OSPAR Convention for the Protection of the Marine Environment of the North East Atlantic

Comprehensive Procedure

(2th Application)

PORTUGAL

Tagus Estuary

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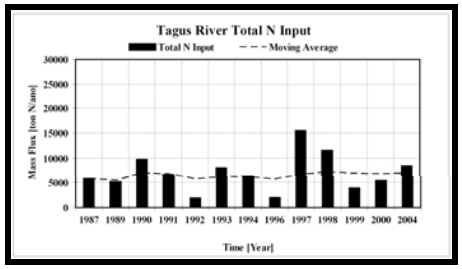
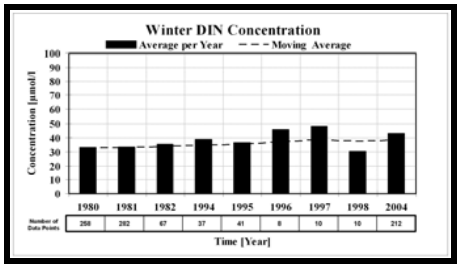
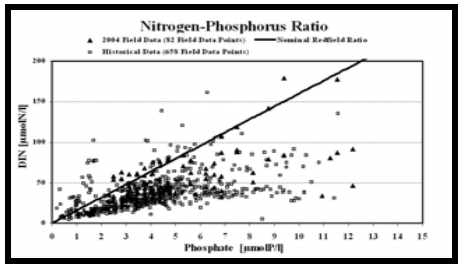
15 de Abril de 2005

TAGUS ESTUARY	Category I – Degree of Nutrient Enrichment					
	Actual Situation (2004[1])		**Criteria of Classification**		**Partial Classification**	**Notes**
1. Riverine Total N and/or Total P inputs and direct discharges (RID)	**Nitrogen** **14300** (ton N/year)	**Description:** Based on 2004 monthly data field registers in stations near the rivers discharge: **Tagus River** 8000 ton N/year **Sorraia River** 1300 ton N/year **Trancão River** 1500 ton N/year **Domestic Load** 3500 ton N/year			-	
2. Winter DIN and/or DIP Concentrations	**43 µmol N/l** (average) **60 µmol N/l** (Percentile90)	**Description:** Based on 2004 monthly data field registers in 24 stations located almost uniformly in all the estuary (212 data field points)	**Background Value[2]** **34** µmol N/l	**Elevated Value[3]** **51** µmol N/l	-	-  Look for complementary information in *Additional Information* table.
3. Increased winter N/P ratio	**10** (average) **16.3** (Percentile90)	**Description:** Based on historical registers (658 field data points)			-	.

[1] 2004 is considered as the actual situation because it is the most recent complete year, having monthly measures.
[2] Assumed as 1980, 1981 and 1982 average value (the oldest years with available data).
[3] Assumed as 50% above the background concentration.

TAGUS ESTUARY	Category II – Direct Effects						
	Actual Situation (2003) [4]		**Criteria of Classification**		**Partial Classification**		**Notes**
1. Maximum and Mean Chlorophyll-a Concentration	**6.1 µg/l** (average) **7.2 µg/l** (percentile 90)	**Description:** Summer of 2004 (170 data points)	**Background Value**[5]	**Elevated Value**[6]	-	-	Look for complementary information in *Additional Information* table.
			9 µg/l	**14** µg/l			
2. Region/Area Specific phytoplankton indicator species	Diatoms are the most important phytoplankton group with indicators species such as *Skeletonema costatum, Pseudonitzschia* spp. and *Chaetocerus subtilis*.[]				-		Not available information on phytoplankton indicator species shifts.
3. Macrophytes including macroalgae (region specific)	**Description:** The study of macrophyte algae in the estuary was carried out between 1985 and 1998. The main substrates colonized by algae in the Tagus estuary were old oyesterbeds located in the intertidal zones within the mixing and seawater salinity zones. The brown alga *Fucus vesiculosus* is the most abundant species while fast growing species such as *Ulva lactuta* reached maximum values two times lower than the *Fucus* maximum. A comparison of maximum algal biomass for fast growing species in the Tagus estuary with that obtained in typical euthrophic systems shows that the maximum biomass for *Ulva lactuta* in the Tagus estuary can be considered low.[2]				-		

[4] 2004 is considered as the actual situation because it is the most recent complete year, having monthly measures.

[5] [5] Assumed as 1980, 1981 and 1982 average value (the oldest years with available data).

[6] Assumed as 50% above the background concentration.

TAGUS ESTUARY	Category III and IV – Indirect Effects and Other possible effects					
	Actual Situation (2004) [7]		**Criteria of Classification**	**Partial Classification**		**Notes**
1. Degree of oxygen deficiency	**7.6 mgO_2/l** (average) **6 mgO_2/l** (percentile 10)	**Description:** 224 data points during 2004.	$\begin{cases} < 2\ mgO_2/l \rightarrow Acute\ toxicity \\ 2-6\ mgO_2/l \rightarrow Deficiency \end{cases}$	-	-	Look for complementary information in *Additional Information* table.
2. Changes/kills in Zoobenthos and fish mortality	Description: No changes/kills in Zoobenthos and fish mortality have been reported in the literature			-		
3. Organic Carbon/Organic Matter	Description: **Data Not Available**					
4. Other possible effects: Algal Toxins (DSP/PSP mussel infection events	Description: No nuisiance or toxic blooms have been reported in the literature			-		

[7] 2004 is considered as the actual situation because it is the most recent complete year, having monthly measures.

OVERALL CLASSIFICATION

Category I Degree of Nutrient Enrichment	**Category II** Direct Effects	**Category III and IV** Indirect Effects/Other possible effects	**Initial Classification**	**Appraisal of all relevant information**	**Final Classification**
-	-	-	**Non Problem Area**	Modelling confirms that the Tagus is a non problem area, because it is a well-mixed estuary with a high dilution potential and production is light limited. Consult *Additional Information* and *Discussion* tables.	**Non Problem Area**

DISCUSSION

In the Tagus estuary the trophic level is limited by light penetration due to the turbidity in the water column, which is associated to the resuspension of the fine sediments deposited in the intertidal areas, by tidal currents and surface waves generated by the long fetch of local wind. As a consequence, a reduction of the nutrient loads discharged by the rivers or by the Urban Waste Water Treatment Plants (UWWTP) has no consequences for the trophic activity in the estuary.[3]

In conclusion, the Tagus estuary is a well-mixed estuary with a high dilution potential and a moderate freshwater inflow. Nutrient inputs to the estuary are considered low with a tendency to be even lower in the future.[2]

ADDITIONAL INFORMATION

DIN and Salinity Distribution

Figure 1 and 2 represent spatial distribution of the properties computed by MOHID Modelling System for the Tagus estuary. Figure 1 establishes the areas in which DIN concentrations are below the background value, between the background and the elevated level and the areas where the concentration is above the elevated. In Figure 2 is shown the salinity distribution in each area. The figures show clearly the existence of three different zones in the Tagus Estuary: seawater zone, mixing zone and tidal fresh zone. The actual situation is however characterized by a large range of values distributed in the estuary, with high values of DIN where the salinity values are lower near the river boundary and low values of DIN where the salinity values are higher near the ocean boundary. This interpretation leads to the conclusion that the nutrients distribution depends essentially from the rivers contribution.

Despite the average value considered to apply the assessment criteria, it is important to note that the model results evidence an important gradient of DIN concentrations in the estuary, characterize the actual situation with a large range of values, between 0 and 100 µmol N/L.

Figure 3 shows DIN vs. salinity curve based on the field data points measure between 1994 and 1998 (historical data) and field data points measure in 2004. The figure evidence a linear relation tendency between the two properties, which can be explained by the fact that the major DIN source (Tagus) is also the major fresh water source. The discrepancies from the major trend are associated to local DIN discharges (UWWTP and other rivers).

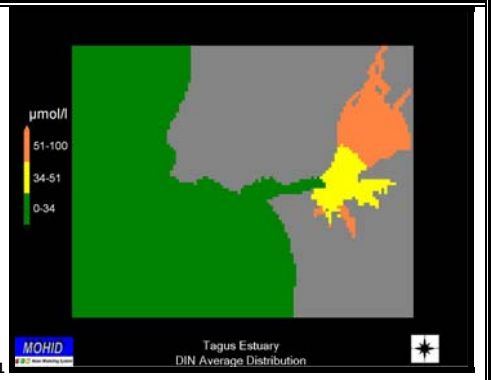


Figure 1

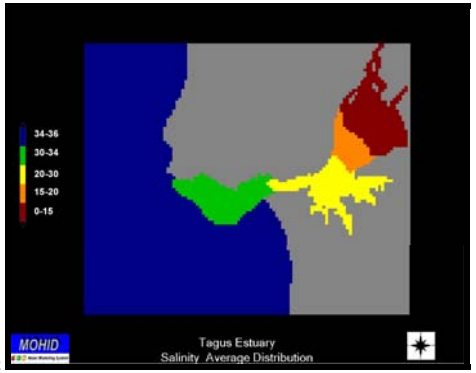


Figure 2

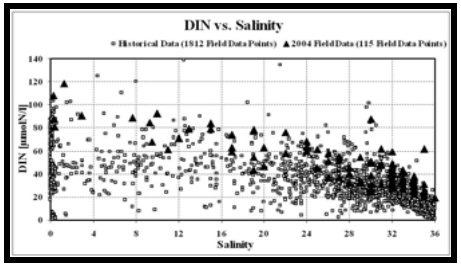


Figure 3

Chlorophyll_a Distribution

Figure 4 shows a time series of average Chlorophyll-a between 1980 and 1999 and also 2004. The figure shows a high interannual variability which can be explained by the number of samples. The background concentration is defined as the average of the oldest years (1980, 1981 and 1982), but it is important to notice the existence of a high variability between different years. This variability can also be related with climatologic factors affecting the river flows (Tagus river mostly) that will affect directly the nutrients offer in the estuary and indirectly the light limitation factor. Together with these effects, variability can be also due to variability of production together with tidal oscillating transport and their influence on sampling. Figure 5 represent the Chlorophyll-a distribution in the estuary, according to the MOHID results.

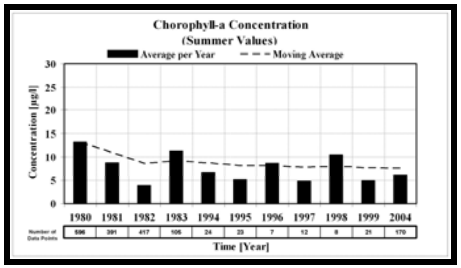


Figure 4

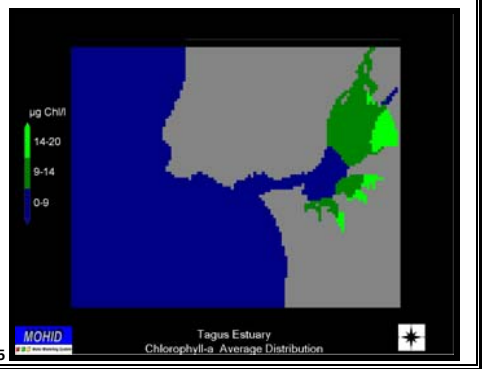


Figure 5

Oxygen Distribution

Figure 6 represents the average distribution of Oxygen in the Tagus estuary, showing concentrations above the limit for deficient conditions, 6 mg/L.

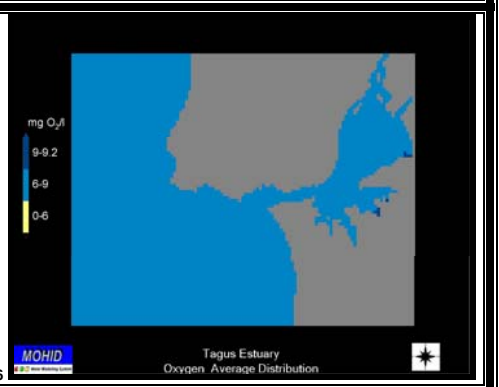


Figure 6

REFERENCES

[1]Cabeçadas, G., M. J. Brogueira, L. Cabeçadas, 2000 – Southern Portugal: The Tagus and Sado Estuaries, Seas at the Millennium: An Environmental Evaluation. Elsevier Science Ltd.

[2]Ferreira, J. G. ,T. Simas, K. Schifferegger, J. Lencart-Silva, 2002. Identification of Sensitive Areas and Vulnerable Zones in Four Portuguese Estuaries, INAG/IMAR.

[3]INAG/MARETEC, 2002. Water Quality in Portuguese Estuaries: Mondego, Tejo and Sado.