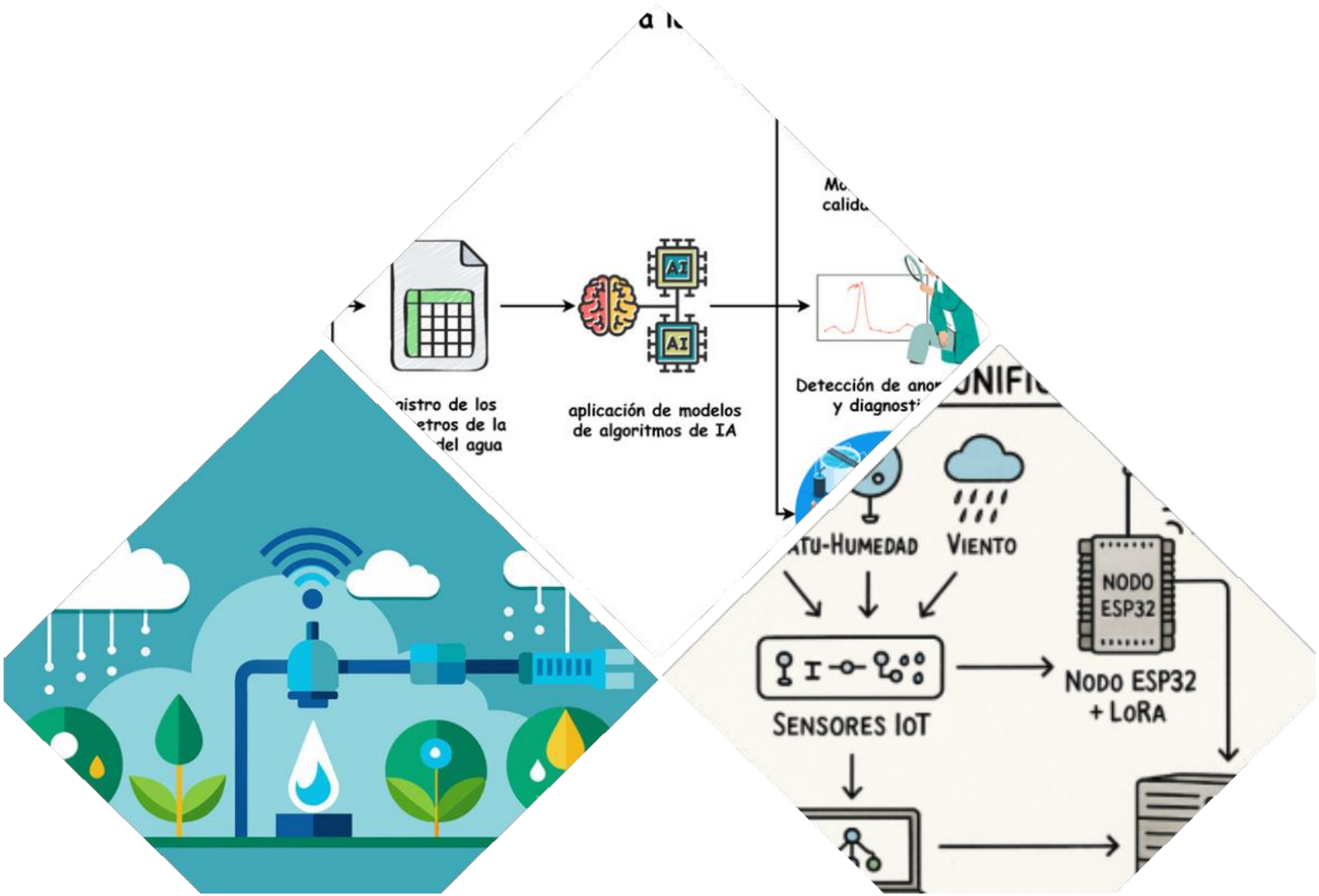
Unified Environmental Monitoring Platform

Public Challenge #3
Technical Report

GovTech Portoviejo 2050
Municipal Policy for GovTech Collaborative Ecosystem



1. Problem Definition

The canton of Portoviejo, capital of the province of Manabí (Ecuador), faces multiple environmental and urban challenges that directly affect its population. Among these challenges are recurrent floods caused by the rising of the Portoviejo, Chico, and Chamotete rivers, as well as heavy rains and deficient drainage infrastructure. In addition, emerging problems include air pollution (mainly from suspended particulate matter), noise pollution in dense urban areas, and high exposure to ultraviolet (UV) radiation, especially in sectors with low tree cover and high solar irradiation.

The lack of an integrated real-time environmental monitoring system limits the response capacity of the Decentralized Autonomous Government (GAD) and emergency entities, hindering timely and evidence-based decision-making. Additionally, citizens lack accessible tools to know the environmental conditions in their parishes and to take preventive measures against extreme weather events or harmful health conditions.

2. Project Description

This project consists of the design and implementation of a distributed network of autonomous environmental monitoring nodes, which will be located in strategically selected areas of the canton of Portoviejo. These nodes will be equipped with sensors to measure critical parameters such as: precipitation (rain gauge), soil moisture, air temperature and humidity, atmospheric pressure, UV radiation, wind speed, environmental noise (sound pressure), and air quality (PM2.5, PM10 particles).

Each node will be energy self-sufficient thanks to the use of 20W monocrystalline solar panels and 18650 rechargeable batteries. Communication between the nodes and the central server will be carried out using LoRa technology, allowing efficient data transmission over long distances with low energy consumption.

The collected information will be centralized and visualized in real time through the municipal app “Portoviejo Previene,” providing authorities and citizens with an early warning system, monitoring of environmental variables, and evidence-based decision-making.

Main Components of the System:

- ESP32 DevKit v1 microcontrollers

- LoRa SX1278 modules (433 MHz)

- Capacitive soil moisture sensor

- DHT22 or AM2301 sensor for air temperature and humidity

- BMP280 sensor for atmospheric pressure

- UV GY-ML8511 sensor for ultraviolet radiation

- Anemometer for wind speed and direction

- Rain gauge (tipping bucket type)

- Analog microphone sensor for sound

- PMS5003 or SDS011 sensor for particulate matter

- 20W solar panel

- 18650 rechargeable batteries and TP4056 chargers

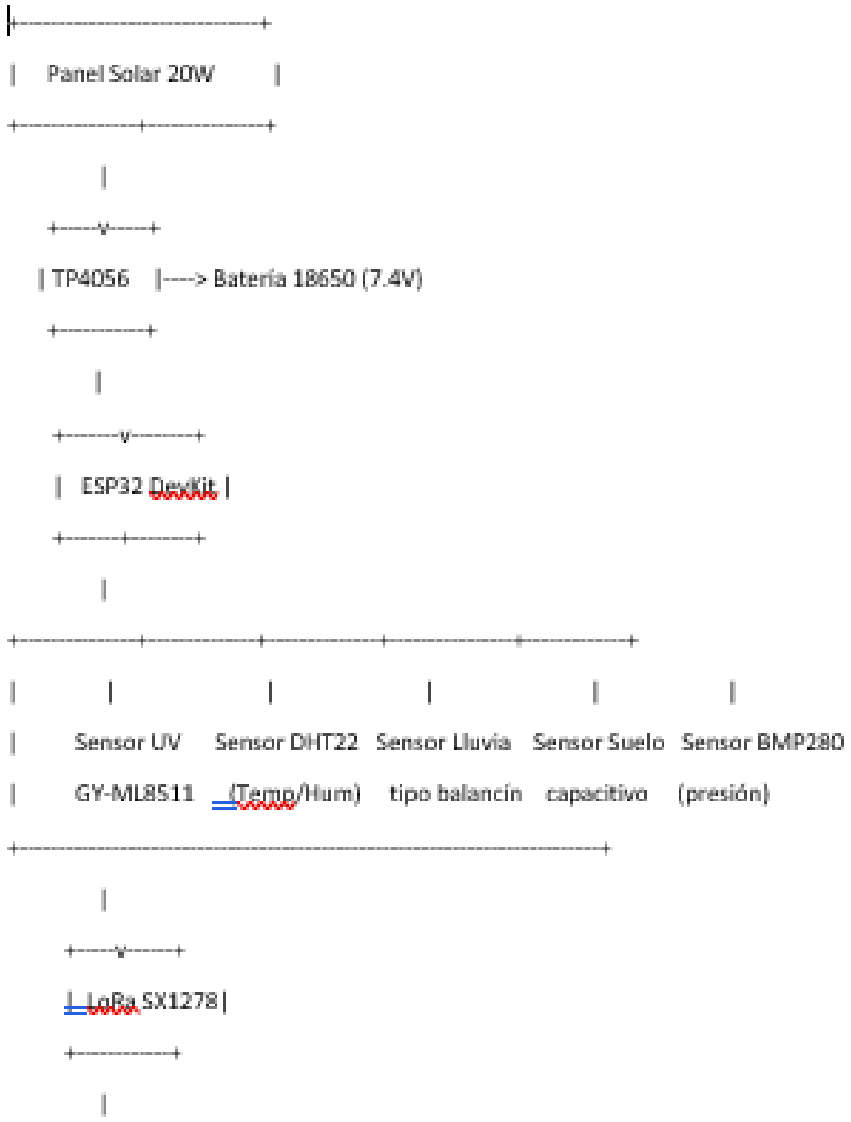
- IP65 waterproof enclosure

Proposed Solution:

This system provides an efficient, economical, and scalable technological solution for urban and rural environmental monitoring. It enables alerts for imminent risks (floods, high levels of pollution), evaluation of exposure to harmful factors (noise, UV radiation), and the generation of historical databases for environmental studies, urban planning, and local scientific research.

3. Prototype Diagram

The prototype consists of the following functional blocks



Transmission to LoRa Gateway (Central)

This diagram represents a block diagram of a typical sensor node. Each node has renewable energy sources, a processing unit, and multiple sensors. It can be adapted with additional sensors depending on the zone.

4. Project Implementation Flowchart

Start → Identification of Critical and Relevant Zones → Selection of Environmental Parameters to Measure → Design of Nodes and LoRa Network Architecture → Acquisition of Components → Assembly and Laboratory Testing → Physical Field Installation (Posts, panels, enclosures) → Communication and Calibration Tests → Integration with “Portoviejo Previene” App → Continuous Monitoring and Maintenance → Evaluation of Results and Expansion → End

5. Human Talent Requirements

Professional Profile	Quantity	Skills/Knowledge
Electronic Engineer	1	Hardware design and assembly, microcontroller programming, LoRa and sensor use
Systems or IoT Technician	1	Physical installation, assembly, field testing, soldering, LoRa communication
Backend/IoT Developer	1	Data integration to server, web/app visualization, databases, MQTT/HTTP.

5.1. Material Requirements

- ESP32 DevKit v1 x7

- LoRa SX1278 module x7

- DHT22 / AM2301 sensor x7

- UV GY-ML8511 sensor x7

- BMP280 sensor x7

- Rain sensor x7

- Soil moisture sensor x7

- Anemometer x7

- 20W solar panel x7

- 18650 batteries (pair) x7

- TP4056 module x7

- IP65 waterproof enclosure x7

- Cables, jumpers, solder, tape, ties

- LoRa Gateway (Raspberry Pi + concentrator)

5.2. Equipment Requirements

- Computers for programming and data management

- Soldering station

- Digital multimeter

- Assembly tools (drill, screwdrivers)

- Mobile device for connection tests

- Server platform and domain for backend

6. Expected Scenario Description

The system will be deployed in the field, distributed among rural and urban parishes of Portoviejo that have been selected for their high environmental vulnerability. Conditions vary: from humid areas with rivers and estuaries, to dense urban areas with heavy traffic.

- Physical conditions: Dry tropical climate with intense seasonal rains. Direct exposure to solar radiation and precipitation. Sloping terrain and low areas prone to water accumulation.
- Technological conditions: No constant electrical grid in all zones, requiring energy autonomy. Cellular connectivity is variable; therefore, LoRa is used for long-range transmission.
- Social conditions: Areas with vulnerable populations, need for capacity building. Potential community participation in environmental monitoring and basic maintenance.

Technical Justification of Selected Areas:

- **Picoazá, Calderón, Río Chico, Colón, Pueblo Nuevo, Chirijos, Alhajuela**: proven records of severe flooding, river overflows, obstructed estuaries, low vegetation cover, and lack of local meteorological stations.

- **Avenidas Manabí, Urbina, and Parroquia 12 de Marzo**: critical noise pollution from vehicle traffic, low tree cover, and high UV exposure. Urban environments requiring urgent intervention to evaluate thermal and acoustic comfort.

- **Areas with high smog concentration:** due to proximity to main roads and industrial zones. The installation of PM2.5, PM10, and radiation sensors will enable monitoring of primary and secondary pollutants (such as tropospheric ozone).

Strategic placement will provide a holistic view of the urban and rural environment of the canton, optimizing resources, improving decision-making, and increasing resilience to climate change and extreme events.