European Commission

NWRM

Natural Water Retention Measures

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Case Study

Restructuring Effluent Web, Italy

Environment

This report was prepared by the NWRM project, led by Office International de l'Eau (OIEau), in consortium with Actéon Environment (France), AMEC Foster Wheeler (United Kingdom), BEF (Baltic States), ENVECO (Sweden), IACO (Cyprus/Greece), IMDEA Water (Spain), REC (Hungary/Central & Eastern Europe), REKK inc. (Hungary), SLU (Sweden) and SRUC (UK) under contract 07.0330/2013/659147/SER/ENV.C1 for the Directorate-General for Environment of the European Commission. The information and views set out in this report represent NWRM project's views on the subject matter and do not necessarily reflect the official opinion of the Commission. The Commission does not guarantee the accuracy of the data included in this report. Neither the Commission nor any person acting on the Commission's behalf may be held Key words: Biophysical impact, runoff, water retention, effectiveness - Please consult the NWRM glossary for more information.

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I. Basic Information

Application ID	*Italy_02*			
Application Name	**RestructuringEffluentWeb_Italy**			
Application Location	Country:	Italy	Country 2:	
	NUTS2 Code		*ITH3*	
	River Basin District Code		*ITA*	
	WFD Water Body Code			
	Description		*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.*	
Application Site Coordinates	Latitude:		Longitude:	
Target Sector(s)	Primary:	Agriculture		
	Secondary:	Hydromorphology		
Implemented NWRM(s)	Measure #1:	*A2*		
	Measure #2:	*N2*		
	Measure #3:	*N4*		
	Measure #4:	*N8*		
Application short description	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. In this framework, the Consorzio Acque Risorgive implemented a series of extended interventions on the area under its responsibility. This case study was implemented as part of these interventions. In particular, it aimed at re-structuring the effluents of the mid course of the Dese river (Rio S. Martino, Rio S. Ambrogio and Scolo Desolino). Such effluents are mostly draining channels, draining water from agricultural fields to the Dese river. The primary objective was the reduction of the amount of N and P reaching the Venice lagoon through phytodepuration. However, at the same time the project carried out the restoration of the draining channel web aimed at reducing flooding issues affecting the area. 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. The following measures were implemented: • Riparian buffer zones • Creation of wetlands • River bed enlargement • Creation and reconnection of floodplain and new buffer strips • Channel naturalization, creation of new meandering channel			

II. Policy context and design targets

Brief description of the problem to be tackled	*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*		
What were the primary & secondary targets when designing this application?	Primary target #1:	Natural assimilation (purification) of effluents through dilution, dispersion, and physic-chemical processes	
	Primary target #2:	Flood control and flood risk mitigation	
	Remarks		
Which specific types of pressures did you aim at mitigating?	Pressure #1:	WFD identified pressure	*2.2 Diffuse – Agricultural*
	Pressure #2:	Floods Directive identified pressure	*Natural exceedence*
	Pressure #3:	WFD identified pressure	*4.1.2 Physical alteration of channel/bed/riparian area/shore of water body for agriculture*
	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.	
Which specific types of adverse impacts did you aim at mitigating?	Impact #1:	WFD identified impact	*Nutrient pollution*
	Impact #2:	WFD identified impact	*Altered habitats due to morphological changes*
	Impact #3:	Floods Directive identified impact	*Community*
	Impact #4:	Floods Directive	*Property*

		identified impact	
	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 impacts.	
Which EU requirements and EU Directives were aimed at being addressed?	Requirement #1:		
	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).		
Which national and/or regional policy challenges and/or requirements aimed to be addressed?	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.		

III. Site characteristics

Dominant Land Use type(s)	Dominant land use	*2.1.2 Permanently irrigated land*
	Secondary land use	
	Other important land use	
	Intensive agriculture (monoculture)	
Climate zone	warm temperate moist	
Soil type	*A detailed soil map is not available – The national map indicates some options:* • Calcisols • Fluvisol • Cambisols	
Average Slope	very gentle (1-2%)	
Mean Annual Rainfall	600 - 900 mm	
Mean Annual Runoff		

Average Runoff coefficient (or % imperviousness on site)		
	Data not found	
Characterization of water quality status (prior to the implementation of the NWRMs)	Data not available. At a general level, all water courses in the area are known to have very low GES before interventions.	
Comment on any specific site characteristic that influences the effectiveness of the applied NWRM(s) in a positive or negative way	*Positive way:* Measures were implemented in a plain area, so geo- and hydro-morphology were not a constraining factor.	
	Negative way: In some cases, negotiations for expropriations posed some challenges	

IV. Design & implementation parameters

Project scale	Medium (eg. public park, new development district)	
Time frame	Date of installation/construction (MM.YYYY)	*05.2009* *(Completion)*
	Expected average lifespan (life expectancy) of the application in years	*As the measures are aimed at mimicking natural processes and habitats, and in some cases at restoring some of them, they are expected to last over the years.*
Responsible authority and other stakeholders involved	*Name of responsible authority/ stakeholder*	*Role, responsibilities*
	1. Consorzio Acque Risorgive	Management, planning and implementation
	2. Veneto Region	Funding (through the "Plan for diffuse pollution prevention and restoration of water in the draining basins of the Venice Lagoon")
	3.Ingegneria 2P e Associati	Consulting (design)
	4. Bruno Boz – free-lance professional and member of CIRF	Consulting (design, implementation and evaluation)
	5. University of Bologna	Monitoring
The application was initiated and financed by	The application was initiated by Consorzio Acque Risorgive and financed by the Province of Venice through the "Plan for diffuse pollution prevention and restoration of water in the draining basins of the Venice Lagoon". According to the Plan, Consortia can apply for funding for implementing measures aimed at retaining N and P into the basin and enhancing phytodepuration, thus decreasing nutrient discharges into the Venice Lagoon. Funding is provided based on the projected amount of nutrients that the project is expected to retain.	
What were specific principles that were	The measures were designed and modeled to protect from flood events generated by precipitations with a 30-years return time.	

<table>
<tr><td>followed in the design of this application?</td><td colspan="3">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.</td></tr>
<tr><td rowspan="2">Area (ha)</td><td colspan="2">Number of hectares treated by the NWRM(s).</td><td>Number of ha</td></tr>
<tr><td colspan="2">Text to specify</td><td>Total area of intervention: unknown.
Only the areas used for the creation of wetland and buffer zones is reported:
- Creation of wetlands: 11,12 ha
- Creation of buffer zones: 9,85 ha</td></tr>
<tr><td>Design capacity</td><td colspan="3"><u>Rio S. Martino</u>
- Creation of a new diversion channel: reduction of discharge from 3.5 m^3/s to 1.5 m^3/s;
- Re-meandering of the first river section: the peak discharge at the entrance of Rio San Martino village was reduced from 5.1 m^3/s to 2.9 m^3/s
- Re-meandering downstream of the village reduced peak discharge from 10.3 m^3/s to 8.0 m^3/s, decreasing the discharge reaching the Dese river.

<u>Scolo Desolino</u>
Re-meandering reduced peak discharge from 7 m^3/s to 5.5 m^3/s, once again decreasing the peak discharge reaching the Dese river.

<u>Rio S. Ambrogio</u>
Thanks to the different measures, in case of peak discharge the river never overflows. Discharges decreased from 11.5 m^3/s to 10.5 m^3/s.

<u>Overall, the peak flows discharged by rivers and channels to the Dese river decreased from 29 m^3/s to 25 m^3/s.</u></td></tr>
<tr><td rowspan="6">Reference to existing engineering standards, guidelines and manuals that have been used during the design phase</td><td colspan="2">Reference</td><td>URL</td></tr>
<tr><td>1.</td><td></td><td></td></tr>
<tr><td>2.</td><td></td><td></td></tr>
<tr><td>3.</td><td></td><td></td></tr>
<tr><td>4.</td><td></td><td></td></tr>
<tr><td>5.</td><td></td><td></td></tr>
<tr><td>Main factors and/or constraints that influenced the selection and design of the NWRM(s) in this application?</td><td colspan="3">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.</td></tr>
</table>

V. Biophysical impacts

Impact category (short name) Select from the **drop-down menu** below:	**Impact description** (Text, approx. 200 words)	**Impact quantification** (specifying units)	
		Parameter value; units	% change in parameter value as compared to the state prior to the implementation of the NWRM(s)
	Measures proved to be very effective in reaching the two key objectives: • Flood reduction: although specific monitoring has not been carried out, the effects are visible. Before implementation, intense precipitations would have caused overflowing of rivers and channels and flooding events. After implementation, precipitations with equal intensity do not cause such phenomena anymore. • Water quality improvements: the simulation conducted in the design phase indicates 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.		
Runoff attenuation / control			
Peak flow rate reduction		Overall, the peak flows discharged by rivers and channels to the Dese river decreased from 29 m^3/s to 25 m^3/s.	13.8% overall reduction of peak flows into the Dese river as compared to the situation before implementation
Impact on groundwater			
Impact on soil moisture and soil storage capacity			
Restoring hydraulic connection			
Water quality Improvements	*Expected impact (forecast based on experimental parameters from previous applied studies):*	*Total N reduction: 12.73*	

	(see more details in the table below)	*t/year Total P reduction: 0.64 t/year*	
WFD Ecological Status and objectives			
Reducing flood risks (Floods Directive)	*Describe any impacts related to the flood risk reduction and the objectives (the biophysical related ones) of the Floods Directive*		
Mitigation of other biophysical impacts in relation to other EU Directives (e.g. Habitats, UWWT, etc.)	*Describe any other biophysical impacts related to pressures and objectives (the biophysical related ones) of other EU Directives, e.g. Habitats Directive, UWWT Directive, etc.*		
Soil Quality Improvements	*Has the NWRM impacted the overall soil quality? In which way? Please provide some explanatory text. Provide details on specific pollutants (N, P, soil carbon/organic matter, physical properties-bulk density, etc.)*		
Other	*Please described any other biophysical impacts not captured in the predefined list*		

	Wetlands		
	Abatement Coeff. (t/year * ha)	Areas of intervention (ha)	Total abatement (t/year)
Ntot	0,216	11,12	7,85
Ptot	0,0507		0,33
	Fragmytes strips		
	Abatement Coeff. (t/year * ha)	Areas of intervention (ha)	Total abatement (t/year)
Ntot	0,216	1,03	0,35
Ptot	0,0507		0,05
	Buffer zones		
	Abatement Coeff. (t/year * ha)	Areas of intervention (ha)	Total abatement (t/year)
Ntot	0,216	8,82	4,53
Ptot	0,0507		0,26

Source: translated from Cornelio et al, 2012

VI. Socio-Economic Information

What are the benefits and co-benefits of NWRMs in this application?	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

<table>
<tr><td></td><td colspan="3">Creation/improvements of habitats and therefore biodiversity in the area
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.</td></tr>
<tr><td rowspan="6">Financial costs</td><td>Total:</td><td>4,131,655 €</td><td>Total costs</td></tr>
<tr><td>Capital:</td><td>Value in €</td><td></td></tr>
<tr><td>Land acquisition and value:</td><td>Value in €</td><td></td></tr>
<tr><td>Operational:</td><td>Value in €</td><td></td></tr>
<tr><td>Maintenance:</td><td>Value in €</td><td></td></tr>
<tr><td>Other:</td><td>Value in €</td><td></td></tr>
<tr><td rowspan="4">Were financial compensations required? What amount?</td><td colspan="3">Was financial compensation required: Yes</td></tr>
<tr><td colspan="3">Total amount of money paid (in €):</td></tr>
<tr><td colspan="3">Compensation schema:</td></tr>
<tr><td colspan="3">Comments / Remarks: 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</td></tr>
<tr><td rowspan="4">Economic costs</td><td colspan="3">Actual income loss:</td></tr>
<tr><td colspan="3">Additional costs:</td></tr>
<tr><td colspan="3">Other opportunity costs:</td></tr>
<tr><td colspan="3">Comments / Remarks:</td></tr>
<tr><td>Which link can be made to the ecosystem services approach?</td><td colspan="3">The improved delivery of ecosystem services after implementation has not been assessed/evaluated. However, looking at the type of interventions made, and the related impacts, it is possible to list the main ecosystem services involved:
• Moderation of extreme events
• Habitat for species/ Maintenance of genetic diversity
• Recreational services
Although measures have had a positive impact on water quality, water from rivers and channels is not used for human consumption, so “provision of clean water” has not been included in the list of ecosystem services.</td></tr>
</table>

VII. Monitoring & maintenance requirements

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. 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 requirements	In theory, measures reproduce natural habitats and processes, so the maintenance requirements are supposed to be very low. 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, as in some cases trees and plants cast shadows on crops.
What are the administrative costs?	Info N/A

VIII. Performance metrics and assessment criteria

Which assessment methods and practices are used for assessing the biophysical impacts?	Info N/A
Which methods are used to assess costs, benefits and cost-effectiveness of measures?	Info N/A
How cost-effective are NWRM's compared to "traditional / structural" measures?	The ability of the measures to address two pressing environmental issues in the area is a key success factor. The measures are in fact able to: (i) reduce nitrogen loads in effluents and, ultimately, into the Venice Lagoon; and (ii) mitigate flood risk in the area. Alternative measures for floods would include, for example, building weirs and protection barriers over large areas, and they would be more expensive than implemented NWRMs. Concerning nitrogen loads, mechanical and chemical treatment of effluents on such a large area is very likely unfeasible.
How do (if applicable) specific basin characteristics influence the effectiveness of measures?	Info N/A
What is the standard time delay for measuring the effects of the measures?	Info N/A

IX. Main risks, implications, enabling factors and preconditions

What were the main implementation barriers?	• 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; • In some cases, negotiations for expropriations posed some challenges • After implementation, there were some little problems with farmers: in some cases, trees and plants cast shadows on crops.
What were the main enabling and success factors?	• Key enabling factor: availability of funding for this type of intervention • The main success factor is the evident effectiveness of the measures! 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 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 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. • 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.
Financing	The application was initiated by Consorzio Acque Risorgive and financed by the Province of Venice through the "Plan for diffuse pollution prevention and restoration of water in the draining basins of the Venice Lagoon". The Plan was developed to implement a Special national Law to safeguard Venice Lagoon. According to the Plan, Consortia can apply for funding for implementing measures aimed at retaining N and P into the basin and enhancing phytodepuration, thus decreasing nutrient discharges into the Venice Lagoon. Funding is provided based on the projected amount of nutrients that the project is expected to retain.
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.

X. 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.

XI. References

Source Type	*Scientific Article*		
Source Author(s)	P. Cornelio, C. Bendoricchio[1], G. Carretta[2], B. Boz[3] e B. Gumiero		
Source Title	Interventi estesi di riqualificazione fluviale lungo gli affluenti del medio corso del Fiume Dese		
Year of publication	2010		
Editor/Publisher	Consorzio di Bonifica Acque Risorgive, Venezia, Italia		
Source Weblink	Weblink		
Key People		*Name / affiliation*	*Contact details*
	1.	*Paolo Cornelio*	*p.cornelio@acquerisorgive.it*
	2.	*Bruno Boz*	*b.boz@cirf.org*

Source Type	*Interview*
Source Author(s)	Paolo Cornelio – Consorzio di Bonifica Acque Risorgive
Source Title	Phone interview – Paolo Cornelio is the person in charge of implementing NWRMs in the Consorzio's area of intervention

1 Consorzio di Bonifica Acque Risorgive, Via Rovereto 12, Venezia, Italia: c.bendoricchio@acquerisorgive.it

2 Ingegneria 2P & associati s.r.l., San Donà di Piave VE, Italia: giovanni.carretta@ingegneria2p.it

3 Biologo, libero professionista: bruno.boz@alice.it

Year of publication	29/04/2014		
Editor/Publisher	Text		
Source Weblink	Weblink		
Key People		*Name / affiliation*	*Contact details*
	1.	*Paolo Cornelio*	*p.cornelio@acquerisorgive.it*

Source Type	*Interview*		
Source Author(s)	Bruno Boz – Centro Italiano Riqualificazione Fluviale		
Source Title	Phone Interview - Bruno Boz was actively involved in the design and implementation of these measures, as well as the other applications implemented by the Consorzio		
Year of publication	04/04/2014		
Editor/Publisher	Text		
Source Weblink	Weblink		
Key People		*Name / affiliation*	*Contact details*
	1.	*Bruno Boz*	*b.boz@cirf.org*

XII. Photos Gallery

Figure 1 Buffer zone on the Piovega di Scandolara channel. The yellow arrow indicated the area were the bank was enlarged –originally, it looked like the opposite bank

(Source: Cornelio, P., Bendoricchio, C., Carretta, G., Boz, B., Gumiero, B., 2012. "Interventi estesi di riqualificazione fluviale lungo gli affluenti del medio corso del Fiume Dese". Consorzio Acque Risorgive)

Figure 2 Wetland and pond created on the Scolo Desolino, before and after intervention

Scolo Desolino before and after re-meandering, river-bed widening and biodiversity improvement

(Source: pictures sent by Paolo Cornelio, Consorzio Acque Risorgive)

Figure 3 Wetland and pond created on the Scolo Desolino, before and after intervention

Scolo Desolino before and after re-meandering, river-bed widening and biodiversity improvement

(Source: pictures sent by Paolo Cornelio, Consorzio Acque Risorgive)

Figure 4 Buffer zones in Piovega di Scandolara, before and after intervention

(Source: pictures sent by Paolo Cornelio, Consorzio Acque Risorgive)

Figure 5 Scolo Desolino before and after re-meandering, river-bed widening and biodiversity improvement

(Source: pictures sent by Paolo Cornelio, Consorzio Acque Risorgive)