CanopyNews

INSIDE

DECAGON DEVICES

Use of the AccuPAR Ceptometer to Quantify Effects of Riparian Vegetation Removal on Stream Energy Balance

When the vegetation along a stream bank is removed, the solar load on the stream increases. This results in increased stream water temperature. Elevated stream temperatures degrade freshwater habitats, shifting species composition, and often endangering some of the species that live in the stream. An increasing awareness of this problem has led to the creation of riparian strips to shade streams when timber is harvested or prescribed burns are undertaken. The challenge is to know how much shade is needed, and how large to make the strips.

Both empirical and physically based models are available for designing the strips. The physically based models use an energy balance for a section of the stream. The energy balance considers all inputs and losses of heat for the stream. The change in temperature is the difference between inputs and losses divided by the heat capacity of the water. The inputs are solar and thermal radiation. Losses are thermal radiation and latent heat. Sensible heat can be either an input or a loss, depending on whether air temperature is above or below stream temperature. Inputs to the stream from ground water can also be inputs or losses, depending on their temperature relative to the stream temperature. Of these, the variable most susceptible to manipulation is the solar radiation, through changing the amount of shade. Manipulating solar radiation also changes the thermal radiation. Incoming thermal radiation from vegetation is greater than incoming radiation from the sky. Thus, increasing cover decreases solar input, but increases thermal input. Since the change in solar radiation is the larger of the two, decreasing solar input reduces stream heating, even though it also increases incoming thermal radiation. Our purpose here is not to present the model. A number of model sources, which give additional information, are cited below. We want to focus on the measurement of solar (and thermal) inputs of radiation to the stream. If the total solar radiation above the canopy is S_o, then the radiation at the stream surface is:

$$S = \tau S_0 \qquad (1)$$

where τ is the canopy transmission coefficient. The value of τ depends on the leaf area index of the canopy above the stream, the angle of the radiation incident on the canopy, the angle distribution of leaves in the canopy, and spatial distribution of canopy elements. Harvesting or burning the canopy along a stream bank reduces the leaf area index and changes the spatial distribution of canopy elements. If we can measure the effect of management on τ will have quantified the main effect of management on stream temperature.

The AccuPAR model LP80 makes a direct measurement of τ. It does this by taking a ratio of radiation measured under the canopy to radiation incident on the top of the canopy. The LP80 is particularly well suited to this type of measurement because it measures light at 80 locations with a single button-click. Light under plant canopies has high spatial variability, so many measurements are required for acceptable accuracy. Several button presses, with the probe in different locations, gives a good estimate of below canopy radiation.

Two questions now arise. First, the measurement of τ is at a particular location and time. How does this measurement relate to the energy balance over whole days and months? The second relates to PAR vs. total solar radiation. Since PAR is attenuated more strongly than

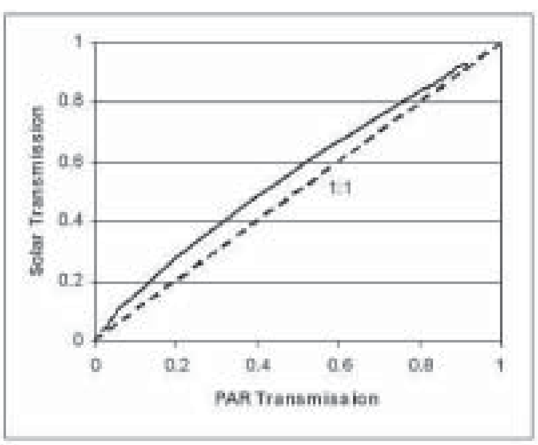


Figure 1 *Solar transmission for a plant canopy as a function of PAR transmission. The dashed line is 1 to 1.*

total radiation by plant canopies, can one be determined from the other? Taking the second question first, Campbell and van Evert (1994) related values of intercepted solar and PAR radiation. Figure 1 shows a similar relationship to theirs, but in terms of transmitted solar and PAR. Note that at total transmission or total interception the two are equal. At 50% transmission of PAR, the transmitted solar is around 60%. At 10% transmission of PAR the transmission of solar is around 20%. The ratio of transmitted solar to transmitted PAR can be computed from

$$\frac{\tau_s}{\tau_p} = \exp\left[-\left(\sqrt{a_s} - \sqrt{a_p}\right)KL\right] \qquad (2)$$

where a is the absorptivity of leaves for either solar or PAR, K is the extinction coefficient of the canopy, and L is the canopy leaf area index. Typical values for a_s and a_p are 0.5 and 0.8. These are the values used for Fig. 1. Using either Fig. 1 or eq. 2 it is easy to convert PAR transmission from the LP80 to total solar transmission.

We turn now to the question of how a transmission measurement at a single time and location relates to the values needed for computing the energy balance of a stream. One could make repeated measurements throughout the course of a day and average the values. This would be a lot of work. An easier way would be to compute the daily value from measurements at a single time of day.

Two possible situations need to be considered. First is one for fairly small streams, such that the shading of the stream is about the same as the shading of areas around the stream. In other words, the canopy in the vicinity of the stream can be assumed to be randomly distributed in space. Measurements with the LP80 give the leaf area index of the canopy. If we assume that, over the course of a day, the transmission of solar and diffuse sky radiation are similar, then the daily solar input to the stream is the diffuse transmission coefficient for the canopy multiplied by the solar radiation incident on the canopy. The diffuse transmission coefficient can be calculated from

$$\tau_d = \exp\left(-K_d L \sqrt{a_s}\right) \qquad (3)$$

where K_d is the diffuse transmission coefficient for the canopy. The value of K_d varies with LAI and leaf angle distribution, but a value typical of stream heating conditions is 0.85 (Campbell and Norman, 1998). Thus, the value of L obtained from the LP80 is used, along with known values of extinction coefficient and leaf absorptivity to find the diffuse transmission coefficient. This is used with measured or modeled solar radiation values to get solar input to the stream. Logging or burning decreases L and thus increases the solar input.

The second situation is one where the stream width disrupts the canopy sufficiently that a random distribution of canopy elements can't be assumed. This is a challenging situation for modeling or measurement. An add-on to a GIS is available for doing some of these calculations (Rich et al., 1995). Measurements could also be made over the course of a clear dayat representative spots across and along the stream. A weighted average of these, weighted by the sine of the solar elevation angle, gives the diffuse transmission coefficient. This, again, is used with solar radiation measurements or estimates to get solar input to the stream.

Conclusion

When vegetation is removed from stream banks, the increased input of solar energy to the water can cause significant stream warming. Leaving buffer strips along stream banks can mitigate this effect. AccuPAR LP80 measurements can be used to quantify the changes that have occurred through management, and can provide inputs to models of stream temperature.

References

Campbell, G. S. and F. K. van Evert. 1994. Light interception by plant canopies: efficiency and architecture. In J. L. Monteith, R. K. Scott and M. H. Unsworth, Resource Capture by Crops. Nottingham University Press, Nottingham.

Campbell, G. S. and J. M. Norman. 1998. An Introduction to Environmental Biophysics, 2 Ed., Springer Verlag, New York

Rich, P. M., W. A. Hetrick, S. C. Saving. 1995. Modeling topographic influences on solar radiation: a manual for the SOLARFLUX model. Los Alamos National Laboratory Manual LA-12989-M

http://www.ce.washington.edu/~lamarche/STRposteragu.htm

And the Award for Most Creative Use of a Porometer Goes to…

DECAGON EMPLOYEES HAVE FOUND some novel uses for the porometer over the years. Since the sensor head measures stomatal conductance simply by determining vapor flux, they've clamped it on everything from fingers to house wrap to raincoats. But Jan Narciso and her colleagues at the USDA in southern Florida have now "clamped" it on something even bigger… **a grapefruit.**

In research studies presented and published last year, Narciso and her colleagues used the porometer to measure vapor conductance through tiny holes, but the holes were laser points in fruit peel rather than stomates in leaves.

New Kind of Fruit Label

Laser labeling is a process that replaces the ubiquitous P.L.U. stickers on fruit with labels etched right into the skin of the fruit. These labels aren't toxic, they can't be washed off, and they save time and money for packers, but there are questions about whether or not microorganisms get into the laser holes and how much water is lost through them.

Measuring Vapor Conductance

The researchers wanted a way to measure immediately how much water was being lost through the lasered peels of different fruits. As research scientist Doug Cobos recalls, "They wanted to play around with the porometer and make it work so they could hold it against an area that had just been labeled and get immediate readings on the treatment—find out how much water was being lost through the lasered holes."

"Press and Read"

Fortunately, that turned out to be an easy job. The electronics in the sensor head of the porometer are all located on one side. Turning it into a "press and read" sensor was just a matter of pushing out the clip pin. The USDA researchers were able to hold the porometer head against the labeled area and get a water loss reading immediately. Narciso and her colleagues also measured to see how much water loss was stopped by various treatments and coatings.

Learn More

Read more about the laser label research in these publications, both available online from the USDA-ARS:

Sood, P., Ference, C., Narciso, J., Etxeberria, E. 2009. Laser etching: a novel technology to label Florida grapefruit. HortTechnology. July-Sept, v. 19, no. 3, p. 504-510.

Sood, P., Ference, C., Narciso, J., Etxeberria, E. 2008. Effects of laser labeling on the quality of tangerines during storage. Proceedings of Florida State Horticultural Society. 121:297-300

New LP-80 Operating System Update

If you are a current LP-80 customer, you may want to update your instrument with this new firmware. Decagon has just released an update to the operating system of the LP-80 that streamlines the user interface and adds a few new long-awaited features.

Among the changes are:

- the ability to add notes to each reading, if desired.
- seconds are added to the time stamp of saved data.
- more user-friendly menu structure.

To update your LP-80, simply go to
www.decagon.com/support/downloads
and click on the link to the new LP-80 firmware. If you have questions or problems updating, please feel free to contact Decagon at support@decagon.com

Coinciding with this new operating system, we also have a new (free) download utility program for downloading data to your computer. It's available at that same location on our website.

Long-battery life, instant real-time PAR and LAI measurements, plus external radiation sensor.

- With the new LP-80, you get instant real-time PAR measurements as soon as you turn it on, and your LAI data is updated with each PAR measurement.
- Intuitive 6-key menu-driven interface
- Included external PAR sensor for simultaneous above and below-canopy PAR measurement
- Large memory capacity
- Low power consumption/4AA alkaline battery-powered (2 years)

Re-calibrate your SC-1 Porometer and ensure sensor accuracy.

Simple step-by-step procedure.
Need a calibration kit? Contact us today and we'll send one free.

When should I calibrate my Leaf Porometer?

- Every day and,
- If environmental conditions change more than 15°C or 20% humidity.

Precautions

- DO NOT get water on the leaf porometer clip. If you do, be sure to dry thoroughly before calibrating or making a measurement.
- DO NOT get fingers near Teflon filter on leaf clip during calibration or measurement.
- NEVER breathe or blow on the sensor.

Before Starting

1. You must calibrate the porometer under field conditions.

2. The leaf clip must be in thermal equilibrium with the environment. This may take 10 minutes or more if the clip starts at a very different temperature (e.g. air conditioned vehicle or office.)

3. Assemble a complete calibration kit:

- Calibration plate
- Filter paper
- Distilled water
- Tweezers

Calibrating the Sensor

1. Use the "Menu" button to select the Configuration menu. Select the Calibration submenu and then Calibrate.

2. Enter sensor serial number (found on cable tag.)

3. Open sensor head (and wave in air to mix air in sensor head.)

The Grant A. Harris Research Instruments fellowship provides $30,000 worth of Decagon research instruments (6 awards for $5,000 each) to graduate students studying any aspect of environmental or geotechnical science.

We congratulate the winner and honorable mention of the 2010 G.A. Harris Research Instrumentation Fellowship for canopy research applications.

WINNER
Tracy Rowlandson
Iowa State University

Investigation into the Spatial Variability of Dew at Field Scale
Investigations into the spatial and temporal variability of dew have implications for both plant disease management and remote sensing of soil moisture. In this study, the process of scaling point measurements of dew to canopy scale will be investigated by determining the contribution of LAI for regions in the canopy with the highest and lowest dew amounts to the total LAI of the canopy. Leaf wetness sensors will be used to determine where in a soybean canopy the greatest dew

4. Wetting the filter paper correctly is critical to a good calibration. The filter paper must be wet, but have no excess water.

■ Saturate filter paper with DI water from dropper bottle.
■ Using tweezers, give the filter paper a sharp flick of the wrist or two to knock off any excess water.
■ Once you have wet the filter paper, DO NOT re-wet during the calibration.
■ If the filter paper dries and falls off the calibration plate, re-wet and re-start the calibration at the beginning
■ See user manual and online video for. more detailed information on wetting the filter paper correctly.

5. Lay the filter paper over the hole in the calibration plate on the side marked “Filter Paper”.

■ The filter paper must lay flat across the hole.
■ The filter paper must cover the entire hole.
■ Check to make sure that no water wicks into the hole from the filter paper.

6. Attach Sensor Head

■ Moist filter must be in place and flat
■ Orient calibration plate with “Metal Block” toward the aluminum side of the leaf clip
■ Calibration plate must be inserted until aluminum block seats firmly against hard stop.

7. Hydrating sensor.

■ Sensor hydration takes 3 minutes.
■ Do not remove calibration plate during hydration.
■ Do not set sensor head on Teflon filter. The water vapor must be able to diffuse freely to the atmosphere. Set the porometer head on its side or upside down.

The Porometer Utility is free and makes loading your data easy.

8. Equilibrate to Ambient Conditions

■ Sensors must be equilibrated back to ambient conditions.
■ Opening the sensor head and waving in air speeds the process.
■ When the indicator bar reaches “AMB”, you will be prompted to attach the sensor head and begin a calibration measurement.

9. Calibration Measurements

■ Follow instructions in step #6 to attach sensor head.
■ 30 second measurement will start
■ Hold the sensor head still or set it down during the 30 second measurement.
■ When the measurement is finished, you will need to equilibrate (step #8 above) and re-attach sensor head (step #6 above) to start another calibration measurement.
■ You will need to repeat the calibration measurement up to 10 times until stable measurements are achieved.
■ The Leaf Porometer will alert you when the calibration is complete.
■ If the you take 10 calibration measurements and don’t achieve stable readings, see the Calibration chapter in the user manual for troubleshooting tips.

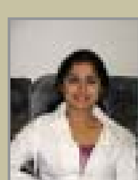
10. Accuracy Verification

It is always a good idea to verify that the calibration was effective. If you wish to do this, go to the measurement menu and make a measurement on the calibration plate. The verification should be conducted immediately after the calibration has finished, and without re-wetting the filter paper. The measured conductance should be close to 240 mmol m^{-2} s^{-1}.

Watch this calibration process online at http:// **www.decagon.com/porocal**

duration (and amount) occurs. Investigation at locations around a field will be examined for variation of dew within a field.

HONARABLE MENTION
Sruthi Narayanan
Kansas State University



Canopy Architecture and Radiation Use Efficiency in Sorghum

This study investigates the influence of canopy architecture on sorghum radiation use efficiency. RUE was calculated as the ratio of above-ground biomass accumulation to cumulative intercepted photosynthetically active radiation (IPAR). Accupar LP-80 ceptometer measurements of PAR above and below a crop canopy provide measures of IPAR and leaf area index. Preliminary results showed 1) lines differed in apparent RUE, which increased with average internode length; 2) positive correlation between RUE and water use efficiency (biomass produced per unit crop water use); 3) the increased productivity was due to increased radiation use efficiency rather than capture considering the similarity among lines in IPAR.

How to apply for an instrumentation fellowship:
www.decagon.com/corporate/scholarships/

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Check Out Decagon's New Educational Videos

These videos are short, usually no more than 5 minutes long, and educational in nature. The basic videos give step by step instructions and explain the science behind the instruments. More in-depth videos describe detailed care and maintenance and show advanced techniques. Canopy researchers may be interested in the following videos: Introducing the handheld Leaf Porometer, Measure PAR and LAI with AccuPar LP-80 Ceptometer, and SC-1 Leaf Porometer Calibration.

Decagon's educational videos can be viewed at *www.decagon.com/videos/*

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Most Thermodynamically Correct Leaf Wetness Sensor Available

Read about Decagon's Leaf Wetness Sensor online at:
www.decagon.com/canopy/leaf_wetness/

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