American Water Resources Association
2009 SPRING SPECIALTY CONFERENCE
Managing Water Resources Development in a Changing Climate
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Wednesday, May 6
1:30 PM – 3:00 PM
Session 33: Changing Energy and Water Balances

1. Impacts of Climate Variability and Change on the Energy and Water Balance of a North Temperate Lake - John Lenters, University of Nebraska-Lincoln, Lincoln, NE (co-authors: Kathleen D. Holman, Jun Wang)

Variations in climate have a significant impact on the energy and water budgets of lakes. These impacts are being monitored in the lake-rich region of northern Wisconsin where, like elsewhere, the climate has been getting warmer in recent decades. In this study, we focus on the effects of climate variability and change on the summertime energy and water balance of Sparkling Lake, a 64-ha inland lake with a mean depth of 11 m. A recent analysis of over two decades of data has shown that not only is the climate of the region getting warmer, but also reductions in cloud cover have led to increased solar radiation at the lake's surface. Together with decreases in relative humidity, these trends have combined to produce significant increases in lake temperature and evaporation, along with notable interannual variations. In addition to the observational data analysis, a simple energy balance model is developed to isolate the relative impacts of increasing air temperature and decreasing cloud cover on the trends in lake physical variables. The results of this study highlight the need to understand multiple atmospheric drivers of lake dynamics, as some factors may be as or more important than trends in air temperature alone.

2. The Importance of Air Mass Condition on Energy Fluxes at a Coastal Arctic Wetland - Anna Liljedahl, University of Alaska, Fairbanks, Fairbanks, AK (co-authors: Larry Hinzman, Yoshinobu Harazono, Donatella Zona, Walter C. Oechel)

A large portion of the Arctic tundra lies within the influence of the Arctic Ocean. Maritime and continental air masses affect local surface energy balance partitioning and the water cycle mainly through evaporation/condensation rates and near-surface air convection. The coastal environment may therefore experience drastically different partitioning of the energy and water fluxes than the interior Arctic regions, and hence, show separate hydrological and thus climatological responses to climate change. Heat fluxes measured over two drained lake basins by the eddy covariance method during five summers in Barrow, Arctic Coastal Plain, Northern Alaska, confirm the general dominance of sensible heat flux over latent and ground heat flux. In Barrow, the summer wind was directed from sea to land 90% of the time, which defines a steady sea breeze induced by the 24-hour solar heating of the land surface. The cool, moist maritime air limited diurnal variations in air temperature and air vapor pressure deficits, favoring sensible heat flux and suppressing latent heat flux. The introduction of cool maritime air above the tundra surface, which receives a large solar radiation input and hence warms, result in a large temperature gradient that favors the convection of air (sensible heat flux). Simultaneously, the nearly saturated maritime air has a limited capacity to carry additional moisture. Only a few days experienced latent heat fluxes larger than sensible heat flux, which coincided with unusually high air vapor pressure deficits and temperatures. Future summer air mass conditions at Barrow are likely to continue to be dominated by a 24-hour sea breeze. Therefore, we could expect vapor pressure deficits and diurnal air temperature variations to continue to be low, which limits future changes of latent heat flux rates and hence, may result in more resilient wetlands along the terrestrial coastal margin than in the interior tundra.

3. Glacier Variability in the Wind River Range and Teton Range, Wyoming, USA - Derrick Thompson, University of Wyoming, Laramie, WY (co-authors: Jake Edmunds, Glenn Tootle, Jeb Bell, Greg Kerr)

The Wind River Range (WRR) is an unbroken 160-kilometer barrier in west central Wyoming that is host to 63 glaciers, the largest concentration of glaciers in the American Rocky Mountains while the Teton Range (TR) is primarily located in the Grand Teton National Park. These glaciers serve as natural water reservoirs and the continued recession of glaciers will impact agricultural water supply in the region. Previous research determined that the glaciers in the WRR contribute approximately 30% of the total streamflow volume during the critical late summer / early fall growing season. However, the previous research was limited in scope to a small number of climatic stations and limited streamflow measurements. The proposed research improves on previous research by evaluating glacier recession in the WRR and TR using remote sensing techniques. Glacier area and terminus position for 42 glacier complexes in the WRR (from 1985 to present) and four glacier complexes in the TR will be evaluated using LANDSAT Imagery and GIS techniques. Next, for selected glaciers, aerial photograph stereopairs will also be obtained from the USGS Earth Resources, Observation and Science (EROS) Data Center in Sioux Falls, South Dakota from 1966 to present. The stereopair images will be utilized to derive the surface elevation of glaciers and calculate volume change. Traditional methods require the user to view the two photos with a stereoscope to view an object in three dimensions. Modern techniques allow this process to be completed digitally. Leica Photogrammetry suite is used to specify the spatial coordinates of each photo and create a block file, a file that consists of two or more photographs of the same area that contain spatial coordinates of each photo. Once the block file is created, the user can view the objects contained in the overlapping portions of the photos and make vertical measurements. This process allows the user to calculate changes in surface area and changes in elevation, thus volume changes can be computed. Glacier meltwater contributions during the critical late-summer / early-fall seasons will be estimated.

4. Implementation of a GRTS Survey Design for Monitoring the Impacts of Climate Change on Aquatic Resources in Alaskan National Parks - Trey Simmons, National Park Service, Fairbanks, AK

The National Park Service Inventory and Monitoring Program is a nationwide effort focused on developing robust programs for monitoring status and trends in park ecosystems. As part of this effort, the Central Alaska Network Flowing Waters program is developing an ecohydrological monitoring program for the streams and rivers of 3 large Alaskan National Parks, totaling 22 million acres of mostly roadless wilderness, with an emphasis on detecting effects of climate change. The program combines intensive chemical, physical and biological monitoring, including continuous temperature and discharge measurements, at a small set of accessible index sites with low-intensity synoptic monitoring at a large number (100) of remote sites. To maximize spatial inference to unsampled streams, we were interested in using a spatially balanced, probabilistic survey design to select the synoptic sites. The EPA Environmental Monitoring and Assessment Program developed such a design, the Generalized Random Tessellation Stratified (GRTS) design, to ensure maximal inference for the Wadeable Streams Assessment, a nationwide biological water quality assessment. We used an version of the National Hydrography Dataset (NHD) for Wrangell-St. Elias National Park and Preserve, edited in house, to generate GRTS samples using the spsurvey library in R. The GRTS was stratified by accessibility (as derived from GIS data) and weighted by stream size to maximize the cost-effectiveness of the design. We used remote sensing and field reconnaissance to screen the initial list of 400 sites. 24% of sites were eliminated prior to field reconnaissance. 116 of the remaining candidate 307 sites were assessed in the field, and 40 (34%) were either sampled or determined to be sampleable and accessible either by foot, fixed-wing aircraft or helicopter. Based on this analysis, we have been able to develop a tentative site list and a robust revisit design for the long-term monitoring program. We will discuss lessons learned during this process, including the challenges of designing a monitoring program for large remote parklands and substantial shortcomings in the Alaska NHD, discuss the design of the monitoring program, and review some preliminary findings from pilot data collection efforts.