Applicability of sensors and internet of things for monitoring of storm and groundwater infiltration in sewage systems

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INTRODUCTION

Våler is one of the fastest growing municipalities of the Viken county (southeast of Norway). It has around 80 km of sewage network mostly from the early seventies, 23 pumping stations and a wastewater treatment plant (650 p.e. from 1981). A deterioration of the sewage infrastructure and significant increase in precipitation due to climate change cause infiltration of both storm and/or groundwater in the sewage system.

The Norwegian Water association (in Norwegian: Norsk Vann BA) estimated a need of investment in Norway (2016) of 28 billion Euros to upgrade water utilities by 2040 [1]. Challenges such as topography, pipe materials (e.g., concrete) and a cost recovery financing scheme are putting pressure on water supply and wastewater treatment utilities in the municipalities. In addition, other factors such as population growth and climate change increase the hydraulic load in the municipal water supply and sewage networks. Municipalities in Norway are experiencing storm and groundwater infiltration in water utilities either as hydraulic load in sewage pipe network or a source of contamination in drinking water supply [2].

In Våler, sewage pipelines and pumping stations transport approximately 20-30% of infiltration water per year to centralized wastewater treatment plants [3]. This amount of infiltrated water in the sewage system represents a significant operational cost (e.g., maintenance of the pumping stations and energy consumption) for the municipality. There is a need for decision making tools that could decrease this operational costs.

AIMS OF THE STUDY

- To apply an internet of things (IoT) digital network of sensors for live water amount measuring as a decision-making tool that could decrease operational costs of municipal sewage systems.
- To design a methodology for effective upgrading of the sewage network and for a more strategic urban planning.
- To reduce the risk of overflow in the municipal wastewater transport system.
- To develop an algorithm that will the base for further development of an artificial intelligence (AI) system.

MATERIALS AND METHODS

The study used six water amount sensors and two rain gauges installed in cooperation with the intermunicipal operational assistance (DaiV IKS) inside manholes and connected to the internet as shown in Fig. 1. The sensor technology was created by the company MIWAS AS and it was sending live data of water level in the manhole (mm), flow rate (L/s) and volume (m^3). The data was stored in a cloud-based solution and displayed in an application portal designed by MIWAS AS.

Figure 1: Water amount sensor connected to a 4G internet network and installed in a manhole.

1. A GIS water utility network application (Gemini VA) was used and outer points in the sewage network were selected as the first step in the upgrading strategy.
2. The second step required to map the outer parts of the sewage municipal network in order to get an overview of the water infiltration.
3. The third step implied to move and install the sensors towards the inner parts of the distribution system of the neighborhoods as well as the city center of the municipality for a more detailed search of the water infiltration.

RESULTS AND DISCUSSIONS

Figure 2 shows the results of level in the manhole (mm), flow rate (L/s) and water amount (L) after 2 weeks in an unaffected area by infiltration of water and usual load in the distribution system.

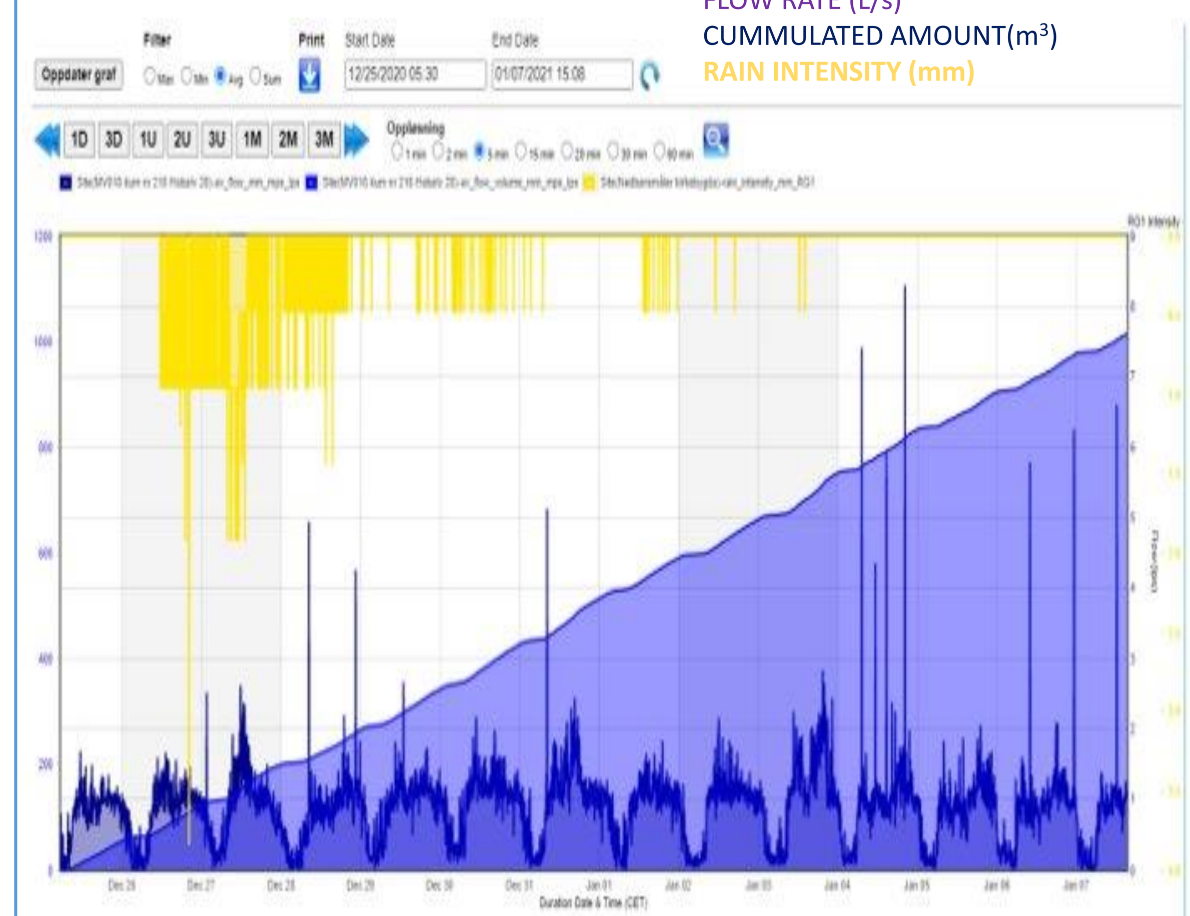

Figure 2: Water amount sensor connected to a 4G internet network and installed in a manhole.

In contrast, one can have a different behavior when there is infiltration of rainwater directly into the municipal sewage system as shown in Fig. 3.

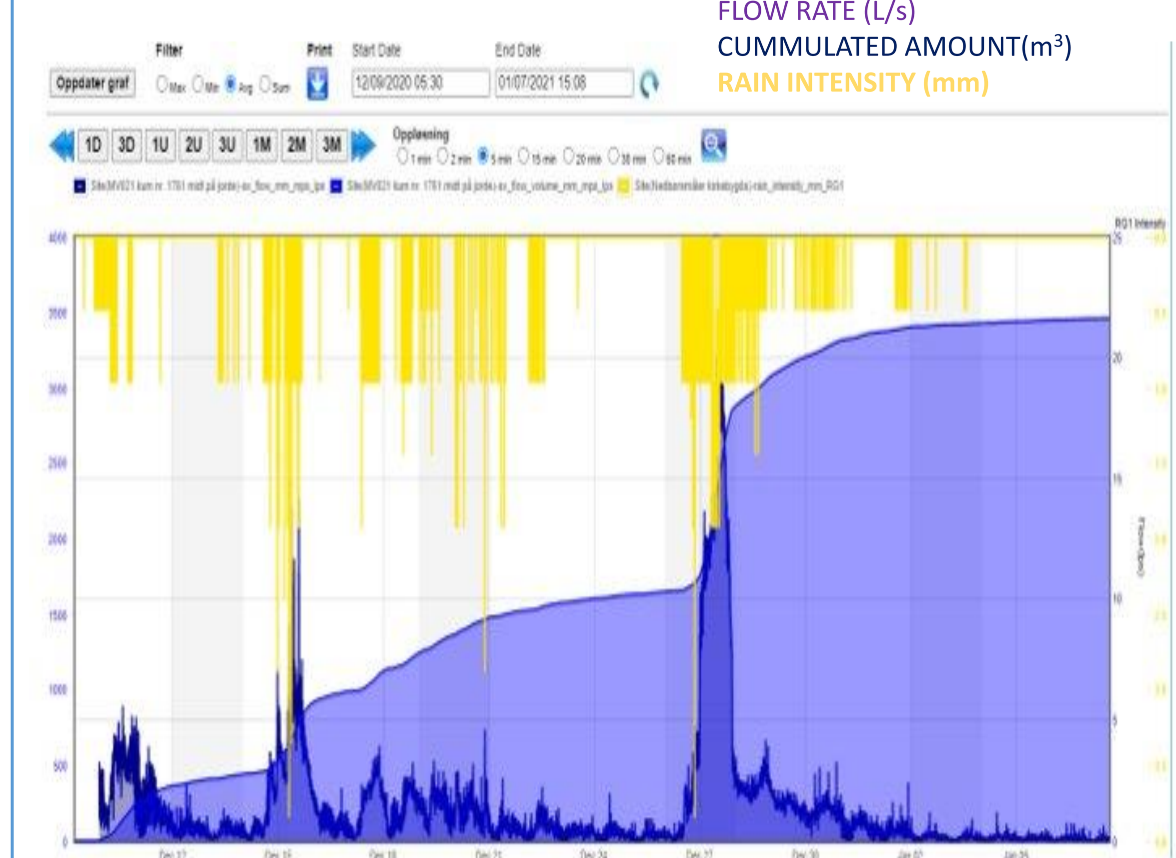

Figure 3: Area affected by infiltration of storm water.

In addition, groundwater can infiltrate and overload the sewage system over a longer period as seen from Fig. 4 and in comparison, to the direct effect of rainwater (Fig. 3).

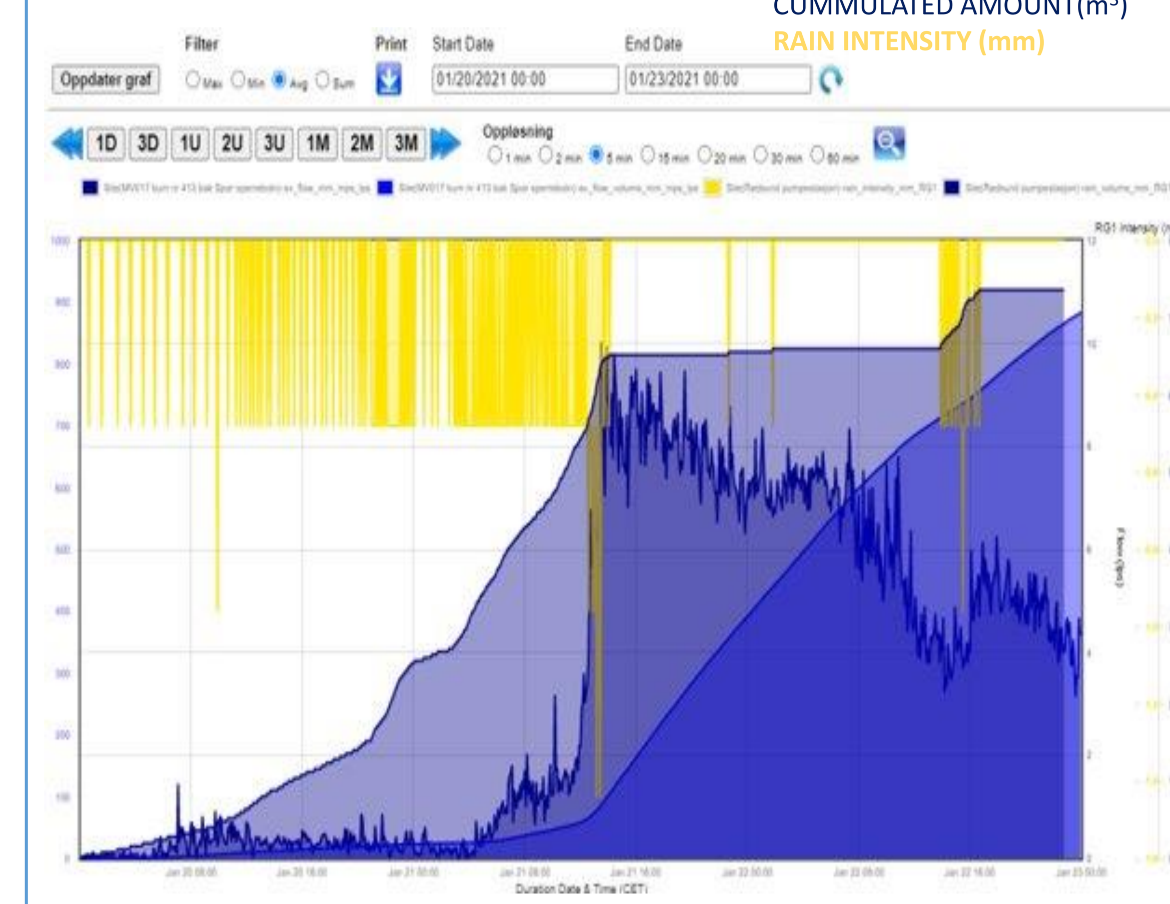

Figure 4: Area affected by infiltration of groundwater.

Water amount sensors placed in strategic points of the sewage network give the possibility to detect infiltration of water [4] at a faster rate than with conventional pipe inspection technologies (e.g., robot/drone with camera). Thereby, the upgrading of the sewage system can be planned in a more effective way. The results confirm that the IoT digital tool combined with a GIS water utility network application can contribute to decision making and to decrease operational costs in Norwegian municipalities.

CONCLUSIONS

- The technology has the potential to detect the amount and type of water infiltration and thereby the overloading of a sewage system.
- An overview of the condition of the whole sewage distribution can be achieved by further developing the methodology.
- This approach can be used for prioritizing the upgrade and maintenance of the sewage system in a more systematic way with real and online data.

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