Drought Research Initiative Special Section on Evapotranspiration

John Pomeroy, Ron Stewart, and Richard Lawford

Drought is ubiquitous and often severe in the Canadian Prairies and a common occurrence in other regions of the country. Drought has played an important role in shaping water resources management over the settled history of the Canadian Prairies and concern for future droughts guides policy and management over the whole region. In response to the major drought of 1999-2004 in western Canada, the Drought Research Initiative (DRI) network was formed (www.drinetwork.ca). DRI is a university and government research network funded by the Canadian Foundation for Climate and Atmospheric Sciences (CFCAS). The overall objective of DRI is to better understand the physical characteristics of Canadian Prairie droughts and the processes influencing them, and to contribute to their better prediction, through a research program focussing on the recent severe drought that began in 1999.

Evapotranspiration is extremely important to prairie droughts and hence to the DRI Network. Evapotranspiration is also notoriously poorly defined and difficult to calculate and measure as it takes place between the interface of the atmospheric, hydrological, soil and plant systems and has a large spatial variability. Estimates of evapotranspiration have considerable variance due to uncertainty and differences in calculation schemes, definition of the process, parameter estimation, tracking of state variables, available forcing meteorology, advection, and atmospheric feedbacks. Uncertainty in estimating evapotranspiration as a region such as the Canadian Prairies enters and leaves drought is particularly large. During non-drought years there is typically an excess of precipitation over evapotranspiration in the Prairies. This excess permits the generation of streamflow from small prairie creeks and rivers and replenishes storage in soil moisture, ponds, depressions and larger lakes and in groundwater. During a drought, actual evapotranspiration may exceed precipitation on an annual basis, resulting in withdrawal of significant amounts of stored water from the surface and subsurface to the atmosphere. Evapotranspiration during a drought is a critical part of the link between atmospheric drought and hydrological and agricultural droughts. However the link between precipitation, storage, streamflow and evapotranspiration is not straightforward on the Prairies because of the strong seasonality of the climate. Precipitation accumulating as snow in late fall, winter and early spring seasons occurs during a time of low energy inputs and hence can easily exceed seasonal evapotranspiration, even in a drought. Subsequent late spring and summer evapotranspiration normally consumes not only the seasonal precipitation but water stored in the previous cool seasons. There is evidence that during droughts the nature of prairie evapotranspiration changes with increasing water scarcity; water bodies disappear, soils crack, aquifers disconnect from the surface, aspen die back, more land is fallowed, and perennial grass roots grow deeper. The challenge for DRI has been to contribute to a better understanding and description of evapotranspiration during droughts and to examine
if better calculations of evapotranspiration will help in prediction of droughts and their impacts.

The papers in this special section were presented at a DRI Evapotranspiration Workshop held at the University of Saskatchewan, Saskatoon in 17 May, 2007 (http://www.drinetwork.ca/07evap/index.php). The goals of the workshop were to:

i) review the current biophysical understanding of the process of evapotranspiration from various surfaces as it relates to drought conditions (including onset and cessation of drought);

ii) evaluate numerical methods for calculating actual evapotranspiration from unsaturated and saturated, frozen and unfrozen surfaces under a variety of atmospheric conditions with particular attention to the purpose, scale, performance, and parameter needs of various methods;

iii) examine alternative means of estimating evapotranspiration parameters and rates using remote sensing, data assimilation, novel model strategies, improved theory, and biophysical methods;

iv) recommend a course for DRI and allied research that will reduce uncertainty and improve accuracy in evapotranspiration estimates for atmospheric and hydrological models.

Of the 16 papers presented at the workshop, a selection were prepared for submission to the Canadian Water Resources Journal and follow in this issue. These papers received the normal reviewing and editing procedure led by the CWRJ editors with the help of anonymous referees, for which we are very grateful. The paper by Alavi et al. (this issue) discusses the improvements in calculating actual evapotranspiration in a land surface scheme when the variability of soil moisture information is taken into account. The paper by Armstrong et al. (this issue) and Hayashi et al. (this issue) also discuss soil moisture considerations, but this time within hydrological and agricultural models, showing how information on soil moisture and its impact on water availability is necessary to accurately estimate actual evapotranspiration during drought conditions. Brimelow et al. (this issue) evaluate the calculation of actual evapotranspiration in an agricultural hydrometeorological model and the role of stomatal resistance and crop phenology in model performance. The papers show the remarkable breadth and exciting new developments in the study of evapotranspiration, not only with regard to its process and prediction but also its impact on the climate and agriculture. They show how the goals of the workshop have been addressed and, together, have provided a course for DRI to reduce uncertainty and improve accuracy in evapotranspiration estimates.

References


