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D.2.2.1 Pilot test actions and examinations implemented in partner cities – Prague

PP5 - SZU, PP4 - CZWa



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1. Introduction

Due to the increasing number of tropical days, bathing and other surface water-related activities have become increasingly popular, particularly in an urban environment. Rivers are also starting to be reused for bathing. However, the opportunity for healthy bathing is often limited due bad water quality, lack of information and sometimes also not sufficient access to bathing water at all. The UrbanBlueHealth project aims to these facts.

The first part of the pilot activity is concerned with water quality and its fluctuation in the flowing parts of the rivers in the Prague area (the Vltava and the Berounka) where beaches are situated. The main goal is gathering of new information and knowledge for reducing health risk from bathing and provide new relevant information to both operators and other interested parties, and last but not least, to the people. Identifying sources of faecal contamination such as storm water overflows and/or tourist traffic (cruise ships) in the centre of Prague are crucial of this process.

Another important part of pilot activity is concerned on phytoplankton incl. Cyanobacteria which cause problems with water quality mainly in standing waters. Monitoring based on satellite data (Sentinel 2 satellites) brings very useful additional information beyond standard procedures (field sampling and laboratory analyses). The main goal for this activity is improve knowledge about phytoplankton occurrence and distribution which will contribute to better information of bathers and will finally lead to reducing health risk from bathing.

In the Czech Republic, bathing water quality is generally regulated by the Public Health Act (No. 258/2000 Coll.) and in the detail by the Decree No. 238/2011 Coll. Both regulations are in line with the EU Directive 2006/7/EC. The legislation is applied to bathing waters situated in reservoirs, ponds, sandpits and quarries. All designated bathing waters must be monitored monthly (microbiological analysis of *E. coli* and intestinal enterococci and simple visual assessment including transparency measurement). Some bathing water suffering from parasites which can cause cercarial dermatitis must be monitored for presence of causative agents of this disease. Those bathing waters with risk of mass proliferation of Cyanobacteria must be sampled every two weeks (or weekly if the limit is exceeded) for chlorophyll-a and phytoplankton analyses (incl. cyanobacterial counts). The results are sent to central database and presented to public in map-portal www.koupacivody.cz and webpages of regional public health authorities, which are responsible institutions for all designated bathing waters without any provider (private, municipality).

2. Pilot activities in Prague

2.1. Initial information about the pilot action

Area executing pilot action	Praha, Czech Republic
Partners	National Institute of Public Health (SZU – PP5), Czech Water Association (CZWa – PP4)

2.2. The importance of pilot action

All (at present) four designated bathing waters in Prague are situated on reservoirs or ponds. Besides about ten designated bathing waters in the reasonable distance from Prague which can be easily accessible for Prague inhabitants by public traffic or car, there are several tens of non-designated bathing waters on small reservoirs, ponds, sand pits and the Vltava or the Berounka River inside Prague and two natural bathing ponds. Beyond "true" natural waters, two public small man-made bathing ponds were built in Prague the last decade (2014 and 2018). This type of bathing water is suitable in urban areas but legal requirements for water quality management are insufficient.

Along the Vltava and Berounka Rivers, there are several beaches used by large number of people (Komořany, Braník, Štvanice Island and Libčice near the Vltava and Mokropsy and Radotín near the Berounka). Large numbers of bathers are not limited to bathing season due increasingly popular winter swimming (communities of winter swimmers regularly enter to the river in Braník and Libčice). Besides the beaches, a channel used for whitewater canoeing is situated in Prague – Troja. None of these waters have been monitored regularly according to bathing water legislation, so information on health risk for bathers has been missing (or they are limited on data from monitoring programmes done for other purposes – e.g. Vltava River Basin Authority). A limited number of monitored parameters and methods done legislation has been another problem.

Excessive development of phytoplankton with cyanobacterial blooms in the top bathing season occurred during several past years in three from four designated bathing waters in Prague and majority of non-designated bathing waters. Cheap and fast tool for assessment of this phenomenon has been highly desirable. Free accessible satellite data have posed a great opportunity in this field.

2.3. Pilot action objective and components

Bathing site mapping

The mapping of the current status of bathing in flowing parts of rivers has been done and included an inventory of beaches (including number of bathers, infrastructure assessment, sources of pollution, pilot analyses of *E. coli* and intestinal enterococci). The same activity has been done for non-designated sites on standing waters. Documents which incorporate all information mentioned above have been prepared for each site (totally 33 documents).

Monitoring of water quality in rivers

Collection of existing data about water quality (relevant microbiological and biological data, turbidity) and quantity in rivers and their tributaries from various sources (e.g. Vltava River basin management) has been done. Monitoring of 7 sampling points along the Vltava and Berounka (see chapter 2.2) during 18th month period (May 2024 – October 2025) has been carried out by SZU. Microbiological analyses have included *E. coli* and intestinal enterococci by standard and new methods (TBX medium and Enterolert DW). These new methods were also tested on another 22 stagnant locations in Prague and the surrounding area (to obtain a larger set of results). Samples from the Vltava River were also part of a validation study for the new ISO 9308-4 standard (TBX medium), in which other partners from this project also participated. *Clostridium perfringens*, *Campylobacter* spp. and other opportunistic pathogens (*Acinetobacter* spp. and *Leptospira* spp.) were also tested in river water. Moreover, a method for microbiological analysis of sand shallow sediments was optimized, focusing on the detection of anaerobic bacteria *Clostridium perfringens*, *Campylobacter* spp. Of the 10 tested bathing locations in Prague and the surrounding area (incl. rivers), two were repeatedly positive for *Campylobacter spp*. Special attention will be paid to short-term pollution events, which are very important for river bathing waters (heavy rainfall, high water levels, etc.). Monitoring of riverine phytoplankton has included chlorophyll-a analysis, microscopic determination and counts and fluorometric quantification (AquaPen fluorometer, PSI). Turbidity and temperature have been analysed. A total of 173 samples of microbiological and biological parameters were analysed, including new methods and shallow sediments.

Assessment of water quality in rivers

According to this assessment at least two places in the southern part of Prague (upper part of the Vltava River) had good quality (good classification according EU Bathing Directive) and no problem

with Cyanobacteria. The best suitable place for designation is the right bank of the Vltava in Braník due to good water quality and large number of bathers. This location has the potential to continue to meet the requirements of the legislation.

Small made-man bathing ponds

Data on natural bathing ponds in the Czech Republic were collected (both from regular monitoring according to legislation and from research activities including sampling and analysis of traditional and new parameters carried out by SZU). Microbiological and biological monitoring of small mad-made pond in Radotín has been carried out by SZU during 17th month period (June 2024 – October 2025). The small man-made bathing ponds topic has been discussed within the UrbanBlueHealth with other partners mainly with the Medical University Vienna (PP7) and results are given at Joint Transnational Strategy.

Phytoplankton sampling and analyses

Repeated sampling of several standing waters in Prague (Hostivař reservoir, Šeberák pond, two non-designated sites Podléský pond and Olšanský pond) by SZU has been sampled during the 2025 bathing season on clear days with satellites overflow. Moreover, other 14 ponds and reservoir were sampled once. A special attention has been paid to the Hostivař reservoir, which has been sampled from bout. Multiply samples have been taken (both spatial distribution in surface layer and vertical profile near dam).

Field and laboratory analyses has included chlorophyll-a analysis, microscopic determination and counts and fluorometric quantification (AquaPen fluorometer, PSI; occasionally also AlgaeLabAnalyser and AlgaeTorch, both bbe Moldaenke), turbidity, Secci disk transparency, temperature and dissolved oxygen (in Hostivař).

In addition, data collected from the Czech bathing water database were gathered (for methodical purpose - regardless if they are situated in the vicinity of Prague).

Sentinel 2 data

Freely available satellite data from the Sentinel 2 satellites has been accessed via Copernicus Browser. Results of field and laboratory analyses and data from national database are being compared with the results obtained by several tools from using Sentinel 2 data. The best tool seems to be APA Scrip for visualisation and MAGO for chlorophyll-a calculation.

Assessment of phytoplankton mass using satellite data planned to be served as a standard supporting tool of bathing water monitoring. The pilot action justified that one is available to improve information gathering on the spatial heterogeneity of phytoplankton and it is also faster than classical on-site sampling methods. More complex data and rapid information are available for laboratories, public health authorities and other water quality management organisations nearly real time. The territorial bonded data – applying GIS technology – make the harmful natural process better manageable, thus effectively protect the health of bathers.

2.4. Key issues addressed in the pilot phase

Unregulated beaches

All of the Vltava and Berounka Rivers beaches in the Prague area are non-designated in the national list of bathing waters. There is no designated bathing water in flowing part of river at all in the Czech Republic. The Czech rivers are believed to be faecal polluted and that they cannot fulfil the microbiological limits of the EU Bathing Directive. One of the key pieces of information arose from the pilot phase is that it is not generally true. At least two sites in the southern part of Prague (upper part of the Vltava River) had good quality (good classification according EU Bathing Directive) and no problem with Cyanobacteria. The best suitable place for designation is the right bank of the Vltava in Braník due to good water quality and large number of bathers.

There are also more than twenty non-designated standing waters which are used for bathing by Prague inhabitants. Some of them have good water quality and sufficient infrastructure. The most promising localities in this are the Eliška pond in Prague - Horní Počernice and the pond Dolejšák in Prague – Zličín. However, if there is sufficient number of bathers for designation in these localities it is not clear.

Raising awareness of decision-makers

The legislation requirements for small man-made bathing ponds are not sufficient. There is no obligation at the European level and the Czech legislation is quite old (released in 2011) and includes only minimalistic requirements. Discussion during transnational workshop in Prague revealed the same problem in Austria. Thus, sharing information in the transnational level is highly desirable. The development of guidelines for improved monitoring and management of natural bathing ponds was a task of the National Bathing Water Group. This could ideally lead to a change in national legislation. The results of this activity were safer bathing in natural bathing ponds.

The results of pilot activities (not just bathing ponds) need to be presented and promoted, because the problem of bathing waters goes beyond the departmental level (Ministry of Health), but also affects the areas of responsibility of the Ministry of Agriculture and the Ministry of the Environment.

Communication and cooperation among the stakeholders

The National Bathing Group plays an important role in communication and cooperation, as its members include a relatively broad spectrum of Czech experts (Ministry of Health and Environment, Regional Public Health Authority in Prague, Vltava River Basin Administration, Prague Planning and Development Institute, Water Research Institute). This bottom-up stakeholder and expert group iterated the pilot work and contributed to the verification of the pilot work through its recommendations.

During the pilot activity the Ministry of Health, regional authorities e.g. Regional Public Health Authority in Prague, Vltava Basin Administration and local operators of the Radotín bathing pond have contributed to the methodological improvement of water quality assessment. In the near future implementation of the pilot results (including new methods, satellite data for bathing water monitoring etc.) the Czech team intend to include other regional public health authorities, hydro analytical labs, river basin administrations bodies and bathing water operators.

As a result of the cooperation of the Czech Water Association (PP4) other group of stakeholders were reached. This cooperation has been and currently is taking place within the framework of various professional events, where the evolution of the pilot activity and project results are presented.

Special events are also planned, related to training on satellite data for bathing water quality monitoring; ones are not only for laboratory workers, but also for other interested parties, especially from the Public Health sector, who could use the pilot methodology as solution in the future.

The impact of climate change on water quality

As already mentioned, in connection with climate change, a warmer climate in cities, a greater number of tropical days and the associated interest in swimming are expected. However, climate change is also expected to intensify water quality issues by altering rainfall patterns, increasing temperatures, and changing the frequency and intensity of extreme weather events such as floods

and droughts. These changes can affect the Vltava and Berounka River's water quality in multiple ways, by promoting phytoplankton development, increasing sediment runoff from surrounding areas, and intensifying the release of pollutants. The pilot phase has included monitoring of the potential impacts of climate change on water quality. The worsened results of microbial pollution were associated with rainy weather and higher flow rates, especially in the Berounka River. The situation in the Vltava seems to be a little better, especially thanks to the mostly regulated flow. Therefore, the Vltava Braník location is a good choice as a bathing place, also from the point of view of climate change.

Early warning system for water quality

To better prepare for and respond to sudden changes in water quality, an early warning system can be developed. Running waters will always be very sensitive to changes in flow rates and microbial pollution (vulnerable profiles - short-term pollution), the most suitable indicator of water quality worsening is rapid changes in turbidity in combination with heavy rainfalls. However, in the Czech Republic, the biggest problem of bathing waters is the mass proliferation of phytoplankton incl. cyanobacteria. The monitoring using data from Sentinel 2 satellites can serve as early warning system which can trigger extraordinary sampling.

3. Summary of the pilot action

New information gathered on the water quality in rivers during 18 months monitoring of 7 river beaches should improve our knowledge on the health risks from bathing in rivers in Prague. It should lead to the establishing of newly designated BW(s), at least in Prague- Braník.

A classification system for the assessment of phytoplankton in bathing waters using satellite data for both designated and non-designated bathing waters is being developed. It will help to the current system of assessment of phytoplankton in bathing waters which based on field sampling and tedious laboratory analyses and can also serve as early warning system.

Monitoring water quality throughout the pilot activity

Improving of requirements for monitoring of Cyanobacteria includes mass proliferation of cyanobacteria causes problems in three out of four designated bathing waters in Prague. The same situation occurs in most of the non-designated waters. The monitoring system in the Czech national legislation is based on visual assessment, transparency measurement, chlorophyll-a

concentration and quantification and determination of cyanobacteria by light microscopy. Fluorescence-based methods for cyanobacteria quantification are also allowed by the legislation, but have not yet been used by any Czech laboratory, although they are much faster than microscopy and the standard method for chlorophyll-a.

The legislation does not provide for the adaptation of monitoring requirements to the current situation (taking into account seasonal development, species composition, etc.). This has led in some cases to redundant sampling and analysis, which makes monitoring more expensive and may discourage operators and health authorities from designating new bathing waters where cyanobacteria proliferation is expected. The development of guidelines for improved monitoring requirements was a task for the National Bathing Water Group. Ideally, this could lead to changes in national legislation.

Collecting and processing data on water quality parameters

Remote sensing as a useful tool for phytoplankton monitoring. Freely available satellite data can also be used as an additional tool for monitoring phytoplankton. The Sentinel 2 pair of identical satellites is the most suitable for freshwaters. The main advantage is the high frequency of passes (once or twice every 5 days) and the information on phytoplankton distribution in the surface layer of the whole reservoir (not just near the sampling point). Disadvantages of this method are lower sensitivity compared to instrumental methods and uncertainty in the expected frequency due to weather conditions (clouds, strong wind). Sampling of several reservoirs in Prague (Hostivař, Šeberák, several non-designated reservoirs) by SZU is planned during the 2025-bathing season on clear days when satellites fly over. In addition, data were selected from the Czech bathing water database time series. Both results were verified with the results obtained by several high-tech tools from using Sentinel 2 data (e.g. Aquatic Plants and Algae Custom Script Detector, MAGO Water Quality Monitoring Tool; Remote Water Quality). The system that gives the most accurate results were selected. A classification system for the assessment of phytoplankton in bathing waters was developed for both designated and non-designated bathing waters.

The pilot action in Prague focused on exploring possibilities for safe river bathing, particularly in the Vltava and Berounka rivers, where no official bathing sites currently exist due to frequent faecal pollution exceeding EU limits. The pilot action, implemented by the National Institute of Public Health and the Czech Water Association, aimed to map existing conditions through inventories of bathing areas, infrastructure, pollution sources, and systematic water quality monitoring. Monthly sampling at multiple sites assessed microbiological and biological parameters, with special attention to short-term pollution events linked to rainfall and river levels.

Another key component addressed natural bathing ponds, which offer urban alternatives to rivers and reservoirs. Properly designed and managed, these ponds can provide high-quality bathing water, but current Czech legislation (last updated in 2011) sets only minimal monitoring requirements.

The pilot activity also highlighted the need to update practical methodology, improve cyanobacteria monitoring methods, and adopt new tools such as fluorescence-based techniques and satellite remote sensing. Sentinel 2 satellite data were tested for phytoplankton monitoring, complementing on-site sampling.

The pilot activity also emphasized raising awareness among decision-makers and promoting transnational knowledge exchange, as similar challenges were identified in Austria. Outcomes included recommendations for improved monitoring guidelines, steps toward legislative change, and progress toward safer, newly designated bathing waters in Prague.