DEGRADATION RATES OF SELECTED ORGANIC COMPOUNDS

RIVER BASIN MANAGEMENT ISSUE

Water Quality						Water Quantity		Alterations		Others
1	2	3	4	5	6	7	8	9	10	
C, M, T		C, M, T	C, M, T							

(1) Diffuse pollution by agriculture
(2) Salinisation
(3) Contaminated sediment and floodplain soils
(4) Large scale pollution due to past mining / industries activities
(5) Pollution by organic matter
(6) Emerging compounds
(7) Water scarcity
(8) Floods and low flow
(9) Hydromorphological alterations
(10) Soil erosion

C = System Characterisation
M = System Monitoring
T = System Trend
R = System Remediation, Mitigation

RIVER BASIN

Danube	Ebro	Meuse	Elbe	Brévilles	Others
✓ - Spec	✓ - Spec	✓ - Spec	✓ - Spec	✓ - Spec	

Spec. : Results specific to selected River Basin

KEY FINDING TYPE

Understanding Processes (lab-scale)	Characterisation (field scale)	Modelling
✓	✓	

BENEFITS TO END-USERS

Technical		Management	Policy	
WFD Implementation	Research	River Basin	Compliance	Policy making
✓	✓	✓		

INTRODUCTION

BGC 5 focuses on the degradation of pollutants under the existing and enhanced conditions present in the Basin cases. Biodegradation rates were determined in the laboratory (batch tests) and in the field (through stable isotopic analyses). Impact of temperature, redoxconditions and oxygen on biodegradation rate was quantified. BGC5 also dealt with bioavailability and toxicity tests of emerging compounds such as nonylphenol and other estrogens.

KEY ISSUES

Degradation batch experiments (mix of sediment and water) enabled to determine degradation rates for selected organic contaminants and samples from Ebro, Meuse, Elbe, Bréville and Danube. Therefore, degradation rates potentially address River basin management issues associated with organic pollutions (e.g. *Diffuse pollution by agriculture (pesticides), Contaminated sediments and floodplain soils, Large scale pollution due to past mining and industrial activities, and emerging compounds*). As knowledge produced in BGC5 applies to organic contaminants in general, the assessment of the results was undertaken with respect to the issue of *Organic compounds contamination in general*. Special notes were made for key parameters and recommendations associated with specific issue (e.g. related to floodplain soil issues for example).

Organic contamination

Measurements of degradation rates enable to address the issues associated with organic pollution by improving the characterisation of the system, by gaining some

insights about the evolution of degradation rate under global change, by understanding future trends of organic compounds degradation and by outlining potential recommendations on mitigation measures.

- ***System characterisation***:
    - Degradation rates determination enables to better characterise soil and water samples and contaminant behaviour and as a consequence to assess risk associated with organic contamination. Degradation rates results showed that all organic compounds studied could be degraded (under anaerobic, aerobic or anaerobic/aerobic conditions). It shows as well that degradation could be stimulated by providing extra sources of electron donor or acceptor to the bacteria (i.e. to the river basins). Site-specific and contaminant-specific degradation rates were measured for samples collected in the Ebro, the Elbe, Bréville, Danube and Meuse basin. Degradation rates results showed that they depend on environmental conditions (site-specific) and on contaminant type. As a consequence, degradation rates did not follow a specific trend. Key parameters which control biodegradation include presence of electron acceptors, and redox conditions.
    - Research results showed that ***bacteria degrading chlorinated solvents were also present in uncontaminated samples***: this finding is novel because the presence of bacteria in samples is usually associated with the presence of contaminants. The uncontaminated samples showed the presence of bacteria that degraded chlorinated compounds. These results could have significant implications on natural soil recovery potential.
- ***Trend:*** BGC5 studied the variation of degradation rates under different conditions. This enables to assess degradation rates variation with respect to some parameters of climate change or agricultural practice change.
    - Climate change: Impact of increase of temperature on degradation rates was determined for a range of temperature (15, 20, 30°C). Degradation rates increased with temperature. Increases in degradation rates were quantified but did not show a specific trend: they were site and contaminant specific. Impact of oxygen loads on degradation rate was determined in order to assess the impact of flood events (generally increasing the oxygen loads of the system) on organic compounds degradation. Degradation rates of non-chlorinated compounds increased with oxygen loads (only for aerobic degradation).
    - Agriculture practice change: BGC5 studied degradation rates of past and current pesticides which have been / are used at the Brévilles catchment in order to assess whether or not new agriculture practice (use of new pesticides) cause less impact on the system than previous agriculture practice. Atrazine (old pesticide) was degraded aerobically, but much less under anaerobic conditions. Acetochlor (new pesticide) seems to be degraded under anaerobic conditions with rates that are comparable to aerobic conditions.

Special knowledge on contaminated sediments and floodplain soils

During flood events, oxygen concentration in the system might increase and as a consequence aerobic degradation of organic contaminants increases. Flood events can increase biodegradation. Moreover, oxygen increase due to floods will not

necessarily kill anaerobic bacteria because they might be located in deep soil and are not as much affected by oxygen increase.

RECOMMENDATIONS

The following recommendations could be drawn from biodegradation rate research:

- In the Meuse case, degradation rates were measured through field measurements. This showed that degradation rates obtained through laboratory experiments were higher that the one obtained through field measurements. ***As a consequence a range of degradation rates must be used as an input to hydrogeological model***. (The degradation or "half-life" data are input for Compute, and it is important that these degradation data are used in a correct way).
- Using raw degradation rates from batch experiments may lead to overestimate biodegradation and therefore underestimate contamination levels. However, it is easier to measure degradation rates in the laboratory than in the field. These batch degradation rates must be used with care, as these data are generated in the lab under more ideal conditions than in the field.
- Knowledge of degradation rates enables to better understand contaminant behaviour and therefore to ***define adequate monitoring plan*** and ***evaluate potential for potential remediation measures such as natural attenuation***.

- Site specific degradation rates related to the Ebro, the Elbe, the Danube, the Meuse and Brévilles could be used by their respective River basin managers.