

# DIRECT TOXICITY ASSESSMENT AND MODELLING IN TRANCÃO RIVER BASIN MANAGEMENT

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## ABSTRACT

Direct Toxicity Assessment (DTA) of wastewaters is an added value in evaluating the vulnerability of ecosystems to complex discharges. However legislation in most countries is still based on chemical parameters for which thresholds have been defined. A major requirement for inclusion of DTA into environmental legislation is the selection of evaluation methods and the ability of assessing the fate of toxic discharges in the receiving waters. EcoRiver (LIFE02/ENV/P/000416) aims to demonstrate the technical advantages of DTA for environmental control and the benefits of including ecotoxicity into environmental legislation. This project uses bioassays with different test species in the assessment of ecotoxicity to ensure the detection of biological effects and includes a model for the fate of toxic compounds in Trancão River Basin, a heavily industrialised area, north of Lisbon, Portugal. After a screening phase of 50 industrial discharges and 2 WWTP, 15 industries from different sectors (Chemical, Food, Printing, Repair, Surface Treatment) and the WWTP were selected according to Daphnia and Microtox test results, the potential for biodegradation and site of discharge. A full characterisation has been performed using species from different trophic levels: *V. fischeri*, *D. magna*, *T. platyurus*, *P. subcapitata*, *L. minor*, both in the selected industries and in the river basin. Results will be presented relating chemical and toxicity values, selecting the more sensitive species and the more toxic discharges. A model was developed for the whole basin to simulate the flow, the sediment transport and toxicity. Simulations considering interaction between toxicity and suspended matter allow the evaluation of the importance of suspended matter for river water toxicity.

## INTRODUCTION

Environmental toxicity is the major problem of industrial wastewater. The establishment of chemical limits for the discharges is an approach that has been shown not to be adequate to ensure receiving waters protection. When there are issues with complex effluents for which many chemicals cannot be quantified and / or interactive effects are likely to be significant or the receiving water is impaired and the causes cannot be identified, the Direct Toxicity Assessment (DTA) approach can provide an added value. A DTA based approach uses bioassays with different test species in the assessment of ecotoxicity.

Modelling water flow and transport processes will be used to support sampling strategy and the study of the fate of toxicity. Different scenarios can be simulated for risk assessment supporting the development of management strategies for environment protection.

A demonstration programme that aims at an ecotoxicological evaluation of municipal and industrial wastewaters is running in the Trancão River Basin, Portugal, a site with severe pollution problems and heavily populated.

## METHODOLOGY

### SAMPLING:

A set of 15 industries, based on the Trancão River Basin, from different industrial sectors namely: Chemical (C), Food (F), Printing (P), Repair (R) and Surface treatment (ST) were selected after a screening phase. Composite or point samples were collected, depending on the sampling conditions. Samples were analysed within 48h kept frozen till analysis.

### CHEMISTRY

Biodegradability Evaluation: BOD<sub>5</sub> - manometric method, WTW-OxiTop® Measurement System  
COD - Reactor Digestion Method - HACH

Biodegradability (%) = (BOD<sub>5</sub>/COD) x 100

### BIOASSAYS

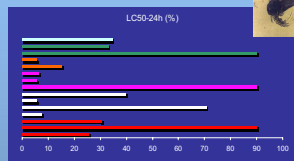
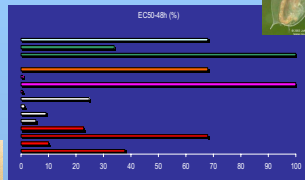
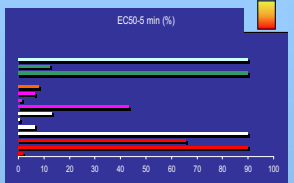
- ▶ Microtox test (Microbics, 1994) - Test organism: *Vibrio fischeri*, Exposure time: 5 min; End point: EC50 (%).
- ▶ Thamocephalus acute test, *THAMNOTOXKIT F TM* - Test organism: *Thamocephalus platyurus*, Exposure time: 24 h; End point: EC50 (%).
- ▶ Daphnia acute test (ISO 6341, 1996), Test organism: *Daphnia magna*, Exposure time: 48 h; End point: EC50 (%).
- ▶ Daphnia chronic (ISO 10706, 2000) - Test organism: *Daphnia magna*, Exposure time: 21 d; End point: NOEC (%).
- ▶ Duckweed growth inhibition test (ISO/CD 20079, 2001) - Test organism: *Lemna minor*, Exposure time: 7 d; End point: Determination of the growth inhibition at 90% sample concentration.

### MODELLING

MOHID is an integrated modelling system applied to Trancão basin, coupled with Tagus estuary, to simulate water flow accounting for the oscillatory character of the downstream of the basin. Results are organised into a GIS.

## RESULTS AND DISCUSSION

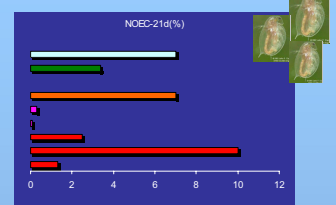
### BIOASSAYS



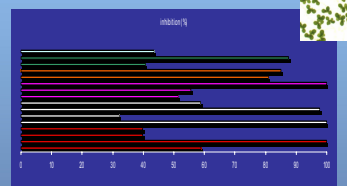
SECTOR LEGEND: CHEMICAL - FOOD - OTHER - PRINTING - REPAIR - SURFACE TREATMENT

Acute toxicity evaluated for the three organisms, *Vibrio fischeri*, *Thamocephalus platyurus* and *Daphnia magna* shows intra- and inter-industries differences. Crustacean bioassays values present strong correlation ( $p < 0.05$ ). *V. fischeri* and *T. platyurus* were the most sensitive species according to Slooff index (1983).

For *Lemna minor* the effects on growth inhibition at 90% sample concentration, show high effects in all tested industrial sectors.

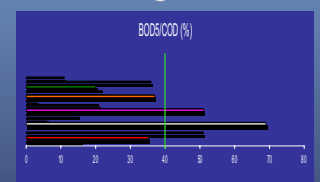


Chronic effects in *Daphnia magna* were evaluated in effluents with low biodegradability

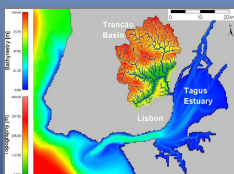


### CHEMISTRY

Biodegradability is low for most of the samples.

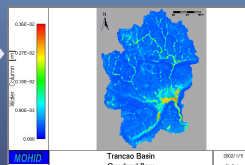


### MODELLING



Modeling Domain: Trancão basin coupled with Tagus estuary considering the influence of tide in water levels and velocity direction.

Simulation of water accumulated in Trancão Basin, after 5 days with constant precipitation of 1 mm/day, considering an impermeable basin.



## CONCLUSIONS

Waste waters and receiving waters were ecotoxicological and chemically characterised. DTA in waste waters seems to be a valuable strategy for river basin management. A GIS and a Hydrodynamical model for Trancão River Basin were developed. The hydrodynamical model was developed in an integrated way to simulate the water cycle covering different temporal and spatial scales and will be used to evaluate different scenarios of transport of sediments, salinity and toxicity for risk assessment.