POTENTIAL FOR CROWDSOURCED HYDROLOGIC DATA ON TFE MF KŘTINY AS A SIDE PRODUCT OF LOCAL RECREATIONAL ACTIVITIES

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Abstract
Citizen science can be simply defined as the practice of engaging the public in the observation and production of reliable data and information usable by scientists. Citizen science is a growing phenomenon with many good results in various fields of science. To this day, there are already a number of examples of crowdsourced hydrological monitoring experiments that can be used as inspiration. One of the big challenges in streamflow measurements in small forest streams are the many potential sources of wrong readings (branches and leaves clogging the weir, animals interfering, ice and snowmelt, etc.) which cause high uncertainty in the measured data. The best way to combat this is to frequently monitor the state of the measuring device, which in remote forest areas can be rather complicated. Using a citizen science approach and allowing people to collect hydrometric data during their leisure activities can be a great way to increase the number of in situ readings and potentially greatly improving the quality of the available hydrological data. In this article we look at the possibilities and technological restrictions for crowdsourced hydrological data as well as their potential benefits at some areas on the Training forest Enterprise Masaryk Forest Křtiny.

Keywords: Citizen science, Streamflow, Small forest streams, Headwater catchments

Introduction

Citizen science can be simply defined as the practice of engaging the public in the observation and production of reliable data and information usable by scientists. A citizen scientist is a volunteer who collects and/or processes data as part of a scientific enquiry (Silvertown, 2009). Citizen science is nothing new it is rather connected to the very roots of scientific endeavors. Science as a paid profession is quite young phenomenon, dating from the later part of the 19th century. With regards to current usage of citizen science we can therefore talk about its rediscovery with new purposes and goals. The information technology revolution and the advent of the Internet and location-aware mobile technologies equipped with cameras and other sensors (Zerger et al., 2010) have greatly increased the capacity of what citizen scientists can do. Citizen science can help to address major conservation challenges simply by identifying and naming current and future utilization of studied areas since citizens are one of the important stakeholders in the landscape (Brus et al., 2020). Citizen science can help namely by (1) enabling science that might not otherwise be feasible because of scale or for other practical reasons, and (2) better engaging the public in helping to make decisions (McKinley et al., 2017). So the goals can be either acquiring scientific knowledge by letting people (citizen scientists “CS”) do the observations or stimulate public input and engagement in environmental management and policy making.

In Hydrological monitoring, it is essential to guide evidence-based decision making necessary for sustainable water resource management and governance. Limited hydrometric datasets and the pressure on long-term hydrological monitoring networks make it paramount to explore alternative methods for data collection. Citizen science in hydrological research has recently gained popularity and crowdsourced monitoring is a promising cost-effective approach for data collection (Njue et al., 2019).

In this paper, we used a suburban forest experimental catchment as a potential hotspot for trying and incorporating citizen science to enable a better and denser measurement network for monitoring and understand hydrological processes. Taking inspiration in current literature and information of similar projects, we aim to design a citizen science operating framework in the study area and estimate its potential.

Material and methods

The study area is the headwater catchment of a small forest stream Melatín located on the property of the Training forest Enterprise Masaryk forest Křtiny. It can be described as a suburban forest area with a dense network of tourist paths and high recreational potential and utilization. The idea is that there are a lot of forest visitors in areas like this, which makes it a perfect representative area of similar suburban forests. The total area of the catchment reaches 2.7 square km, mean altitude around 400 m a. s. l. (Figure 1).

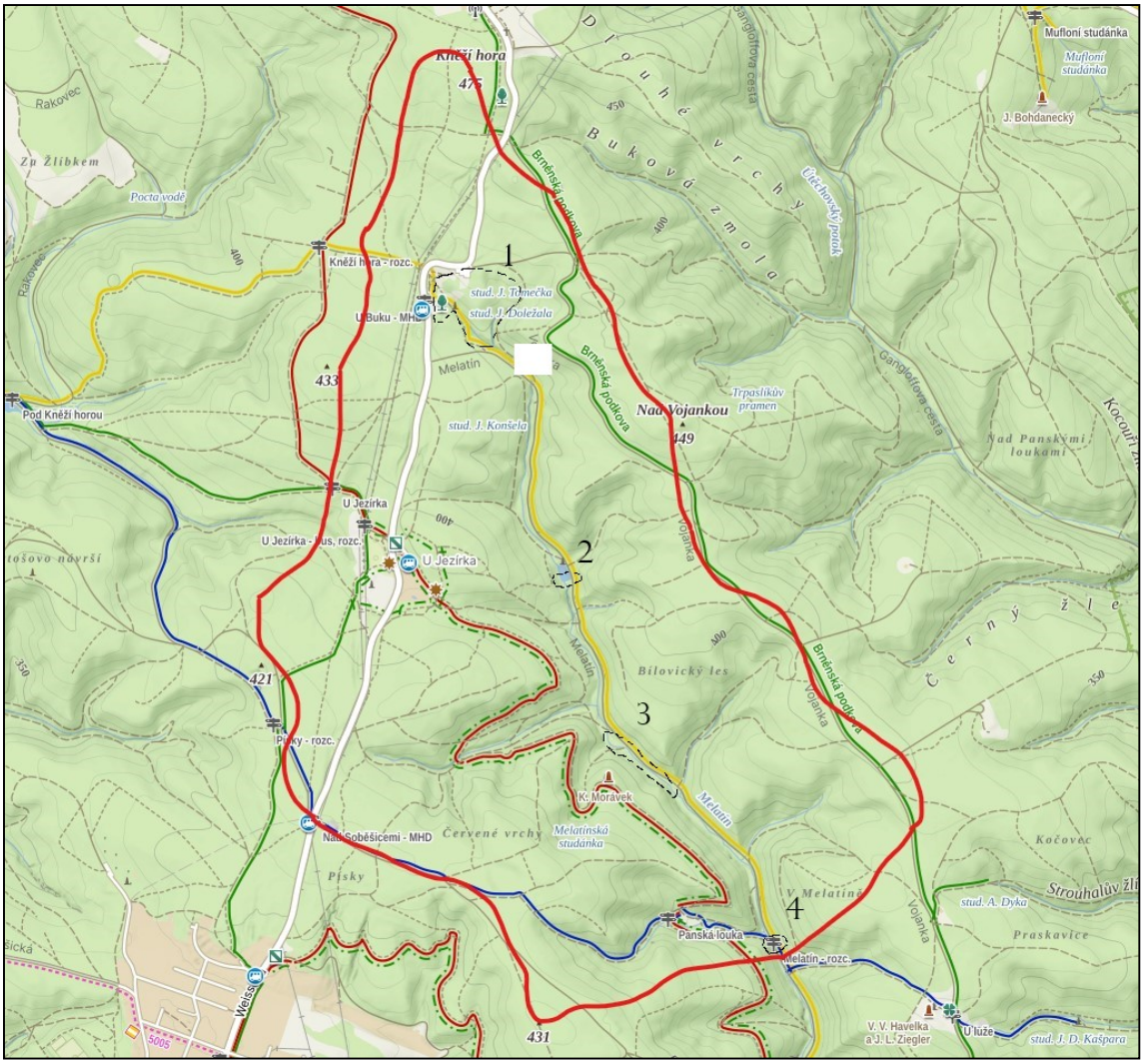

Fig. 1: Localisation of the Melatín experimental catchment

Inside this catchment we designed a network of measurement stations which relies on untrained observers sending measured and observed data via mobile phone text messages to a server (Lowry, 2013). Here, we concentrate on the easily observed or measured variables and processes connected to the water balance of the area (Table 1).

Tab. 1: Description of citizen science measurement stations

Observed variable or process	**Measuring process and equipment**	**Expected results**
Water level	Water height gauge	number in centimeters
Ecohydrology	Visual observations	water in ponds yes/no
Ecohydrology	Visual observations	tributaries on water yes/no
Phenology	Visual observations	phenology phase

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Here is the description of the designed measuring stations:
1. Phenology observations
This is a forest clearing with solitaire trees of different tree species. Here, the CS would be informed about the different phenology phases by a sign near individual trees (some conifers and some broadleaved) and encouraged to observe and text the phase and date at which it was observed. This will serve as an indicator of the growing season and expected evapotranspiration to the scientist while simultaneously educating public.
2. Water level in the reservoir
There would be a water height gauge with appropriate scale on the spillway of the dam. This would enable the CS to take a reading from the gauge and text it to the scientist. This would serve as an indicator of the streamflow and baseflow related hydrological processes.
3. Ecohydrology
Along the stream, there are a number of small ponds on the banks and a number of tributaries. In the middle of these ponds, there would be a water height gauge with appropriate scale indicating the water level of these ponds. This would enable the CS to take a reading from the gauge and text it to the scientist.On the tributaries, the CS would only indicate if there is water in the streams or not. This would serve as an indicator of the wetness conditions in the catchment. There is a possibility that these ponds and streams will be intermittent which would be an interesting factor to observe. These observations can be extended to include the observations of frogs and other wildlife in the ponds.
4. Water level in the discharge profile
At the discharge outlet o the catchment a Thomson weir will be installed for continuous water level measurements via ultrasound sensors. There would be a water height gauge with appropriate scale on the spillway. This would enable the CS to take a reading from the gauge and text it to the scientist. This would serve as an indicator of the streamflow needed for proper calibration of the sensors.

Results
On the area of the experimental Melatín catchment, a number of four measurement stations were designed. They are aimed both at obtaining ecohydrological data sets via crowdsourced citizen science as well as increasing awareness of the forest visitors towards environmental studies and nature as a whole. Both of these goals exploit the fact that the area is frequently visited suburban forest and it is effectively using its recreational potential for scientific and educational purposes.

Discussion
The data obtained by the CS will have to be validated against our own measured datasets. This is possible on the 4th site, where the water level measurements will be performed by an ultrasound sensor. The expected accuracy is quite high (Figure 2). At the same time, field measurements of water level are subject to a number of uncertainties. Most commonly bed material load as well as wood, that gets clogged in the spillway during stormflow events, stream freezing and thawing during winter, falling leave and twigs under windy autumn days (Deutscher et al., 2021). All these sources require timely repairs of the measuring device or the recalibration of the sensors. This cannot be done without in situ water level data. Here, citizen science could be a great source of correct information.
The success of any CrowdHydrology station location is based on both traffic passing by the station and the potential citizen scientist's motivation to send a text message (Lowry, 2013). The motivation of people to send the messages and take their time during recreational walk or other leisure activities needs to be cultivated if this approach aims to be successful. Therefore future communication with local environmental and educational authorities has to be promoted to inform people about citizen science and its benefits and goals.
At the same time, specific efforts should be made to connect our results to other citizen science endeavors, such as the CANDHY working group which is the Citizens and Hydrology Working Group established in July 2017 by the International Association of Hydrological Sciences (IAHS). The principal aim of the CANDHY WG is to support the use of citizen science in hydrology and harmonize research in this context, promoting the value of citizen science for advancing the hydrological sciences and finding answers to the most pressing open scientific, technical, and societal challenges in this field of expertise (Nardiu et al., 2022). Internationalization is the best way forward.

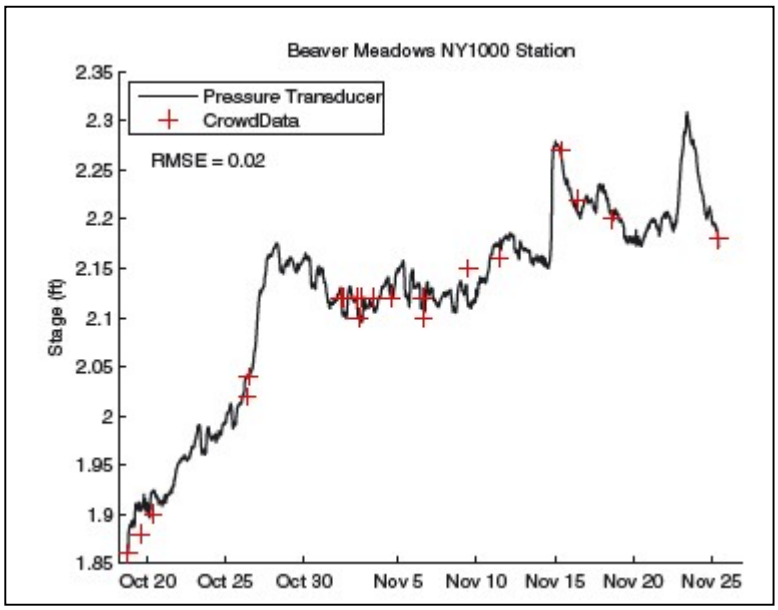

Fig. 2:An illustrative figure taken from Lowry (2013) documenting expected accuracy of crowd data readings compared to instrumental measurements.

Conclusion

In this article we looked at the possibilities of incorporating citizen science to an experimental catchment. We designed a number of measurements sites equipped to enable data readings and observations by citizen scientists who would be willing to take their time do it. We believe that including citizen science can be a great asset to current hydrological monitoring in the field and can be used as a stepping stone for other research activities on the Training forest Enterprise Masaryk Forest Křtiny and other similar suburban forest areas in the broader scale.

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Souhrn

Občanskou vědu lze jednoduše definovat jako zapojení veřejnosti do pozorování a získávání spolehlivých dat a informací využitelných vědci. Občanská věda je rostoucím fenoménem s mnoha dobrými výsledky v různých oblastech vědy. K dnešnímu dni již existuje řada příkladů crowdsourcingových hydrologických monitorovacích experimentů, které lze použít jako inspiraci, jedním z nich je i pracovní skupina CANDHY, což je pracovní skupina Citizens and Hydrology, kterou v červenci 2017 založila Mezinárodní asociace hydrologických věd (IAHS). Na území

experimentálního povodí Melatína byla navržena řada čtyř měřicích stanic. Jejich cílem je jak získání souborů ekohydrologických dat prostřednictvím crowdsourcingu občanské vědy, tak i zvýšení povědomí návštěvníků lesa o ekologických studiích a přírodě jako celku. Oba tyto cíle využívají skutečnosti, že oblast je hojně navštěvovaným příměstským lesem a efektivně využívá svůj rekreační potenciál pro vědecké a vzdělávací účely. Věříme, že zapojení občanské vědy může být velkým přínosem pro současný hydrologický monitoring v terénu a může být využito jako odrazový můstek pro další výzkumné aktivity na Školním lesním podniku Masarykův les Křtiny a dalších podobných příměstských lesních oblastech v širším měřítku.

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