Appendix 4C
Productivity, Hydrologic Conditions, and Consumptive Use

May 2015

4C | Productivity, Hydrologic Conditions, and Consumptive Use

The purpose of this appendix is to provide additional discussion of the interplay between productivity, hydrologic conditions, and consumptive use. Figure 4C-1 presents Upper Basin irrigated acres, consumptive use of Colorado River water, and agricultural productivity. With a 5-year moving average, the consumptive use and irrigated acres data are relatively constant through time, while the productivity data show an increasing trend. However, there is a short-term decrease in Upper Basin productivity from 2000 to 2004. This time period was noted as a historic drought and thus a reduction in productivity due to decreased water availability is not unexpected. In contrast, data for consumptive use of Colorado River water do not show a marked decline that might be expected as a result of drought conditions.

To ensure that the absence of a consumptive use decline during the period in question was not a result of the use of a 5-year average, Figures 4C-2 and 4C-3 show annual consumptive use and irrigated acreage. Year-to-year fluctuations in consumptive use of Colorado River water are relatively minor (average is approximately an 8 percent deviation from the 30-year average). Acreage data are also relatively constant. Further, productivity increases appear to be independent of acreage and consumptive use of Colorado River water.

In contrast, annual precipitation[1] and productivity correlate well with one another in the Upper Basin including, but not limited to, the period from 2000 to 2004 (Figures 4C-6 and 4C-5). Peaks in productivity in the late 1980s and late 1990s coincide with periods of high precipitation, whereas lows in productivity around 1990 and 2004 coincide with low precipitation periods. This suggests that in the Upper Basin, crop production relies on precipitation in addition to Colorado River water.

To further explore this relationship, a plot of Upper Basin irrigation season precipitation (April-August) is compared with productivity (Figure 4C-6).

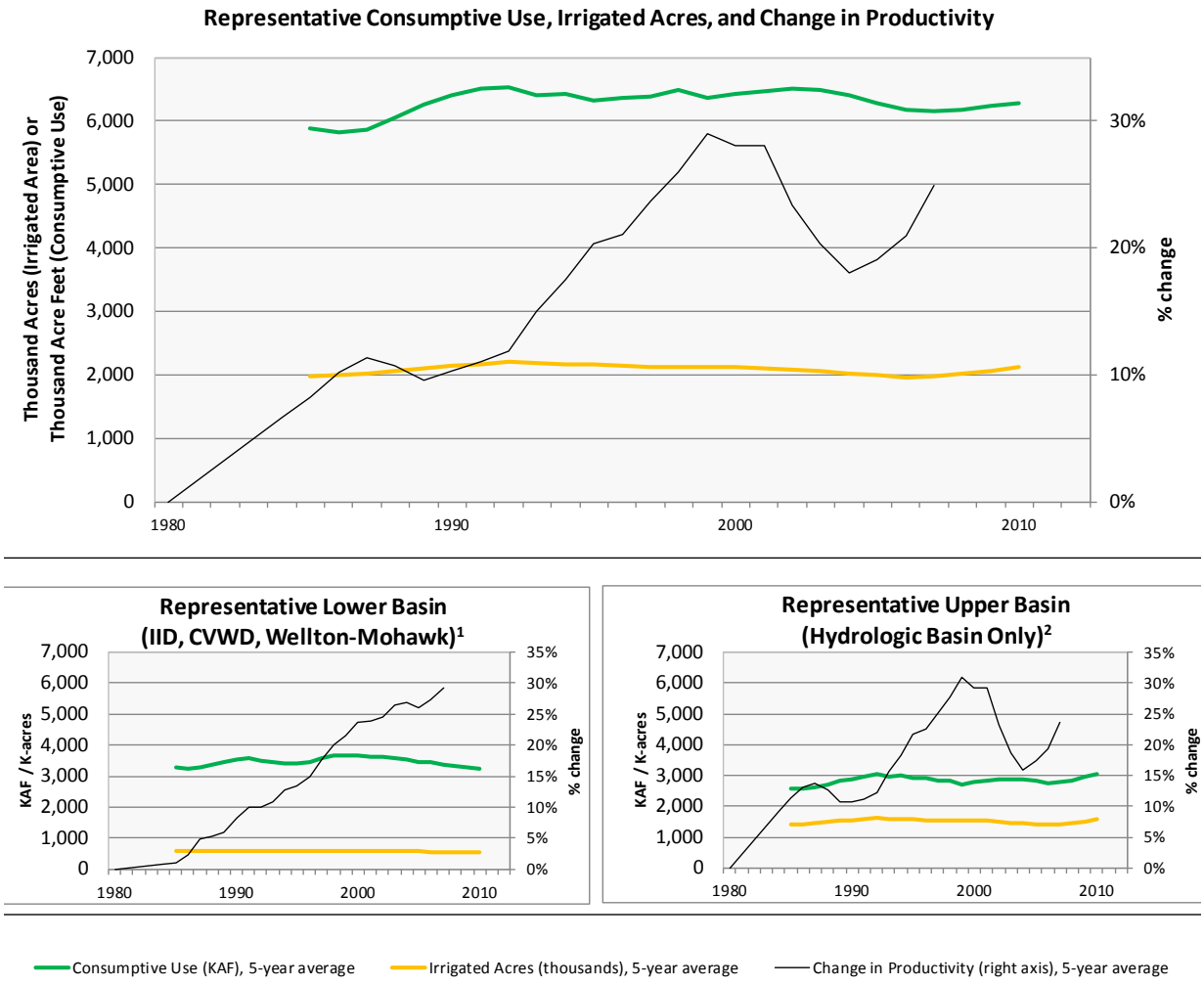
Precipitation during this time has the greatest impact on agricultural and water use. The magnitudes of productivity fluctuations during the late 1980s and early 2000s are consistent with their respective irrigation season precipitation anomalies. Given the apparent relationship between these two variables, Table 4C-1 estimates the significance of irrigation season precipitation in overall crop consumptive use, as detailed below.

During the irrigation season, precipitation in the Upper Basin is on average about 4.1 inches. If a consumptive factor of 75 percent is assumed for precipitation falling directly on fields, this would suggest that precipitation provides roughly 3.1 inches of consumptive use to crops in the Upper Basin. Furthermore, in the Upper Basin, consumptive use associated with irrigation averages 22.6 inches per irrigated acre. Thus, in the Upper Basin, annual consumptive use combined from direct precipitation and irrigation totals approximately 25.7 inches per acre. Therefore, consumptive use associated with direct precipitation is approximately 12 percent of the estimated total crop consumptive use. In contrast, for the Lower Basin, annual precipitation is about 4 percent of estimated total crop consumptive use and therefore has a less pronounced effect on productivity.

Given the drought in the early 2000s, it is anticipated that less Colorado River water would be available for diversion. However, Reclamation's Colorado River System Consumptive Uses and Losses Reports (CU&L Reports) suggest that on a 5-year average basis, a relatively constant supply was available for agricultural users. Note that some state-collected data sets differ from CU&L Reports, suggesting that Colorado River water was less available than in an "average" year. Regardless, during a drought, as shown, productivity in the Upper Basin could be expected to decline even if crops were receiving a typical supply of Colorado River water because overall crops are receiving and consuming less water due to the reduction in direct precipitation.

[1] Precipitation data presented are the average of the four Upper Basin meteorological stations used in Figure 4-3 of the main report.

FIGURE 4C-1
Acreage and Agricultural Consumptive Use of Colorado River Water Compared to Change in Productivity



These data do not reflect 100 percent of actual production and, as such, this plot can be considered generally representative, but not comprehensive.

[1] Lower Basin acres, consumptive use, and productivity presented for areas for which data was collected as part of this Study: Imperial Irrigation District, Coachella Valley Water District, and Wellton-Mohawk Irrigation and Drainage District. Those areas represent approximately 65 percent of the Lower Basin's agricultural consumptive use of Colorado River water.

[2] Upper Basin acres, agricultural consumptive use, and productivity presented for areas within the hydrologic basin, as compiled in CU&L Reports.

[3] Percent change in productivity is calculated as the weighted (acres) average of the percentage change in productivity per acre by individual crop (for example, Alfalfa acres*% change in Alfalfa tons/acre production + cotton acreage * % change in cotton lbs/acres production + …) / total acreage), from National Agricultural Statistics Service (NASS) survey data. Units of productivity depend on the crop type (such as tons or pounds). A 5-year rolling average was then computed. This procedure was completed for crops included in the NASS survey over time. Note that these data do not reflect 100 percent of actual production and, as such, this plot can be considered generally representative, but not comprehensive. In addition, data are by county, so do not align exactly with areas irrigated with Colorado River water.

FIGURE 4C-2
Change in Productivity and Agricultural Consumptive Use of Colorado River Water, Upper Basin Representative Area

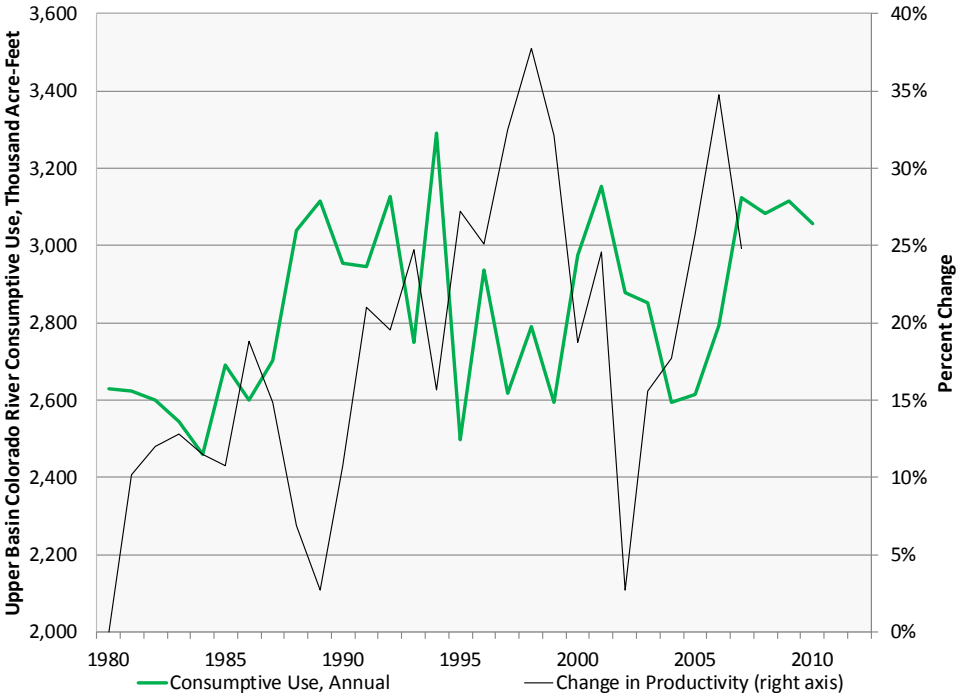


FIGURE 4C-3
Change in Productivity and Irrigated Acreage, Upper Basin Representative Area

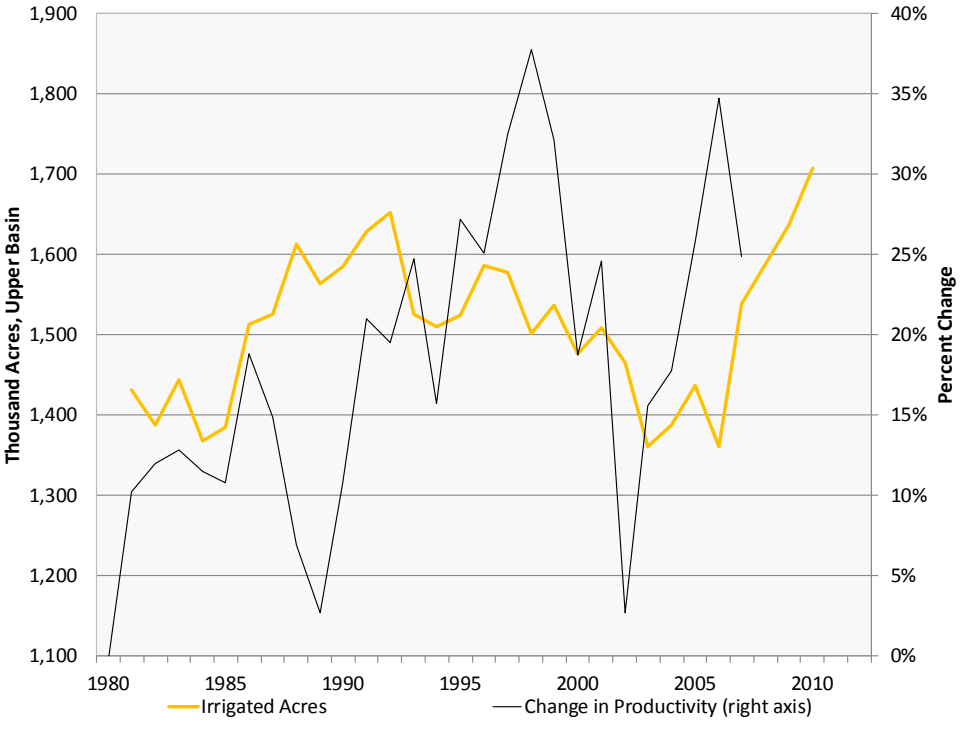


FIGURE 4C-4
Change in Productivity and Precipitation, Upper Basin Representative Area

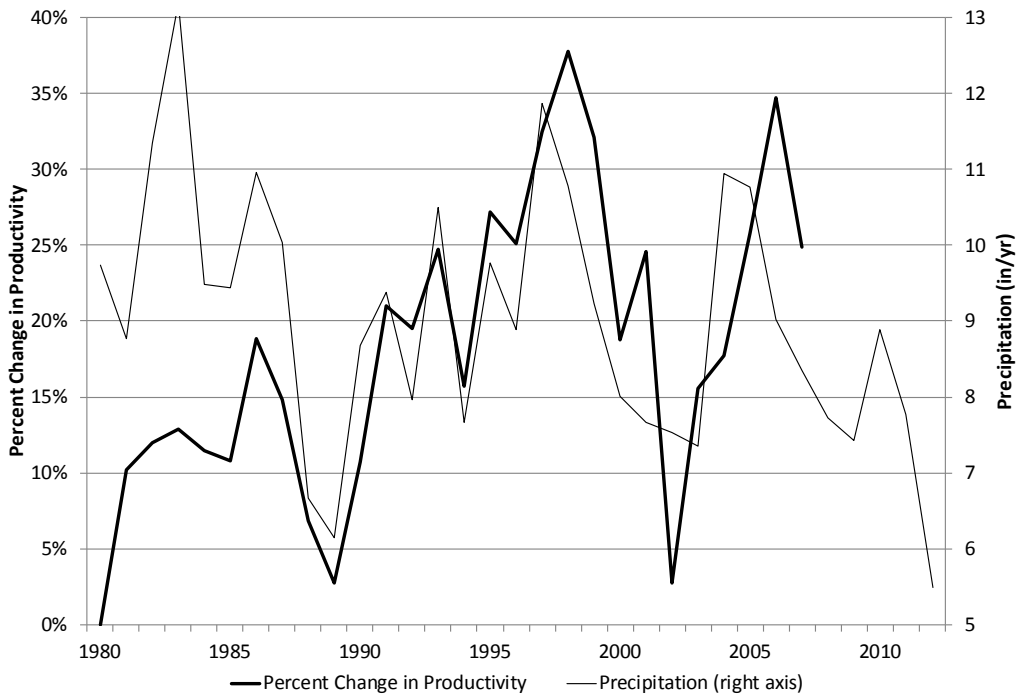


FIGURE 4C-5
Change in Productivity and Precipitation, 5-year Average, Upper Basin Representative Area

FIGURE 4C-6
Change in Productivity and Precipitation, Irrigation Season, 5-year Average, Upper Basin Representative Area

TABLE 4C-7
Contribution of Precipitation to Total Crop Consumptive Use

	Irrigation Season Precipitation[1] (in)	Consumptive Use			Consumptive Use of Precipitation, as Percent of Total Crop Consumptive Use
		Colorado River Water Consumptive Use (in)	Consumptive Use of Precipitation (in)[2]	Estimated Total Crop Consumptive Use (in)[3]	
Upper Basin Representative Area	4.1	22.6	3.1	25.7	12%
Lower Basin Representative Area	3.2	71.5	2.4	59.6	4%

[1] Average precipitation, 1980 to 2009, from meteorological stations shown on Figure 4-3 of the main report. Average of states used. Irrigation season defined as April through August in Upper Basin, and year-round in Lower Basin.
[2] Consumptive use assumed to be 75% of total precipitation.
[3] Consumptive use of precipitation, plus portion of Colorado River consumptive use assumed to be consumed by crops (100% in Upper Basin and Wellton-Mohawk Irrigation and Drainage District; 80% in Coachella Valley Water District and Imperial Irrigation District).