

# NBS for hydro-meteo hazards and climate change adaptation

**Process to NBS implementation and replication; PHUSICOS experience**

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# Outline

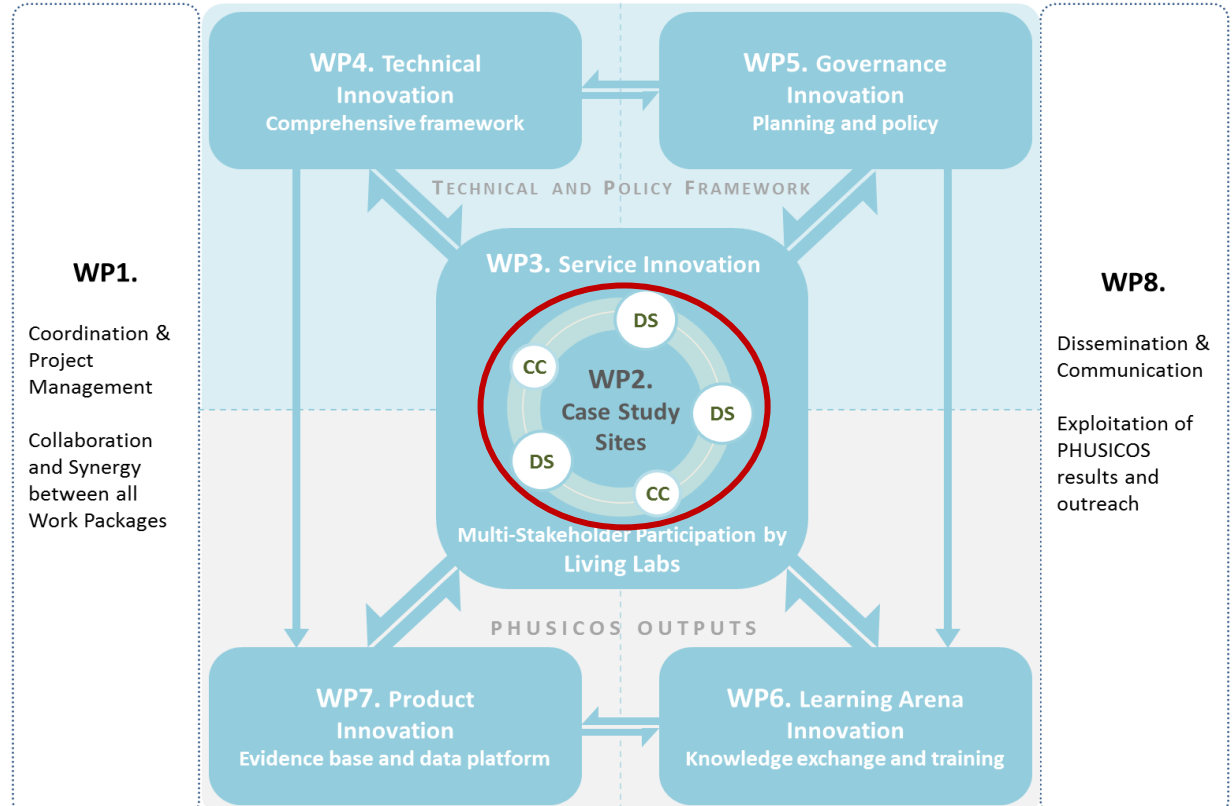
- PHUSICOS project (short)
- Implementation selection criteria
- Implementation examples case sites
- Barriers and enablers
- Presentation of case study, mountain region





# PHUSICOS – a 5 year H2020 project on NBS (in mountainous rural areas)

- 5 years (2018-23), with budget of 10 mill. Euros.
- 15 partners from 7 countries.  
Coordinated by NGI
- Innovation Action: Funding is more focused on closer-to-the-market activities  
(demonstrating, up-scaling, etc.)
- 8 Work Packages centered around case studies, WP2





# PHUSICOS NBS sites

## PHUSICOS' NBS selection criteria:

- Risk reduction / Resilience;
- Technical feasibility;
- Co-benefits (Social, Ecological, Economic);
- Effectiveness;
- Efficiency;
- Potential negative impacts of NBS;
- Stakeholder involvement;
- Harmonization with other PHUSICOS
- WPs;
- Compliance with international and EU agreements and directives





# Selection criteria - Funding

- At least 40% from other sources than PHUSICOS
  - Cash from private or public sponsors
  - In-kind in the form of hours spent, use of equipment, laboratory facilities, etc., etc.
- Maintenance costs can be included, with up to 15% of estimated cost, in its 2018 value.
- The 40% must be specified in the proposal, including sources of the funds.
- All costs to be covered by the project must be eligible in accordance with EU rules (Grant Agreement).





# Selection criteria - Risk reduction and resilience

- Reducing risk and increase resilience regarding hydro-meteorological hazards is the key issue of PHUSICOS!
  - Human life and well-being
  - Ecological state
  - Social structure
  - Economic values
  - Critical infrastructure





# Selection criteria – Co-benefits

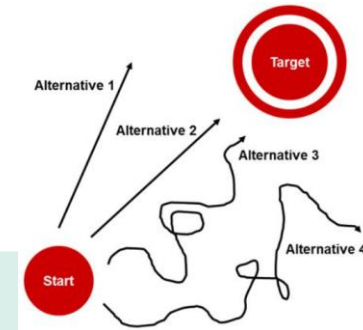
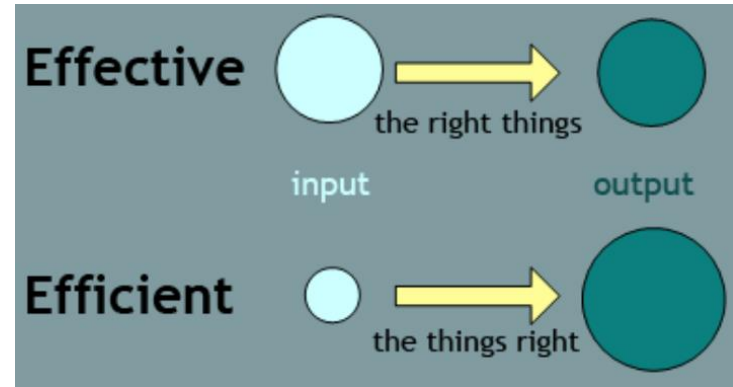
- Ecological impacts:
  - habitat restoration, enhancing biodiversity and ecosystem services (ESS) provisions
  - increased carbon storage capacity, such as increase in biomass.
- Social impacts:
  - provision of human well-being and health (e.g. stakeholder involvement to increase perception of safety)
  - improved quality of life and accessibility for recreation
- Economic impacts:
  - enhancing innovation capacity, e.g. new methods, concepts, etc.
  - increase in human capital for territorial growth (create jobs).





# Selection criteria – Effectiveness (and efficiency)

- Effective vs. efficient:
  - Being effective is about doing the right things, while being efficient is about doing things right.
- The NBS should be effective over long time periods, and designed to withstand changing physical conditions.
- Need for maintenance must be described (and budgeted).





# Selection criteria - Participatory process

- The Living Lab approach (WP3)
  - Evaluation on how the LL approach is being applied, from planning through implementation.
    - Important to also describe the continued participatory process after proposal.
  - Tailored to the local context at each case
  - Much experience among the Isar and Kaunertal site groups.
- **Plus harmonization with other WPs**
  - Partly covered by previous points
  - To show how the various WPs are important for each of the cases.





# Additional criterion

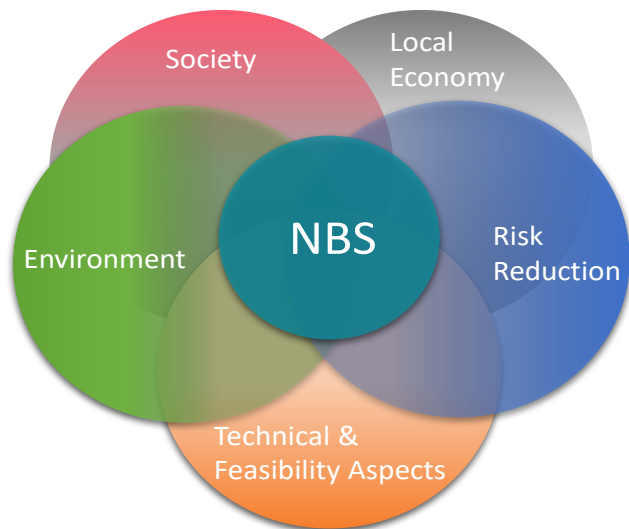
- How the proposed NBS help to fulfill
  - The UN development goals
  - Sendai declaration of DRR, 2015-2030:
    1. Understanding disaster risk
    2. Strengthening disaster risk governance to manage disaster risk
    3. Investing in disaster risk reduction for resilience
    4. Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction





# NBS performance assessment framework

The Framework Tool is based on the assessment of distinctive Indicators, making up a Framework Tool Matrix



| AMBIT                           | CRITERION                                                    |
|---------------------------------|--------------------------------------------------------------|
| Risk Reduction                  | Hazard                                                       |
|                                 | Exposure                                                     |
|                                 | Vulnerability                                                |
| Technical & Feasibility Aspects | Technical Feasibility                                        |
|                                 | Economic Feasibility                                         |
| Environment                     | Water                                                        |
|                                 | Soil                                                         |
|                                 | Vegetation                                                   |
|                                 | Landscape (Green Infrastructure)                             |
|                                 | Biodiversity                                                 |
| Society                         | Quality of life                                              |
|                                 | Community Involvement and Governance                         |
|                                 | Landscape and Heritage                                       |
| Local Economy                   | Revitalization of Marginal Areas                             |
|                                 | Local Economy Reinforcement, including New Job Opportunities |

[https://phusicos.eu/wp-content/uploads/2019/05/D4.1\\_Task4.1\\_UNINA\\_14052019\\_Final\\_withAppendicies.pdf](https://phusicos.eu/wp-content/uploads/2019/05/D4.1_Task4.1_UNINA_14052019_Final_withAppendicies.pdf)



# PHUSICOS NBS

Approved; Various stages  
of implementation (10)

Proposed & approved but  
cancelled (3)

Proposed but declined (1)

- Total 18 proposed
- 14 to be implemented

| Site                       | Proposal                            | Hazard                                | Type intervention                                                    | Status                  |
|----------------------------|-------------------------------------|---------------------------------------|----------------------------------------------------------------------|-------------------------|
| Gudbrandsdalen, Norway     | G1: Jorekstad                       | Flooding                              | -Use of floodplain; receded green barrier                            | Approved, but cancelled |
| Gudbrandsdalen, Norway     | G2: Skjåk                           | Flooding/torrents                     | Living Lab process                                                   | Approved,               |
| Gudbrandsdalen, Norway     | G3: Øyer                            | Flooding / debris flows               | Vegetation, check dam, retention basin                               | Under implementation    |
| Gudbrandsdalen, Norway     | G4: Skurdalsåa                      | Flooding                              | Retention high in catchment                                          | Approved,               |
| Serchio River Basin, Italy | SRB-A: Canals by Lake Massaciuccoli | Erosion, run-off, pollution, flooding | Vegetated buffer strips                                              | <u>Implemented</u>      |
| Serchio River Basin, Italy | SRB-B: Canals by Lake Massaciuccoli | Erosion, run-off, pollution, flooding | Vegetated buffer strips                                              | <u>Implemented</u>      |
| Serchio River Basin, Italy | SRB-C: Dam by Lake Massaciuccoli    | Erosion, run-off, pollution, flooding | Vegetated basin                                                      | Approved,               |
| Serchio River Basin, Italy | SRB-D: NBS Lab                      | N/A                                   | Educational                                                          | <u>Implemented</u>      |
| Serchio River Basin, Italy | SRB-E: Canal system                 | Flooding                              | Improve hydraulic capacity                                           | <u>Implemented</u>      |
| Pyrenees, Spain            | P1: Santa Elena                     | Erosion, rockfall, instability        | Vegetated terraces                                                   | Approved                |
| Pyrenees, France           | P2: Socques                         | Torrents                              | check-dams                                                           | Cancelled               |
| Pyrenees, France           | P3: Artouste                        | Rockfall                              | Wood structures to prevent release and acceleration                  | Approved                |
| Pyrenees, France           | P4: Bastan River                    | Flooding, torrents                    | Change of river long & tranverse profile; allow more room for floods | Cancelled               |
| Pyrenees, France           | P5: Capet Forest                    | Snow avalanches                       | Afforestation in release area                                        | <u>Implemented</u>      |
| Pyrenees, Spain            | P6: Port Ainé                       | Flooding, instability                 | Re-vegetation, erosion control                                       | Declined                |
| Pyrenees, Spain            | Erill-La Vall                       | Debris flows                          | Erosion control, wooden gabions, vegetation                          | Approved                |
| CC - Isar River, Germany   | Educational                         | Flooding                              | Flood plain restoration                                              | <u>Implemented</u>      |
| CC - Kaunertal, Austria    | Revegetation                        | Erosion, landslides                   | Microbe-assisted revegetation                                        | Under implementation    |





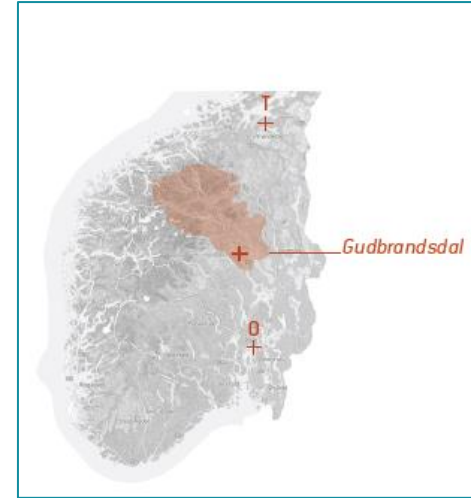
# Stakeholders various NBS projects

| Site                      | Hazard                                | Affected                          | Stakeholders                          |
|---------------------------|---------------------------------------|-----------------------------------|---------------------------------------|
| Jorekstad (Norway)        | Floods, erosion                       | Agricultural area, sports arena   | Farmers, municipality, NGOs, citizens |
| Øyer (Norway)             | Floods, debris flows                  | New housing area                  | Municipality, house owners            |
| Serchio river (Italy)     | Erosion, pollution, run-off, flooding | Agricultural area, lake pollution | Farmers, municipality, region         |
| Capet forest (Pyr.)       | Snow avalanche                        | National park                     | Tourism, NGOs, forestry               |
| St. Elena/Artouste (Pyr.) | Rock fall, erosion                    | Infrastructure (road)             | Travellers, local communities         |
| Erill la Vall (Pyr.)      | Debris flows                          | Village, nature                   | Municipality, citizens, NGOs          |



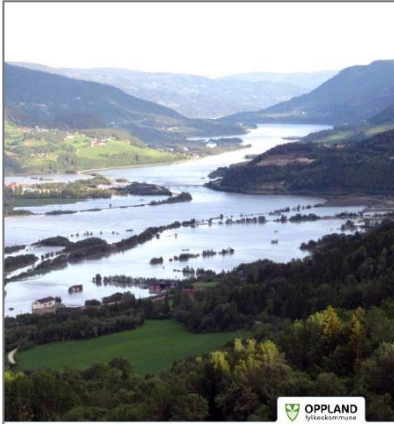


# Valley of Gudbrandsdalen, Norway





# Valley of Gudbrandsdalen, Norway



OPPLAND  
fylkeskommune

## Lågenplanen

Regional plan for Gudbrandsdalslågen med sidevassdrag

- Tiltak for å redusere flom- og skredskader



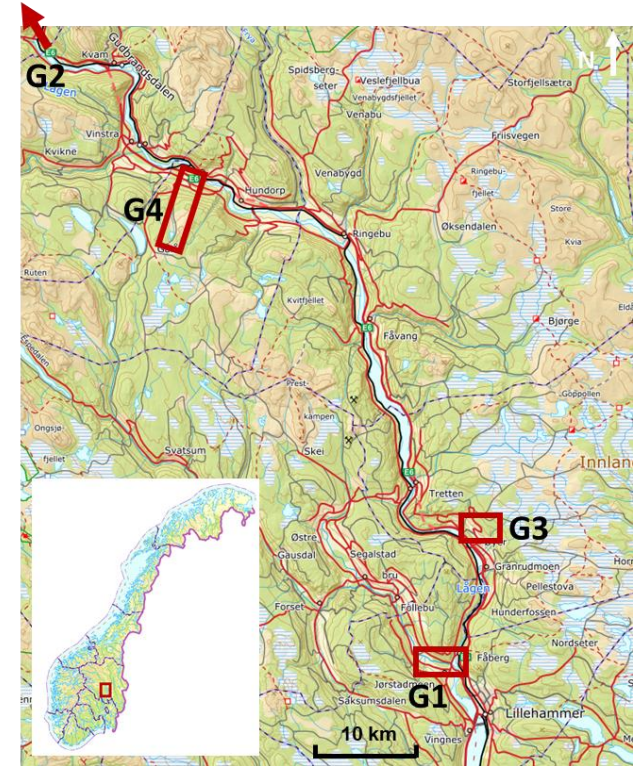
<https://innlandetfylke.no/tjenester/plan-statistikk-og-folkehelse/regionale-planer/>





# Valley of Gudbrandsdalen, Norway

- G1: Jorekstad – case study Bologna summer school
- G2: Skjåk - Living Lab process and interest in using traditional water ways for flood retention
- G3: Øyer - flood and erosion control
- G4: Skurdalsåa - flood retention

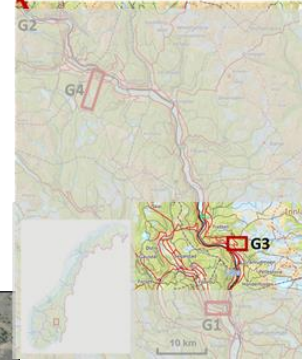




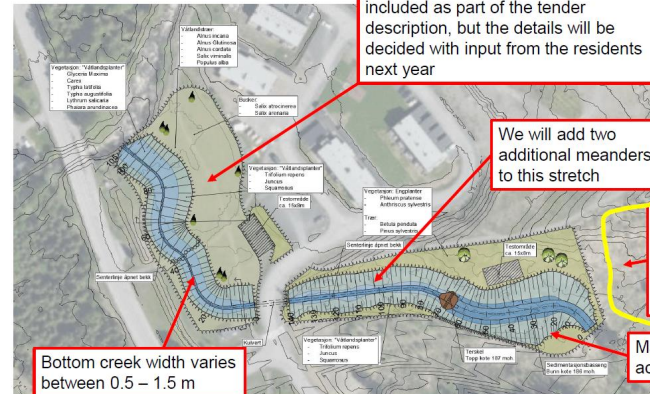
# Gudbrandsdalen: Øyer, flood control

## G3: Øyer, flood / erosion control:

- Previous gravel pit, to be developed into an area for family housing.
- Measure consists of re-opening creek, revegetation, constructing a sedimentation basin in the creek and establishment of blue-green park area with ponds, for flood retention.
- Vegetation species from southern climate (south Norway);
- Planted in two fenced plots to test the growth;
- effectiveness of these species will be tested out as erosion protection measures



## Overview



Benches and playgrounds will be included as part of the tender description, but the details will be decided with input from the residents next year

We will add two additional meanders to this stretch

We will demarcate areas of Trodalsbekken that must remain undisturbed to preserve the natural environment.

Maintenance vehicle access will be here

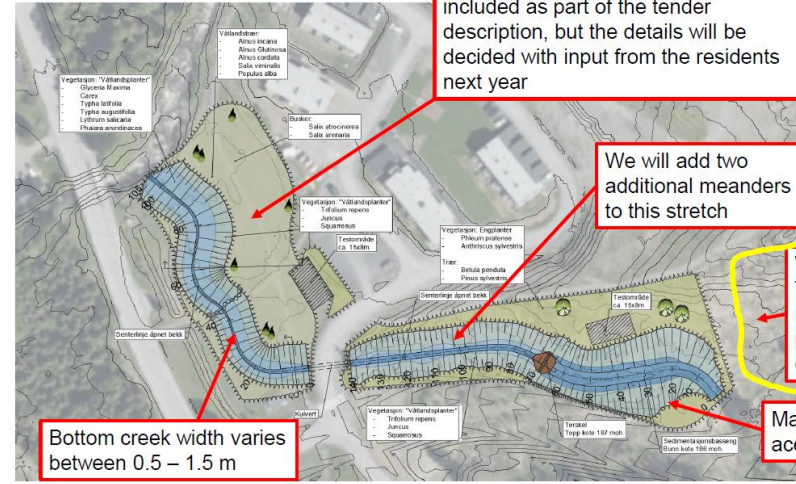
Bottom creek width varies between 0.5 – 1.5 m



# Area plan



## Overview



2021-11-04

2

Norconsult





# Status early July 2022

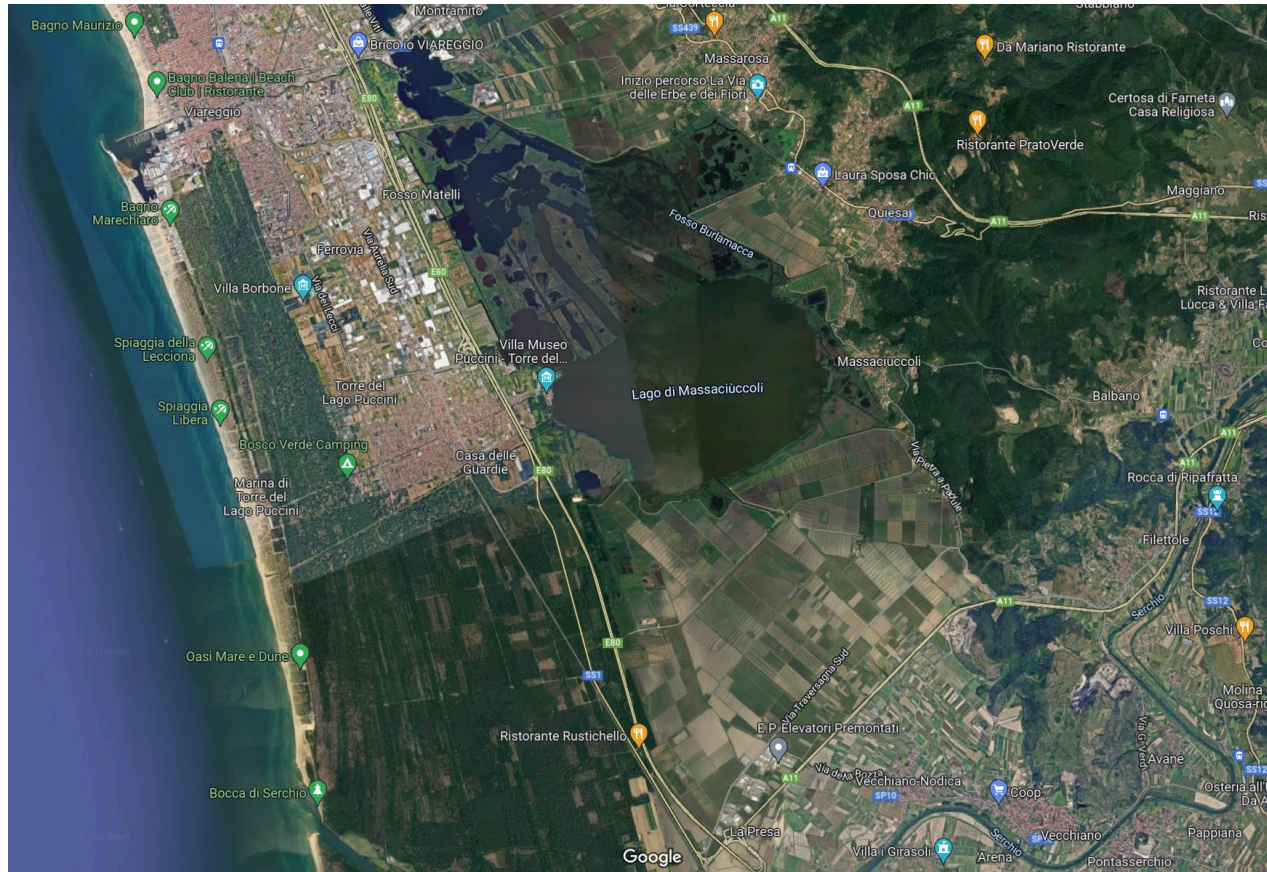




# Serchio River Basin – Lake Massaciuccoli, Italy

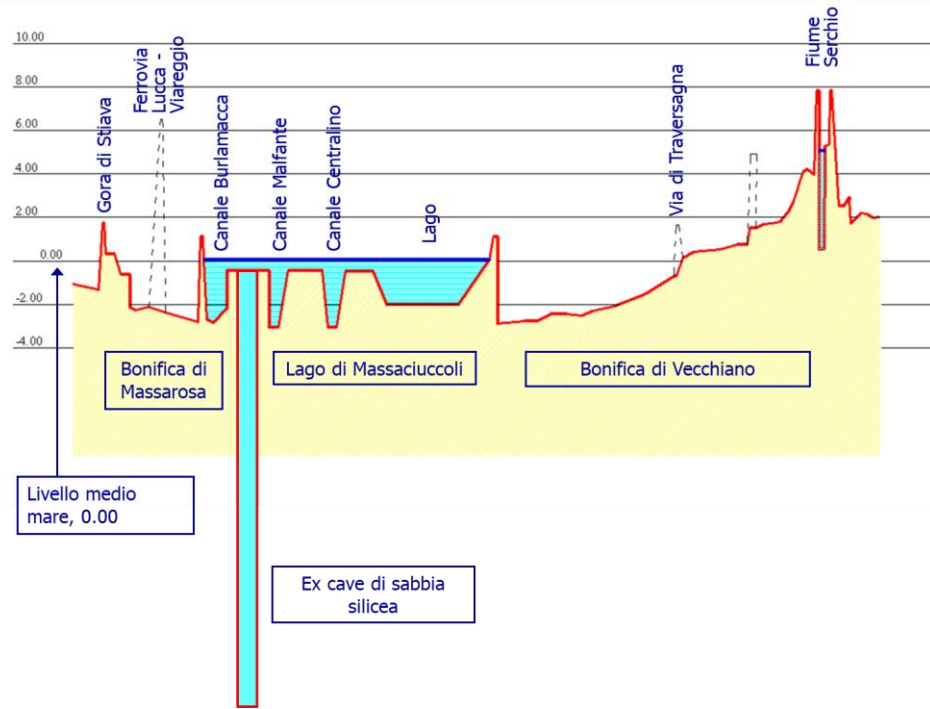


- Lake is in very poor state. Inflow of seawater when lake level is low
- Transfer water from the Serchio River in dry seasons: decrease salinity and maintain lake level
- Prevent runoff of soil, nutrients and pesticides from farmland through NBS
- NBS also for flood control





# PHUSICOS case – Serchio River / Lake Massaciucoli



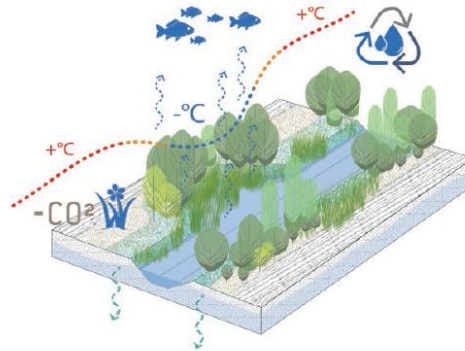
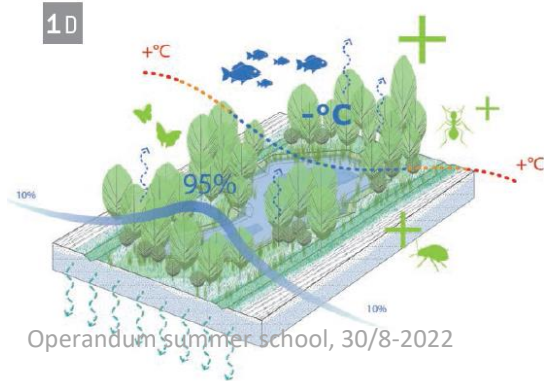
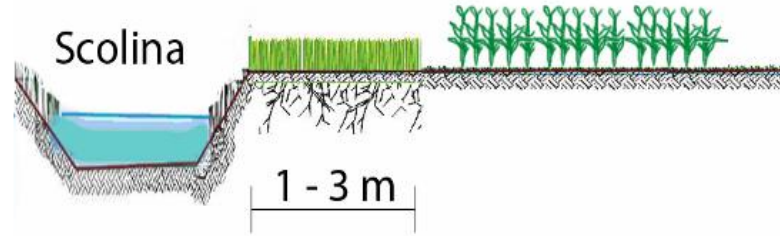
## NBS measures

- Establish vegetation buffer strips along channels
- Establish a sedimentation basin
- Modify canal cross sections to increase their efficiency
- Change crops in parts of the fields





# Measures to reduce runoff from fields, to canals and the lake



- natural water pockets within the engineered network
- possibilities for water buffering/ treatment on site
- ecologically valuable areas for specific species





# M19-M36: Serchio River Basin, Italy - 2

## Total for Serchio River Basin:

- Most progressing as planned! High potential for upscaling. Much interest and publicity, locally and regionally!

### Barriere verdi per la salute del Massaciuccoli

1 Minuto 1 Condividi 1 Tweet 1m Condividi



E' una delle soluzioni individuate per mitigare il rischio idrogeologico legato all'erosione ma anche per abbattere gli inquinanti legati alle colture

MASSAROSA — Si chiamano *buffer strip* e sono barriere verdi, nel senso di aree vegetate, da collocare ai margini dei campi per contrastare a impatto pressoché zero erosione costiera e

inquinazione di inquinanti nelle acque del lago di Massaciuccoli. È questa una delle soluzioni green per mitigare il rischio idrogeologico e migliorare la qualità dell'acqua individuate nel corso di un sopralluogo, il primo, per verificare l'avvio dei lavori previsti dal progetto Phusicos, according to nature.

Finanziato dall'Unione Europea con 1 milione e 425mila euro, all'interno del più ampio programma quadro *Interreg 2020*, il progetto nasce con l'obiettivo di dimostrare l'efficacia di soluzioni basate sulla natura nel mitigare il rischio idrogeologico, nel migliorare la qualità della risorsa idrica e i delicati sistemi ambientali del comprensorio del Lago di Massaciuccoli tra le province di Livorno e Pisa.

Nella sostanza con l'attuazione di tale progetto si mira a dimostrare come interventi di tipo naturalistico, come le *buffer strip*, possano essere altamente efficaci per evitare che le acque dilavanti dalle coltivazioni nei terreni circostanti il lago di Massaciuccoli arrivino al lago cariche di sostanze inquinanti, quali ad esempio nitrati e fosfati.

Le *buffer strip* sono essenzialmente aree vegetate inserite ai margini dei campi coltivati al fine di limitare l'erosione del suolo e migliorare la qualità dell'acqua. Tali misure si mantengono, quindi, perfettamente, nell'attuale tessuto territoriale del lago. Un approccio naturale e di basso impatto ambientale e paesaggistico finalizzato a incrementare la resilienza del territorio, favorendo la biodiversità e fruibilità delle aree naturali.

### LEGGI TOSCANA

NOTIZIE DEL TERRITORIO  
SULLA REGIONE

PRINCIPALI ECONOMIA POLITICA REGIONE CULTURA NEWS TECNOLOGIA

### Massaciuccoli più sicuro: al via EU Phusicos

di [Francesca Vercellotti](#) - [10/02/2021](#)

**Un progetto green da 1,4 milioni di euro che vede in prima linea l'autorità di Bacino**

Soluzioni green per mitigare il rischio idrogeologico e migliorare la qualità dell'acqua. Si fonda nel green water, sul lago di Massaciuccoli. L'opera verde per la qualità dell'acqua del lago di Massaciuccoli. Il progetto Phusicos, secondo la natura. L'Unione Europea con 1 milione e 425 mila euro, all'interno del più ampio programma quadro "Interreg 2020", il progetto nasce con l'obiettivo di dimostrare l'efficacia di soluzioni basate sulla natura nel mitigare il rischio idrogeologico, nel migliorare la qualità della risorsa idrica e i delicati sistemi ambientali del comprensorio del Lago di Massaciuccoli.



Il segretario dell'Autorità di Bacino, Distributore dell'Agente per lo Sviluppo Sostenibile Massimo Lucchesi, davanti al cartello informativo sul lago di Massaciuccoli.

### Lucca in Diretta

1 Minuto 1 Condividi 1 Tweet 1m Condividi

### Massaciuccoli più sicuro, via ai lavori del progetto Phusicos

Soluzioni green per mitigare il rischio idrogeologico e migliorare la qualità dell'acqua

di Redazione - 05 Febbraio 2021 - 11:58

Condividi Stampa Invia notifica 0 mi

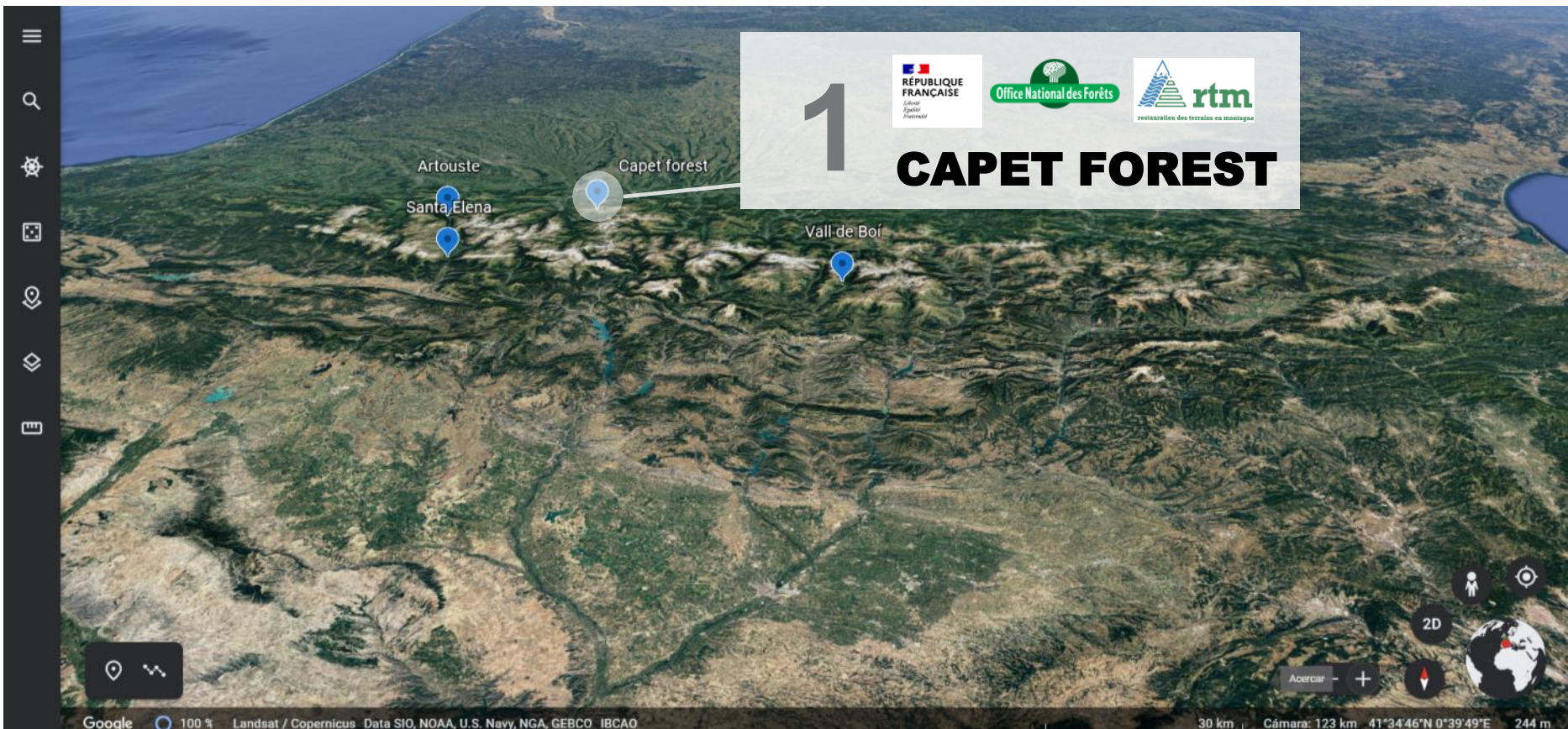
Più informazioni su

agricoltori autorità di bacino interventi green lago di massaciuccoli massarosa progetto eu phusicos vecchiano massarosa versilia



Massaciuccoli più sicuro. Soluzioni green per mitigare il rischio idrogeologico e migliorare la qualità dell'acqua.

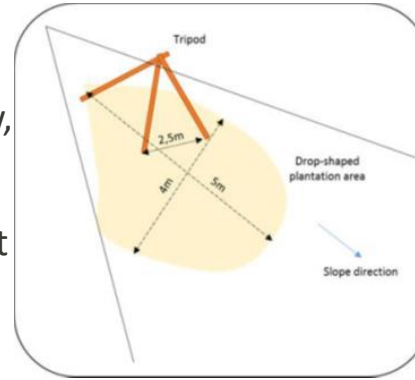






# Pyrenees, Capet Forest: snow avalanches

- Frequent avalanches threats w/ evacuations of the village Baréges.
- Existing snow fences some times too low, and require heavy maintenance.
- PHUSICOS measure is afforestation in release area; altitude adapted local plant species, protected by tripods.
- Complete summer 2022.



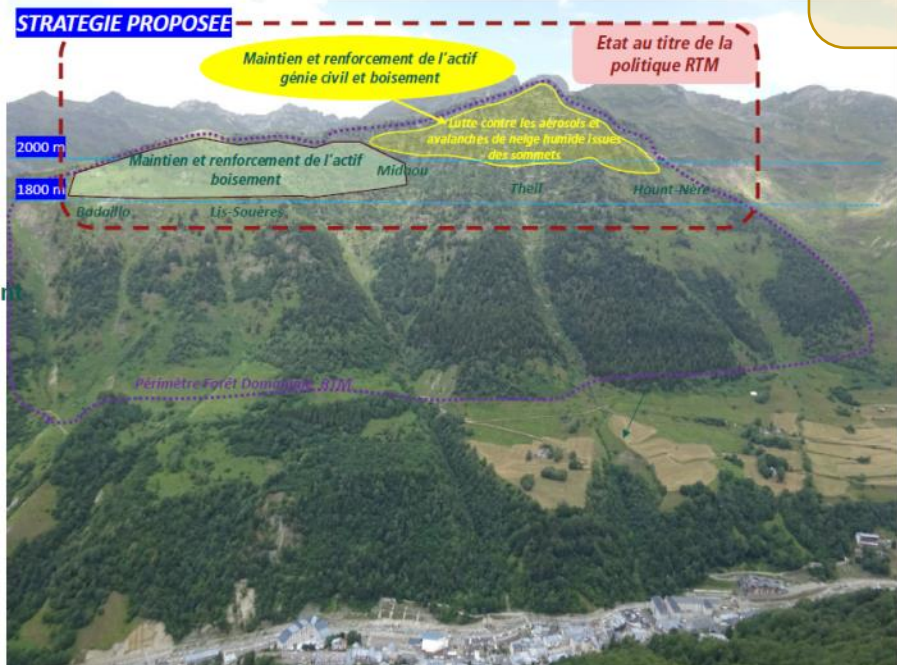


# 1 CAPET FOREST



## Risk of avalanche

**NBS:** plant establishment and tripods



- Last planting campaign during late Spring 2022 (2.000 plants)
- Global strategy of protection planned by ONF-RTM: mixed works (grey + green), housing for workers for maintenance...
- Close coordination between ONF-RTM and Authorities (meeting, public event...)
- Monitoring post PHUSICOS may be reinforced





# Check dams – hybrid solutions



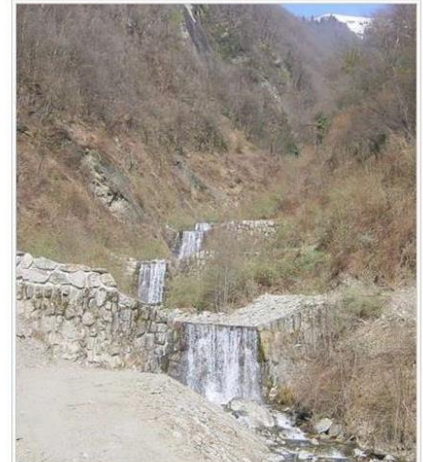
- Combine traditional 'grey' techniques with the use of 'live' and local materials.
- Avoid long transport, concrete and other alien material; also consider emission reduction.



Operandum summer school, 30/8-2022



Le lit du torrent avant la construction des seuils



Cascade de seuils ayant stoppé l'érosion et permis la reconquête de la végétation



# Barriers to uptake and implementation of NBS

1. Lack of political will and long-term commitment
2. Lack of sense of urgency among policymakers
3. Lack of public awareness and support
4. Risk aversion and resistance to change
5. Silo mentality
6. Misalignments between short-term plans and long-term goals
7. Lack of supportive policy and legal frameworks
8. Lack of design standards and guidelines for maintenance and monitoring
9. Lack of skilled knowledge brokers and training programs
10. Functionality and performance uncertainties
11. Perceived high cost
12. Lack of available financial resources
13. Lack of financial incentives
14. Property ownership complexities
15. Space constraints

Sarabi et al. 2019 *Resources*, 8, 121.  
Focus on urban settings

**16. Procurement challenges**

**17. Other factors**

PHUSICOS: additional barriers and  
experience from rural settings





# Barriers – experience receded green barrier

1. Lack of political will and long-term commitment
  2. **Lack of sense of urgency among policymakers**
  3. **Lack of public awareness and support**
  4. Risk aversion and resistance to change
  5. Silo mentality
  6. **Misalignments between short-term plans and long-term goals**
  7. Lack of supportive policy and legal frameworks
  8. Lack of design standards and guidelines for maintenance and monitoring
  9. Lack of skilled knowledge brokers and training programs
  10. **Functionality and performance uncertainties**
  11. **Perceived high cost**
  12. **Lack of available financial resources**
  13. **Lack of financial incentives**
  14. **Property ownership complexities**
  15. Space constraints
  16. **Procurement challenges**
  17. **Other factors**
- General skepticism to NBS, lack of knowledge
- Merging of two counties
- General skepticism to NBS, lack of knowledge
- Too little funding available
- Loss of agricultural land
- Complex, formal objections
- Loss of income from gravel removal





# Polycentric governance as an enabler for NBS

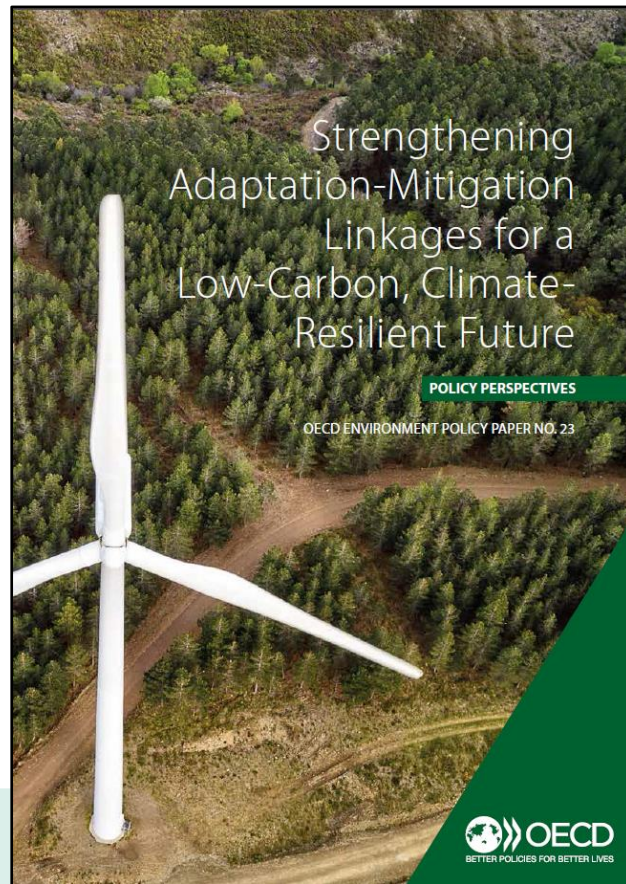


- Decisions are taken across different scales and sectors including collaboration with organisations outside public administrations
- I.e. stakeholder involvement at all levels in co-creation and co-design is important!



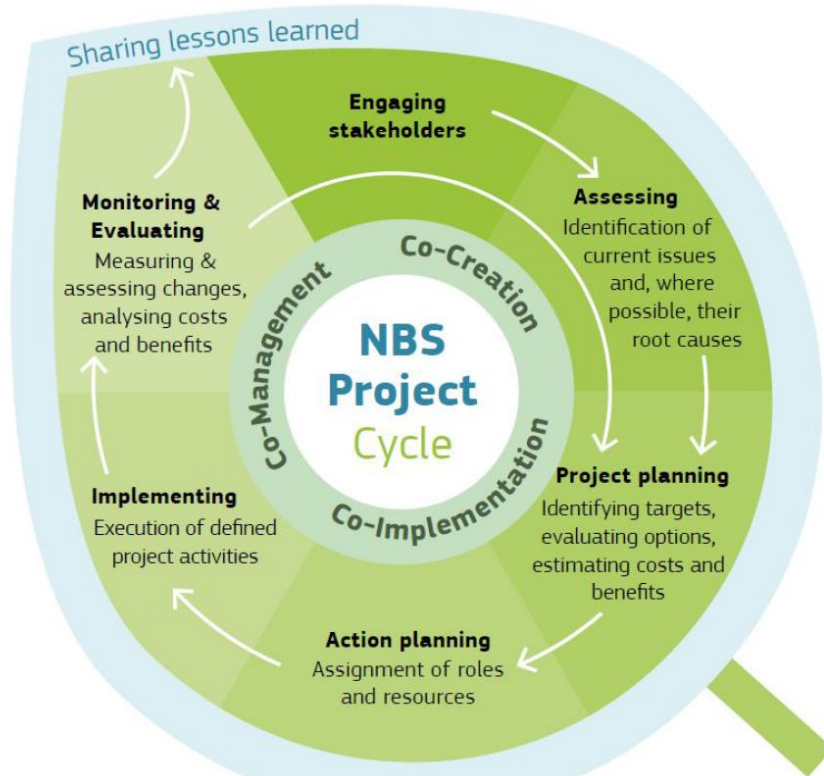
# Integration of NBS into planning processes

- For example:
  - Criteria for infrastructure projects to include NbS evaluations at the planning stage
  - Adopt laws that require a portion of space dedicated to green infrastructure
- Norway's national planning guidelines for climate and energy planning and climate adaptation indicate that NBS should be assessed and justify if not selected





# NBS Life Cycle



## • Stakeholder involvement from the beginning

- All levels in society
- Create 'ownership and enthusiasm
- Utilize local knowledge
- Identify local needs
- Align with local/regional policies
- Involve citizens in designing monitoring schemes and collect data
- Etc., etc.



# Lessons learned from the challenges

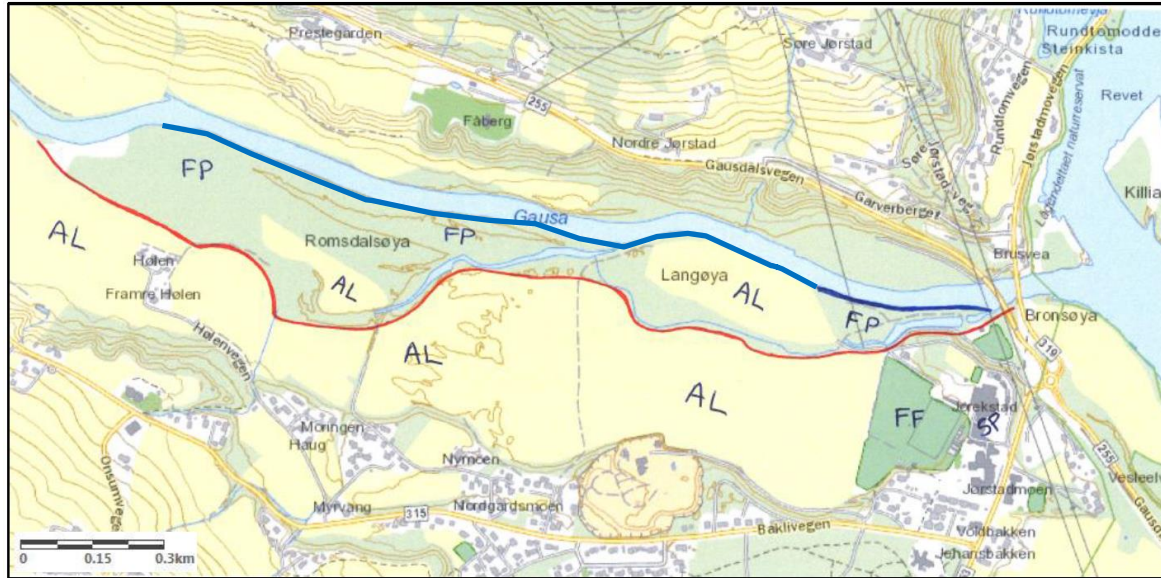
- Plan well ahead. Getting plans through to practical implementation takes more time than one possibly could think of.
- Procurement can be time consuming. Be as detailed as possible in the tender documents. Formal objections will lead to serious delays.
- Bring stakeholders into the process as early as possible, if possible from scratch; co-creation of the measures establishes 'ownership' and increased enthusiasm.
- Use their local knowledge wherever possible and show appreciation.
- Identify ambassadors for the project and work closely with them.
- Identify potentially 'problematic' stakeholders and plan strategies to handle these.
- If at all possible, choose public land for your NBSs.
- NBS take time to establish and become effective, thus plan and implement long-term monitoring programs to document NBS and improve knowledge regarding their uncertainties.





# Case study mountain region – Jorekstad, Norway

## (1/3)



Red line: Possible space for flooding in extreme cases

Blue line: Existing flood prevention measure / erosion protection of the Gausa riverbank

### Action list:

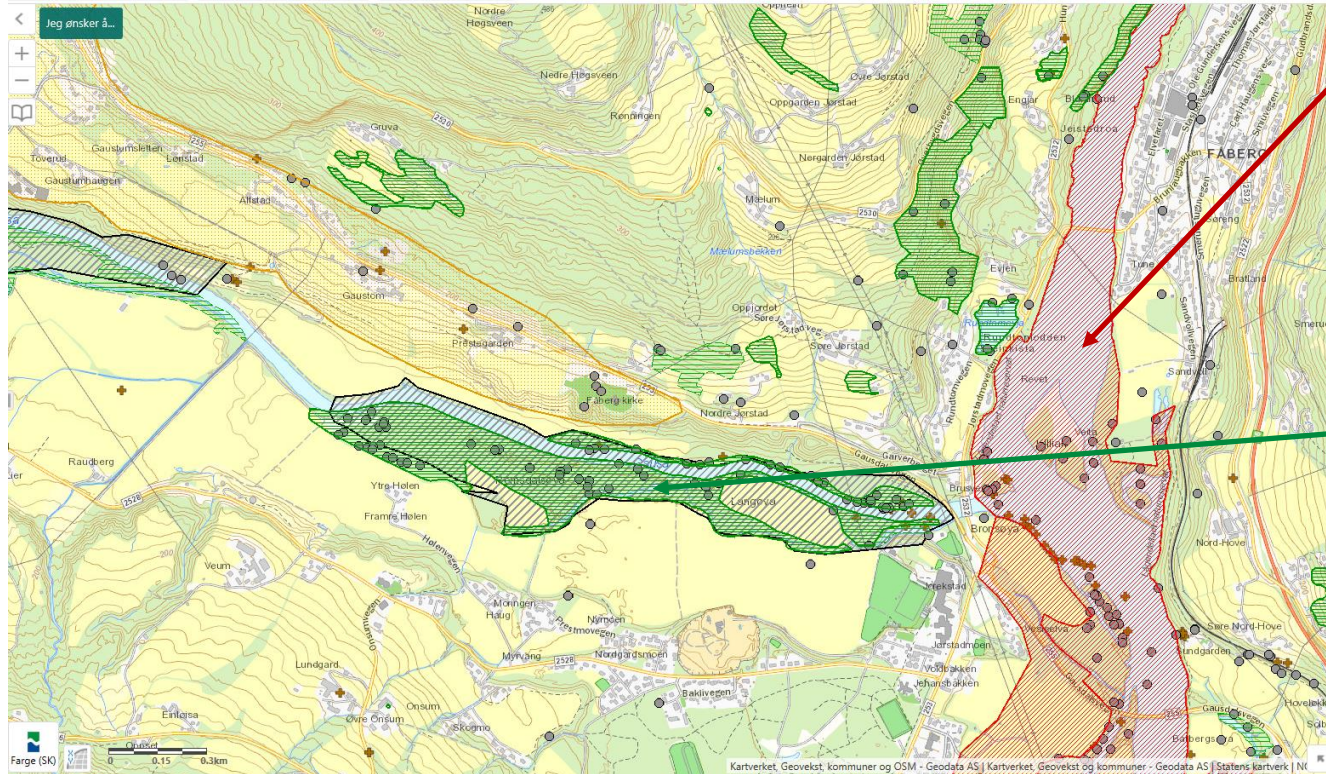
- Restore flood plain (FP) riparian vegetation, with several red-list species.
- Reduce extreme event floods in agricultural land (AL)
- Protect sport facilities and housing, as well as farmland.
- Avoid problems with sediment deposition and shallowing of main river Gudbrandsdalslågen





# Case study mountain region – Jorekstad, Norway

## (2/3)



Protected area

Classified as an area with  
"very important habitat"

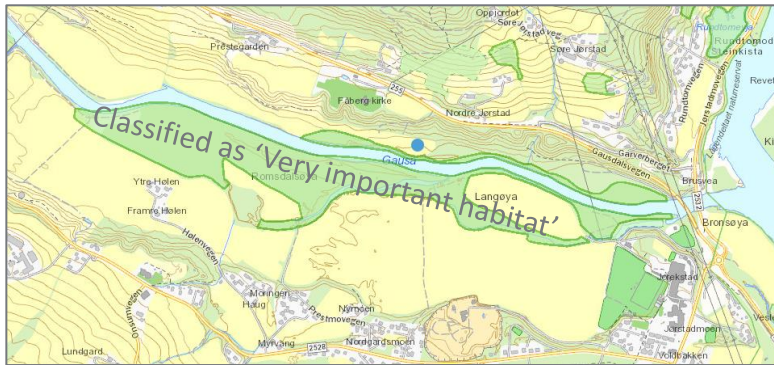
<https://kart.naturbase.no/>





# Case study mountain region – Jorekstad, Norway

## (3/3)



Aerial photographs: 2019 (after) versus 1967 (before) existing flood barrier. The flood barrier changed the riparian zone and some important species disappeared.





This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 776681





# Thank you!

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<https://phusicos.eu/>

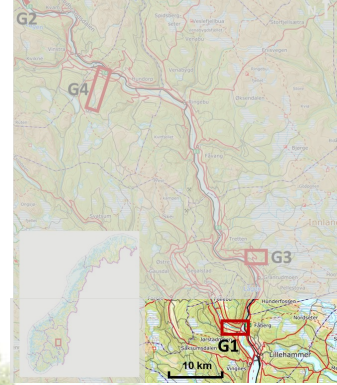
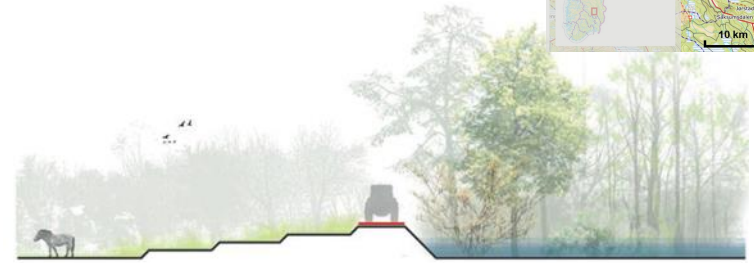
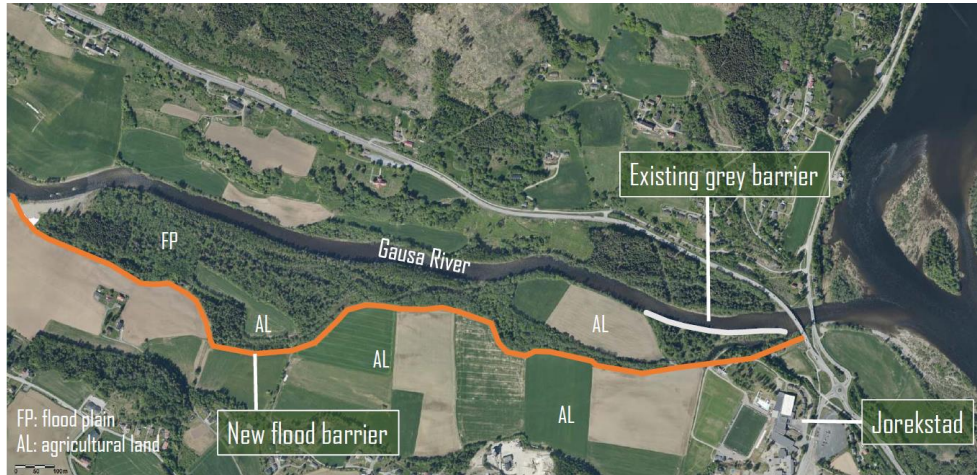
 @phusicos





# Gudbrandsdalen: Jorekstad, flooding and erosion

G1: Receded green flood barrier to allow more space for flooding



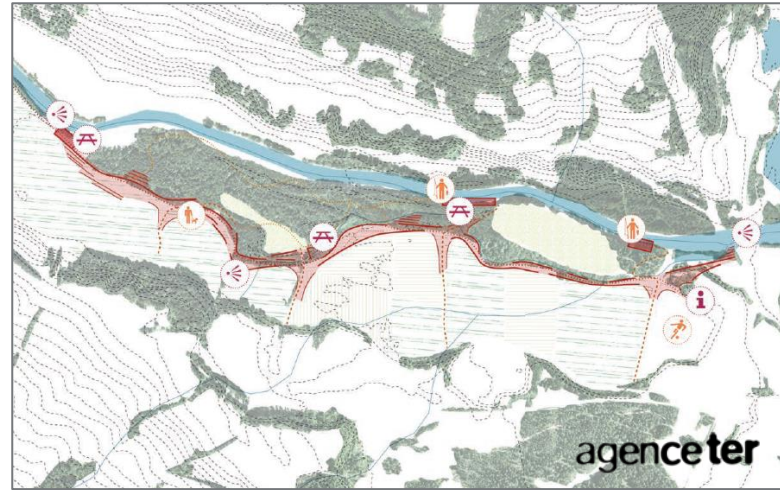
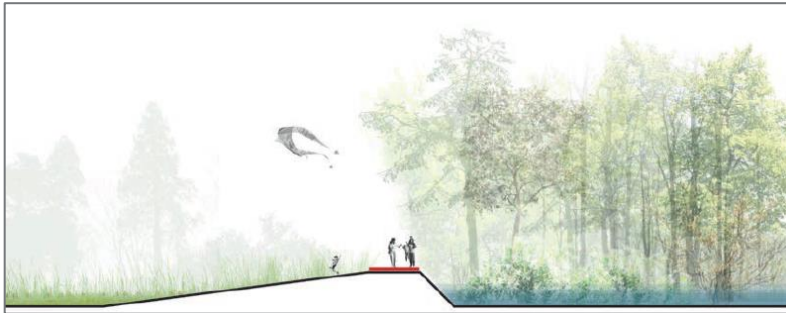
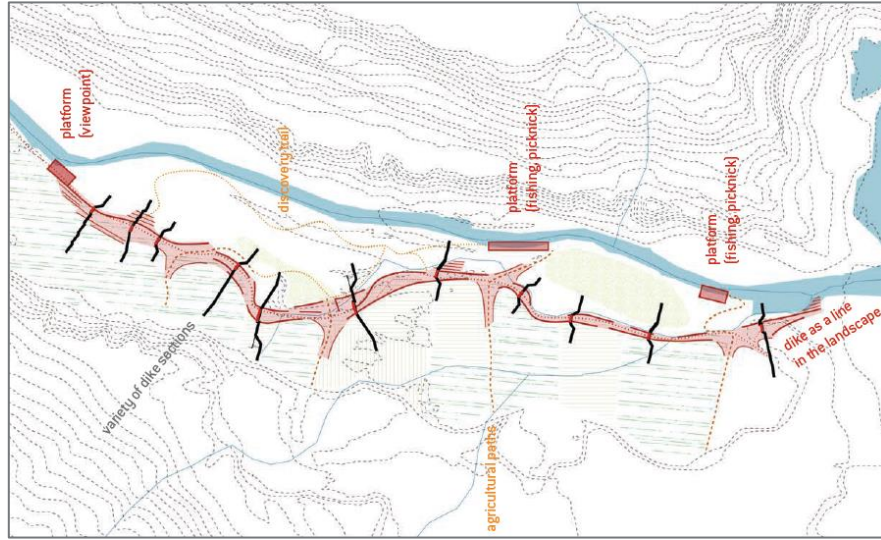
- Protects sport facilities and housing, as well as farmland.
- Avoid problems with sediment deposition and shallowing of main river Gudbrandsdalslågen
- Restore flood plain (FP) riparian vegetation, with several red-list species.



Confidence in the functionality of the solution (tested with models), however it was not implemented due to the barriers encountered (high costs for the municipality, land ownership, traditional thinking, lack of political will)



# Jorekstad 'green' receded flood barrier





# Jorekstad, - design suggestions



Situation today. Red line: proposed barrier

Landscape architects' (AgenceTer, France) ideas for design.

