

Estimates of Climate Change Effects on Crop Irrigation Requirements

Methodology

The following steps were performed to estimate climate change effects on crop irrigation requirements.

1. Obtain estimates of current and future evapotranspiration (ET) rates for a standard reference crop from University of Washington (UW) study for locations in the Yakima River basin. For this document, Sunnyside was used. If this methodology is acceptable, it can be applied to other locations within the Yakima River basin.
2. Locate an equivalent or surrogate area in California which has a similar ET rate to that of Sunnyside under future climate change conditions.
3. Estimate changes in ET under climate change conditions by comparing ET rates for the surrogate California station to the current ET for Sunnyside.
4. Check differences in precipitation between the surrogate California station and Sunnyside under climate change conditions and adjust ET rates as necessary.
5. Estimate the percentage increase in ET under future climate change conditions.

Current and Future ET for Sunnyside

Current and future evapotranspiration (ET) rates for Sunnyside were estimated using UW's monthly grid climate change model data. Using the full period of record (Water Years 1926-2006), average monthly ET rates were computed by UW for current and future conditions for the short grass reference crop. The current ET rates are based on the historical model, and the future ET rates are based on the 2040s (2030-2059) "moderate effect" climate change model (Model 6 – HAD-CM B1) assumed to be used in the RiverWare model run. Table 1 presents the estimated ET rates for the Sunnyside station.

Table 1. Estimated Monthly Evapotranspiration (ET) Rates for Reference Crop (Short Grass) – Sunnyside Station

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Mar-Oct
Current	1.19	1.86	3.24	4.47	6.03	6.84	7.72	6.46	4.25	2.65	1.70	1.19	47.61	41.67
Future	1.21	1.80	3.20	4.46	6.26	7.20	8.38	7.10	4.65	2.73	1.68	1.16	49.83	43.98

Note: All values in inches

Locate an Equivalent Area in California to the Sunnyside Station

The UW study did not contain estimates of ET for crops other than apples and cherries. The ET for apples under climate change conditions was estimated in the UW study to decrease by 22% because of a shorter growing season. The Out-of-Stream Water Needs Subcommittee did not believe this to be accurate and asked the consultant team to derive another estimate. It was assumed that the future climate in the Yakima River Basin could be related to current climate areas of California where temperatures are higher. The Irrigation Training and Research Center

at Cal Poly (Cal Poly-ITRC) has detailed information for 13 of 18 climate zones in California that have a significant amount of irrigated agriculture. Figure 1 presents the California climate zones. Table 2 presents the reference ET rates for each of the zones.

To estimate an equivalent zone, the future ET rates for the Sunnyside station were compared with the ET rates for California zones. Both the annual total and the March-October total were considered. Zone 15 for a wet year was found to have ET conditions most similar to Sunnyside station's future conditions under climate change. Zone 15 is in the Bakersfield area.

Estimate the monthly change in ET rates

The monthly change in ET rates for all crops is estimated by subtracting the Zone 15 Wet Year data (Sunnyside station future conditions) from the estimated ET for Sunnyside under current conditions. Table 3 presents the monthly change in ET for crops using Cal Poly-IRTC Zone data.

Check Differences in Precipitation and Adjust ET

The difference in precipitation was estimated using UW's monthly grid climate change model data. Using the full period of record (Water Years 1926-2006), average monthly precipitation was computed for current and future conditions. The current precipitation is based on the historical model, and the future precipitation is based on the 2040s (2030-2059) "moderate effect" climate change model (Model 6 – HAD-CM B1) assumed to be used in the RiverWare model run. Table 4 presents the difference in precipitation for the Sunnyside station.

Table 4. Estimated Monthly Precipitation – Sunnyside Station

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Current	0.92	0.62	0.64	0.53	0.50	0.45	0.15	0.29	0.51	0.60	0.89	1.13	7.24
Future	0.88	0.64	0.73	0.46	0.42	0.33	0.15	0.17	0.24	0.68	1.07	1.10	6.87
Difference	-0.04	0.01	0.09	-0.07	-0.08	-0.12	0.00	-0.12	-0.27	0.08	0.17	-0.03	-0.37

Note: All values in inches

The monthly future irrigation requirements at the Sunnyside Station were adjusted for precipitation using the following formula:

$$\begin{aligned} \text{Future CIR} = & \text{Monthly Current CIR from Washington Irrigation Guide (WIG)} \\ & + [(\text{monthly difference in crop ET}) - (\text{monthly difference in precipitation})] \\ & * \text{irrigation days} / \text{days in month} \end{aligned}$$

Table 5 presents the estimated future irrigation requirements for Sunnyside station. These results assume that the current irrigation season will remain the same in the future.

Estimate the Average Future Irrigation Requirement Increase

The results in Table 5 show a range of 16 percent lower to 45 percent higher annual irrigation requirements for future conditions. The crop mix from Sunnyside Valley Irrigation District was used to estimate a weighted average to represent the average increase in crop irrigation requirements on a regional basis.. This calculation was performed to simplify the analysis of climate change using the RiverWare model. The RiverWare model does not contain detailed calculations of consumptive use but does use an overall estimate for each district. By using a weighted average, the consumptive use in RiverWare can be more easily changed.

The estimated increase in annual irrigation requirements for Sunnyside station is 13.0 percent. We would expect similar increases elsewhere in the lower Yakima River basin and we propose to use an increase of 13% to represent irrigation requirements under future climate change conditions for SVID, WIP, Roza, NSID and KID. A separate calculation will be performed for Kittitas Valley.