Soil moisture monitoring and irrigation management
iMETOS devices are the perfect solution for the continuous real-time monitoring of many variables that are highly useful in irrigation practices. Devices monitor the soil (its moisture, temperature, salinity, the presence of nutrients and fertility), the plant (dendrometric variations etc.), the atmosphere (all meteorological variables, from which you can also estimate evapotranspiration), and also the plant irrigation (flow, water level, pressure, pH and electrical conductivity of fertilizer etc.).

These measured values can be combined with a high-precision microclimatic weather forecast, which is localized and calibrated on the monitoring site. All the main variables of weather monitoring, such as evapotranspiration or the quantity and probability of rain are provided on an hourly basis for 7 days, along with real time data when you access the service on FieldClimate.com. An essential step after monitoring/measuring is the interpretation of the data. This allows you to implement the best irrigation strategy for your own field. Additional instruments can make your irrigation system much more efficient, for example the modules for water balance calculation that are useful in the analysis of dynamic humidity of the soil (such as the field capacity and the point of irrigation intervention) and other consulting services that help decide exactly when and how much to irrigate, and with it optimize water use for crops.

Last but not least, Pessl Instruments offers various solutions to automate irrigation and fertigation. This irrigation and fertigation is automated on the basis of the variables measured in the field and the whole system can be controlled all the time from your smartphone!

### Fields of application
- Irrigation and fertigation management
- Crops irrigation in open fields
- Soilless crops
- Management of residential green spaces
- Sports lawns and golf course management
- Frost alert and frost automation systems
- Eco-physiological studies
- Forest Applications (forecasting fire risk conditions etc.)
- Flood wave monitoring and flood alert
- Geotechnical monitoring

### Advantages
- **WATER SAVINGS** (reduction and better modulation of irrigation interventions)
- **HIGHER YIELD** (safeguarding the quantity of production and ensuring quality)
- **SAVINGS ON FERTILIZERS** (reduced runoff of nutrients, optimized use of fertilizer)
- **PLANT HEALTH** (reduced impact of phytopathological adversities, ability to stimulate root development and frost protection)
- **SECURITY** (real-time alerting when critical events, such as stress because of water deficit or excess, warning of irrigation system failures and automated troubleshooting, full traceability of transactions)
- **ENERGY SAVING** (consumption of electricity to activate pumps, valves, etc.)
- **SAVE TIME** (automation and rationalization of business operations)
- **LOWER ENVIRONMENTAL IMPACT**
iMETOS® Radio Node is a wireless, battery-powered data logger for measuring soil moisture, temperature, rainfall, water flow, leaf wetness, relative humidity and other parameters. It sends the readings of all the sensors in real time, through an interactive wireless mesh network to the base station; from this, the data is loaded on the web platform via cellular network or via WiFi.

FieldClimate also provides APIs through which specific data, measured by our devices, can be exchanged automatically to support other platforms and work environments.

iMETOS is a robust and versatile data logger. It is easy to install and can be connected to multiple sensors of soil moisture and other physioclimatic variables. iMETOS devices communicate wirelessly through various standards used worldwide and in real-time with the FieldClimate.com platform. Sensor nodes are also available for the construction of communication networks via radio to the base station.

iMETOS® 3.3 is a highly-durable weather station, adaptable to all environmental conditions. It is powered by solar-panel-rechargeable battery and is extremely reliable thanks to an internal non-volatile memory. It can store more than a year of measured data and can receive data from iMETOS Radio Nodes if equipped with the appropriate interface.

iMETOS® ECO D3 is a data-logger powered by solar-panel-rechargeable battery, designed to work in the most difficult conditions and in all climatic zones. It can be equipped with a rain gauge and various sensors, such as water level, temperature, soil moisture, salinity etc. If equipped with appropriate interface, it can receive data from iMETOS Radio Nodes.

iMETOS® Radio Node is a wireless, battery-powered data logger for measuring soil moisture, temperature, rainfall, water flow, leaf wetness, relative humidity and other parameters. It sends the readings of all the sensors in real time, through an interactive wireless mesh network to the base station; from this, the data is loaded on the web platform via cellular network or via WiFi.
Soil moisture sensors

Pessl Instruments offers a wide range of OEM sensors measuring soil moisture, such as profile probes or fork like sensors, which are used to measure volumetric water content (VWC) and tensiometric sensors which are used to measure tension (or suction).

The possibility to choose different technologies and sensors and combine them, allows you to design the best soil moisture monitoring solution based on the characteristics of your soil, crops, irrigation systems, arrangement of the terrain and field management. Specific solutions are available for potted plants and soil-less applications. Some of these sensors can also measure soil temperature or bulk electrical conductivity (EC) or volumetric ion content (VIC), indications particularly useful for fertigation management.

**DRILL & DROP**

**SENTEK**

**10HS (DECAGON)**
- VWC

**5TM (DECAGON)**
- VWC
- Temperature

**GS1 – GS3 (DECAGON)**
- VWC
- Temperature
- EC (0-23 dS/m)

**MPS-2 (DECAGON)**
- Tension
- (0-100 cbar/kPa)
- Temperature

**EC-5 (DECAGON)**
- VWC

**5TE (DECAGON)**
- VWC
- Temperature
- EC (0-23 dS/m)

**TENSIOMETRO (IRROMETER)**
- Tension
- (0-100 cbar/kPa)

**WATERMARK (IRROMETER)**
- Tension
- (0-200 cbar/kPa)

**Other sensors**

**DENDROMETER**

**SOIL TEMPERATURE**

**EC & pH INTERFACE WITH DISPLAY**

**pH**

**EC**

**RAIN GAUGE**

**VOLUMETRIC COUNTER**

**PRESSURE SWITCH**

**WATER LEVEL**

**CTD-10**

For more information about other sensors and data-loggers, please visit www.metos.at where you can download our detailed catalogue.
Data interpretation

All measured data from iMetos is stored and available in real time on the platform Fieldclimate.com and accessible through our free iOS and Android apps.

You can define critical thresholds beyond which you automatically receive SMS alerts and activate the alarm mode in which data communications are intensified for an instant update.

Which information can I obtain from soil moisture data?

<table>
<thead>
<tr>
<th>Soil moisture measurement method</th>
<th>VWC</th>
<th>Tension</th>
</tr>
</thead>
<tbody>
<tr>
<td>How the water moves along the vertical profile of the soil?</td>
<td>🔺</td>
<td>🔺</td>
</tr>
<tr>
<td>Which portion is wet and in what time?</td>
<td>🔺</td>
<td>🔺</td>
</tr>
<tr>
<td>Do water leaks occur for deep percolation?</td>
<td>🔺</td>
<td>🔺</td>
</tr>
<tr>
<td>How does the root system develop?</td>
<td>🔺</td>
<td>🔺</td>
</tr>
<tr>
<td>What is the best modulation of irrigation (when and how much)?</td>
<td>🔺</td>
<td>🔺</td>
</tr>
<tr>
<td>Water availability</td>
<td>🔺</td>
<td>🔺</td>
</tr>
<tr>
<td>How much force must the roots use to extract water from the ground?</td>
<td>🔺</td>
<td>🔺</td>
</tr>
</tbody>
</table>

FieldClimate allows setting values of field capacity and the point of irrigation (refill point). In the graphics below, you can see three differently coloured bands that indicate deficit conditions (red), comfort conditions (green) and excess water conditions (blue).

- **CROP: Blueberry**
- **IRRIGATION SYSTEM: drop**
- **SOIL MOISTURE MEASURING: VWC**
- **PERIOD OF TIME: 9 days**

The crop shown in the graph is initially subject to two irrigation interventions on a daily basis. Thanks to the monitoring of the content of volumetric water, it was observed that the same comfortable moisture level for the plant could be maintained even with only one analogue irrigation intake per day. Result: immediate 50% water saving.

- **CROP: vine (Pinot Noir)**
- **IRRIGATION SYSTEM: drop**
- **SOIL MOISTURE MEASUREMENT: VWC + tension**
- **PERIOD OF TIME: 60 days**

The vineyard of fully grown vines runs under conditions of controlled water deficit. The graph above shows the data of volumetric water content (VWC) at two different depths (light and dark blue) and tensiometric soil moisture measurements (red). The first part of the graph shows a typical drying process with day-night steps due to the plant water uptake, the increased suction indicates the onset of potential stress conditions. This dry phase is attenuated by a rain sequence with different progressive effects of wetting at the different depths. After the second drying process, we can see the effect of an irrigation event, wetting directly the deeper layer. After about 16 hours following the rainfall. The amount of rain and reference to evapotranspiration $ET_0$ are shown in the graph at the bottom.
The potential evapotranspiration $ET_0$ is calculated according to Penman - Monteith (FAO - 56 method). The calculation requires measurements of temperature, humidity, solar radiation and wind speed.

IRRIMET is an application that provides a simple water balance. The model permits the calculation of crop evapotranspiration $ET_C$, applying to the $ET_0$ the FAO crop coefficients $kc$ or other personalized coefficients for different phenological stages. The water balance is calculated in function of $ET_C$, rain and rain efficiency, type and efficiency of irrigation system and irrigation events. The application requires a station with sensors for $ET_0$ calculation and a rain gauge.

**DSS (decision support systems) for irrigation management**

In addition to direct measurement of soil moisture, there are other parameters and tools used for better understanding of when and how much to irrigate, such as the weather and the phonological stage of the crop concerned. FieldClimate provides the calculation of potential evapotranspiration ($ET_0$) and a module for the calculation of the water balance called IRRIMET:

- The potential evapotranspiration $ET_0$ is calculated according to Penman - Monteith (FAO - 56 method). The calculation requires measurements of temperature, humidity, solar radiation and wind speed.
- IRRIMET is an application that provides a simple water balance. The model permits the calculation of crop evapotranspiration $ET_C$, applying to the $ET_0$ the FAO crop coefficients $kc$ or other personalized coefficients for different phenological stages. The water balance is calculated in function of $ET_C$, rain and rain efficiency, type and efficiency of irrigation system and irrigation events. The application requires a station with sensors for $ET_0$ calculation and a rain gauge.

Example of a graphical display of IRRIMET water balance for an apple field. The water balance is shown in red, while blue indicates the trend of the crop coefficient $kc$. The graph below shows rainfall data (blue), of $ET_0$ (yellow) and intervention irrigation (green).

**MyIrrigation and the Aquagri services**

MyIrrigation is a web based software developed by our partner Aquagri, which allows a very user-friendly interpretation of soil moisture data, with the possibility to insert crop and soil settings and helping to decide when and how much to irrigate.

MYIRRIGATION also provides a very detailed water balance data and is the perfect tool to combine with other special Aquagri irrigation and fertigation services.

**Different Aquagri consulting services also include:**

- Defining the values of field capacity, wilting point and the point of irrigation intervention (refill point) to locate the irrigation management groups;
- Setting up the optimum irrigation strategy (when and how much to irrigate) with periodic monitoring of data by specialists and virtual or remote meetings or on-site visits.
In over thirty years of experience in agro-meteorological monitoring at the side of farmers, there have often been requests to create automation solutions for control of devices of irrigation systems, as well as the greenhouse temperature control on the basis of the measured data.

Today, we can offer an integrated solution – a system, which is communicating either via the cellular network or via radio, and can be managed automatically or manually, through an app for smartphone or tablet. The system allows a multilevel programming to meet the real needs of plants, such as the setting of fixed irrigation shifts according to personal criteria and the modulation of smart irrigation/fertigation cycles, according to the data of soil moisture and other meteorological parameters.

The two-way communication of our devices enables you to receive SMS alerts in case of risky situations for your crop or other emergency situations (excessive water or water deficits etc.) and to remotely solve the problems detected by the same devices.

**iMETOS ICA**

iMETOS® ICA 30/60 is a web-based controller that uses GSM/GPRS technology to remotely manage three (ICA30) or six (ICA60) solenoid valves. Both systems include the interface for Pessl Instruments chains that allow the connection of all sensors supported by this technology (different types of soil moisture sensors, temperature, water level, dendrometers, volumetric flow meters, pressure switches etc.). The ICA has one main switch, which connects it to the main controller for timed irrigation cycles (Progres, Toro, Rainbird, Netafim etc.).

**iMETOS WAN**

iMETOS® WAN (WIRELESS ACTIVATOR NODE) is supplied in an IP67 box with lithium battery that provides about 7 years of data logging. The iMETOS WAN user interface allows you to activate time-programmable controller and any other unit of which you can switch from off to on.

**CROP**: corn  
**IRRIGATION SYSTEM**: sprinkler  
**SOIL MOISTURE MEASUREMENT**: VWC + tension  
**PERIOD OF TIME**: 48 days  

iMETOS ICA is connected to a controller that operates nine irrigated areas, with set conventional irrigation cycles with 11 mm daily irrigation, when soil tension drops to less than 25 kPa.

The green graph shows the irrigation interventions (daily opening of a controller for 110 minutes) and you can see that more than half of the interventions, provided by the timed cycle, have been avoided, saving more than 50% of water, compared to conventional irrigation management.