Complex Terrain and Ecological Heterogeneity (TERRECO): Evaluating Ecosystem Services in Mountainous Landscapes

Transpiration of Tree Species and Stands in Temperate, Mixed Deciduous Forest of S. Korea

Eunyoung Jung, Dennis Otieno, and John Tenhunen
Department of Plant Ecology, University of Bayreuth

Introduction:

About 80% of forests in South Korea occur in mountainous regions and are composed of a rich diversity of mixed deciduous tree species. For sustainable water resource management, forest hydrology research is necessary since forests play an important role in global water cycle. High diversity in tree species, however, complicates the upscaling of forest water use by mixed forests. In this study we explored how microclimatic gradients and species diversity impact overall water use and water use efficiency in forests, and identify critical forest ecosystem services, which are significant for human wellbeing.

Objectives:

1. To examine transpiration rate and seasonal pattern of individual trees and mixed deciduous forest stands
2. To determine the contributions of different tree species to overall forest water use and water use efficiency
3. Provide accurate traspiration data for watershed modelling

Research Questions:

How much water is used by forest? **Forest Transpiration / Canopy Conductance**

How is transpiration related to carbon gain? **Water Use Efficiency**

Fig1. (Left) Study site A - Spring, 2009 (Right) Study site B - Summer, 2009

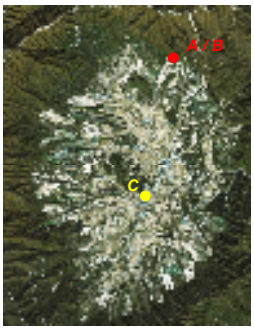

Fig2. Location of the sites

	Elevation	Slope Face	Number of Sample Trees
Site A	700 m	Southeast	15 over- + 10 understory trees
Site B	700 m	Southwest	10 over- + 5 understory trees
Site C	450 m	South	10 overstory trees

Site A	*TDP* - 5 *Quercus dentata*, 4 *Q.mongolica*, 5 *Betula davurica*, 1 *Tilia amurensis* *SHB* - 3 *Q.mongolica*, 3 *Weigela florida*, 2 *Stephanadra incisa*, 1 *Ulmus laciniata*, 1 *Symplocos chinensis*
Site B	*TDP* - 5 *Q.mongolica*, 4 *T.amurensis*, 1 *Q.dentata* *SHB* - 2 *Euonymus alatus*, 1 *Acer pseudosieboldianum*, 1 *Corylus heterophylla*, 1 *T.amurensis*,
Site C	*TDP* - 6 *Q.mongolica*, 3 *Q.dentata*, 1 *Q.serrata*

Table1. Description of the sites and sample tree species

Methods:

Environmental Factors

Meteorological Observation

Temp.
Rainfall
Radiation
VPD, etc.

Soil Water Contents

Tree Water Use

Sapflow Measurements

Fig3. (Left) Thermal Dissipation Probe (TDP) Method - Granier, 1987 (Right) Stem Heat Balance (SHB) Method - Sakuratani, 1981

Methods for Scaling up

Increment Core

Leaf Area

Litter Trap

Vegetation Map

Water Use Efficiency

Leaf Gas Exchange

δ^{13}Carbon Isotopes

Water Potential

Results:

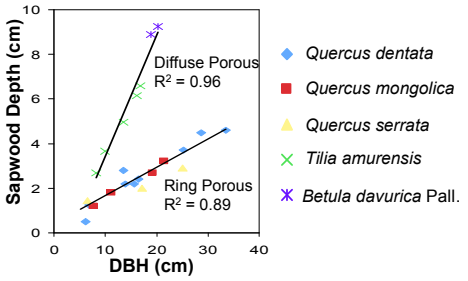

Fig4. Sapwood depth from increment core. Correlation between DBH and sapwood depth was used for estimation of tree water use from sap flux density.

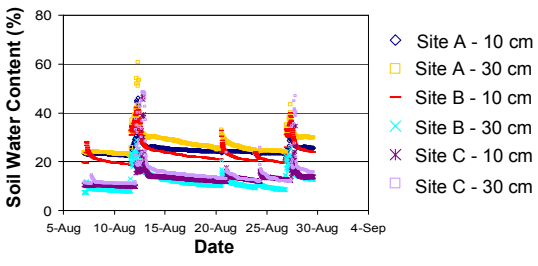

Fig5. Soil water contents of sapflow sites. Site A is wetter than site B and site C. Site C is almost 2times drier than other sites when there is no rain event.

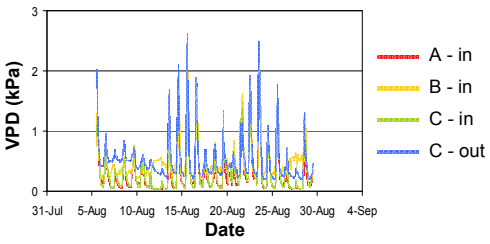

Fig6. Vapor pressure deficit (VPD) of sapflow sites. VPD was measured in the canopy about 2m height in site A, B, C, and out of canopy in site C.

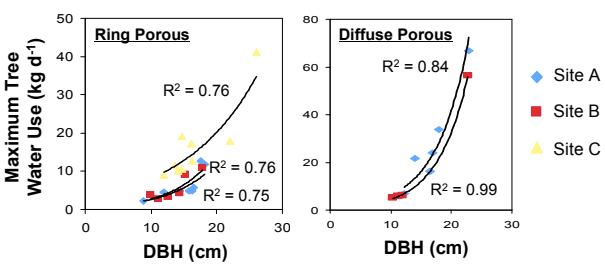

Fig7. Maximum tree water use by ring and diffuse porous trees in site A, B, C. ring porous trees in site C tend to use more water than site A and B.

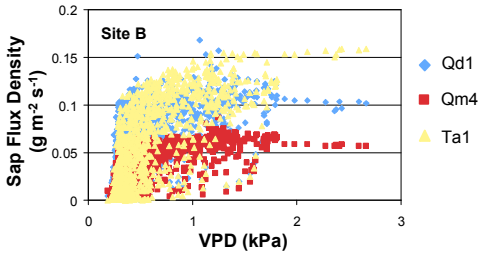

Fig8. Sap flux density (SFD) of trees in site B and VPD. SFD increase with VPD, but maximize when VPD is about 0.4 kPa.

References:

Granier, A., 1987. Evaluation of transpiration in a Douglas fir stand by means of sap flow measurements. *Tree Physiol.*, 3, 309-320

Sakuratani, T., 1981. A heat balance method for measureing water flux in the stem of intact plants. *J. Agric. Meteorol.*, 37, 9-17.

Contact: eun-young.jung@uni-bayreuth.de
dennis.otieno@uni-bayreuth.de