Technical specifications and procurement processes for Demonstrators A and B

Deliverable D2.4

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Authors: TAUW, BDCA

Contributors:

Demonstrators: AAKS, ACA, EAWAG, FHH, Odense, Portofino, UIBK, UNSA

Partners: IHE, TUHH

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Authors (Partner)	V. Penchev (BDCA), C. Fung-A-Loi (TAUW), J. Knegt (TAUW), F. Boogaard (TAUW), A. Kirova (BDCA), R. van Bruggen			
Responsible Author	Name	R. van Bruggen / V. Penchev	Partner	TAUW / BDCA
Contributors (Partner)	Natasa Manojlovic (TUHH), Christian Ebel (FHH), Luis Manuel López Zárate (FHH), Lars Sønderby (Odense), Eva Crego (ACA), Guido Paliaga (CNR), Alberto Girani (Portofino), Judith de Jager (TAUW), Stefan Achleitner (UIBK), Signe Iversen (AAKS), Mario Schirmer (EAWAG), Joao Paulo Leitao (EAWAG), Jelena Batica (UNSA), Manfred Kleidorfer (UIBK), Blanca Perez-Lapena (IHE), Ingwer de Boer (IHE), Zoran Vojinovic (IHE)			

Abstract (for dissemination, 100 words)	This report describes the technical specifications and procurement processes for RECONECT Demonstrators Type A (cases where the co-creation of NBS will be carried out during the project), and Demonstrators Type B (where such works exist and they will serve as reference cases). Demonstrators A and B, focusing on the design and construction works in demonstrators A and on the maintenance and monitoring for demonstrators B. The main objective is to demonstrate the processes during the assessment, design, construction, maintenance and monitoring of NBS with emphasis on the co-design and co-implementation organized through the RECONECT network of Demonstrators and experts, with the active involvement of local stakeholders.
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Executive Summary

The main objective of D2.4 is to present and analyse the technical specifications and procurement processes during the design, construction and maintenance of NBS sites of Demonstrators type A and type B, focusing on the design and preparation of construction works in Demonstrators A, and on the maintenance and monitoring for both demonstrators A and B. The report presents the lessons learned by Demonstrators B, and indicates the path towards replicating innovative technical solutions and good practices demonstrated at their NBS sites. Looking at Demonstrators A, the report underlines the role of co-design and co-implementation activities organized through the RECONECT network of Demonstrators and Experts, with the active involvement of the local stakeholders

Summarizing the technical information provided by the Demonstrators, this report sets the base for further development and update of guidelines for the design, construction and maintenance of NBS in order to optimize the multiple benefits of the NBS.

This report is primarily intended to serve RECONECT Demonstrators and Collaborators in their efforts to establish, maintain and monitor their NBS measures. However, it can also serve as a reference work for government agencies (such as municipalities) and practitioners (water managers, design engineers, etc). It is designed for all organizations aiming to implement NBS in their site.

Most important research findings/lessons:

- Most popular NBS applied by Demonstrators have been identified (e.g. Planting trees/bushes/ vegetation; Slopes stabilization, reconstruction of canal banks; Removal/excavation of dikes or other engineering structures)
- Good technical decisions have been presented in this report (as illustrated on Figure below), and are expected to facilitate further replication and up-scaling of NBS
- Being innovative, NBS calls for new/specific procedures and administrative organisation, in quite some different national rules/legislation between countries. It is difficult to identify some "unified" approach or suggest a common recipe regarding procurement processes and permitting of NBS. Nevertheless, lessons learned by Demonstrators, as presented in this report, still can be used to assist potential stakeholders willing to use NBS

The following recommendations/actions can be outlined:

- Collected information and findings of this report shall be used to develop planned RECONECT upscaling support tools (the NBS Catalogue of measures & services; Guidance for integrating innovative solutions; Draft Standards for design, maintenance, management of NBS; Guidelines for design, construction and maintenance of NBS sites)
- In parallel to the support of individual actions, serious collective coordination activities have to be undertaken to provide relevant exchange of experience, use of available knowledge, and taking advantage of "*good practices*" and avoiding "*bad examples*". Some suggestions have been given to share experience, support and advice, and to achieve timely delivery and accomplishment of planned tasks on design and constructions (for Demonstrators A), as well as on maintenance, monitoring and evaluation (for both Demonstrators A and B):

    1) It is recommended to organise special thematic workshops attached to General Assembly (GA) meetings, focusing on NBS co-design, co-implementation and co-monitoring

2) A series of webinars and online meetings is suggested to be carried out, in order to speed-up and enhance collective and bilateral twinning between Demonstrators A and B, as well as between Demonstrators and Collaborators - this way to facilitate further replication and upscalling of NBS.

- A specific co-creation approach is advised in this report to support the decision-making process in the NBS case. It includes:
  - providing active involvement of the key stakeholders possessing knowledge and understanding of local specifics;
  - raising the awareness and capacity of local decision-makers upon NBS;
  - providing transfer of the experience (lessons learned) and the know-how available at completed NBS projects (Demonstrators B);
  - apply the "RECONECT tools" (under development) such as the NBS Catalogue of measures & services, the Standards for design, maintenance, management of NBS and the Guidelines for design, construction and maintenance of NBS.

More information can be found on RECONECT website: www.reconect.eu.

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Abbreviations

EU FD	EU Floods Directive
FRMP	Flood Risk Management Plan
HRU	Hydrological response units
ICF	Indicator to monitor and evaluate connectivity
ICT	Information and Communication Technology
IHF	Indicator to monitor and evaluate mesohabitats
KPI	Key Performance Indicator
LSBG	Landesbetrieb Strassen, Brücken und Gewässer (Roads, Bridges and Waters, City of Hamburg)
MSFD	Marine Strategy Framework Directive
NBS	Nature Based Solutions
QBR	Indicator to monitor and evaluate vegetation
RBMP	River Basin Management Plan
SCHAE	Schéma de cohérence hydraulique et d'aménagement d'ensemble (Diagram of hydraulic coherence and overall layout)
STUCK	Sicherstellung der Entwässerung küstennaher, urbaner Räume unter Berücksichtigung des Klimawandels (Ensuring the drainage of coastal, urban spaces, taking into account climate change)
WLV	Wildbach und Lawinenverbauung, Österreich (Torrent and Avalanche Control Unit of the Ministry, Austria
WFD	Water Framework Directive

Organisations

AAKS	AARHUS KOMMUNE
ACA	Catalan Water Agency
BDCA	Black Sea - Danube Association of Research and Development
BFW	Austrian Research Centre of Forests Department of Natural Hazards
BOKU-MET	Dept. of Meteorology, BOKU- University of Natural Resources and Life Sciences
DTES	Department of Territory and Sustainability of Catalonia
DTU	Denmark Technical University
EAWAG	Swiss Federal Institute of Aquatic Science and Technology
FHH	Free and Hanseatic City of Hamburg
FOEN	Swiss Federal Office for the Environment
HR	Hydrologic Research BV
IHE	Institute for Water Education, Delft, the Netherlands
InterAct	Inter Act Industrial Automation B.V.
IWA	International Water Association UK
SEI	Stockholm Environment Institute
TAUW	TAUW BV European consultancy and engineering firm
TUHH	Hamburg University of Technology
UFZ	Helmholtz- Zentrum fuer Umweltforschung GMBH
UIBK	University of Innsbruck
UNSA	University Nice Sophia Antipolis

I. Introduction

Implementation of Nature-Based Solutions (NBS) for hydro-meteorological risk reduction offers the possibility to break away from traditional practices and enable to reconnect our land management practices and developments with nature in order to achieve multiple benefits to services and functions of ecosystems. Project RECONECT is an interdisciplinary international project that aims to contribute to European reference framework on NBS by demonstrating, referencing and upscaling large scale NBS and by stimulating a new culture for 'land use planning' that links the reduction of risks with local and regional development objectives in a sustainable way.

In order to contribute effectively to the EU reference framework on NBS and to generate higher impacts across Europe, RECONECT draws upon a number of Demonstrator cases. They have been carefully selected to cover a range of local criteria including i) climatic and geographic conditions, ii) type of hydro-meteorological events (floods, storm surges, droughts, landslides), and iii) vulnerability to these events. Besides these criteria, the potential for collaboration and upscaling has also played a role in the selection process. In order to capitalize on the existing knowledge and experiences on NBS within the RECONECT Consortium and initiate the knowledge sharing and upscaling process already in an early project stage, RECONECT bases its demonstration activities on two types of Demonstrators. These Demonstrators are termed A and B which are at different stages in the NBS co-creation process. In Demonstrators Type A cases, the large scale NBS includes the full co-creation (i.e., co-assessment, co-design, co-implementation, co-monitoring and co-evaluation) and validation process during the project lifetime either by requesting co-funding from the EC and/or by deploying their own funds and resources. The Demonstrators Type B cases have a considerable track record in implementing large scale NBS in natural and rural areas including mountainous and coastal areas, at watershed/landscape scale, with high local/national/international visibility. RECONECT draws upon 4 Demonstrators Type A and 6 Demonstrators Type B. The geographic spread of the RECONECT demonstrators is shown in *Figure I-1*.

Demonstrators A:

DA1: The Elbe Estuary, DE

DA2: Seden Strand, Odense, DK

DA3: Tordera River Basin, ES

DA4: Portofino Park, IT

Demonstrators B:

DB1: IJssel River Basin, NL

DB2: Inn River Basin, AT

DB3: Greater Aarhus, DK

DB4: Thur River Basin, CH

DB5: Var River Basin, FR

DB6: Les Boucholeurs, FR

Figure I-1 The geographic spread of the RECONECT Demonstrators

The main objective of Deliverable D2.4 “Technical Specifications and Procurement processes for Demonstrators A and B*”* is to present the technical specifications and procurement processes during the assessment design, construction and maintenance of NBS sites for RECONECT Demonstrators A and B, as well as to demonstrate the co-design and co-implementation activities organized through the RECONECT network of Demonstrators and experts with the active involvement of the local stakeholders. Monitoring and evaluations activities will be further elaborated in D2.6 “Co-monitoring and co-evaluation plans*”*.

Based on the results of Task 2.1 (Preparing co-creation: stakeholder analysis), Task 2.2 (Establishing baselines; Demand and Supply Analysis), Task 2.3 (Co-assessment: Specifying baselines) and Task 2.4 (Co-design: technical specifications and procurement of contracts for construction of NBS in Demonstrators Type A), this report presents:

- Description of the NBS selection process, details on the design, cost-evaluation, procurement of contracts, and construction works.
- The route Demonstrators B have undertaken to implement their NBS and the considerations for implementation of NBS for Demonstrators A.
- NBS operation and maintenance (tentative) plans for both Demonstrators A and B.
- Summary of the monitoring and evaluation plans, in their final stage for Demonstrators B, and the preliminary plans for Demonstrators A.

Deliverable D2.4 completes the information provided in RECONECT deliverable reports D2.1 “Preparing co-creation: Stakeholder analysis*”*, D2.3 “Co-assessment: Specifying baselines, scoping of detailed requirements*”*, and D2.5 “Report describing preparatory actions for Demonstrators A and B Including copies of building permits / permissions / commissioning”.

Deliverable D2.4 describes the technical specifications and procurement processes for RECONECT Demonstrators A and B, focusing on the assessment, design and preparation of construction works in demonstrators A, and on the operation and maintenance, and monitoring for both demonstrators A and B.

RECONECT partners have already provided first guidelines and recommendations to Demonstrators A. Valuable input has been provided in most of the demonstrator’s cases, concerning guidelines on the selection of NBS (Tordera river), on the planning and design (Hamburg case), on the forthcoming construction (Portofino and Odense cases) considering lessons learnt at Demonstration B sites, and also the specific local circumstances and governance structures at Demonstration A sites. Similarly, advice and guidance have been provided also on maintenance and monitoring to be carried out by Demonstrators B (e.g. in the Var River and Les Boucholeurs). Summarizing the technical information provided by the Demonstrators, this report sets the base for further development and update of guidelines for the design, construction and maintenance of NBS in order to optimize their multiple benefits. Such guidelines will be further specified in D5.4 “Draft standards for design, implementation, management and decommissioning of NBS, and finalized in D2.8 RECONECT Guidelines for design, construction and maintenance of large-scale NBS*”*.

Based on the additional information provided by demonstrators on the technical and procurement processes, potential knowledge sharing aspects can be identified to add to the ongoing twinning process between Demonstrators A and B, as well as between Demonstrators and Collaborators.

This report is primarily intended to serve RECONECT Demonstrators and Collaborators in their efforts to establish, maintain and monitor their NBS measures. However, it is designed for all organizations aiming to implement a NBS in their site.

Lessons regarding technical specifications and procurement processes can be derived from Demonstrators B, as presented in this report. But as the RECONECT project is progressing, the implementation of NBS in Demonstrators A cases will also progress and take a more definite form, and will be used to support RECONECT Collaborators and other organizations who are developing their NBS feasibility studies.

II. Technical specifications and procurement processes for Demonstrators A

1 Demonstrator DA1: Dove/Gose Elbe Estuary, Germany

1.1 Case description

The main goal of the demonstration activities in the German Demonstrator (DA1) is the reactivation and the distribution of the storage capacity upon need of the rivers Bille, Dove and Gose Elbe, their tributaries and trenches (such as Brookwetterung or Curslack) and their flood plains in the area of 175 km^2 (Figure 1-1), to create more retention volume for water during flooding. At the same time necessary stable water levels in the rivers can be provided during droughts. The distribution of the storage volume during flood events will be managed by the RECONECT NBS operation and real time controlling system. It will make use of the previous studies and rainfall- runoff and hydrodynamic models as well as of the conceptual design of the operation system (mainly developed in the STUCK Project, (Hellmers, Ackermann,, Einfalt, & Fröhle, 2017) and further developed to be 'ready-to-use' by the operators and asset owners. Also, RECONECT should pave the road to a NBS driven river basin catchment management in Hamburg and Northern Germany, instead of merely constructing and implementing sluices and pumping stations to solve the flooding issues, which has been a dominating practice so far.

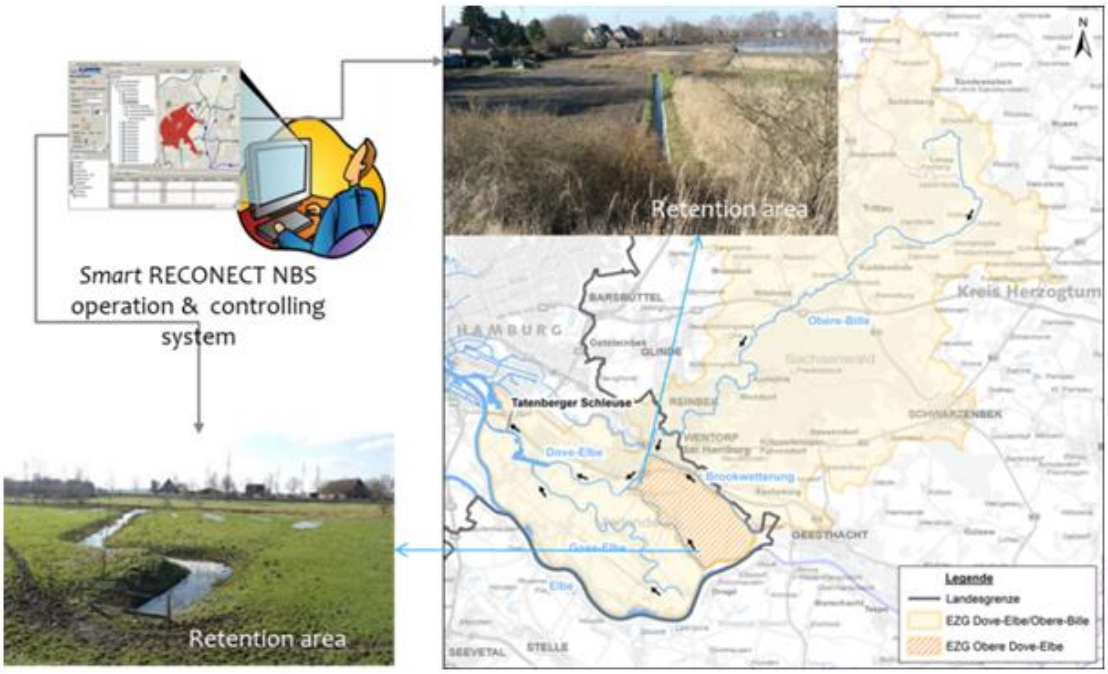

Figure 1-1 The demonstration area Dove/Gose Elbe (marked in yellow) and the typical retention areas

The (improved) management of the retention areas in the Dove/ Gose Elbe river system is expected to generate the following benefits:

- Improved management of the hydrometeorological events being floods and droughts
- Improved ecological condition of the area due to optimized use of the retentions and floodplains
- Improved livability and social value of the area also contributing to the tourism, that is gaining relevance in the area (Meine & Schruttke, 2018)
- The conversion of grey infrastructure into hybrid solutions by combining the existing grey assets (such as pumping stations) with the RECONECT NBS approach
- The expansion of the existing linear and disciplinary approach (a piecemeal approach to floods and drought management) into a holistic approach

The RECONECT German Demonstrator is liaising with other relevant projects in the area in order to synergies the activities and enhance the value of the individual projects. Those projects are related to the implementation of the WFD (2000/60/ES) in the area and The Natürlich Hamburg Projects with the objective to create or enhance the green spaces and nature protection areas in the Greater Hamburg area, including the Dove/Gose Elbe catchment. As both projects are being implemented by the Hamburg Ministry, the coordinated implementation of the projects is made possible.

More information for the NBS case is available in RECONECT deliverable report D2.3.

1.2 Technical specifications of the Demonstrator case

1.2.1 NBS selection

Main steps in the assessment process that lead to the selection of feasible and final NBS measure(s)

Reduction of the flood water volume and water levels during a flood event in the demonstrator area has been a matter of investigations and research in a number of previous projects, both local and national. While in the previous projects a thorough analyses have been performed to analyze the possibilities for the reduction of the probability of occurrence, the flood impact analysis was not systematically taken into consideration.

The major studies on the flood probability reduction towards the NBS in the demonstrator area have been undertaken within the national Project STUCK, where different options for water level reduction have been selected and quantified and are given in the report (STUCK Final Report, 2018).The most relevant options analyzed are given as:

- lowering the ground level in the floodplains close to the normal water level and use these areas as polders;
- optimization of the operation of the sluices and gates to create a certain amount of retention volume.

The results of the study indicated that for the options considered, large areas would be needed to retain the flood volume and, in such way, reduce the water level in the rivers. However, due to the limited space and lack of the areas that can be converted into the retention areas, the idea of a controlled operation of the gates and sluices based on the rain forecasts has been brought to the discussion. Such a ‘smart’ solution would enable controlled distribution of the water volumes among the areas that are available for storage (including the river channels). The hydrodynamic and rainfall runoff models were required to analyse the impacts of the different controlling scenarios.

Determination of the risk reduction target or primary benefit. NBS measures considered feasible in meeting the risk reduction target.

The following NBS measures were considered:

- creation of distributed retention areas across the Demonstration Area
- construction of a polder
- controlled operation of the sluices and gates with a creation of retention areas only upon need

Criteria to choose the final NBS measure(s)

The final NBS has been selected based on the following criteria:

- efficiency in reducing flood risk
- available retention area:
    - in terms of space
    - the contamination conditions
    - ownership
- minimal intervention in the landscape
- no/minimal disadvantages for the ecosystems and people living in the area
- life cycle aspects of the solution

The further research and investigations in the Demonstration area indicated a number of contaminated sites, which cannot be considered for the retention purposes.

A sub-option to create a polder without excavation would imply the construction of new grey infrastructure elements, which would cause considerable costs, without bringing any additional benefits for the area.

Finally, the 'smart operation' of the sluices and gates based on the real-time forecasts and minimized used of the retention areas has been adopted.

Stakeholder involvement in the identification of all feasible, and the final NBS measure(s).

The definition of the final NBS has been a long-term process, which took place over years and has been a matter of investigations of various projects (including STUCK). The development of a concept and the final selection has mainly taken place in a close cooperation between the representatives of the City of Hamburg (LSBG), Hamburg University of Technology (TUHH).

The outcomes of the research and modeling activities have been communicated and discussed with the representatives of the borough of Bergedorf. In addition, a series of meetings have been held with the Water Utility (Hamburg Wasser) and Hamburg port Authority. Finally, the requirements and interests of a number of municipal and local stakeholder groups and interests (such as fishing clubs, tourism, farming) have been acknowledged and considered for the selection of the final NBS.

1.2.2 NBS design

a) NBS design process

Design options considered

The DA1 NBS is composed of 2 main elements:

1. 'smart' real time controlling system

2. retention area to be created based on the operation of the real time controlling system.

For the first element different controlling scenarios have been analysed. The two options increase the amount of water drained into the Elbe; one increases the water flow until the water head reaches 80 cm, while the other one uses water heads between 1,00m and 1,40 m.

A hydrodynamic model has been built in order to perform a detailed analysis of those design options, impacts of flooding in the current situation.

The selection of the retention areas (second element) is dependent of the adopted controlled option and is defined accordingly.

Criteria for selecting the NBS design

The major criteria for the final design of the selected NBS option has been of the risk reduction and reliability side. The adopted design option should allow drainage of a large amount of water into the Elbe river in a small period of time, making possible to lower the water level in the Dove-Elbe to 0,70 m, without putting the structural safety of the sluice at risk.

Stakeholder involvement in the NBS design process

The major communication and the decision-making process took place between the City of Hamburg's representatives and the representatives of the Borough of Bergdorf.

More details on stakeholder's involvement in the NBS design process are presented in RECONECT Deliverable report D2.1.

b) Selected NBS design

Details on the chosen design for the selected NBS

The major design elements of the NBS in the Demonstration area are given as follows:

1. The real-time controlling of the Tatenberg sluice

The Tatenberg sluice is the connection point between the Elbe River and the Demonstration area i.e. the area discharges into the Elbe via this sluice. The operation of the remaining hydraulic infrastructure in the area is based on the water level held upstream of this sluice. The design of the Tatenberg sluice implied the improvements of the discharge in order to lower the water level upstream in the whole system.

As already mentioned, the discharge capacity had to be improved at the same time not compromising the structural safety of the sluice. Because of the tidal influence in the Elbe river it is only possible to drain water into the Elbe during low tide as long as the water head remains smaller than 1,6 m. During this amount of time a maximal water flow about 24,7 m^3/s takes place, at the time the water head reaches 40 cm (see Figure 1-2).

The targeted goal with this design has been the one that increases the drained amount of water and does it in the smaller period of time. This is because the time to drain varies from 1:15 hours to 2:15 hours. The existing hydrodynamic models of the rivers and streams in the demonstration area have been enhanced to support the opening/closing regime of the sluices. This way it is possible to reduce the required retention areas in floodplains as the sluice operates 'just in time' and upon the actual need in terms of retention space.

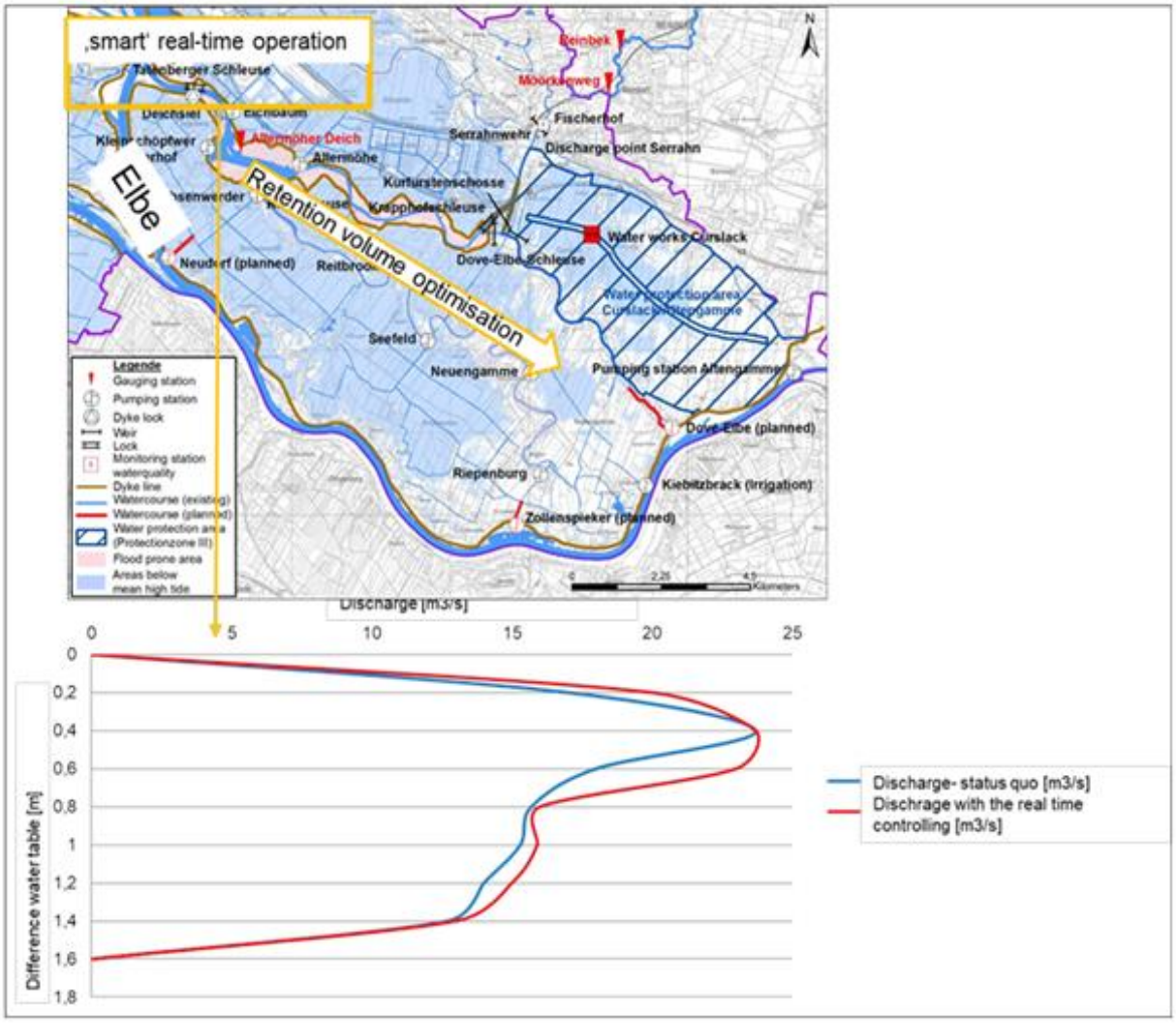

Figure 1-2 The real-time operation of the Tatenberg sluice; red line indicates the changes in the operation of the sluice with the real time operation (Elbe estuary)

2. Retention areas for the real-time controlling scenario

Here different options are still being analysed. As presented above, a number of restrictions is at place when selecting the retention areas.

Outline of the operation and maintenance plan

The real time controlling system operates according to the operational plan as presented in Figure 1-2. Regarding the maintenance, the system will be monitored and maintained by the Agency of the State of Hamburg (LSBG). The operation and maintenance of the hydraulic infrastructure and designated retention areas is carried on by the borough of Bergedorf and Hamburg Port Authority.

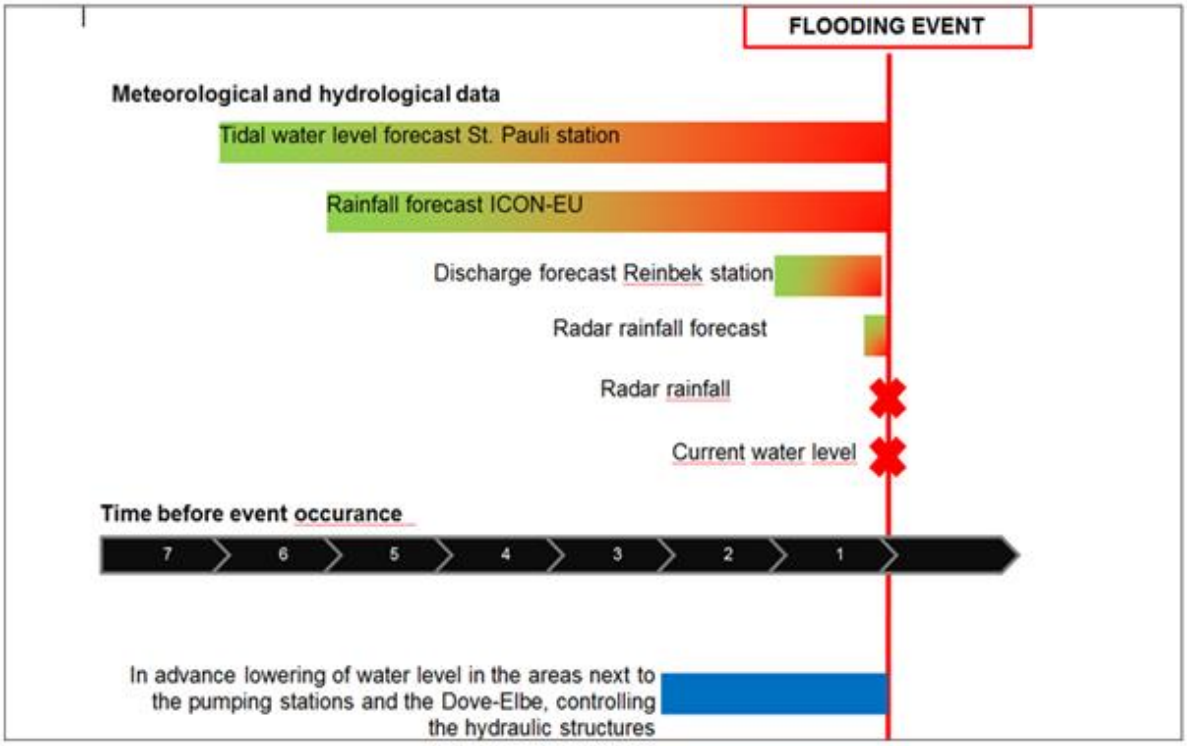

Figure 1-3 Operational plan of the real time controlling system (Elbe estuary)

Outline of the monitoring plan

The monitoring activities of the demonstrated NBS will start with the baseline monitoring and will make use of the previous monitoring activities mainly in relation to the water quantity (such as precipitation or discharge). Moreover, the existing equipment and services will be used for the baseline and after the implementation monitoring. The experience with the monitoring of the 'nature' parameters from the STUCK Project will be used as the basis for setting up the monitoring program and its dynamics. The expertise from the social sciences available in the RECONECT team is needed to set up the monitoring plan for the 'PEOPLE' indicators. The monitoring and evaluation plans, together with the list of indicators, will be presented in detail in deliverable D2.6 "Co-monitoring and co-evaluation plans for demonstrators".

Data Management System

The data required for the implementation is available at the responsible institutions (BUE and LSBG). Moreover, the census data as well as the basic geo data (maps, land use) is available online.

As one of the key demonstration aspects here is to develop a control and operation system as an ICT platform, the activities to integrate the data and information into the RECONECT Services platform are planned for the forthcoming periods.

1.2.3 NBS Cost evaluation

The conventional "grey infrastructure" in the demonstration area already exists and has been constructed and/or installed. Investments which were made in the past are financed by public funds of the City of Hamburg.

The NBS cost evaluation considers the enhancement of the grey infrastructure by a smart and automated steering and operation system. Meaning that the nowadays conventionally operating grey infrastructure is being optimised by a combination of weather forecast elements and the corresponding operating schedules of the drainage system infrastructure by an automated smart steering system. The existing infrastructure (valued approx. 20 Mio Euros) and the new automation of the steering system represents in the given demonstrator the classic hybrid solution NBS element.

To this NBS element RECONECT will contribute of the overall hybrid solution with the investment in the magnitude of 700.000 €.

The maintenance costs have been estimated to 50000 €/year.

1.3 Procurement of contracts

Contract procurement process/methodology

Due to specific conditions in the FHH demonstrator, no contract procurement had to take place. Following the national/local rules, the contract has been given to the LSBG, which has a special authorisation to execute implementation projects of the State of Hamburg. This has been communicated and confirmed by the German National Contact Point.

Criteria for evaluation of contracts

As stated above, no contract procurement took place and the contract followed national/local rules.

There is no information available on measures to ensure the quality performance of the contract works.

1.4 Construction works

For the real- time controlling system, the construction works encompass the following steps/phases:

1) Finalisation of the concept for the real-time controlling system, including the fine-tuning of the module (hydrodynamic modelling)
2) Installation and operation of the server and technical equipment at the Borough of Bergedorf
3) Data Management – definition of protocols and implementation
4) Installation and operation of the forecast model
5) Final testing and permanent installation of the system for the operation

For the retention areas the construction works depend on the final real-time operation option that will be implemented.

1.5 Operation and Maintenance

NBS life-cycle

It is expected that real time controlling system of the Tatenberg sluice and the corresponding use of the retention areas in the demonstration area will be operational beyond the RECONECT project. As the key operational units, being the LSBG and the Borough of Bergedorf are involved in the development and implementation of this solution, the long term perspective of the solution has been one of the criteria to select the NBS option.

Organisation authorised to carry on operation and maintenance. Coordination with relevant authorities & stakeholders

The operation and maintenance of the hydraulic infrastructure is carried on by the borough of Bergedorf and Hamburg Port Authority. Operation and maintenance of the model in the server will be carried on by the LSBG.

Main Operation and Maintenance activities to be done

The following operation and maintenance activities have to be done:

- Permanent model adjustment in the server.
- Maintenance of the potential retention areas.

Potential challenges and possible ways to overcome them

A potential challenge is the final selection of the retention areas. Further modelling exercises and analysis of the soil and further characteristics of the area are required.

2 Demonstrator DA2: Odense Coastal Area, Denmark

2.1 Case description

Due to the change in climate the suburban area at Seden Strand is threatened by flooding due to the rising sea level. At Strand this means that 142 private homes are at the direct risk of flooding as well as up to 66 ha of agricultural land.

Odense Fjord and the surrounding fiord habitats are designated as a Natura 2000 site DK008X075, protected both by EU´s Bird Directive and Habitat Directive. The status of the Natura 2000-site has to be improved because of a decline of habitats due to cultivation and overgrowth among others.

Instead of trying to solve the above challenges separately this project wants to combine the interests and with a holistic approach look at solutions which make (more) space for people, nature and water.

At Seden Strand this includes:

- Removal of existing low coastal summer dikes and moving them inland to a higher location
- Promote rehabilitation of new habitats (salt meadows - 1330) outside the new dikes
- Recreation of meanders of existing streams
- Focus on target species like the avocet (Recurvirostra avosetta) and the natterjack toad (Epidalea calamita)

The project area and planned actions are visualized in Figure 2-1.

Figure 2-1 The project area covers the settlement of Seden Strand close to Odense. Picture taken by Starling Air, December 2016

More information for the NBS case is available in RECONECT deliverable report D2.3.

2.2 Technical specifications of the Demo case

2.2.1 NBS selection

Main steps in the assessment process that lead to the selection of feasible and final NBS measure(s)

Risk of flooding

The project area at Seden Strand is placed at Odense Fjord which is designated as one of 10 special risk areas in Denmark with a high risk of flooding. Seden Strand has experienced several floods. With the expected sea level rice and more unstable weather due to climate changes the risk of floods are expected to occur more frequent. Therefore there has been a wish from citizens at Seden Strand to find a common solution to secure better protection against flooding.

The municipalities around Odense Fjord have prepared a common risk management plan (figure 2-2) to prioritise the actions around the fiord. In the risk management plan the costs of damages due to floods is assessed to be high at Seden Strand.

Nature interests

The shallow parts of Odense Fjord and the salt marshes are of great importance for breeding and migrating birds. The fiord and the surrounding fiord habitats are designated as a Natura 2000 site (DK008X075), protected both by EU Bird Directive and Habitat Directive.

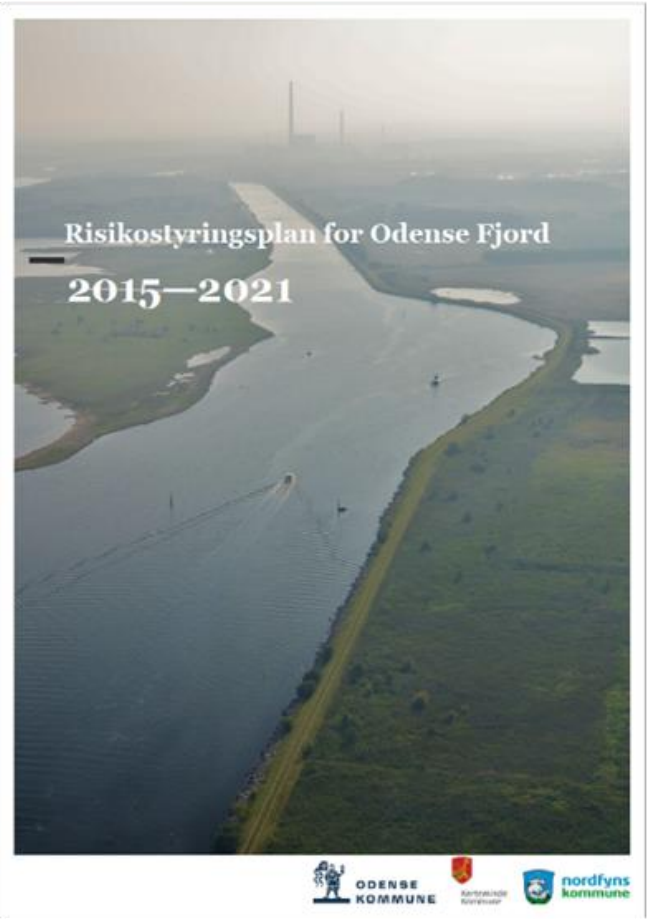

Figure 2-2 The risk management plan for Odense Fjord (produced by the 3 municipalities around the fiord).

Figure 2-3 Natura 2000 action plan for Odense Fjord (produced by the 3 municipalities around the fiord).

The status for the majority of habitats including breeding possibilities for birds has to be improved because of a decline of the habitats due to cultivation and overgrowth among others. The municipalities around the fiord have produced a common action plan for Odense Fjord describing the planned actions needed (Figure 2-3).

Possible synergies

As there is a great overlap in the interests in the area, Odense Municipality wants to combine these interests in using nature based solutions which combine the interests for people and nature/water as equivalent parameters. These synergies are described in the risk management plan as well as the Natura 2000 action plan.

Determination of the risk reduction target / primary benefit. NBS measures considered feasible in meeting the risk reduction target.

The risk management plan for Odense Fjord calculates with a sea level rice up to 30 cm DVR90[1] in 2050.

The Odense Fjord area experienced in 2006 a storm with sea levels up to 1.90 meter DVR90. This storm was assessed as an incident which statistically should occur every 250 year (figure 2-4). With the expected sea level rice in 2050 and more extreme weather this type of storm should occur every 20 year. A 250 year storm in 2050 is instead calculated to happen with a high tide up to 220 centimetres DVR90.

[1] DVR90 height is a vertical CRS last revised on 24. okt. 2019 and is suitable for use in Denmark - onshore. DVR90 height uses the Dansk Vertikal Reference 1990 as its datum. DVR90 height is a CRS for Topographic mapping and engineering survey. It was defined by information from Kort & Matrikelstyrelsen: The Danish height system DVR90, Publ. 4.series, vol. 8, 2000.. Replaces Dansk Normal Null height (CRS code 5733). https://georepository.com/crs_5799/DVR90-height.html

The protection around Seden Strand is planned to be able to give protection against flooding above this level.

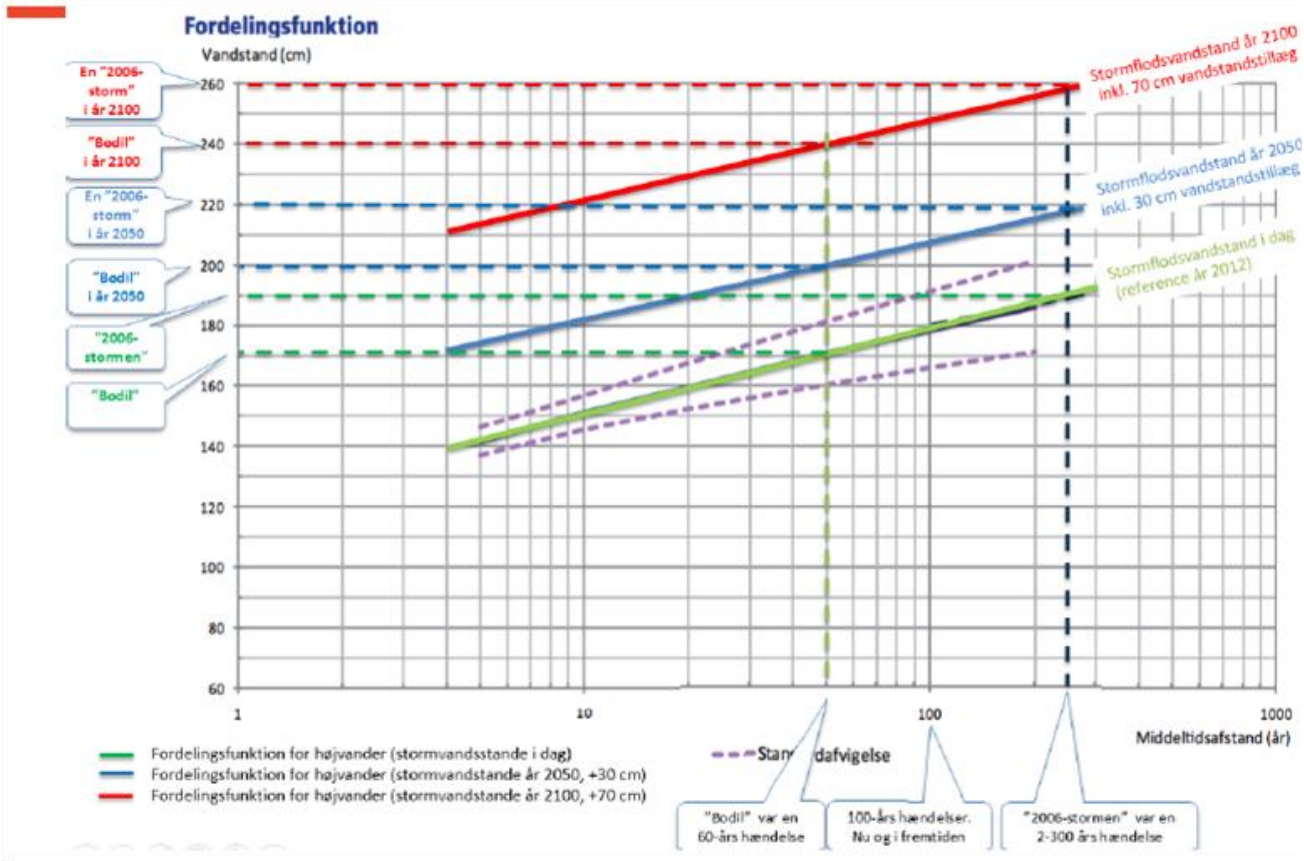

Figure 2-4 Cumulative distribution function for extreme high tide in Odense Fjord

Figure 2-4 is taken from the risk management plan for Odense Fjord. It is a modified version of the Coastal Authority's cumulative distribution function for extreme high tide in Odense Fjord. The actual scope of the statistics is indicated by the green line.

The development of the nature based solution at Seden Strand is based on a preliminary project made by Rambøll for Odense Municipality in 2014 (figure 2-5).

The criteria for this preliminary project was an assessment of the potential to make synergies between the need for improved protection against flooding and improved possibilities for development of new nature at Odense Fjord.

Criteria to choose the final NBS measure(s)

The project at Seden Strand is seeking to maximize the multi benefits of the project. This includes e.g. removal of trees in the project area to improve the habitat for waders, remeandering of streams and improving of the possibilities for dissemination of project within the area.

The potential maximization is still limited by the overall budget of the project and acceptance from the landowners.

Figure 2-5 Illustration of the preliminary project made by Rambøll 2014.

Stakeholder involvement in the identification of all feasible, and the final NBS measure(s).

As the political acceptance of the nature based solution approach has been given though the risk management plan and the nature 2000 action plan, the primary stakeholder involvement has included the landowners who are crucial for implementation of the chosen NBS.

In connection to this there has also been additional information of NGO´s, residents in Seden Strand and the responsible politicians.

2.2.2 NBS design

a) NBS design process

Design options considered

The approach to the design of the nature based solution at Seden Strand has from the beginning been to develop a solution with multi benefits. In this case there has not been any alternatives to a dike. The location of the dike has been changed due to reject from one of the stakeholders. Regarding the design there has also been consideration about the impact in the landscape and the future maintenance.

Rationale in the design of the NBS

Primary target
The primary target in the design of the nature based solution has been:

1. it´s capability to give better protection against flooding
2. improvement of the possibilities for development of new nature (allow nature to migrate)
3. conservation of the open coastal landscape

Secondary target
Secondary the project at Seden Strand has been and will be focused on possibilities to implement further co-benefits in the solution or parallel to the nature based solution. This has included:

1. remeandering of 2 streams in area in front of the dikes to establish more natural hydrology
2. clearing of trees to reduce predation and improve the breeding possibilities for waders
3. establishment of breeding ponds for amphibians (the natterjack toad - Epidalea calamita) but also ponds for improved foraging for birds
4. establishment of “nature plugins on parts of the backside of the dike
5. improvement of the possibilities for nature conservation
6. reduction of emission of nitrogen to Odense Fjord – through the remeandering of streams and extensifying agricultural areas
7. establishment of observation towers, new nature trails and general improvement of the dissemination of the area

Target 6 has also been chosen as they support the municipality´s obligations regarding the EU habitat directive, the EU bird directive and the EU water framework directive.

Criteria for selecting the NBS design

As mentioned above the design option has from the start been focused on dikes. The criteria is that the solution chosen was easy to maintain by the landowners.

Stakeholder involvement in the NBS design process

The landowners as main stakeholders have been involved in the design process both through landowner negotiations and follow up face to face meetings.

Furthermore are the responsible authorities involved which includes Odense Municipality and the coastal authority under the Ministry of Environment and Food of Denmark.

b) Selected NBS design

Details on the chosen design for the selected NBS

Figure 2-6 gives an overview of the planned actions in the project. The design of the nature based solution at Seden Strand includes the construction of a new dike with flat slopes placed at a higher location. The nature based solution is chosen as it also allows the coastal habitats to adapt to climate changes and migrate inland in a future situation with higher sea level.

Nature trails will be established on the outskirt of the dike and improve the connection to the nearby suburbs.
The frame for the nature based solution at Seden Strand is also that it is a solution that shall give multi benefits for nature as well as for people. Therefore the design also includes remeandering of the streams, improvement of the habitats on the seaside of the dike and establishing of “nature plugins” in the dike. In addition to that the design of the dike is also made to minimize the impact on the open coastal landscape.

In order to give Odense Municipality the rights to establish the new dike and improve the habitats the municipality has paid one off compensation to landowners. Figure 2-7 shows areas, where the municipality has paid one off compensations.

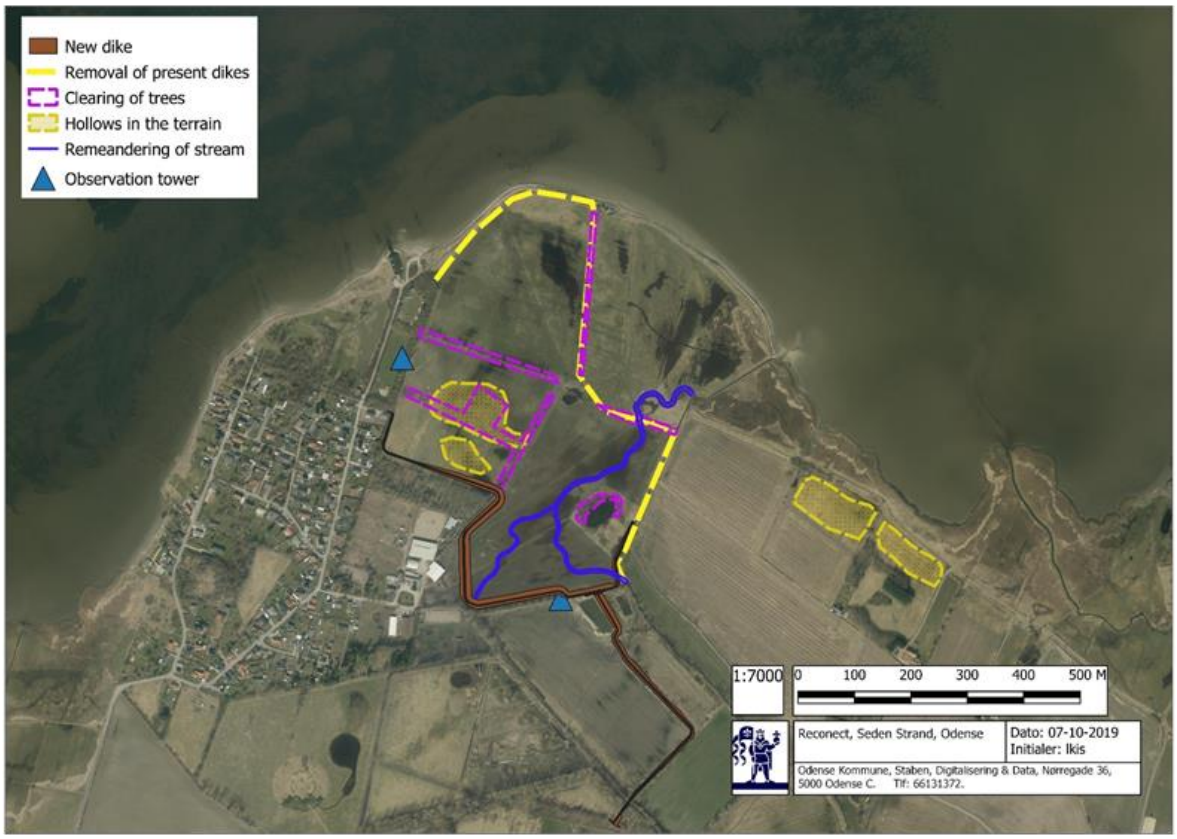

Figure 2-6 Overview of the project area and planned actions (Seden Strand).

Figure 2-7 Areas with one off compensation payment (Seden Strand).

Figure 2-8 Close up view showing the location of the planned dike (green). Rambøll.

Summary of the cost-benefit analysis for the chosen NBS

The condition for the municipality's participation in the project has been, and still is, a good opportunity to achieve multiple benefits. According to the Danish coastal protection act it is a landowners own responsibility to protect land and buildings against flooding. The coastal protection act regulates where and what kind of technical solutions can be used. It means that a solution that would only result in protection of buildings and land could not be financed by the municipality.

The project is based on a preliminary project. Within this preliminary project 2 solutions were developed which represented (1) a nature-optimal solution, and (2) a solution with less nature benefits. The difference in costs for the 2 solutions was not substantial and the costs for both solutions were at a realistic level. This meant that Odense Municipality finally decided to try to realize a solution with optimal benefits for nature.

Outline of the operation and maintenance plan

Odense Municipality will be responsible for maintenance of the streams in the meadow and the sluice lock as for the actual excavated channels. The flat slope in the meadows to the streams will permit grazing of the slopes and the stream, which will minimize the maintenance cost. The general operation and maintenance will be carried out by the landowners according to agreement with the municipality.

Figure 2-9 and 2-10 show cross section drawings of the dike with flat slopes and nature plugins.

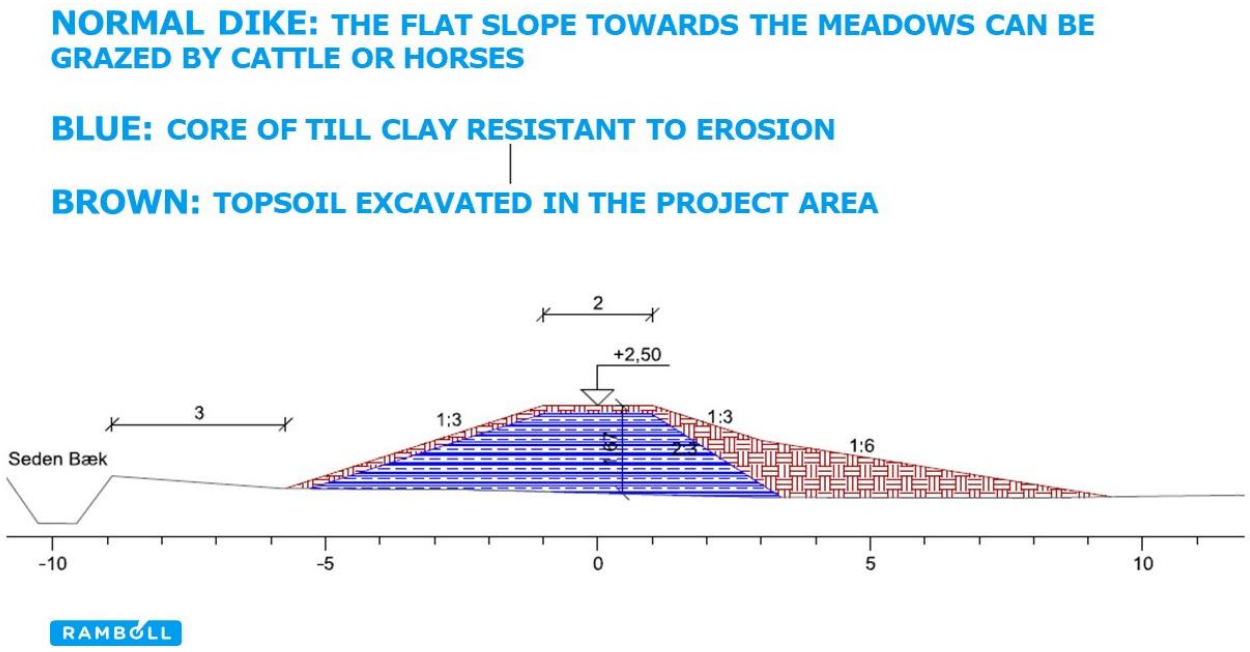

Figure 2-9 Cross section drawing of the new dike at Seden Strand. (Rambøll)

The dikes will be constructed with flat slopes.

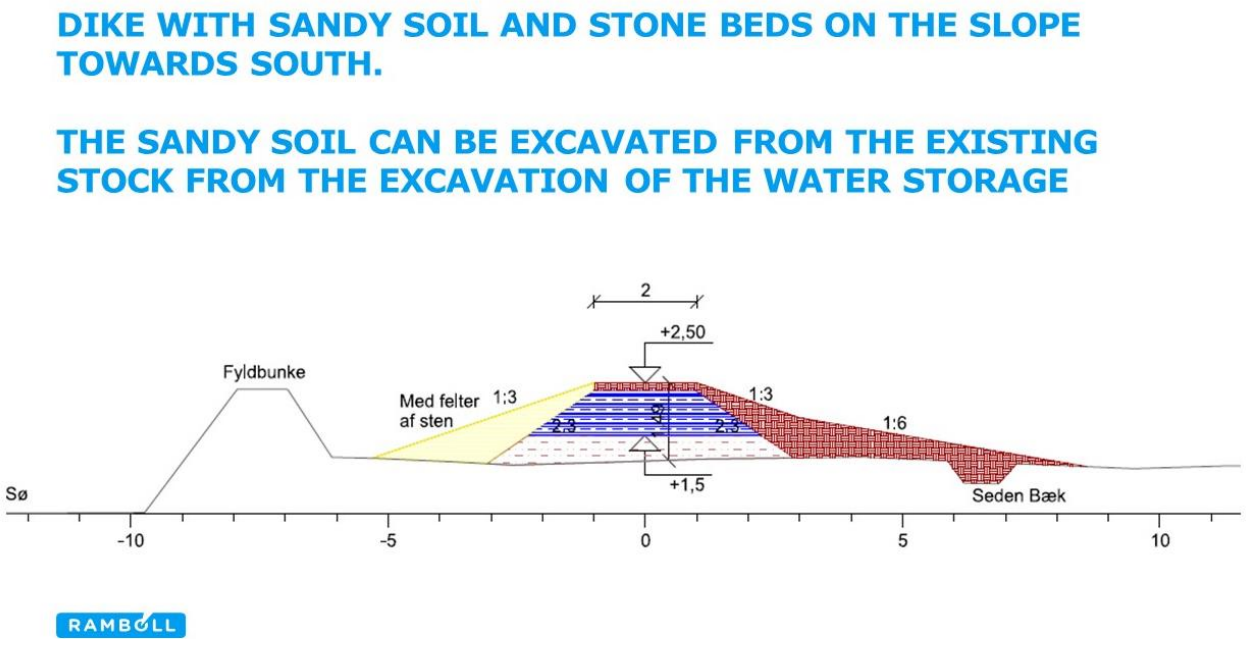

Figure 2-10 Cross section drawing of the new dike with nature plugins.

The area with stones *(Med felter af sten*) are shown on Figure 2-10. The area with "Fyldbunke" is not a part of the dike, but shows the border of a water reservoir for irrigation (Rambøll).

Outline of the monitoring plan

The monitoring program is going to be developed during next months. It is going to be carried out mainly by involved partners. Rambøll is going to be responsible for monitoring and evaluating water and people indicators. Amphi International is going to be responsible for monitoring and evaluating of nature indicators, including innovative method e-DNA. Odense

Commune will be installing some of monitoring equipment (e.g. data loggers for visitors) as well as will be involved in development of e-DNA method.

Historic data concerning nature indicators will be obtained among others from previous surveys under Danish NOVANA national monitoring and assessment programme for aquatic and terrestrial environments (Svendsen et al., 2005; http://novana.au.dk/om-novanaaudk/).

The monitoring and evaluation plans, together with the list of indicators, will be presented in detail in D2.6 “Co-monitoring and co-evaluation plans for demonstrators”.

2.2.3NBS Cost evaluation

Table 2-1 Estimated NBS costs Seden Strand

Estimated NBS costs Seden Strand	**Euro**
Compensation payment	320.850
External consultants compensations payment	9.477
Observation tower	87.010
Nature trails	9.370
Information signs and dissemination	9.370
Clearing of trees	13.386
Mobilisation and Site	13.386
Removal of old pump	1.874
Earth works, dikes and streams	148.064
Piping and wells	8.594
Sluice lock	42.166
Extra work	6.158
Improvement of habitats for amphibians and birds	20.079
Grazing facilities	47.735
Contingencies in construction	40.719
Total estimated costs for NBS	**778.240**

The above described costs shows all costs related to the chosen nature based solution at Seden Strand. All these costs are therefore not directly supported by the RECONECT project, but are support of the multi benefits financed alone by Odense Municipality or together with The Danish Environmental Protection Agency.

2.3Procurement of contracts

Contract procurement process/methodology
The Municipality of Odense complies the national legislation in relation to tenders and the collection of tenders that are regulated in the The Public Procurement Act.

Thresholds in Odense Municipality are as follows:

- Over Dkr 500,000 (€ 67.000) in 4 years = national offer
- Over Dkr 1,500,000 (€ 201.000) in 4 years = EU Offering

Acquisitions / services that are below the threshold values can be entered into by bidding or direct negotiation. Odense Municipality will still where possible to secure the most advantageous price and / or best solution for the project, collect min. 2 offers in each case. The offers are made on the basis of a description (written or oral) prepared by the Municipality of Odense.

All offers are journaled on individual cases for the specific action.

In some cases, for special assignments, suppliers will be selected on the basis of negotiation. In the specific cases, this solution is argued, which is placed as a note on the individual case.

Criteria for evaluation of contracts

The prequalified adequate contractors and the tenderer shall fill in the Tender Schedules. Odense Municipality will evaluate the tenders and the contractor offering the lowest bid and complying with the conditions in tender documents, will be chosen for signing of contract.

Measures to ensure the quality performance of contract works

The works shall be carried out by the contractor in accordance with the drawings from the detailed design and the requirements in the Technical Specifications. Drawings of dikes and new streams have been carried out as 3D-digital drawings, which can be used by the contractor in GPS-controlled machines. In this way, the earthworks will be carried out exactly as designed. The consultants in this case the partners in RECONECT project will provide general supervision during execution of works and commissioning of the completed works.

At the end of each assignment the complete work will also be examined by Odense Municipality Rambøll and Amphi together with the chosen contractor.

2.4Construction works

The construction works at Seden Strand include:

- Clearing of trees and bushes to improve the habitats for waders
- Removal of 825 meter old summer dikes
- Construction of 1,500 meter new dikes with 3 ramps for farm machine crossing of the dikes
- Establishing of nature plug-ins in the new dikes
- Excavation of 930 meter new watercourse and terrain modelling in order to improve water movement and storage and the possibilities for developing of new habitats within the project area.
- Construction of a new sluice lock for Seden-Aasum Skelbæk in the dike
- 16 meter Ø 600 mm pipe with backflow blocker in the dike for Seden Bæk

Extra construction works also include:

- Establishing of nature trails to improve the possibilities for dissemination for the public of the nature based solutions and climate changes effect on the area
- Establishing of grazing facilities to improve and secure the existence of habitats within the project area

2.5Operation and Maintenance

NBS life-cycle

The coastal meadows shall develop according to the dynamic influence from the normal tide and storm tide and no further man-made works shall be done, except cleaning up the streams in the meadows, if the grazing should not be enough to maintain the actual flow from the hinterland. The raise of sea level in Odense Fjord will make the meadows wetter. Deposit of sediments and seaweed will slowly increase the level of the lower meadows. The meadows near Seden Strandby are dry with the actual sea level, so coastal meadows will remain in the project area, also with higher sea level.

The top level and the slopes of the dikes shall be maintained, and damages after storms shall be repaired. The top level is designed for 0,30 m rise of sea level in Odense Fjord.

Main Operation and Maintenance activities to be done

The future maintenance of the new dike will be done by landowners who are directly protected from flooding. Except for the first 3 years after construction where new dikes will be maintained by Odense Municipality according to the signed contract between the landowners and the municipality. The conservation and securing of the new and existing habitats will be done by the municipality who is the responsible authority in close collaboration with the landowners.

Potential challenges and possible ways to overcome them

Raise of the general water level in Odense Fjord more than 0,30 m will reduce the safety level of the dikes to below a 100-year event. The top level of the dikes can be raised by new construction with supply of extra filling materials.

3 Demonstrator DA3: Tordera River Basin, Spain

3.1 Case description

The Tordera River Basin is located in Catalonia, in the north-eastern part of the Iberian Peninsula, and it covers an area of 900 km². The Tordera river is born at Montseny Natural Park (1,076 m.a.s.l.) and it flows into the Mediterranean Sea forming the Tordera Delta. Several cities are located along its course (Blanes: 38,790 inh., Malgrat de Mar: 18,439 inh., Sant Celoni: 17,754 inh., Tordera: 16,937 inh., Hostalric: 4,139 inh.). Tordera River Basin has a typical Mediterranean rain regime (scarce and highly irregular) and flash floods usually occur. Vulnerable activities are found in flood prone areas as the middle part of the basin is highly industrialized and the delta is a popular tourist spot where different camp sites are located.

In the context of the Tordera River Basin Levee Management Plan – a measure included in the Flood Risk Management Plan of the River Basin District of Catalonia and currently under development – different types of NBS will be analysed with the aim to reduce flood risk by means of restoring the natural functioning of floodplains and wetlands, while at the same time enhancing the environmental value associated to these areas. The type of NBS that will be studied include, but are not limited to, water storage areas, wetland restoration, setback of levees, enhancing transversal connectivity. The two main expected benefits of the implementation of NBS in the Tordera River Basin are the reduction of flood risk in highly vulnerable areas and the improvement of the environmental status of some other areas. However, it is also anticipated that some difficulties might arise in acquiring the land required to implement some of the planned measures and/or in signing stewardship agreements with the land owners.

The planned and implemented cases in the Tordera River Basin are visualized in Figure 3-1. More information on the Tordera River Basin is available in RECONECT deliverable report D2.3.

Figure 3-1 NBS planned and implemented in the Tordera River Basin

Besides the Levee Management Plan, ACA is currently carrying out different plans and programmes in the Tordera River Basin as part of its responsibilities implementing the EU Water Framework Directive (2000/60/EC) and the EU Floods Directive (2007/60/EC). These plans and programmes have, again, the twofold objective of reducing flood risk and enhancing the ecological status of water bodies and riparian areas. In this sense, some of the small-scale NBS considered in the Riverbed Maintenance and Conservation programme and/or in the River Restoration Programme will be included as a part of the Tordera River Basin demonstrator to be able to test and evaluate both, large-scale and small-scale NBS.

3.2 Technical specifications of the Demo case

3.2.1 NBS selection

Main steps in the assessment process that lead to the selection of feasible and final NBS measure(s)

(1) First of all, a flood hazard assessment was conducted at a basin scale for the 10, 100 and 500 years return period flood, by means of hydraulic modelling, to identify those areas more at risk.

(2) Secondly, locations are identified in which the implementation of an NBS might be helpful to reduce risk in the most affected areas. Two main types of NBS have been analysed: water retention areas and setting back levees. In this sense, one of the major factors determining NBS location has been land availability.

(3) Once the location for an NBS has been identified, the impact of the NBS in terms of flood risk reduction has been analysed by means of hydraulic modelling. So far, the results of this analysis show that water retention areas do not have a significant impact in mitigating low-probability/high-impact flood hazard.

(4) Once feasible NBS have been identified, the next step is to prioritize them by means of conducting a cost-benefit analysis. A prioritized list of NBS will be ready by the end of January 2020.

Determination of the risk reduction target. NBS measures considered feasible in meeting the risk reduction target.

Spanish legislation regulates land use and activities located within the 100-year and 500-year floodplain. Also, sectorial regulation included in the Management Plan of the River Basin District of Catalonia, establishes that flood protection measures should aim to provide full protection for the 100 years return period flood. In this context, the initial risk reduction target in all studies and works conducted by ACA is to fully protect the most vulnerable areas and activities for the 100-year flood. However, in most urban areas to achieve this risk reduction target is almost impossible, as floodplains have been historically constrained and occupied by different uses and activities. This is the case for the Tordera River Basin, where none of the NBS analysed so far helps in achieving the risk reduction target initially set. In this sense, the initial risk reduction target will have to be lowered. The level of protection that will be finally adopted might be different for each of the NBS analysed, depending on their technical and economic feasibility.

Criteria used to select all feasible NBS measures considered

A comprehensive feasibility analysis has not been conducted yet. However, the main criteria used for the proposal and pre-feasibility analysis of NBS are:

- Land availability, especially for the implementation of water retention areas.
- Location of these areas within the basin, prioritizing those locations that might help to reduce risk in the most vulnerable areas.
- Flood risk reduction achieved with the implementation of the NBS, assessed by means of hydraulic modelling.
- Technical feasibility of the solution.

Criteria to choose the final NBS measure(s)

The final measure to be implemented in the Tordera River Basin has not been selected yet. However, a cost-benefit analysis for all the feasible measures will be conducted, to prioritize the NBS that might help to achieve all the expected co-benefits more effectively.

Stakeholder involvement in the identification of all feasible, and the final NBS measure(s).

At this stage of the project, stakeholders have not been involved yet. However, once all the feasible measures are pre-selected, a consultation among key stakeholders to get their opinion and feedback on the proposed NBS will be conducted.

3.2.2 NBS design

a) NBS design process

Design options considered

This project is still in the pre-design phase. So far, a preliminary geometric definition is available of the NBS which has been introduced in the hydraulic models to be able to evaluate their impact in terms of risk reduction. The type of NBS that are being tested are mainly water retention areas and setting back levees. However, the plan is to also analyse the impact of reopening a secondary arm of the Tordera River in the Municipality of Tordera, as well as the restoration of Estany de Sils, an important wetland within the basin.

We might also consider the combination of different measures if the hydraulic models show that this could be a better solution to reduce flood risk in vulnerable areas.

Rationale in the design of the NBS

The primary target is flood risk reduction (WATER) as the project derives from the Flood Risk Management Plan of the River Basin District of Catalonia. As a secondary target, and in compliance with the EU Water Framework Directive, the aim is to enhance the environmental value of the riparian areas (NATURE). In spite not having defined any specific target/goal for PEOPLE, it is expected that by meeting the WATER and NATURE defined goals, co-benefits for PEOPLE will also result.

Criteria for selecting the NBS design

All feasible NBS will be prioritized based on a cost-benefit analysis. However, the methodology and criteria to be included in this analysis is not defined yet. In this sense, it is very interesting to learn from other experiences how to conduct a comprehensive cost-benefit analysis that takes into account all the expected co-benefits of the NBS in a meaningful way.

Stakeholder involvement in the NBS design process

The project has not reached this stage yet.

More details on stakeholder's involvement in the NBS design process are presented in RECONECT Deliverable report D2.1.

b) Selected NBS design

Details on the chosen design for the selected NBS

Tordera river NBS project has not reached the design stage yet.

Summary of the cost-benefit analysis for the chosen NBS

Tordera river NBS has not reached this stage yet.

Outline of the operation and maintenance plan

The project has not reached this stage yet.

Outline of the monitoring plan

ACA does not have any monitoring programme in place except for those indicators that have to be reported to the European Commission in compliance with the Water Framework Directive. In this sense, the only indicators that ACA will be able to monitor are those related to the ecological status of water bodies and those that can be hydrologically and/or hydraulically modelled. At this stage of the project, it is still uncertain if the monitoring works will be outsourced. Besides, there are a few environmental NGO's working in the Tordera (and already identified as stakeholders), that are expected to be interested in collaborating in the monitoring process of the NBS.

The monitoring and evaluation plans, together with the list of indicators, will be presented in detail in D2.6 "Co-monitoring and co-evaluation plans for demonstrators".

3.2.3NBS Cost evaluation

Tordera river NBS project has not reached this stage yet.

3.3Procurement of contracts

Contract procurement process/methodology

Public procurement procedures in Spain are well defined and established by a specific piece of legislation[2] that transposes into national legislation the 2014/23/EU and 2014/24/EU Directives.

Criteria for evaluation of contracts

Evaluation criteria will depend on the value of the contract and on the type of procured products and/or services, as established by the Spanish public procurement legislation. In this sense, public works contracts under 40.000 € and public service contracts under 15.000 € can be awarded directly, without a bidding process. For contract values exceeding the aforementioned amounts, the evaluation criteria may include both, qualitative and economic criteria, to ensure that the contract is awarded to the tender that offers the best quality/cost ratio. In this sense, qualitative evaluation criteria have to be defined in relation to the subject matter of the contract.

In the case of the procurement of the executive project and construction works of the NBS to be implemented in the Tordera River Basin, these criteria will be established once the type, location and characteristics of the NBS will be defined.

Measures to ensure the quality performance of contract works

There are not specific measures planned to ensure the quality performance of the contracts, except for those included in the public procurement legislation with regard to the execution of contracts and compliance with the requirements of the contract.

3.4Construction works

At this stage of the project, it is difficult to anticipate how the construction works will be executed, as the type of NBS to be implemented in the Tordera River Basin has not been selected yet.

3.5Operation and Maintenance

NBS life-cycle

At this stage of the project, it is difficult to envision the NBS life-cycle, as the Demonstrator has not selected yet the type of NBS to be implemented in the Tordera River Basin. However, most of the flood protection measures that have been constructed and implemented by ACA do not include a decommissioning plan.

Organisation authorised to carry on operation and maintenance. Coordination with relevant authorities & stakeholders

Operation and maintenance of the NBS, in case it is needed, will be responsibility of the owner. However, ACA, as owner of the NBS, will try to set up agreements with those municipalities affected by the NBS to transfer them the operation and maintenance duties.

Main Operation and Maintenance activities to be done. Potential challenges and possible ways to overcome them

At this stage of the project, it is difficult to define the operation and maintenance activities to be done, as well as the potential challenges to be faced and possible ways to overcome them, as the Demonstrator have not selected yet the type of NBS to be implemented in the Tordera River Basin.

[2] Law 9/2017, of November 8th, on Public Sector Contracts, which transposes into Spanish legislation the Directives of the European Parliament and of the Council 2014/23/EU and 2014/24/EU, of February 26th 2014 (https://www.boe.es/buscar/act.php?lang=es&id=BOE-A-2017-12902&tn=&p=)

4 Demonstrator DA4: Portofino Regional Natural Park, Italy

4.1 Case description

The Promontory of Portofino shows views and landscapes among the most famous in the world. Made by conglomerate rock masses overlying marly limestone flysch, it has geomorphologic and microclimatic features that, in a limited territory, have created very different environments. The increase of brief and intense rainfall events, as verified by analysing rain gauges data over the last 100 years, tends to foresee a possible growth in flash flood events that, considering the steepness of the slopes and the accumulated loose coarse soil, can determine favourable conditions for triggering increasingly disastrous debris and mud flows.

The analysis of geomorphological, geological, historical and socio-economic factors has clearly shown that the abandonment of the terraces led to an increase in geo-hydrological risk in an area already struggling to maintain a delicate balance between natural and historical aspects of its landscape.

The Portofino Natural Park is promoting interventions aimed at reducing geo-hazards and vulnerability against climate changes, above all the extreme rainfall events. There interventions are mostly carried out through natural and nature-based solutions, aimed at exploiting and regenerating ecosystem services and natural functions of the area.

NBS works done in the Portofino Natural Park within RECONECT relates in particular:

1. dry-stones walls construction and abandoned terraces restoration, with the aim to preserve the terraced landscape, and push the agricultural activities;
2. hydraulic-forestry operations on water courses;
3. riverbed and tributary operations;
4. natural engineering interventions along hiking paths;
5. interventions of forest amelioration and re-forestation.

Some small catchments involved in RECONECT project include the San Fruttuoso village Catchments (Rio dei Fontanini and Vallone di San Fruttuoso streams) and in the Paraggi village Catchments (Fosso dell'Acqua Viva and Fosso dell'Acqua Morta streams).

More information on the Portofino case is available in RECONECT deliverable report D2.3.

4.2 Technical specifications of the Demo case

4.2.1 NBS selection

Main steps in the assessment process that lead to the selection of feasible and final NBS measure(s)

Three small catchments and some bordering slopes belonging to the areas of San Fruttuoso and Paraggi have been selected in the Portofino Park territory (see Figure 4-1 and Figure 4-2 2). In both areas, important infrastructures, tourism facilities and cultural heritages are exposed to a high geo-hydrological hazard. Tracks, which are a significant element of fruition of the Park, are exposed to deterioration caused by erosion and wood degradation.

Geo-hydrological hazard is correlated with the morphology, which is characterised by high and very high slope gradient, with the lithology and with the peculiar regional rain regime. Flash flood and concurrent shallow landslides, mainly debris flow/hyper concentrated flow, are triggered during intense rain events: manmade terraces, due to their nature of artificial

immobilization of debris along steep slopes, may collapse and contribute to damages and to the saturation of the flow capacity of culverts that are located before the coastline and close to the hazard exposed elements. The floating transport, potentially high due to the several wind and storm events that hit the area in the recent years making fell many trees, magnify the risk level.

NBS have been target considering the risk mitigation strategy at catchments scale with a holistic ecosystem-based approach, starting from the exposed elements in the lower portions and considering streams as debris flow path. Sources of possible debris has been primarily pointed out in abandoned terraces, considering recent destructive events that happened in bordering areas (5 Terre flash flood in 2011 and Leivi debris flow in 2014).

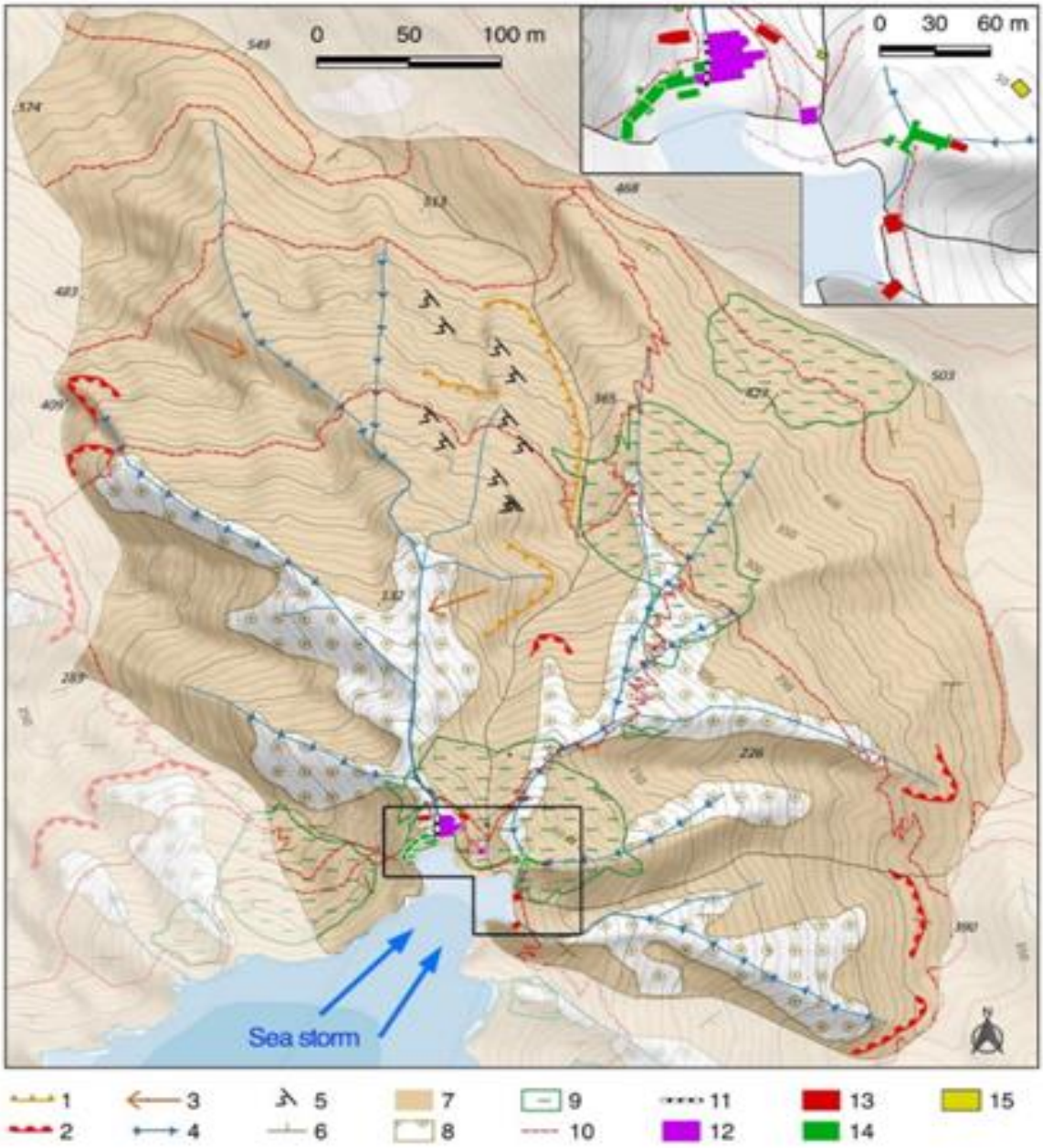

Figure 4-1 San Fruttuoso catchment hazard/vulnerability

1) Dormant landslide scarp; 2) Active scarp; 3) Slope instability and flow directions; 4) Downcutting talweg; 5) Slope erosion; 6) Bedding; 7) Conglomerates with sandstone layers; 8) Debris cover; 9) Terrace 10) Trail; 11) Culvert; 12) Religious building; 13) Residential building; 14) Receptive building; 15) Agricultural/rural building.

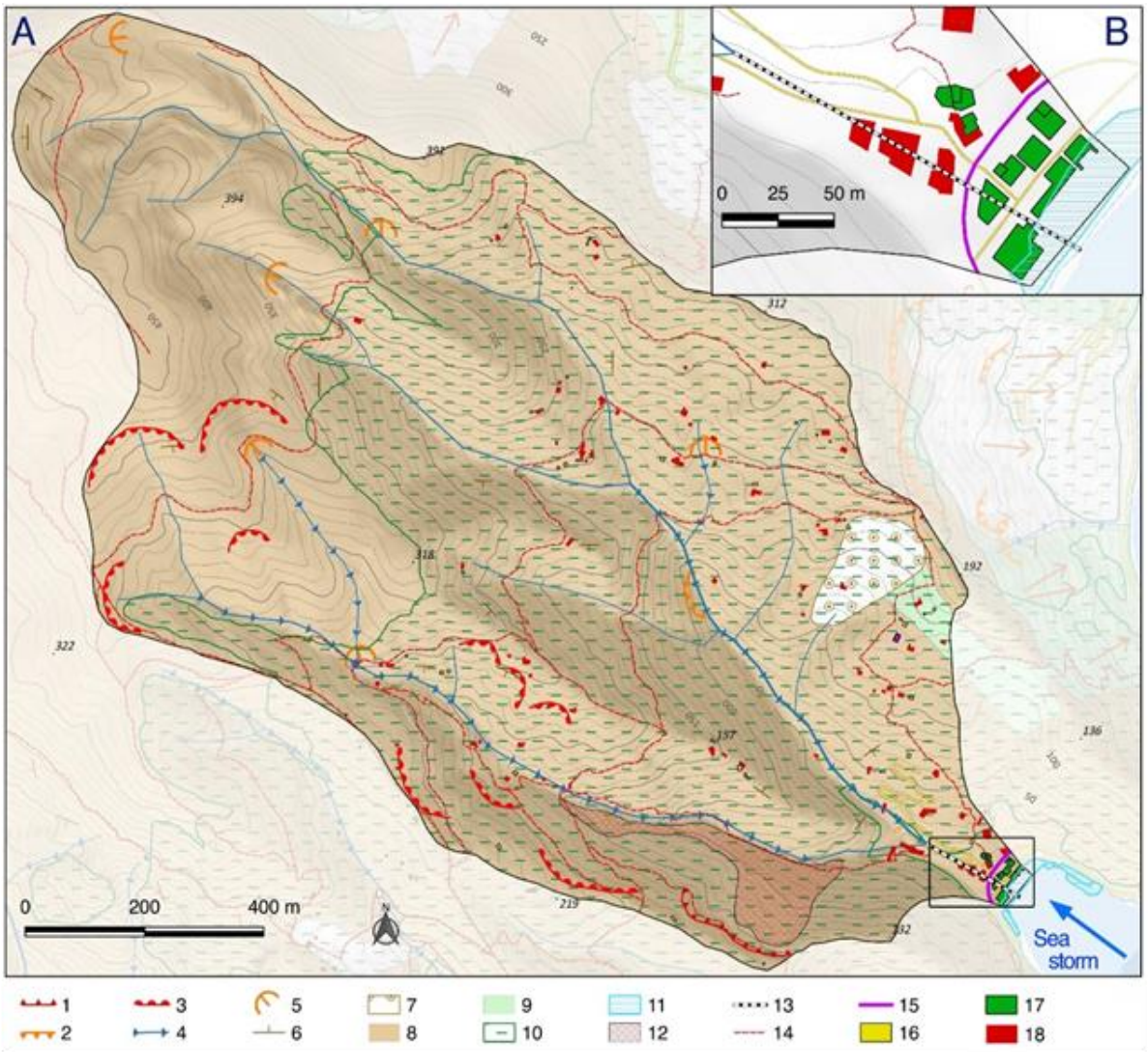

Figure 4-2 Paraggi catchment hazard/vulnerability

1) Active scarp; 2) Dormant scarp; 3) Landslide active scarp; 4) Downcutting talweg; 5) Unmappable landslide; 6) Bedding; 7) Debris cover; 8) Conglomerates with sandstone layers; 9) Marly limestones, clayed marls and marls; 10) Terraces; 11) Marine flood with return time 50y; 12) Landslides; 13) Culvert; 14) Trail; 15) Road; 16) Agricultural/rural building; 17) Receptive building; 18) Residential building.

Determination of the risk reduction target / primary benefit. NBS measures considered feasible in meeting the risk reduction target.

The primary expected benefits are:

1) Decrease of geo-hydrological vulnerability for the main infrastructures and the cultural heritage
2) Re-building/maintenance of dry-stone walls, which will contribute to restore old terraces and re-incentivize agricultural activities, with benefits for the landscape (terraces are part of the landscape and cultural heritage) and for geo-hydrological risk mitigation. With this respect, the analysis of geomorphological, geological, historical and socio-economic factors has clearly shown that the abandonment of the terraces led to an increase in geo-hydrological risk in an area already struggling to maintain a delicate balance between natural and historical aspects of its landscape

3) Decrease of impacts by landslides and slopes instability at coastal sediment amount level.

Several NBS measures have been addressed to mitigate the risk, considering the peculiarities of the area and the difficulty in realizing the interventions in a mountainous area by the sea: the necessity of making small and spread works on the territory coincide with the logistic impediments.

NBS in San Fruttuoso are aimed at:

- Stabilization of rocks
- Mitigation of hydraulic and geo-hydrologic risks, in order to intercept and reduce the solid transport along the rivers and limit the erosion
- Wood amelioration, by removing allochthonous and degraded species of old conifers (Pinus pinea L. and P. halepensis Mill.), which suffer Mediterranean environment and are low adaptive to climate change, in particular *Pinis pinea* L, to favour the natural regeneration of holms (Quercus ilex L.), the climax species in the area
- Dry-stones walls construction and abandoned terraces restoration, with the aim to valorise the terraced landscape, typical of the region, and push the agricultural activities. Reconstruction of terraces and regeneration of natural and man-made ecosystem is implemented also in the Paraggi basin, together with: hydraulic-forestry arrangements on water courses, in particular the removing from the river bed of tree trunks and dead vegetation, with the aim to improve the outflow and decrease solid transport; riverbed and tributary arrangements, such as the construction of weirs (made by wood) to keep coarse material and thresholds (made by stones) to raise the riverbed level and favour the settling of sediments
- Maintenance along hiking paths, such as slopes stabilization, cleaning and removing of dead vegetation and dirt.

Other NBS interventions of wood amelioration and re-forestation are also expected to be undertaken along the RECONECT project years, to recover the original function of Portofino forests and soils and to prevent geo-hydrological instability phenomena.

Criteria used to select all feasible NBS measures considered

All the considered measures are maintenance works at catchment scale and the following main feasibility criteria have been used: the high efficiency in the risk mitigation strategy, the low impact of the works and the low cost. Other complementary criteria are: the compatibility with the natural features of the catchments and the logistic complexity of the area.

Other factors have been considered in the selection process, relating to the expected benefits and co-benefits, as the measures capacity of:

1) reducing risk injuries among park visitors due to instability of slopes in hiking paths during heavy rainfalls

2) supporting the interaction process between private landowners

3) integrating the proposed NBS with regional policies for land management/planning and with River Basin management plans

4) improving the visibility and governance model of the Portofino Regional Park, also in the perspective of becoming a National Park (ongoing procedure)

5) improving the collaboration between the Park Authority and the main local actors

Criteria to choose the final NBS measure(s)

One more criterion has been added to select the final measures: the landscape value of the San Fruttuoso area requests the solely use of stone walls for re-building/stabilizing terraces, avoiding the use of less expensive environmental engineering techniques that have been considered in the Paraggi catchment. A critical constrain for the selection of measures has been the availability of the areas of interventions: while along the streams the property is public, that means no constrain apart obviously the respect of legislation, the measures along the slopes have been designed considering the more critical areas where has been possible to have the agreement with the private owners. Some small areas area owned by many single owners that is almost impossible to gather together for a single agreement.

Stakeholder involvement in the identification of all feasible, and the final NBS measure(s).

At the preliminary design stage, the stakeholders involved in the identification process of NBS measures have been the owners of the slopes where terraces will be re-built/stabilized and the Superintendence for the Landscape and Archaeology, due to the high interest and value of the area, other than the municipalities in the Park (Camogli, Portofino and Santa Margherita Ligure), the council of the Portofino Park Authority, the University of Genoa and the Italian Environmental Fund (FAI) that manages some cultural heritages in the park. Subsequently, and in order to get inputs for the final design, the other stakeholders will be involved: environmental associations, hikers associations, tourism facilities owners, citizens and private owners' associations.

More details on stakeholder's involvement in the NBS design process are presented in RECONECT Deliverable report D2.1.

4.2.2 NBS design

a) NBS design process

Design options considered

The peculiarity of the area requests the adoption of a risk mitigation strategy at catchments scale with a holistic ecosystem-based approach, then a combination of measures have been considered to face the different problems that affect the area.

The combinations of measures for the two areas of San Fruttuoso and Paraggi have been chosen in order to approach critical situations at the catchment scale and to get to a general geo-hydrological risk mitigation: some single measures were impossible to realize for local constrains, even though their functionality would have been certain. It is the case of the sediment trap in San Fruttuoso, where there is no room enough for it before the culvert entrance. A sediment trap is among the designed measures before the culvert inlet in Paraggi (point J in Figure 4-3).

The necessary efficiency of the measures together with the constrains represented by the territory asset and landscape, natural and historical value of the area restricted the possible interventions as the only possible ones and then no other options have been considered.

Rationale in the design of the NBS

The primary target has been the risk mitigation at the catchment scale, considering that debris flow and possible flash flooding may have their higher impact on the exposed elements that are at close to the stream mouth. Then reducing slope instability, erosion, sediments and floating transport in the streams have been the main issues to approach.

Secondly, specific exposed elements have been addressed for their high exposure to risk and to degradation: it is the case of an ancient terraced slope in San Fruttuoso (point C in Figure 4-4) whose collapse represent a damage itself but even a threat for the small but important water treatment plant that is downward of it.

Another case regards the Casa dell'Arco in San Fruttuoso (point A in Figure 4-4), whose protection has been addressed with a specific work.

Co-benefits have been part of the process, as they involve the improve of nature quality (primary vegetation) and the high tourist activity that correspond to a high economic value.

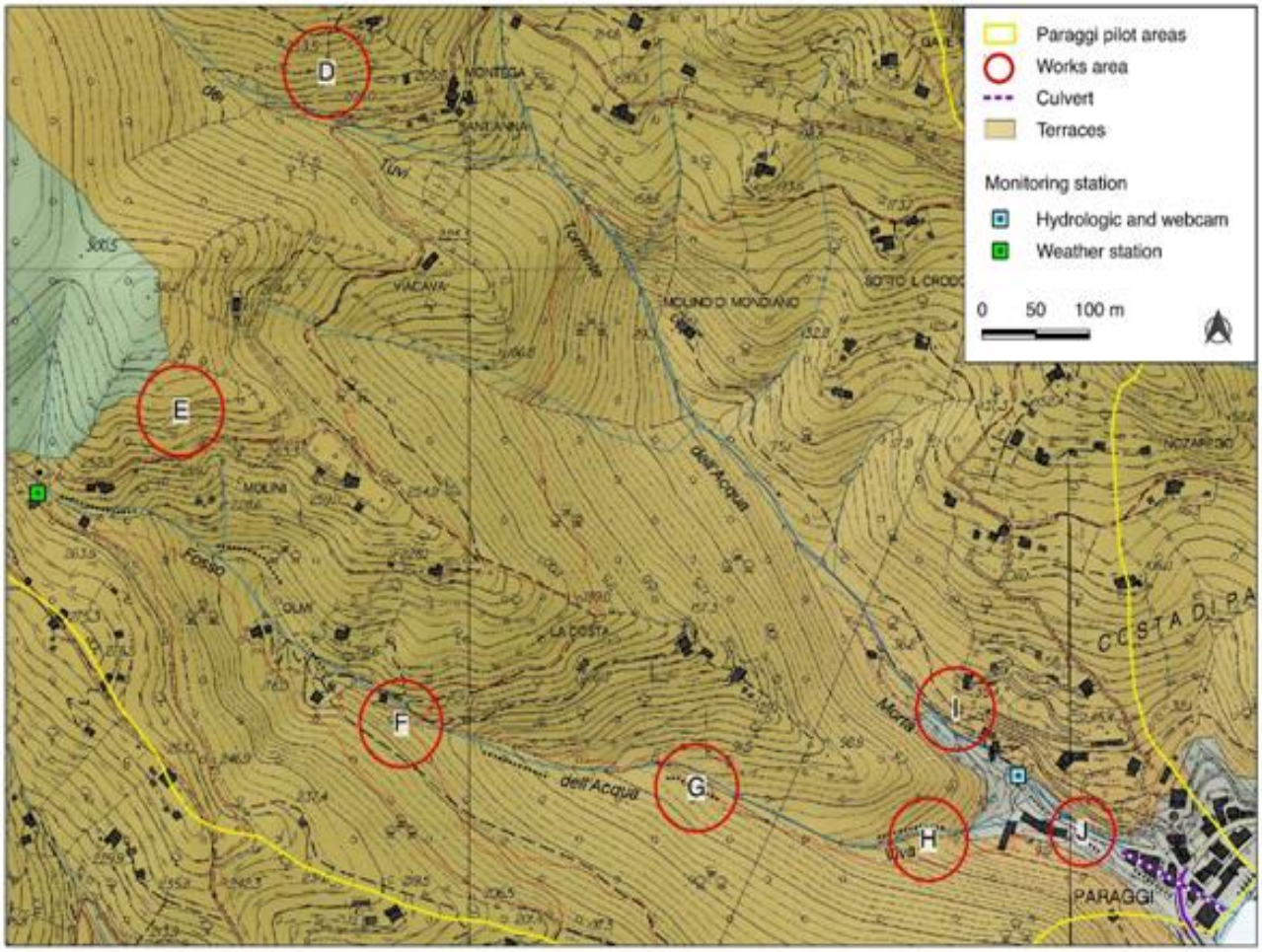

Figure 4-3 Paraggi catchment risk reduction interventions (NBS) and monitoring systems

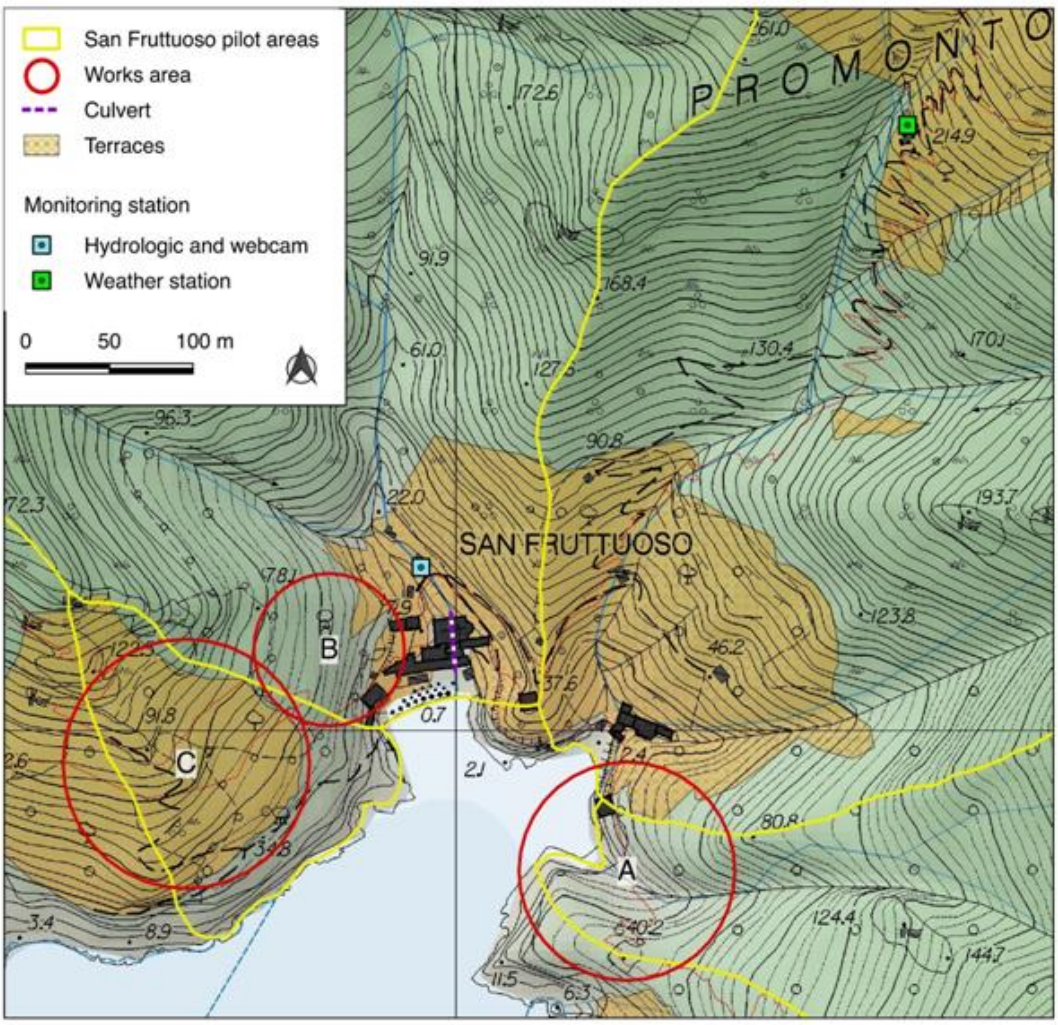

Figure 4-4 San Fruttuoso risk reduction interventions (NBS) and monitoring systems

Criteria for selecting the NBS design

No other design options have been considered.

Stakeholder involvement in the NBS design process

The private owners of the slopes where terraces are going to be restored/re-built have been involved in the design process, as well as the Superintendence for the Landscape and Archaeology and the University of Genoa have been involved in the design process at the present preliminary stage.

b) Selected NBS design

Details on the chosen design for the selected NBS

The designed activities have been thought to act at catchment scale and to address the following issue:

- Reduce the linear erosion along the streams;
- Reduce the diffuse erosion along the slopes and improve stability;
- Improve hydraulic/hydrogeologic conditions;
- Footpath maintenance and erosion reduction.

Referring to Figure 4-3 and to Figure 4-4 the following combination of NBS measures have been designed for the two areas of Paraggi and San Fruttuoso:

San Fruttuoso

The designed measures at catchment scale are Figure 4-4:

A. The actual uncontrolled surface run-off will be properly drained into the compluvium using small stone walls in order to reduce erosion along the slopes; small linear structures longitudinal to the slopes will intercept vegetation and rocks to protect the footpath and the Casa dell'Arco.

B. Compluvium cleaning from totally/partially fell trees to improve water drainage and water treatment and footpath securing; wood amelioration, by removing allochthonous and degraded species of old conifers (Pinus pinea L. and P. halepensis Mill.). Pinus pinea L. suffers Mediterranean environment and are low adaptive to climate change, to favour the natural regeneration of holms (Quercus ilex L.), the climax species in the area that has positive effect on the stabilization of the conglomerate slopes; wood and stone weirs to reduce solid transport into the stream. Consolidation of rock slopes for footpath and building securing.

C. Stone walls recovery and environmental engineering to slopes stabilization; proper plating of Mediterranean autochthonous shrub species to reduce erosion and improve slope stabilization.

Paraggi

The designed measures at catchment scale are Figure 4-3:

D. Terraces recovery by means of environmental engineering techniques to slopes stabilization and to avoid strong contribution of solid transport into the stream.

E. Terraces recovery by means of environmental engineering techniques to slopes stabilization and to avoid strong contribution of solid transport into the stream.

F. Footpath cleaning and recovery.

G. Footpath cleaning and recovery; vegetation cleaning along the stream and water flow improvement.

H. Stone weirs in order to reduce the flow energy and then the erosion along the stream.

I. Vegetation cleaning along the stream and water flow improvement.

J. Selective weir and small sediment trap in order to avoid floating transport to cause a dam effect during heavy rains into the culvert downstream.

Summary of the cost-benefit analysis for the chosen NBS

The designed works are small measures spread in the catchments with the aim to mitigate the overall geo-hydrological risk.

Considering the high value of the elements exposed to hazard, in particular the road at the Paraggi catchment mouth that links Portofino with Santa Margherita Ligure (about 1 million people is the annual passage), the residential buildings (having an high economic value) and the tourism facilities in Paraggi, the cultural heritages and tourism facilities in San Fruttuoso the total cost of the NBS measures make the cost/benefit ratio small.

Outline of the operation and maintenance plan

The NBS measures maintenance plan is going to be divided between the Park authority and the three Municipalities of Santa Margherita Ligure, Portofino and Camogli.

Maintenance will consist essentially of: cleaning of the small sediment trap to be realized before the culvert inlet in Paraggi, particularly after intense rain event; monitoring of all the small measures spread in the two areas, in terms of functionality and stability (i.e. recovered terraces).

Outline of the monitoring plan

Monitoring of the pilot area actually regards only a weather station at the top of Portofino mountain (610 m asl) and ecosystem in the Park and Natura 2000 site. The implementation of other weather stations dedicated to monitoring the parameters in different microclimatic conditions of the pilot areas will allow a better definition of the very local conditions; besides it will allow the possible implementation in a now casting and alert system dedicated to the more exposed areas at the mouth of the streams: the touristic facilities and main road in catchment 3 and historical heritages and touristic facilities in catchments 1 and 2.

The improved monitoring system will be publicly diffused through a web platform, enhancing the distribution of the information to the public that intensively visit the area.

LIDAR data are a consistent element of monitoring due to the highly dynamical processes active in the area: erosion and instability are hardly driven by the high gradient of the slopes and conditions, including terraces, and will be precisely assessed through the use of detailed survey data.

The monitoring and evaluation plans, together with the list of indicators, will be presented in detail in D2.6 “Co-monitoring and co-evaluation plans for demonstrators”.

4.2.3NBS Cost evaluation

San Fruttuoso NBS measures:

- Logistic and construction site preparation: 30.000 €
- Measures along the footpath and rock slope consolidation: 37.000 €
- Stone weirs, debris flow protection, environmental engineering measures to reduce erosion along the slopes and running water drainage: 40.500 €
- Vegetation cleaning, amelioration and planting: 25.000 €
- Stone terraces recovery and re-building: 102.500 €

Total amount: 235.000 €

Considering the cost for the design, security charges, taxes, archaeological dig assistance (compulsory in the area), survey and other compulsory charges, the total amount is:

350.000 €.

Paraggi NBS measures:

- Terraces recovery and re-building: 190.000 €
- Measures along the footpath: 14.250 €
- Stone weirs and vegetation cleaning: 23.250 €

Total amount: 235.000 €

Considering the cost for the design, security charges, taxes, archaeological dig assistance (compulsory in the area), survey and other compulsory charges, the total amount is:

350.000 €.

4.3Procurement of contracts

Contract procurement process/methodology

The procurement contract for the design is conducted by the Portofino Park Authority that is responsible for the area and is the institutional beneficiary of the interventions.

Since the Park is a public entity, it must follow national legislation about public procurements (L. 50/2016) as well as respect the general EU criteria of transparency and equal treatment.

Considering that the estimated amount for the NBS design was lower than the threshold of 30.000 €, the national legislation allowed to directly assign the contract for the NBS design to a group of professionals exclusively on the basis of its previous experience in the area and demonstrated skills. Then, the Park Authority decided to give the design for the two areas of San Fruttuoso and Paraggi to two distinct professionals groups that already successfully realized similar design in the Park territory, after other EU funded projects.

Criteria for evaluation of contracts

The economic offer and the quality of the proposed design according to the Park Authority criteria, following a best value for money ratio.

Measures to ensure the quality performance of contract works

The design has been conducted under the strict control of the technical office of the Park Authority, and according to the defined criteria.

4.4Construction works

Time schedule for design and construction works:

Preparation – 2 months: From January ‘19 (M5) to February’19 (M6). This phase includes the selection and the appointment of 2 working groups of professionals for the NBS design Survey field, key stakeholders consultation and preliminary design, - 6 months: From March ’19 (M7) to August ’19 (M12)

Design workshop with RECONECT partners, stakeholders consultation, final design – 4 months: from September ’19 (M13) to December ’19 (M16)

Procurement of works – 2 months through public procurement process: from January ’20 (M17) to February ’20 (M18)

Works execution – 9 months: From March ’20 (M19) to November ’20 (M28)

4.5Operation and Maintenance

NBS life-cycle

The designed NBS measures are thought to have a long life-cycle: the typology and functionality of the measures should guarantee a good reliability and endurance. The weirs and sediment trap should not need particular maintenance apart from emptying the trap after sever solid transport that should occur after an intense rain event. Terraces functionality will be monitored and eventual maintenance will be executed.

Organisation authorised to carry on operation and maintenance. Coordination with relevant authorities & stakeholders

Park Authority will identify and authorise organisations to perform proper maintenance according to national legislation on public contracts.

Main Operation and Maintenance activities to be done

Emptying the sediment trap, restore eventually damaged stone walls and cleaning weirs and compluvium.

Potential challenges and possible ways to overcome them

Collapse of stone walls may occur in case of very intense rain events and in case of lack of proper maintenance particularly on the running water drainage.

A proper periodic monitoring should avoid this kind of threat.

III. Technical specifications and procurement processes for Demonstrators B

5 Demonstrator DB1: IJssel River Basin, The Netherlands

5.1 Case description

The IJssel River basin project ('Stroomlijn") is implemented under the banner of the 'Room for the River' Programme. Room for the River involves large scale (NBS) measures (for example parallel waterways, shortcuts, by-passes) to increase river discharge during periods of high water levels and improve water safety.

Programme Stroomlijn 'IJssel' is a sub-programme for Room for the river and is aimed at the removal of vegetation (forest, shrubs) which forms a barrier for the discharge of river water. If the water flows into the floodplains, vegetation can impede the water flow, leading to a raise in water levels and an increase of the flood risk. In project 'Stroomlijn' vegetation types are removed / maintained at the river floodplains, and transformed into vegetation types that allow for better water discharge and reduce maintenance costs. The project consists of roughly 300 ha of vegetation in a stretch of approximately 130 km's of river, over 350 owners, and 17 local authorities.

The project consisted of the following main tasks

- Design of the measures (vegetation/landscape management and vegetation removal)
- Stakeholder and land owner management (approvals, access, communication)
- Obtaining formal permits and authorization
- Execution of the work: removal of trees, shrubs, reed areas, transfer into grasslands, and additional measures to ensure sustainable landscape/nature management in flood plains)

The project took roughly 5 years. At the busiest time, 20 people were active every day.

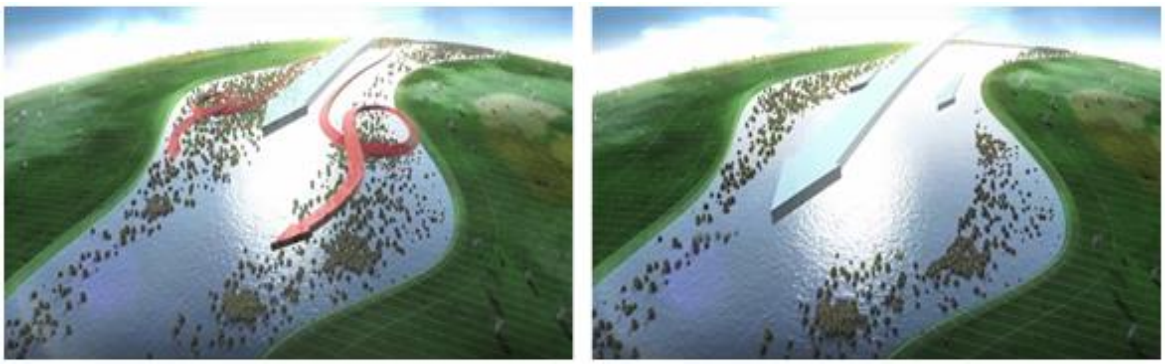

Figure 5-1 Overview of Stroomlijn project rationale; ensuring faster flow/discharge during high water events

An overview of the Stroomlijn project rationale is visualized in Figure 5-1 and more information on this case is available in RECONECT deliverable report D2.3.

5.2 Technical specifications of the Demo case

5.2.1 NBS selection (Stroomlijn as part of room for the river measures)

Main steps in the assessment process that lead to the selection of feasible and final NBS measure(s)

The goal of the Dutch Room for the River Program is to give the river more room to manage higher water levels. At more than 30 locations, measures are taken to give the river space to flood safely while at the same time improve the quality of the immediate surroundings. But if the water flows into the floodplains, vegetation can impede the water flow, leading to a raise in water levels and an increase of the flood risk. Therefore project Stroomlijn IJssel focuses on the removal of vegetation within the floodplains of the IJssel river (Figure 5-1) in places where the river flows fastest at high water levels.

The Room for the River program consists of a wide range of water safety measures implemented along the river's flowpath in the Netherlands. For example, additional bypasses were created, and areas were (re)allocated to allow for flooding during high water levels.

During the implementation of the program, Rijkswaterstaat noticed that maintenance of the vegetation along the rivers banks / in the floodplains was long overdue. Lush and abundant vegetation would restrict/slow down water flow, thereby reducing the river's flow capacity, especially during high water events. Hence, a vegetation removal / maintenance project was incorporated into the RftR program.

Determination of the risk reduction target / primary benefit. NBS measures considered feasible in meeting the risk reduction target

Using hydrological modelling taking into account the vegetation cover/type/height, Rijkswaterstaat modelled the impact of the floodplains' cover onto the water flow. Based on the desired hydrological situation, it was determined that 70% of vegetation needed to be removed.

Criteria used to select all feasible NBS measures considered

Not applicable for this project.

Criteria to choose the final measure(s)

As mentioned before, because the maintenance of the vegetation along the river banks and floodplains was long overdue and the vegetation would slow down the water flow, the project Stroomlijn is implemented as part of the Room for the river project next to other water safety measures.

Stakeholder involvement in the identification of all feasible, and the final NBS measure(s)

Stakeholders were not involved in selecting / determining Stroomlijn as a sub-project of the Room for the River program. Stakeholders were intensely involved in specifying / design of the exact measures, which will be elaborated on in the next sections.

5.2.2 NBS design

a) NBS design process

Design options considered

Project Stroomlijn IJssel focuses on the removal of vegetation within the floodplains in places where the river flows fastest at high water levels. The project area was divided into subplots. Though the aim was to reduce vegetation cover as much as possible, design (of the removal) took into account stakeholders, ownership, legislation, and natural/ecological values. Per sub-plot design options and decisions thus included full removal, partial removal, or no-removal. The commissioners requirement was set at >70% removal of vegetation from ~300 ha of IJssel floodplains.

Rationale in the design of the NBS

The goal of the Dutch Room for the River Program is to give the river more room to manage higher water levels. At more than 30 locations, measures are taken to give the river space to flood safely while at the same time improve the quality of the immediate surroundings. But if the water flows into the floodplains, vegetation can impede the water flow, leading to a raise in water levels and an increase of the flood risk. Therefore project Stroomlijn IJssel focuses on

the removal of vegetation within the floodplains in places where the river flows fastest at high water levels.

The project aimed to maximize vegetation removal. Additionally, landscape and natural values were important, with the project aiming to create a healthy and attractive landscape upon its completion. Protected plant- and animal species were taken into account. However, when the project was in conflict with protected natural areas the authorities gave priority to the Stroomlijn project, because of its national flood risk safety objective.

The project area is divided into two areas; “stroombaan” (in English: flow path) and “stroomluw” (outside of the stroombaan area) area. Stroombaan is defined as the area in the floodplain where the flow rate is higher than 1 m/s during normative high water levels.

The project mainly focuses on the flow path, which is located in the lower and wetter parts of the floodplains. Because these parts are difficult to manage and less suitable for agriculture, causing more natural vegetations such as reed beds and riparian forests to develop. For this project, a distinction is made in the vegetation types:

- agricultural grassland and arable farming lands
- reeds /roughness (0-2m)
- thicket / shrubs (2-5m)
- forest (5m)

TAUW was responsible for the technical design, which consisted (basically) of what vegetation to remove / transform in each subarea and location. Landscape architects were involved and responsible for the final design. This had to take into account a wide range of factors including

- ownership borders
- old landscape structures (e.g. old hedges were investigated and exempt from cutting)
- protected species (flora and fauna) were to be protected (each specific species had its own area (radius) of protected habitat, e.g. 800 m around a beavers home)
- above and belowground infrastructure (that could impede the works)
- nature protection areas
- monuments
- presence of unexploded ordinance
- accessibility, etc.

GIS systems were used to combine all these requirements/limitations as well as results of flora and fauna investigations. Based on the combined overview in GIS, decisions were made on where and what vegetation to remove.

In additional to the technical design, stakeholder management and communication, strongly dominated the projects progress, given the large amount of landowners and other interest groups. (we refer to the section “Stakeholder involvement” below for a detailed description).

The design process thus took the following step-wise approach:

- Technical designs were drafts per project subarea, specifying vegetation removal areas
- Discussion with landowners to obtain permission (implementation agreements)
    - A “Customer requirements specification” was drafted by the owners to include their hard/soft conditions
    - In an iterative process the design was adapted and discussed with owners, to align the client’s (Rijkswaterstaat) and owners’ demands, until agreement could be reached. Without prior agreement the project ran the risk of stakeholders objections during the formal permit procedure with the authorities
    - When approval could not be obtained through discussion/conversation, the case could be ‘escalated’ to the client (and authorities) Rijkswaterstaat, who would have the mandate to ‘force’ the measure. This option was rarely or not used though.
- Coordinated license application (instead of per municipality) where the design was detailed

- As part of the permit application procedure various investigations were conducted as part of the permit procedure (e.g. investigations of flora and fauna, unexploded ordnance, soil, etc.).

Criteria for selecting the NBS design

The designs were based on the following criteria: All vegetation had to be converted to grass- or farmland, except if:

- protected plant or animal species were present
- restrictive cables and pipes were present
- restrictions are present due to permit-technical rules
- the location has a monumental status
- other projects with a higher status (e.g. bypasses of the EU Water Framework Directive) are implemented on location and prioritized

Stakeholder involvement in the NBS design process

There were about 170 parties entitled to the floodplains (landowners, -renters and users). The land was owned largely (52%) by various government organisations (e.g. State Forest Service) and foundations (e.g. Natural Monuments foundation) as well as numerous private landowners. In addition to landownership, more than **400 direct stakeholders** were involved. We distinguished:

1. (aforementioned) 170 entitled to the floodplains (landowners, -renters and -users);
2. Interest groups (nature organisations, landscape organisations, cultural-historical heritage, flora and fauna organisations)
3. Permit authorities and enforcers (Waterboard, province, municipalities for nature protection law permits, flora and fauna law permits, project plan water law permit).
4. Direct stakeholders (managers, residents, users; about 400 involved)

Table 5-1 depicts an influence and interest matrix of the stakeholders.

Table 5-1 Influence and interest matrix of the stakeholders IJssel River basin

	Low Interest	**High Interest**
High Influence	Press, Gas Union (Gasunie), Utility companies, Government Real Estate Company (RVB)	Ministry of Infrastructure and Environment Directorate General Spatial Development and Water Affairs (DG Ruimte en Water) Ministry of Economica Affairs government service for Lnad and Water Management (DLG) Dutch Water board (RWS) Dutch Federation of Agriculture (LTO) Municipalities, Provinces, Regional Water boards (agencies), Environmental protection Agency, Land management organisations (SBB, Natuurmonumenten)
Low Influence	Association/federation of Recreation, Dutch tourist association, knowledge institutes, fisheries, other citizens/users of the area	Ministry of Education, research, culture, Ministry of Defence, Landowners, camping owners, farmers, marinas, renters, investors

More details on stakeholder's involvement in the NBS design process are presented in RECONECT Deliverable report D2.1.

Stakeholder management

One of the largest project challenges was managing the many land owners and other stakeholders. These, in general, provided a lot of 'resistance' to the implementation of the project. Stakeholder communication involved many citizen information evenings (at least 1 per community), meetings with land owners (3-6 meetings per land owner), and meetings and

discussion with the many other stakeholders (authorities, nature or cultural interest groups and protection agencies). The project put a large focus on communication of plans and designs prior to permit applications, to try to prevent citizens/stakeholders objecting to the plans in the formal permitting procedure.

Resistance to the plans/design resulted from the following:

- Land owners not wanting to change the landscape/vegetation on their property
- Local authorities objecting to the national authorities' plans
- Nature interest and protection groups/associations trying to protect natural areas or specific trees (though they were not the land owners)

A coordinated permit procedure (aligning the timing of applying for all permits) was used, where one public procedure for all permits for a certain set of designs is applied. Citizens/stakeholders were able to 'object' against the permit application/plans by means of submitting their 'view', requiring an official response. In the formal permit procedure, only parties that had already submitted a 'view' were allowed to submit a formal objection/appeal to the 'Council of State' (Raad van State), which is the highest court in administrative law.

b) Selected NBS design

Details on the chosen design for the selected NBS

The project started with a scope of about 300 hectares of vegetation. This area covered over 17 municipalities, 2 provinces, 3 water boards and 350 owners.

In the end, 134 designs were made in which about 60% of the vegetation was made 'flowable'. Around 30% of the vegetation has been removed and converted into grass-/farmland, and for the other 30% the forest is crowned and thicket/shrubs is removed from the reeds/roughness. The remaining 40% was retained, largely due to ecological restrictions. One of the design (cluster 13090) is provided in Figure 5-2 below.

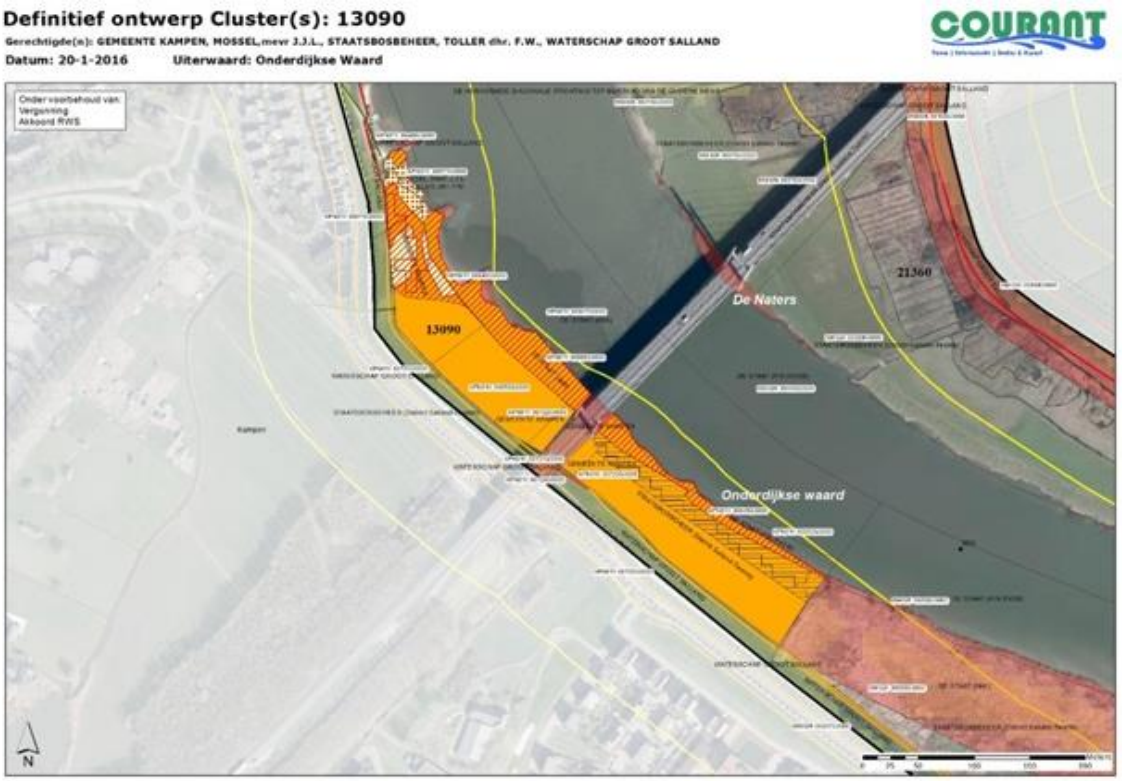

Figure 5-2 Design for the works to be implemented at the new bridge in Kampen, IJssel River basin

Along the IJssel river, part of the reed (orange colour) will be converted to grassland. The thicket on the North side will be removed and converted to grassland. To comply to the WFD rules, some trees will be retained along the water's edge.

Central to the project design and execution was the GIS model. The size of the study area, amount of stakeholders and different expert fields required a common denominator; the geographical location. Every aspect of the project was put in a geographical information system (GIS). Every expert was required to put their conclusions, questions, research result, etcetera into this GIS-system, ranging from ecological information to information obtained through talks with stakeholders. Also, information on the river flow path was included, to enable selection of those areas particularly advantageous to obtaining the project objective (Figure 5-3). At the same time the information in GIS was made available to the whole project team with a web-viewer. This made sure that every team member had the same up-to-date information available and that all the information was specified for one of the 300+ locations.

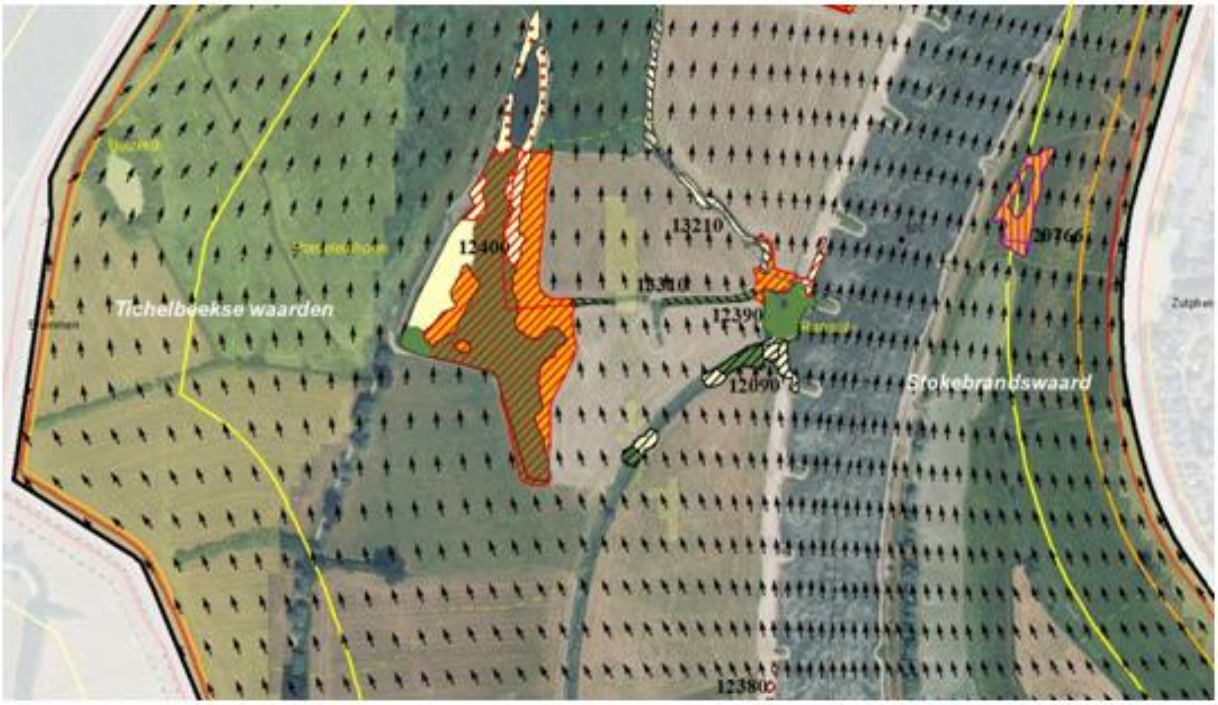

Figure 5-3. Display of flow direction in GIS for a Stroomlijn project location.

With the use of GIS (Figure 5-4) it was possible to portray relevant project data by location. Relations between different aspects became immediately apparent, more so than by reading trough different reports. For instance, a designer could look at all the protected species in one area, read the agreements with an owner, check for explosives and dangerous cables, etcetera, and change the design accordingly. Another example is that once permits were acquired for a design, these were also put in GIS so contractors were able to read the permits with all the stipulations in the field.

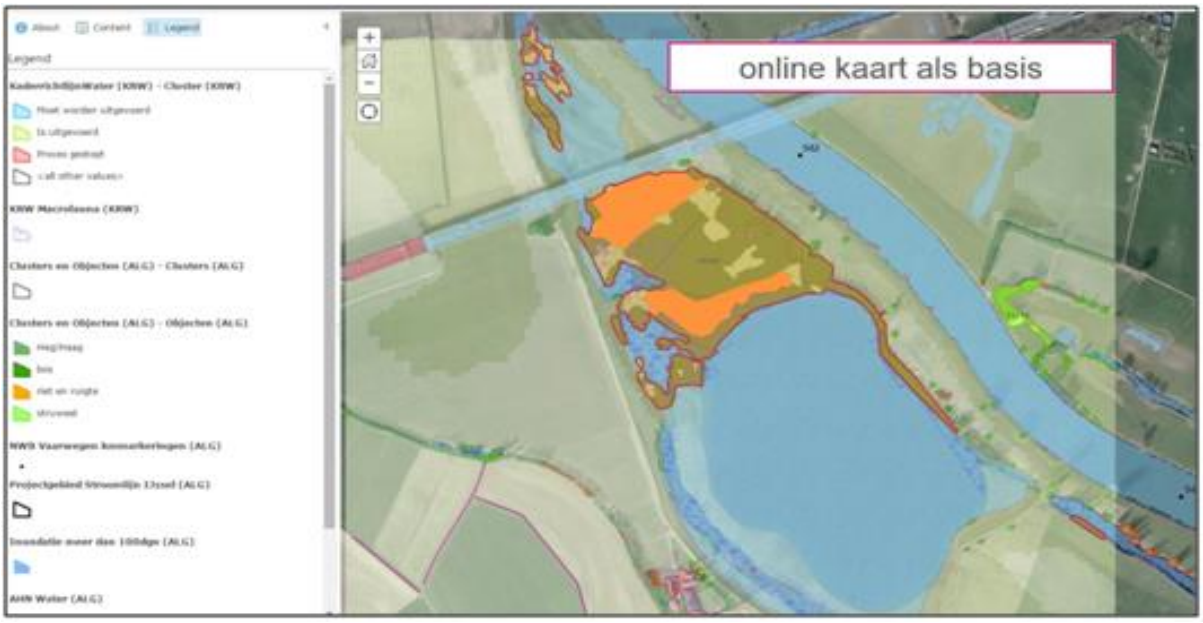

Figure 5-4. Display of GIS system used during the Stroomlijn project.

Summary of the cost-benefit analysis for the chosen NBS

Not applicable for this demonstration case.

Outline of the operation and maintenance plan

Maintenance plans were drafted and proposed to land owners. However, signing, arranging, monitoring and controlling maintenance work was not part of the project. Rijkswaterstaat's vision was to delegate maintenance to the landowners, meaning to make sure the cut vegetation status was maintained. Landowners would receive financial compensation. However, land-owners did not agree to the proposed management plan & compensation scheme as the compensation was generally deemed not sufficient to cover cost.

Outline of the monitoring plan

In terms of monitoring, the progress of the implementation was determined. This includes checking whether vegetation was removed properly. Drones and photographs were used to compare the vegetation before and after the work. Contractors (who removed the vegetation) had to take photos before, during and after the removal. Digital forms (linked to GIS) were used to obtain data of each location.

Redevelopment of the vegetation was not monitored. This was not part of the project.

The client RWS has a monitoring system on vegetation growth and hydraulic parameters in the IJssel in cooperation with research institute Deltares (Figure 5-5).

Figure 5-5. Screenshot of Rijkswaterstaat/Deltares monitoring of vegetation and hydraulic parameters along the IJssel river. Source: https://www.openearth.nl/vegetatiemonitor

Regular monitoring is performed by Rijkswaterstaat and partners (such as Deltares) and data is shared on a platform. Rijkswaterstaat is involved in many national programs (eg data exchange with KNMI) and has links with EU monitoring network/facilities in projects such as RECONECT.

The plans and executed monitoring involves connecting remote sensing with high tech measurements, this can be used for early warning systems. Tauw's contribution is the Stroomlijn project which forms part of the wider 'Ruimte voor de Rivier' ('Room for the River') program. The 'Room for the River' program will demonstrate new innovative techniques for monitoring rivers. The aim of the measurements is to obtain data concerning the cross section of the river, the river slope, the degree of vegetation in relation to the discharge of the river and the water quality.

The high-quality equipment to be employed is listed below.

- The width of three cross sections will be measured with a total station as well as a high-end Global Navigation Satellite System (GNSS) GPS device. This will also allow us to measure the water surface slope over a section of 300 meters.
- The measurements will also be made by an aerial drone to map the dry flood plains next to the river. A DSM (digital surface model) can be made by processing the pictures with photogrammetry software. We will also experiment with using an aerial drone to try to estimate the surface flow velocity.
- The discharge and wet perimeter will be measured using an ADCP (Acoustic Doppler Current Profiler) attached to a Jet-ski.
- Finally an underwater drone equipped with water quality sensors will be used to map the quality parameters of a section of the river.

This NBS site was monitored in December 2018 and February 2019. The following measurements will continue:

- The width of three cross sections will be measured with a total station as well as a high-end Global Navigation Satellite System (GNSS) GPS device. This will also allow us to measure the water surface slope over a section of 300 meters
- The measurements will also be made by an aerial drone to map the dry flood plains next to the river. A DSM (digital surface model) can be made by processing the

pictures with photogrammetry software. We will also experiment with using an aerial drone to try to estimate the surface flow velocity

- The discharge and wet perimeter will be measured using an ADCP (Acoustic Doppler Current Profiler) attached to a Jet-ski

Finally, an underwater drone equipped with water quality sensors will be used to map the quality parameters of a section of the river.

The monitoring and evaluation plans, together with the list of indicators, will be presented in detail in D2.6 “Co-monitoring and co-evaluation plans for demonstrators”.

5.2.3NBS Cost evaluation

The project was financed by Rijkswaterstaat (commissioner/client). The budget for the Stroomlijn project was Euro 5.2 million, including a provisional sum of 1.3 million Euros (of which only 850 000 Euros was used). The project was executed within budget. The full budget was not used because less vegetation was removed. Still, the requirements were fulfilled (of the assumed 70% vegetation removal, between 50-60 % is realized).

There were no other financial contributions.

5.3Procurement of contracts

Contract procurement process/methodology

Rijkswaterstaat (public authorities) published the tender (public tender procedure) for the overdue floodplain vegetation maintenance required to meet high water safety objectives. The scope of the assignment was the design, permit process, stakeholder communication and realization. The bids were evaluated based on EMVI criteria (economically most attractive offer). In addition to the price, the tender was assessed based on quality criteria. In this project, the most important focus in the qualitative evaluation the bids was on stakeholder management and risk management and planning (securing in time delivery).

TAUW(consultant), with Eelerwoude (consultant) and Bruins&Kwast (vegetation maintenance company), formed a consortium “Courant” and won the bid. The consortium met the tender requirements (e.g. project references) and had the best reviewed plan of approach. Remarkable is that the consultancy firm TAUW (and consortium) acted as the contractor in this project, thus bearing relatively high risk.

The contract used was “UAVGC”, a design and construct contract, including a fixed price for the preparation and design, and flexible tariffs of ‘volume’ of actual vegetation removal. Courant (incl. TAUW) subcontracted several additional parties during execution of the project.

- Executive contractor GMB for carrying out the sustainable management measures (grids and earthwork on banks)
- Research agency Bombs Away for carrying out literature research on unexploded ordnance
- Research agency Armaex for conducting field research on unexploded ordnance

The contracts with the subcontractors were not drawn up in a tendering procedure, but from the existing network. The coordination of the subcontractors was largely done by TAUW.

Criteria for evaluation of contracts

As mentioned above, both quantitative criteria / requirements were used in the tender. Quantitative criteria included project references with a minimum contract value, CO_2 sustainability performance score, etc. Qualitative criteria focussed on the review of the plan of approach.

Measures to ensure the quality performance of contract works

Quality was driven and enforced by an elaborate project organisation and governance structure. Also, the commissioner RWS was intensely involved, and though quality control during the work, and project evaluation upon completion, contributed to the high quality and timely delivery of the works:

Project organisation and governance

Both the client (Rijkswaterstaat) and contractor (TAUW in Courant consortium) worked according to the integral project management model (IPM) which was developed by Rijkswaterstaat, in which each IPM core team role needs to be fulfilled by a different individual. The roles are: Project manager, Project control manager, Contract manager, Stakeholders manager, Technical manager.

Aside from the IPM core team, Courant deployed other staff (specialists, designers,) and also quality coordinator.

There was a board of directors with representatives of all parties (client and contractors). The Board was responsible for monitoring and control of the project. Also, they formed a so-called escalation line in case of (threatening) conflicts or far-reaching decisions (time and money). Tasks, roles, expectations, and escalations procedures were agreed upon in the 'project-management' plan.

Technical evaluation

For supervision of the work, Rijkswaterstaat used a system-based contract management during the execution. This is a method of conducting supervision that fits in an integrated contract and assumes risk-based implementation of audits at the organizational level (e.g. ISO certifications), (work) processes and products.

All designs were approved by the commissioner Rijkswaterstaat. Curing implementation, the design was available digitally in a GIS viewer. The contractor was required to make photographs before, during and after the works. These were all geotagged and linked in the GIS system. TAUW was responsible for the verification and validation of process components. For each deliverable, a verification and validation report had to be submitted. RWS made field visits to check the works. GIS data, status updates, photographs, transcripts of the weight of cut vegetation were requested and delivered digitally. The design file was updated into a 'completion file', a digital map with the result of the work (new vegetation type) and offered for approval by RWS.

Project evaluation

The project was monitored by Courant (the contractor) and reported in key performance indicators and a four weekly progress report in consultation with the client. Herein, the quality of the collaboration (client-contractor relationship) itself was put onto the agenda. A digital tool was used, in which both client and contractor filled out questionnaires regarding the quality of the collaboration.

Together with Rijkswaterstaat, the project was evaluated several times in Project-Follow Ups. These were supervised by an independent expert in which, in addition to the KPI's, attention was also paid to the collaboration. At the end of the project in November 2018, a final evaluation was carried out with Rijkswaterstaat. In January 2019, a final evaluation was conducted at consultancy firm TAUW (internally) to sum up the lessons learned for future projects.

5.4Construction works

The main constructions work consisted of the removal of vegetation (trees, reeds and roughness and thicket/shrubs), removal of hedges and hedgerows and landscaping (cutting hedges and crowning solitary trees). In a number of situations poorly maintained gullies/trenches have been restored. Some small waterways have been constructed to reduce the terrain suitable for vegetation growth.

Implementation took place in 3 phases:

- Phase 1: land parcels where flora and fauna data are known, and with stakeholders agreements, started in 2015 for an estimate of 40% of the area.
- Phase 2: land parcels where flora and fauna data are known, but where more effort was needed to reach agreements with stakeholders, started at the end of 2015 for another estimate of 40% of the area.
- Phase 3: parcels where the flora and fauna data still had to be (further) explored and risks of appeal procedures in the permit applications existed, started in 2016 for an estimate of 20% of the area

The main challenges in the implementation phase were the weather and terrain conditions (too wet or too dry). According to the nature law, it is not allowed to work from March to August in Natura 2000 areas. In the period January to May it was too wet (because of high water) and the owner did not agree on working on his terrain (because of land deterioration by used vehicles). September to December was the only option to implement the project, which was also difficult due to terrain conditions (clay too wet and difficult to reach parts), but also high water. A general height map of the Netherlands is used to prioritize lowest parts in the floodplain, with which implementation started in September.

The entire project took 5 years, of which the implementation (removing vegetation) took 3 years. An overview of the timeline is provided in Table 5-2.

Table 5-2 IJssel River Basin overview of the project's timeline from 2014-2018

			Year 1 2014				Year 2 2015				Year 3 2016				Year 4 2017				Year 5 2018			
			M3	M6	M9	M12	M15	M18	M21	M24	M27	M30	M33	M36	M39	M42	M45	M48	M51	M54	M57	M60
			Feb	May	Aug	Nov	Feb	May	Aug	Nov	Feb	May	Aug	Nov	Feb	May	Aug	Nov	Feb	May	Aug	Nov
0	Baseline monitoring					*Start*																
1	Preparation and Planning																					
2	Creation, co-creation, (co)-design																					
3	Land acquisition																					
4	EIA and permitting																					
5	Tendering, Procurement, contracting	*Tauw as contractor*																				
6	Execution of the works												*T1*					*T2*			*T3*	
7	Monitoring																					
8	Evaluation and Closure																					

5.5Operation and Maintenance

NBS life-cycle

The project was a 'one-off' event, with the maintenance remaining the responsibility of the commissioner Rijkswaterstaat. Vegetation was removed in a one-off landscape maintenance project. Vegetation is expected to grow back within years (shrubs, low vegetation) to decades (trees). The project (or similar) shall thus need to be repeated to retain its value for flood risk management.

Organisation authorised to carry on operation and maintenance. Coordination with relevant authorities & stakeholders

Maintenance plans were drafted and proposed to land owners. However, signing, arranging, redevelopment of the vegetation was not monitored as part of this project. It is unclear if RWS

has implemented any maintenance plans and / or has monitored the results. It is unclear if RWS has monitored the hydrological effects of this (landscaping) measure.

Main Operation and Maintenance activities to be done

Maintenance will consist of regular cutting of vegetation to maintain the assigned vegetation type, and limit the vegetation's height and retarding effect on the river flow.

There are no "operation activities".

Potential challenges and possible ways to overcome them

Main challenges to ongoing maintenance will be finance, approval and cooperation with (many) landowners, conflicting interest with land-owners and nature (protected species) and accessibility of the terrain.

6 Demonstrator DB-2: Inn River Basin, Austria

6.1 Case description

The focus of the Austrian Demonstrator is on the interaction of urban and torrential features in an alpine environment in the upstream part of the Geroldsbach until it reaches Götzens. The catchment is located near Innsbruck in Austria, in south-west direction. The overall catchment comprises of the torrential catchments located upstream the municipality of Götzens. From there, the creek is flowing further downstream and contributes to the River Inn which has a catchment area of ~5700 km^2 at this location.

This Demonstrator Type B catchment comprises different types of NBS being installed in the torrent since the early 1950ies. The NBS installed over the last decades included:

- Afforestation of high-altitude areas
- Buffer strips and hedges along water courses
- Slope stabilization by means of greening
- Protection forest management

Since then, the municipality increased in population and size. Potential installation of NBS in the urban parts versus increased settlement density is considered as second impact onto the overall runoff situation. Potential NBS in the urban part can be

- Green roofs
- Infiltration swales
- Retention ponds

Using field test approaches and modelling the different NBS are evaluated post-execution. Measurements at plot and catchment scale support modelling and generalization to assess other catchments.

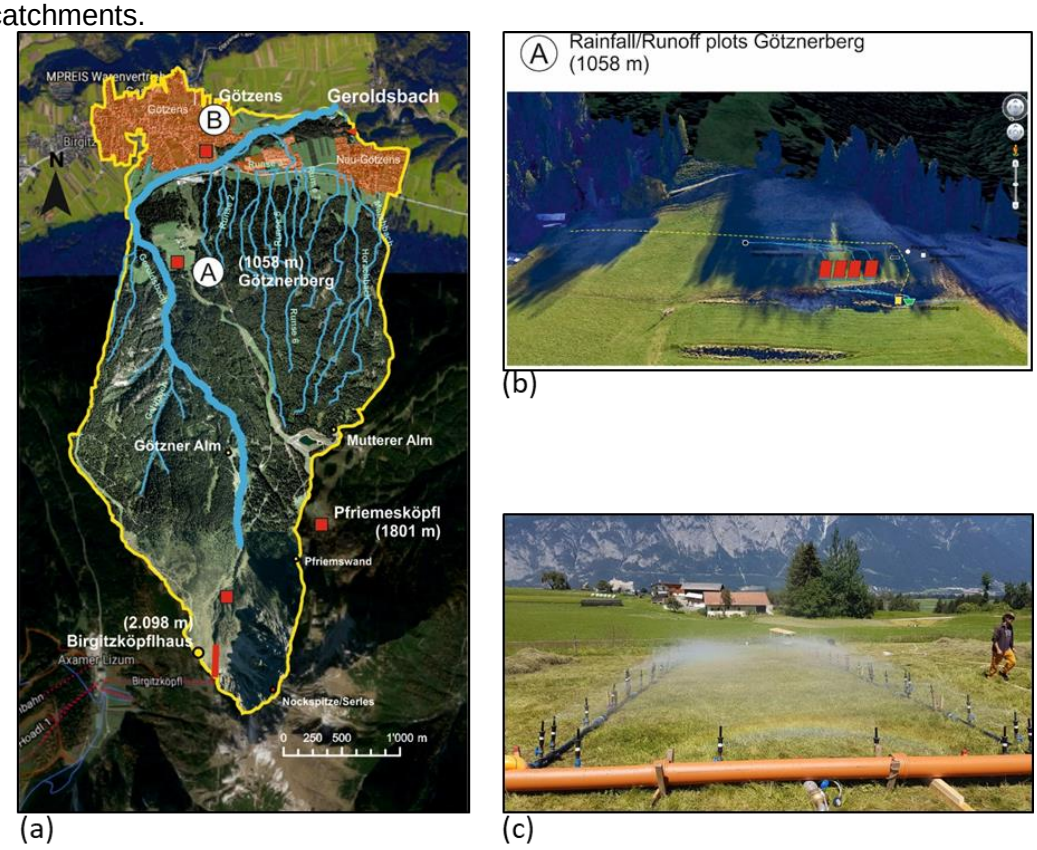

Figure 6-1 (a) Overview on the torrential/urban catchment, (b) (c) setup of the field test site for surface runoff testing

The catchment Geroldsbach- Götzens (see Figure 6-1) is used as a lead catchment, being typical for numerous similar urban/rural configurations. All installations for monitoring and process assessment take place where the results can be transferred to all other investigated catchment areas on a modelling basis.

More information on the NBS case is available in the RECONECT report deliverable 2.3.

6.2 Technical specifications of the Demo case

6.2.1 NBS selection

Main steps in the assessment process that lead to the selection of feasible and final NBS measure(s)

The main risk reduction target (i.e. the primary benefit of the NBS) developed from historical torrent events observed in the catchment. In a historical assessment from Bunza (2016a) the catchment is described as followed:

The Geroldsbach is a typical torrent with source area, erosion stretch, short gorge run (in places rocky) in front of the alluvial cone neck and a former landing stretch (alluvial cone). The latter originally ran north with the mouth into the Axamer Bach (neighbouring catchment).

The Geroldsbach can be classified, due to its gradient conditions, the existing solid matter sources and corresponding discharges having a potential for debris flow. This is shown in the torrent's chronicle but is as well proven by its alluvial fan with a volume of approx. 8 million m³, on which a large part of the Götzens settlement area lies. High flow events (torrent events) are documented from the years 1575, 1748, 24.07.1750 (the church and a large part of Götzens mauled), 1782 (4 dead and 22 destroyed houses) and in the 19th and 20th century (after FLIRI last in the 60s of the last century).

Criteria for the selection of measure was to reduce the discharge in the catchment as well as the stabilization of Blaike[1)] areas.

Due to afforestation being started decades ago in the catchment, the process of the assessment which lead to the selection of feasible and final NBS is difficult, if not impossible to track. Still, from the long lasting experience in the field, the WLV and the responsible administrative bodies developed a respective guideline (TRL-WLV (2015)) covering various aspects in frame of development and realisation of measures in torrential catchments. Thus, as being practiced today in Austria, the technical guideline covers following types of measures being relevant:

- structural (technical) measures (construction measures)
- bio-engineering measures
- forestry measures (protection forest management, high-altitude afforestation)
- Provision and improvement of protective areas (e.g. retention and deposition areas)
- Monitoring and early warning systems
- hazard zone planning[3]

In order to support such measures by means of public (federal) money, a clear public interest must be the case. A comprehensive list of measures that are to be prioritized is given in section 4.1 of the technical guideline TRL-WLV (2015).

[3] [1)]*Blaike is a term used for hillslope parts that are open soil areas and potential subject to intensive erosion. Often the term is connected to local naming of different area such as e.g. Bärenmais+blaike=Bärenmaisblaike. Thus, in this section, such areas may be named according to the original literature sources*

Determination of the risk reduction target / primary benefit NBS measures considered feasible in meeting the risk reduction target.

The risks associated to the Geroldsbach are typical hydro-meteorological risks associated to flood flows in a torrential catchment. Thus, risk reduction target is equivalent to avoid and reduce impacts of historical torrential events such as observed in the past. Subsequently, the chronology of the most severe historical events of the Geroldsbach is presented.

1575 Outbreak of the Geroldsbach, exact damage not known

1748 Overtopping and proliferation of the Geroldsbach brook

1749 Overtopping and proliferation of the Geroldsbach. Flooding in Götzens including the church, 20 houses heavily damaged, 70 ha of cultural land was devastated.

1782 Flood and debris flow in Geroldsbach after a thunderstorm with hailstorm, 4 dead, 22 houses destroyed, 40 ha of cultivated land devastated [This event was the starting point of the construction of the protective wall]

1830 Overtopping and proliferation of the Geroldsbach brook

1846 Geroldsbach breaks through the protective wall and surrounds the area between Götzens and Birgitz; Debris is reported to lie 5-6 shoes (similar to English unit of feet) high; Damage is reported to be 40,000 fl (florins/gulden).

1855 Geroldsbach breaks through the protective wall again, several houses wormed in, 23 ha of fields and meadows devastated.

1881 Overtopping and proliferation of the Geroldsbach, Götzens flooded with church, 20 houses badly damaged, 70 ha of cultural land devastated.

1882 Overtopping and proliferation of the Geroldsbach, several houses walled in, approx. 20 ha of cultivated land gravelled over.

1908 Geroldsbach breaks through the 4 m thick bank wall again, 22 houses and 40 ha of cultivated land wrecked.

1967 Jam of the Geroldsbach near the Landesstraßenbrücke, several houses flooded, drinking water system destroyed, damage in the area of Siegelanger approx. 5 gardens and houses flooded

1986-88 Construction of the arch barrage in Geroldsbach

In the 19th century, after the last great flood, the population of Götzens and Birgitz built an 800 m long, up to 12 m high and 4 m thick protective wall at the alluvial cone in order to push the brook eastwards. In 1908 a mudslide broke through the wall and caused damage to the cultural grounds (see Figure 6-2).

Figure 6-2 Left: Flood and Debris flow event breaks through the stonewall; Right: Postcard from 1908 asking for the donations for the mitigation of the disaster

Source: Picture are copied from Götzens (2017), Gemeindegeschichte; Original Source: Tiroler Landesmuseen

Thereafter, due to the repaired wall, the Geroldsbach runs above Götzens in the orographically right channel of its alluvial fan and flows into the Inn after overcoming the Inntal-terrace at Unterfigge.

Criteria used to select all feasible NBS measures considered

At the time of realization of the protective measure (technical and biological measures), the NBS selection procedures developing today were not given. Still, similar aspects as today led to the decisions for selecting a combination of measures. From a structural point of view, technical measures such as deflection and retention walls were chosen. Dimensioning of the structures was based on simple discharge and sediment quantity estimates given at that time. Basis was prior observed events causing severe damages.

At the same time, the knowledge was already available the technical stand-alone measures would - on the long term - not lead to satisfying results for retaining future discharge events. Thus, the technical measures set, were combined with afforestation and greening attempts initiated in parallel. It can be seen from Figure 6-3 that in such extreme locations both technical measures and near-natural solutions require ongoing supervision and supplementation.

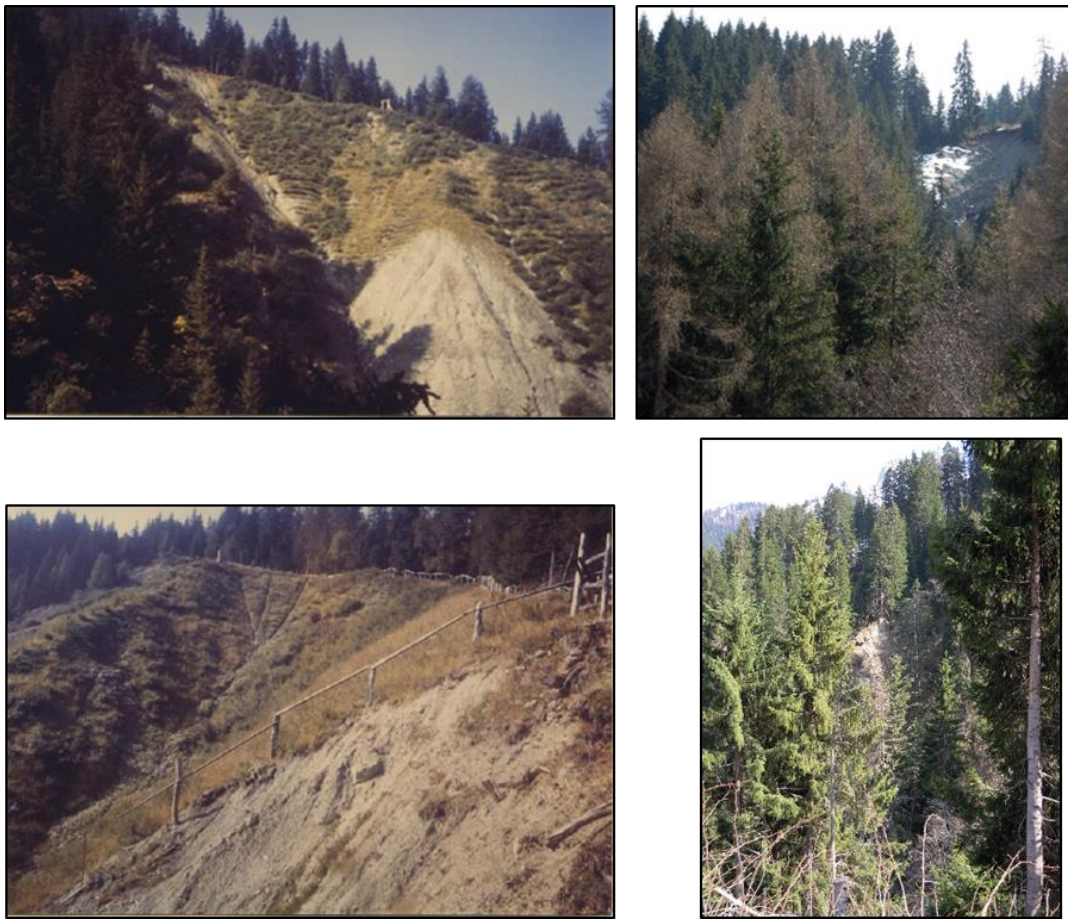

Figure 6-3 Geroldsbach – "Große Blaike"

Left - 1961: several years after successful slope stabilization with bioengineering methods (e.g. hedge brushing), Source: WLV-technical report

Right – 2010: new erosion areas at the upper edges of the "Große Blaike"

Today's guideline for realizing measures in torrential catchments includes a number of criteria to be considered when WLV is planning a measure or combination of measures to be realized. In the following, criteria are taken from the guideline TR-WLV (2015) (3.1 overarching objectives of protection against natural hazards)

1. to protect people, their living and settlement areas as well as cultural assets from natural hazards.
2. safeguarding the public interest in protection against natural hazards and the principles of legality, economy and practicality.
3. priority of precaution (prevention) over aftercare (repair of damage according to disaster events).
4. priority given to the conservation of natural protective effects over the implementation of technical protective measures.
5. to protect water bodies and their environment as natural habitats and securing and restoring of the good ecological status (ecological potential) within the framework of protection tasks
6. planning of protective measures according to the principles of interdisciplinarity, the ecosystem approach, the sustainability of their impact and the state of the art.
7. improvement of the water and bed load balance.
8. nationwide uniformity, objectivity and traceability in the fulfilment of tasks.

Criteria to choose the final measure(s)

As described above, some of the single measures planned originally were not realized due to political constraints. Namely, the start of the world war made the creation of a second retention wall impossible. All other planned measured were widely realized.

A review of the measures taken on 08.10.1959 showed that the biological measures were successful, especially if the terrain was previously calmed by technical measures. (Stern & Markart 2010)

Stakeholder involvement in the identification of all feasible, and the final NBS measure(s).

The construction of measure (NBS) was under the responsibility of the WLV (Wildbach und Lawinenverbauung; Torrent and Avalanche Control Unit of the Ministry). Within the project RECONECT the WLV is stakeholder and was self-responsible for the selection and realization of the NBS in the construction period.

Beyond WLV, a number of other stakeholder are in one or the other aspect involved in the process of identification of the final NBS measure(s). For details, see section 6.2.2 - subtitle " Stakeholder involvement in the NBS design process" in this document. The results described are aligned with finding shown in D2.1 in RECONECT.

6.2.2 NBS design

a) NBS design process

Design options considered

As described above, the design of the here investigated measures dates back to the beginning of the last century for a first set of measures (1908) and a second planning phase in the mid of the last century (1950). All available sources have been checked carefully. For cost reasons, it was not possible to push technical structures for slope stabilization; the near-natural measures were much more cost-effective. As mainly final designs have been kept in the archives of the WLV (avalanche and torrent control section/stakeholder), no assessment of design options given at that time can be made. In fact, according to personal discussion with contemporary witness (retired WLV employee involved in the realization) design options as such were not compared since the measures realized were without an alternative at that time.

Rationale in the design of the NBS

The biological measures implemented focused on the stabilisation of eroded slopes (Blaiken) by greening and afforestation. Aside of these biological measures, technical measures such as retention walls (concrete arch dam) were realized to retain water and sediments transported.

The biological measures (here considered as NBS type measures) had and have the primary target to retain and reduce surface runoff in a spatially distributed manner in the catchment. Secondly the measures aim to reduce sediment inputs to the torrent.

It is unlikely, that co-benefits (e.g. like increasing biodiversity) as we understand them today in the context of NBS were considered in the rational of the design at that time. Still, this does not mean that Co-Benefits were not given for the measures implemented.

With regard to specific criteria applied in the afforestation process, the focus was clearly put on the use of autochthonous tree species. Today, the trees being selected for afforestation are as well legally constrained to a list of local tree species and can be found in the appendix of the forestry act 1975 (Forstgesetz 1975), woody plants according to §1a Abs.1. Further, the aim was to select trees which can physically withstand long and hard winters at low temperatures. Further, the physiology of the trees needs to be able to deal with dry summer conditions as well.

Thus, the WLV (avalanche and torrent control service) used trees that were grown in their own tree nursery garden located in Tyrol. The main benefit of using these trees is in the higher resilience of these trees to disturbances and climatic extremes. In contrast, lowland trees transferred to higher altitudes show lower resistance and increased susceptibility to pests or frost.

Mycorrhiza describes a very close coexistence of fungi with the roots of higher plants, from which both sides profit through mutual mass exchange. The two types distinguished are ectomycorrhiza and endomycorrhiza. Ectomycorrhiza occurs in most of the local tree species such as beech, oak, birch, spruce, larch, fir, pine and Douglas fir. The hyphae of the fungi wrap around the root tips and penetrate in a net-like manner into the root interior, but not into the root cells of the trees themselves. Today, the artificial overdosing with mycorrhiza is an option to improve the resistance and growth of trees.

Criteria for selecting the NBS design

One single design was chosen, based on the experiences with NBS in several other alpine catchments.

Stakeholder involvement in the NBS design process

The hydro-meteorological risk is heavy rain and flooding by the torrential creek of Geroldsbach. Flooding might be caused by high tide in the river Inn as well. The affected cities of Götzens and Innsbruck have, as most municipalities in the Alps, a century long history of risk awareness and local measurements. The public national Forest Engineering Service for Torrent and Avalanche Control (WLV) is responsible since 1884 to provide solutions for the protection of residents (founded after a series of serious and deadly flood events in Austria). Looking at perceptions in an historic perspective the major risk around the important city of Innsbruck was and still is deriving from avalanches, predominantly from the northern side. Torrential rivers are often seen as secondary threat in Austria, but as urbanised areas spread out into rural catchments these perceptions are subject to change. There are 15 rivers/creeks around Innsbruck classified as torrential being a threat as well. In the northern part different creek (e.g. the Höttinger Bach) pose a flood flow risk. On the south west side of Innsbruck (right side of the river Inn) risks due to avalanches are of minor importance. Here the hazard risk from torrents is dominant.

Nature based solutions (NBS) were discussed by the Innsbruck demonstrator team; one focal point are standardized bioengineering measures. Reforestation is seen to have benefits for biodiversity, especially at the beginning. Still, this effect depents on the chosen type of trees. Restoring ecosystems in general is important for implementing the EU WFD and the ecological water quality status. NBS have socio-economic benefits e.g. on job market, as reforestation can provide long term jobs in sustainable forest management.

After flooding in 1882 the Austrian state founded the new institution, the historical predecessor of today's Wildbach- und Lawinenverbauung (WLV) and looked towards solutions developed in France, where reforestation is a major successful measure with valuable social-economic co-benefits. It was discussed that NBS discourses in an historic perspective come and go, follow similar patterns, interests, perceive similar benefits like today. Periods with preference for nature based solutions like today in Austria are followed by periods with a strong belief in engineering and technical solutions.

Municipal politics are not seen as important drivers for NBS. It is believe that instead, the interest in NBS is event-driven. It is usually the national level that relevant instruments like flood risk management plans or forest supervisors are established and then implemented in each municipality.

Altogether, the following stakeholders were identified at the Innsbruck demonstrator site in regards to their roles in the management of the hazard(s) as well as their role at NBS.

More details on stakeholder's involvement in the NBS design process are presented in RECONECT Deliverable report D2.1.

b) Selected NBS design

Details on the chosen design for the selected NBS

The afforestation of the "Große Blaike" (see Figure 6-4) was planned along with a retention wall in the main channel in 1962. Still, in the construction approval from 1970 the foreseen afforestation and greening was mentioned as "not realized". Legal background was, that the works actually did not take place in frame of the WLV based project, but were started much earlier (around 1952) initiated by a WLV employee (Hassenteufel). The financing was realized in frame of the ERP (European Recovery Program) of the Marshall Plan Foundation until approx. 1960. Thus, NBS (afforestation and greening) and technical solutions were realized in parallel.

In April 2010 an investigation of the 'Großen Blaike' by Stern and Markart (2010) showed the bioengineering measures of the 60ies were partly successful but require continuous maintenance. The continuous combined operation of natural and technical measures was suggested.

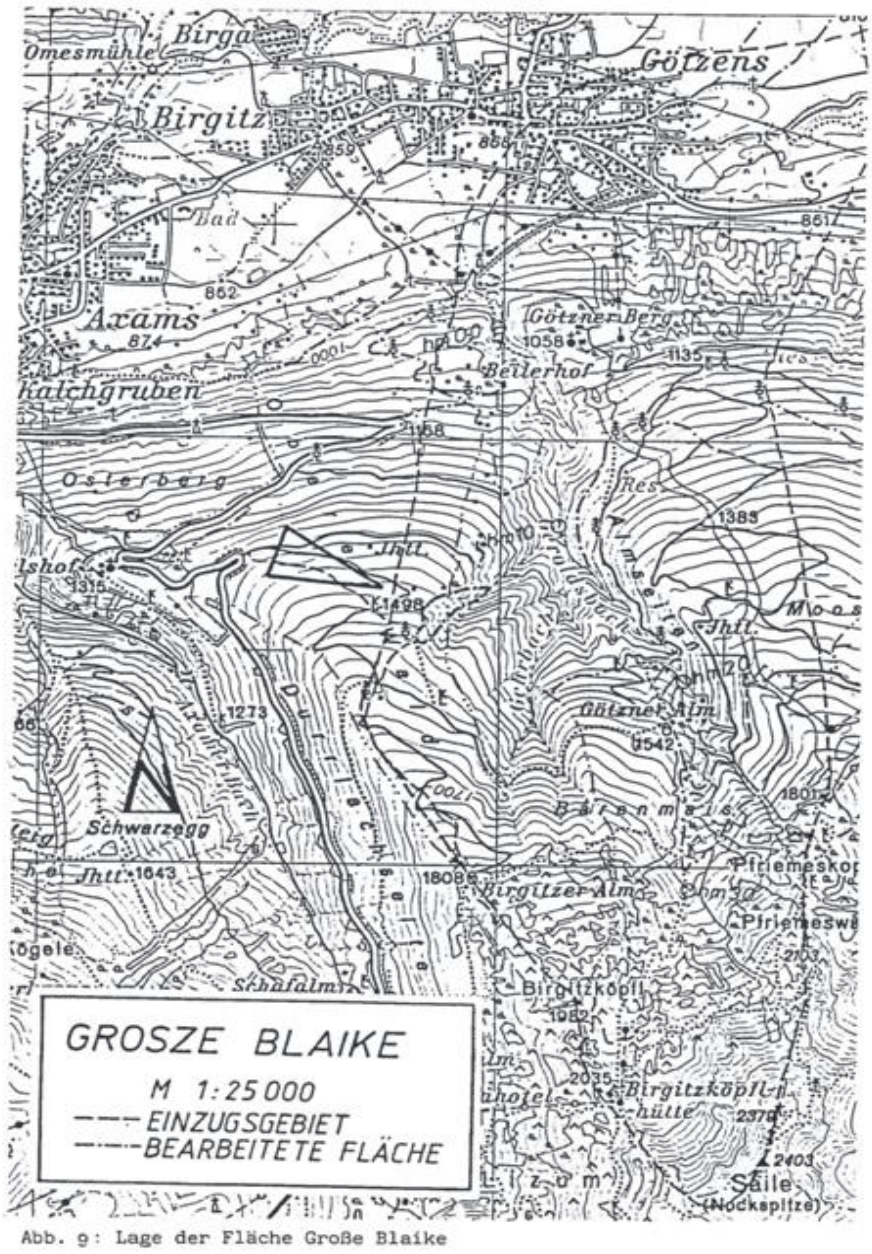

Figure 6-4 Historical map of the Geroldsbach catchment including the location of the Große Blaike (taken from Grünwald, 1987)

The exact areal extends is planned to be evaluated within the project. Similar urban extends are evaluated for past situations. Both rely on series of areal photogrammetry being earliest available in the 1950ies.

Due to the long history of the NBS implementations, information on permits, problems during that implementation or commissioning procedures are rarely available. In fact, most of the today legal acts associated with the implementation of such measures did not exist at that time.

Thus, in the following description regarding permits and legal procedures, not only the past situation is described. In addition, the current legal situation is described as if the implementation procedure would take place today following today's legal requirement applying, when WLV is realizing such projects.

Figure 6-5 shows the greening of the ‘Großen Blaike’ in 1951 and Figure 6-6 shows the ‘Großen Blaike’ 8 years later.

Figure 6-5 Greening of Großen Blaike in 1951

Figure 6-6 Große Blaike in 1959

Summary of the cost-benefit analysis for the chosen NBS

At the time of construction, no CB analysis was made. The measures set over time and the costs associated were found to be as followed:

After 1908 the planning of constructions in the Geroldsbach began:

- The Landesbauamt (state construction authority) restored the protective wall at the alluvial cone and reinforced it.
- The WLV erected an 8 m high barrier at the end of the valley.
- At the same time, the WLV worked out a general project, which proposed the securing of the large openings by a number of transverse works in connection with drainage and

soil binding work. In addition, the existing dam was to be raised and a new one erected (157,000 crowns). Due to the war, the plans for retention walls were not realized.
- 1950 new project: Greening of open soil areas (costs 340,000 AT - estimated)
- 1950 - 1955: Embankment of the Great Blaike; 107 drainage ditches; 2 supporting structures, 8 dry walls; 3 ha greened and fenced (protection against livestock); several bottom belts;

Total costs estimated: 455,000 AT (33,066 EUR - not index corrected).

The responsible WLV section was authorized to work out a project to continuation the securing of the Geroldsbach. The project was planned as followed:

- Round out the edges of the fractures; slope the embankment areas;
- Planting (straw bitumen emulsion) and willow bushes;
- some retaining walls in dry construction (consolidation);
- 2 concrete arch barriers
- Fencing in; afforestation with larches
- Increase of the bed load recirculation barrier (2,500 m^3)
- in the Bärenmaisblaike a set of 7 concrete barriers should be erected in case of a deterioration of local conditions

The total costs of the planned measures were estimated to be approx. 2.3 million AT (167,151 EUR - not Index corrected).

Today's equivalent costs could be estimated by means of recent similar constructions in other catchment, todays planting costs (WLV internal and/or external realisation).

Outline of the operation and maintenance plan

Forested parts are in an operational context covered by continuous checks by qualified personnel. In Tyrol, but as well in other federal states, forest rangers and forest wardens are responsible for the observation of the forest and its integrity.

Throughout the centuries, measures have been taken to protect the forest. Originally, it was mainly the care for the preservation of hunting that was decisive. The appointment and implementation of person being responsible for the forest dates back to the 16th century, where the term „Waldhüter" (forest ranger) is included in the forest regulations.

Today's legal background is that according to § 5 Tiroler Waldordnung 2005 (TWO), each municipality in Tyrol must appoint a person appointed and promised by the district administrative authority in accordance with § 3 TWO as municipal forest supervisor for each forest management area.

Technical measures are in the responsibility of the individual communities. After construction and realisation, the structures are transferred. From this time on, the mayor of a municipality is responsible to check the state of the structures and their operational readiness. E.g. after flood/sediment events, the cleaning of retention basins and disposal of sediment is in their responsibility.

Outline of the monitoring plan

The monitoring includes rainfall runoff experiments in the catchments, including permanent installation. The installations are planned to be used to continuously monitor metrological parameters as well as resulting surface runoff throughout the year.

Runoff is planned to be as well measured in side tributaries to clearly locate the source of flows. The same is done in urban part as a part of the integrated catchment. In addition to discharge measurements, associated fluxes of sediments are planned to be monitored. This is foreseen at neuralgic locations such as in the or downstream of the given retention basins.

Consequently the foreseen monitoring consists of four parts:

- Artificial irrigation (torrential / urban) with runoff measurement
- Discharge measurements in torrent and sewers (measurement campaigns)
- Metrological monitoring (rainfall, temperature, humidity)
- Spatially distributed soil moisture sensors in the catchment

The monitoring is conducted by partner UIBK together with subcontractor BFW. Realisation of discharge measurements and spatial distributed soil moisture sensors is subjects to stakeholder decisions in the municipality or private land owners.

In contrast to existing rainfall runoff tests, the here foreseen investigations include several novel aspects:

(1) The event based artificial rainfall tests are examined for very high rainfall intensities.

Where past test are limited to intensities of 50 to 100 mm per hour, up to 200m per hour are envisaged in this project.

(2) In extend to state of the art rainfall test, the here planned installations include runoff from upstream (RunOn) to simulate more realistic field conditions. Conditions in the lead catchment are unique, since high quantity water supply in an alpine environment is given. Supported by the Muttereralm mountain ski-park, water supply is granted via an automated artificial snowmaking systems. Water supply from the snow-making facilities only, allows multiple repeated artificial rainfall simulations with extreme intensities on the hillside scale. In case of the unlikely event that the water supply is not available, an own reservoir and pumping system supplied by the nearby creek is foreseen.

(3) The here planned approach aims for a long term monitoring and process research. A novel aspect is, that in contrast to existing site, continuous measurements and operation is planned.

The collected data is used to set up and parameterize a hydrological model in order to test different NBS solutions (e.g. reforestation) based on model results.

The monitoring and evaluation plans, together with the list of indicators, will be presented in detail in D2.6 “Co-monitoring and co-evaluation plans for demonstrators”.

Data Management System

Data is stored in data loggers and transferred central data storage (ftp server) at UIBK. The Data formats, intervals and contents are described and are in alignment with the needs and formats in the data presentation of the overall project. Transfer of data is realized by means of a ftp protocol, allowing the visualisation of data at the RECONECT Services platform.

To date, the first set of data as well as the basic GIS data sets are provided for Interact (Partner in RECONECT). In the course of upcoming implementation and continuous extend of the measurement site Götzens, the data sets will be expanded.

6.2.3NBS Cost evaluation

The costs arising in the implementation of the measures (including the NBS) are shown in chapter 6.2.2. - Section "Summary of cost-benefit analysis for the chosen NBS" earlier in this document.

6.3Procurement of contracts

Contract procurement process/methodology

Due to the installation and construction in the 1950, no detailed information on the procurement process is available. Today's procedure would comply with the current legal boundaries.

Following the WLV (2019) for the Administrative Instructions for the Technical Guideline for Torrent and Avalanche Control, chapter 10 - Awarding of contracts are required to meet the following standards. Contracts are awarded on the basis of the BVergG 2018 BGBl I, No. 65/2018, as amended. With regard to the authorisation of the Forest Engineering Service for Torrent and Avalanche Control to award services in their own area of responsibility, the valid decrees of the BMNT must be complied with.

Criteria for evaluation of contracts

Contract works are usually taken care of by the employees of the WLV, taking over the planning and contracting works for the municipalities. Standards and guideline developed for and within the WLV assure widely a comparable and high quality procedure of planning and contracting. For legal aspects of the same, see the description above in " Contract procurement process".

Measures to ensure the quality performance of contract works

The planning and implementation of the measures must be based on or comply with the provisions of this Technical Guideline and the legal and technical standards, guidelines and recommendations listed in TR-WLV(2015) Chapter 1.2 to Chapter 1.4.

Beyond the requirement to cover all important legal and technical guidelines, the TR-WLV (2015) gives guidance for the invoicing and final audit.

The final audit is the examination of the proper execution of a measure and the correctness of the construction accounting for the purpose of handing over to the interested parties.

For a proof of execution, a certificate of completion must be drawn up for each field of work after the end of the calendar year.

The proof of execution shall contain:

- Construction report (action report)

In addition to the general information on the field of work, the construction report also contains a

  - Breakdown of expenditure by type of costs and breakdown of hours
  - Breakdown of hours worked
  - Use of materials and equipment
  - Breakdown of expenditure by type of structure
  - mass distribution
  - Major deviations from the approved project with reasons
  - unit price determination

In the construction report, special features of the construction work and the delimitation of services must be pointed out.

- Plans and other documents on the measures carried out.

The plans must be drawn up in accordance with the provisions for detailed planning. It is possible to combine several calendar years in justified cases.

- Photo documentation of the conditions before, during and after the implementation of the measures.

The procedure is followed by the Final Audit and the documentation of the final audit being described as well in the TR-WLV (2015).

6.4Construction works

The construction (planting) was mainly influenced by seasons. Typical periods are either spring or autumn. At Geroldsbach the average altitude is around 1.500 m above sea level. At southern slopes the planting could be started already in March, at northern slopes in May but roads were still blocked during that period. Experiences showed that willow bushes cut and planted in spring withered in summer as the roots were not able to penetrate deeper soil layers. As a consequence the willow bushes were then cut in autumn and planted in March which should much higher success.

Details on the planting and construction can be found for the Große Blaike in e.g. Grünwald, 1987.

The hangers of the mussel burst were used several times for biological engineering work. In 1949 the slope was embanked and willow bushes were installed. In the years 1952 to 1955 from the south beginning in northern direction continuous embankments were carried out and bushes were brought in. In 1960 two small green areas were planted.

6.5Operation and Maintenance

NBS life-cycle

The NBS realized in this case is not subject to a life cycle as such, since we are dealing with a natural, living and growing measure. Thus, the forested parts are foreseen as permanent measures subjected to constant observation. Although no planned Decommissioning in the forest life cycle is foreseen as such, following threats to forest can be named:

- Windthrow
- Fires
- Frost Damage
- Insect Pests
- Diseases
- Animal Damage
- Invasive Species
- Climate Change

Whereas windthrow, fires and frost Damage can be categorized as natural disaster related (single catastrophic impacts), the remaining threats are of biotic and abiotic type.

An example for an invasive species threat is the Buxus borer (Buchsbauzünserl) being recently introduced to Germany and Austria causing massive die-off of Buxus plants. In Götzens, first cases of buxus die off were observers located primarily in the urban catchment part (see Figure 6-7).

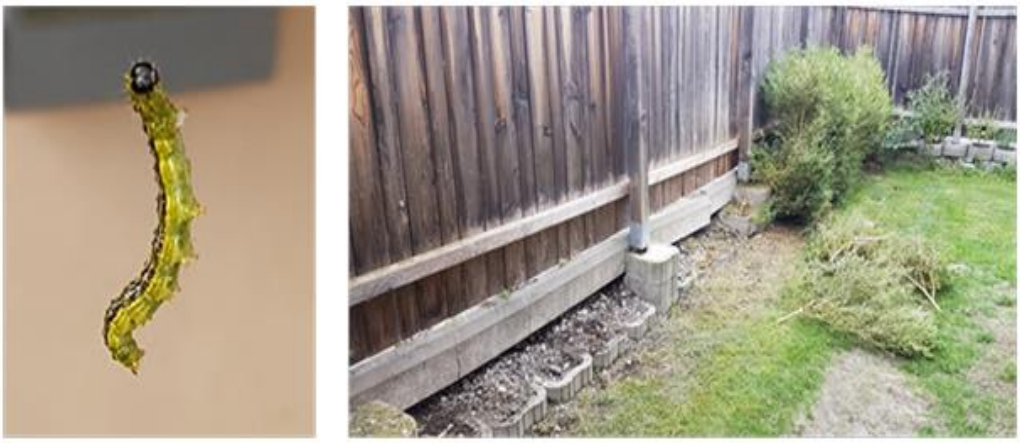

Figure 6-7 Left: Buxus borer; Right: Die-off of Buxu plants

Within the torrential catchment, the Buxus borer specifies is clearly of less relevance. Threatening species are not a problem today in Tyrol. Still, Climate Change may introduce a problem related to bark beetle or the red bark beetle in combination with spruce trees. Ashes are facing currently a fungi related issue. Specifically in the Geroldsbach, the Ashes are of minor relevance.

Organisation authorised to carry on operation and maintenance. Coordination with relevant authorities & stakeholders

The concept of the installed "Waldaufseher" (Forest Inspector) is described above. The forest inspectors together with the responsible units at the federal state and the Federal Ministry for Sustainability and Tourism are the responsible and coordinating bodies in terms of operation and maintenance.

Potential challenges and possible ways to overcome them

No specific challenges which are not already covered within installed mechanisms (responsible authorities, operational mechanism) are foreseen.

7 Demonstrator DB3: Aarhus, Egå Engsø and Lystrup, Denmark

7.1 Case description

DB3 Aarhus contains 2 case-areas, respectively Lake Egå and Lystrup.

The demonstration site "Egå Engsø" (Lake Egå) lies in a low situated and former drained area immediatelynorth of Aarhus. The area now consists of a shallow lake surrounded by meadows.The purpose of establishing the wetland "Egå Engsø" was to reduce the nitrogen supply to Aarhus Bay, to improve the natural conditions in and around Egådalen (the valley of Egå) and to reduce the flood risk from the river Egå. In addition, the wetland provides the basis for a better recreative utilization of the area.

Figure 7-1 The shallow lake Egå Engsø surrounded by grazed meadows looking southeast. The bay of Aarhus in the background.

Figure 7-2 Lystrup, a suburb to Aarhus - Egå Engø is lying in the background and the bay of Aarhus in the upper left of the picture

The demonstration site Lystrup is a suburb that lies on a hillslope just north of Egå Ensø in the catchment-area of river Egå. Between Lystrup and Egå Engsø the landscape is intersected by a highway that lies as a barrier disturbing the biological and hydrological.

The main problem is the lack of hydrological connectivity between Lystrup and Egå Engsø. It is addressed by two sub-projects (two big pibes), that improve the passage of surface water below the highway.

In the upper part of Lystrup the main problem is that during intense rainfall the relatively steep and impermeable surface (paved areas and claysoil) leads to surface runoff that might exceed the capacity in the sewage system. Here the solutions consist of varied types of local surface modulations e.g. basins, gullies, speed bumps, changing of street profiles and rainbeds that all together represents a large scale solution for the whole suburb.

In the case of Lystrup the total project area originally contained 12 sub-projects (Figure 7-33) where 6 are owned by the local wastewater company Aarhus Water A/S (Hedeskovparken, Sønderskov, Hovmarksparken Øst, Majsmarken, Hovmarksparken Vest, Egå Mosevej), 5 are owned by Aarhus Municipality (Ellebækkevej, Old Ellebæk, Ellebæk, Sønderskovvej, Elsted) and 1 has a shared ownership (Lystrup Centervej). One of the municipal projects (Elsted) was never realized.The description in the following sections focuses on the sub-projects (Lystrup Centervej, Ellebækken, Old Ellebæk and Hovmarksparken), which are most interesting in relation to the RECONECT project.

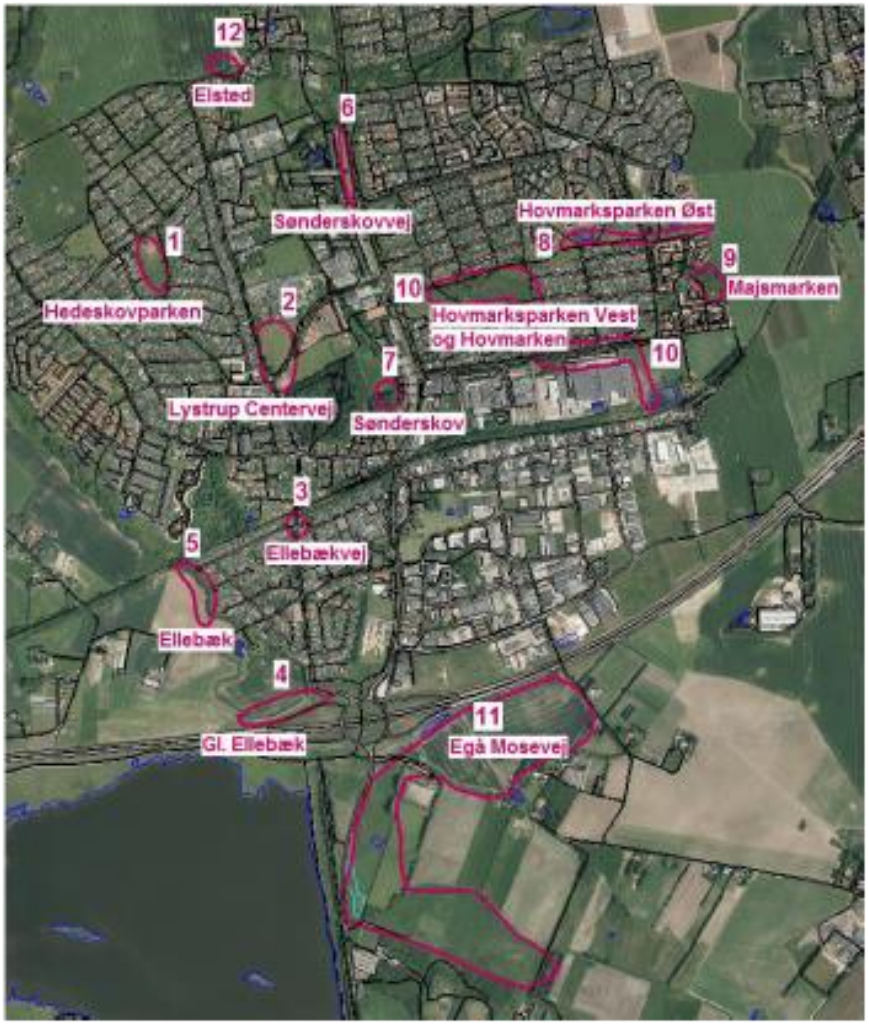

Figure 7-3 Lystrup overview

More information on NBS case DB3 is available in the RECONECT deliverable report 2.3.

7.2 Technical specifications of the Demo case

7.2.1 NBS selection

Main steps in the assessment process that lead to the selection of feasible and final NBS measure(s)

Lystrup

The figure below (Figure 7-4) shows the main steps in the process of selecting the final NBS Measures:

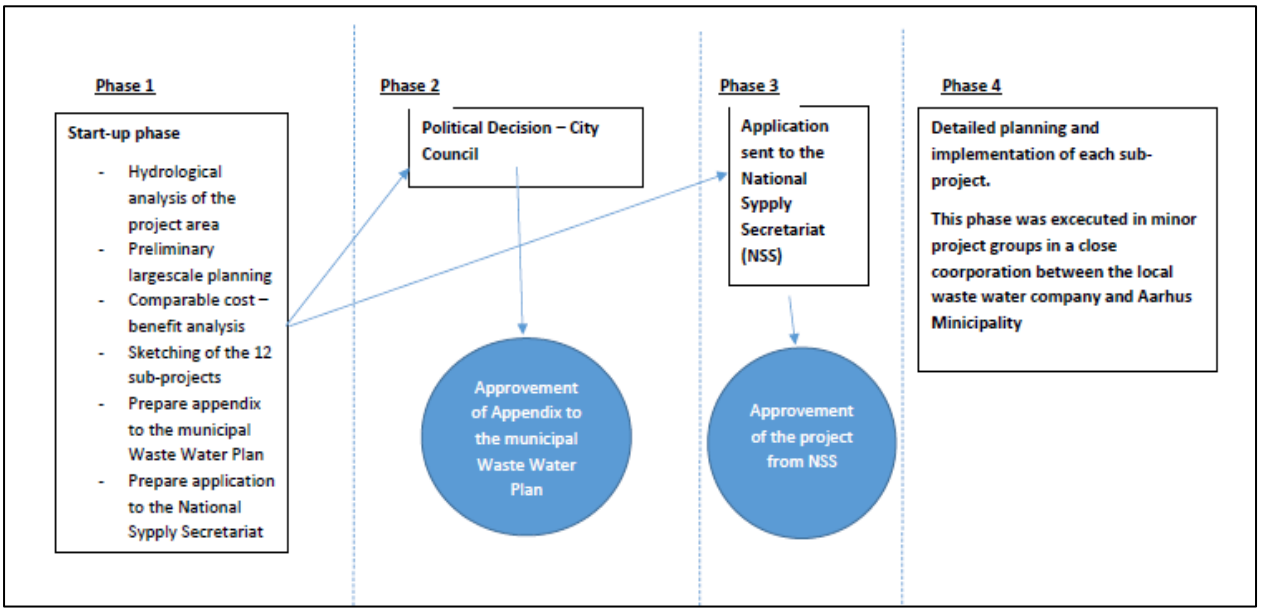

Figure 7-4 Overview - process

Lake Egå

At the time of construction back in 2005-2006, the main purpose of lake Lake Egå was to reduce the nutrient load to Aarhus Bay. In order to receive national financial subsidy, the calculated reduction of the nitrogen load had to meet governmental criteria. The design was therefore primarily based on the nitrogen reduction potential. However, the design was also influenced by river discharge and lake retention potential.

Nature and recreational benefits as well as flood risk reduction was of secondary importance.

Determination of the risk reduction target / primary benefit. NBS measures considered feasible in meeting the risk reduction target.

Lystrup

The determination of risk reduction target was coupled to a severe flooding situation in Lystrup in august 2012, where a cloudburst with the statistical incident of a 75 years incident occurred. The risk reduction target in the project was thus decided to be a 100 years incident projected to 2100.

Lake Egå

The risk reduction was not directly calculated, but the effect was based on generally evidence of reduced peakflow and delay in rivers after passing lakes.

Criteria used to select all feasible NBS measures considered

Lystrup

This preliminary part of the project was carried out in a rather fast and intensive process, since there was a great urgency amongst local politician to create solutions in Lystrup, that could prevent future floodings, like the one experienced in 2012 which was approximately a 75-years incident. In Lystrup the waste water was already separated from rain water. It meant that selection of feasible NBS measures was only focused on handling excess surface water in case of cloudbursts. The main criteria was thus 'preventing the suburb from similar flooding in the future'. At the same time there was a measure about creating as much green spaces as possible within the frames of the relevant legislation and the economic frames.

Lake Egå

Only lake construction was considered. Permanent wetted area was decided based on demand of maximum nitrogen reduction. Dike height was calculated based on retention volume above wetted area and known river discharges.

Criteria to choose the final measure(s)

Lystrup

The process of choosing final NBS measures were carried out in 'one-tak'. See description above.

Lake Egå

Only lake construction was considered. Criteria was potential nitrogen reduction (kg N/ha) and cost (DKK/kg N reduced).

Stakeholder involvement in the identification of all feasible, and the final NBS measure(s).

Lystrup

The Climate Adaption project was a co-creation project between the municipality and the local waste water company. Following stakeholders was directly involved in the preliminary process of project design: Municipality of Aarhus, Aarhus Water A/S (local waste water company), private engineer advisors.

Lake Egå

The Environmental Protection Agency was involved as granting authority. Former County of Aarhus as Project Manager. Municipality of Aarhus was involved as new landowner as the consequence of land consolidation (exchange of land between landowners). Besides, former landowners and different NGO's was involved.

7.2.2 NBS design

a) NBS design process

Design options considered

Lystrup

In august 2012 the suburb suffered severe floodings from a cloudburst, and the overall design of the pilot project where very much a 'one-take-decision' because of an urgent pressure from both citizens and politicians. It means that the preliminary design phase was carried out very fast during 3 months.

Lake Egå

Only lake construction with retention volume was considered.

Rationale in the design of the NBS

Lystrup

Lystrup is a suburb which already had a system of separate handling of rainwater and sewage water when the climate adaption project was planned. In Denmark the rain water system in separated areas is dimensioned for handling normal rains (5 years incident). It meant that the main purpose of the pilot project was to create a surface system, which could manage and delay excess surface water in case of future extreme precipitation events – thus preventing future material and human damages. This could only be done by using existing free spaces, changing them to water management.

Because of the local topography (both the natural and the city-topography) the chosen free spaces were placed on different sites on the hillslope, which gave way for design of a system that consisted of 12 smaller sub-projects which all together were meant to adapt Lystrup to a 100-years rain incident in 2100.

Lake Egå

The main purpose of lake Lake Egå originally was to reduce the nutrient load to Aarhus Bay. Nature and recreational benefits as well as floodrisk reduction was considered as secondary objectives/co-benefits, but still very important.

Criteria for selecting the NBS design

Lystrup
In the preliminary design phase few but crucial criteria were considered:

- Adapting the whole suburb to a 100 years incident in 2100
- Handling as much water as possible on the surface
- Using non-built areas
- Using public owned area
- Adding green, recreational and nature features where possible (we were limited by National rules, that prevents the waste water company from investing in any features which are not linked to water management.

Lake Egå
Not relevant.

Stakeholder involvement in the NBS design process

Lystrup

External stakeholders - primarily the citizens in Lystrup - were involved (informed) in the project on citizens meetings. Since they have had recent bad experience with floodings, they were rather positive towards the proposed actions.

The citizens were not given the chance to influence the chosen risk-reduction level or the overall principles for the project.

However, in Hovmarksparken the citizens engagement was intensified because the University of Aarhus engaged in developing the specific area to recreational purposes. The Citizens were invited to several workshops led by University of Aarhus together with a private company ‘Habitats’, where they generated ideas about future recreational use of the area Hovmarksparken. The Citizens involvement here was a part of a new concept called ‘Wild on Purpose’ which aims at bringing more biodiversity into cities on private initiatives. Thus the

stakeholder involvement want further than just ‘informing’, since the citizens ware actually a part of selecting recreational features in the area.

Lake Egå

Stakeholders were primary involved in connection with official hearings laid down in the legislation. Still there was a very close communication between the stakeholders under the design process.

More details on stakeholder’s involvement in the NBS design process are presented in RECONECT Deliverable report D2.1.

b) Selected NBS design

Details on the chosen design for the selected NBS

Lystrup

Lystrup Centervej

During the cloudburst I 2012 large amounts of surface water used Lystrup Centervej as a temporary ‘watercourse’ and was lead to the lowlaying part of the suburb. The project (Figure 7-55) consist of waterpond, changed road profile and terraced rain-beeds.

The waterpond is permanently wet and the waterlevel differs from 0,8 m to 2,0 m. The volume is 4800 m3 (storage volume: 3550 m3 / wet volume: 1250 m3). The waterpond is dimensioned to have one overflow in 10 years and has a drainage on 100 l/s. The total catchment area is 33.350 m2.

The rain-beds are designed to have an overflow every 5th year to the waterpond through a Ø200 sewer. The total volume is 186 m3 and the total catchment area is 3350 m2 paved area. Filter soil on 0,5 m depth is used to secure infiltration and retention of heavy metals.
The changed road profile is dimensioned to lead excess surface water directly to the waterpond in extreme situations. This is done by – on a short distance - sloping the road profile in opposite direction to the driving direction and by lowering the height of the road edge.

Figure 7-5 Lystrup Centervej sith waterpond, rain beds and changed road profile

Old Ellebæk

During the cloudburst I 2012 all the surface water from Lystrup was cought in the low areas north of the highway and flooded the surrounding houses.

The project area (Figure 7-6) consists of a changed watercourse profile on 114 m in length leading to a wider part (appears as a lake) of the watercourse in front of an inlet. The terrain around the watercourse is modelled to be able to delay excess surface water in extreme situations. From the inlet – which is formed as an 'amphitheatre' - the water is directed through a large Ø2000 pipe which runs 250 m along the highway with an outlet into river Ellebæk. The outlet is designed to withstand/absorb large waterpulses. At the same time two overflow edges are established from Lystrupvej. Different kinds of wildflowers and berry bushes are planted to finish the project to encourage the local citizens to recreational use of the area.

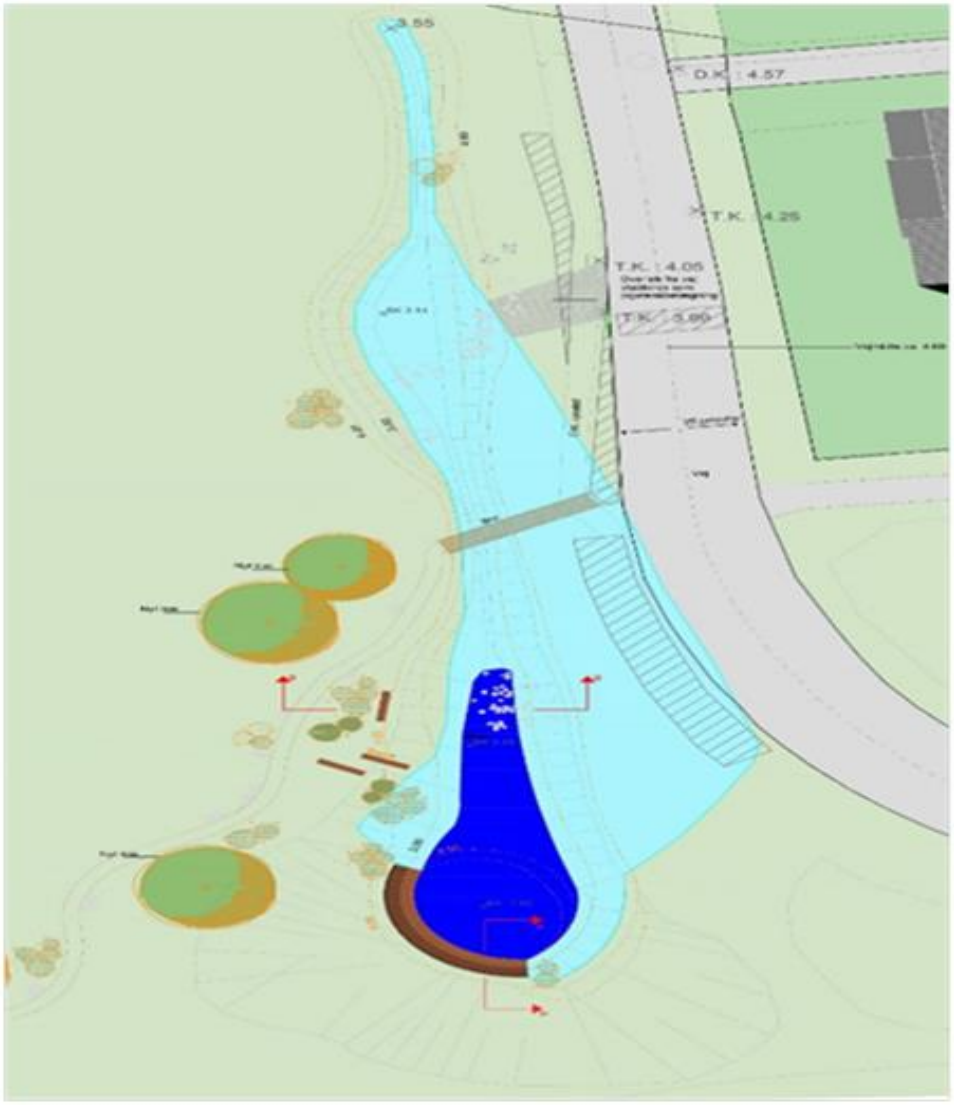

Figure 7-6 Technical Overview - Olde Ellebæk.

Dark blue: permanently wet; Light blue: Wet when excess surface water is delayed; Brown: inlet to Ø2000 pipe

Ellebæk

During the cloudburst in 2012 the houses near Ellebæk was flooded with water from the watercourse. The project (Figure 7-7) consist of a 320 m side course on the western bank of the watercourse Ellebæk with 4 overflow channels that allows excess water into the side course in situations with extreme discharge. A single overflow channels allows the water to flow back into the main water course. The side course and overflow channels are reinforced with mixed stones and special dike-vegetation.

A 70 m dike between the Ellebæk and the suburb prevents the nearest houses from flooding. The side course takes effect when the discharge exceeds the 'Winter median max' which is 200 l/s. The max discharge in the side course is 600 l/s, which corresponds to a 100 years incident.

Figure 7-7 River Ellebæk with side course for overflowing water,

5 overflow channels and dike to protect the houses from flooding, Piped part of Ellebæk – changed from Ø200 to Ø 2000

Hovmarksparken

During the cloudburst I 2012 large amounts of surface water from the green areas flooded the houses south og Hovmarksparken. The project (Figure 7-8) consists of a water pond, elevation of the terrain and overflow to gullies that leads the water to a green area southeast of Hovmarksparken.

After Establishing the water pond, flora that favours nutrient poor soils were introduced and mineral soils were used as surface soil. The purpose was to introduce new species into city areas and thus enhancing the biodiversity.

A cow grazing union maintains the green areas west of the water pond.

Green elements – general feature

In all the green areas of the projects in Lystrup wildflowers were introduced to enhance the biodiversity and recreative value.

Lake Egå

The chosen design (Figure 7-9) was based on the construction of a lake area with retention volume above normal water level. The water level may rise 70 cm before it overflows the eastern dike. The maximum retention volume in that case is nearly 1 million m^3 of water. In this situation some 30 ha around the lake is flooded.

Figure 7-8 Hovmarksparken – waterpond with elevation of the terrain in the south eastern part of the area.

Overflow from the waterpond is let through a gully that follows the pathways and ends in green areas

Figure 7-9 Project area before construction Lake Ega

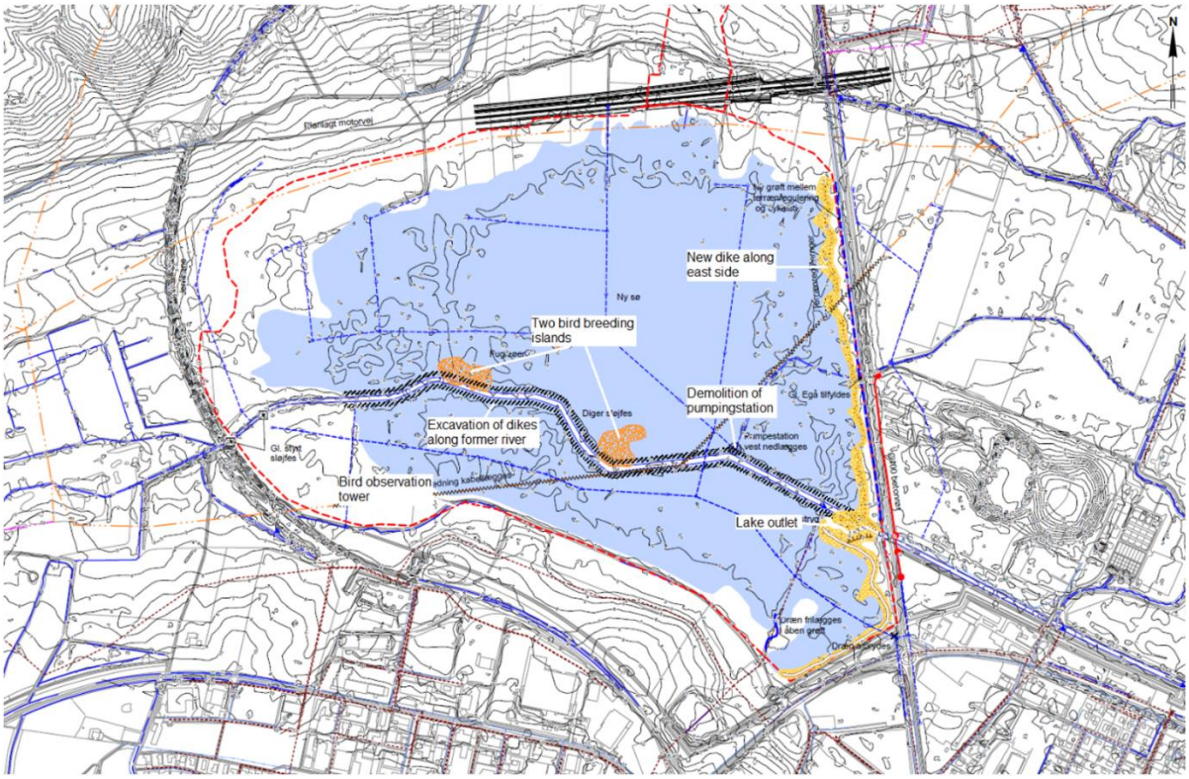

Figure 7-10 Project design Lake Ega

Figure 7-11 Project area after construction Lake Ega

Summary of the cost-benefit analysis for the chosen NBS

Lystrup

Calculation of investment, operation and maintenance was budgeted in connection with the preliminary application to the National Supply Secretariat, who is the legal body that approves the economic aspects of climate adaption projects. A part of this application is a cost-benefit analysis that compares a usual 'grey solution' with an alternative 'green climate adaption solution' (which is the one applied for). According to the application total investment costs in a usual grey solution will be around 22.5 mio. EUR against 4.5 mio. EUR for the alternative green solution including all sub-projects. The maintenance costs however are estimated to be higher in the green solutions than in a usual grey solution.

Lake Egå

The cost-benefit analysis was not based on flood risk but on governmental cost-benefit analysis in relation to reduction of nutrient reduction.

Outline of the operation and maintenance plan

Lystrup

According to national Danish law the waste water company can only be responsible for maintenance of parts of the projects that are crucial for the water management. Maintenance of e.g. recreational fixtures accrues to either the owner, the operator or to specific user groups in the project area. In some cases the maintenance of the water management functions can also be the responsibility of other than the waste water company – e.g. the owner of the area or the Municipality. In most cases the maintenance is partitioned between different departments in the Aarhus Municipality.

For each subproject a maintenance plan was developed. The maintenance plans include description of the project, specifications of ownership, responsibilities, description of the functionalities in terms of water management, specification of maintenance actions. The plans also contain agreements on the costs of maintenance.

Lake Egå

There is no specific operation and maintenance plan for the NBS project. The NBS is considered as a natural part of the river system. Maintenance of the river system is carried out by the municipality in accordance with the statutory watercourse regulations.

Maintenance of the recreational facilities and landscaping is carried out by the municipality as landowner.

Outline of the monitoring plan

The expertise from the water-, nature- and social sciences available in the RECONECT team is needed to set up the monitoring plan for the 'Water' 'Nature' and 'People' indicators. Dialogue is in progress, and the final monitoring plan including the time-plan for monitoring will be adjusted when the expertise and the time plans of the thematic experts (for the assessment and monitoring of the Water, People and Nature indicators) will be available.

The monitoring and evaluation plans, together with the list of indicators, will be presented in detail in D2.6 "Co-monitoring and co-evaluation plans for demonstrators".

7.2.3NBS Cost evaluation

Lystrup

Table 7-1 shows budgeted investment and maintenance costs for certain projects in Lystrup.

Table 7-1 Budgeted investment and maintenance costs for certain projects in Lystrup

Subproject	Main activities	Project owner	Investment costs (EUR)	Maintenance/year for 75 years (EUR)
1. Lystrup Centervej	Change of roadprofile, raingully, Waterpond	Aarhus Municipality / Aarhus Water	484.800	16.833
2. Old Ellebæk	Change of watercourse, pipe-dimensions, inlet + outlet, Irish crossing in road	Aarhus Municipality	485.579	21.490
3. Ellebæk	Establishment of sidecourse to watercourse	Aarhus Municipality	109.002	4.000
4. Hovmarks-parken	Expansion of a waterpond and establishment of ditches. Introducing biodiversity and establishment of a cow grazing union*	Aarhus Water	502.800	17.500

**The recreational features were not a part of the water management project.*

Lake Egå

The total cost amounted to EUR 2,27 mio broken down by:

- consultancy services EUR 0,2 mio
- construction costs: EUR 1,27 mio
- land acquisition EUR 0,8 mio

7.3Procurement of contracts

Contract procurement process/methodology

Lake Egå and Lystrup

All contracts and agreements between Aarhus Municipality and subcontractors / contractors in Lake Egå and Lystrup are based on the Municipalities common standards and specifications for contracts and procurements, which again are based on national and European regulations. The process is described thoroughly in our quality management system, and contains focal points as:

- Specify requirements
- Request for tenders
- Choice of subcontractor / contractor
- Writing contracts
- Assure quality of the contract and approval from the head of the department if the contract exceeds a specific limit of each employee
- Controlling the delivery
- Evaluating subcontractor / contractor

Since Lake Egå was constructed more than 10 years ago, some procedures might have changed since then. The specific procedures for each subproject might differ a bit depending on the price of the subproject.

Criteria for evaluation of contracts

Lake Egå and Lystrup

Request for tenders contains in some cases individual criteria for selection, e.g. price vs. cooperation. All offers from subcontractors are individually assessed according to any criteria or according to an assessment of e.g. price vs. professionalism, cooperation, experience (portfolio list), skills (CV's) etc.

Measures to ensure the quality performance of contract works

Lake Egå and Lystrup

According to the quality management system the quality of the performance is assessed by:

- Controlling invoices
- Assess the quality of each delivery according to the specification of requirements
- Assess environmental impacts
- Assess requests to work environment
- Assess whether necessary skills are available

7.4Construction works

Lystrup

The construction of the 11 sub projects in Lystrup was carried out in parallel timelines between 2014 and 2015. Each sub-project was managed as independent project with own project managers.

Specific timelines for each subproject are not available.

Lake Egå

The main construction works included:

- Excavation of 30,000 m^3 dikes along the river
- Backfilling of 1,400 m existing watercourse with 10,000m^3 soil from the dikes
- Demolition of pumping station
- Suspension of drains and exposing of existing storm water drain
- Establishment of 900 m dike in east end along the road "Lystrupvej"
- Establishment of 475 m pipeline for road drainage
- Establishment of outlet from the lake with double profile, constructed as a natural fish bypass channel
- Establishment of 5,500 m path/trail around the lake
- Establishment of two islands for bird breeding
- Establishment of bird observation tower

The construction work was performed by a contractor after tender.

Main working period 4 month (July - October).

The area had many archaeological findings, therefore the contractor had attention on this while working.

7.5Operation and Maintenance

NBS life-cycle

Lystrup

The expected lifetime of the subprojects in Lystrup are 75 years, which requires continuous maintenance and thorough descriptions of the functionality including a liable system for storing important information for future management.

Lake Egå

The expected lifetime of the subproject Egå Engsø is supposed to be more than 100 years. This mainly requires maintenance of dikes, in- and outlets and recreational installations.

Organisation authorised to carry on operation and maintenance. Coordination with relevant authorities & stakeholders

Lystrup

The waste water company is responsible for maintenance linked to the hydrological functions of the project. Different department of the municipality is responsible for:

The road department: maintenance of road related part of the projects.

The green maintenance department: responsible for maintenance of green parts of the projects.

The Watercorse authority: responsible for maintenance of the watercourses due to national law.

Cow grazing Union (Hovmarksparken): Responsible for grazing neighbour areas to the waterpond.

Lake Egå

The owner of the project area – in this case the Municipality of Aarhus is responsible for the maintenance of the projects. Different departments of the Municipality take care of different parts of the maintenance.

Main Operation and Maintenance activities to be done

Lystrup

The operation and Maintenance activities differs between each sub-project. Below is mentioned different kinds of actions:

Lystrup Centervej (waterpond, raingully and road with changed length profile) contains a system that leads excess-water from the road to the waterpond. The primary maintenance activity includes securing that the overflow area between the road and the pond is maintained in cases where the road undergoes usual road-maintenance. The Municipality (CBA) is responsible for road maintenance.

It also includes maintenance of the waterpond, sewer etc. which accrues to the waste water company and consists of removal of sediments, keeping the raingully free from excess-vegetation etc.

Areas around the waterponds accrues to the owner of the area, who is the local school.

Ellebækken (watercourse) sub-project contains a side-course to the primary watercourse with 5 overflow points and a dike. The primary maintenance activities include securing that the sideflow and the overflow points are kept free from branches and vegetation like bushes and trees that can prevent the water flow in extreme situations. The maintenance of the primary watercourse accrues to the Watercourse Authority (VoN) and the maintenance of the sideflow accrues to the owner of the area who is Aarhus Municipality (CBA). Estimated cost/year: 4.000 EUR.

Old Ellebæk (Change of profile of watercourse and piped part of watercourse, waterpond, establishing of inlet, Irish crossing) contains a system that catches excess surface water from a rather large catchment area in Lystrup and leads it underneath the highway, through a waterpond and a pipe, into Lake Egå. Aarhus Municipality (CBA) is responsible for the primary maintenance which consists of emptying of sandtraps, keeping the waterpond and the

passway under the highway free from excess vegetation. Maintenance of the primary watercourse Ellebæk accrues to the Watercourse Authority (VoN). Estimated cost/year: 23.500 EUR.

Hovmarksparken (waterpond and ditches) maintenance consists removal of sediments from the waterpond, keeping the raingully free from excess-vegetation etc. The green areas around the Water Pond is owned by the municipality, Department for maintenance of green areas, who is responsible for the vegetation. The western part of the area is used by a cow grazing union, where the animals are contributing to maintenance of the green areas and at the same time contributing to creating biodiversity.

Lake Egå

Normal river maintenance. On the green areas beside the lake vegetation maintenance has to be done, like maintenance of recreational matters such as paths, roads, shelters, info-signs etc.

Potential challenges and possible ways to overcome them

Lystrup

Potential challenges are to make the maintenance manuals as detailed and easy to follow as possible, since the functionality of the projects depends very much on, that the surface levels (elevation) are kept as planned and that interflows in and between the subprojects are kept free of vegetation and waste.

The long lifetime of 75 years will also cause challenges in securing that the maintenance costs are prioritized and that the knowledge about the projects is preserved in the administration throughout all 75 years – if not the projects are changed in the meantime.

Lake Egå

Climate changes resulting in additional increase in discharge can result in a need for increasing the lakes retention volume in order to avoid overflow. This can be overcome by increasing the height of the dike at the east end of the lake. If the dike is elevated by 1 m, the retention volume will be more than doubled, from 1 million m^3 up to 2,6 million m^3.

8 Demonstrator DB4: Thur River Basin, Switzerland

8.1 Case description

The Thur catchment is prone to flooding and has very sensitive areas, e.g. urbanized areas with industries and camping sites. To reduce flooding risk and to enhance the ecological status, NBS have been and are currently being implemented throughout the entire catchment.

The hydraulic measures currently being implemented, as well as the additional planned actions included in the flood risk management plan were comprehensively evaluated in terms of economic, ecological and hydraulic impacts. Examples of such measures are: river restoration projects, and construction of retention areas for flood protection and artificial groundwater recharge. These measures, in addition to reduce flood risk, they aim also to ensure the provision of enough water during dry periods.

Figure 8-1 shows a river restoration example at Niederneunforn where Eawag and its research team with the water management partners, has worked for the last 10 years. This work was performed within the framework of the transdisciplinary RECORD and RECORD Catchment projects (http://www.eawag.ch/en/department/wut/projects/record-catchment). These two project outcomes and constructed infrastructure in the entire Thur catchment with its comprehensive monitoring and evaluation system is open to all RECONECT partners; this Swiss approach will be adopted to other economic, ecological and hydraulic conditions as necessary.

Figure 8-1 Thur river at Niederneunforn

Left panel: before restoration started in 2002. Right panel: after restoration in 2008. (© BHAteam, Frauenfeld)

8.2 Technical specifications of the Demo case

8.2.1 NBS selection

Main steps in the assessment process that lead to the selection of feasible and final NBS measure(s)

The NBS at the Thur river site at Niederneunforn had two goals. The first was the revitalisation of this part of the river which contained a floodplain forest of national importance and to a lesser extent risk reduction in term of flooding risks further downstream. The restoration was done in accordance with the cantonal restoration strategy of the Cantons of Thurgau and Zurich. Only after the restoration was accomplished in 2002, a federal restoration law came into place 2012.

The main criteria for site selection and the selection of measures was the ownership of the land close to the river and the possibility to acquire the land if it was in private hand. In a second step it was evaluated what the best possible measures were. Different consulting companies developed projects and the cantonal authorities pre-selected the best with respect to technical feasibility, prospects of success and costs. Then, the best project was selected by the cantonal authorities and a detailed project plan was developed. This detailed plan was posted and any stakeholder including the public was able to give his/her opinion in writing. Afterwards, the cantonal authorities evaluated the petitions submitted and adopted the project or disregarded the petitions by stating the reasons.

Determination of the risk reduction target / primary benefit. NBS measures considered feasible in meeting the risk reduction target.

Revitalisation itself was the main target of the restoration measure. This included biodiversity, recreational purposes and connectivity of the river with the floodplain forest. Flood protection for downstream areas was also a target but not so important as the restoration aspect. In addition, it had to be made sure that the close-by water production well is not affected by the restoration measures.

Criteria used to select all feasible NBS measures considered

The selected measures were first the feasibility to remove engineering structures from the river, then gravel and sand was redistributed and new gravel was introduced to the site. Furthermore, it was made sure that the floodplain forest is connected to the river in case of high river water. Finally, to a limited extent, pioneer vegetation was planted but more as an experimental exercise.

Criteria to choose the final measure(s)

All feasible NBS measures were finally chosen (see paragraph above).

Stakeholder involvement in the identification of all feasible, and the final NBS measure(s).

The main stakeholders were the authorities of the Cantons of Thurgau and Zurich (Departments of Civil Engineering, Forestry and Water Supply). They identified the NBS measures. These were discussed with consulting companies for their feasibility. After discussion with the communities close to the site and the general public, the measures were implemented.

8.2.2 NBS design

a) NBS design process

Design options considered

The rationale behind the design options was to restore the river reach. This was the primary target. A secondary objective was flood protection for downstream river reaches. Co-benefits were recreational uses.

Rationale in the design of the NBS

The rationale in the design was to create as much biodiversity as possible. Furthermore, recreational possibilities had to be given and the connectivity of the river with the floodplain forest had to be accomplishes. Flood protection for downstream areas was also a rational but not so important as the restoration aspect. The river reach close-by a water production well was left out from the measures due to possible negative effects on water quality.

Criteria for selecting the NBS design

The selected design was to remove engineering structures from the river, then gravel and sand was redistributed and new gravel was introduced to the site. Furthermore, it was made sure that the floodplain forest is connected to the river in case of high river water. Finally, to a limited extent, pioneer vegetation was planted but more as an experimental exercise. This was the overall design as agreed upon.

Stakeholder involvement in the NBS design process

As for the selection of the NBS measures, the main stakeholders were the authorities of the Cantons of Thurgau and Zurich (Departments of Civil Engineering, Forestry and Water Supply). They identified the NBS measures. These were discussed with consulting companies for their feasibility. After discussion with the communities close to the site and the general public, the measures were implemented.

More details on stakeholder's involvement in the NBS design process are presented in RECONECT Deliverable report D2.1.

b) Selected final NBS design

Details on the chosen design for the selected NBS

The selected design was to remove engineering structures from the river. With big machinery, the concrete blocks were taken out. In a second step, diggers loosened the sand and gravel in these zones. In several cases, the gravel and sand was redistributed to achieve heterogeneous conditions. In addition, new gravel was introduced to the site. Furthermore, it was made sure that the floodplain forest is connected to the river in case of high river water. This was initiated by the introduction of three trenches. Finally, to a limited extent, pioneer vegetation was planted but more as an experimental exercise. Figure 8-2 shows the geological cross-section representing the restored (*left; R044 to R070 whereas R stands for piezometer*) and channelized (*right; R084 to R068*) transects at the test site Niederneunforn. (Schneider et al., 2011). This represents a snap shot in time seven years after construction was accomplished. Right after restoration, the site was left on its own and changed morphologically constantly. Gravel bars within the river appeared and disappeared.

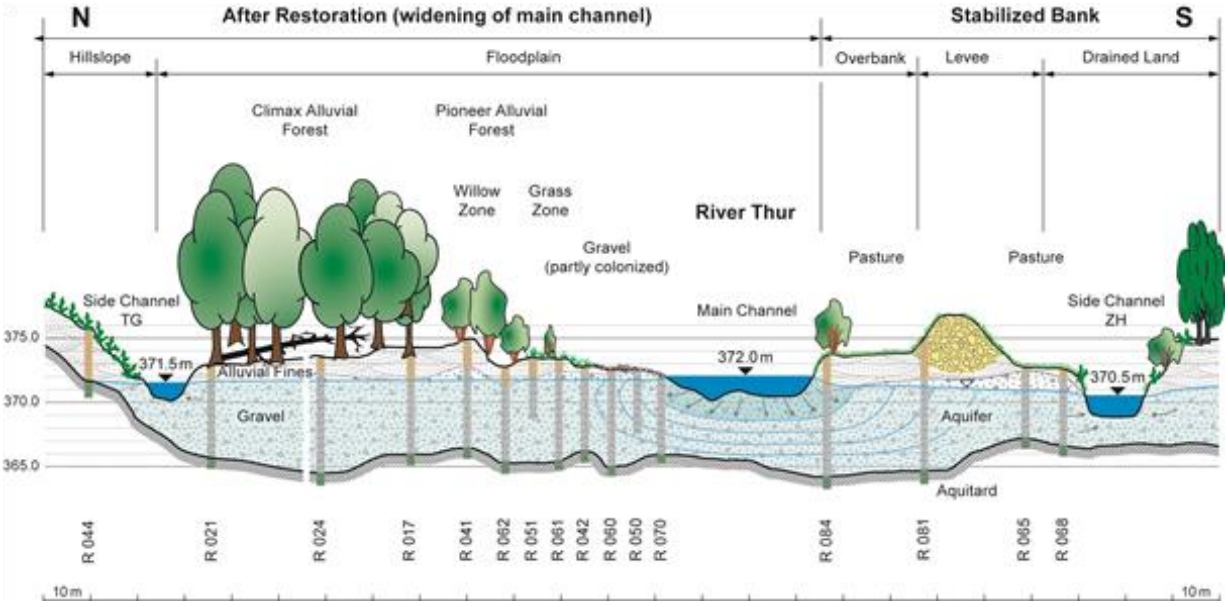

Figure 8-2 Geological cross-section representing restored and channelized transects at the test site Niederneunforn.

The restored parts comprises gravel bars developed naturally after restoration in 2002 – including the gravel zone, sparsely colonized with pioneer plants, and the grass zone characterized by thick layers of young alluvial overbank sediments densely colonized with

mainly reed grass (Phalaris arundinacea) – the willow zone where older alluvial sediments were stabilized during restoration by planting young Salix viminalis, and the alluvial forest dominated by ash and maple growing on older alluvial sediments

The construction work for the restoration measures was accomplished within a time frame of approximately six weeks. Five years after completion, the large-scale, multi-disciplinary research project RECORD was initiated (Schirmer et al., 2014). Within this project investigation and monitoring strategies were implemented to understand the morphological, hydro(geo)logical, biogeochemical and ecological changes over time.

Summary of the cost-benefit analysis for the chosen NBS

Cost-benefit analysis (CBA) are very difficult to obtain because a lot of assumptions need to be made. For the first time in Switzerland, Logar et al. (2019) did a CBA for the Thur site at Niederneunforn. The authors state that CBA results demonstrate that the benefits outweigh the costs in the Niederneunforn case study and hence that restoration efforts are justified from an economic point of view. A sensitivity analysis shows that the main results and conclusions do not change when the authors change some of the key assumptions underlying the CBA. For more details, the reader is referred directly to the publication (Logar et al., 2019).

Outline of the operation and maintenance plan

At the moment, there is no special plan for operation and maintenance. The site is regularly monitored as this is done based on the cantonal monitoring program along any river in the Cantons of Thurgau and Zurich.

Outline of the monitoring plan

The Thur river catchment was a case study in the two EU-Projects REFORM (http://www.reformrivers.eu/home) and ADVOCATE (http://www.theadvocateproject.eu/). Over a period of 10 years, Eawag and its research, as well as water management partners have worked on the Thur catchment. This work was performed within the framework of two transdisciplinary projects: RECORD and RECORD Catchment: (http://www.eawag.ch/en/department/wut/projects/record-catchment/).

In addition, there was a large number of subsequent research projects at Eawag and its partners, which were funded by the Swiss National Science Foundation.

Our existing data platform (a custom geodatabase and WebGIS platform) for water quantity will be further developed. It subdivides the Thur catchment into six sub catchments and fully captures the hydraulic dynamics at the outlets of the sub catchments. This information will help to characterize dominant runoff generation processes and to define Hydrological Response Units (HRUs) within these sub catchments. The goal is to generically include the groundwater flow system into the semi-distributed model. By constantly monitoring electrical conductivity (EC), water temperature and water level at a large number of locations throughout the catchment, an adaptive and event-based water quality monitoring scheme for selected locations will be developed. At these locations, auto-samplers will be installed for subsequent chemical analyses. Based on the event and prior information on the trends in water quality changes, sampling intervals and locations will be adapted. The ultimate goal is to only measure EC, water temperature and water level in the end, and use these measurements as surrogates to predict the changes in water quality during any event.

The NBS river restoration measures at the Niederneunforn site are implemented. This went along with detailed monitoring and evaluation of river discharge, groundwater levels, water quality of surface and groundwater, ecology, biodiversity, soil parameters, acceptance of the inhabitants and economical considerations.

Currently, monitoring is ongoing for electrical conductivity (EC), water temperature and water level at many different locations throughout the catchment. This will be further developed to have an adaptive and event-based monitoring scheme for selected locations. At these

locations, auto-samplers will be installed for subsequent chemical analyses. Based on the event and prior information on the trends of water quality changes, sampling intervals and locations will be adapted.

The monitoring and evaluation plans, together with the list of indicators, will be presented in detail in D2.6 “Co-monitoring and co-evaluation plans for demonstrators”.

8.2.3NBS Cost evaluation

The costs for the restored Niederneunforn site are summarized Table 1 of Logar et al. (2019). The non-recurring costs (total) were about 6.4 million CHF. From the total, the following costs occurred: planning and project design costs 730,000 CHF; construction costs of relocating or extending the levees 3.8 million CHF; land acquisition costs 758,000 CHF; other construction or investment costs 99,000 CHF and costs of bank stabilisation 1 million CHF.

The recurring costs as total over a 35-year period are estimated to be of about 1.2 million CHF for operation and maintenance. This comes down to estimated annual maintenance costs of 34,500 CHF. These costs include the sampling, monitoring and chemical analyses for water quality assessments.

8.3Procurement of contracts

Contract procurement process/methodology

The procurement was done in an open call for proposals with benchmarks that had to be fulfilled in terms of the design and the construction. As mostly the case, any consulting company can hand in a tender. Usually several of the best offers are chosen to hand in a more detailed project description with detailed costs. This is based on technical feasibility, prospects of success and costs. Then, the best project is selected by the cantonal authorities and a more detailed project plan is developed. This plan is posted and any stakeholder including the public is able to give his/her opinion in writing. Afterwards, the cantonal authorities evaluate the petitions and adopt the project or disregard the petitions by stating the reasons.

Criteria for evaluation of contracts

The evaluation criteria are based on federal and cantonal laws and rules. This is done by the cantonal authorities.

Measures to ensure the quality performance of contract works

The cantonal authorities work together with the contractors and make a quality check. Only after quality assurance is given, the full amount of money is paid.

8.4Construction works

The construction work began with the removal of the engineering structures from the river. With big machinery, the concrete blocks were taken out. In a second step, diggers loosened the sand and gravel in this zone. In several cases, the gravel and sand was redistributed to achieve heterogeneous conditions. In addition, new gravel was introduced to the site. Furthermore, it was made sure that the floodplain forest is connected to the river in case of high river water. This was initiated by the introduction of three trenches. Finally, to a limited extent, pioneer vegetation was planted but more as an experimental exercise.

8.5Operation and Maintenance

NBS life-cycle

At the time of construction, there was no federal law in place to force or encourage river restoration. This law was implemented in 2012. The restoration efforts were done in

accordance to the cantonal environmental strategies. Therefore, there was no NBS life-cycle defined. It was shown that the restored site is constantly changing.

Organisation authorised to carry on operation and maintenance. Coordination with relevant authorities & stakeholders

There is little maintenance at the site. Like at every other river reach, the cantonal authorities monitor the site. For sampling and monitoring, the cantonal authorities have own departments and laboratories to perform these tasks. Since watercourses in Switzerland are under cantonal law usually no other stakeholders need to be involved.

Main Operation and Maintenance activities to be done

As described above, the usual monitoring programs of the Cantons come into place.

Potential challenges and possible ways to overcome them

Potential challenges are given when the river removes large parts of the shoreline as was the case in 2010. At that time a line of intervention was defined. As the river came close to this line, a trench was constructed inland and filled with large rocks. At the point when the river reached the rocks, the erosion stopped. One year later, the river deposited large amounts of gravel and a natural gravel bar appeared. With this the problem was solved until today.

9 Demonstrator DB5: The VAR Éco-Vallée, France

9.1 Case description

The Var Éco-Vallée in the Lower Var river basin is a flagship project of the French Government and represents an innovative approach to manage and combine different environmental challenges, including the hydro-meteorological events in suburban and urban areas. Low valley of the Var river is a good example of a long history of human interference in its morphological and sedimentation processes. Different measures in the valley and upstream of it have been implemented over the years. At the beginning the focus was on the structural measures followed by hydraulic structures along the Var river.

The new project Eco-Vallee, focuses on new urban development of this area forcing both, grey green and blue infrastructures. The highlight is on:

- Green dikes, combining the increase in retention capacity with the enhancement of habitats.
- Installation of eco-district in the upstream part of the valley in the village called St Martin-du-Var

Figure 9-1 NBS site, Var low valley, Nice, France

Figure 9-1 shows the Var low Valley NBS site. More information on this case can be found in D2.3.

9.2 Technical specifications of the Demo case

9.2.1 NBS selection

Main steps in assessment process that lead to the selection of feasible and final NBS measure(s)

Creation of new urban zone in the west part of Nice resulted in creation of NBS system unique by its size and technological innovation. Located in the west part of Nice, the new zone was challenging.

One of the main goals in the project of national interest is to create an urban zone under the predefined strategic content. The area is created on three complementary axes: ecology, planning and economy. A priority is given to natural based solutions focusing on the river Var with the main goal to return stable longitudinal profile and balance sediment transport regime. These two components were disrupted in the last century with application of different measures that had a negative long term effect of morphological status of the river Var.

At the same time, the new plan is to change land use of floodplains taking into account major challenges, with enhancing the value of the area and develop the balance between nature, agriculture and urban development. The first step in this process was to preserve existing natural resources: water, soil and biodiversity potential. Next, the consideration of the natural risks within existing prevention plans and programs. At the end, but not less important the focus is on territory innovation, with application of technologies of the future, particularly those linked to sustainable development, in order to diversify functions and develop jobs and at the same time create the affordable housing prices to meet needs of the developed city.

Determination of the risk reduction target / primary benefit. NBS measures considered feasible in meeting the risk reduction target.

The main measure regarding the risk reduction is on river Var and revitalisation of the river longitudinal profile and stabilisation of sediment transport. On the other side, the urban habitat in the new development area is adapted to existing and projected natural risks. This relates to new buildings, with new materials (such as wood, solar panels, energy efficiency materials, etc) and new innovative infrastructure.

Criteria used to select all feasible NBS measures considered

All feasible solutions that met river restoration criteria and provision of the acceptable natural risk are adopted and applied. With the reasons explained in the paragraph above the solutions considered for the river Var and for the urban development of the floodplains create a system of NBS unique by it functionality.

Criteria to choose the final measure(s)

See paragraph above.

Stakeholder involvement in the identification of all feasible, and the final NBS measure(s).

The whole zone is acknowledged as a one big project with high national interest, a national urban planning operation with particular legal regime. This unique legal setting is organized as follows; the French state and not the municipality is issuing land permits and in some cases building permits. The new development zone, within the project is within the Prefect[4] decision and not the municipality. Within this setting the French state invested financially in this project along with regional, departmental and local community's contribution.

[4] Prefect - is the State's representative in a department or region.

The urban demand was one of the key drivers in starting this big operation. Operation started in 2008 year starting the Operation of National Interest (Opération d'intérêt National, OIN) of the low valley of the river Var (Eco Vallée Nice Côte d'Azur). Alongside with the creation of the OIN the urban development agency is established. The main purpose of new agency is to carry out sustainable development project with defined parameter. This operation structure is under the supervision of the State where the State is represented by the board of directors, composed of the State representatives, Region, Department and local authorities and in our case Nice Sophia Antipolis University, Chamber of Commerce and Industry and a representative of Sophia Antipolis. The board of directors is headed by Christian ESTROSI and the board is a key stakeholder for this area. The main mission of this entity is to Their main mission is to manage any actions that are promoting urban and economic development of the area. At the same time the focus is on the diversity of urban function, social interaction in the new habitat and environmental protection of the area taking into account environmental risks.

This structural organisation has its life circle. In March 2012, the partnership protocol is created for the period from 2011 to 2026 and this year (2019) the protocol is extended by 2032.

9.2.2 NBS design

a) NBS design process

Design options considered

The design option is focused on restoration of the low valley with the main goal to heal morphological status of the river taking into account longitudinal profile and sediment transport capacity. Regarding the floodplains, the design is focused on new living and business development area that take into account sustainable development, diversity of functions, transportation hub, new jobs and affordable housing prices.

Rationale in the design of the NBS

The rational in the NBS design focuses on bringing natural look to the river bed while abandoning the previous measures that were focused on creation of set of weirs with small hydropower plants. The original design was optimistic with beneficial contribution to local agricultural land owners, increased green areas and energy production.

This selection resulted in morphological imbalance. In Figure 9-2 below the original idea that was adopted in the 60's is presented.

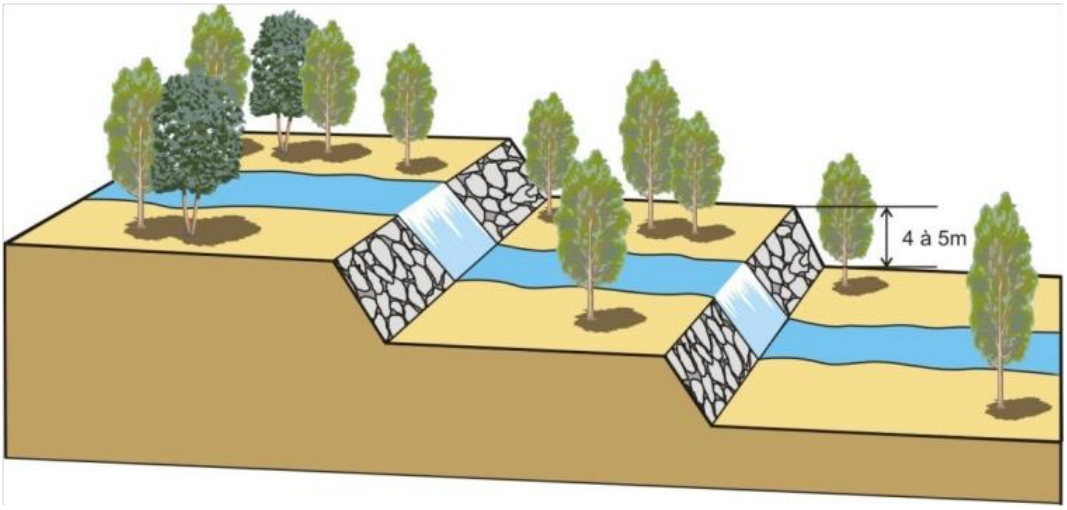

Figure 9-2 Original design of the weirs with vegetation

This setting regarding the restoration was not very efficient and imbalance of the river morphology was evident. The flood event that occurred in November 1994 (Figure 9-3) called

for serious consideration of moving the weirs. Operation of lowering the weirs started few years after the event with primary effect of bringing back the balance to the valley.

Figure 9-3 An example of the weir 4 after the event 1994.

Criteria for selecting the NBS design

As stated in the paragraph above, the main criteria was to preserve a natural status of the river, focus on sustainable development in floodplains, taking into account natural risks and creation of affordable house pricing.

Stakeholder involvement in the NBS design process

This specific setting was created under the project of national interest with main financial contribution of State. As a main decision maker the Prefect is responsible for the urban plan approval, construction permits, etc.

More details on stakeholder's involvement in the NBS design process are presented in RECONECT Deliverable report D2.1.

b) Selected NBS design

Details on the chosen design for the selected NBS

The selected design focuses on removing engineering structures and preserving the natural look of the river. The mentioned event in November 1994 triggered the process of rethinking the approach. Today, the river started to get a natural look, seeking for a balanced morphology..

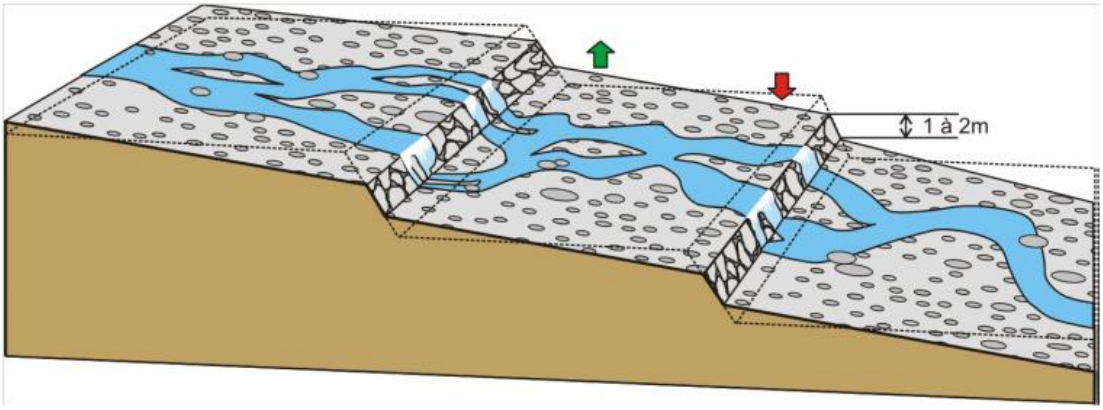

Figure 9-4 Effects after removing the weirs

As presented in Figure 9-4 after lowering the weirs the longitudinal profile is corrected. Operation started after the event and still is ongoing process. Actual situation is focused on restoration of the equilibrium slope, scarce vegetation, and braided river. In the Figure 9-5 and Figure 9-6, the works done on weir 9 are presented as well as the effects after 2 years.

Figure 9-5 Work done on the weir 9 before and after the intervention

Figure 9-6 Effects on the weir 9, 2 years after intervention

Based on the main strategy with highlighted economy, urban planning and ecology the second part of NBS system located on floodplain is created as a set of mixed functions and uses. Here we are speaking about existence of different activities, housing areas, recreational and sport areas, public facilities.

The first smart grid on the neighbourhood scale is located here. The thermal needs of the entire set of buildings are covered by a geothermal production network that distributes the whole district.

The technical installations offer solutions, smart grid ready. Finally, the pooling of needs and mixed use batch will promote the optimization of the powers to install.

The projected building plan of the district is given below in Figure 9-7. The focus is on energy efficiency buildings with different urban functions (public buildings, schools, residential, recreational facilities).

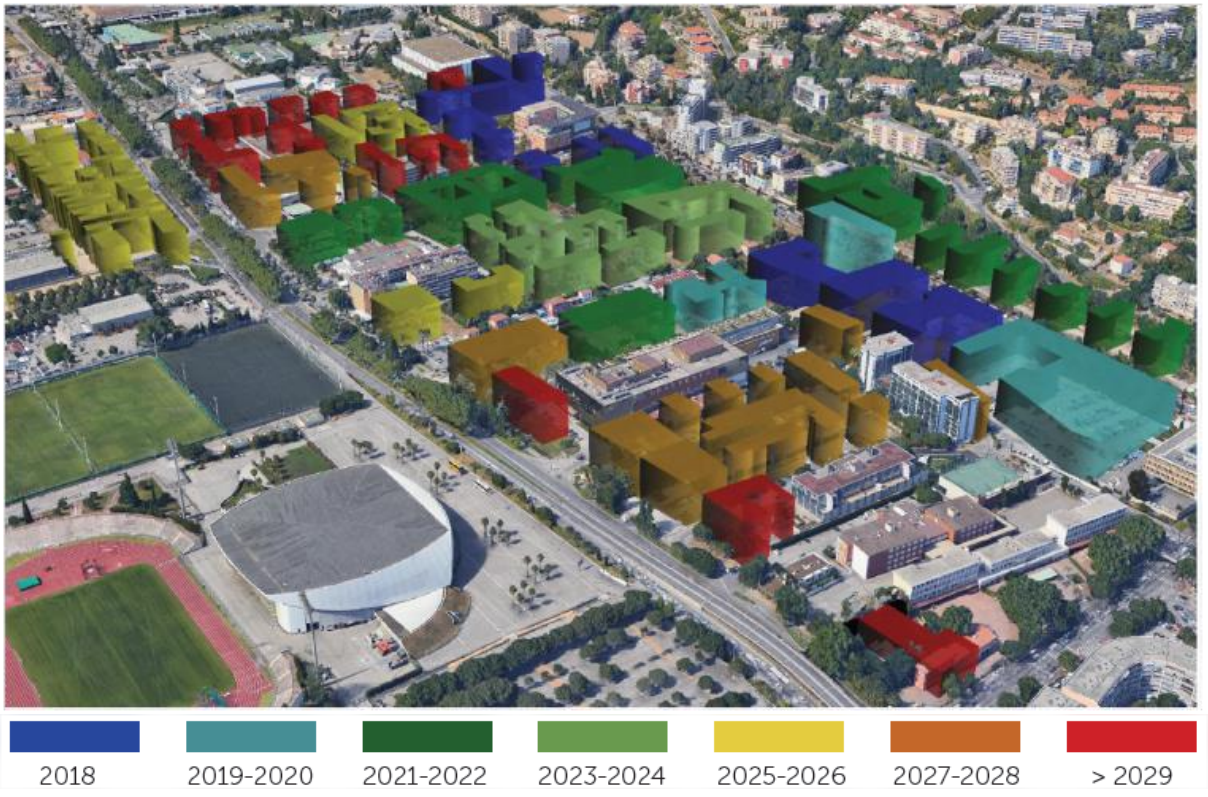

Figure 9-7 Planned urban development in the area for next years

Summary of the cost-benefit analysis for the chosen NBS

There is no relevant data available.

Outline of the operation and maintenance plan

At this time, no maintenance plan is set.

Outline of the monitoring plan

The Eco Var Valley project was a case study in two previous related projects:

CORFU - FP7 project (2010-2014) where Nice was a case study. Collaborative Research on Flood Resilience in Urban areas (CORFU) is a major project involving 15 European and Asian institutions, funded by a grant from the European Commission, Seventh Framework Programme. The overall aim of CORFU is to enable European and Asian partners to learn from each other through joint investigation, development, implementation and dissemination of short to medium term strategies that will enable more scientifically sound management of the consequences of urban flooding in the future. The focus in this project and related to the NBS was new approach in flood risk assessment and adaptation strategies.

AquaVar project - Project supported by VEOLIA, UNSA, Polytech Nice Sophia Antipolis, Nice Cote d'Azur, Conseil General Alpes Maritimes and Agence de l'Eau, with the initial goal of to develop a modelling system to study the hydrology, river hydraulics and groundwater hydraulics in the lower Var river valley. The final aim of the project is to develop a deterministic modelling system which is able to simulate the water cycle at the catchment scale and to simulate the river-aquifer exchange at the sub-catchment scale. (https://var.aquacloud.net/)

Some monitoring activities on (e.g. water level, number of tourists) have been already carried out within Meteo France and tourist organization.

Data available will be used as baseline data, to support further assessment of the performance of the NBS. The monitoring and evaluation plans, together with the list of indicators, will be presented in detail in D2.6 “Co-monitoring and co-evaluation plans for demonstrators”.

9.2.3 NBS Cost evaluation

A partnership protocol was signed on March 12, 2012 between Éco-Vallée's funding partners. It specifies the distribution of responsibilities and commitments, including financial. The financial protocol is important for the leverage it will enable to put in place. Indeed, by sharing the 64.5 million euro financing between the signatory partners, the protocol allows the EPA to commit nearly 379 million Euros of expenses for the plain of Var, which will trigger in their turn almost 2 billion Euros of private investment.

9.3 Procurement of contracts

The public consultations are in place along with the decision that is coming from board of directors. The creation of NBS is influencing reshape of existing urban setting and creation of new urban habitat with ecological footprint.

Contract procurement process/methodology

Along with establishment of decision makers for the area a guide for the purchasing and procurement is created. Guide of the Public Establishment Ecovallée Plaine du Var (hereinafter EPA) aims to provide the thread of the purchase, from the assessment of needs to the notification of the contract and its execution. It helps to ensure the conformity of procedures with the rules of the public order, while ensuring the consistency of the practices of the purchase within the whole of the Establishment. In addition, it facilitates the efficiency of the purchase of the EPA and the proper use of public funds. This guide has been drawn up in accordance with the provisions of Ordinance No. 2015-899 of July 23, 2015 and Decree No. 2016-360 of March 25, 2016 relating to public procurement.

9.4 Construction works

As written in the paragraphs above the NBS system consider river Var and urbanisation of left floodplain. The new energy efficiency and ecological district are in construction phase. These actions are part of national project that is forcing new, efficient building that are consuming less energies. For example the energy for the new district come from renewable sources in 80% and 20% of energy comes from nuclear power plants.

9.5 Operation and Maintenance

At the moment there is no maintenance plan regarding NBS but finalization of this project will bring new procedures and policies that support this NBS system taking the maximum benefits from its characteristics.

Potential challenges and possible ways to overcome them

The main challenge is the length of the project itself. An NBS system is one part of this project of national interest. Although the project will end in 2032 the full potential will not be presented during the RECONECT project.

10 Demonstrator DB6: Les Boucholeurs, France

10.1 Case description

Following the storm Xynthia in 2010, the municipality of Châtelaillon-Plage has set up, with the municipality of Yves, Aix and Fouras, a system to fight against different types of flood called PAPI (Program of Actions Of Flood Prevention).

The purpose of this system is to protect people, goods and activities against the risk of marine flooding. The various actions are carried out within PAPI. The three major themes are taken into account:

1) Prevention and forecasting: Improving knowledge and awareness of risk, surveillance, flood and flood forecasting, crisis alert and management.
2) Spatial planning: Taking risk into account in urban planning, actions to reduce the vulnerability of property and people.
3) The works of protection: Managing flows of water (from the sea and marshes), creation of protective structures (e.g., breakwater, re-ensemblement, enhancement and thickening of existing coastal structures). The structures are designed to withstand a more important event than Xynthia (Xynthia + 20cm).

The demonstration NBS activities include:

4) Multi-purpose wetlands (oyster farming risk reduction)
5) Engineering solutions (hybrid configuration)

Figure 10-1 Case study area, Châtelaillon-Plage (Les Boucholeurs), France (Source: Google map)

Figure 10-1 shows the case study area Châtelaillon-Plage and more information on this case can be found in D2.3

10.2 Technical specifications of the Demo case

10.2.1 NBS selection

Main steps in the assessment process that lead to the selection of feasible and final NBS measure(s)

Creation of NBS in this small coastal community is a very good example of how people are organized on local level in order to protect their living space. Following the consequence of the Xynthia on 2010, the imperative was to create a protection system based on the existing structures, green areas and use of existing canals.

Before catastrophe event, the protection system was presented with protection wall and several wave breaches. After the event several aspects were taken into account:

- Reduction of harmful consequences of a marine submersion on the population, the goods, the economic activities, the environment and the heritage.
- Promotion a system of protection and defence against the sea while preserving socio-economic interests.
- Guarantee the realization of the projects thanks to the financial support of the state and local authorities.
- Bring all the local actors together when setting up and implementing the scheme.
- Develop awareness of risk at the municipal level, especially among citizens, elected representatives and professionals,
- Optimize and develop alert and crisis management tools,
- Master urban planning and adapt it to risk.

Determination of the risk reduction target / primary benefit. NBS measures considered feasible in meeting the risk reduction target.

For targeting risk reduction on the local level the various actions are carried out. Actions were divided into four major themes:

- **Risk Prevention and Prediction**: Improving Risk Awareness and Awareness, Monitoring, Flood and Flood Forecasting.
- **Alert and crisis management**: communal organization for safeguarding populations.
- **Spatial planning**: Taking into account risk in urban planning, actions to reduce the vulnerability of people and property.
- **Protective works**: the management of water flows (coming from the sea and marshes), the creation of protection works (breakwater, groynes, recovery, raising and thickening of existing littoral structures, etc).

Criteria used to select all feasible NBS measures considered

The general criteria were to create more protective system for upcoming events taking into account the type of flooding in this area. In this sense, the focus is on the structural protection e.g. littoral protection from the water that is coming from the ocean.

Criteria to choose final measure(s)

At final, a set of measures is chosen to insure protection of the population and property. These measures were mixture of grey, green and blue infrastructure. The gray infrastructure is presented with protection wall along the coast line of the area. The blue infrastructure is revitalisation of the capacity of the canal Punay. The green infrastructure is using the potential of marches were in consideration is the fact that this area is protected and marked as NATURA2000 site.

Stakeholder involvement in the identification of all feasible, and the final NBS measure(s).

During the event 2010, the whole area was hit and other communities bordering the Les Boucholeurs had significant consequences and damages. In 2011, Mayors of the communities Châtelaillon-Plage, Yves, Fouras-les-Bains and Ile d'Aix joined forces to create a public

structure for the protection of persons and property against the risks of marine submersion: SILYCAF. This union carries an important project of protection and defence against the risk of marine submersion on the 4 communes.

In 2018, this union evolved into a mixed syndicate in which the Communities of Agglomeration of La Rochelle and Rochefort are represented to be in charge of the management of aquatic environments and the prevention of floods. It consists of about forty shares estimated at 42 million Euros, which will have to be completed by 2021.

10.2.2 NBS design

a) NBS design process

Design options considered

As mentioned in the paragraph above the focus is on the coastal protection, having on mind the type of flooding that occurred in 2010. In this case this was a reinforced protection wall, creation of flood alert tools and use of existing green areas, marches that will accept water in cases when it is necessary.

Rationale in the design of the NBS

The rationale in design of the NBS was to use existing structures, do reconstruction and increase capacity of the whole system to accept the strike of upcoming storm surges.

Criteria for selecting the NBS design

There were no several design options in this case.

Stakeholder involvement in the NBS design process

The whole process of construction and reconstruction is under the guidance of already mentioned syndicate SYLICAF.

More details on stakeholder's involvement in the NBS design process are presented in RECONECT Deliverable report D2.1.

b) Selected NBS design

Details on the chosen design for the selected NBS

Rehabilitation of the canal de Port Punay (see Figure 10-2) was done as the first phase of the protection work in the village of Boucholeurs. The work took place between October 2013 and April 2014.

Figure 10-2 Revitalisation of the Canal de Port Punay, Les Boucholeurs

During rehabilitation the canal banks, both left and right, were reconstructed in the 550m length. Also, the rehabilitation of the lock house is done. The total cost for this phase was 800 000 €. The reconstruction of the canal was creation of concrete culvert in the 550m length. The cross section presented in Figure 10-3 and below show the level of rehabilitation.

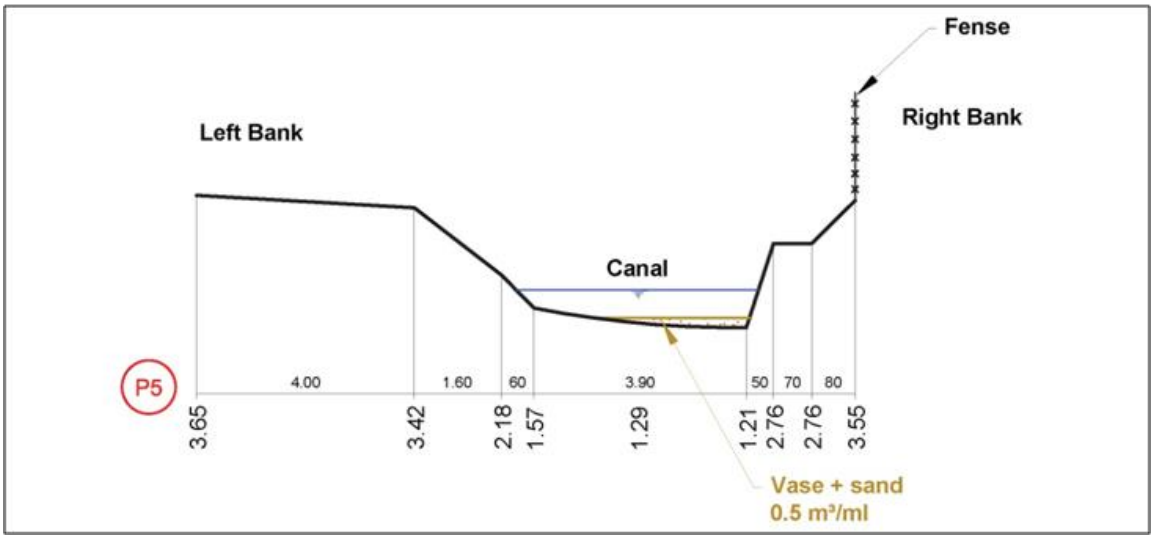

Figure 10-3 Cross section of the reconstructed canal de Port Punay

Next segment in rehabilitation is protection of the north beach of Châtelaillon-Plage. Work was done from spring 2014 to June 2015, where a breakwater was created north of the Châtelaillon coastline and a new beach was born (see Figure 10-4).

The North breakwater is consisted of diorite stones weighing between 1 and 4 tons implanted on 200m long and 20m wide. It is sized to break the swell before it reaches the coast. On the North Beach, in total, more than 80.000 m^3 of sand were brought, behind the breakwater. This project involved a Franco-Dutch company specialized in dredging. The sand was extracted off the island of Oléron 16km from our side, and then pushed back in a pipe laid on the foreshore. Then, a bulldozer was tasked to level the sand as and when. An operation lasted more than 40 days. This project was completed in June 2015 and allowed tourists to enjoy a new beach that has grown to 16.000 m^2.

This protection work has become a real tourist asset for the resort. Amount of works and studies for this section of the protection is 2.4 Million Euros.

Figure 10-4 Breakwater structures located in the ocean close to the beach

The next section was protection works of Les Boucholeurs. The first protection works were carried out in the spring of 2011. This work consisted of reinforcement of riprap along the beach, installation of removable cofferdams at each opening on the sea and raising of 50cm of the wall between the Place André Hesse and the recreational area in Yves (see Figure 10-5).

Figure 10-5 Reinforcement of the protection wall in les Boucholeurs with cofferdams along the walk path

In overall the development made under the PAPI (Programme D'actions de Prévention Contre les Inondations) had a role of marine submersions control device. Under this programe the work done between October 2015 and 2017 was consisted of:

- Strengthening the existing breakwater and creating two new breakwaters
- The linearization of the coastline with the reinforcement of the existing dike and the creation of a bitter maintenance track over 1.6km long from the Boucholeurs port to the Oasis road
- The creation of a runway at the foot of the structure for its stabilization and the passage of shellfish convoys
- Improvement of the rainwater network for the watering of submersion volumes
- The creation of hydraulic cutting works in the marsh
- Rehabilitation of the Port-Punay Canal Outlet
- The installation of removable cofferdams
- The strengthening of the eastern bank of the Port-Punay canal 450m upstream from the Port-Punay road
- Cleansing ditches in connection with the Port-Punay canal
- The creation of anti-submersion walls.

Summary of the cost-benefit analysis for the chosen NBS

Regarding detail cost benefit analysis there are no data available. However work done in Les Boucholeurs up to now is crucial for the population and the action taken to increase protection of infrastructure, property and people are already beneficial. For example after the reconstruction and additional protection of the North beach, the tourist activities become higher and this have the direct influence on economic benefit for the community.

Outline of the operation and maintenance plan

The reconstruction process is not finished yet and no maintenance plan is active. Having on mind that people in this community are very involved for sure the maintenance will be one of the priority.

Outline of the monitoring plan

Les Bouscholeurs project was a case study in two previous related projects:

CRISMA - FP7project (2012-2015) with main focus on modelling crisis management for improved action and preparedness. CRISMA Integration Project focused on large scale crisis scenarios with immediate and extended human, societal, structural and economic, often irreversible, consequences and impacts. Typically, these crisis scenarios cannot be managed alone with regular emergency and first responder resources, but require multiorganisational and multi-national cooperation including humanitarian aid.

The CRISMA project developed a simulation-based decision support system, for modelling crisis management, improved action and preparedness. The CRISMA System facilitates simulation and modelling of realistic crisis scenarios, possible response actions, and the impacts of crisis depending on both the external factors driving the crisis development and the various actions of the crisis management team.

PEARL - FP7 project (2014-2017) The main goal of PEARL is to develop adaptive, socio-technical risk management measures and strategies for coastal communities against extreme hydro-meteorological events minimising social, economic and environmental impacts and increasing the resilience of Coastal Regions in Europe.

Both project had this area as a case study.

Some monitoring activities on (e.g. water level, number of tourists) have been already carried out within Meteo France and tourist organization. Data available will be used as baseline data, to support further assessment of the performance of the NBS. Selected indicators for monitoring will be re-evaluated in the coming months and then the final decision will be made.
The monitoring and evaluation plans, together with the list of indicators, will be presented in detail in D2.6 “Co-monitoring and co-evaluation plans for demonstrators”.

10.2.3NBS Cost evaluation

There is not data available except of the amounts of money given in the description of each segment of NBS reconstruction:

- Canal de Port Punay: 0.8 MIllion Euros
- North beach backwater protection: 2.4 Million Euros
- Protection works of Les Boucholeurs: 11 Million Euros

10.3Procurement of contracts

Contract procurement process/methodology

Process of procurement is done following the national legislation. There is no data available about the evaluation and quality performance for the contracts.

10.4Construction works

The construction works are presented within the section of NBS design.

Operation and Maintenance

At the moment there is no data available yet about the operation and maintenance.

Potential challenges and possible ways to overcome them

Increase importance of existing NBS and the multi benefits. While the engineering approach in protection is still the mayor, the NBS application should be more promoted. The solutions where mixture of grey, blue and green infrastructure is providing protection, additional economic benefit and wellbeing is something that need s further promotion.

IV. Conclusions and Recommendations

11 Synthesis of technical specifications and procurement processes. Lessons learned.

Demonstrators A

The four Demonstrators A are at different stages of preparing / permitting / planning / design activities in their NBS pre-construction phase. While DA4 Portofino is at the start of the construction works (recovery of stone terraces), DA2 Odense is planning to start the construction works in 2020, DA1 Hamburg is in the design phase, DA3 Tordera river basin are still in the phase of the feasibility study and selection of NBS types.

Considering the design of NBS at various Demonstrators' sites:

- DA1 applies a hydrodynamic model to perform a detailed analysis on design options, and impacts of flooding in the current situation. Main stakeholders, the City of Hamburg's and the Borough of Bergdorf, are actively involved in the co-design.
- DA2 has concluded the pre-design stage, expecting to complete the definite design soon, including EIA and final approval of the project in December 2019 – January 2020, and start construction works in March 2020.
- Regarding the NBS project in DA3, a preliminary geometric definition is available of the NBS which has been introduced in the hydraulic models to be able to evaluate their impact in terms of risk reduction.
- DA4 has completed the design of some components (stone terraces), and is carrying out further design on other NBS components.

With regard to public procurement, as of October 2019 DA4 Portofino is in an active procurement process (incl. procurement for delivery of monitoring equipment and services), DA2 (Municipality of Odense) is in process of preparing tender documentation in accordance to national legislation. No contract procurement had to take place at DA1Hamburg, where following the national/local rules the contract has been given to the LSBG. Procurement stage will follow for DA3 Tordera river after the final approval of their NBS project.

There are clear concepts for monitoring, what and where will be monitored by Demonstrators A, who have already pre-selected the NBS Key Performance Indicators. DA1 Hamburg and DA4 Portofino established their preliminary monitoring plans, based on design on both the technical and organisational parts, in parallel with permitting procedures and design works. DA2 Odense and DA3 Tordera river are still in the development phase, and are expected to set their tentative monitoring plans within the coming months.

The preparatory actions, pre-feasibility and feasibility studies, design, and procurement procedures at Demonstrator A sites have been supported by guidance and advice provided by the RECONECT network, in particular by the local experts supporting Demonstrators, but also by other RECONECT partners within the Demonstrators A and B groups. This has been done by:

- bilateral meetings (e.g. between DA1 Hamburg and DA2 Odense, August 2019; between WP2 leaders and DA5 Var River and DA6 Le Boucholeurs, February 2019);

- discussions during collective forums of the RECONECT network (GA meetings, special workshops - e.g. workshop on “NBS Design”, Nice, October 2019)
- E-conferences (e.g. monthly calls with Demonstrators A to discuss NBS project progress), and other.

It has to be stressed also that all the technical and organisational advancement of Demonstrators A has been assisted by the active involvement of local stakeholders who were mobilised with the assistance of RECONECT (details on Stakeholder mapping and stakeholder involvement are available also in Deliverable report D2.1 “Report describing stakeholder (involvement in co-creation) analysis”.

In general it can be concluded that all Demonstrators A have reported successfully upon their NBS technical specifications and procurement processes, as presented in this report. In most cases they are in line with their time schedule for the implementation of the NBS projects. Some delay is reported by DA3 Tordera river, due to some time discrepancy of the planned NBS activities with the official flood risk management plans (FRMP) in the Tordera river basin. It can be expected however that this challenge will be overcome soon after FRMPs are put in place. RECONECT (partners, WP leaders, experts) will pay more attention to this NBS case, providing advice and recommendations, and will contribute as much as possible to speed up the process of finalizing the design and construction of the NBS works.

An indicative graph showing the NBS project progress of Demonstrators A is shown in Figure 11-1.

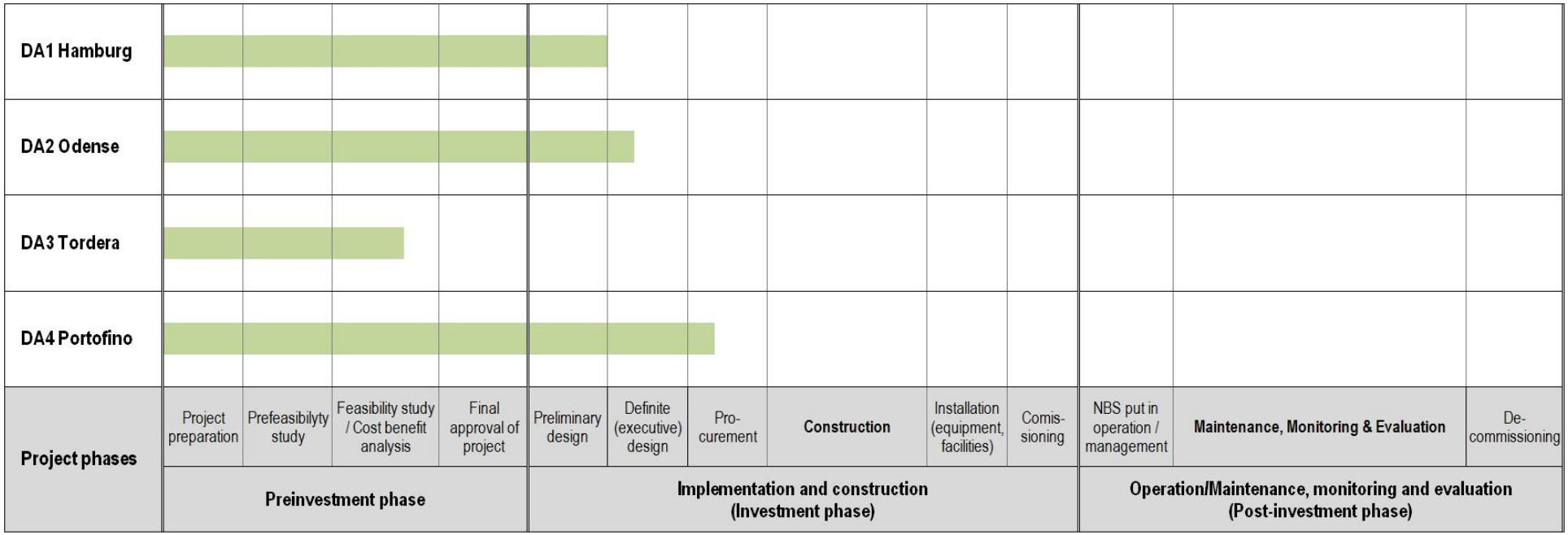

Figure 11-1 Estimated NBS Project progress (technical and organizational advancements) of Demonstrators A, October 2019

Demonstrators B

Demonstrators B are at different stages of their implementation and post-investment stages, as some of the NBS are completed (e.g. Stroomlijn project, DB1 Ijssel river), while others are still quite dynamic, with operation and maintenance on some existing NBS measures and at the same time ongoing design and/or construction works for the new NBS (DB4 Thur river, DB5 Var River).

In all Demonstrator B cases there is control of the technical and organisational planning of the maintenance works, and the monitoring activities, which is a basic condition for the success of the demonstration activities.

Information provided in this report by Demonstrators B concerning design specifications, procurement processes, NBS maintenance planning, and planned monitoring and evaluation is of high importance for Demonstrators A and Collaborators who are following a similar path in their project developments.

It can be concluded that good technical examples have been given in this report and are expected to facilitate further replication and up-scaling of NBS.

It is worth noting that Demonstrators B (as is the case also with Demonstrators A) acknowledge the importance of guidance and advise provided by RECONECT partners, as well as the role and support of the stakeholders, who are actively involved in all phases of the NBS project developments.

An indicative graph showing the NBS project progress of Demonstrators B is shown on Figure 11-2.

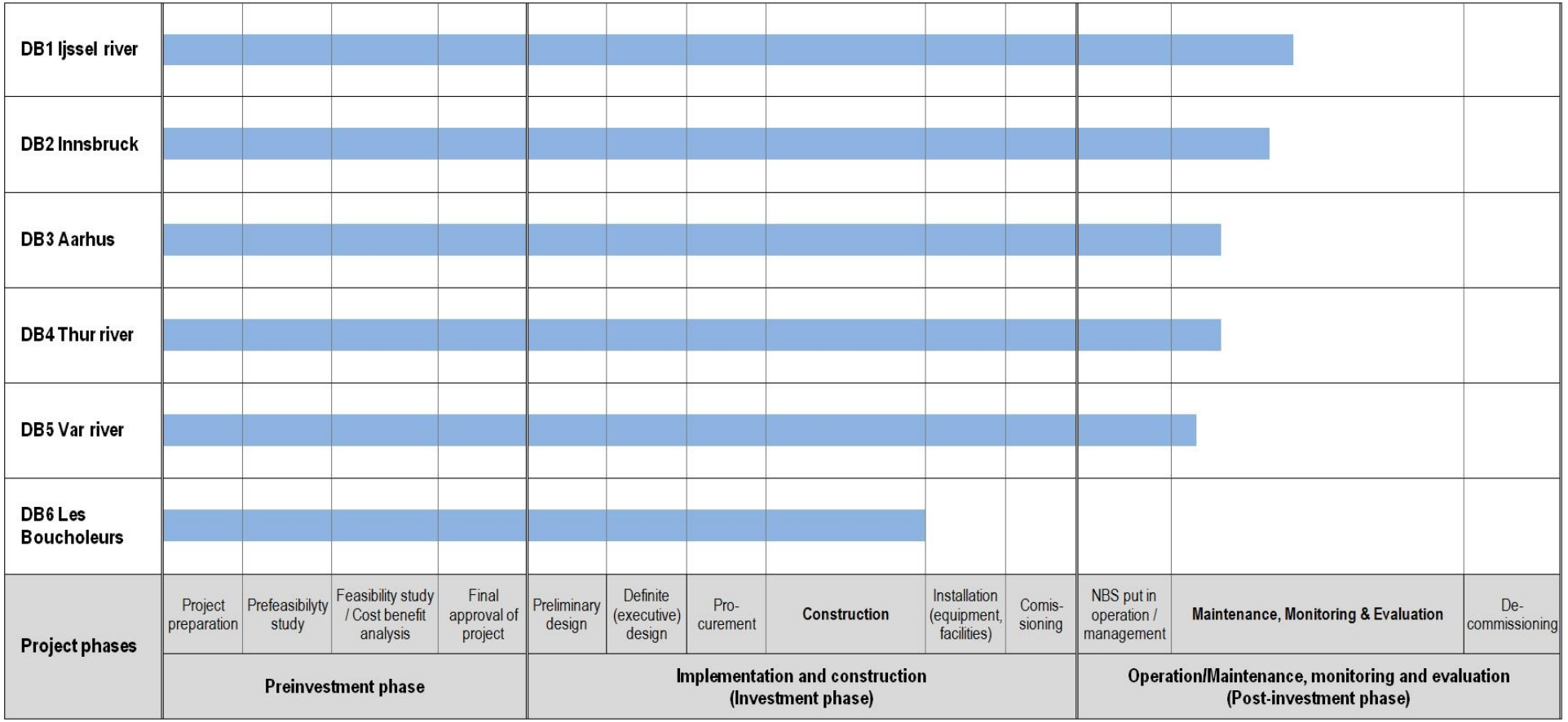

Figure 11-2 Estimated NBS project progress (technical & organizational advancements) of Demonstrators B, October 2019

Based on the considerations presented above, at the end of the first year of the RECONECT project, some common characteristics as well as some significant differences can be identified between the NBS types / technical solutions, or the procedures applied in the different countries by both demonstrators A and B

Regarding technical specifications/procurement process, the difference in involvement of landowners as main stakeholders in the NBS demonstration cases needs to be highlighted. In the case of DB1 Ijssel and DA2 Odense, landowners were intensively consulted and involved, leading to some sort of compensation for their land. DA-3 Tordera is on the same path where they are in contact with stakeholders and are going to find appropriate way to compensate them in the future. Regarding the other demonstrators, in most cases the State authorities do the decision-making without intensive consultation/involvement of specific landowners, as the authorities already own the land. In DB-2 Aarhus for example, the municipality was the new landowner of Lake Ega as a result of land consolidation, while another key stakeholder is local wastewater company Aarhus Water A/S which owns 6 out of 12 sub-projects of the area in the case of Lystrup. DA4-Portofino park for example is a “public body” under specific ownership, which also differs from the other Demonstrators.

The technical specifications provided by the Demonstrators indicate that some of them are planning, or have already established, identical or similar technical measures. It can be argued that (with some minor exceptions) most demonstrators adhere to the NBS types already proven in practice, such as slopes stabilization, reconstruction of canal banks, planting trees/bushes/vegetation, removal of dikes, re-meandering of streams, etc. An exception is for example the case of Portofino (see section 4 above), where very specific local solutions are applied, that can only be replicated in very similar terrain and climate conditions. Table 11-1 illustrates the concurrence of NBS technical solutions applied by different Demonstrator’s at their NBS sites - that is a basis for sharing information and experience, as well as for twinning between Demonstrators Type A and B.

Table 11-1 Common NBS Technical solutions applied by Demonstrators

№	NBS Technical Measures / Construction works	Planned by Demonstrators A	Implemented by Demonstrators B	Bilateral Twinning Potential, DA ↔ DB based on technical solutions (matches)
1.	**Construction of retention area, rain beds**	DA1	DB1, DB3	**DA1↔DB1 (2)** **DA1↔DB3 (1)**
2.	**Real time controlling system, flood alert tools**	DA1	DB1, DB6	
3.	**Removal of vegetation, removal of hedges and hedgerows, cleansing ditches**	DA2	DB1, DB6	**DA2↔DB3 (4)** **DA2↔DB6 (3)** DA2↔DB1 (2) DA2↔DB4 (2)
4.	**Re-meandering of streams, restoring gullies/trenches**	DA2	DB1, DB3, DB4	
5.	**Removal/excavation of dikes or other engineering structures**	DA2	DB3, DB4, DB5	
6.	**Construction of new dikes or other engineering structures**	DA2	DB3, DB6	
7.	**Construction of new specific zones (recreational - beaches, or biodiversity - birds islands, etc)**	DA2	DB3, DB6	

	Technical Measures / Construction Works to be decided	DA3	All DBs	tbd
same as 3.	**Removal of vegetation, removal of hedges and hedgerows, cleansing ditches**	DA4	DB1, DB6	**DA4↔DB2 (3)** **DA4↔DB4 (3)** DA2↔DB1 (2) DA2↔DB6 (2)
8.	**Planting trees/bushes/vegetation**	DA4	DB1, DB2, DB4	
9.	**Terraces restoration, Re-building/maintenance of protective walls**	DA4	DB2	
10.	**Slopes stabilization, reconstruction of canal banks**	DA4	DB2, DB4, DB5, DB6	
11.	**Drainage systems, creating bypasses, pumping stations demolition**	tbd	DB1, DB2, DB3	n/a

Within Task 2.4 (and the present report) some specific information on legal issues and procurement procedures has been collected, concerning design and constructions works (for Demonstrators type A), as well as maintenance, monitoring and evaluation of NBS in demonstration areas (for Demonstrators A and B). Specifics of the national legal / permitting process, as well as procurement practices followed by Demonstrators was studied in the very early stage of the project (month 1 to 6) within Task 2.5, and the information provided by Demonstrators was analysed and presented in deliverable report ***D2.5: Report describing preparatory actions for Demonstrators A and B with copies of building permits/permissions of uses / commissioning works***, where some conclusions and recommendations were given. The focus was on Demonstrators B, where the permitting process for the construction phase have been already completed.

The analysis of information on legal/permitting process and procurement procedures carried out in Tasks 2.4 and 2.5 shows that it is difficult to indicate some "unified" approach in issuing permits, or in organising procurements, due to the fact that the issuance of permits and the organization of tender procedures is an exclusive function of the national legislation that can be quite different in different states (even being members of the EU). Some quite wide variation of price thresholds for organizing of open tender, or single tender procedures, as well as of the conditions for negotiated tenders (single supplier), have been reported by Demonstrators. The terms and deadlines for obtaining permits are also quite variable, depending on local rules, and most of all of the specifics and unique character of some of the selected NBS.

Detailed information on permitting can be found in Tables “Summary information on procedures and/or permits” in each Demonstration site (deliverable report D2.5).

Considering that there are standard criteria often used in EU countries to evaluate proposals regardless of project type (such as timeline, budget, relevant experience, and organizational and staffing capabilities of prospective consultants), it is worth to emphasize that new solutions to water management and reducing hydrometeorological risks like NBS call for new procurement and administrative processes. The most common selection criteria used in Demo cases–the low cost option may result in low-quality solutions that do not fully address the needs, and may not deliver the advantage of multiple benefits and the adaptability that offers the greatest lifecycle of an investment. Recommendation for up-scaling NBS is to follow a holistic, integrated management approaches that satisfy the diverse needs of the stakeholders in order to fulfil all goals and sub-goals. This is why it is crucial to create a procurement process that focuses on the best possible solution for the specific case first, before negotiating details to suit unique circumstances. A competitive proposal process in which the most qualified provider is selected, and price is not used as an initial selection factor should be preferred. Once the most qualified provider is selected, then negotiations for fair and reasonable compensation of professional services can follow.

Within RECONECT the NBS cases have access to effective selection process providing wide-ranging expertise being in contact with an advisory group with members of varying expertise that can help inform and assist the selection in making the best decision possible.

A comprehensive approach on selection of criteria (evaluation process) applicable for NBS cases is presented by Leung et al. (2018), giving different weight of Technical approach, Specialized experience, Personnel, Quality assurance and quality control. This approach can be used as general guidance for procurement process, as well as for further upscaling of solutions demonstrated by RECONECT.

Information collected on technical specifications and procurement processes will be further complemented and analysed within WP5. A *"Catalogue defining regions with comparable demands and characteristic features of NBS"* that will be delivered in month 50 within WP5.

12 Conclusions and Recommendations

Summarising the information provided by Demonstrators on technical specifications and procurement processes at their NBS demonstration sites, as well as on the involvement of RECONECT partners and stakeholders in co-design and co-implementation processes, the following main conclusions are derived:

- All Demonstrators, being assisted by RECONECT partners and advised by stakeholders, have put due efforts in relevant project activities (planning and design for Demonstrators A; maintenance, monitoring and evaluation for Demonstrators B), and have provided the requested information on the technical specifications and procurement processes, presented above in their individual reports (Sections II and III of this report). The information and details on technical specifications and procurement processes presented in this report give the reason to conclude that that the RECONECT demonstration activities runs in line with the time plan set for the overall project as per the DoA.
- Based on the information provided by the Demonstrators A and B, a synthesis is made in order to assess current progress of NBS projects, and identify lessons that can be learned in terms of technical specifications and procurement processes for a NBS. The synthesis is presented in this report separately for demonstrators A and B, giving an assessment of the current state of their NBS demonstration activities. It can be concluded that all Demonstrators A and B are in line with their time schedule for the implementation of the NBS projects.
- Both Demonstrators A and B are at different stages of their NBS implementation, and they already started using of the high potential for knowledge sharing and interaction between them. In this way, the Demonstrators A benefit and are inspired by RECONECT ideas by having close exchange with the Demonstrators B and the NBS experts. The next step twinning of demonstrators is underway, providing necessary basis for further up-scaling of NBS for reducing hydro-meteorological risks.
- In most of the Demonstrators, in particular of the A type, the co- benefits of NBS are now regarded in a holistic manner, covering the different dimensions (WATER, NATURE, PEOPLE) within a comprehensive monitoring and evaluation strategy, and focusing on the multiple benefits of NBS - that is being relevantly addressed by Demonstrators in the technical design, preparation of construction works, planning of maintenance and monitoring activities. It must also be addressed that with new gained insights and projects' dynamics, monitoring indicators may change / evolve in time.
- One of the most important conclusions in this report is that the Demonstrators together with RECONECT team managed to achieve the desired involvement of key stakeholders in the co-design and co-implementation processes, starting with discussions on technical specifications and procurement processes, as presented in this report (and demonstrated also in report D2.1 "Report describing stakeholders involvement in co-creation").

Based on the synthesis of technical specifications and procurement processes for Demonstrators A and B, and assessing the involvement of the project partners and stakeholders in co-creation processes of NBS in Demonstration sites, the following recommendations and future actions are suggested:

- Building upon involvement of key stakeholders and RECONECT experts, and exploring the collected Information on NBS selection process, technical design, construction works,

as well as on the specifics on the procurement process for NBS projects (as presented in sections II. and III.), this report marks the successful start of the co-design process of providing guidelines to the Demonstrators for design, implementation and maintenance of NBS in order to optimize the multiple benefits of NBS. Further development and update of such guidelines will take place within Work Packages 1, 3, 4 and 5, in accordance to the work plan of RECONECT, providing a number of supporting tools and documents which will be produced within RECONECT framework to assist potential developers willing to implement NBS:

- The knowledge and experience gained by demonstrators in optimizing the multiple benefits of NBS, shall be used in WP1 to provide a ***Guidance document on integrating innovative technologies into existing landscape, maintenance issues and long-term sustainability*** (deliverable report D1.4, month 30)
- Collected input of Demonstrator's as presented in this report will be used to facilitate development of the ***Catalogue of NBS Measures for reducing Hydro-Meteorological Risk***, as well as of the ***Multi-Criteria Analysis (MCA) tool*** that will be used for screening criteria process and selecting applicable NBS measures at Collaborators' cases in WP4 (Deliverable report D4.2, *Report describing baseline assessment and potential for NBS in Collaborators*, month 26)
- Collection of technical specification information is going to continue, and will serve as a drive tool to advise further development of Draft ***Standards for design, maintenance, management of NBS*** that will take place within WP5 (deliverable report D5.4, month 50)
- All the above mentioned upscaling-related RECONECT developments will be presented to, and discussed with, potential stakeholders within Task 6.3 ***Develop and deliver a MOOC (Massive open online course)***, as well as within Task 6.6 ***Organize and conduct National Workshops in each Demonstrator and Collaborator cluster*** (months 50-60).
- Further promotion of good practices and study of best examples will be carried out in parallel with the development of the NBS demonstration projects, and finally the consolidation of the RECONECT ***Guidelines for design, construction and maintenance of large-scale NBS*** will be done (deliverable report D2.8, month 60), which will serve as a valuable tool for developers of future NBS projects, and basic tool to support NBS upscaling.

- In parallel to the support of the individual actions of Demonstrators, comprehensive collective coordination activities have to be undertaken to provide relevant exchange of experience, use of available knowledge, taking advantage of "*good practices*" and avoiding "*bad examples*". A series of thematic workshops (on Social Innovation, Monitoring, Maintenance, etc.) will take place during next GA meetings - following the good experience of the 2 workshops on "Design of NBS" and "Collaborator's Workshop", organised during the 3rd GA meeting in Nice in October 2019; A series of webinars and meetings are planned within the framework of the twinning process in order to provide sharing of experience, support and advice, and to achieve timely delivery and accomplishment of planned tasks on design and constructions (for Demonstrators A), as well as on maintenance, monitoring and evaluation (for both Demonstrators A and B).These, together with already running co-design and co-implementation activities - with active involvement of stakeholders - will provide the relevant contribution for successful implementation of the planned RECONECT demonstration activities.

- It is important to emphasize how decisions will be made on the final choice of NBS type and on the construction/implementation technologies, at Demonstrator's A, as well as at Collaborator's sites. Based on the synthesis of the information provided by Demonstrators within this report, the following co-creation approach is advised to support the decision-making process in the NBS case:
  - provide active participation / involvement of the key stakeholders possessing knowledge and good understanding of local specifics;
  - raise the awareness and capacity of local decision-makers upon NBS (here the role of RECONECT can be of crucial importance)
  - provide transfer of the experience (lessons learned), and the know-how available at completed NBS projects (Demonstrators Type B), as demonstrated in RECONECT exploring the already started "twinning" process between demonstrators A and B, as well as between Demonstrators and Collaborators.
  - use the "RECONECT tools" (various tools developed within RECONECT project), such as the NBS Catalogue of measures & services, the Standards for design, maintenance, management of NBS (D5.4), and the Guidelines for design, construction and maintenance of NBS (D2.8).

The above approach has the potential to facilitate building a compelling business case for increased ecosystem health/resilience, and for the use of NBS to deliver it.

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