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Study of water turbidity in the Port of Pollença (Balearic Islands)

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The Bay of Pollença is in the north of Majorca, between the capes of Formentor and Pinar. The Port of Pollença is located to the north-west of the bay. It is 610 m long and 2700 m wide, with a maximum depth of 7 m.

The Port has in the last years suffered a problem of turbidity during the summer months. This was particularly serious and longlasting in 1987, and prompted an investigation into its causes which was initiated at the end of that year.

The present contribution shows the results from one year's (1988) monitoring of the following parameters: temperature, total suspended matter, dissolved oxygen, nitrates, nitrites, phosphates, silicates, pigments and phytoplankton according to the most common methods (APHA, 1981; Strickland & Parsons, 1972). Water was sampled monthly, and weekly in the summer, at surface from six stations: five near the shore and one in the centre of the Port.

Minimum (Min.), maximum (Max.) and average (Med.) values for the three stations along the shore, with a maximum depth of 2 m (A), and for the other three stations, with a maximum depth between 2 and 7 m (B) are presented in table 1.

TABLE 1. Results of water analysis

	A			B		
	Min.	Max.	Med.	Min.	Max.	Med.
Susp. Matter (mg/l)	5.20	29.70	12.60	5.20	31.51	9.80
Temperature (°C)	12.50	28.30	21.80	12.30	27.30	21.25
Oxygen (mg/l)	3.86	8.85	5.96	3.75	8.72	5.81
Phosphates (µg at P/l)	0.10	3.04	0.45	0.14	2.91	0.43
Nitrates (µg at N/l)	0.09	8.36	1.86	0.06	4.85	1.59
Nitrites (µg at N/l)	0.03	1.74	0.29	0.03	0.60	0.22
Silicates (µg at Si/l)	0.80	14.70	2.56	0.70	5.00	1.59
Chlo. a (mg/m ³)	0.03	3.81	0.79	0.00	1.54	0.28

On one occasion, at the end of summer, sediments were sampled with a dredge sampler from 13 stations and analyzed for: Loss-on-ignition (LI), organic carbon (OC), total nitrogen (TN) and particle size: percentage of sand (Sa), silt (Si) and clay (Cl), according to the standardized methods (M.A.P.A., 1986).

Throughout the year, low dissolved oxygen content and very substantial nutrient and total suspended matter contents were the most significant features of the study area, and not very different from other western mediterranean areas (Rodriguez & Vives, 1984; Establier *et al.*, 1987).

Nutrient release into the water column from sediments is probably very important. Fine sediments with high organic matter levels are accumulated in the centre of the Port (Table 2: St. 1, 2, 3, 10, 11). Organic matter can have an autochthon origin or it may be allochthonous near the mouth of seasonal streams Table 2: St. 6, 13).

TABLE 2. Results of sediment analysis

Station	%LI	%OC	%TN	%Cl	%Si	%Sa
1	15.8	6.0	0.2	18.0	21.0	50.2
2	16.4	6.5	0.3	17.5	21.0	52.2
3	16.6	4.9	0.3	15.0	22.0	57.0
4	7.6	2.0	0.1	8.0	5.5	79.0
5	5.4	1.7	0.1	5.0	2.0	91.2
6	11.0	3.3	0.1	7.5	10.0	76.2
7	5.6	1.4	0.2	2.7	5.3	86.2
8	4.2	1.3	0.1	4.1	5.5	80.5
9	6.8	2.0	0.1	4.5	6.5	70.2
10	20.1	5.8	0.4	27.5	24.5	38.7
12	7.5	2.0	0.2	6.5	9.5	74.0
13	15.6	4.5	0.3	14.0	4.0	69.7

The nutrient content in the water column together with high summer temperatures and a low level of marine dynamics creates ideal conditions for a phytoplankton bloom. In August the most confined area of the Port (Table 1: A) showed maximum chlorophyll a values. Thus the phytoplankton density, normally between 2 and 6. 10³ cells/ml, reached values between 43 and 47.10³ cells/ml as a result of a massive development of nanoplankton and small dinoflagellates and diatoms.

The phytoplankton bloom is an important component of the total suspended matter and also of water turbidity in the summer. There is also an inorganic component, source of which is the sand derived from an artificial beach in the bay. The continuous input of allochthonous matter prevents a correct sedimentation and turbulence favours a resuspension of sediments which contribute to the turbidity of water.

In the Port of Pollença, an enclosed coastal area exploited for various touristic uses (artificial beach, leisure harbour,...), seawater undergoes an increasing process of eutrophication, which prevails in the summer months, and is reflected by a high level of turbidity.

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