KSHETRIK-MITRA

(Real Time Monitoring and Data Analysis)

Abstract:

A water monitoring is required to maintain water quality for circulating any life process. To verify and monitor the water quality in a large area such as lake, river, and aquaculture requires an automated water monitoring system. This system usually takes the measure of parameters related to water quality such as temperature, pH, Dissolved Oxygen, Turbidity, Conductivity, TDS, Salinity, etc in real time. Beside real time monitoring ,it becomes very important to study the behaviour of water parameters over a time period. This helps to reach to the root cause of the degradation of water quality in a particular location and find a solution for it. KSHETRIK-MITRA is capable of monitoring water quality in real time and also allows to analyse tha data collected during monitoring.Cloud based solution is provided to make the process less complicated more efficient and accurate.

Background:

India is more dependent on water pumped from aquifers than any other nation — it accounts for about a quarter of global demand for groundwater, according to the World Bank. More than 90 percent of groundwater in India is used for irrigated agriculture. The remainder — 24 billion cubic meters — supplies 85 percent of the country's drinking water.

According to the latest assessment by the National Institution for Transforming India (NITI), a government-run think tank, nearly 70 percent of all of the country's fresh water — in the ground or on the surface — is contaminated. India's rivers, lakes, and aquifers are more polluted than the waters of any other major nation.

Irrigation Water Quality

Irrigation Water Quality Criteria ,Soil scientists use the following categories to describe irrigation water effects on crop production and soil quality:

Salinity	***total soluble salt content***
Sodium	***relative proportion of sodium to calcium and magnesium ions***
pH	***acidic or basic***
Alkalinity	***carbonate and bicarbonate***
Specific ions	***chloride, sulfate, boron, and nitrate***

Alkalinity and pH are two important factors in determining the suitability of water for irrigating plants.

The desirable range for irrigation water is 0 to 100 ppm calcium carbonate. Levels between 30 and 60 ppm are considered optimum for most plants.

Water pH may need to be adjusted before being used for mixing some pesticides, floral preservatives, and growth regulators.

Standard for Safe Drinking Water

The Bureau of Indian Standards (BIS) has specified drinking water quality standards in India to provide safe drinking water to the people. It is pertinent that drinking water sources be tested at regular intervals and ensure that water is meeting the prescribed standards or not.

IS 10500 : 2012

Table 2 General Parameters Concerning Substances Undesirable in Excessive Amounts
(*Foreword* and *Clause* 4)

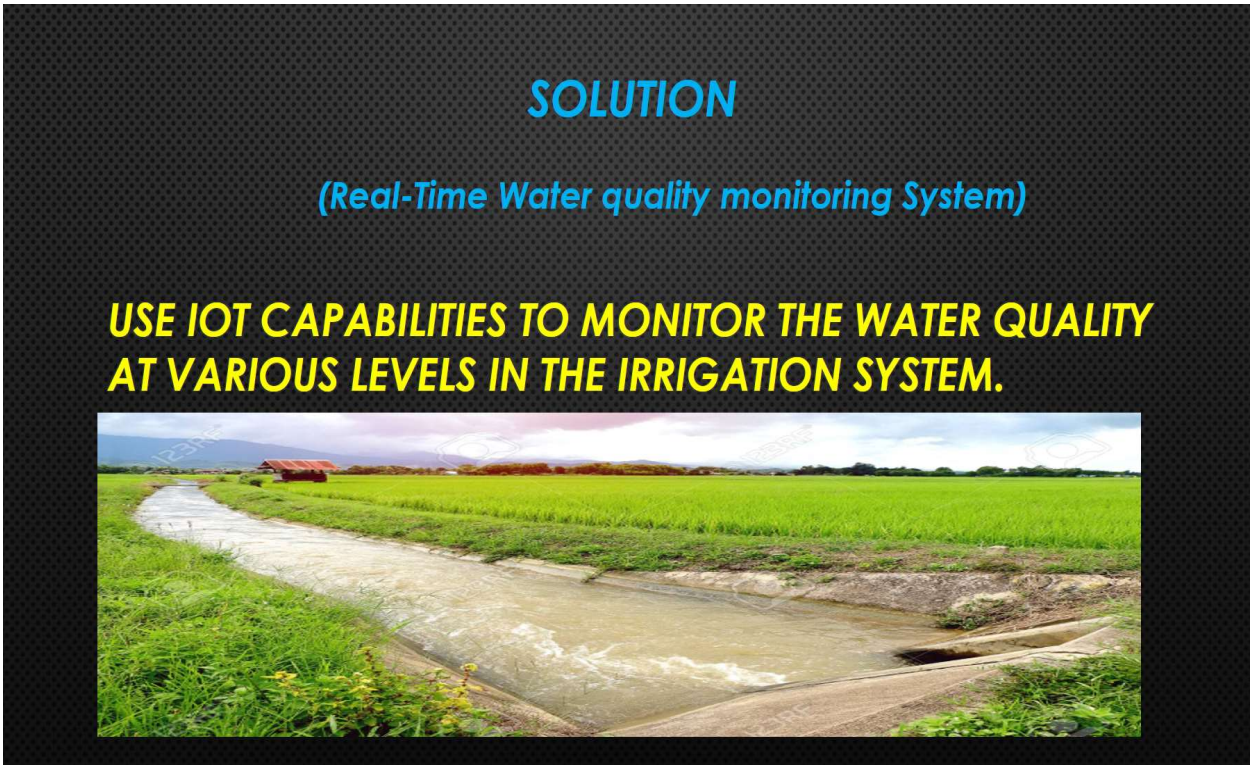
Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Aluminium (as Al), mg/l, *Max*	0.03	0.2	IS 3025 (Part 55)	—
ii)	Ammonia (as total ammonia-N), mg/l, *Max*	0.5	No relaxation	IS 3025 (Part 34)	—
iii)	Anionic detergents (as MBAS) mg/l, *Max*	0.2	1.0	Annex K of IS 13428	—
iv)	Barium (as Ba), mg/l, *Max*	0.7	No relaxation	Annex F of IS 13428* or IS 15302	—
v)	Boron (as B), mg/l, *Max*	0.5	1.0	IS 3025 (Part 57)	—
vi)	Calcium (as Ca), mg/l, *Max*	75	200	IS 3025 (Part 40)	—
vii)	Chloramines (as Cl_2), mg/l, *Max*	4.0	No relaxation	IS 3025 (Part 26)* or APHA 4500-Cl G	—
viii)	Chloride (as Cl), mg/l, *Max*	250	1 000	IS 3025 (Part 32)	—
ix)	Copper (as Cu), mg/l, *Max*	0.05	1.5	IS 3025 (Part 42)	—
x)	Fluoride (as F) mg/l, *Max*	1.0	1.5	IS 3025 (Part 60)	—
xi)	Free residual chlorine, mg/l, *Min*	0.2	1	IS 3025 (Part 26)	To be applicable only when water is chlorinated. Tested at consumer end. When protection against viral infection is required, it should be minimum 0.5 mg/l
xii)	Iron (as Fe), mg/l, *Max*	0.3	No relaxation	IS 3025 (Part 53)	Total concentration of manganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
xiii)	Magnesium (as Mg), mg/l, *Max*	30	100	IS 3025 (Part 46)	—
xiv)	Manganese (as Mn), mg/l, *Max*	0.1	0.3	IS 3025 (Part 59)	Total concentration of manganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l

Reference : ***http://cgwb.gov.in/Documents/WQ-standards.pdf***

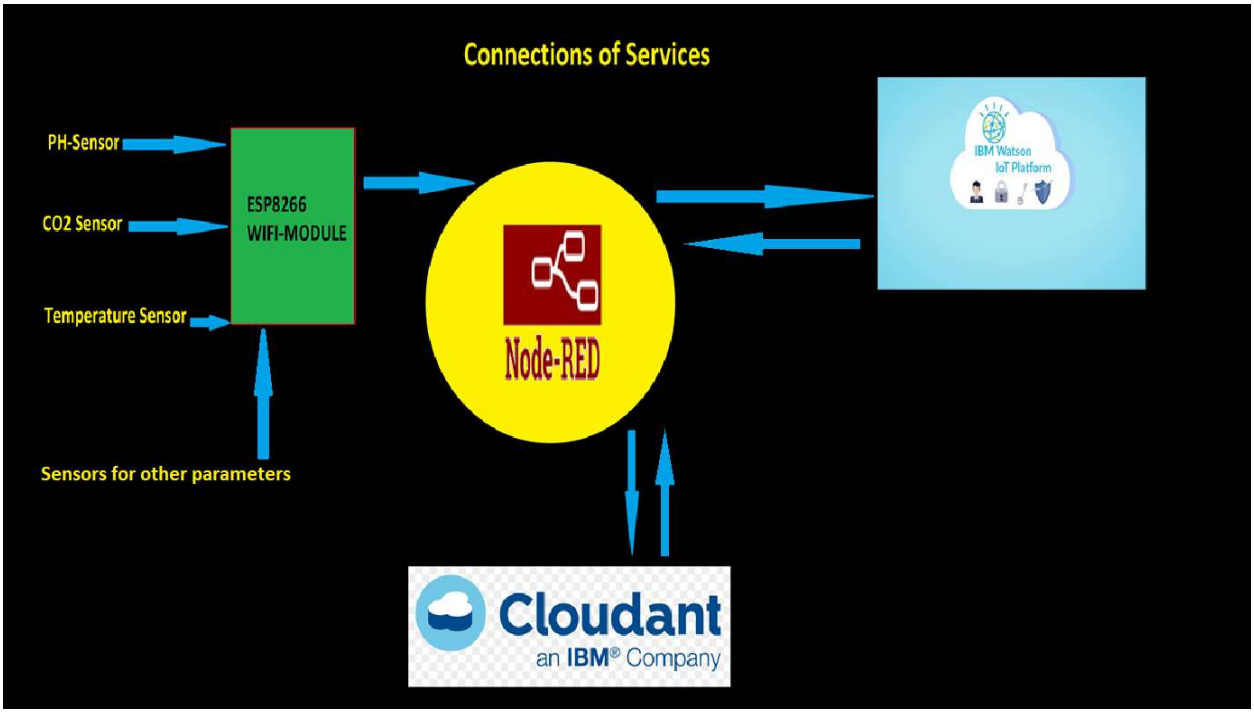
Requirement : ***It becomes necessary to keep a control over the quality of water used for drinking and irrigation.***

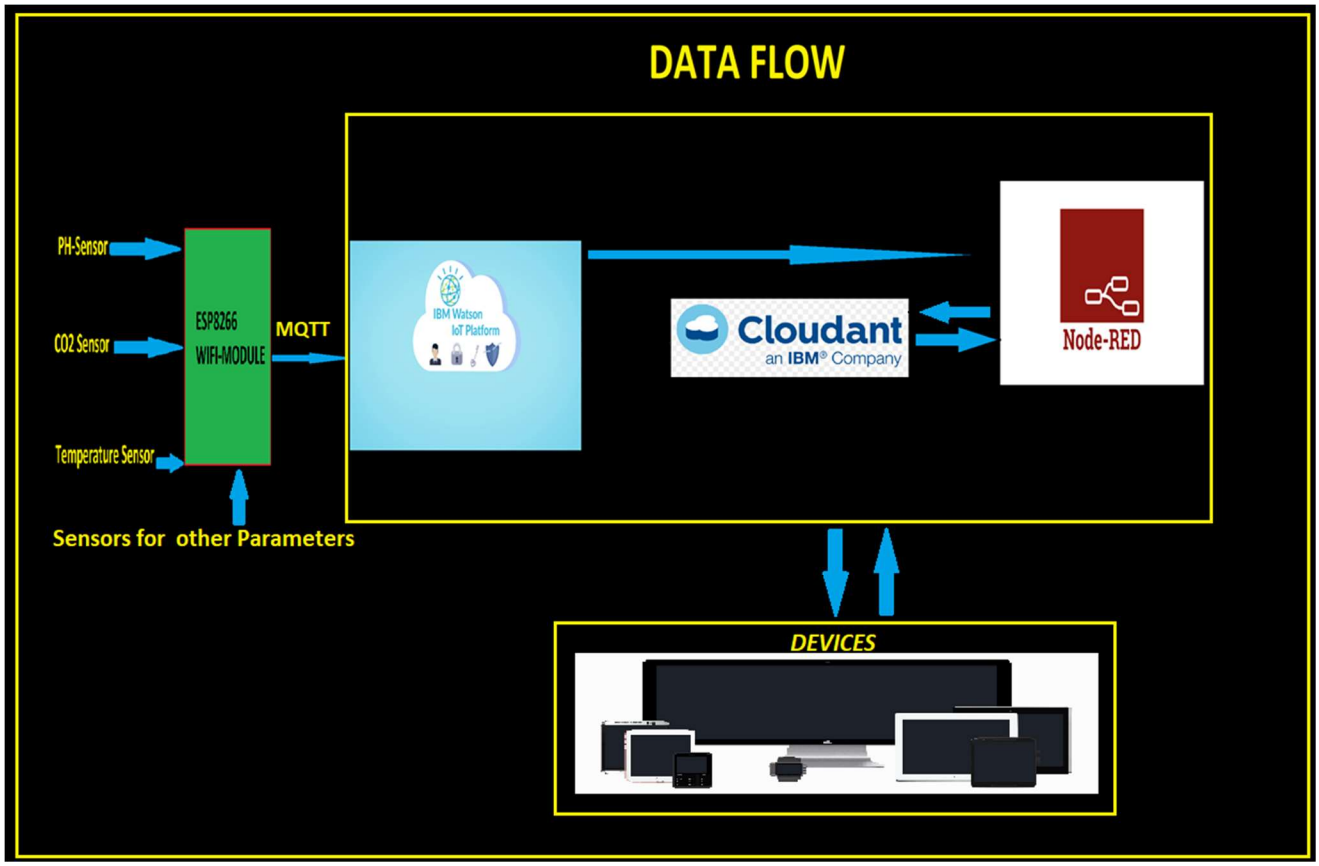
Traditional methods have the drawbacks such as long waiting time for results high cost, low measurement precision, and complicated methodology . We offer less complicated and more accurate water quality monitoring system. This system performs mainly following functionality:

1) ***Monitor the real time data***
2) ***Data analysis of Historical data***



System Connections





WORK FLOW

When Device is switched on, System turns into active state. Sensors send the MQTT messages to IBM Watson IOT Platform. DATA is then send to IBM Node-RED which sends the data to IBM Cloudant Object in form of JSON.

Node-RED Application performs mainly three Tasks:

1)Send the incoming data to the IBM cloudant object

2) Monitors the real time Data coming from the sensors.

3)Plots the graphs using the Data from the cloudant object.

KSHETRIK-MITRA Application provides a Cloud based Solution to the Water Quality problems faced by farmers worldwide. Its user friendly and provides an accurate water quality monitoring system.

Product Highlights:

1) Monitoring real time data: Helps avoiding the crop destruction and degradation of crop quality due to use of contaminated water for irrigation .Alert the User if WQ crosses tolerance.

2) Analysis of Water Quality Behavior: Helps in understanding the behavior of Water Quality in an area throughout season.

3) It helps improving the Quality of agriculture products and maximizing the farm production.

4) Ease of installation: Integrating of New Devices/Sensors with Application is dynamic and effortless without making changes in application.

Hardware Used:

- ***ESP8266:*** *The ESP8266 can connect to a 2.4GHz network supporting 802.11 b/g/n.*
- *DHT11 Temperature / Humidity Sensor [* ***DHT11 or DHT22(more accurate)****]*

Configuration of ESP8266 with IBM WATSON IOT:

```
// Watson IoT connection details
#define MQTT_HOST "z53u40.messaging.internetofthings.ibmcloud.com"
#define MQTT_PORT 8883
#define MQTT_DEVICEID "d:z53u40:ESP8266:dev01"
#define MQTT_USER "use-token-auth"
#define MQTT_TOKEN "password"
#define MQTT_TOPIC "iot-2/evt/status/fmt/json"
#define MQTT_TOPIC_DISPLAY "iot-2/cmd/display/fmt/json"
#define CA_CERT_FILE "/rootCA_certificate.pem"
#define KEY_FILE "/SecuredDev01_key_nopass.pem"
#define CERT_FILE "/SecuredDev01_crt.pem"
```

Payload publishing from ESP8266:

```
    // Send data to Watson IoT Platform
    status["temp"] = t;
    status["humidity"] = h;
    serializeJson(jsonDoc, msg, 50);
    Serial.println(msg);
    if (!mqtt.publish(MQTT_TOPIC, msg)) {
      Serial.println("MQTT Publish failed");
    }
  }
```

Reference: https://binnes.github.io/esp8266Workshop/part2/CERT2.html

Payload Received at IBM WATSON IOT

"Humidity" and "Temperature" data are there from the Sensors at ESP8266 end .So before sending the payload to IBM Cloudant , payload is added simulated data:

- ***Timestamp***
- ***Ph***
- ***Sensors/ESP8266 location name***
- ***Latitude***
- ***Longitude***

Simulated data is added to prepare a database content which receives and stores Water Quality parameters' value from different location. Application will be getting all parameters value from sensors .

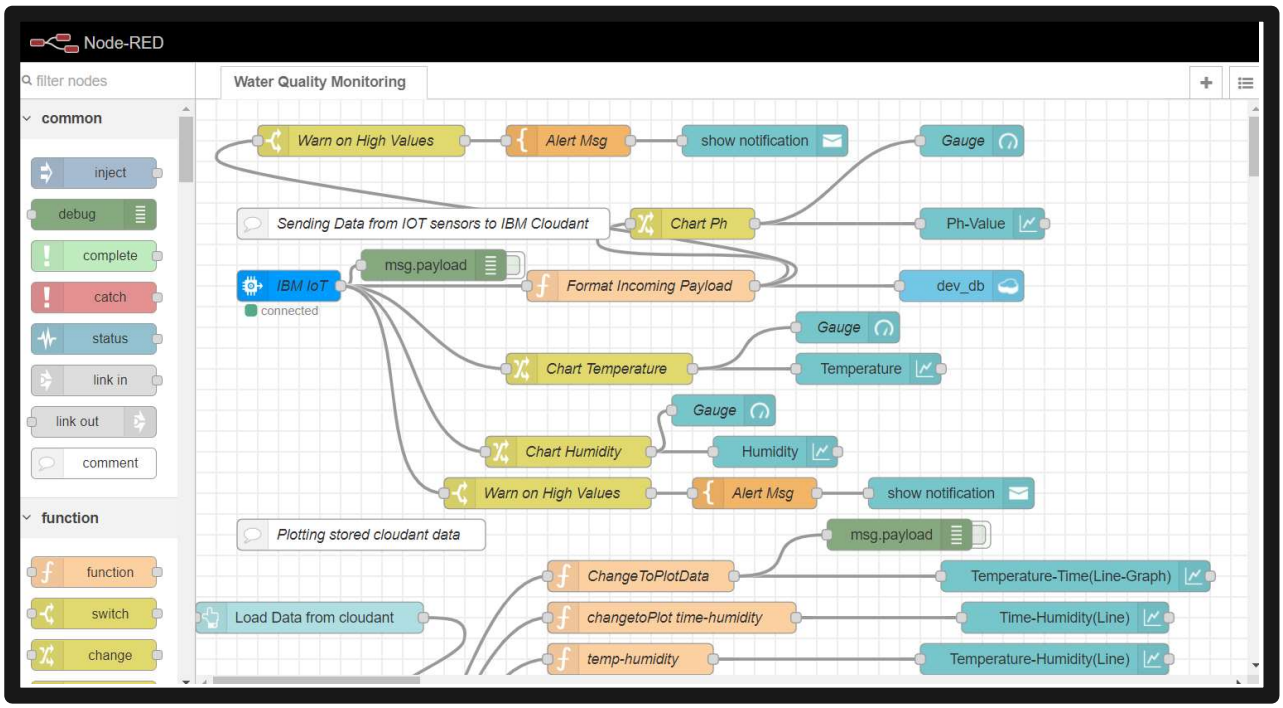
Payload Received at IBM Cloudant


```
{
  "_id": "12edc00422027018734700497c2eb49e",
  "_rev": "1-352489a45f60e0ca13c2ab1a35b6c1b1",
  "topic": "iot-2/type/ESP8266/id/dev01/evt/status/fmt/json",
  "payload": {
    "time": 1594994420367,
    "temp": 27,
    "humidity": 82,
    "ph": "12.501",
    "lat": 12.972442,
    "lon": 77.580643,
    "name": "Bangalore"
  },
  "deviceId": "dev01",
  "deviceType": "ESP8266",
  "eventType": "status",
  "format": "json"
}
```


Payload Attribute description:

"time"	***Timestamp at which data is received by IBM Watson IOT Instance***
"temp":	***Temperature at the device end***
"humidity"	***Humidity measured by device***
"ph"	***Parameter measured by device***
"lat"	***Latitude of the device location***
"lon"	***Longitude of the device location***
"name"	***Name of the place of device sending Data to the Cloud***

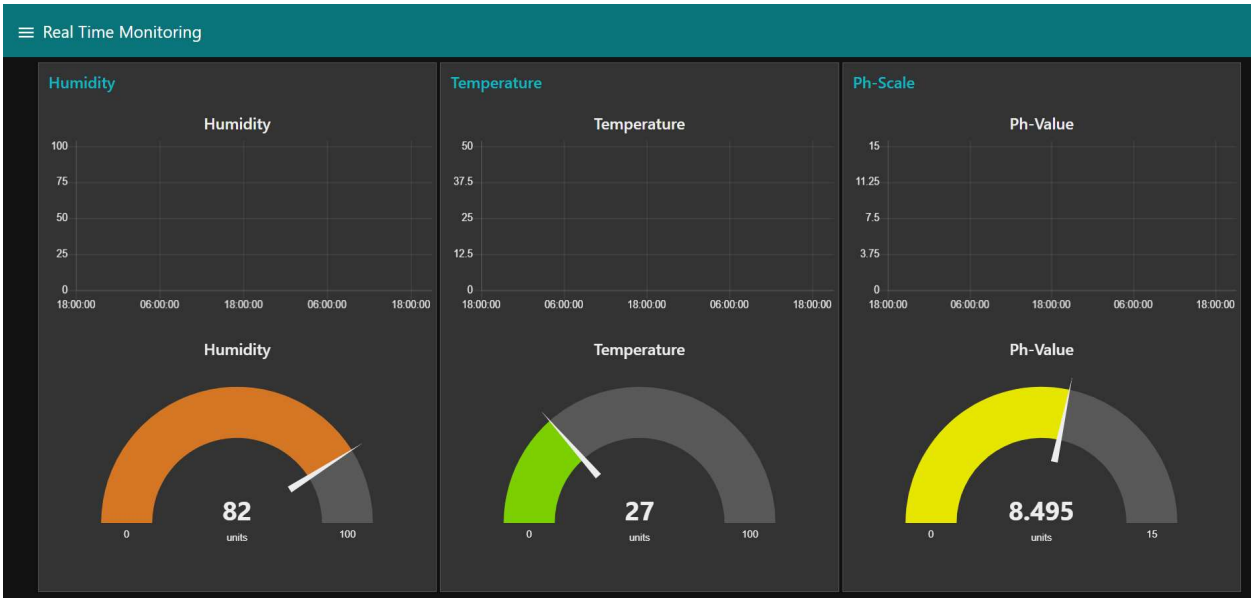
NODE RED



Real Time Monitoring:

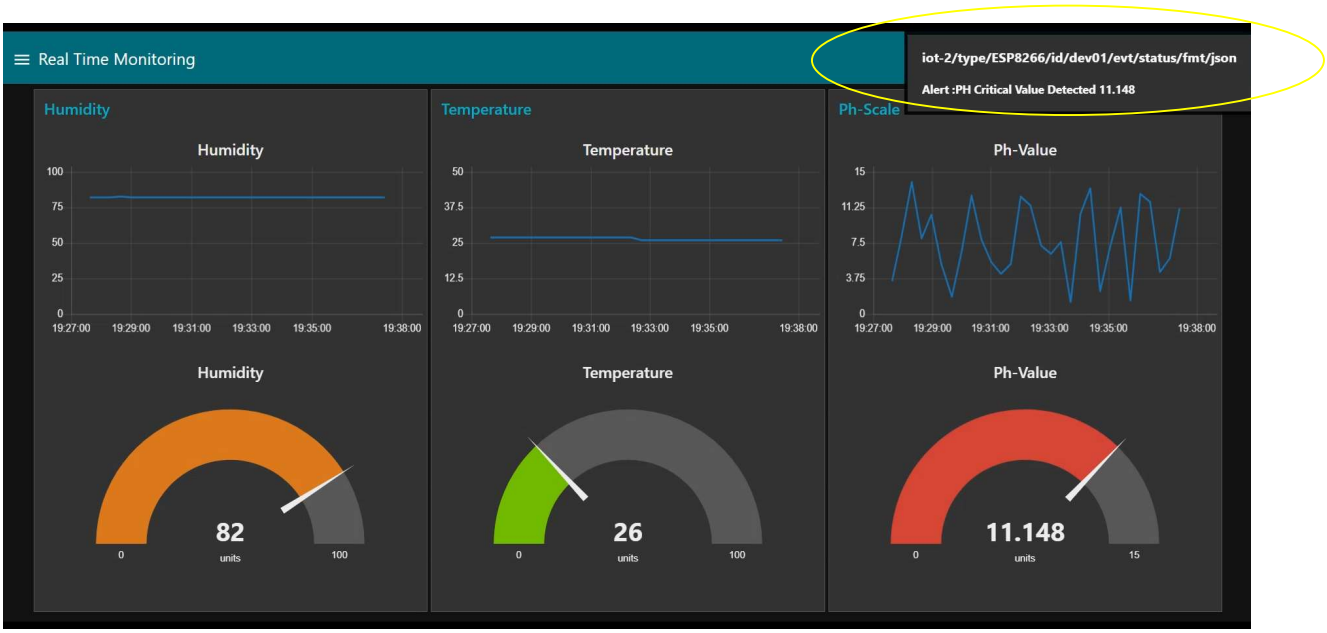
Dashboard:

1) When device is not connected



2) When device is connected and sending Water Qualities' parameters

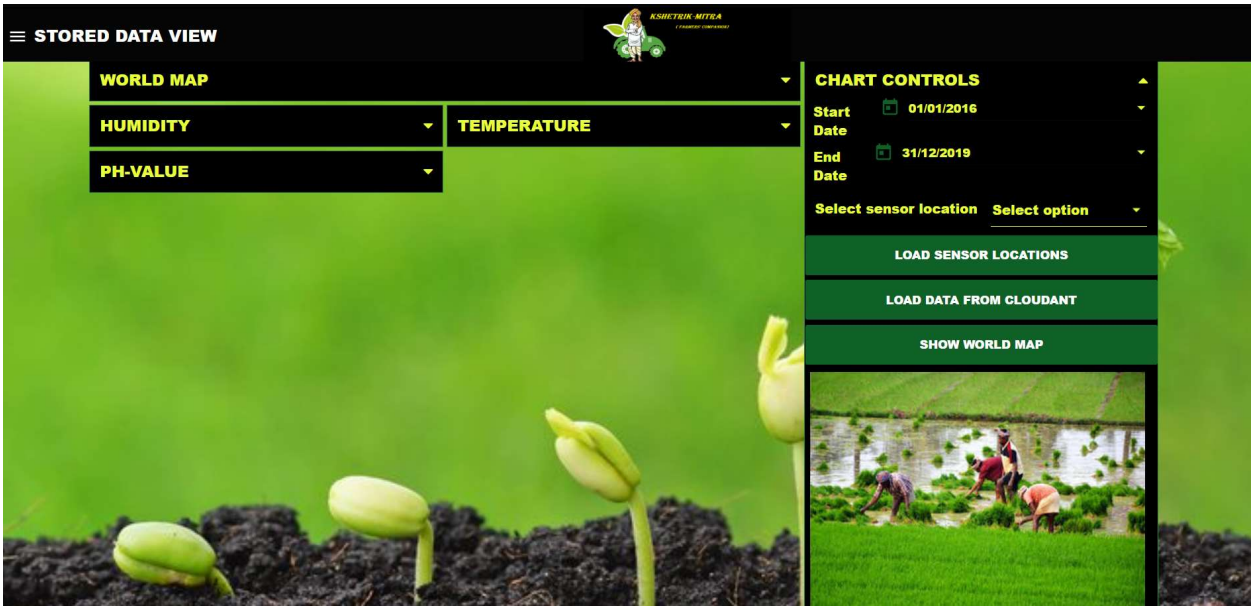
3) Gives "<u>alert message</u>" in case any of the parameters goes out tolerance specifying the parameter name and value. Colour of the indicator also changes accordingly.



Stored/Historical Data Analysis

Dashboard:

➔ *One can see the data between given range of timestamp.*



➔ *"<u>Load Sensor Location</u>" Button is used to load all the location where devices are deployed.*

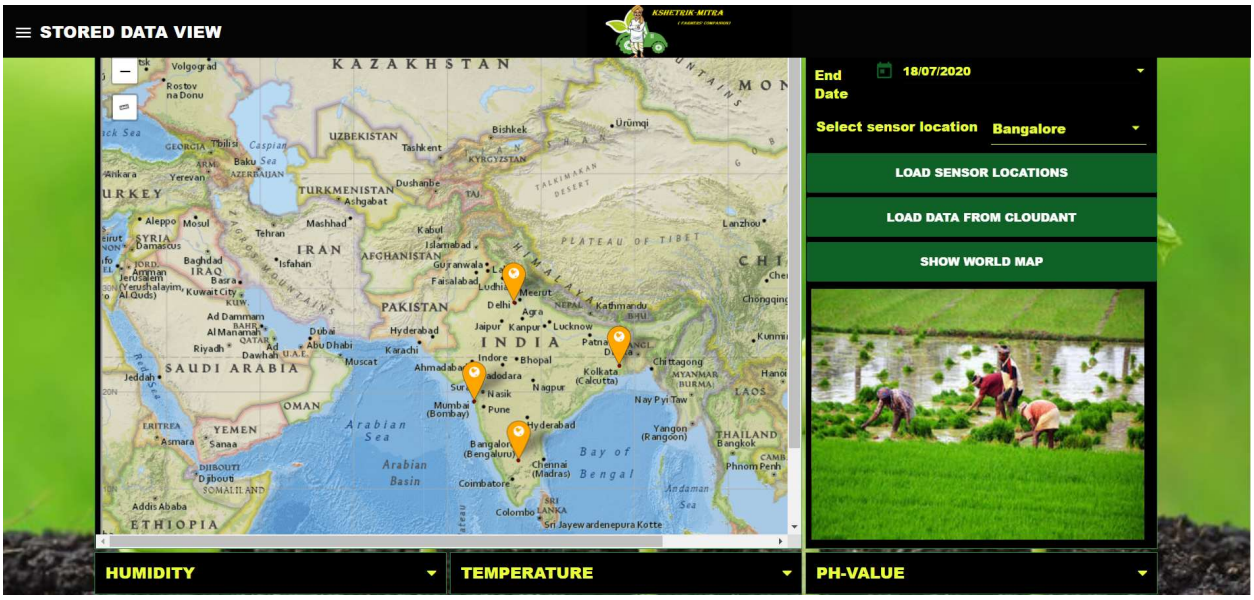
➔ *Select sensor location dropdown provides all location where devices are deployed.*

➔ *One can select to see data of selected location devices for a given time range.*

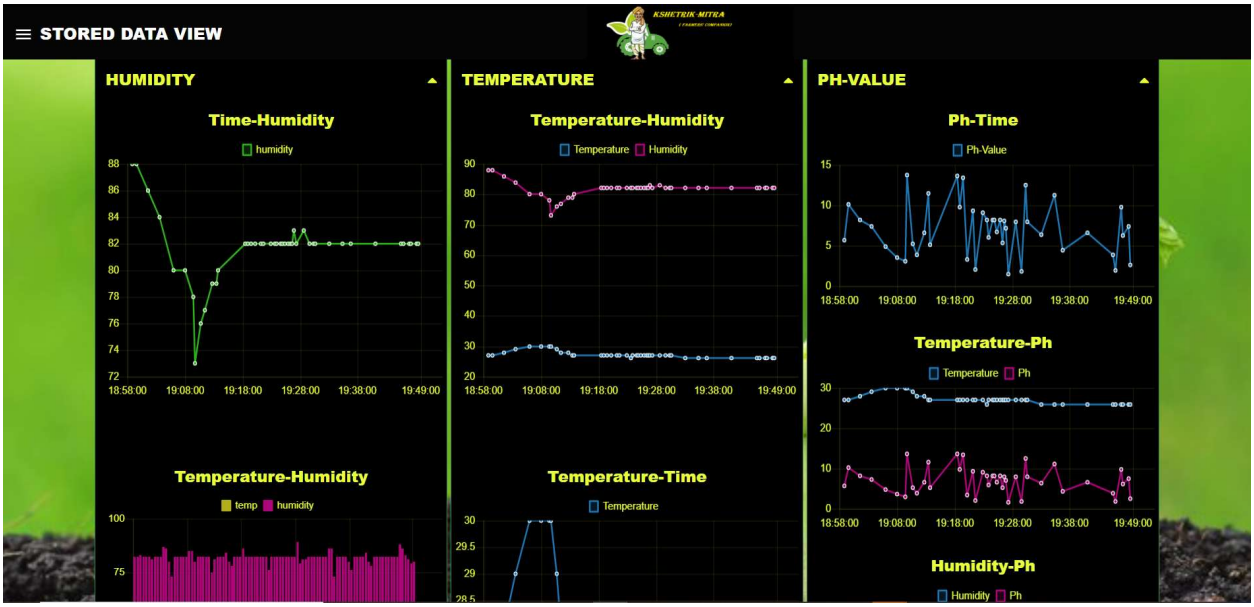
➔ ***<u>New device can also be added to send data to the same database in IBM cloudant</u> (with same payload structure)without making change in the code(Node-Red Application). Clicking "Load Sensor Location" takes the distinct location from cloudant object and push it into dropdown for selection.***

➔ ***"<u>Show World Map</u>" button pushes world map into the dashboard for view.***

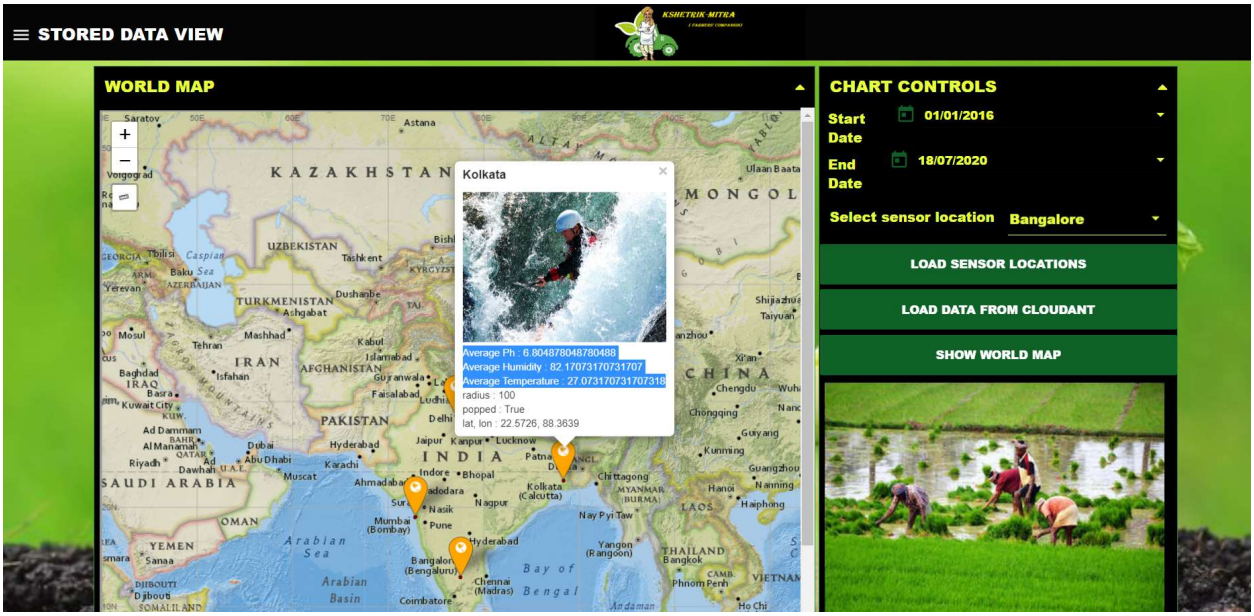
➔ ***"<u>Load Data From Cloudant</u> "button loads the places into the MAP where devices are deployed.***



➔ *"<u>Load Data From Cloudant</u> "button plots the data into the graph for better observation of behaviour of Water Quality Parameters.*



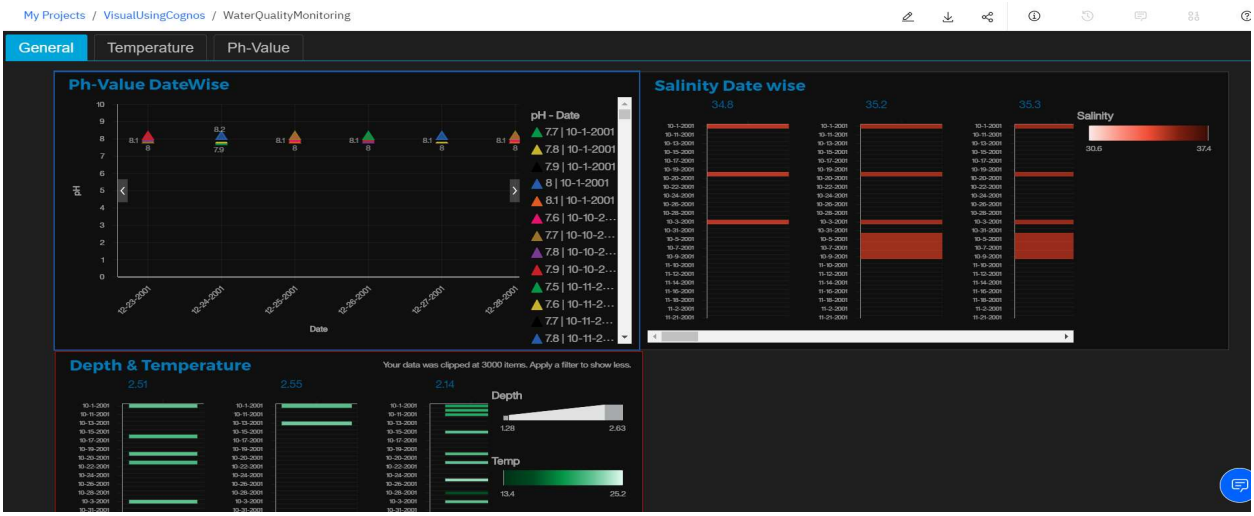
➔ *One can see the average parameter of a given location in the selected range of timestamp by clicking over the location.*



Viewing Historical data using 'IBM COGNOS'

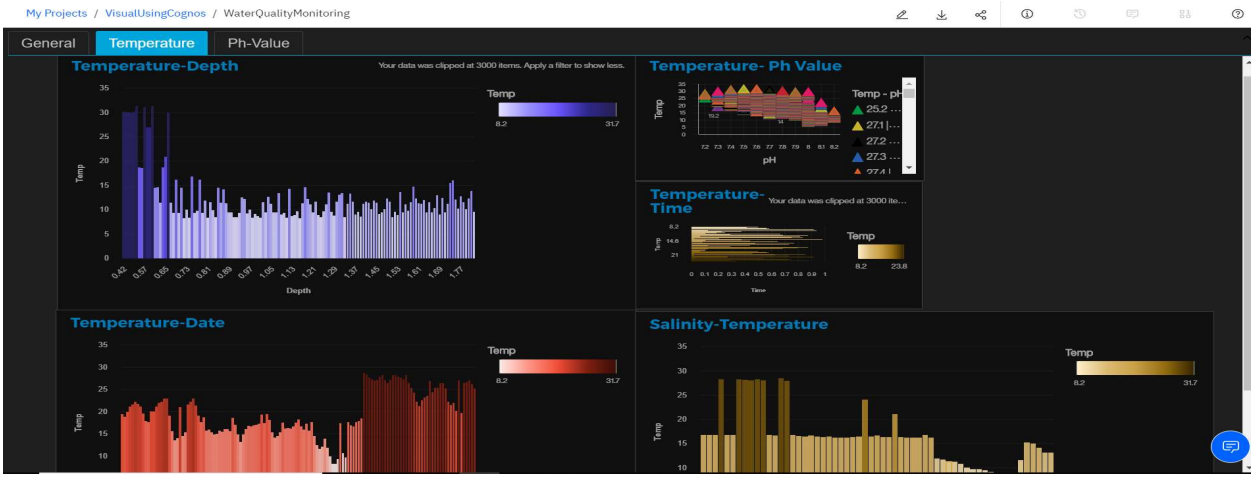
Using real dataset : ***Data Set is taken from Baruch Institute's Water Quality Long-Term Monitoring Database for the North Inlet and Winyah Bay Estuaries, South Carolina***

Reference : https://www.baruch.sc.edu/water-quality-chemistry-databases



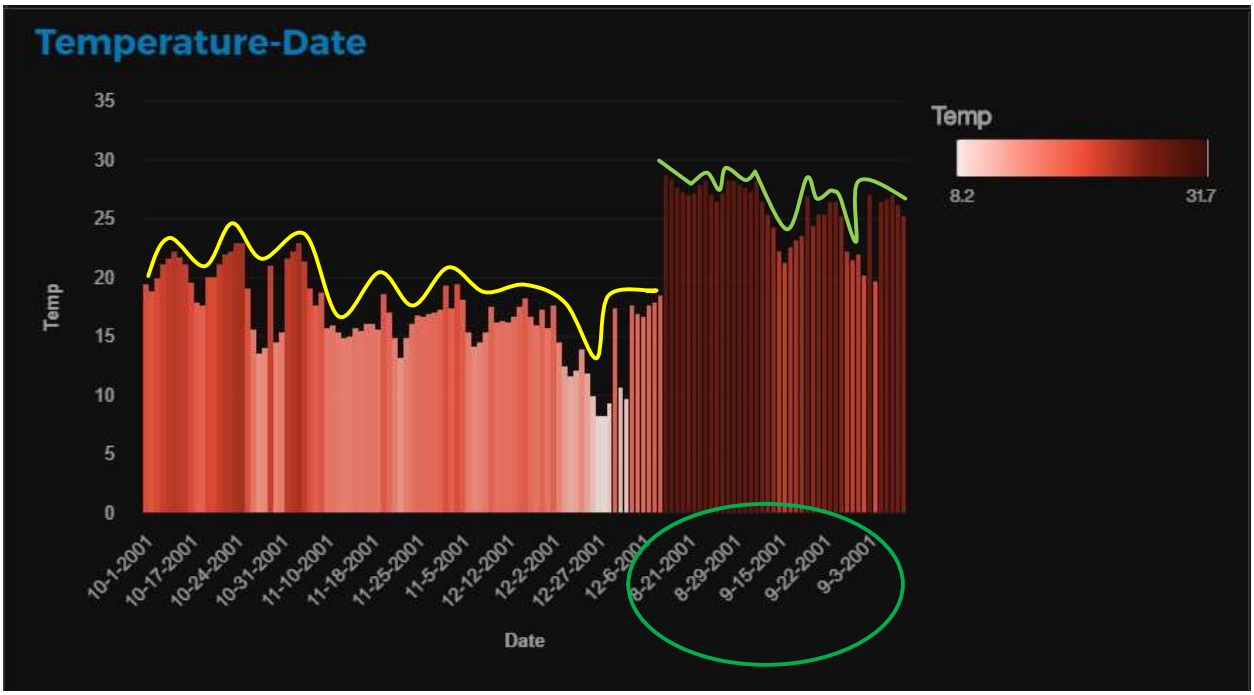
Graph "Ph-Value DateWise" shows the distribution of Ph-value everyday and over period of time.Frequency of parameters measures used half and hour.Graph shows the max and min Ph-Value that is recorded on a particular day.

Similarly, Salinity Date wise shows the distribution of Salinity over time. Heat Map shows value through color intensity in different segment.

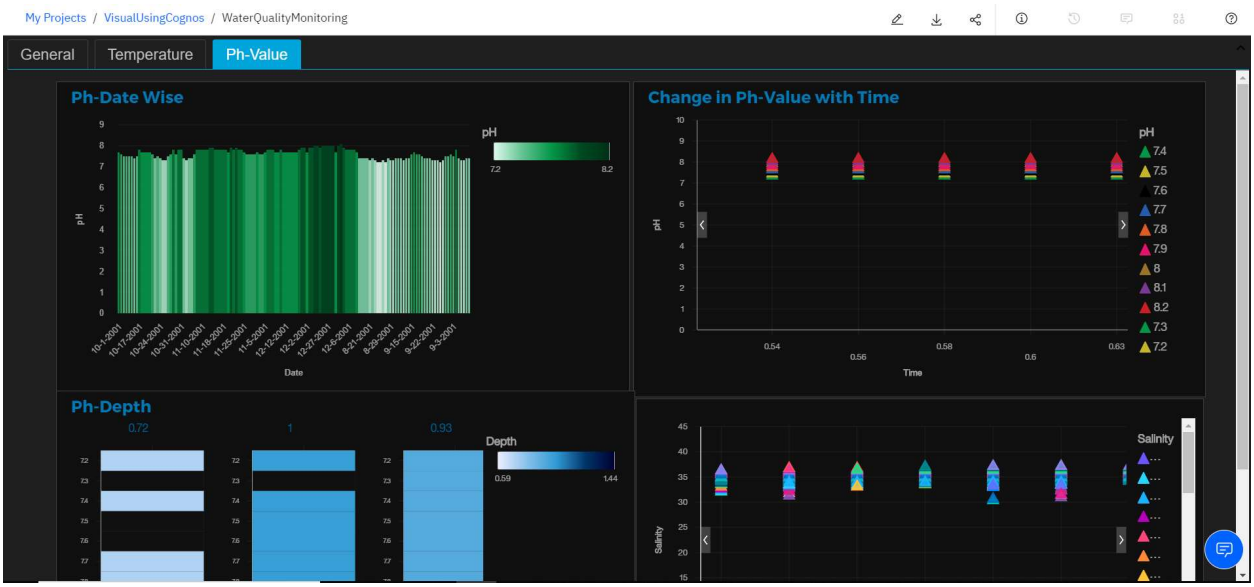


Temperature-Depth: Behaviour of Temperature with respect to Depth.Temperature decreses as the depth of the river increses.This can be viewed through colour distribution too where colour intensity decreses with depth.

<u>Temperature-Date:</u> Change in temperature w.r.t Date. Temperature during mid months of year remains high.



Water is having higher Ph-Value during month of November and December.It remains same during the day time.There is not a fixed distribution of Ph with Depth cause at a particular depth ,it shows all range of Ph measured.



Similar way, other parameters behaviour w.r.t other parameters and time be analysed through graph.