RIVER MONITORING GOES BIG DATA – DaaS APPROACH FOR REAL TIME RIVER MONITORING OF GANGES

By Lukas Kornfeind, Andreas Weingartner, Robert Wurm and Elisabeth Ebner

River Ganges

36 s::can stations monitor the quality of the water in the Ganges River in India and continuously send real time water quality data to the Central Pollution Control Board (CPCB) in New Delhi, the local government authority. The collected information strengthen the regulation and oversight of the river's pollution load by helping planners better understand the origins of pollution, as well as to assess the impact of treatment on the water's quality. The project is outstanding due to its size and the used DaaS business model, which is new in the water monitoring industry and shifts a lot of the project risk from the customer to the data provider. ☞ **www.s–can.at**

The Ganges is a trans–boundary river which flows through India and Bangladesh. The 2,525 km river rises in the western Himalayas in the Indian state of Uttarakhand, and flows South and East through the Gangetic Plain of North India into Bangladesh, where it empties into the Bay of Bengal. By discharge, it is the third largest river of the world after Amazon and Congo River. The Ganges basin covers nearly one–fourth (26.3 percent) of India's total geographical area, and is the largest river basin with a catchment area of 760,407 km^2.

Due to fast population growth, migration and industrialization, the pollution of the Ganges has become a major issue for India and one of the biggest environmental challenges on earth. The Ganges River is a holy river and a goddess

A NEW CONCEPT IN RIVER MONITORING, "DATA AS A SERVICE", WAS ESTABLISHED FOR COSTUMER WHICH MAKES SECOND PHASE OF GANGA CLEANING CERTAINLY A PIONEER PROJECT IN TERMS OF WATER QUALITY MONITORING WORLDWIDE.

according to Hindu religion, thus it is a major concern for every Hindu to reanimate and keep it alive. To clean the river is not only a big technical challenge, but also of enormous cultural and spiritual importance. Therefore, an Action Plan was initiated by the Indian Government in 1984 with the financial support of the World Bank and the Government of Netherlands, aiming at the control of the rising levels of pollution. The plan was to identify and mitigate major sources of wastewater and other point–source discharges into the River through the construction of interceptor sewers, sewage diversion mechanisms and sewage treatment plants.

In order to monitor and control pollution, a pilot project was initiated in 2013. The installation of a smart water quality monitoring network was part of the "Clean Ganges" initiative. Supported by the World Bank, 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.

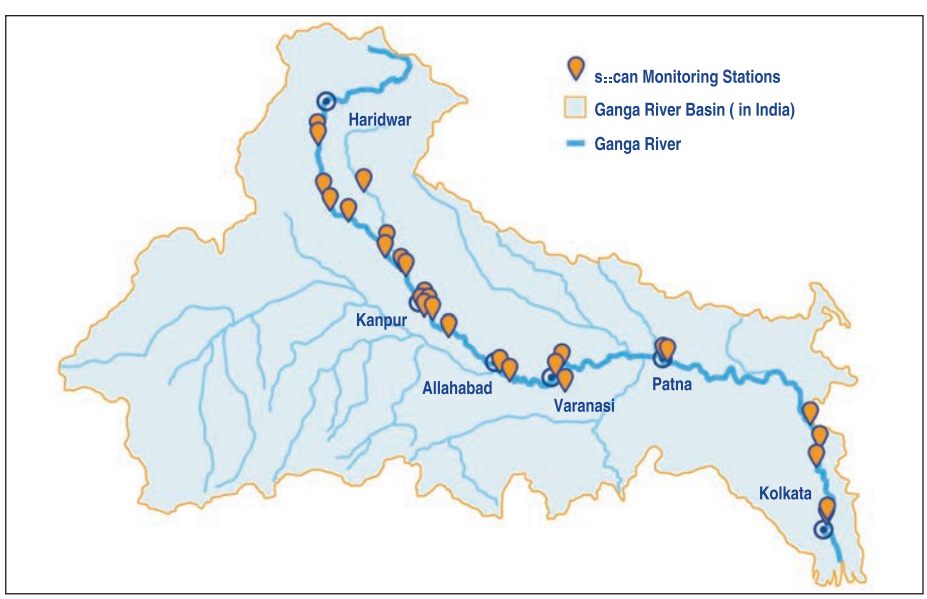
Due to the excellent performance of the pilot project, a 5 year water quality data supply contract was signed by s::can Messtechnik GmbH and CPCB in July 2016. Starting from s::can's project office in India, the s::can Ganges project team coordinated the installation and organization even in the most 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. On March 11th 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. This project is the 2nd phase of an even larger program to acquire reliable water quality data along the Ganges, and other Indian rivers. It will be a reference for other global water monitoring networks: a new concept in river monitoring, "Data as a Service", was established for the costumer which makes the second phase certainly a pioneer project in terms of water quality monitoring worldwide.

Data as a Service (DaaS) Approach

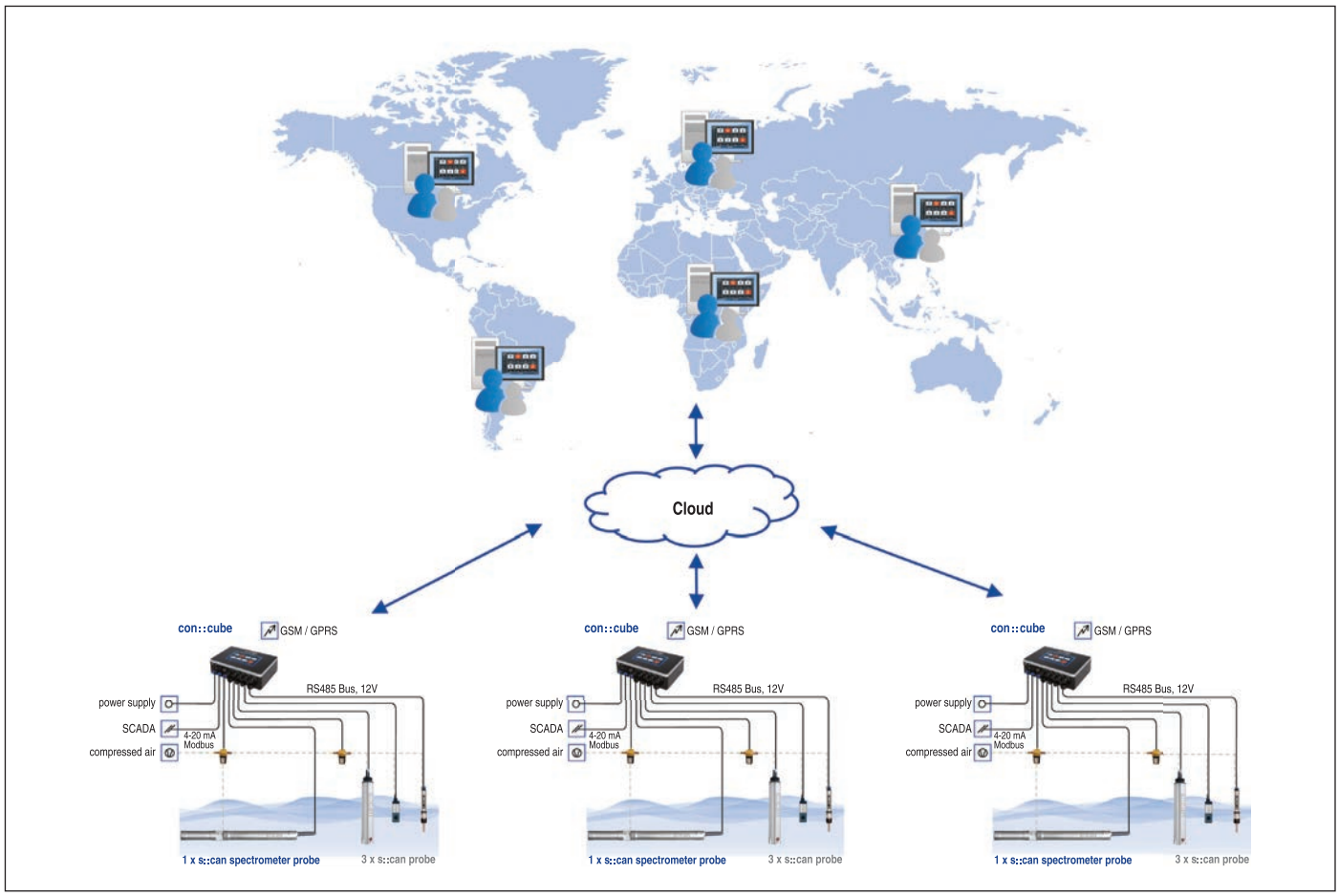
s::can, known as technology leader in online spectrometry and producer of innovative water quality sensors and systems, used a new business model for this outstanding project. The new concept of "Data as a Service" was established within the contract between s::can and the CPCB. The service provider s::can is compensated for the delivered data, under the condition that the network is online and transmits the parameters of each single station, as criteria of a functional monitoring grid. The CPCB controls with the help of grab samples the quality of the data. This provides

s::can Energy Autarkic – s::can Monitoring Station

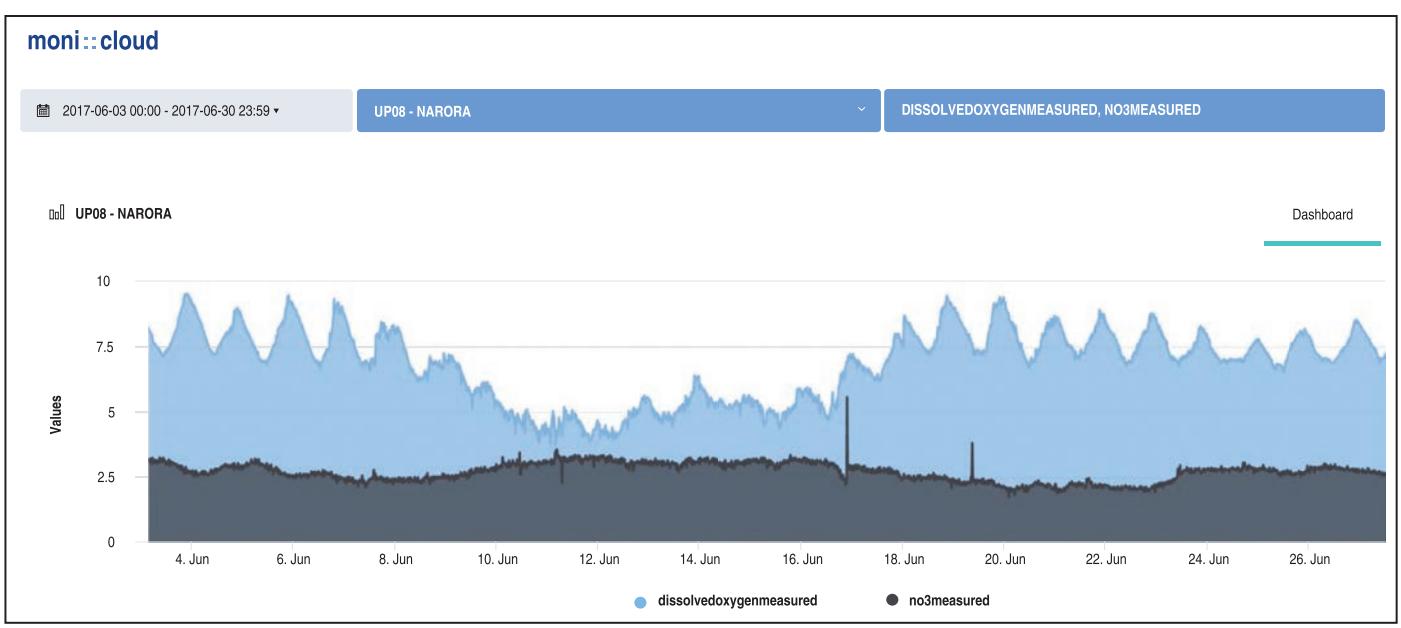
s::can Monitoring Station



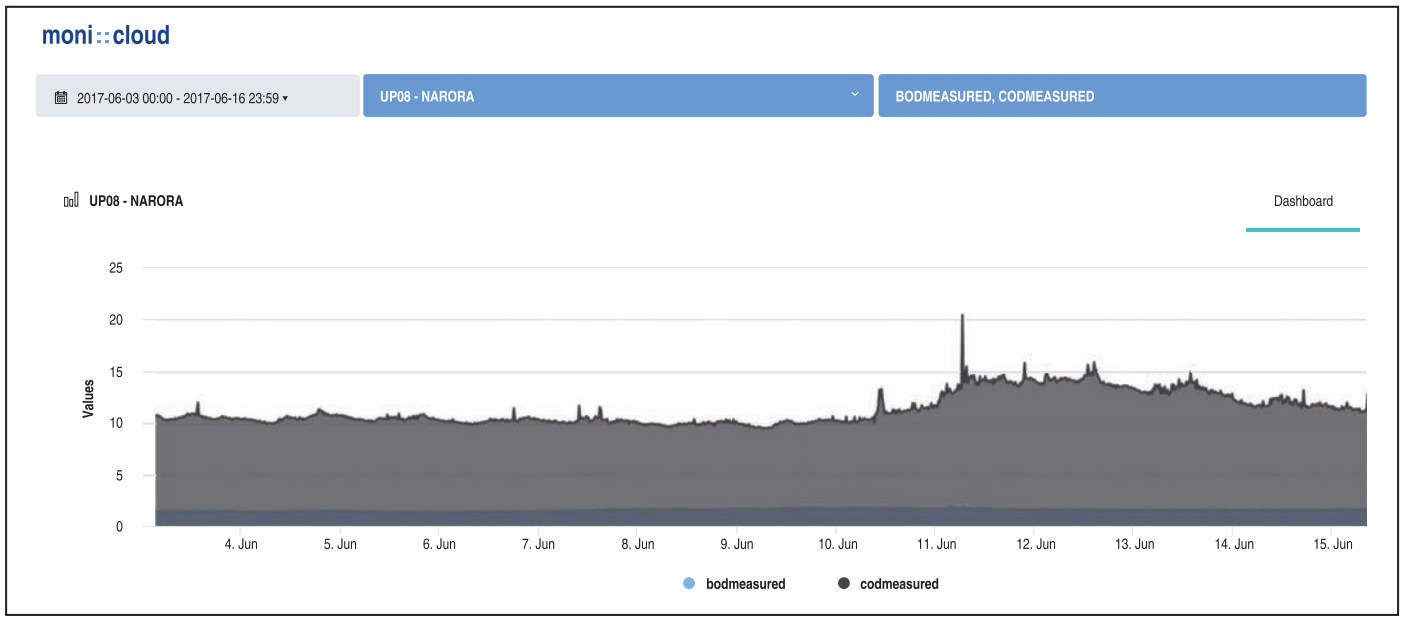
s::can Stations Monitoring Ganges



Example of a Scheme of Worldwide s::can IoT Network



NO_3 and Oxygen Conditions in North Remote Areas of the Ganges



BOD and COD Values Low Carbon Fractions in the North

many benefits for the CPCB, as the government authority only pays for the data they really get. The project risk hereby is shifted to the provider. This innovation will be the fundament of a future design in water quality monitoring approaches as in most cases the customer is only interested in the data and the related information. This content will be directly implemented in state of the art data solutions for comfortable data handling and preventive software solutions. New approaches are never an easy path to go, as visionary solutions always create challenges. Minor adoptions in complex monitoring systems create very positive effects in highly differentiated regions.

Challenges of a Pioneer Project

During the first project starting in 2013 to 2015 s::can learned many lessons facing all kinds of local challenges. Considering Ganges monitoring as a global reference this pilot phase had a deep impact on the design and development of the 36 follow up stations, creating the basis for the data supply contract.

Major improvements compared to the first project were realized in the monitoring network:

- Mechanical design: Adoptions to local needs and challenges in extreme environmental conditions
- Vandalism protection: As in some areas vandalism is a problem, a design focus was on protection against third party interference.
- Energy supply: As the crucial element of rural situated monitoring stations the whole energy demand had to be adapted to guarantee an autarkic supply solution
- Telemetry: Data supply is always dependent on reliable transfer rates. New solutions had to be developed in profound work with close cooperation partners.
- Cloud & software solution: Due to big amounts of data which have to be processed and evaluated, moni::cloud, special designed 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 huge river monitoring projects.
- Reliable reference data (laboratory) for interval calibration of the instruments.

Description of a Real Time Water Quality Monitoring System

Monitoring stations were installed by s::can together with local alliances at 36 different locations along the Ganges River, to monitor a maximum of 17 parameters : Total Suspended Solids (TSS), Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Electrical Conductivity (EC), pH, Temperature, Ammonium (NH4–N), Nitrates (NO_3–N), Dissolved Oxygen (DO), Chloride, Potassium, Fluoride, Turbidity, Total Organic Carbon (TOC), BTX, Water Level and Temperature.

The main interest is focused on organic pollution (expressed by COD and BOD), and to nitrogen nutrients (NH4, NO3). Especially for those normally expensive and difficult to measure parameters, a so far unknown level of reliability and stability has been reached. All parameters are measured by innovative sensors, preferred optical, that are reagent–free and operate almost without maintenance.

The monitoring stations consist of:

- Up to 6 sensors each to measure 17 parameters (more possible)
- Station terminal with SQL postgress data base, interfaces for – almost any number of – digital and analogue sensor inputs, SDI–12, Modbus, USB, TCP/IP–Ethernet, 4–20 mA, and other interfaces.
- moni::tool station and data management, data validation and event detection software
- Battery charging system (battery, solar charger, solar panel)

- Autobrush cleaning for energy optimized cleaning of sensors
- VPN access for remote control
- Cameras and alarm sirens, security cages and other protection against vandalism

Although all stations are secured against vandalism, local people take care of the stations because they are in favor of such project to protect their holy Ganges River against pollution.

All real–time data are automatically transferred via a GPRS network and a secure SSH protocol to a receiving cloud server and afterwards directly sent to CPCB central office in New Delhi. The central data system has the capability to receive, analyze, display and store the data received from the 36 remote monitoring stations, and links the information to a GIS–system for geographical display and analysis. All the monitoring stations are operational in a real–time mode, and each station can be accessed from the central server.

Smart Data and IoT Solution

In case of the DaaS Ganges project s::can creates more than 22 million data sets per year. As data handling becomes more and more challenging as the data volume increases automatically smart solutions have to be implemented.

In the first place reliable data availability has to be provided for a smart solution. The telemetry design was adapted with elements specifically produced for field applications. Equipped with multi–provider SIMs, with intelligent switching between network carriers according to signal strength, the data transmission is also in remote areas of the Ganges catchment guaranteed.

Every day, thousands of data files are transmitted directly into an Azure cloud and there processed into a SQL data base. This IoT (Internet of Things) instrument guarantees nearly 100% availability and accessibility of data. Linked to the data base, moni::cloud provides a visualization tool and widespread utilities for data and asset management. Alarming as well as preventive maintenance tools create a platform for project steering and big data handling.

In case of huge DaaS projects, these tools are indispensible to guarantee the customer with a reliable data supply.

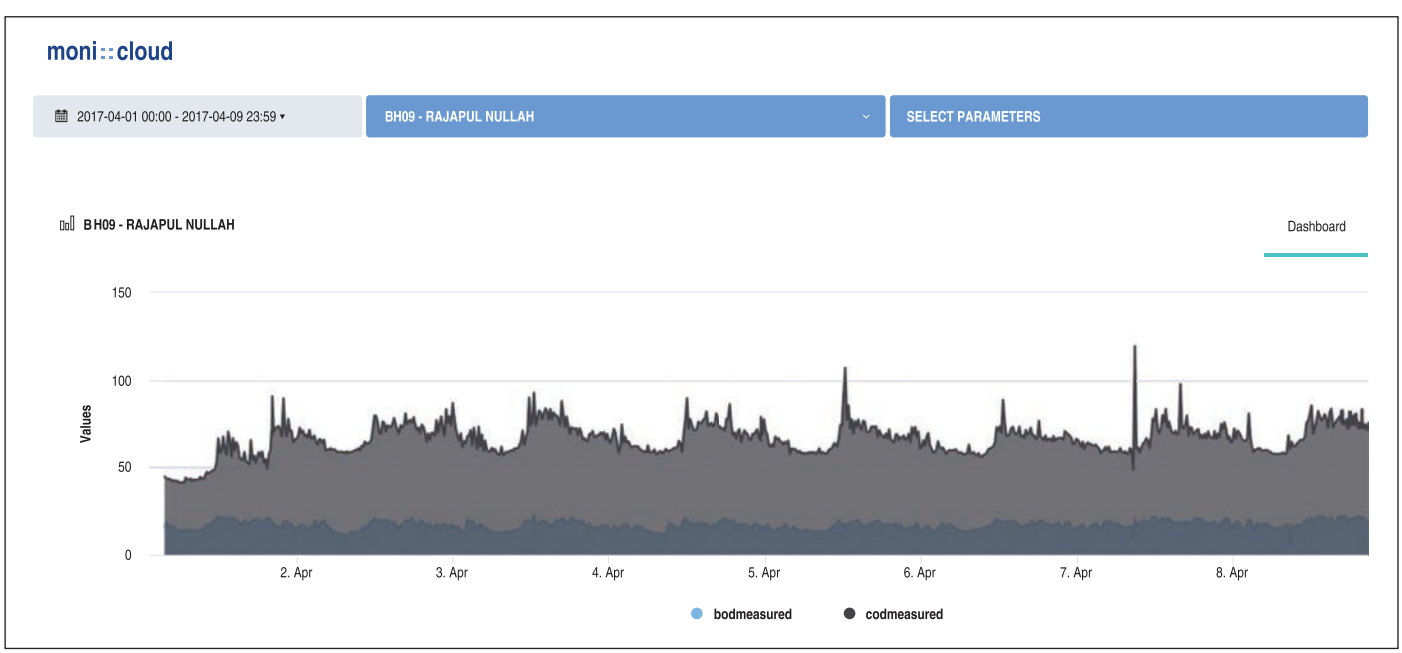
Monitoring Networks and their Contribution to Water Quality

The main focus of the Ganges real time monitoring project is to find organic and nitrogen pollutions in the river catchment and to analyze where most of the pollution occurs. In combination with classical parameters like pH, conductivity and dissolved oxygen the “pollution fingerprint” of river water can be created. With internal online validation tools in s::can terminals (vali::tool), pre evaluation of data is arranged for the further correlation between the different parameters in moni::cloud.

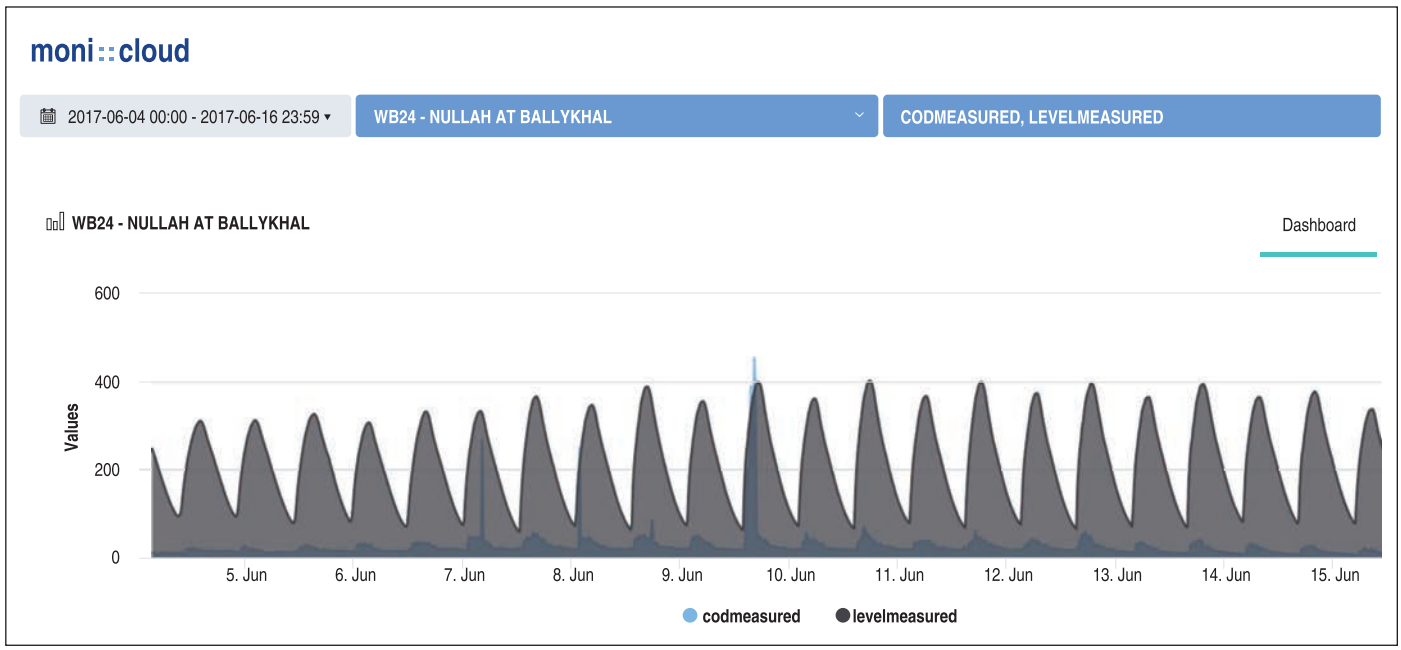
Because of the huge catchment of the Ganges River, the physicochemical conditions vary. In the northern remote areas where the anthropogenic pollution loads can be naturally metabolized through biologically processes and dilution, the Ganges River carries very low BOD and COD levels. This information in combination with correlations to oxygen and nitrogen level shows the image of a clean river.

In the central area between Kanpur and Varanasi, the pollution increases as many tributary discharges into loads of organic compounds into the Ganges. Not only domestic wastewater influences the water quality in this region, also industrial influences have a major contribution to the pollution. As well, the dissolved oxygen level drops nearly to zero due to high biological activity.

In the eastern region the Hooghly river, a distributaries of the Ganges river, discharges



High BOD and COD Pollutions in Ganges Tributaries



Tidal Effects in West Bengal

the West Bengal sea. Kolkata, the capital city of West Bengal is the last contributor to the river before entering the sea. Monitoring stations were placed in channels to measure the organic pollution discharging into the river. As Kolkata is located only 80 km from the sea, tidal effects are influencing the channels as freshwater is pushed into domestic waster, bringing dissolved oxygen to activate biological processes.

One of the advantages of online monitoring networks is the continuous measurement to detect pollutions over a certain time frame. Traditional discrete measurements are always only a snapshot of the conditions, and sampling and transportation can lead to major losses of organic pollution components and consequently a misinterpretation of the water quality. The online measurement of the Ganges, in a dense monitoring grid, will be the fundament for CPCB for further steps in the "Clean Ganges" initiative.

Benefits

The described DaaS is a new business model in the field and offers a vast amount of benefits for the client. The risk stays with the data provide, as the client only pays for the data he receives. The client does not need to take care of operation, service and maintenance of the stations. In case of the Ganges project even data pre evaluation is made to guarantee the customer reliable data. The costs are foreseeable and can be exactly calculated in advance. The main purpose in online water quality monitoring is the received data. DaaS, as new business model in this field, gives the customer the option only to compensate the service provider for this information. s::can products in combination with a DaaS model provide a comfortable possibility for the customer to acquire water quality data with no risk and little effort.

About the Authors

Lukas Kornfeind is the responsible s::can project manager for the Ganga River monitoring project. After 8 years working for the Technical University of Vienna he brings extensive water quality monitoring knowledge to the field.

Andreas Weingartner is the owner and president of s::can. He is the best example of a visionary pioneer in the water industry. He has dedicated his life to find smart, simple and affordable ways on how to measure water quality in real–time. His vision is to monitor and secure water quality on a large scale, millions of spots worldwide, and have that information available and transparent on the smart phone of every citizen of the world.

Robert Wurm is s::can's Sales Director. He has more than a decade of international s::can experience and is a well–respected person in the water industry.

Elisabeth Ebner is Head of Marketing at s::can with many years of experience in technical industries and passionate about innovations and water.

s::can has given its heart and soul to online water quality measurement. Since its foundation, nothing else has come out of the development department, and nothing else has left our production sites. s::can offers a complete set of accurate, reliable, low–maintenance and inexpensive measuring instruments for comprehensive and time–resolved water quality monitoring. s::can products measure a wide range of parameters in the areas of drinking water, wastewater, environmental monitoring and industrial applications.

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