



Canadian Foundation for Climate
and Atmospheric Sciences (CFCAS)
Fondation canadienne pour les sciences
du climat et de l'atmosphère (FCSCA)

2007 DRI Progress Report

Project Title:

Investigator: Masaki Hayashi

1.0 Progress (beginning January 2007 to end December 2007)

1.1 Describe progress towards meeting the project objectives for those theme areas where you have received funding for 2006-2007. How are the original milestones being met (be specific)? List the key objectives and results achieved to date as well as any relevant application(s) of the results.

1.1.1 Objectives

The overall objective of the Drought Network Initiative (DRI) is *to better understand the physical characteristics of and processes influencing Canadian Prairie droughts, and to contribute to their better prediction, through a focus on the recent severe drought that began in 1999.*

To address this overall objective, the Network is focussed on complementary and cross-cutting research objectives that correspond to the following themes:

- 1. Theme 1: Quantify the physical features of this recent drought:**
 - a) spatial and temporal features,**
 - b) flows of atmospheric and terrestrial water and energy into and through the region, and their storage and redistribution within the region.**

Theme 1 (20 %)

A brief survey of the Alberta Environment Groundwater Observation Well Network (GOWN) indicated that the groundwater level was steadily going down in some regions, presumably due to over pumping, and the effects were particularly pronounced during the drought. We started a case study examining the relation among groundwater level, water usage, and meteorological forcing in southern Alberta. This type of study is very important for understanding the impacts of drought on groundwater resources and its sustainability.

- 2. Theme 2: Improve the understanding of the processes and feedbacks governing the formation, evolution, cessation and structure of the drought.**

Theme 2 (70 %)

We continued with the detailed process study at the West Nose Creek watershed focusing on; 1) snowmelt, 2) evapotranspiration, and 3) soil water balance and groundwater recharge. For snowmelt processes, the data analysis showed the importance of sensible heat inputs for mid-

winter snowmelt events driven by the Chinook. For evapotranspiration and soil water balance, the flux data collected by an eddy covariance system indicated that plant roots tend to access deeper soil water as the surface soil becomes dry, resulting in the upward flow of soil water from the water table. These findings have significant implication for the modeling of land-atmosphere exchange of water and energy.

3. Theme 3: Assess and reduce uncertainties in the prediction of drought and its structure.

Theme 3 (10 %)

Our objective for Theme 3 is to develop a groundwater recharge model and couple it with existing groundwater flow model. The coupled model will provide an effective tool for the prediction of drought impacts on groundwater resources. In 2006, we selected the Versatile Soil Moisture Budget (VSMB) model as a prototype of recharge model. The VSMB is used operationally by the DRI partners, Alberta Agriculture and Food (AAF) and Prairie Farm Rehabilitation Administration (PFRA). Therefore, any improvement made on the VSMB by DRI will directly benefit these partners. In 2007, we made improvements in potential evaporation and snowmelt modules of the VSMB, incorporating our results in Theme 2.

1.2. What contributions have you made, if any, to the unfunded themes of DRI through support in kind.

Theme 4: Compare the similarities and differences of the recent drought to previous droughts over this region and those in other regions, in the context of climate variability and change.

Theme 5: Apply our progress to address critical issues of importance to society.

1.3 Describe you plans for research during the coming year and the following year and outline how the expected results will support the deliverables and goals of DRI.

We will continue to conduct process studies and data analysis at the West Nose Creek watershed (Theme 2), further improve the VSMB (Theme 3), and start coupling it with a groundwater flow model. We will also expand the case study on groundwater level change before, during, and after the drought (Theme 1). The expected results will improve our understanding of the feedback among meteorological forcing, soil moisture, and groundwater. The improved understanding will feed into integrated models of surface water and groundwater, which will be used to examine the response of surface and groundwater resources to meteorological forcing during droughts.

2.0 Impact

2.1 Describe the significance / impact of the results achieved to date and how this new knowledge has influenced research policy, enhanced research collaboration or competitiveness, or helped attract or train skilled personnel.

Address the following items, as appropriate:

- **The impact of the project on government policy development (federal, provincial or municipal);**

As part of the DRI project, we developed the methodology for implementing locally-based groundwater monitoring network in the West Nose Creek pilot study. The methodology has been adopted by the Municipal District of Rocky View, who is in the process of implementing the district-scale groundwater monitoring network.

- **How the project has expanded contacts in partner organizations, or increased cross-disciplinary cooperation;**

We are working with AAF and PFRD, both DRI partners, to improve the VSMB model.

- **Whether and how it has improved the reliability of predictive methods;**

Our study will result in the improved reliability of the VSMB model.

- **The impact of the project on your own institution;**

Hayashi was granted Canada Research Chair in Physical Hydrology in November 2007, partly in recognition of his work conducted as part of the DRI project.

- **Whether and how the project has helped increase funding from other agencies, or led to new partnerships;**

A grant from the Canada Foundation for Innovation was approved in November 2007 for establishing a hydrological observatory at the West Nose Creek.

- **Any current (or potential) commercial or social applications, which the results may have;**
- **Links with international initiatives and the potential impact of these;**
- **Anticipated benefits of the work for Canadians.**

3.0 Dissemination

- 3.1 Provide information on dissemination of the research results (publications, including journal names and whether refereed), conference contributions, seminars, workshops or videos, websites or other methods of transferring the results.**

Refereed journal

Grieff, L.A. and Hayashi, M. Establishing a rural groundwater monitoring network using existing wells: West Nose Creek pilot study, Alberta. Canadian Water Resources Journal (in press, December 2007 issue).

Conference presentations

Hayashi, M. Effects of wet-dry cycles on groundwater sustainability in the prairies. Drought Research Initiative Workshop, Winnipeg, January 11-13, 2007.

Hayashi, M. Rural water well monitoring program for sustainable groundwater development: West Nose Creek study. Bow River Watershed Science Forum, University of Calgary, May 1, 2007. [invited]

- Hayashi, M. Evaluation of ET modules in the Versatile Soil Moisture Budget in the West Nose Creek Watershed. Evaporation Workshop for Drought Research Initiative, University of Saskatchewan, May 17, 2007.
- Hayashi, M. and van der Kamp, G. Using prairie pothole analogues to understand the hydrological response of closed lake systems. Annual Meeting of the Geological Society of America, Denver, Colorado, October 28-31, 2007.
- Jackson, J., Chen, R. and Hayashi, M. Testing the Versatile Soil Moisture Budget model for groundwater recharge estimation in a northwest Canadian Prairie setting. Joint Annual Meeting of the Canadian Meteorological and Oceanographic Society, Canadian Geophysical Union, and American Meteorological Society, St. John's, Newfoundland, May 28 - June 1, 2007.