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Design of a Weather Station with IoT in the Wetlands of the District of Ventanilla – Callao.

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Abstract**—— Currently, pollution and global warming is a very controversial problem, due to the various consequences and effects it generates on health and the environment. There are studies that highlight that the main pollutants are due to human action that generates the extermination of certain ecosystems, as well as the increase in various acute and chronic diseases. The ecosystems most neglected by the authorities and the citizens are the wetlands, which can be seen reflected in the wetlands of Ventanilla, whose surface has been reduced from 1,500 to 275.45 hectares due to overpopulation and contamination by the citizens themselves in recent years. These accessions endanger the extermination of the habitat of 126 birds and 27 species of native plants that inhabit a certain place, which is of great concern because these ecosystems are rapidly degrading. That is why, in the face of this problem, the design of a weather station applying the internet of things is proposed, which aims to inform the caretakers of the current state of the wetlands through a web server, where it will serve to carry out preventive actions. regarding the care of a certain ecosystem that are essential for the stabilization of CO2 emissions. This system is made up of the ESP32 platform, which will activate the emergency lights and a siren when the DHT 22, BMP180, ML8511 and MQ135 sensors detect abnormal values in temperature, humidity, atmospheric pressure, altitude, UV radiation and toxic gases.**

Keywords**— Weather station, Internet of things, Web server, global warming, wetlands.**

I. INTRODUCTION

In recent years, the World Meteorological Organization (WMO) has prepared a report based on climate change, in which it calls for immediate action to reduce greenhouse gas emissions in the context of climate change and care for ecosystems world level [1]. Much of the changes are due to human action, which is a threat to the livelihoods of these ecosystems. Generally, wetlands are one of the ecosystems that is being threatened by climate change, in which it is estimated that 40% of the extension of said ecosystem was reduced worldwide.

Being so alarming since wetlands intervene in the reduction of carbon dioxide (CO2) emission generated by the greenhouse effect [2]. In Peru, wetlands are considered fragile ecosystems according to the Ministry of the Environment (MINAM), this is due to the pressures created by anthropogenic threats to which they are continuously exposed. For that reason, wetlands have a serious danger to preserve these ecosystems. In the Peruvian territory, there are 46 wetlands reflected in approximately 8,000 hectares, in which only 14 are considered RAMSAR sites (Convention on Wetlands of International Importance), whose mission is the conservation and rational use of wetlands through of local and national actions through international cooperation [3].

Of the 46 wetlands in Peru, not all of them have state control or protection. This can be seen reflected in the wetlands located in Ventanilla, which went from 1,500 to 275.45 hectares. This reduction is due to the overpopulation in the capital of Lima, which causes citizens to invade certain places, threatening the extension of that ecosystem. Likewise, global warming and the pollution of the citizens themselves are other threats of this problem that the wetlands of Ventanilla host, due to the lack of interest of the authorities to conserve or at least inform the citizens of the importance of caring for this biodiversity [4].

It is so, that when seeing this problem that welcomes the wetlands of Ventanilla. The objective of this research work is to implement a weather station applying IoT, in order to visualize the current state of wetlands through a computer or smartphone, which will be an essential tool to periodically monitor certain habitats and take preventive actions in together with the citizens who live around a certain ecosystem. Additionally, the web system has a database where the environmental magnitudes of the temperature, humidity, atmospheric pressure, ultraviolet radiation and toxic gases sensors will be recorded daily.

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In addition, by being registered in a free hosting, it will make it easier for us to enter the web platform anywhere in the world, as long as there is internet. On the other hand, the weather station has an alert system through siren and emergency lights, which will turn on when there are excessive variations in any of the magnitudes, such as toxic gases, temperature, humidity and high level of ultraviolet radiation, which are crucial magnitudes to control the level of contamination of certain habitats and human settlements that are affected by these environmental alterations.

The present work is structured as follows, in section II the literature review will be explained, in section III the methodology, in which the design of the system and the operation of the devices to be used in the weather station will be indicated. In section IV the results will be evidenced, section V the discussion and finally, section VI the conclusions will be displayed, as well as recommendations of the research work.

II. Literature Review

Today, there are various climatological information systems that are used to monitor the main locations of a city. However, they do not count as an alternative the use of an implementation model of a weather station based on free resources to obtain data in real time and in places where weather stations are not installed. That is why, in this section, various research works related to the proposed topic will be reviewed.

In recent decades, a monitoring system has played an important role in our lives, because it provides us with certain climatological information to predict or prevent some climate changes that are experienced worldwide today. That is why, when the author sees this problem, he proposes in his article [5] the design of an automated weather station that allows dynamic and real-time data to be obtained from a given area. In which, I use the Internet of things and integrated systems technology as a tool for the development of your project, where you propose to use a DHT11 sensor and toxic gas sensors (MQ 7, MQ 131, MQ 136) to detect ranges from 50 to 600 ppm (parts per million) that will be used to monitor carbon monoxide (CO) and carbon dioxide (CO2). This data captured by the sensors will be collected by an Arduino platform and sent to a web application. In the same way, article [6] proposes a prototype that captures different climatic factors and makes them available to users through different methods. Only in the latter it uses the Raspberry pi platform as a control circuit, which will work as a base station.

On the other hand, in Indonesia, the author proposes in his article [7] a weather station using the IoT platform, to make it easier for users to know the weather condition through the internet network in real time, since human activities in that country depend on the climatic factor. The system is made up of an Arduino mega 2560 as the main component, after the DHT22 temperature sensors, BMP180 air pressure sensor, an ESP 8266 WIFI module, an SD module and finally a 3.5 LCD touch screen. After the description of the devices, the results obtained in the tests corresponding to monitoring are shown below. First, they compared the temperature measurement using the DHT22 sensor and the PCE-THB 40 Module, in which the greatest temperature error was 3 ° C and the average error of 1.35˚C. In addition, in the air measurement, the maximum range that reached the humidity was 61%. and the lowest of 24%. Finally, it is concluded that the system can be connected to the internet and have the data obtained by the DHT22 temperature and humidity sensor and the BMP180 air pressure sensor recorded. It should be noted that these sensors obtained favourable results despite the fact that in the respective tests there was a difference in measurements of no more than 5%.

Also, in the article [8] it tells us that, during pandemics of airborne diseases such as the current situation, people should pay attention to the quality of ambient air. Since the concentration of different gases present in the air is a determinant of the value of air quality. That is why the author proposes a weather station designed to measure weather conditions and air quality in free or open spaces. That design is made up as the main component of the ESP32 module that will be in charge of transmitting the data wirelessly to a web server, as well as sensors to measure humidity, temperature, air pressure. As results of the implementation, it was obtained that the temperature and humidity sensors (DHT 11) have an accuracy of 95%, the atmospheric pressure sensor 99.8%, while the weather vane reached an accuracy of 52%, because it had a rotation resolution at 45º, it should be noted that the sensors operated 24 hours to verify the accuracy shown. Finally, it is concluded that the implementation of the weather station integrated with the measurement of the atmospheric gas level has been successfully achieved using IoT technology. Also, that all weather sensors are better than 90% accurate and only wind direction measurements are less than 90% accurate.

In the same way, talking about meteorological data, such as temperature, pressure, humidity, wind speed and among other magnitudes, is the way to prevent those weather problems. In which, a more informative station is one of the keys to obtaining accurate weather forecasts and understanding the characteristics of the climate. That is why the objective of that research work was to design and implement a prototype weather station capable of monitoring and collecting data in real time. That system works with an Arduino board and other devices capable of measuring temperature (SHT30), humidity (SHT30), wind speed and direction, ozone, toxic gases (mq131), barometric pressure and precipitation data. The system focuses on a wide range of IoT devices, savings, battery life, and connection density. Therefore, in this project they use the Narrowband Internet of Things (NBIoT) to transmit data to the MySQL database server through the Restricted Application Protocol (CoAP). As an experimental result, it was obtained that in the sending of data from the Arduino Mega 2560 to the NBIoT Shield, is greater than the maximum memory. Therefore, some data in the stream will be lost when this event occurs, in which case, this problem is solved by reducing the data string to 100 bytes of data. by chain. Regarding the temperature and humidity sensor, according to the manufacturer, it indicates that it can work at 5 °C – 60 °C and 20% HR – 80% HR, but experimentally certain maximum values were not reached, but it met the expectation, as well as it happened with barometric pressure (4.35 - 15.95 psi). Finally, as future work, all the data will be used to build a weather forecast model using machine learning algorithm. In particular, this article has as its purpose, the application in the tourism sector, especially in the Rajamangalax beach where it is proposed to install [9].

On the other hand, in the article [10], the author focuses on the use of modern technology for educational tools and the design of a Thing Speak cloud-supported weather station. In which, the system connects with each other by programming microcontrollers, sensors, cloud APIs, MATLAB scripts, which are useful for analysing stored data and developing Windows or Android applications. That is why it proposes a weather station made up of an Arduino mega 2560 platform, an esp8266 WIFI module, an HD44780 LCD screen, a BMP180 pressure sensor, a DHT 11 temperature and humidity sensor. In which, in the respective tests, I observe that in the last 10h, the humidity was in a range of 63 to 67%, while the temperature ranged between 23 to 24ºC and the pressure in 1014 to 1015 hPa.

Thus, concluding that the design and implementation of the educational model of the IoT weather station sent the correct data through the ESP8266 WIFI module to the free Thing Speak web server and to the LCD screen that the system counted.

In the same way, in the article [11] the author comments that, in Greece, there is a growing need for automated observation systems that provide scientists with the real-time data necessary to design and implement environmental policies. Therefore, this article reviews the technologies most currently used to implement weather stations, where they use the Internet of Things, Edge Computing, Deep Learning, LPWAN and more. That is why, in this article, it proposes a design that is made up of a Raspberry Pi Zero platform, a 16 GB SD card, a Wi-Fi module (ESP32) and temperature sensors (SHT-10), humidity (DHT22), atmospheric pressure (BMP180), wind vane and rain gauge. After the implementation of the system, it is observed in the results that the DHT22 sensor is closer to a typical mercury thermometer than the BMP180 and MCP9808 sensors. Likewise, the BMP180 sensor provided a standard error estimate of 1.3Cº, while the MCP and DHT sensors obtained a standard error of 1.455 and 1.57.

Similarly, the article [12] intends a meteorological station to verify that the photovoltaic module technology is the most suitable for an installation in the localities of Portugal. That station consists of three technologies of photovoltaic modules (polycrystalline, monocrystalline and amorphous silicon), each one connected to a dedicated DC power converter with the maximum power point control (MPPC) function, as well as a set of sensors (irradiation solar, temperature, humidity, wind speed and direction) that are used to measure the local climate. The acquired data is processed and stored locally in the weather station and, if necessary, the user can download the data to an Android mobile device via a Bluetooth Low Energy (BLE) wireless network connection using the mobile application. In the experimental tests, it can be seen that the monocrystalline module produced the greatest amount of energy (300mW), while the amorphous module (150mW) produced the least amount of energy. The meteorological sensors worked correctly in the temperature reaching a range from 12 to 24ºC and humidity 45 to 95%. It is thus concluded that the system could be verified with experimental tests, collecting data from the sensors and photovoltaic modules. In addition, the information was stored locally in the weather station, transmitting data to an Android smart phone device via BLE.

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Data transmission performance was evaluated under different scenarios, measuring weather station data upload time, as well as measuring BLE connection performance according to different network priorities. Connection.

In summary, it was seen that the authors have contributed to the development of various prototypes of meteorological stations according to the needs of their problem. However, I believe that this environmental monitoring initiative could be improved in ecosystems that are fundamental to society, such as wetlands that are currently being degraded due to human actions and global warming. That is why, in this article, the design of a meteorological station focused on wetlands is proposed, since this biodiversity is a main source that helps us to stabilize the greenhouse effect due to its CO2 emission.

III. METHODOLOGY

In this section it will be a proposal that we will classify according to the different areas of interest. Which develops each part of the segmentation of the design of a weather station for the detection of various environmental parameters. All the mentioned steps are shown in the flowchart in Figure 1.

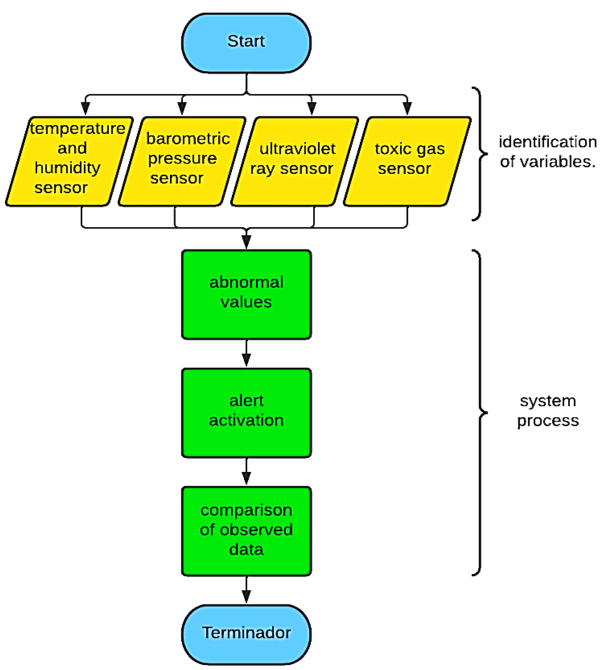

Fig. 1. Flow chart for the detection of environmental parameters.

A. *Identification of variables.*

At that stage, the 4 types of sensors that the weather station will use are described. In which, they will identify 6 environmental values, which are: temperature, humidity, barometric pressure, altitude, ultraviolet radiation and toxic gases.

*Temperature and humidity sensor: DHT*22, is a digital sensor of easy implementation, in which it is used for the detection of temperature and humidity. That type of sensor is internally made up of a thermistor and a capacitive sensor that are responsible for detecting the 2 physical variables already mentioned [13]. Next, it is shown in table I, the main characteristic that must be considered before its implementation of the DHT 22 sensor.

TABLE I
CHARACTERISTICS OF THE DHT 22 SENSOR.

Model	DHT 22
Power supply	3.3 -6 VDC
Operating range (humidity)	0 – 100 % RH +/- 2%
Operating range (temperature)	-40 -80ºC +/- 5ºC
Resolution	Humidity (0.1%RH) temperature (0.1ºC)

Barometric pressure sensor: The BMP180 sensor allows the measurement of height associated with sea level, its operation is based on the relationship between atmospheric pressure and height. Its main characteristic is to provide a range from 300 to 1100 hPa (Héctor Pascal), with absolute precision of up to 0.03 hPa [14]. Likewise, that sensor works with a resistive foot system, designed for its applications with microcontrollers through I2C communication. Table II will show more characteristics of the mentioned sensor.

TABLE II
CHARACTERISTICS OF THE BMP180 SENSOR.

Model	BMP180
Power supply	3.3 -5 VDC
Operating range	300 a 1100 hPa
Resolution	1Pa
Measurable height range	0-9100 m

*UV light sensor:*ML8511 is a sensor that outputs an analogy signal based on the amount of UV light it detects. It is used in projects to monitor environmental conditions such as the UV index.

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It detects light with wavelengths from 280 to 390 nm, which covers the UVB and UVA spectra [15]. The analogy output is linearly related to UV intensity (mW/cm2). Next, table III will show more reference to its characteristic of that sensor.

TABLE III
CHARACTERISTICS OF THE ML8511 SENSOR.

Model	ML8511
Power supply	5 VDC
Operating range	280 a 390 nm
Voltage output	analog
Linear output	mW/cm2

Toxic gas sensor: The MQ135 sensor is used to detect the following gases, such as benzene, alcohol, ammonia and other harmful gases [16]. That sensor has motivated the implementation of various projects related to the monitoring or warning of the presence of polluting gases in the environment. Next, table IV will show the main characteristics of the mq135 sensor.

TABLE IV
CHARACTERISTIC OF THE MQ 135 SENSOR

Sensor model: MQ 135	
Operating voltage and current	5VDC – 150mA
Operating temperature and humidity	-20°C~70°C - <95%
Ppm detection	10ppm~1000 ppm
Ammonia (NH3) analysis level	10 to 300 ppm.
Benzene analysis level (C6H6)	10 to 1000ppm
Alcohol Analysis Level (C2H5OH)	10 to 300ppm

B. System Process

After having described the main characteristics of the 4 sensors, the brief operation of the system will be explained. To do this, we know that each device has an independent way of converting a physical magnitude to an electrical magnitude so that it can be processed by a platform, which will also be described below.

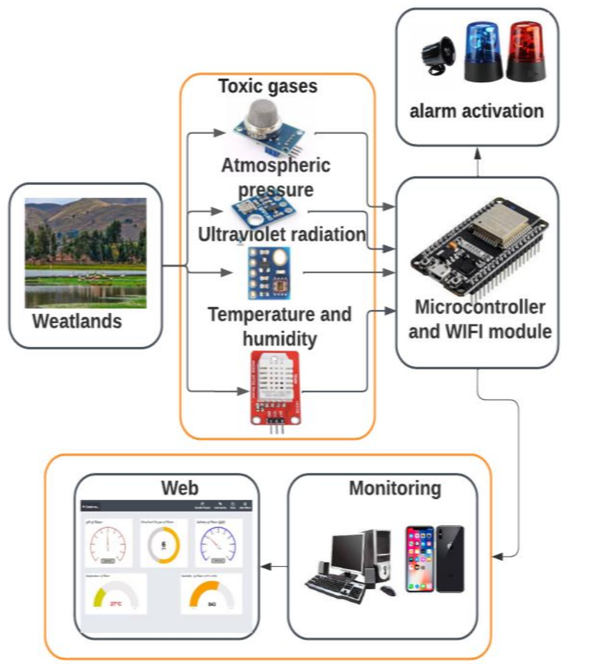

Fig 2. Block Diagram.

As can be seen, Fig. 2 shows the physical components used in the system. In which, the main component is the ESP32 microcontroller, which will be in charge of collecting the data from the 4 aforementioned sensors, which will detect toxic gases, humidity, temperature, atmospheric pressure, altitude and ultraviolet radiation from the Ventanilla wetlands. Likewise, the system will have indicator devices such as emergency lights and a siren that will turn on when the magnitude level has exceeded the permitted parameters, which will be indicated in more detail later. In the same way, the magnitudes collected by the microcontroller will be processed by a web server. free, where the daily monitoring levels of the weather station will be shown through statistical tables.

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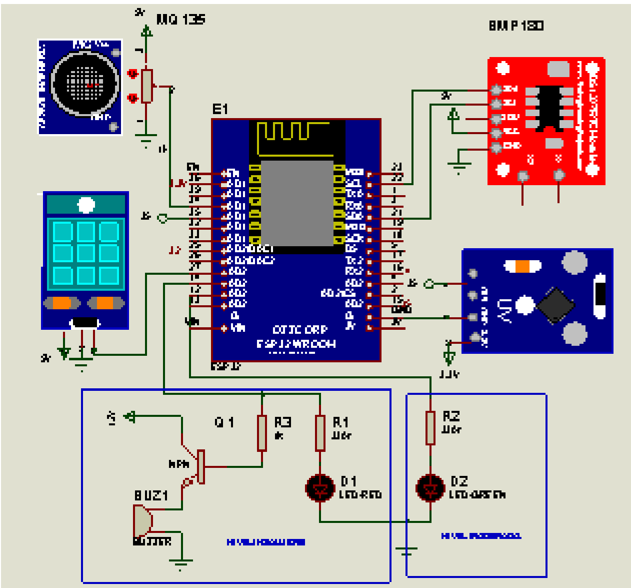

Fig. 3 Circuit simulation.

Thus, after briefly knowing the operation of the system, it can be seen in Fig.3 the simulation in Proteus, in which the sensors are connected to the ESP32 module, respecting the technical characteristics shown above in table I, II, III and IV, where you show us the measurement ranges of the devices, the operating voltage and the transmission medium, as is the case of the BMP 180 that transmits its data through I2C, the MQ135 and ML8511 analogy output and finally the DHT 22 that works with digital output. Subsequently, the buzzer and the LED indicators were simulated to show us if the environment to be monitored is in a moderate state (green lights on) shown in Fig. 4 or an unhealthy state that is displayed in Fig. 5 (red light and on). buzzer). For this, the various intervals or range of the sensors that measure toxic gases, ultraviolet radiation, temperature and humidity were considered. It should be noted that the atmospheric pressure sensor was not considered because it is a magnitude that remains constant. Next, the ranges that were established in the levels already mentioned will be shown.

- *Moderate*: Toxic gas level less than 100ppm, temperature greater than 10ºC and less than 28ºC, Humidity in ranges from 55 to 85% and finally the UV index must be between 1 to 5.
- *Unhealthy:* Toxic gas level greater than 100ppm, temperature less than 10ºC and greater than 28ºC, Humidity less than 55 or greater than 85% and UV index greater than 5.

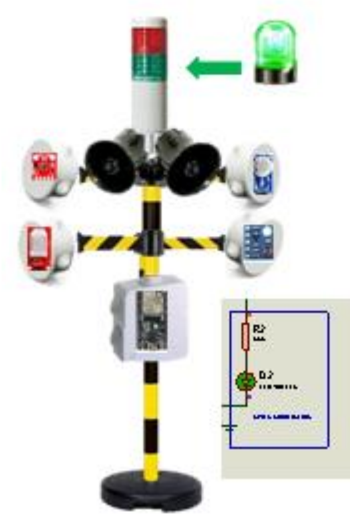

Fig. 4. Moderate level, green led on

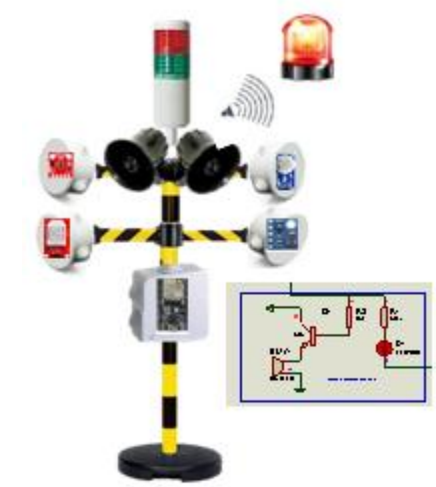

Fig. 5. Unhealthy level, siren activation and Red lights.

After knowing the operation and the devices that will be used in the weather station. We will proceed to talk about the ESP32 platform as a second point, in which it is in charge of transmitting the data captured to a web server via WIFI. This communication process can be seen reflected in Fig. 6, where the communication of the ESP32 to the cloud is indicated, in which María DB is used as a database management system and the Grafana software to create the statistical tables of the weather station [17].

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Fig. 6. ESP32 communication in the cloud.

On the other hand, the proposed meteorological station intends to be installed in the various strategic points of the Ventanilla wetlands, as well as in the ecological park "El Mirador" visualized in Fig 7 and 8. With the objective of monitoring the various environmental magnitudes by through a computer or a cell phone where they will indicate the real-time readings of the sensors through a web platform that can be seen in Fig.10.

Fig. 7. ESP32 communication in the cloud.

Fig. 8. ESP32 communication in the cloud.

IV. RESULTS

At this stage, mention is made of the results obtained in the implementation process. In which the various comparisons of the 4 sensors that make up the circuit were carried out. That installation can be seen in Fig. 9.

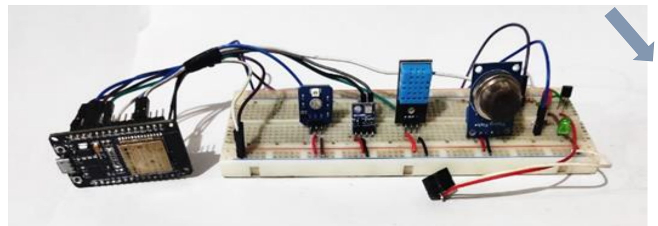

Fig.9 Weather station hardware.

Likewise, after the installation of the system, the web platform developed for the meteorological station is displayed in Fig 10 and 11, in which it is characterized by the ease of handling, with respect to the statistical flows and the real-time reading of the sensors. It should be noted that the purpose of the graphs is to carry out an analysis and compare the daily records captured in the wetlands of Ventanilla.

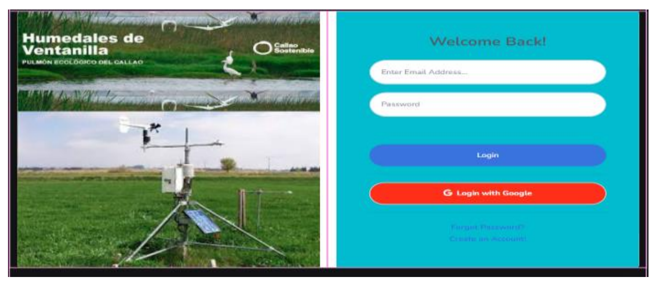

Fig.10 Initial platform of meteorological stations.

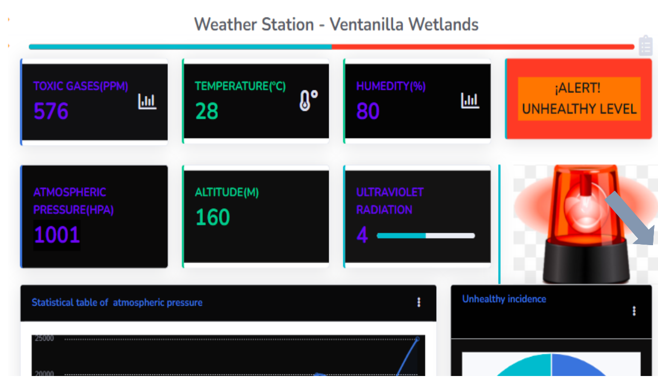

Fig.11 Main platform of meteorological stations.

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After observing the implementation of the hardware and software of the weather station, the various tests were carried out, in which they generated positive results that can be seen in Table V, where the values recorded during 5h are shown. It is evident that it was previously switched on for 24 hours to obtain the most stable sensor values according to the manufacturers' recommendations.

TABLE V
RESULTS OBTAINED IN THE WEATHER STATION TESTS

Weather Station	Resulted
Operation time.	5h
Temperature operated in the simulation	18ºC - 27ºC
Supply voltage to the circuit	5VDC - 1A
minimum and maximum reading of sensor mq135(ppm)	10ppm - 580
Minimum and maximum reading of the sensor BMP180(hPa)	1000 -1008
Height reading above sea level sensor BMP180(meters)	65 - 140
DHT22 sensor reading (%)	70 - 85
ML8511 sensor reading (index)	1 a 5

In the same way, after verifying that the sensors are correctly calibrated, the correct operation of the alert levels was verified, as shown in Fig 12., where the activation of the green LED is verified, indicating that we are in a moderate environment, in which it was verified through the statistical tables of Fig 14,15,16 and 17 where it is shown that there was a stability in the environmental magnitudes in the hours from 9 to 11 am.

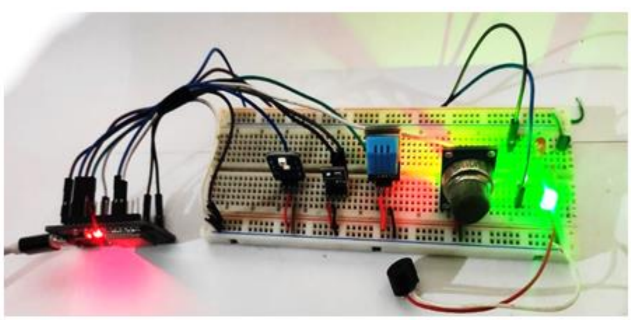

Fig.12. Weather station, moderate alert level.

While in Fig 13. It indicates the lighting of the red led, where the buzzer was automatically activated indicating that we are in an unhealthy alert level, in which it was possible to highlight that the temperature in a time from 1 to 2 pm was constant at 27 to 28ºC, proving to be at the limit of the unhealthy level.

The same thing happened with the level of toxic gases that we reached peaks of 576 ppm because we used a lighter to generate monoxide and reach a certain level of unhealthiness, this is because in the tests there was no incidence of toxic gases in the area of monitoring.

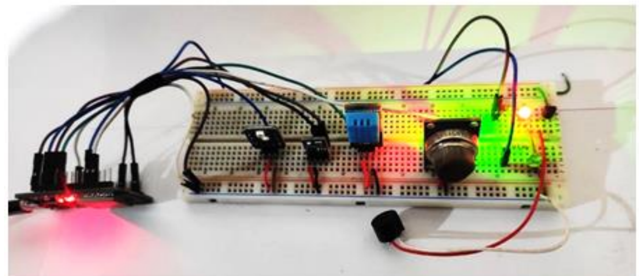

Fig.13. Weather station, unhealthy alert level.

On the other hand, in Fig. 14, the statistical graph of the atmospheric pressure monitored for approximately 5h is shown. In which, it is observed that the atmospheric pressure remained constant in ranges from 1002 to 1006 hPa. Indicating that the altitude remained at an average of 60 to 80 meters above sea level, this is because certain magnitudes are inversely proportional. Likewise, in Fig 15 it indicates the ultraviolet radiation, where it can be seen that it remains constant at a UV index of 3 established at 280 to 390 nm, indicating that they are at a moderate level during the 5 hours of testing.

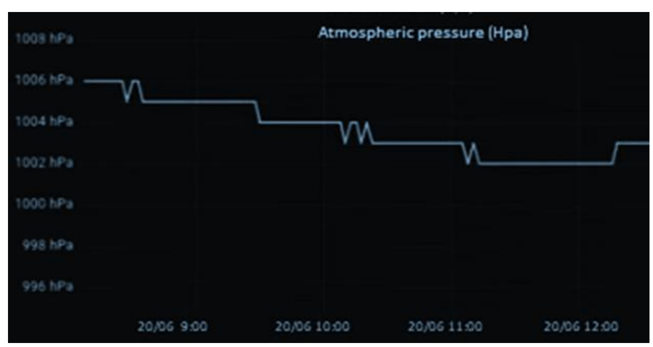

Fig.14. Statistical graph of atmospheric pressure

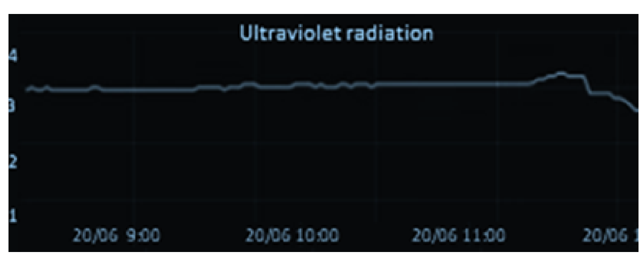

Fig.15. Statistical graph of ultraviolet radiation

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On the other hand, in Fig 16 and 17, the monitoring of temperature and humidity is shown, respectively. Where you can see, there was a lot of irregularity in temperature from 11:30 am onwards, even though we started with a constant value of 23ºC. This is due to various factors in which the sudden change in climate that is currently being experienced has generated. In the same way, it happened with the humidity that started with 80%RH and was going down, reaching values of 70% in the last hours of the test.

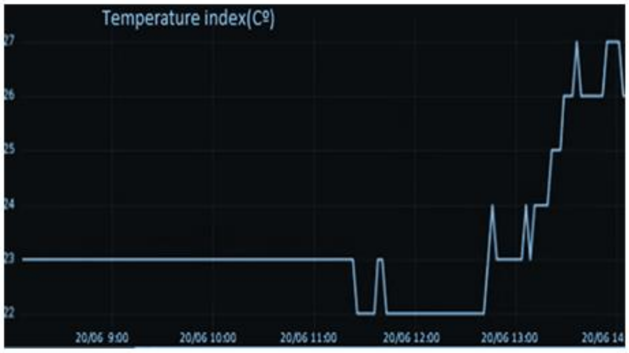

Fig.16. Statistical graph of temperature.

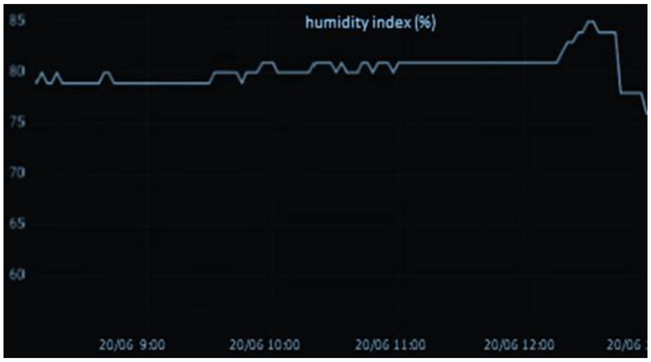

Fig.17.Statistical graph of Humidity

Finally. It is important to emphasize that the various comparisons were made with the weather station on the Meteoblue company website, where it was seen that the temperature had a variation of +- 2ºC and the humidity +- 1% RH. Despite this margin of error, the expectations and technical characteristics that the manufacturer provided in the sensors used in this research work are met, where it is shown in Table I. That is why it was considered that the proposed weather station worked efficiently with respect to environmental readings. In the same way, it happened with the web platform, which provided us with an efficient statistical table despite having its limitations due to being a free platform.

V. DISCUSSIONS

As can be seen, the ESP32 module was used in the research work, in order to process and transmit the information recorded by the sensors via WIFI. While on the contrary, the research work [12] uses an Arduino MEGA module as the main component and an ESP8266 module that is in charge of transmitting the data remotely. Unlike ESP32, that module has fewer features and certain limitations in sending data to a web server.

Likewise, it is important to indicate that job [7] uses the same component as job [12], only an LCD screen and an SD reader are added. In which, I consider that if we seek to reduce costs in an implementation, I would apply the proposed system that we propose, because it is economical and provides us with easy installation and adaptation in control and data transmission. In addition, we are applying a free database that is María DB.

On the other hand, with respect to the results obtained, it can be seen that when simulating the system, sensor values were obtained in various ranges shown in table V, which indicates that the BMP180 sensor reached a maximum altitude level of 140m and an atmospheric pressure of 1008 hPa. Likewise, in temperature and humidity there was an average of 23.9ºC and 75%, generating an error of +- 2ºC and +-1%, respectively. Therefore, a certain simulation shares a relationship with the work [7], in which when performing their simulation, they also averaged an error of 1.35ºC in temperature and humidity +- 2%. Concluding that the DHT22 and BMP180 sensor meets the expectations that the manufacturer gives us in the margin of error, shown in TABLE I and II.

In the same way, in the respective tests of the sensors for 5 hours, it was possible for the mq-135 toxic gas sensor to reach a maximum level of 580 ppm due to the fact that a lighter was used to simulate the toxic gases. as is carbon monoxide. In which, this estimation of the value of the gases, was also achieved in the research work [5] where they carried out a gas analyzer for vehicle emissions, where they generated a reading of 300 to 500ppm due to the varieties of octane they used. such as 90 and 95 gasoline, which they tested in simulation vehicles for CO_2 and CO emissions. Through this similarity, the great efficiency of the system to detect abnormal values of the toxic gas sensor of the MQ family is verified. It should be noted that it is important to have it turned on for 24 hours beforehand to obtain an adequate value, since in the first hours of testing it was seen that it was very unstable.

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Additionally, it was verified that the sensors operate correctly on the web platform developed in Grafana, together with the Maria DB database, where the update of the environmental values is displayed every 10 seconds. Likewise, this software provided the data of each sensor that was programmed according to what the manufacturer indicated, such as temperature (0 to 100 Cº +/- 5% accuracy), humidity (20 to 80%), ultraviolet radiation (280 at 390nm +/- 1UV) and air quality index (10 to 1000 ppm). In the same way, it was applied in the work [14], where they also monitored for 10h and established the ranges of the sensors indicated by the manufacturer , only that in this work they used the Think Speak platform as a web server, in which , I consider that It is a platform that is easy to adapt , only that it is limited when using different sensors continuously , which unlike Grafana works without a problem , and it also has more functions and icons to improve our proposed weather station , together with the database what do we use.

After making the various comparisons between the proposed station and the existing ones. It is important to recognize that there are currently several systems that mostly have customized software and a more sophisticated web platform. In addition, it has several high-precision sensors that guarantee a better reading, but that require periodic maintenance and calibration, which makes its value very high and its price is not so accessible for its implementation. That is why, in That article proposes an economic weather station with an educational and reliable component, which will serve as an information medium for citizens.

VI. CONCLUSIONS

As shown in the results, the proper functioning of the system is identified, thus being very useful when detecting dangerous levels of toxic gases, temperature, humidity, UV and atmospheric pressure. In addition, its application will serve as an informative medium, which aims to raise awareness among the population about the importance of conserving wetlands and ecosystems that are in danger of extension, due to global warming and the human actions that we ourselves carry out.

On the other hand, the system aims to influence more research on the monitoring and care of the planet's biodiversity. That is why it is essential to recognize that the educational devices applied in that design are effective and easy to operate, such as the ESP32 module, in which it is a platform that has free software and is compatible with operating systems in general.

As future work, it is proposed to improve the web server using more tools in the database, similar to what the authors of the work propose [9]. Likewise, it is intended to add more sensors, depending on the requirement that is desired in the place of implementation, as well as add a more sophisticated and robust alarm level where it includes an IP camera for better monitoring and use of radio link devices such as Lora WAN.

Finally, it is recommended that when using the system, some limitations of the circuit should be considered, which are that it must previously be kept on for at least 24 hours to stabilize the sensors. In addition, it must also consider an internet network available 24 hours a day so that it can be monitored by IoT, since, if we do not have good internet quality, the values captured by the weather station will not be constantly updated. Likewise, it should be considered that the ESP32 module has a limited transmission distance, as well as the sensors in which it is recommended to view its datasheet to avoid certain inconveniences or breakdowns. On the other hand, it is important to use an adequate power supply for the emergency lights and the siren that is intended to be used, since they are the devices that consume the most current in the proposed system.

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