Baseline assessment: demand and supply analysis

Deliverable D2.2

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Abstract (for dissemination, 100 words)	This reports presents the results of a Demand and Supply Analysis we conducted in order to assess the general demands of demonstrators A and B with regard to aspects relevant for the realisation of NBS. The Demand and Supply Analysis forms the basis of all upscaling activities in RECONECT. Within the RECONECT project context, scaling-up is made operational by means of so called twinning activities. The document provides an overview on the demands of all demonstration A and B sites and

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Executive Summary

This report presents the results of a Demand and Supply Analysis we conducted in order to assess the general demands of demonstrators A and B with regard to aspects relevant for the realisation of NBS. The Demand and Supply Analysis forms the basis of all upscaling activities in RECONECT. Within the RECONECT project context, scaling-up is made operational by means of so called twinning activities. Therefore, we organise forms of collective twinning centring on topics of high relevance for a larger group of partners as well as rather bilateral forms of twining that are organised around demonstrators that share similar characteristics and demands and that face similar challenges. The document provides an overview on the demands of all demonstration A and B sites and makes also first suggestions on how to structure twinning activities within the consortium.

This report is designed to address two audiences. The first includes project partners within RECONECT. Second, the report can also be interest to researchers and practicioners beyond RECONECT who are engagend with various aspects related to the realisation of NBS.

Contents

List of figures

List of tables

Abbreviations

AAKS	Aarhus Kommune
ACA	Agencia Catalana del Aigua/Catalan Water Agency
BUE	Behörde für Umwelt und Energie Hamburg
CNR	Consiglio Nazionale delle Ricerche Italy
DRR	Disaster Risk Reduction
Odense	Municipality of Odense
DTES	Department of Territory and Sustainability of Catalonia
DTU	Technical University of Denmark
EAWAG	Swiss Eidgenössische Anstalt für Wasserversorgung, Abwasserreinigung und Gewässerschutz
EU WFD	European Union Water Framework Directive
(EU) FD	(EU) Flood Directive
FHH	Freie Hansestadt Hamburg
GISIG	Geographical Information System International Group
HYDS	Hydrometeorological innovative solutions
LSBG	Landesbetrieb Straßen, Brücken und Gewässer Hamburg
NBS	Nature Based Solution
OIN	Operation d´interet national France
RECONECT	Regenarating ECOsystems with Nature-based solutions for hydrometeorological risk rEduCTion
TUHH	Technische Universität Hamburg
UFZ	Helmholtz Zentrum für Umweltforschung Leipzig
UIBK	Universität Innsbruck
UNSA	Universität Nizza Sophia-Antipolis
WLF	Wildbach- und Lawinenverbauung Österreich

1 Introduction

This reports presents the results of a Demand and Supply Analysis (DASA) we conducted in order to assess the general demands of demonstrators A and B with regard to aspects relevant for the realisation of NBS. Demands are often a result of lacking capacities, challenges or barriers that demonstrators have identified and which they would like to overcome. While some demonstrators might for instance want to better understand how to assess different options for mitigating risks related to hydro-meteorological hazards or how to design a specific NBS within a given context, other demonstrators might want to learn more from good practices on how to overcome public resistance to NBS to mitigate flood risks. At the same time various project partners, including demonstrators, collaborators and others, have a specific expertise or had particularly experiences they would like to share with others. Therefore, this report documents both what demonstrators need with respect to a more effective realisation of NBS as well as what they and others can supply to enhance demonstrators' capacity to realise NBS.

This report is designed to address two audiences. The first includes project partners within RECONECT. Second, the report can also be interest to researchers and practicioners beyond RECONECT who are engagend with various aspects related to the realisation of NBS.

The following sections provide a description of the methodology used to conduct the DASA and present the validated results of the anlysis together with the suggested twinning activities.

2 Methodology

This section describes the methodology underlying the DASA. Figure 2.1 provides an overview on the steps there were taken to produce this report. This included a scoping survey specifically tailored to the needs of D2.2, a workshop session focusing on demand and supply (DAS) as well as semi-structured interviews with all demonstrators. The methodologies and how they are linked to RECONECT' social innovation approach are described in D.1.2. Based on the outcome of the scoping survey, the workshop session, semi-structured interviews the DASA analysis was conducted resulting in a first set of preliminary results, which were then further substantiated by taking into account the insights from other scoping survey produced for D2.3, D2.4 and D2.5. This resulted in the results of the DASA as well as in specific suggestions on how to organise the twinning activities in RECONECT. Both the results of the DASA analysis and first suggestions for the twinning process were presented and validated during another workshop session with all relevant partners. Based on this step, the DASA was finalised and twinning activities specified which are presented in this deliverable. In the next section, the single steps are explained in more detail.

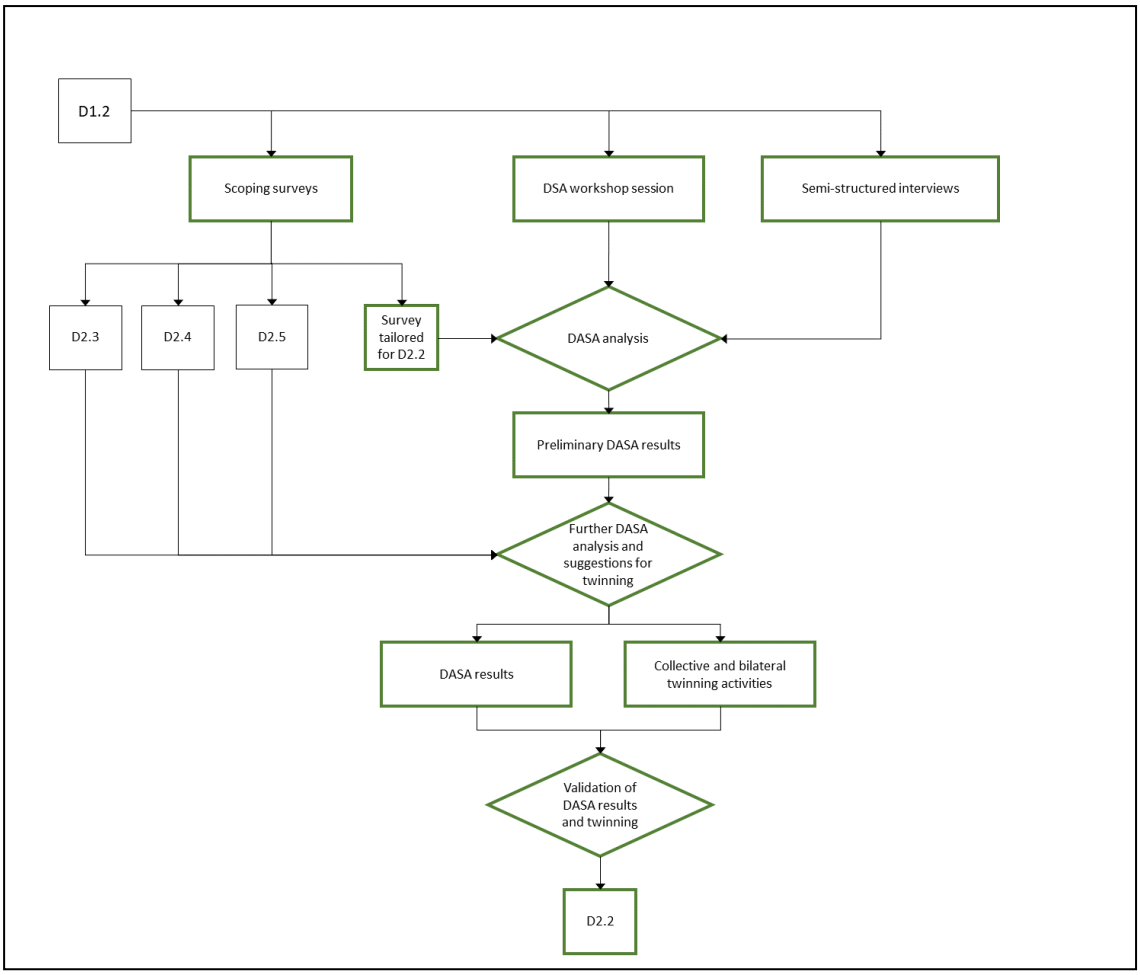

Figure 2.1 Overview on single steps underlying the DASA

2.1 DASA structure

Any demand and supply analysis requires the d definition of some kind of **backbone-structure** along which the demands and supplies can be structured and assessed. The DASA in RECONECT is organized with respect to the management of NBS comprising the phases of (1) assessment, (2) design, (3) implementation, (4) operation and maintenance, (5) monitoring and evaluation of NBS. At the same time, we also considered the wider management context and how it shapes decision-making processes. Therefore, the DASA also considers governance aspects which have been identified as relevant for RECONECT. This includes (6) participation, (7) barriers, (8) upscaling, (9) adaptive governance and (10) other topics[1]. With respect to all ten topics, the need of demonstrators was collected as well as topics they can supply expertise to others. In addition, we also asked demonstrator A with which other demonstrators they would like to exchange more intensively on a bilateral level in order to stimulate exchange, and peer-to-peer learning. Furthermore, all other project partners were asked what kind of expertise they can supply to others.

In order to better understand the needs of demonstrators, we also include an **analysis of demonstrators' capacities** to realise NBS (including their working routines, previous experience, motivational, financial as well as knowledge related aspects) (Kuhlicke et al., 2011). By highlighting key aspects related to the **political and regulatory context** as well as with respect to the **wider social climate with respect to the realisation of NBS**, we also develop a better understanding of how regional, national as well as European policies and legislations, trust in responsible organizations, or the general acceptance of NBS as a way to reduce hydro-meteorological risks may support or hinder the realization of NBS in the Demonstration sites. The results are presented with respect to the political and regulatory context as well as with respect to the wider societal climate, and represent a preparatory step, as a more thorough analysis of supporting and hindering factors will be conducted in Task 4.6. Results will be presented in deliverable D4.6.

The outcomes of the DASA are based on the methods and topics described in the following subsections.

2.1.1 Scoping surveys

A scoping survey, which was specifically tailored for this deliverable, was conducted among all demonstrators was conducted in a first step. This scoping survey was semi-standardized and focused on the following topics (see Table 2.1): Understanding the objectives and motivations of demonstrators to participate in RECONECT, getting a first overview on what kind of NBS they are focusing upon and which risks they dress as well as tasks they consider as particular relevant within RECONECT, other demonstrators/collaboratrs they would like to exchange with more intensively as well as expertise and lessons learned they can supply to other demonstratros.

[1] We would like to point out that the backbone structure presented here has been advanced since the proposal stage. During the proposal stage a more narrow focus was envisioned, at least partially. During the assessment of needs of Demonstrators it turned out that there was no need to exchange with respect to local and national strategies, performance standards, operational guidelines and life-cycle costs. They were therefore not included. The thematic structure presented here is more encompassing and comprehensive and was considered as more useful for all project partners involved in the demand and supply analysis.

Table 2.1 Topics and questions of the first expectation survey

Topic	Questions
Objectives and motivation	• What objectives does your institution/organisation/company aim to achieve through your involvement in the RECONECT project (e.g. in regards to the outcomes of the project, the interaction with other partners, potential to learn new skills, etc.)? Please provide your three top objectives. • Why did you choose a nature-based solution (NBS) over other potential solutions?
Information on NBS and risks addressed	• What makes your project a NBS? • Please list the NBS technologies that you have implemented/plan to implement in your demonstration site. • Which stage of the implementation is your demonstration site at? (e.g. design, permission, planning, construction, etc.) • What risk are you trying to/did you manage by using NBS? • Please rate the relevance of the following (potential) co-benefits for your NBS (1= not relevant and 5 = very relevant): Climate resilience, water management, air quality, green space management, coastal management, urban regeneration, participatory planning and governance, social justice and cohesion, public health and wellbeing, green jobs.
Cooperation, demand and supply	• Are there any tasks within any of the WPs that you feel are of particular relevance for your demonstration site? Please provide a short explanation? • Please list any specific demonstrators/collaborators with whom you would like to exchange with at this stage of the project. Please provide a short explanation. What information would you like to receive from these sites? • What type of expertise/lessons learnt (e.g. in regards to NBS implementation and evaluation) can your demonstration site provide other demonstrators and collaborators with?

In addition, previous outcomes from other scoping surveys conducted to produce deliverables D2.3, D2.4 and D2.5 were also reviewed as they provide additional information for the DASA and for structuring the twinning activities.

2.1.2 DASA workshop session

A DASA workshop session was conducted during the second General Assembly (GA) meeting at Zwolle (May 2019). To safe budget and resource, the session was organised during the GA to take full advantage of the presence of almost all project partner and **it focused in collecting the demands as well as supply of all participating project partners** (Results for collaborators will be presented in D4.4).

The session started with a general introduction to the idea of 'twinning' and how it was intended to be made operational in the specific context of RECONECT. This included also a generic

definition, and the potential benefits of twinning activities. In a next step the specific objectives of the session were briefly introduced (see Figure 2.2).

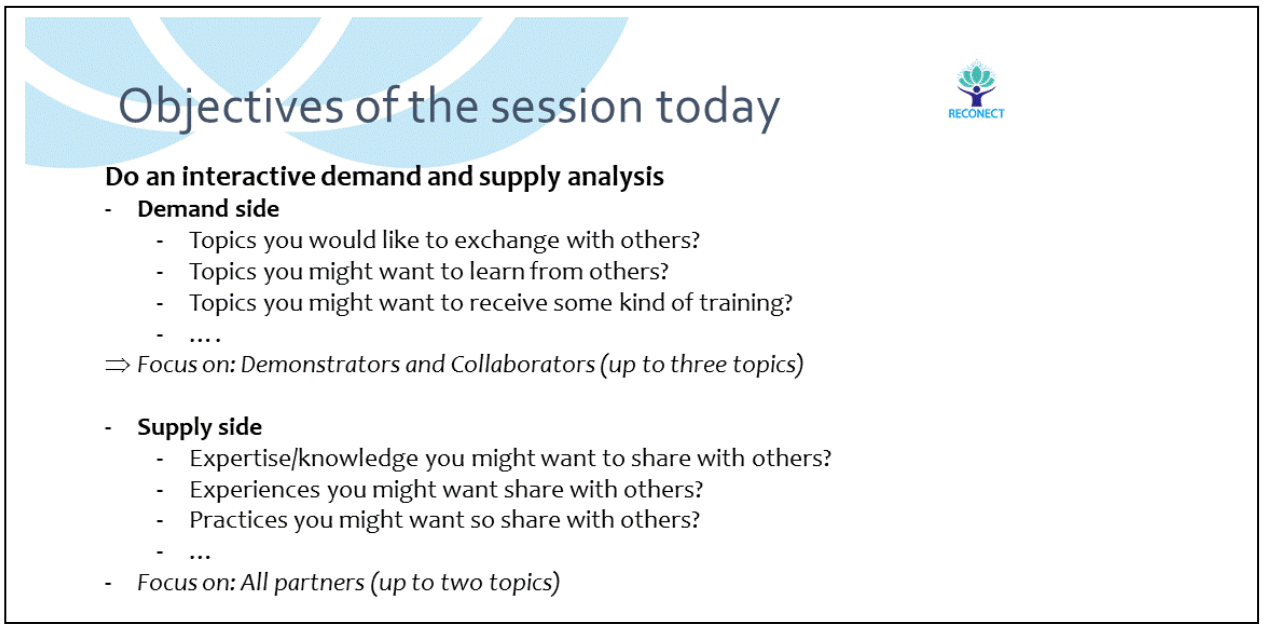

Figure 2.2 Objectives of the DASA workshop session

In a next step the backbone structure of the DASA was presented by providing some examples on the different phases of the management and goverance cycles.

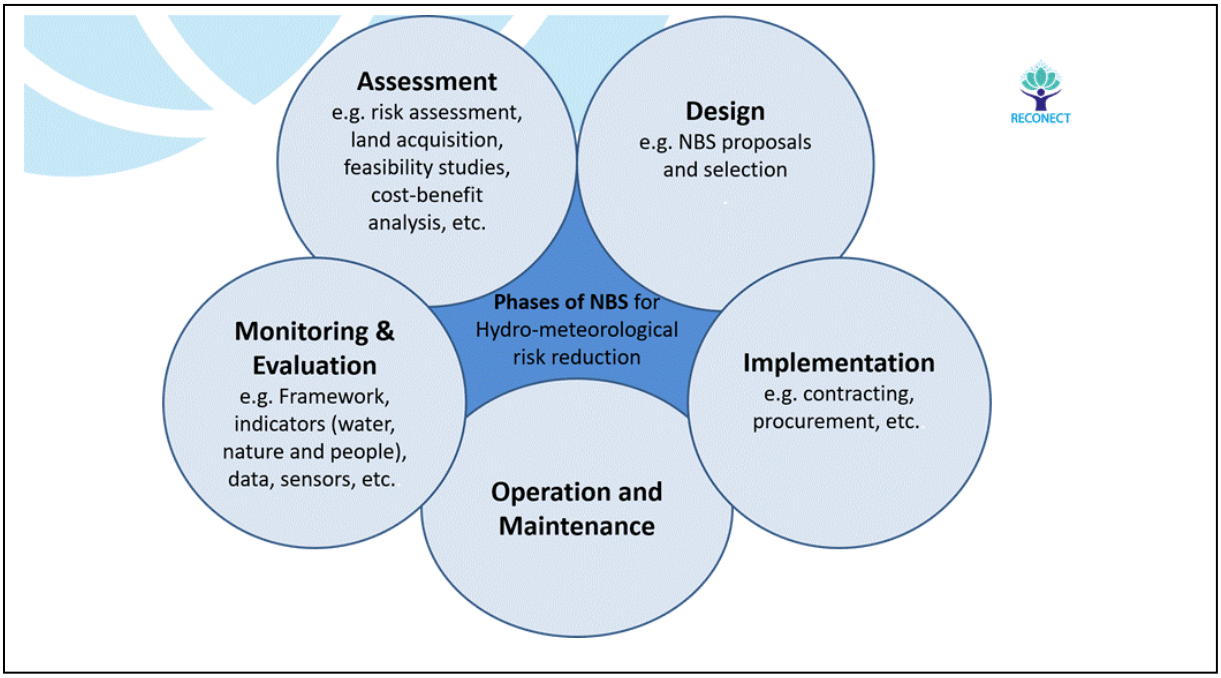

Figure 2.3 Phases on realising NBS

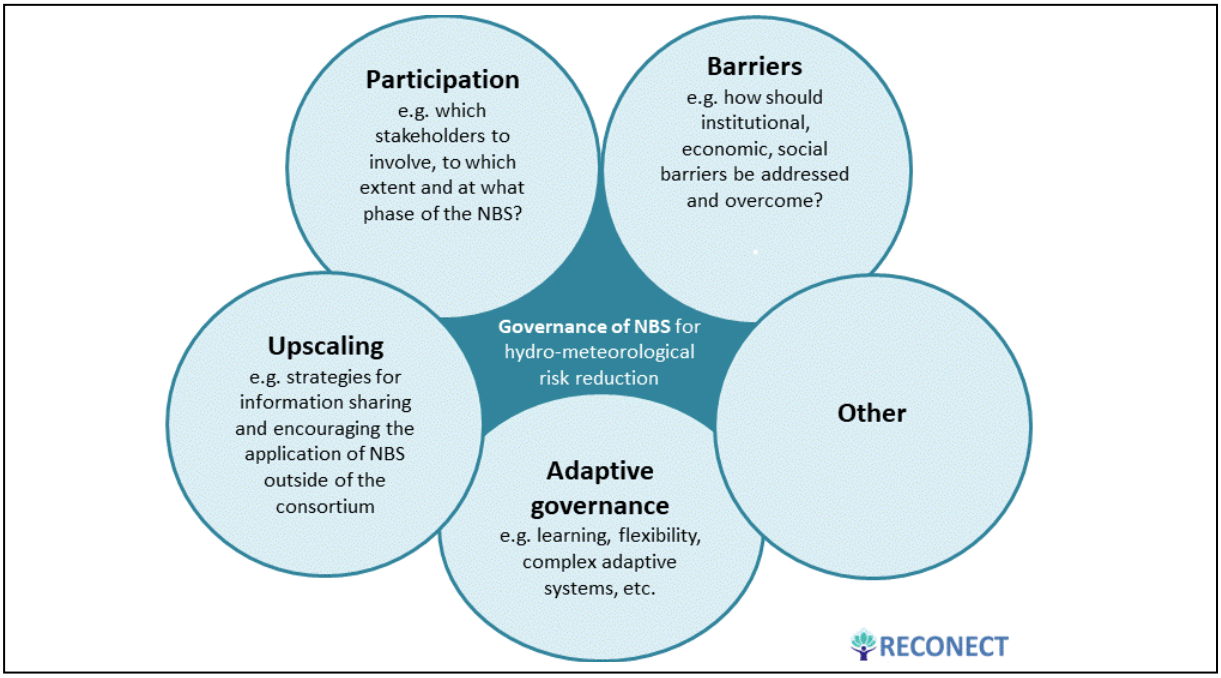

Figure 2.4 Key governance topics for NBS

In a next step, all demonstrators and collaborators had a chance to look at posters prepared by all demonstrators and collaborators to get an overviews on the kind of expertise that is provided by them. In a next step, all demonstratros were asked to present three topics they would like to exchange with others by stating their knowledge needs along the stages of the NBS project cycle (i.e. assessment, design, implementation, operation and maintenance, and monitoring and evaluation) as well as for the wider governance context.

During this session, all projects partners were also asked to identify topics they could provide expertise to others (i.e. expertise/knowledge, experiences, and practices they might want to share with others). Demands and supplies were written down on cards and pinned to a white board with the management and governance cycle in the background.

Through this collective and highly interactive format, we were able to create transparency among all members of the consortium as the results produced are immediately visible to all participants at the white boards. Figure 2.5 provides an image of the workshop setting. Through this open session, individual members of the session were enabled to better understand their single contributions to the project and to identify topics which appear of high relevance to a larger group of participants. At the same time, it highlighted needs that are of high relevance for single partners (or a smaller group of partners). Based upon this workshop session, we identified needs/supplies of single partners, of demonstrators A and B.

Figure 2.5 Picture taken during the DASA workshop session

2.1.3 Semi-structured interviews

Semi-structured interviews were conducted among demonstrators before, during and after the General Assembly meeting in Nice (Sept/Oct 2019) in order to develop a more detailed understanding of the reasons underlying the demands expressed by demonstrators. Therefore an interview guide was developed that focused on demonstrators' **capacities to realise NBS** (i.e. pervious experiences, motivational, financial and knowledge-related aspects) as well as r**elevant national and local/regional policies and barriers that demonstrators have faced already or might face in the future.** This included also a validation of the needs expressed in previous rounds (e.g. the expectation survey and the DAS workshop session).

Table 2.2 Topics and questions of semi-structured interview guide

Topic	Questions
Previous Experience and Capacities	• Previous [before RECONECT started as a project] experience with regard to realizing NBS (personal/organizational)? [personal/organisational]; If yes, which experience? • How high/low is your organisation's motivation to realise NBS? [please provide a short explanation] • How high is your organisation's commitment to realise NBS? [please provide a short explanation] • How high is the interest from elected public officials in realising NBS? [please provide a short explanation] • Other relevant actors? [please provide a short explanation] • How well is your organisation financially equipped to realise NBS? [please provide a short explanation] • How well are you equipped with staff members and other personnel to effectively realise NBS. [please provide a short explanation] • What is the relevance of realising NBS in your day to day business in comparison to other tasks of your organisation? [please provide a short explanation] • How relevant/knowledgeable are you/your organisation with respects to the different phases of the management cycle? [assessment, design, implementation, operation/maintenance, monitoring/evaluation] [please provide a short explanation]
Policies	• Please name relevant European, national/regional/local policies that support the uptake of NBS in your pilot site [list of relevant EU policies was provided]
Barriers	• Did you experience so far any barriers in realising NBS and/or do you expect barriers in the future [barriers can by institutional, economic, legal, cultural etc.)?
Needs	• Next to the needs you mentioned already (e.g. expectation survey, workshop session), are there additional needs you have with regard to the realization of NBS?

2.1.4 Validation of results and of twinning activities

In a final step, all results that were produced based on the outlined methodologies were presented, discussed and validated with relevant projects partners during the third General Assembly (GA) meeting at Nice (Sept/Oct 2019). To safe budget and resource, the session was organised during the GA to take full advantage of the presence of almost all project partner. The validation was organised in the following way: First the results of the DASA were presented. In a next step feedback was collected. In addition, first ideas on the twinning actitivies were presented, including bilateral and collective forms of twinning. These activities were intensively discussed. Thereafter clear responsibilities were established and all relevant project partners agreed on a timeline. The outcome of these activities are presentex in section 3.

2.2 From DASA to twinning activities in RECONECT

The DASA forms the basis of all upscaling activities in RECONECT. Within the RECONECT project context, scaling-up is made operational by means of so called **twinning activities**.

The idea of twinning looks back at a relatively long history and is particularly prominent among cities and towns. It is based on the idea that cities with similar characteristics (e.g. demographic situation, economic prosperity) and that face similar challenges (e.g. shrinkage due to demographic change) pair so that they share experiences and develop solutions jointly.

In RECONECT, a broader perspective on twinning is pursued. Restricting twinning to single partners would result in exchange processes that might be too limited and too specific considering the thematic width of the project. Therefore, in RECONECT twinning means to bring together partners that face similar challenges/demands with regard to implementing NBS for hydro-meteorological risk reduction. Twinning activities therefore aim at initiating a substantive exchange of experience, information, expertise, and good practice across cases. This can include the substantive exchange among a small group of partners, but it can also include a rather loose exchange among a larger number of project partners. The ambition of twinning activities is to produce knowledge and expertise and to enhance the relevant capacities of demonstrators for the realization of NBS. Outcomes of twinning can take many different forms, including mutual site visits and exchange among partners, joint workshops dedicated to specific topics, webinar series dedicated to a series of topics, and capacity building and training activities, but also short written reports on specific topics.

Therefore, we will organise forms of **collective twinning** centring on topics of high relevance for a larger group of partners as well as rather **bilateral forms of twining** that are organised around demonstrators that share similar characteristics and demands and that face similar challenges. The different twinning activities can result in different means for how to make them operational. While activities centring on demonstrators might rely on mutual field visits and two-day workshops, collective twinning activities can be based on webinars, workshops, and training activities.

3 Results

The objective of this section is to provide an overview of the demands that demonstrators have identified with regard to the realisation of NBS as well as that kind of expertise and knowledge they and other partners in the consortium can supply. The outcome of the analysis is the basis of matching demonstrators with specific demands with partners that are able to supply expertise. The results presented here are a summary of the collective findings of the scoping surveys, the DASA workshop and the interviews described in Section 2.1. The detailed case by case responses to the scoping survey for D2,2 and questionnaire are presented in Appendices A and B. In this section, the summarized results are presented. In addition, information on demand and supply of demonstrators from D2.3, D2.4, and D2.5 are also presented.These results forms the backbone of mutual exchange and learnings within the project. First suggestion on how to set-up this process by means of bilateral and collective twinning activities are provided at the end of this section. The first section will focus on demonstrators A, followed by demonstrators B. The final section provides suggestion on how to organise the twining process.

Figure 3.2 provides a simplified and synoptic overview of the outcomes of the demand and supply analysis based on the general phases and challenges related to the realisation of NBS. It includes the information provided by demonstrators as well as other project partners. The information derrived from different steps in the DASA and includes information provided during the workshop session, information provided in the expectatoin survey for D2.2, information provided during the interviews. In addition, we also took into account information provided in other suveys and which are documented in D2.3, D2.4 and D2.5. The bars in darker colours are based on the DAS workshop session conducted at the GA in Zwolle. They are based on how often a specific topic was noted on a post-it during the workshop session (see Figure 3.1 for an example) The more often a specific topic was noted during the workhop, the larger the bar.

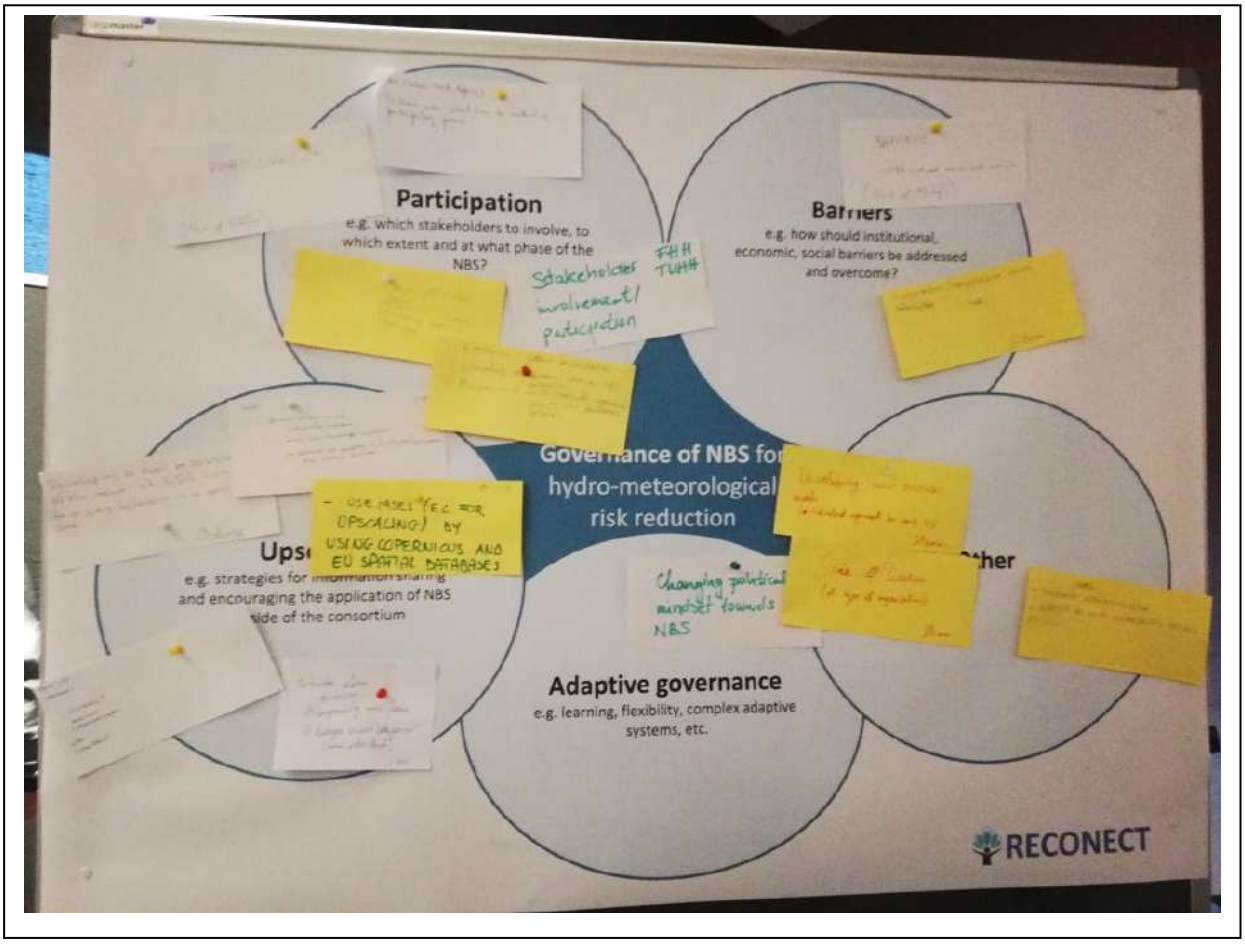

Figure 3.1 Example of how demands (yellow) and supplies (white) were collected during the workshop

The bars in lighter colour are based on information derrived from other deliverables in WP 2. They indicate that partners can supply expertise on this topic. The answers provided by collaborators during the DAS workshops session are not included in this document as they will be reported in D4.2.

Figure 3.2 indicates three important lessons:

- First, the greatest need for exchange relates to the “monitoring and evaluation” phase of NBS realisation. At the same time, this is also the topic where demonstrators as well as other project partners can supply most expertise. The strong focus on monitoring and evaluation is a reflection of key objectives of RECONECT – develop a holistic ecosystem-based evaluation framework and form the basis of a proof-of-concept for the realisation of NBS.
- Second, it underlines that all topics on which demonstrators expressed a need to exchange, expertise can be supplied by other demonstrators or project partners.
- Third, there was no need expressed by demonstrators to exchange with respect to the topics of “implementation”, “operation and maintenance” as well as with respect of “adaptive management” and “others”. The reasons therefore are that all Demonstrators have great expertise with respect to implementing and operating/maintaining risk reduction measures. They can largely rely thus on their expertise. With respecti to “adaptive management”, it can be expected that there will be an increasing deamdn to

exchange on this topic as RECONECT is progressing and other more immediate topics (e.g. evaluation and monitoring, design of NBS) have been addressed.

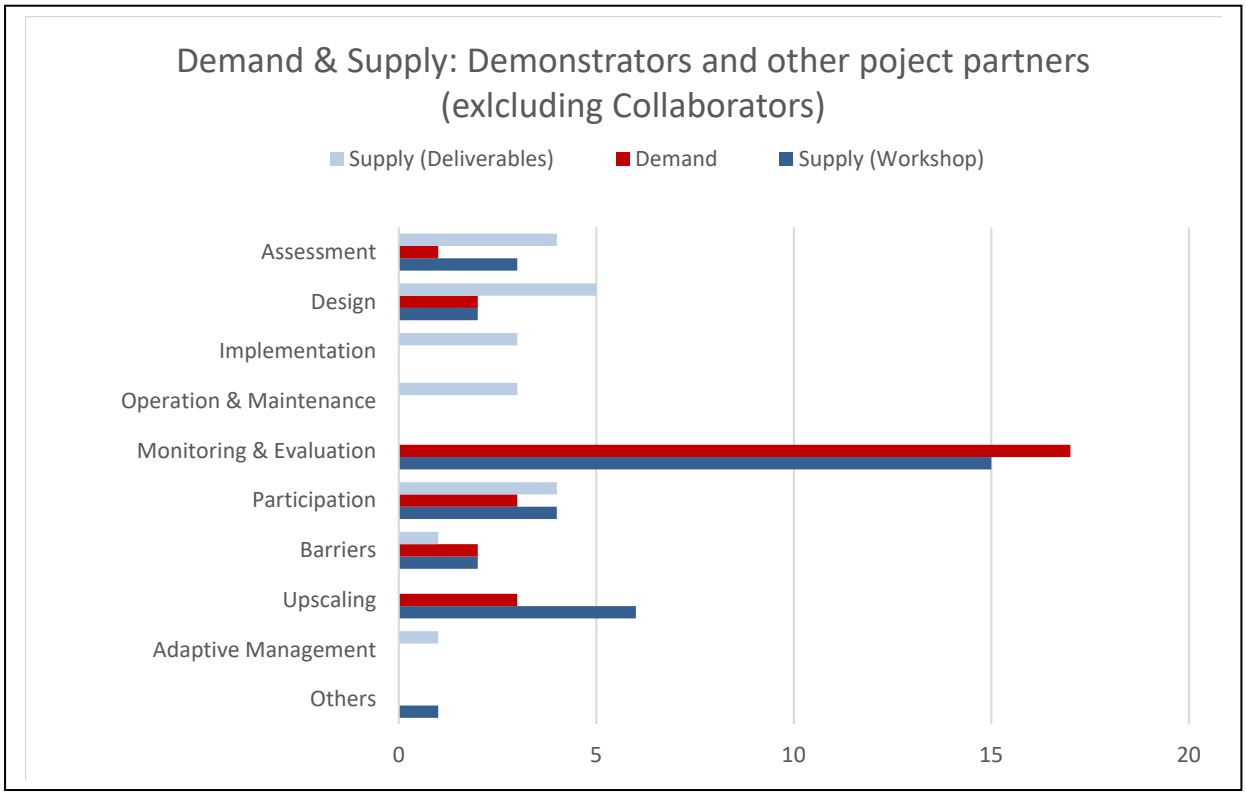

Figure 3.2 Results of the Demand and Supply Analysis conducted among all demonstrators

The following three sub-sections provide a comprehensive overview on the demand and supply of demonstrators A and B as well as what other project partners can supply.

3.1 Capacities, demand and supply of demonstrators A

Three out of the four demonstrators A partners are concerned with the hydro-meteorological risk of flooding resulting either from river floods (Dove/Dose Elbe & Tordera River Basin) or from tidal flooding (Seden Strand). At the Portofino Park, the hydro-meteorological risks caused by strong rainfall events are predominantly from landslides. Furthermore, at the Dove/Dose site in Hamburg, the risk resulting from water shortage, with negative feedbacks on the ground water recharge, is also of concern. In addition to these hydro-meteorological risk reduction benefits, all demonstrators expect additional co-benefits for nature, water and people as a result of their NBS. This includes the increase of biodiversity and improvement of ecological conditions in their area, improving water quality and/or enhance ground water recharge (Dove/Dose), and improve the quality of life and social value in the sites, e.g. for recreational purposes.

All of the demonstrators A are highly motivated to realise NBS and this not just on the personal and organisational level, but in most cases also on the political level. Furthermore, all demonstrators A have extensive experience with regard to the management of hydro-meteorological risks, including the assessment of hazards and risks, the planning and design of risk reduction measures as well as, at least in some cases, the monitoring of relevant indicators (mostly in the context of the Water Framework Directive).

However, for all demonstrators A, the realisation of NBS is a relatively new topic, which implies that they expressed the needs to exchange on various topics highlighted in Figure 3.3. Table 3.1 provides more detailed information for each demonstrator A partner. It summarizes the capacities of demonstrator A partners, theirs needs and thematic fields they can provide expertise to others as well as their expressed wishes with which other Demonstrator they would like to exchange more intensively on a rather bilateral level.

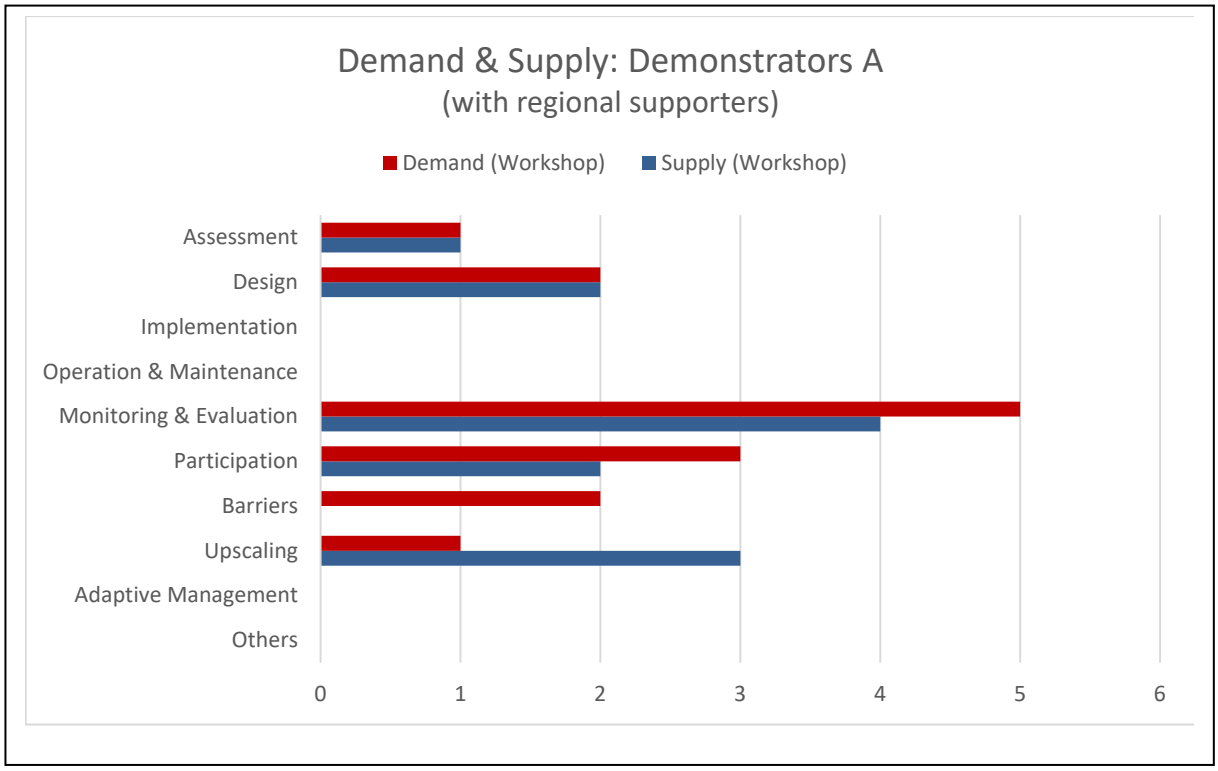

Figure 3.3 Results of the Demand and Supply Analysis conducted among demonstrators A

- There is a large demand from demonstrator A partners with respect to exchanging on the topic of "**monitoring and evaluating**" the co-benefits of the NBS to the realised. At the same time, there is also a profound stock of expertise among demonstrators documented through the high share of expertise that they can be supplied on the topic of "monitoring and evaluation". More specifically, demands were predominantly concerned with how to choose, monitor and evaluate people and nature indicators. While there is comprehensive expertise with respect to water-related indicators among demonstrators A, they expressed a strong desire to exchange on ways to evaluate indicators related to people and nature. This demand can only partially be satisfied within this group: While there is expertise on how to monitor and evaluate nature indicators, there is no supply mentioned with respect to people indicators; a point we return to further below.
- The second highest ranked need is with respect to "**participation**", followed by the demand to exchange on the "**design of NBS**" and how to address and overcome "**barriers**" with regards to realising NBS. With respect to "design" there is a general desire to learn from experiences made already by others and to share ideas on how to design NBS. On the supply side, this demand can be met with respect to the design of NBS along the shoreline. With respect to risks triggered by riverine flooding, no supply is mentioned by demonstrators A. With regard to barriers, how to address and how to overcome them, there is a general demand for learning more from others on how to

change the (political) resistance of NBS and how to overcome institutional, economic and other barriers. Among demonstrators no expertise is supplied on this topic.

- There is a great stock of expertise among the demonstrators A partners with regard to "**upscaling**", including financial instruments as well as expertise related to the hosting and support of data bases demonstrating the added value of NBS.

Demonstrator A have also stated with which other demonstrator they might want to exchange more intensively on a bilateral level. Details are provided in Table 3.1. They suggest that Hamburg and Odense expressed a mutual desire to exchange more intensively, ideally supported by the demonstrator B Var River/Les Bouscholeurs; that the demonstrators Todera would like to exchange with the demonstrators B Var River/Les Bouscholeurs, Thur River, Ijssel River and the demonstrator A Seden Strand; that Portfofino would like to exchange more intensively with the demonstrator B Var River/Les Bouscholeurs and the Inn River.

Table 3.1 Capacities, Needs and Supply of Demonstrator A

	Capacities	Demands	Supply	Bilateral twinning
Dove/Dose Elbe Estuary (Germany)	• High motivation to realise NBS on personal, organisational and political level • Sound knowledge about different aspects of realising NBS; focus currently on water-related aspects (see also supply), including the assessment of flood-related risks, planning and implementation of risk reduction measures.	• Design: Learn from other experiences of NBS design • M & E[2]: Monitoring, Nature and People Indicators • Participation: Design of participation processes • Barriers: Changing political mind-sets towards NBS	• Assessment: The assessment of water quantity (water level, discharge) with hydrodynamic numerical modelling and rainfall-runoff modelling • Monitoring & Evaluation: Water Indicators	• The demonstrator expressed the wish to exchange more intensively with Seden Strand (Denmark)
Seden Strand, Odense (Denmark)	• High motivation to realise NBS on personal, organisational and political level • Sound knowledge about different aspects of realising NBS, rather general and not detailed • Eager to learn more about monitoring and evaluation; of high relevance for demonstrating benefits of NBS	• Design: Sharing ideas on designing NBS (Odense) • M & E: Choosing and how to monitor people indicator (Odense); • M & E: Nature Indicators; how to choose them, collect data, resources, etc. (Amphi) • Upscaling: Develop a tool demonstrating benefit of NBS compared to grey solutions (Odense)	• Design: Liveable/living shoreline implementation (Ramboll) • Monitoring and Evaluation: Designing of nature monitoring and indicators (Amphi) • Participation: Cooperation and negotiations with stakeholders (Odense) • Participation: Stakeholder experiences and facilitation (Ramboll) • Upscaling: Business case for NBS; Socio-economic calculations for CBA (Ramboll) • Upscaling: Business case for IFI-financing and climate justice (Ramboll)	• The demonstrator expressed the wish to exchange more intensively with Var River/Les Bouscholeurs (France) as well as with Dove/Dose (Germany)
Tordera River Basin (Spain)	• High motivation to realise NBS on personal and organisational; not so pronounced on the political level; Sound knowledge about different aspects of realising NBS; focus currently on water-related aspects (see also supply), including the assessment of flood-related risks, planning and implementation of risk reduction measures.	• Assessment: To learn more about different type of innovative NBS and how to conduct an effective cost-benefit analysis (ACA) • M & E: Ways to align WFD indicators with the needs of the RECONECT project, conduct a cost- and time-effective monitoring based on available data/tools (specially for nature and people indicators) (ACA) • Participation. To learn more about how to conduct a participatory process (ACA)	• Monitoring & Evaluation: Early Warning Systems + Decision support, Systems for Monitoring, (HYDS) • Monitoring & Evaluation: Data management and exploitation platform for monitoring, including analysis and visualisation (HYDS)	• The demonstrator expressed the wish to exchange more intensively with Var River/Les Bouscholeurs (France); Thur River (Switzerland), Ijssel River (NL) and Seden Strand (Denmark)
Portofino Park (Italy)	• High motivation to realise NBS on personal and organisational level; low financial capacity to support the realisation of NBS on a large scale. • Sound knowledge relevant to the implementation of NBS in the Demo site	• M & E: Maintenance of monitoring system sensors • Participation • Barriers: Institutional, economic and other barriers	• Design: Relationship between shallow landslides and flash floods, lidar data analysis, dry stone walls on slopes • Upscaling: Use cases (e.g. for upscaling) by using Copernicus and EU databases (GISIG)	• The demonstrator expressed the wish to exchange more intensively with Var River/Les Bouscholeurs (France) and the Inn River (Austria)

[2] M & E = Monitoring and Evaluation

3.2 Capacities, demand and supply of demonstrators B

Demonstrators B are represented by different organisations, including one city (Aarhus), one consultant (TAUW) and three research institutions (Inn, Thur and the two French Demonstration sites). While one research organisation is supported by practical partners responsible for the realisation of NBS (Innsbruck), the City of Aarhus is supported by a research organisation (DTU) and a consultant (AMPHI). Apparently, both the background of involved partners largely shaped their capacities and demands.

Generally, all demonstrator B partners report high motivation with respect to the realisation of NBS, which is also underlined by the very fact, that in all sites NBS were realised in the past. The expertise of demonstrator B partners is both rather specialised in the case of the research organisation – here it refers above all to the aspect of monitoring and evaluation (The Var Éco-Vallée/Les Bouscheleurs and Thur) - as well as comprehensive in the case of demonstrators constituted by multiple partners (Inn and Aarhus) or consultants (e.g. TAUW).

Reflecting the particular role of demonstrators B within the RECONECT project (they serve as reference cases with a focus on monitoring and evaluation co-benefits and sharing knowledge and experience with demonstrator A) and they supply expertise to other project partners that will implement NBS in the future (i.e. demonstrator B, collaborators), demonstrator B see the greatest need with respect to “monitoring and evaluating” the co-benefits of NBS (see Figure 3.4 for an overview and Table 3.2 for more detailed information). In addition, they can supply expertise on all aspects relevant for the realisation of NBS.

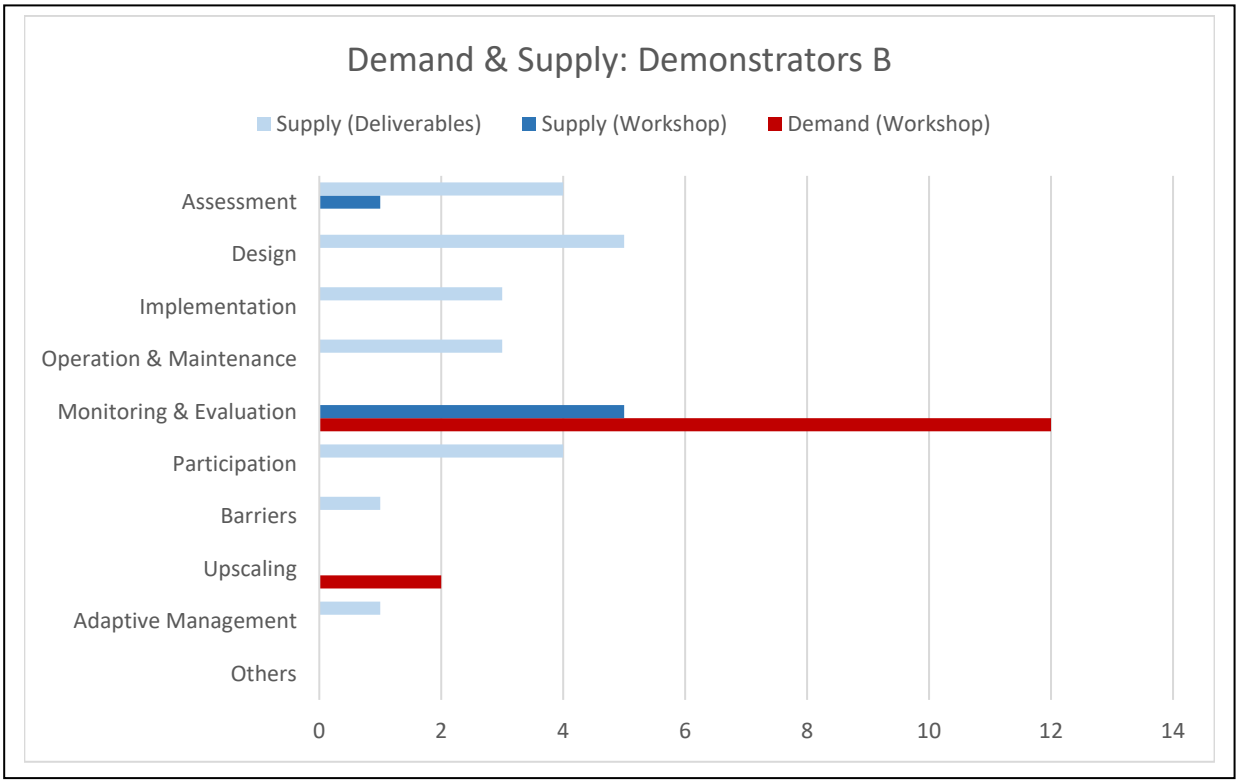

Figure 3.4 Results of the Demand and Supply Analysis conducted among demonstrators B

Demonstrators B mostly expressed a need to exchange on quite specific topics with respect to the monitoring and evaluation of NBS. This includes procedural aspects (e.g. how to ensure synergies and comparability between different case studies? How to ensure the sustainability of the monitoring system after the end of the project), technical aspects related to sensor technology as well as interlinkages between different evaluation domains (e.g. water and nature). At the same time, demonstrators B have strong capacities in this domain and therefore can also supply expertise to others. In addition, they can supply expertise on upscaling aspects, which also reflects their role within the RECONECT context.

Table 3.2 Capacities, Needs and Supply of Demonstrator B

	Capacities	**Demands**	**Supply**
Ijssel River Basin (The Netherlands)	• A consultant represents this demonstrator	• M & E: Knowledge Exchange on cost effective monitoring (maintenance) (TAUW) • Upscaling: Continuous upscaling on an (inter)national scale; jointly with other Demo B	• M & E; Experience from the Room4River, including implementation, best management practices and case studies (TAUW) • Assessment: risk assessment, feasability studies, cost-benefits analysis (TAUW, D2.4) • Design: Vegetation removal, landscape management/design (TAUW; D2.3, p. 82ff; D2.4) • Implementation: Obtaining forma permits and authorization; execution of work (incl. Contracting and procurement) (TAUW; D2.3, p. 82ff, D2.4) • Operation & Maintenance: NBS life cycle (D2.4), • Participation: Stakeholder and land owner management (TAUW; D2.3, p. 82ff)) • Barriers: Overcoming resistance among land-owners, local authorities and interest groups (TAUW; D2.3, p. 82ff)
Inn River Basin (Austria)	• While the demonstrator is represented through a research organisations, it is also supported by different administrative partners; • High motivation to realise NBS on personal, organisational and political level; this also includes sound financial and personal capacities; • Sound knowledge about different aspects of realising NBS resulting from the broad expertise of partners involved in this site.	• M & E: Sensor technology, knowledge exchange on water quality in the runoff, focus on urban plotscale, • M & E: Sensor technology, knowledge exchange (monitoring): soil/moist, runoff plot, hillslope (ski) • Upscaling: Scenario building for post afforestation sceneries! Comparable case studies? Methods for mapping of forest areas from historic pictures (GIS methods) (all UIBK)	• Assessment: Approach to address climate change on: convective storm, design storm (short duration/ convective) with an emphasis on: inland/alpine/pre-alpine regions (UIBK) • Assessment: risk assessment, feasability studies, cost-benefits analysis (UIBK, D2.4) • Design: Buffer strips, hedges, slope stabilization (UIBK; D2.3, p. 103ff.; D2.4) • Operation and maintenance: Ensuring quality performance, NBS life cycle, protection forest management, driftwood management, afforestation (UIBK; D2.3, p. 103ff., D2.4)
Aarhus, Egå Engsø and Lystrup (Denmark)	• The City of Aarhus represents this demonstrator supported by a research organisation;	• M & E: Monitoring of social impact indicators: property value, usage, perception, health, if possible economic	• M & E: Human well-being indicators (people), eco-system services indicators (nature) (DTU)

	• High motivation to realise NBS on personal, organisational and political level; this also includes relative sound financial and personal capacities; • Sound practical knowledge about different aspects of realising NBS resulting from the experiences made already in the past.	evaluation + making monitoring design (Aarhus) • M & E: How does the NBS affect water quality and nature (interlinkages) (Aarhus) • M & E: How do we create synergies between indicators on different case areas? (Aarhus) • M & E: Method selection support: how will it work (who provides this services) in RECONECT?) (DTU) • M & E: Indicator selection to ensure: i) comparability across cases; ii) linkages across "categories" (nature, water, people) (DTU)	• M & E: Model-based Monitoring (DTU) • M & E: Support for people indicator (TDU) • M & E: Support for water indicators: use of drones for environmental monitoring of surface water, technological development/advancement; Water quantity -> surface water elevation; Water quality -> parameters related to environmental / ecological status; also a relevant innovation for RECONECT (DTU) • Assessment: risk assessment, feasability studies, cost-benefits analysis (Aarhus, D2.4) • Design: Designing wetlands, green surfcace solutions, urban drainage (Aarhus, D2.3, p. 119ff.; D2.4) • Implementation: Procurement of services and works and overseeing contstructing work (Aarhus, D2.3, p. 119ff.) • Participation: Strong stakeholder interaction and negotation (Aarhus, D2.3, p. 119ff.)
Thur River Basin, (Switzerland)	• As a research institution (EAWAG) represent the demonstrators, the motivation to engage with NBS scientifically is high; but also high degrees of support are reported on the political and institutional level; • Great scientific expertise with respect to monitoring and evaluation, including also communicating relevant outcomes to responsible politicians and administrative bodies.	• M & E: Sensor technology: knowledge exchange (monitoring): groundwater; soil/moisture (Eawag) • M & E: Surface water – groundwater interactions (Eawag) • M & E: People indicators, with an emphasis on perception (Eawag)	• Assessment: risk assessment, feasability studies, cost-benefits analysis (Eawag, D2.4) • Design: River restoration, retention areas, artificial ground water recharge (Eawag, D2.3; p. 138ff., D2.4) • Implementation: Contracting relevant partners and companies (Eawag, D2.3; p. 138ff; D2.4) • Operation and maintenance: Ensuring quality performance, NBS life cycle (Eawag, D2.4) • Participation: Strong stakekholder collaboration, including surveys and workshop meetings (Eawag, D2.3; p. 138ff.; D2.4) • Adaptive management: creating an adaptive self-learning management sytem (Eawag, D2.3; p. 138ff.)
The Var Éco-Vallée & Les Bouscheleurs (France)	• As a research institution represents both Demonstrators, the motivation to engage with NBS is grounded rather in scientific reasons and refers to the aspect of monitoring and evaluation; at the same time, relative high commitment is reported on the political and institutional level.	• M & E: Exchange needed on timeline for monitoring or chosen indicators? Monthly? Yearly? – and how to ensure sustainability after end of project? (UNSA)	• Design: green urban develoment, urban drainage, retention basins (UNSA, D2.3; p. 150ff.; D2.4) • Participation: strong stakeholder collaboration (UNSA, D2.3; p. 165ff.; D2.4)

3.3 Supply of other project partners (excluding collaborators)

In this section we provide an overview on the expertise that be supplied by other project partners (i.e. they are neither demonstrators, including their supporters, nor collaborators).

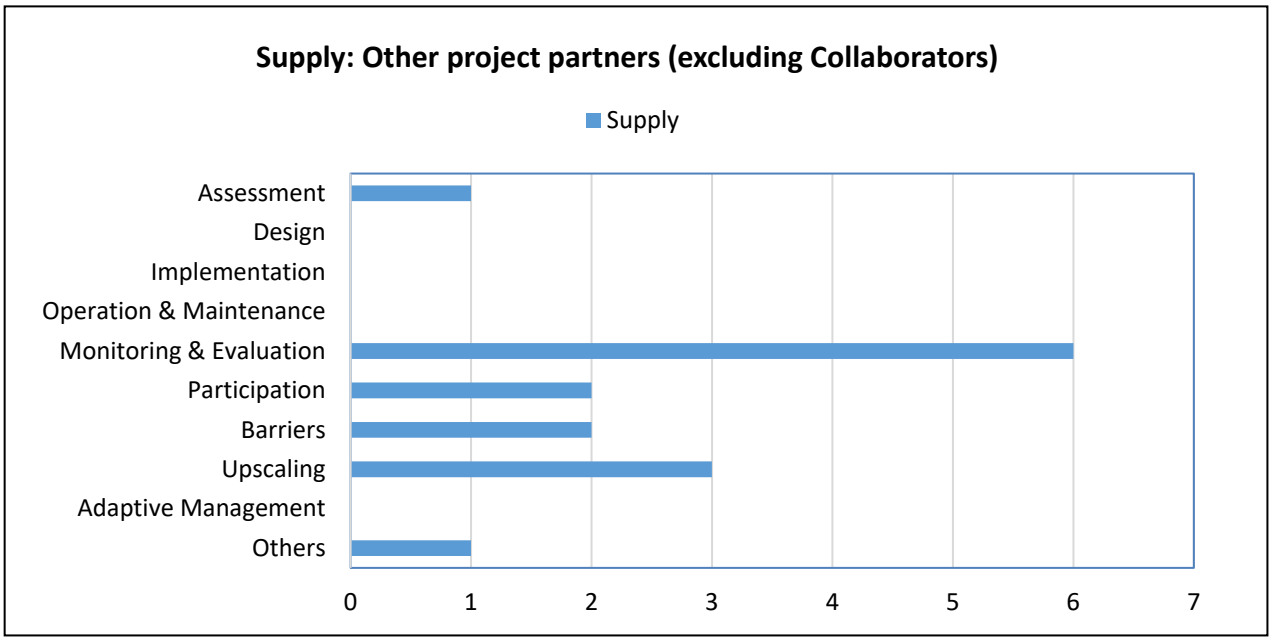

Figure 3.5 Supply of other project partners (excluding collaborators)

As Figure 3.5 shows, other project partners can provide expertise for most of the topics where there is a demand among demonstrators to more intensively exchange upon with others. This includes the following aspects:

- Assessment: The assessment of social vulnerability (indicators, assessment, analysis), including gender and social equity issues, assessments/social acceptance/perceptions/benefits (SEI); the conduction of feasibility study as well as framework for integrative risk assessment (IHE).
- Monitoring and evaluation: Supporting monitoring and evaluation through geographical data (maps) as well as through remote sensing data (aerial images, lidar, satellite data) (Eurosense); Advise on sensors, connecting sensors directly to ICT platform, visualising data in SCADA, GIS and mobile APP based formats, (realtime) control actuators directly from the ICT platform (IA); Supply crowd sourcing data as well as weather forecast data (+ archive) (HR).
- Participation: Co-creation, stakeholder engagement; addressing perceptions/benefits/ acceptance; Interaction of private–industry–research-communities (SEI); Good practices of participation during different phases of the co-creation process (UFZ).
- Barriers: Policy relevant research/science communication, policy- institutions - cross-level governance: barriers, opportunities, drivers, institutional fit; Indicators, feasibility, research for policy (tailored products for different audiences) (SEI); Analysis of hindering and promoting factors for the realisation of NBS among demonstrator and collaborators (UFZ).
- Upscaling: Providing an analysis of the needs with regard to a more effective realisation of NBS of a wider group of stakeholders (UFZ); Developing new business models (individual approach for each CS) and spin-off creation (all type of negotiation) (STRANE).

3.4 Suggestions for twinning activities: RECONECT's twinning menu

Based on the results of the DASA, we suggest in this section collective and bilateral twinning activities. While **collective twinning** centres on topics of high relevance for a larger group of partners, **bilateral forms of twinning** that are organised around demonstrators that share similar characteristics and demands and that face similar challenges. Twinning within the RECONECT context will be organised predominantly through different means, including:

- Mutual site visits and exchange among partners
- Joint workshops dedicated to specific topics
- Webinar series dedicated to a series of topics

In this section, first suggestions are made on how to thematically cluster the respective twinning activities. The suggestions have already been validated during the GA in Nice where both key outcomes of the DASA were presented and potential twinning activities have been presented and discussed intensively with both demonstrators and relevant other project partner. Based on the DASA and the feedback we obtained during the GA in Nice, we suggest to organise **collective twinning activities** with respect to the following topics (1) assessment, (2) design, (3) monitoring and evaluation, (4) participation, (5) upscaling and (6) barriers.

As demonstrators are currently engaging, above all, with the practical aspects of realising NBS is was agreed upon that the **focus during the first half of the year 2020** will be on the assessment, design, monitoring and evaluation of NBS as well as on participation. Furthermore, the following rules for the organisation of webinars and workshops were agreed upon.

Rules for **Webinars**:

- Organised by presenter (usually one or two partners with key expertise on the topic) and scheduled by WP2 coordination (scheduled at least one month in advance)
- Participants need to do their "homework"! (e.g. read deliverables where applicable)
- Webinars will last for about two hours each, including questions and discussion
- Structure: 30-60 min intro with slides, followed by questions and then discussion
- In closing; check for new topics + if questions are answered
- Will be recorded and disseminated
- Registration: Open to all

Rules for **Workshops**:

- Half a day to one day maximum
- Ideally taking place back to back with a GA
- No more than two workshops with each GA
- Sheets / content will be disseminated
- Registration: Open to all

In addition, **field visits** are organised on a regular basis in order to present a a Demonstration case to others and to discuss – with other demonstrators, collaborators and partners – the various topics, issues, challenges and lessons specific to the visited Demonstrator. The following field visits have already been organised/are scheduled.

- September 2018: Portofino as part of GA
- May 2019: Demo B 'Stroomlijn IJssel' / 'Room for the River', Netherlands, as part of GA in Zwolle
- October 2019: Demo B Var River, as part of GA in Nice
- May 2020: Demo B Thur in Zurich

(1) Assessment

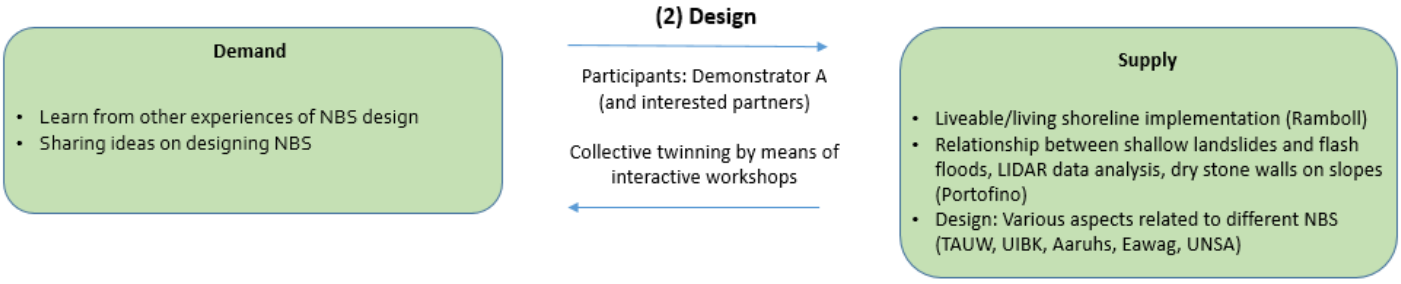

Figure 3.6 Assessment: Relevant topics for twinning activities

Generally, the demand with respect to the assessment of NBS was expressed by one partner (see Figure 3.6 for details). However, it was agreed upon that this topic might also be of relevance for other demonstrators (and potentially also for collaborators). Therefore, it is suggested that a webinar will be organised on how to conduct a both a cost-benefit analysis with respect to NBS as well as on how to conduct a social vulnerability assessment.

(2) Design

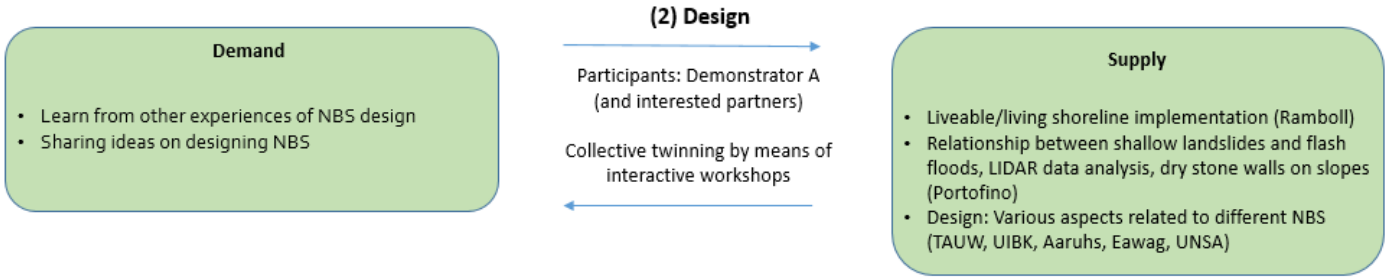

Figure 3.7 Design: Relevant topics for twinning activities

How to “design NBS” is a topic of high relevance for demonstrator A as they often have not immediate experience of designing NBS. At the same time, it is a topic of pressing relevance as all demonstrators A are currently engaged/about to start designing NBS in their pilot sites (see Figure 3.7). We propose that twinning activities on the design of NBS are predominantly based on formats that allow strong interaction as it is to be expected that detailed questions will arise to different technical aspects. Therefore interactive workshops seem to be a promising means of exchanging on to design NBS. Reflecting the expertise supplied, it is suggested that Ramboll is leading these twining activities.
The following activities have already been undertaken:

- Ramboll organized two design workshops, which focused on “From grey to hybrid systems, working with severe or irregular weather conditions and flow regimes, and other”. The workshop took place before and after the GA in Nice (29.9.2019 + 02.10.2019). All interested demonstrators A were invited to participate. Following up activities are foreseen, including more focused exchange and field visits.

(3) Monitoring and evaluation

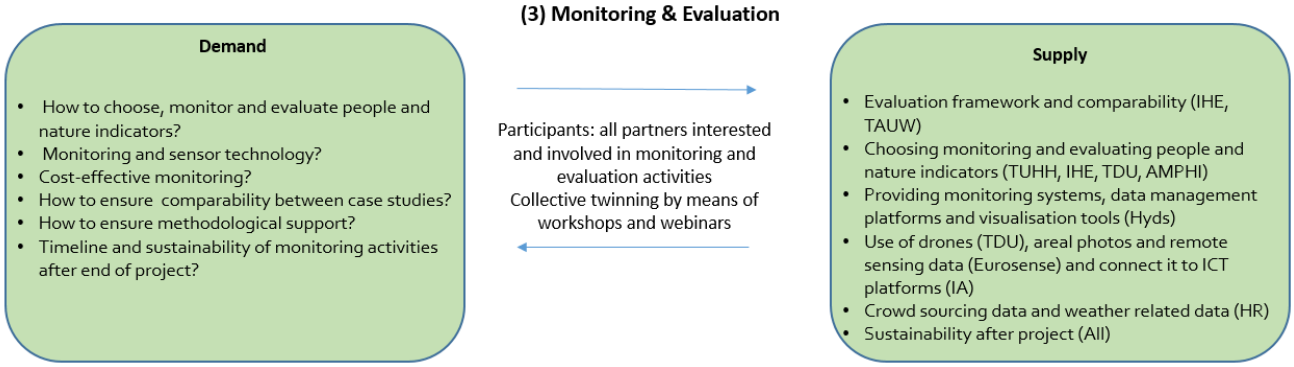

Figure 3.8 Monitoring and evaluation: Relevant topics for twinning activities

"Monitoring and evaluating" the effects of NBS is a topics that most demonstrator A and B partners expressed a need to exchange upon more intensively (see Figure 3.8). This includes both fundamental questions (How to choose indicators? What are appropriate indicators with respect to the RECONCT dimensions of "Nature" and "People" as well as more specific procedural aspects (How to ensure methodological support?). At the same time, the consortium offers comprehensive expertise on this topic. Reflecting the great relevance of the topic both with respect to the needs of demonstrators as well as with respect to some of the key objectives of RECONECT, first collective twining activities have already been undertake; further steps are foreseen. It is suggested to start with more fundamental questions and then proceed to the more specific procedural aspects of implementing the monitoring and evaluation activities. The following means of organising the collective twinning activities are predominantly organised through **webinars** allowing for the participation of a larger group of interested project partners:

- Aligning terminology between projects and Indicator Assessment tool (webinar);
- Selection of case specific relevant indicators & monitoring (WATER) (webinar);
- Selection of case specific relevant indicators & monitoring (NATURE) (webinar);
- Selection of case specific relevant indicators & monitoring (PEOPLE) (webinar);
- Introduction of available data management methods and tools in RECONECT (webinar).

The following means of organising the collective twinning activities are predominantly organised through **workshops** allowing for the intensive exchange of a smaller group of partners:

- (Planning for) cost-effective monitoring and evaluation methods and tools (related to D2.6) (orkshop)
- Application of data management tools (workshop)
- Innovative approaches and technologies for monitoring hydrological features and aspects (e.g. drones). Including application of ClimateCafe methodology ('demo in field') (workshop)

(4) Participation

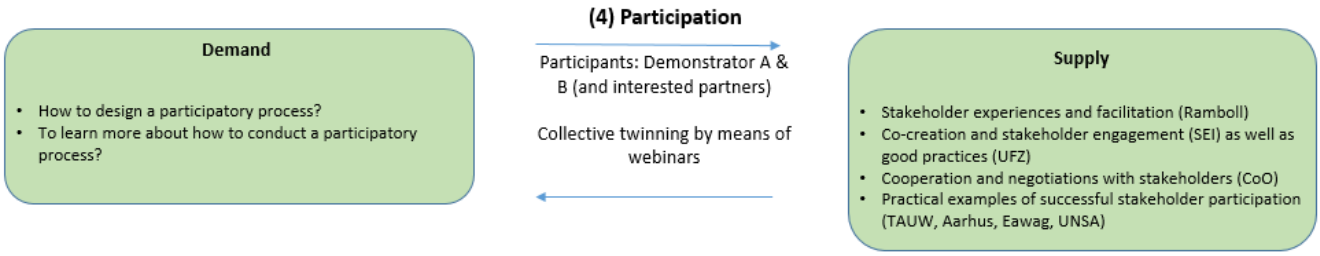

Figure 3.9 Participation: Relevant topics for twinning activities

Participation is key to RECONECT approach with its emphasis on co-creating NBS. First ideas on how to make co-creation operational throughout RECONECT were presented in de D1.2. While all demonstrator have made some kind of experiences with respect to participators processes, they also expressed the need to more intensively exchange with others on how to design and set-up a participatory process (see Figure 3.9). At the same time, expertise can be provided by others (social science) partners as well as hands-on experience by a consultant and demonstrator A partner. The following means of organising the collective twinning activities are predominantly organised through webinars allowing for the participation of a larger group of interested project partners:

- Approaches to enhance stakeholder participation and negotiation in project realization (webinar)
- Approach to co-creation and stakeholder engagement (also from the private sector and industry, research, communities) and on cross level governance (Webinar)
- Mechanisms for interaction with public authorities and sectoral agencies (webinar)

(5) Upscaling

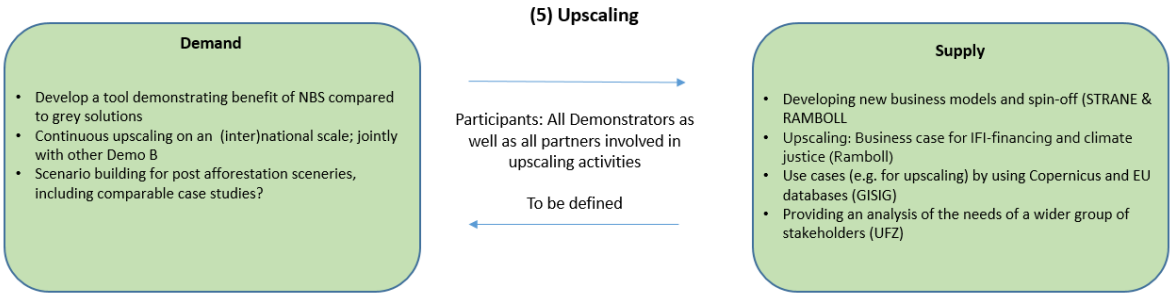

Figure 3.10 Upscaling: Relevant topics for twinning activities

It was decided that the topic of upscaling should be addressed more systematically during the second half of 2020.

(6) Barriers

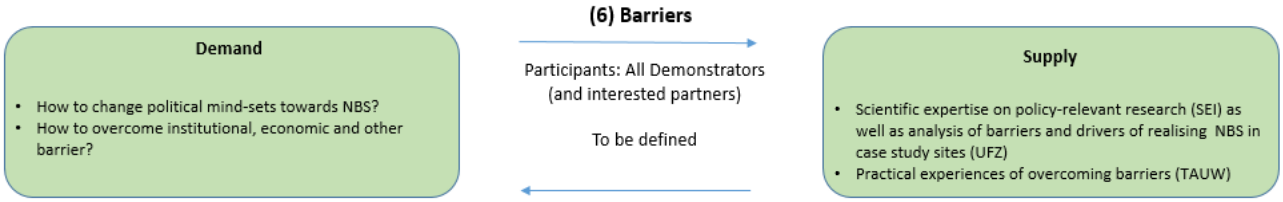

Figure 3.11 Barriers: Relevant topics for twinning activities

It was decided that the topic of how to address and overcome barriers should be addressed more systematically during the second half of 2020.

(7) Bilateral twinning

In addition, the collective twinning activities, the potential for knowledge sharing and twinning between demonstrators A and B has also been assessed and further specified. First ideas were presented in D2.3 taking into account the six main factors assessed for each Demonstration A and B case, including:

a. Type of hydro-meteorological hazard identified and type of the NBS project (flash flood, fluvial flood, landslide, coastal flood, etc.)

b. Geographical location, distance between partners

c. Similarity in natural conditions (climate, terrain, hydrology, river basin scale)

d. Similarity of NBS type - the technical solutions e. Status of Works

e. Expressed wish by the demonstrator for twinning and knowledge exchange

Based upon these five criteria as well as first twinning activities, the following bilateral twinning activities are proposed:

- Demonstrator A partner Odense and Hamburg are already in close cooperation and exchange, including mutual field visits. It is suggested that they are supported by demonstrator B partner Aarhus, Ijsel and Les Boucholeurs.
- It is suggested that demonstrator A partner Tordera twins with Thur and Var River
- It is suggested that demonstrator A partner Portofino twins with Inn and Var River

Based on the DASA, the following RECONECT twinning menu (see Table 3.3) was agreed upon by all partners during the GA in Nice (Sept/October 2019). It is a first outline of specific twinning activities that will take place in 2019 and the first half of 2020. Apparently, the twinning menu will evolve as the RECONECT project is progressing. This menu is thus to be understood as an open document that will be adapted according to the demands of demonstrators.

Table 3.3 RECONECT's twinning menu (preliminary version, November 2019)

Phase / Theme	Field visit	Workshop/session	Webinar
Assessment Design Implementation Cooperation & Maintenance	Various field visits to present a Demonstration case to others and to discuss – with other Demonstrators, Collaborators and Partners – the various topics, issues, challenges and lessons specific to the visited Demonstrator. ➢ September 2018: Demo A Portofino as part of GA ➢ May 2019: Demo B 'Stroomlijn IJssel' / 'Room for the River', Netherlands, as part of GA in Zwolle ➢ April 2019 : Demo A Hamburg ➢ August 2019: Demo A Odense and Demo B Aarhus ➢ October 2019: Demo B Var River, as part of GA in Nice ➢ May 2020: Demo B Thur in Zurich as part of GA	➢ **Ramboll** organized design workshops. Topics: From grey to hybrid systems, working with severe or irregular weather conditions and flow regimes, and other: 1. Date: 29-9-2019 Intro to design of NBS (in GA Nice) 2. Date: 02-10-2019 Design NBS (in GA Nice)	➢ **SEI**: Assessment - Demonstrate how to conduct social vulnerability and cost benefit analysis. Date: 26th March 2020
Monitoring & Evaluation		➢ **Eurosense & IHE**: Workshop on (planning for) cost-effective monitoring and evaluation methods and tools (related to D2.6) – small group; Eurosense, IHE, Uni of Exeter, Amphi, DTU. Optional: Tauw and BDCA. Date to be decided. ➢ **Tauw**: Workshop on innovative approaches and technologies for monitoring hydrological features and aspects (e.g. drones). Including application of ClimateCafe methodology ('demo in field'). Date: 4th GA in Zurich ➢ OPTIONAL: **Interact**: Workshop on application of data management tools. Date: 5th GA	➢ **University of Exeter**: E&M - Selection of case specific relevant indicators & monitoring (WATER). Date(s): 5th December 2019 ➢ **Amphi**: E&M - Selection of case specific relevant indicators & monitoring (NATURE). Date(s): 19th December 2019 ➢ **DTU**: E&M - Selection of case specific relevant indicators & monitoring (PEOPLE). Date(s): 30th January 2020 ➢ **IHE**: A E&M - ligning terminology between projects and Indicator Assessment tool (23-5-2019, WP3). Date(s): end of March 2020 ➢ **Interact:** E&M - Intro on available data management methods and tools in RECONECT. Date: 16th April 2020
Stakeholders Participation Barriers in governance Upscaling Adaptive governance Other (non)topics			➢ **Aarhus and Odense**: Participation - Approaches to enhance stakeholder participation and negotiation in project realization. Date(s): 6th February 2020 ➢ **SEI and UFZ**: Participation - Approach to co-creation and stakeholder engagement (also from the private sector and industry, research, communities) and on cross level governance. Date(s): 20th February 2020 ➢ **BDCA and Varna**: Participation - Mechanisms for interaction with public authorities and sectoral agencies. Date(s): 12th March 2020

4 Conclusions

This report presented the results of the DASA we conducted in order to assess the general demands of demonstrators A and B with regard to aspects relevant for the realisation of NBS. The demands and supplies were structured and assessed along the management cycles of NBS and also included governance aspects: (1) assessment, (2) design, (3) implementation, (4) operation and maintenance, (5) monitoring and evaluation, (6) participation, (7) barriers, (8) upscaling, (9) adaptive governance and (10) other topics. In order to better understand the needs of demonstrators, we also include an analysis of demonstrators' capacities to realise NBS (including their working routines, previous experience, motivational, financial as well as knowledge related aspects). By highlighting key aspects related to the political and regulatory context as well as with respect to the wider social climate with respect to the realisation of NBS, we also develop a better understanding of how regional, national as well as European policies and legislations, trust in responsible organizations, or the general acceptance of NBS as a way to reduce hydro-meteorological risks may support or hinder the realization of NBS in the Demonstration sites.

The results underline that the greatest need for exchange relates to the "monitoring and evaluation" phase of NBS realisation. At the same time, this is also the topic where demonstrators as well as other project partners can supply most expertise. Second, the results underline that all topics on which demonstrators expressed a need to exchange, expertise can be supplied by other demonstrators or project partners.

Based on the DASA, specific forms of twinning were suggested. While collective twinning centres on topics of high relevance for a larger group of partners, bilateral forms of twining are organised around demonstrators that share similar characteristics and demands and that face similar challenges. The different twinning activities can result in different means for how to make them operational.

Bilateral twinning within the RECONECT context will be organised predominantly through different means, including: Mutual site visits and exchange among partners, joint workshops dedicated to specific topics, webinar series dedicated to a series of topics.

Collective twinning activities will focus on the following topics (1) assessment, (2) design, (3) monitoring and evaluation, (4) participation, (5) upscaling and (6) barriers.

As demonstrators are currently engaging, above all, with the practical aspects of realising NBS is was agreed upon that the focus during the first half of the year 2020 will be on the assessment, design, monitoring and evaluation of NBS as well as on participation. Collecltive twinning activities will take place through webinars, workshops and field visits.

In this report, various forms of twinning have been outlined. The list of twinning activities will be updated as the project is progressing.

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Annex A. Detailed information on the demand and supply baseline analysis - Demonstrators A

This Annex provides detailled information for demonstrators A, including information about the risks and vulnerabilities they are facing, their capacities and needs with respect to the realisation of NBS, the expertise they can supply to others as well as first information on the wider socia climate with respect to NBS, including information on potential barriers.

A1. Dove/Dose Elbe Estuary (Germany)

Overview

The demonstration site Dove/Dose Estuary is located in the City of Hamburg, which has a population of more than 1.8 million inhabitants; the second largest city in Germany. Within the German federal system, Hamburg is considered both a city as well as a state (Bundesland). The Free and Hanseatic City of Hamburg is the lead partner on the Dove/Dose Estuary demonstrator in the RECONECT project with the Technical University of Hamburg supporting the realisation of the NBS at the case site. The demonstration site is located in the south-eastern part of the city and includes the Elbe-tributaries Bille, Dove and Gose, small tranches such as the Brookwetterung or Curslack, and the surrounding flood plains. With an area of 175 km², the demonstration site is relatively large in comparison to the other sites of the type A demonstrators (with the exception of Tordera River Basin). Figure A.1 provides an overview of the catchments (the Bille catchment is marked in yellow). The catchment of the Bille is largely located in the state of Schleswig-Holstein. However, the key areas of the demonstration site are located within the limits of the City of Hamburg, which are marked with a red line in Figure A.1.

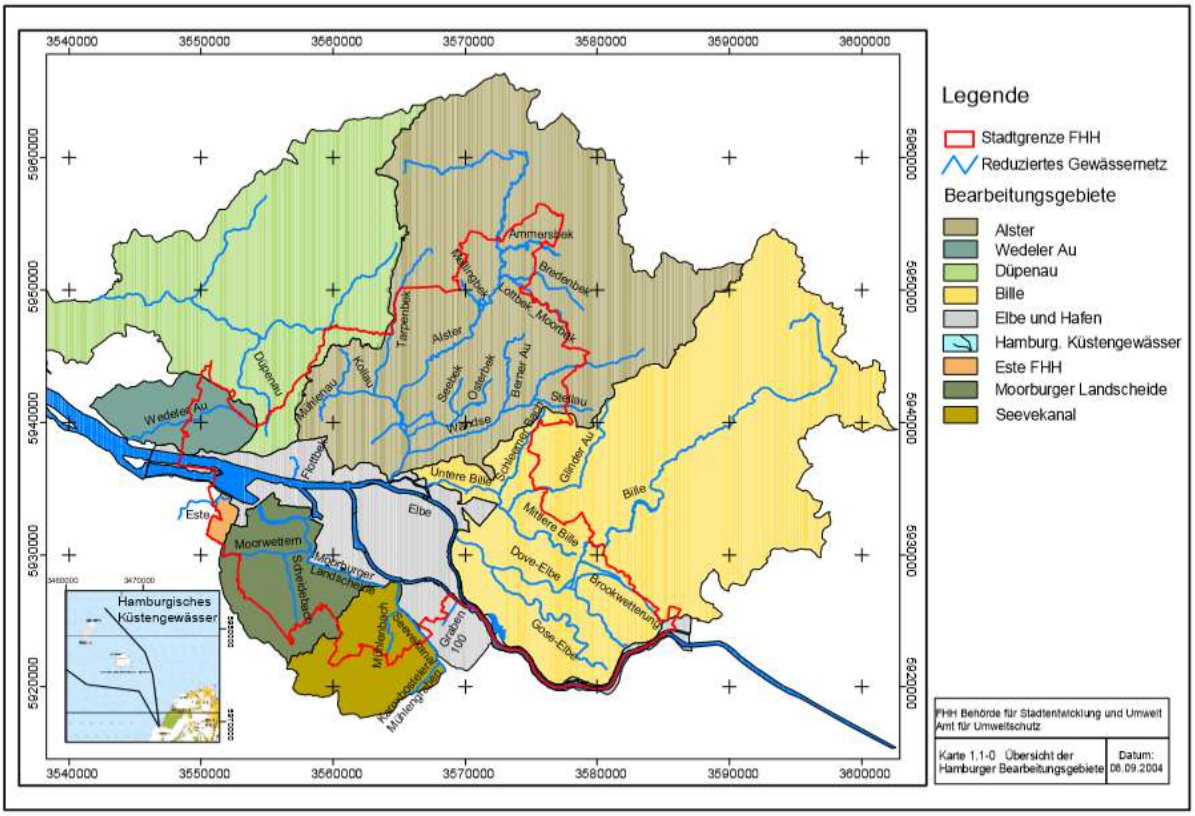


Figure A.1 The Dove/Dose Elbe Estuary demonstration site (Bille catchment in yellow; City of Hamburg marked by the red line)

Risk, vulnerability and risk reduction through NBS

Although the demonstration site is within the city limits of Hamburg, the area has a rather rural character. More than 27.000 inhabitants live in the area (Census Data Hamburg North, 2015). To understand current risks and vulnerabilities in the area, a more comprehensive view is needed. The case site has been substantially altered during the last centuries. This includes the construction of small dikes along the rivers, the construction of artificial ditches for draining the area, the relocation of river courses to provide more space for settlement areas, intense urbanisation processes as well as the construction sluices, such as the Tatenberger Schleuse (sluice) in 1952 (see the upper left corner in Figure A.***2***). With the construction of sluices, the influx of the Elbe River to the Dove and Gose has been prevented and the entire catchment has since been decoupled from daily tides of the Elbe Estuary. The site is currently used for various societal purposes and faces numerous environmental risks because of all these activities. By decoupling or (re)connecting rivers, tranches or ditches in the area, a complex network of surface waters has developed. The two main rivers of the system – Dove Elbe and Gose Elbe – are branches of the Elbe River that have been hydraulically decoupled from Elbe River by dikes and sluices. In order to regulate the water levels within the drainage area, a highly complex system consisting of the two main rivers including smaller rivers, ditches and pumps as well as water management facilities was developed over time. Furthermore, during the 1970s, the Dove river was straightened around Tatenberg/Eichbaumsee and has since then been used as a local recreational area that includes a rowing course and a harbour for sport boats (see Figure A.***2***: the Jachthafen Moorfleet and the Jachthaften Tatenberg). The situation is quite similar at the lower part of the Bille.

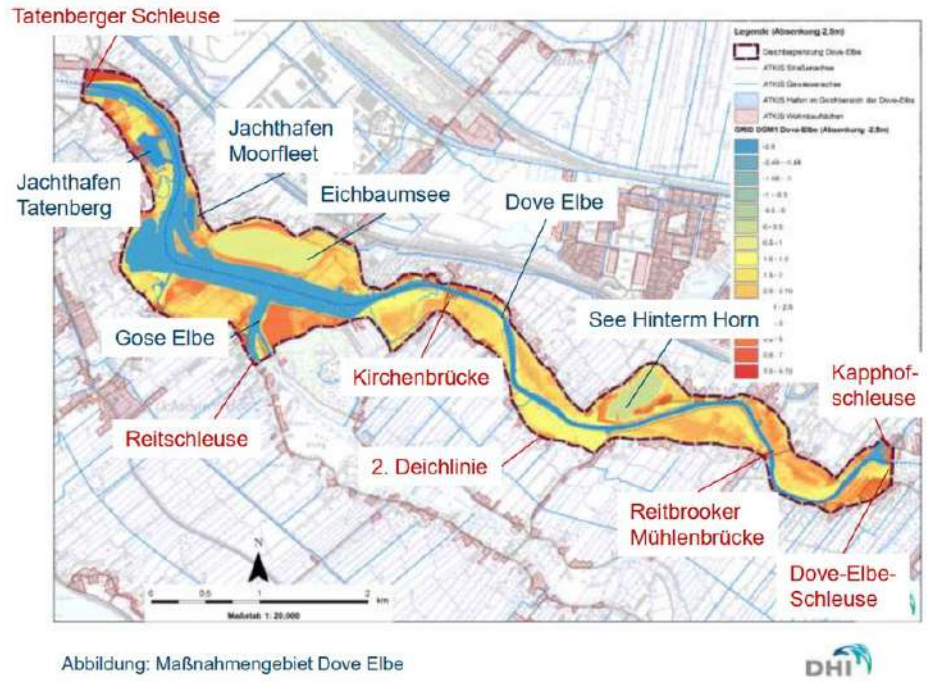


Figure A.2 The Dove Elbe3

[3] Source: https://www.forum-tideelbe.de/files/download/180713-dove-elbe-ergebnisse-phase2-monika-donner.pdf

Particularly around the Eichbaumsee (see Figure A.2), the area is increasingly used by citizens as a place to escape the city and for recreation. This trend was enforced during the 1980s when the Waterpark Dove-Elbe was created offering places for swimming, renting rowing boats or simply taking a walk around the lake (see Figure A.3).

Figure A.3 Picture showing recreational areas in the Demonstration site (Eichbaumsee)4

In addition to recreational purposes, the area is also intensively used for agricultural purposes. In the so called “Vier- und Marschlande”, vegetables, plants and flowers are grown. Among the local population, the area is also called the “Gemüsegarten” (vegetable garden) of Hamburg and it is considered one of the largest connected agricultural areas for planting flowers and vegetables in the whole of Germany[5].

Because of the enormous transformation of the area, it faces a number of environmental risks, including the risk of flooding, water scarcity, and impacts on water quality as well as biodiversity.

The surface water bodies do not meet the requirements of the Water Framework Directive. A report concerning the realisation of the EC Water Framework Directive concluded in 2004: “The initial characteristics of the landscape through meadow, mudflat, areas of flat water and deeper water have been transformed by humans dramatically in this area” (Freie und Hansestadt Hamburg, 2004). Table A.1 gives an overview on which activities are impacting the water quality of the river catchment.

[4] Source: https://geheimtipphamburg.de/geheimtipp/dove-elbe-baden-natur-im-suedosten-hamburgs/
[5] https://www.ndr.de/ratgeber/reise/hamburg/Vier-und-Marschlande-Hamburgs-Gemuesegarten,vierlande6.html

Table A.1 Dominant human usage of the Bille, Gose and Dove River[6]

	Shipping	Use of harbour	Flood protection	Water high regulation	Urbanisation
Lower Bille	X	X	X	X	X
Gose + tributaries			X	X	X
Dove + tributaries	X	X	X	X	X

Because of the previously described activities, natural littoral areas have been replaced by vertical walls which reduced the quality of the ecosystem and the water considerably, and the original shallow water areas are no longer available for fish spawning and resting. In addition, the natural fluctuation of the water body is no longer possible due to sluices, dikes and pumping stations, etc. Consequently, the river system was defined in 2004 in the context of the Water Framework Directive as a "substantially modified surface water body" (WRR 2004, 19 ff.).

However, it is not just surface water that has been impacted; the groundwater is also severely affected by the intense human use of the area. Groundwater is a relevant parameter in the demonstrator project, due to its exploitation for drinking water supply. The groundwater body is considered to be in a poor state, with respect to chemical and quantitative status, due to locally high concentrations of chloride caused by saltwater intrusions.

The settled area is also prone to the risk of flooding, particularly neighbourhoods near to the rivers. According to the flood risk assessment and the flood risk maps produced for the Flood Directive (Source)[7], a total of 230 people are exposed to a flood event with a low probability (i.e. with a statistical return interval of 200 years).
Figure A.4 provides a generic overview of the areas exposed to the risk of flooding, both from rivers as well as from tidal floods (black boxes inside the red circle).

[6] https://www.hamburg.de/contentblob/4237770/75541b37ff4fe08c359c83de2235eac6/data/d-landesinternerbericht-este.pdf
[7] https://www.hamburg.de/hwrm-karten/

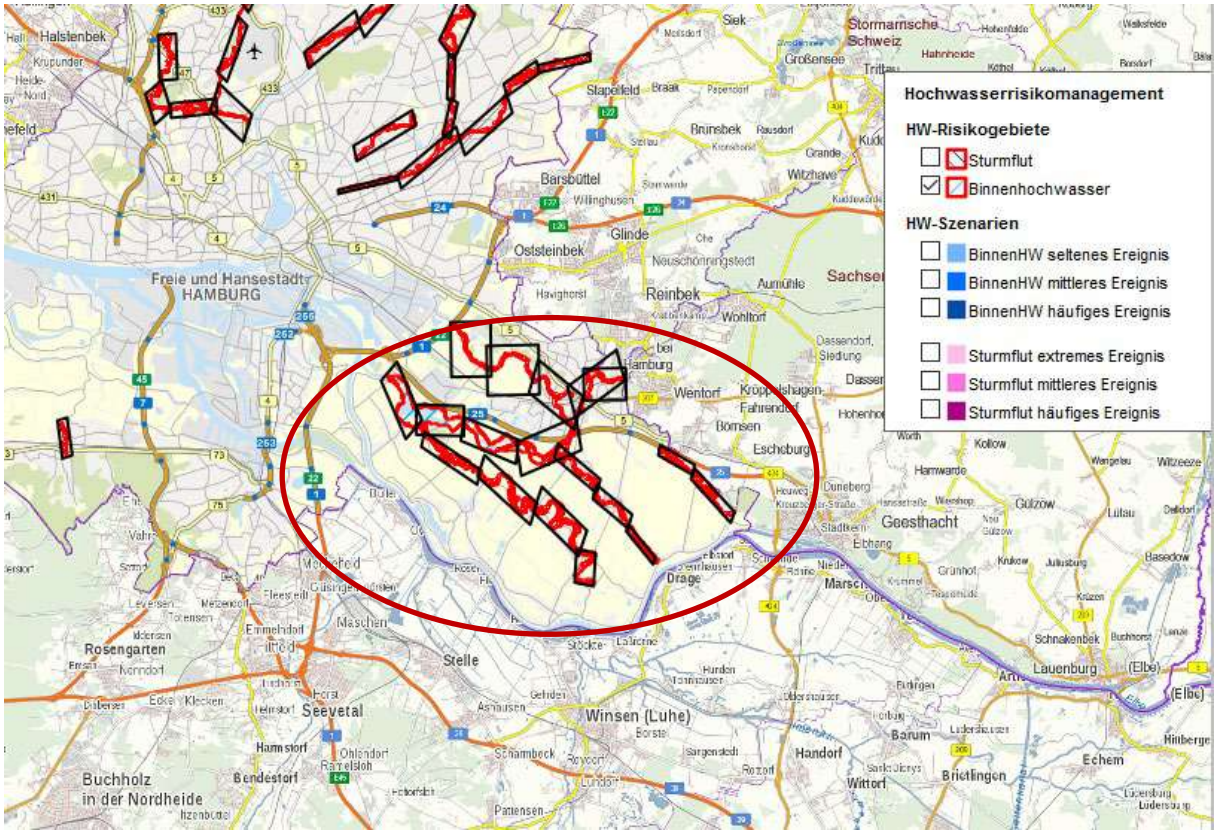


Figure A.4 Flood risk areas in the Demonstration site (within the red circle)8

In light of the risks outlined in the previous section, the City of Hamburg aims to reduce two **sources of risk**:

1. It aims to reduce the risk of riverine and tidal flooding by increasing the retention capacity of the catchments;
2. It aims to decrease the risks resulting from droughts by also increasing the storage capacity of the catchments;

Generally, it aims at connecting both objectives by overcoming the current piecemeal approach through the utilisation of high technology and NBS. 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, such as floods and droughts;
- Improved ecological condition of the area due to optimised use of the retentions and floodplains;
- Improved liveability and social value of the area, including tourism which is gaining relevance in the area;
- The conversion of grey infrastructure into hybrid solutions by combining the existing grey assets (such as pumping stations) with the RECONECT NBS approach;

[8] Source: https://www.hamburg.de/hwrm-karten/

- The expansion of the existing linear and disciplinary approach (a piecemeal approach to floods and drought management) into a holistic approach.

To achieve the multiple benefits, the demonstrators are pursuing a strategy that is based both on NBS as well as on the smart monitoring and management of the river systems. More specifically, the demonstrators aim at reactivating the storage capacity of the rivers Dove and Gose Elbe, their tributaries and tranches (e.g. Bille, Brookwetterung, Curslack) and their flood plains over an area of 110km^2 in order to create more room for water during flooding (spatial dimension) and to enhance the storage capacity during times of water scarcity. Therefore, an innovative controlling and operating system will be used to enable the optimal distribution of the water during floods while at the same time providing the necessary water levels in the rivers during dry seasons. The NBS application is, therefore, a hybrid containing physical, technical and model-based components. One of the key ambitions of the demonstrators is to investigate whether it is possible to manage the water level in the rivers for different purposes (flood reduction, groundwater generation). Emphasis is therefore put on numerical modelling to demonstrate that clever volume management is not just possible, but can generate wider co-benefits both for ecosystems and society.

Capcities and needs with respect to realising NBS

The demonstrators are composed of representatives from the City of Hamburg and the Hamburg University of Technology (TUHH). Both have **distinct objectives** they want to achieve through participating in the RECONECT project. The **City of Hamburg** is interested in enhancing their networking and knowledge capacity by interacting with other international partners and learning more from them on how to realise NBS. The City of Hamburg is also interested in improving their understanding and making progress in the political dimension of NBS realisation. **TUHH** also shares an interest in enhancing their networking capacity by interacting with partners from academia, administration and industry, and also increasing their visibility through the process. At the same time, TUHH wants to enhance its knowledge capacity in conducting research on NBS and hydro-meteorological risk reduction, including an improvement of their teaching activities and materials by utilising methods, tools and outcomes generated by RECONECT.

There is also a high **motivation** among involved partners to develop and test alternative solutions to establish risk mitigation approaches. This relates both to the high complexity of the demonstration site which is already serving multiple, sometimes conflicting purposes, but also to the need to develop solutions aimed at finding a compromise between the multiple interests while still creating a range of co-benefits. The high relevance and motivation to more effectively realise NBS in this area is also demonstrated by the very partners and units contributing to the Demonstration cluster, including, in addition to a scientific institution, the relevant political, strategic and executive authorities of the City of Hamburg. The measures planned to be implemented in RECONECT are well financed. The team comprises of a considerable number of people who meet regularly to ensure the effective execution of the project and guarantee an effective flow of information among all partners, indicating the relevance of making progress on both the working and operational levels.

Generally, the City of Hamburg and its involved bodies have **great experience and a comprehensive capacity** with respect to all phases of the realisation of NBS, including the assessment of hydro-meteorological risks, the planning and designing of risk reduction

measures and their implementation and monitoring. There is a particularly high competence in various modelling approaches. This includes topics related to the implementation of the EU FD (such as the establishment of flood risk maps and the establishment of flood risk management plans), integrated rainwater management (such as the planning and implementation of innovative concepts to prevent flooding by also reducing hydrological stress and corresponding pollution in urban streams), and competencies resulting from the responsibility for storm tide prevention in Hamburg and for the design of public dykes. Also the financial capacities to realise NBS are evaluated as quite satisfactory.

Against this background, the demonstrator has expressed that they can supply expertise on the following aspects:

- Assessment: The assessment of water quantity (water level, discharge) with hydrodynamic numerical modelling and rainfall-runoff modelling:
- Monitoring & Evaluation: Competencies with respect to monitoring and evaluating water indicators.

At the same time, the demonstrators have expressed needs to exchange knowledge with respect to the following aspects:

- Design: Gaining stronger expertise on how to design NBS for drought as well as for flood related risks;
- Monitoring and Evaluation: Gaining more expertise on how to monitor and evaluate aspects related to “nature” and “people”;
- Participation: Gaining more expertise on how to design and conduct a participatory process and how to get stakeholder on board during the realisation of NBS;
- Barriers: Good examples or practices of how to change resistance to realise NBS.

Political and regulatory context (incl. relevant policies)

In this section, we provide a general overview of the wider organisational-institutional context as well as policies that are relevant for the realisation of NBS in the area. First, we provide an overview of the wider policy context of the City of Hamburg and then proceed by further describing the roles of the demonstrators within the institutional context before describing specific European and national policies that support the uptake of NBS in this site. We also include additional information to better understand the case.

In the German context, the **City of Hamburg** is a unique place. It is not just the second largest city in Germany with 1.8 million inhabitants; as a so-called City State (*Stadtstaa*t) it also has a special position within the political landscape of Germany (similarly to the City of Bremen and Berlin). Hamburg is therefore both a city and a state. Furthermore, the citizens of Hamburg not only elect the Parliament of Hamburg (representative democracy), they also have a relatively strong approach to direct democracy. Citizens can initiate their own legislations (*Volksgesetzgebung*) and they have the possibility to oversee, engage with, and control the work of the administration of Hamburg (so-called D*eputationen*).

The City of Hamburg is represented through three different units. Of high political relevance is the participation of the **Senate Chancellery.** It represents the central political institution in the region with direct access to all the related administrative units in the region. Furthermore, it designs international policy supporting the transfer from content papers into political formats.

The **Ministry for Environment and Energy** (BUE) of the city of Hamburg represents a highly relevant technical competence within the demonstrator. It controls, executes and implements all the environmental protection related legislation in the City State of Hamburg. All integrated water resources management measures and planning decisions taken by public authorities and private stakeholders are carried out under monitoring and supervision (i.e. with consent from the BUE). For concrete implementation and planning procedures, the BUE assigns tasks to third parties, for example, the municipal Agency of Roads, Bridges and Waters (LSBG) or other sub-contractors (sub-contractor in this project), who carry out specific tasks with their own expertise under supervision and control of the BUE.

The LSBG (**Agency for Roads, Bridges and Waters**) is the technical service agency of the City of Hamburg, responsible for infrastructure planning, project realisation and maintenance of existing infrastructure in the areas of streets, bridges, tunnels, traffic systems and waterbodies, in particular, flood protection, coastal protection and related constructions. The Agency is represented through the Department Planning and Design of Rivercours, which is comprised of four teams: research and modelling, strategy risk management, water management and measures, and major projects.

The realisation of the planned NBS relates to and is supported by **various relevant EU, national and local/regional policies** (see Table A.2 for an overview):

Table A.2 Relevant policies for the realisation of NBS in the Demonstration site

Relevant European policies	Relevant national policies	Relevant regional/local policies
Flood Directive 2006/60/EC	Federal Water Law	Water Law of the City of Hamburg
Water Framework Directive 2000/60/EC		
Bathing water Quality and Repealing Directive 76/160/EEC		
Nitrate Directive 91/676/EC		
Waste Water Directive 91/271/EC		
European Bird Directive 79/409/EC		
Habitats Directive 92/43/EC		

In addition, Hamburg is positioning itself as a "**Smart City**", the relevance of which has been emphasised by the demonstrators. It will also shape the activities of RECONECT as both NBS and the usage of smart technologies in RECONECT for monitoring and evaluation is in line with the cities' overarching strategies. Hamburg is growing rapidly like most metropolitan areas around the world. This growth is challenging because political, ecological and social demands need to be bundled in order to ensure sustainability, quality of life and economic growth. This is why Hamburg aims at turning its Smart City approach into reality by establishing smart technologies and implementing numerous interdisciplinary pilot projects. These tangible steps in the fields of energy, mobility, logistics, governance, society and science benefit not only the city's innovative and

sustainable development but social progress as well. This approach is documented in the Senate's Program "Strategy Digital City"[9].

Wider social climate (including potential barriers)

In this section, we provide some background information on the wider social climate, including trust in the responsible organisations as well as the general acceptance of NBS as a way to reduce hydro-meteorological flood risks. This information will also help prepare the work detailed in Task 3.5 (validation) where the focus will be on what stakeholders expect from the NBS to be implemented at their sites. This can include potential co-benefits, but also risks that are associated with the realisation of NBS.

Currently, there are intense debates in the region about the reconnection of the Dove River and its catchments with the main Elbe River. This discussion is initiated by and organised through the Forum Tideelbe. The Forum was established in 2016. Its key objective is to ensure the sustainable development of the Tideelbe (that is the Elbe River stretching from the City of Hamburg towards the North Sea). Therefore, it brings together the states of Lower Saxony, Schleswig-Holstein, the City of Hamburg as well as the Federal Government of Germany (*Bund,)* and it ensures the exchange and cooperation between municipalities, cities, and relevant organisation along the river. At the centre of the Forum is a structured and thematically focused exchange that aims to consider different interests and perspectives of the affected parties along the river in order to find a shared agreement.

The Demonstration site is located within an area that is also affected by the discussion on the reconnection of the Dove River and the Elbe River. Through the reconnection of both rivers, the ecological status of the catchments shall be improved and additional retention capacity generated. On the website of the Forum, the challenge is framed in the following way:

> “The 18 km long branch of the Elbe was already dammed up in 1952 by the construction of the Tatenberg lock from the Tideelbe. By reconnecting the Dove-Elbe to the northern Elbe, additional tidal volume could be created to a relevant extent. Due to the existing restrictions, the opening of the Dove Elbe will only be possible to a limited extent, but the hydrological effect of this measure to dampen the tidal range is nevertheless estimated to be considerable.
>
> From an ecological point of view, the measure has so far been assessed positively with regard to the oxygen balance, the connection of shallow water zones and the development possibilities for the tidal reed beds in the tidal Elbe, although the potential for upgrading the area compared to valuable stands has been assessed as low.
>
> Conflicts arise in particular in the area of flood protection and with existing uses. The area is one of the largest water sports recreation areas in the Hanseatic City of Hamburg, an Olympic training area and a popular fishing area”[10].
>
> *Translated with www.DeepL.com/Translator*

[9] https://marketing.hamburg.de/smartcity.html
[10] https://www.forum-tideelbe.de/massnahmen/ausgewaehlte-massnahmen?id=0

Currently, citizens' initiatives are forming in order to prevent the outlined planned. Citizens fear that the reconnection would have negative impacts on the area, with respect to both recreational aspects and the agricultural use of the area.

At the current state, however, the discussions taking place in the Tideforum are considered as boundary conditions of the work to be performed in RECONECT; it is expected that it will not negatively influence the realisation of the planned activities.

A2. Seden Strand/City of Odense

Overview

With 179,601 inhabitants, Odense is the third largest city in Denmark[11] and is located on the island of Funen. Odense is represented in RECONECT by the City of Odense (Odense Commune). In addition, Amphi International ApS and RAMBOLL DANMARK A/S are supporting the realisation of the NBS at the case site.

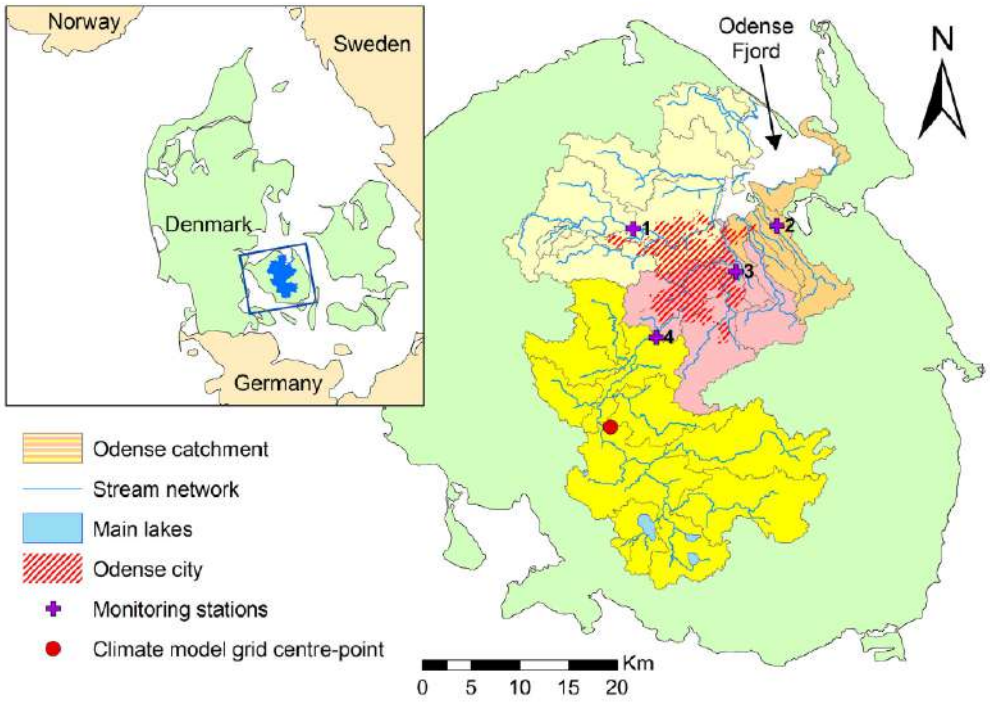


Figure A.5 Odense Fjord and the Odense catchment (Source: Molina-Navarro et al., 2018, 255)

The demonstrator site in RECONECT, Seden Strand, is located at the norther part of Odense. It comprises 142 building (most of them residential) as well as 66 ha of agricultural land, and is located next to the Odense Fjord which is connected with the Baltic See (see Figure A.5 and Figure A.6). The Odense Fjord is a rather shallow fjord with a catchment area of approx. 1100 km^2, including rivers and lakes (Molino-Navarro et al., 2018). The actual fjord has a size of about 46 km^2 with a mean water depth of 0.8 m at the inner fjord.

[11] https://www.statistikbanken.dk/statbank5a/default.asp?w=1920

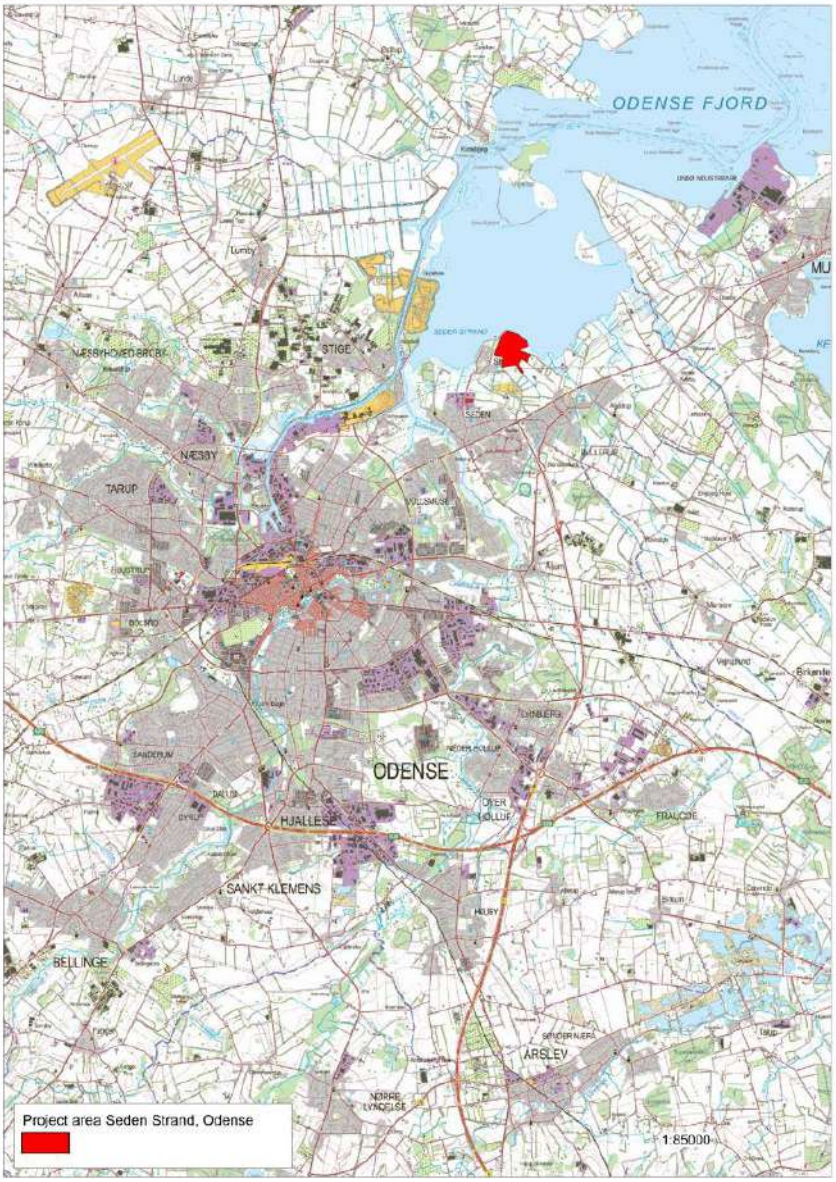


Figure A.6 City of Odense and Demonstration site12

Risk, vulnerability and risk reduction through NBS

Odense has a relatively high share of impervious surfaces within the city centre, and with its proximity to the Odense fjord north of the city and the Odense River running through the city, it is highly exposed to the risk of flooding during times of intense rainfall and storm surges. More recent flood events have unravelled the vulnerability of the city, including negative effects on the "transport infrastructure, buildings, human health, aquatic environments, recreational areas, and historical and cultural heritage" (Kaspersen and Halsnæs, 2017, 59). Against this background, it is hardly surprising that the Odense Fjord in the Odense Municipality is designated as one of the ten areas in Denmark with the highest potential and substantial risk of flooding.

Seden Strand is predominantly exposed to the risk of flooding from storm surges as well as, in the long run, from rising sea-levels. As Figure A***.7*** reveals, the current exposure of

[12] Source: https://www.klimatilpasning.dk/sektorer/natur/synergiprojekter/odense-kommune-seden-strandby/

Seden Strands results from a relatively recent, but rapid urbanisation process that began in the northern part of Odense in the early 1970s and resulted in 142 buildings that are currently vulnerable to the risk of storm surges from the nearby Odense Fjord.

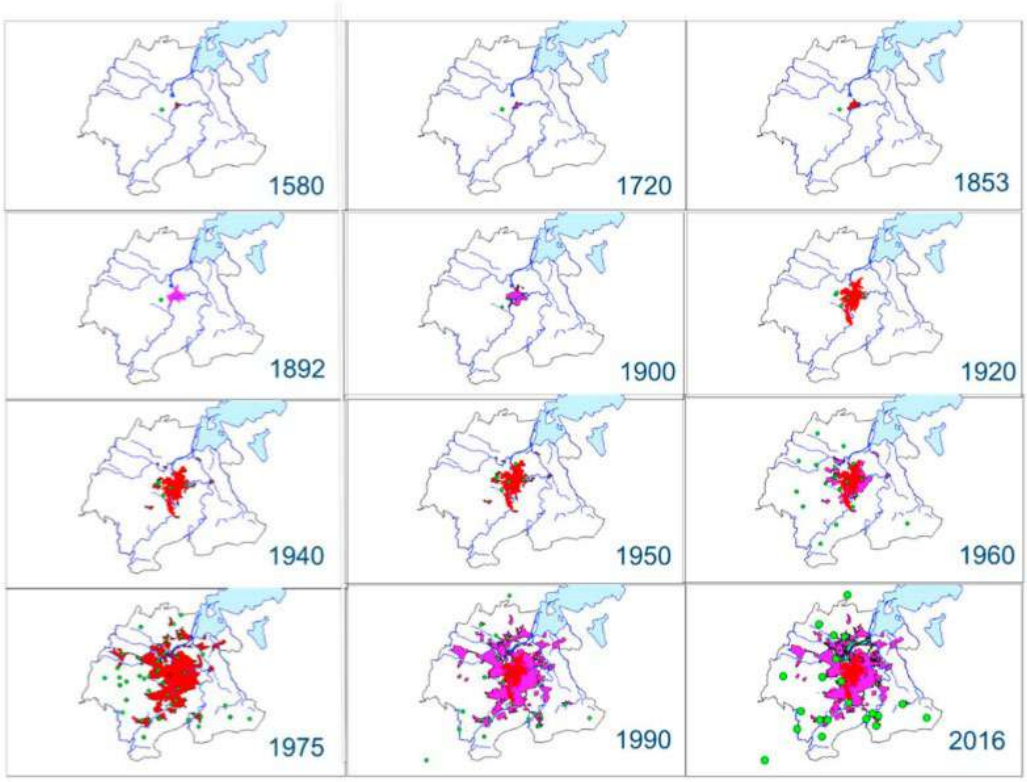


Fig. 2. City Growth from the early 17th century and until today, within the Municipality of Odense (Copyright: KMS)
Green dots represents well fields. [2]

Figure A.7 The historical urban development of the City of Odense (Source: Laursen and Linderberg, 2017, 106)

Concurrently, Seden Strand and the surrounding neighbourhoods represent valuable areas with regard to recreational activities as well as with regard to nature and forested land. In a study conducted by Kaspersen and Halsnæs in 2017, Figure A.8 shows that Seden Strand represents a site value of about 350 to 650 K € per year, underlining the wider socio-economic benefits the area provides to Odense.

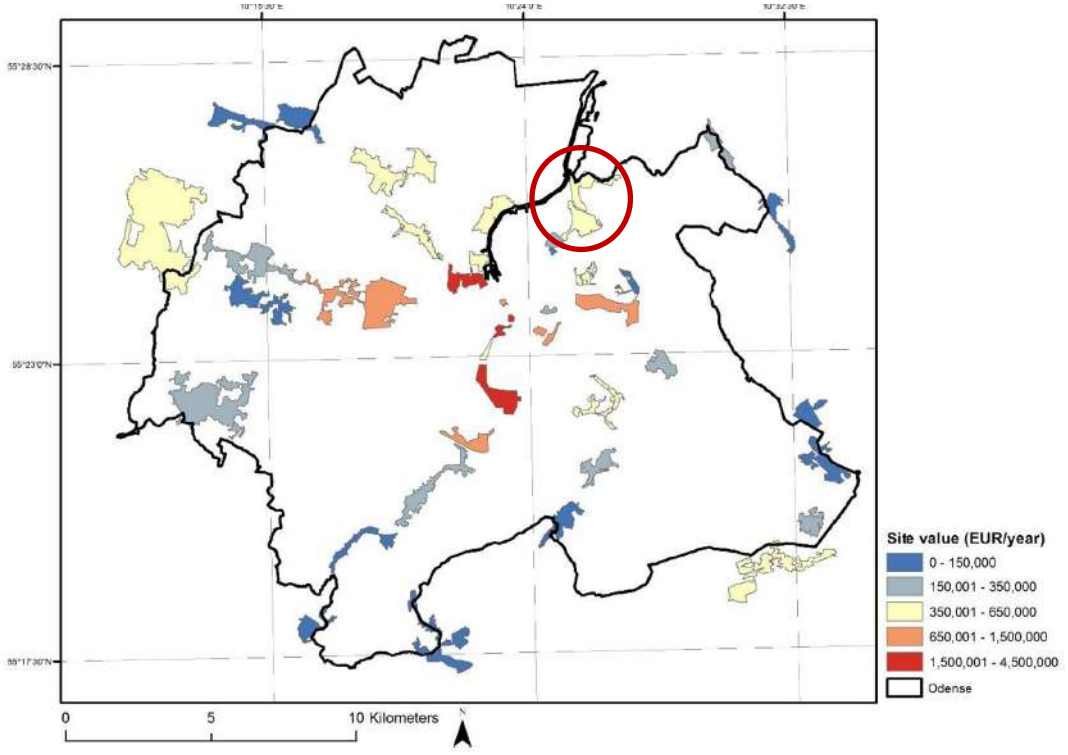
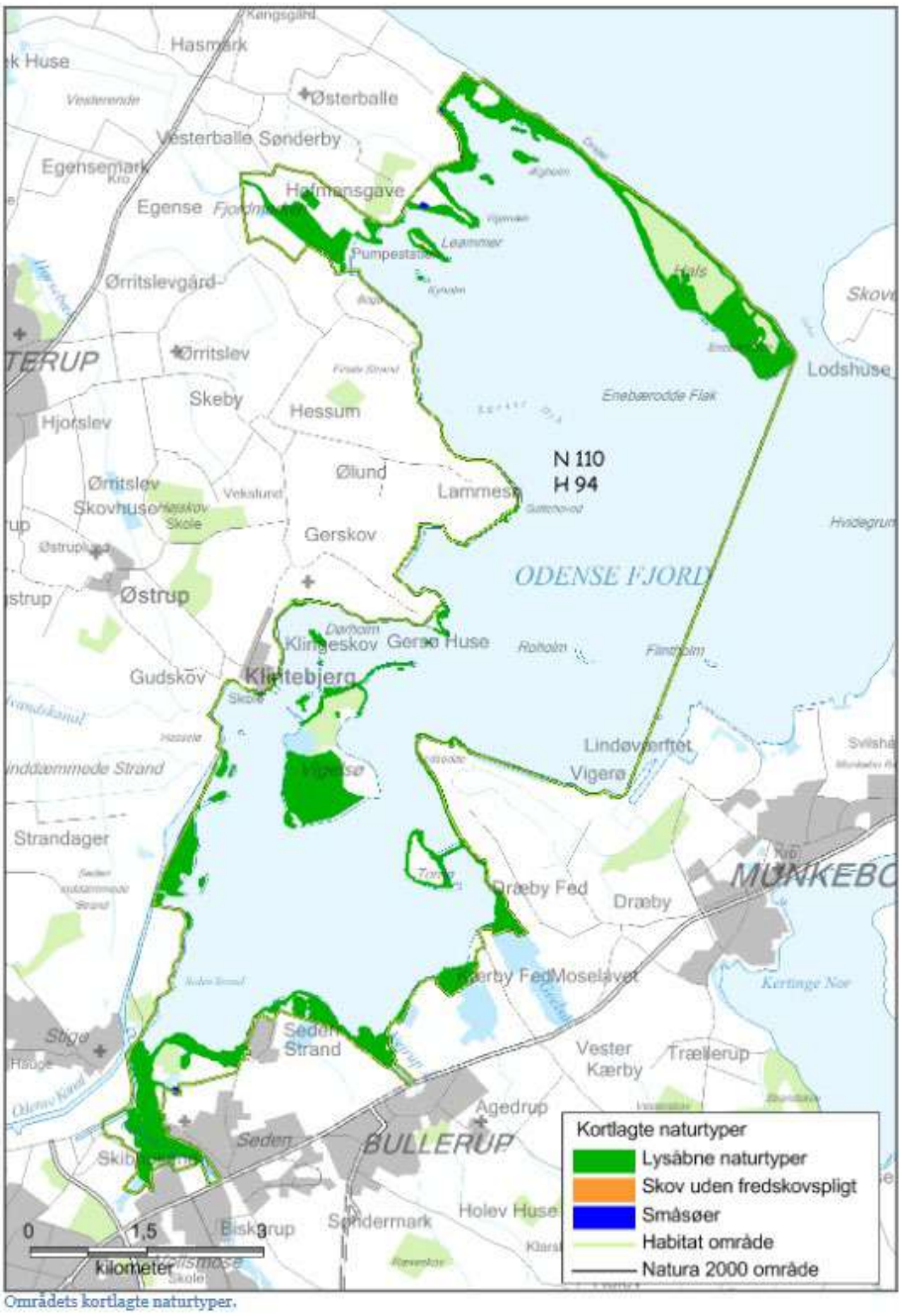


Figure A.8 Annual value of recreational, nature and forest areas in the municipality of Odense (Demonstration site in red circle) (Source: Kaspersen and Halsnæs, 2017, 59)

In addition to the exposure of the terrestrial environment, Seden Strand and more generally Odense Fjord also face biodiversity and water quality risks due to intense human activities. The catchment area of the Odense Fjord is dominated by agricultural use (68%), followed by urban areas (16%) and forested lands (10%) (Thodsen et al., 2015). Therefore, the water quality and the marine ecosystem of the fjord are negatively affected by environmental pollution resulting from elevated nutrient input leading to, among others, hypoxia, algal blooms and the disappearance of seabed vegetation and fauna. Despite several national action plans, the ecological status of the fjord is "classified as moderate/bad with a high risk of not achieving the environmental objective of good ecological status set in the next river basin management planning cycle" set out within the Water Framework Directive (Molina-Navarro et al., 2018, 255).

The Odense Fjord was declared a Natura 2000 area comprising of both the protection of endangered natural habitats and bird protection areas, highlighting the fragility and enormous societal value of the area (see Figure A.9). The fjord includes, among others, large areas of mud and reefs providing foraging sites for several migratory birds, such as swans and songbirds, as well as breeding birds, such as broods, splinters, fjords, oats and sea eagles. There is also a large population of beach meadows present (Naturstyrelsen, 2016, 8).

As Figure A.9 shows, Seden Strand is considered an open semi-natural habitat type ("Lysabne natutyper") and comprises areas that fall under the Habitat Directive as well as under the Natura 2000 Directive.



Områdets kortlagte naturtyper.

Figure A.9 Natura 2000 area at the Odense Fjord (Source: Naturstyrelsen, 2014, 12)

In light of the risks outlined in the previous section, the City of Odense aims to reduce two **sources of risk**:

1. The risk of flooding resulting from storm surges, coastal erosion and sea-level rise at Seden Strand;
2. The risk of an increasing loss of biodiversity and highly valuable habitats along Seden Strand.

The reasons for choosing NBS and not more established protection means, are grounded in the possibility of NBS to link both ambitions: Improving the protection of Seden Strand, its inhabitants and infrastructures, while at the same time stopping (or at least slowing

down) the further degradation of biodiversity within and outside the Natura 2000 sites by also improving the states of the valuable coastal landscape at Odense Fjord. Therefore, new small dikes will be constructed to protect the settlement and to restore a more natural habitat in the areas between the dikes and the Fjord. According to Ramboll, this approach represented a paradigm shift in the design of dikes for the protection of communities against sea-level rise and storm flooding. Existing summer dykes that are currently protecting grass fields and cultivated areas will be removed and replaced by new dykes, which will be located farther from the fjord and at a higher elevation.

Resettling the dikes also falls under the Odense Municipality initiatives outlined in the action plan for the Natura 2000 area at the Odense Fjord. One of the key initiatives is to create better conditions for coastal meadows and shorebirds, especially the Pied avocet (Recurvirostra avosetta) and the European golden plover (Pluvialis apricaria). The new dykes will contribute to this goal by enhancing the hydrological and biological conditions of existing coastal meadows and expanding and connecting the small areas into a cohesive coastal meadow area. The new dykes will continue to serve their purpose of protecting the cultivated land and buildings against storm tides, but by bringing a new design approach with a stronger focus on creating benefits for nature and water, the outcome of the project will deliver, as expected by the demonstrators, important results in terms of biodiversity and socio-economic benefits for the local community.

Capacities and needs with respect to realising NBS

The demonstrators include the City of Odense as well as two consultants, Amphi International ApS and Ramboll Danmark A/S. They **objectives** they want to achieve through participating in the RECONECT project overlap, but also differ between the participating partners. For the **City of Odense**, the most **important objectives** to be achieved in RECONECT are improved protection of Seden Strandby against the risk of flooding and decision support tools that help the city to better realise NBS, including a demonstration of the wider benefits of NBS against other, more technical solutions. In this sense, there is both a practical motivation as well as a knowledge-related motivation underlying its participation. There is also the ambition to enhance knowledge capacity by learning more about the wider effects of using NBS in order to reduce the risk of flooding. This is considered important, as it helps to find arguments in the political-administrative arena on why NBS might be more advantageous compared to more established, technical or “grey solutions”. **Amphi International ApS** objectives for RECONECT relate to methodological as well as network-related aspects. They aim at co-developing and co-implementing ‘on the ground’ methodologies that help to measure the benefits of NBS, particularly with regard to biodiversity. Another objective is to increase their visibility and excellence with respect to “biodiversity and ecosystem restoration as well as monitoring” by co-operation with other demonstrators in different regions and landscapes across Europe, and by doing so, enhance experience and knowledge exchange with other partners in Europe. Similarly, **Ramboll** aims at expanding their European/global network among climate adaptation, resilience and urban sustainability practitioners. Their objectives include gaining better access to state-of-the-art knowledge, tools and innovative products or schemes, which together with their knowledge of and presence in the market, can help with the creation of new business models for replication and upscaling of NBS projects; and to enhance their multi-disciplinary approach to address hydro-meteorological risks, based on RECONECT’s outputs on co-creation tools, social innovation models and new financing mechanisms.

The **motivation of the demonstrator** to realise NBS is very high, on the personal, organisational and political level. Not only was this expressed by the City of Odense's representative, but it is also reflected in the fact that before the RECONECT project started, the City of Odense was already pursuing an integrative strategy that aims at linking the objectives of climate resilience and increasing the biodiversity of the area. In a press release published in April 2017, the City of Odense underlined the relevance of both objectives[13]. By designating Odense Fjord as a Natura 2000 site, the City of Odense highlighted its special responsibility for drawing up plans to protect and improve the state of nature in the fjord. Particularly for Odense Fjord, the emphasis in the following years will be on "linking efforts for good habitats to the area's bird life with efforts to combat climate change as well as work to increase and maintain nature conservation" (see footnote 4; translation of the Danish original). While the ambition of connecting both objectives was already very high before RECONECT, only through RECONECT was the City of Odense put in a position to take concrete steps to realise NSB serving both objectives. In this sense, RECONECT is also a relevant financial resource as it ensures the financing of the measures to be taken. Moreover, RECONECT does not just provide the financial resources to realise NBS; it also provides the expertise and resources to monitor and evaluate potential multiple benefits that might be associated with NBS. This is considered particularly positive as it allows the demonstrator to show the added value of NBS which may increase the acceptance of such NBS-based measures in the City of Odense and beyond.

The key person in charge of leading the realisation of the NBS at the Demonstration site is an experienced employee of the City of Odense with an extensive background on the planning and completion of nature and flood related projects. However, both the City of Odense and the key person have no experience with respect to the realisation of NBS. Overall, there is sound **expertise and knowledge capacity** with regard to all aspects relevant for the realisation of NBS: However, as a practical partner engaged with many different aspects related to NBS, their knowledge is broad but lacking depth as many activities fall outside the scope of their immediate responsibility. For instance, the City has capacities to conduct a risk assessment, but only on a general level. Similarly, there is knowledge on how to design an NBS, but typically the specific design work is subcontracted to companies to avoid liability issues. The monitoring and evaluation of the NBS is a relatively new task for the City; they are usually more concerned with realising projects and less with monitoring and evaluating the effects post-implementation. However, monitoring and evaluating the wider potential benefits of NBS is highly valuable, and having the resources and the time as well as the interdisciplinary expertise to evaluate the benefits for Water, Nature and People is a great asset to the project.

In this context, the regional partners Ramboll and Amphi provide essential support as they have key expertise on the design of NBS and on monitoring nature and water indicators. Ramboll has extensive experience in project management of large and small projects within infrastructure resiliency planning, storm water management, green infrastructure design and flood risk management for cities, regions and infrastructure operators. They have a particular focus on NBS from the development stage to design and implementation of NBS. AMBHI has extensive experience on aspects related to biodiversity and ecosystem restoration, including rainwater management; recovery plans for locally threatened Amphibian species; and restoration and monitoring of water quality in

[13] https://www.odense.dk/presse/pressemeddelelser/pressemeddelelser-2017/odense-er-klar-til-stoerre-indsats-for-aaen-og-fjorden

Amphibian habitats - including pesticide analysis, toxicological tests and evaluations, nutrient measurements, heavy metal analysis, and macro-invertebrate surveys. Through the relative spatial proximity of TDU and their expertise on evaluating indicators on People, the demonstrators can build on an already great stock of expertise from internal resources.

Against this background, the demonstrators have expressed that they can supply expertise on the following aspects:

- Design: Liveable/living shoreline implementation
- Monitoring and Evaluation: Designing nature monitoring and indicators
- Participation: Cooperation and negotiations with stakeholders
- Participation: Stakeholder experiences and facilitation
- Upscaling: Business case for NBS; Socio-economic calculations for CBA
- Upscaling: Business case for IFI-financing and climate justice

At the same time, the demonstrators have expressed needs to exchange knowledge with respect to the following aspects:

- Design: Sharing ideas on designing NBS
- Monitoring and Evaluation: Choosing and approaches to monitoring a people indicator
- Monitoring and Evaluation: Nature Indicators; how to choose them, collect data, resources, etc.
- Upscaling: Develop a tool demonstrating the benefits of NBS compared to grey solutions

Political and regulatory context (incl. relevant policies)

Politically the City of Odense is governed by the City Council with 29 elected members. Furthermore, there are about 13,500 public servants working for the City of Odense, including the Mayor's Department, The Department of Culture, Sport and Urban Development, The Department of the Elderly and Disabled, The Department for Children and Youth Affairs and The Department of Employment and Social Services[14]. The Department involved in RECONECT is The Department of Culture, Sport and Urban Development. The main authority within the project is Odense Municipality. The municipality is responsible both for dealing with climate changes locally and the conservation of nature, excluding marine habitats.

In the context of the project, it is important to highlight that the Odense Fiord in the Odense Municipality is designated as one of ten areas in Denmark with the highest potential and substantial risk of flooding. Therefore, the Odense Municipality has created a climate adaptation plan in corporation with the neighbouring municipalities outlining key steps to be taken to adapt to the consequences of climate change. It is the ambition of Odense, to link efforts of climate change adaptation with biodiversity protection, reflected in various policies that are relevant for the demonstration site, including that fact that Odense Fjord is a Natura 2000 site (DK008X075), is protected both by the EU´s Bird Directive[1] and the Habitat Directive[2].

The Odense Municipality is the local authority responsible for a majority of environmental issues which are affected by several EU directives and policies, such as the flood directive, the water frame directive, the habitat directive and the bird directive. Additionally, the Odense Municipality administers the relevant laws in Denmark such as the Coastal

[14] https://english.odense.dk/about-odense/city-government-and-administration

Protection Act, The Nature Protection Act, The Act on Rivers and Watercourses, The Planning Act and The Environmental Protection Act. All these acts and policies shape the uptake of NBS in the pilot site area.

Wider social climate (including potential barriers)

In contrast to the other demonstrators, the demonstration site is spatially quite clearly defined and rather small. According to the demonstrator no barriers were faced so far. There was one farmer, who was initially resistant to providing land for the realisation of the NBS. However, an agreement was found between the farmer and the City of Odense. This is also a result of a strong cooperative approach underlying the Danish flood risk management approach. Solutions are always developed in strong cooperation with those stakeholder affected by both the solutions developed as well as by the risks mitigated. The reasons therefore is also grounded in the fact, that stakeholders need to at least co-finance risk reduction measures and therefore have a strong right to be involved in decision-making processes. As relevant stakeholders haven been involved from the outset of the planning phase, and are regularly informed about the progress, the demonstrator does not expect future barriers, expect time: Within RECONECT there is a clear time limit for when measures are to be realised by to allow time for monitoring and evaluating the wider benefits of the NBS. Time is thus rather not a barrier, but a critical boundary condition that is shaping the implementation process, which should ideally take place rather early.

A3. Tordera River Basin (Spain)

Overview

The Tordera River is 55 km long and it flows along the Catalan Pre-coastal Mountain Range,
its basin comprises 894 km^2. 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. Tordera River Basin is represented in RECONECT through The Catalan Water Agency (Agencia Catalana del Aigua).

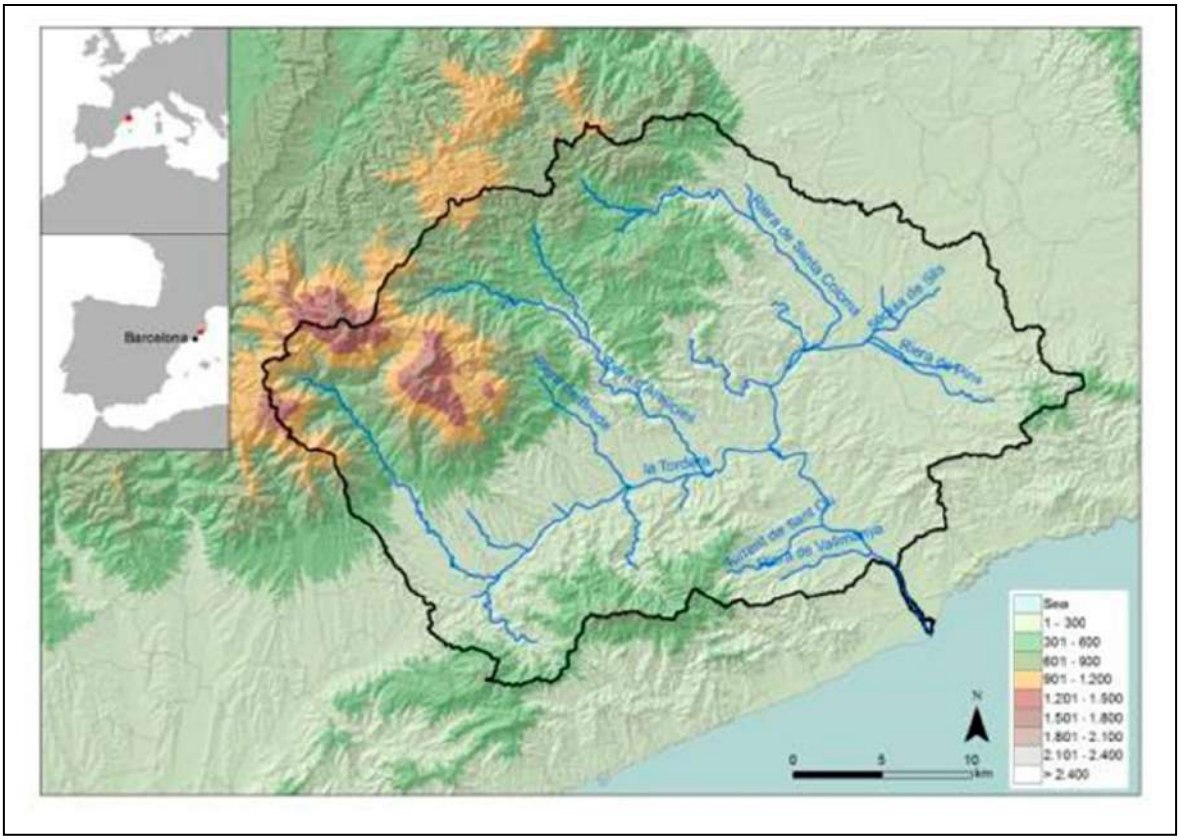


Figure A.10 The location of the Tordera River Basin (Source: Sanchez-Plaza et al., 2019, 6)

The predominant land cover categories in the Tordera River Basin are forest (64%) and shrubs (15%). Urbanized areas account for 8% of the total area of the basin, whereas 11% of the area is covered by agricultural fields and 1% by infrastructures (roads and railways). The area represented three different geomorphological types.

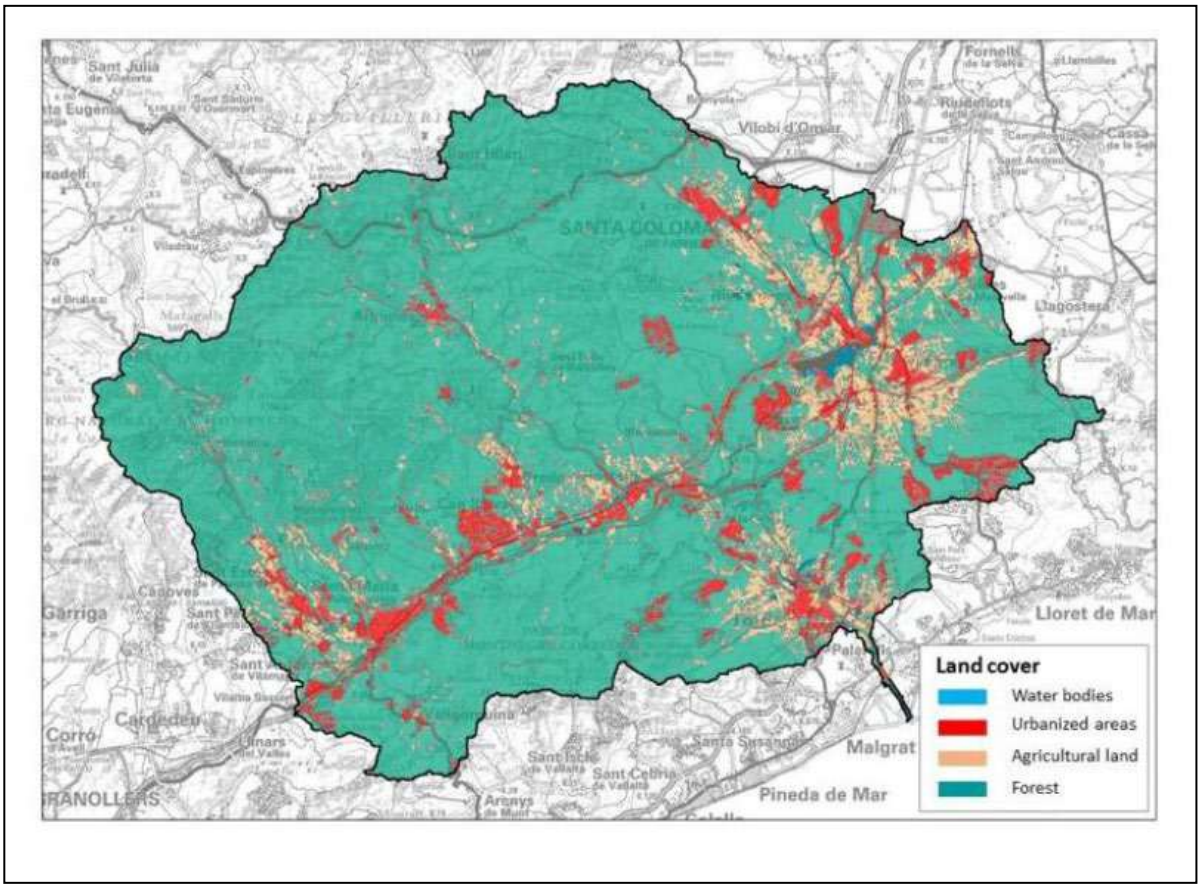


Figure A.11 Dominant land-cover in the Tordera River Basin

The upper reach, that stretches from the Tordera source to the municipality of Sant Celoni, presents the geomorphological characteristics of mountain streams (coarser river bed material and steeper slopes). The middle and lower reaches of the Tordera River present lower slopes (< 1%) and finer bed material, becoming a sand-bed river from the confluence of one of its main tributaries, Riera de Arbúcies, to the outlet at the Tordera Delta.

Table A.3 Selected key characteristics of the Tordera River Basin Demonstration Site (Source: Verkerk et al., 2017, 3)

	Key characteristics of the Demonstration Site
Area Size (km²)	• 865 km²
Population (2011)	• 157,500 People
Climate	• 14 ° C Mean temperature; 748 mm precipitation per year
Dominant Land use %	• Forest: 64 %; Shrubs 15 %; Agriculture 11 %; Urbanized areas 8 %; Infrastructure 1 %

Risk, vulnerability and risk reduction through NBS

This Demonstration area is exposed and defined by a typically Mediterranean, translating into quite typical climate related risks. The Demonstration site is characterized by wet and mild winters and dry and hot summers. The precipitation regime is highly seasonal and irregular, with two dry seasons (January-February, June-August) and two rainy seasons (March–May, September–December), being the months of October and July the rainiest and the driest, respectively. Flash floods are the main climate driven hazard in the Tordera River Basin, occasionally causing serious material damages to vulnerable areas. Flash floods are caused by events of intense precipitation, occurring mainly in autumn. Important parameters that define this type of hazard are total amount of rainfall, rainfall intensity, infiltration and retention capacity of the basin, topography, and land use, among others.

The areas is facing various challenges resulting from the consequences of global environmental change. A participatory assessment conducted by the BeWater15 project reveals a multitude of drivers that have an impact on the region. Due to the effects of climate change river flows will decrease, especially in the upper parts of the Basin. At the same time, there is an increasing risk of heavy cloud burst resulting in heavy rainfalls as well as storm surges. Flow regime will also shift into new patterns, affecting flora and fauna of the basin. As an implication, humid forests in the upper part of the basin will suffer the effects of climate change. Agriculture in the basin will face the effects of climate change too. Agronomic calendar changes will induce different crop and irrigation water management. For the people living in the basin, climatic conditions will become more uncomfortable. Higher temperatures may also increase domestic water consumption levels.

In light of the risks outlined in the previous section, the Tordera River Basin demonstrator aims to reduce two **sources of risk**:

1. Coastal erosion and storm surge flooding. In the Tordera Delta the coastline is receding and threatening infrastructures and other activities present in the area. Flooding due to storm surges also occur from time to time.
2. Urban flooding due to in-site heavy rainfall is also a problem in some of the urban areas located within the basin.

Capacities and needs with respect to realising NBS

The Tordera River Basin demonstrator is represented by an administration, The Catalan Water Agency (ACA) and an SME, Hydrometeorological Innovative Solutions (HYDS). They have **pursuing different objective** by participating in the RECONECT project. **ACA** aims gaining a better understanding of definition of indicators and variables intended to monitor and evaluate the benefits of NBS; aims at gaining knowledge about monitoring the processes of the aforementioned indicators through appropriate instrumentation, technology and algorithms and to thus have a better understanding of the effectiveness of NBS to also be able to better plan and communicate the added value of NBS in the future. **HYDS** aims at gathering more knowledge about the ICT-related needs from stakeholders

[15] The BeWater project was funded under the Grant Agreement Number 621385 during 7th Framwork Program. http://www.bewaterproject.eu/

involved in the realisation of NBS, expand their own ICT platform capabilities and enter in the marked of technology providers in the framework of NBS.

Generally, the **organisation's motivation** to realise NBS is quite high and also of high relevance as the CWA is overseeing and implementing river restoration projects in the region. However, and this is quite interesting, these activities are not labelled as NBS but rather understood as classical restoration project. Therefore, the organisation is also highly committed to realise such restoration/NBS projects. The motivation on the political level needs to be differentiated. Elected politicians in the region have a high interest to reduce flood risks; If they are convinced that NBS can effectively reduce flood risks, they would rather support it. However, if they are less convinced about their effectiveness, support and motivation to realise such measure will probably be rather low. In this line the NBS envisioned to be implemented in RECONECT are well financed. However, additional measures are currently not foreseen or financed (beyond restoration projects).

Generally, ACA has **great experience and a comprehensive capacity** with respect to the implementation of the Water and Floods Directive, including the assessment of hydro-meteorological risks, the planning and designing of risk reduction measures and their implementation. However, the emphasis is rather on grey flood risk reduction measures and less on NBS (with the exception of river restoration). Next to the assessment, there is also a high competence with respect to planning grey solution and initiating the implementation process through contracting companies. A task the demonstrator is eager to build up competences relates to monitoring and evaluation activities. This is something that is not part of daily activities of ACA. However, this is regarded as a topic of high relevance, also to show the co-benefits of NBS and to have good arguments in the political realm for why more attention should be paid to the realisation of NBS to reduce hydro-meteorological risks. This can also help to overcome potential barriers on the political and institutional level. Supported is ACA by HYDS, which can particularly provide support with respect to monitoring activities as well as developing demand-driven ICT platforms.

Against this background, the demonstrator has expressed that they can supply expertise on the following aspects:

- Monitoring & Evaluation: Early Warning Systems + Decision support, Systems for Monitoring;
- Monitoring & Evaluation: Data management and exploitation platform for monitoring, including analysis and visualisation.

At the same time, the demonstrators have expressed needs to exchange knowledge with respect to the following aspects:

- Assessment: To learn more about different type of innovative NBS and how to conduct an effective cost-benefit analysis:
- Monitoring and Evaluation: Ways to align WFD indicators with the needs of the RECONECT project, conduct a cost- and time-effective monitoring based on available data/tools (specially for nature and people indicators);
- Participation. To learn more about how to conduct a participatory process.

Political and regulatory context (incl. relevant policies)

ACA is the agency responsible for managing the water cycle in Catalonia, according to the guiding principles of the European Water Framework Directive as well as the European Floods Directive. Key documents are the River Basin Management Plan (RBMP) and the

Flood Risk Management Plan (FRMP) for the River Basin District of Catalonia, which are both in compliance with the EU Water Framework Directive and the EU Floods Directive, respectively. ACA is currently developing the Tordera River Basin Levee Management Plan, measure included in the FRMP that was approved in March 2018. The main objective of the Plan is to characterize flooding conditions in the basin as well as to analyse and plan the NBS (among other types of measures) to be implemented in the Tordera River Basin to help reduce flood risk. All NBS planned and realised need to comply with this framework plan.

Another important set of actors are the municipalities in the basin, as they are responsible for land use planning and civil protection at local level. In this sense, those municipalities in which NBS will be located and implemented will necessarily become key stakeholders to be taken into account in the design, implementation and maintenance of the measures. They will grant construction permits for those NBS located more than 100 meters away from the river bank. They may also help with land acquisition and to arrange stewardship agreements when needed.

Table A.4 Relevant policies for the realisation of NBS in the Demonstration site

Relevant European policies	**Relevant national policies**	**Relevant regional/local policies**
Flood Directive 2006/60/EC		Flood Risk Management Plan Tordera River Basin Levee Management
Water Framework Directive 2000/60/EC		River Basin Management Plan (RBMP)

The Department of Territory and Sustainability of Catalonia (DTES) is also of relevance as it has responsibilities in land use planning and environmental planning at regional level, and it is developing a programme of green infrastructure at Catalan level. Coordination between ACA and DTES will be needed in the design and implementation stage of the project to make sure that NBS follow the requirements to be considered green infrastructure. In addition, DTES may help with land acquisition as well as to arrange stewardship agreements when needed. Previous to the construction stage, and in case it is needed, DTES will evaluate the environmental impact assessment of the NBS and grant the necessary permits.

Wider social climate (including potential barriers)

Although NBS have not yet become part of the official rhetoric in Demonstration site and first positive experience with respect to river restoration project have been made, the Demonstrators expects future barrier. There is currently a focus on risk reduction on the administrative, political and public side. NBS implies that also other objectives are pursued and that risk reduction is not the sole focus but multiple perspective and co-benefits are included. As a result, stakeholder might fear that measures are less effective and too much priority is given to other benefits. There might also be a tendency that elected politicians favour solutions that are favoured by the wider population. Such a demand-driven approach can be in conflict with the idea of implementing NBS. However, these are just potential barriers, that have not yet become apparent.

A4. Portofino Regional Nature Park (Italy)

Overview

This Demonstration site encompasses the Portofino Regional Nature Park, including the municipalities of Camogli, Portofino and Santa Margherita Ligure (see Figure A.12). The park gets its name from the picturesque former fishermen's village Portofino, a famous tourist attraction located on a small peninsula in relative close proximity to the City of Genoa, Italy. The partners of the demonstrator site are GISIS Geographical Information Systems, The Portofino Park Authority and Consiglio Nazionale delle Ricerche (CNR).

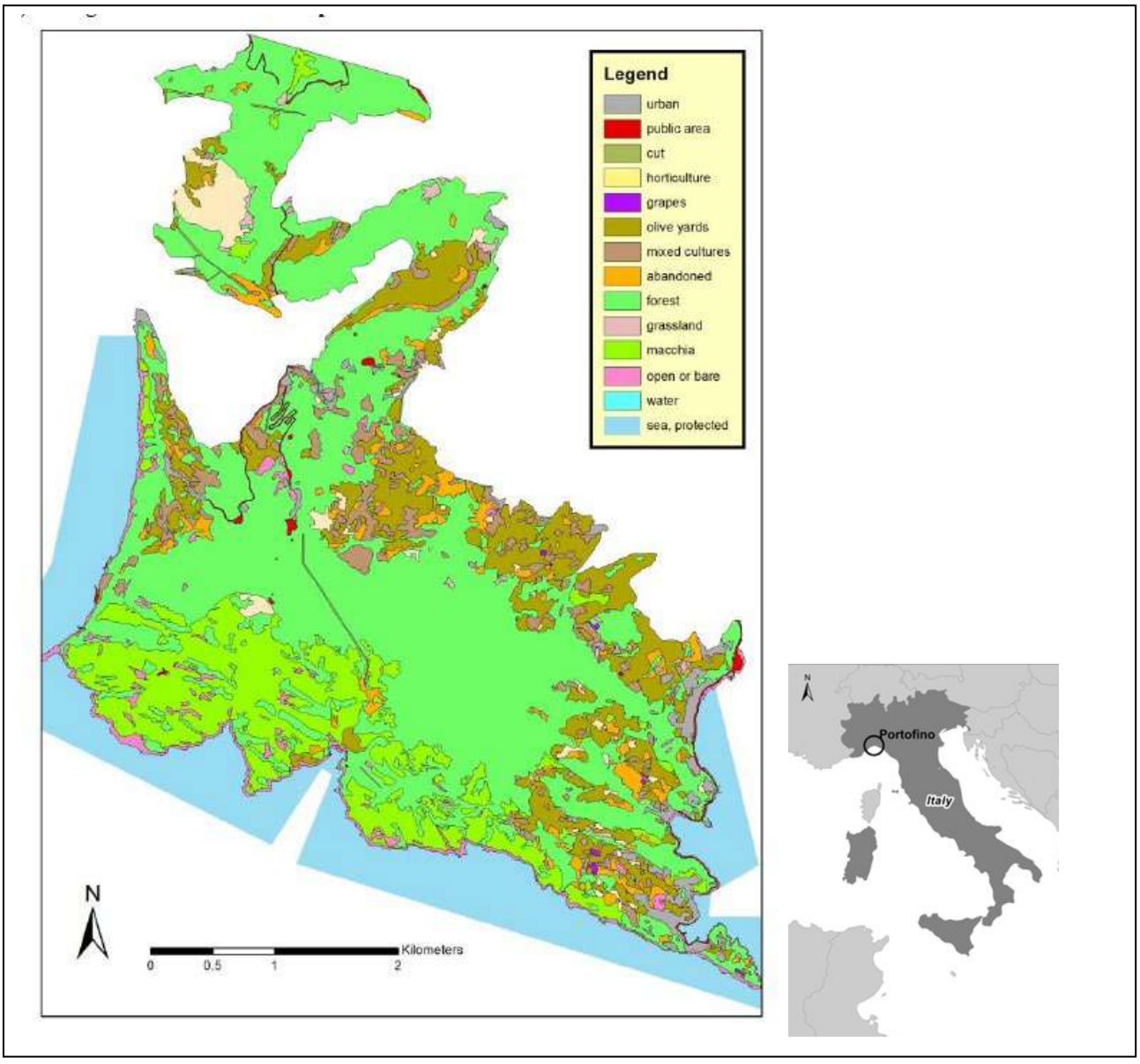


Figure A.12 Vegetation and land-use map for Portofino

A large area of the territory has been part of the Parco del Monte di Portofino since 1935, which gained the status of a Regional Nature Park in 1977. In 1996, the current Portofino Park Authority was constituted, with administrative and functional autonomy. In 2001, within the park and under the competence of the Park Authority, the surrounding Sites of Community Importance (SICs) were included. The Natural Park of Portofino has less than 700 inhabitants, although it is frequented by about 4,000,000 visitors per year.

Figure 5. View of Portofino Promontory from the SE. The geomorphological landforms and processes are strongly controlled by the tectonic features (photo by A. Girani).

Figure A.13 View of Portofino Demonstration site from the South-East (Source: Faccini et al., 2008, 457)

A main feature of the peninsula is the steep south-faced ridge that rises from sea level up to the Monte di Portofino (610 m). Figure A.13 provides a view of the Demonstration site from the southeast. The geology and microclimatic variations together with the various expositions and slopes of the place, have decisively determined its vegetation differentiation. Furthermore, there are two major geological formations in the area: the Portofino conglomerate which overlies the Monte Antola limestone. Natural vegetation types are the most common, and apart from the macchia-covered south slopes, the area is mostly forested with approximately 20 % of the area having an agricultural function.

The climate is mild Mediterranean, the mean temperature ranges from 13.5-15.5 degrees and the average rainfall is 1227 mm (Van Der Sluis et al., 2014). However, as Figure A.14 indicates, the micro climate has a high variability of factors such as altitude, exposure, air humidity and vegetation cover of different topoclimates (Faccini et al., 2008). The

maximum rainfall occurs in autumn and the minimum in summer, with mean annual rainfall ranges between 900 and 1300 mm, dependent upon the orographic features (see Figure A.14).

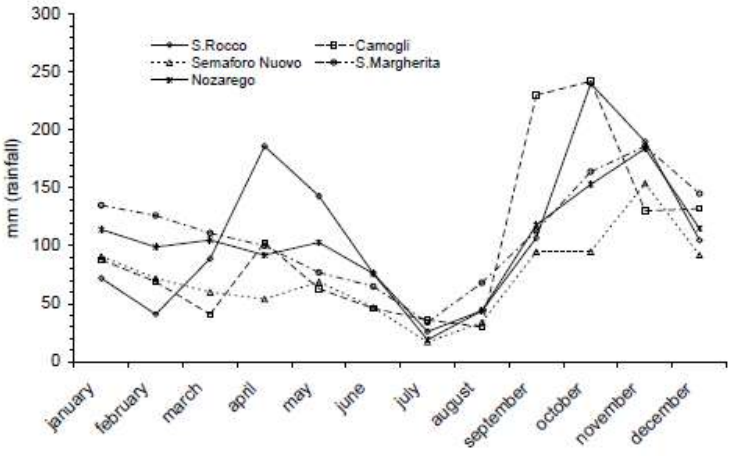


Fig. 2. Distribution of annual mean rainfall.

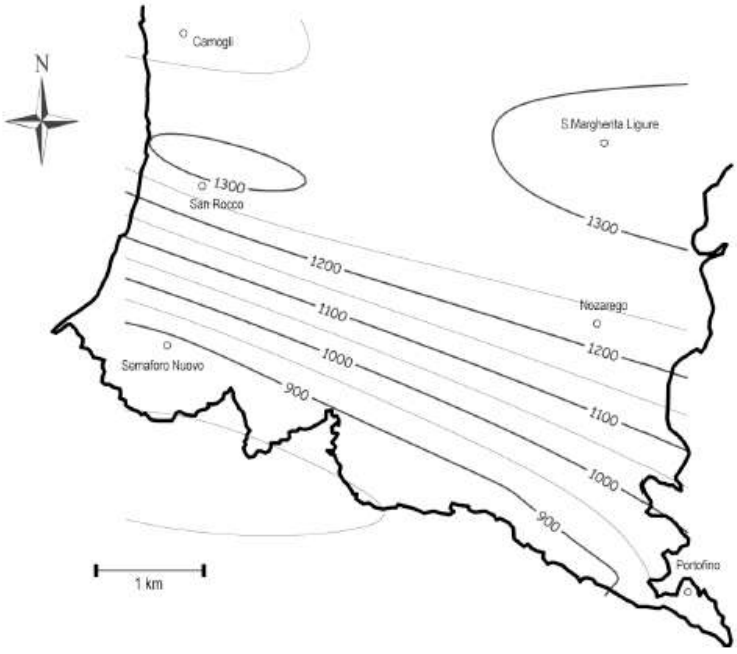


Fig. 3. Isohyet map with meteorological stations.

Figure A.14 Annual precipitation and isohyet map of Portofino Area (Source: Brandolini et al., 2006, 564)

Table A.5 provides on overview on selected key characteristics of the Portofino Demonstration site.

Table A.5 Selected key characteristics of the Portofino Demonstration Site (Source: Van Der Sluis et al., 2014, 27)

	Key characteristics of the Demonstration Site
Area Size (km²)	• 42 km²
Population (2011)	• 18,000 people
Topography	• Mountainous, with 90% sloping land, highest elevation of 610m
Climate	• Ranging from sub-humid in the South (920 mm precipitation) to swamp in the North (1300 mm precipitation)
Geology - soils	• Dominant is the very hard calcareous conglomerate (northern slopes) that is overlying the soft clayey limestone (southern slopes).
Land use %	• Agriculture (total): 365.4 ha (20%), Olive yards 250.0 ha (14%) • Other agriculture 115.5 ha (6%), Abandoned 72.4 ha (4%) • Infrastructure 67.1 ha (4%). Natural Vegetation 1340.9 ha (67%)
Terracces	• Two types: stone walls and embankments. Stone walls are mostly parallel – braided terraces but in some cases half-moon shaped supporting one tree

Risk, vulnerability and risk reduction through NBS

The Portofino Regional Natural Park is exposed to an increasing amount of relatively intense and brief rainfall events, as verified through the analysis of rain gauge data over the last 100 years. It is expected that the intensity of rainfall will increase during the next decades. This results is a number of geo-hydrological hazards that translate to specific risk patterns which are described in more detail in this section.

Current risks and vulnerabilities in the Portofino Demonstration sites are a mix of long-term historic human habitation (from prehistoric times onwards) and more recent developments, which have both shaped the current landscape (Van Der Sluis et al., 2014).

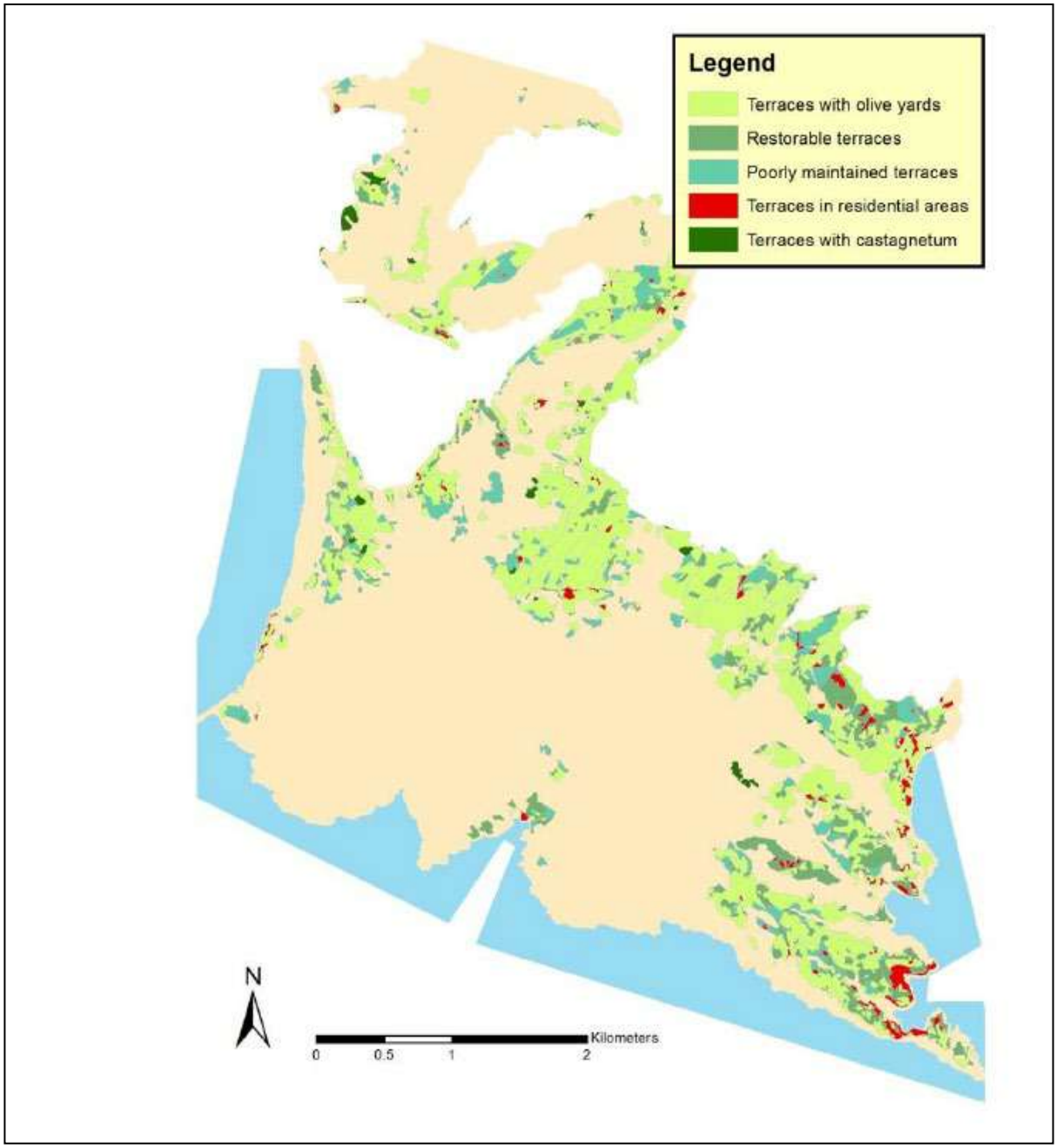


Figure A.15 The state of terraces in Portofino Regional Natural Park in 2000 (Source:Van Der Sluis et al., 2014, 35)

For a long time the main economic activity along the coast, and particularly in the village of Portofino, was fishing. From the 16th century onwards, multifunctional land use was quite common. Over the past decades this changed gradually, and tourism, habitation and nature conservation have become important. Intensive farming areas have therefore been largely abandoned in the region which has had far-reaching consequences for the current landscape formation. Typical features like farming terraces, olive yards, and upland

grasslands have been decreasing since 1950, similarly to many other Mediterranean areas. According to an analysis by Van der Sluis et al, agriculture is widespread in the east of the park, amounting to about 150 ha inside the current limits of the park (2014). In the eastern part of the region, about 50% of the land was cultivated. Terraces and orchards, which have been partially abandoned, are still giving testimony to this time. In the past, there were also terraces in the western part of the Park, but these have been abandoned and are now entirely eroded. Figure A.15 provides an overview on the state of terraces in the year 2000.

Generally, the terraces are of great relevance for the landscape as they stabilize hillslopes, enable cultivation and often contribute to an increasing degree of biodiversity. Although the first terraces seem to date back to prehistoric and Roman times, documentation of large scale terracing dates back to the Middle Ages on the south side of Portofino, when the San Fruttuoso Abbey and other churches were a driving force behind terrace construction. The maximum extent was reached during the 19th century, and during the 20th century, terraces were constructed on the higher south-eastern slopes for reforestation purposes (see Figure A.15). In these areas, two types of terraces are found: stone-walls and embankments. The dry-stone walls have a “loose matrix” and are not cemented. The second type, embankment systems are earthen walls which are of rather gentle slope and either placed on a rock foundation or on soil.

The r**eduction of the number of terraces** has negative effects on biodiversity and results, among others, in increased soil erosion, less rainwater infiltration and increased flood risk (Van Der Sluis et al., 2014).

Current vulnerabilities are also a consequence of the strong **influence of tourism** in this area. Although the Portofino area became an internationally well-known touristic hot spot in the early years of the 20th century, only in more recent decades has there been a strong pressure on the coastal area of Italy. This has resulted in, among others, a spread of villages and towns due to economic activities as well as tourism which have had detrimental effects on the coastal zone. According to Van der Sluis et al. the region surrounding Portofino is therefore today “a well-known resort and an attractive site for the ‘rich and famous’, for second houses, and for investors to develop facilities for tourism” (2014, 27).

Next to the exposure of building and residents, **tourists are a particular vulnerable group** in this region, particularly if they are moving in the landscape. The many trails in the coastal area of Portofino are frequently used by tourists for trekking or as pathways to small villages and some of the more isolated beaches along the coast. As the analysis of Brandolini reveals (2006), the site is characterized by a dense network of trails, with a total length of more than 70 km, partially on steep slopes, distributed in an area slightly exceeding 1000 ha. In particular, the trails on the southern slope leading to San Fruttuoso are steep, often with steps in the rock and narrow winding turns. There are sometimes difficult parts in ascent and descent. Both the trails and passing tourists are exposed to a number of hazards including dangerous processes triggered by gravity, running water and wave motion resulting from strong precipitation events which affect the slopes and the cliff. In the time between 1999 and 2004, an average of 5–6 rescue efforts per year were undertaken by local rescue crews (Brandolini et al., 2006), and rescue operations predominantly occur between May and September (the main tourist season).

There are also numerous **cultural heritage sites** (e.g. San Fruttuoso village, including the the ancient Abbey, the monastic complex and historical buildings as the Casa dell'Arco) as well as **geoheritage sites** that are vulnerable to the consequences of hydro-geological hazards. Particularly the geoheritage sites – understood here as "geological elements that present a certain value due to human perception or exploitation, e.g., elements with high scientific, educational, aesthetic, and cultural value" (Faccini et al., 2019, 2) - are of relevance with respect to the production of vulnerable conditions as the trail network follows to a large extent the distribution of the terrestrial geosites, which are widespread all over Portofino Park, as an analysis by Faccini et al. (2019) revealed (See Figure A.16).

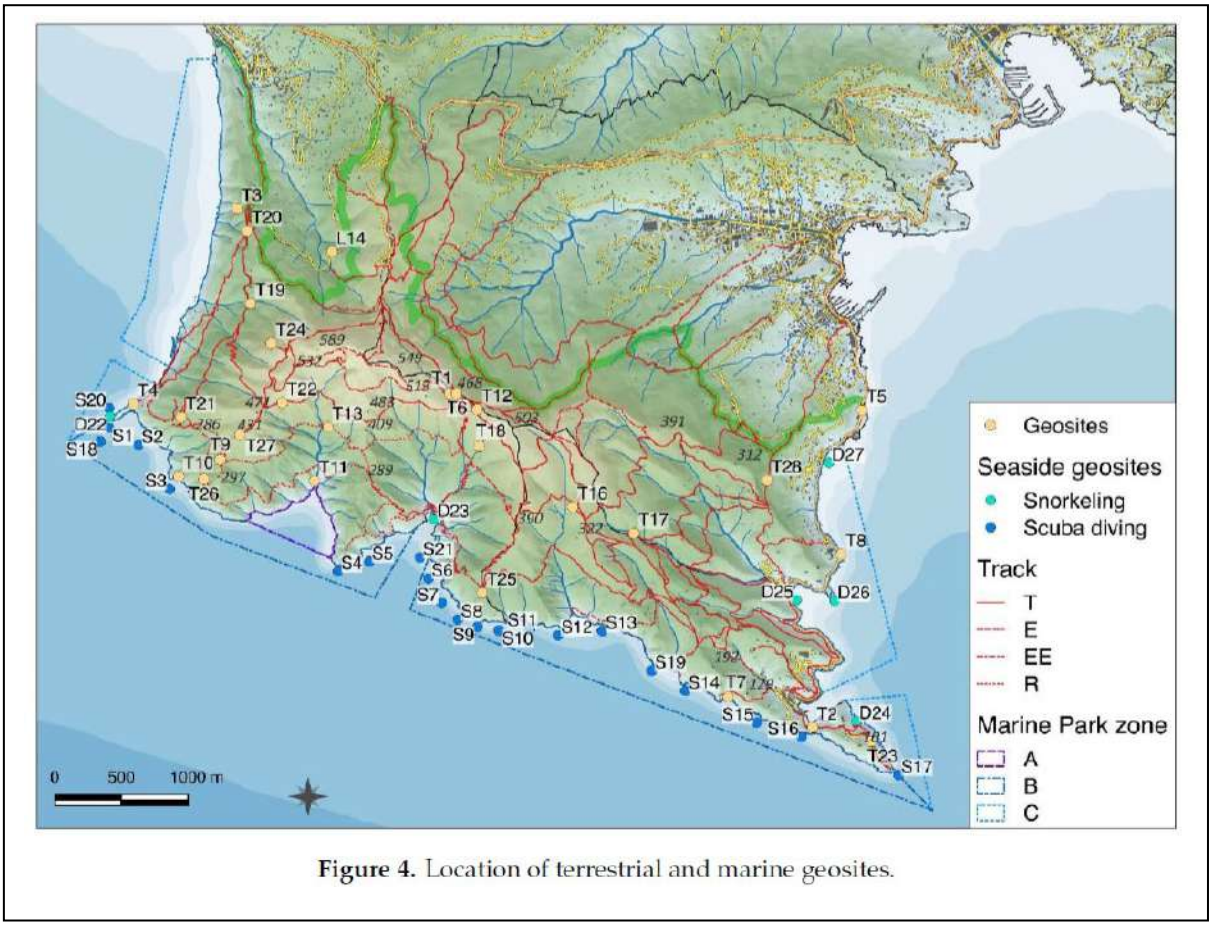


Figure 4. Location of terrestrial and marine geosites.

Figure A.16 Location of terrestrial and marine geosites in Portofino Regional Natural Park (Source: Faccini et al., 2019, 14)

They identified twenty-eight terrestrial geosites and twenty seven marine geosites in the Portofino Regional Natural Park. The terrestrial geosites are mainly sites of geomorphological interest of tectonic origin, gravity-induced slope landforms or even coastal landforms. Marine geosites are mainly concentrated between Punta Chiappa di Levante and Punta Portofino.

In light of the risks outlined in the previous section, Portofino Regional Natural Park aims to reduce risks stemming from **geo-hydrological hazards** resulting, above all, from extreme rainfall events. More specifically, the risks resulting from floods (flash floods and hyperconcentrate floods) and landslides (shallow landslide and rockfall) shall be reduced. Additionally, the associated risk of injuries for park visitors hiking along the trails and the

risks to cultural heritages, private buildings and roads shall also be mitigated. Reducing, or halting, the loss of biodiversity and ecosystem services is another major aim.

To reduce the mentioned risks, interventions are mostly carried out through natural and nature-based solutions, aimed at exploiting and regenerating the ecosystem services and natural functions of the area. NBS works to be done in the Portofino Natural Park within the RECONECT project include:

1. Dry-stone wall construction and abandoned terrace restoration, with the aim to preserve the terraced landscape and support 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.

The work to be performed in RECONECT will focus on some small catchments, including the San Fruttuoso village Catchments (Rio dei Fontanini and Vallone di San Fruttuoso streams) and the Paraggi village Catchments (Fosso dell'Acqua Viva and Fosso dell'Acqua Morta streams).

The RECONECT project is an opportunity for the demonstrator to demonstrate the effectiveness of alternative/complementary risk mitigation solutions to grey infrastructure to help exploit the natural predisposition of ecosystems to face and secure natural disasters. Besides, NBS are the most appropriate approach to geo-hydrological risk mitigation in a context where a natural framework is of high value, both for itself and for recreational and touristic motivations. According to the demonstrator, NBS help to recover those ecosystems that have been threatened both by human action and by the impact of extreme hydro-meteorological events that accelerate the natural development resulting in instable processes. Beyond the importance of improving the ecosystems' resilience to climate change for their intrinsic value, NBS enhance their functionality in retaining soil in high gradient slope areas and improving water infiltration. This mitigates the effects of meteorologically intense events and protects both unrenewable cultural heritages and high value touristic services and infrastructures. This approach is replicable at different scales and contexts, but the peculiar features of the project area make NBS, which are characterised by a high adaptability, the only possible solution. Finally, recovering dry stone terraces and water course arrangements by means of natural engineering techniques will help in recovering ecosystem services, enhancing their efficiency and facilitating the return to an equilibrium between anthropogenic modifications and the natural environment. Through taking such actions, it is anticipated that the geo-hydrological vulnerability of cultural heritage, real estate and, in general, natural and urbanized areas within the Park can be decreased in addition to risk reduction of injuries among the Portofino Park visitors. If well demonstrated and tested in the Portofino pilot area, the replication and upscaling potential of NBS in the Liguria region is rated as very high by the demonstrators.

Capacities and needs with respect to realising NBS

The demonstrators include The Portofino Park Authority, GISIS Geographical Information Systems, and CNR. The **objectives to participate** in the RECONECT project overlap but also differ between the participating partners. The **Portofino Park Authority** aims to acquire new skills through participation in RECONCT and to improve their knowledge about the part of the territory. In addition, they also hope to learn from others on how to improve governance aspects with respect to the realisation of NBS. The two scientific partners are GISIG and CNR. **GISIG's** motivation is to provide GISIG members with a new, NBS focused approach and technology for land use planning and climate change adaptation, to further develop the syllabus of existing learning management systems hosted and maintained by GISIG with new courses and topics, and to connect the Copernicus and INSPIRE communities with the NBS community. **CNR's** motivation to participate in RECONECT is grounded in their desire to improve their knowledge on soil instability processes, learn from experiences related to geo-hydrological risk mitigation actions, and to assess NBS efficiency and the relationships between ecosystem services and geo-hydrological risk mitigation actions.

The **motivation of the demonstrator** to realise NBS is very high, on the personal and organisational level. This is expressed by the very participation of the Portofino Regional Natural Park. As shown in the previous section, the NBS planned to be implemented (e.g. terraces) have been great relevance historically to the park as well as for the Mediterranean region in general. Therefore, the Park has a great interest in developing solutions that are not just increasing the resilience of the region, but which might also serve as frontrunner examples to showcase the added value to other stakeholders in the Mediterranean region. The idea is to promote a "new culture" for land use planning and climate change adaptation by integrating NBS into strategies and policies. In addition, the demonstrator also has the ambition to improve the collaboration between the Park Authority and the main local actors, (model of "governance"). Therefore, the approach pursued within the RECONECT project and the goal of realising NBS is relevant to the day to day business of the Portofino Park Authority. This is also being reflected in the fact that the demonstrators evaluate their own staff working on the realisation of NBS as very positive.

However, the situation is somehow different with regard to the **financial capacity and political support** for the uptake of NBS. The financial capacity to realise NBS is rated as quite low. Of course, RECONECT provides financial means to design, construct and to monitor and evaluate first NBS is the region. However, against the background of the abundance of agent terraces, the substantial change of the landscape due to a variety of human uses (e.g. abundance of agriculture, tourism etc.) and an ever-increasing pressure on landscape, the challenge with regard to long-term risk reduction, particularly in the face of climate change, is much more profound and fundamental. NBS are considered in this context (Natural Park) as one of the few possibilities to reduce the risk in a sustainable manner in the long-run. However, financial means are currently hardly available to the extent needed and/or there is a lack of political will to more actively look and apply for public funding to support the realisation of NBS on a larger scale.

Generally, the interest of elected public officials and other relevant actors is rated as rather low. In the past, the demonstrators have experienced deep-seated cultural resistance to the willingness to consider NBS more often for risk reduction purposes. The emphasis is still on more traditional, grey infrastructure, which are immediately visible and indicate to

the wider public that elected officials have done “something” to reduce geo-hydrological risks. NBS are less visible and become part of the landscape eventually, appearing less effective as explained by one of the demonstrators. Therefore, the RECONECT project, and particularly the outcomes of the monitoring and evaluation efforts, are (similarly to the Odense case) of high relevance for the demonstrators in order to more effectively address and eventually overcome some of the cultural and institutional **barriers** outlined here.

The key organisation and person designated to the realisation of the NBS in the Demonstration site is a very experienced employee of the Park Authority. With over 40 years of experience in solutions aimed at stabilising mountain slopes to improve water management and reduce associated risks, including the application of bioengineering techniques (i.e. choosing Salix species), the demonstrators can rely on a **great knowledge capacity** relevant for realising the NBS planned in RECONECT. This also includes teaching experiences, among others, at the University of Genova, with a focus on sustainable development, and in particular, on the planning and management of protected areas. This expertise is complemented by the CNR, particularly on the assessment and monitoring of various processes related to geo-hydrological hazards (e.g. analyses of erosion, transport and deposition phenomena, monitoring, prediction and prevention of natural instability phenomena). The expertise of GISIG is also valuable, particularly with respect to upscaling the experiences made in the Portofino area with regard to the realisation of NBS and its benefits to other regions.

Against this background, the demonstrators have expressed that they can supply expertise on the following aspects:

- Design: Relationship between shallow landslides and flash floods, lidar data analysis, construction of dry stone walls on slopes
- Upscaling: Use cases (e.g. for upscaling) by using Copernicus and EU databases

At the same time, the demonstrators have expressed needs to exchange with respect to the following aspects:

- Monitoring & Evaluation: Maintenance of monitoring system sensors
- Participation: How to design and conduct a participatory process to realise NBS
- Barriers: How to address and overcome institutional, cultural, economic and other barriers.

Political and regulatory context (incl. relevant policies)

In this section, we provide a generic overview on the wider organisational-institutional context as well as policies which are relevant for the realisation of NBS in the area. First, we provide an overview of the wider policy context of the Portofino Regional Natural Park and then proceed by further describing the roles of the demonstrators within the institutional context before describing specific European and national policies that support the uptake of NBS in this site.

Portofino Park is managed by a Council, responsible for overseeing all aspects relevant to managing the park, including the planning and programming of instruments and the approval of all administrative, accounting and financial measures. The Council is composed of five representatives appointed by the Park Community (its advisory body). Three of them are identified by local authorities located within the limits of the Park, and one (at least) represents general interests. The Board is chaired by the President, who represents the Park Authority to third parties, convenes the Board, and promotes and takes

initiatives aimed at guiding the management activity of the entity according to the objectives of the Board.

In the context of the project, it is important to note that only one third of the Park's territory is public property; the remaining area is privately owned. Public properties, with the exception of the coastline, ports and waterways, are largely occupied by forests (see Figure A.12), which are managed by the Park Authority in agreement with the Municipalities that own these areas. This means that NBS can only be realised in areas which are maintained by the Park Authority or by the related municipality. However, there is an agreement that NBS can be installed at private properties. Generally, private properties are managed according to the rules stated in the Park's plan, which provide, upon a private - public agreement, that areas where NBS are implemented will be maintained by the Park in the future.

The realisation of the planned NBS relates to and is supported by **various relevant EU, national and local/regional policies** (see Table A.6 for an overview).

Table A.6 Relevant policies for the realisation of NBS in the Demonstration site

Relevant European policies	Relevant national policies	Relevant regional/local policies
Habitats Directive 92/43/EC	National Natural Park Laws	Regional Natural Park Laws
European Bird Directive 79/409/EC		
Biodiversity Strategy 2020 (2011)		
Flood Directive 2006/60/EC		

The Habitat Directive, Bird Directive and Biodiversity strategy 2020 are essential as Portofino is a Natural Park and Nature 2000 area. Furthermore, the Floods Directive provided a foundation on the monitoring and prevention strategy underlying the RECONECT approach, although the Directive itself addresses small catchments and areas with a particular geomorphologic asset to a lesser extent. Again, national and regional Park laws are essential as they provide the legal basis and boundary conditions for the NBS realisation process.

Wider social climate (including potential barriers)

As outlined in Section 6.3, the general interest of elected public officials and other relevant actors with regard to the realisation of NBS is rated as rather low. In addition, many powerful stakeholders in the region have an interest to keep the images as a touristic area of great international attractiveness untouched. This means that risks associated with the increasing slope instability and intensifying rainfalls are not always openly communicated. Upcoming work needs to more systematically explore the wider effects this strategic ignorance among stakeholders has on the realisation of NBS as a means to reduce geo-hydrological risks. Moreover, the complex structure of public and private properties and responsibilities within the Park also needs to be explored more systematically. Realising NBS on a large scale is not only dependent on the monetary resources, but also on the willingness of private landowners to cooperate. Currently, this willingness is rated as rather low, as many landowners do not want NBS or any actions related to risk reduction on their

land. It is expected that if the demonstrator is advancing an NBS-focused strategy within the Park too quickly, they will face strong public and political resistance. However, the demonstrator has also noticed initial changes in public perception as a result of experiencing enormous cloudbursts and thunderstorms in more recent years. The perception of risks and thus the acceptability of alternative measures seem to be changing. Therefore, the Portofino case offers great potential to monitor possible changing attitudes towards NBS.

Annex B. Detailed information on the demand and supply baseline analysis - Demonstrators B

This Annex provides detailled information for demonstrators B, including information about the risks and vulnerabilities they are facing, their capacities and needs with respect to the realisation of NBS, the expertise they can supply to others as well as first information on the wider socia climate with respect to NBS, including information on potential barriers.

B1. Ijssel River Basin (The Netherlands)

Overview

The Ijssel River basin project ('Stroomlijn") is implemented under the banner of the 'Room for the River' Programme. The demonstrator is represented by TAUW in the RECONECT project. 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. It is considered as a forerunner project with respect to integrated water and flood risk management that has the potential to serve as an exemplary project on the European and international level (Rijke et al., 2012).

The Room for the River Programme developed an alternative view on managing water and flood events. In the Netherlands, similar as in other countries, for a long time a civil-engineering approach was dominating management activities in order to control flood events (Rijke et al., 2012). However, in response to the 1995 extreme flood events, which nearly caused dike breaches in the Netherlands which would imply the inundation of large parts of the country and which resulted in the evacuation of 250,000 people and 1 million cattle, an enhanced awareness amongst the public, politicians, public administration and water professionals grew that established approaches were not sufficient to manage current and future flood risks. Therefore, a new policy line, the Room for the River Directive, was developed by the Dutch government, which eventually resulted in the 2.2 billion Euro Room for the River Programme that followed two main objectives:

- "(1) improving safety against flooding of riverine areas of the Rivers Rhine, Meuse, Waal, IJssel and Lek by accommodating a discharge capacity of 16,000 m3/sand;
- (2) contributing to the improvement of the spatial quality of the riverine area" (Rijke et al., 2012, 370)

At the start of the programme, a set of 39 locations was selected for giving more Room for the Rivers through, for example, flood by-passes, excavation of floodplains and dike relocation.

The Programma 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 (see Figure B.1). 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 took roughly 5 years (2014-2018). At the busiest time, 20 people were active every day, which also underlines the scope of this particular project.

The aim of the project was to remove vegetation from the river's summer bed in order to increase the velocity of the water travelling from the mountains to the sea (see Figure B.1). The project began in 2014 and was completed in 2018. Specifically, the unofficial aim was to remove 70% of the vegetation within the project area. The "Stroomlijn" (or Streamline) Project was implemented by the "Courant" (or Current) Team, which consisted of three organisations, including TAUW, Eelerwoude and Bruins en Kwast.

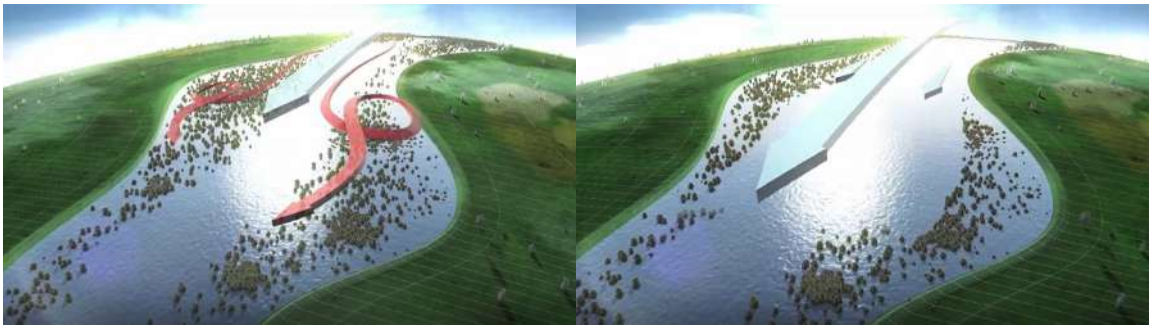


Figure B.17 Visualisation of project concept: the removal of vegetation from the riverbed to increase water velocity

Risk, vulnerability and risk reduction through NBS

The Room for the River Programme is above all and foremost a response to flood risk. The Rhine and IJssel delta experiences annual flooding. In 1993 and 1995, floods threatened to devastate surrounding regions of the delta. With ongoing climate change and yearly river floods, sediment is distributed throughout the floodplain, reducing the space that was initially allowed for annual floods. 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 39 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 in order to reduce barriers for the discharge of river water. These vegetation types are transformed into agricultural vegetation types and with introducing new cost effective maintenance methods (as cattle) the nature based values are induced for ecology and man.

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).

Capacities and needs with respect to realising NBS

The Ijssel River Basin demonstrator is represented by TAUW. They pursue two main objective participating in this project. Their **ambition** is to expand their existing European as well as global network of climate adaptation, resilience and urban sustainability practitioners and would like to link such activities strong to their offices across Europe (France, Italy, Spain). Furthermore, they would like to have access to state-of-the-art knowledge, tools and innovations as an input for ongoing NBS-relates projects and for initiating new initiatives.

The **motivation of the demonstrator** to realise NBS is very high, on the personal, organisational and political level. In general, TAUW strives to provide 'sustainable solutions' for a better environment. Part of these solutions may be classified under the concept NBS. As states by representatives of TAUW, the company with more than ~1000 employees is motivated to improve the safety and quality of the environment. As NBS can achieve this, and as they may offer greener or more attractive solutions than established grey solutions, the motivation within the company to implement these is generally high. However, TAUW is an engineering firm, which implies they are to a high degree dependent on the demands and wishes of their commissioners/ clients. Their 'motivation' is equally, if not more important than the motivation of TAUW and finally shaping the possibility to realise NBS. On the political level, the support of NBS as a means to reduce hydro-meteorological risks is evaluated as quite high. Specifically regarding the project Stroomlijn, the interest of the elected politicians but also responsible administrative bodies was high, as they were the commissioner of the project. As TAUW itself is not directly responsible for the implementation of NBS, they depend on the budget of a commissioner or client. The personal capacity of TAUW is quite substantial. TAUW has over 1000 employees with a background in civil/hydrological/environmental engineering and science. It is this multi-disciplinary background as well as their good connection to authorities, contractors, and knowledge institutes that makes them quite well equipped to design, implement and manage the realisation of NBS, once they were commissioned to do so. This is also reflected in the share of projects dedicated to the realisation of NBS. The demonstrator evaluates that about 10-20 % of all project relate to the concept of NBS, depending though on the definition of NBS chosen.

Generally, TAUW has great **experience and a comprehensive capacity** with respect many aspects relevant for the realisation of NBS. This includes personal and organisational experience in the planning and design and implementation of NBS. Tauw. With respect to organizational experience, Tauw conducts many project that relate to nature, landscape, or city planning. Some of these project can be classified as 'nature based solutions' (though not all). The same holds for our hydrological engineering project. Nature based solutions are also used in soil remediation, by making use of the soils natural processes to degrade polluting components. On the personal level, NBS examples relate to the planning, design and permitting of 300 ha area (Ijssel Delta Zuid); the design and implementation of a reed swamp, as a nature compensation measure responding to the Natura 2000 policy. This includes also management activities on the programme level, including the programme management Natura 2000 for landscape of Overijssel province and the involvement of various nature/landscape recovery/rehabilitation projects. Also on the urban scale TAUW was involved in numerous NBS project. A comprehensive selection of NBS project, realised by TAUW and others, is presented on the web platform: www.climatescan.org

Climatescan Platform
Mapping Best Management Practices around the world on open source web platform with several global partners.

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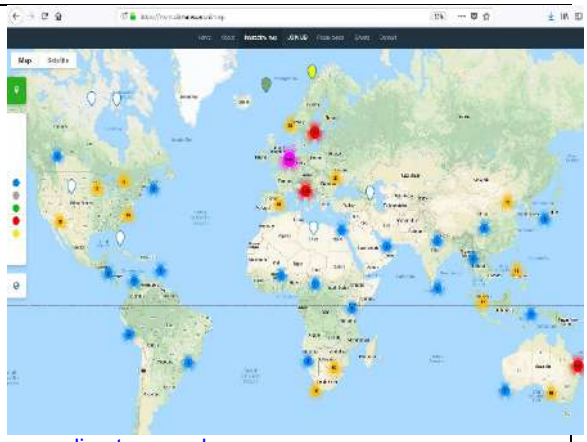
To be published

F. Boogaard, Rick Heikoop, *Sharing Best Management Practices on resilient cities using the City Climatescan method, Results of a web-based international knowledge exchange tool on urban resilience: www.climatescan.nl, will be published as chapter in Designing Resilience in Asia book (edited by National University of Singapore), 2019*

Several scientific papers using climatescan as tool eg:

Floris Boogaard, Terry Lucke,: Long-term Infiltration Performance Evaluation of Dutch Permeable Pavements using the Full-Scale Infiltration Method, Water February 2019, 11(2), 320; doi: 10.3390/w11020320



www.climatescan.nl

presentations, videos and instructions on:
https://www.climatescan.nl/projects/2262/detail

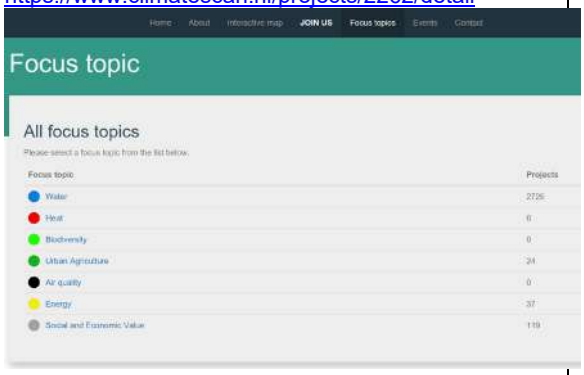


Figure B.18 ClimateScan platform and relevant publications

Along the management cycle, TAUW's expertise covers the following more specific aspects: TAUW is generally highly experienced and active in the 'assessment' part of the management cycle. TAUW staff conduct investigations into soil, ecology, and city planning on a daily basis. They are also highly capable with regard to assessing legal, permitting, and compliance requirements, both for authorities, and industrial clients. With respect to 'design', TAUW works in city planning (design of wide ranging aspects, e.g. water ways, lighting, parks, sewage, roads etc.), rural planning and landscape design, and design of water safety infrastructure and measures (e.g. dikes). They are also able to design soil remediations, and aspects relating to site development (e.g. brownfields), or decommissioning of sites. With respect to cooperation and maintenance, TAUW generally cooperates closely with both clients, authorities, and contracting parties to ensure high quality and sustainable implementation of the designs and solutions developed, this includes taking over different roles,, such as program manager, project manager, contract manager, stakeholder managers, or and (environmental) supervisors during implementation of the project. However, as a consultant, TAUW is generally not responsible for practical maintenance, but may draft maintenance plans. Also with respect to monitoring and evaluation, TAUW has profound experience. TAUW is often involved in monitoring and evaluation activities, specifically regarding environment pollution, or aspects that require regular monitoring for compliance purposes (e.g. emissions at factories or maintenance related monitoring on dikes, bridges and roads).
Against this background, the demonstrators have expressed that they can **supply expertise** on various aspects related to the realisation of NBS and can provide specific supply upon request be other demonstrators, but feel particularly dedicated to Monitoring and Evaluation phase. Here they can contribute with their experience made with respect to the Room for the River Programme and how its effects were monitored and evaluated (including implementation, best management practices and insightful case studies. The demonstrator expressed a **demand** to exchange more intensively on cost effective monitoring systems and approaches and on how to upscale the experiences made by demonstrators B to other spatial scales.

Political and regulatory context (incl. relevant policies)

Generally, the Room for the River programme, is following a multi-level governance approach that is based on an integrated perspective, includes the involvement of various stakeholders (Fliervoet et al., 2013), applies a mix of centralised and decentralised governance approaches and addresses multiple objectives.

In response to the 1993/1995 flooding, a new Room for the River established the guiding idea that 'water' should become a guiding and structuring principle for spatial development in the Netherlands which eventually was adapted by the Dutch governmental advisory Commission Water Management 21st Century" that water-related and spatial conditions should become in their mutual interlinkages the new leading structuration principles (Rijke et al., 2012). These general principles for the translated into the Room for the River programme and connected with an initial budget of 2.2 billion Euros in 2006 (van Herk et al., 2015; Zevenbergena et al., 2013).

Underlying the Room for the River programme is a (multi-level) governance approach in which government agencies operating on different levels (national, regional, local) and in different sectors (e.g. water safety, planning, agriculture and nature) need to actively collaborate. The overarching decision frameworks for establishing improved water safety

and spatial quality are set by the national government, whilst the plans and designs are formulated and decisions taken by local and regional stakeholders within the 39 regional projects, including the the possibility for allowing for bottom-up initiatives (Edelenbos et al., 2017). In addition, the national government has also established a central programme office to build up capacities with respect to the management and monitoring of the progress, including the evaluation of the quality of designs and the facilitation of regional projects through guidelines, providing expert knowledge, community building and where needed, applying political pressure, As Rijke et al. 2012 observer, this approach "provided the opportunity for decentralized governments to link local issues such as new developments and the development of natural and recreational areas with the nationally defined water safety agenda" (2012, 370).

The Programma Stroomlijn 'Ijssel' is such a regional sub-programme. The demonstration projects consists of 250 ha of vegetation in a stretch of app 100 km's of river, over 400 owners, and 16 local authorities The program directorate Room for the River of Rijkswaterstaat is in charge of the Stroomlijn project. Other important stakeholders include: 170 entitled to the floodplain (landowners, -renters and -users); interest groups (nature organisations, landscape organisations, cultural-historical heritage, flora and fauna organisations); permit authorities and enforcers (Water board, province, municipalities for nature protection law permits, flora and fauna law permits, project plan water law permit); directly affected stakeholders (managers, residents, users; about 400 involved).

The governance structure of the Stroomlijn project include several authorities with their own roles. The program directorate Room for the River of Rijkswaterstaat was in charge as the client. A project bureau called Courant was formed by TAUW, Eelerwoude and Bruins en Kwast, which provided for the different permits/exemptions, and reported the following to the supervising authorities; compliance with the coordination obligations for all permits, exemptions, authorizations, notifications and decisions. There were also government authorities involved who are also landowners (for example: State Forestry Service, Rijkswaterstaat, Ministry of Defense).

The basis of the Stroomlijn project was Dutch policy relating to water safety, and improving peak river discharge levels for all major rivers. During the implementation, the project faced mainly EU legislation, including the Natura 2000, the EU Water Framework Directive.

Wider social climate (including potential barriers)

With regard to the Stroomlijn project, the largest barriers were managing the large group of stakeholders (landowners, authorities, other civil society orgainsations and NGO's). Secondly, the practical implementation of the project was made difficult by the poor accessibility of the project area. The area was largely inaccessible during parts of the year because of protection of habitat (e.g. birds) as well as flooding / wet conditions of the soil. For projects relating to N2000 legislation (EU nature and protected species regulation), often 'space' is the main barrier. Land is claimed for nature development leaving very little space for farmers to develop their agricultural activities. However, it needs to be stated that 'barriers' for NBS will depend largely on the specific NBS project and its context, so that barriers for our project Stroomlijn cannot be defined in more general terms. For the future, the financing and durable maintenance appears to be difficult. NBS projects in general may require more maintenance/monitoring than 'hard infrastructure'. This is also highlighted by more recent research on the Room for the River programme (Fliervoet and van den Born, 2017).

B2. Inn River Basin (Austria)

Overview

The Inn River Basin is located near Innsbruck, Austria, in south-west direction. The overall catchment comprises of the torrential catchments Geroldsbach (12 km²) and Marbach (1.2 km²) located upstream different parts of the municipality of Götzens. From there, the creek flows further downstream and contributes to the River Inn which has a catchment area of ~5700 km² at this location.

The demonstrator is represented by the University of Innsbruck (UIBK) and The Department of Natural Hazards of the Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW) (as a subcontractor). The focus of this demonstrator site is on the upstream part of the Geroldsbach until it reaches Götzens and addresses the interaction between urban and torrential features in alpine environment. This demonstrator type B site comprises different types of NBS being installed in the torrent since the early 1950s. The NBS installed over the last decades included: Afforestation of high-altitude areas; buffer strips and hedges along water courses; greening; protection forest management (see Figure B.3).

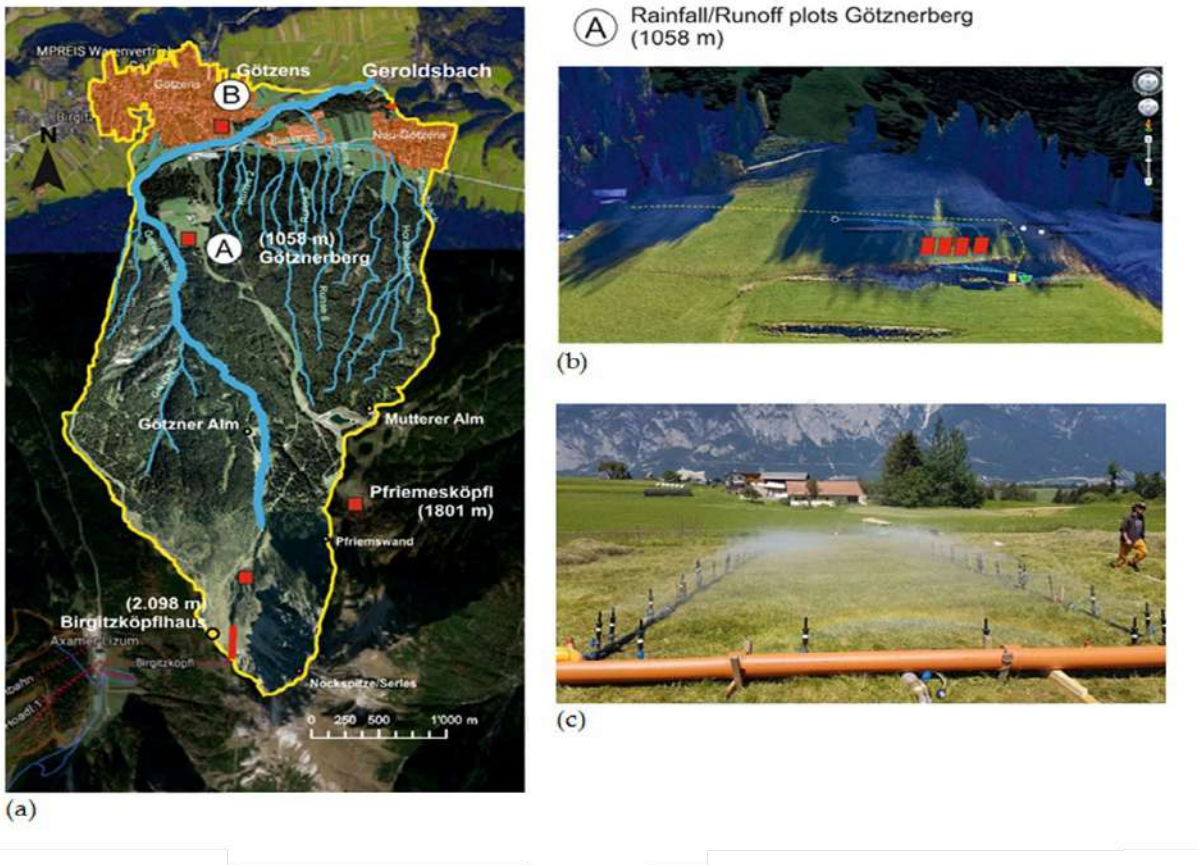


Figure B.19 (a) Overview on the torrential/urban catchment, (b) (c) setup of the field test site for surface runoff testing (source: D.2.3)

Risk, vulnerability and risk reduction through NBS

For the demonstration site, there are two exposed areas. The first are is exposed to the risk of flooding from the small river of Geroldsbach and relates to the community of Götzens. The second is flooding resulting from high water levels in the River Inn and the inundation of parts of Innsbruck. Figure B.4 displays the parts of Innsbruck exposed to the River Inn.

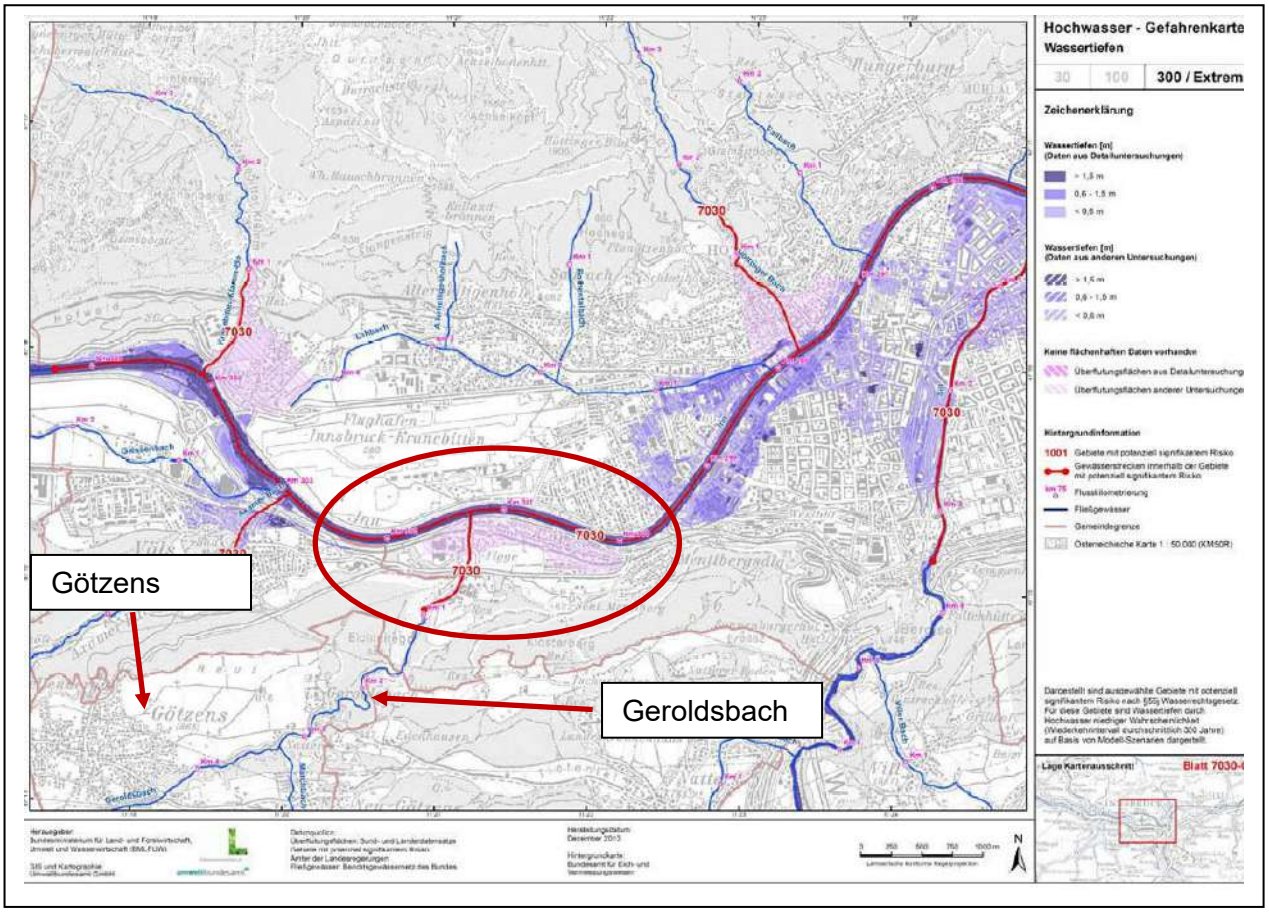


Figure B.20 Exposed areas at the City of Innsbruck (return period 1/300 years (extreme) at the confluent of the Geroldsbach at the Inn River (red circle) (Source: City of Innsbruck, 2016, C52)

Generally, the torrential catchment faces (as typical for such type of catchments) convective precipitation events leading to high discharges associated with sediment transport. Downstream of the torrential part, the river interacts with the urban sub catchments. The torrential catchment Geroldsbach is located above Götzens (~868 m.a.s.l.). Its river spring is at an elevation of ~1920 m.a.s.l. near the mountain Birgitzköpfl and is enclosed at the top by the mountain peaks Nockspitze (Saile; ~2404 m.a.s.l.) and Birgitzköpfl (~1982 m.a.s.l.). Total length of the torrent main channel is 8 km, whereas after 9.4 km the Geroldsbach joins the River Inn (see also Figure B.4). Along its pathway the river merges with several small side rivers and tributaries, like Gehrbach, Grosser Blaikenbach, Tödersbach, Kirchbach, Horachbach and Marchbach and some other smaller tributaries. The main part of the catchment area, around 73.2 %, is overgrown with forest.

The Geroldsbach is passing the municipality of Götzens in the south-east and has resulted in a number of historical inundations of Götzens (1575, 1748, 1750, 1781, 1782). In order to reduce the risk of flooding, an impressive brick wall was built by member of the community during the 18th and 19th century, which however collapsed in 1846 and 1908 resulting in another disastrous inundation of Götzens[16] as more the 22 building were destroyed in the centre of the municipality (Schiechtl, 1962).

It is important to note that until 1925 the Geroldsbach was running through the centre of the village; only in 1925 it was rechannelled and by-passes since then the municipality of Götzens. Furthermore, during the 1950ies and 1960ies major advancements were made in the alpine area with respect to changing the paradigm of reducing torrential risks. This paradigm was based on the rapid and intensive application of what one might call today NBS. At the time such measures were yet named differently. A paper published in 1962 refers to "Grünverbauung" (green control structures) to explain how nature itself was increasingly used to reduce risk resulting from torrential processes. The definition provided is strickly similar to more recent NBS definitions:

> "As the name G r ü n v e r b a u n g already says, it does not limit itself to making a patch of earth green, but uses various methods that belong much more to construction than to gardening. These methods are largely eavesdropped on nature [i.e. copied from nature], as is the basic idea of healing nature's wounds by its own means. Building materials are the living plants and parts of them (Schiechtl, 1962, 90).
>
> *Translated with www.DeepL.com/Translator*

Also Götzens profited from such early NBS, as in the upper parts of the Geroldsbach large areas benefited from reforestation, which is a decisive part of the NBS realised in this region. Figure B.5 and Figure B.6 provide a visual impression on how reforestation helped to increase slop stability in the area above Götzens and how it helped to retain heavy rainfalls in the surround areas

[16] http://www.geschichte-tirol.com/orte/nordtirol/bezirk-innsbruck-land/1035-gns.html

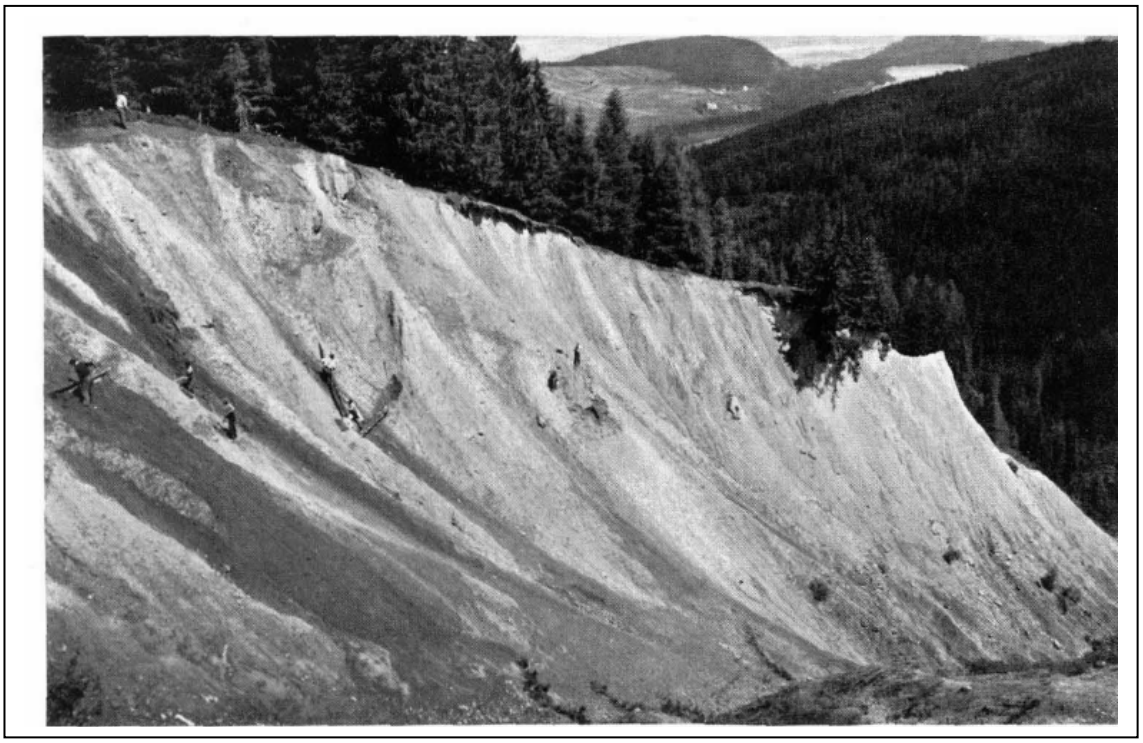


Figure B.21 Part of the so called "Blaike" at the Geroldsbach above Götzens. The picture was taken in 1951 when the ground was prepared for realising NBS (Source: Schiechtl, 1962, 94)

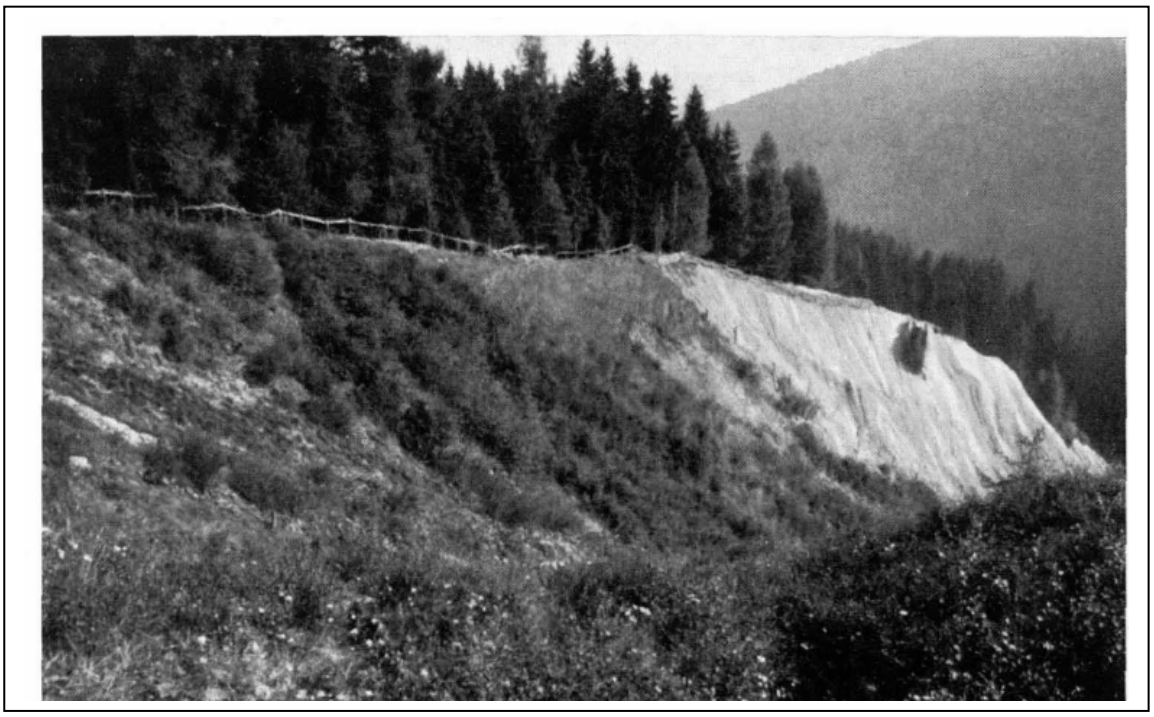


Figure B.22 Part of the so called "Blaike" at the Geroldsbach above Götzens. The picture was made in 1959 when first part of the area began to re-green (Source: Schiechtl, 1962, 94)

Also as a result of the NBS realised, the municipality of Götzens as not experienced major flood events during the last decades.

However, the municipality is still affected by the risk. As of January 2018, the municipality of Götzens has 4.062 inhabitants. Götzens has undergone, similarly as many alpine communities in proximity to larger cities (in this case Innbsruck), an enormous population growth during the last decades. Particularly from the 1960 to the 1990ies the municipality has grown quite rapidly (see Figure B.7). Also due to this rapid growth of many communities and cities throughout Austria, it is estimated that around 13% of the total building stock is significantly exposed to natural hazards, and around 9% of those buildings are in areas that are prone to river flooding (Fuchs et al., 2015). For Götzens, the torrential risk is highly relevant not just in terms of exposure; due to associated land use regulations (see section 8.5), available land which can be used for settlements is restricted. Already today land price is high and the pressure to provide affordable living space is increasing. Additionally both municipalities are touristic regions in both summer and winter tourism. Consequently this means, that there is the demand to reduce the torrential risk (to protect urban settlements) while at the same time providing a high quality recreational area.

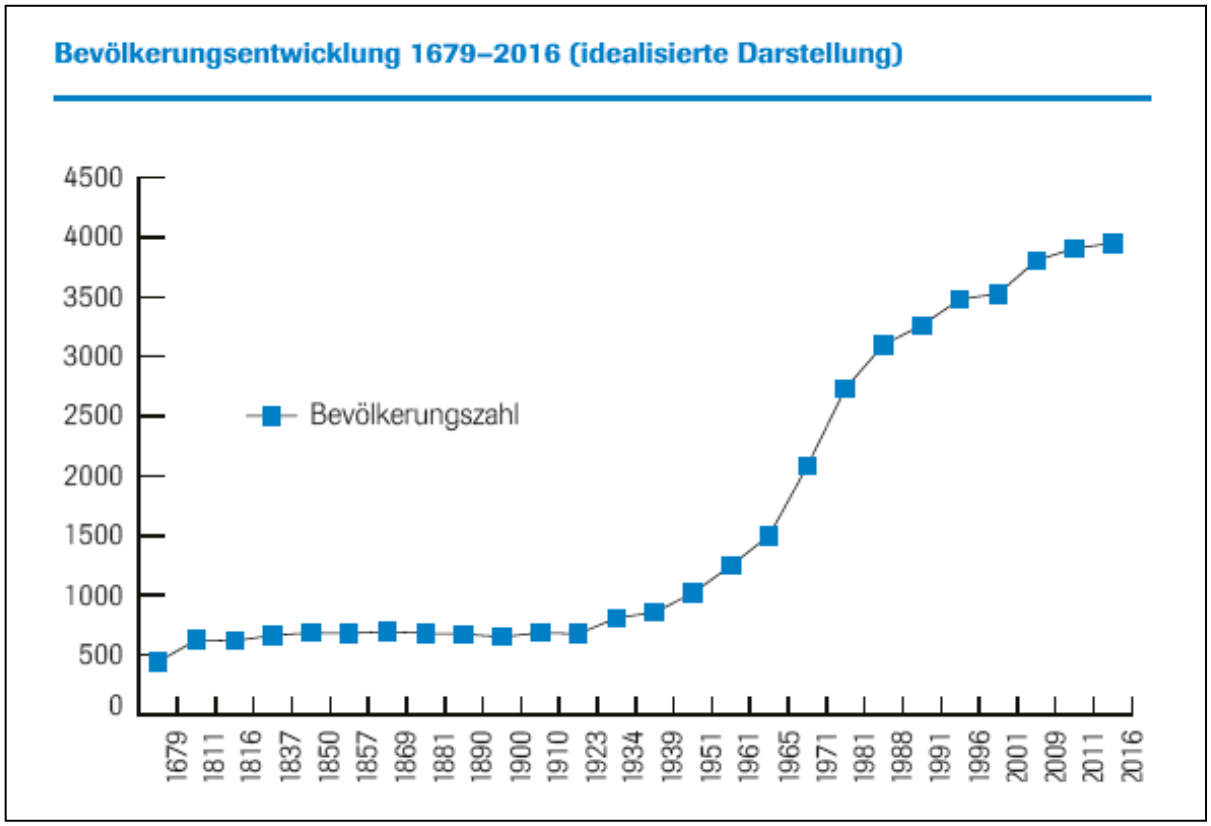


Figure B.23 Population development of Götzens from 1679 to 2016 (Source: Piff, 2017, 61)

Therefore, different types of NBS have been installed in the torrent since the early 1950ies, including:

- Afforestation of high-altitude areas
- Buffer strips and hedges along water courses
- Driftwood management

- Slope stabilization by means of greening
- Protection forest management

Since the municipality has increased in population and size. Potential installation of NBS in the urban parts versus increased settlement density will also be considered in RECONECT 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-ex. Measurements at plot and catchment scale support modelling and in order to also enable to generalization of results to other catchments.

Capacities and needs with respect to realising NBS

The demonstrator includes the University of Innsbruck (UI) and The Department of Natural Hazards of the Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW) (as a subcontractor). The **motivations of UIBK to participate** in the RECONECT project is mostly grounded in their ambition to link plot scale continued measurements with hydrological modelling, to include data on land use change in torrential / urban catchment models and to analyse the interaction of urban and natural catchments under climate change.

As outlined above, NBS are a key component of the management of torrential hazards in this region and are part of the everyday practice of responsible organisations. However, neither UIBK nor BFW had made prior experience with respect to realising NBS. The BFW is a multidisciplinary research and training institution with focus on sustainable multifunctional use, management and protection of forest ecosystems. The BFW Department of Natural Hazards and Alpine Timberline is a research institution dedicated to the development of practice-oriented methods for the sustainable protection of human settlements and infrastructure from impact of natural hazards with special focus to protection forest effects. UIBK, and particularly the Unit for Hydraulic Engineering, has great expertise in fields of alpine infrastructure engineering and computational engineering, including alpine hydrology, hydraulics and sediment transport linking the engineering disciplines to risk concepts and natural hazard management.

Against this background, the demonstrators have expressed that they can **supply** expertise on the following aspects:

- Assessment: Approach to address climate change on and its impacts on convective storm, design storm (short duration/convective) with an emphasis on inland, alpine, pre-alpine regions.

The demonstrator expressed a **demand** to exchange more intensively on:

- Monitoring and Evaluation: There is a need to exchange on sensor technology, knowledge exchange on water quality in the runoff, focus on urban plot scale;
- Monitoring and Evaluation: Exchange on sensor technology, knowledge exchange ion how to monitor soil/moist, runoff plots, hillslope;

- Upscaling: Scenario building for post afforestation scenerios. There is an interest to find comparable case studies; including methods for mapping of forest areas from historic pictures (GIS methods).

Political and regulatory context (incl. relevant policies)

According to Rauter et al. (2019), in Austria, several administrative bodies at different federal levels bear competencies in the management of risks resulting from river inundations and torrential processes, including the federal state (water law, flood protection and funding), the nine provinces (planning, building codes and emergency management) and 2100 municipalities (zoning, spatial development and emergency planning). Several acts exist on federal and provincial levels which do not align and hence lead to interpretational differences in their execution. Furthermore, three administrative bodies, the Austrian Service for Torrent and Avalanche Control, the Federal Water Engineering Administration and the Austrian Ministry for Transport, Innovation and Technology hold legal duties concerning water management and engineering. Those bodies are subject to the federal government; however, certain sub-disciplines are assigned to the provinces. In addition, the legal competency to advise land use development lies with these authorities.

To make this more specific, in the catchment of the Geroldsbach two different legal gears are relevant (Figure B.8). While in the lower sub-catchment (i.e. at the confluent of the Geroldsbach and the Inn River) legislation embedded in water management are relevant, for the upper part of the catchment (i.e. area surround Götzens) legislation embedded in torrent and avalanche control service are more relevant, including the forest act. Therefore, the following key actors are involved in the management of NBS in this demonstration site: The Austrian Service for Torrent and Avalanche Control (WLV), the State of Tyrol, the community forester as support for the torrent monitory and documentation system. The WLV is the responsible governance organization. In extend to that, the community forester - employed at different municipalities - supports the permanent monitoring and documentation for the WLV. Depending on the catchment size and attribution within respective laws, the state of Tyrol is responsible for larger catchment units and rivers. In case of torrents, the state of Tyrol may as well be interpreted as stakeholder as their responsibility is linked to downstream locations.

Relevant policies include the Water Framework Directive and the national Forestry Strategy.

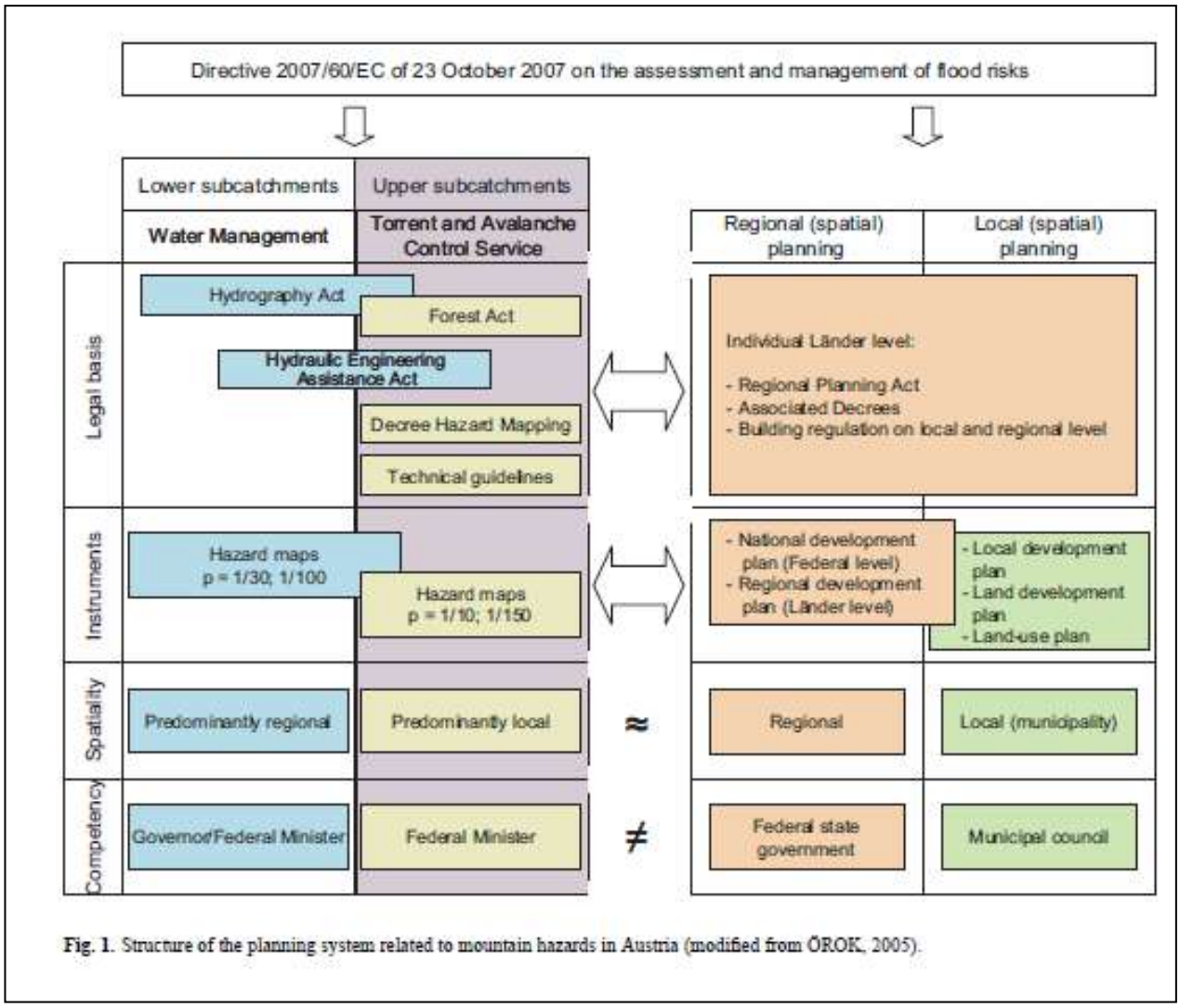


Fig. 1. Structure of the planning system related to mountain hazards in Austria (modified from ÖROK, 2005).

Figure B.24 Administrative structure of the planning system related to mountain hazards in Austria (Source: Holub and Fuchs, 2009, 525)

Wider social climate (including potential barriers)

The NBS realised in the demonstration site can be considered as the accepted state of the art (including technical regulations of how to realise NBS) that complement risk reduction strategies that are based on grey solutions. There are no institutional, political or cultural barriers apparent in this demonstration site. Particularly, during the last 20 years, the demonstrators observe an increasing acceptance of NBS that has started to replace the for a long time dominating 'Techinkgläubigkeit' (believe in the superiority of technical measures). If resistance to NBS has become obvious it usually relates to a lower perceived risk reduction efficacy of NBS (i.e. reforestation), as such measures need a longer time to become effective then grey measures.

B3. Aarhus, Egå Engsø and Lystrup (Denmark)

Overview

This Demonstration site encompasses two location, both located at the City of Aarhus: Lystrup and Egå Engsø. The demonstration site **Egå Engsø** (Lake Egå) lies in a low situated and former drained area immediately north 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.

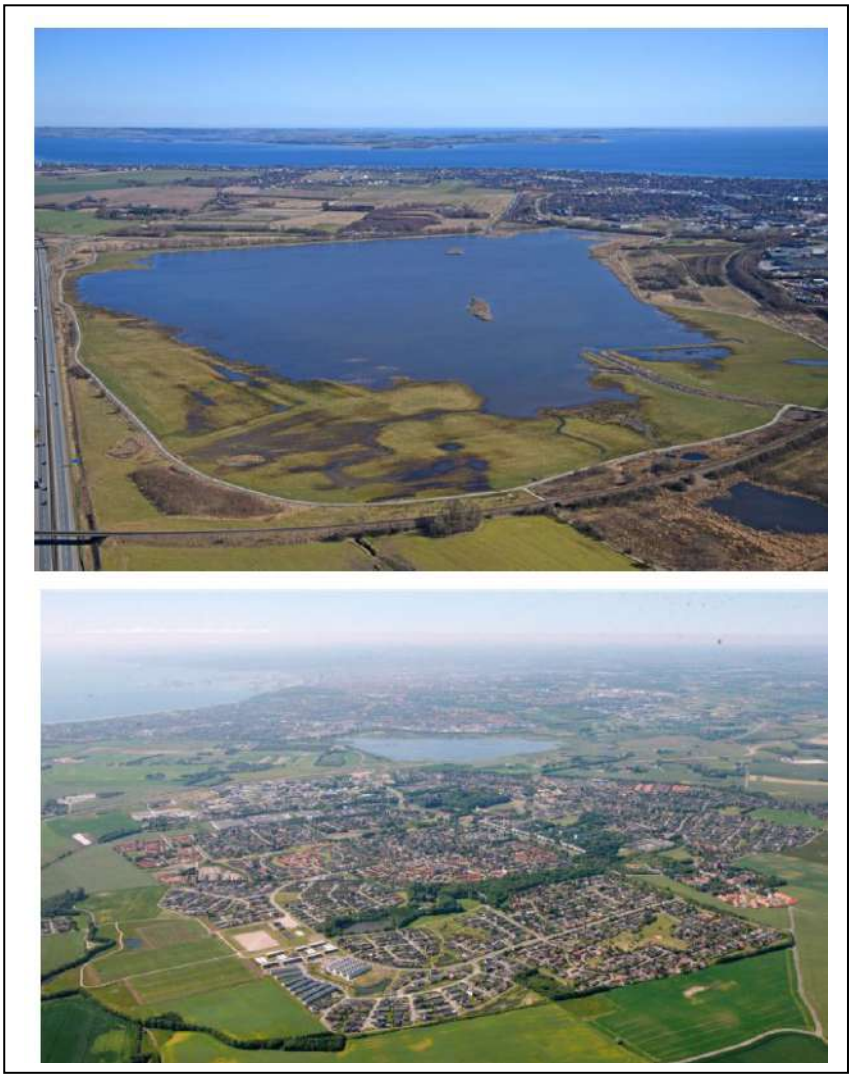


Figure B.25 Upper picture: The shallow lake Egå Engsø surrounded by grazed meadows looking southeast; the lower picture: Lystrup, a suburb to Aarhus, with lake Egå Engsø in the background (smaller lake)

In addition, the wetland provides the basis for a better recreative utilization of the area.

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 demonstrators is represented by Aarhus Kommune (AAKS) and the Denish Technical University (DTU).

Risk, vulnerability and risk reduction through NBS

The main hydro-meteorological hazard that **Lystrup** handles, is flooding from excess rainwater during heavy rainfalls. An extreme event in summer 2012 flooded the highway and private property next to the suburb of Lystrup. This event made decisions-makers in the city council think about new solutions. **Nature Based Solutions (NBS**) here are understood as smart combinations of green and grey infrastructure. One of the sub-projects handles extreme water flow in the minor watercourse 'Ellebækken'. 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 rain beds that all together represents a large scale solution for the whole suburb. All in all 12 subprojects were planned for, but only 11 of the subprojects was realized due to difficulties in getting the necessary agreements for the 12th.

More generally, the climate adaptation projects in Lystrup was the first of its kind in the Municipality of Aarhus. And only a few other places in Denmark had experiences with similar adaptation projects at that time. The principle builds on modifying the surface using suitable green spaces, watercourses and roads in an ordinary Danish suburb where rainwater is separate from sewage to delay the run-off of excess water during heavy rainfall.

The area is quite vulnerable. The Lystrup projects lies in a suburb with 10.500 inhabitants and a typical Danish composition of one-family housings, non-profit apartment housings and small to middle sized industries. The demographics are mostly families and older people who own their own house. The amount of industries/businesses in Lystrup is 1.200, mainly trade, transport and services. There are also public institutions like schools, kinder gardens and nursing homes. The land use are typical for a Danish suburb partly paved, and partly green public areas.

The main hydro-meteorological hazards that **Egå Engsø** handles, is river flooding. Besides that, the area is protected from high coastal water level with a dike and a lock with a pumping station further downstream. The demonstration site Egå Engsø is an example of created wetlands that reduces the risk of flooding from rivers by acting as a buffer that holds water during and after rainfalls. The solution is relative low cost and has many positive side effects in relation to environment, nature and recreational activities. The project Egå Engsø directly affected the agricultural land-use in the area. The 23 farmers were compensated economically or by replacement land in connection with the land consolidation. The project now reduces the risk of flooding that could affect part of the settlements in downstream Risskov and Egå, as well as important infrastructural facilities such as roads and Wastewater Treatment Plants. The demonstration area also has

important positive effect on the areas recreational value, education, public accessibility, carbon savings and probably also public health and wellbeing.

Capacities and needs with respect to realising NBS

The demonstrator includes the Municipality of Aarhus (AAKS) and theTechnical University of Denmark (DTU). AAKS expressed **the following objectives** it aims to achieve during the RECONECT project: It aims at demonstrating and evaluating the positive effects of the NBS realised in the past on reducing hydrological risks, improving the state of nature and enhance the recreational capacity of the area; Develop a solid base for being able to demonstrate to responsible politicians that NBS are actually beneficial, if they are planned and implemented well, and that they are indeed a business case; To gain insights and benefit from exchange from experts and stakeholders from across Europe.

Generally, the **motivation of the demonstrator** to realise NBS is very high, on the personal and organisational level. On the organisational level, and particularly in the section of the City of Aarhus that is involved in RECONECT (Water and Nature) the motivation to realise NBS is very high. In other parts of the Municipality (e.g. Environmental and Technical Department) the motivation is also high, but the interests are more divers and therefore need to be balanced with other more technical aspects. Also on the political level, the relevance of NBS to reduce future hydro-meteorological risks is recognized, as the uptake of NBS in the past has demonstrated already. Generally, the financial capacities to realise NBS is rated as rather low, at least if the ambition is to realise such measures on a larger scale. Often NBS need to be co-financed (for instance by the Aarhus Water, the local wastewater company), so that there is also a dependency on the availability of funds from other partners. Yet, within the Municipality the availability of staff to realise NBS is rated as quite positive.

As an organisation, AAKS has a comprehensive knowledge capacity related to different aspect necessary for realising NBS, including the realization of NBS projects. This includes Lake Egå, Åilot project of Lystrup, a number of nature based watercourse restauration projects (some of them also addressing climate change adaption) and a rather large nature-restoration project in Geding/Kasted Mose, which is also addressing climate adaption/risk management. Furthermore, Aarhus Water is working on different climate adaption projects in the city, with the aim of also creating green recreational areas. Therefore the demonstrators evaluates their on capacity on different aspects of realisation NBS (i.e. design, implementation, cooperation and maintenance) as quite knowledgeable. Similar as other collaborators representing practice-oriented administrative bodies, the greatest need for enhancing capacities is seen with respect to monitoring and evaluating the benefits of NBS as this is a task that is often not of top priority in the day to day work.

Against this background, the demonstrators, and here above all DTU, have expressed that they **can supply expertise** on the following aspects:

- Monitoring and Evaluation: Human well-being indicators (people), eco-system services indicators (nature)
- Monitoring and Evaluation: Model-based Monitoring
- Monitoring and Evaluation: Support for people indicator
- Monitoring and Evaluation: Support for water indicators: use of drones for environmental monitoring of surface water, technological development/advancement; Water quantity -> surface water elevation; Water

quality -> parameters related to environmental / ecological status; also a relevant innovation for RECONECT

At the same time, the demonstrators have expressed needs to exchange with respect to the following aspects:

- Monitoring and Evaluation: Monitoring of social impact indicators: property value, usage, perception, health, if possible economic evaluation + making monitoring design
- Monitoring and Evaluation: How does the NBS affect water quality and nature (interlinkages)
- Monitoring and Evaluation: How do we create synergies between indicators on different case areas?
- Monitoring and Evaluation: Method selection support: how will it work (who provides this services) in RECONECT?

Political and regulatory context (incl. relevant policies)

In Lystrup the Municipality of Aarhus gave the necessary permissions according to environmental legislation, traffic legislation and watercourse legislation. However, the overall economic authority was the National 'Supply Secretariat' in the Ministry of Business and Industry, who gave the water company the essential permission to execute the projects, because they were estimated to be cost effective compared to normal (grey) solutions. Certain of the sub-projects were subsequently adopted in the municipality's Waste Water Plan.

In Lystrup it has been very important to involve the local citizens, because the climate adaption projects are situated on public green areas which means that their local environment is affected. It has also been important to adapt the projects to the needs and the concerns of the citizens. Therefore the local joint council consisting of local interest organisations has been closely involved. Especially in the sub-project 'Hovmarksparken', the citizen's involvement has been strong. The result is, for example, the establishment of local cow grazer union, the setting up of Book and insect hotel, which is also used as a starting point for local nature tours, as well as the experiments with the establishment of low-nutrient biotopes and the planting of rare species around the rainwater pond. In Lystrup 11 of the 12 sub-projects are situated on public owned areas and only one sub-project are situated on private property. The project-ownership of the sub-projects are determined by their status according to the economic water-legislation and are thus divided by the Municipality, who owns 5 sub-projects and Aarhus Water who owns 7 sub-projects.

In Egå Engsø, The County of Aarhus had the authorities to give all permission according to the different Danish Nature- and Environmental Acts. Permissions was given before construction works began. Originally the demonstration area Egå Engsø was owned by 23 private farmers. In connection with the implementation of the project a land consolidation was executed, whereby the demonstration area came into public ownership (Municipality of Aarhus). The municipality is now responsible for the maintenance of the area and the project.

The maintenance of the water management parts of the projects are paid by Aarhus Water, which means by the water-taxes, and the maintenance of the parts of the projects that

concerns added values accrues to the owner of the area except if any special maintenance-agreement has been made.

A core stakeholder is the Aarhus water utility. The city council initially decided to finance and implement the NBS by transferring a grant to the water utility. The water utility is for example negotiating with the farmers and other landowners about land use restrictions, access to private property and compensations. If private landowners allow water retention on their properties, this can be compensated by the water utility (e.g. reduction of connecting fees). The spending of the water utility are supervised by the national utility council, as the water utility is only allowed to finance water management related tasks.

All famers around the Egå Engsø Lake and the residents at the former river basin, agreed to land change and or compensation. The farmers in Lystrup accepted compensation. The national lobby for farmers is in favour of these kinds of deals as usually the individual farmer profits. But some farmers might stay resistant as they perceive their land as holy.

Relevant policies on the Euroean level include the Habitat Directive (1992), Bird Directive (1979/2009), Biodiversity strategy to 2020 (2011), Forestry Strategy (2013); LIFE+, the Water Framework Directive and the Floods Directive (2006). National policies include, the Environmental Protection Law, Water Course Law, Nature Protection Law, Planning Law and the Co-financing Law (about wastewater companies possibilities ability to co-finance climate adaption projects). Relevant local policies, include the Municipality Plan, and the Municipal Waste Water Plan.

Wider social climate (including potential barriers)

Although, NBS have been successfully realised in this demonstration site, there are a couple of barriers that have been mentioned, including the financing of NBS, the negotiation with landowners, as well as political barriers due to conflicting interests. But there are also organisational barriers, as different departments within the municipality need to work together, which also can result in conflicts. Particularly, the latter barriers has been pro-actively addressed by the municipality.

As quite beneficial for the realisation of NBS, the demonstrator evaluated the existence of the Aarhus model for citizen involvement (see https://aarhus.dk/media/6603/policy-for-active-citizenship.pdf). It was developed and conducted by the local university. Every resident around the NBSs was integrated and the process is perceived that it developed new trust. Solutions like the cattle on the public meadow were found, in the interest of the municipality and the residents at the same time.

B4. Thur River Basin (Switzerland)

Overview

The river Thur is located in the North-Eastern part of Switzerland, draining the front ranges of the Swiss NE Limestone Alps (S of the Lake Constance basin). It is a tributary of the River Rhine which flows into the North Sea. The river Thur catchment is primarily rural, with agricultural activity mainly in the lowlands, and a few towns and villages. Water quality in the Thur catchment is adversely influenced by intensive agriculture and sewage water inflows mainly in the lower part of the catchment.

In RECONECT the focus in on a demonstration site that is located at the Thur River at the border between the Kanton Thurgau and Zürich (see Figure B.10). The idea of the project was to combine structural measures with the idea of river restoration to enhance flood protection, restore ecological functions, and reduce erosion of the riverbed. The plan was realized from 1993 to 2002 (Seidl and Stauffacher, 2013[17]).

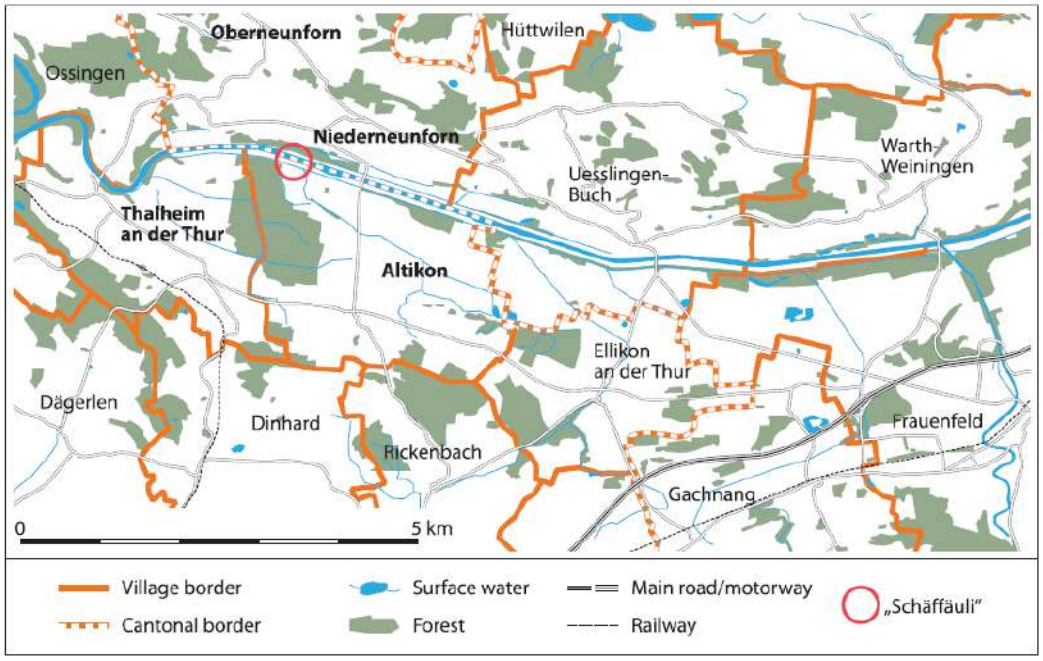


Figure B.26 Map of the area around the restoration project, including the affected municipalities, Thur River Basin (Source: Seidl and Stauffacher, 2013)

Figure B.27 Condition at the Thur section (left) before and (right) after the restoration (Source: Seidl and Stauffacher, 2013).

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, aim also to ensure the provision of enough water during dry periods. Figure B.11 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[18].

Risk, vulnerability and risk reduction through NBS

The Thur river is the largest Swiss river (127 km) without a natural or artificial reservoir and exhibits fluctuations in discharge and water table similar to unregulated alpine rivers (low discharge: 3 m3s-1; annual mean discharge: 23.3 - 76.4 m3s-1; peak flows up to 1100 m3s-1). Snowmelt and strong rain events in the pre-alpine headwaters cause short but

[18] http://www.eawag.ch/en/department/wut/projects/record-catchment

rapid increase of discharge. During base flow outflows of sewage treatment plants are significant flow contributors.

During the 19th and 20th century, various projects have been undertaken to reduce the risk of flooding in the region. Between 1874 and 1893, the first correction of the Thur was implemented, resulting in straightened river bed (Rösch et al., 2012) (see Figure B.12).

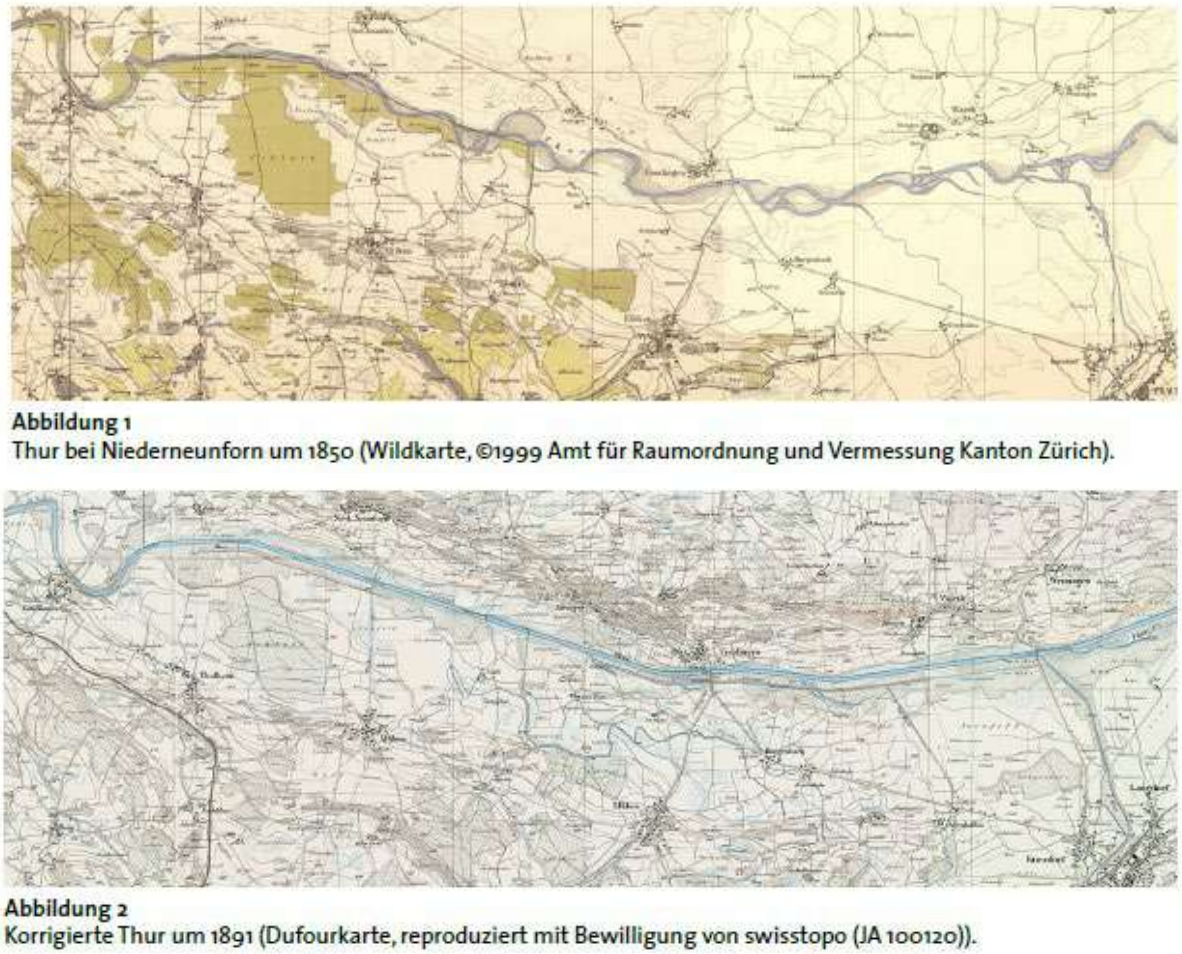


Abbildung 1
Thur bei Niederneunforn um 1850 (Wildkarte, ©1999 Amt für Raumordnung und Vermessung Kanton Zürich).

Abbildung 2
Korrigierte Thur um 1891 (Dufourkarte, reproduziert mit Bewilligung von swisstopo (JA 100120)).

Figure B.28 Thur at Niederneuform around 1850 (before the first correction) (Source: Rösch et al., 2012, 4)

However, the levees were not able to prevent future flooding. Two extreme floods in 1977 and 1978 caused significant damage to the region. As Seidl and Stauffacher report, the affected canton of Thurgau decided to intervene to better protect the people and infrastructure surrounding the Thur. After considerable discussions, debates, investigations, and evaluations, a plan was presented addressing the shortcomings. Instead of just building higher levees, the plan was to combine structural measures with restoration to enhance flood protection, restore ecological functions, and reduce erosion of the riverbed. The plan was realized from 1993 to 2002. Levees were built higher, and stronger and additional space was provided to the river (Seidl and Stauffacher, 2013).

The realisation of this project resulted in quite a number of benefits, including a widening of the river channel and a reduction of water levels further downstream of about 1 meter; an improved water quality; an improvement of ecological status of river and its riparian zone resulting, above all, from changes in the morphology, and, finally, a high level of acceptance among the local population (Rösch et al., 2012)

Capacities and needs with respect to realising NBS

The demonstrator is represented through EAWAG, the Swiss Federal Institute of Aquatic Science and Technology. The objectives to participate are to establish research collaborations on river restoration, to gain new direction, ideas and insights on how to deal with hydrological extreme events and to evaluate the NBS realised along the Thur River in an European context.

As demonstrated by the realisation of NBS along the Thur River the **motivation of the demonstrator** to realise NBS is very high, on organisational as well as on the political level. As AEAWAG is a research institute, the focus is on doing research on NBS instead of realising NBS, with one exception. The Chriesbach restoration (mentioned above) was financially supported by EAWAG because the restored stretch of Chriesbach lies directly at EAWAG. It was planned and executed under participation of Eawag personnel and administration. This occurred in close collaboration with the city of Dübendorf and the Agency for the Environment (AWEL) of the Canton of Zurich. Similarly, the interest of elected politicians and responsible administrative bodies to realise NBS is very high, at least with respect to river restorations, as this is required by law in Switzerland (see next section). As a consequence of this law, the affected communities have also a high interest to realise NBS. The funding comes to a large percentage (sometimes 100%) from federal and cantonal resources.

EAWAG has great experience related to different aspects relevant for monitoring and evaluating the wider benefits of NBS, including the RECORD-Catchment project which started in 2012 to investigate the coupled ecological, hydrological and social dynamics in restored and channelized corridors of a river at the catchment scale.

At the same time, the demonstrators have expressed needs to exchange with respect to the following aspects:

- Monitoring and Evaluation: knowledge exchange (monitoring): groundwater; soil/moisture
- Monitoring and Evaluation: Surface water – groundwater interactions
- Monitoring and Evaluation: People indicators, with an emphasis on perception

Political and regulatory context (incl. relevant policies)

The political context in this demonstration site is distinct from all other demonstration sites and this in several ways. First, it is not underlying European legislation. The realisation of NBS is thus purely driven by national legalisations. Second, Switzerland is one of the few countries, if not the only country in the world practicing direct democracy through referenda on a regular basis at the national level. In this system, important changes in the constitution or (new) legislation are typically subject to a popular vote (referendum). The popular initiative is another mechanism which allows Swiss citizens to propose a change in the law or constitution. It was such a popular initiative that led to the revision of the Swiss Waters Protection Act in 2011, which defines the scale of river restoration and the required financial investment. The absence of opposition to this amendment of the law indicates that there is strong public support for this funding (see also chapter 10.4). In this Act the Swiss Federal government set out the target to restore 4000 km of rivers in the country by 2090 (Logar et al., 2019). This corresponds to one-quarter of the total length of running waters in Switzerland and requires a restoration rate of 50 km per year. Such an ambitious plan places Switzerland at the forefront of river restoration efforts globally. The costs of restoring these 4000 km of rivers have been estimated at 60 million Swiss Francs (CHF)1 per year, which is equal to 4.8 billion CHF over the entire period of 80 years or 1.2 million CHF/km (1200 CHF/m). The federal government has committed itself financially to cover 65% of these costs. The remaining share has to be financed from other sources, such as regional or local governments in those areas where the river restoration takes place. The cantons who are responsible of the water courses work closely with the Federal Office for the Environment (FOEN) to accomplish the tasks. If there are obstacles as for example objections by people against the measures, these have to be resolved.

Wider social climate (including potential barriers)

The wider social climate with respect to realising NBS in order to reduce flood risks and to restore river beds is quite positive in this demonstration site, at least on the political and level level. However, as Seidl and Stauffacher (2013) show that acceptance of the restoration has also increased as a result of the restoration among the population. There are also differences between different groups: Farmers have a specific relationship to ‘‘nature’’ because they directly deal with soil and plants and their financial well-being depends on the yield of their land. Thus, it is not surprising that farmers differ from non-farmers in their judgment about acceptance (i.e., they agree to a lower degree that the restoration was reasonable). Farmers show significantly higher values for the perception of threat from flooding. Thus farmers actually focus more on flood protection and are more concerned about the flood threats. In fact, non-farmers acknowledge flood protection and the importance of animal and plant diversity after restoration, but overall, they focus much more on aesthetic aspects.

Furthermore, Logar et al. (2019) performed a cost-benefit analysis for the restoration measures that took place at the Niederneunforn site. Their analysis demonstrated that in this case the social benefits outweighed the costs for the restoration efforts.

B5. The Var Éco-Vallée & Les Boucheleurs (France)

In this chapter we provide an overview on two Demonstration sites: the Var Éco-Vallée and Les Boucheleurs (both France). As both demonstrators are represented in RECONECT by one research institution, that is the Universite des nice Sophia Antipolis / Polytech Nice Sophia (**UNSA**), this chapter will provide an overview on both sites, but focus on the demand and supply of UNSA.

Overview

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 B.29 Demonstration site, Var low valley, Nice (France)

The realisation of NBS in **Les Boucholeurs** is a response to the devastating Xynthia storm in 2010. 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 so 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:

- Prevention and forecasting: Improving knowledge and awareness of risk, surveillance, flood and flood forecasting, crisis alert and management.

- Spatial planning: Taking risk into account in urban planning, actions to reduce the vulnerability of property and people.
- The works of protection: Managing flows of water (from the sea and marshes), creation of protective structures (e.g., breakwater, reensablement, 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:

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

Figure B.30 Demonstration site, Les Bouscheleurs (France)

Risk, vulnerability and risk reduction through NBS

The **Var** is located in Alpine area (southeast of France) and its characterized as torrential river with steep slopes. The river Var has a total length of 114 km, with the Tinée, Estéron and Vésubie as its main tributaries cross five main sub-catchments (Tinée, Estéron, Vésubie, Upper Var, and Lower Var). The river section concerned in this project is the Lower Var in total length of 22km approximately, which was previously running freely between the valley slopes and therefore featured large, very mobile gravel bars composed of coarse bed material.

From the early 19th century on until the 1960s the landscape has undergone some substantial changes, including the canalisation of the river over the entire length of the lower valley, reducing its width (cross section) from about 1000 m (in average between valley slopes) to a 300 m, and even 200 m in the last cross sections close to the sea. To compensate the lowering of the river bed as a result of the extraction of building materials, fixed weirs were constructed to bring the water table back to its original level.

Climatically, the area is located in a centre of polar and tropical air masses resulting in the alternation of a rainy season during the winter season and a dry season during hot summer seasons. The average annual temperature of 15° and a mean annual rainfall of 826 mm conceal an uneven distribution of temperature and precipitation during the seasonal cycle.

The shape of the area is river valley, with flat flood plains. These characteristics are influential on the risks listed for demonstration site especially for:

- Floods: they arise from extreme weather conditions that affect the flow of rivers and may cause intense storm runoff,
- Landslides: storm runoff during heavy rainfall on steep slopes can cause landslides, falling rocks, etc.

Les Boucholeurs is a district of Châtelaillon-Plage located on the limit of Yves, two cities of the Charente-Maritime County. This district count approximately 600 houses and have an important activity in oyster and mussel farming. Les Boucholeurs extends in border of a vast bay and presents houses on the sea front directly exposed to waves as well as setback constructions on the location of former leveed marshes. The Storm Xynthia caused in 2010 enormous damages. The rare extreme event Xynthia occurred in early morning of 28th February 2010 as a result of atmospheric depression created on 27th February morning. Described as an explosive storm with the depression of 20hpa in more than 24h, Xynthia went through the country very fast. Based on the meteorological parameters (atmospheric pressure Xynthia has not reached the exceptional storms Lothar and Martin in December 1999, neither Klaus in January 2009. Even so, the effect of Xynthia on flooding and erosion is significant, especially in the department Vandee and Charente-Maritime.

In Les Boucholeurs, the urbanized zone has experienced also devastating impacts resulting from the overtopping on the sea front (the strong exposure to waves caused two deaths) in the north and water entrances on a very large linear due to levees and dunes overflowing in the south. The canal that crosses the urbanized area (the Punay port canal) contributed to store the water in the high stakes zone. The foreshore ramps were not equipped with locking devices and allowed the passage of large flows. The lighter marshes were severely damaged after being submerged. However, the permeability of road and railway infrastructures allowed a part of the water to spread outside the most vulnerable areas.

In the aftermath of the storm, Xynthia in 2010, a group of municipalities (Châtelaillon-Plage, Yves, Aix and Fouras) came together to implement the flood risk management strategy, PAPI in roder to reduce the risk from future storm surge event. After the storm surge, as part of the **Nature based solution (NBS),** existing flood walls were reconstructed and raised. No new walls were built. In addition to the flood walls, the oyster farmers are now considered to provide retention in the case of river and ground water flooding. Retention is also provided by a marshland which is also a Natura 2000 protected reserve. This combination of grey, green and blue measures is seen as the NBS to ensure a more holistic and effective flood protection then using grey solutions alone.

Capacities and needs with respect to realising NBS

The main interest of **UNSA** with respect of participating in the RECONECT project is to learn more about potential indicators for monitoring biodiversity. Stakeholder narratives deriving from the other demonstration sites are also of interest as well as better evaluating and understanding the up-scaling potential of both French Demonstration sites.

As demonstrated by the realisation of NBS in both sites, the motivation of the demonstrator to realise NBS is very high, on the political level. However, similar as in other sites, the projects realised are not labelled as NBS. The initiative for the **Var Éco-Vallée** goes back

to the then Minister of Urban Planning in 2008 and was declared as a project of national interest (*Opération d'Intérêt National*, OIN)[19]. This status is provided to projects that are in accordance with the federal governmental national strategies and which have a national impact. To indicate that relevance of the demonstration site: There are currently only thirteen OINs in France. Reasons that this project was declared as being of national interest are among others increasing the attractiveness of Nice on the European level, encourage policies favouring a focus on biodiversity and sustainable development.

Also in **Les Boucholeurs** there is a high support of NBS, although there is a clear emphasis on risk reduction and a high priority of reducing risks effectively, which is also a consequences of the devastations caused by Xynthia in 2010. Since then a couple of changes were initiated on the policy level, a point we return to in the next section.

As a scientific partner, **UNSA** as a multidisciplinary team of scientists and researchers who are focusing their research activities on water issues in urban environments and on smart buildings. The team is actively developing international collaboration and active links with industries and collectives, including research on urban waters management and ICT, flood modelling and risk assessment, data acquisition and management in natural and built environments, numerical modelling techniques.

Against, this background, the demonstrator has expressed a needs to exchange with respect to the following aspects: With respect to monitoring and evaluation, there is a need to exchange and agree on a timeline on how to monitor indicators (e.g. on a weekly, monthly, early basis?) and on how to ensure sustainability after end of project? (UNSA)

Political and regulatory context (incl. relevant policies)

The initiative for the **Var Éco-Vallée** goes back to the then Minister of Urban Planning in 2008 and was declared as a project of national interest (Opération d'Intérêt National, OIN). This is a major driver for the successful implementation of NBS in this demonstration site.

Also the realisation of NBS in **Les Boucholeurs** is a result of a strong national policy framework. In 2011 the French Government published as a response to the storm event in 201ß, the so called "Plan submersions rapides: Submersions marines, crues soudaines et ruptures de digues". The plan lays out for priority areas (Cunge and Erlich, 2014):

- A strong control and regulation of urban developments in areas prone to the risk of flooding;
- Improvements in coastal forecasting and warning;
- Strengthening of flood defences;
- Developing a "culture of risk awareness".

Although it is not specific, in Les Boucholeurs measures were realised that not just provide protection, they also provide additional retention and enhance the quality of the marshland, which is also a Natura 2000 protected reserve. In addition, the Flood Directive provided also an important policy context for the realisation of the NBS in this demonstration site. The EU framework was laid down in the 12 July 2010 Act on the national commitment to the environment, known as "Grenelle 2" , transposing the European Directive of 23 October 2007, known as the "Floods Directive".

[19] http://www.ecovallee-plaineduvar.fr/node/106

Wider social climate (including potential barriers)

More information on the wider social climate will be provided in upcoming Deliverables (i.e. D6.4).