SMART WASTEWATER NETWORK MANAGEMENT – INTEGRAL TO INDIA'S SMART CITY MISSION

By Sam Konstantinov

To guide cities on how to successfully adopt a smart wastewater network, SWAN, together with leading industry partners developed the Interactive Wastewater Network Management Tool available for free on the SWAN website (http://www.swan–tool.com/wastewater–network–management). Cities can click on individual technology components within the SWAN five–layer architecture to learn about their function, benefits, and system requirements shown in Figure 5.

For example, clicking on the "Rain Gauge" icon, located in the Level 2 sensing layer leads to a page that describes the function of the rain gauge within a data–driven wastewater network. It highlights the ability to alert a system during a particularly large rain event and describes the benefits of collecting real time rain data and the existing system requirements to properly implement such a device. The Tool then demonstrates how a Level 3, RTU device stores and sends data from the sensing level to the management and display interfaces. Ultimately, Tool users can understand how a smart wastewater interconnects, drill–down on individual technology components, and view practical case studies and benefit analyses which illustrate the business case for adopting these solutions. SWAN's Solutions Provider page further allows cities to navigate through a database of smart water technologies by SWAN member, according to their interests.

Sanitation remains a primary concern for India, as 70% of urban household waste goes untreated. Rapid population growth and unpredictable weather patterns such as monsoon rains have exacerbated India's already poor infrastructure vastly increasing the volumes of sewage overflows in urban areas. This poses a severe risk to the health and safety of the population, as well as river ecosystems. Given India's ambitious initiative to create 100 Smart Cities by 2020, effective wastewater network management should be recognized as integral to this goal.

India's Current State of Sewerage Infrastructure

According to a 2017 census, only 33% of Indian urban households are connected to a modern sewage system. Sewage systems in many cities are not well defined, thus open flow channels transporting raw sewage to rivers remain an issue. Many outfalls designed to transport stormwater deliver partially treated and untreated wastewater to nearby rivers shown in Figure 1.

Almost 40% of the total sewage treatment capacity of India exists in just two cities: Delhi and Mumbai. This concentration demonstrates the underdevelopment of nationwide sewage treatment systems. A lack of critical infrastructure has a direct negative impact on India's economy. For instance, in 2008, India's Ministry of Urban Development stated that lack of sanitation

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infrastructure cost India INR 2.4 trillion, amounting to over 6% of its GDP (Ministry of Urban Development, 2008).

Unpredictable weather patterns also have a large impact. Monsoon rains result in approximately 75% of India's annual rainfall. When overwhelmed, storm systems back up, combine with wastewater networks and cause severe floods. In addition to environmental damages, these floods destroy property and infrastructure. Flooding is estimated to cause USD 5 million dollars in damage per event. Therefore, India's lack of developed infrastructure and severe weather patterns are major hurdles which must and can be addressed through data–driven solutions.

A Smart Approach to Wastewater Network Management

The goal of a Smart City is to increase the quality of life for its inhabitants. The Smart Cities Council defines a "Smart City" as a city that uses information and communications technology (ICT) to enhance its livability, workability and sustainability. A "Smart Wastewater Network" incorporates real–time information to allow city operators to stay informed about events out in the field and respond quickly and appropriately when a problem arises. At the basic level, this includes raising alerts to potential flooding and pollution problems and at the most advanced level, actively managing flows to protect customers from flooding and the environment from pollution events, while balancing flows in the network to allow treatment systems to operate at the optimal efficiency level. ☞ www.swan–tool.com

Smart wastewater network solutions can constantly analyze rainfall, flow and level data, integrate it with historical information, and then apply predicative models like real–time rainfall–runoff simulation, watershed management, real–time operation optimization, asset management and capital planning models. This enables planners to correlate data streams over select timeframes and export the data for offline analysis. Such solutions can also be used to increase treatment efficiency by balancing flows throughout the process, depending upon underlying environmental conditions, and ensuring flows through the process are always within permitted conditions. Depending upon the capacity that is available, this can limit the requirements for additional temporary flow storage facilities. The two case studies of Indian smart wastewater network management deployed in Delhi and the Ganges River are: ☞ www.swan–forum.com

Figure 1: An Outfall in Varanasi, India Discharging Unprocessed Sewage

Advanced Network Modeling in Delhi

In 2014, the Delhi Jal Board implemented a network modeling solution as part of their 2031 Master Plan to develop new sewerage infrastructure. The plan covered an area of 1,500 sq. miles and cost $3.25 billion (Smart City Council, 2017). AECOM, which specializes in developing, building, financing and designing major infrastructure, created hydraulic designs for the initiative and Delhi Jal Board used Bentley System's SewerGEMS software to analyze the 10,000 km of sewerage network in Delhi. (Smart City Council, 2017). The ongoing project is divided into a "sewershed area phase" and "unsewered phase." The sewershed phase includes auditing 30 existing sewage treatment plants at 17 locations, hydraulic modeling of the trunk sewer for integration with the unsewered zone, flow monitoring and wastewater sampling at strategic locations, and conditional assessment of 500 manholes (AECOM, 2017). The unsewered phase comprises an extensive geotechnical investigation for 2,200 unsewered colonies, developing a wastewater management

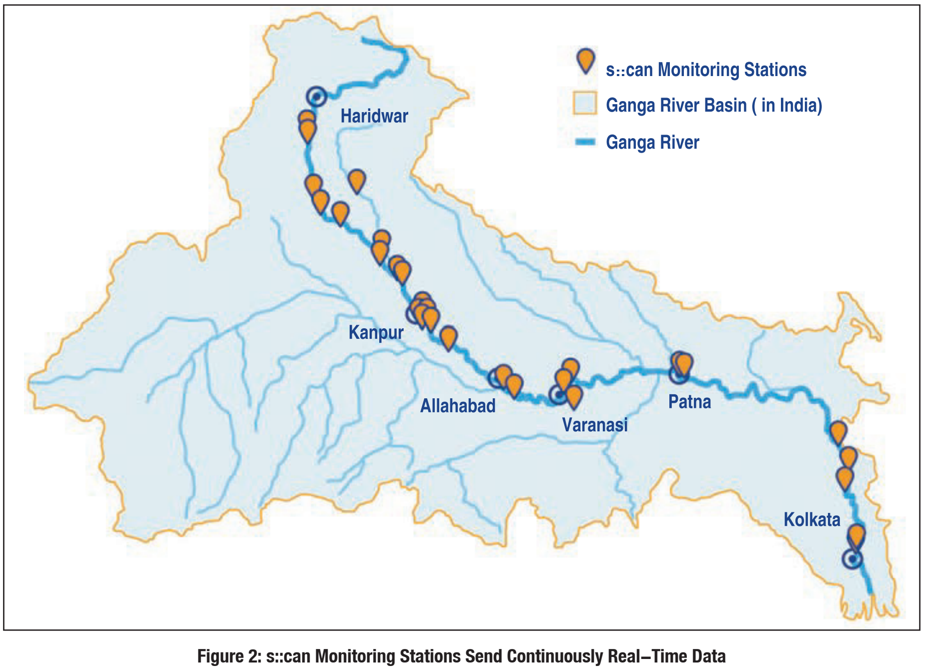

Figure 2: s::can Monitoring Stations Send Continuously Real–Time Data

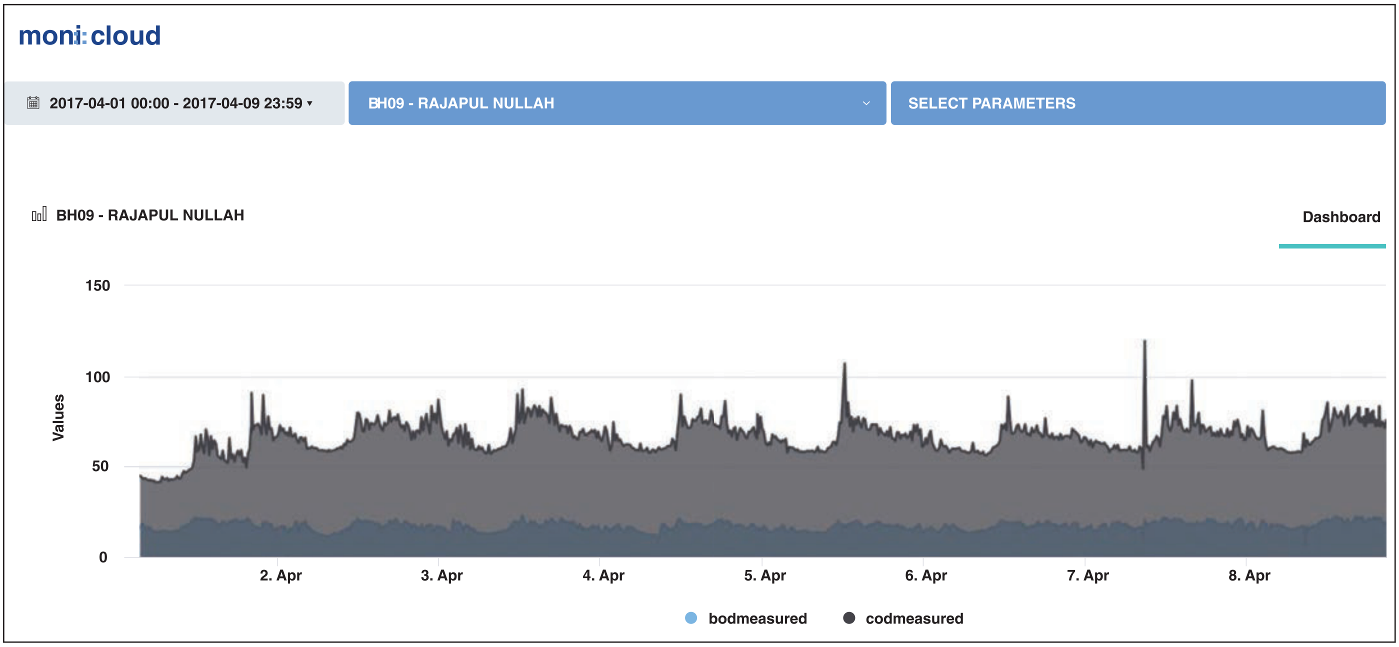

Figure 3: Visualization of High BOD and COD Pollutions in Ganges Tributaries (s::can, 2017).

information system, including development of an enterprise geographic information system (GIS) framework, integrating and close coupling of sewerage information in the GIS database to carry out hydraulic modeling, and evaluating the unsewered area for 1,600 remote colonies (AECOM, 2017).

Real–Time Water Quality Monitoring in the Ganges River

The Ganges River is an important source of water for over 400 million people in India and also has valuable cultural significance.

Figure 4: SWAN's 5–Layer Smart Water Architecture Model

Due to fast population growth, migration and industrialization, the pollution of the Ganges has become a major issue. Therefore, the "National Mission for Clean Ganga" was born in 2011 by the Indian government. The installation of a smart water quality monitoring network was part of this initiative. The Central Pollution Control Board (CPCB) assigned s::can Messtechnik GmbH and their local partners with the design and implementation of a 10–station pilot network. Due to the excellent performance of the pilot project, a 5 year water quality data supply contract was signed by s::can and CPCB in July 2016. Starting from s::can's project office in India, the s::can Ganges project team coordinated the installation and organization even in the most remote areas of India. The water quality network was designed, installed and now is operated by s::can in close co–operation with their local joint venture partner. In March 2017, the 36 additional s::can monitoring stations went online. The measuring stations continuously send real time water quality data, on hourly basis to the CPCB in New Delhi. Below, Figure 2 shows the location of the monitoring stations.

17 parameters are monitored: TSS, COD, BOD, EC, pH, Temperature, NH4–N, NO3–N, DO, Cl, K+, F–, Turbidity, TOC, BTX, Water Level and Temperature. For processing and evaluating tremendous amounts of data, moni::cloud, a specialized software solution, was designed. This software not only includes data evaluation, alarming and visualization elements, but also a focus on asset –and stock management to manage logistics for global monitoring projects. Below, Figure 3 shows one possibility how parameters can be visualized in moni::cloud.

The collected information strengthen the regulation and oversight of the river's pollution load by helping planners to understand the origins of pollution, as well as to assess the impact of treatment on the water's quality.

The Role of SWAN in the Smart Wastewater Discussion

SWAN, the Smart Water Network Forum is a global hub for the smart water and wastewater sectors. A non–profit organization, SWAN brings together key players in the water sector to collaborate and share knowledge while offering access to cutting–edge research, global networking opportunities, and the ability to proactively influence the future of the water industry. To help cities better understand how a Smart Water Network interconnects, SWAN devised a five–layer, architecture model given in Figure 4.

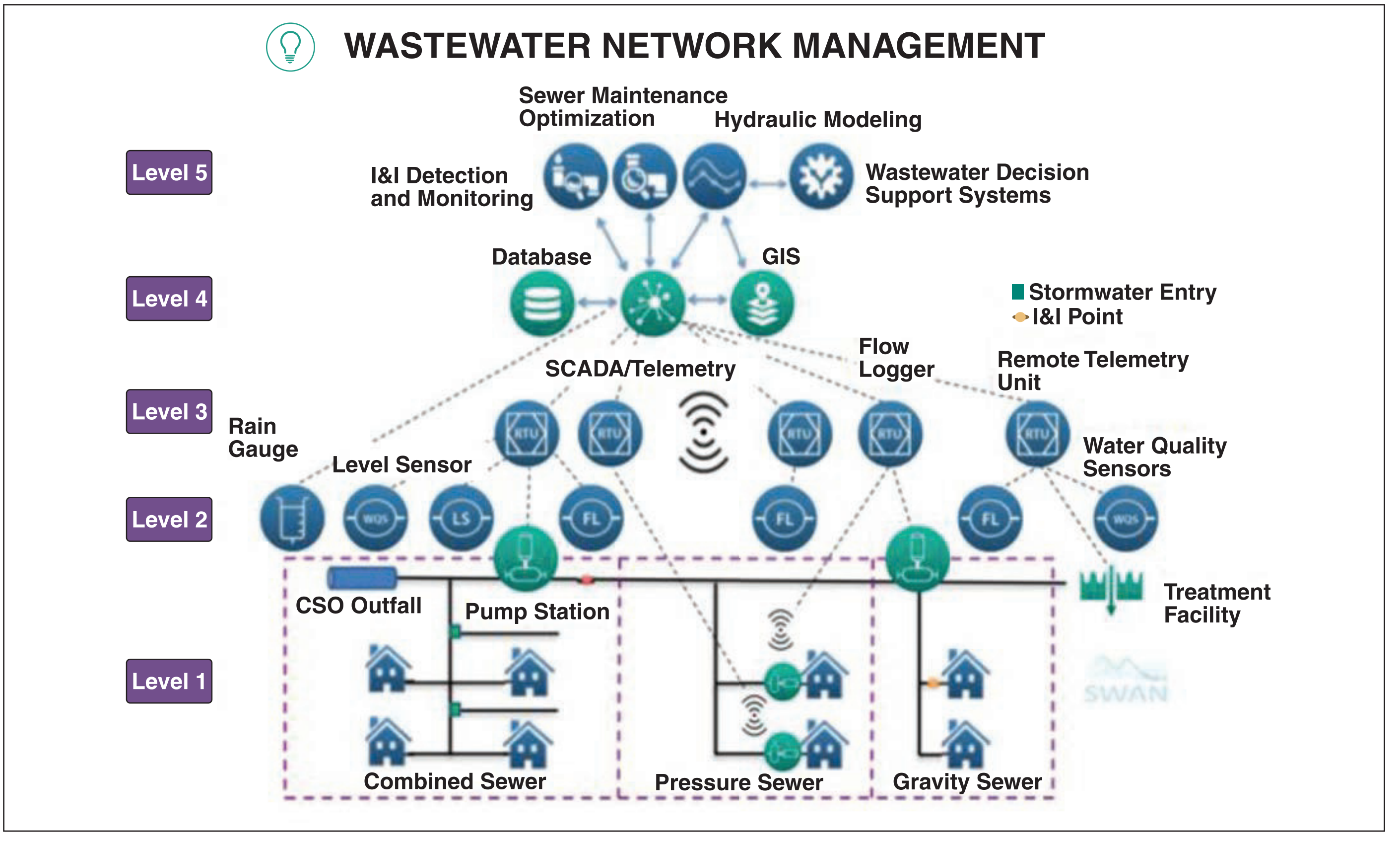

Figure 5: SWAN Wastewater Network Management Solution

The first, "Physical" layer brings together the components for delivering water (i.e. pipes, pumps, valves, reservoirs and delivery endpoints). The second, "Sensing and Control" layer, comprises equipment and sensors that measure various parameters (e.g. water quality, rain, flow, reservoir levels, water temperature, pressure, etc.). This data is then transmitted and stored through the "Collection and Communications" layer, which includes fixed cable networks, radio, cellular, Wi–Fi, etc. The fourth layer, "Data Management and Display" interfaces information for human operators such as dashboards, SCADA (Supervisory Control and Data Acquisition), GIS (Geographic Information System), and other network visualization tools. The fifth and most advanced layer, "Data Fusion and Analysis" integrates data from the below four layers to provide hydraulic modeling, decision support systems, inflow and infiltration detection systems, etc. Applying these different layers to smart wastewater network can help cities become more efficient and reduce health and environmental impacts of sewage overflows.

Building Towards a Smart Wastewater Future

India's ambitious plan to build 100 Smart Cities by 2020 has placed a strong emphasis on utilizing data–driven solutions to address urban challenges. However, in much of the county, there is no basic water or sewage infrastructure. Thus, cities will need a long–term approach in addressing their wastewater network challenges.

The SWAN Wastewater Network Management Tool provides cities an interactive resource to learn about available solutions and view existing global case studies.

About the Author

Sam Konstantinov is a Research Analyst at the SWAN Forum. Sam has experience analyzing data from smart water systems that monitor combined sewer overflows, stormwater infiltration, and treatment plant operating practices. He holds a Bachelor's degree in environmental studies from Temple University, Philadelphia.

Smart Water Networks Forum (SWAN) is a global non–profit promoting the use of data–driven technologies in water and wastewater networks worldwide. By aligning industry leaders and fostering collaboration, SWAN can proactively influence the future of the water industry. SWAN itself offers a central source of information about the smart water and wastewater networks through cutting–edge research, webinars, workshops, an annual conference, numerous networking opportunities, and the new SWAN Asia–Pacific Alliance, which is free to join and will act to accelerate smart water and wastewater development in the APAC region.

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