residential and commercial): : 19 M€ (14-35 M€)

CLUSTER E: MAPPING THE DEMAND

STEP 9. WHO OWNS THE PROBLEM	Inhabitants of the flood plain, workers in the floodplain, people circulating on roads and paths in the floodplain, tourists passing by the floodplain, highway managers.
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STEP 10: CUSTOMER SEGMENTS

10A. Direct beneficiaries	Inhabitants of the flood plain Workers in the floodplain People circulating on roads and paths in the floodplain, tourists passing by the floodplain, highway managers
10B. Clients	Inhabitants of the basin
10C. Indirect beneficiaries	Workers in the floodplain, people circulating on roads and paths in the floodplain, tourists passing by the floodplain, highway managers, insurance companies

CLUSTER F: MAPPING THE ABILITY/WILLINGNESS TO PAY

STEP 11. REVENUE STREAMS	Local taxes (residential and companies), national taxes (residential and companies)
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STEP 12: FUNDING

12A. Tariffs	None
12B. Taxes	GEMAPI tax (40€ max /house/year, eventually raised at basin scale) Tax on Agence de l'eau tariff (14% tax on water tariff, yet implemented) Fond Barnier (12% tax on all insurance policies of houses and cars in France, yet implemented)
12C. Transfers	Eventual regional authority funding
12D. Private funds	None so far

CLUSTER E. MAPPING THE SUPPLY-DEMAND INTERACTIONS

STEP 13. CUSTOMER RELATIONSHIP	Dedicated personal assistance: citizens of the basin elect politicians who are part of the decision board in the SMIAGE and CASA.
STEP 14. CHANNELS	Public and information workshops, Official letters and communications, Social media

CLUSTER H: IMPACT

STEP 15. IMPACT through KPIs	Decrease in flooding area for given peak discharge (m ² flooded) Decrease in damages for given peak discharge (m ² flooded) Decrease in blocking of bridges by large wood (number of bridges clogged for given flood time return)
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ADDITIONAL STEPS

STEP 16. Success conditions	Acceptancy of house acquisitions to widen the river corridor
STEP 17. Existing or potential barriers	Funding insufficient (existing) Unwillingness of inhabitants to leave their houses (potential)
SOURCE/S	<i>Deliverable D6.1, Deliverable D6.2, Deliverable D6.3. NAIAD Brague Demo reported by Guillaume Piton, IRSTEA.</i>

NAS strategies in urban/city scale demos



LODZ DEMO NAS STRATEGY: A display of green infrastructure is the city of Lodz

CLUSTER A. FLOW OF SERVICES

STEP1. PROBLEM TO BE ADDRESSED

Pluvial flooding and drought related to unsustainable management of rain water and decline of ecosystem services

STEP2. VALUE PROPOSITION

2A. Primary service and value

Pluvial flooding reduction (Damage costs: reduced expenditure in elderly people healthcare, general reduction in health care, reduced expenditure in grey solutions)
Groundwater recharge (Avoided costs: lower maintenance costs for the Green Ring)
Climate regulation (Avoided costs: more humidity would reduce health risk and thus healthcare costs).

2B. Secondary services and values

Method: survey with 400 questionnaires about people asking about co-benefits. The co-benefits were valued in importance by the respondents, but the variability of answers was very high and there was no significant trend.
Reduced water logging in water treatment plant (Value: avoidance of paying the fee for releasing low quality water).
Groundwater recharge
Climate regulation
Aesthetics
Recreational places
Health benefits
Reduction of heatwaves
Availability of habitat for species
Educational values (related to water harvesting and biodiversity)
Air cleaning
Noise reduction

CLUSTER B: REGULATORY CONTEXT

STEP 3. REGULATION

National level: WFD, City climate adaptation plans, Polish Water Law
City level: Integrated Development Strategy of Lodz Metropolitan Area 2020+(2017); Integrated Development Strategy of Lodz 2020+ (2012) (not very strong executing power); The Study of Determinants and Directions of Spatial Development.

CLUSTER C: MAPPING THE SUPPLY

STEP 4. WHO IMPLEMENTS

Municipality, Marshal Office, City companies, private investors (4, 5), Housing cooperatives (group of people inhabiting a building and taking care of the management), State cooperatives (composed of boards of inhabitants)

STEP 5. KEY ACTIVITIES

1. Blue-green network
2. Green ring around the city
3. Woonerfs (multifunctional streets believed as NBS but a step towards NBS. They support functions not necessarily ecological, but can have ecological side effects).
4. Pocket parks
5. Green backyards
6. River rehabilitation
7. Reservoirs and biofilters in the city

STEP 6. KEY RESOURCES

Funds, human labour (academics, civil workers), new skills, enabling legal environment, awareness, commitment (at the political and civil society levels)

STEP 7. KEY PARTNERS

Experts (engineers, environmentalists, sociologists, facilitators to engage society,...), academics, people involved in education, companies providing Polish knowhow, NGOs, Housing cooperatives, State cooperatives

CLUSTER D: MAPPING THE COSTS OF THE SERVICE

STEP 8. COST STRUCTURE

8A. Lifecycle costs

1. Blue-green network (only maintenance cost of preserving nature)
2. Green ring around the city (only maintenance cost of preserving nature and connecting the ring)



	3. Woonerfs – implementation 326k€ - 600k€, maintenance 12k€ /yr 4. Pocket parks – implementation 60k€, maintenance 4 - 16k€/yr 5. Green backyards – 7k€-10k€, maintenance – 0.5-3k€/yr (the basic costs of cleaning etc. remind the same) 6. River rehabilitation – restoration of the bed and riparian zone, depending on the scale of action from 600k€/km, maintenance 12-20 k€/yr/km 7. Biofilters on urban rivers - depending on complexity and size starting from 7k€ (area 150m², single plant buffering zone), e.g. 35k€ for 3 zone, 300m², maintenance 250 €/yr/item
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8B. Opportunity costs

Not available

CLUSTER E: MAPPING THE DEMAND

STEP 9: WHO OWNS THE PROBLEM

Citizens, particularly poor people (public buildings have been taken by the government and given to poor people from the countryside, which has put them into a poverty loop), elderly people
Municipality (as owner of old buildings and streets that get flooded).

STEP 10: CUSTOMER SEGMENTS

10A. Direct beneficiaries

All citizens, and particularly those in the neighbourhoods where NBS have been implemented.
Building owners with highest flooding risk
Departments which maintain infrastructure

10B. Clients

Municipality, city companies and Marshal office
Indirectly by citizens through taxes

10C. Indirect beneficiaries

Municipality (because of the increased natural value of the city, i.e. expohorticulture, they need to demonstrate that green areas are playing a role) and international recognition.

CLUSTER F: MAPPING THE ABILITY/WILLINGNESS TO PAY

STEP 11. REVENUE STREAMS

Expenditures by visitors to nature related expositions
Attraction of more funding for implementation based on achieved impact

STEP 12: FUNDING

12A. Tariffs

Tariff for the release of rainwater to the system paid to Polish Waters company that will be used to fund NBS.
Tariff for reduced infiltration capacity in large scale projects or interventions with impermeable grey infrastructures reinvested in NBS

12B. Taxes

Taxes paid by citizens, wastewater tax and stormwater tax

12C. Transfers

Transfers from the municipality: to citizens and NGOs through the Civilian budget for projects developed by citizens, and for direct implementation by the Municipality.
EU funds: the city will not invest in anything that has less than 50% funding from the EU.
Structural funds, LIFE+ funds, RIAs (i.e. NAIAD)

12D. Private funds or investment

Citizens investing in their own property

CLUSTER G. MAPPING THE SUPPLY-DEMAND INTERACTIONS

STEP 13: CUSTOMER RELATIONSHIP

Personal assistance (in projects developed by citizens)
Transactional (small grants given by the Municipality to the citizens to build small interventions).
Community (through State and Housing cooperatives)
Co-development (through workshops with citizens for rehabilitation of some parts).
Legal or economic obligation to investors (e.g. now each developer has to negotiate with the State how much water is going to use, and they need to provide a NBS or solution to offset (15% of requested).



STEP 14: CHANNELS	Workshops with citizens Legal obligations Media (mostly newspapers and radio) Letters and official communications Tenders for grants
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CLUSTER H: IMPACT

STEP 15: IMPACT through KPIs	Blue-green network: - No of bottom up initiatives to complement BGI Woonerfs: - No of visitors - Attraction of small business - No of citizens projects applying to civilian budget Pocket parks: - No of visitors - City visibility - Success of grant applications - No of citizens projects applying to civilian budget Biofilters: - N and P reduction by 40-70% - Cyanobacteria blooms – complete reduction - Reservoirs availability for recreation – continuous River rehabilitation: Property prices
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ADDITIONAL STEPS

STEP 16. Success conditions	Having European Funding for the implementation Enabling political environment Promotion of direct implementation of NBS through showcasing fairs and exhibitions (e.g. Horticultural expo). Demonstration cases as stimulators for private investors/implementers (e.g. civilian communities get ideas from what they see). Example woonerfs.
STEP 17. Existing or potential barriers	Regulatory gaps for some of the measures Use of investment as a political weapon to gain voters
SOURCE/S	<i>NAIAD Lodz Demo. Assessment by Kinga Krauze, ERCE.</i>



COPENHAGEN DEMO NAS STRATEGY: URBAN RIVER RESTORATION IN COPENHAGEN

CLUSTER A: FLOW OF SERVICES

STEP1. PROBLEM TO BE ADDRESSED	Urban groundwater flooding aggravated by cloudburst and climate change
STEP2. VALUE PROPOSITION	For cloudburst management measures the avoided costs are higher than NBS costs. For groundwater flooding avoided costs have been estimated for the urban river catchment to be about 20 million DKK (~ 3 million Euro). This estimate constitutes the lower boundary as other avoided costs and done assumptions indicate a (much) larger amount. This is further described in D6.3 for the Copenhagen Demo and the results will be further refined during the Copenhagen WP4/6 SIWI/GEUS workshop
2A. Primary service and value	Mitigation of urban flooding effects (avoided costs for reduced flooding including damage costs and avoided water treatment costs) Avoided damage costs: 3 million euros (see note above) Avoided water treatment costs which would have occurred in case of cloudburst tunnel and road solutions: pending estimation.
2B. Secondary services and values	The valuation of co-benefits is pending to be finalised during workshop 3 (Copenhagen WP4/6 SIWI/GEUS workshop). NBS green infrastructure value. City attractiveness. Improved public health. Less pollution. Branding of Copenhagen as green city and export of knowledge of solution. Green jobs

CLUSTER B: REGULATORY CONTEXT

STEP 3. REGULATION	Climate Adaptation Plan Cloudburst Management Plan Water Framework Directive Floods Directive
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CLUSTER C: MAPPING THE SUPPLY

STEP 4. WHO IMPLEMENTS	The city of Copenhagen and Frederiksberg, water utilities, various private contractors / subcontractors
STEP 5. KEY ACTIVITIES	Motorway ramp (Bispeeng) removal, urban planning activities for created space including urban river restoration
STEP 6. KEY RESOURCES	Monetary resources provided by the municipalities and state, and supplemented by revenue from selling real-estate space and building rights and taxes. Political agreement and legislation Knowledge and capacities (specific/new profiles within public administration/engineering companies)
STEP 7. KEY PARTNERS	Municipalities of Copenhagen and Frederiksberg State who transfers the Bispeeng motorway ramp to municipalities Water utilities for Copenhagen (HOFOR) and Frederiksberg (Frederiksberg Forsyning) Consultants

CLUSTER D: MAPPING THE COSTS OF THE SERVICE

STEP 8. COST STRUCTURE	The costs structure is composed of the construction and maintenance costs to implement the NBS. Additional costs of side measures implemented along with the NBS include for removal of Bispeengbuen motorway ramp, shared between state and municipalities Costs for establishing various traffic part, as tunnels and roads (to replace the motorway ramp), all involved construction costs. Associated analyses by consultants and municipalities Maintenance costs
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8A. Lifecycle costs	The costs above are not part of the NAIAD CPH demo (only NBS part is considered) Costs of restoring (reopening) the urban river plus possibly tributaries further upstream Costs to maintain ecologic flow in urban river, drainage to river, pumping, water treatment (cleaning) etc
8B. Opportunity costs	Under consideration
CLUSTER E: MAPPING THE DEMAND	
STEP 9: WHO OWNS THE PROBLEM	Municipality of Copenhagen and Frederiksberg, urban citizens, local business, insurance companies, who suffers e financial loss, and public properties, who is self-insured.)
STEP 10: CUSTOMER SEGMENTS	
10A. Direct beneficiaries	Municipality of Copenhagen and Frederiksberg, water utility companies, citizens.
10B. Clients	State, municipality of Copenhagen and Frederiksberg, real-estate companies and citizens who buy / rent houses / apartments and pay taxes (income and real-estate)
10C. Indirect beneficiaries	Citizens in general, businesses in more attractive area, tourists (branding value of city), insurance companies
CLUSTER F: MAPPING THE ABILITY/WILLINGNESS TO PAY	
STEP 11. REVENUE STREAMS	Sale of real-estate space and building rights to companies, an increase in tax revenue because of an higher income, due to more wealthy citizens moving in, and from newly developed businesses (shops, cafés,etc.) Income from green jobs and revenues from branding the city and exporting NBS solutions;
STEP 12: FUNDING	
12A. Tariffs	N/A. Once the urban river NBS is established there are no tariffs involved for use of the NBS
12B. Taxes	No direct taxes, but indirect via real estate taxes which contributes to financing the urban river NBS
12C. Transfers	Funds contributed by the Municipality and the State.
12D. Private funds or investment	No
CLUSTER G. MAPPING THE SUPPLY-DEMAND INTERACTIONS	
STEP 13: CUSTOMER RELATIONSHIP	The demand of measures against urban flooding expressed by the municipalities, citizens, insurance companies and businesses is met by the supply of a restored urban river NBS Automated relationship between the Municipality and the citizens, businesses, etc., who would be informed of the NBS implementation via official communications or automatic vehicles (I guess?). If there is any involvement of the citizens/beneficiaries to design the measures, there would be co-development relationship as well.
STEP 14: CHANNELS	Meetings at all levels between the responsible municipalities and stakeholders, including representatives of municipal departments, state, interest organisations (NGO's) and citizen fora
CLUSTER H: IMPACT	



**STEP 15: IMPACT
through KPIs**

Urban flooding mitigation in Bispeeng area (3 million euros avoided costs)
Improved water quality
Improved green space management
Improved biodiversity (urban river and connected green infrastructure)
Improved air quality
Reducing urban heat island effect
Negative impact: gentrification, substantial increase of housing prices after implementation of NBS forcing some people to move away to more affordable part of the city or move to suburban areas

ADDITIONAL STEPS

**STEP 16. Success
conditions**

Political agreement and available funding

**STEP 17. Existing or
potential barriers**

Missing political agreement and/or budget constraints
The restoration of the urban river is constrained by the political process to
(1) transfer the motorway ramp which needs to be removed to create space for real estate development, road tunnels and climate adaptation, including possibly the urban river. The motorway ramp is currently state property and needs to be transferred to Copenhagen and Frederiksberg municipality who share the public space under consideration;
(2) after transfer from state to municipalities, the latter need to find financing on their budget for years to come. This needs negotiation between political interests.

SOURCE/S

NAIAD Copenhagen Demo. Assessment by Peter van der Keur, GEUS, Morten Ejlsing Jørgensen, Municipality of Copenhagen.

ROTTERDAM DEMO NAS STRATEGY 1: URBAN WATER BUFFER, SPANGEN, ROTTERDAM (IMPLEMENTED MEASURE IN HYBRID NBS STRATEGY)

CLUSTER A. FLOW OF SERVICES:

STEP1. Problem to be addressed:	Local pluvial flooding, use of potable water for stadium irrigation, need for green space in neighbourhood.
STEP2. Service provision and Value proposition:	Reduce flood risk, provide a local, alternative water supply, whilst also adding green space and improving the aesthetic value of the neighbourhood.
2A. Primary service and value	1400 m ³ of retention to reduce local flood risk, valued at €700,000 ³ Alternative local water source, supplying 15,000 m ³ of filtered rainwater per year to Sparta football stadium = €682,000 ⁷
2B. Secondary service and value	Savings from reduced pumping requirements = €75,000⁴. Energy savings from reduced water production = €44,000². Emissions savings from reduced water production = €8,000⁵. Increased greenery and improved aesthetics resulting in higher property values = €561,000⁶. Increased water awareness due to visibility of the urban water cycle; increased water quality; local temperature regulation; improved biodiversity habitat; air quality improvements (presumed qualitative benefits that need validation). <i>Above co-benefits have been estimated using a combination of data taken from the implemented NBS and value transfer from literature. See NAIAD D6.3 for full documentation of methodology and results applied to a broader neighbourhood strategy.</i> 1. Estimates from site data 2. Value over 50 years, 0.35 kWh/m³ of avoided water production (Vewin 2017), electricity = €0.17/kWh 3. Value to municipality of retention in Spangen = €500/m³ (Personal communication, Gemeente Rotterdam, 2019) 4. Value over 50 years, avoided pumping costs = €0.05/m³ (Arcadis, 2019) 5. Value over 50 years, electricity = 569g CO₂/kWh (Moro et al., 2018), carbon price of €54/ton (High Level Commission on Carbon Prices, 2017) 6. 4% increase on 100 households nearest to UWB (Bervae, 2004), average property WOZ value in Spangen = €140,233 (Gemeente Rotterdam, 2019) 7. Value over 50 years, water tariff = €0.91/m³

CLUSTER B: REGULATORY CONTEXT

STEP 3. Regulation	Broader context - Municipal water Plan (2011); Municipal Water Plan (revised, 2012), Rotterdamse Adaptatiestrategie (2013); Resilient Rotterdam and Water Sensitive Rotterdam Programs; Waterbeheerplan Defland 2016-2021; Keur Delfland Specific relevant regulations Infiltratiebesluit bodembescherming 2009; Streefwaarden Circulaire Bodemsanering 1 juli 2013; Beleidsregel Grondwateronttrekkingen en infiltraties 2015; European Union Environmental Objectives (Groundwater) (Amendment) Regulations 2016).
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CLUSTER C: MAPPING THE SUPPLY

STEP 4: WHO IMPLEMENTS:	Municipality of Rotterdam & Hoogheemraadschap Delfland (Waterboard)
STEP 5. KEY ACTIVITIES:	Urban Waterbuffer: A 1400 m³ underground retention tank collects runoff from a 4 ha impervious catchment, which is then fed to a 90 m² biofilter. After filtration, the water meets quality requirements for deep aquifer storage, which is achieved through the installation of an infiltration and recovery well. Stored water is then supplied to Sparta Stadium for irrigation purposes. Activities: Design & Engineering. Construction of retention tanks, biofilter and infiltration and recovery wells. Monitoring of water quality to gain infiltration permit. Operation & maintenance.
STEP 6. KEY RESOURCES.	Stakeholder engagement; suitable geohydrological conditions; technical knowledge/support on water management, water treatment, ASR systems; permits; political support.



STEP 7. KEY PARTNERS:

Design, Engineering & Supply: Field Factors, KWR, Codema BE-deLier; **Contractors:** Van Gelder, Schijf Bronbemaling; **Operators:** Field Factors, KWR/Codema, Evides Water Utility; **End-users:** Sparta Stadium; **Regulator:** Delfland.

CLUSTER F: MAPPING THE COSTS OF THE SERVICE

STEP 12. COST STRUCTURE

12A. Lifecycle costs:

Capital expenses: €1,245,876
Regular maintenance: €425,089
Capital maintenance: €16,326
Direct support: €10,000
Indirect support: €18,000
Total: €1,715,291

12B. Opportunity costs:

€11,700 - 33,480 opportunity cost, because land where 90 m² biofilter is located cannot be used for other purposes (land value of €130 - 372/m² – Levkovich et al., 2018).

CLUSTER D: MAPPING THE DEMAND

STEP 8: WHO OWNS THE PROBLEM

Inhabitants, Local Businesses, Sparta Football Club.

STEP 9: CUSTOMER SEGMENTS:

9A. Direct beneficiaries

Local residents, Local Businesses, EVIDES Water Utility.

9B. Clients,

Municipality of Rotterdam, Hoogheemraadschap Delfland Waterboard.

9C. Indirect beneficiaries

Sparta stadium, local residents.

CLUSTER G: MAPPING THE ABILITY/WILLINGNESS TO PAY

STEP 13. REVENUE STREAMS:

Sparta Stadium - payments for water supply
Residents - increased tax revenue from higher property values
Evides - In kind contributions: operational responsibility in exchange for exploitation of the water well

STEP 14: FUNDING:

14A. Tariffs:

Water tariff of €0.91/m³ to cover operational costs

14B. Taxes:

Indirect funding through water taxes to the Waterboard.

14C. Transfers:

Innovation fund (case specific)

14D. Private funds

None

CLUSTER E. MAPPING THE SUPPLY-DEMAND INTERACTIONS

STEP 10: CUSTOMER RELATIONSHIP:

Long term partnerships, Consortium Agreements

STEP 11: CHANNELS:

Direct communication, stakeholder meetings, documentation and reporting on system performance, operation & maintenance contracts

CLUSTER H: IMPACT

STEP 15: IMPACT through KPIs:

Number of separated sewer overflows / year → Target: < 2 per year
Amount of infiltrated/stored water → Target: 30,000 m³/year
Amount of water supplied → Target: 15,000 m³/year
Quality of water after treatment → Target: Ongoing compliance with legislation on water quality for infiltration and reuse.

ADDITIONAL STEPS

STEP 16. Success conditions

Political willingness embedded in Resilient Rotterdam strategy; commitment and pioneering of key initiators; successful public-private partnership; innovation funding (pilot project); demand for spatial improvements by inhabitants, capitalisation on multi-sector window of opportunity for investment planning.



STEP 17. Existing or potential barriers

“Business as usual dies hard” → strong preference for well-known water management caused; uncertainty about effectiveness and lifetime of the system; multiple stakeholders to be involved; limited interest in alternative water sources, as drinking water is currently still readily and cheaply available in Netherlands; Integral approach required funding out of different single-purpose budgets. Different standpoints and views over the problem

SOURCE/S

NAIAD Rotterdam DEMO D6.1, D6.2, D6.3. Reported by Thomas Biggin and Kieran Daartee, Field Factors
Arcadis. (2019). *MKBA Klimaatbestendige Inrichting Pilotwijken: Pilot Spangen (Rotterdam) en Mariahoeve (Den Haag)*.
Bervaes, J. (2004). *De invloed van groen en water op de transactieprijzen van woningen*, Altera-Rapport 959. Wageningen.
High-Level Commission on Carbon Prices. (2017). *Report of the High-Level Commission on Carbon Prices*. Washington DC.
Levkovich, O., Rouwendal, J., & Brugman, L. (2018). Spatial planning and segmentation of the land market: The case of the Netherlands. *Land Economics*, 94(1), 137–154.
Moro, A., & Lonza, L. (2018). Electricity carbon intensity in European Member States: Impacts on GHG emissions of electric vehicles. *Transportation Research Part D: Transport and Environment*, 64(July 2017), 5–14.
Vewin. (2017). *Dutch Drinking Water Statistics 2017: From source to tap*, available at: <https://www.vewin.nl/SiteCollectionDocuments/Publicaties/Cijfers/Drinkwaterstatistiek-n-2017-EN.pdf>