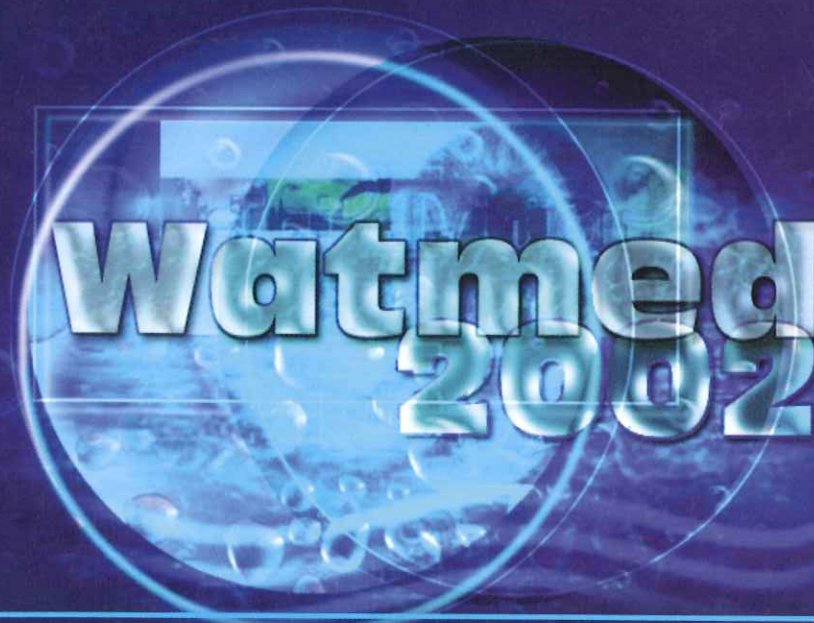


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Biological quality in the piave river basin

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Abstract

Biological monitoring of the quality of river basins has assumed noteworthy significance at both national and international levels in the past decades.

These investigation techniques based on the study of the benthonic macro-invertebrate community using the I.B.E. Method (Ghetti 1986,1997) permit highly significant results to be obtained in the definition of the level of ecological quality in bodies of water defined as the final measurement system for the combined effects of the various sources of pollution and the alteration of fluvial environments.

This study is the result of six years of investigation (1995-2000) conducted in the basin of the Piave River, which flows into the northern part of the Adriatic Sea.

The results demonstrate the overall quality of the water in the Piave Basin to be fairly good in the various areas examined: in the Belluno mountainous district, over 70% of the stations examined were found to be in excellent or good condition and only 20% appeared to be compromised; in the Treviso foothills district, the situation is slightly worse, given that approximately 65% of the stations examined were found to be in excellent or good condition. In the plains in the Province of Venezia however, the river was observed to almost always be in condition of evident pollution. Although not particularly critical, the pollution added to the sea by these waters is rather consistent, and must certainly be kept under control due to its various types of origin, which are primarily agricultural and urban and occasionally industrial.

The most compromised factor in these waters might well be the modification of trophic mechanisms and the related phenomena of eutrophication manifested especially on occasions of exceptional weather and climatic conditions (mucilaginous growths).

Key words : I.B.E. (Extended Biotic Index), benthonic macro-invertebrates, river environment, biological monitoring, Piave River

Introduction

The attention dedicated in recent years to the role of the river considered as a succession of different ecosystems, the environmental value of fluvial corridors, and the importance of safeguarding the aquatic biosphere for the protection of the quality of the water itself has required the use of biological indicators for an assessment of the efficacy of water reclamation plans, the level of environmental quality of entire hydrographic networks, the impact produced by concentrated or diffused discharges of pollutants, and the degree of conservation of river environments of particular ecological value.

Aquatic ecosystems provide immediate response to modifications of their environment. Such variations are caused primarily by the development of the economy, once purely based on woodlands and pastures and now on tourism-recreational income with marked industrial expansion; the increasing utilisation of water resources for hydroelectric and industrial purposes, and the canalisation and straightening of rivers also promote the gradual deterioration of both the quality and quantity of the water.

Biological monitoring of our water resources currently appears to be the most appropriate method for the assessment of the overall quality of a hydrological network, as also emphasised in Italian Law Decree No. 152/99.

Area descriptions

The Piave River, composed of a basin of 4200 Km² and a length of 220 km, is the most important river basin in the Veneto Region and entire Northern Italy. The Piave has its source among the peaks of the Peralba Group at a height of 2,037 meters above sea level, and flows into the Adriatic Sea, passing through the provinces of Belluno (126 km), Treviso (59 km) and Venezia (59 km) in its final section (Zanetti *et al.* 1993).

Matériels and Methods

Biological analyses were conducted using the I.B.E. method (Ghetti, 1997). This index is based on the analysis of the communities of macro-invertebrates that populate the different river sections. The index value, conventionally expressed as an integer within a limited scale, provides a reliable assessment based on the qualitative modification of the community sampled as compared to a reference community. It must be remembered that in order to facilitate reading, the samplings were taken in two different periods of the year, low and high, which usually correspond to the months of May and September.

The data acquired in this way were processed using a preordained model (Tab. 1) that ranks the stations by classes of environmental criticality according to an established scoring system, primarily for providing a more-detailed analysis of the areas most compromised, or in other words, the areas in which the biological quality was observed to have been either polluted or highly polluted (III - V quality classes) at least once.

Table 1. Criticality class divisions

SCORE %	CRITICALITY CLASSES	
1 - 20	A	Very low
21 - 40	B	Low
41 - 60	C	Medium
61 - 80	D	High
81 - 100	E	Very high

The number of occasions from 1995 until 1999 that a given sampling station had been found to be either highly polluted (Class III) or very highly polluted (Class V) was then counted, and the results were expressed in percentage form.

Discussion and conclusion

The results of the study on the quality of the water in the Piave River basin have been divided by the provinces involved starting from its mountain origin downstream through the provinces of Belluno, Treviso and Venezia.

The percentage results of the water quality classes determined using the I.B.E. Method in the samplings taken in the **province of Belluno** (Tab. 2) from 1995 to 2000 from a total of 75 sampling stations, 16 of which from the river and the remaining samples from its tributaries (Zanetti *et al.* 2000, Zanetti *et al.* 2001). The analyses of results demonstrate these river environments to be in good condition in terms of biological quality (I class) due to the fact that they represent an average of 30% of the cases examined, with maximum and minimum values of respectively 45.3% and 22.6% (Figure 1).

Table 2 – IBE percentage results for the Piave River basin in the Province of Belluno

PERIODS	I	I-II / II	II-III / III	III-IV / IV / V
HIGH '95	22.6	50.7	21.3	5.4
LOW '95	24.0	61.3	9.3	5.4
HIGH '96	36.0	41.3	14.7	8.0
LOW '96	34.6	42.7	16	6.7
HIGH '97	25.4	49.3	14.7	10.6
LOW '97	24.0	48.0	21.3	6.7
HIGH '98	29.3	46.7	20	4.0
LOW '98	37.3	45.4	13.3	4.0
HIGH '99	29.3	41.3	26.7	2.7
LOW '99	30.7	52.0	14.6	2.7
HIGH '00	29.3	46.7	16.0	8.0
LOW '00	45.3	34.7	13.3	6.7

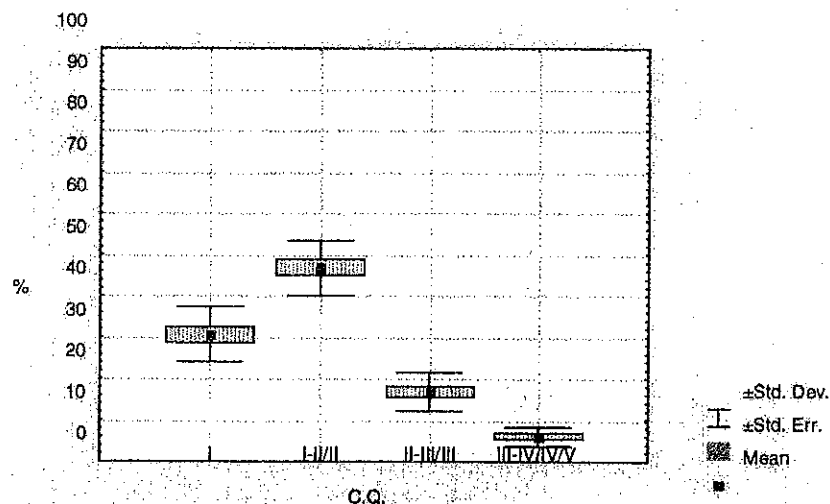


Figure 1. - Percentages of water quality class variation from '95 -'00 in 75 sampling stations

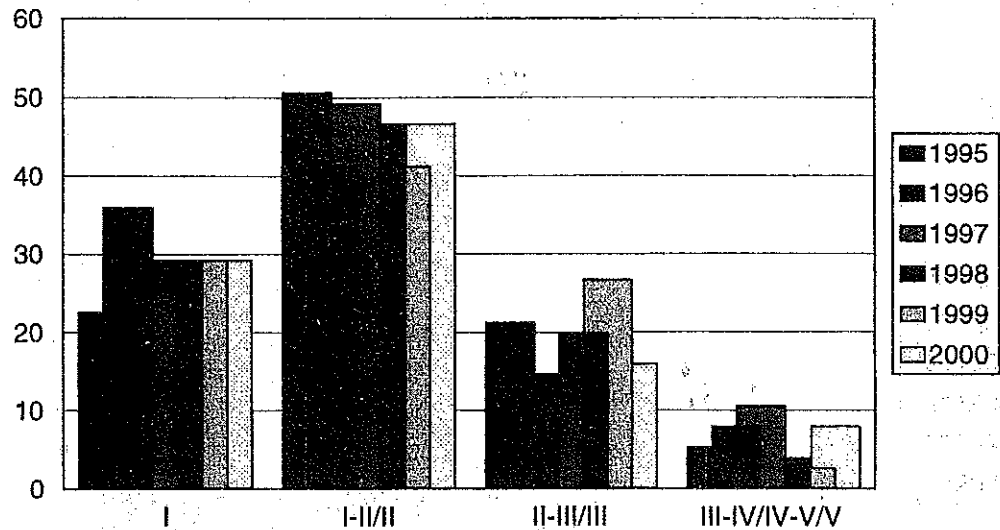


Figure 2. - IBE results for the Piave River basin in the Province of Belluno - High period.

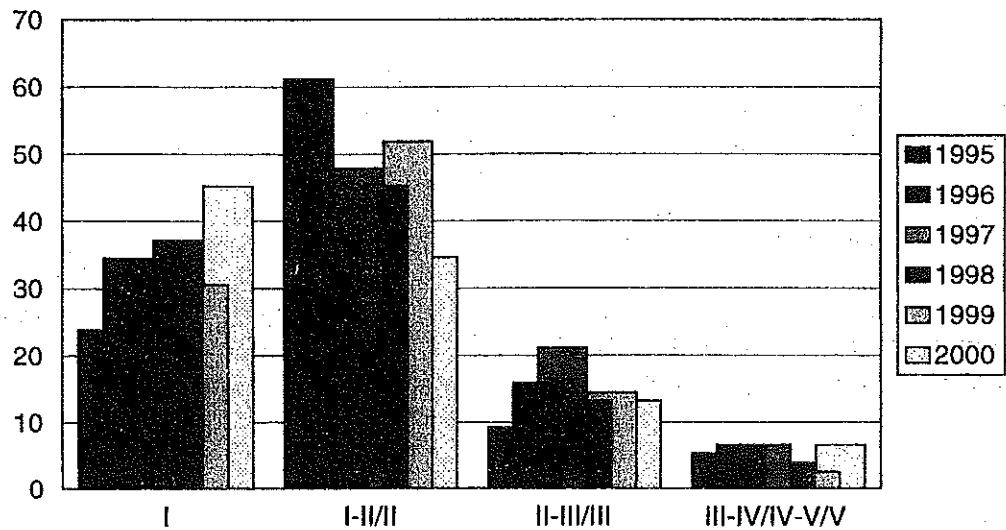


Figure 3. - IBE results for the Piave River basin in the Province of Belluno - Low period

An analysis of the temporal data on the basis of the river's high and low periods reveals that the trends change over the years, but while the high periods showed a decrease in the number of areas with slight pollution over the years, the low periods - with the exception of the final sample taken - showed an increase in the number of stations included in this class (Tab. 2).

The analysis regarding the river's high period (Fig. 2) demonstrates the degree to which Class I environments remained more or less constant, with a peak recorded in 1996, while during the low period (Fig. 3) the evolutionary trend appears to reflect the previous trend but with the maximum values recorded in 2000. During the high period, an increase in these environments occurred until 1997, with a decrease occurring between '98 and '99, characterised however by a pronounced worsening in the final sampling period. The trend during low periods appears similar over the years even if the values are lower.

An analysis of both sampling periods in 2000 reveals that the considerable improvement during the low period does not correspond to the data expected because with normal flow rates a slight worsening of the overall biological conditions usually occurs in this period.

The slightly polluted river environments represent an average of almost 46% of the total, with a minimum percentage recorded during the high periods in 1996 and 1999 (41.3%) and a maximum percentage recorded in the low period of 1995 (61.3%). Polluted sections of the river represent an average of 16% of the cases examined, with a maximum percentage of 26.7% during the 1999 high period and a minimum of 9.3% during the 1995 low period.

In the spring, following the period of decrease observed in 1996 with a period of stasis that lasted until '97, a clear increase in this type of environment was observed until 2000. During the low period, on the other hand, a progressive increase was observed until 1997 before a period of decrease was recorded during the final three years of study without however, ever reaching the values measured in '95.

The environments to be considered very polluted represent on the average almost 6% of the cases observed, with respective maximum and minimum values of 10.6% in the 1997 high period and 2.7 in the 1999 low period. (Table 3)

Table 3. Variations between high and low periods each year expressed in percentage

Variation %	I	I-II / II	II-III / III	III-IV / IV / V
1995	+1.4	+10.6	-12	0
1996	-1.4	+1.4	+1.3	-1.3
1997	-1.4	-1.3	+6.6	-3.9
1998	+8	-1.3	-6.7	0
1999	+1.4	+10.7	-12.1	0
2000	+16	-12	-2.7	-1.3

Only three sampling stations on the Piave River recorded a negative result; these were the stations in which a medium or high level of criticality (Tab. 4) was registered at least once during the six-year investigation period.

Table 4. Criticality classes for the Belluno Province section of the Piave.

CODE	STATION	CRITICALITY CLASS
2	River Piave - Lerpa	B
3	River Piave - Campolongo	C
4	River Piave - Santo Stefano	C
5	River Piave - Lozzo	E
6	River Piave - Sacco	A

Twelve sampling stations in the **province of Treviso** were analysed from 1997 - 2000 (Tab. 5), six of which on the Piave River (Zanetti *et al.* 1997, Zanetti *et al.* 1999, Zanetti *et al.* rel. tecnica 2001). The results of the samplings taken during the two seasons in March and September were combined because data were available for only two stations during the autumn.

Table 5. IBE results for the section of the Piave River basin in the Province of Treviso.

PERIOD	I	I-II / II	II-III / III	III-IV / IV / V
1997	13	78	13	-
1998	40	50	10	-
1999	40	50	10	-
2000	11	56	33	-

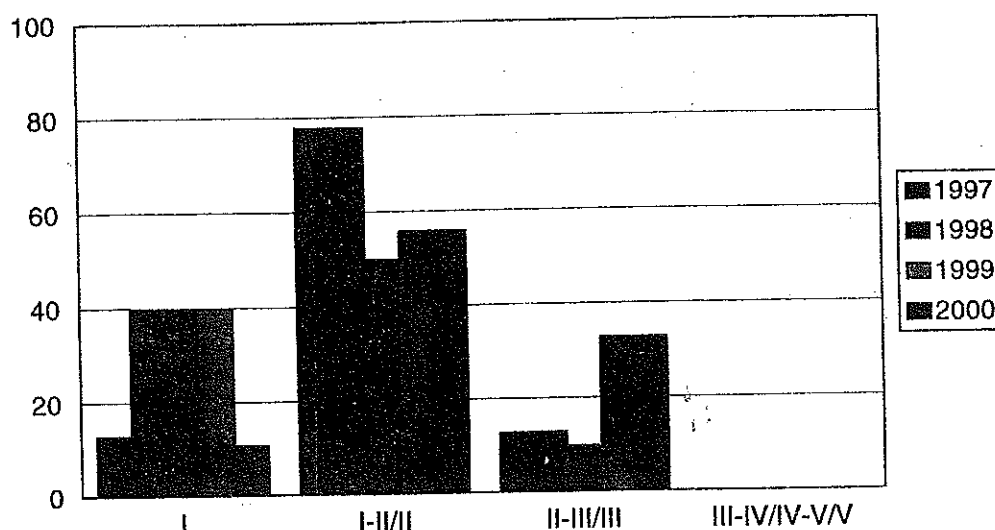


Fig 4. IBE results for the section of the Piave River basin in the Province of Treviso - low period.

An analysis of the results (Fig. 4) reveals that the sections of the river considered in good condition in terms of biological quality account for slightly more than 25% of the stations examined. Slightly polluted environments accounted on average for almost 60% of the total, while polluted conditions amounted to little more than 15%. Highly or very highly polluted conditions were not observed in the province of Treviso during sampling.

As with the Province of Belluno in this case as well the decision was made to translate the results obtained into classes of criticality in order to provide a more clear interpretation of the data available. Unfortunately however, the limited amount of data permitted processing only when data from at least three years of survey were available.

Statistical processing indicated the only area in critical condition to be Zenson di Piave, which lies at the border of the provinces of Treviso and Venezia and provided a *score* of 75% and therefore ranking at a very high level of criticality (D).

The fragmentary nature of the data available for the short section of the River flowing through the **Province of Venezia** did not permit the statistical processing performed for the other two provinces investigated. At any event, studies conducted in the past years (Turin *et al.* 1994) had already indicated compromised conditions and provided negative results (III class) corresponding to a polluted environment. That most probably describes the current situation, as well given the station located at the lower part of the Treviso territory presented an equivalent condition.

In conclusion the quality of the water in the Piave River basin is fairly good: as regards the Province of Belluno over 70% of the sampling stations examined were observed to be in excellent or good condition, with 30% in Class I and 48% in Class II, and only 22% in compromised condition. The situation in the Province of Treviso is only slightly less positive with approximately 65% of the stations examined in excellent or good condition (14% in Class I and 51.2% in Class II). In the Province of Venezia however, the river is in conditions of evident pollution almost everywhere (Class III).

These results confirm the extent to which pollution in the river usually increases downstream, even when the rate industrialisation is equal in all the areas through which it flows as in case in question, and that the pollution caused by agriculture and urban wastes predominates and is much less easy to control. These two types of pollution, composed as they are primarily by organic or eutrophication loads, become all the more dangerous under special weather-climatic conditions and contribute to the threat to the use of the beaches raised by both hygiene/sanitary (bathing) and environmental (mucilaginous growths) reasons, especially in a closed sea such as the Adriatic.

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