

GEOGRAPHIC AND CLIMATIC CHARACTERISTICS OF THE
PECOS RIVER BASIN IN NEW MEXICO

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ABSTRACT

The Pecos River is the principal tributary of the Rio Grande River, arising on the second highest peak in New Mexico and leaving the state at its lowest ground elevation. The river drops rapidly in its headwaters, and then gradually through the widening, north to south sloping valley, where there is intensive agriculture. The general semi-arid, continental climate of the Pecos River Basin is described, including the various influencing air masses. The annual march of climate from cool, dry winter, through changeable, windy spring, hot, rainy summer, and cooling, drying fall is outlined. Average annual sunshine, cloudiness, wind, evaporation, and relative humidity are described, and deviations noted.

TOPOGRAPHY

The Pecos River originates on South Truchas Peak in the Sangre de Cristo Mountains which is the second highest point in New Mexico, elevation 13,102 feet above mean sea level. The river flows southward in New Mexico, entering Red Bluff Reservoir, Texas just beyond the southern New Mexico border. In Texas, the Pecos River meanders south-eastward, joining the Rio Grande River, of which it is the principal tributary, just above Del Rio, about 900 miles from its origin. The lowest elevation in New Mexico is at the point where the Pecos River leaves the state, 2,840 feet. The Pecos River Basin in New Mexico covers an area of approximately 25,000 square miles, which is about 55 percent of the total Pecos basin area of New Mexico and Texas combined.

The Pecos River Basin in New Mexico is bounded on the east by the Caprock escarpment, formed by erosion, which rises several hundred feet above the valley terrain and is the boundary of the High Plains to the east. This escarpment is a west-facing wall in southern New Mexico running northward along the eastern border of Chaves and Roosevelt counties, then turning northwestward through Guadalupe County and merging with the foothills of the Sangre de Cristo Mountains in San Miguel County. In its first 30 miles of southward travel to the town of Pecos, the river drops over 6,000 feet in elevation. Its slope then decreases and the river goes southeastward at the base of Glorietta Mesa, to the southwest, and on to Santa Rosa and Alamogordo Dam, 4,300 feet mean sea level. In this portion of the basin are the tributaries from the east, the main tributary being Gallinas River flowing past Las Vegas, and Alamogordo Creek flowing into Alamogordo Dam.

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To the west of the Pecos Valley in southern New Mexico is a north-south series of mountain ranges; composed of the Jicarillas, Sierra Blancas, Capitans, Sacramentos, and Guadalupe, the latter extending about 20 miles south of the Texas border and having the highest point in Texas, Guadalupe Peak, elevation 8,751 feet. These mountains rise abruptly to elevations of mostly 7,000 to 8,000 feet, but peaks above 12,000 feet are reached in the Sierra Blanca area.

Most tributary streams to the Pecos River rise in these mountains to the west, while the Pecos River flows close to the eastern edge of its basin. Among the primary tributaries from the west are the Rio Hondo, Rio Felix, Rio Penasco, and Black River, which are perennial only in their upper reaches. Numerous arroyos approach the valley floor from the mountains and downward sloping rolling hills. Slopes of the southern mountains are part of the Lincoln National Forest, and the headwaters are in the Santa Fe National Forest.

The lower portion of the Pecos Valley in New Mexico is oriented north-south, is about 100 miles wide, and extends about 200 miles north of the Texas border. Intensive cultivation produces cotton, truck gardens, and row crops, which are grown under irrigation. Much of the area is used for grazing, and there are rich sources of potash, gas and oil in the southeast.

GENERAL CLIMATE

The climate of the Pecos River Basin is predominantly continental, characterized by rapid temperature changes, marked temperature extremes, and large daily and annual temperature ranges. Small areas have mountain climate, cooler throughout the year than the adjacent lowlands. Temperatures are generally mild, increasing in an irregular pattern from north to south in response to latitudinal and elevation changes.

Precipitation amounts generally increase with elevation. However, because of the high plateaus or mesas, mountain ranges, canyons, and valleys, there are great variations in climate over short distances. Although much of the southern Pecos River Basin in New Mexico receives an average annual precipitation of near 12 inches, it increases at higher elevations to become 24 inches or more in the small areas of higher mountains. An annual total of 62.45 inches was measured at White Tail, in the Sierra Blanca Mountains, in 1941, while only 2.61 inches was measured at Lake Avalon during the year 1917. Large variability may be noted at a given location over a period of time, also, as illustrated by an annual total precipitation at Lake Avalon of 36.27 inches in 1941, compared to the 2.95 inches accumulated in 1917, a range of over 33 inches.

Temperatures in the Pecos River Basin have ranged from extremes of 116 degrees Fahrenheit at Artesia, June 29, 1918, which ties with Orogrande for the highest temperature in New Mexico, to 27 degrees below zero Fahrenheit at Cowles in February 1899. Summer temperature

at the mountain located station of Cowles has been as high as 90 degrees, despite its 8,000 feet elevation.

In general, the Pecos Basin slopes upward from southeast to northwest, and it is the gradual rise that plays a very important role in the weather and climate of the area. Air flowing over the area from the northeast through south is cooled adiabatically as it is raised by the terrain, and when moist, condensation results in increasing low cloudiness, fog, or drizzle. This effect is most pronounced with a southeasterly or easterly flow, and least pronounced with a southerly flow. Persistent southeasterly flow for several days will, at times, result in low cloudiness all the way from the Gulf of Mexico to the mountains of central New Mexico. The same lifting, particularly during hot summer weather, helps to trigger the thunderstorms.

When the airflow over the Pecos Basin is from the southwest through northwest, adiabatic heating results from the downslope movement. This results in warming temperatures, and when from west to southwest brings minimum cloudiness.

The central New Mexico mountains help to block moisture bearing air from the Pacific Ocean source region from the Pecos Basin. Already, much moisture has been lost from the air through condensation and precipitation in passing over the mountains of California, Arizona, and New Mexico. Meager rains and snows result when the supply of moist Gulf of Mexico air is cut off from southeastern New Mexico, because this is its major source of moisture.

AIR MASSES

The predominant air mass in the Pecos River Basin is tropical maritime, being present practically all of the rainy season, May through September. The Bermuda high pressure area strengthens and extends westward in late spring and summer, and southeast to south circulation about this high brings warm, moist air from the Caribbean and Gulf of Mexico into the Pecos valley and against the central mountains of New Mexico. Entry of this air is favored by the lower elevation and broader expanse of the valley at the south. Orographic lifting of the air as it flows upward over the valley floor towards the mountains to the north and west produces the frequent showers and thunderstorms of the rainy season. Squall lines may often form over the mountains and move eastward across the valley and high plains. Air mass flow from the Gulf of Mexico may also occur, but with less frequency, during the winter months, after the Bermuda High has retreated eastward.

Hot, dry topical continental air from over the high plateaus of Mexico and desert area of California and Arizona occasionally intrudes into the Pecos Valley in late spring and early summer. This hot, very dry air brings almost cloudless skies, and is responsible for the occasional "heat waves" which seldom last for more than a few days.

Polar maritime air occasionally enters the Pecos Valley from the northwest. Because of the high mountain barriers to the west which remove much of the moisture as condensation and precipitation, this air usually arrives in eastern New Mexico as cool, relatively dry air, ordinarily bringing but light precipitation. High winds and blowing dust may accompany this air, and frequently cloudiness arrives just behind its leading edge.

Polar continental air masses are most common in the winter and early spring, entering the Pecos Valley from the Great Plains and northward. This air brings the intense and sustained periods of cold weather which occasionally reach southeastern New Mexico. The degree of cold depends upon the source, region, and southward penetration of this cold air and the amount of warming as the Canadian or Arctic air moves overland. Precipitation generally does not occur, except when this air mass interacts with moisture bearing air masses, and then is usually light snow in the higher elevations and light rain in the lower elevations of the south. Winds may be strong and gusty along the leading edge of this cold air mass.

SEASONAL CLIMATE

WINTER - Four seasons are generally definable in the Pecos Basin. Winter, December through February, is the cold, dry period, but usually mild in the afternoons. Average high temperatures range from 50 degrees at Las Vegas to 61 degrees at Carlsbad, while average low temperatures range from 18 at Las Vegas to 30 at Carlsbad. Temperatures drop to freezing on most days in the north and about two-thirds of the days in the south, but seldom do temperatures fail to rise above freezing during the day, or drop to zero or below. January is the coldest month, but lowest temperatures may occur almost as often in February. Temperature changes are frequent, but cold spells seldom last more than two or three days. The average change in mean temperature from one day to the next is 6 degrees, but has been as great as 21 degrees. At Roswell, only 8 percent of these mean temperature interdiurnal changes exceed 11 degrees, but have been as great as 26 degrees. Precipitation in the Pecos Valley averages near one-half inch in each of the winter months, the driest season of the year. Much of the winter precipitation falls as snow in the mountains and high plains, but little snow falls in the lower elevations. The average annual snowfall at Carlsbad is 3.1 inches. In the north part of the basin about half of the seasonal snowfall occurs in the three winter months, averaging an annual total of 30.7 inches at Las Vegas and 81.2 inches at Cowles. The daily range of temperatures is large, averaging about 31 degrees, a daily range which changes but little throughout the year.

SPRING - The months of March through May - is the season of most rapid and pronounced weather changes, especially March and April. There is a rapid succession of warm and cold spells, but with slightly

less frequency and range than in winter. Average maximum temperatures range from near 64 degrees at Las Vegas to 80 at Carlsbad, and average minimum temperatures from 33 at Las Vegas to 47 at Carlsbad. Average temperatures near these values occur again in the fall. Monthly temperatures gradually rise about 16 degrees from March to May. Strongest winds and most severe dust storms of the year occur during spring, and also the most adverse flying weather of the year. Average monthly precipitation increases in March and April, and much more rapidly in May as maritime air from the Gulf of Mexico increases its flow into the Pecos Valley. Thunderstorm season begins in May, accompanied by occasional tornadoes. The average date of the last spring temperature of 32 degrees or lower falls in the spring ranging from early April in the south to early May in the north. The tornado season begins in the spring, with most occurrences in May, and continues into June and decreases in July. Two-thirds of the years in the past 49 have gone without tornadoes, and the maximum number in any one year was 6 in 1962. Because of the open nature of the land, few tornadoes cause damage, and but one injury due to flying materials has been reported

SUMMER - the months of June through August - is the hot and rainy season. July has the highest average temperature of the months, but is little higher than June due to the moderating effect of the increasing rains. Average high temperatures range from 84 degrees at Las Vegas to 96 at Carlsbad, while average low temperatures range from 52 at Las Vegas to 67 at Carlsbad. Maximum temperatures of 90 degrees or greater are frequent in the south, the average number of days per year at Carlsbad being 122, while only 14 occur at Las Vegas. On many of these days the temperature may reach 100 degrees or more. A few 90 degree or greater days occur in May and September in the north and several in the south. In the north portion of the Pecos Valley, July and August are the months of greatest precipitation, while a small decrease from May is seen during June. In the southern portion, however, the precipitation is more evenly distributed from May through September, with some of the heaviest rains in late spring and early fall. Nearly one-third of the annual precipitation falls during the months of July and August, while over half the annual rain falls during the four-month period, June through September. Twenty-four hour total rainfalls of over 5 inches have been most frequent in July and August, but may occur from June through October. Heaviest amounts of 6 and 7 inches have occurred in the fall months of September and October. The greatest 24-hour amount of record at usual measuring stations in the Pecos Valley was 7.71 inches at Meek, Lincoln County, September 16, 1919; however, a total of 11.5 inches was unofficially measured at Dave McColleum Ranch, in the Guadalupe Mountains, September 20, 1941.

FALL - the months of September through November - has a combination of moderate temperatures, relatively low wind speeds, and frequent intrusions of mild, dry polar air, making fall the most pleasant season of the year. Average temperatures lower throughout the season

and precipitation falls off sharply after September. Fall frosts occur, with the average date of the first fall temperature of 32 degrees or lower ranging from near October 8 in the north, to late October in the south. This limits the average "growing season" to a period ranging from 153 days in the Las Vegas area to 216 days (or over 7 months) at Carlsbad.

SUNSHINE AND CLOUDINESS

Throughout the year sunshine is plentiful in the Pecos River Basin, which is not too far distant from the area of maximum sunshine in the United States, near the California-Arizona border. About 75 percent of the possible time of sunshine is experienced, with little difference by season of the year. About 3,300 hours of sunshine may be expected annually, ranging from a total of near 220 hours during the shorter days of January to near 340 hours during the longer days of July.

Average cloudiness is less than one-half the sky covered by clouds, and thin cloudiness included in this average allows sunshine to reach earth. Averages during a 16 year period at Roswell show an annual number of 183 clear days (those with 0 to 3 tenths average cloudiness), 99 partly cloudy days, and 83 cloudy days (those with 8 tenths cloud cover to overcast).

WINDS

The prevailing direction of surface winds in the Pecos River Basin closely follows the course of the river, but opposite to the water flow. At Carlsbad and Roswell the annual prevailing direction is from south-southeast, while at Las Vegas on the Gallinas River branch it is from southwest. Prevailing monthly wind directions deviate from the annual by backing to south in winter at Las Vegas, and by veering to west-southwest during winter and early spring at Carlsbad. Wind speeds are generally lightest from north through east-southeast, particularly in the fall, averaging near 9 miles per hour. Strongest average wind speeds are from south-southwest through west-northwest, primarily in the spring, averaging near 14 miles per hour. Annual average wind speed is near 12 miles per hour through most of the basin, but Roswell has less wind with an average nearer 9 miles per hour.

EVAPORATION

Solar radiation, temperature, and wind movement are major influences on amount of evaporation. Values generally increase from north to south in the Pecos Valley, with a range, measured from standard "Class A" evaporation pans, of from near 75 inches in the Las Vegas area to near 115 inches annually at Lake Avalon. This potential

evaporation is 10 times the average annual precipitation measured at Lake Avalon. About two-thirds of the evaporation occurs during the six-month primary agricultural season, May through October. Spring months generally have greater evaporation than the fall months, mainly because of the stronger winds of spring. Extremes of annual evaporation have been as high as 131 inches at Lake Avalon, and as low as 86 inches at Bitter Lakes Wildlife Refuge. Lower evaporation amounts in the north and mountains result largely from their lower mean temperatures.

RELATIVE HUMIDITY

Because relative humidity is a function of temperature, there is a general gradual decrease from north to south in the Pecos River Basin of New Mexico, but annual values remain in the low and middle fifties. The higher humidities are usually measured in the early part of the day, the average being near 65 percent at 6:00 A.M., mountain time. During the hotter part of the day, the relative humidity averages near 40 percent. Lowest monthly average humidities are in the spring and early summer, and are about 20 percent lower than in the late summer and early fall rainy season.

BOOKS RECOMMENDED

Books recommended as sources of further details of geographical and climatological characteristics, and historical development of the Pecos River Basin in New Mexico and Texas include: Robert T. Lingle and Dee Linford, THE PECOS RIVER COMMISSION OF NEW MEXICO AND TEXAS, The Rydal Press, Santa Fe, New Mexico, 1961, 284 pp.; and Robert B. Orton, THE CLIMATE OF TEXAS AND THE ADJACENT GULF WATERS, U. S. Department of Commerce, Weather Bureau, Washington, D. C., 1964, 195 pp. Detailed daily, monthly, and annual climatological data for the Pecos River Basin in New Mexico may be found in monthly and annual issues of CLIMATOLOGICAL DATA, NEW MEXICO, U. S. Department of Commerce, Weather Bureau, and a general summary in CLIMATES OF THE STATES, NEW MEXICO, Climatology of the United States No. 60-29, available from Superintendent of Documents, Washington, D. C. 20402.