KELLER IN THE BUSH

IOT WATERLEVEL PILOT PROJECT WITH A SURPRISING OUTCOME AT KOLOLO GAME RESERVE

Kololo Game Reserve is located near Vaalwater, Limpopo (South Africa), with several accommodations, a fine restaurant and a swimming pool. Kololo is part of Welgevonden Game Reserve (a Big Five game reserve*), with the specialty that the area itself does not accommodate the Big Five. Summarized, Kololo is a family friendly game reserve with its own access to the Big Five, i.e. the best of both worlds.

Kololo is located in a rural area and therefore self-sustaining regarding water and electricity. Although Kololo is connected to the electricity network, this network fails now and then so for backup purposes there is a diesel electricity generator standby.

Kololo's water system

Kololo's water system consists of 3 stages: A water well, eight accumulating tanks, and finally, distribution of the water through pipes and hoses to the lodges, the restaurant and the pool. Kololo's main water source is a well at a depth of 100 m. To reach the well's water, a borehole is drilled. Measuring the level in the well is important to predict the stock of water in the well, as stock is not infinite.

The tanks called Jojo's

The water from the well is pumped over a distance of 1 km into eight tanks of 5000 liters each. These tanks are called «Jojo's» because of the name of the manufacturer (Jojo) and are located high on a hill. In fact the Jojo's work as an accumulator. From the Jojo's, the water is distributed by pipe downhill, assisted by gravity, to the lodges and the pool.

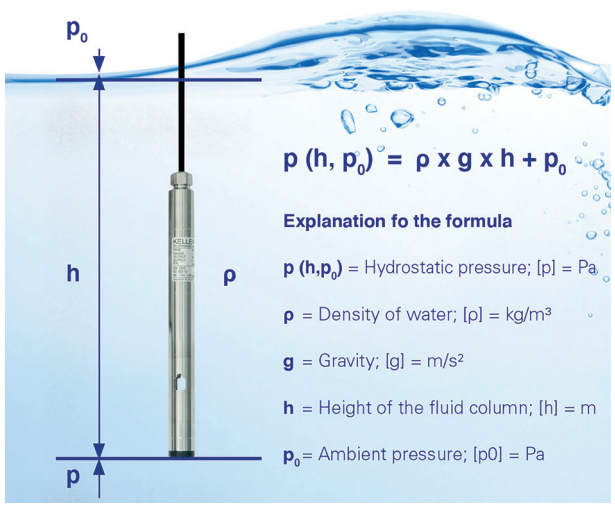
Measuring levels

Measuring the water level in both the well and the Jojo's is important to get a good insight in the current level which is representative for stock of water over a certain period. Therefore in February 2020, KELLER installed a complete level measurement system in one of the Jojo's, which is wirelessly readout via a LoRa network. All eight Jojo's are connected to each other. Thus, the level in one Jojo is representative for the level in all Jojo's.

KELLER has a wide variety of both analogue and digital level sensors. Optionally, beside level and temperature which are standard measured parameters, the digital level sensors can even measure conductivity. As the data is finally stored in a database of KELLER's KOLIBRI Cloud, also historical data is available over time, which gives further insight in consumption, leakage etc.

How to measure water level with a pressure sensor?

Ever felt your ears hurt when diving in water? You feel the weight of the water column above you. The weight is a force, calucalated with the formula F = m x g, where m = mass and g = gravity. As pressure is force per area, we can measure the fluid column with a pressure sensor.

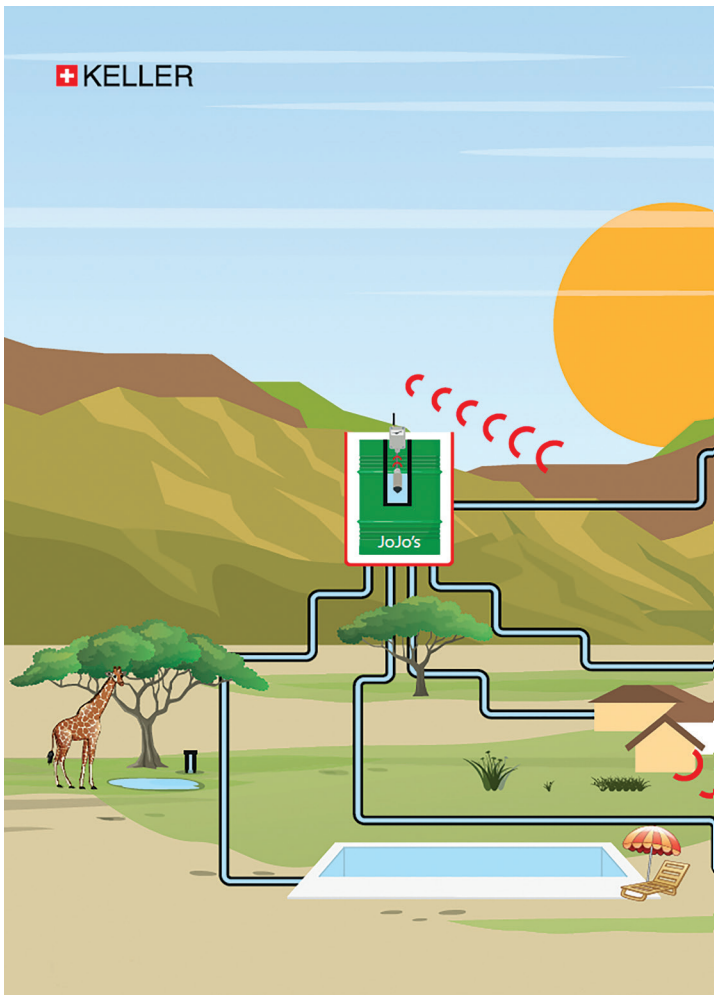


Pressure / water column conversion

Knowing the density of the fluid, we can convert the pressure to a length (= fluid column) and when we know the length, the area and the density of the fluid, we can convert the measurement to a volume in litres.

Wireles LoRaWAN based system

Kololo is not the biggest game reserve but nevertheless a big area of 3000 Hectares (i.e. 4500 footbal pitches) and thus too big for wired sensors. This project asks for a wireless IoT* solution, but due to the fact that Kololo is located in a rural area there is hardly cellular coverage. 4G and NB-IoT (i.e. provided networks) are therefore not available. However, Kololo does have acess to the internet.



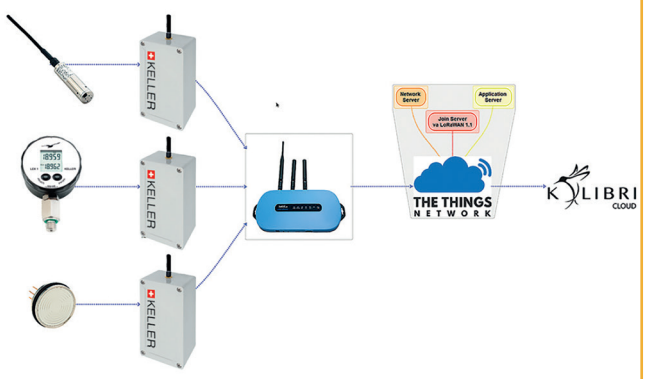
** Big 5 stands for the five most dangerous animals to hunt and comes from those day where hunting precious animals was seen from another perspective. The big 5 are the elephant, rhino, leopard, buffalo and of course the lion.*

LoRaWAN stands for Long Range Wide Area Network: an energy-saving network communication protocol for wireless applications (in particular IoT). With data rates of max. 50 kbit/s, this technology is designed for comparatively simple data, such as measured values from sensors (in contrast to, for instance, an HD video stream). LoRaWAN has a range of several kilometres and also penetrates buildings.

There are several wireless IoT* systems like LoRaWAN and Sigfox. Among LoRaWAN, Loriot and The Things Network (TTN) are the most known ones.

The big advantage of TTN is that one can easily create local coverage by installing a TTN compatible gateway and connect it to the internet.

A typical local LoRa network consists of 3 basic elements.

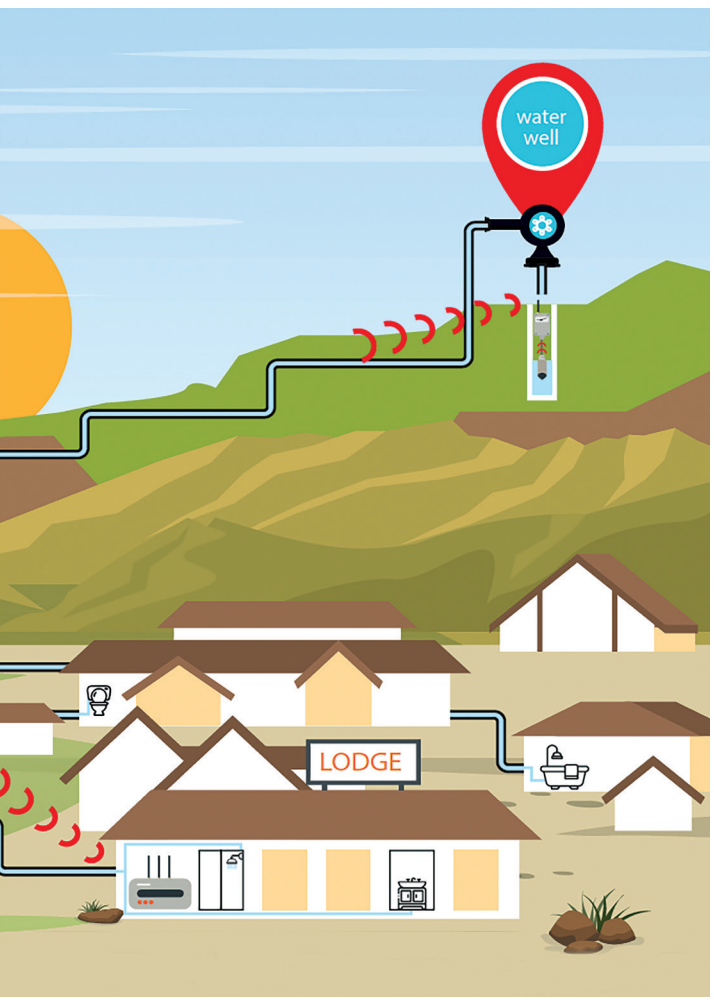


KELLER LoRa scheme

1. A (digital) sensor or gauge
2. A LoRa transmitter which transmits the measurements
3. A LoRa gateway, the receiver, which is connected to the internet by ethernet or Wifi, and forwards the measurements to KELLER's KOLIBRI Cloud.

In the case of Kololo, the LoRa gateway is a Laird Sentrius gateway, and the LoRa transmitters are KELLER's own ADT1 LoRa Modem. To this ADT1 a KELLER Series 36XW digital level sensor is connected, measuring pressure (= water level) and temperature.

The ADT1 is retrieving the level from the level sensor and transmits the data, together with barometric pressure and air temperature, to the LoRa gateway. Finally the LoRa gateway forwards all the data via the internet to KELLER's KOLIBRI Cloud where data is stored.



Data can be viewed in KELLER's KOLIBRI Cloud Web app, offering you lots of more features than just viewing data.

Among these features are export and printing of data, converting data to other units or even tank content calculations, to name just a few.

Installation

Testing LoRa reception at the measurement spot

STEP 1 Install the LoRa gateway in the office of the technical manager, and to register it at TTN (The Things Network).

STEP 2 Detecting LoRa reception at the measuring spot to see if the KELLER ADT1 LoRa modem could connect properly to the LoRa gateway. When the gateway and the ADT1 connect well, it is assured that data from the level sensor will find its way to the internet and finally to KELLER's KOLIBRI Cloud.

STEP 3 Set up the ADT1 to register and connect it to the TTN network

STEP 4 Connecting the level sensor PAA-36XW to the ADT1 LoRa modem and install it in or on top of the tank.

Installation and setup took a while as finding the right transmitting power, without over powering, had to be done precisely. It's not an area where you easily go back to change batteries for example. After installation and setup the system started measuring every hour.

Next day first measurements were visible with a down sloping chart. Inspection of the difference between 2 measurements during the night, showed a difference of approx. 100 liters per hour.

A leakage was the only possible cause. At the bottom of the

Installing the level sensor and LoRa modem

tanks the leakage was found: one of the pipe threads was partly pulled out of junction.

Thus, the system proved itself already after a day.

The system might be extended with a KELLER Series 26X digital level sensor for the borehole to have an insight in the basic water stock.

*Internet of Things: the virtual networking of objects, with the aim of improving the way that they work with each other and with humans. Information from sensors, actuators, software and human inputs is provided to the network and can be used to improve the detected situation. Applications for smart factories/ smart homes and Industry 4.0 are examples of applications that rely on IoT networks of this sort.

Kololo's Electricity System

Kololo is connected to an electricity network, but it can happen that power fails. To have a backup at those moments Kololo has a diesel electricity generator.

It can happen that supply tanks are not cleaned properly and water gets into the diesel tank during refilling. Theft of diesel might occur as well and to mask the theft, the taken amount of diesel is sometimes compensated with water. For a diesel generator this can be a catastrophe. Water in an engine will cause big damage with high repair costs.

As a LoRa system cannot measure faster than once per 15 minutes, detecting a change of the diesel level with just a level sensor might not always work if the level is compensated with water to the old level within 15 minutes.

However, based on conductivity one can detect a change in the mixture. Water is heavier than diesel, and water has a different conductivity than diesel. The change in conductivity therefore represents the presence of water in the diesel tank.

The KELLER Series 36XiW-CTD is a digital combined level and conductivity sensor. With this sensor we can detect changes in level and conductivity, thus detect presence of water in the diesel.

Series 36XiW-CTD

Conclusion

A level measurement system, gives actual data about fluid levels. When readout wirelessly and data stored in a database, a data history is built up, giving enormous statistical insight in consumption and/or malfunctioning which was unknown before. Thus, it can lead to great savings or prevention of unnecessary repairs and non-revenue problems. This system can be applied in all fluid level measurements across a variety of industries. Game reserves, boreholes, agriculture, petrochem and many more. Every KELLER sensor with a digital output (RS485 or SDI12) can be applied in IoT applications.

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Martijn Smit is the commercial director of the KELLER subsidiary Netherlands, and responsible for Netherlands, Belgium and Southern Africa. He is familiar with the whole KELLER product range and a specialist regarding KELLER water solutions. Martijn is with KELLER since 1997.

KELLER PAA-36XW digital level sensor

KELLER ADT1 Lora modem

Laird Sentrius LoRa gateway

Adeunis LoRaWAN Tester

Used Equipment / Software