WeatherTRAK®
ET Everywhere Data Service
Technical Overview

Overview

HydroPoint utilizes a proprietary system to determine evapotranspiration (ET) for customers throughout the U.S. – this is one component of the WeatherTRAK ET Service known as ET **Everywhere**. In order to deliver this service HydroPoint first acquires weather data from existing weather stations throughout the US and validates its quality. Then, using sophisticated modeling techniques and an array of supercomputers, ET values are calculated down to a resolution of 1 square kilometer for 90% of the country. Using existing ET weather stations throughout the country, HydroPoint has and continues to validate the accuracy of its daily ET Everywhere data to a standard deviation of .01 inches of daily ET. Next, the ET values created for each ET zone are checked, validated and prepared for sending. Finally the zone specific ET data is transmitted to all of the **WeatherTRAK** controllers in each respective zone via the HydroPoint's communication process over redundant wireless networks. With the ET Everywhere service, HydroPoint is able to calculate and leverage geographically specific ET values to automatically adjust irrigation schedules as each customer's local weather changes.

Data Acquisition

ET Everywhere utilizes existing weather stations throughout the US to provide input parameters for its ET calculations. Daily weather data is collected from up to 12,000 weather stations throughout the country via the NOAA weather network, which provides data to key organizations including the National Weather Service and US Military. Additionally, HydroPoint works with various cities, states, water districts and public and private organizations to obtain their 'mesonet' weather station information (i.e. California's CIMIS ET Network, Colorado's ET Network, Georgia's AEMN and a host of others). HydroPoint has the capability to include weather station data from any qualified station or network if requested by a partner or customer. Such requests will go through a qualification process and will be integrated into the ET Everywhere calculations once they are validated for quality standards. Additionally HydroPoint's Data Operations team is continually conducting R&D on new sources of data from existing or developing weather station networks. All of this data is collected using custom software programs that import and standardize the data from many different sources and formats into the ET Everywhere Database (ETE-DB). HydroPoint does not rely upon simply an ET reading from any given station. All of HydroPoint data acquisition routines collect the raw weather parameters from each station such that HydroPoint can calculate its own ET value using the Penman Monteith ET equation and ensuring that there is consistency across all areas of service coverage.

Quality Control

Before any of the weather station data is used, it goes through several validation steps at the HydroPoint Data Center. After collecting raw data and storing it in ETE-DB, HydroPoint analyzes each station's data via a series of scripted heuristics and human validation processes. Anomalies are flagged for review and data that is rejected per HydroPoint's quality standards is omitted from that day's ET calculations. Secondarily, data from the NOAA weather network is continually being validated and corrected by various government agencies including the National Weather Service and FAA. These corrections are continually gathered by HydroPoint and stored in the ET Everywhere Database. This data is again run through a series of heuristic quality control checks, and if necessary, is used to adjust zone specific ET values that are sent to WeatherTRAK controllers as part of the daily ET transmission. Repeated data anomalies that are identified by HydroPoint are communicated to the various operators of each respective weather station network for them to review.

Calculating ET

ET Everywhere - Accuracy & Flexibility

HydroPoint utilizes gathered weather station data together with advanced climatologic modeling techniques to calculate ET down to one square kilometer across the entire US. HydroPoint's modeling technique is based on a process that was developed and is managed by scientists Penn State University and used by government organizations such as the FAA, US Forest Service and US Military. These tested and proven techniques account for things such as changes in elevation and upper atmospheric conditions to model weather data and are used by HydroPoint to leverage existing real weather station data and essentially create virtual weather stations every 1 sq

km (includes temperature, solar radiation, relative humidity, and wind). These 1 sq km weather readings are then run through the Penman Montheith FAO 56 ET equation to calculate at this same 1 sq km resolution.

Using ET weather station data from the last 10 years, gathered from existing dedicated ET networks throughout the country (CIMIS, Colorado, FAWN etc.), HydroPoint has and continues to validate the accuracy of its ET Everywhere data modeling to a standard deviation of .01 inches of daily ET.

Additionally HydroPoint integrates ongoing data updates and corrections that are part of the NOAA data set to calculate 'day after off-sets' to each day's ET value if necessary. This flexibility allows HydroPoint to continually address data issues as they are discovered and continue to drive towards the most efficient automated irrigation schedule possible.

ET Equation

ET Everywhere utilizes the FAO 56 Penman-Monteith ET equation as the default equation to calculate ET. If there are special circumstances, either scientific or political, that require a particular region to use a different ET equation, the ET Everywhere system is capable of using a customized equation for any region.

The FAO 56 Penman-Monteith ET equation is a modified Penman-Monteith equation that has been adopted by the UN as the standard to determine evapotranspiration throughout the world. The equation follows the form:

$$ET_o = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T+273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34 u_2)}$$

where

ETo	reference evapotranspiration [mm day -1],
Rn	net radiation at the crop surface [MJ m -2 day -1],
G	soil heat flux density [MJ m -2 day -1],
T	mean daily air temperature at 2 m height [°C],
u2	wind speed at 2 m height [m s -1],
Es	saturation vapor pressure [kPa],
Ea	actual vapor pressure [kPa],
es- ea	Saturation vapor pressure deficit [kPa],
Δ	slope vapor pressure curve [kPa °C -1],
γ	psychrometric constant [kPa °C -1].

The equation requires five location specific parameters: latitude and longitude, average wind speed, minimum and maximum temperatures, minimum and maximum relative humidity and solar radiation. With this information, the UN FAO has found that using the FAO 56 Penman-Monteith ET equation provides for the most consistent and accurate data describing actual water use worldwide.

Transmitting ET

ET Zones – Dynamic Grouping

On a daily basis ET values are calculated down to 1 square km micro zones. Next, these micro zones are grouped into ET zones based on geographic areas with the same ET. An ET zone may be a group of multiple 1 km micro zones or a single micro zone by itself. ET values for each ET zone are then transmitted to WeatherTRAK Controllers via HydroPoint's communication process over a redundant wireless communication network. Each WeatherTRAK controller can be addressed via five main categories: serial number, micro zone, ET zone, zip code, and water district number. If at any time it is determined that a micro zone should belong to a new ET zone, the ET Everywhere service is able to automatically migrate all WeatherTRAK controllers in that micro zone to a new ET

zone. Similarly, if any individual WeatherTRAK controller is required to be migrated to a new ET zone that can also be done automatically by addressing the controller's serial number via the ET Everywhere network and making the appropriate change.

ET Zones and You

How do I know what ET zone I am in?
HydroPoint will figure that out for you. Upon installing each WeatherTRAK controller, you or your installers will call the 800 HydroPoint Customer Service line to activate their ET Everywhere Service. You will supply HydroPoint with the physical address of the WeatherTRAK installation, which will automatically generate and transmit to you a HydroPoint ET micro zone based on longitude and latitude location of the controller. With the ET micro zone and ET zone now set, the WeatherTRAK controller will begin receiving daily ET updates that will automatically adjust your irrigation schedules as required.

Do I Need a Weather Station?
No. There is no need to buy, install and or manage costly weather stations to gain the benefits of ET Everywhere. The ET Everywhere Data Service pulls information from multiple weather stations in your area and then uses that to data to model the weather for your particular area, providing you with location specific ET on a daily basis.

How do I know if there is wireless coverage in my area?
HydroPoint's coverage has been proven in 90% of the US. To verify coverage in a questionable area, users can go to the diagnostic mode on the WeatherTRAK controller that allows the user to easily view strength of all the wireless carriers in their area and thus verify coverage. Because the controller will be static once installed it is not likely to experience service drop outs like users are used to with mobile phones. Furthermore, customers can call HydroPoint's customer support at any time and see if there are existing customers in their area to further verify wireless coverage. HydroPoint also manufactures and sells simple antenna enhancements that allow for better reception in any locations that prove to be problematic.