MEASUREMENTS OF MICROBIAL ACTIVITIES USING MOLECULAR TOOLS (FOR DEGRADATION OF SPECIFIC ORGANIC CONTAMINANTS)

RIVER BASIN MANAGEMENT ISSUE

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

(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. : 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 4 deals with analyses at a molecular level (DNA and RNA). It aims at detecting general or specific bacteria, depending on the process of interest, and the type of compounds they degrade. Different types of organisms are present at the site depending on the site conditions (especially redox conditions) and type of contamination. BGC4 develops methods to quantify the amount of bacteria present in groundwater, soil, and sediment samples and to quantify the activity of these bacteria, expressed as the amount of enzymes present. The enzyme quantity reflects (or corresponds to) the microbial activity of the bacteria. A large quantity of enzymes means that the bacteria are active and therefore that the degradation takes place. Especially when comparing the results of non-contaminated and contaminated areas within a site, conclusions about the role of the bacteria can be made. Using the amount of bacteria to assess biodegradation is used more and more over the past years. **Quantifying the bacterial activity for various degradation processes (by quantifying the responsible enzymes) to assess biodegradation for the selected contaminants is an innovative process developed by BGC4, e.g quantitative Polymerize Chain Reaction (PCR) or even multiplex quantitative PCR.**

KEY ISSUES

BGC4 focuses its research on measuring microbial activities to assess degradation of organic pollutants. Therefore, it addresses river basin management issues associated with *organic pollution* (i.e. *Diffuse pollution by agriculture (pesticides),*

large scale pollution due to industrial activities, contaminated sediments and flood plains).

Organic pollution

Results and data obtained in BGC4 are mainly related to the system characterisation and more specifically to the microbial characteristics of soils, sediments and surface water. The microbial activity measurement tools can also be used as a monitoring tool. Results of microbial tools can be used to assist system trend prediction and system mitigations.

- ***System characterisation***: Characterisation of microbial activities (characterisation of the system based on presence and activity of the bacteria) was undertaken on soils, sediments or water samples. The target bacteria selected for analysis depends on the type of contamination present in the media. Bacteria activity is therefore linked with the type of contaminants present and the site conditions (more specifically redox conditions of the samples). With molecular techniques, it was shown that bacterial activity was variable over the seasons (activity was higher in summer than in winter). The measurements showed that microbial activity was site-specific. Bacterial activity enabled to qualitatively assess environmental degradation capacity and assess how the system can cope with new pollution. Degradation mainly occurs via the water phase as the contaminant has to be dissolved. Bacteria are present in the water phase but can also be sorbed to soil and sediment particles. No real trend of elevated or low microbial activities was observed so far. Contaminated areas might have bacteria that are adapted to the degradation of a specific compound, but also non-contaminated sites show degrading capacities. Key parameters which influence microbiological activities include environmental conditions, such as temperature, redox conditions, water saturation and presence of other toxic compounds.
- ***System trend***: *It is possible to detect and identify specific bacteria and enzymes, thus making it possible to predict if an ecosystem can deal with contaminants, changing (redox) conditions etc. Global warming may increase biodegradation and show that the system can better adapt to the change if temperature and microbial activity increase. In general, most bacteria have an optimum temperature around 30-37^{o}C, but soil bacteria are used and adapted to lower temperatures. However, there are also a few bacteria known that have an optimal growth temperature > 90^{o}C.*
- ***Monitoring***: Measurements of bacterial activities can be used to assess whether a compound will be degraded. It can be used as an indicator for contaminant degradation. The presence of new contamination can increase the microbial activity of the system, if the present bacteria are able (or can adapt) to degrade the introduced contaminant. This tool enables to assess natural attenuation processes and to quantify whether or not a decrease in contaminant is due to biodegradation or other factors (dilution, sorption). This knowledge can be of use for river basin managers to select best monitoring and management plan (i.e. use natural attenuation as a management practice).
- ***Mitigations***: *Molecular tools to measure microbial activities can be used to assess natural attenuation or bio-treatment as they show the amount or activity of present bacteria, and this can be compared to reference values (either in time or in space).*

RECOMMENDATIONS

The research carried out in BGC4 enabled to draw the following recommendations:

- **None so far, as bacteria activity has not shown specific trends.**