SmartWT: an IoT device for the remote monitoring of water levels in rice paddies

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1 - General Context

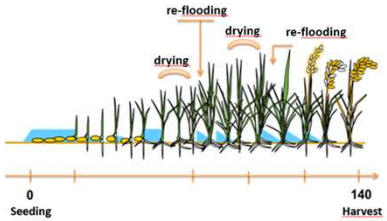
Rice in Italy is cultivated traditionally using flooding methods.

Climate change and competition for water resources are leading to water scarcity.

The EU has introduced stringent limits on gas emissions and heavy metals content in grain.

Alternate Wetting and Drying (AWD)

- water use
- gas emissions
- grain As accumulation



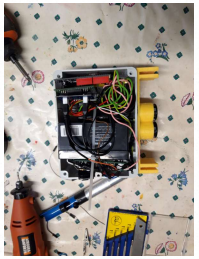
AWD guided by water levels measured in a Water Tube (WT)

2 - Why SmartWT

Manual WT monitoring encounters several problems, among which:

- Difficult access conditions of paddy fields
- Time-consuming operations

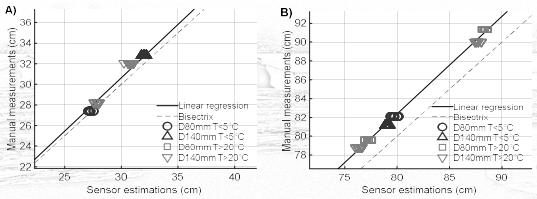
A tool for continuous remote monitoring is needed
→ SmartWT



Advantages

- Online Server ThinkSpeak for real-time visualisation and data storage/export
- Arduino-based, higly customizable for different applications
- Narrow-band IOT GSM connection to send data cheaply and everywhere
- Cost-effective solution: around 200 euros

4 - Accuracy assessment and calibration



Distance (cm)

T (°C)	30	50	80
14	30.5 (0.52)	50.9 (0.86)	81.4 (1.38)
20	30.2 (0.20)	50.3 (0.34)	80.5 (0.54)
30	29.7 (-0.30)	49.5 (-0.50)	79.2 (-0.80)
40	29.2 (-0.78)	48.7 (-1.29)	77.9 (-2.07)

Accuracy of SmartWT was evaluated in different lab experiments against manual measurements, considering: pipe diameters, temperatures, and distance sensor-water surface. Key findings:

Minimum **distance of 25-30 cm** between the sensor and the maximum water level are needed for correct readings.

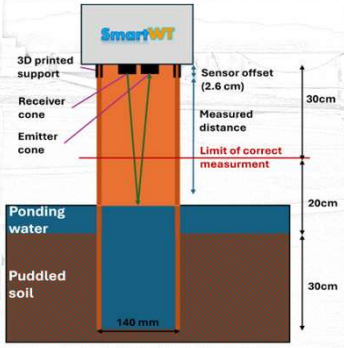
Pipe size (over 100 mm) doesn't affect the device's measurements.

Changes in **air temperature** slightly affect measurements as sound speed varies.

SmartWT and manual readings show a **strong linear relationship**; deviations are corrected using the following calibration formula:

$$\widehat{Hfinal} = 1.028 \cdot H_{Measured}$$

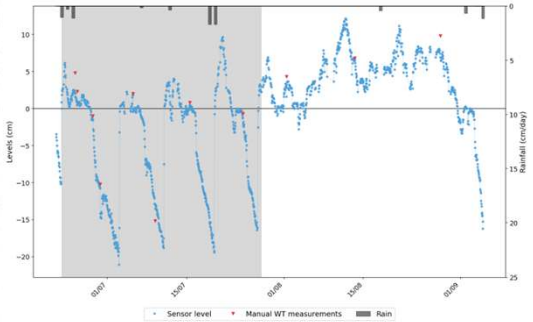
3 - SmartWT: remote monitoring of field water level



- **Based on open-source hardware and software**
- **Waterproof ultrasonic sensor for measuring the distance of the water surface, not in contact with water**
- **GSM module to send data to an online server for easy and real-time monitoring**
- **Efficient battery management ensuring long battery life (2-3 months)**

5 - Field data acquisition

SmartWT was tested in 9 rice fields. It records water levels every 10 min (*customisable*) and transmits data only if level variation in two time steps exceeds a certain threshold (*customisable*) or after a fixed time, enabling real-time monitoring with low energy consumption.



6 - Conclusions

The device's accuracy has been demonstrated to be adequate for monitoring rice fields ponding water level.

The field tests demonstrated that the sensor tolerates the difficult conditions characterising rice paddies.

SmartWT is an accurate, efficient and cost-effective solution for monitoring water levels in rice fields.

Acknowledgements

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