"RICHIE" – the virtual sewer worker for improved monitoring data quality, network maintenance and operation

Andy Disch[1],*, Annina Brupbacher[2], Frank Lükewille[3], Claudio Manz[4], Simon Kramer[2], David Dürrenmatt[2], Jörg Rieckermann[1]

[1]Swiss Federal Institute of Aquatic Science and Technology, Eawag, Switzerland
[2]Rittmeyer AG, I nwilerriedstrasse 57, CH-6341 Baar
[3]Abwasserverband Altenrhein, Wiesenstrasse 32, 9423 Thal
[4]Hunziker Betatech AG, Pflanzschulstrasse 17, 8400 Winterthur
**Corresponding author email: andy.disch@eawag.ch*

Highlights

- We develop the virtual co-worker "Richie", which foremost supports the operational workforce by supervising i) data quality, ii) infiltration/inflow and iii) the functioning of CSO tanks.
- It is designed to overcome the lack of data literacy and system-level understanding of the sewer maintenance staff by automating repetitive tasks and including engineering domain knowledge.

Introduction and methodology

Some day in the future: *"Mr. Pipe arrives at the office at the small Cleanlake Wastewater Utility on Monday morning. He has to ensure the functioning of 20 CSO tanks and pumping stations of 8 municipalities, troubleshoot alarms and plan operations. In the past, manual supervision of the trendlines from the SCADA system alone took 3 hours per week - an unpopular job with the crew that led to a bad morale in the team already at the beginning of the week. Today, the virtual employee RICHARD (nick name: "Richie"), who is on duty day and night, has already completed the analysis of pump cycles, water levels and power consumption. Overall, strikingly little wastewater is flowing, but this is not unusual for the winter vacations in Cleanlake. Mr. Pipe calms down. However, Richie has also done the 3-monthly I/I analysis and points out that 20% more clean groundwater enters the network from the branch of the municipality Investmentsparse than is permitted. Mr. Rohr needs to discuss this with his supervisor. Richie also recommends that pump No. 23 be serviced in the medium term, but no urgent action is needed yet."*

Although SCADA systems are already used in many sewer networks to collect measurement data, such data are not yet analyzed in an automated manner as in the hypothetical utility Cleanlake – in spite of the considerable replacement value of urban drainage systems in Switzerland of 65 billion CHF (Peter, 2009). Interestingly, many sewer networks are already monitored in detail today (Manny et al. 2019), but the value of the data is neither tapped for operational optimization nor for deficit analysis (Hoppe et al. 2019).

One challenge is likely the low level of data literacy among many staff, especially in sewer system operations, so that even simple analyses are perceived as cumbersome. Although it is recommended that operators check data daily, many operators do not evaluate measurement data (13%) or do so irregularly (49%) (Manny et al.2019). Accordingly, it is not surprising that only about 1/3 of the collected measurement data are plausible (Dittmer et al. 2015; for 300 plants in Baden-Württemberg). And poor data quality usually means too expensive planning (DWA-M 151).

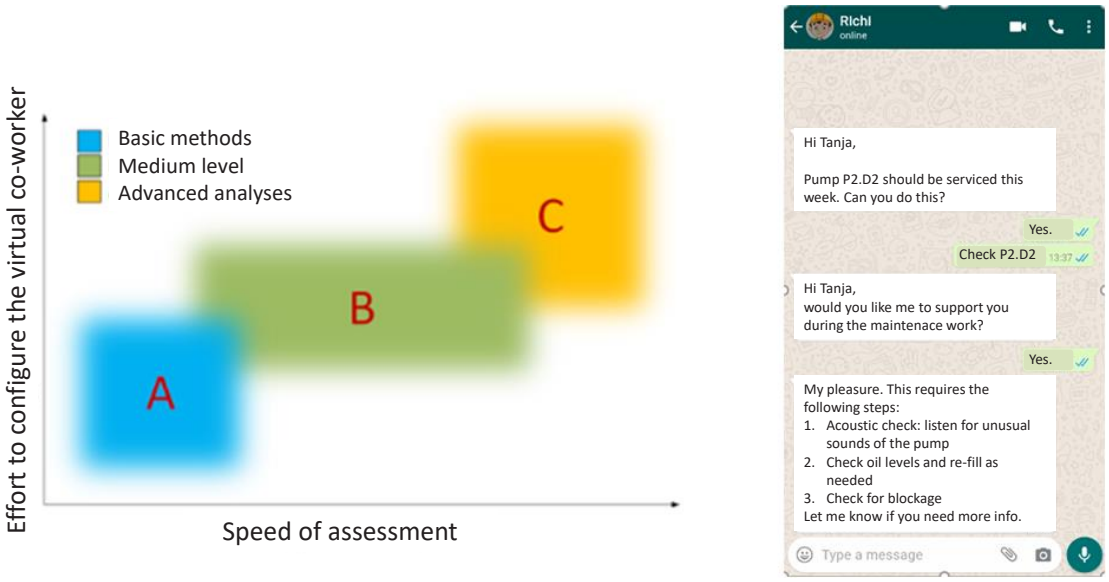

Figure 1: (left) The modular control engine of "Richie" is designed to enable operators to implement flexible signal processing chains using predefined building blocks. The building blocks can provide different evaluation methods depending on the availability and quality of the measurement data. (right) An adapted user interface, e.g. via Messenger, would be advantageous in order to provide optimum support for employees during operation.

For this reason, a virtual employee for sewer network operation is being developed in the RICHARD (RICH Analytical Rule-engine for operational and strategic Decision support) project that can automate recurring data analyses, present key figures clearly, and support employees with important auxiliary information (Fig. 1, right). The 2-year project started in summer 2020. In this article, we would like to discuss the concept and present interim results from a market analysis.

The core technology of "Richie" is a modular rule engine. This enables operators to build flexible signal processing chains based on predefined building blocks. The building blocks can provide different evaluation methods (Fig. 1). The initial goal is to implement three different classes of analysis methods, which have been identified from a market analyses in Switzerland. On the one hand, these consider the customer requirements in terms of speed of assessment and desired configuration effort (Fig. 1, left). On the other hand, they take into account the available information, such as number of signals, data volume, speed and variety. Typically, "basic" type methods use simple, specific thresholds or statistical methods for individual signals. "Medium" methods, on the other hand, process signals from multiple sensors and incorporate external information, such as weather and rainfall data (Garbani et al. ,2019). "Sophisticated" methods are used to monitor the overall system and use data-driven or mechanistic models.

Results and discussion

To assess the potential and tasks of Richie, we conducted a qualitative survey of 18 sewer network operators and 7 cantonal offices responsible for urban drainage in Switzerland. Both smaller and larger operators participated.

Operators would like to see solutions for operational data evaluation, better water protection in rainy weather and analyses of Infiltration and Inflow. Regulatory authorities also see great potential.
The topics discussed were divided into problems of the operators, as well as the potential for virtual assistants and possible tasks for Richie and presented in word clouds (Fig. 2). The larger an expression is

Figure 2. Results of the survey, shown as word clouds. (left) Problems are shown on the left, potential in the middle. Frequently mentioned expressions are larger than rare ones. Opposing statements are distinguished by the colors orange and blue. (right) Assessment of the potential, how motivated the respondents would be to use Richie and whether he would cover the right task area (0- not at all, 10- fully).

represented, the more often it was mentioned. Opposing statements are distinguished by the colors orange and blue.

It was found that the most common problem for operators in Switzerland was that they do not know how reliable their measurement data are. This seems to be independent of the purpose for which the data is being used. Another problem which was mentioned frequently is infiltration and inflow. A distinction was made between the difficulties with temporary discharges and infiltration of rainwater or surface water affecting operations. As the age of the infrastructure increases, so does the effort and problems in maintenance. Periodic evaluations and reporting would also particularly facilitate exchanges with the cantonal regulatory. This should lead to a better understanding of the state of the system, for example through the systematic evaluation of duration and frequencies of CSO spills or alarms for pumping stations, etc.

Based on the results of the survey, the possible scope of Richie's tasks was specified. The main modules will support: i) sewer network operation, e.g. identify and classify anomalies and faults based on monitoring data, support maintenance of pumping stations, provide a standardized screening assessment of an event, ii) infiltration, e.g. by evaluating temporary measurements, help in determining the cost splits, support in identifying sources of I/I, iii) water pollution control: make the performance of CSO tanks transparent based on different metrics.

Conclusions and future work

We conclude that the data literacy gap is serious and will even be more difficult to overcome, when skilled workforce is missing due to over aging. Automating repetitive task does not only support high-level operator employees, but helps everyone who cannot program and does not intend to spend working time in front of a computer. This requires moving RICHIE away from a classical computer interface towards a mobile application. We will validate the acceptance and performance in a broad-based test including many operators.

References

Dittmer, U. et al. (2015) Kenngrössen für die Bewertung des Betriebes von Regenüberlaufbecken, Jahrestagung der Lehrer und Obleute der Kläranlagen- und Kanal-Nachbarschaften des DWA-Landesverbands Baden-Württemberg am 25./26. März 2015

DWA-M 151 - Messdatenmanagementsysteme (MDMS) in Entwässerungsystmen, DWA-M 151 C.F.R. (2014).

Garbani-Marcantini, L., Cereghetti, G., Muschalla, D., Regneri, M., Schegg, S., Rieckermann, J. (2017). Playing the rain: a chess-based rating algorithm for the performance assessment of real-time control in urban drainage networks (p. (8 pp.). Presented at the 14th IWA/IAHR International conference on urban drainage (ICUD). Prague: CZWA; CTU.

Hoppe, H. et al. (2019). Datenbasierte Planungs-, Betriebs- und Vollzugskonzepte zur nachhaltigen Regenwasserbehandlung. In J. Pinnekamp (Ed.), Gewässerschutz - Wasser - Abwasser: Vol. 250. 52.

Manny, L., Fischer, M., Staufer, P., & Rieckermann, J. (2019). Saubere Gewässer dank Messdatenmanagement. Instrumente für einen guten Umgang mit Messdaten in der Schweizer Siedlungsentwässerung. Aqua & Gas, 99(1), 58-65.

Peter, M. (2009): Wiederbeschaffungswert der Umweltinfrastruktur. Umfassender Überblick für die Schweiz. Umwelt-Wissen Nr. 0920, Bundesamt für Umwelt (BAFU). Bern.

Rieckermann, J. et al. (2017): Zukunftsfähige Systeme zur Regenwasserbehandlung brauchen datenbasierte Betriebs-, Planungs- und Vollzugskonzepte, Aqua Urbanica 2017, TU Graz. Graz.