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"COMPREHENSIVE AGRICULTURAL AND WATER RESOURCE CONSULTING"

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TO: Mike Sullivan, Mary Halstead, and James Heath with Colorado Division of Water Resources and the RGDSS Peer Review Committee
FROM: Kirk Thompson
SUBJECT: Phase 6 - Effective Precipitation Methodology
DATE: 7/19/2012

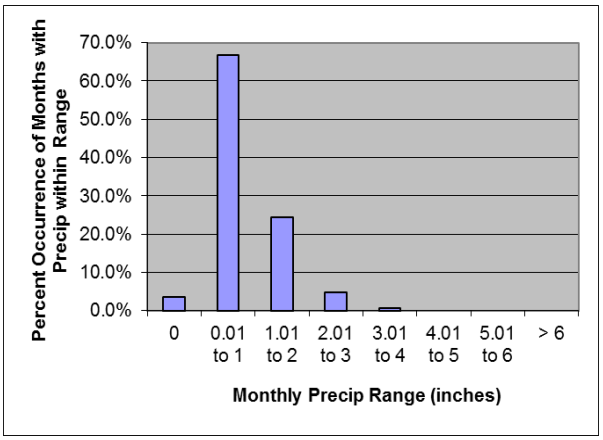
Effective precipitation is the component of precipitation that is available to meet crop consumptive use. StateCU is capable of estimating monthly effective precipitation using one of two methods. Effective precipitation can be calculating using the Soil Conservation Service (SCS) TR21 method or the United States' Bureau of Reclamation (USBR) method. The equations for both methods are presented in Section 4.1.2 of the RGDSS StateCU documentation (Colorado DWR, 2008). In the SCS method, effective precipitation is calculated as a function of total monthly precipitation, the net depth of application, and the average monthly consumptive use. In the USBR method, effective precipitation is calculated from a set of linear functions dependent on monthly total precipitation.

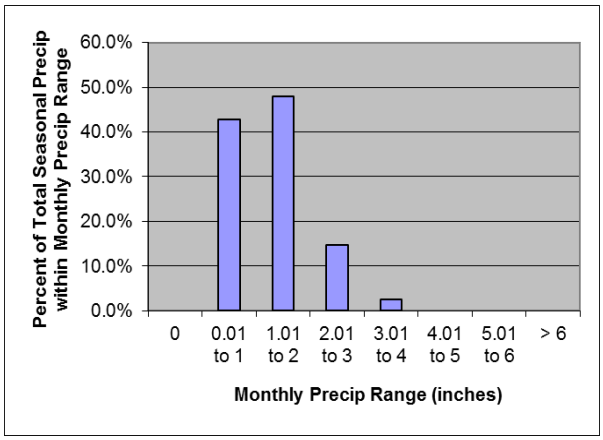
Predominantly, the land slope in the San Luis Valley is flat with soils of sands and gravels with high infiltration rates. Frequent and large precipitation events are uncommon, and amounts of monthly precipitation are typically quite low. In our experience, only a small amount of the "ineffective" portion of precipitation is a result of surface runoff. A portion of the precipitation that is considered "ineffective" by the SCS method is based on an estimation of surface runoff. It is our opinion that the lower amount of surface runoff predicted by the USBR method for small precipitation amounts is more appropriate for Division 3 than the surface water runoff predicted by the SCS method.

By definition, effective precipitation is the portion of total precipitation that is available to meet crop consumptive use. It does not include precipitation lost through runoff and deep percolation below the root zone. I would add that it also does not include the portion of a precipitation event that evaporates prior to the rain water entering the root zone. In our experience, the San Luis Valley tends to have a lot of very light precipitation events (misting events) that are not effective and will result in an over-estimation of the effective precipitation if the USBR method is used without some additional consideration.

To illustrate this point, we looked at daily total precipitation values as measured at the Center CoAgMet meteorological station between 1980 and 2010. Average growing season (April through October) precipitation at this station is 5.6 inches. The majority (70%) of occurrences of monthly precipitation fall within the 1 inch per month or less range. Nearly all of the remaining occurrences (24%) had monthly precipitation between 1 and 2 inches. There are only 9 months on record at this station with rainfall exceeding 2 inches per month. When weighted by precipitation as the percent of total seasonal precipitation that occurs within each monthly precipitation range, 43% of seasonal precipitation fell within the 1 inch per month or less

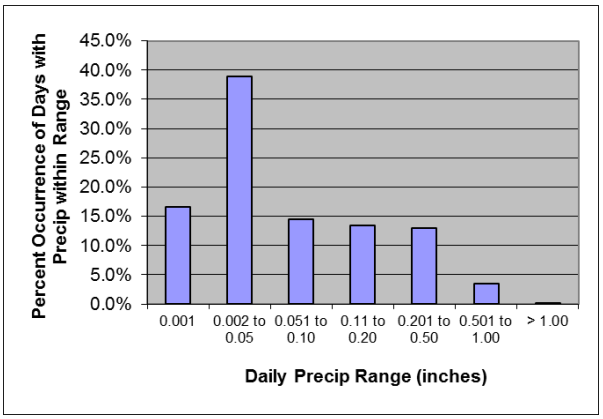
category and 48% of seasonal precipitation fell within the 1 to 2 inch per month category. Consequently, using the USBR method will weight effective precipitation heavily toward the 95% and 90% effective categories. Applying this method to the Center data results in an average effective precipitation of 92.9% in comparison to an average effective precipitation of 77% with the SCS method.

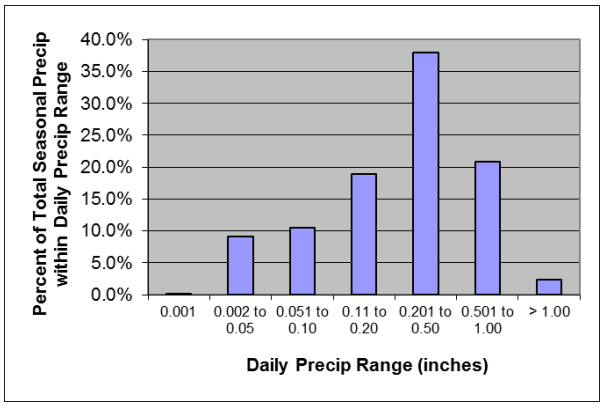




In our experience, an effective precipitation of 90%+ is too high. As described earlier, the amount of surface runoff resulting from precipitation is very small (and negligible in most circumstances) in the San Luis Valley. However, I do not agree with the statement that most, if not all, precipitation enters the soil moisture zone and that the majority of ineffective precipitation becomes deep percolation. There is also a component of precipitation that evaporates directly before it can enter the soil moisture zone. I believe that this component of wet soil evaporation and leaf surface evaporation (not transpiration) of precipitation is significant in the San Luis Valley.

To explain, we evaluated the daily data from the Center station to illustrate the occurrence of individual precipitation events. 17% of rainfall events occur at only trace levels. 56% of the individual rainfall events drop less than 0.05 inches of precipitation. 70% of the individual rainfall events drop less than 0.1 inches of precipitation. 26% of individual rainfall events produce between 0.1 inches to 0.5 inches, and only 4% of individual rainfall events produce more than 0.5 inches.





When weighted by the rainfall amount, 9.1% of the seasonal precipitation occurs in individual rainfall events of less than 0.05 inches. It is my opinion that none of this precipitation is effective and that all of this rain evaporates directly before entering the soil profile.

It is true that precipitation events do reduce daily crop irrigation requirement. When a rain event wets the plants leaves, energy from solar radiation will evaporate these water droplets before causing additional plant transpiration. Consequently, it would be appropriate to consider these light precipitation events as effective rainfall and subtract this amount from the crop evapotranspiration when estimating crop irrigation requirement. I believe this to be true for light rainfall events between 0.05 and 0.2 inches. However, in my experience, the rain events that are less than or equal to 0.05 inches per day are very inconsequential misting events that only result in plant leaves being wet for a half an hour or less and, in my opinion, they do not significantly affect the daily crop evapotranspiration or crop irrigation requirement.

We would recommend that for Phase 6 of the RGDSS model runs, StateCU use the USBR method of calculating effective precipitation, with daily precipitation events less than or equal to 0.05 inches subtracted from the monthly totals, and considered 0% effective. With the normal pattern of rainfall at the Center station, this modification to the methodology would result in a seasonal effective precipitation of 84%, which seems more reasonable than the 93% that results using the USBR method without modification. Since phase 3, the RGDSS groundwater model assumes 10% of rainfall on irrigated land (and 3% on non-irrigated land) is considered to become recharge. In StateCU, the recommended methodology should provide results that are relatively consistent with the amount of recharge assumed in the groundwater model.

Sincerely,

Kirk Thompson, P.E. C.C.A.

References:

Colorado Division of Water Resources, September 2008, *RGDSS StateCU Documentation: StateCU Interface Version 7.0, StateCU Fortran Version 13.0*.