PROGETTO LIFE WAMARIBAS

WAter MAnagement at RIver BAsin Scale

Life Environment 2002-2005

Co-funded by the European Commission

LAYMAN'S REPORT

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REGIONE MARCHE

S.I.I.NO.S. S.p.A.
Servizio Idrico Integrato Nord Sardegna

DHI WATER & ENVIRONMENT

ASPES SpA

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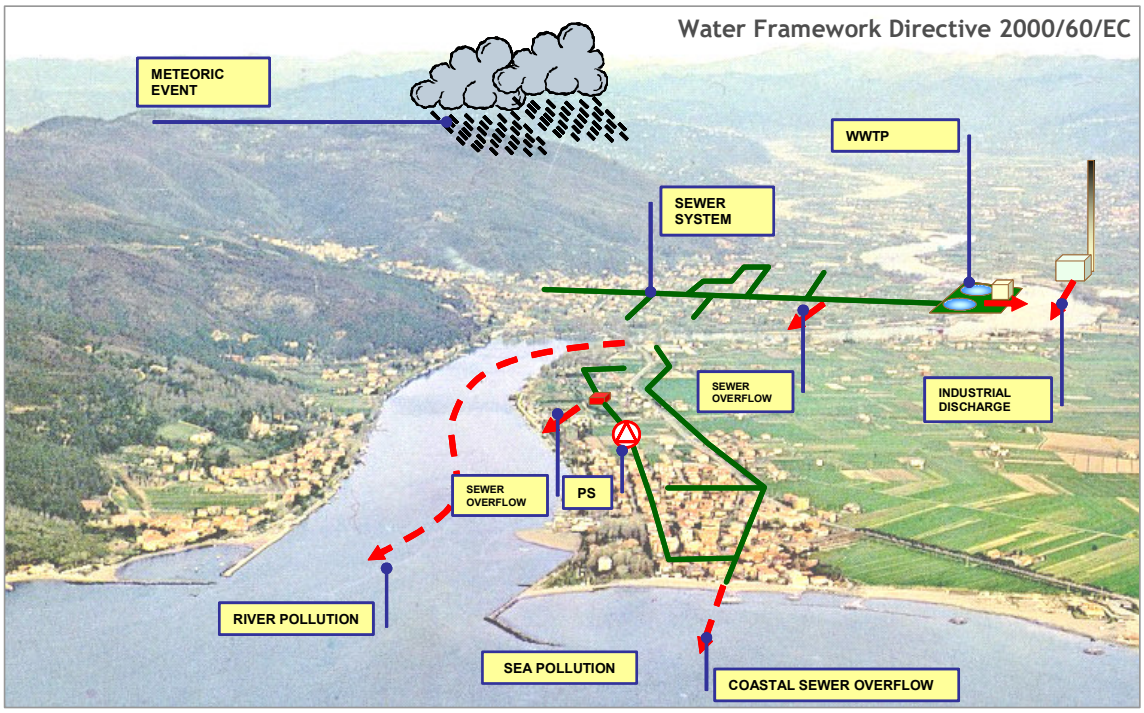
ARPAM AGENZIA REGIONALE PER LA PROTEZIONE AMBIENTALE DELLE MARCHE

SPS Società Progettazione e Servizi

GENERAL DESCRIPTION OF WAMARIBAS PROJECT

WAMARIBAS is a research project aiming at the implementation of the new EC Water Framework Directive (Directive 2000/60/EC) establishing the integrated water management at basin scale. The target of the directive is to fix an EC framework for the protection of internal surface water, transition water, coastal and ground water, ensuring pollution prevention and reduction, facilitating sustainable water use, protecting environment, improving water ecosystems and mitigating flood and drought effects.
The project, lasted 3 years, was co-financed by the European Community within the LIFE Environment programme.
It is worth to notice that WAMARIBAS is one of the first actual implementations of the new directive in Italy and therefore it is an important stage in the progress that will lead, within nine years since the directive establishment, towards the drafting of a management plan and an operating programme for every basin area, taking into account the results of basin characteristics analysis, assessment of the impact on water of anthropic activities and economic analysis of water uses.



PROJECT TARGETS

The main targets of the WAMARIBAS project are the following:

- Applying an innovative methodology for river basins and waste water management by means of integrated numerical modelling “Integrated Catchment Simulator (ICS)”.

- Arranging the support tools for the implementation of the Water Framework Directive 2000/60/EC (WFD).

- Implementation of the project results in other situations both in Italy and abroad. This stage is one of the main targets of the European Community.

- Capacity building of users and institutions dealing with surface water by means of training programmes about management techniques, modelling and monitoring of catchment areas.

The pilot river basins, chosen for their particular characteristics which well represent various hydrographic kinds, are:

- Foglia River – Marche Region
- Salso Imera River – Sicily Region
- Rio Mannu River – Sardinia Region

GENERAL DESCRIPTION OF PILOT SITES AND ENVIRONMENTAL ISSUES

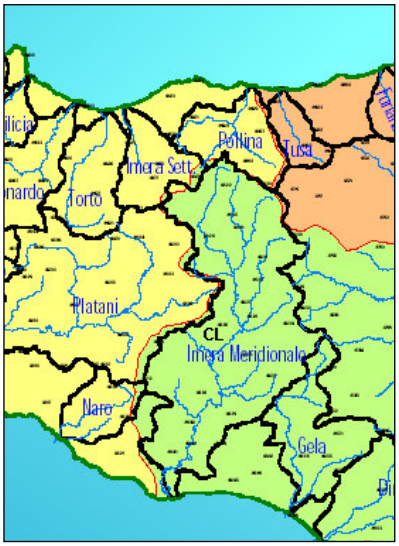
Pesaro - The Foglia river basin lies in central Italy in the northern part of Marche region. Foglia river rises in Sasso Aguzzo Mountain (980 mt, province of Arezzo), flows throughout the province of Pesaro, inlet and outlet of the Mercatale or Sassocorvaro lake and, after flowing for more than 80 Km, discharges into the Adriatic sea. The catchment area surface is more than 700 Km2. The figure shows the catchment map. Rainfalls are irregular with minimums in July and maximums in October, November and December. Summer drought is remarkable and lasting. Only the Foglia high valley is covered by snow in winter, but generally it lasts briefly.

About in the middle of the catchment there is a dam forming an artificial lake, named Mercatale, used by the Consorzio di Bonifica (public utilities for river reclamation) to irrigate the Foglia Valley. The lake remarkably alters the regime of river flows recorded downstream the dam.
Therefore, in summer, flows are poor and in winter, in spite of poor rainfalls, the river reaches flood condition due to big flows discharged by the dam for its different uses.
Upstream the dam there are no significant resident or industrial settlements, but downstream waste water discharges into the river increase and the worst situation is in Pesaro where very high pollution rates have reached.
Protection and rehabilitation of the Foglia river are imperative, since it is exploited also for drinking uses. Indeed Pesaro province is lacking in ground water of good quality and 55% of drinkable water is supplied by surface water made drinkable through chemical-physical treatments.

Caltanissetta – The Salso-Imera river basin, named also Imera Meridionale (Southern Imera), is one of the largest in Sicily. It covers about 2049 km^2 and affects four provinces: Palermo, Caltanissetta, Enna and Agrigento.
The Salso-Imera river rises in the Madonie in Pizzo Catarineci (m 1660) place and flows in north- south direction throughout the island discharging into Sicily Sea, in the southeast of the island. The river is 144 km long and receives the Salso river in the northern part of its basin, after

which the name Salso-Imera, flowing for about 28 km.

Along its course it flows through two natural parks having considerable environmental-naturalistic importance: Imera park and Madonie park. So it is very important to protect water quality in order not to spoil the ecosystem of the two natural parks.



At present, in the Imera Meridionale basin, three artificial lakes have been made: the Villarosa (in Enna province), Olivo (in Caltanissetta province) and Gibbesi (on the border between Caltanissetta and Agrigento provinces) but they are used for neither watering nor drinking purposes yet.

Caltanissetta province is one of the Sicily areas where rainfall average is one of the lowest, due to the particular orographical characteristics of this province. Rainfall distribution trend is the same as we find in the rest of the region, that is two main periods can be individuated: a dry season from April to September, which is characterised by a 10 ÷ 20% average of total rainfall, and a rainy season from October to March with the 80 ÷ 90% left.

In the last two decades there has been a reduction of the average rainfall connected to a lengthened dry season causing a flow reduction and water availability needed for water ecosystem livelihood in some times of the year. Thus, the river is characterised by a permanent regime even though sometimes with scarce flows.

In the last 40 years the rainfall peaks have been higher bringing about torrential downflows, because of global climate changes.

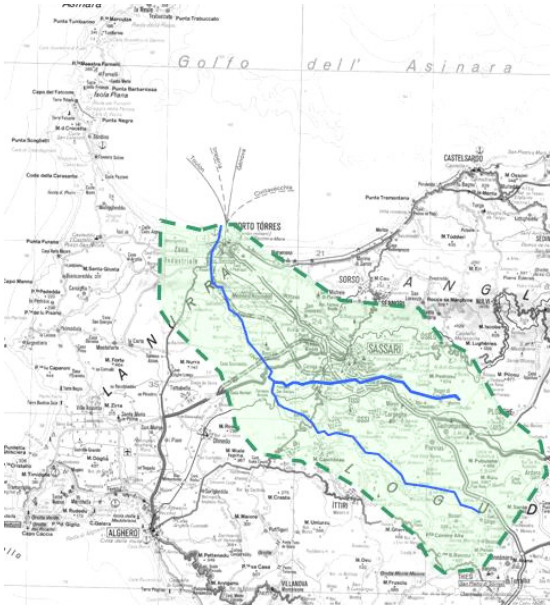
The territorial situation of the Salso-Imera basin has a lot of problems due to poor resources and its peculiar characteristics.

Only in its upstream section, for about 20 km, it conveys fresh water, while, for the rest of its course, as it crosses a former ore district, which is rich in sulphur, high salty water flows into it, so that it cannot be used for drinking nor irrigated uses. The Imera basin was indeed the main ore pole in Sicily for the digging out of sulphur.

Another particularly important problem affecting the basin is the inordinate water intakes from wells for watering purposes, causing the impoverishment of ground water tables and sea intrusion, which sometimes prevents water from being used due to the high salt content.

Sassari - The Mannu pilot basin lies in the north west of Sardinia and affects the province of Sassari. Catchment area spreads out from south-est to north-west between the Rio Silis basin and the Catala river basin. It involves the plain looking on to the Gulf of Asinara and the mountainous area of M. Santo (733 m), Monte Pelao (730 m) and M. Nostra Signora di Bonaz (767 m). The catchment, having a 670 Km^2 overall surface, affects twenty municipalities, among which Sassari Porto Torres. In the district, Rio Mannu di Porto Torres flows, surely the most important stream in the area; it rises in the municipal area of Cheremule and Bessude. The main Rio Mannu tributaries are: on the right, the Rio Bidighinzu, Rio Mascari and Rio di Ottava; on the left the Rio Minore and Rio Ertas.

Along the Rio Bidighinzu the homonymous reservoir with about 10 million m^3 capacity was built. In the district there are two more reservoirs, the Bunnari lakes, placed in the higher section



of the Rio Scala di Giocca, a tributary of the Rio Mascari.

The Mannu river network is the focus of the surveyed catchment since this stream receives polluting substances and, on its turn, it is a risk for the receiving sea water body as it flows into the Gulf of Asinara and affects coastal water quality in places of high environmental tourist value. The protection of the Mannu river is a crucial point as well, for its drinking uses.

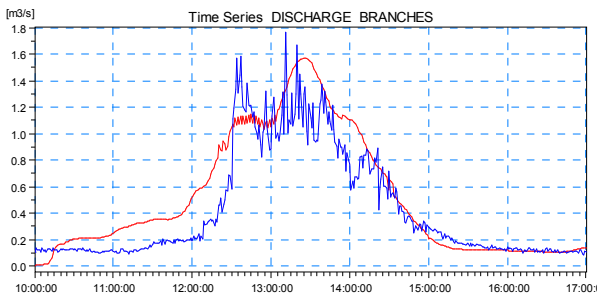
In order to classify the basin environmental issues, data about wastewater flowing into the Mannu, Rio Ottava and Mascari streams, and so interacting with the Gulf of Asinara coastal area, have been collected.

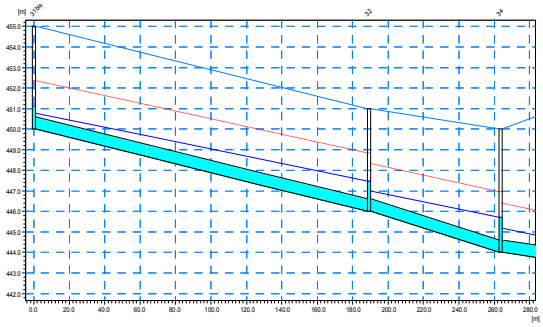
SOFTWARE DESCRIPTION AND WORK METHODOLOGY

Within Wamaribas project various operating scenarios have been simulated, by using the following calculating codes of the Danish Hydraulic Institute:

MOUSE for sewer system modelling.

It is used for sewer system design and analysis through storm water events simulation. MOUSE uses a hydrologic modulus of run-off, a hydraulic modulus of flow in pipes and a modulus of water quality which, by integrating with the hydrodynamic modulus, is able to simulate advection-dispersion phenomena and quality processes developing in sewer network. This latter, together with the hydrodynamic modulus, was used to assess the pattern of organic loads entering waste water treatment plants as well as total amount discharged by overflows, during storm water events in outward receiving bodies.

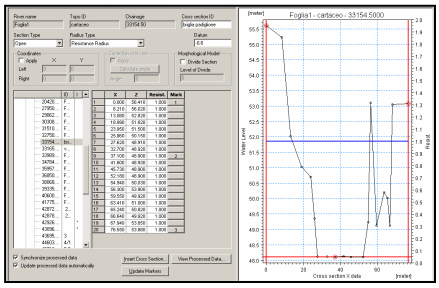


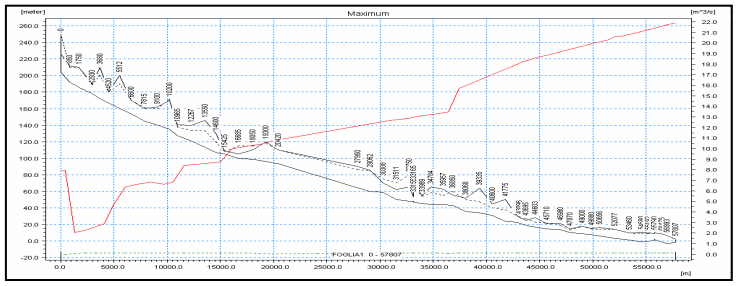


MIKE11 for river system modelling.

MIKE11 is a general programme for free surface simulation in estuaries, rivers, watering systems and water bodies; it simulates unidimensional flow, whether it is steady or not, of vertically homogeneous fluids in any channel or river network. By means of this programme it is possible to solve the hydrodynamic problem of unsteady flow with a very efficient numerical solution scheme, reducing calculation time and permitting a suitable representation of flood wave trend

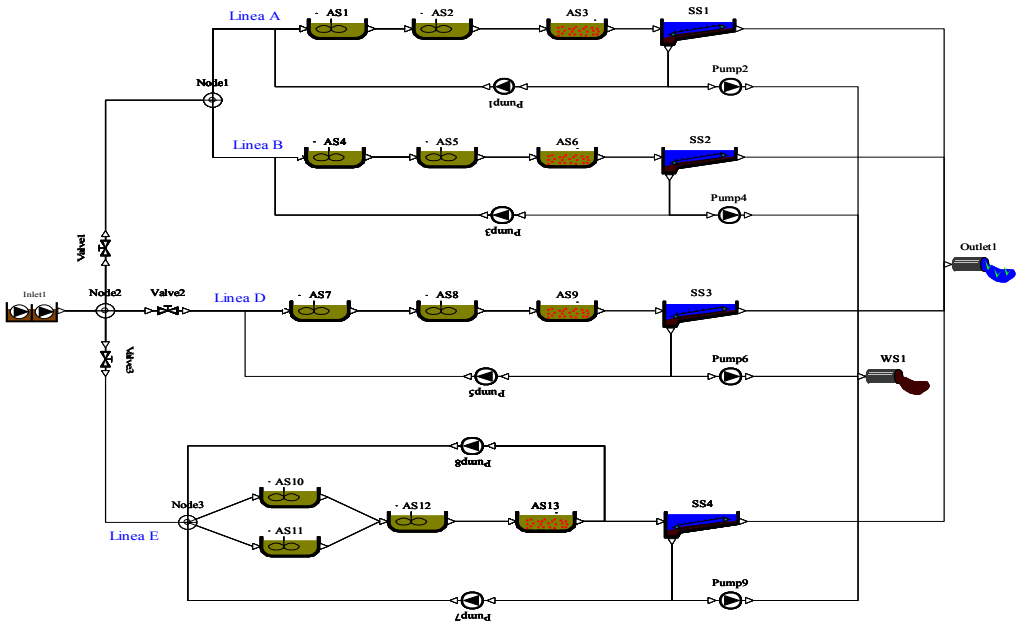
over time. The AD (Advection-Dispersion) modulus simulates conveyance and dispersion of conservative and non-conservative substances. The modulus is based on the solution of the unidimensional equation of mass conservation of a dissolved or suspended substance; the two simulated conveyance phenomena are the convective one (motion of the dissolved substance in average velocity flow conditions) and the dispersive one due to concentration gradients.





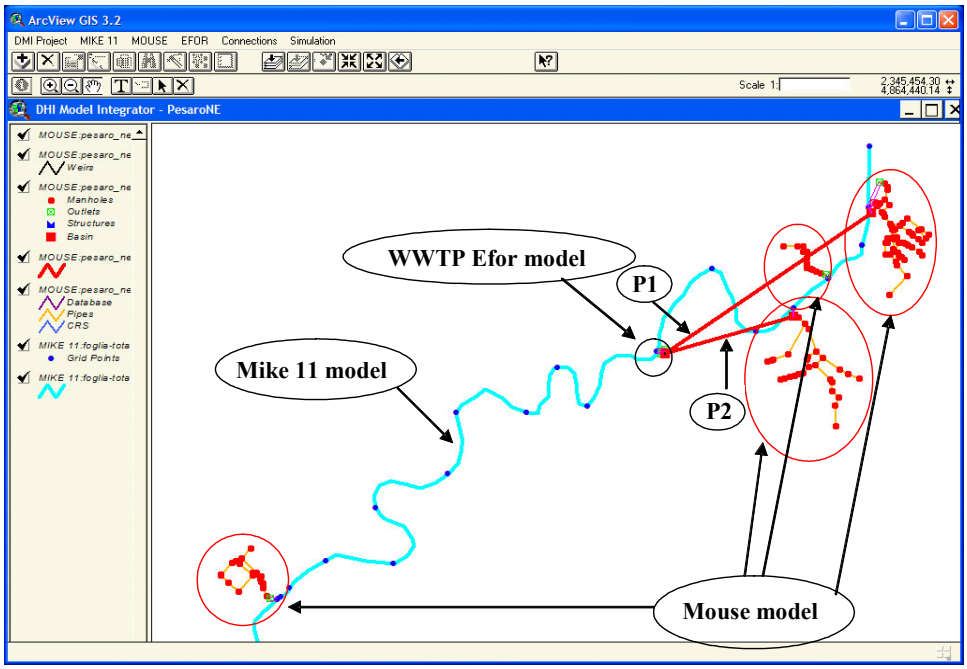
EFOR for waste water treatment plant modelling.

EFOR is a programme for the modelling of processes taking place into a waste water treatment plant (or WWTP). By inputting features and dimension of tanks, machinery performances and waste water composition, the programme simulates dynamically plant processes and calculates treatment efficiency, such as, for example, the consumption of oxygen and chemical substances. This model can be used for optimising performances and analysing problems met during the process as well as testing different strategies for their implementation.



Integrated Catchment Simulator (ICS) for the connection of each model in one GIS-based integrated modelling environment .

Therefore it was possible to effect a performance analysis of the basin river area. So the integrated model ICS becomes a tool for the analysis and management of the whole basin area.



In order to perform the simulations, the following monitoring activities have been carried out:

-**Rainfalls** with pluviometers;

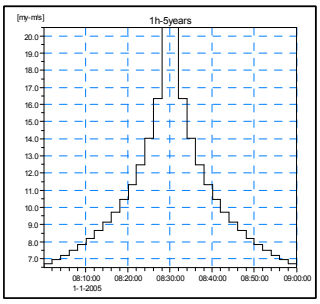
-**Discharges** with level and velocity ultrasonic sensors;

-**Quality** with water quality automatic samplers in order to analyse the main parameters of organic pollution such as COD (Chemical Oxygen Demand) and TKN (Total Nitrogen).

Thanks to the ICS package it was possible to assess interactive processes between rivers and pollution sources in order to assess discharges impacts on the water bodies examined in the three pilot areas and therefore to propose works aimed at upgrading quality of these water bodies.

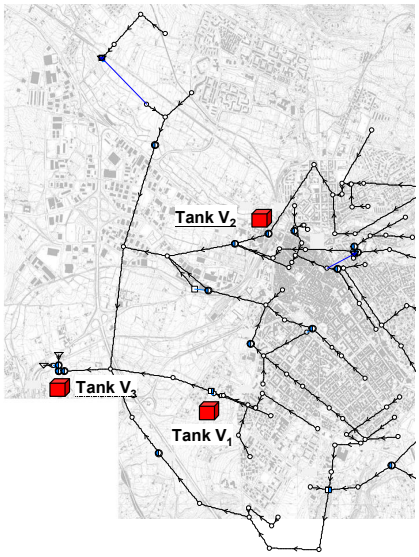
PERFORMANCE ANALYSES AND UPGRADING WORKS

Performance analysis has been effected by simulating water systems behaviours during heavy rainfalls, in order to analyse the various problems of the pilot basins. Once hydraulic-environmental criticalities were assessed, upgrading works aiming at increasing, with the best cost-effective ratio, the environmental protection of receiving water bodies were proposed. Particular attention was paid to polluting amounts discharged in surface water bodies by combined sewer overflows of the sewer systems. This analysis has been implemented by means of mathematic models with both real important rainfalls of local pluviometric regime measured by pluviometers in the monitoring period, and project storm water events with static-based.



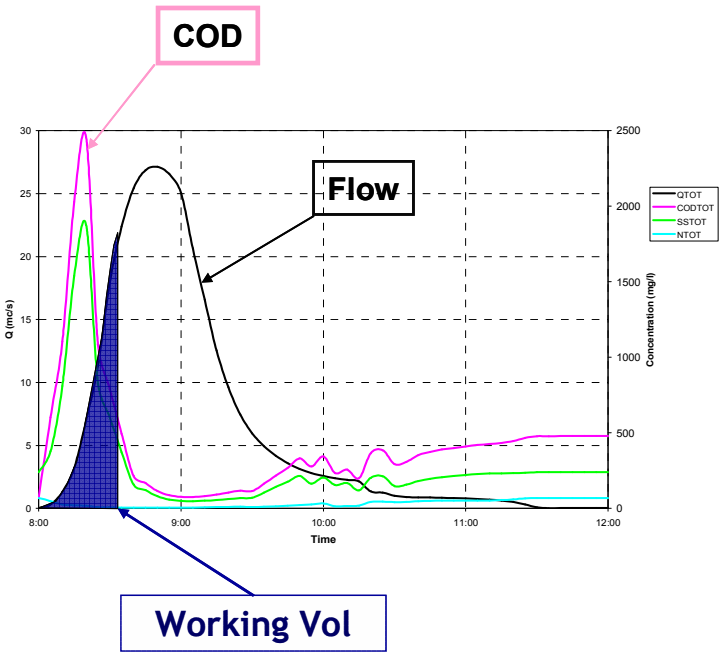
Design Event - 5 Y 60'

The modelling integration through the ICS permitted to define upgrading actions for surface water protection, in compliance with the requirements of the EU water directive.



In order to reduce polluting amounts from combined sewer overflows during storm water events, implementation of storage tanks near main overflows was considered, in order to catch combined flows which, in standard situations, are not delivered to treatment plant. These tanks are designed to contain the most polluted fraction of overflows, which is notoriously the early storm water and which the so-called "first flush" phenomenon is due to.

The dimensioning was effected by designing the optimum volume maximising advantage in terms of pollutant amount caught by tanks, taking as a benchmark the design event with hourly duration and Return Time 5 years. It is worth to notice that the optimum size of these tanks, related to the impervious area of urban basins involved, is comparable for the three pilot basins: 30 m^3/ha for Caltanissetta, 33 m^3/ha for Sassari e 35 m^3/ha for Pesaro.



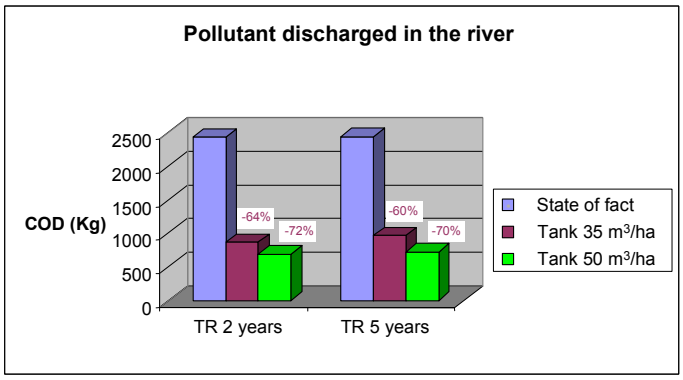
Following, it was possible to compare, through cost-benefit analyses, the adopted solutions to reduce pollutants discharge into the surveyed rivers.

ECONOMICS ASSESSMENTS

For design storm water events, the comparison between current and two planned solutions was made: the optimum tank for each basin and tank with volume according to Lombardy Law.

Lacking specific regulations for dimensioning tanks, we made use of the directions provided by the Regional Plan of Water Improvement (Piano Regionale Risanamento Acque or PRRA) of Lombardy Region, which proposes early storm water tanks holding 50 m^3 per ha of impervious area of the catchment subtending the sewer system section relating to the tank itself. Lacking further directions, it permits for a uniform and consistent approach to all the surveyed pilot areas. The Lombardy PRRA, moreover, is a criterion used not only in Lombardy, but represents a widespread and reliable criterion to be used when official regulations are lacking, as it arises from surveys carried out in a region, which is particularly state-of-the-art and careful about spread pollution, and it fills in a gap in Italian technical regulations. In the relevant Italian legislative decree (D. Lgs 152/99) and its following emendations, indeed, regulations about "early storm water" are referred to Regions without giving them particular project directions.

Results: improvement solutions



Comparision between State of Fact and Design Hypothesis, for T_R=2 e T_R=5 years

To quantify effectively upgradings found out, advantages due to the tanks as for reduction of polluting (COD example) discharged into the receiving water body, were assessed. So a cost-benefit analysis comparing the two alternative solutions providing different dimensionings was implemented. Analysis with the model permitted to get remarkable investment savings in comparison with the 50 m^3/ha traditional dimensioning. Environmental benefit, indeed, as for reduction of AE flowing into the river, reaches a deadline, for which it does not increase as the tank volume increases.

	CALTANISSETTA	PESARO	SASSARI
Tanks Volume (m^3)	3.800	4.250	9.800
Specific Volume (m^3/ha imp.)	30	35	33
Cost	3,1 m€	3,4 m€	6,5 m€
Saving in comparison with Lombardia Law (50 m^3/ha imp.)	-1,6 m€	-1,2 m€	-2,6 m€
Benefit	4.500 AE	12.300 AE	16.700 AE

Once analysed the above-mentioned issues at basin scale, the effected survey supplies the guidelines to extend analysis to a wider area, the river district, as well as to a longer term. On the basis of water condition in the pilot basins, as well as their socio-economic and ecological characteristics, advices for water management at a global level was put forward.

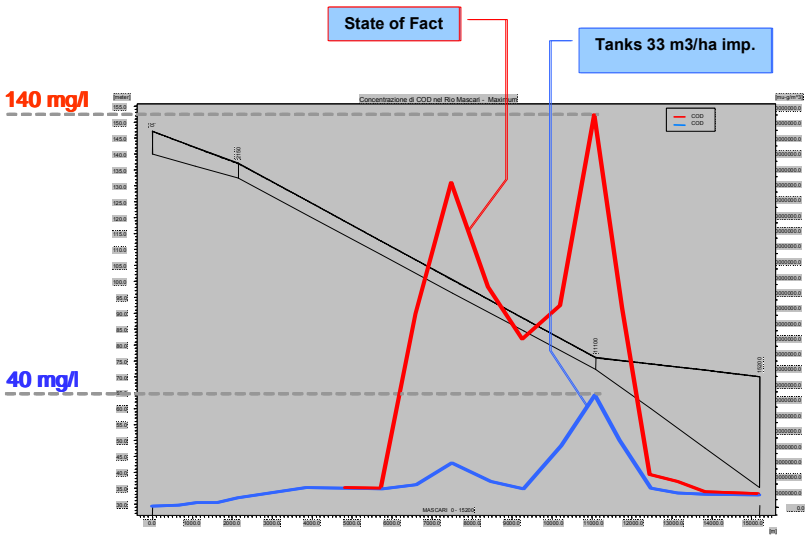
ENVIRONMENTAL BENEFITS

Lacking catching works, volumes exceeding waste water treatment plant capacity overflow the sewer system and discharge directly into the receiving water body, remarkably worsening its quality. When storm water events occur, indeed, flows produced by run-off following the washing away of urban impervious areas enter the sewer network where get mixed with waste waters. The increase of following spreading velocity brings about removal and fast conveyance of part of sediments lying on inner surfaces of mains. This situation causes the so-called "*first flush*" phenomenon, that is the discharge of overflow, which, at least in the beginning, has higher polluting concentrations and so potentially dangerous for the ecosystem balance and surrounding environment fruition (watering, bathing, recreational activities, etc.).

Examples of pollution produced by sewer flood overflows in surface water

Tanks have the function to catch early storm waters containing large amounts of concentrated polluting substances, and then gradually release them, at the end of storm water event, into the sewer system and finally convey them to the waste water treatment plant, so bringing in a remarkable environmental benefit in terms of polluting reduction discharged into receiving water bodies.

IMPROVEMENT OF THE RECEIVING WATER BODIES



CONSIDERATIONS AND CONCLUSIONS

The basic hypothesis of the project is to use advanced tools, such as mathematic modelling, GIS, systems for data acquisition (SCADA), etc., in order to develop a methodology permitting water resources management at basin scale, so the various elements interacting in integrated water management (water supply system, sewer system, waste water treatment, receiving bodies) can take advantage from the added value resulting from the integration of the various components of water cycle. The project foresees applying of tools which are the state-of-the-art in mathematic modelling and permit to simulate the processes at basin scale in one package software environment, thanks to the "Integrated Catchment Simulator" (ICS) software.

The project foresees the joint use of modelling and systems monitoring flow and water quality (SCADA system) both in network systems and receiving water bodies. The numerical models, calibrated with field data, are able to simulate systems operation in various operating situations, and so anticipate risk situations. Indeed the project is going to use forecast modelling together with SCADA system to find out events such as overflows in receiving bodies, city floods, bad water quality discharges, etc., to anticipate their impacts and so implement the most proper steps to prevent social and/or environmental damages.

The three pilot surveys of the project get together the various stakeholders involved in environmental management and protection, that is actors/users of water service and control authorities, as their harmonize is very important to define in agreement the interventions needed to implement Catchment Plans in compliance with the EU Water Framework Directive. Besides, the project aims at favouring the joint action by all the stakeholders, pointing out the advantages of an "integrated" planning in comparison with a separate management for every jurisdiction area, and so starting Basin planning.

The project outcomes are the following:

- Definition of a conceptual concerted scheme for water management at basin scale involving stakeholders and Local Authorities, in compliance with the Directive 2000/60/EC (WFD Water Framework Directive).
- Assessment of urban pollution loads in the three pilot rivers and definition of measures to reduce impacts produced by human activities on surface water bodies.
- Adjustment and validation of integrated modelling in the three pilot basins.
- dissemination and implementation of the tools defined in Wamaribas project in different river basins both in Italy and abroad.
- Organisation of monitoring systems of rainfalls, flows an water quality both in Pesaro, Caltanissetta and Sassari urban sewer systems, and along the rivers of their respective basins.
- Definition of guidelines to optimise surface water management on river district scale, taking into account specific socio-economic and environmental situations.

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IMPLEMENTATION OF THE PROJECT IN DIFFERENT SCENARIOS

The possibility of the technical implementation of the project in similar ambits in Italy and Mediterranean area is remarkable. The choice of pilot basins indeed involves three representative areas in Central and Southern Italy. Surface water in Italy, and generally in Southern Europe, are very polluted and suffer from the problems due to unrestrained discharges of urban and industrial waste waters, intensive agriculture polluted products, besides drought events, which, in the last decade, became worse due to climate changes. Coastal waters, interacting and being the final receiver of discharges produced by cities and rivers, are so much polluted as to damage sea ecosystems and tourism itself. This worrying situation is worsened by inordinate water use. The implementation of the project in different scenarios is assured also by the fact that standard software packages are used, as well as monitoring techniques which have been well-established and implemented for several years in many European countries, but are not fully implemented in Italy because water managers are not very willing to use advanced technologic tools.

Potential users of this project are all those Authorities which, as they manage sewer systems, treatment plants and river basins, can make use of results of mathematic modelling and monitoring systems at an operating/decision-making/planning level to determine works aiming at upgrading surface water bodies quality.

PARTNERS

SPS Srl – (Beneficiary)
Società Progettazione e Servizi, is a consulting company specialised in the field of hydraulic and environmental engineering and applied research.
www.spswamaribas.com

ARPAM Marche
www.arpa.marche.it

Aspes Spa
Is the owner of the water and gas distribution network and production plants of Comune di Pesaro.
www.aspes.it

Comune di Caltanissetta
www.comune.caltanissetta.it

Provincia di Caltanissetta
www.provincia.cl.it

DHI - Water & Environment
DHI is an international independent consulting and research organisation specialised in environmental engineering with head office in Denmark.
www.dhi.dk

SIINOS Spa
Water Utility of Comune di Sassari
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LIFE02 ENV/IT/000049

LAYMAN'S REPORT
Regarding the activities from 01/12/02 to 20/11/05

Emission Date: 20/02/06