Snow Surveys and Hydrometeorology Data Collection in 2009 Winter Field Season at Smith Creek Basin

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This report describes the data collection being conducted in 2009 winter field season at Smith Creek Basin. The data collection consists of two components: snow surveys and hydrometeorology. The following sections explain the procedures of collecting these data and show a comparison to the data from last winter field season.

1. Data Collection Procedures

1.1 Snow Surveys

Three times of snow surveys were conducted through the winter of 2009. For each time, 420 samples of snow depth and 102 samples of snow density were collected from 18 field transects. The transects spread across basin and consists of various land use: fallow, stubble, grassland, woodland, wetland, river channel, and roadside ditch. The transects are in the vicinity of the main weather station, rain gauge and wetland water level monitoring sites. The UTM coordinates of the main weather station, rain gauge and wetland water level monitoring sites are shown in Table 1. These sites are also illustrated on the basin map (Figure 1). Each transect except for woodland transect has 25 points of snow depth measurements at about 5-metre interval and five points of snow density measurements for every other four snow depth points. Woodland transect has 10 points of snow depth measurements and two points of snow density measurements having the same spatial dimension. A 1-metre metal ruler was used to measure snow depth; gravimetric method was employed in place to determine snow density, using ESC30 red handle snow tube and weighing scale (BSE 87-012). The tare of snow tube (W_{tare}, in g) and weight of snow tube with snow sample (W_{snow}, in g) were measured and used with snow depth (d, in cm) to calculate snow density (ρ, in g/cm^3) based on the following equation:

$$\rho = \frac{W_{snow} - W_{tare}}{d} \quad (1)$$

The mean transect snow density (ρ_{ave}, in g/cm^3) was determined and used with snow depth to estimate snow water equivalent (SWE, in mm) according to the following equation:

$$SWE = 10 * d * \rho_{ave} \quad (2)$$

The snow survey data were compiled for the 18 transects and are shown in the spreadsheet file “Smith Creek Snow Survey 2009”.

Table 1. Snow survey transects and UTM coordinates of the nearby stations.

Snow Survey Transects	Easting	Northing
LR-3 Standing Stubble	299463	5656559
LR-3 Wetland (shrub)	299463	5656559
LR-5 Roadside Ditch	293224	5659357
LR-6 Burned Stubble	301954	5653926
LR-6 Wetland (shrub)	301954	5653926
SCR-2 Cultivated Stubble	303281	5652861
SCR-2 Grassland	303281	5652861
SCR-2 Woodland (tree)	303281	5652861
SCR-4 Grassland	298481	5665505
SCR-6 Standing Stubble	302037	5644310
SCR-6 Grassland	302037	5644310
SCR-6 Wetland (drained site)	302037	5644310
SCR-7 Grassland	298045	5652832
SCR-7 Woodland (tree)	298045	5652832
SCR-10 Standing Stubble	314375	5636004
SC-1 Grassland	308685	5642902
SC-1 Standing Stubble	308685	5642902
SC-1 Smith Creek Channel	308685	5642902

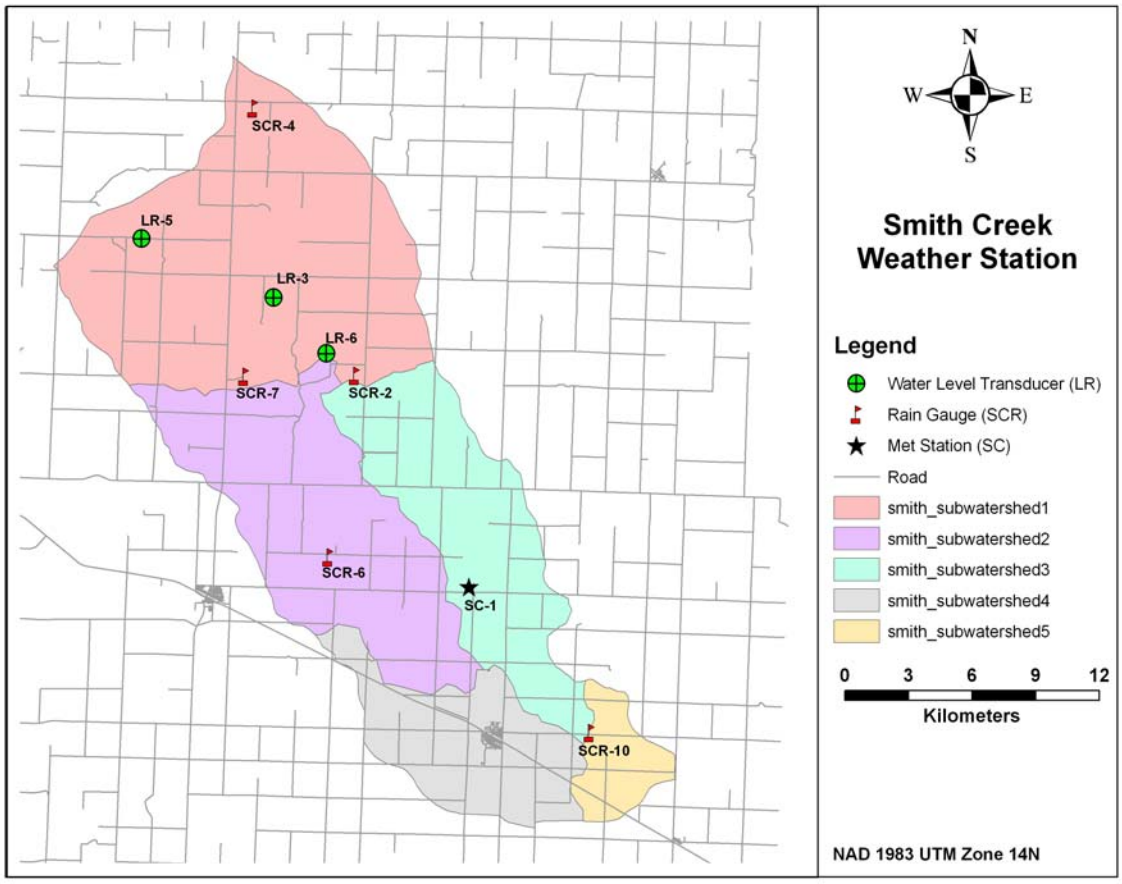

Figure 1. Snow surveys transects and the nearby stations

1.2 Hydrometeorology Data

The collection of hydrometeorology data for the 2009 winter field season was carried out at Smith Creek main weather station (SC-1). Its UTM coordinates are shown in Table 1 and the station is mapped out on the basin (Figure 1). The station was initially set up in July 2007 and completely established in November 2007 with additions of geonor gauge and station telemetry. The station provides the following measurements:

- air temperature (measured by Campbell HMP45C212 probe)
- relative humidity (measured by Campbell HMP45C212 probe)
- radiation (incoming short-wave and long-wave; outgoing short-wave and long-wave; net-all wave) (measured by CNR1 net radiometer)
- wind speed (measured by Campbell RM Young's anemometer; 2.4 m above ground)
- wind direction (measured by Campbell RM Young's anemometer; 2.4 m above ground)
- soil moisture (measured by Campbell CS616 probe, two levels: 0-10 cm and 10-40 cm)
- soil temperature (measured by Campbell 107B probe, two levels: 0-5 cm and 0-20 cm)
- snow depth (measured by Campbell SR-50 sensor; 0.86 m above ground)
- precipitation
    - all type of precipitation (measured by alter shield geonor T200B gauge)
    - rainfall (measured by Campbell TB4 tipping bucket rain gauge and standard storage rain gauge)

All the data were collected and stored with Campbell CR3000 datalogger. Downloading of the data to the university computer was via telemetry by cellular modem. The raw data were complied for the hydrological winter of 2008-09, from 1st November 2008 to 23rd March 2009 and are shown in spreadsheet file "Smith Creek Hydrometeorology Data 2009". There are three time-steps in the data collection: 15-min, 4-hour and daily. Each header of data item is described and commented in the spreadsheet file. It should be noted that the weather station was shut down during period of 23rd December 2008 to 17th January 2009 due to power failure as a result of cold snap; consequently, that resulted in a data gap in this period. Also, the daily Smith Creek weather summaries are displayed on the website, http://128.233.99.232/command=RTMC&screen=SmithCreek.

2. Comparison of Snow Surveys and Hydrometeorology Data

2.1 Snow Surveys

The mean SWE of each snow survey transect was calculated for the three survey dates of 2009 winter field season: 4th and 5th February, 3rd March, and 20th March. Also, the average SWE of the same snow survey transect was estimated for the 2008 winter field season on: 6th and 7th February, 28th February, and 20th March. The results are shown in Table 2. The survey dates between the two field seasons are nearly identical. In general, the mean SWE of each snow survey transect on all three dates in 2009 are higher than those in 2008, except for the transect of SC-1 Smith Creek Channel. That may be attributed to the fact that snow accumulation is highly variable along the channel, and a few blowing snow events can change the distribution significantly. Moreover, the

averaged SWE values of all 18 transects were calculated for both winter field seasons. On average, there are 11.1 mm, 18.1 mm, and 18.1 mm more snow accumulation on the three survey dates in the 2009 winter season, respectively, compared to the 2008 winter season.

Table 2. Comparison of snow surveys between 2008 and 2009 winter seasons.

	SWE in 2008 (mm)			**SWE in 2009 (mm)**		
Snow Survey Transects	Feb. 6th & 7th	Feb. 28th	Mar. 20th	Feb. 4th & 5th	Mar. 3rd	Mar. 20th
LR-3 Cultivated Stubble (Standing Stubble in 2009)	32.8	45.6	45.9	45.8	70.1	69.0
LR-3 Wetland (shrub)	64.8	69.8	78.5	70.2	111.7	124.9
LR-5 Roadside Ditch	54.9	92.3	52.2	62.8	104.9	109.8
LR-6 Standing Stubble (Burned Stubble in 2009)	25.0	51.3	45.5	36.9	68.7	58.3
LR-6 Wetland (shrub)	71.8	118.4	108.7	95.9	130.7	118.6
SCR-2 Cultivated Stubble	23.4	39.8	38.4	49.9	80.9	82.0
SCR-2 Grassland	55.6	75.0	64.5	53.3	79.4	79.2
SCR-2 Woodland (tree)	39.7	66.0	71.3	64.3	91.4	85.2
SCR-4 Grassland	37.9	50.5	50.3	49.1	92.7	86.1
SCR-6 Standing Stubble	52.8	48.5	47.4	53.3	71.8	69.6
SCR-6 Grassland	34.7	32.1	27.7	59.6	76.7	86.4
SCR-6 Wetland (drained site)	103.3	115.5	128.0	109.2	141.9	159.7
SCR-7 Grassland	46.3	63.0	70.3	64.9	95.3	90.0
SCR-7 Woodland (tree)	45.4	75.3	75.2	42.6	76.9	87.8
SCR-10 Cultivated Stubble (Standing Stubble in 2009)	25.4	32.4	17.2	54.4	77.9	65.8
SC-1 Grassland	46.6	58.1	61.6	61.7	102.3	95.7
SC-1 Standing Stubble	28.9	35.1	35.8	47.5	68.6	64.5
SC-1 Smith Creek Channel	105.3	314.7	380.1	73.1	166.6	192.0
Average	**49.7**	**76.8**	**77.7**	**60.8**	**94.9**	**95.8**

2.2 Hydrometeorology Data

Air temperatures during the hydrological winter period of 1st November to 23rd March for 2007-08 and 2008-09 are shown in Figure 2. The mean air temperatures during this period are -14.2 ºC and -12.9 ºC for 2007-08 and 2008-09, respectively. However, there was a data gap during 23rd December 2008 to 17th January 2009 due to power failure as a result of cold snap with air temperature consistently lower than -20 ºC; thus, the mean air temperature during the period of 1st November to 23rd March for 2008-09 would be lower if the air temperature during the cold snap was added.

In addition, cumulative daily precipitations during the hydrological winter period of 1st November to 23rd March for 2007-08 and 2008-09 are illustrated in Figure 3. The total daily precipitations are 67.3 mm and 78.7 mm on 23rd March 2008 and 23rd March 2009, respectively. It should be noted that the cumulative daily precipitation from 23rd December 2008 to 17th January 2009 is flat as shown in Figure 3; this does not mean that there was no precipitation but indicates the data gap. Also, a sharp increase on 18th January 2009 is not the daily precipitation on 18th January 2009 but is the total precipitation during 23rd December 2008 to 17th January 2009.

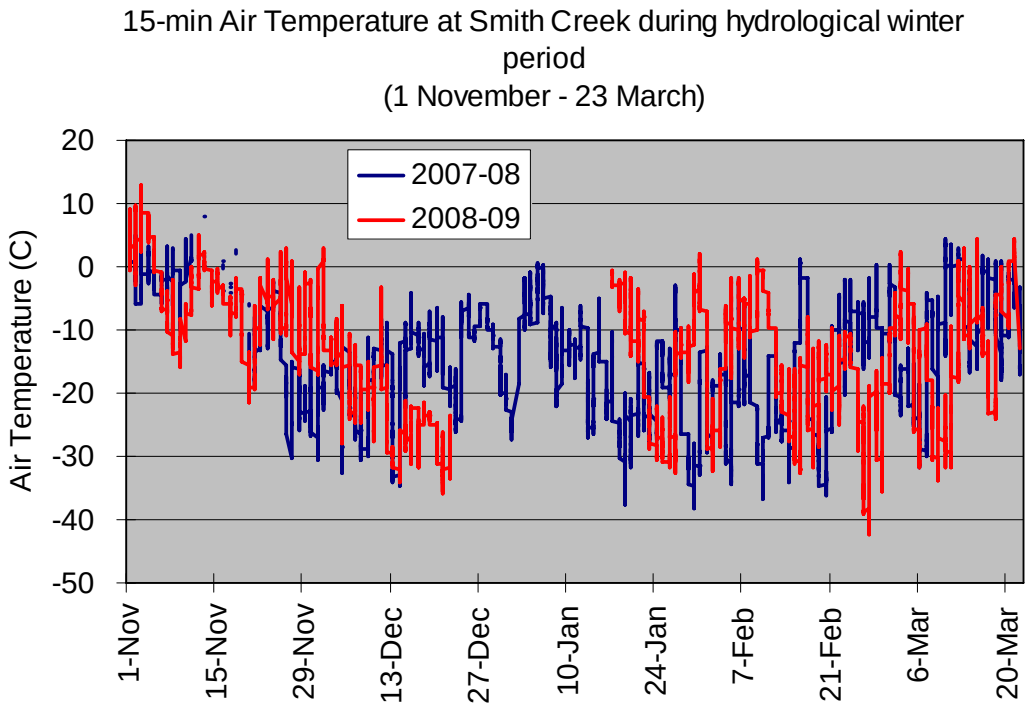

Figure 2. Raw data of 15-min air temperature at Smith Creek during hydrological winter period.

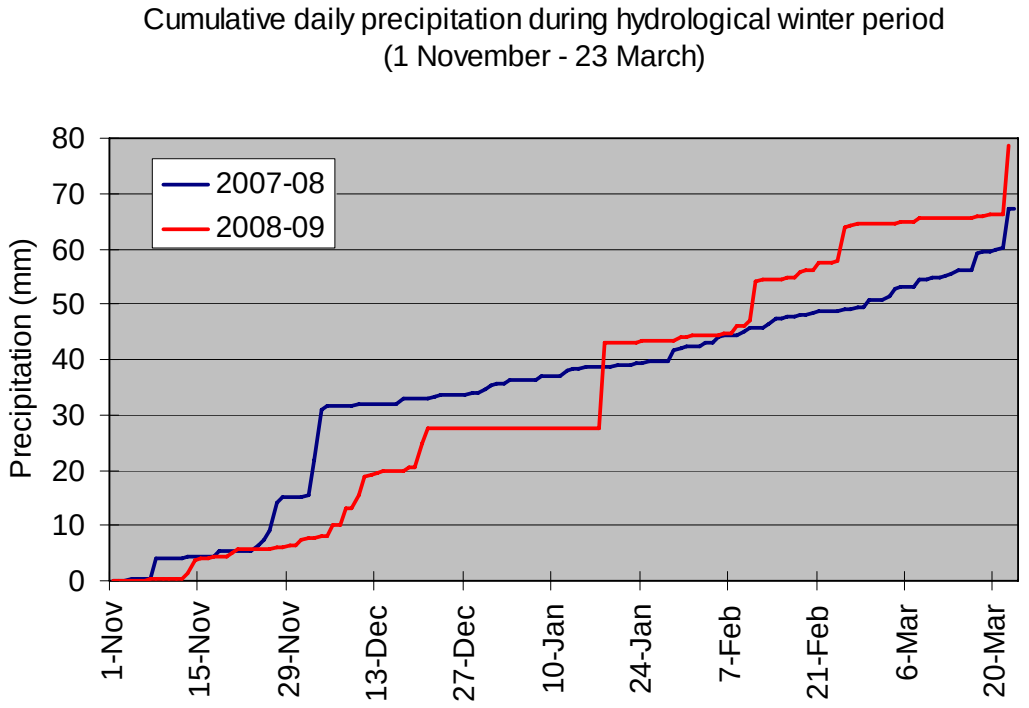

Figure 3. Raw data of cumulative daily precipitation at Smith Creek during hydrological winter period.

Also, the values of volumetric soil moisture collected at Smith Creek main weather station grassland area in the fall of 2007 and fall of 2008 are shown in Table 3. The table indicates that at 0-10 cm and 10-40 cm depth, prior to the freeze-up, soil was wetter in 2008 compared to 2007.

Table 3. Fall volumetric soil moisture at Smith Creek main weather station grassland area.

	2nd November 2007	2nd November 2008
0-10 cm Volumetric Soil Moisture	0.168	0.271
10-40 cm Volumetric Soil Moisture	0.418	0.47