Description of Analytical Tools

Name: Consumptive Use model (CU)

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Availability of Technical Support:

1. "Consumptive Use Program Documentation", George Barnes, Jr., DWR Memorandum, Statewide Planning Branch, DWR, April 11, 1979
2. "Consumptive Use Model and Depletion Analysis Overview", DWR and WRMI, Inc, November 18, 1991.

Categories: Ag Water demand, Urban Water Demand, Evapotranspiration, Hydrology

Main Features and Capabilities:

- Input-data driven (generic)
- *Monthly* time step for any number of years
- Spatial scale set by *user*
- Calculates the monthly agricultural and urban water demands through a simplified root zone soil moisture accounting
- The demands are calculated at both a historical level (historical land use that varies by year) and a projected level (future level land use that is fixed for the duration of the simulation)
- Code written in FORTRAN and updated for FORTRAN 77, FORTRAN 90, FORTRAN 95.
- An EXCEL version of the code exists for a single year simulation, and is being extended to simulate multiple years

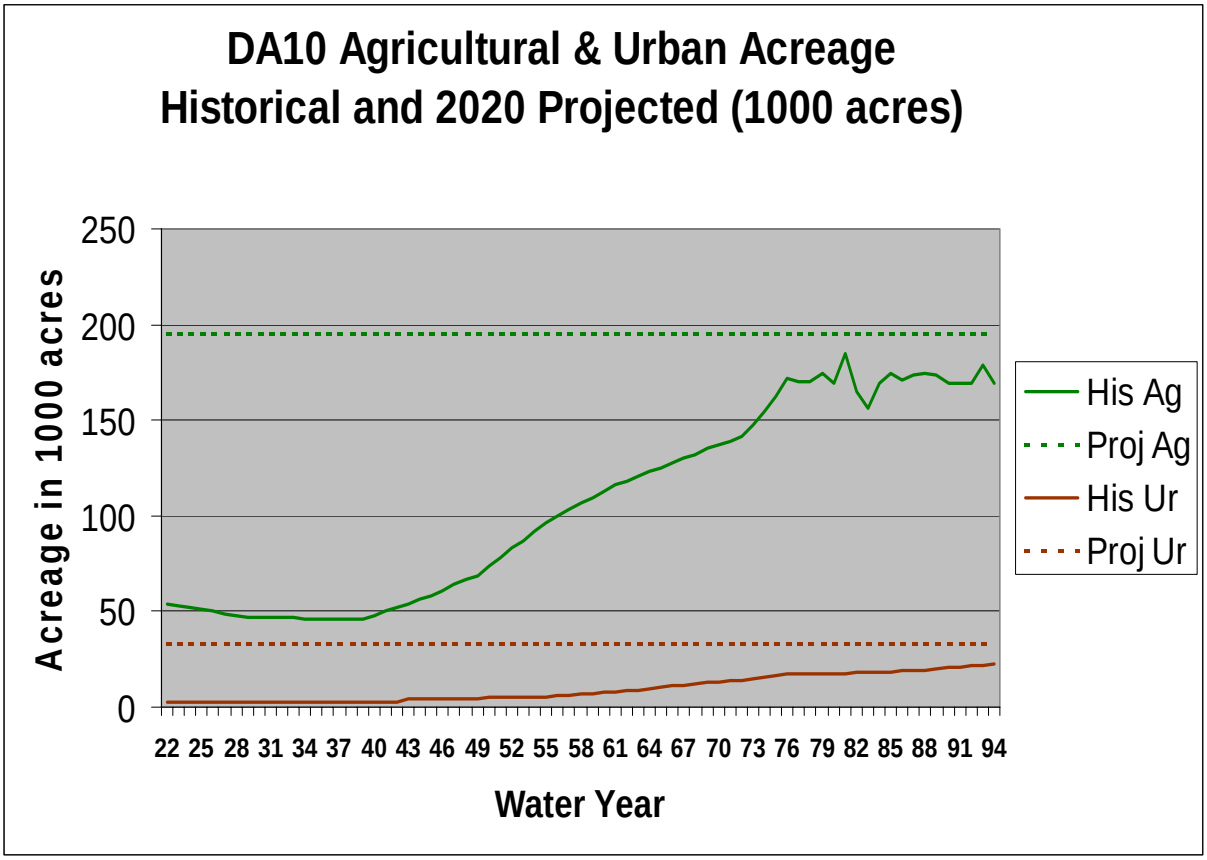
Applications: The model has been applied to all Central Valley areas tributary to the Delta for calculating input to the planning models of the SWP/CVP systems (DWRSIM and CalSim). The model has also been applied to individual water district areas

Calibration/Validation/Sensitivity Analysis: Calibration or validation of the CU model has not been performed due to lack of comparable historical data available for a region to check against model results. Sensitivity analysis of key input parameters has been performed as part of the sensitivity analysis of CalSim results (report in preparation by the Bay-Delta Office)

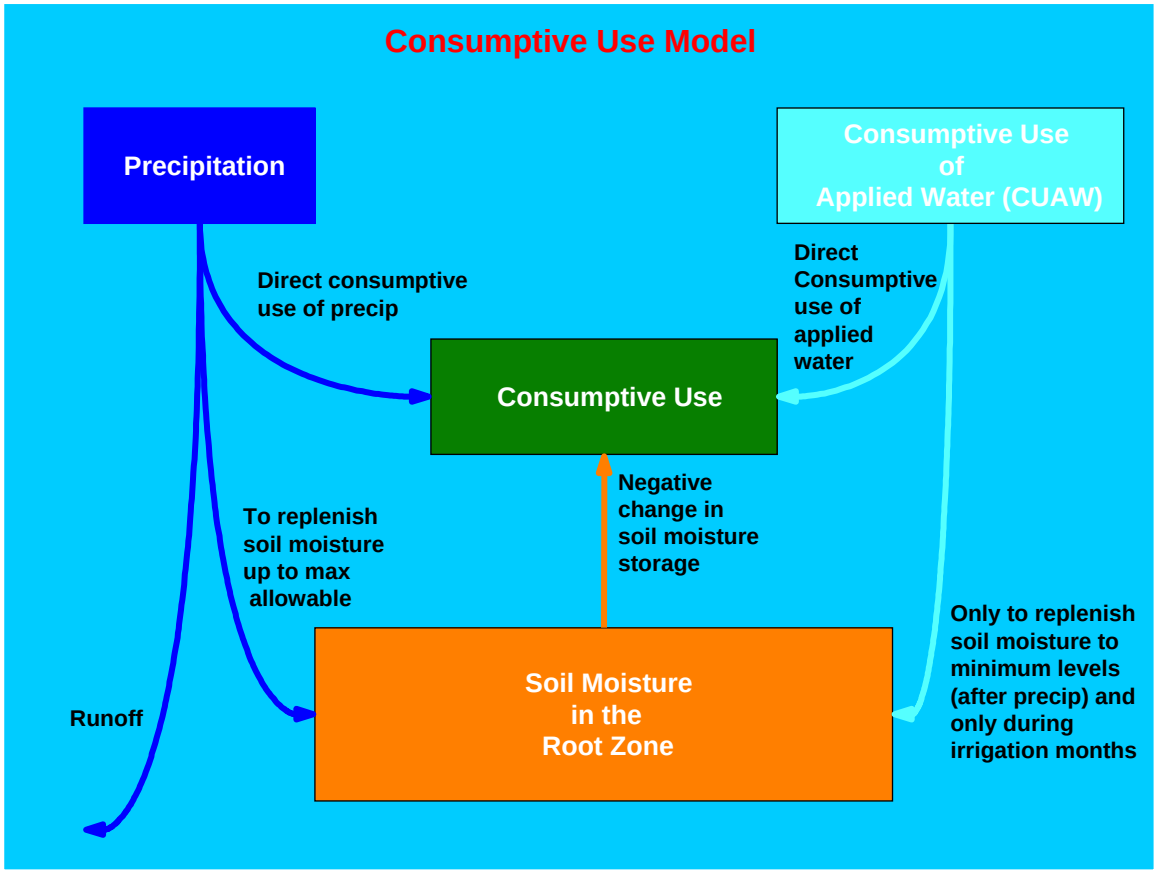
Peer Review: No formal peer review yet.

Anatomy of the CU Model:

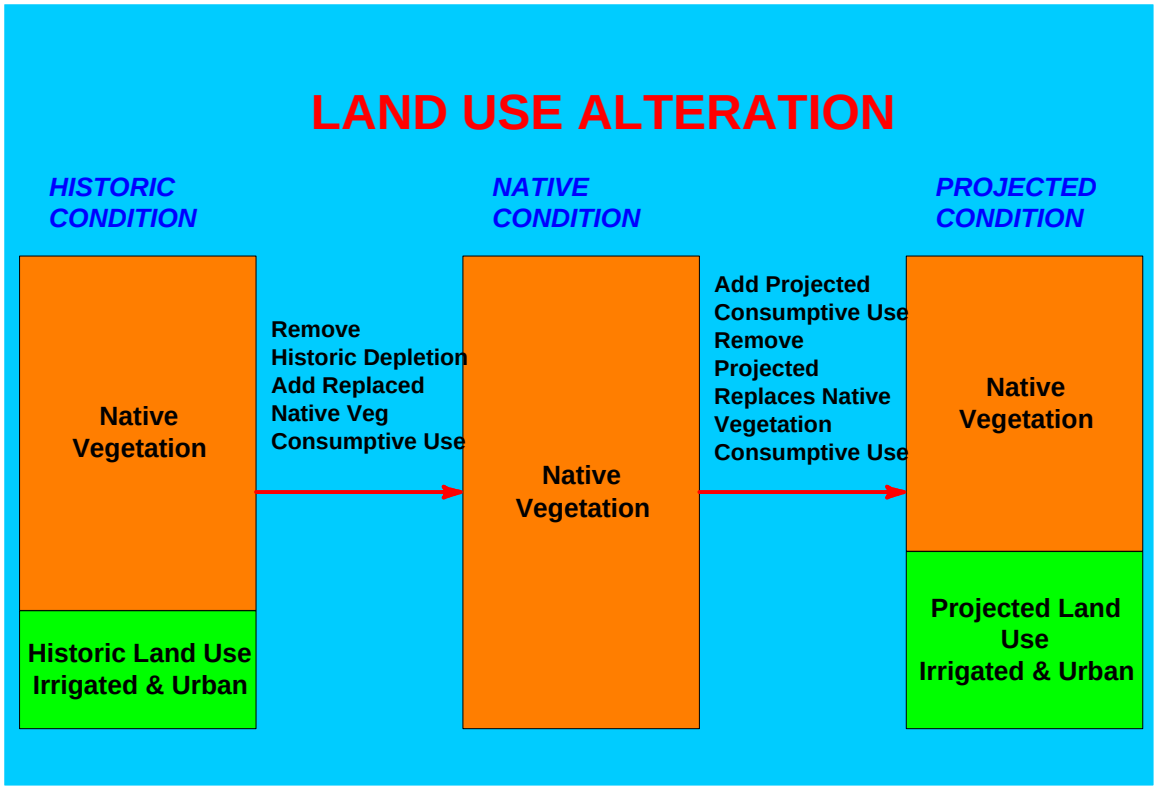
-Conceptual Basis. The primary objective of the CU model is to calculate the monthly water demand for agricultural crops and outdoor urban needs, given the land use acreages, a precipitation trace, crop ET requirements, and soil moisture characteristics at both a historical and projected level of land use development. This would represent the water requirement not satisfied by precipitation, and to be supplied from surface water diversions and/or ground water pumping. Another major output is the additional runoff caused by crop and/or urban changes from historical to projected levels. Typically acreages vary by year at a historical level, and assumed to remain fixed at a projected level (while varying the hydrology) as shown in the figure below.



-Theoretical Basis: The theoretical basis of the CU model is a simple root zone soil moisture accounting that determines the additional water requirement (surface water diversions and/or ground water pumping) that is not met by precipitation occurring in that month or stored in the soil from previous months. As shown in the figure below, precipitation is assumed to meet the ET crop requirement in that month, or stored in the soil for subsequent use in future months. If the soil moisture holding capacity is exceeded, then the remaining precipitation is assumed as runoff/deep percolation. The crop ET is met either by precipitation in that month, soil moisture moisture available, or applied water. Applied water can be used to meet any crop potential ET requirement, or to raise the soil moisture level to predetermined minimum levels.



The change in acreage from historical to projected levels (as shown in the Figure below) causes additional runoff (e.g. crop and/or native vegetation changed to urban causes additional runoff because of the hardtop component of the urban acreage).



-Numerical Basis: A simple mass balance accounting is maintained every month of the simulation, and the only connection of one month to the next is the carry-over soil moisture storage.

Input and Output: The main inputs to the CU model are:

1. Land use data: crops identification (either individual crops or a category representing multiple crops with similar ET and soil moisture characteristics).
2. Monthly precipitation
3. Rooting depths
4. Soil moisture criteria

and the main outputs are:

1- Monthly ag crop water requirements
2- Monthly urban vegetation water requirements

Data Management: The CU model is written in FORTRAN and all the input and output files are flat files (ASCII). There is also a version of the CU model that handles the data through a combination of flat files (for the fixed data) and HEC-DSS files (for the time series data). Finally, an EXCEL version of the CU model is being developed.

Software: The CU model is input data driven. The code is written in FORTRAN and will require re-compilation if the application exceeds the internally set dimensions (e.g. maximum years of simulation, number of crops being simulated). Both the code and executable are available and no proprietary software is required (other than the FORTRAN compiler for recompilation).