UW-WyCEHG Ecohydrogeophysics (EHG) Course
Summer 2013 – Summer 2016
EHG Timeline

2013 – UW & Jackson St. Univ. students participate in Laramie, WY, Late June 2013 – 14 attendees (7 – UW & 7 - JSU), 5 UW Faculty Instructors, 2 UW Staff, Blair-Wallis, and Snowy Range sites.

2014 – UW & Jackson St. Univ. students participate in Jackson, MS, May 2014 - 15 attendees (8 – UW & 7 - JSU), 5 UW Faculty Instructors, 1 JSU Faculty, 3 UW Staff, Collaboration with USACE-Vicksburg at Buck Chute site.

2015 – UW & HBCU students participate in Laramie, WY, May/June 2015, course restricted to 12 – 11 attendees (4 - UW & 7 – HBCU), 1.5 UW Faculty Instructors, 2 Graduate TA’s, 1 UW Staff, Blair-Wallis site.

2016 – UW & HBCU students participate in Laramie, WY, Late July 2016, course restricted to 12 – 13 attendees (11 – UW & 2- HBCU), 1 UW Faculty Instructor, 3 Graduate TA’s, Blair-Wallis site.

2017 – Not Offered
EHG Goals/Learning Outcomes

• In the beginning (2013 & 2014), the course was exclusively available to UW and Jackson State Univ. (MS) students. Students were exposed to the various methods & tools for studying the sciences of Ecology, Botany, Surface Hydrology, and Geophysics. The four sections of the course were independent and little integration between the disciplines was required of the participants.

• At the end (2015 & 2016), the course was opened up to students from any HBCU in the U.S. Additionally, the course objective was to integrate Ecological, Botanical, Hydrological and Geophysical methods to investigate, image and map the surface and subsurface water distribution/movement as it exists and influences the plant life, root zone and upper soils at a predetermined site.
  - Simply put, students attempt to quantitatively solve the water balance for the site and evaluate those results within the framework of an hypothetical future scenario/condition at that same site (e.g. fire, road construction, pumping well installation, etc.).
Earth is a closed system which means it has a continuous water cycle.
EHG Instructors & Participants

Instructors:
2013 – Brad Carr, Brent Ewers, Steve Holbrook, Scott Miller, Dave Williams, Liz Nysson, Jordan Hayes, Brady Flinchum

2014 – Brad Carr, Brent Ewers, Ezat Heydari (JSU), Steve Holbrook, Scott Miller, Dave Williams, Liz Nysson, Suman Chitrakar.

2015 – Brad Carr, Dave Williams, Liz Nysson, Suman Chitrakar, Heather Speckman


Student Attendees:
University of Wyoming – 30
Jackson State University – 17
Howard University - 3
North Carolina A&T - 1
Southern University - 1

Major/Emphasis:
Ecology - 4
Botany - 3
Hydrology - 9
Earth Science - 13
Civil Engineering - 14
Computer Sci – 6
Atmospheric Sci – 1
Petroleum Eng. - 1

Graduate/Undergraduate:
Graduate – 14
Undergraduate - 38
Field Methods
Geophysics

Objective: Collect and analyze DC Resistivity Data

AGI Super Sting R8/IP/SP Resistivity Meter

- Water table, bedrock depth and structure
- Use pole dipole method
Hydrology

Objective: Figure conductivity, turbidity, and streamflow

HOBO Conductivity Data Logger+Salt Slug
- Two separate sections, 200 grams NaCl each

OTT MF-Pro
- Stream discharge for cross section

Photo Credit: www.hobodataloggers.com and Dan Beverly
Ecology

Groundwater wells
- Contained pressure transducer

Sapflow Sensors
- Granier-type sapflow sensors

Meteorological Tower
- Eddy Covariance, vertical wind speeds
- Sonic Anemometers: sensible/latent heat flux
Ecology: Water Isotopes

Collect a variety samples to later extract water isotopes in the Stable Isotope Facility

- Surface/Ground Water
- Tree Xylem
- Soil
Ecology: Vegetation

Pressure Bombing

- Tree samples collected and
- Dried for pressure difference

Tree Core Collection (sapwood)

- Aspen cores, pine cores, willow branches
Results
Hydrology

### SALT SLUG

<table>
<thead>
<tr>
<th>Date</th>
<th>Q1</th>
<th>Q2</th>
<th>Qnet</th>
<th>QNet</th>
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</thead>
<tbody>
<tr>
<td>7/19/2016</td>
<td>0.007841</td>
<td>0.008883</td>
<td>0.0010419</td>
<td>0.0021 m3/s</td>
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<td>0.007291</td>
<td>0.010694</td>
<td>0.0034031</td>
<td>1.80E+11 mm3/day</td>
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<td>7/26/2016</td>
<td>0.004095</td>
<td>0.005888</td>
<td>0.0017926</td>
<td>270.55 mm/day</td>
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### MFPRO

<table>
<thead>
<tr>
<th>Date</th>
<th>Q1</th>
<th>Q2</th>
<th>Qnet</th>
<th>QNet</th>
</tr>
</thead>
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<tr>
<td>7/19/2016</td>
<td>0.009</td>
<td>0.009</td>
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<td>-0.0010 m3/s</td>
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<tr>
<td>7/22/2016</td>
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<td>0.007</td>
<td>-0.002</td>
<td>-8.64E+10 mm3/day</td>
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<td>7/26/2016</td>
<td>0.006</td>
<td>0.005</td>
<td>-0.001</td>
<td>-130.12 mm/day</td>
</tr>
</tbody>
</table>

- **QNet calculated from Salt Slug and MFPro**
- **ΔS from Water table depths**
- **ΔS also calculated from**

-1.691926841 \( \Delta S \) [mm/day]
Geophysics

Use resistivity data from multiple days to obtain a difference in resistance and determine percent change in soil water content
Soil Water Content from Geophysical Data

<table>
<thead>
<tr>
<th>Depth</th>
<th>Electrodes</th>
<th>5</th>
<th>16</th>
<th>27</th>
<th>38</th>
<th>50</th>
<th>water content at electrode</th>
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<td>245.6</td>
<td>184.9</td>
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<td>80.2</td>
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<tr>
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<td>273.2</td>
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<tr>
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<td>267.1</td>
<td>159.6</td>
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<tr>
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</tr>
<tr>
<td>4.5</td>
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<td>4137.5</td>
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<td></td>
<td>3.061657 1.177528 3.629683 5.503114 3.445202</td>
</tr>
</tbody>
</table>
Isotope
Ecology

Tree transpiration = -0.925 mm/day

Tower ET = -2.541 mm/day
Did we close the water budget equation?

\[ P = ΔS + ET + Q_{\text{Net}} \]

\[ 0 = -1.48 + (-0.925 + (-2.541)) + (-130.12) \]

\[ 0 \neq -135.006 \text{ mm/day} \]

\[ P = 0 \text{ mm/day} \]

\[ Q_{\text{Net}} = -130.12 \text{ mm/day} \]

\[ ET = \text{Tree transpiration} + \text{Tower ET} \]

\[ \text{Tree transpiration} = -0.925 \text{ mm/day} \]

\[ \text{Tower ET} = -2.541 \text{ mm/day} \]

\[ ΔS = -1.48 \text{ mm/day from resistivity data} \]

or

\[ -1.69 \text{ mm/day from water table data} \]
Conclusions

- Water Budget Equation was not closed
  - Need more data
  - Expand study site or change area for better Eddy Covariance Tower data with wind direction

Case Scenario

- Hypothesis 1: Water storage will increase with less demand from trees/understory, at least in the case of a moderate fire or moderate thinning.
- Hypothesis 2: ET will actually increase after a moderate severity fire.
Fire starts due to lightning strike at the bottom of the study area. Replacing crown fire burns 50% of the over-story and 75% of the under that no precipitation occurs within the study area, develop a plan based on the scenario.

Some questions that could be proposed:

- How does evapotranspiration be affected by high intensity fire?
- How does discharge predicted to be affected post-fire?
- How will water storage or ground water increase or decrease post-fire?
Hypotheses

- **Hypothesis 1:**
  - The reduction in tree canopy and understory coverage from a high severity fire will increase water storage because of less water demand from trees.

- **Hypothesis 2:**
  - Evapotranspiration will decrease after the fire because of the loss of 50 percent of canopy and 75 percent of understory.
Evapotranspiration after high intensity fire

- Study site is a mixed forest with predominantly Aspen and Willow tree species, which both recover from fires by resprouting.
- After a high intensity fire in a resprouting eucalypt forest, ET has been observed to reduce up to 41%.
- ET in a forest burnt at high intensity fire does not recover until around 8-12 years post fire.
- Observed a cumulative decrease in ET of around 18% over 5 years, 13% over 10 years.

Discharge after moderate severity fire

- Surviving trees have higher rates of transpiration post fire
- Mod = $\uparrow$\(E_T\) and $\downarrow$\(Q\)
- \(E_T\) is higher at Mod. sev. site for 0-3 years post fire vs. high sev. Site
- Declines in Q due to increased \(E_T\) following moderate severity wildfire were of similar magnitude to Q declines driven by a drought that coincided with a fire.
- Greater reduction in Q is expected when wildfire occurs during prolonged dry periods

Reference: Nolan et. Al 2015
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Thank you