Report for 2003ID10B: Improved Short Term Operational Streamflow Forecasting for Snow Melt Dominated Basins

- Conference Proceedings:
  - Brian Harshburger, Troy Blandford, Brandon Moore, Karen Humes, Von Walden, Russell Qualls, and Wenguang Zhao, 2004, Improved short-term operational streamflow forecasting for snow-melt dominated basins in Idaho, in American Association of Geography Annual Conference, Philadelphia, PA.

Report Follows

Basic Project Information

Title: Improved Short-term Operational Streamflow Forecasting for Snow-melt Dominated Basins

Project Number: KEK303
Start Date: March 1, 2003
End Date: February 28, 2004
Research Category:
Focus Category #1: SW
Focus Category #2: MOD
Focus Category #3: WQN
Lead Institution: University of Idaho

Principal Investigators:

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Problem and Research Objectives:

Most of Idaho's winter precipitation is stored as snow at high elevations and contributes to streamflow during the spring season. The timing of the accumulation and melt of the snow pack is crucial for decision-makers in federal and state agencies, as well as Idaho citizens whose livelihoods are directly affected by water availability (for example, farmers and tourism operators).

The objective of this project is to develop a short-to-medium range forecast system for streamflow prediction within small basins in the state of Idaho. This research is highly applied and is intended to bridge the gap between models in the hydrological and meteorological research communities, utilize newly available satellite data products, and fulfill the needs of operational agencies. This project is organized into three main activities: (1) Evaluation and validation of meteorological forecasts for use by the Snowmelt Runoff Model (SRM), (2) Validation of SRM on representative basins using actual surface and streamflow observations (retrospective analysis), (3) Development of an interface between SRM and meteorological forecast model output, real-time data from surface observations, and operational snowcover data (MODIS) from remote sensing.

Methodology:

The Snowmelt Runoff Model (SRM) is used to simulate and forecast daily streamflow in high-resolution (catchment scale) sub-basins of the Snake River (Big Lost and Big Wood River Basins). Model inputs include both forecasted and actual surface observations of precipitation, temperature and snow-covered area (SCA). SRM is a quasi-distributed model, thus input values are distributed among several hydrologic response units (HRUs) within the watershed. Several disaggregation schemes are being evaluated to determine the best way to divide up the basin into HRUs (slope, aspect, elevation, land cover, etc.). Spatial interpolation schemes, which incorporate topographic information, are being used to convert point-based ground measurements of precipitation and temperature into aerial values. This includes both the use of synthetic stations (a spatial weighted average of all stations located in each basin) and other more contemporary methods (i.e. detrended kriiging, PRISM). These values are used in both retrospective analyses (to fine tune the model) and to update the model in forecast mode. Retrospective analysis is used to identify the optimal parameter values (degree-day factor, runoff coefficients, etc.) for input into SRM. This provides a set of pre-tested values, which are needed to run the model in forecast mode. Real-time forecasts of meteorological variables, such as temperature and precipitation, will eventually be incorporated into SRM, to predict streamflow for one to two weeks into the future.

Principal Findings and Significance:

We have evaluated several different approaches for incorporating meteorological forecasts into SRM. We have chosen to use model results produced by NOAA's Climate Diagnostics Center (Hamill et al., 2004) rather than our original plan to use either MM5 results from the University of Washington or NOAA's Eta Meso-west model. The reasons for this decision are that the CDC model produces 2-week forecasts rather than the shorter-term forecasts produced by the MM5 and Eta Meso-west models. Also, the CDC model has a long historical forecast record (1978-current), which can be used to "downscale" the forecast model output to individual meteorological stations within snowmelt basins. We plan to use the downscaling procedure outlined by Clark et al. (2004) to provide meteorologic forecasts because they've demonstrated good results in snowmelt-dominated basins in the West.

The results from the retrospective model runs indicate that SRM accurately simulates both the timing and magnitude of stream discharge peaks within the snowmelt season. This includes both the peak flow and other (much smaller) discharge events. The average R^2 value for the retrospective model runs was approximately 0.93 with an average volume difference of 7%. The shape of the simulated hydrographs were similar to the actual, however the modeled recession limbs tended to be less steep than the actual. We have also evaluated several basin disaggregation and spatial interpolation methods, with varying degrees of success; however further analysis is needed.

We have preliminarily tested the model to assess its medium range forecasting ability. A forecast was issued for a one week period in April. In doing this, we have successfully integrated various data into SRM, including MODIS snow-cover images and temperature and precipitation forecasts issued for a single location within the Big Wood River Basin.

References:

Hamill, M., J.S. Whitaker, and X. Wei, 2004: Ensemble Forecasting: Improving medium range forecast skill using retrospective forecasts. *Monthly Weather Review,* 132, 1434-1447.

Clark, Y.M., S. Gangopadhyay, L. Hay, B. Rajagopalan and R. Wilby, 2004: The Schaake Shuffle: A Method for Reconstructing Space-Time Variability in Forecasted Precipitation and Temperature Fields. *Journal of Hydrometeorology,* 5, 243-262.

Descriptors:

Articles in Refereed Scientific Journals: N/A

Book Chapters: N/A

Dissertations and Theses:

"Improved Short-term Operational Streamflow Forecasting for Snow-melt Dominated Basins in Idaho", by Brian Harshburger, PhD in progress

"The evaluation of the lapse rate and advanced spatial interpolation methods for input into SRM ", by Troy Blandford, M.S. in progress

"The evaluation of meteorologic forecasts for input into SRM", by Brandon Moore, M.S. in progress

Water Resources Research Institute Reports: N/A

Conference Proceedings:

AAG 2004 abstract: "Improved short-term operational streamflow forecasting for snow-melt dominated basins in Idaho", by Brian Harshburger, Troy Blandford, Brandon Moore, Karen Humes, Von Walden, Russell Qualls, and Wenguang Zhao.

Other Publications: N/A