Restructuring the effluent web in Italy

Year of issue

2025

Summary

The case study lies in the draining basin of the Venice Lagoon, an intensively farmed area crossed by a dense network of drainage channels. Here, measures were implemented on channels discharging to the Dese River, a major tributary of the Lagoon. The Veneto Region financed riverbed recalibration and ecological restoration under the “Plan for diffuse pollution prevention and restoration of water in the draining basins of the Venice Lagoon”; Consorzio Acque Risorgive delivered the works around 2008–2009.

The project re-structured the mid-course effluents of the Dese - Rio San Martino, Rio Sant’Ambrogio and Scolo Desolino - whose primary function is to drain agricultural fields. Objectives were to retain nitrogen and phosphorus through phytodepuration and to mitigate frequent floods aggravated by urban sprawl, soil sealing and culverts (notably highlighted by the 2006–2007 Mestre events). Measures included riparian buffer strips, in- and out-of-channel wetlands, channel widening/meandering, and floodplain reconnection.

Subsequent technical documentation shows the programme extended beyond these three reaches to other local drains (e.g., Piovega di Scandolara, Piovega di Cappella, Piovega di Levada, Piovega dei Tre Comuni). Overall cost was about €4.13 million. Hydrological modelling and design analyses indicate peak flows delivered to the Dese fell from ~29 to ~25 m^3/s (≈14% reduction), with tributary-scale decreases (e.g., Rio S. Martino 10.3→8.0 m^3/s; Scolo Desolino 7.0→5.5 m^3/s; Rio Sant’Ambrogio 11.5→10.5 m^3/s).

Evidence from the implementer adds scale and design detail: about 14 km of channels were tackled in the Dese sub-basin; ~5.3 km of woody buffer strips were established across these reaches, and an out-of-channel wetland with a “double flow path” was created at Rio San Martino. On the Rio San Martino & Piovega di Scandolara sub-site specifically, ~1.6 km of new riparian woodland was planted.

Monitoring remains limited in the public domain: ARPAV was expected to monitor but little was published; the consortium ran some site-specific monitoring and used results from its NICOLAS experimental site for nutrient-removal parameters. Nonetheless, the combination of buffers, wetlands and planform restoration is credited by local sources with significant nutrient retention and visible flood-risk mitigation, supporting positive public perception.

Status on external registries is “complete”, and consortium material documents continued maintenance and allied works within the jurisdiction into the late 2010s. The case demonstrates multi-benefit restoration at drainage-network scale in a low-slope agricultural plain, aligning water-quality and flood-risk objectives under the Venice Lagoon Plan.

Photo Gallery



Location

45.343, 12.0629

Project

NWRM

National ID

Italy_02

Sector

Agriculture

Installation Date

2009-05

Implementation status

Completed

Contact

Gloria De Paoli, ACTeon

Overview

Location of the project

The case study is located in the draining basin of the Venice Lagoon. It is characterized by intensive agriculture and by a web of drainage channels discharging into the rivers. This case study, in particular, includes measures on the drainage channels discharging into the Dese river, one of the main water bodies of the Venice Lagoon basin.

Country

Italy

NUTS2 Code

Veneto

Sponge measures implemented in the case study

Buffer strips and hedges

Stream bed re-naturalisation

Floodplain restoration and management

Re-meandering

Wetland restoration and management

Forest riparian buffers

Objectives

Expected impact on water quality (forecast based on experimental parameters from previous applied studies, caluclated in the design phase)
Total N reduction: 12.73 t/year
Total P reduction: 0.64 t/year
Mitigate flood risk by restoring the drainage channel web and reconnecting floodplain. Design target against ~30-year return period events; modelling indicated peak flows delivered to the Dese reduced from ~29 to ~25 m^3/s (≈13.8% reduction).

Involved partners

Authority type	Authority name	Authority role	Comments	Authority responsibility

Local water authority	Consorzio Acque Risorgive	Initiation of the measure	Consorzio di bonifica: local water authority in charge of managing and maintaining the irrigation network as well as the provision of irrigation water	Responsible
Regional / sub-national water authority	Veneto Region	Financing	Provincial Administration - Funding (through the †œPlan for diffuse pollution prevention and restoration of water in the draining basins of the Venice Lagoon†□)	Supporting
Architects / Engineers	Ingegneria 2P e Associati	Determination of design details of the measure	External consulting firm (contractor) - design of measures	Supporting
Architects / Engineers	Bruno Boz – free-lance professional and member of CIRF	Determination of design details of the measure	External Consulting (design, implementation and evaluation)	Supporting
Research institute / University	University of Bologna	Monitoring	—	Supporting

Documents

cs-it-02-final_version.pdf (1.54 Mo)

Site Information

Climate Zone

Warm temperate moist

Temperature (°C)

13.00 °C

Slope range

0-1%

Soil type

Calcisols

Vegetation class

The case study area is described as intensively farmed. Regional analysis of the Venice Lagoon draining basin shows agricultural areas exceed 77% of the territory. Together, these indicate the predominant cover is cultivated cropland (arable land) rather than natural grassland. In CORINE terminology this corresponds to class 2.1 “Arable land” (non-irrigated and irrigated fields).

WFD Ecological status

Bad

WFD Chemical status

Good

Design and Implementation

Project scale

Meso

Project scale specifications

Creation of wetlands: 11,12 ha
Creation of buffer zones: 9,85 ha

Basis of design

The measures were designed and modeled to protect from flood events generated by precipitations with a 30-years return time.

Principles

The measures were designed and modeled to protect from flood events generated by precipitations with a 30-years return time.
Over the years, the area has in fact been subject to massive urban development (new residential and industrial areas), with consequent soil sealing and culverted effluents: this had a devastating effect on the hydrological system. The strong floods of 2006 and 2007 on the city of Mestre, for example, were a consequence of this.

Factor constraints

Measures were implemented in a plain area, so geo- and hydro-morphology were not a constraining factor. The design of measures was based on hydrologic and hydraulic modeling.

Financing

Total cost

4131655.00 €

Total cost information

Scope extended beyond the 3 drains named on NWRM to include other local channels (e.g., Piovega di Scandolara, Piovega di Levada, Piovega dei Tre Comuni). Total treated length ≈ 14 km in the Dese sub-basin north of Scorzè. Project cost: €4,131,655.20.

Financing authorities

Authority name	Type of funding	Comments
Veneto Region	Sub-national funds	Through the "Plan for diffuse pollution prevention and restoration of water in the draining basins of the Venice Lagoon" financed measures of re-calibration of riverbeds aimed at the renaturation of the hydraulic web, to increase the time of permanence of water and phytodepuration processes in the draining basin.

Compensations

Oui

Compensations basis information

Measures were implemented on private land, which was thus expropriated – Expropriation involves compensation for landowners, although the price paid is lower as compared to a purchase of land on the market

Compensations scheme information

Measures were implemented on private land, which was thus expropriated. Expropriation involves compensation for landowners, although the price paid is lower as compared to a purchase of land on the market.

Policy and Governance

Policy description

The project tackles two problems at the same time:
- Retain part of the N and P loads from agricultural activities in the basin through phytodepuration ,thus reducing the amount of nutrients reaching the Venice Lagoon (the Lagoon is affected by serious eutrophication issues)
- Reduce the incidence and intensity of flood events in the area. Flooding issues had increased in the decades before the interventions mainly because the sections of the drainage channels were too narrow to contain water discharges in critical periods of the years. When the channels were built, their size was sufficient to contain high discharges, but then the landscape had changed: urban sprawling increased impermeable land, and also agricultural drainage practices (e.g. tubular drainage)had changed increasing discharge into channels.
According to the project's authors, in the framework of integrated landscape planning these two objectives proved to be totally synergic

Land ownership

The works were implemented on private land that was expropriated, with compensation to landowners (below market purchase price).

Policy targets

Pollutants Removal

Peak-flow reduction

Improved Biodiversity

Oher Societal Benefits

Target remarks

Natural assimilation (purification) of effluents through dilution, dispersion, and physic-chemical processes
Flood control and flood risk mitigation

Policy pressure

Directive	Relevant pressure
WFD identified pressure	2.2 Diffuse – Agricultural
Floods Directive identified pressure	Natural exceedence
WFD identified pressure	4.1.2 Physical alteration of channel/bed/riparian area/shore of water body for agriculture

Pressure remarks

The interventions were not carried out as WFD or FD measures. The measures were rather made possible (and funded) by the “Plan for diffuse pollution prevention and restoration of water in the draining basins of the Venice Lagoon” (entered into force in 2000). It is also important to point out that interventions were mostly made on artificial drainage channels, which are not considered as “water bodies” according to the WFD (however, these channels do discharge into the Dese water body).
However, the objectives of the interventions, as well as the principles followed in their design and implementation, are in line with WFD and FD principles, so it has been possible to identify both WFD- and FD-related pressures.

Policy impact

Directive	Relevant impact
WFD identified pressure	Nutrient pollution
WFD identified pressure	Altered habitats due to morphological changes
Floods Directive identified pressure	Community
Floods Directive identified pressure	Property

Policy challenges requirements

The “Plan for diffuse pollution prevention and restoration of water in the draining basins of the Venice Lagoon” (entered into force in 2000) is aimed at addressing the serious eutrophication issues affecting the Venice Lagoon. The draining basin of the Venice Lagoon is in fact characterized by intensive agriculture, responsible for the discharge of large amounts of nutrients (N and P) into the lagoon.

Part of a wider plan

Oui

Wider plan

Name	Comments
Plan for diffuse pollution prevention and restoration of water in the draining basins of the Venice Lagoon	The "Plan for diffuse pollution prevention and restoration of water in the draining basins of the Venice Lagoon" (entered into force in 2000) is aimed at addressing the serious eutrophication issues affecting the Venice Lagoon. The draining basin of the Venice Lagoon is in fact characterized by intensive agriculture, responsible for the discharge of large amounts of nutrients (N and P) into the lagoon. The Veneto Region, through the "Plan for diffuse pollution prevention and restoration of water in the draining basins of the Venice Lagoon" financed measures of re-calibration of riverbeds aimed at the renaturation of the hydraulic web, to increase the time of permanence of water and phytodepuration processes in the draining basin.

Public consultation

Non

Has contractual arrangements

Non

Impacts and Monitoring

Monitoring System

Monitoring requirements

Monitoring is supposed to be carried out by the Regional Agency for Environmental Protection, but actually little has been done so far. The Consorzio carried out some monitoring in some sites, but these data were not shared.

Monitoring parameters

Monitoring is supposed to be carried out by the Regional Agency for Environmental Protection, but actually little has been done so far. The Consorzio carried out some monitoring in some sites, but these data were not shared. Specific monitoring of N retention was carried out in another site, where similar measures were also implemented by the Consorzio, in the experimental site NICOLAS.

Maintenance

Maintenance requirements

In practice, in some cases a more regular maintenance is needed (e.g. to avoid that buffer zones shed shadows on cultivated crops). In the case of intermediate meanders, no maintenance is needed –although this caused some resistance among farmers.

Impact Assessment Methodology

Performance impact assessment method

Catchment outlet

Performance impact estimation information

Unclear - In general, discharge measurements

Socio-economic Impacts

Direct benefits information

Recreational benefits for local inhabitants and visitors (creation of recreational trails). The measures created pleasant natural environments and residents are now using the area for recreation (walking, biking). This has a great value in an area otherwise dominated by monoculture, with very little natural spaces.
Flood impact reduction: 13.8% overall reduction of peak flows into the Dese river as compared to the situation before implementation Water quality improvement and reduction of N and P reaching the
Venice lagoon indirect benefits: biodiversity, tourism potential

Biophysical impacts: Hydrology

Peak flow reduction

14.00

Peak flow reduction unit

% Percent

Information on peak flow reduction

Overall, the peak flows discharged by rivers and channels to the Dese river decreased from 29 m3/s to 25 m3/s (13.8% overall reduction of peak flows into the Dese river)

Information on ecosystem flood control volume

Overall, the peak flows discharged by rivers and channels to the Dese river decreased from 29 m3/s to 25 m3/s (13.8% overall reduction of peak flows into the Dese river)

Biophysical impacts: Biodiversity

Improved biodiversity

Oui

Information on improved biodiversity

Overall, the environmental quality has increased, and new habitats were created. However, data on biodiversity improvements are not available

Biophysical impacts: Water & Soil Quality

Water quality overall improvements

Positive impact-WQ improvement

Information on water quality overall

Water quality improvements: the simulation conducted in the design phase indicate that a significant amount of nutrients can be retained by the measures. In addition, this is just one intervention areas, as similar measures were implemented in several other sites by the Consortium, as part of the Plan for the Venice lagoon: and, overall, since these interventions started the N content in the lagoon has actually decreased.

Information on water quality improvements (P)

Expected impact (forecast based on experimental parameters from previous applied studies)
Total P reduction: 0.64 t/year

Information on water quality Improvements (N)

Expected impact (forecast based on experimental parameters from previous applied studies)
Total N reduction: 12.73 t/year

Biophysical impacts: Others

Ecosystem impact climate regulation

Increased permanent biomass

Information on ecosystem impact climate regulation

In buffer zones (but limited area)

Lessons Learned

Key lessons

The visible positive impact and effectiveness of the measures was a key success factor, as well as a key element to increase environmental awareness in the area. In particular, the ability of the measures to address two pressing environmental issues in the area, while raising environmental quality at the same time, is a key success factor.

The evident effectiveness of the measures were key in positively influencing public perception over interventions, and in particular:

• During the implementation phase, some residents complained for the annoyance (e.g. the dust lifted by the machinery). However, during the first intense precipitation, the rivers/ channels didn't overflow (they would have before implementation), so residents understood the key role of measures for flood mitigation.

• The overall decrease of N levels in the Venice lagoon, which followed the implementation of these and other similar measures in several sites of the draining basin, contributed to gain a positive public perception of these measures.

In addition, the measures created pleasant natural environments and residents are now using the area for recreation (walking, biking). This has a great value in an area otherwise dominated by monoculture, with very little natural spaces.

Network-scale design matters: treating multiple small drains yields a measurable catchment-level flood-peak reduction to the main stem.

Pairing buffers + wetlands is effective: woody buffers intercept sub-surface farm runoff while in-/off-channel wetlands provide residence time—together delivering quantified P (and reported N) reductions.

Adaptive maintenance is key: keep most vegetation, intervene selectively (e.g., one bank/upper slopes), and use simple control weirs to maintain wet habitats without sacrificing conveyance.

Long-term stewardship: documented post-project maintenance and extensions by the consortium sustain functionality and social acceptance.

Barriers

Barrier type	Barrier role	Comments
Limited staff and consultant knowledge	Secondary barrier	The design of intervention was contracted to an external engineering firm, which did not have a capillary knowledge of the area and the territory, so this created some problems
Attitude of relevant stakeholders	Secondary barrier	In some cases, negotiations for expropriations posed some challenges
Other	Secondary barrier	After implementation, there were some little problems with farmers: in some cases, trees and plants cast shadows on crops.

Drivers

Driver type	Driver role	Comments
Availability of subsidies	Main driver	The Plan for the Venice Lagoon subsidized interventions to reduce eutrophication. The Consorzio chose NWRM because these measures also address flooding issues, quite common in the area

Success factors

Success factor type	Success factor role	Comments
Attitude of the public	Secondary factor	The measures created pleasant natural environments and residents are now using the area for recreation (walking, biking). This has a great value in an area otherwise dominated by monoculture, with very little natural spaces. Furthermore, the possibility of doing recreational activities has raised residents' awareness and interest towards the importance and role of measures, as well as on the importance and value of natural areas.
Financing possibilities	Main factor	Availability of funds for this type of measures created by the Plan for the Venice Lagoon
Other	Main factor	The ability of the measures to address two pressing environmental issues in the area, while raising environmental quality at the same time, is a key success factor.
Public participation	Secondary factor	The measures created pleasant natural environments and residents are now using the area for recreation (walking, biking). This has a great value in an area otherwise dominated by monoculture, with very little natural spaces. Furthermore, the possibility of doing recreational activities has raised residents’ awareness and interest towards the importance and role of measures, as well as on the importance and value of natural areas.
Attitude of the public	Main factor	—

Cost effectiveness

Alternative measures for floods would include building weirs and protection barriers over large areas, and they would be more expensive than implemented NWRMs. Concerning N loads, mechanical/chemical treatment of effluents at scale is unfeasable.

Flexibility / Adaptability

The measures reproduce or re-establish natural conditions and require little maintenance, so the sites should be able to adjust to changing baseline conditions.

Transferability

These type of measures can be seen as “standard” agricultural measures, and they can in principle be applied in all plain areas where intensive agriculture is practiced, with a dual objective (i) nutrient reduction and (ii) flood mitigation, while improving habitats and the environmental quality at the same time.

Sources

Sources

Interventi estesi di riqualificazione fluviale lungo gli affluenti del medio corso del Fiume Dese

Phone interview Italy

Bruno Boz was actively involved in the design and implementation of these measures, as well as the other applications implemented by the Consorzio

Gli affluenti del fiume Dese: la riqualificazione ambientale e i vantaggi per la sicurezza idraulica (in Riqualificazione Fluviale, Issue 4/2011)

Il progetto di riqualificazione ambientale diffusa nel comprensorio di competenza del Consorzio di Bonifica Acque Risorgive

Program of Guided field trip – Consorzio di Bonifica Acque Risorgive (Mestre), 25 May 2017 (LIFE RINASCE)