# Application for 2009-2010 TWRI Mills Scholarship

**Di Long**

**Department of Biological & Agricultural Engineering**

| Applicant: Di Long, PhD student<br>Address:<br>E-mail:<br>Phone number: | Advisor: Dr. Vijay P. Singh<br>Address: Scoates Hall 321<br>E-mail: vsingh@tamu.edu<br>Phone number: (979)-845-7028 |
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**Proposed Research**

**Estimation of actual evapotranspiration across the state of Texas from remote sensing data**

Evapotranspiration (ET), including evaporation from the soil surface and vegetation transpiration, is a key variable for water and energy balances on the Earth's surface. Main methods (e.g. lysimeter) used conventionally to measure ET are subject to individual, field or landscape scales, but regional/watershed ET cannot be measured directly or interpolated due to inherent high heterogeneity of the land surface at different spatial and temporal scales. Therefore, quantifying ET of the land surface at different spatial and temporal scales has become a central focus in hydrology and water resources communities especially after the advent of satellite technology (Allen et al., 2007).

The state of Texas has an area of 685,000 $km^2$ and a population of 21 million people. Climate, terrain and water management of Texas show a high variability and heterogeneity from the arid west to humid east (Wurbs, 2005). Desert mountains in the west have mean annual precipitation of around 200 mm; the forest sections in the east have mean annual precipitation of around 1,500 mm. In an average rainfall year, it is estimated that about 42% of the precipitation falling on Texas evaporates directly back into the atmosphere and about 47% is lost through vegetation transpiration (Arnold et al., 1999). That means ET accounts for around 90% of the precipitation across this state. Population and economic growth combined with depleting ground water reserves have resulted in increasing demands on surface water resources throughout the state (TWDB 2002). To quantify the magnitude and distribution of actual ET of Texas is critical for evaluating hydrological and institutional water availability and reliability for water supply diversions, municipal, industrial, agricultural and recreation uses, environmental instream flows, hydroelectric energy generation, and reservoir storage. Traditionally, lumped ET for a watershed at yearly scales could be pragmatically obtained with the water balance equation combining the precipitation of a watershed from hydro-meteorological stations within or adjacent the watershed and the streamflow at a gauge station. However, detailed information on distributions of ET amount across a variety of land covers and crop systems could not be derived in terms of this methodology. Remote sensing-based models tend to capture spatially consistent and reasonably distributed ET estimates across large heterogeneous areas. The ET outputs will thus assist professionals in quantifying detailed distributions and magnitudes of ET of Texas.

During the 20th century, the average temperature of the United States rose by about 0.6°C (Wurbs et al., 2005). It is expected that a significant increase in average temperature of 3 to 5°C in the U.S would occur in the 21th century (National Assessment Synthesis Team, 2000). The temperature rise may cause variations in hydrological variables like more extreme precipitation and faster evapotranspiration, therefore significantly impacting water resources availability, uses of water on irrigated and non-irrigated agricultural lands in Texas.

The proposed research aims to derive distributions of actual ET over Texas from a remote sensing-based model SEBAL (Bastiaanssen, 1998) using free MODIS (Moderate Resolution Imaging Spectroradiometer) data products in conjunction with ancillary meteorological data. The outputs will benefit orderly planning, development, management, and conservation of the water resources including water availability assessment, water resources allocation, irrigation water supplying planning, and crop water consumption estimation in Texas. In addition, time series of estimates of actual ET (e.g. 10 years) will help to quantify the effects of historical climate change on ET and to evaluate the impact of the variation in actual ET on agricultural water use, assisting decision-makers in developing reliable water management strategies under possible climate change scenarios in the future.

## References


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Arnold, J. G., Srinivasan, R., Ramanarayanan, T. S., and DiLuzio, M., 1999. Water resources of the Texas Gulf Basin. Water Science and Technology, 39 (3):121-133.

Bastiaanssen, W.G.M., Menenti, M., Feddes, R.A. and Holtslag, A.A.M., 1998. A remote sensing surface energy balance algorithm for land (SEBAL) - 1. Formulation. Journal of Hydrology, 213(1-4): 198-212.

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Texas Water Development Based (TWDB). 2002. Water for Texas. Document No. GP-7-1, Vols. I-III, Austin, Texas.

Wurbs, R. A., Muttiah, R. S., Felden, F. 2005. Incorporation of climate change in water availability modeling. Journal of Hydrologic Engineering-ASCE, 10(5):375-385.


## Academic Qualifications

| Course taken | Grades | Course taken | Grades |
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| Undergraduate GPR | | | |
| Graduate GPR | | | |
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## Proposed use of funds & Intended career path

The potential funds are to assist the applicant in attending academic conferences for presenting the outcome of the proposed research and paying fees for 2009-2010 academic years. The applicant is intended to be a faculty or an engineer after completing Ph.D to help address water resources-related problems in Texas and the U.S.