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PARTICIPATORY MONITORING AS A SUPPORTIVE TOOL FOR BETTER SITUATIONAL AWARENESS IN CONTAMINANTS' LEAKAGE AND PREVENTION OF ENVIRONMENTAL POLLUTION*

Outi Laatikainen[1], Tatiana Samarina[1], Pia Haapea[2], Anna Belenikhina[1]**

[1]KAMK University of Applied Sciences, School of Engineering, Ketunpolku 3 PL 52, 87101 Kajaani, Finland
[2]LAB University of Applied Sciences, School of Engineering, Department of Energy and Environmental Technology, Mukkulankatu 19, P.O. Box 214, FI-15015 Lahti, Finland

Abstract

Prevention of contaminants' leakages or nutrient leaching into natural water bodies forms a remarkable part of solid circular economy concepts. This study presents two showcases on adopting participatory observations as a supportive tool for creating better situational awareness on presence of chosen pollutants and their transitions with runoff water. The availability of feasible technological solutions with advanced data services is limited. Thus, integrating new monitoring features for required monitoring purposes forms a part of the study. At showcase 1, an environmental load caused by runoff water contamination is monitored utilizing mobile data service solutions provided by PHD Nordic. Measurement methods for integrating new monitoring parameters are developed in ongoing projects. Monitoring pilots include e.g. observations of pH, ammonium and oil traces. All the parameters are monitored via chromaticity indications. Automated measurement result readings by means of customized color calibration are developed during the monitoring pilot. At showcase 2, experiences of environmental status were monitored in student projects using Envirate mobile app. The solution is based on personal sensory estimations and provides a possibility for an easy and cheap solution for collecting indicative background data. Experiences from these pilot studies give valuable information on user experiences, technological performance of selected solutions and stakeholder viewpoints for utilizing obtained environmental data in e.g. city planning actions. Concerning the gathered monitoring information, the aim is to encourage further activities on prevention of water contamination and to control of treatment measures more effectively by increasing situational awareness of publicity on

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** Corresponding author: e-mail: outi.laatikainen@kamk.fi

contamination flows via participatory observation campaigns. Engaging in increased communication and dialogue with local stakeholders and inhabitants is also seen as an information source for further planning of recreational area development, since the discourse helps to understand the behavior of recreational area users.

Keywords: environmental assessment, environmental monitoring, participatory observations

1. Introduction

Achieving good situational awareness in environmental monitoring is a challenging task, since very often the availability of relevant and up-to-date background data on environmental phenomenon is very often limited. This is usually due to scarce availability of feasible technological solutions with advanced data services and relatively high cost of environmental monitoring provided by external accredited parties for limited periods only. Nevertheless, creating a comprehensive picture of the existing situation would be a basic precondition for problems to be identified in time in order to optimize corrective or preventive actions. Interaction with different local communities can also provide for planners, decision makers and authorities with the necessary background information on, for example, people's behavior, hopes and expectations. This approach called participatory observation can also be used to gather intangible, cultural or economic information.

As a comprehensive guideline, it is the right of every citizen to participate in and influence the planning of their living environment. Participation can also increase the sense of transparency of administrative and industrial activities in design processes and environmental protection (Conrad and Hilchey, 2011; Gharesifard and Wehn, 2017). In Finland, possibility of inhabitants' involvement as part of the land use planning process is required by law. Article 10 of the European Union Participatory Democracy Compendium also states that the citizen has the right to participate, and regulations must be made as openly and as closely as possible to the citizen (EESC, 2011). The focus of participation should be shifted more from commenting on and interacting with plans to the earliest possible stage of the process. The possibility to participate gives a valuable way to assist in the creation of environments that better meet the needs of residents and stakeholders.

Participatory observations also provide a possibility to integrate socially vulnerable groups in dialogue building, which might help to integrate these groups into societal interaction, through various methods and ways. The choice should take into account the process itself, who it applies to, what model will be used and what area and stakeholders it concerns, as well as when and where the process itself will be done. The traditional means of involvement are e.g. interviews and surveys. There are also various models based on spatial data, for example the Finnish application SoftGIS (Kyttä and Kahila, 2011). Nowadays, user-centered design and co-creation have become more common. The various means and methods of involvement related to visualization, service design and digitalisation have also increased considerably (Andrachuk et al., 2019).

This article presents two different examples of case studies from KAMK University of Applied Sciences and LAB University of Applied Sciences on integrating participatory observations as a supportive tool for creating better situational awareness on local circumstances.

The main objective of this study is to pilot new technological solutions and receive feedback on the utilization possibilities of collected data and on related societal viewpoints. To this end, relevant parameters to be most interested for monitoring were discussed preliminary with local authorities. The requests of inhabitants in getting of particular information on nearest environments were also taken into consideration.

In the course of these studies, also the ways for motivating parties concerned to participate in environmental campaigns were observed, and stakeholders and vulnerable group representatives were engaged in societal dialogue.

This work is divided in three main parts:

- Case study in Kajaani, Northern Finland. A new monitoring concept to support participatory observation of runoff water contamination was developed. A commercially available data service, provided by PHD Nordic, was used as an information distribution channel. Monitoring pilots included observations of organoleptic (appearance, smell, color) and chemical parameters (pH, nutrient content,). The parameters were monitored visually or via chromaticity indications. Automated measurement result readings utilizing color calibration are developed during the monitoring pilot. Smart color calibration homogenizes the result reading and provides independence from existing background light circumstances, which might affect the automated result interpretation.

In the reported case study, the aim is to find cost-effective tools for gathering background information concerning sources of pollution and extent of contamination occurring in runoff water flows in the area of Kajaani city, Northern Finland.

- Case study in Lahti, Southern Finland. At LAB, experiences of environmental status were monitored in student projects utilizing Envirate mobile app. The solution is based on personal sensory estimations and provides a possibility for easy and cheap solution for collecting indicative background data.
- Data processing, results' interpretation and conclusions; achieved experiences and conclusions for future work are discussed; the potential impacts of smartphone technologies in developing situational awareness and citizens' involvement in monitoring processes.

2. Materials and methods

Case study 1, Kajaani: monitoring pilots are carried out in ongoing RDI projects, e.g. for stormwater pollution and monitoring of environmental waters in the vicinity of industrial activities. Concerning industrial activities, the appearance and amounts of sulphate has been brought up strongly in local public discussion. Monitoring sulphate levels in natural waters supported local inhabitants in gaining understanding on the phenomenon. For runoff water, the selection for relevant parameters to be included in the monitoring concept was done according to comprehensive sampling and analysis of runoff water samples in the target area.

In these campaigns, a selection of parameters causing environmental load for water bodies are measured using colorimetric measurement, i.e. a measurement based on color changes, and a smartphone application implemented by PHD Nordic Oy. The measurements and results acquired by the participants are stored using a mobile application in an information database, from which the data can be viewed on a map template with a time, place stamp, and relevant image made on-site.

As sensing materials, commercially available paper-based strips were used. The reading of the strips takes place either visually or with a smartphone camera. System adapts customized color calibration to balance possible deviations caused by background light by applying an innovative algorithm.

At first site, sulfate and pH determination were carried out and details on experimental results reported could be found elsewhere (Laatikainen et al., 2019). In addition to already available solutions, KAMK is also developing monitoring methods for new, more challengingly measurable parameters (bioavailable forms of nutrients). The results gathered through mobile application were then compared to results of standard laboratory analysis (EPA methods). This development work requires an understanding of chemical and

biological phenomena in water bodies and the control of measurement methods for parameters describing changes. Measurement protocol setup is introduced in Fig. 1.

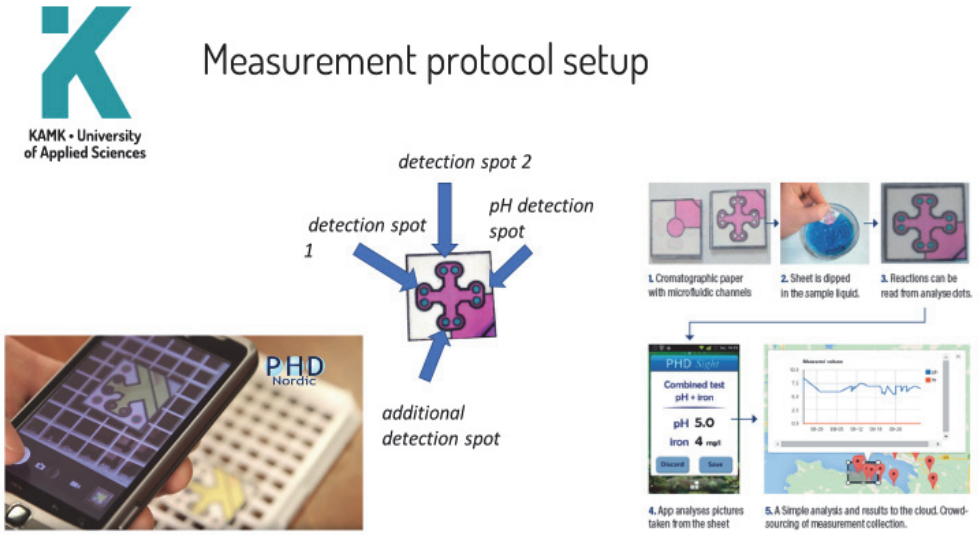

Fig. 1. Measurement protocol setup in case study 1

In case study 2, the involvement of students was piloted at LAB University of Applied Sciences. During 2019, a student project based on collaboration with company Envirate Oy was launched. The aim was to get the students acquainted with the use of mobile application by observing the Lahti town area environment. The application works globally and can form a global data bank of human perceptions, by means of inclusion (LAB University, 2020). The gathered information is useful for individuals, businesses and policy makers alike and can be viewed with a few clicks. The application is designed to be very user-oriented, which means that it is easy and simple to use. All that is needed to make environmental observations is the above-mentioned application, as well as the use of three different senses for organoleptic evaluation: smelling for possible contaminations, hearing for noise pollution, and sight for visual control. Through those the status of the environment was evaluated on a scale of 0 to 5, and results are presented in Fig. 2. The observation was also inspired by the game component connected to the application, in which the observers competed with each other. The competition was open to all Lahti residents, with especial focus on students. The application was also tested for high school students in Lahti in cooperation with the "Sustainable Inclusion" theme workshops organized by the City of Lahti.

3. Results and discussion

For Kajaani's showcase, there were two different social requests, which defined places of pilots. The awareness of harm effect of inlet waters containing sulphate ions was related to real-estate issues as well though diminishing recreational use of water source.

The second site was located in Kajaani city, where citizens were highly awarded of status of a city lake subjected eutrophication. More than 11 parameters were chosen for laboratory monitoring campaign (forms of P, N, metals, physical indicators), and 3 parameters for adapting them in mobile platform (pH, N-NH4, N-NO3).

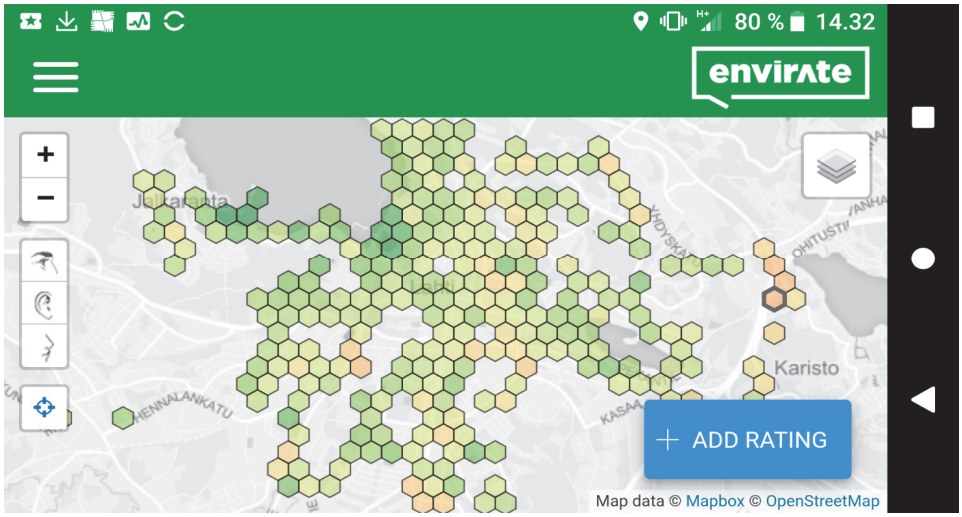

Fig. 2. Example on Envirate monitoring info outcome. The greener the area, the more pleasant was the user experience

User experiences for participatory observation pilots have been positive in general. From the authority and for example urban planning point of view, this kind of information is seen as a informative background material, which at its best helps to target further control and investment activities more efficient than earlier. After first trials, it was decided by authorities to use participatory observation to prove an efficiency of a lately constructed biological filtration system for nutrient removal.

Concerning technological performance and accuracy of the presented methods, the gathered data is recommended to be handled as indicative background data rather than precise information, on which further decisions would be based on. The developers were taken special attention to robustness of the observation. To avoid of possible influence of observants, data interpretation was not allowed. The mobile system just collected the data and all processing were made independently. For this reason, the limits of acceptance were not provided to participants as well. The results were presented as open plotted data for this stage at the end of the trials.

The applications presented here represent options, which are currently available to each of us for valuing and engaging the environment. A longer time span and a larger amount of data also allow decision-makers, to react to changes in the state of the environment and to plan improvements to environments that people find unpleasant.

All the other interviewed stakeholders, others than the pilot users, stressed the need for careful information management protocol in order to mitigate the risk for distribution of intentionally distorted information. The concern of misusing the pilot results has been taken into account when planning the pilot implementation, target areas and related stakeholders.

4. Concluding remarks

Based on monitoring pilots, affected community members described the participation in environmental field monitoring as a positive experience. Similar positive experiences in ICT assisted citizen observations have been reported in previous studies. Affected community members reported that the active participation strengthened their sense of being active members in their community. Participants suggested that stakeholder participation in

carrying out environmental monitoring could enhance the amount and quality of information available to the public at large. However, full costs for developing and maintaining smartphone apps need to be evaluated and reported.

In conclusion, while recognizing possible validity and reliability issues we postulate that stakeholder participation in environmental monitoring may provide valuable additional data to enhance the more traditional monitoring conducted by environmental authorities and industry representatives. Involving community members in field data readings allows more comprehensive data gathering and monitoring of larger and sometimes also environmentally sensitive areas, with relatively low costs. While monitoring by contracted experts is usually conducted on one-off basis, affected communities and other stakeholder could conduct monitoring on regular basis. A comprehensive data analysis aids to eliminate data deviations and improves the reliability of the field data.

In these case studies, we piloted stakeholder participation in the environmental monitoring by engaging community members to conduct water quality readings and personal estimations on environmental status. The presented concepts have wider potential and more studies are warranted to explore new ways, how the local community members could actively participate in sustainability monitoring rather than playing a passive role in receiving information from environmental agencies, industry representatives, local authorities and media. The stakeholder participation in monitoring activities not only has the potential to provide more frequent and more nuance primary data, but also to cover wider areas than typically are covered by monitoring protocols.

In conclusion, active participation in the monitoring processes improves trust in environmental monitoring process among stakeholders. Stakeholder participation in environmental monitoring processes builds social capital and could even support in obtaining social license to operate.

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