Modern methods of water analysis

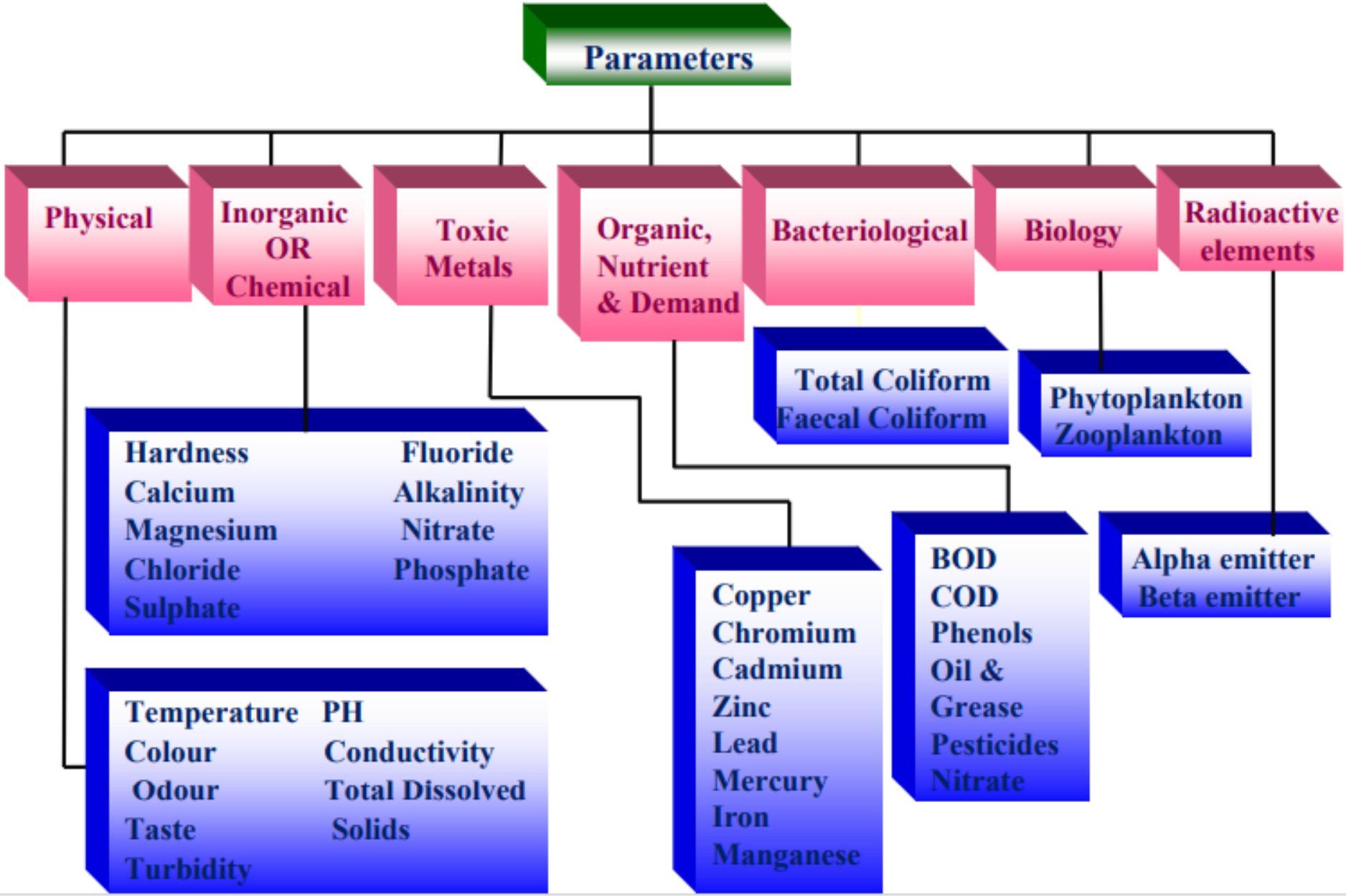
Importance of Water Analysis

- Water analysis is essential to ensure its quality or to detect pollutants that should be removed by water treatment.

- However, water quality does not mean making the water suitable for human consumption; it depends on its end use.

- For example, completely different quality standards are applied in case of industrial water compared to those applied to drink water, i.e., drinking water must be fit for human consumption, while industrial water should be free from any contaminants that may corrode or damage equipment.

Water Quality Assessment : Potable & Industrial Uses

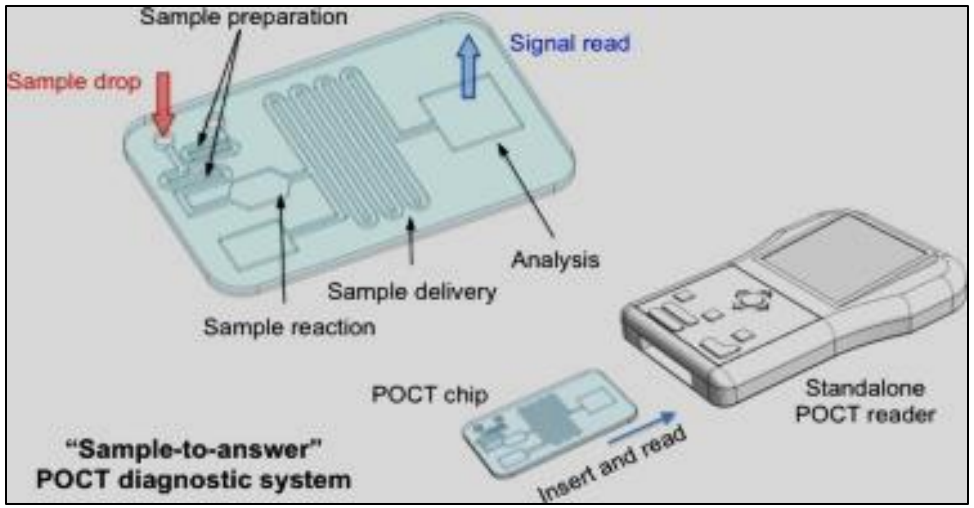


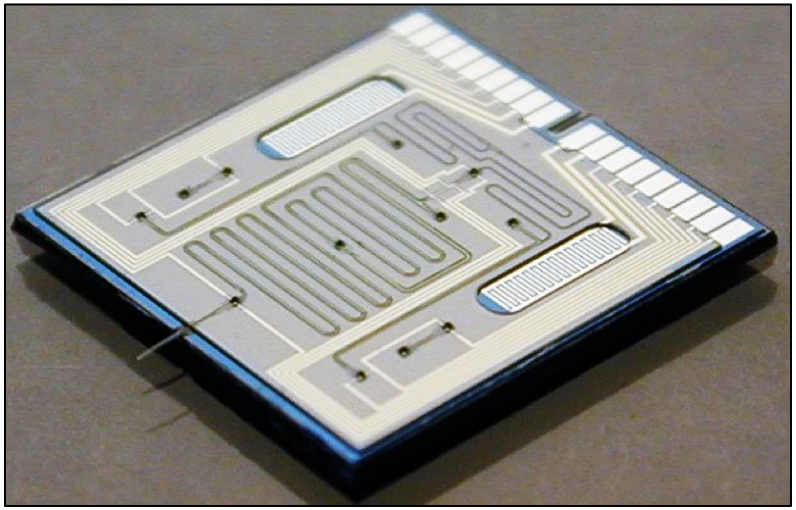
Modern methods of water analysis

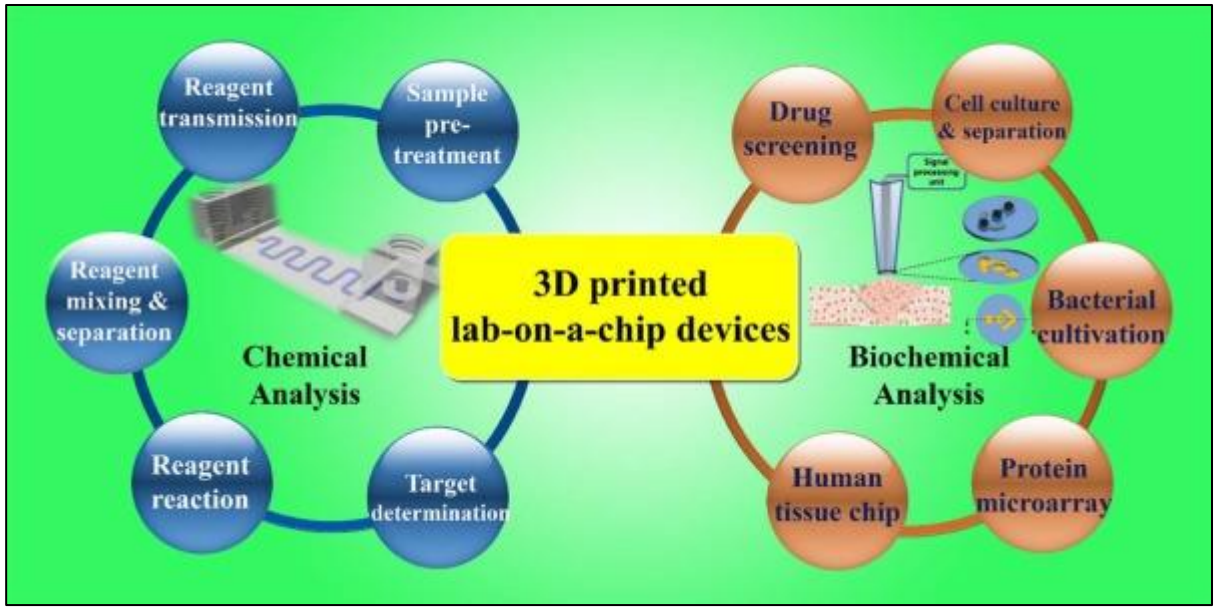
- **Limitations of Traditional Methods of Water Analysis**
  - The traditional analysis includes chemical analysis, colorimetry, spectrometry, chromatography, and atomic absorption.
  - Although these techniques differ in sensitivity and accuracy, most of them are highly accurate.
  - Nevertheless, they require sampling, expensive devices, and manpower; besides, they are time-consuming and difficult to conduct onsite.

Current Applications in Water Analysis

- Lab-on-a-chip technology is rapidly developing and being used in different industrial and research fields.
- Most biological lab-on-a-chip devices are commercialized, while those for water analysis are still developing.
- However, some lab-on-a-chip applications in water analysis are already established, such as pH testing and detection of various chemicals (e.g., nitrates and nitrites, manganese, phosphates, and silicates).
- For example, the microfluidic pH analysis uses sulfonephthalein as the main indicator.
- It includes the absorption cell, a static mixer, as well as a syringe pump and four valves attached to the chip to regulate the flow.







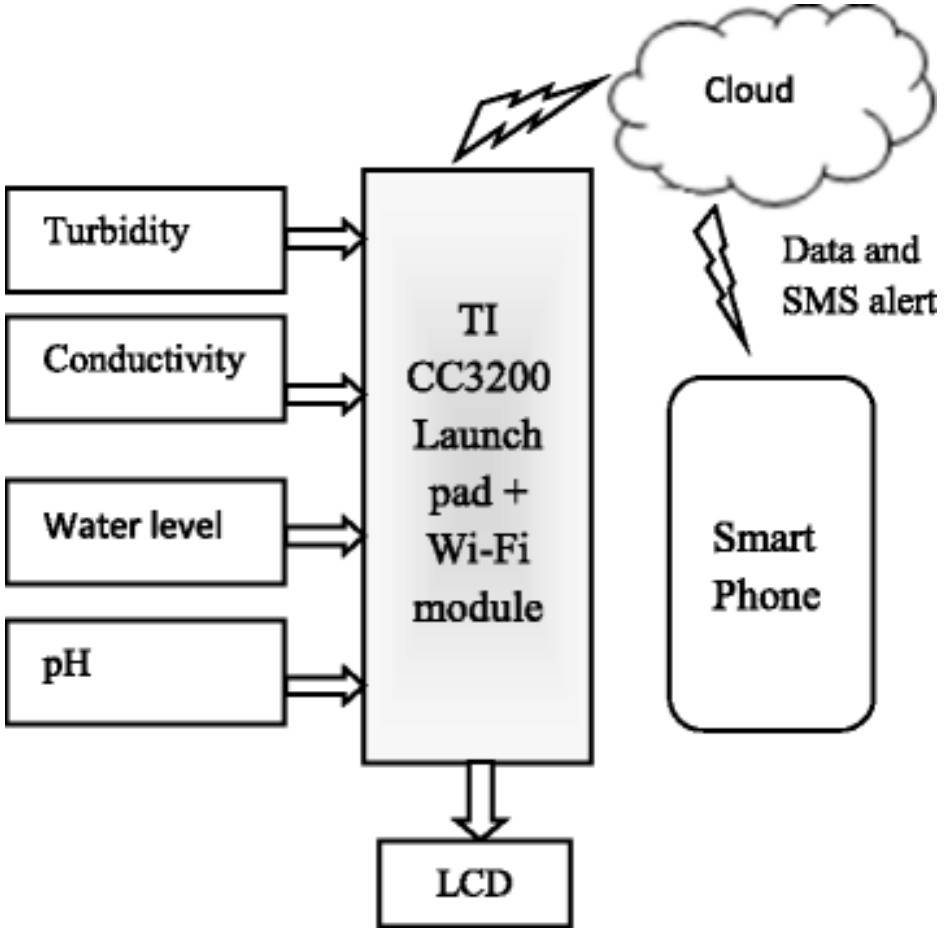
References:

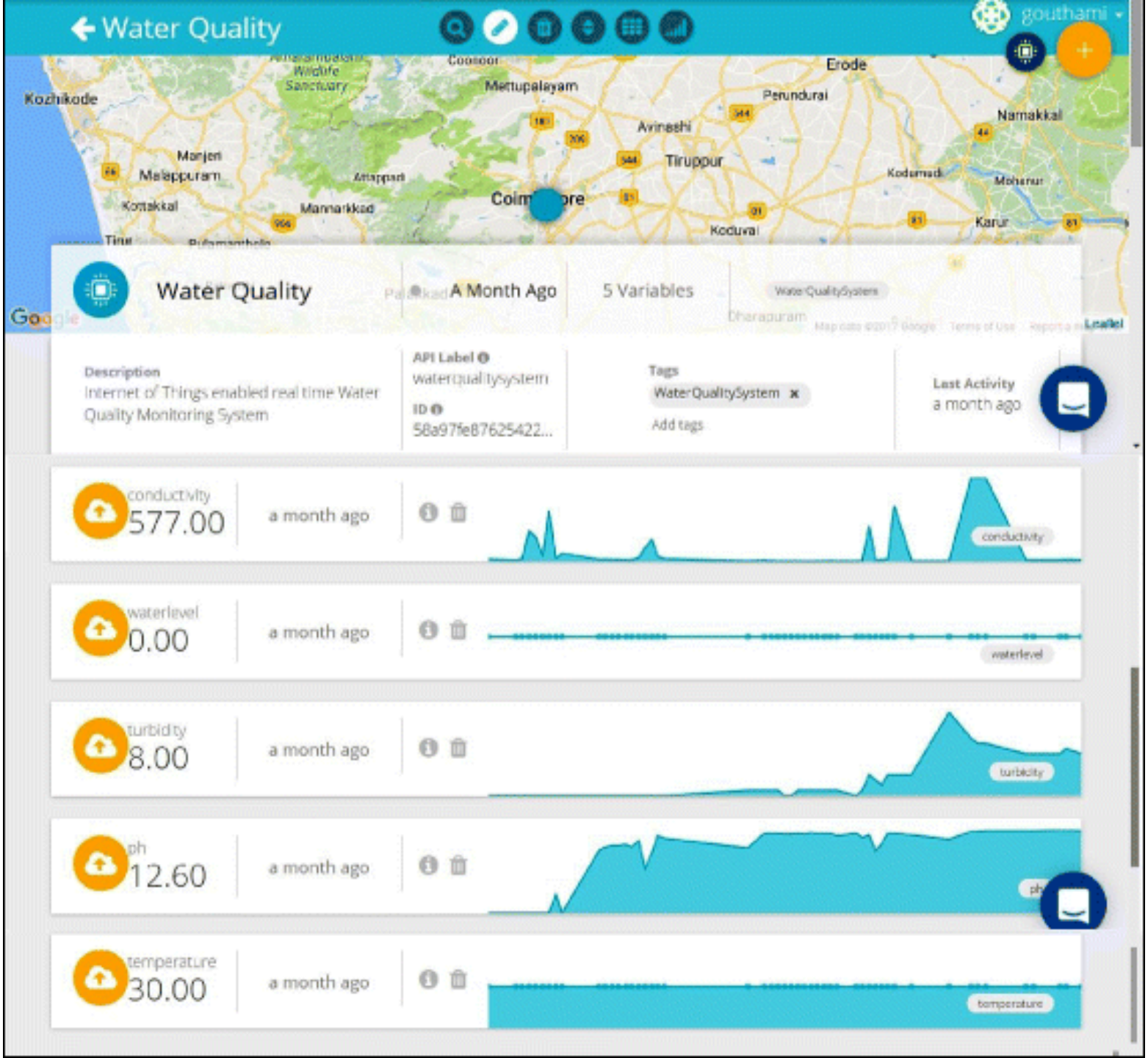
1. J. Cleary, C. Slater, D. Diamond, Analysis of phosphate in wastewater using an autonomous microfluidics-based analyser, World Acad. Sci. Eng. Technol. 52 (2009) 196–199.

2. R. Paul Payel, "Lab on a Chip" Systems for Environmental Analysis, University of Stavanger, 2014.

Sensors

- pH
- Conductivity
- DO
- Temperature
- Transparency

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Mettupalayam
Erode
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Namakkal
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Tiruppur
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Manjeri
Malappuram
Kottakkal
Mannarkkad
Water Quality
A Month Ago
5 Variables
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Internet of Things enabled real time Water Quality Monitoring System
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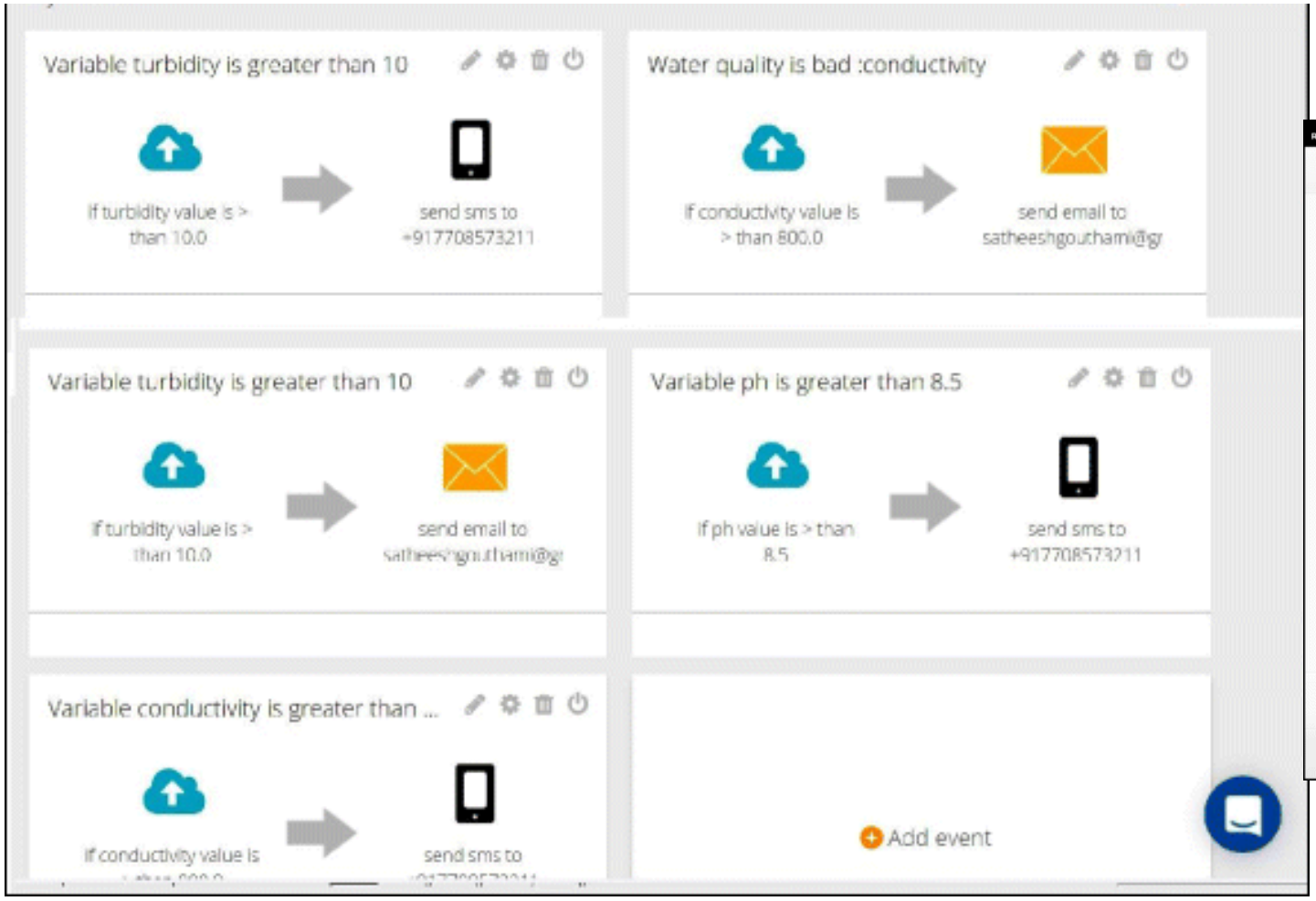
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Water quality is bad :conductivity
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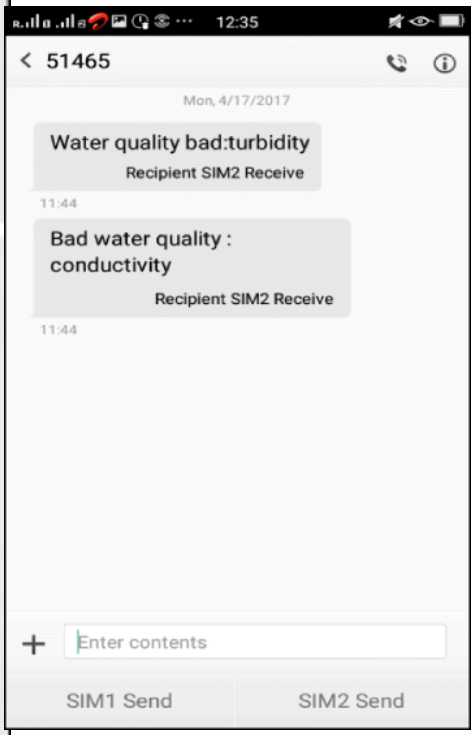
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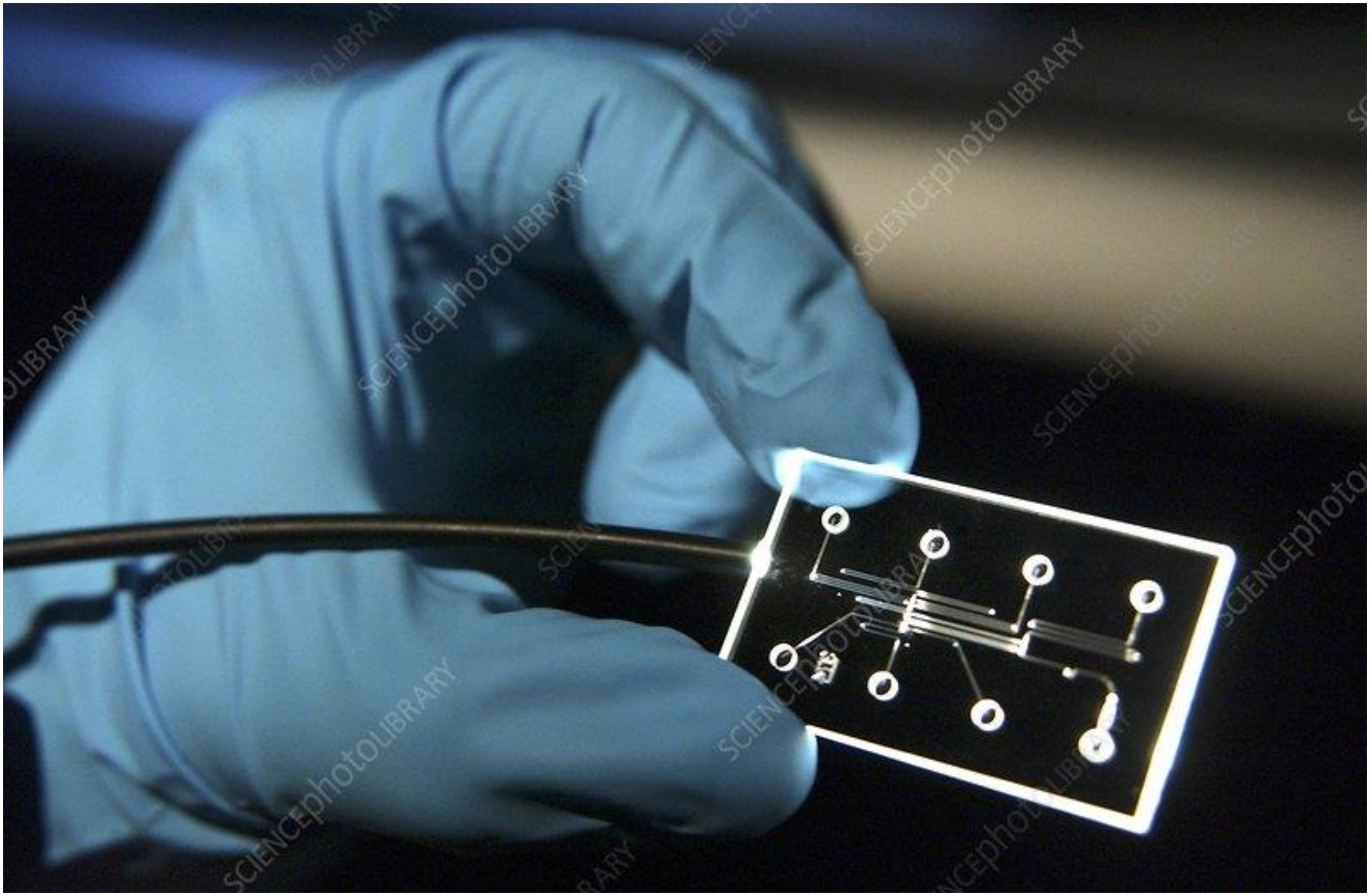
Lab on Chip – water quality monitoring



Lab-on-a-chip

- A lab-on-a-chip (LOC) is a device that integrates one or several laboratory functions on a single integrated circuit (commonly called a "chip") of only millimeters to a few square centimeters to achieve automation and high-throughput screening
- Lab-on-a-chip devices are a subset of microelectromechanical systems (MEMS) devices and sometimes called "micro total analysis systems" (μTAS)
- LOCs may provide advantages, which are specific to their application. Typical advantages are:

a) low fluid volumes consumption (less waste, lower reagents costs, and fewer sample volumes)

b) faster analysis and response time due to short diffusion distance & high surface to volume ratio.

c) better process control because of a faster response of the system compactness of the systems due to the integration of much functionality and small volumes

d) lower fabrication costs, allowing cost-effective disposable chips, fabricated in mass production

e) safer platform for chemical, radioactive or biological studies because of integration of functionality, smaller fluid volumes, and stored energies

Lab-on-a-chip

Microfluidics and Lab-On-A-Chip for Water Analysis

- Microfluidics and lab-on-a-chip systems are advanced technologies that may replace the traditional methods of water analysis in the near future.
- Lab-on-a-chip technology employs microfluidics, which deals with very minute amounts of fluids in microchannels, to perform the analysis.
- The lab-on-a-chip device is a chip that resembles electronic chips, but with micro-channels instead of electrical circuits.
- It shrinks the lab to the chip size and can perform complete analysis or even series of analysis.

Advantages of using lab-on-a-chip for water analysis:

- can reduce time and manpower in the sampling process because this technology can offer immediate, onsite results.
- In addition, this technique is much less expensive and offers higher accuracy, because of the small volumes analyzed and the possibility of eliminating the sampling process, which reduces the human error

Components of Lab-on-a-chip systems

The main components of a lab-on-a-chip system for water analysis are; a liquid delivery system (injector and fluidic transporter), mixer, reactor, separator, and power supply.

- **The Injector** is used to deliver precise volumes into the chip. The most common types of the injectors are syringe pumps and robotic pipets.
- **Transporters** control all aspects of the flow. They can be active, which need an energy source, or passive, which are achieved by manipulating the geometries of the channels and do not require any energy source. The choice between the active and passive types is based on the application. There are multiple types of active transporters, but the most preferred is electrochemical pumping systems, such as microsyringe pumps, because they eliminate the design complexity.

Components of Lab-on-a-chip systems

- **Mixers** are used to mix different fluids into the channels. Similar to the transporters, the types of mixers are divided into passive, which are achieved by design manipulation, and active, which require power.
- **The Reactor** is where the reaction takes place. There are three types of reactors used in lab-on-a-chip systems: gas phase, liquid phase, and packed-bed reactors.
- **Controllers** are used for controlling all types of activities in the chip as well as data acquisition and signal processing.
- **Power supplies**, such as batteries, are essential to run the lab-on-a-chip systems. Many research studies focus on finding more advanced power supplies because some types of lab-on-a-chip systems require high voltage.