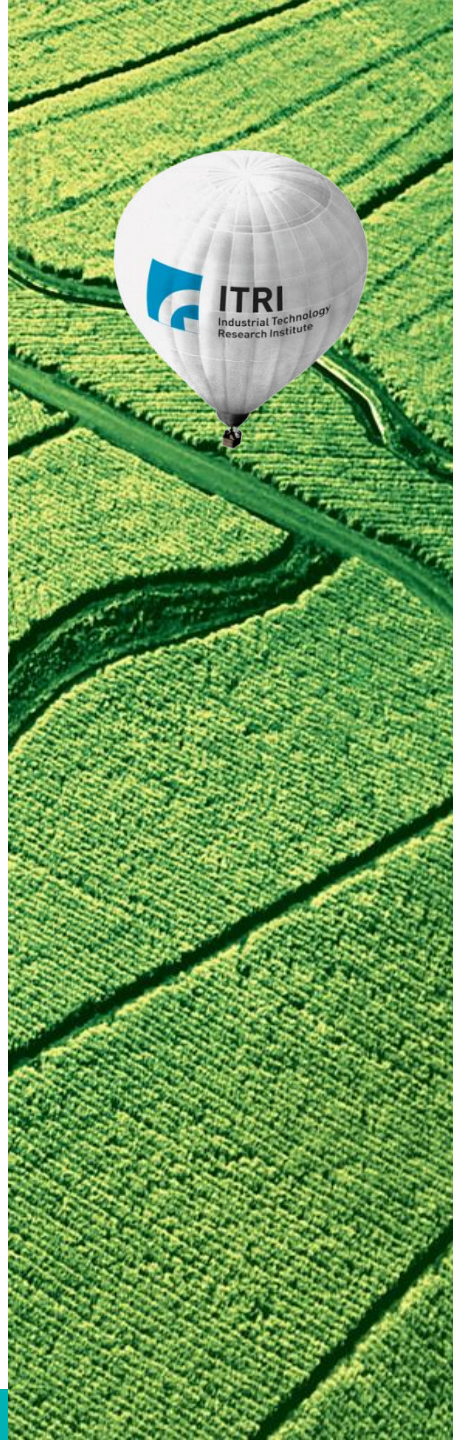
ITRI
Industrial Technology
Research Institute



Strategy for the Deployment of Water Internet of Things (WIoT) in Taiwan

Chen-Yang, Hsu, Engineer, Green Energy and Environment Research Laboratories, Industrial Technology Research Institute, Taiwan

The project is supported by EPA Taiwan

IARIA

Mr. Chen-Yang, Hsu

ambrosehsu@itri.org.tw

Mr. Chen-Yang Hsu obtained his Master's degree in Engineering from Tamkang University, Taiwan in 2010. He presently works as an Engineer in the Environmental Management Department of the Industrial Technology Research Institute (ITRI) in Taiwan. His core responsibilities include conducting water quality IoT analysis, energy-saving and carbon reduction analysis, and chemical governance.

ITRI
Industrial Technology Research Institute

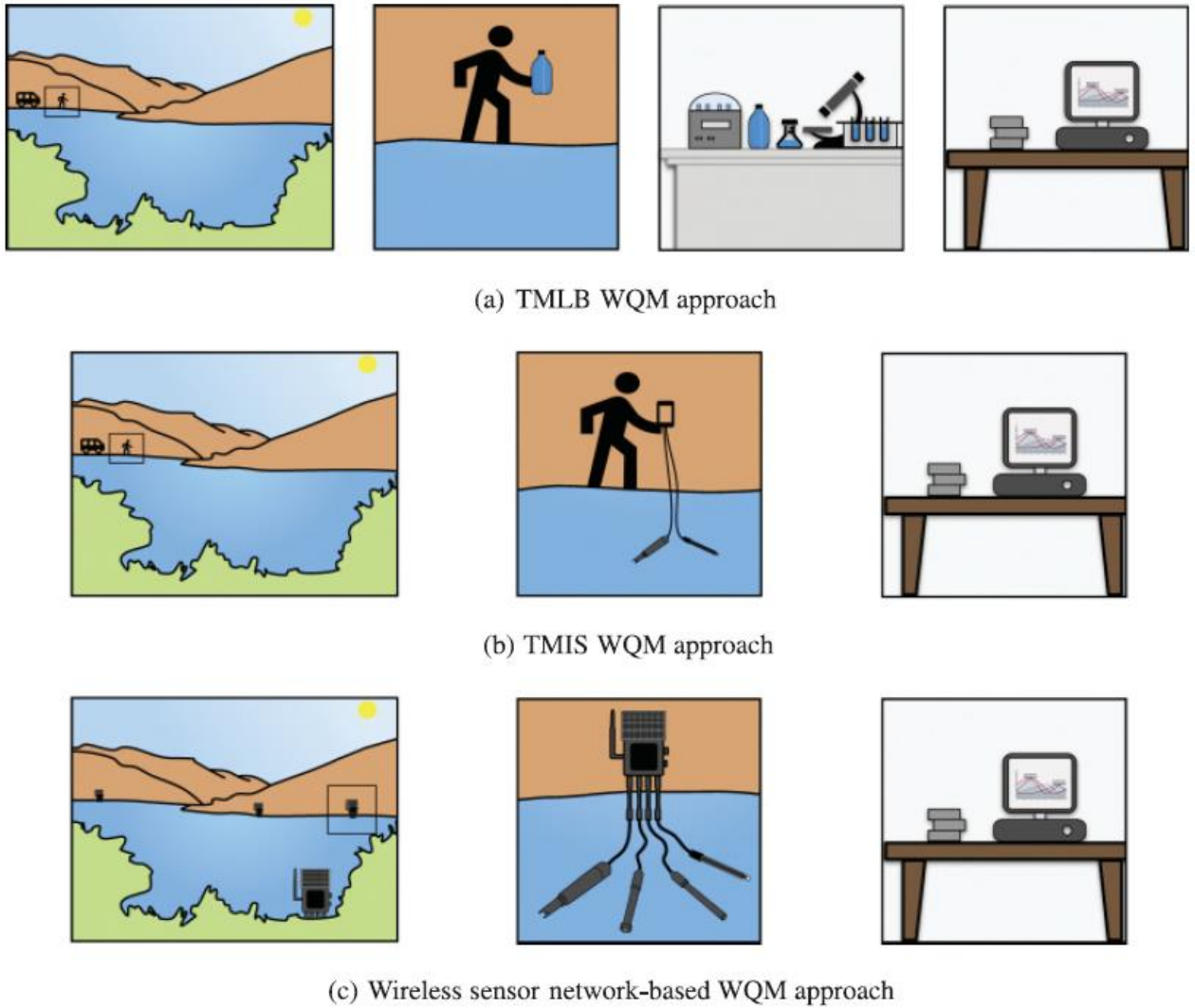
Introduction

Traditional water analysis is carried out via manual analysis of sample water to ascertain pollution.

- Insufficient analysis in terms of time and space.
- Difficulty in having a firm grip on changing trends in water quality.

Emerging application of wireless sensing network (WSN) technology in other countries.

Online water-monitoring system



(a) TMLB WQM approach

(b) TMIS WQM approach

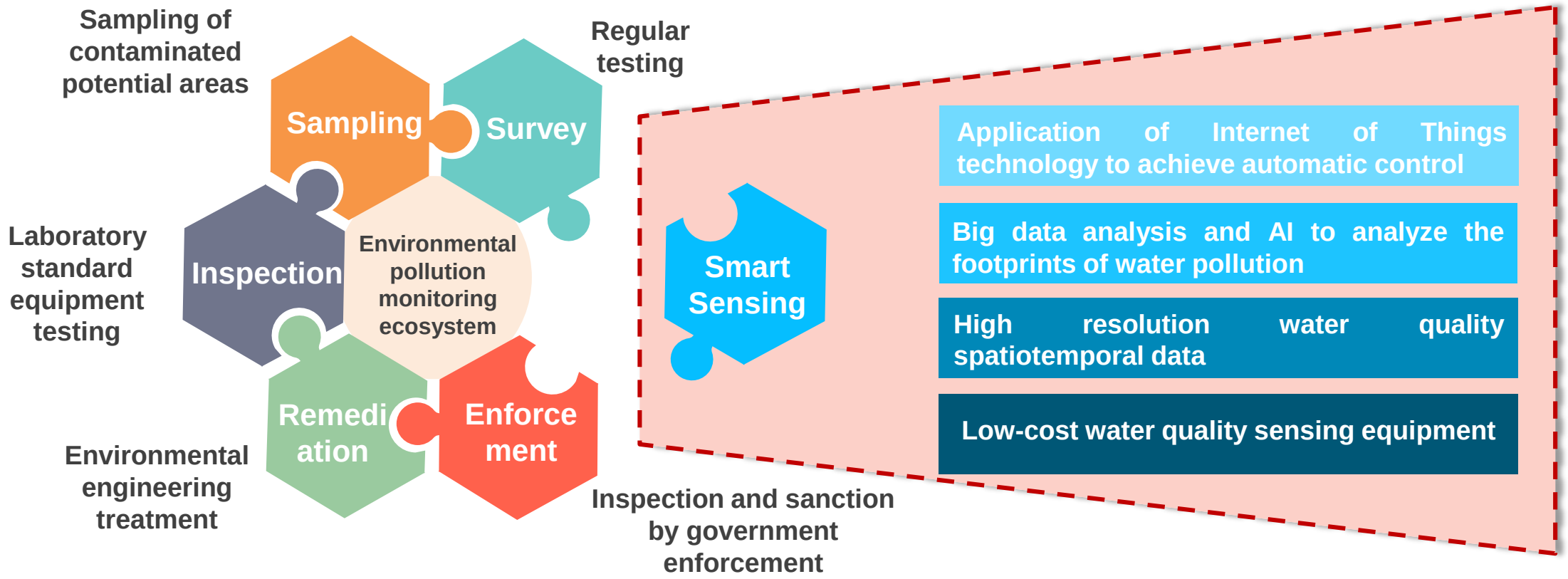
(c) Wireless sensor network-based WQM approach

(K.S. Adu-Manu et al., 2017)

ITRI Industrial Technology Research Institute

The Core Challenge

With the advancement of data analysis, big data processing and wireless transmission technologies, EPA Taiwan has established a set of total solutions for continuous water quality monitoring with the help of IoT, which completes the last piece of "smart sensing" with the technology of environmental IoT.



ITRI Industrial Technology Research Institute

Goals

Iot Total Solution And Decision Support Systems (DSS) Of Water Quality Management

1

High-resolution water-quality data

Acquisition of massive water-quality data via low-cost water-quality sensors(In this study: pH, EC, Temp, DO). Other module(COD, Cu^{2+})

2

Establishment of optimized site selection guideline for smart deployment

Supplemented with monitoring sensors for achieving the function of early warning and autonomous notification

3

Data analysis and DSS model

Analysis of water-quality data feature, coupled with cross-area information analysis for locating abnormal water-quality hot spot in terms of time and space, for upstream tracing and downstream warning

Water Quality Monitoring System

Detection principles:

Chip-based sensing technology

Specifications and size:

- Wireless module : GSM/LoRa
- pH : 0 - 14(±0.1 pH)
- EC : 300-4000 μS/cm(±15%)
- DO : ±1.0mg/L
- Temp : ±0.5℃

Fixed-point sensing

Industrial wastewater pollution sensing

Drifting sensing

Agricultural water safety sensing

Technology features

- Short response time, rapid analysis
- Miniaturization, small size, low power consumption (5 W)
- Furnishing of communications modules facilitating linkage with IoT
- Reasonable cost, suitable to massive deployment
- Detection frequency: 1 minute

ITRI Industrial Technology Research Institute

Deployment Strategy - 1

Principles for deployment area selection

A

- i. Area with frequent excessive monitoring data in the past
- ii. People complaint / pollution incident
- iii.Sensitive acceptors in neighborhood / downstream
- iv. Area with easy deployment and maintenance

B

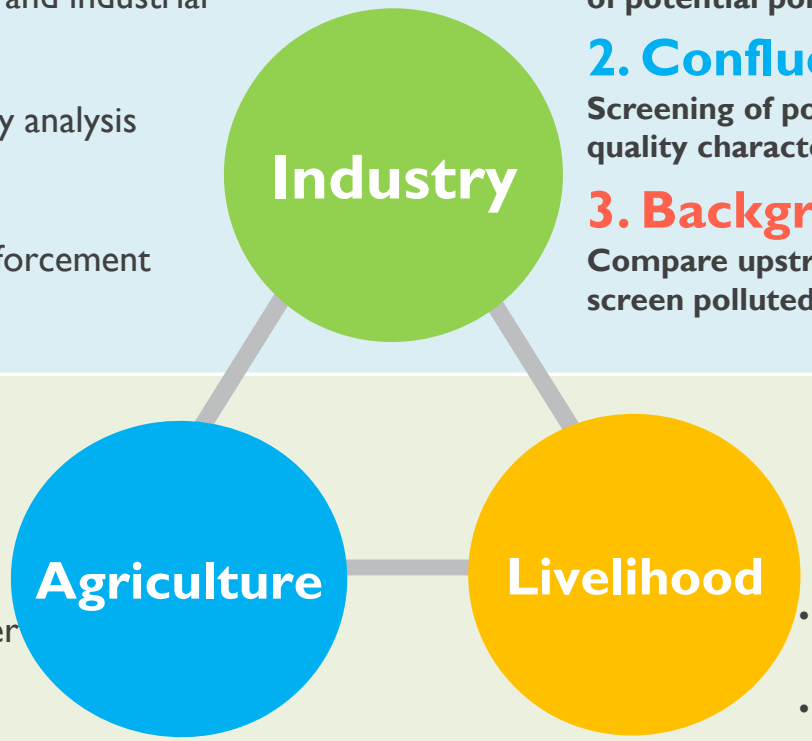
- **Distinguishableness** — Monitoring sites must have distinguishableness, representing different tributary
- **Representativeness** — Representative of the water quality of monitored environment, such as major water intake and agricultural canal
- **Completeness** — Complete grip on drainage area, covering upstream, midstream, and downstream area
- **Purposefulness** — Problem-solving-oriented, sensor deployment near the suspected source of pollution

ITRI Industrial Technology Research Institute

Deployment Strategy - 2

Potential Pollution Source Sensing

- Monitoring of specific rivers and industrial areas
- Spatial and temporal anomaly analysis
- Pollution source screening
- Intelligent environmental enforcement application



1. Discharge Port

Analyze the time of water quality abnormalities of potential pollution sources

2. Confluence

Screening of pollution sources through water quality characteristics

3. Background Water Quality

Compare upstream and downstream data to screen polluted watersheds

Irrigation Water Sensing

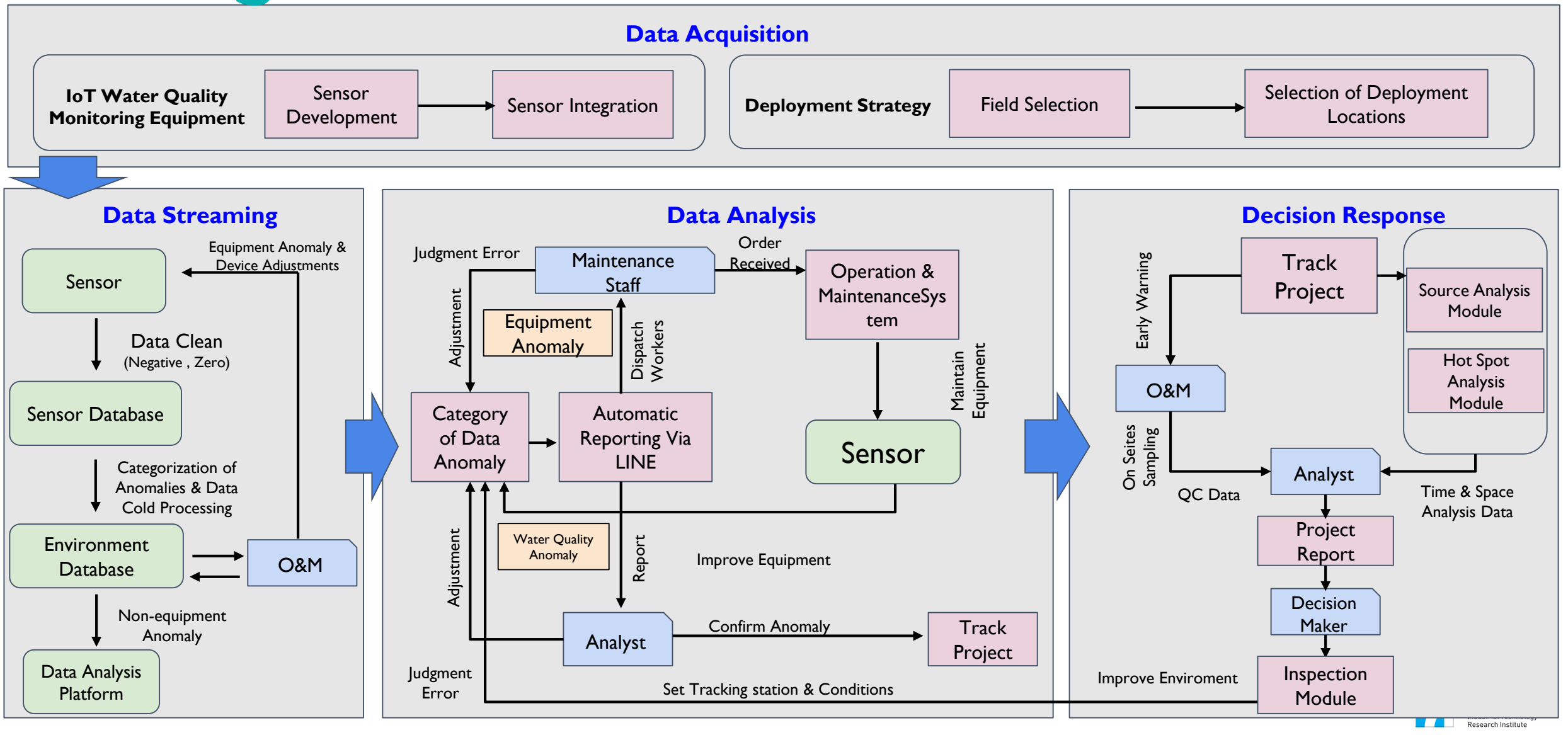
- Water quality sensing in water intake and agricultural canals
- Water quality abnormal early warning
- Watergate opening and closing, water time decision application

Drinking Water Sensing

- Monitoring of raw and freshwater quality
- Combine with ORP and other measurements to control disinfection efficiency
- Sensing of water quality at the customer end of secondary water supply

ITRI Industrial Technology Research Institute

Iot Water Quality Monitoring And Management Framework in Taiwan

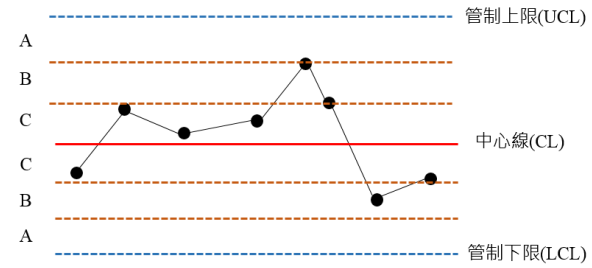


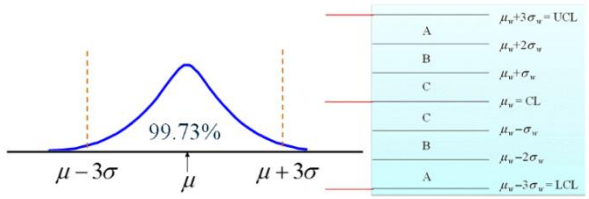
Data Analysis Model - 1

Early Warning Mode For Water Quality/Equipment Abnormality

Set up early warning rules based on the concept of statistical process control (SPC) for analysis abnormal hot spot in terms of time and space.

Modeling in reference to SPC theory



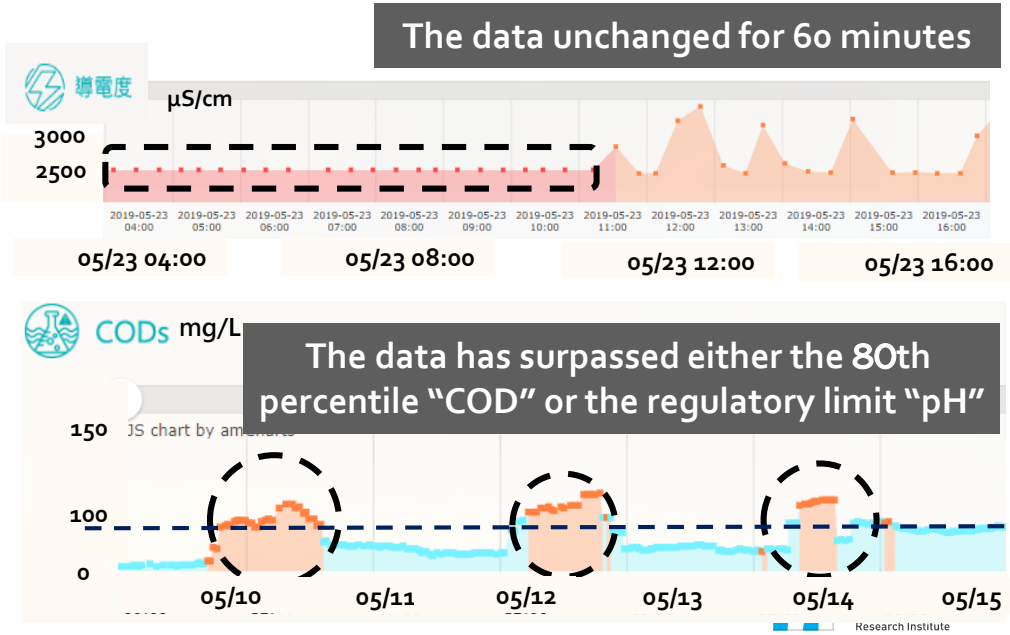


Rules for discernment of water-quality/equipment abnormality

Analyze linkage among different detections of sensors via time/space early warning mode and make interpretation with accumulated experience and statistical analysis, leading to detect water-quality/ equipment abnormality

Result of early warning

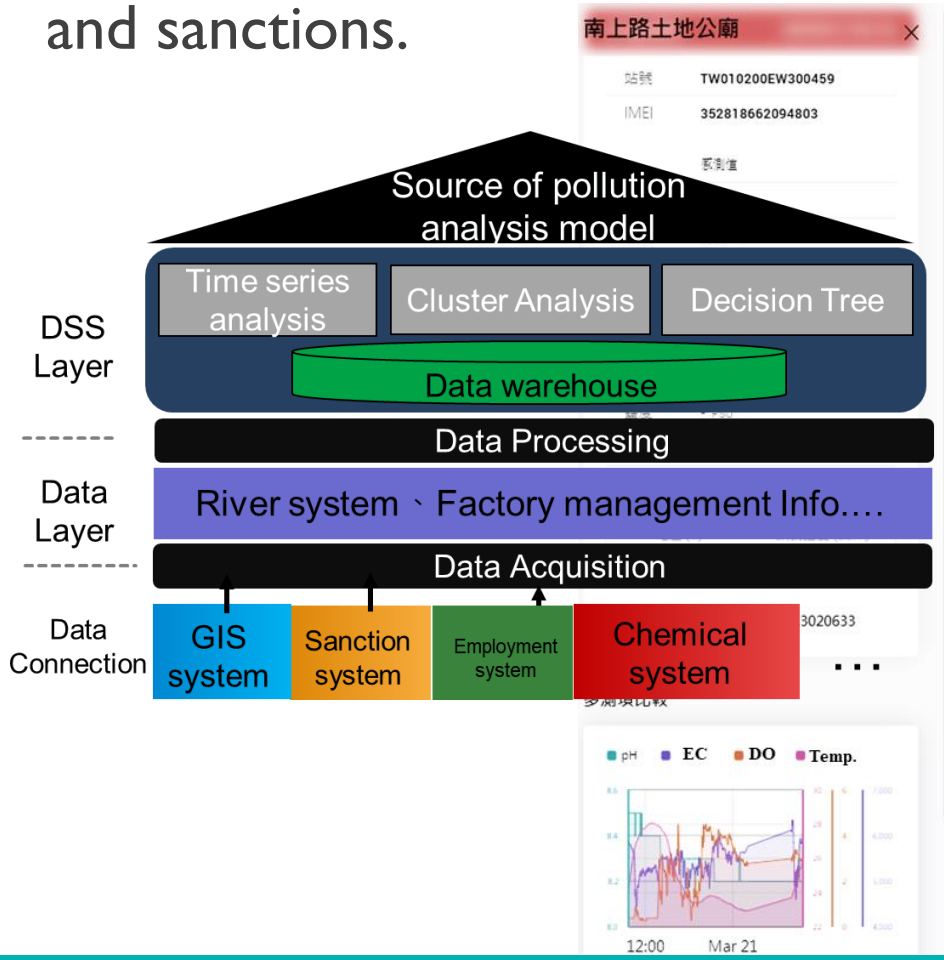
Autonomous process judgment and marking of abnormal time period

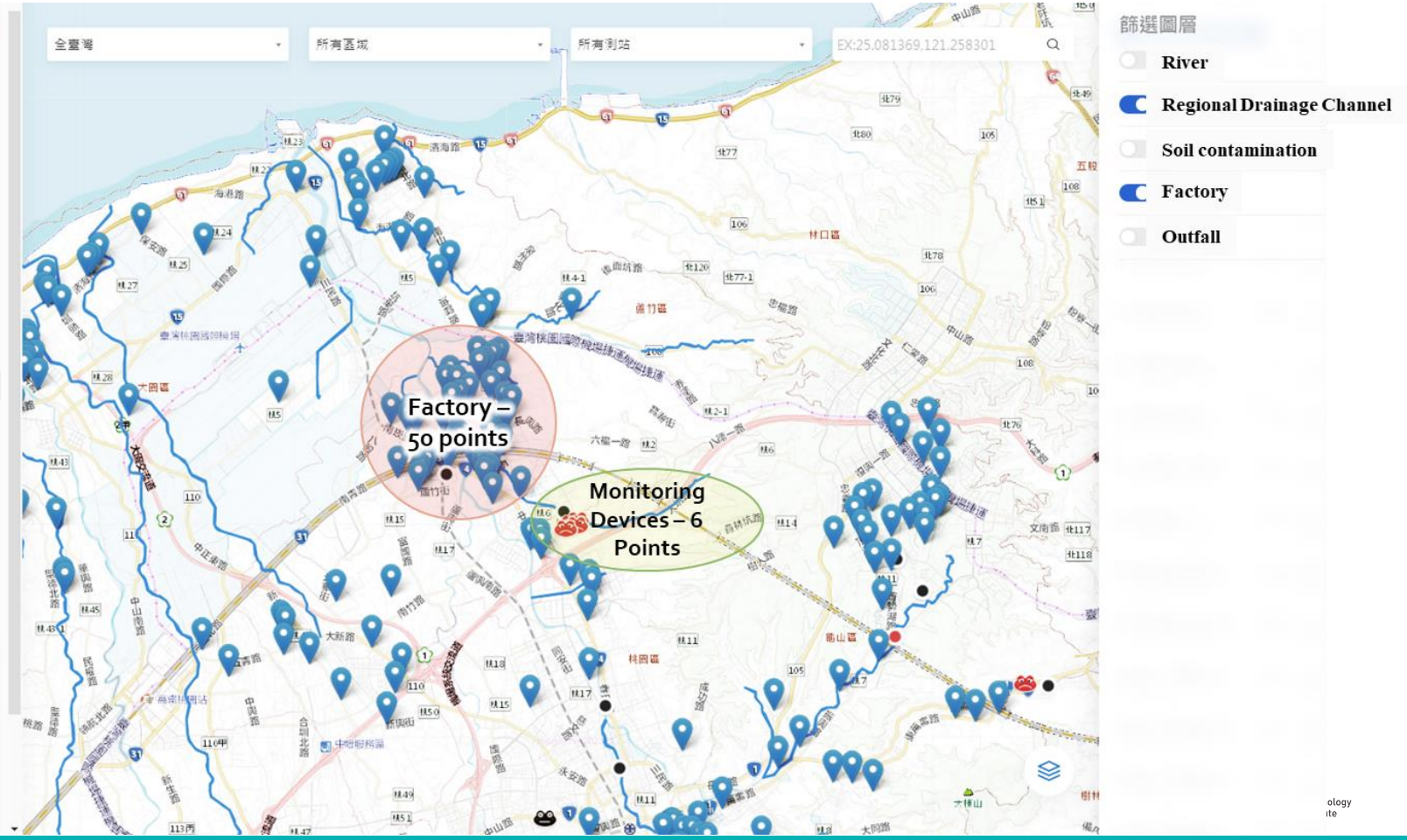


Data Analysis Model - 2

Source Of Pollution Analysis Model

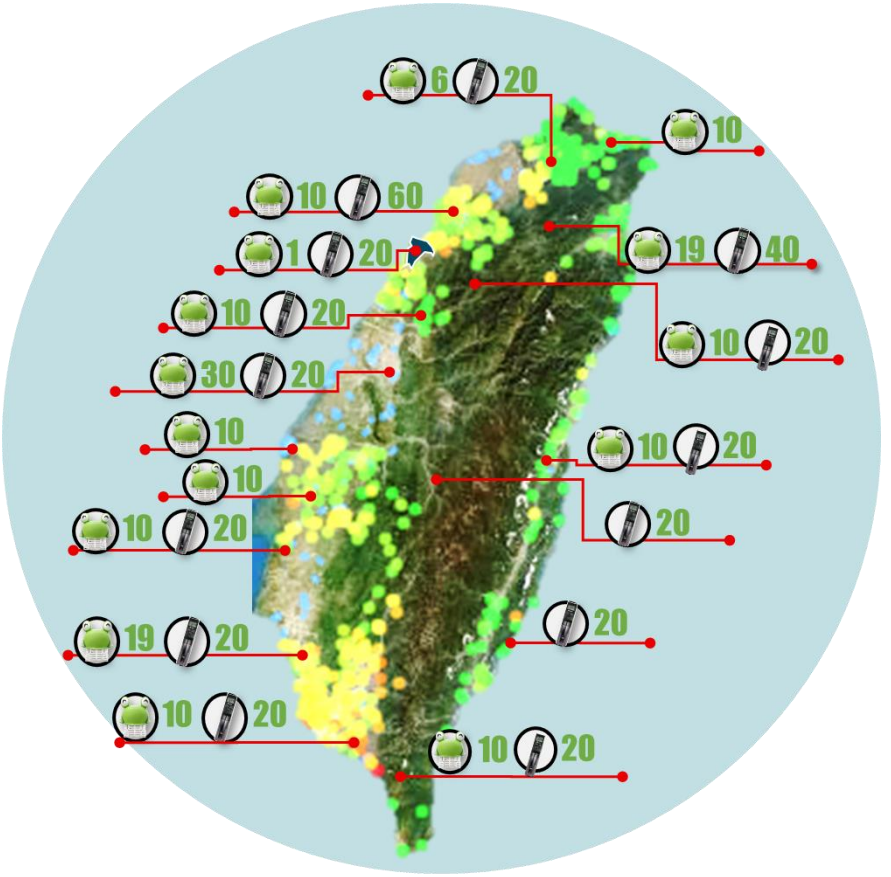
Screen upstream plants using GIS cross-sectional data based on past employment, chemicals, and sanctions.





CONCLUSIONS

- Taiwan, an IoT site, provides guidance on innovation and R&D and deploys a vast water quality network to mitigate pollution and safeguard the environment. Our software and hardware services and experiences are being duplicated and exported. We are continuously improving our products and services to ensure a sustainable environment.
- The feasibility of the deployment strategy and data analytical model has been verified in more than 100 deployment areas in Taiwan by applying it to pollution cases selected by models.



Taiwan projects

21 Industrial areas covering **60** River basins covering

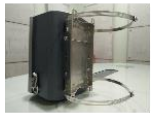
176 24/7 Water quality sensing equipment operating **450+** Citizens' scientific sensing points

ITRI Industrial Technology Research Institute

One More Thing...

Air Quality Sensor

Wall Mount



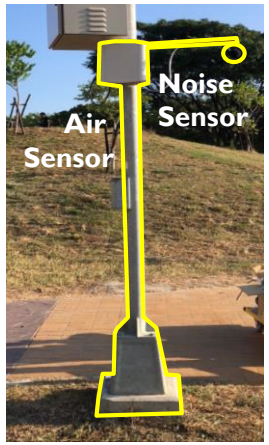
Street Light

Complete Housing & Mounting Solution

Multiple Sensors

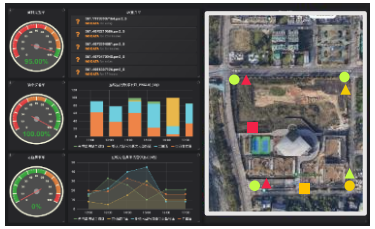
Diverse Communications

LTE NB-IoT LoRa WiFi



- Length: 180 mm; width: 265 mm; height: 460 mm
- Capable of measuring Temp., humidity, O_3, CO, $PM_{2.5}$, Noise, and VOC
- Components:
  1. Main chassis: Equipped with a power supply module, backup battery, control board, radio transmitter module, memory card, and terminal panel.
  2. Radiation shield: Equipped with a sensor board and various types of sensor components.
  3. Mount: A U-shaped ring is used to secure the sensor to the utility pole.
  4. Power requirements: 110/220V AC, 1A.
- System architecture: After the sensor board inside the radiation shield has collected all types of data from the sensor modules, it will transmit the data in Modbus RTU format to the control board. The main control board then sends the data back to the server wirelessly.

Smart Construction Sites



Smart Management Platform

PM2.5/10 exceeds the ambient concentration: alarm, activate the sprinkler system
Noise exceeds regulatory standards: Alarm, control machine operation

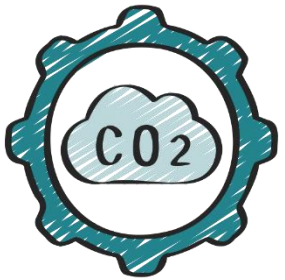
Display Board

Digital water pressure gauge Control of sprinkler system

Exceeds regulatory standards: Alarm, close drainage

ITRI Industrial Technology Research Institute

One More Thing...



One-stop sustainable carbon management platform

Core technical advantages

- Localized database: Grasp of over 10,000 product carbon coefficients in over 20 industries for applications by the government and industries.
- Inventory optimization: Automated introduction of industrial inventory table (categorization rules) for carbon-emission hotspot analysis and suggestion.
- Technological advantages: Autonomous management, precision coefficients, smart analysis, emission-reduction hotspots, linkage to international verification system.

Applications & Key Services

Domestic Small And Medium Enterprises

- Several S&MEs in the fields of petrochemical, synthetic fiber, packaging, and papermaking.
- Analyze supply-chain upstream and downstream raw materials' carbon coefficients (Scope 3) for providing product lifecycle carbon footprints to branded enterprises.

Large Business Groups In Petrochemical Industry

- Precision calculation of carbon footprints, provision of concrete carbon-abatement strategy.
- Enhance product competitiveness and enliven exports, boosting annual production value to over NTD $1.8 trillion.

ITRI Industrial Technology Research Institute