

## Natural Water Retention Measures in the Altovicentino area (Italy) <sup>[1]</sup>

Image from [Climate Adapt](#) about this case study

[2]

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91% of Italian municipalities are currently under risk of river and pluvial flooding, an important increase as compared to 2015 when 88% of municipalities were at risk ([ISPRA, 2018](#) <sup>[3]</sup>). These already fragile hydrogeological conditions are worsened by the growing consumption of soil, which occurs more in Northern Italy than in the rest of the country. Related effects are evident in Veneto (Italy), where floods, landslides, and erosive phenomena have deeply affected the region in recent years. The Altovicentino area makes no exception in this respect, with flooding events that have been occurring with growing frequency and intensity over the last decades and are expected to continue in the future.

In this context, two municipalities of the Altovicentino area, Santorso and Marano Vicentino, decided to promote the diffusion of Natural Water Retention Measures (NWRMs) to increase the resilience of the territory to flooding. Within the [BEWARE](#) <sup>[4]</sup> “Better Water Management for Advancing Resilient-communities in Europe” LIFE funded project, the two municipalities (in collaboration with the project partners: TESAF - University of Padua, Consorzio di Bonifica Alta Pianura Veneta, ALDA, Veneto Agricoltura) have implemented seven interventions including NWRMs. The catalogue available through the [NWRM platform](#) <sup>[5]</sup> was used to identify the finally designed and implemented measures. Five interventions are placed in Santorso and two are located in Marano Vicentino. The interventions aim at solving existing hydraulic problems and preventing future ones due to climate change. They are also used as virtuous examples in an ongoing participatory process promoting knowledge transfer on and implementation of NWRMs in the entire Altovicentino area.

### Case Study Description

#### **Challenges:**

Floods, landslides, and erosive phenomena have deeply affected the Veneto region in recent years and, according to climate change projections, such events will likely occur more and more intensively.

The Altovicentino area was affected by different flood events in recent years, including both localized floods in urban areas due to high intensity rainfalls, and river overflows. Among the latter, the most catastrophic episodes occurred in 1966, 1982 and more recently in 2010, between the 30th of October and the 2nd of November. During the 2010 flood, heavy rains fell in the lower mountain belt between the provinces of Verona and Vicenza in conjunction with other negative atmospheric conditions (increase of the temperatures melting the snow and southern winds opposing the regular water downflow). As a result, 140 square kilometres were flooded, affecting 130 municipalities and about 500,000 citizens. Moreover, 3 persons and more than 150,000 animals died, and damages were estimated at 429 M€. Other significant, even though less intense, events took place in the same area in 2011, 2012, 2013 and 2014.

Climate change is expected to increase the frequency of intense rainfall events and related flooding risk in many regions across Europe, including northern Italy. The flooding risk is exacerbated by the growing land use and its progressive waterproofing seal, which undermines the effectiveness of the natural water infiltration system. In Italy, rapid urbanization combined with the high vulnerability of the Italian territory (due to climate aspects and geomorphological conditions) have caused a significant increase of exposed elements at hydrometeorological risk. The Italian Institute for Environmental Protection and Research (ISPRA) highlights that 22.5% of the

national surface (68,038 km<sup>2</sup>) is at risk of flooding, endangering an estimated 16 million people. In some regions (e.g. Lombardy and Veneto), the percentage of soil consumption has drastically increased: urbanised areas occupied about 2-3% of the total regional surface in the fifties of the last century, while now cover more than the 10%. Therefore, in Veneto region, both climate change and land-use are contributing to a significant increase of short duration floods and to an increase in the number of flooded locations ([Sofia et al., 2017](#) [6]).

At the same time, local communities are unprepared for similar events and still incapable to anticipate and mitigate their effects. In Veneto region, only a few initiatives have been launched to improve the water retention of soils in public and private areas. Indeed, most efforts have been devoted to implement high-cost hydraulic works (reinforcement of river banks and creation of detention basins), which can certainly prove to be effective in avoiding target/design floods and related damages, but do not provides the multiple benefits of natural water retention measures.

### **Objectives:**

The BEWARE project aims at developing adaptation capacity to urban and rural flooding, through the involvement of local communities. The project is built on the belief that the widespread use of small and affordable nature-based hydraulic measures to infiltrate and store rainwater can generate even more significant hydrologic results than large engineering projects. Based on this premise, BEWARE adopts a multilevel approach to enhance hydraulic safety and spread good practices on rainwater management by promoting and facilitating the adoption of NWRM. This main goal is pursued through:

- Implementing NWRM to increase water infiltration and water storage capacity and to reduce flood risk in urban areas (municipalities of Santorso and Marano Vicentino) as well as to mitigate flood and drought problems of some agricultural areas (Marano Vicentino). These measures have both technical and demonstrative purposes.
- Activating a participatory process involving all main stakeholders to identify shared actions and foster citizens' commitment to reduce the flooding risk in the Altovicentino area.
- Promoting a regulatory framework and specific technical skills facilitating the widespread use of NWRM.

### **Solutions:**

NWRM were implemented in five specific areas of Santorso municipality:

- In order to improve rainwater drainage and mitigate the surface water flooding episodes that take place in the southern part of a Piazzale della Libertà parking lot, following interventions were implemented: (1) a rain garden in the green area located in the southern part of the parking lot, and (2) an underdrain bioretention in the green area located in the eastern side of the parking lot.
- The second intervention is located along the Collina Del Grumo, a hill in Santorso. Surface water runoff flowing down along the northern side of hill accumulates in residential area located at the hill foot. During high intensity rainfall events, episodes of flooding have been documented in some of the houses located in this area. To reduce vulnerability to those events, three NWRM were constructed: (1) a swale intercepting the surface water runoff flowing along the northern side of the hill; (2) a live fascine (about 15 m long) with a hidden pipe to transport the intercepted water along the steepest part of the hill side (due to the nature of the soil, other solution to transport water based on infiltration could not be locally implemented); (3) a bioretention area enabling water accumulation and infiltration.
- The third intervention aims to improve management of surface water runoff during intense rainfall and avoiding flooding events in a new residential area of Via Volti. The measure consists in a detention basin: surface water flowing along Via Volti is collected by a sewer equipped with pumps that brings the water into a detention basin. The detention basin is split in three sub-basins; the first one to be always left inundated. A green recreational area was created around the basin.
- The fourth intervention was implemented in the private residential area of Corte Acquasaliente. It consists of two rainwater harvesting systems, accumulating 2000 l of water discharged by the roofs of two houses, and of two dry wells enabling the infiltration of water runoff coming from a private street. The NWRM were

constructed to reduce flooding risk of some houses ground floor during intense rainfall events.

- Finally, the fifth intervention takes place in the parking lot of the new graveyard of Santorso municipality. As the others, it aims at mitigating surface water flooding events documented in recent years. Specifically, following NWRM were constructed: (1) two rain gardens, one in each of the two green areas located in the southwestern part of the parking lot, (2) an infiltration trench in the northern part of the parking lot, and (3) a porous paving still in the northern part of the parking lot, near the infiltration trench.

Other two interventions take place in the territory of Marano Vicentino. One has been realized in a school complex. The intervention aims at improving the management of rainfall runoff affecting the northern part of the elementary school's recreational area and the western part of the close secondary school. In this context, the following NWRM have been constructed: (1) two rain gardens, respectively in the recreational area of the secondary and elementary schools, (2) a highly porous paving in the recreational area of the elementary school, (3) a tree-lined swale near the porous paving, and (4) a stormwater planter under a gutter of the secondary school.

The second intervention consists of a detention basin able to store 2,500 cubic meters of water. It was implemented in the agricultural area of Giavenale locality with a double purpose: retain water in order to mitigate the hydraulic risk of a portion of the territory of Marano Vicentino, and ensure, even in dry periods, the availability of water resource for agricultural. The basin is surrounded by vegetation in order to increase the biodiversity of the area and create a habitat for different animal species.

#### **Importance and relevance of the adaptation:**

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Additional Details

#### **Stakeholder engagement:**

BEWARE and related NWRMs are implemented through a participatory approach that actively involves local stakeholders; to this purpose, following stakeholders have been involved:

- Citizens are considered important actors to proactively spread the adoption of small-scale actions aiming to collectively improve the hydraulic resilience of a territory.
- Local municipal administrators and technicians play a key role in driving the design and implementation of concrete adaptation measures. In this perspective, the project foresees a series of actions aiming at the improvement of the local governance dealing with hydraulic resilience and safety. Implemented actions include ad hoc trainings and the activation of a participatory process involving local administrators for the update of local building codes and the elaboration of an inter-municipality action plan on hydraulic safety.
- Engineers, surveyors, architects, agronomists and foresters are involved through targeted training, as they contribute in disseminating knowledge on NWRM and encouraging their adoption.
- Farmers are encouraged to adopt measures and practices for the good management of water resources in the agricultural sector;
- Students represent another key target group of the project. The creation of an adaptation culture is a gradual process requiring a bottom-up approach, considering education, training and awareness raising key actions for the development of new skills.

The project foresees results capitalizations towards other Italian and European municipalities, through study visits and on-site training.

#### **Success and limiting factors:**

The availability of EU funds granted in the framework of the LIFE Programme proved to be essential for the implementation of the NWRMs, allowing the whole initiative to be developed on a larger scale than initially planned. At the same time, the municipalities of Santorso and Marano Vicentino have long been committed to the adoption of sustainable solutions for rainwater retention and infiltration, which resulted being another important driver. This also led them to involve respective communities in the identification of areas at hydraulic

risk. Some of these areas were later selected for the implementation of NWRMs.

**Budget, funding and additional benefits:**

The total cost of the 7 NWRMs amounts to €362.276. The BEWARE project total budget is €2.103.964, (EU co-funds €1.188.160). The cost for the implementation of the NWRMs represents the 17,2% of the total budget.

The project includes a cost-benefit analysis of considered NWRM and other project actions (in particular dealing with the participatory process), which is still on-going. One of the most important expected benefits is the reduction of the hydraulic hazard and risk for private and public infrastructures and related indirect effects. Specifically, the following effects are going to be evaluated:

- reduction of direct and indirect infrastructural damages due to flooding;
- increased awareness of flood risk which can improve preparedness actions (evacuation plans, emergency supply kits, training on what to do in case of emergency) at individual and local community level;
- increase in spreading of “environmentally friendly” behaviours aiming at mitigating flooding risk (including NWRMs realization in private areas);
- increased yearly average income from farming due to higher water availability in potential periods of water shortage and to reduced flooding risk;
- increase and amelioration of recreational facilities.

Up to now, the analysis focused on the collection of data about infrastructural damage caused by heavy rainfall events in Santorso and Marano Vicentino, in the period 2010-2019. Data were collected both through the consultation of the two municipalities database on flooding damages and a questionnaire-based sample survey, which covered the database information gaps and enabled gathering more detailed damage data.

Collected data allowed the definition of the pre-intervention baseline scenario. According to the analysis, flood related costs in the considered period amounts to €1.3 million. These include damage costs, defensive and restoration costs for both private and public assets, as well as prevention costs incurred by the public. Indeed, the amount of private prevention costs is difficult to estimate, since the administrative datasets are rather incomplete on these specific issues. This likely brought to an underestimation of the overall flood related costs in the two municipalities. If overall prevention costs are excluded, defensive and restoration costs account for more than € 0.8 million, namely 61% of the total damage. Moreover, the defensive and restoration costs show an upward trend over the ten-year timespan under consideration in this analysis. In the latest years both Santorso and Marano Vicentino witnessed a growing number of affected households. When considering both public and private defensive and restoration costs, these components of the flood related costs have been increasing since 2017. This has happened despite the implementation of several costly defensive interventions.

Results of the cost-benefit analysis will be available in 2022, at the end of the project and will be published on the project web site when ready.

**Legal aspects:**

The initiative operates also at the legal level to facilitate the adoption of NWRMs. In particular, BEWARE involves a large number of municipalities in a common path for the inclusion of provisions on and incentives for NWRMs in the local building codes. In addition to that, the project foresees stakeholders’ engagement for the elaboration of an action plan aiming to improve hydraulic safety and resilience in the area. The outcome of this latter process will be then brought to the attention of and promoted at the national and European level through a series of ad hoc initiatives.

**Implementation time:**

Design of NWRM started in September 2018 within the LIFE BEWARE project, which will end in June 2022. The seven NWRM interventions have been already implemented. In the upcoming years, this kind of measures will be promoted in other EU and Italian municipalities thanks to demonstrative interventions, dissemination initiatives, broad communication and education, with the final aim of favouring the capitalization of the proposed actions.

#### Reference Information

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##### **Websites:**

<http://www.lifebeware.eu/en> [9]

##### **Sources:**

EU LIFE funded project BEWARE “Better Water Management for Advancing Resilient-communities in Europe”

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### Links

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[2] [https://adaptecca.es/sites/default/files/1.-flooding-event-in-schio---03\\_07\\_2019.jpg](https://adaptecca.es/sites/default/files/1.-flooding-event-in-schio---03_07_2019.jpg)

[3] <http://www.isprambiente.gov.it/it/evidenza/pubblicazioni/no-homepage/dissesto-idrogeologico-in-italia-pericolosita-e-indicatori-di-rischio-2013-edizione-2018>

[4] <http://www.lifebeware.eu/en/>

[5] <http://nwrn.eu/measures-catalogue>

[6] <https://www.nature.com/articles/srep40527>

[7] <mailto:info@lifebeware.eu>

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[9] <http://www.lifebeware.eu/en>