

Seasonal and Diurnal Discharge Fluctuations In Medano Creek, Great Sand Dunes National Monument

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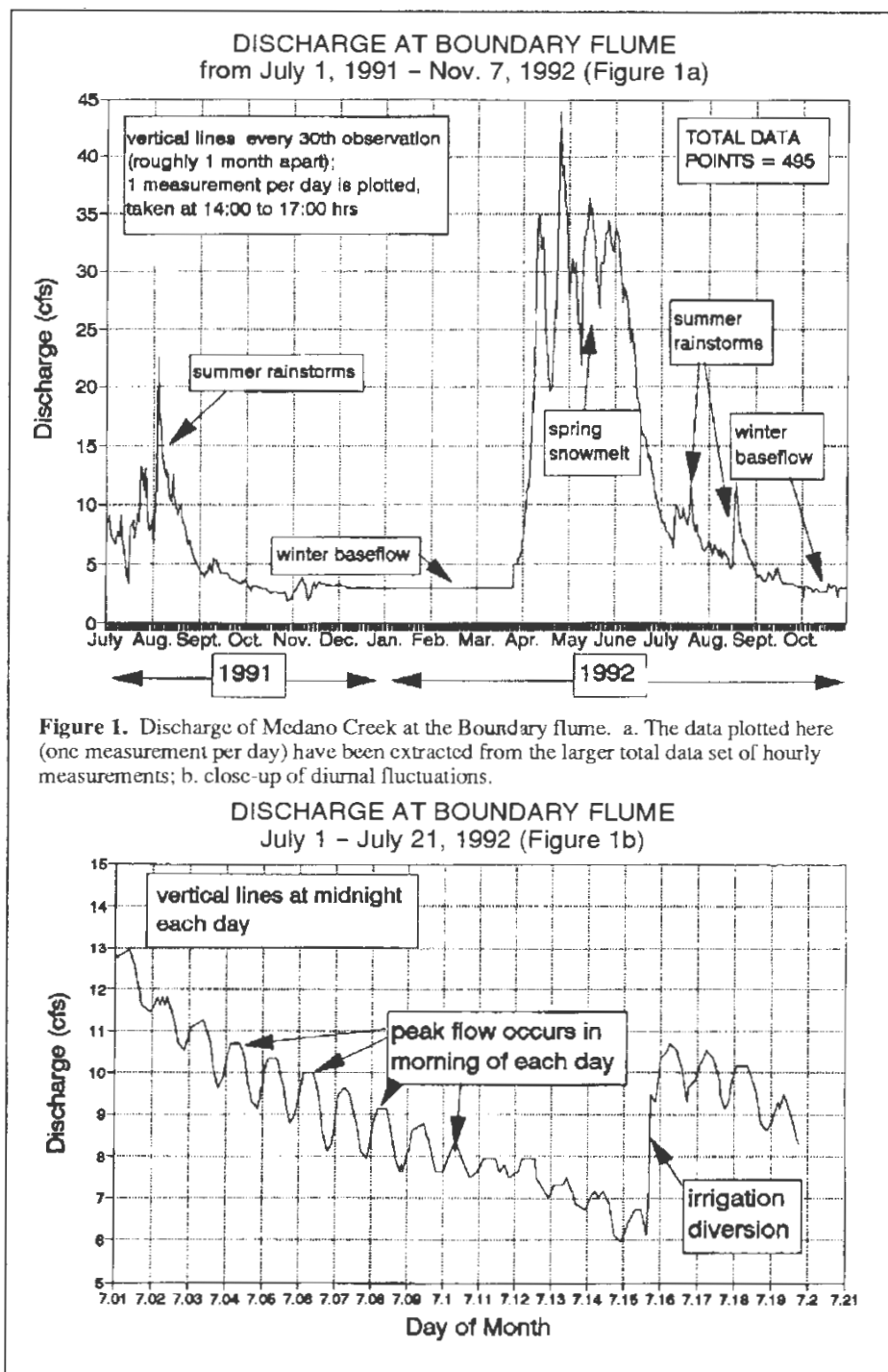
Medano Creek at the Great Sand Dunes National Monument has long been noted for its unique surge-flow behavior (Bean, 1977; Schumm and others, 1982). However, little was known of the discharge characteristics of the creek because it never had been gauged. The impetus for this collection of multi-year baseline discharge data was the projected decline of the regional water table (as much as 150 ft) underneath Medano Creek, due to groundwater pumping on adjacent property north of the Monument. The projected decline was thought to pose potential adverse effects to the surge flow in Medano Creek, and possibly to the NPS water right.

The 2-year study began in June 1991. Two standard dimension 3 ft-wide Parshall flumes were constructed of plywood and sheet metal and installed in Medano Creek at two locations. Because the area is in Wilderness, flume components were hand-carried to the sites and assembled on site, without the aid of machinery. The Boundary flume is located 5 km downstream. These flumes record creek stage via a float gauge and Omnidata (TM) DP-115 data logger in an adjacent stilling well. The Boundary flume was installed on June 28, 1991 and has a continuous record of discharge measured hourly. Corresponding measurements of depth to shallow groundwater in the floodplain are given in McCalpin (1992).

Discharge of Medano Creek at the Boundary flume is shown in Figure 1a for the 16-month period July 1991 to November 1992. The record begins after the 1991 peak snowmelt had occurred, and discharge had declined to less than 10 cfs (cubic feet per second). The mid- and late-summer seasons in both 1991 and 1992 are marked by a slow decline in discharge (due to decreasing baseflow from snowmelt), interrupted by two types of increases in discharge.

The largest discharge increases come from summer rainstorms. Large storm systems, such as the one in August 1991 (Fig. 1) can increase discharge up to 15 cfs, with the receding part of the hydrograph lasting up to one month. Smaller storms (such as mid-August 1992) create smaller flow increases (7 cfs) lasting a shorter time (one week). On more detailed hourly graphs of discharge (McCalpin, 1992) even smaller rainstorm effects can be observed—increases of 2-3 cfs over several hours.

The second summer increase occurs on July 16 of each year, when about 5 cfs of water is returned to Medano Creek from an irrigation diversion at Medano Pass. This increase



merely shifts the declining part of the hydrograph up by about 5 cfs, and does not alter the overall trend.

In both 1991 and 1992, surface flow declined to a winter baseflow of ca. 3 cfs by October 1. Flume measurements from mid-October through late March were made only by visual observations every 2-6 weeks because stilling wells were frozen.

Spring snowmelt began rapidly in early April 1992, and reached discharges of over 30 cfs (peak=44 cfs) that lasted for two months. The pronounced peaks and troughs in the snowmelt discharge record reflect variations in weather, mainly in temperature, as recorded by the weather station at Monument Headquarters. The highest discharge peaks occur during warm, sunny



weather when snowpack is melting rapidly. Troughs in discharge are created by cool, cloudy weather systems accompanied by light snow. For example, cooling of 10 degrees F. during mid-April and early May led to decreases of 15 and 20 cfs in discharge, respectively, merely by suppression of solar-induced snowpack melt. Once the surface snowpack was melted from all but the highest parts of the drainage basin, discharge declined rapidly, dropping from ca. 35 cfs in early June to <10 cfs in early July. In a typical year this decline would continue in an exponential curve unless interrupted by summer rainstorms or irrigation diversions.

Unexpectedly, we observed significant diurnal fluctuations in discharge throughout the year in Medano Creek (Fig. 1b). During the initial 1992 spring snowmelt (April 1-9), the peaks and troughs of discharge appeared 2-3 hours later at the downstream (Castle Creek) flume than at the Boundary flume. Peak flow at the Boundary flume occurred at about 8-9 p.m., after the hottest part of the day, but did not appear at the Castle Creek flume until midnight. The timing of peak discharge in the early evening, and the lag time between the flumes, suggests that each day a "slug" of snowmelt water enters the channel from high in the basin during the late morning and afternoon, and this slug travels downstream at about the velocity of water in the stream. To travel the ca. 5 km between the flume sites in 3-4 hours, velocities of 2-3 ft/sec are indicated. Current meter measurements confirm this as the average water velocity in the channel.

In contrast, the fluctuations during June-September are exactly in phase between the two flumes (Fig. 1b). This similarity is unusual, and suggests that a simultaneous mechanism is controlling flow at both sites. This mechanism may be phreatophyte transpiration by streambank cottonwoods, which would withdraw water from Medano Creek. As discharge decreases throughout the summer and fall, so does the amplitude of diurnal fluctuations. For example, during the spring snowmelt (April 9-14, 1992) discharge fluctuates as much as 5 cfs at discharges of 15-30 cfs. By July, fluctuations are down to 1-2 cfs at discharges of 8-15 cfs. In early September fluctuations are less than 1 cfs at 4-7 cfs, and decrease to about 0.25 cfs in October at 3 cfs.

The seasonal fluctuations in discharge observed in Medano Creek are typical of mountain streams that receive most of their precipitation as snowmelt. In contrast, the diurnal fluctuations in discharge are unusual and have not previously been described in the literature in much detail. The diurnal fluctuations in Medano Creek thus have two unique aspects. First, the creek is one of the few well-documented cases of diurnal stream fluctuations supported by nearly 2 years of high-quality, hourly discharge measurements. Second, the diurnal fluctuations induce diurnal changes in the position of the surface flow terminus at Medano Creek. The terminus advances each day during the hours of peak discharge, and retreats upstream during times of low discharge. Observant visitors, who must wade across the creek to access the main dune mass, can now appreciate two rare

fluvial phenomena at the same time--surge flow, and abnormally large diurnal discharge fluctuations.

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Literature Cited

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