DECAGON DEVICES

Measuring Water Content of Compost

IT IS WELL KNOWN that correct moisture management is the key to successful composting. If the moisture in the compost is too low, microbial processes are slowed and compost doesn't reach its optimum temperature. If it is too high, processes become anaerobic and the compost pile becomes an air pollution hazard.

However, the suggestions in published literature for compost moisture monitoring methods typically are not very helpful. Oven drying is the only sure method for measuring compost water content, but even with this method, there are potential pitfalls. Drying the compost at too high a temperature or trying to dry it in a microwave oven to speed up the process can cause the sample to loose organic material or combust. The literature lacks reports of suitable *in situ* moisture measurement methods. A squeeze test has been recommended for a rough moisture measure. When the compost is at the right moisture level, water can be squeezed out with some effort, like a moist sponge. Several electronic probes have been tried, but these were described as being rough measures with poor absolute accuracy. Tensiometers have also been used to measure

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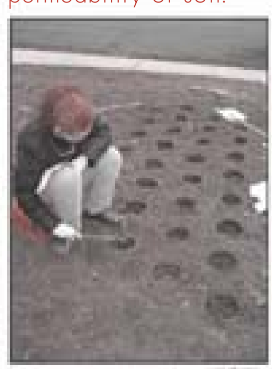
Free Teaching Aids for Soils and Environmental Science

Soil Science education for ages 8 to 108.

REMEMBER the good teachers we had in school, in the lab or even in short courses? It was easy to stay awake and (even better) to pay attention during the lecture.



■ Eva Gillis-Buck researches the permeability of soil.

These classes typically were sprinkled with stories, experiences and hands-on demonstrations. You might have even learned something!

With the right tools, even a boring topic can be transformed into a fascinating experience; potentially igniting in your students the same interest and passion for agricultural research we all share.

When you look into your tool bag for teaching and lab ideas, don't overlook the instruments you use for your everyday research. There are a

continued on page 4 ►

INSIDE ►

Using Soil Moisture Sensors in Environmental Sensing Networks

Katalin Szlavecz, Andreas Terzis and Alexander Szalay
The Johns Hopkins University, Baltimore

■ Tmote Sky wireless module with Decagon EC-5 Photo by: Razva Musaloiu-E

THE RECENT EMERGENCE of small, inexpensive wireless sensor platforms is fundamentally changing the way we approach many scientific problems. This technology is particularly well suited for environmental monitoring where high-resolution, continuous measurements are needed in a heterogeneous habitat [1]. Low-power wireless devices allow an affordable, non-invasive, easily deployable, scalable design for large-scale monitoring systems. At last, we have the means to study not only the gross effects of the environmental parameters, but detect subtle relations between gradients and small temporal changes.

We are currently deploying a system of 200 Tmote Sky wireless modules [2], each connected to two to three Decagon ECH$_2$O-5 moisture sensors and a self-designed soil temperature sensor. The motes form a hierarchical network with an on-line Internet connection. Data are uploaded into an on-line SQL Server database where they are calibrated and reorganized. Spatial and temporal tags are stored with each measurement. Other related data sets (weather, soil biota, land cover, land management) are also loaded into the database for analyzing cross-correlations. Various interfaces, based on web-services provide an easy visual and tabular access to the data[3]. The database design enables us to have a summary of the data on various spatial and temporal scales, while still retaining the ability to look at every bit of raw data as well.

The main objective of this deployment is to gain insight on how belowground physical conditions vary across several spatial and temporal scales. This data set, combined with our sampling and observations on soil fauna abundances, activity and biogeochemical processes will enable us to a much better understanding of the patterns and processes in the soil ecosystem.

The project is an integral part of the Baltimore Ecosystem Study (BES) monitoring activities. BES is one of the recent additions of the NSF funded LTER (Long-Term Ecological Network) sites [3]. One of the BES central questions is how urbanization alters relationships between ecosystem structure and function. Several ongoing projects, such as invasive species ecology and patterns of soil nutrient cycling, will greatly benefit from the data provided by the sensor network The network will also provide input data for urban hydrology models. Further details of the prototype system can be found at [4]. ■

[1] http://www.nature.com/news/2006/060320/full/440402a.html

[2] http://moteiv.com/

[3] http://lifeunderyourfeet.org/

[4] http://www.beslter.org/}

2007 Trade Shows

Society of Range Management
February 9-16, 2007, San Antonio, Texas

1st International Soil Moisture Conference
March 19-21, 2007, Honolulu, Hawaii

American Society for Enology and Viticulture
June 27-30, 2007, Sacramento, California

Ecological Society of America
August 2-10, 2007, San Jose, California

American Society of Agronomy
November 4-8, 2007, New Orleans, Louisiana

New for Decagon Customers: Virtual Seminars

Making Stomatal Conductance Measurements
January 24, 2007

Measuring Soil Moisture
April 25, 2007

DECAGON DEVICES

For more information regarding the Virtual Seminars, contact Laura at marketing@decagon.com

Successful Soils Workshop at the World Soils Congress

DESPITE THE WARM WEATHER, scientists from around the globe came to Philadelphia a day early, this July, to learn about soils from Decagon's scientists. Like the differing countries and cultures, everyone came with different goals: learning about Decagon equipment, refresher training and to expand their soils knowledge.

Many attendees also had specific inquiries and spent time after the workshop talking with the instructors.

No matter what your goals, Decagon workshops are flexible to help attendees fully understand the topic - even if we have to stay after the workshop has ended.

Some comments from workshop participants:

"Presenters understand their stuff; highly qualified and have updated materials for the subject. "

"Things I liked about the workshop- Decagon's scientist's expertise, hands-on equipment use, straight facts about the performance of various types of equipment, and all in a good sized groups."

"I really liked learning about the theory behind the measurements."

Watch your email box for new workshops and future virtual seminars. ■

◀ Dr. Doug Cobos showing student how to make a solute break through curve.

Soil Science Education for

continued from cover

■ The inspiration: the sidewalk across from Eva's house.

lot of teaching opportunities using the same instruments you publish with.

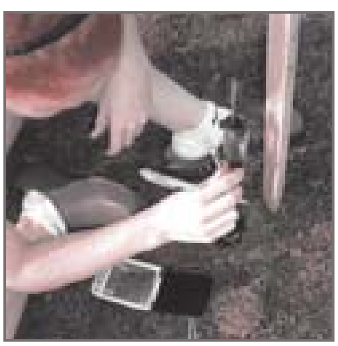
In order to help educators and scientists, Decagon has published two workbooks for soils and environmental education that give teaching ideas and experiments that can be used with Decagon equipment.

Workbook 1: Soil Science— covers hydraulic conductivity and erosion, effects of runoff, soil texture analysis, ground cover, pore size diameter and capillary force, osmosis, plant water relations, soil bulk density, and porosity.

■ Eva setting up her research area.

Workbook 2: Measuring Soil Moisture— covers the concepts of volumetric and gravimetric water content and how to make the measurements of each.

Both of the workbooks are free with the purchase of a Mini Disk Infiltrometer or ECH_2O Probes and Echo Check. Each workbook includes an accompanying CD, which will allow teachers modify the experiments and print off worksheets for students.



■ Making a measurement.

You can also use the ideas for science fair projects for your family members. Case in point: last year Decagon awarded Eva Gillis-Buck a scholarship for her use of the minidisk infiltrometer as part of her 10th grade science project.

Procedure

- Cut 30 cans to 15 cm long cylinders
- Drove cans 10 cm deep and 16 cm apart to create isolated treatment cells
- Ripped up sod, tilled/raked upper 4 cm soil surface
- Collected composite sample, sent to A&L Great Lakes Laboratory
- Used conductivity meter to measure electrical conductivity
- Used minidisk infiltrometer to measure hydraulic conductivity
- Assigned treatment cells into 5 groups of 6, based on baseline hydraulic conductivity ranking

Baseline Hydraulic Conductivity of Treatments

	Control	Gypsum	NaCl	NaCl + Gypsum	NaCl + Gypsum + PAM
Replication	Baseline HC (cm/sec)	Baseline HC (cm/sec)	Baseline HC (cm/sec)	Baseline HC (cm/sec)	Baseline HC (cm/sec)
1	1.605E-03	1.061E-03	2.105E-03	1.716E-03	1.015E-03
2	1.407E-03	1.321E-03	1.691E-03	1.306E-03	1.309E-03
3	1.025E-03	1.286E-03	1.008E-03	1.160E-03	1.286E-03
4	7.294E-04	9.012E-04	8.842E-04	8.705E-04	9.630E-04
5	7.160E-04	6.295E-04	7.294E-04	5.802E-04	6.420E-04
6	2.580E-04	1.728E-04	2.098E-04	5.052E-04	4.681E-04

I teach
The earth and soil
To them that toil,
The hill and fen
To common men
That live just here;

The plants that grow,
The winds that blow,
The streams that run,
In rain and sun
Throughout the year;

And then I lead
Thro' wood and mead,
Thro' mold and sod,
Out unto God.
With love and cheer,
I teach.
-Unknown-

DECAGON DEVICES

Ages 8 to 108

Eva noticed that deicing salts applied to roads or sidewalks during the winter often kill plants near a path across the street from her house. Last year, she found that fewer spring oat seeds germinated in soil treated with sodium chloride deicing salt, possibly because the sodium dispersed soil structure and prevented ideal soil permeability. She wondered if sodium-damaged soil could be treated to improve the soil structure and permeability, which would make for more ideal germination conditions for replanting in the spring.

To read the complete description of Eva's work and conclusion go to www.decagon.com/instruments/agdownload.html

To see samples of Decagon's workbooks, either stop by at one of the tradeshows or view them on our website— www.decagon.com/instruments/agdownload.html ■

Free Teaching Aids for Soils and Environmental Science

Conclusion

My hypothesis was supported.

- **Sodium chloride (deicing salt) treated soils had lower soil hydraulic conductivity (permeability), suggesting damaged soil structure.**
- **Hydraulic conductivity increased of sodium chloride treated soils increased dramatically when treated with gypsum and polyacrylamide, compared to gypsum alone.**
- **Gypsum added to soils that were not treated with sodium chloride has little effect.**
- **Gypsum and polyacrylamide quickly increased soil permeability and improved soil structure of soils damaged by sodium chloride deicing salt.**

■ Decagon scholarship winner Eva Gillis-Buck.

Measuring Water Content of Compost

continued from cover

water potential of compost with varying success.

One reason for the poor accuracy of some of the measurements may be confusion over the moisture content units convention for compost. Publications generally agree on a moisture content range of 45 to 65% with 50 to 60% being optimal. They never say, though, whether this is volume or mass basis moisture, or whether it is wet or dry basis. This is not a trivial matter. Gravimetric soil moisture is, by convention, reported on a dry basis (mass of water divided by mass of oven dry soil). If a compost sample had a dry basis gravimetric water content of 50%, its wet basis water content would be 33% and its volumetric water content would be 13%. It should be obvious that merely stating a percentage is not enough. One has to specify volume or mass and wet or dry basis for the number to mean anything. Though the basis for the calculation is not specified in composting literature, example calculations indicate that the numbers given for guidelines are wet basis gravimetric water contents (mass of water divided by mass of wet compost). The basis for compost moisture reporting is therefore not the same as for soil water content.

The only direct measurement of gravimetric water content is made with a balance and an oven. Probes, like Decagon's ECH_2O dielectric sensors, measure volumetric water content. To convert from volumetric to gravimetric water content, we need to know the wet density of the compost. For conversions, please refer to the conversion chart on page 7.

An example of a calculation one might do to determine the water content of compost with a Decagon EC-5 probe follows. Assume we inserted the probe into the compost and obtained a volumetric water content reading of 21%. We fill a bucket level full with the compost at its normal density (the density in the pile) and find the weight of the compost in the bucket to be 1500 grams. The same volume of water weighs 4,000 grams. The ratio of water density to compost density is therefore the water mass divided by the mass of an equal volume of compost, or 4000/1500 = 2.7. The gravimetric water content of the compost is therefore $w_{wet} = 2.7 \times 21\% = 57\%$.

It is clear that density has a significant effect on volumetric water content. Since density changes during the composting process, one would want to make density measurements more than once to do the conversions. ■

■ Composting is Nature's way of recycling. Composting refers to a solid waste management technique that uses natural processes to convert organic materials to humus through the action of microorganisms. Compost is a mixture that consists largely of decayed organic matter and is used for fertilizing and conditioning land.

DECAGON DEVICES

Grant Harris: scientist, chairman, friend

Dr. Grant A. Harris, longtime chairman of the Decagon Board of Directors, passed away June 21, 2006, at the age of 91. His wife, Jennabee, passed away the previous December. Among the founders of the company, Grant and Jennabee traveled to trade shows to exhibit Decagon instruments for several years following his retirement as Professor and Chairman of the Department of Forestry and Range Management at Washington State University. Grant's scientific expertise and Jennabee's charm made them perfect ambassadors for the company. Grant also used his knowledge of biophysical ecology to help develop some of Decagon's early products. They are both sorely missed by the Decagon family. ■

New Face at Decagon

Laura Bresnahan is the new Marketing Communications Coordinator for the Research Agriculture Group at Decagon. Laura is responsible for ensuring our marketing campaigns are communicated effectively to you, our customers. Our Ebrochures, workshop announcements, and direct mail pieces are coordinated to keep everyone informed of what's going on at Decagon. Laura recently moved to the Palouse area from Iowa and enjoys all that Washington has to offer. ■

Water Content Conversions

w_d (kg/kg)	$w_d = \frac{M_w}{M_s}$	$w_d = \frac{w_w}{1 - w_w}$	$w_d = \frac{\rho_w}{\rho_{dry}}\theta$
w_w (kg/kg)	$w_w = \frac{w_d}{1 + w_d}$	$w_w = \frac{M_w}{M_w + M_s}$	$w_w = \frac{\rho_w}{\rho_{wet}}\theta$
θ ($m^3\ m^{-3}$)	$\theta = \frac{\rho_{dry}}{\rho_w} w_d$	$\theta = \frac{\rho_{wet}}{\rho_w} w_w$	$\theta = \frac{V_w}{V_t}$

Definitions

w_d	mass water content, dry basis
w_w	mass water content, wet basis
θ	volume water content
ρ_{dry}	dry bulk density (kg m^{-3}) = M_s/V_t
ρ_{wet}	wet bulk density (kg m^{-3}) = $(M_s + M_w)/V_t$
ρ_w	water density (kg m^{-3}) = 1000 kg m^{-3}
M_s	mass of dry solid
M_w	mass of water
V_w	volume of water
V_t	total volume, soil, water and air

■ Decagon's water content, temperature, and electrical conductivity probe wins the annual AE50 award for outstanding innovations. This award is given to new products that save producers time, cost and labor while improving user safety and operating in an environmentally-friendly fashion.

DECAGON DEVICES
950 NE Nelson Court
Pullman, Washington 99163

The Wacker family diligently researched turn-of-the-century barn designs to get authentic proportions and symmetry of the windows. They then built an unconventional home like a barn—right down to the red metal siding and gambrel galvanized roof and silo.

The concepts and theory of Decagon's instruments are, also, genuinely researched—the end result is functional, practical, and fairly priced.

Good luck in your research—or heaven forbid—home building this year.

Bryan Wacker

P.S. Ask me about our teaching aids for Decagon's soil moisture probes.

Cable Armor Protects your Sensors and Data

Have you ever had an ECH_2O probe that wasn't recording data, only to find the true problem was a rodent had been chewing on your instrument cables? Rodents can cause damage to your instrument cables, thus causing you to lose essential data. Decagon offers just the solution- Rodent-Resistant Cable Armor, which will help you protect your instrument cables from rodents. The easy to install rodent-resistant

plastic shield surrounds your sensor cables to protect them from penetration. The Cable Armor includes a tool which makes threading the Echo probe cable fast and easy. Call us today for a quote at 800-755-2751/USA & Canada or 509-332-2756 Internationally, or email us at sales@decagon.com ■