Individual Practical Assignment

Project report

Dilni De Silva 103616345

Video link: https://youtu.be/sMcycMlyNIU

Topic Background

Topic: Impact on sea level in coastal cities due to climate change and global warming

In recent times in the 20th century, climate change and global warming have been contentious topics of discussion. This report provides a small scale prototype of an IoT smart device solution to monitor sea levels rising due to climate change and global warming. Additionally, this will discuss climate change, global warming and other IoT projects.

Climate change is the weather patterns and conditions. Hotter summers, more extreme storms and even dangerous fire seasons and even floods. According to [5] and [8], these drastic changes in weather patterns are ultimately greenhouse effects, heating the earth and melting ice caps is global warming, increasing overall water in the ocean. UN [8] also highlights climate change extreme weather conditions may burn, flood and destroy residential areas and places of food production. Causing these places to be inhibitable to citizens. Creating climate refugees. Particularly people who live in small island countries, are most vulnerable to rising sea levels and storms.

Aforementioned global warming of the earth's temperature increases due to the burning up of fossil fuels [17]. Additionally, this process according to[16] discusses global warming caused by greenhouse effects. Gasses build up in the atmosphere and trap heat which increases the temperature of the earth. This [14] is a natural process as it enables the eath to keep a constant temperature. However, overconsumption of fossil fuels leads [9] to a build-up of these gasses in the atmosphere. Thus trapping heat that would escape into space. Occurring due to the burning of these fossil fuels is defined by [6] as decomposed organic made up of decomposed plant and animal matter. Made of hydrocarbons burned to create energy used in electronic devices. Fossil fuels [15] can come in different forms such as coal [13] a type of rock that is formed by carbonisation. Heat, pressure and lack of o2 allow it to form. Natural gas[12] has a similar process of methanogenesis creating methane as a byproduct.

The effects of global warming are depicted in many ways such explained before climate change. Such as where great barrier reef where coral is bleached due to water temp and acidity changing. is breached due to water temp and acidity changing. Accumulation of gasses in the atmosphere and increases in temperature affect people with respiratory issues. Additionally the rising sea levels and their effect on cities and residential areas in those cities. Caused by [22] icecaps from the north and south pole melting. An estimation of this [22] flooding maybe that 3 degrees increase in global temperature will cause 275 million people to be affected as the area they live in will be flooded.

The conversation [2] for example has pointed out that in the last 20th century. Tokyo has experienced subsidence sinking 4 meters underwater. Osaka [22] predicts if coastal flooding were to occur, the displacement of 19 million people. Concequnecesently increase 3 degrees celsius. Like other cities, they have constructed sea walls to minimise land sinking but not a permanent solution. Furthermore [2] Jakarta capital of Indonesia, with a population of 10 million people, where floods cause damage to buildings city. To combat this issue sea walls and ground pumps have been used to drain water out but can only last so long until the problem is addressed. Shanghai [2] a population of 26 million due to subsidence has moved 2.5 cm per year. Ultimately will have an impact on metro lines, and roads and their many skyscrapers cause water damage. Therefore [22] displacing 17.5 million people from shanghai. Airport's historical monuments and the Chongming island will be submitted. A drainage system and sea walls have been implemented to prevent/reduce the damage done by flooding to the city and its surrounding areas.

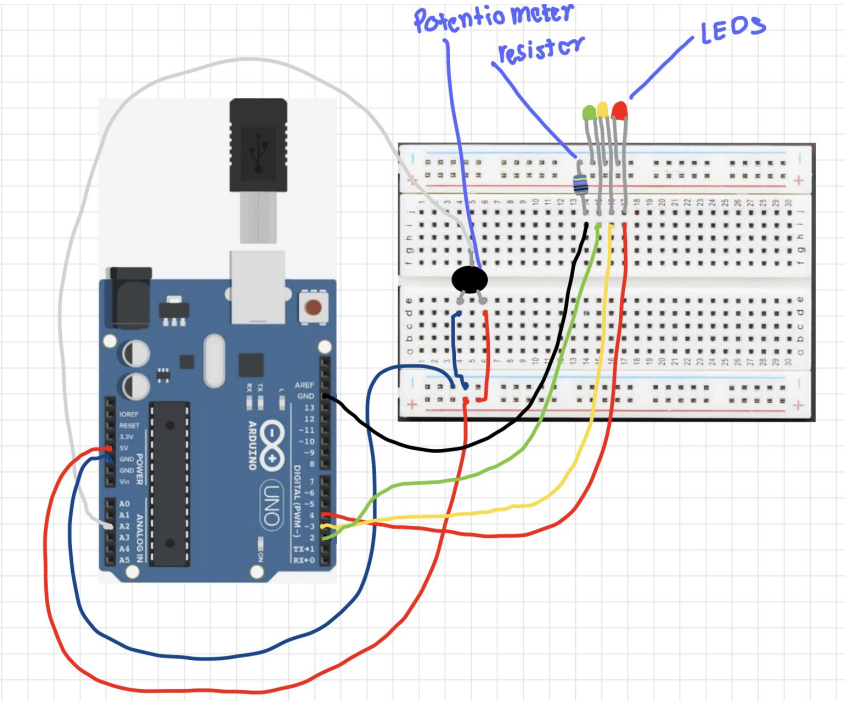
Copenhagen [1] another coastal city was impacted as it has been by a storm in 1902 that caused a rise in sea level of 154cm. Additionally by larger storms in 2006 and 2007. Respectcily water levels rise to 131 and 142 cm. Alexandria a city in Egypt [22] 3 degrees celsius increase will lead to a 0.5-meter sea-level rise and then displacement of 8 million people. Similarly, Rio de Janeiro Brazil will have flooding done to beaches, airports and residential areas due to this 3-degree temperature increase. Consequently, these are a few examples of smart coastal cities that would go through many disasters due to rising sea levels caused by global warming.

Multiple IoT solutions are implemented to monitor and combat the rising sea levels.[3] The creation and implementation of a water level sensor network. The goal is to monitor water levels and help report data on the approaching of a flood. Additionally to validate hydrodynamic flood models. Using and integrating an already implemented to create this network. The already implemented system is called the commonwealth centre for recurrent flooding resiliency tide watch tidal forecast system. Sensors have been deployed around many cities in the US. Newport new, Virginia Beach and Norfolk, in 28 bridges. Cost-effective ultrasonic Sensors are used to transmit data via cellular transmission protocols or long-range wireless area networks.

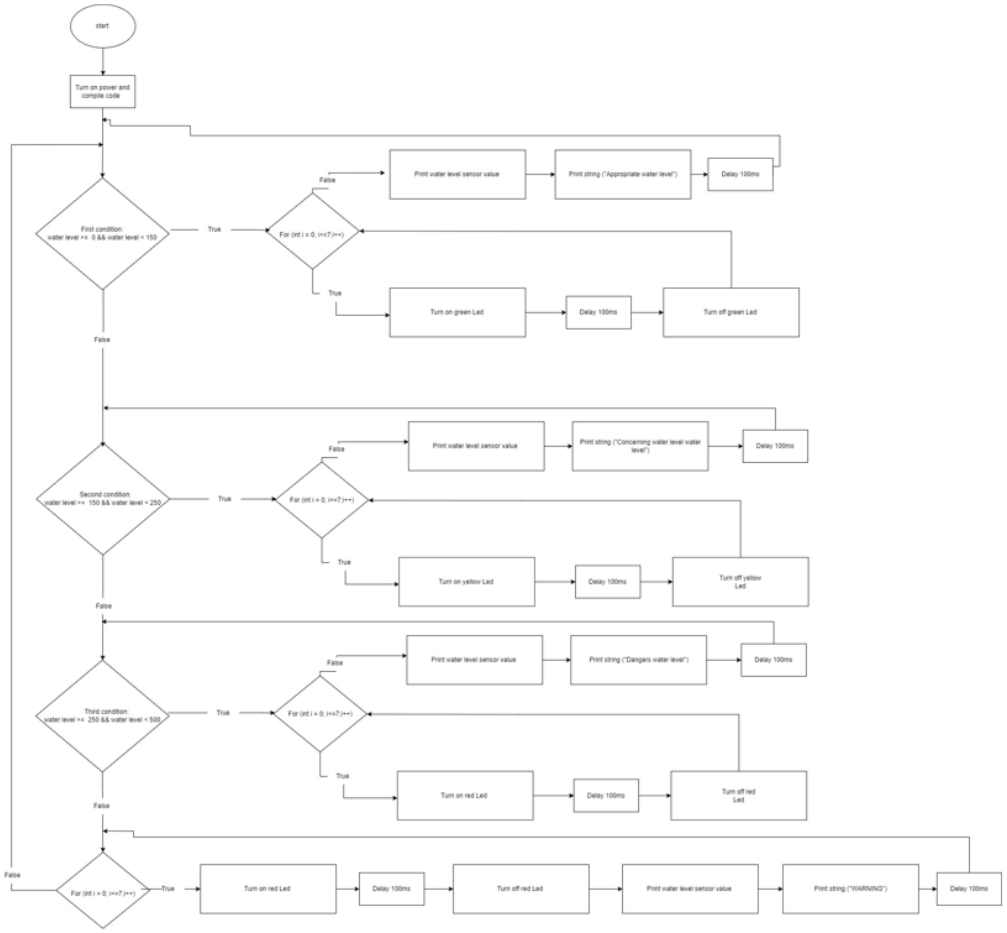
[7] The main goal is to measure and monitor potential flooding in real-time as well as predict floods with the data collected. Water level sensors, a cloud platform to load data onto a relational database onto a web interface are used. Also having mobile implementation where GPS module enables environmental data to be gathered such as location, time and speed variables. The use of an MQTT broker enables interaction between IoT devices using MQTT protocols and manages all subscription and production topics. Furthermore, the data gathered from the water sensors are protected using MQTT protocols to set encrypted server-side credentials for each device and user.

Conceptional design

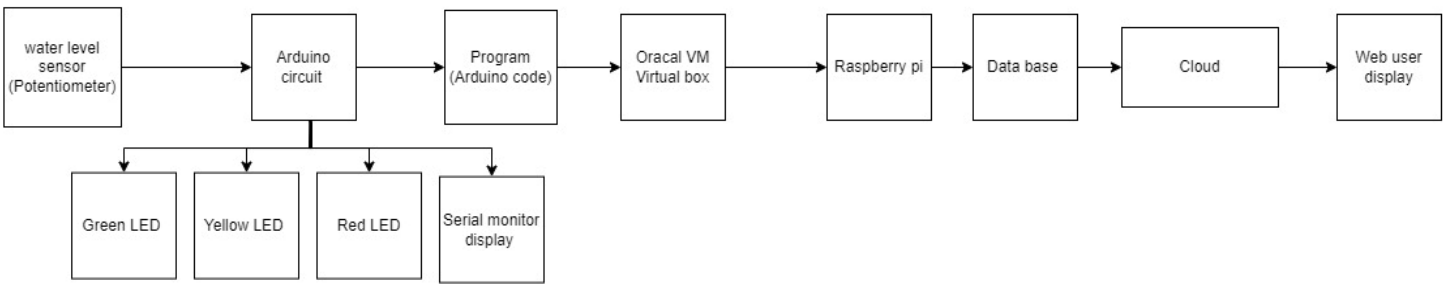
Circuit diagram



Flow chart (Look at end of the document for a clearer image)

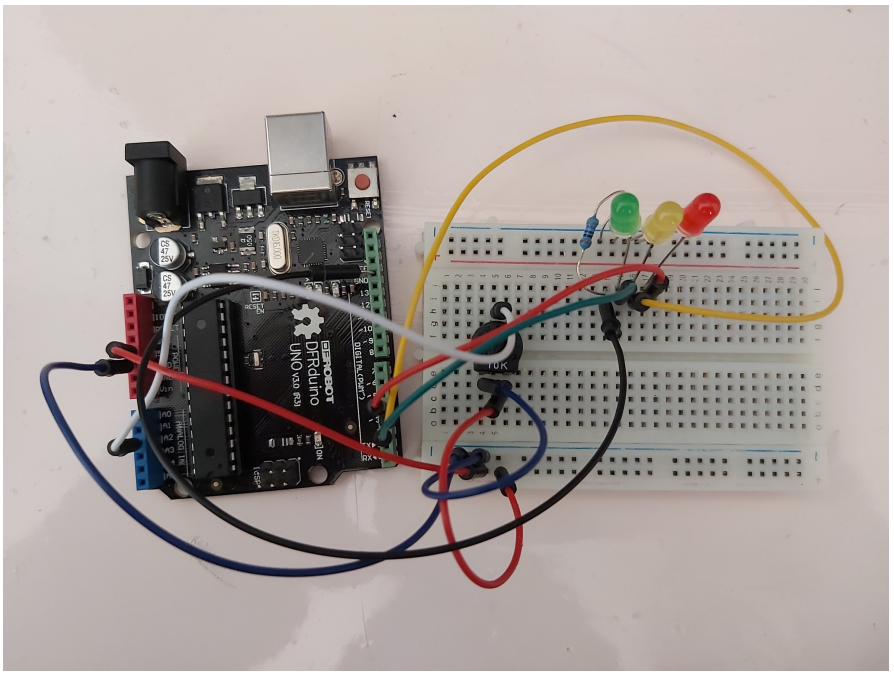


Block Diagram



Implementation

Adriano circuit

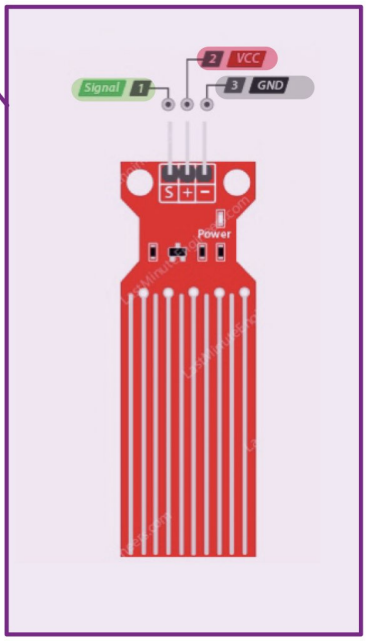


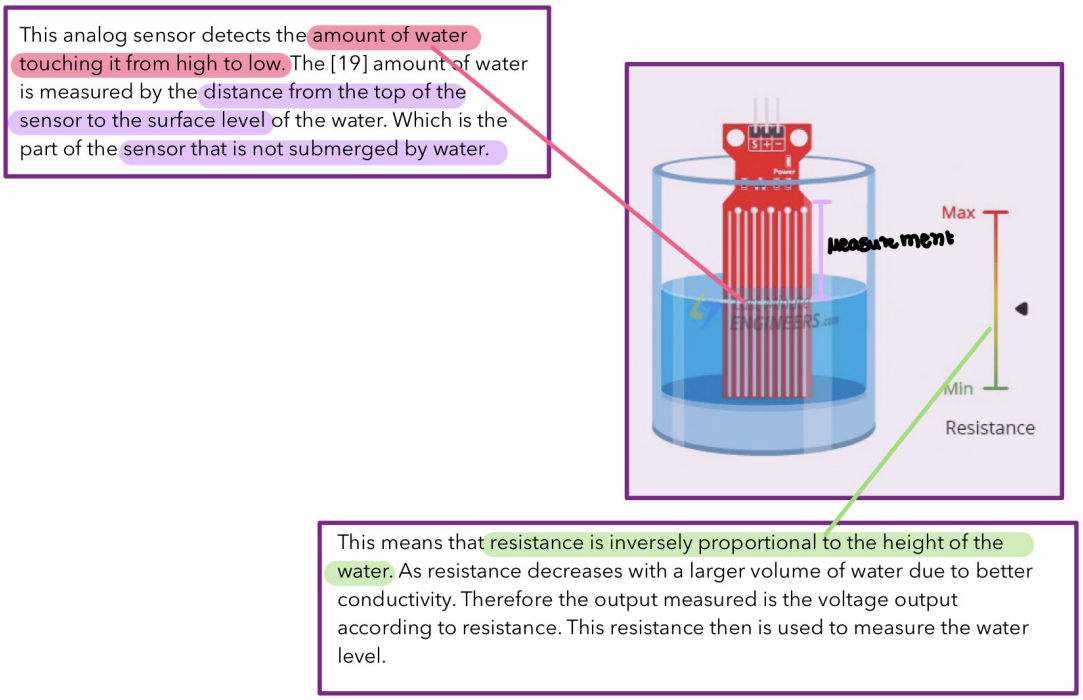
Components of system

Sensor: water level sensor

The sensor purchased from [21] was intended to be used as a water level sensor for Arduino [LB-LR0043]. However, due to shipping issues, it has not arrived. Hence I replaced the sensor with a potentiometer and build my project around it.

The water level sensor uses three pins [19]. The analog pin, the power supply or the positive and the negative ground pin.





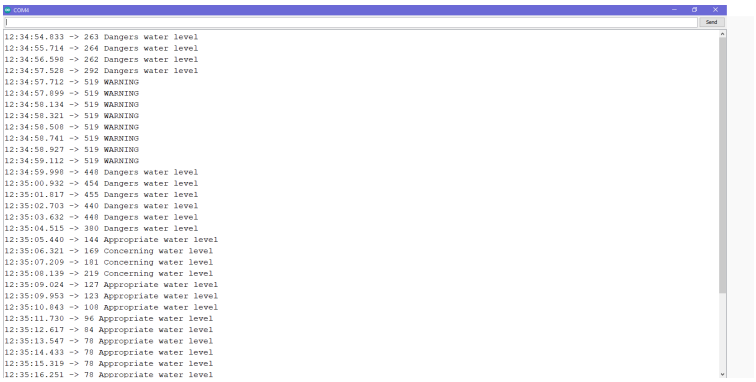
The goal is to measure the level of water in a given area specifically the ocean, where sensors will be deployed around a dock area near a coastal city. However, demonstrated in this report in a smaller scaled-down prototype. Henceforth the sensor will measure the wave intensity as the sensor measures water touches it. This may help in the prediction and warning of extreme weather conditions like floods and tsunamis. Secondly, the gradual increase of the sea level specific to that city can be used as a way to prep the city for subsidence.

Moreover, measuring the sea level will allow people enough time to prepare for disasters such as providing more resources such as food, water and medical supplies to people living in areas in the city building Additionally, building other structures like sea walls as prevention. Even helping relocate people early before a flood. These are some examples of ways that the sensor will help the effects of global warming and climate change. The water level sensor is integrated into an Arduino board that transmits the data collected and outputs it in two ways firstly as LED signals and then as a serial output viewed in the serial monitor which will be linked to a web interface showing data. This will be explained further in the actuator's explanation of its implementation.

Additionally, the data collected from the sensor will be uploaded using an edge device which is raspberry pi to a database where all the data collected can be viewed in a database table. When a certain level range of resistance is measured which corresponds to the water level a LED lights additionally the value the water sensor detected is printed with the corresponding measurement and message. This data from the database collected from the sensor attached to the Adriunio will be additionally displayed in a web interface.

Actuators: LEDs and Webpage interface

I used two types of actuators. Three LEDs are three distinct and different colours. Additionally, the data is then printed onto a serial output in the serial monitor. The data outputted onto the serial monitor will be integrated by loading these outputs of data by loading them from a raspberry pi to a local database, onto a database table using SQL queries. In addition, a web server will have a webpage holding the data from the serial monitor loaded from the database. The goal of these actuators is to have this certain output so that people in charge of cities can monitor the sea level near their city. Preventivality making directions to either relocate or give resources to the residents of the city. Additionally, build prevention measures.



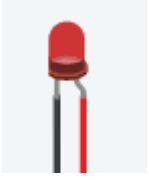
First Output Condition

Green: When a value is 0ml to 150ml the green lights blink and additionally the value of the water level is printed into the serial monitor and a string " Appropriate water level".

Second Output Condition

Yellow: when a value is 150 - 250ml the yellow light blinks then the value is printed with a message. “Concerning water level”.

Third Output Condition



Red: When the value is in the range of 250 - 500ml the red light blinks then the value is printed with a string message dangerous water level. In addition to this, if the water level completely surpasses all three conditions, the red lead will blink however faster and give a fast message of “warning”. This is opposed to simulating an emergency sea level rise such as in a tsunami situation or flood.

Software / Libraries :

The software that I created and implemented does not have any additional libraries or computer software. Just the use of Oracle VM virtual box where my virtual raspberry pi was. Hence where the raspberry pi would load data to a local database of all the data gathered by the sensor. Additionally, the Adriano IDE was also used to write out the Adriano sketch and to compile and run the functionality of the program with the Adriano board.

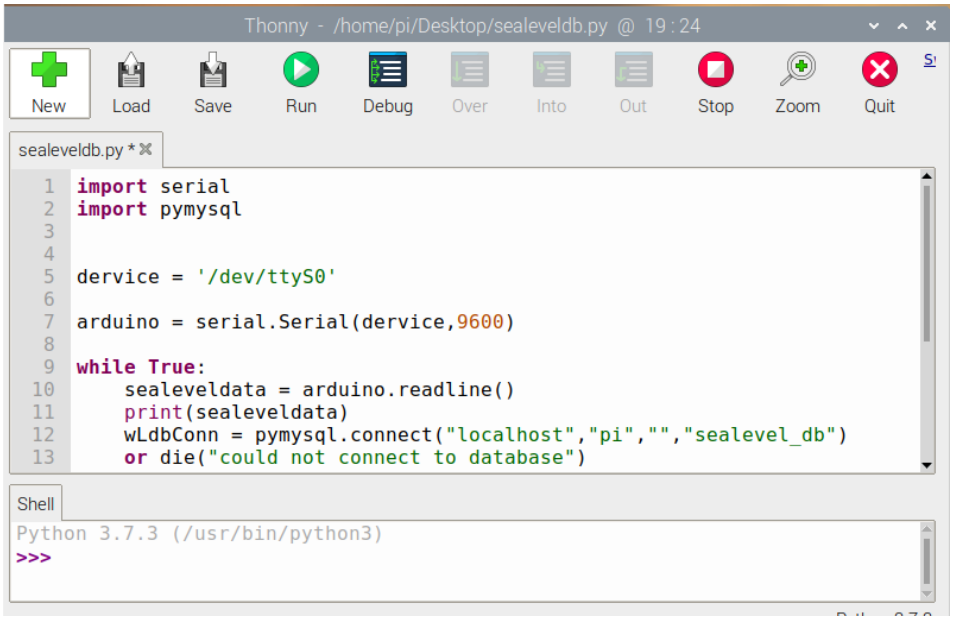
Code

Arduino Sketch

```
  // Setting Led pins to correct values
  const int greenPin = 2;
  const int yellowPin = 3;
  const int redPin = 4 ;

  void setup() {
    Serial.begin(9600);
  pinMode(greenPin , OUTPUT);
  pinMode  (yellowPin,OUTPUT);
  pinMode(redPin,OUTPUT);

  }


void loop() {
  //Setting the water level sensor pin(Potentiometer)
  int waterLevelsensorpin  = analogRead(A2);

if(waterLevelsensorpin >= 0 && waterLevelsensorpin < 150) // Fisrt condition: Is the water level in the range of 0-150ml
{                                                         // --> yes then water level in safe level
  for(int i = 0; i<=7;i++)                                      // --> NO --> fisrt condtion false
  {
    digitalWrite(greenPin,HIGH);
   delay(100);
    digitalWrite(greenPin,LOW);
  }
   Serial.print(waterLevelsensorpin);
   Serial.println(" Appropriate water level");
delay(100);
}

 else if (waterLevelsensorpin >= 150 && waterLevelsensorpin < 250) // Second condition: Is the water level in the range of 150-249ml
 {                                                                 // --> yes  then water level is becoming unsafe level
   for(int i = 0; i<=7;i++)                                        // --> NO --> second condition fasle
   {
     digitalWrite(yellowPin,HIGH);
    delay(100);
     digitalWrite(yellowPin,LOW);
   }
    Serial.print(waterLevelsensorpin);
    Serial.println(" Concerning water level");
 delay(100);
 }

else if(waterLevelsensorpin >= 250 && waterLevelsensorpin < 500) // Third condition: Is the water level in the range of 250-499ml
{                                                                // --> yes then water level is unsafe level
  for(int i = 0; i<=7;i++)                                       // --> NO --> third condition flase
  {
    digitalWrite(redPin,HIGH);
   delay(100);
    digitalWrite(redPin,LOW);
  }
   Serial.print(waterLevelsensorpin);
   Serial.println(" Dangers water level");
delay(100);
}
```

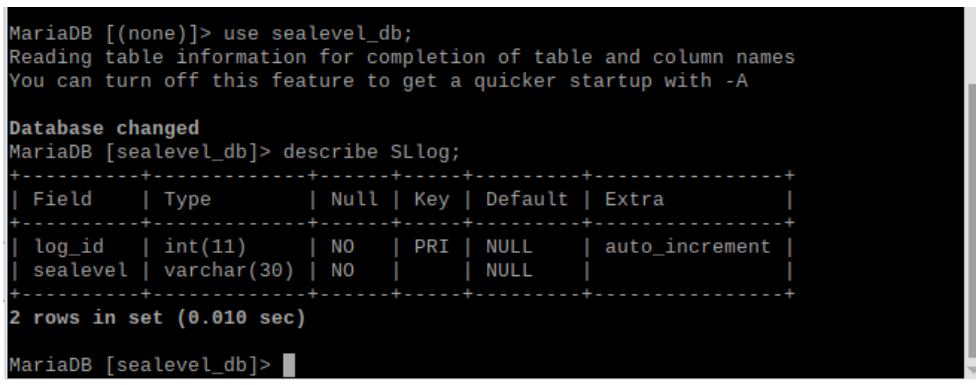
```
else // IF the water level is higer than 500 this else function will excute
{
  for(int i = 0; i<=7;i++)// This loop casues a flaster blink as everything is togther
  {
  digitalWrite(redPin,HIGH);
  delay(100);
    digitalWrite(redPin,LOW);
    Serial.print(waterLevelsensorpin);
    Serial.println(" WARNING");
  delay(100);
  }
}
        }
```

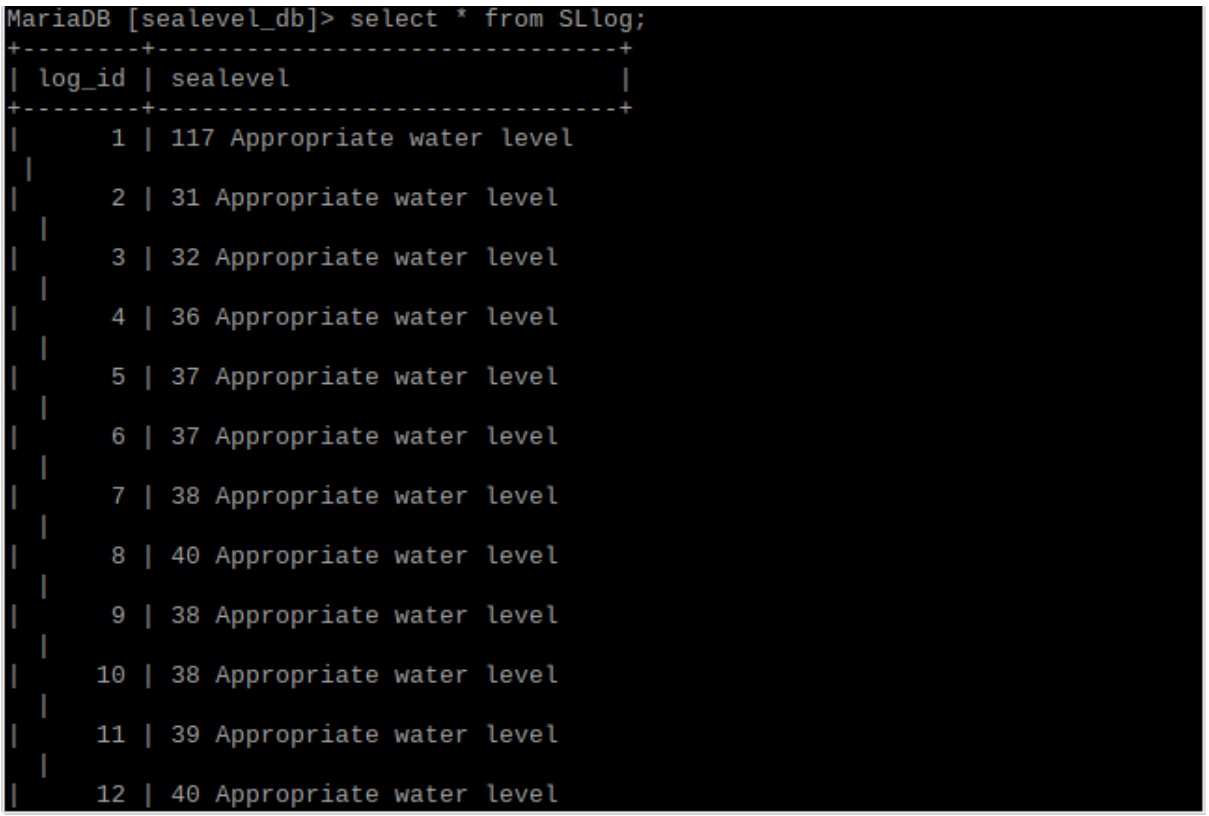
SQL database queries




```
14
15 #print(wLdbConn)
16     with wLdbConn:
17         cursor = wLdbConn.cursor()
18         cursor.execute("INSERT INTO SLlog (sealevel) VALUES(%s)",
19                        sealeveldata)
20         wLdbConn.commit
21         cursor.close()
22
```

Database





```
MariaDB [sealevel_db]> select * from SLlog;
+--------+------------------------------+
| log_id | sealevel                     |
+--------+------------------------------+
|      1 | 117 Appropriate water level
 |
|      2 | 31 Appropriate water level
  |
|      3 | 32 Appropriate water level
  |
|      4 | 36 Appropriate water level
  |
|      5 | 37 Appropriate water level
  |
|      6 | 37 Appropriate water level
  |
|      7 | 38 Appropriate water level
  |
|      8 | 40 Appropriate water level
  |
|      9 | 38 Appropriate water level
  |
|     10 | 38 Appropriate water level
  |
|     11 | 39 Appropriate water level
  |
|     12 | 40 Appropriate water level
```

Appendix:

Water sensor specification

- birdelectronics, L., 2022. *Water Sensor for Arduino*. [online] Water Sensor for Arduino [LB-LR0043]. Available at: <https://littlebirdelectronics.com.au/products/water-sensor-for-arduino> [Accessed 25 April 2022].

Adriano references

- Arduino, A., 2019. *for - Arduino Reference*. [online] Arduino.cc. Available at: <https://www.arduino.cc/reference/en/language/structure/control-structure/for/> [Accessed 25 April 2022].

- Arduino, A., 2019. *Arduino - Print*. [online] Arduino.cc. Available at: <https://www.arduino.cc/en/serial/print> [Accessed 25 April 2022].

- Arduino, A., 2022. *If Statement (Conditional Statement)*. [online] Docs.arduino.cc. Available at: <https://docs.arduino.cc/built-in-examples/control-structures/ifStatementConditional> [Accessed 25 April 2022].

- arduino2go, a., 2022. *Chapter 6: Analog input – Arduino to Go*. [online] Arduinotogo.com. Available at: <https://arduinotogo.com/2017/02/28/chapter-6-analog-input/#:~:text=The%20v

alues%20that%20we%20get,called%20analog%20to%20digital%20conversion.> [Accessed 25 April 2022].

Tutorials:

- Tutorial w01
- Tutorial w04 - w05
- Tutorial w07

Research links

1) Hallegatte, S., Ranger, N., Mestre, O. et al. Assessing climate change impacts, sea-level rise and storm surge risk in port cities: a study on Copenhagen. Climatic Change 104, 113–137 (2011). https://doi.org/10.1007/s10584-010-9978-3

2) Brown, S. and Nicholls, R., 2022. *Sea levels are rising fastest in big cities – here's why*. [online] The Conversation. Available at: <https://theconversation.com/sea-levels-are-rising-fastest-in-big-cities-heres-why-157077> [Accessed 25 April 2022].

3) Loftis, D., Forrest, D., Katragadda, S., Spencer, K., Organski, T., Nguyen, C. and Rhee, S., 2022. *StormSense: A New Integrated Network of IoT Water Level Sensors in the Smart Cities of Hampton Roads, VA*. [online] National Library of Medicine. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6512834/> [Accessed 25 April 2022].

4) Denchak, M., 2022. *Are the Effects of Global Warming Really that Bad?*. [online] NRDC. Available at: <https://www.nrdc.org/stories/are-effects-global-warming-really-bad> [Accessed 25 April 2022].

5) Climate Office, N., 2022. *Global Warming vs. Climate Change | North Carolina Climate Office*. [online] Legacy.climate.ncsu.edu. Available at: <https://legacy.climate.ncsu.edu/edu/DefineCC> [Accessed 25 May 2022].

6) Kopp, O., 2022. *fossil fuel | Meaning, Types, & Uses*. [online] Encyclopedia Britannica. Available at: <https://www.britannica.com/science/fossil-fuel> [Accessed 25 April 2022].

7) Moreno, C, Aquino, R, Ibarreche, J, Pérez, I, Castellanos, E, Álvarez, E, Rentería, R, Anguiano, L, Edwards, A, Lepper, P, Edwards, RM & Clark, B 2019, 'RiverCore: IoT Device for River Water Level Monitoring over Cellular Communications', *Sensors*, vol. 19, no. 1, p. 127, accessed from <http://dx.doi.org/10.3390/s19010127>.

8) Nations, U., 2022. *What Is Climate Change?*. [online] United Nations. Available at: <https://www.un.org/en/climatechange/what-is-climate-change> [Accessed 25 April 2022].

9) Denchak, M., 2022. *Greenhouse Effect 101*. [online] NRDC. Available at: <https://www.nrdc.org/stories/greenhouse-effect-101> [Accessed 25 April 2022].

10) Shaftel, H., Susan, S., Jackson, R., Bailey, D. and Callery, S., 2022. *FAQ: What is the greenhouse effect?*. [online] Climate Change: Vital Signs of the Planet. Available at: <https://climate.nasa.gov/faq/19/what-is-the-greenhouse-effect/> [Accessed 25 April 2022].

11) Pisupat, S., 2022. *Products of Combustion | EGEE 102: Energy Conservation and Environmental Protection*. [online] E-education.psu.edu. Available at: <https://www.e-education.psu.edu/egee102/node/1951#:~:text=Products%20formed%20during%20combustion%20of%20fossil%20fuels.&text=The%20primary%20pollutants%20are%20Carbon,%2C%20and%20Hydrocarbons%20(HCs).> [Accessed 25 April 2022].

12) Turgeon, A., Morse, E., Evers, J., Editing, E. and Sue, C., 2022. *Natural Gas*. [online] National Geographic Society. Available at: <https://www.nationalgeographic.org/encyclopedia/natural-gas/> [Accessed 25 April 2022].

13) Turgeon, A., Morse, E., Crooks, M., Evers, J., Editing, E. and Sue, C., 2012. *Coal*. [online] National Geographic Society. Available at: <https://www.nationalgeographic.org/encyclopedia/coal/> [Accessed 25 April 2022].

14) Ghosh, I., 2021. *Since 1850, these historical events have accelerated climate change*. [online] World Economic Forum. Available at: <https://www.weforum.org/agenda/2021/02/global-warming-climate-change-historical-human-development-industrial-revolution/#:~:text=Evidence%20shows%20that%20key%20historical,an%20increase%20in%20human%20demand.> [Accessed 25 April 2022].

15) Brown, T., Borgia, G., Sullivan, J., Appleton, S. and Willis, M., 2019. *Fossil Fuels*. [online] National Geographic Society. Available at: <https://www.nationalgeographic.org/encyclopedia/fossil-fuels/> [Accessed 25 April 2022].

16) MacMillan, A. and Turrentine, J., 2021. *Global Warming 101*. [online] NRDC. Available at: <https://www.nrdc.org/stories/global-warming-101#warming> [Accessed 25 April 2022].

17) Pappas, S., 2022. *What Is Global Warming?*. [online] livescience.com. Available at: <https://www.livescience.com/37003-global-warming.html> [Accessed 25 April 2022].

18) Shaftel, H., Callery, S., Jackson, R. and Bailey, D., 2022. *Overview: Weather, Global Warming and Climate Change*. [online] Climate Change: Vital Signs of the Planet. Available at: <https://climate.nasa.gov/resources/global-warming-vs-climate-change/> [Accessed 25 April 2022].

19) Engineers, L., 2021. *In-Depth: How Water Level Sensor Works and Interface it with Arduino - Last Minute Engineers*. [online] Last Minute Engineers. Available at: <https://lastminuteengineers.com/water-level-sensor-arduino-tutorial/> [Accessed 25 April 2022].

20) admin, R., 2021. *Water Level Sensor | What, How, Where, Benefits, Types - Renke*. [online] Renkeer.com. Available at: <https://www.renkeer.com/water-level-sensor-definition-applications-benefits-types/> [Accessed 25 April 2022].

21) birdelectronics, L., 2022. *Water Sensor for Arduino*. [online] Water Sensor for Arduino [LB-LR0043]. Available at: <https://littlebirdelectronics.com.au/products/water-sensor-for-arduino> [Accessed 25 April 2022].

22) Holder, J., Kommenda, N. and Watts, J., 2022. *The three-degree world: cities that will be drowned by global warming*. [online] the Guardian. Available at: <https://www.theguardian.com/cities/ng-interactive/2017/nov/03/three-degree-world-cities-drowned-global-warming> [Accessed 25 April 2022].

23) Grizhnevich, A., 2022. *IoT for Smart Cities: Use Cases and Implementation Strategies*. [online] Scnsoft.com. Available at: <https://www.scnsoft.com/blog/iot-for-smart-city-use-cases-approaches-outcomes> [Accessed 25 April 2022].

Video Link

https://youtu.be/sMcycMlyNIU