Experiences of Real Time Water Quality Monitoring System

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Traditional Laboratory Methodology

Monitoring Water Quality

Predict the safety and potability of water supplies based on physical and biological factors , including:

Temperature

Dissolved Oxygen

pH

Nitrates

Phosphates

Turbidity

Demand Parameters for Oxygen

Bio-indicators

Water Quality Scientist use many instruments to check water quality

Thermometer

Dissolved Oxygen meter

Conductivity meter

pH meter

Spectrophotometers

look for various indicators

substances dissolved

Macro and microorganisms that live in the water

Physical Indicators

Dissolved oxygen

Less oxygen creates stress in organisms leading to sickness

Temperature

Colder water can hold more oxygen than warmer water

pH

Measure of how acidic or basic

Turbidity

Measure of how clear water

Chemical Indicators

Inorganic Dissolved salts

Concentration of Cations and Anions

Organic substances

Carbon, Nitrogen and Phosphorus and their complex combinations

Refractory substances

Heavy/Trace Metals and Pesticides/Insecticides Groups

Biological/Microbiological Indicators

Bioindicators organisms

Organisms need specific conditions

Trout need water with lots of oxygen

More diverse the organisms, the cleaner the water

Dirty water, there is less competition for resources

Some species survive in polluted water

Microbiological Indicators

Coliform group of bacteria

Standards for Analyzing Results

Standards are framed in accordance to water uses

Comparison of analytical results provide details on compliance

Needful actions are suggested

How Useful are Traditional Methodology

Time series data provided base line information

Actions initiated based on the data

Follow up monitoring carried out

Repeated all the steps periodically for compliance and surveillance

What is lacking in traditional monitoring?

Time Gap in monitoring and results

In consistency in reporting process due to manual management

Lacking real time information

Objective of Water Quality Monitoring- Perspective of Pollution Control Authorities

Rational planning of pollution control strategies and their prioritization;

Evaluate effectiveness of pollution control measures already is existence;

Evaluate water quality trend over a period of time;

Assess assimilative capacity of a water body thereby reducing cost on pollution control;

Understand the environmental fate of different pollutants

Assess the fitness of water for different uses in order to plan policies for prevention and control of pollution.

Real Time Water Quality Monitoring

Innovative Real Time Monitoring of Water Quality

Advantages

Real-time monitoring relies on the collection of sensor data/raw data

Automated/real-time water quality monitoring systems can provide timely information

Systems can directly process the data collected from monitoring mechanisms

Enabling quick responses to address to objective of monitoring

Limitations

Methodology differentiation from traditional wet chemical to electronics/electrical/AI

Understanding of false values

Qualification of data

Why Real Time Monitoring

Manual monitoring although provides realistic information however lacks

Understanding on the diurnal variation

Events of episodal discharges

Availability of high frequency data

Implementation of Real Time Water Quality Monitoring

Automatic Water Quality Monitoring of River Ganga

First Attempt Of Automatic Water Quality Monitoring Of River Ganga -1992-95

System Performed for A Couple Of Months

System Did Not Have Telecommunication System

Data Downloading Through Floppy Diskettes

Monitoring Data Have Erratic Values

System Did Not Improved Despite Efforts

Contract With The Supplier Of Floating Boat And Equipments Terminated

Led To Arbitration And Litigation

Bitter Experience For Two Decade

Automatic Water Quality Monitoring of River Ganga

Automatic Water Quality Monitoring of River Yamuna

Second Attempt Of Automatic Water Quality Monitoring Of River Yamuna -1998

Monitoring System Was Analyser Based

System Performed For A Couple Of Months

System Did Not Have Telecommunication System

Data Downloading Through Floppy Diskettes

Monitoring Data Have Erratic Values

System Did Not Improved Despite Efforts

Real Time Water Quality Monitoring under HP-II

River Ganga

Haridwar- upstream of Upper Ganga Barrage-BhimGoda

Kannauj (Nanamau Bridge), Downstream

Kanpur (Jajmau Bridge Kanpur)

Allahabad (Shastri Bridge), Upstream

Varanasi, Upstream

Varanasi, Downstream

Gandhi Ghat, Patna (floating platform)

Garden Reach, Kolkata

River Yamuna

Delhi Upstream, Wazirabad

Delhi Downstream Okhla

Water Quality Parameters

Real Time Water Quality Monitoring system was capable of monitoring ten parameters

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pH

Turbidity

Electrical Conductivity

Temperature

Dissolved Oxygen

Dissolved Ammonia

Chemical Oxygen Demand

Bio-chemical Oxygen Demand

Chloride

Nitrate

(optional parameter Colour added at Allahabad on river Ganga and at Wazirabad on river Yamuna)

Components of the system

Field Station-Real Time Water Quality Monitoring System (RTWQMS)

- Data logger and transmission system with build in display, suitable signal conditioning, for analog/digital sensors, serial (RS-232 interface) SDI-12 interface, and PCMCIA/USB port, software, cables, etc.
- GSM/GPRS transmitters
- Sensor package for 10 parameters
- Battery Charging System for remote stations (battery, regulator, solar panel)
- Single Point Grounding System for field stations
- Floating Platform/Buoy

- Enclosures

Central Receiving Station

Central receiving station has capability to receive, analyze and archive the data received from ten unmanned Remote stations.

Communication between Remote and Central Receiving station has two-way communication system utilizing GPRS.

Remote station has built in GPS receiver for automatic position determination.

Central Receiving Station serve through Web and was accessible anywhere through internet.

Web software distributed the data and products to authorized users with highly secured mode.

WEB dissemination system was advanced capable of producing tables, plots, maps, and download of data.

Central Receiving Station could process data and correct data through a Quality Control Process.

Calibration, Operation and Maintenance

Spectro::lyser™ sensor used in the RTWQMS was equipped with a Global Calibration for all the parameters configured.

Spectro::lyser™ contains all the settings and algorithms (for specific parameters) that enable the instrument to measure multiple parameters in river water.

Global Calibration was the tool that allows the spectrometer probe to make sense of water; it interprets the spectrum, knowing what to expect in the application it is used in.

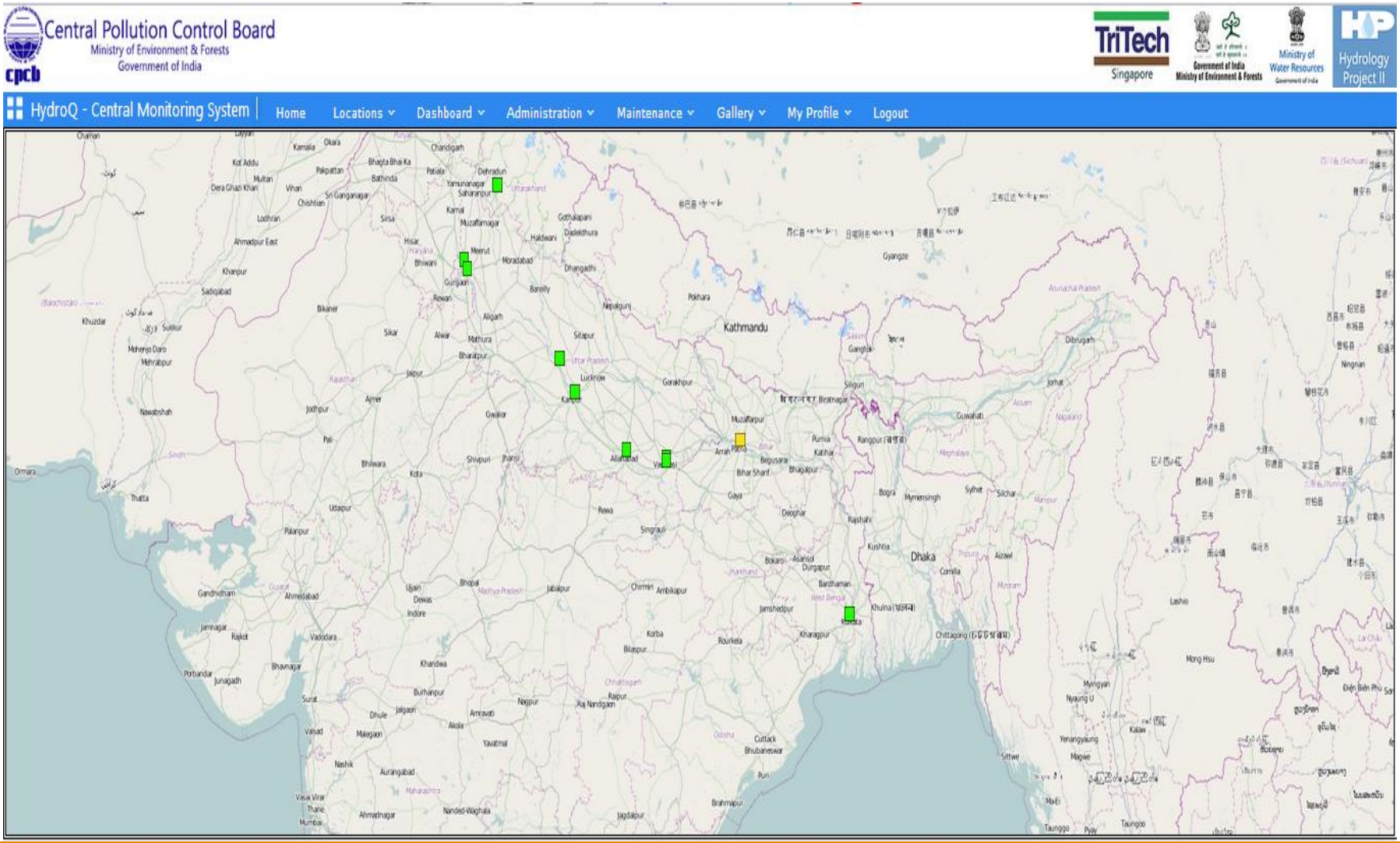
It provides reliable results without the need to extensive calibrations.

All parameters are calibrated locally using NIST Traceable Standards.

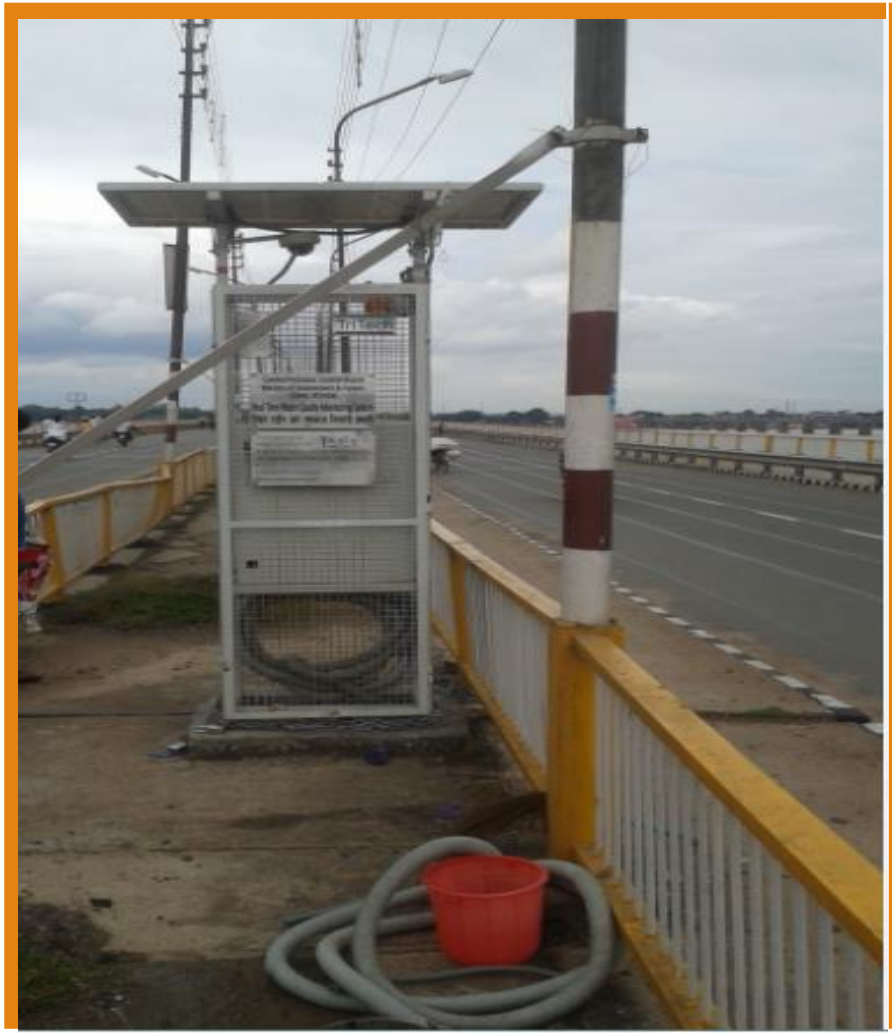
Equipment's required fortnightly manual cleaning to ensure that there are no sediments stuck on the measurement paths and electrodes.

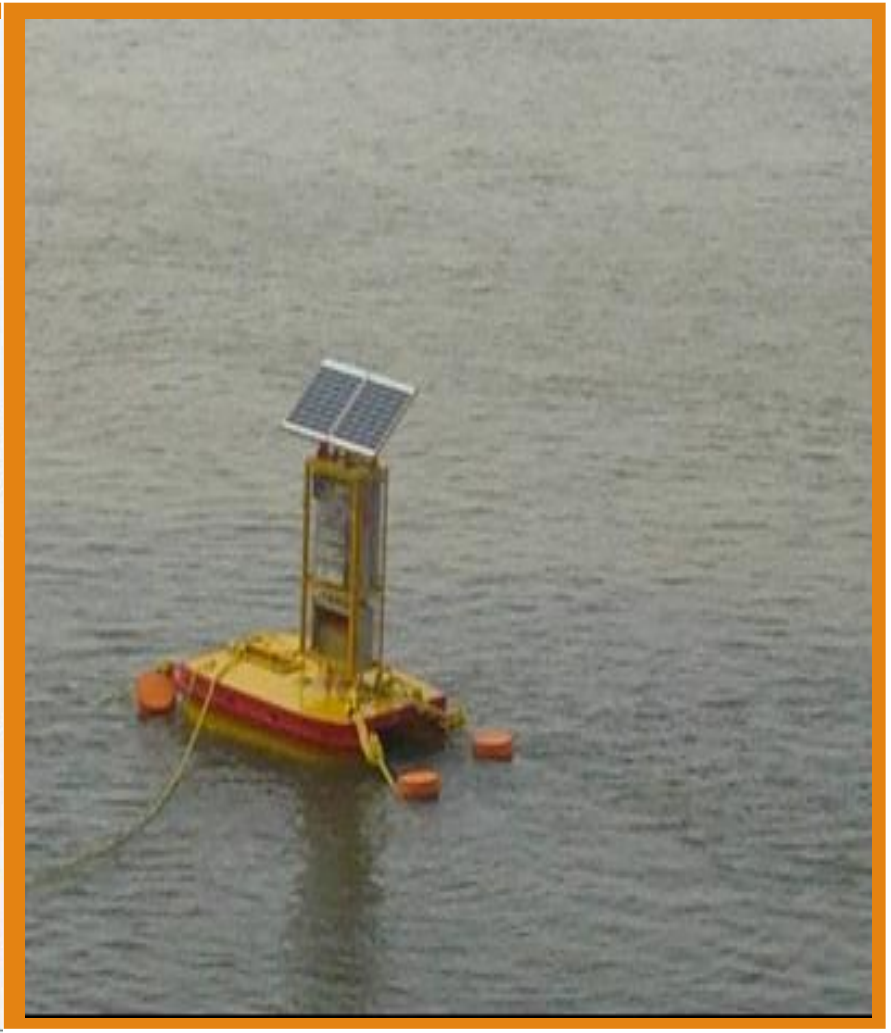
System was equipped with compressed air based cleaning system that automatically cleaned the sensors before any measurement starts.

Monitoring Location



RTWQM Station on River Ganga –Fixed & Floating





Monitoring Station

JAJMAU BRIDGE KANPUR-FIXED

VARANASI DOWNSTREAM-FLOATING

Data Logger and Battery

Sensor Cage with sensors

Monitoring Station-Fixed

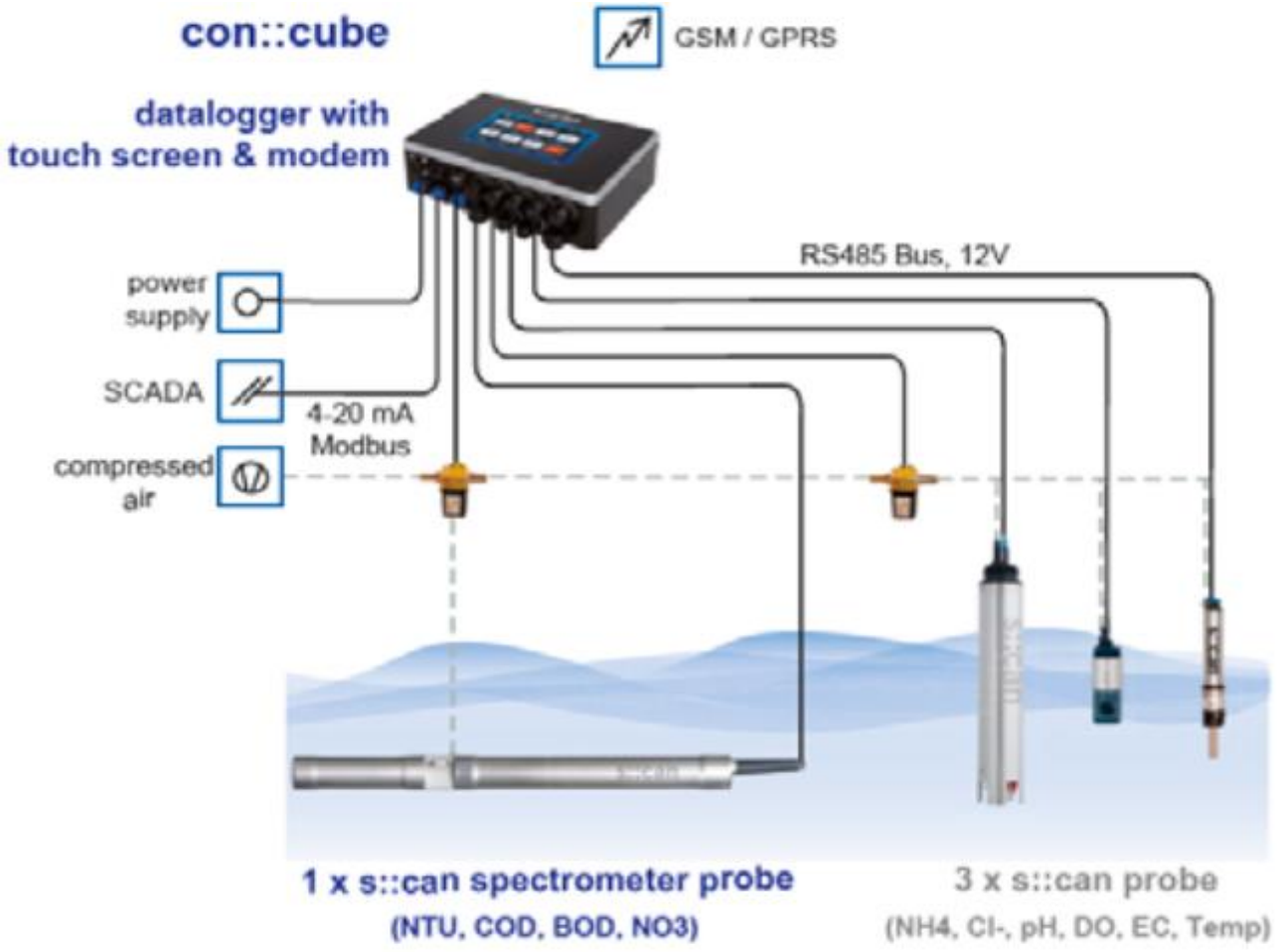
SHASTRI BRIDGE-ALLAHABAD

Monitoring Station-Fixed

ANCHOR OF CAGE TO BRIDGE

ANCHOR OF CAGE TO BRIDGE PILLAR

Data Logger connected to Sensors



Central Receiving Station

Comprising of three Servers

Data collection and Data base server - Windows Server Edition, Software with SQL Database

Real-time Quality Control Software for alarms by SMS messages based on thresholds

Quality Assurance and Application Server (Windows Server Edition), Time Series

Web Accessible Remote Station and Computer Maintenance Log Software

WEB Server, Data Dissemination/visualization software

UPS for Computer Systems

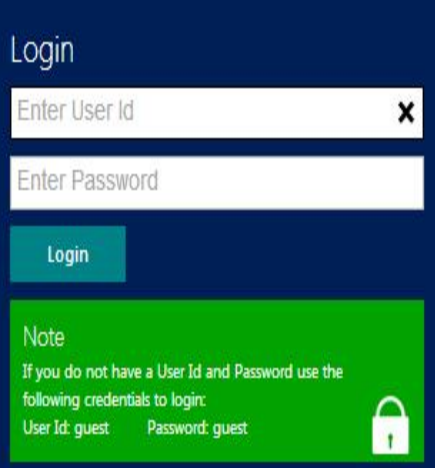
Computer Rack

Network Router with Hardware

Network Switch (HUB)

HydroQ - Central Monitoring System

TriTech Group Ltd, Singapore
TechSpan Engineering Pvt Ltd



Limitations/Achievements

Site Selection And Timely Clearance/Permission For Installation

Frequent Calibration Was Required

Security In Remote Areas A Cause Of Concern

Variation In Real Time Values In Respect Of Some Parameters

Relatively Reliable Observations In Respect Of Other Parameters (Ph, DO, Temperature, Colour, Conductivity, Turbidity, Chloride And Ammonia)

System Is Workable However Drop Time Observed Invariably Due To Communication Failure Or Power Disruption

Data Used During Maha Kumbh Event And Issues With Water Quality Intake Point Of Delhi On Yamuna For Instant Reporting

Real Time Monitoring Network
River Ganga under Namami Gange-2017

Real Time Monitoring Network - River Ganga & Tributaries

State	River	Location
Uttar Pradesh	River Ganga (13)	Bijnore, Anupshahr, Narora, Badaun, Farrukhabad, Kannauj, Bithoor, Kanpur, Fatehpur, Allahabad, Ghazipur
	Tributaries (7)	Banganga-Sukratal, Ramganga-Moradabad, Kali-Tahirpur village, Ramganga-Kannauj, Pandu-Kanpur, Varanasi-Varuna & Gomti
West Bengal	River Ganga (7)	Farrakha(2),Behrampore(2) Srirampore, Belgharia, Howrah

Real Time Monitoring Network on Drains

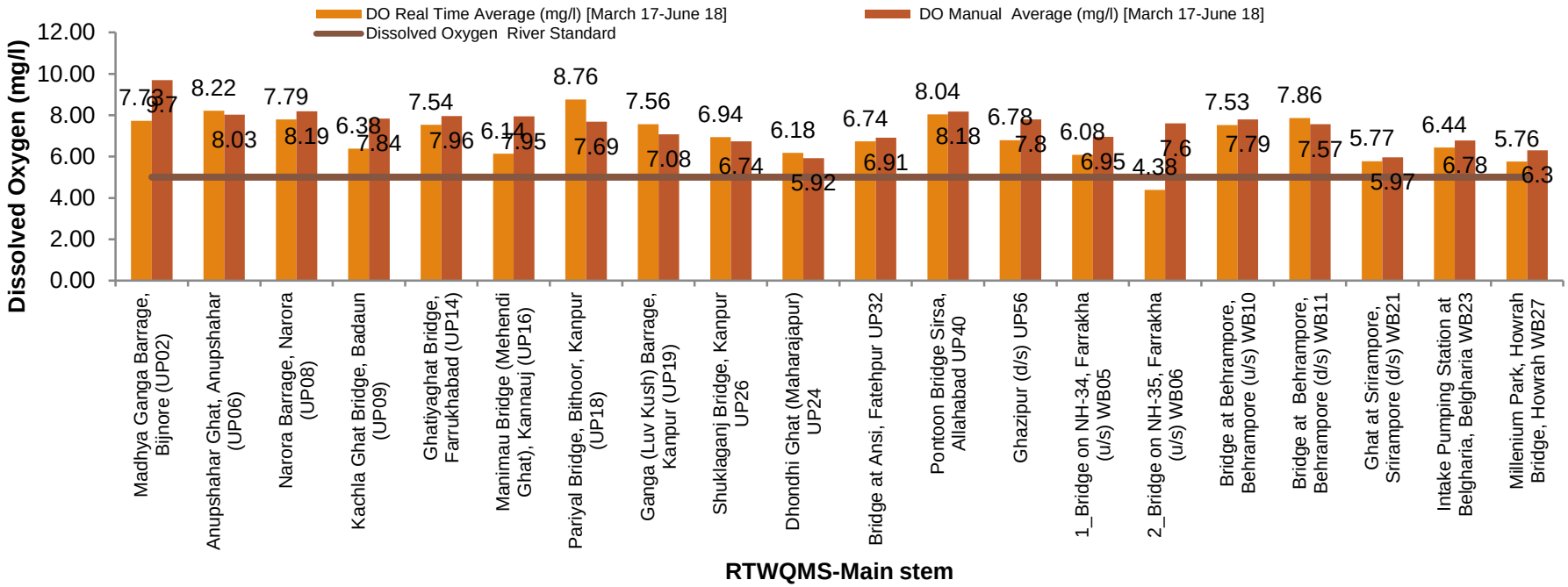
State	Location
Uttarakhand	Jagjeetpur STP, Haridwar
Uttar Pradesh	Mawaiyanala, Allahabad
Bihar	Kurzi Nala,Anta Nala,Mandiri Nala & Rajpul Nala
West Bengal	Srirampore Nala, Ballykhal Nala & Chitpur Nala

Real Time Water Quality Parameter

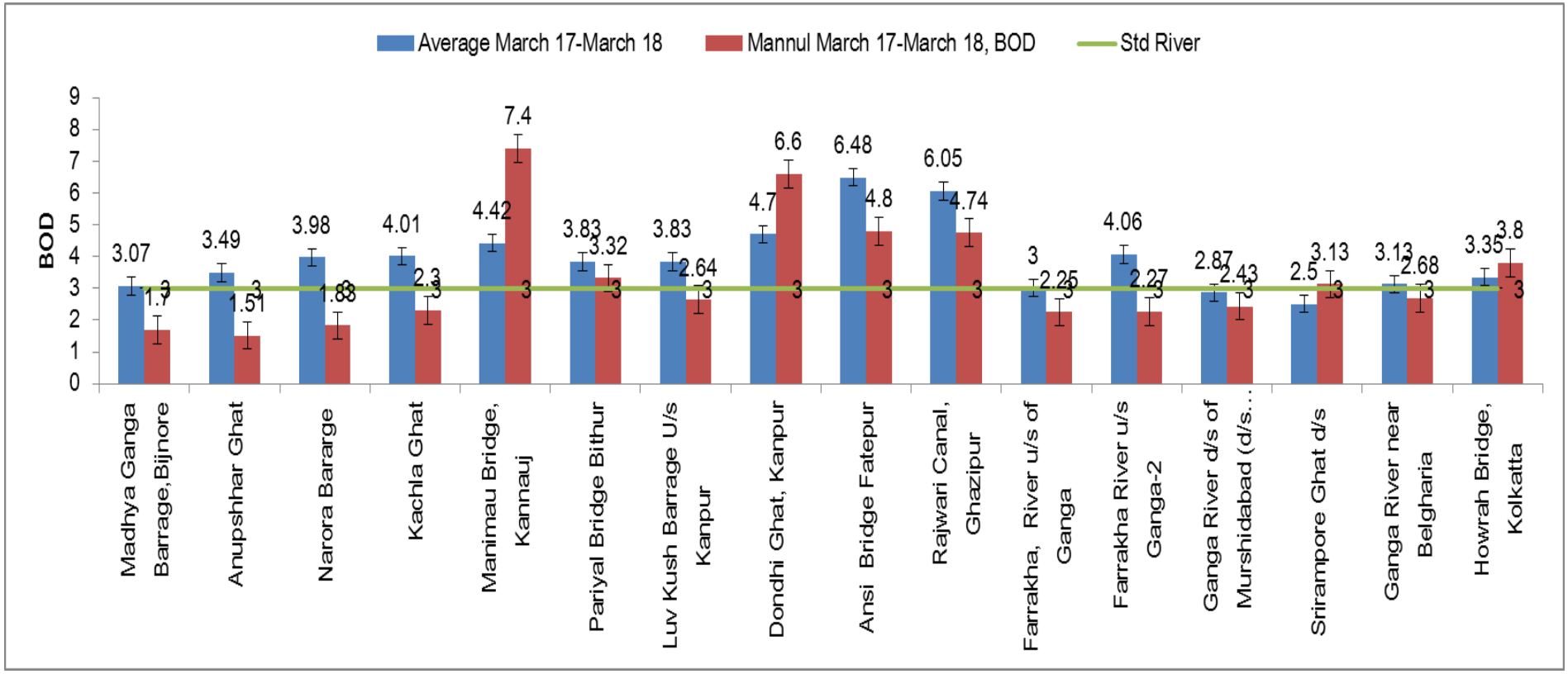
pH Temperature BOD DO EC COD TSS Turbidity Ammonia	Chloride Colour Potassium Fluoride Nitrate BTX TOC

Real Time Water Quality Stations on River Ganga

Water Quality trend –River Ganga- Real Time & Manual [Average Dissolved Oxygen]



Water Quality trend -River Ganga- Average Real Time & Manual
[Biochemical Oxygen Demand]



In-house Data Validation Exercise

Real Time Water Quality Monitoring Stations (RTWQMS) were established at 36 Locations and commissioned on 07.03.2017.

Concept Of Data Purchase was Adopted Under World Bank Component.

In Absence Of Data Qualification Consultant, Data Validation Process was Performed By CPCB And Data Service Provider.

RTWQM System was Calibrated On The Basis Of Data Validation As Per The Protocol For The Stretch

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Haridwar-Badaun -7 Locations- Delhi

Farrukhabad-Ghazipur -15 Locations-Lucknow

Patna- Howrah-14 Locations- Kolkatta

Qualitative Assessment Of RTWQMS Data - Based On Manual Monitoring

Data Reliability

Increased Efficiency Of Existing Water Systems Will More Than Ever Require Reliable Data

Reliable Data Play A Key Role In The Analysis, Monitor, And Forecast Of Water System Behaviors As Bad Quality Data May Result In An Erroneous Decision Scheme

Data Are Provided In A Large Part By The Measuring System, In Which A Sensor Is An Important Element

Sensor Measures A Physical Quantity And Converts It Into A Signal That Can Be Read By An Observer Or By An Instrument

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Measuring System Then Converts The Sensor Signals To Values Aiming To Represent Certain “Real” Physical Quantity

Values, Known As Raw Data, Needs To Be Validated Before Other Use In Order To Assure The Reliability Of Results From Data Application

Data Reliability (contd.)

Generally raw data may include errors such as noise, drift, outliers, malfunctions, etc.

In addition to the possible measurement deviations related to the sensor performance itself, the errors can occur due to various reasons, e.g., the sensor installation problem and the measurement assumption violation

It is important to equip the data system with procedures that can detect the related problems and assist the user in monitoring and processing the incoming data

The data validation is an essential step to improve data reliability

Data validation is a subject associated to various domains and thus mechanisms and techniques have been developed in different fields including water quality

Data Validation Software Requirement

Data validation software requires two main processes

Faulty data detection- identifies doubtful values or errors in data

Faulty data correction- process to provide methods to deal with problematic data.

In each category, a number of different tools and methods exist.

Faulty Data Detection

Step 1: Zero value detection

Step 2: Flat line detection

Step 3: Minimum and maximum values detection based on geometric, hydraulic and data quality constraints

Step 4: Minimum and maximum thresholds consideration based on historical values

Step 5: Statistical test of variables that follow certain distributions

Step 6: Multivariate statistical test using principal component analysis (PCA)

Step 7: Artificial neural network (ANN) non linear regression model for modeling one of the measured variables

Step 8: One-class support vector machine classification

Step 9: Physical modal's such as Manning's equation

Faulty Data Correction Methods

Step1 Interpolation

Step 2 Smoothing method

Step 3 Data mining technology

Step 4 Data reconciliation

Step 5 Other assisting techniques or tools

Step 6 Check of status of sensor

Step 7 Check the duration after sensor maintenance

Step 8 Data context classification

Step 9 Calibration of measuring systems

Step 10 Uncertainty consideration

Way Forward

Generate WQI through software and to disseminate it, with an automated Bulletin generation. Automatic deployment of bulletin for public on daily basis through automated system at a specific interval.

Develop a Mobile APP to get the feedback on water quality.

Develop standard interface to collect information (through MobileAPP) on public complaints lodged by the citizens and their redressal.

Develop reports through which data needs to be disseminated in tabular, graphical formats using statistical procedures like minimum, maximum, average, standard deviation, regression etc.


Thank You for Patience