

# Pharmaceuticals in wastewater and its interaction with groundwater: a case study of wastewater infiltration locality in Czech Republic

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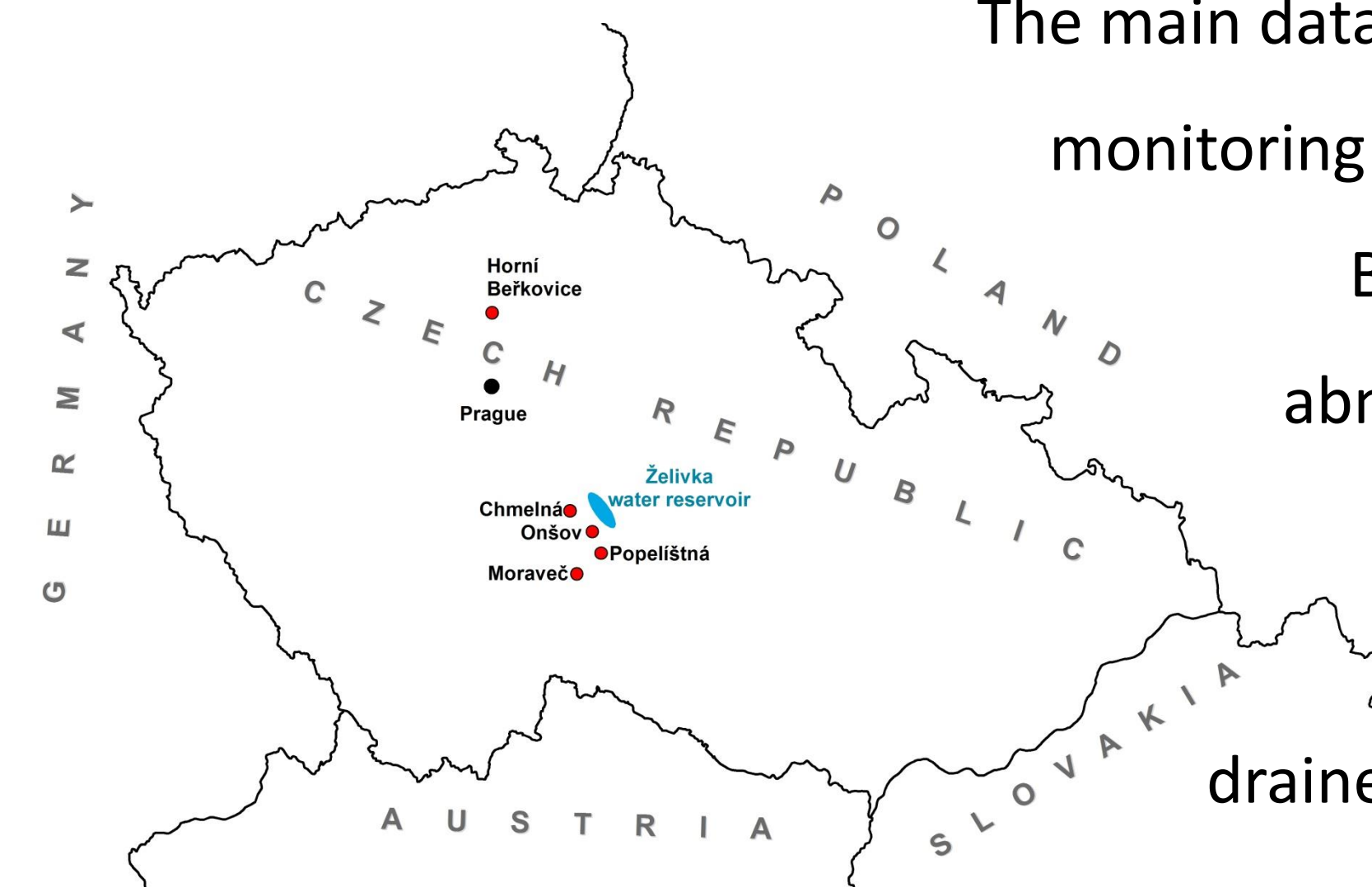
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## INTRODUCTION

Micropollutants in the environment are becoming a topical water management issue. Some pharmaceuticals are not effectively eliminated in most of current wastewater treatment plants (WWTPs). This specific type of pollution is therefore transferred from wastewater to surface water and successively to groundwater. Their effect on environment and human health is still uncertain, but we can expect more and more calls for concentration limits and standards for such substances in coming decades. Better understanding of occurrence and behavior of emerging pollutants like pharmaceuticals is our priority issue. The purpose of our study is to evaluate the removal of pharmaceuticals in conventional wastewater treatment plants in Czech Republic and describe the occurrence and fate of pharmaceuticals on locality with infiltration of treated wastewater.

## PILOT AREA



The main dataset for the research was gained by a monitoring system in Horní Beřkovice in Central Bohemia, where local wastewater is abnormally loaded by pharmaceuticals, due to sewage from psychiatric hospital. The treated water is drained into three recharge ponds located among fields and orchards, which are surrounding the village. It is recharging shallow aquifer formed by Quaternary sediments of Elbe river and partly fractured bedrock. The hydraulic conductivity of the fluvial Quaternary aquifer ranges between  $1.3 \times 10^{-5}$  and  $1.3 \times 10^{-3}$  m/s.

This is a unique example of wastewater infiltration in Czech republic, which is permitted, because there is no appropriate surface stream in the wider area of the village, where the effluent could be discharged.

The main dataset from Horní Beřkovice was compared with results from other localities in Želivka

water reservoir catchment, where no concentrated pharmaceutical source is present.



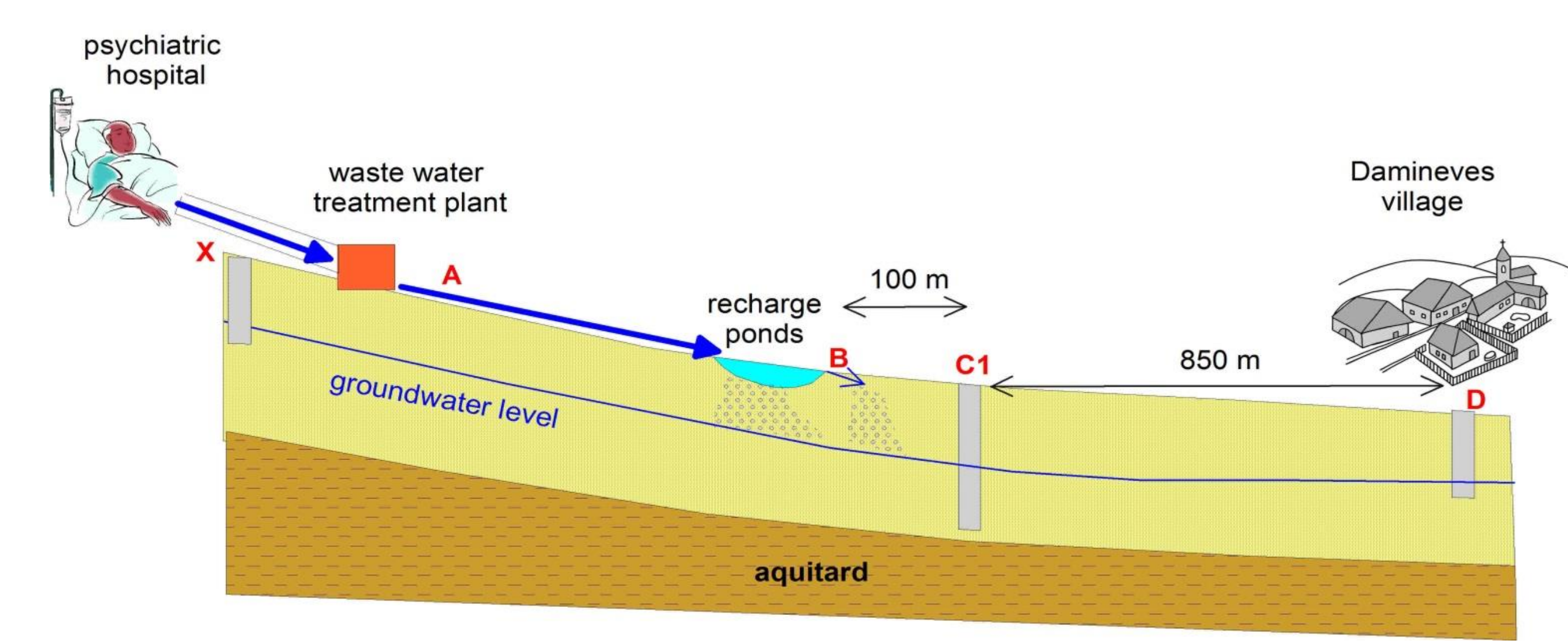
well in Daminěves



recharge pond

## METHODS AND MONITORING SYSTEM

The monitoring systems was designed to control quality of the wastewater, the efficiency of WWTP and processes of natural attenuation. The monitoring was intended to identify and describe the migration path from the source of contamination by pharmaceuticals, which is the psychiatric hospital at Horní Beřkovice, all the way to the potential consumer of contaminated water, the residents of the village of Daminěves lying in the direction of groundwater flow.



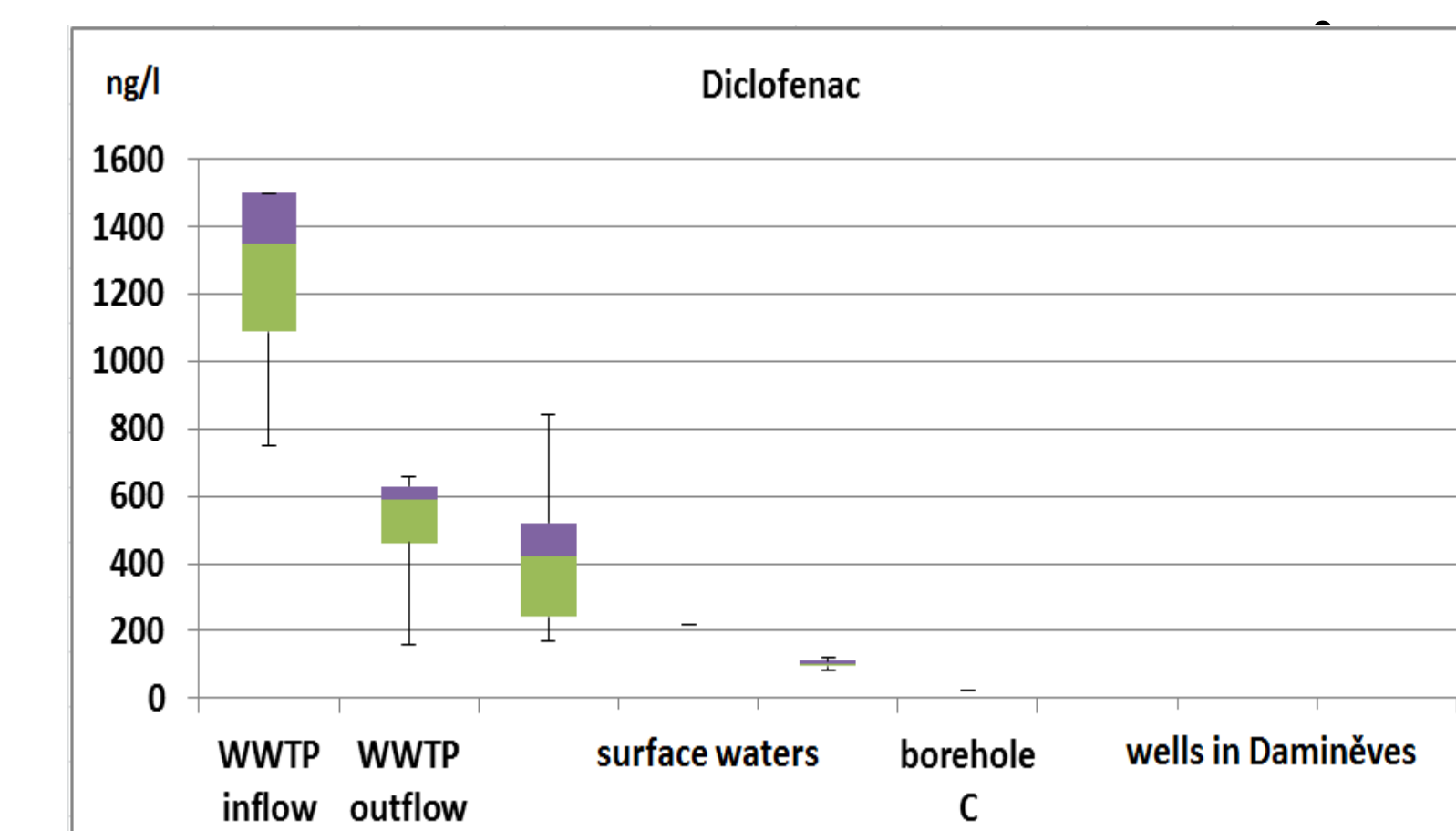
Monitoring borehole characterizes hydro-chemical processes of wastewater, which take place in saturated zone during short residence time in aquifer. Samples from Daminěves village characterize attenuation processes after longer residence times. Sediments were sampled in bottom of the recharge ponds and in the unsaturated zone under the ponds. Chemical analysis cover wide range of 42 pharmaceuticals and their intermediate products.

## RESULTS AND DISCUSSION

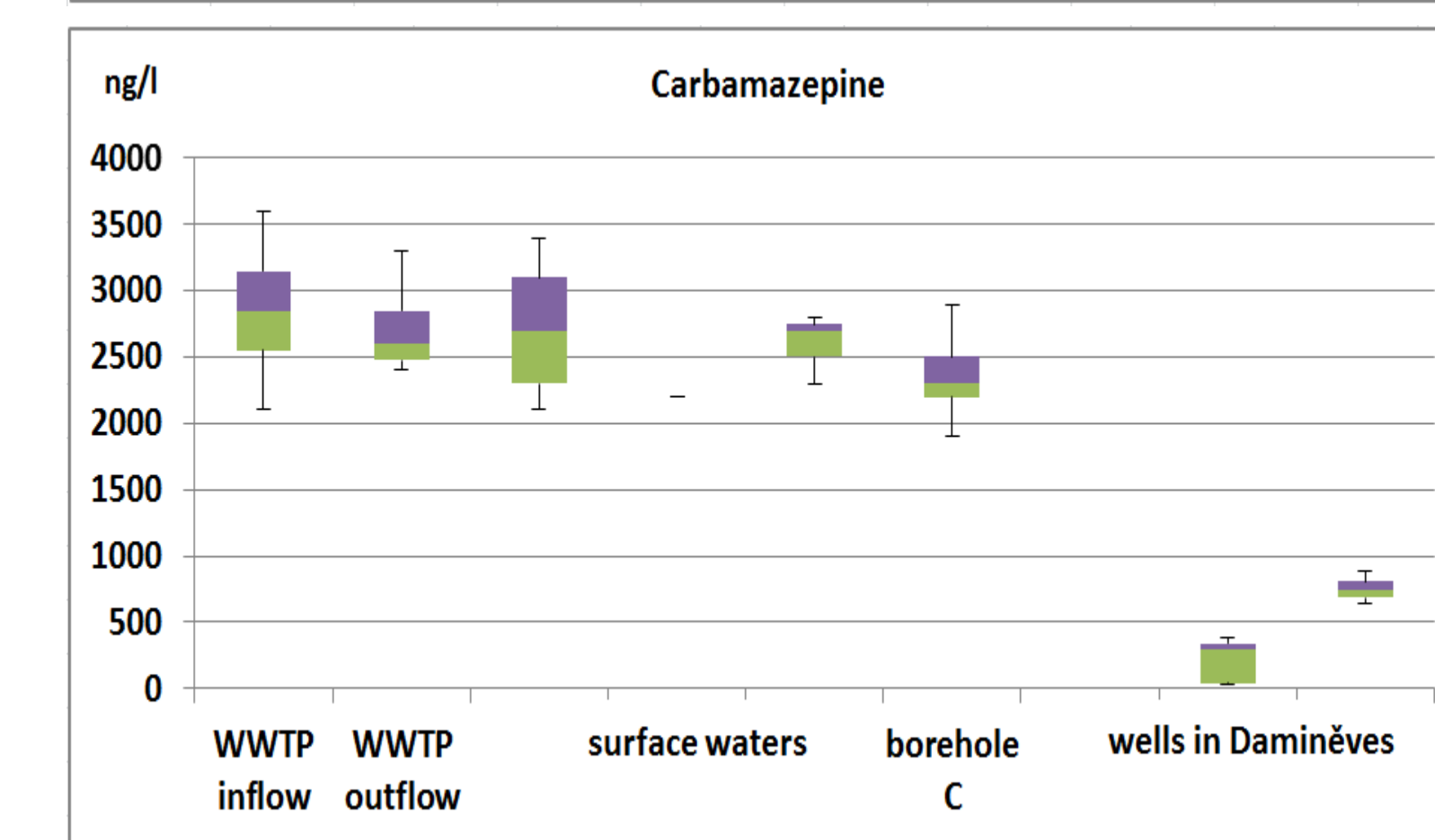
The comparison of results confirmed uniqueness of Horní Beřkovice locality, with high concentrations and wide range of detected pharmaceuticals (detected 35 substances of the 42 tested)

Very high concentrations of pharmaceuticals were detected in sediments of infiltration ponds. For some even several orders higher than in WWTP inflow. This indicates that these substances are sorbed on the deposited sediments, and may act as a secondary source of contamination.

According to persistence in the environment, we can define 4 groups of substances:



**easily removed in WWTP;** 23 substances; e.g. Ibuprofen, Naproxen, Paracetamol, Gabapentin, Atenolol, ...



**partly removed in WWTP and partly attenuated in the environment** (surface water and after infiltration); e.g. Diclofenac, Warfarin, Sulfamethazine, Venlafaxine, Sertraline, Ranitidine

**not removed in WWTP but efficiently attenuated in the environment;** e.g. Tramadol, Hydrochlorothiazide, Sulfapyridin, Sulfametoxazol

**very persistent;** e.g. Carbamazepine, Carbamazepine 10-11 epoxy.

Attenuation processes and especially dilution in the aquifer apparently have a great influence on the decrease of pharmaceuticals contents in groundwater. The results from the monitoring borehole located 100 meters behind the last infiltration pond show that the majority of pharmaceuticals is below the detection limit.