Water Body Monitoring and Alerting System Using IoT

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***Abstract*—The aim of this paper is to develop automated "Internet of Things (IoT) based Water Quality monitoring and Flood Alerting System".**

Keywords— Internet of Things, Power of Hydrogen (Ph), Liquid Crystal Display, Turbidity, Temperature, ThingSpeak

I. INTRODUCTION

Water is the source of all life and a necessity for almost all living beings on the planet. When water level rises in dams, river beds etc. it causes lot of destruction. It causes a huge loss to our environment and living beings as well. So, it is very important to get emergency alerts of the water level situation for different conditions in the river bed. The aim of this paper is to develop automated Internet of Things (IoT) based Water Quality Monitoring and Flood Alerting System. Different sensors are used to monitor different parameters of water. The whole System has Arduino to interface the sensors. The device is also useful for measuring and accessing the quality of water in the body. We are presenting the design and development of a cost-effective solution for real time water monitoring [1]. The device also measures other physical and chemical properties of the water. The Apparatus consist of modules such as Turbidity Sensor, pH sensor & Temperature [5]. All sensors are connected with Arduino, it converts the signal form into system readable form and sends it to WIFI module. The WIFI Module will send the sensed data to cloud which can be accessed through the python script which acts as a basis for sending and receiving alerts through mail and SMS.

II. COMPONENTS

These are the components which are used to develop the proposed model.

A. Arduino Uno

The Arduino Uno board is a microcontroller supported by the ATmega328. It's fourteen digital input/output pins within which six may be used as PWM outputs, a 16MHz ceramic resonator, AN ICSP header, a USB association, six analogue inputs, an influence jack and a push button.

B. Bolt WIFI module

BOLT is an online of Things platform (Hardware + Cloud) that allows user to create IoT products. Using BOLT, users will manage and monitor devices from any a part of the globe. It provides the flexibility to plant Wi-Fi/GSM capabilities inside alternative systems, or to operate as a standalone application. The BOLT WIFI module has 2 LEDs – blue and green – which represent it's connection to WIFI and Cloud [9].

C. Ultrasonic Sensor

An ultrasonic sensor is a device that measures the distance of a target body by emitting ultrasonic sound waves, and converts the mirrored sound into an electrical signal. Ultrasonic waves travel quicker than the speed of audible sound (i.e. the sound that humans will hear). Ultrasonic sensors have 2 main components: the transmitter (which emits the sound by peizoelectric crystals) and also the receiver (which encounters the sound once it's journey to and from the target)

D. 16*2 LCD Display

It is an associate electronic module and encompasses a wide selection of applications. A 16x2 LCD display is incredibly basic module and is often employed in numerous devices and circuits. A 16x2 LCD means that it will display 16 characters per line.

E. LED

A semiconductor diode (LED) is a semiconductor source of illumination that emits light once current flows through it. Electrons within the semiconductor recombine with negatron holes, producing energy within the kind of photons

F. pH sensor

DIY MORE pH Sensor Kit can measure pH values of different liquids with good accuracy. The board comes with a pair of trimmers through which we can adjust the Analog reading offset, before connecting the BNC pH probe to the pH interface circuit [6].

G. Turbidity Sensor

The DIY additional turbidity sensor detects water quality by measuring the degree of muddiness, or the opaqueness. It uses light to observe suspended particles in water by measuring the emitted light rays transmission and scattering rate, that changes with the quantity of total suspended solids (TSS) in water. If TTS increases, it means the liquid muddiness level increased too [3].

H. DS18B20 Water Proof Temperature Sensor

With the assistance of DS18B20 one wire temperature device we are able to know the temperature from -55℃ To 125℃ with accuracy of ±5. Every DS18B20 temperature device encompasses a distinctive 64-bit serial code. this enables you to wire multiple sensors to a same data wire. So, we'll be able to get temperature from multiple sensors by only using 1 Arduino digital pin [7].

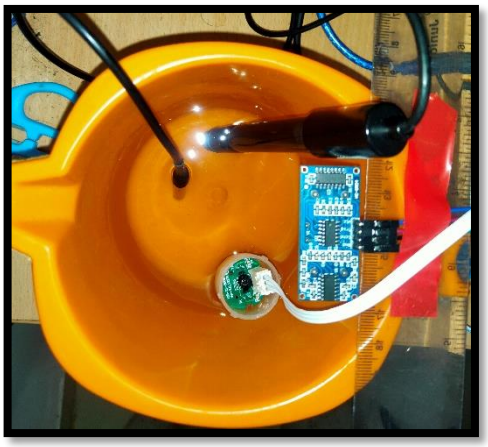


Fig.1 Shows the different sensors implemented in System

III. METHODOLOGY

Firstly, the Arduino and Bolt WIFI module is powered using their respective USB ports through any source . Also simultaneously run the python program (that is Main.py in the same folder which contains conf.py). The Ultrasonic sensor, pH sensor, Turbidity sensor and LM35 sensor will sense the different parameters of water then the Arduino program helps to calculate and calibrate the raw sensor inputs. Also the sensed water level will be displayed on LCD display(in Percentage) along with other parameters of water in their respective units.

The working and its flow in the System are mentioned below. First, the level of the water is calibrated in the code during which it is sent to the BOLT WIFI module through serial communication which is retrieved in the main script when it is running. The full water tank/container is divided into 3 zones that is Green, Orange and Red zones.

A.

When water level is at Min/Normal level. It resembles 'Green Zone'. This means that water is at normal position and there aren't signs about flood. Also green LED will glow and it shows Green alert in LCD display with water level.

B.

When water level crosses the Intermediate level. It resembles 'Orange Alert'. This means that water has crossed the 55% mark and there are chances of flood condition at that place. With increase in water level the system sends SMS and Email alerts to the authority or any registered users in the code from Twilio and Mailgun services respectively. The orange LED glows and it will also show Orange alert in the LCD display.

Also, SMS and Email is sent to registered user with proper message and current temperature of that place.

C.

When water level crosses the Max Level, it resembles 'Red Alert'. This means that water level has crossed 80% and the place is currently being flooded. With increase in water level the system sends SMS and Email alerts to the authority or registered user in the code from Twilio and Mailgun Services respectively. Also red LED will glow while displaying Red alert in the LCD display.

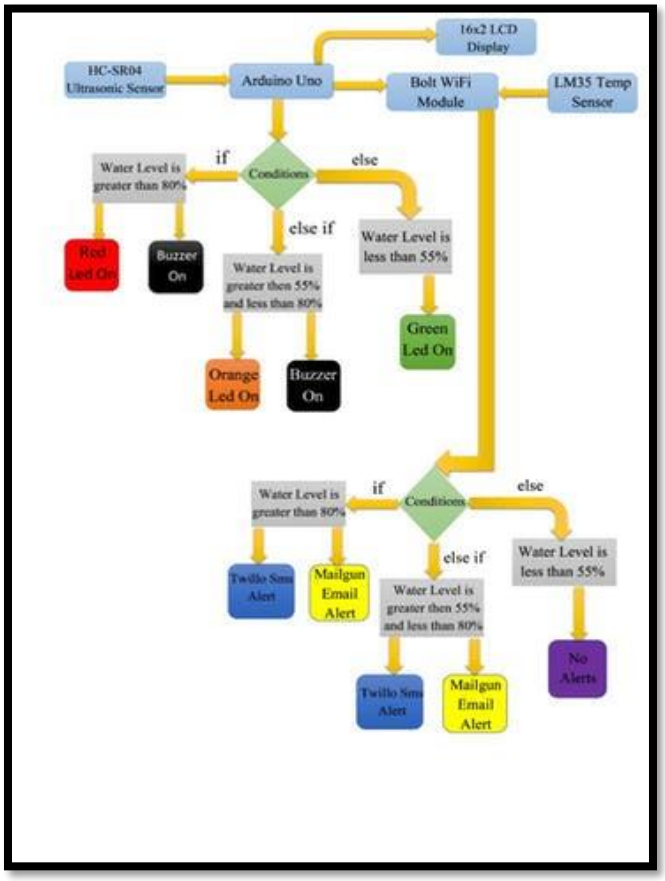


Fig.2 Shows the flow of the System w.r.t Water Level

After a loop of this process, the python script writes the value of float data type water level into a ThingSpeak channel, a free IoT analysis platform. The data which gets stored in ThingSpeak is so valuable when we're monitoring a real-life water body [8]. The data can act as a dataset to train a machine learning model which in turn, with years of such input, can predict accurately what might happen during a specific-time of the year with great precision thereby providing us with possible threats before actually the event taking place.

The conf.py script contains all the related addresses and declarations like API keys, URL's and Device ids etc which are required for the BOLT WIFI module, Twilio SMS service, Mailgun API and ThingSpeak.

Similarly, the same process is repeated for the other parameters such as Water Temperature, Turbidity, pH which are retrieved similarly as the Water level from BOLT whereas Temperature of Surroundings is retrieved directly from the analog input A0 on BOLT WIFI module. In this way, we can run the script anywhere irrelevant with the distance from the sensor-node and get results. This is really helpful because the sensor-node might even get to the middle of the water body without worrying about the distance.

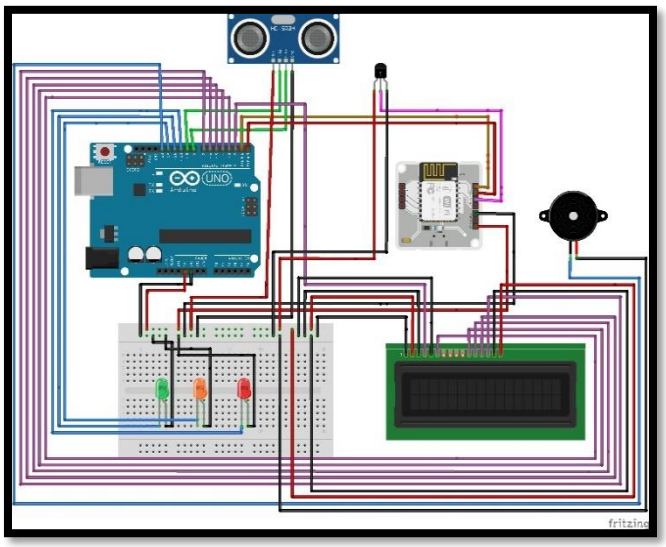


Fig.3 Shows the schematic diagram of the System

The following code in Arduino is used to calculate the percentage of water level in the analogous water body we created that is a mug with a max height marked at 6.5cm from the bottom of the mug and 3.1cm away from the ultrasonic sensor.

```
float dur;
float dist;
float per;
digitalWrite(out,LOW);
delayMicroseconds(2);
digitalWrite(out,HIGH);
delayMicroseconds(10);
digitalWrite(out,LOW);
dur=pulseIn(in,HIGH);
dist=(dur*0.034)/2;
per=100*(9.6-dist)/6.5;
if(per<0)
{
  per=0;
}
if(per>100)
{
  per=100;
}
```

Fig.4 Shows the Arduino code that converts the raw value into percentage based on the height of the mug

These values should be interchanged with that of the water body and the distance between the ultrasonic sensor and max water level mark. Since the values are represented in float, the values might fluctuate on the display but the error will be well within the range of 5%. Make sure that the sensor is placed such that there won't be any disruptions between the ultrasonic sensor and the surface of water.

IV. Connections

A. Connecting LED's

For Green LED

- VCC of Green Color LED to Digital Pin '10' of the Arduino.
- GND of Green Color LED to the GND of Arduino.

For Orange LED

- VCC of Orange Color LED to Digital Pin '11' of the Arduino.
- GND of Orange Color LED to the GND of Arduino.

For Red LED

- VCC of Red Color LED to Digital Pin '12' of the Arduino.
- GND of Red Color LED to the GND of Arduino.

B. Connecting pH sensor

- P0 of pH circuit to A0 of Arduino.
- VCC of pH circuit to VCC of Arduino.
- GND of pH circuit to GND of Arduino.

C. Connecting HC-SR04 Ultrasonic Sensor

- VCC of Ultrasonic Sensor to 5V of Arduino.
- GND of Ultrasonic Sensor to GND of Arduino.
- Echo of Ultrasonic Sensor to Digital Pin '8' of Arduino.
- Trig of Ultrasonic Sensor to Digital Pin '9' of Arduino.

D. Connecting BOLT WIFI Module

- 5V of Bolt WIFI Module to 5V of Arduino.
- GND of Bolt WIFI Module to GND of Arduino.
- TX of Bolt WIFI Module to RX of Arduino.
- RX of Bolt WIFI Module to TX of Arduino.

E. Connecting LM35 Temperature Sensor

- VCC of LM35 to 5V of Bolt WIFI Module.
- Output Pin of LM35 to Pin 'A0' of Bolt WIFI Module.
- GND of LM35 to GND of Bolt WIFI Module.

F. Connecting Turbidity sensor

- Analog output pin of turbidity circuit to A1 of Arduino.
- VCC of turbidity circuit to 5V of Arduino.
- GND of turbidity circuit to GND of Arduino.

G. Connecting DS18B20 Water Proof Temperature Sensor

- Data output pin of DS18B20 to digital pin 12 of Arduino.
- VCC of DS18B20 to 5V of Arduino.
- GND of DS18B20 to GND of Arduino.

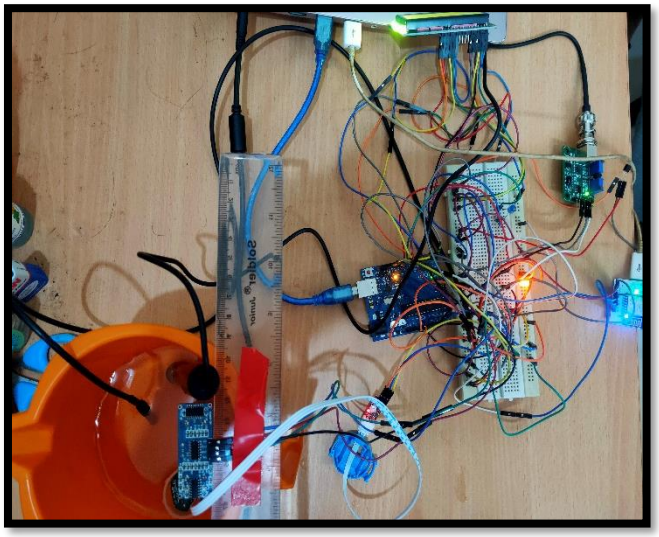


Fig.5 Shows the completely assembled sensor node

V. Threshold Values

- For the Water Level attribute, the orange alert is set at 55% and red alert is set at 80% [4]
- For the pH level attribute, the alert is set at below 6 and above 8.5 [4]
- For the Turbidity level attribute, the alert is set at 10 NTUs (for drinking purposes, actually it can be well above 100NTU in lakes and rivers) [4]
- For the Water Temperature attribute, the alert is set at 40℃ [4]
- For the Surrounding Temperature attribute, no alert is set [4]

VI. Real Life Implementation

The ultrasonic sensor is attached to a river structure such as a bridge or installed on a pole adjacent to the river that needs to be monitored. The Ultrasonic sensor is connected and installed above the body of water. Now, the sensor will be measuring the distance between itself and the surface of water. The respective values in the code will be adjusted to correctly measure the level of water in the body.

The design, implementation, and deployment for water quality application pose additional problems compared with land or non-aquatic application. This is because of the impact of the moisture and water on the electronic components used, thus floatation or buoy has big importance. We are proposing a buoy composed of a rubber tube of which is 750 cm in diameter and 250 cm in height.

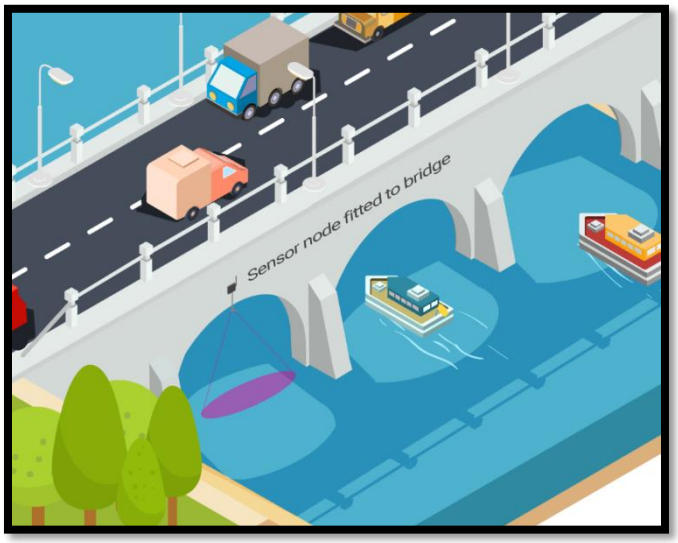


Fig.6 Shows the ultrasonic sensor interfaced over a river

The tube sides were wrapped with thin aluminium to protect it from pointed floating materials in the water bodies. The electronic equipment and battery are situated on top of the buoy in a watertight box of relevant dimensions. Note that the buoy only consists of other sensors except that of ultrasonic sensor. The buoy is tied so that it won't float far away from the shore and can be retrieved easily. The sensors will be kept in water from the buoy itself so the length of wires connecting the sensors won't be an issue.

The energy source is an important issue to consider and the only viable method to power the sensors located in middle of water bodies is to use a battery. The system can be implemented with 6 V/3.5 amp hour (Ah) lead acid battery to power the sensor node. This battery has longer life and nearly excellent long-run and self-discharge rates. Energy renewing system is composed of one solar panel on top of the buoy which also serves as a renewable resource. It constantly charges the battery on the buoy to preserve for continuous monitoring.

Fig.7 Shows the buoy over a water body

VII. Result

The Arduino transmits the data to BOLT using Serial monitor in Arduino which measures the water level and other important parameters and sends the data to the BOLT IoT module which are then pushed as notifications at appropriate times. From this we were able to measure water level of the given water body and able to detect whether the body was flooded or dried up possibly and other consequences such as abnormal pH, turbidity and temperature of water. The Twilio, BOLT and Mailgun API were used to push notifications and the LEDs glow to reflect the water level while the LCD screen shows the measured water level. The LM35 sensor measures the surrounding temperature and unlike others, the analog input is directly taken in python script and calibrated.

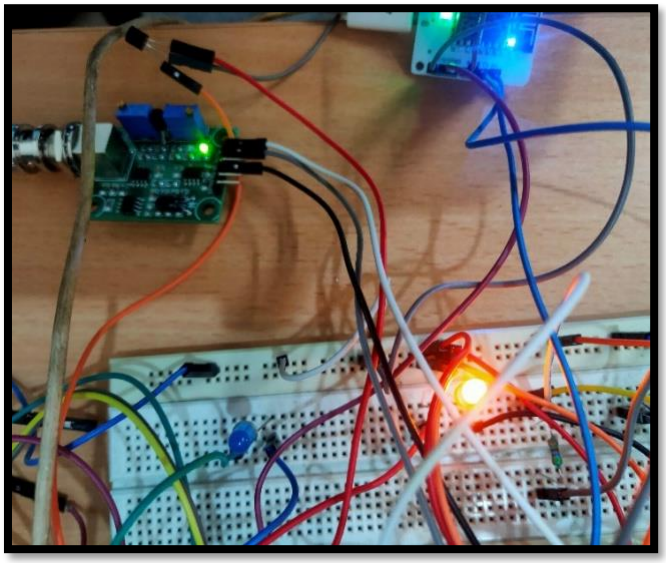
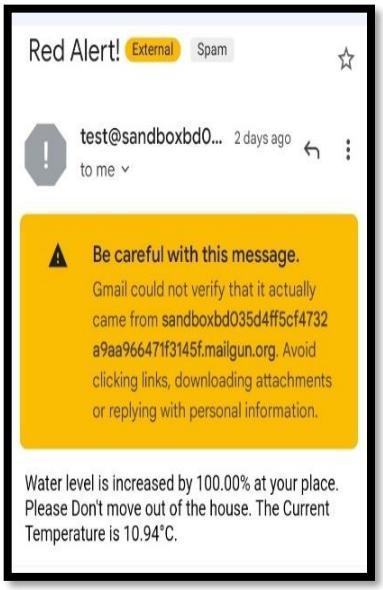


Fig.8 Shows the functioning of LED's



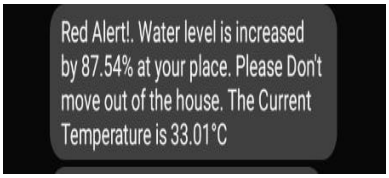


Fig.9 Shows the SMS and Email Functioning

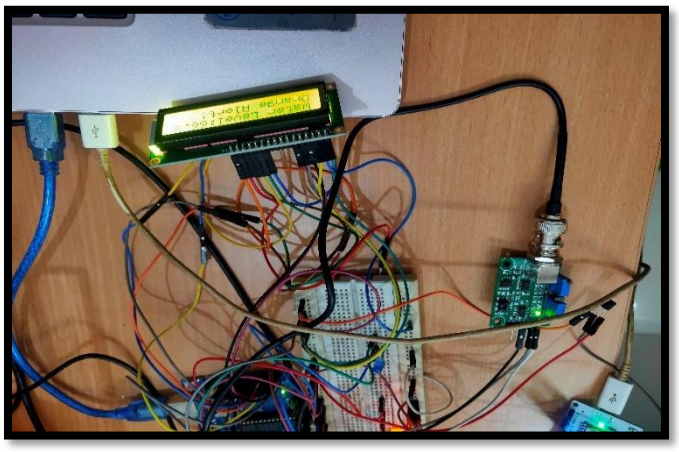


Fig.8 Shows the LCD and it's functioning

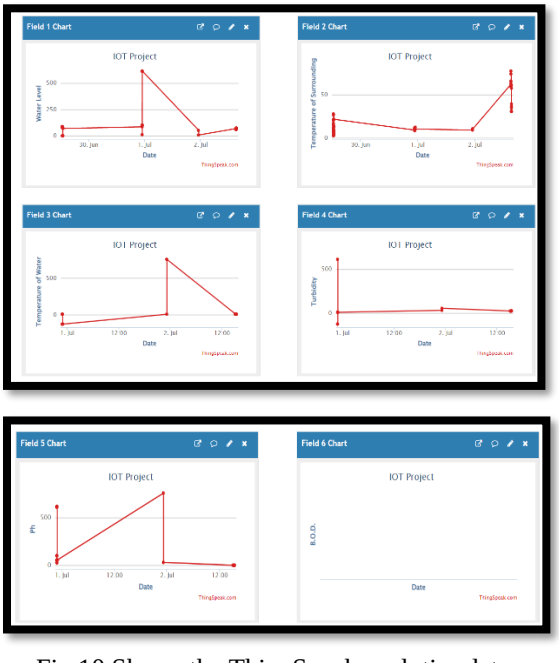


Fig.10 Shows the ThingSpeak analytics data collected over a short amount of time

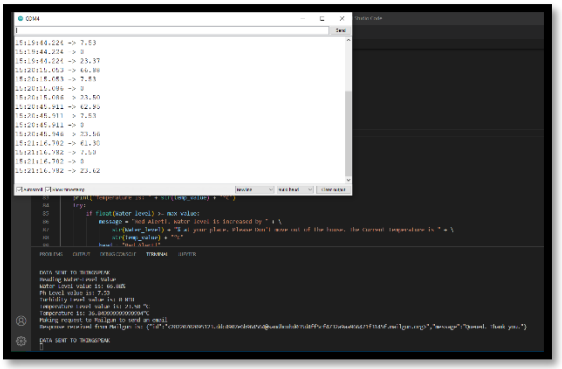


Fig.11 Shows the Arduino Serial Monitor and python script with data from the sensor node

The system developed is tested in various conditions such as mixing the water with lemon juice to increase its pH, adding small quantities of soap, adding dirt to check turbidity fluctuations, mixing cold water to decrease the temperature of water etc.. In every given scenario, the change is detected and alerts are sent successfully.

VIII. CHARACTERSTICKS

A. *Strengths*

- Real Time Monitoring
- Alerts via both SMS and Mail
- Economical than many present methods

B. *Weaknesses*

- Requires a power-source all time
- Can't really depend on ultrasonic sensor because it might sense other objects between the sensor node and the water surface
- Turbidity, pH and TDS values of the water body are greatly effected by the rain and flow of fluids into the body. So, it's not possible to hold fixed threshold values all the time [4].

C. *Future Scope*

- Switching to a completely Solar-Power based solution
- To use rain sensors and machine learning to predict the exact time-frame of floods and other events of the water body.

IX. CONCLUSION

Nowadays the Internet Of things (IoT) is broadly used worldwide. Water is the basic source of survival for all living beings. This project is helpful to Departments such as Meterological etc.. to continuously monitor dams and other water bodies properties. With this project, we can save many people lives by giving alerts when the water level crosses beyond the limit or the pH, Turbidity of a drinking water source goes beyond threshold or in water storages where monitoring temperature of water is critical. The proposed system is cost-effective, flexible and productive in areas where it floods often.

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