Data Article

Dataset for a wireless sensor network based drinking-water quality monitoring and notification system

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A R T I C L E   I N F O

Article history:
Received 16 September 2019
Received in revised form 6 November 2019
Accepted 7 November 2019
Available online 16 November 2019

Keywords:
Water quality parameters
Sensors
Internet of things
Wireless communication
Micro-controller
Water monitoring
Water safety

A B S T R A C T

This paper presents the collected experimental data for water quality monitoring which was conducted in ten experiments by using five different common sources of water contaminants namely soil, salt, washing powder, chlorine and vinegar and their combination. The data were collected indoors at room temperature during the day for several days using sensors that measure pH, turbidity, flow rate, and conductivity in water. The water consumption risk (CR) was calculated as deviation based on the water quality parameters standards proposed by the World Health Organisation (WHO) and the South African Department of Water Affairs (DWA), with respect to the sensor measurement readings obtained. While the error measurements were calculated based on the expected parameter measurement per conducted experiment and repeated for 26 measurements. Pure tap water was the benchmark of water safe for human consumption. The first five experiments were performed by introducing each contaminant into the water and thereafter, two contaminants in the sixth experiment and their additions until all different contaminants were experimented at once in the last experiment.

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https://doi.org/10.1016/j.dib.2019.104813
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1. Data

The dataset is published online in the Mendeley data repository [1]. The presented data were collected for all ten experiments conducted with the first being data for pure tap water and the rest being data for contaminated water using different contaminants and their additions until all different contaminants were experimented at once. Table 1 present the benchmark WHO standards of water parameters for safe human consumable water. The graphs portray the trends of each experiment showing the change in parameter values due to introduction of contaminant(s) with scaling for pH, conductivity and LDR (Light Dependant Resistor) and real-time scaling as data was collected in real-time. The real-time measurement values are presented in Tables 2–11. Conductivity, pH and LDR resistance (representing turbidity) were measured for the first six experiments and only pH and LDR values were measured for the last four experiments because the values were beyond the conductivity meter rating of 0–1999 µS/cm. Fig. 1 portrays the trends for pure tap water and their range, which is the benchmark quality parameters used in comparison to WHO water quality standards. Furthermore, it is vital that the water quality ranges of the water used must be analysed and known in order to ensure the quality and validity of the results. Fig. 2 shows the trends for soil contaminated water. Fig. 3 shows the trends for chlorine contaminated water. Fig. 4 depicts salt contaminated water parameter trends. Fig. 5 shows washing powder contaminated water trends. Fig. 6 shows vinegar contaminated water trends. Trends for vinegar + washing powder contaminated water are portrayed in Fig. 7. Fig. 8 shows the trends for vinegar + washing powder + chlorine contaminated water. Trends for vinegar + washing powder + chloride + salt contaminated water are presented in Fig. 9. Fig. 10 shows the trends for vinegar + washing powder + chloride + salt + soil contaminated water.
2. Experimental design, materials, and methods

Fig. 11 depicts the water supply design set up by which the data was gathered and analysed. It also shows how each sensor was mounted on this subsystem. All the sensors were integrated into the water supply subsystem in a way that they can accurately gather measurements from the analysed water. The pH sensor was installed inside the pipe as it functioned accurately in that location. Two valves were used to monitor and control the flow rate of water inside the pipe. The LDR was mounted on the surface of the water tank as it depends on light and since there is no light but darkness inside the pipe (where the pH sensor was mounted), otherwise the LDR would not work properly but only produce the same results for changes in water colour. The water tank was wrapped in a white paper to confine and reduce the error in measurement of the LDR for changes in water colour and for usage in indoor environment. A one (1) litre water tank was selected, to enable mobility of the system, and also to save and conserve water for the duration of the testing phase. The twenty (20) litre container was used to drain both the pure tap water and the contaminated tap water after each analysis and testing.

2.1. List of hardware components and materials

- pH sensor
- Flow sensor
- 2× valves
- LDR
- 1L water tank
- 20L drainage bucket
- 1 m plastic pipe
- Arduino Microcontrollers
- HFY radio modules

2.2. Methods

Pure tap water parameters were measured first to validate the water quality standards as well as the performance of the system developed. Then five contaminants were used namely; soil, chlorine, salt, vinegar and washing powder. The soil was chosen because water can be contaminated by the soil in events of leakages on the water supply and distribution system. Chlorine was chosen because water can be overtreated and distributed without proper analysis, this is a mistake that might happen in water industries. Salt was chosen because of its ability to dissolve in water, and also to test the LDR, pH response and the conductivity. Water with high dissolved substances is not healthy for consumption, so the system must be able to detect such effects. Washing powder is known to be soapy, thus alkaline. This contaminant was chosen to test the system’s response to soapy substances present in water. Vinegar is known to be a sour substance, thus acidic. It was chosen to test the system’s response to acidic substances present in water. This phenomenon occurs mostly in corrosive pipes, which produces

| S/N | Parameter               | Quality Range | Units |
|-----|-------------------------|---------------|-------|
| 1   | pH                      | 6.5–8.5       | pH    |
| 2   | Electrical Conductivity | 500–1000      | μS/cm |
| 3   | Turbidity               | 0–5           | NTU   |
| 4   | ORP                     | 650–800       | mV    |
| 5   | Temperature             | –             | °C    |
| 6   | Free Residual Chlorine  | 0.2–2         | mg/L  |
| 7   | Dissolved Oxygen        | –             | mg/L  |
| 8   | Nitrates                | <10           | mg/L  |

Table 1
Water quality parameters proposed by WHO and South Africa, DWA [5,6].
an acidic substance. Later experiments are conducted by the addition of the above-mentioned contami-
nants one at a time and checking the system's response for combined contaminants in water.

2.3. Arduino sketches (codes)

1) Measuring subsystem

```c
#include <RH_ASK.h>  // Radio Amplitude Shift Keying library
#include <SPI.h>      // dependent SPI library

RH_ASK radio;   // radio variable

// Variables
int sensor = A0;  float pHvalue; String pH, Conduct;
int sensor1 = A1; float value1, Conductivity; String ldr, str_out;
int flowPin = 2;  float flowRate; String str_flowRate;
volatile int count;  // This integer needs to be set as volatile to ensure it updates correctly during the interrupt process.

//transmission led
int trans_led = 7;

void setup() {
    // put your setup code here, to run once:
    Serial.begin(9600);

    radio.init();
    pinMode(sensor, INPUT); pinMode(sensor1, INPUT);
    pinMode(flowPin, INPUT);

    pinMode(trans_led, OUTPUT);
}

void loop() {

    pHvalue = analogRead(sensor); value1 = analogRead(sensor1);
    pHvalue = (pHvalue/1023)*15;
    count++;  // Reset the counter so we start counting from 0 again
    flowRate = (count * 22.5);  // Take counted pulses in the last second and multiply by 22.25mL
    flowRate = FlowRate * 60;  // Convert seconds to minutes, giving you mL / Minute
    FlowRate = flowRate / 1000;  // Convert mL to Liters, giving you L / Minute

    pH = String(pHvalue); ldr = String(value1);
    str_flowRate = String(FlowRate);

    Serial.print(pH);
    Serial.print("\n");

    str_out = pH++; "\nldr"++=str_flowRate;

    digitalWrite(trans_led, HIGH);  // turn on led when transmitting, led blinks

    static char *msg = str_out_c_str();
    radio.send((uint8_t*)msg, strlen(msg));  // send measurements to receiver
    radio.waitPacketSent();  // wait until packet is sent

digitalWrite(trans_led, LOW);
delay(100);
}
```
2) Analysis and notification subsystem

#include <RH_ASK.h> // Radio Amplitude Shift Keying library
#include <SPI.h> // dependant SPI library
#include "MegaunoLink.h" // to plot and store data

RH_ASK radio; // radio variable

//variables
TimePlot Graphs;

String str_out, str_pH, str_ldr, str_flowRate, temp;

//notification pins
int red_led = 7; int green_led = 8;
int buzzerPin = 9; int orange_led = 13;

//notification variables
float low_pH = 6.5, high_pH = 8.5, str_ldr_f;
float low_ldr = 100, high_ldr = 250;

void setup() {
  radio.init(); // initialising radio variable
  pinMode(red_led, OUTPUT); pinMode(green_led, OUTPUT); pinMode(orange_led, OUTPUT);
  Serial.begin(9600); // setup serial monitor
}

void loop() {
  uint8_t buf[28]; uint8_t buflen = sizeof(buf);

  if(radio.recv(buf, & buflen)== true){
    str_out = String((char*)buf);

    for(int i=0; i<str_out.length(); i++){
      if(str_out.substring(i, i+1)==" "){
        str_pH = str_out.substring(0, i);
        str_ldr = str_out.substring(i+1);
        break;
      }
    }

    for(int z=0; z<str_ldr.length(); z++){
      if(str_ldr.substring(z, z+1)==" "){
        temp = str_ldr.substring(0, z);
        break;
      }
    }

    Serial.print(str_pH); Serial.print(" ");
    Serial.print(temp); Serial.print(" "); // ldr
    Serial.print(str_flowRate);
    Serial.print("\n"); //converting from string to float type
    str_pH_f = float(str_pH.toFloat());
    str_ldr_f = float(temp.toFloat());
  }
}
Table 2

| Real-Time | pH m   | pH CR          | Cm (μS/cm) | Conductivity CR | LDR m (kΩ) | LDR CR |
|-----------|--------|----------------|------------|-----------------|-------------|--------|
| 46:25.5   | 6.98   | No Risk        | 736        | No Risk         | 304         | No Risk|
| 46:30.6   | 7.39   | No Risk        | 715        | No Risk         | 301         | No Risk|
| 46:35.6   | 6.92   | No Risk        | 665        | No Risk         | 302         | No Risk|
| 46:40.7   | 7.45   | No Risk        | 643        | No Risk         | 306         | No Risk|
| 46:45.7   | 7.42   | No Risk        | 714        | No Risk         | 305         | No Risk|
| 46:50.8   | 6.92   | No Risk        | 659        | No Risk         | 304         | No Risk|
| 46:55.8   | 7.43   | No Risk        | 626        | No Risk         | 304         | No Risk|
| 47:00.8   | 6.94   | No Risk        | 769        | No Risk         | 304         | No Risk|
| 47:05.9   | 7.77   | No Risk        | 699        | No Risk         | 306         | No Risk|
| 47:10.9   | 6.5    | No Risk        | 660        | No Risk         | 304         | No Risk|
| 47:15.9   | 7.42   | No Risk        | 761        | No Risk         | 304         | No Risk|
| 47:21.0   | 6.3    | 1.43%          | 654        | No Risk         | 306         | No Risk|
| 47:26.0   | 7.67   | No Risk        | 656        | No Risk         | 304         | No Risk|
| 47:31.1   | 7.49   | No Risk        | 769        | No Risk         | 306         | No Risk|
| 47:36.1   | 7.1    | No Risk        | 650        | No Risk         | 306         | No Risk|
| 47:41.1   | 7.42   | No Risk        | 630        | No Risk         | 305         | No Risk|
| 47:46.2   | 7.73   | No Risk        | 714        | No Risk         | 304         | No Risk|
| 47:51.2   | 7.73   | No Risk        | 717        | No Risk         | 300         | No Risk|
| 47:56.3   | 6.86   | No Risk        | 737        | No Risk         | 307         | No Risk|
| 48:01.3   | 6.89   | No Risk        | 617        | No Risk         | 303         | No Risk|
| 48:06.4   | 6.89   | No Risk        | 762        | No Risk         | 305         | No Risk|
| 48:11.4   | 7.45   | No Risk        | 649        | No Risk         | 309         | No Risk|
| 48:16.4   | 6.88   | No Risk        | 778        | No Risk         | 301         | No Risk|
| 48:21.5   | 7.24   | No Risk        | 781        | No Risk         | 308         | No Risk|
| 48:26.5   | 7.48   | No Risk        | 724        | No Risk         | 312         | No Risk|
| 48:31.6   | 7.02   | No Risk        | 761        | No Risk         | 308         | No Risk|
| Analysis | Total measurements | 26 | 26 | Min LDR | 300 |
|----------|-------------------|----|----|---------|-----|
| Fault measurements | 1 | 0 | Max LDR | 312 |
| Error in measurements (%) | 3.85% | 0.00% | Error in measurements (%) | 3.85% | 0.00% |
| Total CR | 1.43% | 0.00% | Total CR | 1.43% | 0.00% |

Table 3
Soil contaminated water real-time readings and analysis.

| Real-Time | pH m | pH CR | $C_m$ (µS/cm) | Conductivity CR | LDR m (kΩ) | LDR CR |
|-----------|------|-------|---------------|----------------|-------------|--------|
| 47:51.5   | 7.62 | No Risk | 871 | No Risk | 159 | 28.20% |
| 47:56.5   | 6.96 | No Risk | 972 | No Risk | 160 | 28.00% |
| 48:01.5   | 6.98 | No Risk | 924 | No Risk | 161 | 27.80% |
| 48:06.5   | 6.99 | No Risk | 838 | No Risk | 162 | 27.60% |
| 48:11.5   | 6.76 | No Risk | 921 | No Risk | 165 | 27.00% |
| 48:16.5   | 6.82 | No Risk | 881 | No Risk | 164 | 27.20% |
| 48:21.5   | 6.69 | No Risk | 880 | No Risk | 164 | 27.20% |
| 48:26.5   | 6.63 | No Risk | 924 | No Risk | 164 | 27.20% |
| 48:31.6   | 6.73 | No Risk | 971 | No Risk | 164 | 27.20% |
| 48:36.5   | 6.77 | No Risk | 962 | No Risk | 166 | 26.80% |
| 48:41.6   | 6.92 | No Risk | 932 | No Risk | 166 | 26.80% |
| 48:46.6   | 7.57 | No Risk | 913 | No Risk | 167 | 26.60% |
| 48:51.6   | 7.77 | No Risk | 860 | No Risk | 169 | 26.20% |
| 48:56.6   | 7.7  | No Risk | 908 | No Risk | 170 | 26.00% |
| 49:01.6   | 6.88 | No Risk | 857 | No Risk | 172 | 25.60% |
| 49:06.6   | 7.71 | No Risk | 959 | No Risk | 167 | 26.60% |
| 49:11.6   | 6.95 | No Risk | 850 | No Risk | 171 | 25.80% |
| 49:16.6   | 7.6  | No Risk | 924 | No Risk | 175 | 25.00% |
| 49:21.7   | 6.94 | No Risk | 864 | No Risk | 173 | 25.40% |
| 49:26.7   | 6.47 | 0.20% | 840 | No Risk | 171 | 25.80% |
| 49:31.7   | 8.09 | No Risk | 938 | No Risk | 181 | 23.80% |
| 49:36.7   | 6.67 | No Risk | 913 | No Risk | 172 | 25.60% |
| 49:41.7   | 7.2  | No Risk | 901 | No Risk | 172 | 25.60% |
| 49:46.7   | 8.05 | No Risk | 943 | No Risk | 173 | 25.40% |
| 49:51.7   | 7.87 | No Risk | 965 | No Risk | 180 | 24.00% |
| 49:56.7   | 7.84 | No Risk | 961 | No Risk | 174 | 25.20% |

Analysis

| Total measurements | 26 | 25 | 169 | 26 |
| Fault measurements | 1 | 0 | 0 | 0 |
| Error in measurements (%) | 3.85% | 0.00% | 0.00% | 0.00% |
| Total CR | 0.20% | 0.00% | 26.29% | 0.00% |
Table 4
Chlorine contaminated water real-time readings and analysis.

| Real-Time | pH m | pH CR | Cm (µS/cm) | Conductivity CR | LDR m (kΩ) | LDR CR |
|-----------|------|-------|------------|-----------------|-------------|--------|
| 14:21.5   | 9.24 | 4.93% | 1929       | 46.45%          | 323         | 2.20%  |
| 14:26.5   | 9.28 | 5.20% | 1986       | 49.30%          | 326         | 2.80%  |
| 14:31.5   | 8.5  | No Risk | 1799   | 39.95%          | 325         | 2.60%  |
| 14:36.5   | 8.9  | 2.67% | 1944       | 47.20%          | 321         | 1.80%  |
| 14:41.5   | 8.9  | 2.67% | 1804       | 40.20%          | 330         | 3.60%  |
| 14:46.5   | 8.9  | 2.67% | 1774       | 38.70%          | 325         | 2.60%  |
| 14:51.5   | 8.9  | 2.67% | 1814       | 40.70%          | 325         | 2.60%  |
| 14:56.5   | 8.9  | 2.67% | 1822       | 41.10%          | 332         | 4.00%  |
| 15:01.5   | 8.9  | 2.67% | 1975       | 48.75%          | 324         | 2.40%  |
| 15:06.5   | 8.9  | 2.67% | 1964       | 48.20%          | 325         | 2.60%  |
| 15:11.6   | 9.27 | 5.13% | 1854       | 42.70%          | 324         | 2.40%  |
| 15:16.6   | 9.09 | 3.93% | 1851       | 42.55%          | 325         | 2.60%  |
| 15:21.6   | 9.25 | 5.00% | 1961       | 48.05%          | 325         | 2.60%  |
| 15:26.6   | 8.59 | 0.60% | 1938       | 46.90%          | 324         | 2.40%  |
| 15:31.6   | 8.64 | 0.93% | 1820       | 41.00%          | 324         | 2.40%  |
| 15:36.6   | 8.55 | 0.33% | 1787       | 39.35%          | 325         | 2.60%  |
| 15:41.6   | 8.58 | 0.53% | 1938       | 46.90%          | 323         | 2.20%  |
| 15:46.6   | 8.64 | 0.93% | 1939       | 46.95%          | 328         | 3.20%  |
| 15:51.6   | 8.93 | 2.87% | 1864       | 43.20%          | 324         | 2.40%  |
| 15:56.6   | 8.78 | 1.87% | 1981       | 49.05%          | 324         | 2.40%  |
| 16:01.6   | 8.78 | 1.87% | 1934       | 46.70%          | 324         | 2.40%  |
| 16:06.7   | 8.52 | 0.13% | 1873       | 43.63%          | 323         | 2.20%  |
| 16:11.7   | 8.67 | 1.13% | 1986       | 49.30%          | 325         | 2.60%  |
| 16:16.7   | 8.59 | 0.60% | 1832       | 41.60%          | 323         | 2.20%  |
| 16:21.7   | 9.06 | 3.73% | 1962       | 48.10%          | 323         | 2.20%  |
| 16:26.7   | 8.7  | 1.33% | 1956       | 47.80%          | 325         | 2.60%  |

Analysis

|                  | 26 | 26 | 325 | 26 |
|------------------|----|----|-----|----|
| Total measurements |    |    |     |    |
| Fault measurements | 1 | 0  | 0   | 0  |
| Error in measurements (%) | 3.85% | 0.00% | 0.00% | 2.56% |
Table 5
Salt contaminated water real-time readings and analysis.

| Real-Time | pH m | pH CR | Cm (μS/cm) | Conductivity CR | LDR m (kΩ) | LDR CR |
|-----------|------|-------|------------|-----------------|------------|--------|
| 47:51.5   | 8.23 | No Risk | 1789       | 39.45%          | 371        | 11.80% |
| 47:56.5   | 8.23 | No Risk | 1856       | 42.80%          | 356        | 8.80%  |
| 48:01.5   | 8.45 | No Risk | 1797       | 39.85%          | 354        | 8.40%  |
| 48:06.5   | 8.76 | 1.73%  | 1803       | 40.15%          | 364        | 10.40% |
| 48:11.5   | 8.56 | 0.40%  | 1790       | 39.50%          | 363        | 10.20% |
| 48:16.5   | 8.56 | 0.40%  | 1807       | 40.35%          | 371        | 11.80% |
| 48:21.5   | 8.79 | 1.93%  | 1797       | 39.85%          | 397        | 17.00% |
| 48:26.5   | 8.94 | 2.93%  | 1817       | 40.85%          | 365        | 10.60% |
| 48:31.6   | 8.87 | 2.47%  | 1792       | 39.60%          | 367        | 11.00% |
| 48:36.5   | 8.78 | 1.87%  | 1844       | 42.20%          | 366        | 10.80% |
| 48:41.6   | 8.78 | 1.87%  | 1769       | 38.45%          | 372        | 12.00% |
| 48:46.6   | 8.56 | 0.40%  | 1812       | 40.60%          | 369        | 11.40% |
| 48:51.6   | 8.98 | 3.20%  | 1785       | 39.25%          | 362        | 10.00% |
| 48:56.6   | 9.01 | 3.40%  | 1795       | 39.75%          | 369        | 11.40% |
| 49:01.6   | 9.01 | 3.40%  | 1851       | 42.55%          | 397        | 17.00% |
| 49:06.6   | 8.58 | 0.53%  | 1845       | 42.25%          | 362        | 10.00% |
| 49:11.6   | 8.58 | 0.53%  | 1778       | 38.90%          | 368        | 11.20% |
| 49:16.6   | 8.23 | No Risk | 1839       | 41.95%          | 365        | 10.60% |
| 49:21.7   | 8.23 | No Risk | 1811       | 40.55%          | 341        | 5.80%  |
| 49:26.7   | 9.01 | 3.40%  | 1816       | 40.80%          | 339        | 5.40%  |
| 49:31.7   | 9.01 | 3.40%  | 1880       | 44.00%          | 363        | 10.20% |
| 49:36.7   | 8.78 | 1.87%  | 1777       | 38.85%          | 363        | 10.20% |
| 49:41.7   | 8.78 | 1.87%  | 1832       | 41.60%          | 362        | 10.00% |
| 49:46.7   | 8.65 | 1.00%  | 1830       | 40.50%          | 371        | 11.80% |
| 49:51.7   | 8.57 | 0.47%  | 1841       | 42.05%          | 360        | 9.60%  |
| 49:56.7   | 8.53 | 0.20%  | 1783       | 38.25%          | 361        | 9.80%  |

Analysis

|                  | Total measurements | Fault measurements | Error in measurements (%) | Total CR   |
|------------------|--------------------|--------------------|----------------------------|------------|
|                  | 26                 | 5                  | 19.23%                     | 1.77%      |
|                  | 25                 | 0                  | 0.00%                      | 40.57%     |
|                  | 365                | 0                  | 0.00%                      | 10.66%     |
### Table 6
Washing powder contaminated real-time readings and analysis.

| Real-Time | pH m | pH CR | Cm (µS/cm) | Conductivity CR | LDR m (kΩ) | LDR CR |
|-----------|------|-------|------------|-----------------|------------|--------|
| 24:15.0   | 9.14 | 4.27% | 1708       | 35.40%          | 244        | 11.20% |
| 24:20.0   | 9.14 | 4.27% | 1649       | 32.45%          | 244        | 11.20% |
| 24:25.0   | 9.16 | 4.40% | 1629       | 31.45%          | 244        | 11.20% |
| 24:30.0   | 9.16 | 4.40% | 1709       | 35.45%          | 244        | 11.20% |
| 24:35.0   | 9.21 | 4.73% | 1712       | 35.60%          | 245        | 11.00% |
| 24:40.0   | 9.16 | 4.40% | 1674       | 33.70%          | 246        | 10.80% |
| 24:45.0   | 9.2  | 4.67% | 1706       | 35.30%          | 244        | 11.20% |
| 24:50.1   | 9.21 | 4.73% | 1738       | 36.90%          | 245        | 11.00% |
| 24:55.0   | 9.18 | 4.53% | 1661       | 33.05%          | 244        | 11.20% |
| 25:00.1   | 9.18 | 4.53% | 1668       | 33.40%          | 245        | 11.00% |
| 25:05.1   | 9.16 | 4.40% | 1721       | 36.05%          | 245        | 11.00% |
| 25:10.1   | 9.14 | 4.27% | 1685       | 34.25%          | 245        | 11.00% |
| 25:15.1   | 9.21 | 4.73% | 1714       | 35.70%          | 246        | 10.80% |
| 25:20.1   | 9.26 | 5.07% | 1732       | 36.60%          | 246        | 10.80% |
| 25:25.1   | 9.56 | 7.07% | 1731       | 36.55%          | 246        | 10.80% |
| 25:30.1   | 9.8  | 8.67% | 1659       | 32.95%          | 245        | 11.00% |
| 25:35.1   | 9.23 | 4.87% | 1695       | 34.75%          | 246        | 10.80% |
| 25:40.1   | 9.56 | 7.07% | 1665       | 33.25%          | 247        | 10.60% |
| 25:45.1   | 9.56 | 7.07% | 1728       | 36.40%          | 246        | 10.80% |
| 25:50.2   | 9.23 | 4.87% | 1698       | 34.90%          | 246        | 10.80% |
| 25:55.2   | 8.78 | 1.87% | 1701       | 35.05%          | 247        | 10.60% |
| 26:00.2   | 8.12 | No Risk | 1739 | 36.95% | 246 | 10.80% |
| 26:05.2   | 8.14 | No Risk | 1690 | 34.50% | 247 | 10.60% |
| 26:10.2   | 8.8  | 5.00% | 1652       | 32.60%          | 247        | 10.60% |
| 26:15.2   | 8.23 | No Risk | 1639 | 31.95% | 247 | 10.60% |
| 26:20.2   | 9.01 | 3.40% | 1648       | 32.40%          | 248        | 10.40% |

**Analysis**

|                      | 26  | 25  | 246 | 26  |
|----------------------|-----|-----|-----|-----|
| Total measurements   |     |     |     |     |
| Fault measurements   | 3   | 0   | 0   | 0   |
| Error in measurements (%) | 11.54% | 0.00% | 0.00% | 0.00% |
| Total CR             | 4.79% | 34.52% | 10.88% |
Table 7
Vinegar contaminated water real-time readings and analysis.

| Real-Time | pH m | pH CR | Cm (µS/cm) | Conductivity CR | LDR m (kΩ) | LDR CR |
|-----------|------|-------|------------|-----------------|------------|--------|
| 48:46.6   | 3.72 | 18.53%| 1368       | 18.40%          | 310        | No Risk|
| 48:51.6   | 3.72 | 18.53%| 1361       | 18.05%          | 310        | No Risk|
| 48:56.6   | 3.71 | 18.60%| 1376       | 18.80%          | 310        | No Risk|
| 49:01.6   | 3.7  | 18.67%| 1372       | 18.60%          | 310        | No Risk|
| 49:06.6   | 3.68 | 18.80%| 1381       | 19.05%          | 311        | No Risk|
| 49:11.7   | 3.68 | 18.80%| 1372       | 18.60%          | 310        | No Risk|
| 49:16.7   | 3.67 | 18.87%| 1357       | 17.85%          | 310        | No Risk|
| 49:21.7   | 3.68 | 18.80%| 1357       | 17.85%          | 310        | No Risk|
| 49:26.7   | 3.67 | 18.87%| 1372       | 18.60%          | 310        | No Risk|
| 49:31.7   | 3.65 | 19.00%| 1366       | 18.30%          | 310        | No Risk|
| 49:36.7   | 3.67 | 18.87%| 1356       | 17.80%          | 310        | No Risk|
| 49:41.7   | 3.64 | 19.07%| 1382       | 19.10%          | 311        | No Risk|
| 49:46.7   | 3.68 | 18.80%| 1355       | 17.75%          | 309        | No Risk|
| 49:51.7   | 3.65 | 19.00%| 1364       | 18.20%          | 309        | No Risk|
| 50:01.8   | 3.64 | 19.07%| 1359       | 17.95%          | 309        | No Risk|
| 50:06.8   | 3.62 | 19.20%| 1378       | 18.90%          | 309        | No Risk|
| 50:11.8   | 3.64 | 19.07%| 1375       | 18.75%          | 309        | No Risk|
| 50:16.8   | 3.64 | 19.07%| 1379       | 18.95%          | 309        | No Risk|
| 50:21.8   | 3.64 | 19.07%| 1361       | 18.05%          | 310        | No Risk|
| 50:26.8   | 3.59 | 19.40%| 1369       | 18.45%          | 309        | No Risk|
| 50:31.8   | 3.59 | 19.40%| 1381       | 19.05%          | 309        | No Risk|
| 50:36.8   | 3.61 | 19.27%| 1373       | 18.65%          | 309        | No Risk|
| 50:41.8   | 3.58 | 19.47%| 1383       | 19.15%          | 309        | No Risk|
| 50:46.8   | 3.56 | 19.60%| 1365       | 18.25%          | 308        | No Risk|
| 50:51.9   | 3.59 | 19.40%| 1354       | 17.70%          | 309        | No Risk|

Analysis

|                          |       |       |          |          |          |
|--------------------------|-------|-------|----------|----------|----------|
| Total measurements       | 26    | 26    | 310      | 26       |
| Fault measurements       | 0     | 0     | 0        | 0        |
| Error in measurements (%)| 0.00% | 0.00% | 0.00%    | 0.00%    |
| Total CR                 | 19.01%| 18.45%| 0.00%    | 0.00%    |
Table 8
Vinegar + washing powder contaminated water real-time readings and analysis.

| Real-Time | pH m  | pH CR  | LDR m (kΩ) | LDR CR |
|-----------|-------|--------|------------|--------|
| 53:51.1   | 3.86  | 17.60% | 354        | 8.40%  |
| 53:56.1   | 3.87  | 17.53% | 353        | 8.20%  |
| 54:01.1   | 3.89  | 17.40% | 354        | 8.40%  |
| 54:06.1   | 3.87  | 17.53% | 354        | 8.40%  |
| 54:11.1   | 3.89  | 17.40% | 354        | 8.40%  |
| 54:16.1   | 3.84  | 17.73% | 354        | 8.40%  |
| 54:21.2   | 3.86  | 17.60% | 353        | 8.20%  |
| 54:26.2   | 3.86  | 17.60% | 353        | 8.20%  |
| 54:31.2   | 3.87  | 17.53% | 354        | 8.40%  |
| 54:36.2   | 3.87  | 17.53% | 354        | 8.40%  |
| 54:41.2   | 3.87  | 17.53% | 354        | 8.40%  |
| 54:46.2   | 3.87  | 17.53% | 354        | 8.40%  |
| 54:51.2   | 3.87  | 17.53% | 354        | 8.40%  |
| 54:56.2   | 3.87  | 17.53% | 355        | 8.60%  |
| 55:01.2   | 3.87  | 17.53% | 354        | 8.40%  |
| 55:06.2   | 3.87  | 17.53% | 353        | 8.20%  |
| 55:11.3   | 3.86  | 17.60% | 354        | 8.40%  |
| 55:16.3   | 3.86  | 17.60% | 354        | 8.40%  |
| 55:21.3   | 3.86  | 17.60% | 354        | 8.40%  |
| 55:26.3   | 3.84  | 17.73% | 354        | 8.40%  |
| 55:31.3   | 3.84  | 17.73% | 353        | 8.20%  |
| 55:36.3   | 3.83  | 17.80% | 352        | 8.00%  |
| 55:41.3   | 3.83  | 17.80% | 352        | 8.00%  |
| 55:46.3   | 3.83  | 17.80% | 351        | 7.80%  |
| 55:51.3   | 3.84  | 17.73% | 351        | 7.80%  |
| 55:56.3   | 3.83  | 17.80% | 351        | 7.80%  |

Analysis

|                  |       |       |     |      |
|------------------|-------|-------|-----|------|
| Total measurements| 26    | 353   | 26  |      |
| Fault measurements| 0     | 0     | 0   |      |
| Error in measurements (%)| 0.00% | 0.00% |      |      |
| Total CR         | 17.61%| 8.27% |      |      |
# Table 9
Vinegar + Washing powder + Chlorine contaminated water real-time readings and analysis.

| Real-Time | pH m | pH CR | LDR m (kΩ) | LDR CR |
|-----------|------|-------|------------|--------|
| 14:21.0   | 5.42 | 7.20% | 320        | 1.60%  |
| 14:26.0   | 5.23 | 8.47% | 320        | 1.60%  |
| 14:31.0   | 5.26 | 8.27% | 320        | 1.60%  |
| 14:36.0   | 5.21 | 8.60% | 321        | 1.80%  |
| 14:41.0   | 5.28 | 8.13% | 321        | 1.80%  |
| 14:46.0   | 5.24 | 8.40% | 321        | 1.80%  |
| 14:51.0   | 5.26 | 8.27% | 321        | 1.80%  |
| 14:56.0   | 5.24 | 8.40% | 321        | 1.80%  |
| 15:01.0   | 5.63 | 5.80% | 322        | 2.00%  |
| 15:06.0   | 5.64 | 5.73% | 323        | 2.20%  |
| 15:11.0   | 5.64 | 5.73% | 322        | 2.00%  |
| 15:16.0   | 5.54 | 6.40% | 323        | 2.20%  |
| 15:21.0   | 5.55 | 6.33% | 323        | 2.20%  |
| 15:26.0   | 5.5  | 6.67% | 324        | 2.40%  |
| 15:31.0   | 5.64 | 5.73% | 324        | 2.40%  |
| 15:36.0   | 5.63 | 5.80% | 324        | 2.40%  |
| 15:41.0   | 5.63 | 5.80% | 325        | 2.60%  |
| 15:46.0   | 5.46 | 6.93% | 325        | 2.60%  |
| 15:51.0   | 5.43 | 7.13% | 326        | 2.80%  |
| 15:56.0   | 5.24 | 8.40% | 326        | 2.80%  |
| 16:01.0   | 5.56 | 6.27% | 325        | 2.60%  |
| 16:06.0   | 5.23 | 8.47% | 326        | 2.80%  |
| 16:11.0   | 5.23 | 8.47% | 326        | 2.80%  |
| 16:16.0   | 5.21 | 8.60% | 327        | 3.00%  |
| 16:21.0   | 5.42 | 7.20% | 327        | 3.00%  |
| 16:26.0   | 5.23 | 8.47% | 328        | 3.20%  |

**Analysis**

|                   |       |       |
|-------------------|-------|-------|
| Total measurements| 26    | 324   |
| Fault measurements| 0     | 0     |
| Error in measurements (%) | 0.00%  | 0.00% |
| Total CR          | 7.29% | 2.30% |
## Table 10

Vinegar + washing powder + chlorine + salt contaminated water real-time readings and analysis.

| Real-Time | pH m  | pH CR | LDR m (kΩ) | LDR CR |
|-----------|-------|-------|------------|--------|
| 14:21.0   | 5.65  | 5.67% | 345        | 6.60%  |
| 14:26.0   | 5.65  | 5.67% | 342        | 6.00%  |
| 14:31.0   | 5.66  | 5.60% | 341        | 5.80%  |
| 14:36.0   | 5.65  | 5.67% | 343        | 6.20%  |
| 14:41.0   | 5.66  | 5.60% | 345        | 6.60%  |
| 14:46.0   | 5.63  | 5.80% | 345        | 6.60%  |
| 14:51.0   | 5.67  | 5.53% | 345        | 6.60%  |
| 14:56.0   | 5.65  | 5.67% | 344        | 6.40%  |
| 15:01.0   | 5.65  | 5.67% | 340        | 5.60%  |
| 15:06.0   | 5.66  | 5.60% | 342        | 6.00%  |
| 15:11.0   | 5.63  | 5.80% | 343        | 6.20%  |
| 15:16.0   | 5.66  | 5.60% | 344        | 6.40%  |
| 15:21.0   | 5.66  | 5.60% | 343        | 6.20%  |
| 15:26.0   | 5.65  | 5.67% | 341        | 5.80%  |
| 15:31.0   | 5.65  | 5.67% | 339        | 5.40%  |
| 15:36.0   | 5.63  | 5.80% | 342        | 6.00%  |
| 15:41.0   | 5.63  | 5.80% | 342        | 6.00%  |
| 15:46.0   | 5.63  | 5.80% | 342        | 6.00%  |
| 15:51.0   | 5.63  | 5.80% | 341        | 5.80%  |
| 15:56.0   | 5.63  | 5.80% | 340        | 5.60%  |
| 16:01.0   | 5.66  | 5.60% | 342        | 6.00%  |
| 16:06.0   | 5.66  | 5.60% | 344        | 6.40%  |
| 16:11.0   | 5.65  | 5.67% | 344        | 6.40%  |
| 16:16.0   | 5.63  | 5.80% | 343        | 6.20%  |
| 16:21.0   | 5.65  | 5.67% | 341        | 5.80%  |
| 16:26.0   | 5.65  | 5.67% | 340        | 5.60%  |

### Analysis

|                     |       |       |       |
|---------------------|-------|-------|-------|
| Total measurements  | 26    | 342   | 26    |
| Fault measurements  | 0     | 0     | 0     |
| Error in measurements (%) | 0.00% | 0.00% | 0.00% |
| Total CR            | 5.68% | 6.08% | 6.08% |
Table 11

Vinegar + washing powder + salt + soil contaminated water real-time readings and analysis.

| Real-Time | pH m  | pH CR  | LDR m (kΩ) | LDR CR |
|-----------|-------|--------|------------|--------|
| 14:21.0   | 5.53  | 6.47%  | 138        | 32.40% |
| 14:26.0   | 5.54  | 6.40%  | 144        | 31.20% |
| 14:31.0   | 5.53  | 6.47%  | 146        | 30.80% |
| 14:36.0   | 5.54  | 6.40%  | 150        | 30.00% |
| 14:41.0   | 5.53  | 6.47%  | 153        | 29.40% |
| 14:46.0   | 5.54  | 6.40%  | 153        | 29.40% |
| 14:51.0   | 5.53  | 6.47%  | 159        | 28.20% |
| 14:56.0   | 5.53  | 6.47%  | 159        | 28.20% |
| 15:01.0   | 5.54  | 6.40%  | 162        | 27.60% |
| 15:06.0   | 5.53  | 6.47%  | 164        | 27.20% |
| 15:11.0   | 5.53  | 6.47%  | 168        | 26.40% |
| 15:16.0   | 5.53  | 6.47%  | 173        | 25.40% |
| 15:21.0   | 5.54  | 6.40%  | 175        | 25.00% |
| 15:26.0   | 5.53  | 6.47%  | 174        | 25.20% |
| 15:31.0   | 5.53  | 6.47%  | 176        | 24.80% |
| 15:36.0   | 5.53  | 6.47%  | 177        | 24.60% |
| 15:41.0   | 5.53  | 6.47%  | 180        | 24.00% |
| 15:46.0   | 5.51  | 6.60%  | 184        | 23.20% |
| 15:51.0   | 5.53  | 6.47%  | 188        | 22.40% |
| 15:56.0   | 5.53  | 6.47%  | 189        | 22.20% |
| 16:01.0   | 5.51  | 6.60%  | 189        | 22.20% |
| 16:06.0   | 5.53  | 6.47%  | 188        | 22.40% |
| 16:11.0   | 5.53  | 6.47%  | 189        | 22.20% |
| 16:16.0   | 5.51  | 6.60%  | 190        | 22.00% |
| 16:21.0   | 5.53  | 6.47%  | 192        | 21.60% |
| 16:26.0   | 5.51  | 6.60%  | 195        | 21.00% |

Analysis

|                   |       |       |       |       |
|-------------------|-------|-------|-------|-------|
| Total measurements| 26    | 171   | 26    |
| Fault measurements| 0     | 0     | 0     |
| Error in measurements (%) | 0.00% | 0.00% |
| Total CR          | 6.47% | 25.73%|

Fig. 1. Pure tap water quality parameters.
Fig. 2. Salt contaminated tap water parameters.

Fig. 3. Soil contaminated tap water parameters.
Fig. 4. Chlorine contaminated tap water parameters.

Fig. 5. Washing powder contaminated tap water parameters.
**Fig. 6.** Vinegar contaminated tap water parameters.

**Fig. 7.** Vinegar + washing powder contaminated tap water parameters.
**Fig. 8.** Vinegar + washing powder + chlorine contaminated tap water parameters.

**Fig. 9.** Vinegar + washing powder + chlorine + salt contaminated tap water parameters.
Acknowledgments

This work was supported by the Department of Electrical and Electronic Engineering Science at the University of Johannesburg, South Africa.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Fig. 10. Vinegar + washing powder + chlorine + salt + soil contaminated tap water parameters.

Fig. 11. Schematic diagram of the water supply system used for data gathering.
Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dib.2019.104813.

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