

# INTEL-IRRIS

Intelligent Irrigation System for Low-cost Autonomous Water Control  
in Small-scale Agriculture



This project is part of the PRIMA  
Programme supported by the  
European Union



Intel-IrriS



**PRIMA**  
PARTNERSHIP FOR RESEARCH AND INNOVATION  
IN THE MEDITERRANEAN AREA

# Intelligent Irrigation System for Low-cost Autonomous Water Control in Small-scale Agriculture

*Système intelligent, autonome et à faible coût pour optimiser l'irrigation dans les petites exploitations agricoles*



## The INTEL-IRRIS starter-kit targeting smallholder farmers

Prof. Congduc Pham  
<http://www.univ-pau.fr/~cpham>

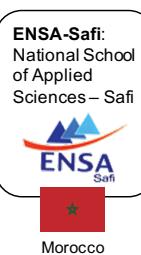


**Intel-IrriS** **RESICOOLINK**  
Advanced and disruptive IoT/AI technologies targeting the smallholder community for increased resilience

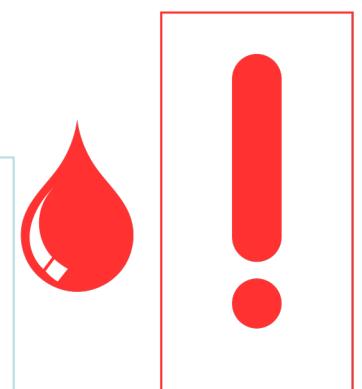
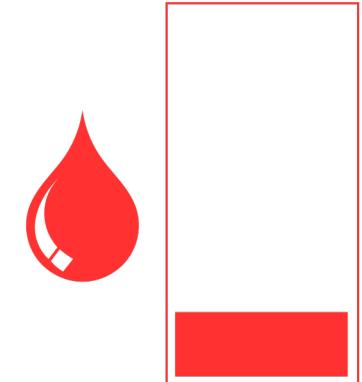
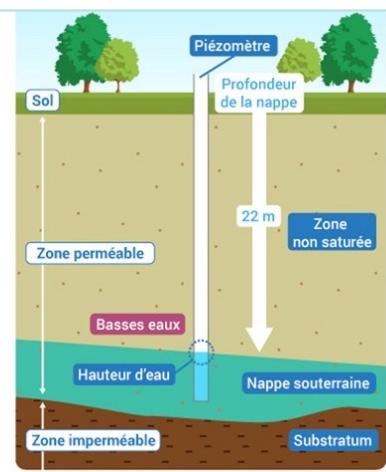
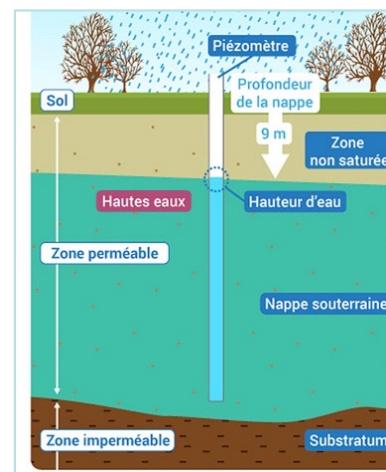
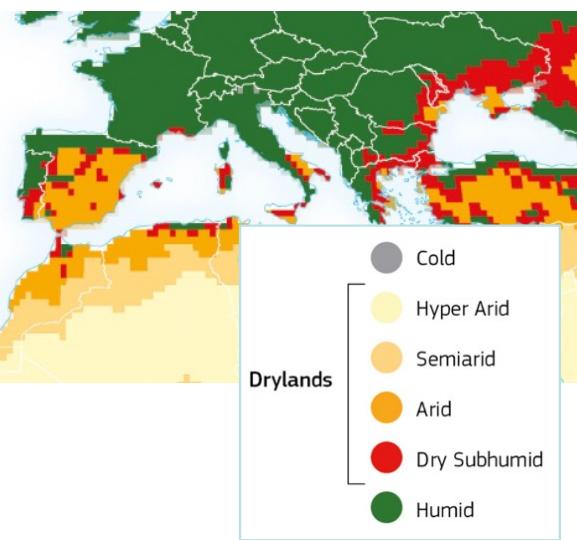
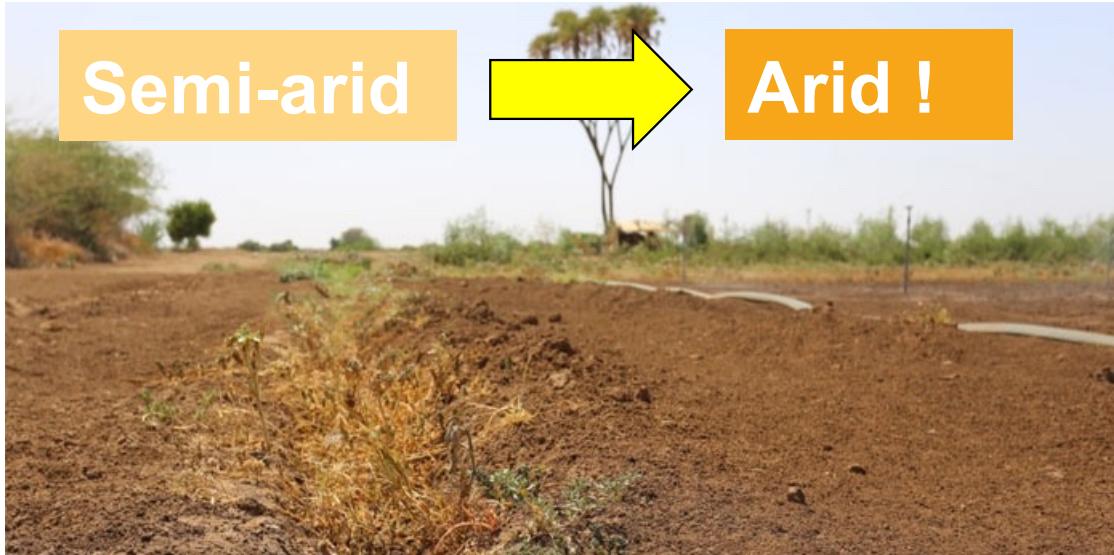
# PRIMA S2 2020 INTEL-IRRIS

- Partnership for Research and Innovation in the Mediterranean Area
- R&I approaches to improve water availability and sustainable agriculture distressed by climate change, urbanisation and population growth
- Appel à projet: Section 2 Multitopic 2020
- Thematic Area 1-Water management
  - Low cost, lean solutions for enhancing irrigation efficiency of small-scale farms

<https://prima-med.org/>



# Water resource is precious!



# Optimizing irrigation in agriculture

- About 70% of water is used for agriculture activities
- **Digital technologies** can help reducing and optimizing usage of water, **but...**



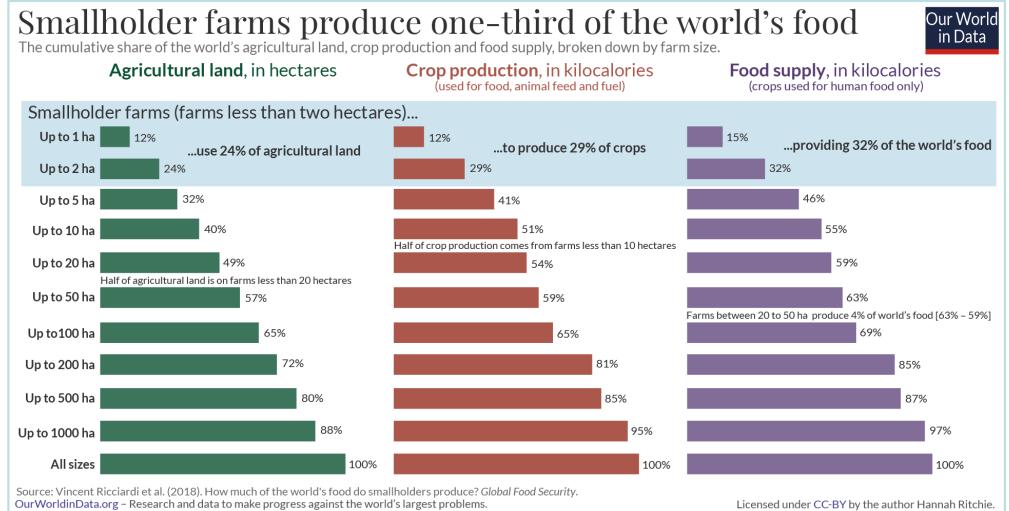
Possible for large farms



Out of reach for  
smallholders!

# Smallholders – up to 2ha

- Most (84%) of the world's 570 million farms are smallholdings
- Provide about 32% of world food supply, on about 24% of agriculture land

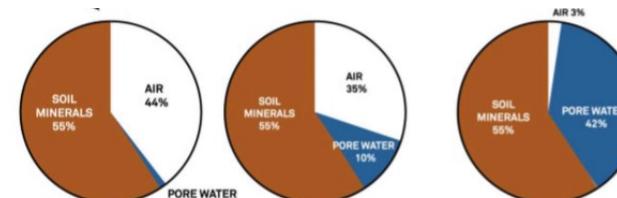
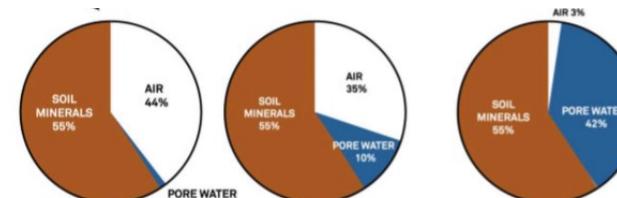
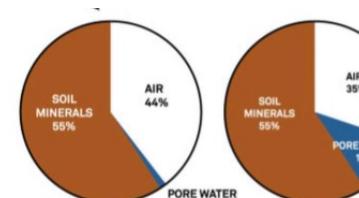
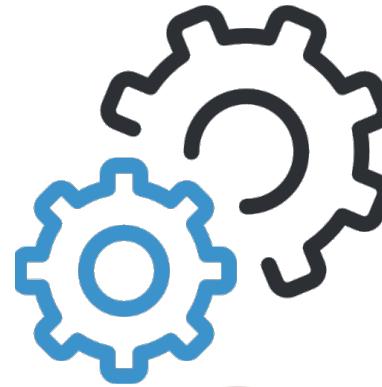
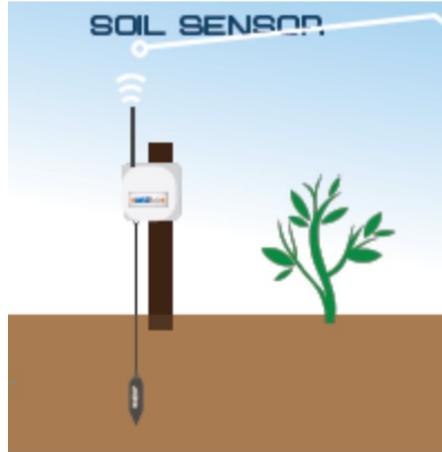


<https://ourworldindata.org/smallholder-food-production>

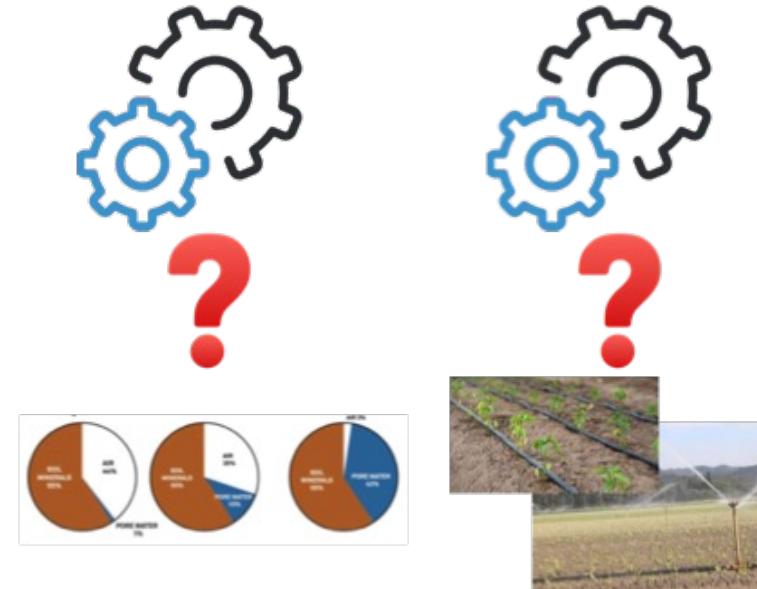


Too expensive  
 Too integrated  
 Highly specialized  
 Difficult to customize  
 Difficult to upgrade

# Irrigation with soil moisture sensing



# Not as simple as it seems 😞



Volumetric Water Content,  
Water Potential, Water  
Tension,....

TDR, FDR, capacitance,  
resistance, ....

Soil characteristics: bulk  
density, soil salinity, soil  
texture & soil type

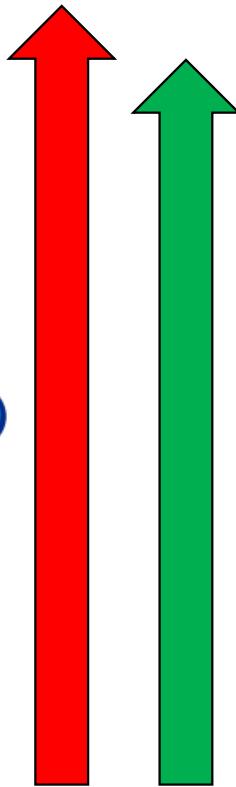
Evapotranspiration, soil-  
plant-atmosphere  
continuum,....

Irrigation type: drip,  
furrow, sprinkler,...

Plant/Crop varieties

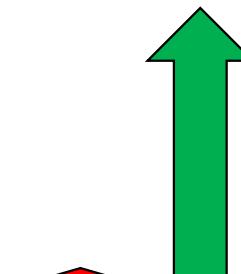
Relationship with other  
agriculture inputs

# It is always a tradeoff...

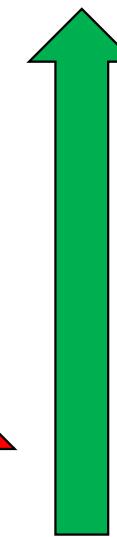
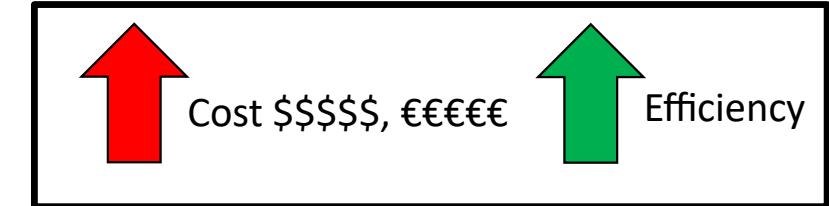


High-end systems,  
dedicated hardware,...

Big companies with high  
expertise, targeting large-  
scale farms



Smallholder  
Farmers



Smallholder  
Farmers



# Not only the cost barrier...



**High acceptability  
of technologies,  
even complex ones**

4

Improve farmer's knowledge on water-related issues, foster local adaptation of technologies, increase local innovation capacity and facilitate technology appropriation

5

Large-scale adoption of low cost smart irrigation system by smallholders, stimulating synergies between various local actors

# INTEL-IRRIS starter-kit

- At the beginning: **an idea...**
- "Intelligent Irrigation in-the-box", "plug-&-sense"

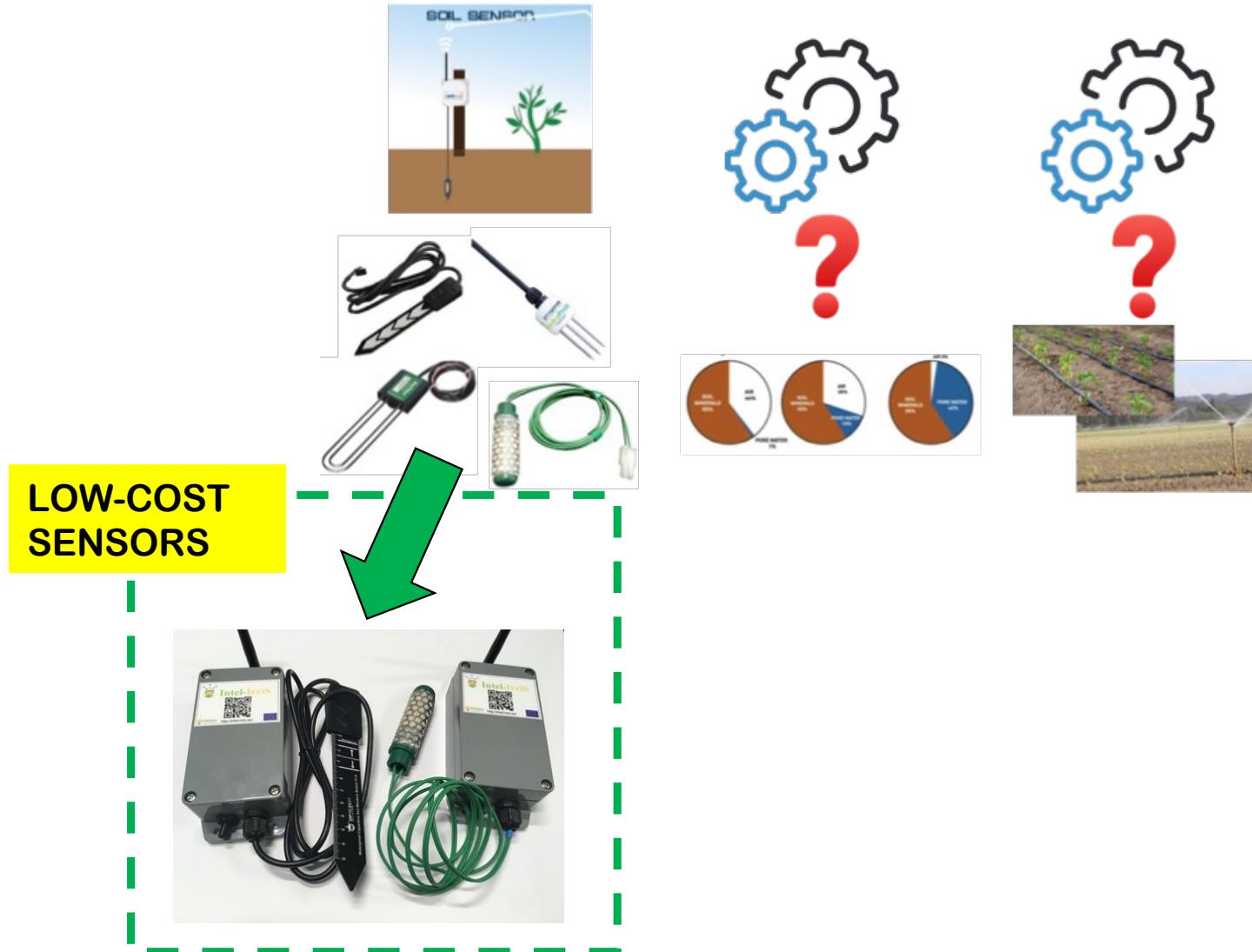


# 2 versions of the soil device

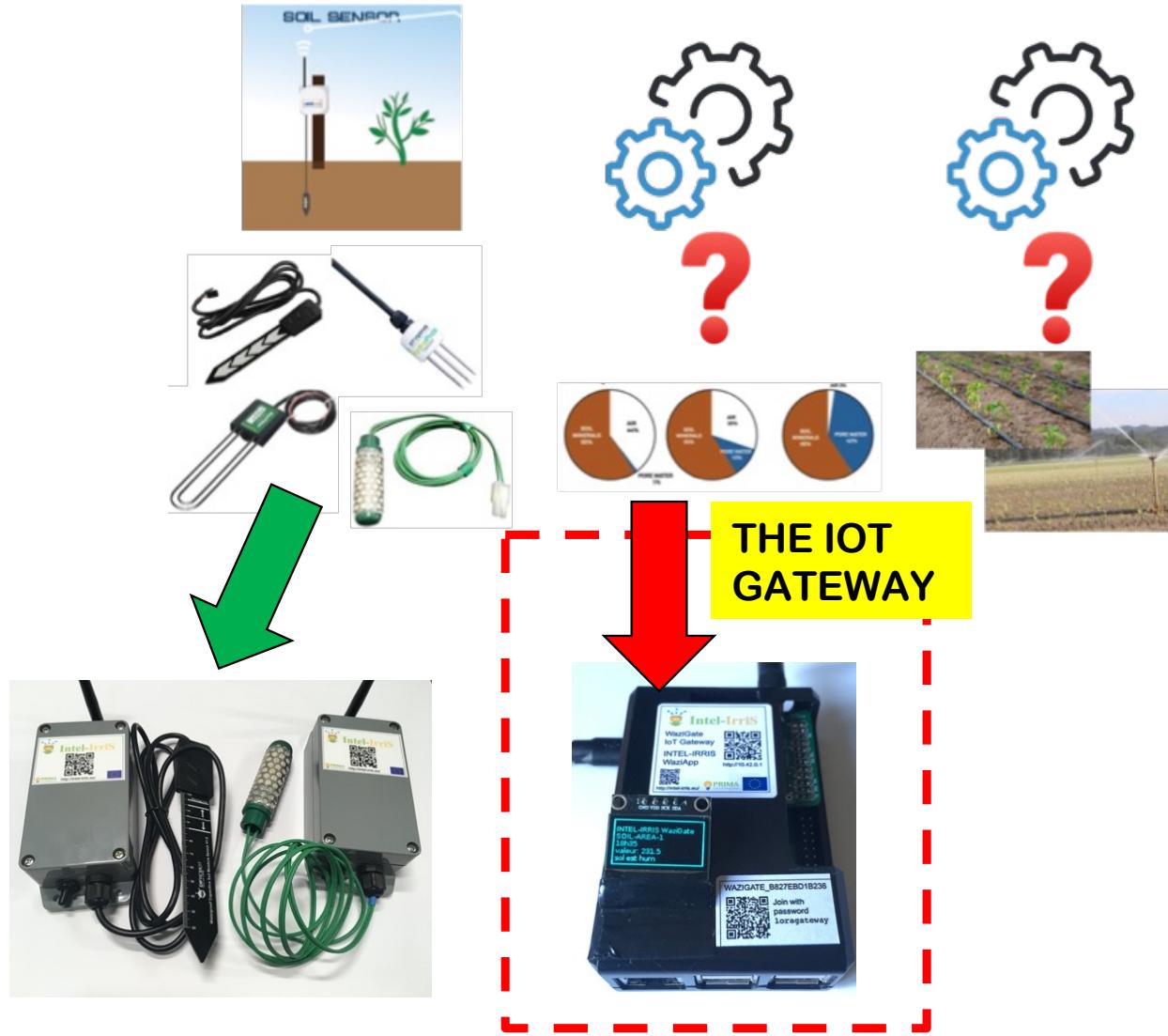


A soil temperature sensor can be added

# INTEL-IRRIS: sensing node part



# INTEL-IRRIS: gateway part



**نظام ري ذكي - النموذج الابتدائي - Intel-Irris**

عرض آخر قيمة تم الحصول عليها وحالة رطوبة التربة

INTEL-IRRIS Wazigate SOIL-AREA-1 0 mins valeur: 915 sol est très sec

SEN0308 capacitive sensor Watermark WM200 Water tension sensor

يتم تسليمها مع بوابة واحدة ومستشعر سعوي أو مقاييس رطوبة التربة

دالة الرطوبة

مرتوفي  
رطب  
رطب  
جاف  
جاف

Testing with capacitive device

INTEL-IRRIS Wazigate SOIL-AREA-1 0m00 valeur: 915 sol est très sec

Testing with tensiometer device

INTEL-IRRIS Wazigate SOIL-AREA-2 0m00 valeur: 34 sol sec-hum

SOL-AREA-1 915 0mins très sec

SOL-AREA-2 34 0mins sec-hum

اختر المزيد من الميزات مع تطبيق INTEL-IRRIS IRRIGATION WAZIGATE! الذي تم تثبيته على!

https://www.irrometer.com/basics.html#using

نطاق الري المعناد

-1 :		255 :	
بدون جهاز استشعار		بدون جهاز استشعار	
0 - 83	مرتوفي	0 - 10	مرتوفي
84 - 166	رطب	11 - 30	رطب
167 - 249	رطب	31 - 60	جاف
250 - 333	جاف	61 - 100	جاف
334 - 416	> 416	> 100	!

النموذج الابتدائي لا يزال في مرحلة التطوير والاختبار، والتعدل بالقيم المبنية هي إرشادية لمرحلة الاختبار.

لوحة العيادة التي تعرض بيانات المصنع الأصلية لأجهزة الاستشعار

ID b827eb6d21eb1c

http://10.42.0.1

PRIMA

SOIL-AREA-1 ID 639c34b368f3190904...

Soil Humidity Sensor Raw value from SEN0308 3 hours ago

Battery voltage volt, low battery when lower than 2.85V 3 hours ago

SOIL-AREA-2 ID 639c34b468f3190904...

Soil Humidity Sensor centbars from WM200 3 hours ago

Soil Humidity Sensor scaled value from WM200 realx10 3 hours ago

Soil Temperature Sensor degree Celsius 3 hours ago

Battery voltage volt, low battery when lower than 2.85V 3 hours ago

عرض آخر قيمة مستلمة وحالة رطوبة التربة

Testing with capacitive device

INTEL-IRRIS Wazigate SOIL-AREA-1 0m00 valeur: 915 pas de capteur!

Testing with tensiometer device

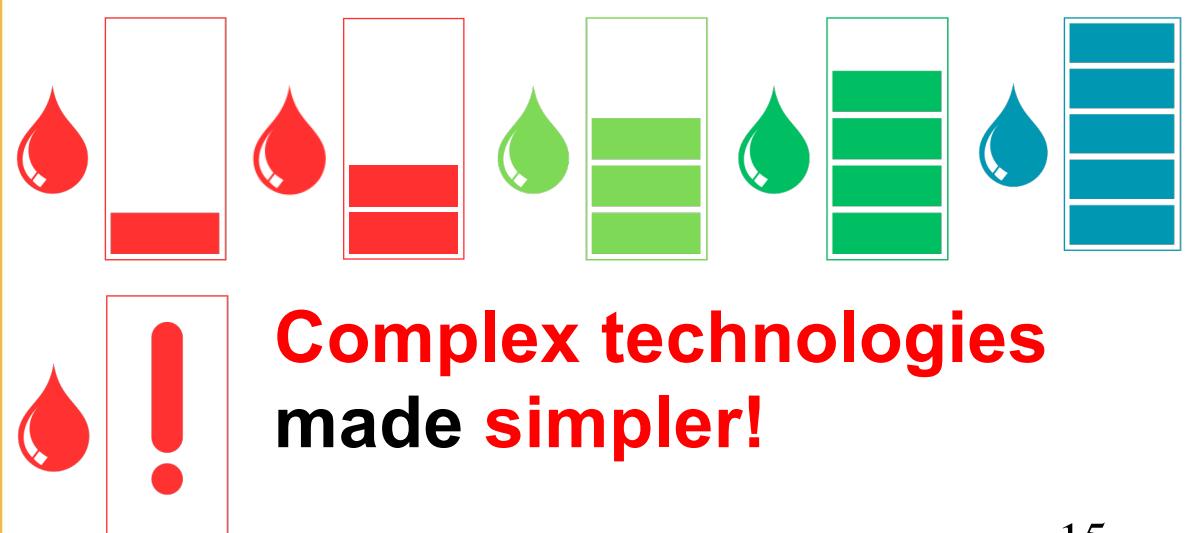
INTEL-IRRIS Wazigate SOIL-AREA-2 0m00 valeur: 34 pas de capteur!

SOL-AREA-1 915 0mins très sec

SOL-AREA-2 34 0mins sec-hum

اختر المزيد من الميزات مع تطبيق INTEL-IRRIS IRRIGATION WAZIGATE! الذي تم تثبيته على!

10.42.0.1:5000

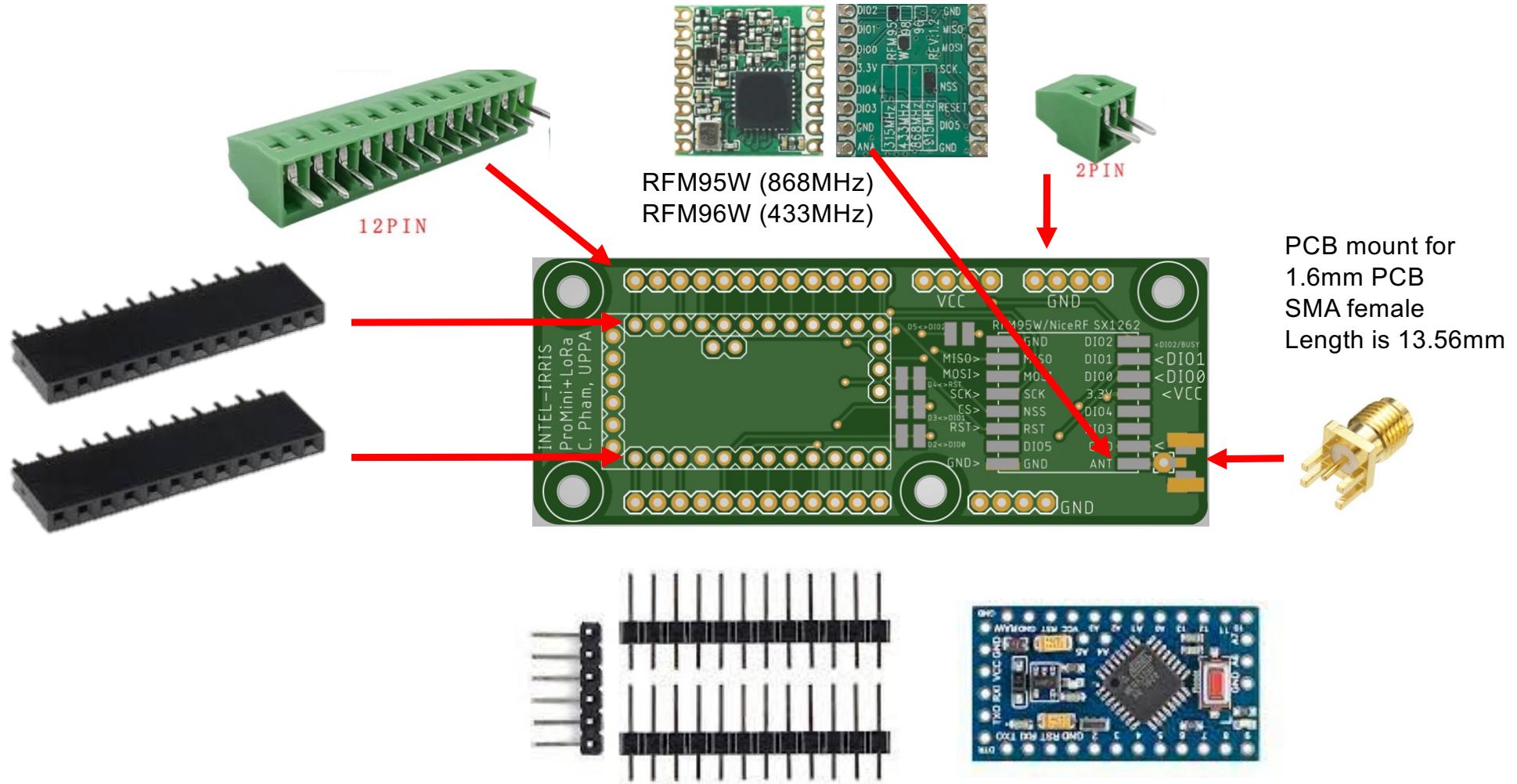


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## LOW-COST?

# Soil sensor: simple electronic parts

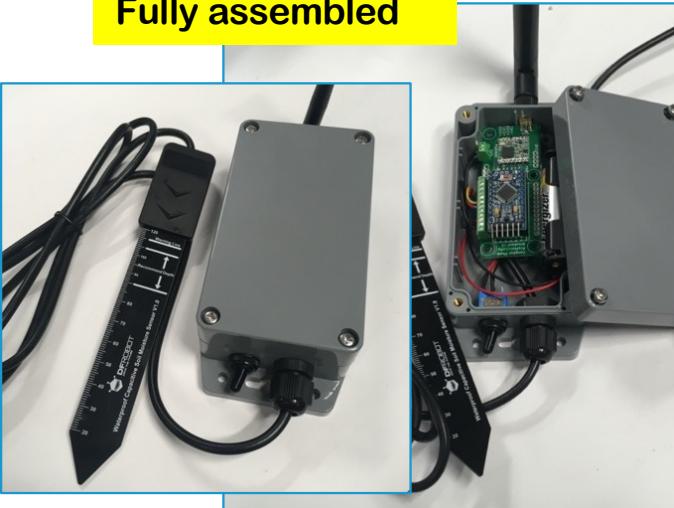


# Soil sensor: easy integration



# Starter-kit...in kit!

Fully assembled



Packaging in enclosure



To be assembled

# A generic platform

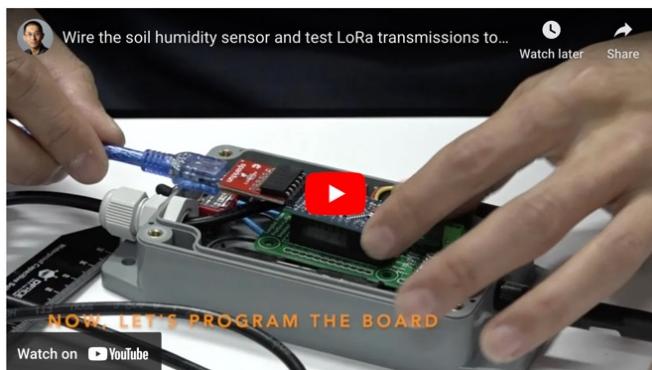
- Low-cost: < 20€
- Off-the-shelves composants
- Easily duplicated
- Assembling by local partners
- Can connect several sensors
- Can be further adapted by local partners



# Available tutorials

- Instructional videos provide technical information for local partners to build locally the soil sensor devices

<https://intel-irris.eu/tutorials-slides>



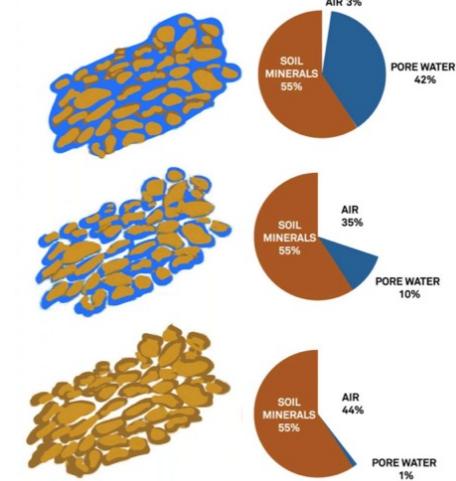
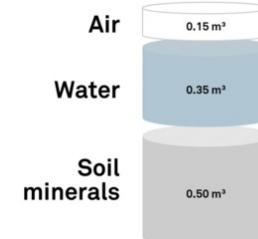
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# ACCURACY?

# Capacitive sensor

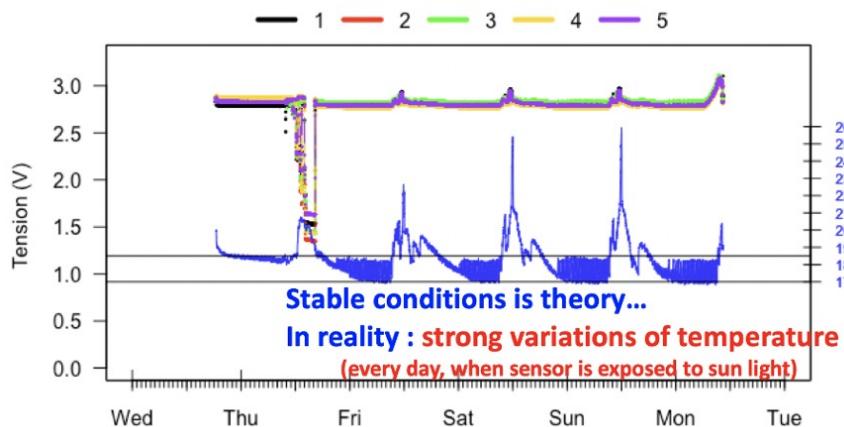
- Capacitive soil moisture sensors usually measure volumetric water content
- Soil density & soil texture are important parameters



From METER group



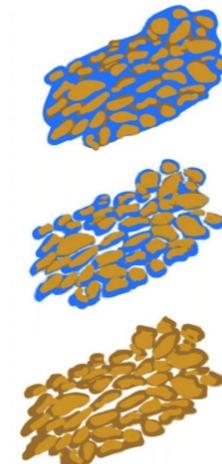
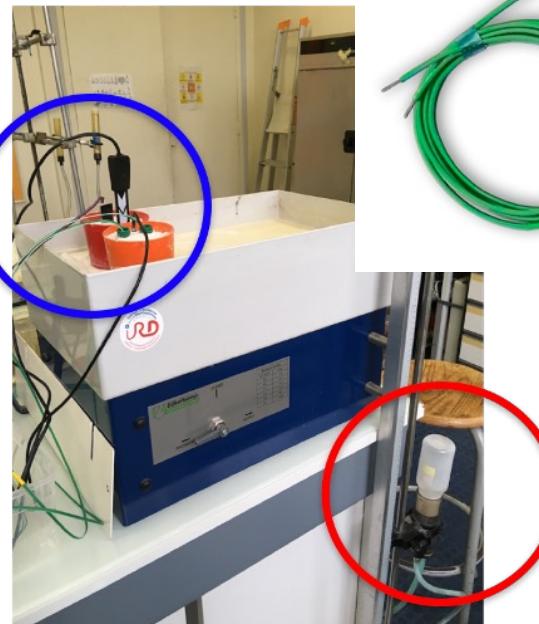
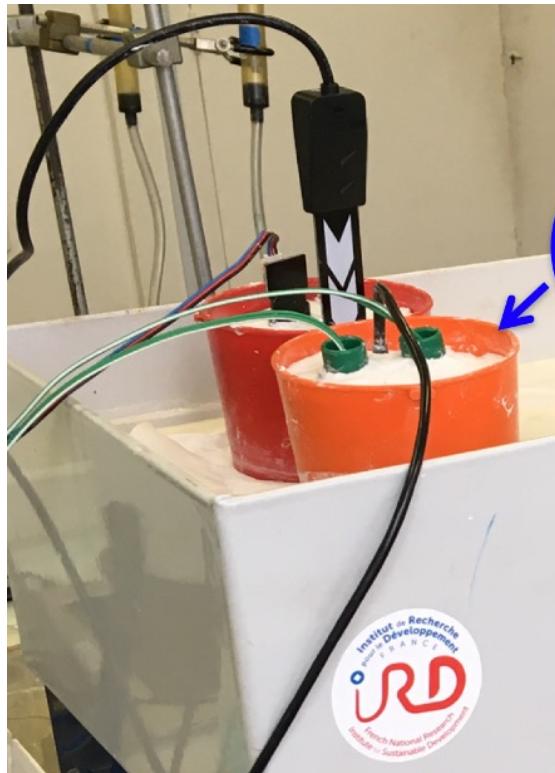
5 sensors are placed in a sand tank at constant water content



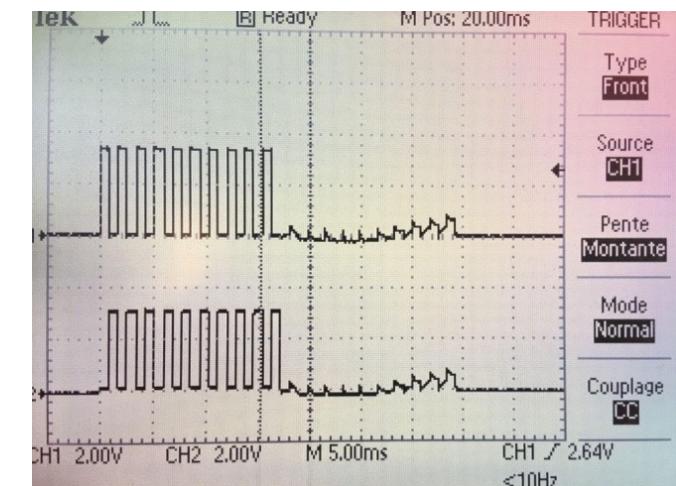
IRD in conducting extentise test on the accucary and the stability of the low-cost SEN0308 capacitive sensor    23

# Water tension sensor

- Water tension sensor measures the amount of force required to extract water from soil's pores



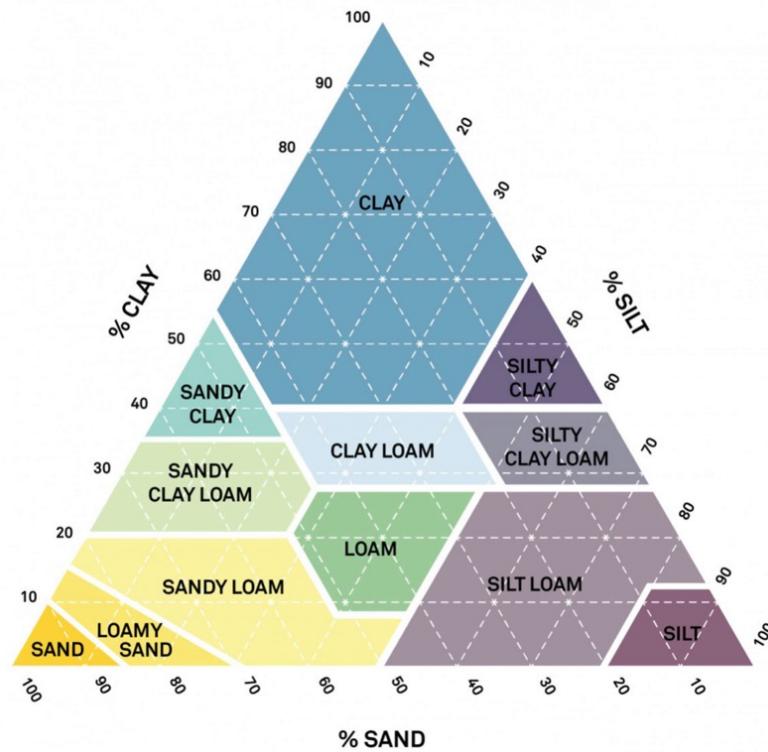
From METER group



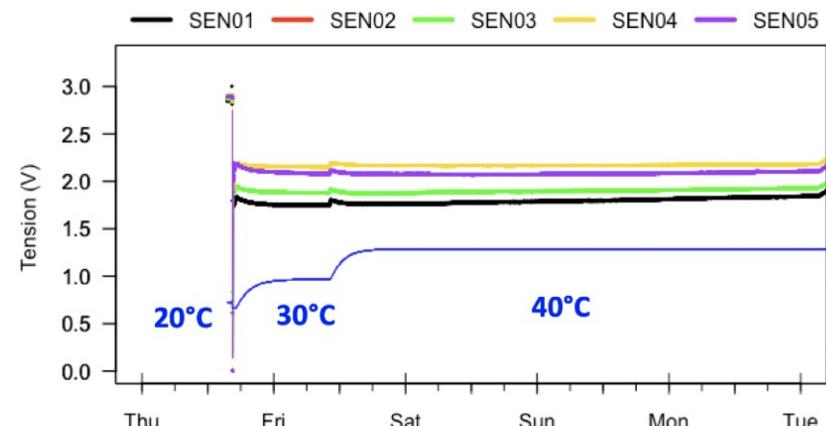
IRD in conducting extensive tests on the stability & suitability of microcontroller-based usage of the Watermark water tension sensor

# Calibration

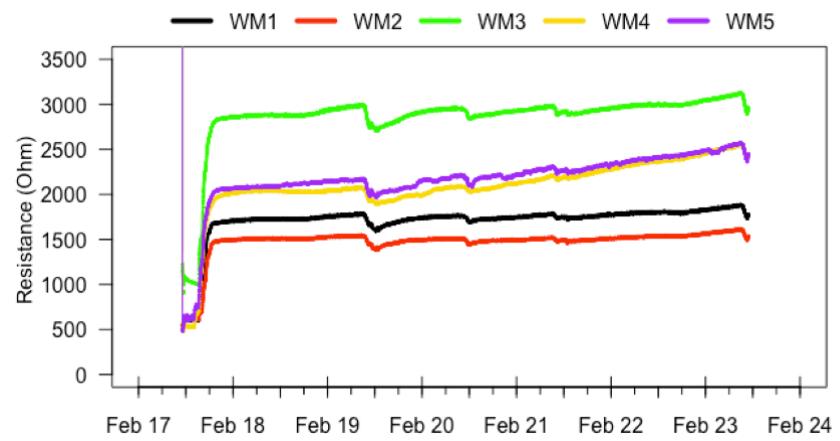
- Soil-specific calibration
- Impact of external "noise"



**SEN 0308**



Ambient air temperature has low impact, except...



# INTEL-IRRIS

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# AUTONOMOUS?

# Gateway: collect sensor data

**WAZIGATE GATEWAY**

**FULL EDGE-COMPUTING  
(NO INTERNET)**

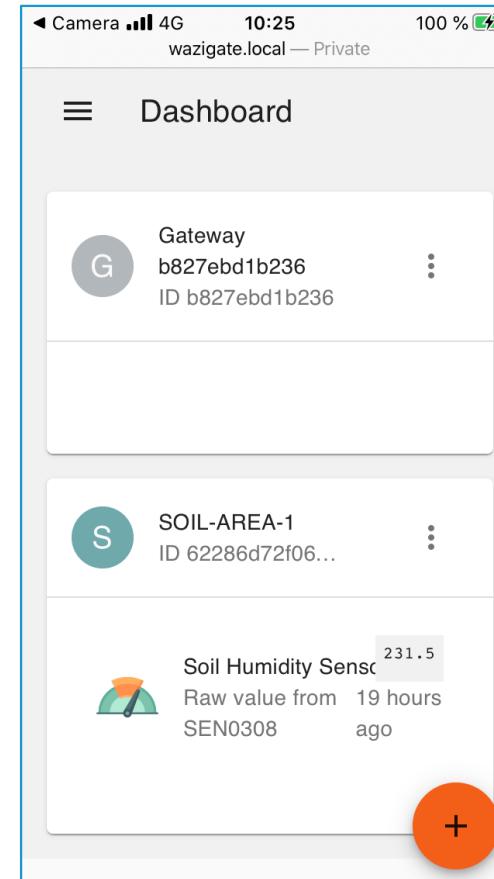
**ALL DATA PROCESSING  
CAN BE DONE LOCALLY**



**1 GATEWAY HANDLES  
SEVERAL DEVICES**

**< 50€**

**EMBEDDED WEB INTERFACE**



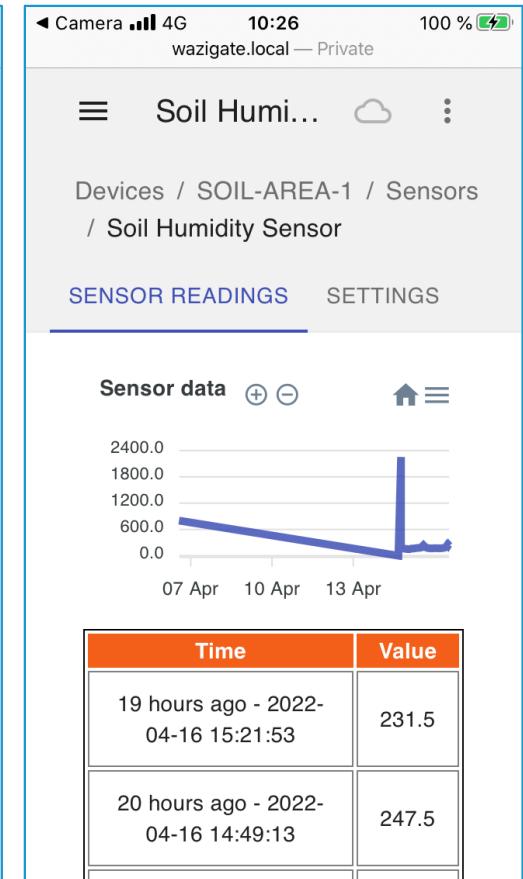
Camera 4G 10:25 100 % wazigate.local — Private

Dashboard

G Gateway b827ebd1b236 ID b827ebd1b236

S SOIL-AREA-1 ID 62286d72f06...

Soil Humidity Sensor 231.5 Raw value from 19 hours SEN0308 ago



Camera 4G 10:26 100 % wazigate.local — Private

Soil Humi... Devices / SOIL-AREA-1 / Sensors / Soil Humidity Sensor

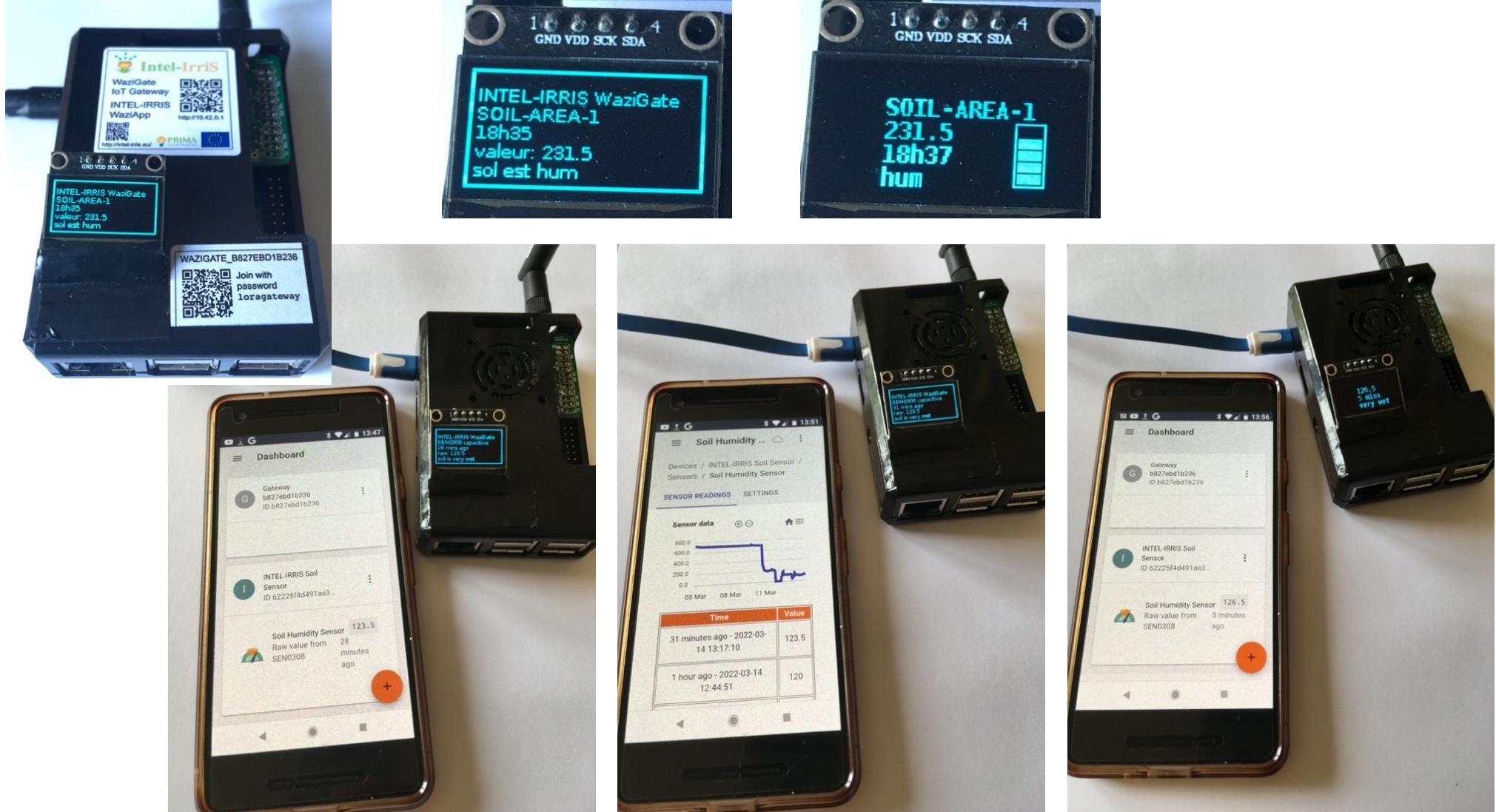
SENSOR READINGS SETTINGS

Sensor data

Time	Value
19 hours ago - 2022-04-16 15:21:53	231.5
20 hours ago - 2022-04-16 14:49:13	247.5

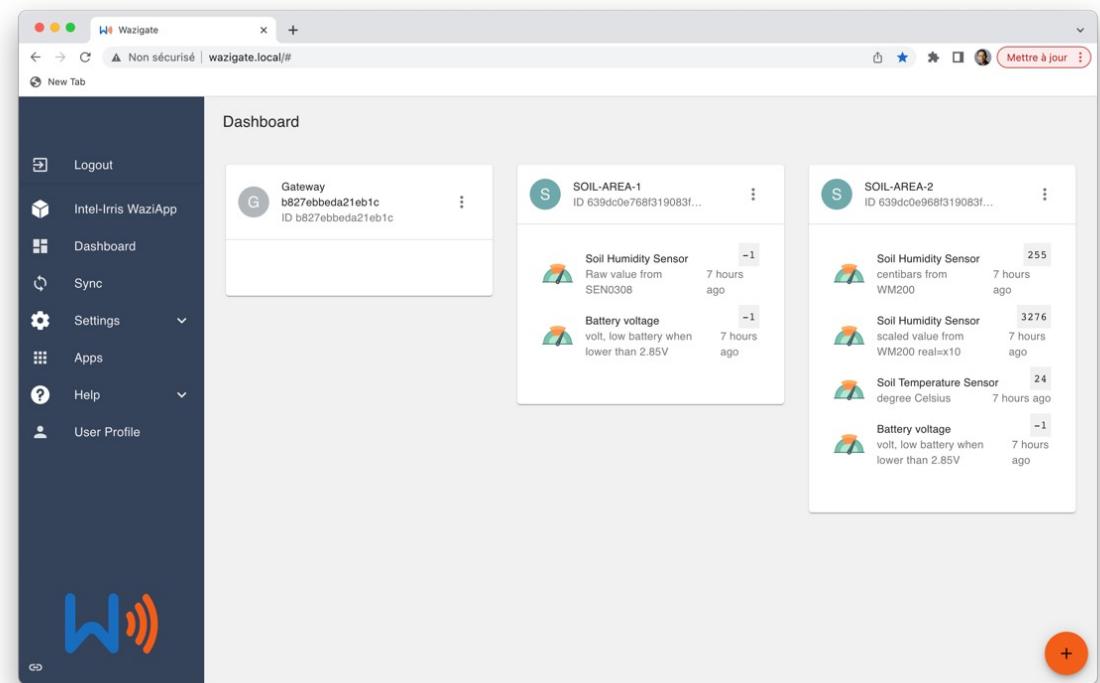
**ACCESSED FROM A SMARTPHONE**

# Multiple user interfaces



# Default gateway configuration

- ➊ For the starter-kit, the INTEL-IRRIS gateway will be ready for
  - ➊ 1 capacitive sensor named SOIL-AREA-1 with address 26011DAA
  - ➋ 1 tensiometer sensor named SOIL-AREA-2 with address 26011DB1
- ➋ Capacitive device will show humidity and battery values
- ➌ Tensiometer device will show centibar, raw resistance, soil temperature and battery values



# INTEL-IRRIS starter-kit

- "Intelligent Irrigation in-the-box", "plug-&-sense"
- From idea to reality!

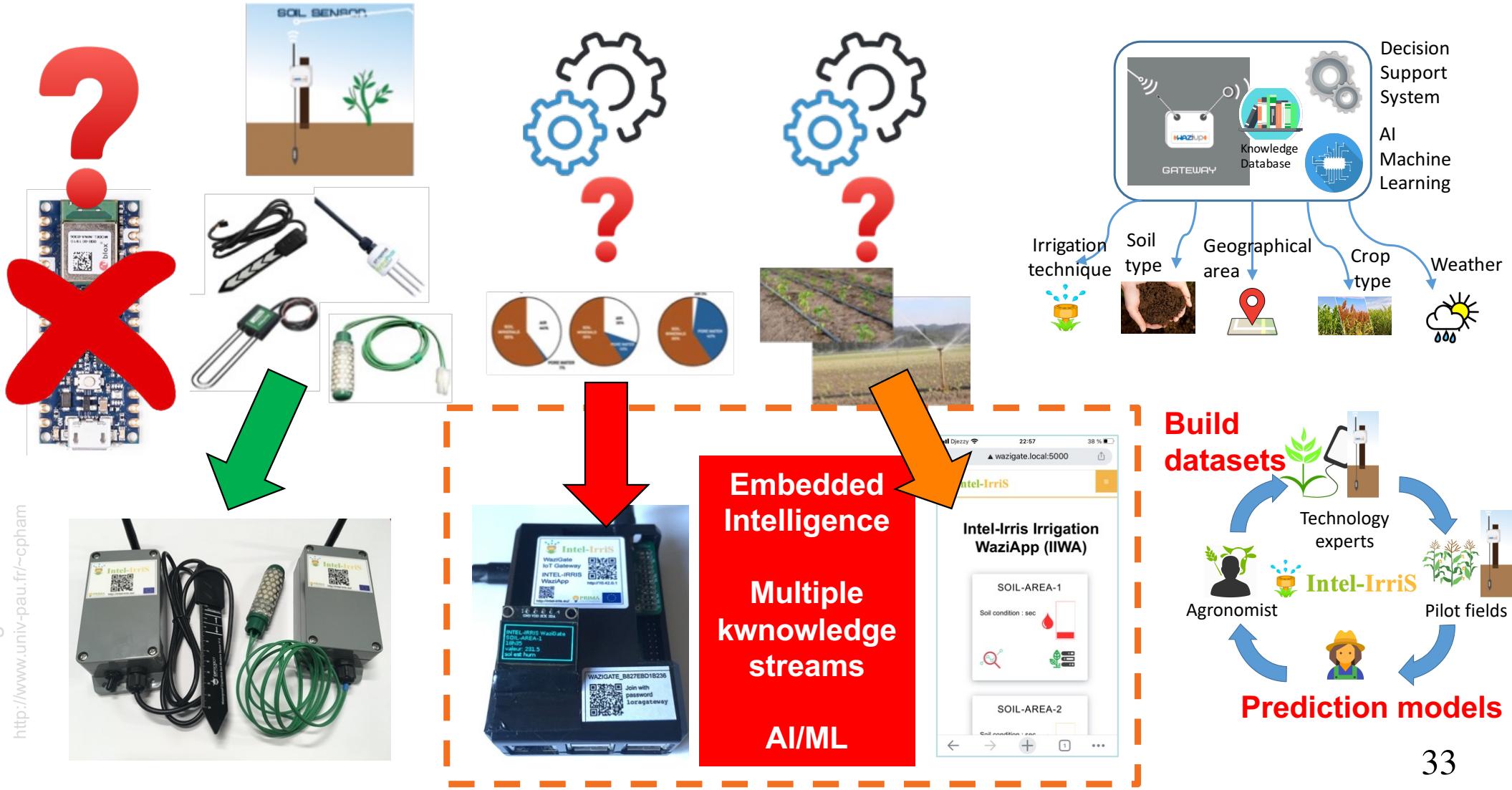


# INTEL-IRRIS

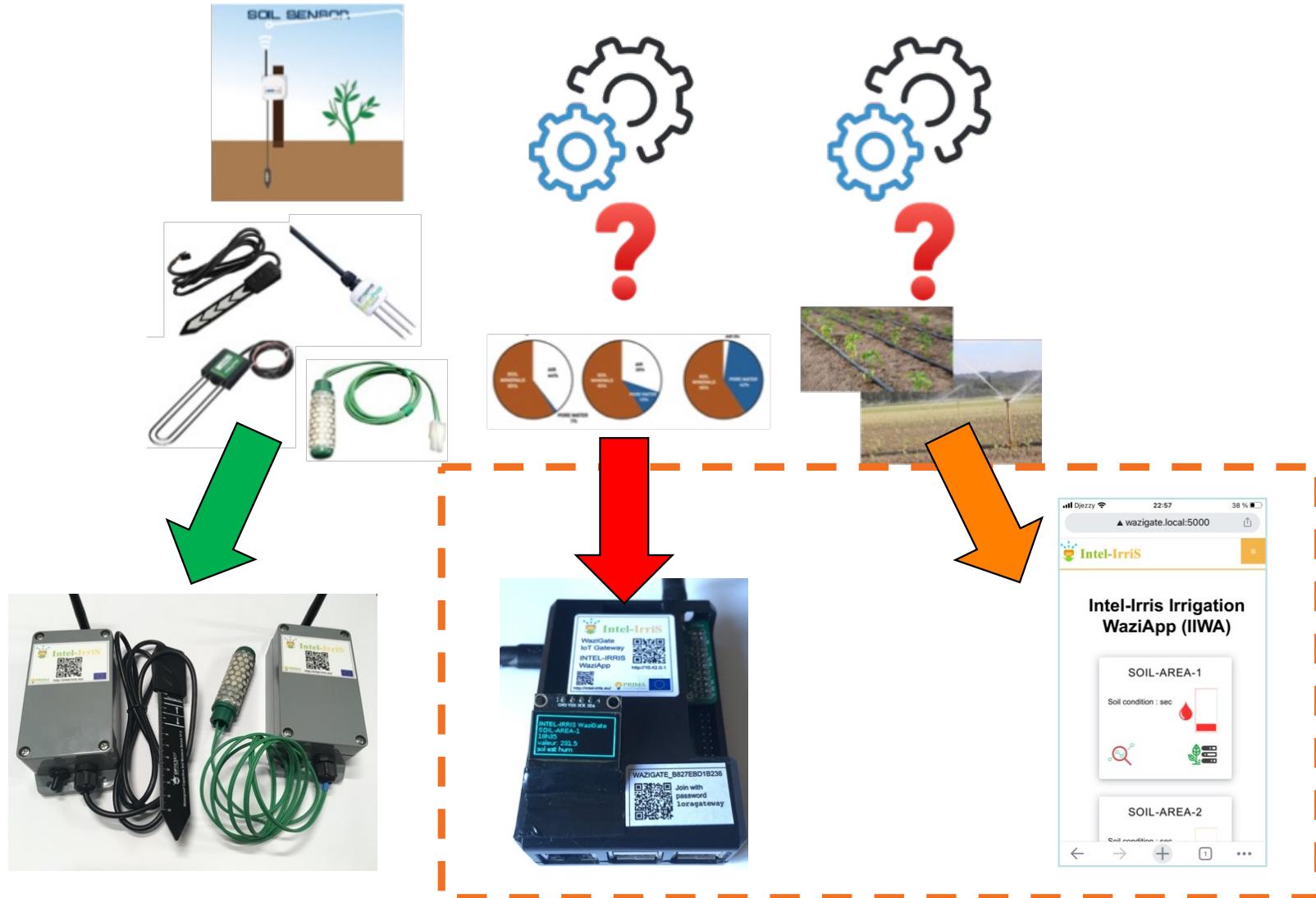
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## SMARTER?

# Embedding intelligence

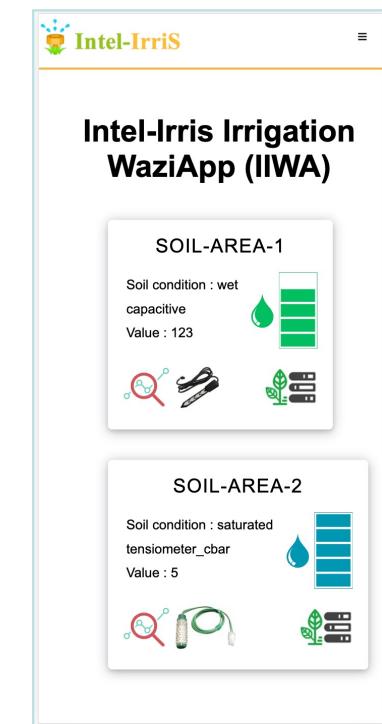


# INTEL-IRRIS Irrigation WaziApp



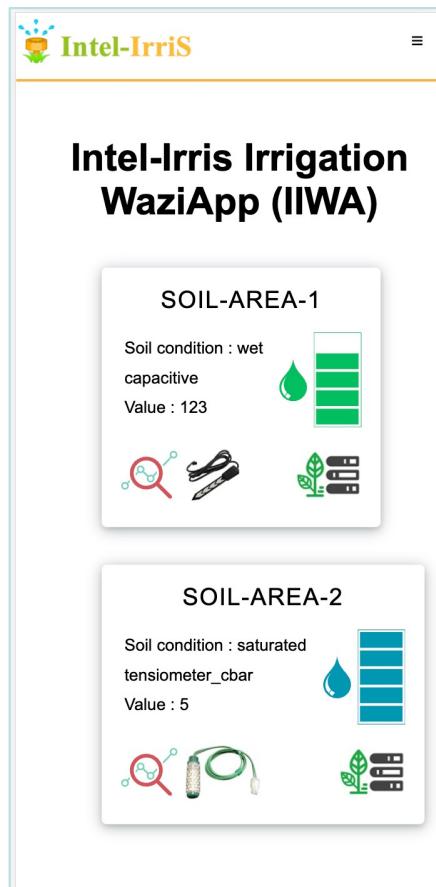
# INTEL-IRRIS Irrigation WaziApp

- Embedded application running on the INTEL-IRRIS gateway
- Included in the starter-kit to implement the "**intelligent Irrigation in-the-box**" & "**plug-&-sense**" approach
- Enhances the irrigation indication by applying sensor calibration models with soil/plant/weather parameters

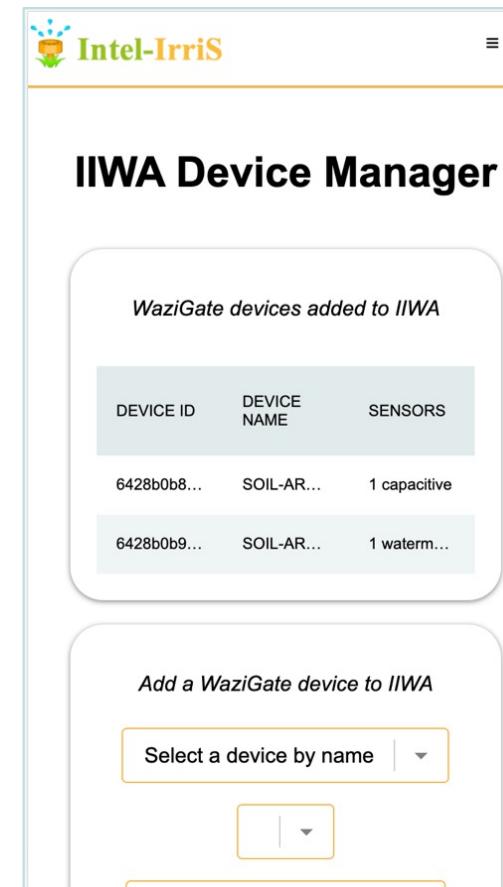


# IIWA main screens

- Dashboard, Device Manager and Sensor Configuration



Dashboard



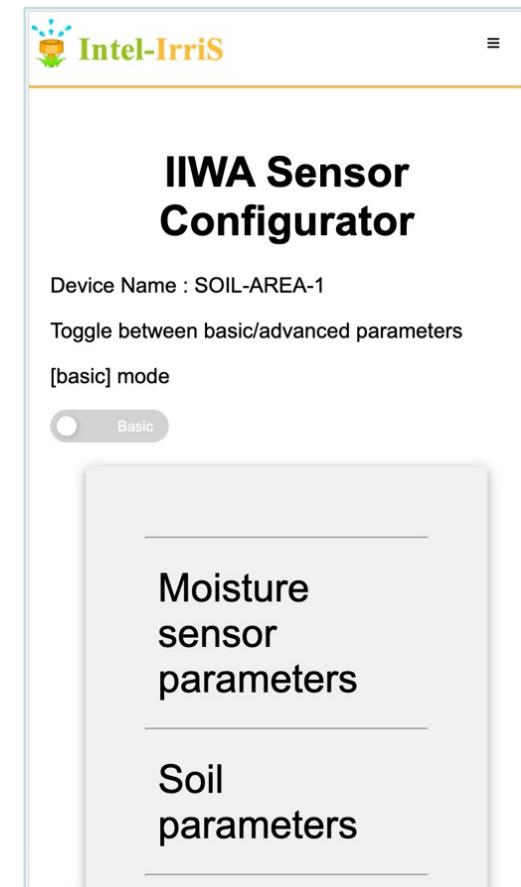
WaziGate devices added to IIWA

DEVICE ID	DEVICE NAME	SENSORS
6428b0b8...	SOIL-AR...	1 capacitive
6428b0b9...	SOIL-AR...	1 waterm...

Add a WaziGate device to IIWA

Select a device by name

Device Manager



Device Name : SOIL-AREA-1

Toggle between basic/advanced parameters

[basic] mode

Basic

Moisture sensor parameters

Soil parameters

Sensor Configuration

# List of advanced parameters

Basic

## Moisture sensor parameters

### Sensor Type

- Capacitive
- Tensiometer (cbar)
- Tensiometer (raw)

## Soil parameters

## Plant parameters

## Moisture sensor parameters

## Soil parameters

### Soil Type

Silty

### Soil Irrigation Type

- Submerison
- Furrow
- Sprinkler
- Drip
- Subirrigation

## Moisture sensor parameters

## Plant parameters

### Plant type

Tomatoes

### Planting Date

01/04/2023

## Moisture sensor parameters

## Weather parameters

### Region

Semi-Arid

Save configuration

Advanced

## Moisture sensor parameters

### Sensor age

0

### Maximum sensor value

800

### Minimum sensor value

0

## Soil parameters

## Moisture sensor parameters

## Soil parameters

### Soil Salinity

empty or -1 for disabled

### Soil Bulk Density

empty or -1 for disabled

### Soil Field Capacity

empty or -1 for disabled

## Moisture sensor parameters

## Plant parameters

### Plant category

Vegetable

### Plant Variety

feiza tomatoes

## Moisture sensor parameters

## Weather parameters

### Weekly evaporation (in mm) value in mm

### Weekly pluviometry (in mm) value in mm

Save configuration

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## PILOTING

# Smallholder Piloting Program

- Participatory approach to co-design & test the innovative solutions in fields
- Take into account region-dependent technical, agricultural, social, climatic and environmental aspects
- Runs for 24 months to ensure that the proposed irrigation systems are well tailored for the specificities of the regional context
- 13 farms already enrolled to participate in the Piloting Program



Bousfer farm, Algeria



UMAB farm #1, Algeria



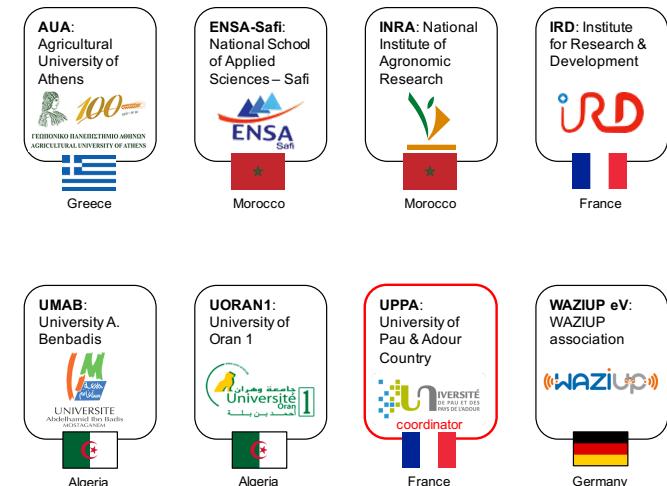
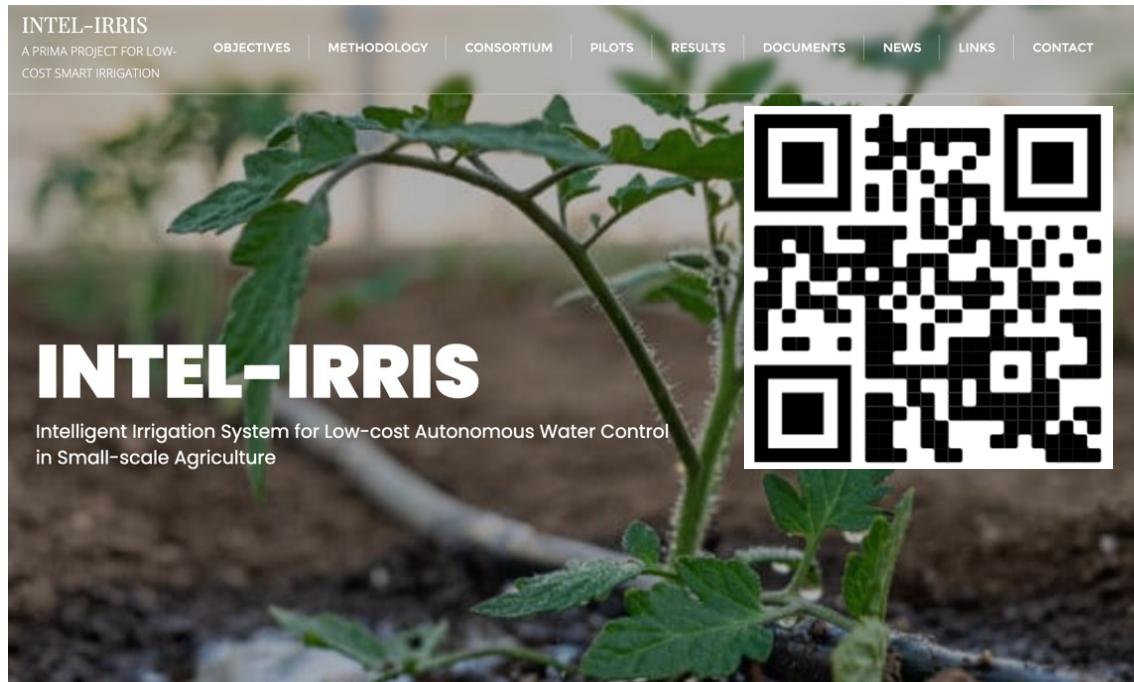
INRA farm #1, Morocco



INRA farm #2, Morocco

# More information

- Web site: <http://intel-irris.eu>



- Twitter: [@Intel\\_Irris](https://twitter.com/Intel_Irris)



**Intel\_Irris**  
 @Intel\_Irris

# Intelligent Irrigation System for Low-cost Autonomous Water Control in Small-scale Agriculture

