

# Municipality of Rotterdam – Sensor Cases.

This README provides an overview of the various sensor JSON files, describing the functionality and data types associated with each sensor. The method of data reception for these sensors is via the LoRa network. The data is deciphered through the ChirpStack platform. After decryption, the payload is translated into the measurement values outlined below and forwarded to our sensor management platform. Along with this file, additional resources are provided: different JSON file examples as they appear in ChirpStack, an Excel file containing the sensor placement locations, and details of the different sensor types.

## Connections:

Upon request can a direct connection be made to the selected sensor data through a MQTT or HTTP integration for the testbed pilot, during the time the testbed takes place. For more information about the connections within the Chirpstack LoRaWan network Server see:

<https://www.chirpstack.io/>

Chirpstack HTTP integration.

<https://www.chirpstack.io/docs/chirpstack/integrations/http.html>

ChirpStack MQTT integration.

<https://www.chirpstack.io/docs/chirpstack/integrations/mqtt.html>

## Generic:

For the documentation of types of events that can be transmitted see:

<https://www.chirpstack.io/docs/chirpstack/integrations/events.html#up---uplink-event>

Additional useful information that is currently not utilised; such as on which gateway the message is received, battery status or other relevant pilot details. All info can be utilized during testing when deemed relevant. Each sensor comes with a timestamp and device identifier (devEUI, deviceProfileName). Note that not all sensors provide separate timestamps for measurement time and transmission time; refer to the JSON files for details.

## Sensors:

### 1. Groundwater Level Sensor

**Description:** Measures the groundwater level based on pressure readings.

**Key Features:** Provides pressure measurements within monitoring wells to determine water table depth.

**Data Outputs:** Groundwater pressure (hPa) and temperature (degrees Celsius) are measured inside monitoring well on the depth of the sensor relative to NAP (inhangdiepte).

To calculate water level: Ambient air pressure data (hPa) on location is retrieved from the KNMI.

Ambient air pressure (hPa) is used to adjust the inner pressure with the ambient pressure.

This gives the following equation to calculate the water level:

$$P_{corrected} = \frac{P_{sensor}[hPa]}{100} - \frac{P_{air}[hPa]}{100}$$

$$h_{waterlevel} = b + \frac{P_{corrected}}{\rho * g} - d_{sensor}$$

- $h_{waterlevel}$  is the groundwater level (m)
- $b$  is the reference level
- $P_{corrected}$  is the water pressure in the sensor (Pa)
- $\rho$  is the Density of water ( $998 \frac{kg}{m^3}$ )
- $g$ : Acceleration due to gravity ( $9,81 m/s^2$ )
- $d_{sensor}$ : Depth of the sensor in the well (m)

## 2. Soil Moisture Sensor

**Description:** Measures soil moisture levels based on electrical conductivity.

**Key Features:** Indicates soil water content to monitor irrigation and plant health.

**Data Outputs:** Conductivity (S/cm) reflects soil moisture levels. Temperature (Celsius) provides soil temperature for correlation with conductivity readings. The calculated moisture content (%) is calculated within the sensor based on 'standard' soil, but ultimately should be calculated based on saturation profiles (done in the lab) on the used soil.

## 3. People Counter

**Description:** Tracks the number of people or bicycles passing a location using LiDAR technology.

**Key Features:** Locally processes LiDAR data to output count data. High accuracy for monitoring foot traffic, not very accurate to measure bike traffic.

**Data Outputs:** People Count (integer) is the number of people passing by. Bike Count (integer) is the number of people/bicycles detected.

## 4. Soil pH and Temperature Sensor

**Description:** Measures the pH level and temperature of the soil.

**Key Features:** Helps in monitoring soil health and suitability for different crops.

**Data Outputs:** pH Level (pH units) indicates soil acidity/alkalinity, Temperature (Celsius) records the soil temperature.

## 5. Water Leakage Sensor

**Description:** Detects water leaks and measures local temperature and air humidity.

**Key Features:** Provides binary water leakage detection. Includes environmental monitoring.

**Data Outputs:** Leak Status (boolean) indicates if there is a leak (0/1). Temperature (Celsius) monitors the ambient temperature. Humidity (%RH) tracks the relative ambient humidity.

## 6. Atmos 12-in-1 Weather Station

**Description:** A weather station measuring various atmospheric parameters.

**Key Features:** Combines multiple sensors into one unit for diverse weather monitoring.

**Data Outputs:** Temperature (Celsius) measures air temperature. Humidity (%RH) records relative humidity. Barometric Pressure (Pascals) measures atmospheric pressure. Wind Speed (m/s) indicates wind velocity. Wind Direction (degrees) shows the direction of the wind. Rainfall (mm) measures precipitation amount. Solar Radiation ( $W/m^2$ ) captures solar energy received. UV Index (index) measures the intensity of ultraviolet radiation. Lightning strikes (integer) provides amount of lightning strikes measured. Lightning distance (km) provides the estimated lighting distance. Dew Point (Celsius) is a calculated value that indicates the temperature at which dew forms.