

MANAGEMENT PLAN FOR NORTH WEST AREA OF MILAN

D.T3.1.3 | Pilot North West of Milan area

Summary
09 2019

AMIIGA Project

The concept of AMIIGA project originated considering that in Central European urban areas many groundwater are affected by a significant contamination caused by the long-term and widespread use of polluting substances. Moreover, groundwater contamination is a problem that goes beyond administrative boundaries of a local public authority and in Europe there is little experience on the management of groundwater contamination at the proper scale, the Functional Urban Area (FUA).

The goal of the project is then to develop a Management Strategy on groundwater contamination in Functional Urban Areas of Central Europe. To do this, a groundwater Management Plan for each of the seven AMIIGA partner pilot sites has been developed.

Lombardy Region has developed a groundwater management plan for the north-west area of Milan. The Management Plan for the pilot area integrate the activities and the plan issued for the area north-east Milan giving a more complete framework of Milan FUA.

1. Introduction

The northern part of metropolitan area of Milan, Milan FUA, has been historically characterised by a dense agglomeration of industries (automotive, refineries, chemical plants, steel and tires production) that led, over the years, to a significant contamination of soil and groundwater. Because of the high hydraulic conductivity and the high groundwater withdrawal rate, the groundwater contamination reached Milan that represents the natural drainage area of the groundwater in the north.

In the last decades Lombardy Region spent many efforts to push polluters to characterize and reclaim soil and groundwater in their sites, having important results in terms of water and soil quality at local scale. Moreover, the data provided by polluters, improving the knowledge on the distribution of groundwater contamination, highlighted the possible presence of a second form of contamination, the so named “diffuse pollution”.

The reference standard that defines the concentration thresholds for aquifers are defined by the national decree (d.lgs 152/06) and, among the others, establish the limit values for PCE (1.1 µg/l) and for TCE (1.5 µg/l).

Lombardy Region started dealing with diffuse pollution in the metropolitan area of Milan since 2013 with an important work of systematization and integration of the existing data. Based on the results of the studies carried out, in 2017, Lombardy Region delimited the first area affected by diffuse pollution and approved management measures and the discipline for remediation procedures. The area, which is north - east of Milan (and includes the City of Milan), is affected by diffuse contamination of chlorinated hydrocarbons (CHC).

Furthermore, the studies developed highlighted that several plumes that originate North - West of Milan have a significant effect on the deterioration of the groundwater quality in Milan and affect some pumping stations used for the water supply services and also the presence of a contamination characterized by low concentrations and stability during the time that seemed to be of diffuse nature.

The plumes origins, their shape and the characteristics contamination outside the plumes (extension, magnitude, temporal and spatial distribution) have been investigated under AMIIGA project. The pilot action area covers the surface of 12 Municipalities at north west of Milan (including a part of Milan).

The management plan summarizes the results of the investigations and the actions required to protect the public health and increase the awareness of the population on groundwater pollution in Milan north-west pilot area.

Definitions:

Concentrations representative for the diffuse contamination (CRDC): represent the magnitude of the diffuse contamination in the area.

Reference concentration for remediation (RCR): these values are set as new thresholds and act as new targets for the remediation in an area affected by diffuse pollution. They can differ from the CRDC, being generally lower, depending on other constraints like the results of the risk analysis.

2. The Pilot Area of Milan FUA

The pilot area covers 12 municipalities in the north-west of the Milan FUA and is about 157 km² wide; within the area live about 617.773 inhabitants.

From the hydrogeological point of view, the main aquifers interested by the contamination are the shallow aquifer and semi-confined aquifer that, in the area under study, are separated in the northernmost part and communicating in the southern portion.

The extensive dataset available for the Milan FUA, with the main hydro-chemical groundwater features, was analysed by the statistical analysis (exploratory data analysis) in order to identify the Perchloroethene (PCE) and Trichloroethene (TCE) hot spots and distinguish punctual sources from diffuse contamination.

Then, thanks to the inverse transport model (Monte Carlo analysis), it was possible to track the particles of the contaminants both forward to estimate the influence of parameter uncertainty on simulation, and backward in order to find, in a probabilistic way, the areas where the pollution takes its origin.

Moreover, the numerical transport and flow modelling (MODFLOW, MT3DMS¹) was applied to represent the groundwater flow and contaminant transport phenomena in the studied aquifers allowing to feature/depict the PCE and TCE plume extensions, the mass flow rate released from sources and their spatial evolution (from 1954 to 2017).

Diffuse groundwater contamination identified at medium-scale (FUA scale) allows public administrations to introduce specific management measures making local remediation actions more sustainable.

Finally, a multivariate analysis and factorial, in association with geostatistical analysis, was applied to the dataset in order to give a picture of the distribution and to determine the concentrations representative for the diffuse contamination. Maps of diffuse PCE and TCE contamination distribution, were provided for the shallow and the semi-confined aquifers, split in 3 levels associated to ranges of concentrations representative for the diffuse contamination.

The model tools and elaborations developed on the groundwater data base, allowed to:

- depict an extensive profile on the contamination by chlorinated solvents in the pilot Area of Milan
- detect the six main plumes of contamination, depicting their extension, feature, possible evolution in time and space and the most probable origin/historical potential sources
- distinguish both punctual sources and plumes from diffuse contamination
- draw the maps of diffuse PCE/TCE contamination distribution associated to ranges of concentrations representative for the diffuse contamination.

Given above technical outcomes representing the picture of the groundwater contamination of the pilot area, the management plan deals with the major challenges and critical issues highlighted.

3. Goals of the Management Plan and of the measures

The strategic aim of the Management Plan is to protect the public health in areas affected by diffuse pollution, control and manage diffuse contamination and of its effects on environment and increase the awareness of the population on groundwater pollution

Measures are aimed to:

- protect citizens health from eventual risks deriving from chlorinated hydrocarbons in groundwater;
- achieve the “good ecological status” of groundwater as forecasted by 2000/60/EC;
- intervene on plumes origins to stop their contribution to the contamination;

¹Harbaugh, A. W., Banta, E. R., Hill, M. C., & McDonald, M. G. (2000). MODFLOW-2000, the US Geological Survey modular ground-water model: User guide to modularization concepts and the groundwater flow process. *U.S. Geological Survey*, 121.
Zheng, C., & Wang, P. P. (1999). http://www.geo.tu-freiberg.de/hydro/vorl_portal/gw-modellierung/MT3DMS_Ref_Manual.pdf



- monitor the evolutive trend on groundwater quality;
- Increase of the population awareness on groundwater contamination.

4. Measures

To achieve the main goals, the MP the following measures are defined:

- Protection of water supply system
 - Periodical monitoring of the drinking water
 - Activation of specific treatments for potabilization of water
 - Periodical check of the efficiency of potabilization systems
- Remediation procedures and actions on plumes
 - CHC contaminated Sites
 - Periodical check on the advancement of remediation procedures and activities
 - Eventual support to the Municipalities on the procedure management
 - Actions on priority plumes
 - Periodical check on the advancement of remediation procedures and activities
 - Activation/reactivation of the administrative procedures for the remediation
 - Identification of the polluter
 - Eventual substitution of the polluter in the remediation activities
 - Eventual support to the Municipalities on the procedure management
- Management of diffuse contamination
 - **Milan City:** confirmation of the reference concentration for remediation (RCR), estimated in the previous studies and confirmed with AMIIGA. These values will be the target values for the remediation

Valori di CRB [$\mu\text{g/l}$]	Fascia Gialla	Fascia Rossa
Comune di Milano (acquifero A)	PCE 5,1	PCE8,5
	TCM 0,7	TCM 1,5

- **Other municipalities** of the pilot area: definition of a range of concentrations representative for diffuse contamination (CRDC) in the other

Municipalities. RIG decided not to adopt CRDC nor RCR for other Municipalities due to the inhomogeneity on the data distribution and transferred thresholds definition to further, deeper investigations.

- Improvement and update of the knowledge framework
 - Hydrogeological Data Base updating
 - Monitoring of groundwater quality
 - identification of a monitoring network for the plumes
 - identification of a monitoring network for the diffuse contamination
 - periodical monitoring
- Diffusion of knowledge on groundwater contamination and on enacted measures
 - Regional web page dedicated to groundwater contamination
 - Organization of dedicated events
- Monitoring on the implementation of the management measures and eventual introduction of corrective actions
 - the implementation of the forecasted measures will be guarantee by the settlement of a Technical Table, same structure and members of the RIG, in charge for the implementation of the plan and, if the case, the modify, integration, revision of the measures of the Management Plan.

5. Implementation

In the following table, the duties and responsibilities are set for each public body involved in the management plan implementation.

Lombardy Region	Municipalities	Provinces	Regional Agency for Environmental Protection	Water supply providers
Prioritizes polluted plumes in the area	Carry out procedures for the remediation of source of contamination of plumes	Give support to the identification of the polluters	Supports RL in the monitoring of performed measures	Provide data of their own monitoring networks
Coordinates local authorities for the implementation of MP measures (RIG)	Carry out remediation activities in place of the polluters (substitution)	Give support in the monitoring of the networks	Manages a specific monitoring network for plumes	Activation of specific treatments for potabilization of water
Coordinates the application of the Monitoring plan to evaluate the evolution of diffuse pollution and the effects of the intervention measures	Apply the new threshold values, the reference concentration for remediation (RCR)		Manages the monitoring network for diffuse pollution	Periodical monitoring of the drinking water

Monitors the evolution of plumes of contamination			Implements the hydrochemical Data Base of the FUA with new data	Periodical check of the efficiency of potabilization systems
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Actions will be implemented during the all life of the Management Plan and will be eventually revised after 6 year during the review of the Regional Plan for Water Protection. The RIG will be extended after AMIIGA Project, in the form of a Technical Table, aimed to monitor and coordinate the Management Plan implementation.