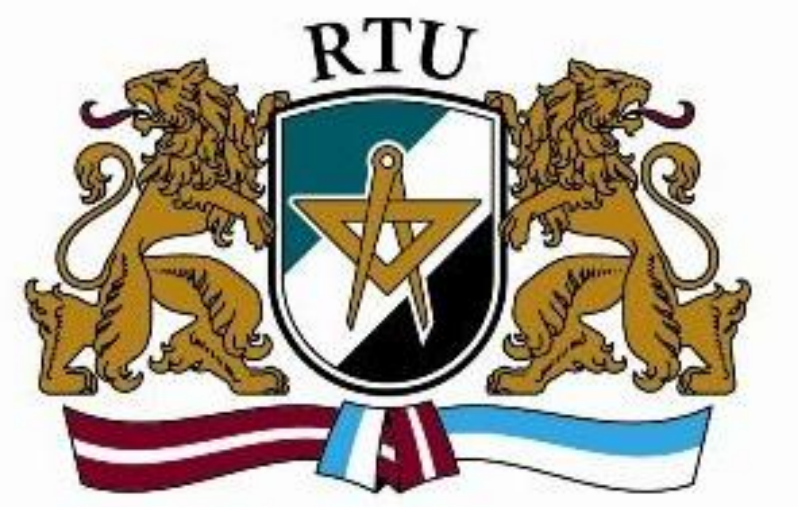


# Algal Microcystins Removal During Artificial Groundwater Recharge Under Aerobic And Anaerobic Conditions

Talis Juhna<sup>1</sup>, Aivars Spalvins<sup>1</sup>, Ingrida Purina<sup>3</sup>, Ieva Barda<sup>2</sup>, Maija Balode<sup>2,3</sup>



<sup>1</sup>Riga Technical University, Department of Water Engineering and Technology  
<sup>2</sup>University of Latvia, Faculty of Biology, Department of Hydrobiology  
<sup>3</sup>Latvian Institute of Aquatic Ecology, Department of Experimental Hydrobiology



## Objectives & Approach

Microcystins - cyclic heptapeptide hepatotoxins are produced by cyanobacteria most frequently belonging to the genera *Microcystis*, *Anabaena*, *Nostoc* and *Oscillatoria*. These algae are frequently found in eutrophic waters that are used for production of drinking water by artificial groundwater recharge. It is known that removal of MC-LR during transport through aquifer is a result of biodegradation [1], however there is concern that due to slow removal rate toxins will contaminate drinking water. The aim of this study - to determine removal efficacy of MC-LR during artificial groundwater recharge in aerobic and anaerobic conditions. For this the removal rate was studied in laboratory conditions and the obtained constants were used for the developing the mathematic modeling for removal MC-LR during artificial groundwater recharge in Riga, Latvia.

### Research site

The city of Riga (Latvia) with population of 750 000. About 30% of drinking water is supplied from groundwater which is produced by recharging infiltration basins from eutrophic lake M. Baltezers.

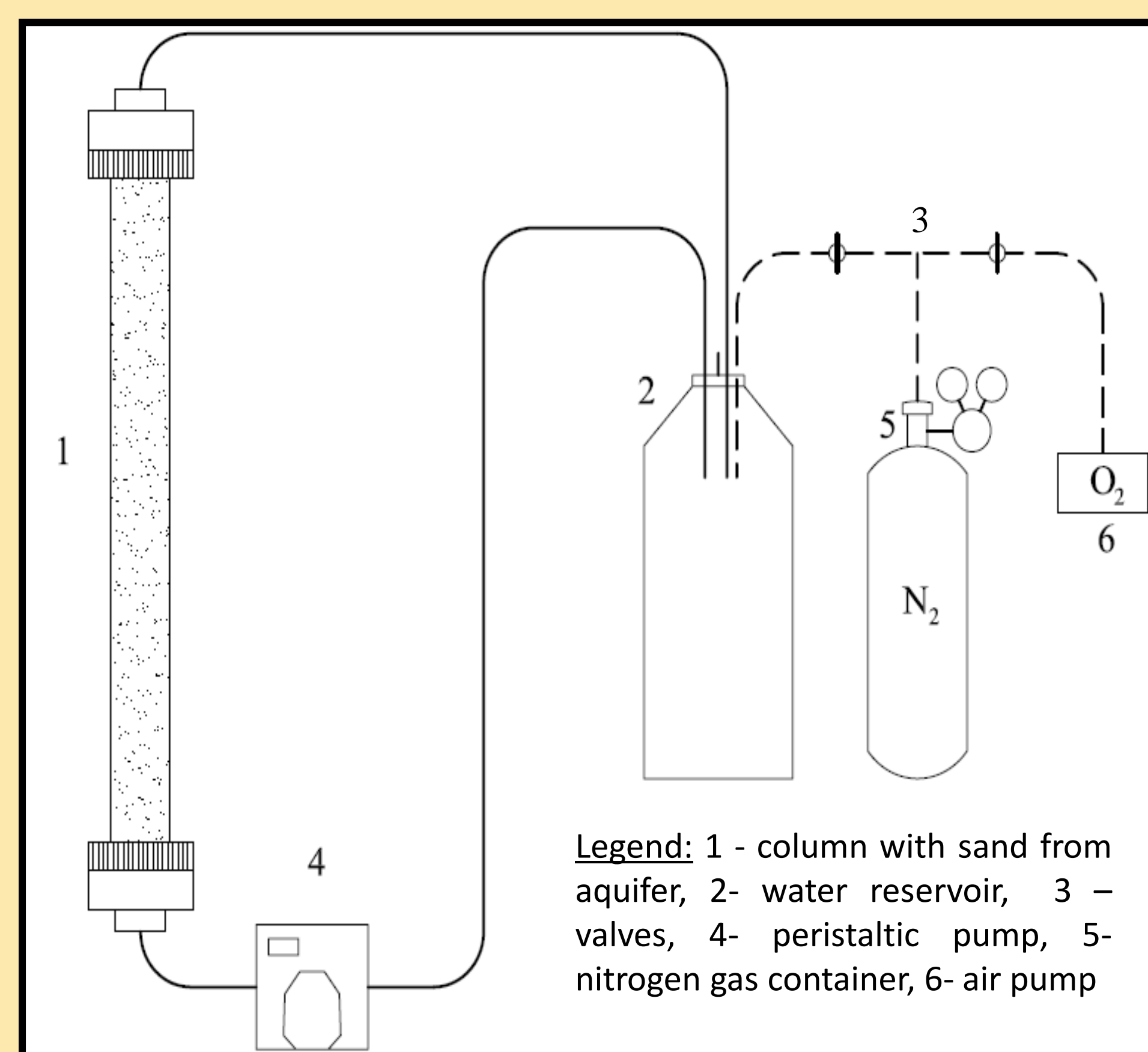
### Sample collection and extraction

Phytoplankton biomass for microcystins extraction was collected in summer 2005 during algal bloom maximum (from July to September) from lake M. Baltezers and other lakes nearby Riga. Concentrated algal samples for microcystin MC-LR analyses were taken by plankton net, freeze-dried and extracted with 75% methanol.



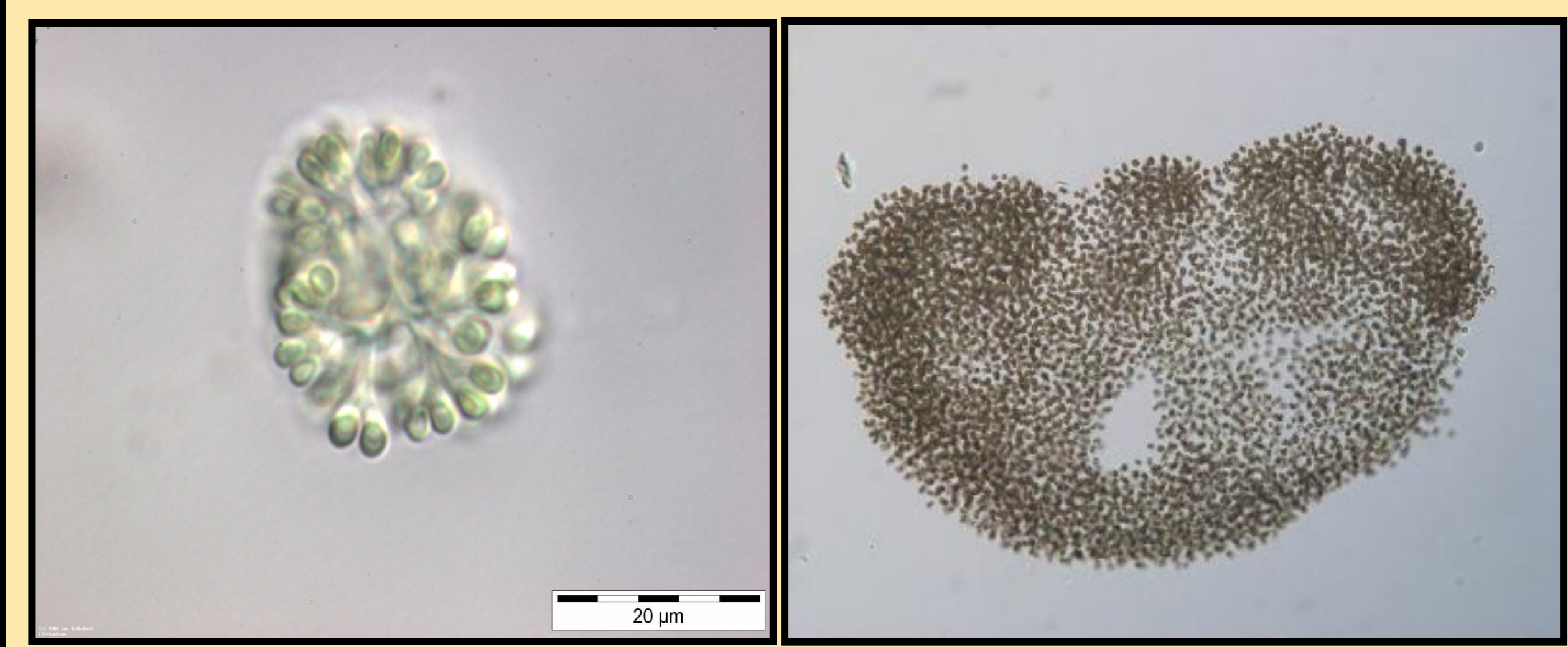
### Laboratory experiments

The removal of MC-LR was studied in lab scale (see below) by recycling of water in aerobic (9 mgO<sub>2</sub>/l) and anoxic/anaerobic (<0.8 mgO<sub>2</sub>/l) conditions (pH 8.1-8.3, temp = 15-16 °C) through the sand from M. Baltezers area. Removal rate was measured during one month.



### Modeling approach

The hydrodynamic models for the site developed by applying the MODPATH and MT3D systems. The rate constants derived in the laboratory were used for the development of the model.



### MC-LR analyses

All samples were analyzed at the Finnish Institute of Marine Research with chromatographic systems consisting of pump, columns (C18, 3.9 x 150 mm, 5 µm particles or polar embedded C18, 4.6 x 150 mm, 3 µm particles) and UV/VIS detector. The mobile phase consisted of 0.01 M (NH<sub>4</sub>)<sub>2</sub>HPO<sub>4</sub>, pH 2.0 (70%) and CH<sub>3</sub>CN (30%) and was used isocratically at either 1.0 or 1.1 ml min<sup>-1</sup> flow rate depending on the column.

## Results & Discussions

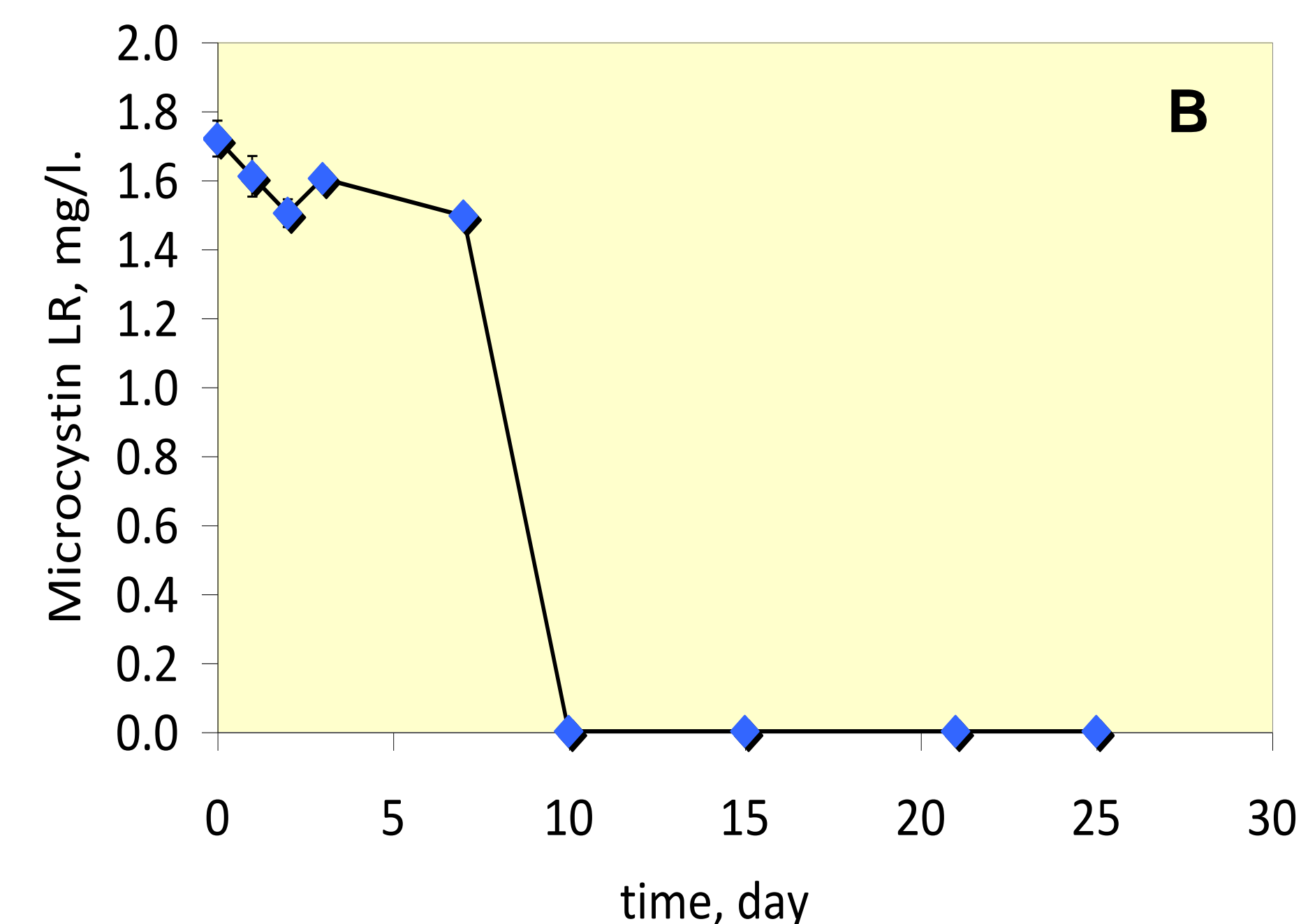
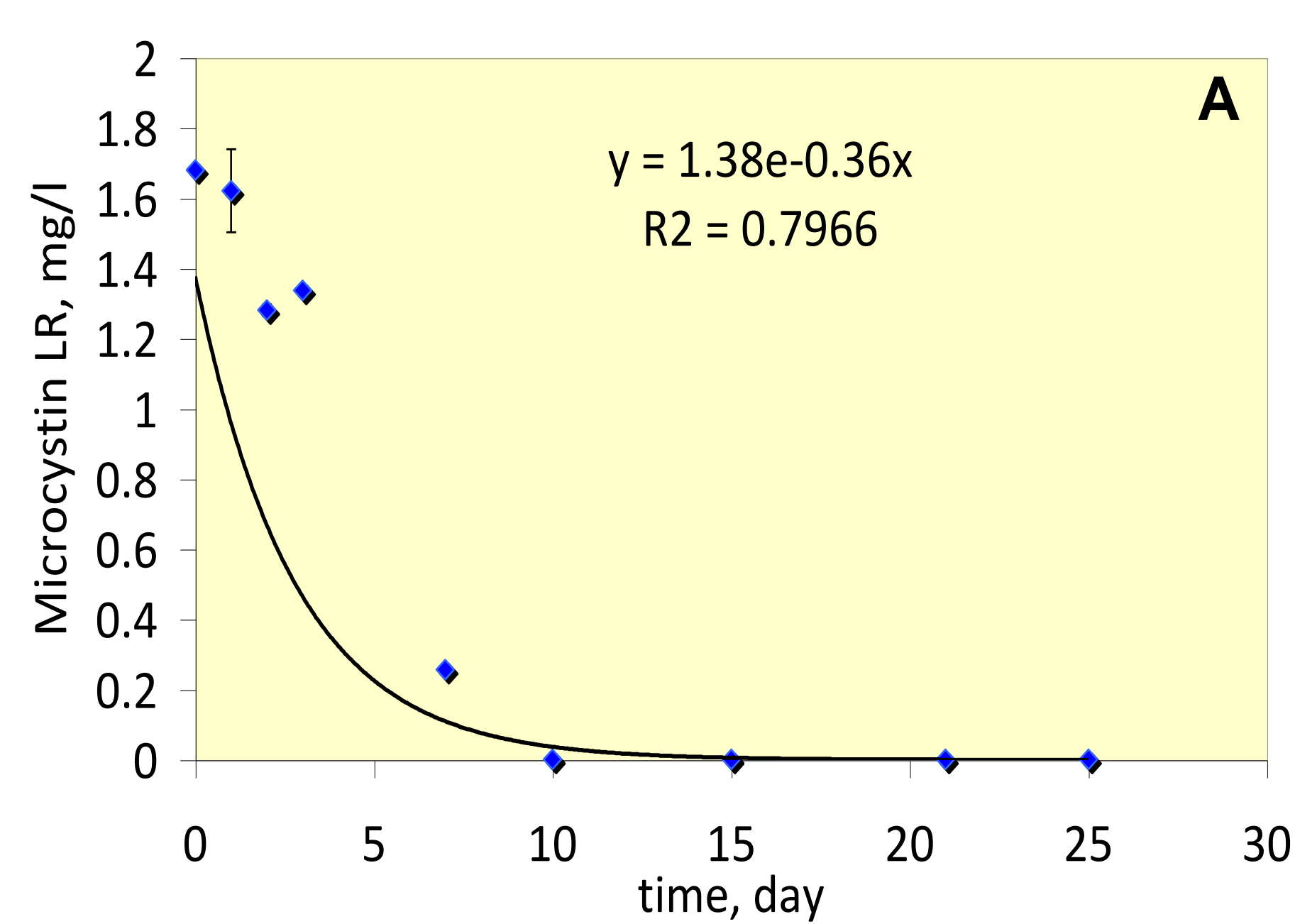


Figure 1. Removal of MC-LR in laboratory columns in aerobic conditions (A) and anaerobic (B) conditions.

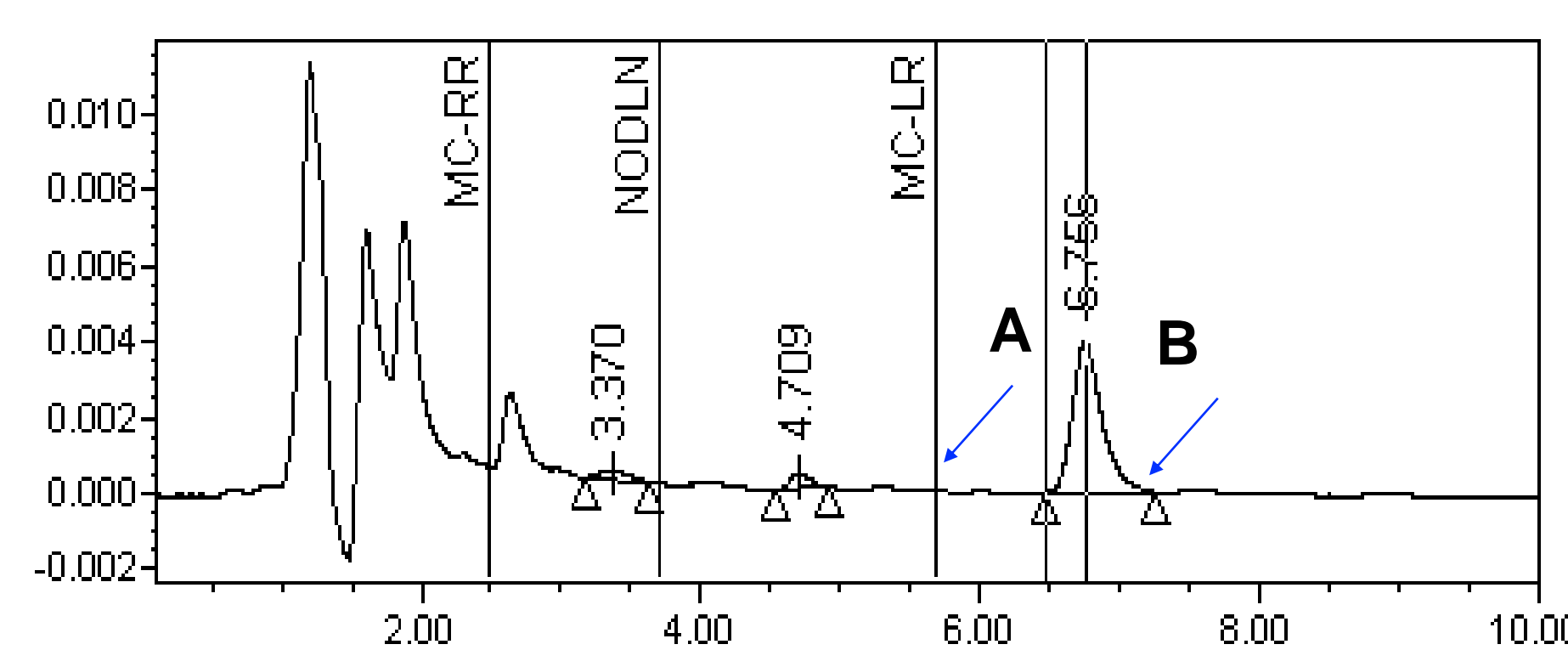


Figure 2. Chromatic patten of water at the outlet from the anaerobic column at day 15.

In laboratory scale microcystin MC-LR removal was fast and followed the first order rate kinetic (0.36 d<sup>-1</sup>) (Fig. 1 A). In anaerobic conditions rate was low during the first seven days, whereas after this adaptation period the removal rate was the highest (Fig. 1 B). However, unknown substances (Fig. 2 B) were produced in anaerobic column. The modeling in real situation showed that microcystin MC-LR will be very effectively biodegraded during 60 days below 1 µg/l.

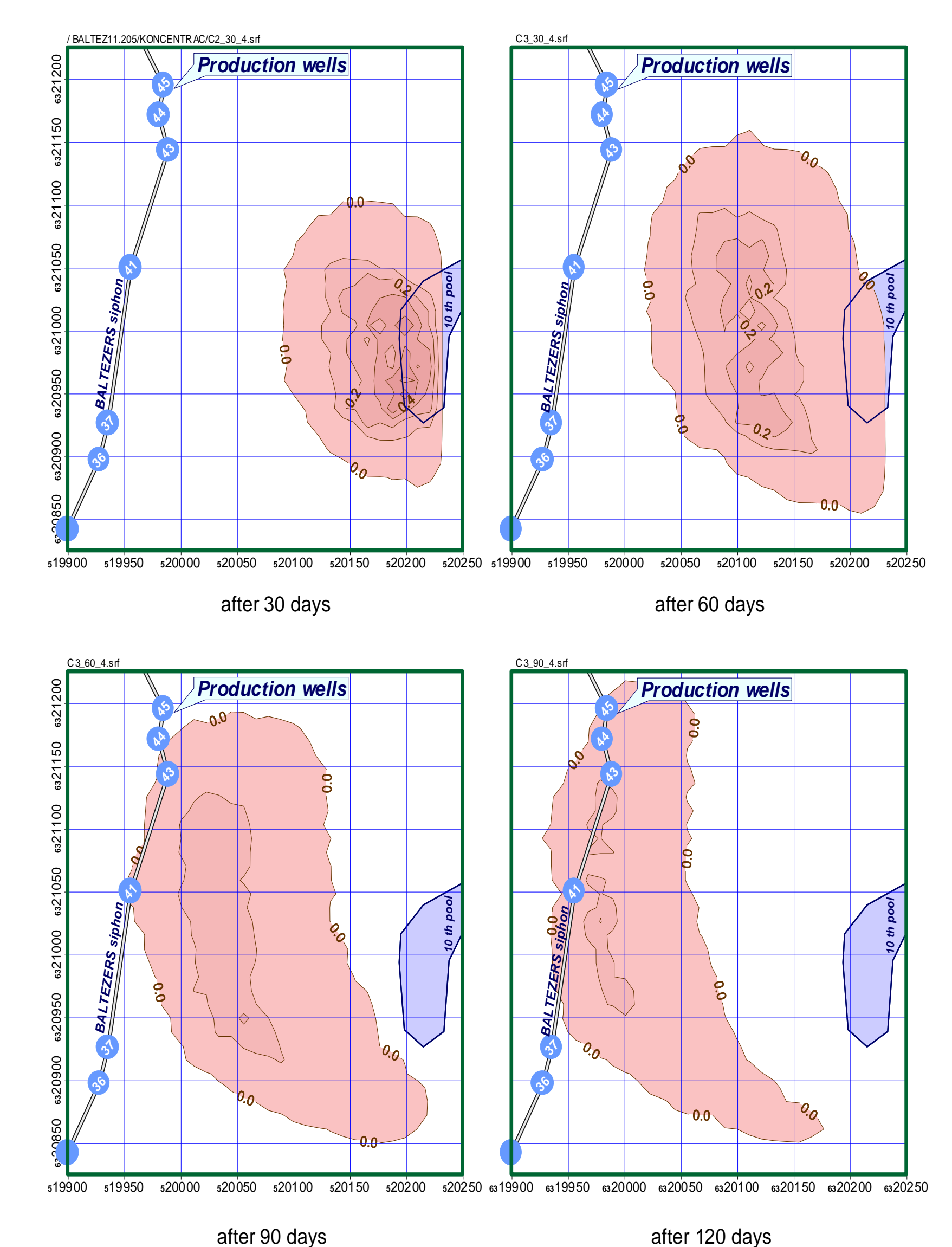


Figure 3. Modeling results showing changes of MC-LR concentration as water is traveling from the infiltration basin to abstraction well.

## Conclusions

- Removal of microcystin MC-LR occurred both under aerobic and anaerobic conditions during water passage through the aquifer, however for the start of significant removal in anaerobic zone adaptation period of about one week was needed
- In anaerobic conditions unidentified substances were produced as the results of microcystins degradation
- According to mathematical modeling in underground microcystin MC-LR could be removed below 1 µg/l during the water residence time of about a month

### References:

1. Thomas Holst, Niels O. G. Jørgensen, Claus Jørgensen, Anders Johansen (2003) Degradation of microcystin in sediments at oxic and anoxic, denitrifying conditions Water Research, 37, 19, 4748-4760  
Source of pictures: [www.nature.ne.jp](http://www.nature.ne.jp), [www.planktonforum.eu](http://www.planktonforum.eu), [www.biolib.cz](http://www.biolib.cz)

### Contact info:

Prof. Talis Juhna  
[talis.juhna@rtu.lv](mailto:talis.juhna@rtu.lv)



Dr. Maija Balode  
[maija@hydro.edu.lv](mailto:maija@hydro.edu.lv)

