APPLICATION NOTE - AGRICULTURAL

SOIL MOISTURE MONITORING

APPLICATION BACKGROUND

Soil Moisture Monitoring is used in agricultural water management applications such as irrigated fields, and in the turf industry for large grassed areas such as sports playing fields and market gardens to optimise the use of reticulation / irrigation system water usage. There is also a very large installed base in the viticulture industry.

These systems may employ a range of different soil moisture sensors. The simple approach is to measure soil moisture directly and then decide on the best settings for a reticulation / irrigation system.

A more complex and more detailed approach is to measure Evapotranspiration (ET). ET is the most significant indicator to measure water movement for agriculture. ET refers to two processes: water loss from surfaces such as soil (evaporation) and water loss from the leaves of crops (transpiration).

The weather affects ET like solar radiation, air temperature, air humidity and wind speed. But ET also depends on the nature of the crop, how it changes with time and soil moisture levels.

Evaporation and transpiration occur simultaneously and dependently, so are treated as one process. When a crop is first planted, the soil is exposed to the sun and most of the water loss initially is through evaporation. But as the crop grows and starts to shade the soil, evaporation decreases and transpiration increases.

APPLICATION DETAIL

For the simple approach single soil moisture sensors can be an older style of gypsum block, measuring resistance across that block or a modern sensor using Time Domain Reflectometery (TDR) techniques to send out a pulse and measure the return echo to determine the water / moisture content of the soil.

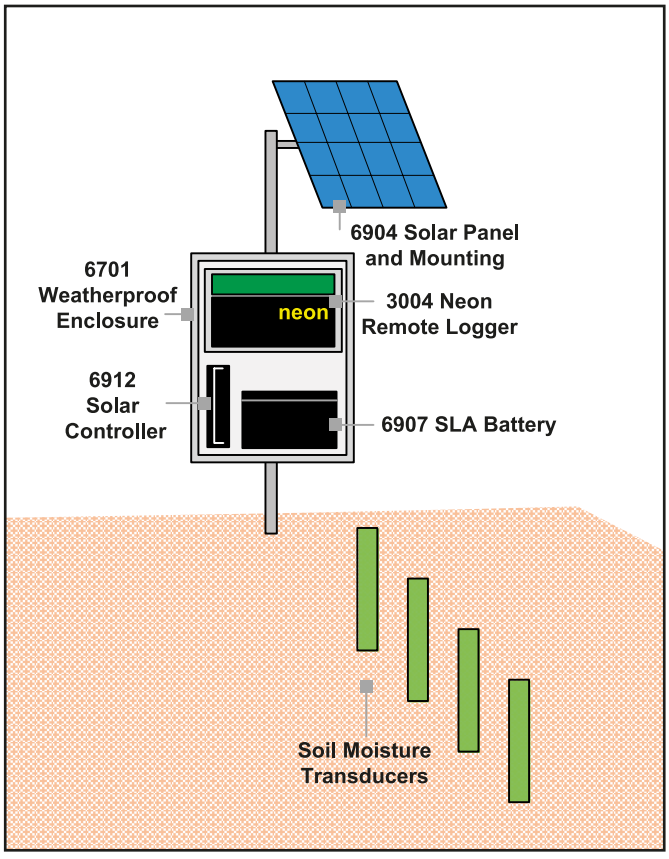
The soil moisture sensor is connected to a Neon Remote Logger and a scheme / program is set up to measure, store, and optionally display soil measurement data locally, or routinely send that data via the internet to a Neon Server, so it can be viewed on a standard web browser.

The Neon Remote Logger can also be programmed to react to certain events. For example, if it has rained and the soil is very moist, the data logger could be programmed to signal an irrigation system that it did not need to run at that time.

The turf industry, especially those that operate on sandy soil areas has been slow to take up soil moisture monitoring. With recent advances in technology and communications, however, soil moisture monitoring is now a real option.

Modern soil moisture probes are reliable and affordable. Telemetry options, like mobile phone or satellite network modems are becoming more and more affordable as well. Moving data from the field to the website as well as access to this data through either, mobile web browsers or specialised mobile apps, makes it easy for turf manager and irrigators to check soil moisture readings whenever they need.

The Unidata partner, Future Turf, produces a complete system. This turf irrigation tracker system is easy to install and there is minimal disruption to the sports oval playing surface. The user gets instant



collection and transfer of data through its "plug and play" nature and soil moisture data is well presented on easy to understand graphs either on an iPad or Laptop. It is also easy to relocate the probe if needed.

The Irrigation Tracker generates important information for irrigation managers, such as confirmation of the amount of irrigation applied, monitoring irrigation depth, monitoring the soil moisture status of the root zone, monitoring root zone salinity and monitoring root zone soil temperature.

The Irrigation Tracker components are securely housed in a standard valve box or buried below the turf surface. A 40cm sub-surface probe with four sensors measures soil moisture, salinity and temperature at 10, 20, 30 & 40cm depths. The Neon Remote Logger stores data collected from the probe and sends that data back to a Neon Server daily. With a daily reporting period a battery pack can power the entire system for 2 years.

For the more complex and detailed approach to measure ET we can estimate ET from meteorological data, but a far more direct, accurate and defensible measurement uses the 'Eddy Covariance' (EC) method. Instruments on the EC tower continuously and rapidly sample the turbulent airflow that transports water vapor, heat and carbon dioxide used, or given off, by plants during photosynthesis or respiration. This method is accurate, but complex and to get good results, we pay detailed attention to specifics.

The EC tower uses the following sensors to telemeter several parameters needed to accurately calculate ET:

- a sonic anemometer to rapidly and continuously measure turbulence in the air
- a sensor/analyser to continuously measure the concentration of carbon dioxide and water vapor in the air next to the anemometer
- a net radiometer to measure the difference between incoming solar radiation and radiation reflected back to the sky
- a quantum radiometer to measure only that part of solar radiation that the plants use for photosynthesis, when they use carbon dioxide and water to grow
- a pyranometer to measure radiation from sun and sky
- an air temperature/humidity sensor a heat flux sensor to measure heat flow into and out of the ground.

Water passing through the soil can be measured using lysimeters located near EC towers. Sites need careful preparation and require a significant amount of excavation to create two underground bunkers where the measurement equipment is housed.

Containment vessels or barrels can be used to isolate a cylindrical core of the crop along with the soil it grows in.

Barrels like this are then positioned in the field, with the lysimeter opening at the ground level, so it shares the same environmental conditions as the rest of the crop, in this case pasture.

You can measure the amount of water leaching through the contained soil by piping it out the bottom of the barrel to a rain-gauge located below it in the underground bunker. You can then compare the amount of water that flows through the lysimeter (water out) with the rainfall or irrigation (water in) that we measure in another rain-gauge at the same location.

To get a continuous representative vertical soil moisture profile, more than one lysimeter should be used at the same site to measure soil moisture at different depths.

TYPICAL CONFIGURATION

APPLICATION SPECIFIC INSTRUMENTS/INPUTS

Options	Unidata Part Number	Description
Moisture and Temperature Probes	EP100GL-04/08/12	4, 8 or 12 sensor moisture and temperature probe
WXT536 measures barometric pressure, humidity, precipitation, temperature, wind speed & direction	6501V-H	Vaisala Weather Transmitter RS232/422/485 SDI-12
Rain Gauge	6506C	Rain Gauge / Tipping Bucket

NEON TELEMETRY - NRL / RTU / FIELD UNITS

Options	Unidata Part Number	Description
Ethernet	3016A-000 / 3008A-000	Neon Remote Logger-16 or 8 Analog Ch / Touch Screen Display
Ethernet & 3G/4G	3016A-C00 / 3008A-C00	Neon Remote Logger-16 or 8 Analog Ch / Touch Screen Display
Ethernet & 3G/4G and LoRa	3016A-CL0 / 3008A-CL0	Neon Remote Logger-16 or 8 Analog Ch / Touch Screen Display
Equatorial Orbit Satellite-Inmarsat	3016A-00I / 3008A-00I	Neon Remote Logger-16 or 8 Analog Ch / Touch Screen Display
Equatorial Orbit Satellite-Inmarsat & 3G/4G	3016A-C0I / 3008A-C0I	Neon Remote Logger-16 or 8 Analog Ch / Touch Screen Display
Low Earth Orbit Satellite - Globalstar	3016A-00G / 3008A-00G	Neon Remote Logger-16 or 8 Analog Ch / Touch Screen Display
Satellite - Iridium Short Burst Data	3016A-00R / 3008A-00R	Neon Remote Logger-16 or 8 Analog Ch / Touch Screen Display
Standalone RTU/NRL - Industrial	3004A-00 / 3004A-0L	Neon Remote Logger-4 Analog Ch with or without Touch Screen Display
Cellular RTU/NRL 3G/4G - Industrial	3004AC0 / 3004A-CL	Neon Remote Logger-4 Analog Ch with or without Touch Screen Display
M – Series Standalone RTU/NRL	3004A-M000 / 3004A-M0B0	Neon Remote Logger-4 Analog Ch with or without Li Battery
M – Series Cellular RTU/NRL 3G/4G	3004A-MC00 / 3004A-MCB0	Neon Remote Logger-4 Analog Ch with or without Li Battery
M – Series LoRa RTU/NRL	3004A-ML00 / 3004A-MLB0	Neon Remote Logger-4 Analog Ch with or without Li Battery
M – Series Ethernet RTU/NRL	3004A-MEBL	Neon Remote Logger-4 Analog Ch, Li Battery & LCD are optional
M – Series Microsatellite RTU/NRL	3004A-MHBL	Neon Remote Logger-4 Analog Ch, Li Battery & LCD are optional
M – Series Iridium Short Burst Data RTU/NRL	3004A-MIBL	Neon Remote Logger-4 Analog Ch, Li Battery & LCD are optional

NEON APPLICATION SOFTWARE - CUSTOMER SERVER

Options	Unidata Part Number	Description
Neon Applications Software	2302A	Neon Server Software Licence Incl 5 NAL
Neon Applications Software	2302A-10	Additional 10 NRT Access Licence
Neon Applications Software	2302A-20	Additional 20 NRT Access Licence
Neon Applications Software	2302A-50	Additional 50 NRT Access Licence

NEON HOSTING SERVICE - UNIDATA SERVER

Options	Unidata Part Number	Description
Neon Hosting Service	2301A	Neon Data Initial Subscription Setup Fee
Neon Hosting Service	2301A-01	Neon Data Service Fee for 1-50 NRT
Neon Hosting Service	2301A-02	Neon Data Service Fee for 51-100 NRT
Neon Hosting Service	2301A-10	Neon Data Service Fee Metering

DATALOGGER MANAGEMENT SOFTWARE

Options	Unidata Part Number	Description
Starlog V4 Management Software	6308A-AUE	STARLOG V4 Full Licence Key