Delta Evapotranspiration of Applied Water (DETAW v2.1)

User's Manual

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1. Introduction

DETAW v2.1 enhanced the model interface to alignment with the California Simulation 3.0 (CALSIM3) model based on DETAW v2.0. DETAW v2.1 inherit all the model parameters and algorithms from DETAW v2.0, except the planning study input and output. The DETAW v2.1 model output is used for the CALSIM3 planning studies only.

DETAW v2.0 simulates the daily actual evapotranspiration(ET) and root zone water balance on 168 subareas in the Sacramento-San Joaquin River Delta. The root zone water balance on each Delta subarea counts as part of the applied water, rainfall, seepage and the change in soil water content to satisfy the water demand, ET. The model calculates and outputs all the elements related to the root zone water balance.

The major technical algorithms in DETAW 2.0 are described in two documents in this package. One is the DETAW v1.0 report which describes the fundamental technical algorithm, and the other is Chapter 3 of 2017 Delta Modeling Annual Report which describes the technical improvements in DETAW v2.0.

This document serves as a guide for setting up all the input files of the DETAW and running the model. All the required inputs for running DETAW v2.1 from October 1921 through September 2016 have been included in the package. Since DETAW v2.1 inherits all the model parameters and algorithm from DETAW v2.0, two versions have the same schematic. A schematic representation of the file structure for the DETAW v2.0 is given in Figure 1.

Figure 1. The file structure for the DETAW v2.0

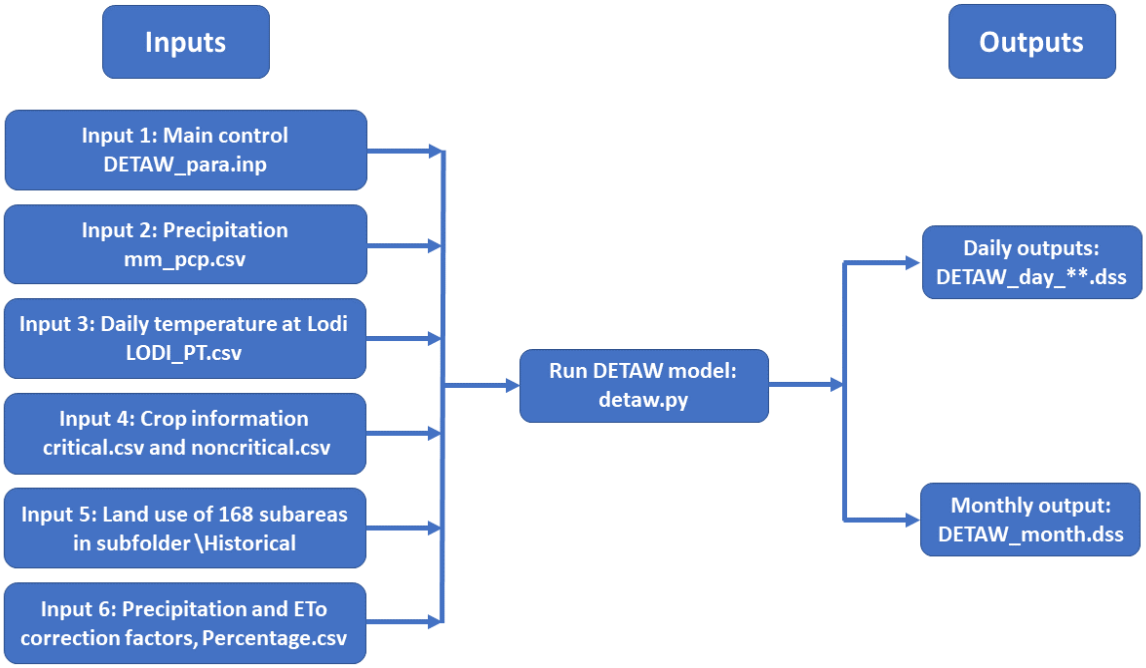

Figure 1 shows that the inputs of the historical scenario include main control parameters, the daily precipitation at seven stations, Lodi daily maximum and minimum temperature, parameters related to 15 crop categories, and the annual land use for 168 sub-areas.

At this time, the provided data format of each input file should be followed if changing inputs. DETAW was initially developed to understand Delta island consumptive use and the model's flexibility for easily studying other factors is currently limited. However, changing inputs is possible with some minor change. For example, for a planning study with different climatic data and land use, keep all the paths and names of the input files as the historical scenario but replace the climatic data and land use following the same format as in each original input file.

A general overview of the input files for DETAW v2.1 is provided below, followed by instructions for running the model.

2. Model Inputs

2.1 Input 1: Main Control Parameters

The main control parameters are in the input file, \DETAW\Input\DETAW_para.inp. The options for each parameter are listed and explained in Table 1. All the parameters are set for CALSIM3. This file should keep same for all the CALSIM23 planning studies.

Table 1 The options of the main control parameters.

Parameter	Query	Possible Responses
Daily Output	Produce daily output?	1 – Yes, 0 – No. The default value is 1.
Monthly output	Produce monthly output?	1 – Yes, 0 – No. The default value is 1.
Yearly output	Produce the yearly output?	1 – Yes, 0 – No. The yearly output is rarely used, so the default value is 0.
Delta output	Generate ETc, ETaw, Espg and Er for the whole Delta?	1 – Yes, 0 – No. The default value is 0.
Daily output unit	Specify unit of the original daily output terms.	1 – "A-FT", 0 – "mm". The default value is 1 for DSM2 study.
forDSM2_daily	Is the daily outputs for the DSM2 model or according to original output setting?	1 – The daily output is for DSM2, 0 – all the outputs are generated as the original output set. Further description of the option is provided below.
End year	Specify the end water year.	The end year. For example, 2016, for the simulation used in this package.
Days	Specify the number of days the model simulates.	The simulation days, for example, 34700 days from Sep.30,1921 to Sep.30,2016. Open the input files LODI_PT.csv or mm_pcp.csv and the rows of each file minus one is the simulation days.

If the parameter "ForDSM2_daily" is set to 0 to obtain the original output set, the daily outputs should include most factors related to the root zone water balance calculation, such as reference ET(ETo), crop ET(ETc), total precipitation(Pcp), effective rainfall(Er), calculated seepage based on the plant rooting depth(Spg), effective seepage(Espg), the daily drop in soil water content(Dsw), ET of applied water(ETaw), soil water depletion(SWD), field capacity(FC), soil water content(SWC),yield threshold(YT), net irrigation application(NA), and in-season cumulative values (CPcp, CEr, CEspg, CETc, CDsw, CETaw).

If the parameter "ForDSM2_daily" is set as 1 to obtain input for the DSM2 model, the daily outputs only have ETc, Pcp, Espg, Dsw, ETaw, and Er.

2.2 Input 2: Precipitation (\DETAW\Input\planning_study\mm_pcp.csv)

Precipitation data can be retrieved from the California weather database, Statewide Integrated Pest Management Program, University of California (UC IPM). This database collects the data from California Irrigation Management Information System (CIMIS) and National Climatic Data Center(NCDC) in National Oceanic and Atmospheric Administration (NOAA). Generally, DETAW uses NCDC data. If the national climatic data is not available, CIMIS data substitutes.

The precipitation data comes from seven stations, Brentwood, Davis, Galt, Lodi, Rio Vista, Stockton, and Tracy. UC IPM currently only provides the precipitation data at Davis, Lodi, Stockton and Tracy. The other three stations do not have data for recent years. During the development of DETAW v1.0, correlations were established to estimate the precipitation at these three stations:

$$P(\text{Brentwood}) = 1.37 * P(\text{Tracy}) \quad [1]$$

$$P(\text{Galt}) = 1.01 * P(\text{Lodi}) \quad [2]$$

$$P(\text{Rio Vista}) = 0.98 * P(\text{Davis}) \quad [3]$$

The precipitation input file, mm_pcp.csv in this package includes the precipitation data for water years 1922 through 2016. Although this file consists of daily data, any updating must include an entire year as the running loop in the program requires increments of water years. For example, if the observed data is available until Nov. 30th, 2015, the file must be extended to Sep. 30th, 2016 and the table from Dec.1st, 2015 to Sep.30th, 2016 must be filled with some placeholder values.

2.3 Input 3: Air Temperature (\DETAW\Input\planning_study\LODI_PT.csv)

Daily maximum and minimum air temperature at Lodi is a required input of DETAW. This can also be downloaded from UC IPM. UC IPM collects data at two Lodi stations, LODI.C from NCDC and LODI_WEST.A from CIMIS. LODI.C is preferred as the primary air temperature source since all the precipitation data in DETAW also comes from NCDC. If errors or missing data for this station are found, data from LODI-WEST.A are used. The air temperature data at these two stations match very well.

The air temperature input file, LODI_PT.csv, in this package has the air temperature data at Lodi from water years 1922 through 2016. The same as for the precipitation input file, this input file

must be extended for the entire water year. If the simulation includes part of an incomplete year, data for the future days to the end of the water year must still be filled.

2.4 Input 4: Crop Information (\DETAW\Input\planning_study\critical.csv and noncritical.csv)

DETAW v1.0 defined 15 crop categories in the Delta and its report specified how to classify crops according to the crop categories. Table 2 shows the parameters needed for each of 15 crop categories. Two input files, critical.csv and noncritical.csv in Table 3 and Table 4 respectively, provide crop information under critical and noncritical (normal and wet) water year types. The crop coefficients in the two csv files are the result of being calibrated in DETAW v2.0, so should only be changed after further analysis.

Table 2 Crop and soil information

Symbol	Variable
BD	Beginning calendar date for the in-season period
ED	Ending calendar date for the in-season period
BD	Beginning day of the year for the in-season period
ED	Ending day of the year for the in-season period. Subtract 365 for bigger numbers.
F	Frequency of irrigation during initial growth of type 1 crops (default = 30days)
Kc1	Crop coefficient on date B and between dates A and B
Kc2	Crop coefficient between dates C and D
Kc3	Crop coefficient on date E
a-b	Percentage of the season from date A to B
a-c	Percentage of the season from date A to C
a-d	Percentage of the season from date A to D
SDx	Maximum soil depth (mm)
RDx_Lo	Maximum crop root depth in Delta lowlands (mm)
RDx_Up	Maximum crop root depth in Delta uplands (mm)
AW_Lo	Available water content in Delta lowland soil (mm)
AW_Up	Available water content in Delta upland soil (mm)
AD%	Allowable depletion of available water (%)

Table 3 The critical year information of 15 crop categories

			Irrig				Irrig		Truck				Riparian	Native	Non-irrig	Water
Crop		Urban	Pasture	Alfalfa	Field	Sugarbeet	Grains	Rice	Crops	Tomato	Orchard	Vineyard	Vegetatio	Vegetatio	Grain	Surfaces
Code	Type	UR	PA	AL	FI	SB	GR	RI	TR	TO	OR	VI	RV	NV	DG	WS
Number	#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Type		3	2	2	1	1	1	1	1	1	3	3	3	3	1	2
BD		1-Jan	1-Jan	14-Apr	28-Apr	14-Mar	31-Oct	14-May	28-Jan	31-Mar	30-Mar	31-Mar	1-Jan	1-Jan	31-Oct	1-Jan
ED		31-Dec	31-Dec	30-Oct	29-Sep	29-Sep	30-May	29-Sep	3-Dec	30-Aug	13-Nov	31-Oct	31-Dec	31-Dec	31-May	31-Dec
BD		1	1	105	119	74	305	135	29	91	90	91	1	1	305	1
ED		366	366	304	273	273	516	273	339	243	318	305	366	366	517	366
F		30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Kc1		0.59	0.75	0.77	0.21	0.2	0.33	1.2	0.37	0.3	0.55	0.45	0.8	1	0.33	1.1
Kc2		0.35	0.75	0.77	0.9	0.8	1.1	0.8	0.6	0.7	0.75	0.45	0.85	0.5	0.9	1.1
Kc3		0.59	0.75	0.77	0.57	0.95	0.15	0.8	0.38	0.65	0.8	0.35	0.8	1	0.15	1.1
a-b		0	0	0	19	15	20	22	14	25	0	0	0	0	20	0
a-c		33	33	33	44	45	45	37	31	50	49	25	33	33	45	33
a-d		67	67	67	76	80	75	86	92	80	75	75	67	67	75	67
SDx		1524	1524	1524	1524	1524	1524	1524	1524	1524	1524	1524	1524	1524	1524	1524
RDx_Lo		400	610	1219	610	1219	610	305	1219	1219	1524	1219	1524	762	610	1524
RDx_Up		400	610	1829	1219	1524	1219	610	1524	1524	1829	1524	1524	610	610	1524
AW_Lo		0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
AW_Up		0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
AD %		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50

Table 4 The noncritical year information of 15 crop categories

			Irrig				Irrig		Truck				Riparian	Native	Non-irrig	Water
Crop		Urban	Pasture	Alfalfa	Field	Sugarbeet	Grains	Rice	Crops	Tomato	Orchard	Vineyard	Vegetatio	Vegetatio	Grain	Surfaces
Code	Type	UR	PA	AL	FI	SB	GR	RI	TR	TO	OR	VI	RV	NV	DG	WS
Number	#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Type		3	2	2	1	1	1	1	1	1	3	3	3	3	1	2
BD		1-Jan	1-Jan	14-Apr	22-Apr	14-Mar	31-Oct	14-May	2-Feb	31-Mar	21-Mar	31-Mar	1-Jan	1-Jan	31-Oct	1-Jan
ED		31-Dec	31-Dec	30-Oct	6-Sep	29-Sep	30-May	29-Sep	27-Nov	30-Aug	3-Nov	31-Oct	31-Dec	31-Dec	30-May	31-Dec
BD		1	1	105	113	74	305	135	34	91	81	91	1	1	305	1
ED		366	365	304	251	273	516	273	333	243	308	305	366	366	516	366
F		30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Kc1		0.62	0.75	0.77	0.2	0.2	0.45	1.2	0.43	0.3	0.55	0.45	0.8	1	0.33	1.1
Kc2		0.35	0.75	0.77	0.9	0.8	1.1	0.8	0.6	0.7	0.75	0.45	0.85	0.5	0.9	1.1
Kc3		0.62	0.75	0.77	0.47	0.95	0.15	0.8	0.42	0.65	0.75	0.35	0.8	1	0.15	1.1
a-b		0	0	0	19	15	20	22	15	25	0	0	0	0	20	0
a-c		33	33	33	44	45	45	37	33	50	49	25	33	33	45	33
a-d		67	67	67	76	80	75	86	90	80	78	75	67	67	75	67
SDx		1524	1524	1524	1524	1524	1524	1524	1524	1524	1524	1524	1524	1524	1524	1524
RDx_Lo		400	610	1219	610	1219	610	305	1219	1219	1524	1219	1524	762	610	1524
RDx_Up		400	610	1829	1219	1524	1219	610	1524	1524	1829	1524	1524	610	610	1524
AW_Lo		0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
AW_Up		0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
AD %		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50

2.5 Input 5: Land Use (\DETAW\Input\planning_study\Landuse)

Identical to DETAW v1.0 and v2.0, DETAW v2.1 depicts the Delta as 168 subareas. The land use of each subarea is assigned to 15 land use categories. Table 5 lists the crop categories used to identify the Delta land use in DETAW v2.1.

Table 5 15 crop categories in DETAW v2.0

	Crop categories	Land Use ID
1	Urban	UR
2	Pasture	PA
3	Alfalfa	AL
4	Field crops	FI
5	Sugar Beets	SB
6	Grain	GR
7	Rice	RI
8	Trucks	TR
9	Tomatoes	TO
10	Orchards	OR
11	Vineyards	VI
12	Riparian Vegetation	RV
13	Native Vegetation	NV
14	Non-irrigated Grain	DGR
15	Water Surfaces	WS

In DETAW v2.1, the planning study assumes that the same land use for all the years as the 2015 historical land use. It has 168 csv files for the land use data from 1922 through 2016, under the folder \DETAW\Input\planning_study\Landuse\.

If the land use data need to be extended after 2016, all the 168 files must be appended in the same format.

2.6 Input 6: Precipitation and ETo correction factors

(\DETAW\Input\planning_study\Percentage.csv)

DETAW first estimates the precipitation at seven weather stations and ETo at the Lodi NCDC station. Then local values are spatially distributed onto 168 sub-areas with the rules described in the DETAW v1.0 report. Percentage.csv provides the percentages and correction factors for the spatial distributions. CALSIM3 planning studies have no additional reliable data to justify the input data, so the original data set should be used.

3. Run DETAW v2.1

3.1 Prerequisites

Three software programs should be installed before running DETAW v2.1.

3.1.1 Python

Download Python 3.7 64 bit Windows version from the websites of Python or Anaconda.

The software has been included in this model package. The Anaconda3 executable file Anaconda3-2020.02-Windows-x86_64.exe can be found in the folder /tools. Double click the executable file to install.

3.1.2 Pyhecdss

It supports to retrieve and process the DSS file data for the DETAW and DCD models. Found the zipped file detaw_env in the folder /tools. Unzipped the file first and run the batch file detaw_env/Scripts/activate.bat. It builds up the pyhecdss environment.

3.1.3 HEC-DSSVue

Download and install HEC-DSSVue. All the DETAW v2.1 output files are in the DSS format. HEC_DSSVue is convenient to visualize, examine, and process the model outputs.

3.2 Launch DETAW v2.1

Once all the required software and the model inputs are prepared, DETAW can run under the Anaconda Navigator or Prompts. Run DCD1.1.py in the navigator window or type the following line in the prompt window.

```
python DETAW2.1.py
```

The released package includes all the inputs for the CALSIM3 base study from October 1922 through September 2016. The model results can be used directly for the CALSIM3 base study by running the model directly without any change to the released input files.