DROUGHT WATER RIGHTS ALLOCATION TOOL

January, 2022

RIPARIAN FORMULATION

$$0 \leq P_k \leq 1$$

for all basins, k

Basin proportions P_k are between 0 and 1.

$$A_i = P_k u_i$$

for all i users, in each basin k

Each user's allocation A_i is user i's basin proportion P_k, of i's demand u_i.

$$A_k = P_k U_k$$

for all k basins

Basin demand U_k is the sum of all user demand u_i in each basin k. Basin allocation A_k is the basin proportion P_k of basin demand U_k.

$$\sum_{i \in k} A_i \leq v_k - e_k$$

for all i users that are within each basin k

Mass Balance: within every basin k, the sum of all users' allocations are less than or equal to flow v_k in basin k, less any environmental instream flow requirement e_k.

$$P_j \leq P_k$$

for all basins j and all basins k

Upstream basin proportions P_j cannot exceed downstream basin proportions P_k.

$$w_k = \frac{n_k}{n_{k,\ system\ outlet}}$$

for all basins, k

A basin penalty w_k is applied that increases with the ratio of the number of basins n_k upstream of basin k, to the total number of basins in the watershed.

Riparian Objective Function:

$$\text{Maximize } z = \sum_i A_i - \sum_k A_k w_k$$

For all users i, and all basins, k

Maximize total user allocations A_i less the sum of downstream penalty w_k weighted basin allocations A_k.

APPROPRIATIVE FORMULATION

$$0 \leq A_i \leq u_i$$

for all users, *i*

Each appropriative user's allocation A_i must be between 0 and her reported demand u_i

$$\sum_{i \in k} A_{i,(appropriative)} \leq v_k - e_k$$

$$- \sum_{i \in k} A_{i,(riparian)}$$

for all users *i*, in all upstream basins *k*

Mass Balance: the sum of all appropriative allocations $A_{i,appropriative}$ that are in basin *k*, must be less than or equal to available flow *vk*, less any environmental instream flow requirement e_k, less the sum of all upstream riparian allocations, $A_{i,riparian}$.

Appropriative Objective Function:

$$\text{Minimize } z = \sum_i p_i(u_i - A_i)$$

for all users, *i*

Minimize the difference between demand and allocation, or shortage, $(u_i - A_i)$ weighted by the inverse of the priority of user *i*.