2010 work plan

Estimation of stand level gas exchange fluxes

E. Jung and P. Zhao
Water use by forests in Haean Catchment

Sap flow measurements in South Korea, 2010

Eun-Young Jung and Dennis Otieno
Dept. of Plant Ecology
Introduction

Water Balance of an Ecosystem
Waring and Running 1998
Introduction

How much water is used by forests in Haean catchment?

- Different Elevation
- Different Forest Structure
- Different Meteorological Condition
- Different Species Composition
- Different On/Off Set

⇒ Estimate Stand Transpiration!
2009 Result
Elevation, Forest Structure, Species Composition

<table>
<thead>
<tr>
<th>Species</th>
<th>% of Basal Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>T. amurensis</td>
<td>70</td>
</tr>
<tr>
<td>F. rhynchophylla</td>
<td>20</td>
</tr>
<tr>
<td>Q. mongolica</td>
<td>10</td>
</tr>
<tr>
<td>B. davurica</td>
<td>10</td>
</tr>
<tr>
<td>Q. dentata</td>
<td>60</td>
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</table>

Total $BA (m^2/ha) = 18.6$

Site A – 700 m, SE
2009 Result
Elevation, Forest Structure, Species Composition

Site A – 700 m, SE

Total BA (m²/ha) = 18.6

- T. amurensis
- F. rhynchophylla
- Q. mongolica
- B. davurica
- Q. dentata

Overstory BA (m²/ha) = 15.0

Understory BA (m²/ha) = 3.6
2009 Result
Elevation, Forest Structure, Species Composition

Site B – 700 m, SW

M.amurensis
A.pseudosieboldianum
Q.serrata
F.rhynchophylla
Q.dentata
T.amurensis
Q.mongolica

Total BA (m²/ha) = 22.9

% of Basal Area
2009 Result
Elevation, Forest Structure, Species Composition

Site B – 700 m, SW
Overstory BA (m²/ha) = 13.0
Understory BA (m²/ha) = 9.9
2009 Result
Elevation, Forest Structure, Species Composition

Site C – 450 m, S

P. densiflora
T. amurensis
Q. dentata
U. davidiana var. japonica
Q. aliena
Q. serrata
A. sibirica
Q. mongolica

% of Basal Area

Total BA (m²/ha) = 23.7

Site C – 450 m, S

A / B
2009 Result
Elevation, Forest Structure, Species Composition

Total BA (m²/ha) = 23.7

Site C – 450 m, S
Overstory BA (m²/ha) = 13.0
Understory BA (m²/ha) = 10.7

% of Basal Area

- P. densiflora
- T. amurensis
- Q. dentata
- U. davidiana var. japonica
- Q. aliena
- Q. serrata
- A. sibirica
- Q. mongolica
2009 Result
Stand Transpiration

Haean A

Haean B

Day
2009 Result
Stand Transpiration

Correct over-estimation of understory transpiration!

Add measurements to interpret forest stand transpiration of Haean catchment

No more data gaps!
2010 Work Plan

1. Sap flow measurements

Quantify tree water use by over- and under-story species

2 different sap flow methods

- Thermal Dissipation Probes
  \(\text{TDP, Granier 1987}\)
  \(\Rightarrow\) Overstory (DBH > 10 cm)

- Stem Heat Balance
  \(\text{SHB, Sakuratani 1981}\)
  \(\Rightarrow\) Understory (DBH < 10 cm)
2010 Work Plan

1. Sap flow measurements

Quantify tree water use by over- and under-story species

Install sap flow sensors
“15 TDP + 6 SHB
4 over + 2 understory species” at all the sites

Add “Site D” at 900m elevation

2 different sap flow methods
- Thermal Dissipation Probes
  (TDP, Granier 1987)
  ➔ Overstory (DBH > 10 cm)
- Stem Heat Balance
  (SHB, Sakuratani 1981)
  ➔ Understory (DBH < 10 cm)
2010 Work Plan
2. Site Climate and Soil Water Content monitoring

Climate condition below the canopy and over the canopy?

- Light sensors – PAR (Licor), photodiodes, HOBO
- Humidity + Temperature sensors – Funky
- Soil moisture sensors – Ech₂o (Decagon Device)
2010 Work Plan

3. Leaf Area Measurements

How leaf area changes along the seasons?

Leaf Seasonality Observation

(Nasahara et al. 2008)

1. Select sample shoots
2. Count number of the leaves on the shoot
3. Measure width and length of 20 randomly selected leaves

5 Litter Traps at each sites

50 x 50 x 50 cm
2010 Work Plan
4. Leaf Transpiration and Leaf Water Potential

What are the species-specific characteristics of water use?

Measure **Stomatal Conductance** \( (g_s) \)
- Leaf Porometer (Decagon Device)
- Examine Leaf Transpiration \( (E) \)

Measure **Leaf Water Potential** \( (\psi_L) \)
- Potable Pressure Chamber (PMS Instrument)
- Examine Hydraulic Lift

To understand *water supply from the roots* and *water loss at the leaf surface*

**Specific leaf hydraulic conductance**

\[
\frac{E}{(\psi_{pd} - \psi_L)}
\]

Otieno et al. 2005
2010 Work Plan

Achieve better understanding of species-specific water use

- Light-capture efficiencies of different species?

![Graphs showing projection and display efficiency over time for Arbutus and Heteromeles.](image)

- Smaller, steeply angled leaves (mean = 72°) in *Heteromeles*
- Relatively large horizontal leaves in *Arbutus*

*Arbutus* projects and displays more of its leaf area towards the sun than does *Heteromeles*.

*Pearcy et al.* 2005

www.bayeer.de
2010 Work Plan
6. Carbon Isotope Discrimination ($\delta^{13}C$)

Water use efficiency before / after Monsoon?

Water Use Efficiency (WUE) = the ratio of carbon gain to water use
- Maximize carbon gain when soil water was abundant
- Minimize water loss during the progressing drought

Tieszman and Archer 1990
## 2010 Work Plan
### Time Schedule

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<th>APR</th>
<th>MAY</th>
<th>JUN</th>
<th>JUL</th>
<th>AUG</th>
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<td>Sap flow measurements</td>
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<td>Site Climate and Soil Water Contents Monitoring</td>
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</table>
Summary

LONG-TERM CONTROLS

STATE FACTORS

Interactive controls

BIOTA

Plant functional types

TIME

Soil resources

PARENT MATERIAL

CLIMATE

SHORT-TERM CONTROLS

Indirect controls

Surface roughness

Boundary-layer conductance

Photosynthetic capacity

Stomatal conductance

Water-holding capacity

Net radiation / VPD

Precipitation

Water availability

Scaling factors

Leaf area

Sapwood area

Chapin et al. 2002
References


Thank you!