WATER RESOURCES RESEARCH, VOL. 37, NO. 11, PAGES 2819–2823, NOVEMBER 2001

Thirty-five years of research data collection at the Reynolds Creek Experimental Watershed, Idaho, United States

Charles W. Slaughter,[1] Danny Marks, Gerald N. Flerchinger, Steven S. Van Vactor, and Mike Burgess

Northwest Watershed Research Center, Agricultural Research Service, U.S. Department of Agriculture Boise, Idaho, USA

Abstract. Comprehensive, long-term hydrologic data sets for watershed systems are valuable for hydrologic process research; for interdisciplinary ecosystem analysis; for model development, calibration, and validation; and for assessment of change over time. The Reynolds Creek Experimental Watershed in southwestern Idaho, United States, was established in 1960 and provides a research facility and comprehensive long-term database for science. Spatial data layers for terrain, soils, geology, vegetation, and basic site mapping features and databases for fundamental hydrologic parameters of precipitation, snow, climate, soil microclimate, and stream discharge and sediment concentration are now available for water years 1962–1996 and are described in the following eight data reports.

1. Introduction

Flooding and associated damage, droughts and water shortages, and compromised water quality are major concerns currently facing populations worldwide. Understanding these issues requires that the hydrologic research community have access to high-quality long-term data sets. Hydrologic data acquisition, processing, analysis, and archiving, however, is often arduous and is always expensive.

The *National Research Council* [1999] recognized the special need for research and monitoring that is long-term and integrated across scales and time frames and further emphasized the research value of watersheds of "intermediate" size (tens to a few thousand square kilometers) which encompass complex landscapes with slopes and floodplains supporting a variety of processes, including temporary storage of water, sediment, and associated chemical species with the recommendation that "Particular emphasis should go to maintaining sites with exceptionally long-term records." The Reynolds Creek Experimental Watershed (RCEW), first described by *Robins et al*. [1965] in the first volume of *Water Resources Research*, has been just such a vital field laboratory for hydrologic research for over 35 years. In this paper we provide an historical context for the Reynolds Creek Experimental Watershed, describe the characteristics of RCEW, the data collection and telemetering system, and introduce a series of eight data reports that present data from the 35 year period (1962–1996).

2. Reynolds Creek Experimental Watershed

The northwest Hydrology Research Watershed was authorized by congress in 1959 to address five essential issues of water supply, seasonal snow, soil freezing, water quality, and rangeland hydrology. Development began in 1960 in the semiarid rangelands of the interior Pacific Northwest. The 239 km^2 Reynolds Creek Experimental Watershed (Plate 1) is located in the Owyhee Mountains of southwestern Idaho, approximately 80 km southwest of Boise. It was initially recognized that long-term, whole-catchment and subcatchment field measurements are necessary to characterize the landscape and its hydrologic regime and to support process research, model development, and validation. The field instrumentation therefore was designed to encompass the spatial complexity of topography, climate, and vegetation of a mountainous rangeland watershed. The measurement program was planned for long time series to encompass temporal variability in climate, weather, and hydrologic regime.

Reynolds Creek is a third-order perennial stream that drains north to the Snake River and ranges in elevation from 1101 m mean sea level (msl) to 2241 m msl. About 77% of the watershed is under public (federal or state) ownership, with the remainder being privately owned. Primary land use of the watershed is livestock grazing with some irrigated fields along the creek at lower elevations. There is wide diversity in local climate, geology, soils, and vegetation across the Reynolds Creek landscape. Precipitation varies from ~230 mm at the northern lower elevations to >1100 mm in the higher regions at the southern and southwestern watershed boundaries where 75% or more of annual precipitation occurs as snowfall (Plate 2).

Soils derived from granitec and volcanic rocks and lake sediments are present on the watershed and range from shallow, desertic soils at lower elevations to deep commonly moist soils at the higher elevations which are dominated by forests. Plant communities at lower elevations are typical of the Great Basin Desert, while forest and alpine plant communities may be found in the higher, more mesic sectors. Sagebrush-grassland communities dominate most of the watershed, while mountain big sagebrush, aspen, subalpine fir, and Douglas fir communities are found in areas of higher snow accumulation. Annual water yield varies over the watershed from a few millimeters in small subdrainages in lower portions of RCEW to

[1] Retired July 2000.

Paper number 2001WR000413.

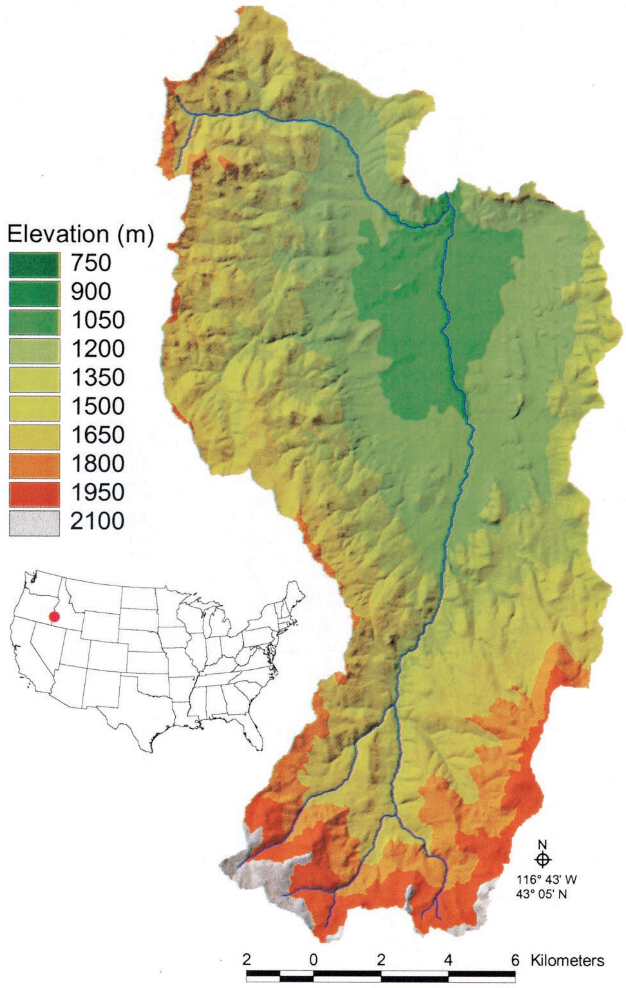

Plate 1. Map based on the 30 m digital elevation model showing the topographic structure of the Reynolds Creek Experimental Watershed and its location in southwestern Idaho.

>583 mm in the higher elevations at the southwestern edge of RCEW. Average annual water yield measured at the outlet is 75 mm or 0.564 m^3/s. The largest streamflow recorded at the outlet occurred on December 23, 1964, during a rain-on-snow with frozen soil event that peaked at just over 107 m^3/s.

3. Telemetered Data Acquisition System

The research methodology for gathering data has gone through a vast change since the establishment of RCEW. Data recording has evolved from spring-driven chart recorders which were reduced and digitized by hand to the design and construction of custom data loggers and telemetry systems to the current use of standard commercial data loggers, instrumentation, and telemetry. This has significantly reduced the time and cost of maintaining the database for RCEW. Replacement of custom, hand-made sensors, data recorders, and telemetry systems has allowed us to take full advantage of the technological advances in electronics during the last decade.

The RCEW instrumentation network consists of 25 telemetered data acquisition systems located throughout the Reynolds Creek Experimental Watershed. Data are telemetered to the U.S. Department of Agriculture, Agricultural Research Service, (USDA ARS) Northwest Watershed Research Center in Boise, Idaho, approximately 80 km away by a combination of telephone lines and a land-based VHF radio system. The data are automatically uploaded to the central computer database once each day.

Extensive hydrologic records have been collected since the early 1960s. From inception, there has been a concerted effort to establish, maintain, and upgrade the field instrumentation network to obtain the most reliable, accurate, and representative information possible. The current basic network is supplemented as appropriate for individual research projects.

4. Reynolds Creek Experimental Watershed Data Reports

The Reynolds Creek *Water Resources Research* data reports make available to the global hydrologic community a long-term, spatially distributed series of hydrologic and supporting environmental data from Reynolds Creek Experimental Watershed (RCEW) in southwestern Idaho, United States. We present a comprehensive information set for RCEW for the water years 1962 through 1996. Variation in the period of record for individual sites and parameters results from construction schedules, improvements in instrumentation science, changes in research emphasis, and varying budgetary constraints over three and a half decades.

In the following series of data reports, eight types of basic data are presented along with tables showing the period of record, number of measurement sites, methods used, and examples of how each has been used in publications over the years. The first is the geographic data report [*Seyfried et al*., this issue (c)] which presents both spatially continuous and spatially discrete site location data for all parameters described in this series of data reports. The spatially continuous data are georeferenced to a 30 m digital elevation model (DEM) (universal transverse Mercator (UTM), zone 11, projection) derived from U.S. Geological Survey contours, as shown in Plate 1. In addition to basic topographic data from the DEM this data report includes watershed boundaries, stream channel locations (Plate 3b), geology, soils, vegetation, land ownership, and road network data. These are available as 14 separate data layers. The site locations of all the instrumentation described in these data reports (e.g., weirs, precipitation gauges, etc.) are presented in the same UTM coordinate system (Plates 3a–3c), both as measured by global positioning system (GPS) and as represented on the base DEM. These data are presented in tabular form and are available in eight separate data layers.

Table 1 summarizes the data presented in the subsequent seven data reports showing for each which parameters are included, the maximum number of measurement sites, the number still active in 1996, the inclusive period of record, and the sampling interval at the end of the data set in 1996. The number of stations varied extensively for precipitation, while only a few neutron probe and stream gauging stations have been discontinued. The lysimeter record covers a period of only 16 years, and none of the lysimeters are currently in operation. For nearly all measured parameters the start date varies from site to site, and there are periods of missing data caused by instrument failure or site damage. The sampling interval also varied through time as the transition was made from manual and strip chart data recording to increasingly more reliable electronic data recording systems. Each of the data reports is introduced below.

Both hourly and breakpoint precipitation data are presented

Plate 2. Climate, snow, and precipitation measurement site near Fir forest in the southern, higher-elevation region of the Reynolds Creek Experimental Watershed during December. Snocat is used for instrument maintenance and data collection during winter.

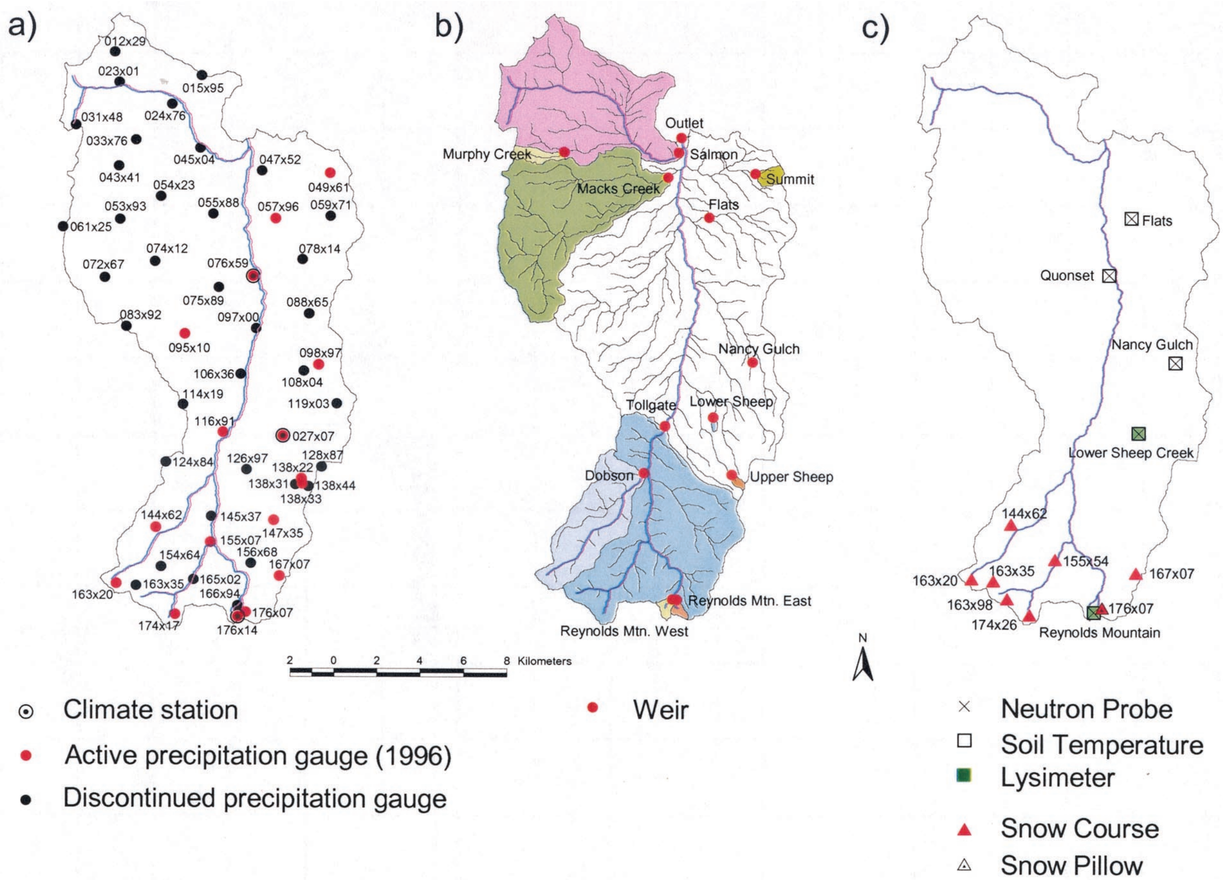

Plate 3. Maps of measurement site locations and subwatershed boundaries within the Reynolds Creek Experimental Watershed showing (a) location of climate stations and active and discontinued precipitation gauges; (b) weir locations, the stream channel network, and the subwatershed boundaries; and (c) neutron probe, soil temperature, lysimeter, snow course, and snow pillow locations.

Table 1. Summary of Data Presented in the Series of Data Reports

Data Report	Parameter Measured	Number of Stations		Years of Record[a]	1996 Sampling Interval[b]
		Maximum	1996		
Precipitation	shielded precipitation	53	17	1962–1996	breakpoint,[c]
[*Hanson*, this issue]	unshielded precipitation				15 min
	calculated precipitation				
Snow	snow course SWE	8	8	1961–1996	biweekly
[*Marks et al*., this issue]	snow pillow SWE	1	1		15 min
Daily climate	T_{max} and T_{min}	3	3	1964–1996	daily
[*Hanson et al*., this issue]	pan evaporation			1974–1996	
Continuous climate	air temperature	3	3	1981–1996	15 min
[*Hanson et al*., this issue]	humidity				
	solar radiation				
	wind speed and direction				
	barometric pressure				
Soil lysimeter	lysimeter water content	4	0	1976–1991	hourly
[*Seyfried et al*., this issue (b)]					
Neutron probe	soil water content	18	14	1970–1996	biweekly
[*Seyfried et al*., this issue (d)]	(various depths)				
Soil temperature	soil temperature	5	5	1981–1996	15 min
[*Seyfried et al*., this issue (a)]	(various depths)				
Discharge and sediment	stream discharge	13	8	1963–1996	breakpoint,[d] 15 min
[*Pierson et al*., this issue]					
	suspended sediment	3	3	1965–1996	event based

[a]The period of record indicates the initial and final year of data considering all sites. Some sites may have started later or ended earlier, and gaps in the record may occur.
[b]The 1996 sampling interval may not be the same as the data recording interval in the database.
[c]Nominal value is 0.25 mm of precipitation or 15 min sample.
[d]Nominal value is 0.5 mm of stage in 5 min or 15 min stage sample for small weirs and fixed 15 min stage sample for large weirs.

by *Hanson* [this issue]. The locations of the 53 precipitation sites are shown in Plate 3. The period of record for the 53 precipitation sites varies from as little as 6–8 years for a few sites to the entire 35 water years for 15 of the sites. Included with the precipitation data are measurements of shielded and unshielded precipitation and the computed wind-corrected value [*Hanson*, this issue].

Marks et al. [this issue] present 35 years of biweekly data from eight snow courses and 14 years of hourly snow water equivalent (SWE) data from the snow pillow operated in the upper portion of the watershed. Locations of the snow measurement sites are shown in Plate 3c. The snow course data include average SWE and snow depth from the five samples taken along each snow course.

Hanson et al. [this issue] present 35 years of climate data from three sites in the watershed, including daily values of maximum and minimum air temperature and pan evaporation for nearly the entire 35 water year period. The locations of the three climate stations are shown in Plate 3a. Over 15 years of hourly values of air temperature, relative humidity, vapor pressure, dew point temperature, solar radiation, wind speed at two heights, wind direction at one height, and barometric pressure are presented beginning in mid-1981.

Seyfried et al. [this issue (b)] present lysimeter water content data measured with paired lysimeters at two sites, soil water content profile data measured by neutron probe at 18 sites [*Seyfried et al*., this issue (d)], and soil temperature profile data from five sites for periods ranging from 15 to 25 years during the 1962 to 1996 water year period [*Seyfried et al*., this issue (a)]. The locations of all of the soil moisture, lysimeter, and soil temperature sites are shown in Plate 3c. Lysimeter water content changes are reported daily from 1976 to 1984 and hourly from 1984 through water year 1992, when the instrumentation was discontinued. Neutron probe data are presented both as raw data (counts/30 s with standard count) and as a calibrated volumetric water content at 2 week intervals for a period between 1971 and 1977. Soil temperature data from five sites are presented for water years 1981 through 1996.

Pierson et al. [this issue] present hourly and breakpoint streamflow data from 13 weirs and breakpoint suspended sediment data from three weirs in RCEW. Plate 3b shows the location of all 13 weirs. Nine weirs are still in operation, with periods of record ranging from 23 to 35 water years. Four weirs have been discontinued with records ranging from 6 to 30 water years. Suspended sediment data were collected by manual sampling and several different automated samplers on an event basis.

5. Data Availability

Data presented in each of these reports are available from the anonymous ftp site ftp.nwrc.ars.usda.gov in the directory "databases/rcew" maintained by the USDA ARS Northwest Watershed Research Center in Boise, Idaho, United States. Each type of data presented is stored in an appropriately named subdirectory as ASCII files that have been compressed using a standard "zip" compression utility. Each file has an ASCII header providing brief information on file contents, location (easting and northing, UTM zone 11), both the GPS elevation and the DEM elevation, time format, period of record, column contents and units, missing data key, and contact, citation, and disclaimer information. In addition, in a subdirectory "documents" a viewable version of a more detailed description of each data set, including additional photographs, data analysis, and graphical data presentation, is stored in PDF format as intro.pdf, geog.pdf, precip.pdf, climate.pdf, snow.pdf, soil_micro.pdf, and flow_sed.pdf. (Note that the data described by *Seyfried et al*. [this issue (a), this issue (b), this issue (d)] are combined into a single very long report soil_micro.pdf.) An ASCII README file in each directory gives a detailed description of the file formats and contents. Mention of a manufacturer or trade name is for information purposes only and does not constitute an endorsement by the United States Department of Agriculture Agricultural Research Service.

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M. Burgess, G. N. Flerchinger, D. Marks, C. W. Slaughter, and S. S. Van Vactor, Northwest Watershed Research Center, Agricultural Research Service, U.S. Department of Agriculture, 800 Park Blvd., Suite 105, Boise, ID 83712-7716, USA. (mburgess@nwrc.ars.usda.gov; gflerchi@nwrc.ars.pn.usbr.gov; danny@nwrc.ars.usda.gov; svanvact@nwrc.ars.usda.gov)

(Received September 6, 2000; revised March 7, 2001;
accepted April 16, 2001.)