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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, USA, was established in 1960 and provides a research facility and comprehensive long-term database for science. The 239 km^2 watershed is in high-relief rangelands in which seasonal snow is the primary source of water, and has high spatial and temporal diversity in local climate, annual and seasonal precipitation, streamflow, sediment yield, vegetation, and land use. Spatial data layers for terrain, soils, geology, vegetation, and basic site mapping features, and databases for fundamental hydrologic parameters of precipitation, snow, climate, soil micro-climate, and stream discharge and sediment concentration are now available for water years 1962 - 1996, and are described in the following six data reports. These data are publically available and can be accessed on the USDA-ARS Northwest Watershed Research Center's anonymous FTP site *ftp.nwrc.ars.usda.gov* in the directory "publicdatabase".

Key words: hydrological data, watershed, rangeland, streamflow, precipitation, snow, climate.

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 always expensive. Burt (1994) stressed that long-term monitoring and data acquisition can provide important evidence of environmental change, is the key to understanding hydrologic processes, and can provide the initial data with which meaningful research hypotheses can be formulated. Rodda (1995) concluded that hydrological data must be maintained to manage and protect the world's water resources and to insure against the hazards of an unforeseen future.

The National Research Council (1998) 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 km^2) which encompass complex landscapes with slopes and flood plains 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 (RCEW), describe the characteristics of RCEW, the data collection and telemetering system, and introduce a series of six data reports that present thirty-five years of data from this watershed.

2. REYNOLDS CREEK EXPERIMENTAL WATERSHED

Development of Reynolds Creek Experimental Watershed (RCEW) began in 1960 to support research addressing issues of water supply, seasonal snow, soil freezing, water quality, and rangeland hydrology in the semiarid rangelands of the interior Pacific Northwest. The 239 km^2 Reynolds Creek Experimental Watershed (Figure 1) is located in the Owyhee Mountains of southwestern Idaho, approximately 80 km southwest of Boise, ID. It was initially recognized that long-term, whole-catchment and sub-catchment 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 (Slaughter and Hanson, 1998).

Reynolds Creek is a third-order perennial stream that drains north to the Snake River and ranges in elevation from 1101 m 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 (Plate 1). There is wide diversity in local climate, geology, soils and vegetation across the Reynolds Creek landscape. Precipitation varies from about 230 mm at the northern lower elevations, to over 1100 mm in the higher regions at the southern and southwestern watershed boundaries where 75% or more of annual precipitation occurs as snowfall (Hanson, 2000) (Plate 2).

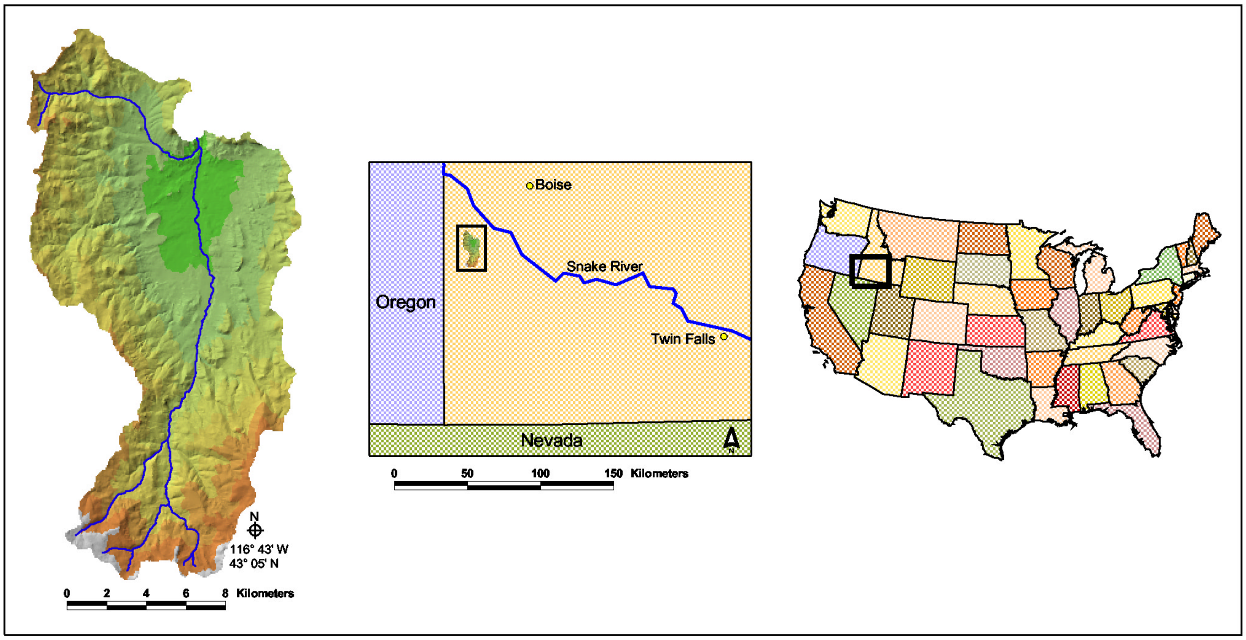

Figure 1. Map showing the location of the Reynolds Creek Experimental Watershed in southwestern Idaho

Soils derived from granitic, volcanic and lake sediments are present on the watershed and range from shallow, desertic soils at lower elevations to deep organic soils at the higher elevation which are dominated by forests (McIntyre, 1972; Stephenson, 1977). 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, sub-alpine fir and Douglas fir communities are found in areas of higher snow accumulation (Stephenson, 1977). Annual water yield varies over the watershed from a few mm in small sub-drainages in lower portions of RCEW to over 583 mm in the higher elevations at the southwestern edge of RCEW (Pierson et al., 2000). 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 and 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 battery and line powered 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 telemetery. This has significantly reduced the time and cost of maintaining the database for RCEW. Replacement of custom, hand-made data recorders and telemetry systems has allowed us to take full advantage of the technological advances in electronic during the last decade. Commercial sensors and related instrumentation became available and began to replace the proprietary in-house designed equipment.

The RCEW instrumentation network consists of 25 telemetered data acquisition systems located throughout the Reynolds Creek Experimental Watershed. Data are telemetered to the 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 1960's. From the 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 (Figure 2) is supplemented as appropriate for individual research projects.

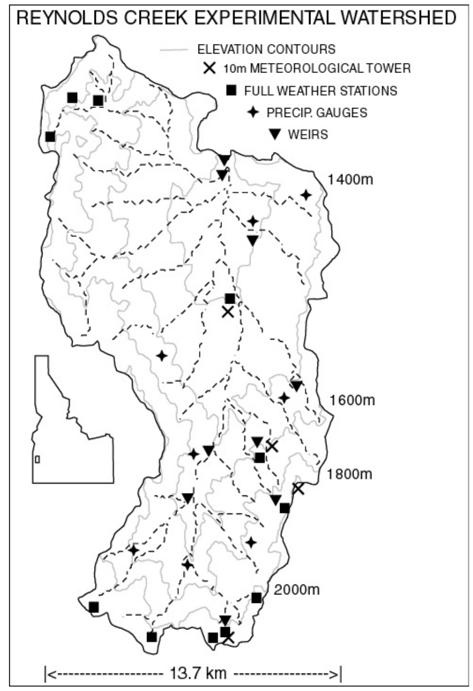

Figure 2: RCEW data acquisition and telemetry network.

4. THE REYNOLDS CREEK EXPERIMENTAL WATERSHED DATA REPORTS

The Reynolds Creek 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, USA. We present a comprehensive information set for RCEW for the water years 1962 through 1996. We immediately note that there is variation in the period of record for individual sites and parameters. This variation results from construction schedules, improvements in instrumentation science, changes in research emphasis, and varying budgetary constraints over 3 ½ decades. For example, the initial precipitation network was designed to be comprised of one precipitation gauge per public land survey section (2.59 km^2) which required nearly 100 precipitation sites in RCEW. The original network was reduced to 55 precipitation sites in the late 1960's, 28 in the early 1980's, and only 17 by the end of the 1996 water year (September 30, 1996). Similarly, streamflow was initially monitored at 13 sites, but only nine were being operated at the end of the 1996 water year.

In the following series of data reports six types of basic data are presented. The geographic data report (Seyfried et al., 2000b) presents both spatially continuous and spatially discrete, site location data. The spatially continuous data are georeferenced to a 30 m digital elevation model (DEM) derived from USGS contours. In addition to basic topographic data in the DEM, this data report includes watershed boundaries, geology, soils, vegetation, land ownership and road network data. These are illustrated in a series of figures and 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 Universal Transverse Mercator coordinates, both as measured by geographic positioning system and as represented on the base DEM. These data are presented in tabular form and are available in eight separate data layers.

Both hourly and break-point precipitation data are presented by Hanson (2000). 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, 2000). Marks et al. (2000) present 35 years of bi-weekly 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. The snow course data include average snow water equivalent (SWE) and snow depth from the five samples take along each snow course.

Hanson, et al. (2000) 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. Over fifteen 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., (2000a) present lysimeter water content data measured with paired lysimeters at two sites, soil water content profile data measured by neutron probe at eighteen sites, and soil temperature profile data from five sites for periods ranging from 15 to 25 years during the 1962 to 1996 water year period. 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. Measurements were initiated at most sites between 1971 and 1977 and made at approximately two-week intervals for soil profiles ranging in depth from 0.15 m to 2.7 m (most profiles do not extend beyond 0.9 m) through 1995. Soil temperature data from five sites are presented from water years 1981 through 1996. Measurements were made at a variety of depths, on an hourly basis at some sites, weekly at others. After 1992 all sites reported hourly data at 10 depths to a maximum depth of 1.8 m.

Pierson, et al. (2000) present hourly and breakpoint streamflow data from 13 weirs, and breakpoint suspended sediment data from 3 weirs in RCEW. 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 using several different automated samplers, on an event basis. These data are presented in the breakpoint discharge file for three of the weirs for most of the 35 water year record.

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 "publicdatabase" maintained by the USDA Agricultural Research Service, Northwest Watershed Research Center in Boise, Idaho, USA. Each type of data presented is stored in an appropriately named sub-directory 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 (see Seyfried et al., 2000b), time format, and period of record, column contents and units, missing data key, contact, citation and disclaimer information. An ASCII README file in each directory gives a detailed description of the file formats and contents.

Any publications which are generated from these data should cite the appropriate data report, and acknowledge the USDA-ARS Northwest Watershed Research Center as the source. In addition we request that you notify NWRC of all publications, including theses and dissertations, which use or refer to these data. Citations may be sent to *publicdatabase@nwrc.ars.usda.gov* by email or to: USDA-ARS Northwest Watershed Research Center, 800 Park Blvd., Suite 105, Boise, ID 83712-7716 by surface mail. Your cooperation in this matter will promote further research and cooperation, help to validate the usefulness of the ARS experimental watersheds and data collection activities, and influence agency policy regarding future data collection.

6. SUMMARY

This introductory paper and the six data reports that follow describe the baseline hydrologic data collection effort that has been conducted over a 35-year period on the Reynolds Creek Experimental Watershed. These papers and the accompanying data provide a very unique long-term hydrologic data set to the research community. Our hope is that these data sets will generate new avenues of research and be a valuable resource for hydrologic process research, model development, and interdisciplinary ecosystem analysis.

7. DISCLAIMER

The mention of trade names or commercial products does not constitute endorsement or recommendation for use. The Agricultural Research Service (ARS) is a research organization. There are no legal mandates for the agency to collect or to distribute data collected for specific research projects. These data are being made available to the research community to promote the general knowledge of the processes relating to our country's natural resources.

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Plate 1. View of the Reynolds Creek Experimental Watershed looking up from the Romero ranch to the northwest ridge in February.

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. Sno-cat is used for instrument maintenance and data collection during winter.