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WATER RESOURCES PLANNING: THE ACTIVITY IN THE PO RIVER BASIN AND THE WFD

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SUMMARY – Following a brief excursus of the innovative elements introduced by the WFD and the more recent Italian legislation regarding the rational management and protection of water resources, the presentation describes the activities carried out by ART to support catchment management planning, with reference to characterisation of the catchment area and analysis of the impact of human activities on water conditions (Hydrological accounting, for determination of the water accounting – Article 22 of Legislative Decree 152/99; the Eutrophication Plan for the definition of quality objectives - Article 44 of the same decree) and regarding some particularly innovative aspects that in some way anticipate national transposition of the WFD: the economic analysis and the public participation.

Keywords: eutrophication, hydrological accounting, economic analysis, public participation

1. INTRODUCTION

Over the years the consideration of water, understood as a “good”, has evolved with repercussions on legislation, with attention moving progressively away from the risks linked to the hydrogeological protection of the territory towards the problems of preservation and protection of the resource from phenomena of pollution, to reach, in the last few decades, the consideration of water as a “scarce” economic resource, which cannot be used without respecting the principles of intra-and infra-generational solidarity and sustainability, considering the growing role of this resource at social and production level.

At European level, the Directive 2000/60 (WFD) constitutes an important achievement in the evolution of the EC water policy.

The innovative elements it introduces mainly concern:

- management at catchment area/hydrographic district level;
- the integrated quality and quantity approach to achieving the quality objectives of the water bodies;
- the integration of a wide range of measures, including economic and financial issues (price policies), which play an important part;
- a decision making process to select the (infrastructural and management) measures in which economic indicators have as much an effect as the participation of civil society and the stakeholders, and monitoring and forecasting elements.

While not having been fully taken on board in Italian legislation, many of the aspects that characterise the WFD appear to be anticipated by the most recent reference laws concerning the rational management of water resources and water protection.

In chronological order:

- Law no. 183/89 concerning soil protection, which establishes the foundations for a new approach to territorial management, identifying in the catch basin the reference ecosystem for an effective governmental activity for soil and water protection;
- Law no. 36/94 concerning integrated water services, which while specifically dealing with drinking water services (integrated water service), therefore a relatively small portion of the used resource, introduces some new elements into the applicable legislation, including the public nature of water, the requirement to ensure the reproductivity of the resource, the

principle of the integral coverage of the costs of the services through the rates;

- Legal decree no. 152/99 concerning the protection of water from pollution, which defines a framework for integrated action for the protection of the water ecosystems.

The overall legal framework provided by national and European regulations offers an important challenge for the planning and management of water resources, the outlines of which have been progressively clarified, the first steps taken and the first results achieved.

To this regard, some basic results achieved in the framework of the activities carried out by our company on behalf of the Po River Basin Authority, the largest Italian catch basin, may be considered indicative.

Mainly, the studies carried out to define the quality objectives foreseen under the Legal Decree no. 152/99 and defined as part of the Eutrophication Control Plan and those aimed at determining the basin water balance, as defined in article 3 of the law no. 36/94.

2. OUTLINE OF THE EUTROPHICATION CONTROL PLAN (PSE)

The Eutrophication Control Plan falls within the new water resource planning and management activities outlined in the Legislative Decree no. 152/99, which in article 44 appoints the Basin Authority to define the objectives and intervention priorities at basin level.

With regard to the overall panorama of the problems linked to the protection of water bodies, the plan deals only with the phenomenon of eutrophication of internal waters, in particular the large Alpine lakes and the coastal waters of the Adriatic Sea, to respond in a suitably timely manner to one of the priority problems.

The anthropic modifications of the trophic state of water bodies are on one hand linked to the different factors of nutrient generation (point and scattered sources), and on the other to their means of transport through the natural and artificial drainage network.

Having identified phosphorus as the limiting factor in eutrophication control, the plan has been developed along two priority lines:

- the characterisation of the phenomenon in terms of generation methods and nutrient transport, in order to identify the areas of high load, therefore considered a priority for the reduction interventions;
- the definition of the reference trophic state, expressed in terms of Maximum Admissible Concentration of phosphorus set in strategic points.

The nutrient load evaluation in the basin has been one of the most time consuming activities.

The nutrient load characterisation methodology began with the evaluation of the potential load, in order to then define the effective load and carrying load.

The calculated effective loads were differentiated by unit value, type of pollutant and type of receptor.

The areas with the highest specific load were identified as priority areas for the plan intervention.

The intervention programme was defined according to the assumption of the Maximum Admissible Loads in the Po River (in four representative sections) and in the large Alpine lakes.

Table 1. Characteristics of the strategic sections along the Po River trunk and Maximum Admissible Concentrations

Section	Subtended area /Area (km^2)	Population (*) (inhabitants)	Maximum Admissible Concentration (mg P/l)	
			2008	2016
Isola S. Antonio	24,053	3,946,000	0.12	0.10
Piacenza	41,529	10,100,000	0.14	0.12
Boretto	55,980	12,457,000	0.14	0.12
Pontelagoscuro	71,239	15,245,000	≤ 0.12	≤ 0.10

* ISTAT data, 1991

The maximum admissible concentration of total phosphorus for the large Alpine lakes was defined using the comparison of the current concentration of phosphorus with the natural concentration.

Given the average deviation observed between the current and natural values, the plan objective was set to the natural phosphorus concentration, increased by 25%.

3. DETAILED STUDY OF THE SURFACE WATER BODY HYDROLOGICAL ACCOUNTING

This study was designed as a supporting information tool, to determine the water accounting in the basin, as defined in the Legal Decree no. 152/99.

The overall design has considered the particular gaps in knowledge that are typical of the whole sector in terms of natural availability and the use of water resources, both surface and (above all) underground, in the catch basin, and has therefore foreseen a certain amount of flexibility in the defined information tool, making it possible to be progressively adjusted as the framework of information is updated.

This was due to the awareness that the knowledge acquisition process requires the development of a monitoring system covering the various components involved, the results of which can only be made available in the medium-long term.

The study aimed to identify and characterise the criticalities present in the basin, criticalities understood as situations of insufficient satisfaction of the water demand or modifications of the hydrological regime of the water body that are not compatible with the environmental quality requirements of the water body itself.

These criticalities are scaled to each catch basin, linked therefore to the water shortage conditions detected in the basin due to usually complex and interacting causes that affect large portions of the subtended sub-catch basin and which on that scale must be dealt with both in terms of information analysis and type of intervention.

3.1. Methodology

The study involved the entire territory of the Po basin, divided into:

- mountain sub-basins,
- large Alpine lakes,
- flat stretches of primary waterways,
- the main trunk of the Po River.

Mountain sub-catch basins were defined as the portion of the basin where major streamflow formation takes place.

Hydrological characterisation of the mountain sub-catch basins was carried out by reconstructing the average long-term streamflows, on a daily basis, in the section of where the main waterway flows into the plain.

For each mountain basin closing section, the long-term average annual hydrograph of the streamflows over ten-year periods, under natural, realistic conditions was reconstructed by applying inflow-outflow models.

Each hydrograph was integrated with the estimate – for each decade – of the maximum and minimum flow rates for the observation period.

The calculation methodology used to reconstruct the streamflows along the main downstream river trunk referred to surface water only, in terms of the algebraic sum of the inflow into the closing section of the mountain basin, that diverted or returned as a result of the various water use activities along the tract under consideration as well as the inflow from tributaries.

The streamflow activity of the following bodies of water was reconstructed:

- the main trunk of the Po River, from Moncalieri (TO) to Pontelagoscuro (FE);
- the main tributaries in the flat areas: there are 32, 22 of which are direct tributaries of the main trunk.

The calculation programme provides the real flow rate for each decade and for each subsequent hectometre of the main river trunk and allows simulations to be carried out on each waterway depending on the diversions and returns.
Moving towards the valley, the outflow from the upstream basin is increased by the inputs from the tributaries indicated and the returns from hydroelectric withdrawals and is decreased by diversions.
The inputs from tributaries with catchment basins that, in terms of size, are relevant to the scale of the study are calculated by applying the inflow-outflow transformation model.

As regards use, we decided to place a high priority on irrigation due to the large quantity of water that is withdrawn for this purpose as compared to other uses. Based on the scale of the study and considering the difficulty in finding homogeneous information on a basin level with regard to both large and small diversions for irrigation purposes, the study was aimed exclusively at large diversions (having an average allowable flow rate greater than 1,000 1/s or an irrigable surface area greater than 500 ha, pursuant to Legislative Decree 275/93).

Water use for hydroelectric purposes was also considered; as compared to irrigation, this use has much less effect on the streamflow regime at the basin level, since, although a large quantity of the resource is withdrawn, it is also returned, thus having only a localised effect on streamflow trends.
Potable and industrial water use, on the other hand, was deemed to be irrelevant, as much smaller volumes are diverted than with other uses and are typically taken from groundwater.
For hydroelectric diversions, the maximum allowable flow rate and the flow returned – which is the same as the maximum allowable flow rate – were used.
In evaluating the overall effect of irrigation and hydroelectric use, the reciprocal complementarity with regard to seasons that often characterises these uses was also considered.

3.2. Results

The calculation methodology applied to the flat areas of the basin's main waterways reconstructs the streamflow trends for each 100 m tract of the secondary waterways and every 500 m of the Po.
The results show the streamflow trends in areas of constant streamflow variations, i.e. in points where water is drawn for irrigation use.

The following diagram is an example of the surface streamflow trends for the Mincio River. For each waterway analysed, the graph shows the water availability in terms of the volume of water that passes through the confluence area of the waterway in an average year (actual availability), the volumes that would pass if no water were utilised (natural availability) and the difference between natural and actual availability.

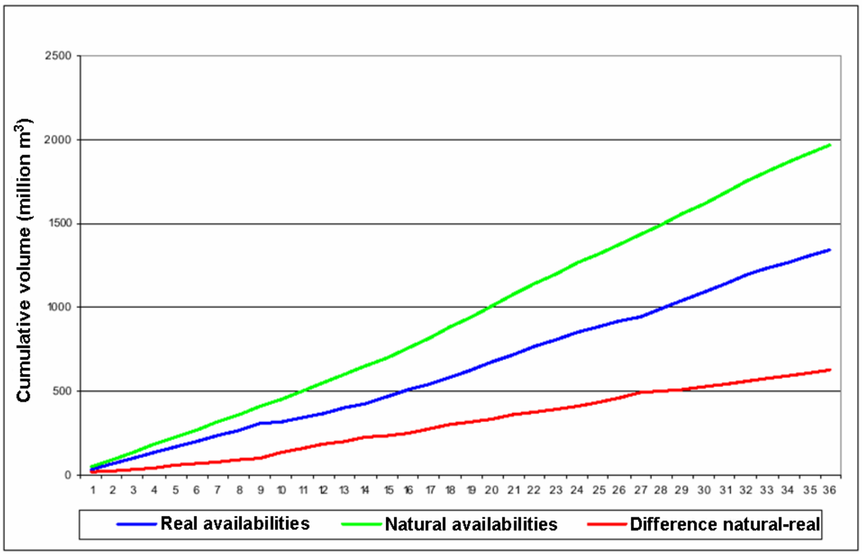

Figure 1. Mincio River – Water availability in the confluence area of the Po

An overview of the results indicates that there is a high variation in the level of exploitation of the surface water resources in the various waterways.

In view of the assumptions and methodological simplifications adopted, the results of the study can be considered sufficiently representative of actual water use and availability on a basin level.

For a correct interpretation of the data, certain factors must, in fact, be taken into consideration.

The fact that small irrigation diversions were not considered in reconstructing the uses may have resulted in an underestimation of actual withdrawals in the areas of the basin where parcelisation of the irrigation system is greater and where small diversions can, as a whole, have a significant effect on a waterway or portions of such waterway.

This consideration, for example, could partially explain the low percentage level of exploitation seen in many waterways in the Piedmont region, which is historically characterised by an irrigation structure that is highly subdivided and is in the process of being reorganised.

It is also likely that this methodological simplification had some impact on the results from the rivers in the Emilia Romagna region, some of which – such as the Parma River – are not subject to major diversions.

Another factor that influenced the evaluations was the phenomenon of surface water–groundwater interaction. This factor was not taken into consideration for the study, although we know it has a significant influence on certain systems, such as the large alluvial fans in the Apennines and areas of groundwater upwelling.

4. CONCLUSIONS

The research carried out, which is briefly explained above, is, as we have already mentioned, only the first step on the complex path to characterising water resources at a catchment basin level for use in catchment planning and management.

Based on the results obtained, further studies should be conducted in line with the approach suggested by the WFD. In our opinion, these should focus on:

- an in-depth analysis of surface water accounting, in order to fully characterise the quantitative status of the resource in the basin and the associated uses, with the implementation of adequate monitoring systems and the first steps of the plan;
- determination of the economic value of the uses of the basin's water resources, as this relates to the results regarding water accounting; in this regard, as the Po River Basin Authority has done, the first step of the guidelines defined by WATECO must be taken: characterisation of the basin/hydrographic district in terms of the economic impact of the uses and water services and the current cost-recovery situation with regard to water services.
- public information, consultation and participation actions geared to facilitate the management planning and implementation processes defined by the WFD.

The provision requiring that Member States encourage the active participation of all interested parties in implementing the directive, in terms of preparing, reassessing and updating management plans regarding hydrographic districts is of considerable importance on a European level.

In this regard, a tool should be developed to enable the involvement of the public and the partner network; this tool should be organised based on the principles of communication and shared administration and with the goal of increasing the interest of stakeholders both in the phase of formalisation of the plan as well as in implementing the measures defined therein.