BIOGEOCHEMICAL PROCESSES INVOLVED IN THE INORGANIC POLLUTANT TRANSFER IN THE ROOT ZONE, UNSATURATED ZONES AND SATURATED ZONE

RIVER BASIN MANAGEMENT ISSUE

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

(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

BGC3 studied the transfer functions (Kd) for selected metals (As, Pb, Zn, Cd and Hg). Measurements of Kd were performed on soil and sediment samples collected in the Ebro and the Meuse basin. Soil samples were collected from the vadose zone and the saturated zone. Statistical analysis of measured Kd enabled to define Kd functions for each selected contaminant and for the vadose zone and the saturated zone. First Kd functions were defined. For the root zone, a modelling approach enabled to estimate the sorption coefficient that will integrate the relevant processes affecting the fate of heavy metal in the root zone. The Kd functions will be further developed over the next 2 years of AquaTerra project. In addition, BGC3 studied biogeochemical processes associated with the release of metals from soil in the vadose zone, the root zone and the saturated zone. Impact of bacterial activities on the transfer of metals in the vadose and saturated zone is characterised from studies of bacterial biodiversity using molecular techniques. Impact of climate change (different oxygen concentrations, temperature, pH, bacterial activity), different land use (nitrate concentrations), increasing pollution (varying sulphate concentrations) and environmental parameters on the behaviour of the considered inorganic pollutants in the vadose zone and the saturated zone are assessed.

KEY ISSUES

Biogeochemical processes involved in inorganic pollutants transfer have been studied in soil samples from the Meuse. Therefore, research results help to

understand the transfer of inorganic contaminants from soil to water (and from water to soil). As a consequence, BGC3 addresses river basin management issues associated with the presence of metal contamination in soil and water and more specifically to *Large scale pollution due to past mining / industry activity*.

Large scale pollution due to past mining activity

Biological processes study enabled to gain knowledge in the understanding of metals release process from soil to water and to improve knowledge on how the system can be monitored.

- ***System characterisation:*** In general, oxidation of Arsenic (As) yields to retention of As on the soil surface, while reduction of As tends to increase its mobility and release from soil to water. Hence, characterisation of bacterial activities and its role in oxidation or reduction of As enables to improve the understanding of As release from soil to water. Bacterial activity and diversity were studied and correlated with Arsenic mobility in the vadose zone (for soil samples from the Ebro, the Dommel and the Flémale site). The presence of bacterial genes involved in As oxidation and of bacterial genes involved in As reduction were detected in all the samples. Both populations co-exist and their respective activities depend on environmental conditions such as physico-chemical parameters (oxygen, organic matter, etc.), temperature and water content (water filled pore space). The study showed that bacterial genes involved in oxido-reduction of As were detected in agricultural soils free of As and that these genes could be potentially reactivated.

  Key parameters associated with mobilisation are organic matter content, soil aeration and temperature. Increase of organic matter content favours the mobilisation of As through physico-chemical process (chelating of As and organic matter) and microbiological. Increase in aeration favours the immobilisation of As through chemical or biological oxidation. Temperature increase generally yields to an activation of microbial activities. In this case, the dominant type of biological activities (oxidising or reducing) depends on other environmental factors (such as oxygen or organic matter content).

- ***Mitigations / Remediation:*** Organic matter and soil aeration are important parameters with regards to As mobilisation. As a consequence, these two parameters need to be considered when soil management measures are proposed.

RECOMMENDATIONS

The following recommendation could be drawn from BGC3 research:

- ***Modelling:*** As biological activities play an active role in As and Hg mobilisation, it is recommended to take into account biological factors in inorganic contaminants transfer modelling.
- ***System characterisation:*** This study enabled to define and measures bio-indicators of As reduction and oxidation. These bio-indicators assess the potential of the soil for As release. Molecular biology measurements enable to assess whether bacterial populations are present, whether they are active and in which proportion. Use of these bio-indicators in contaminated land management is recommended.