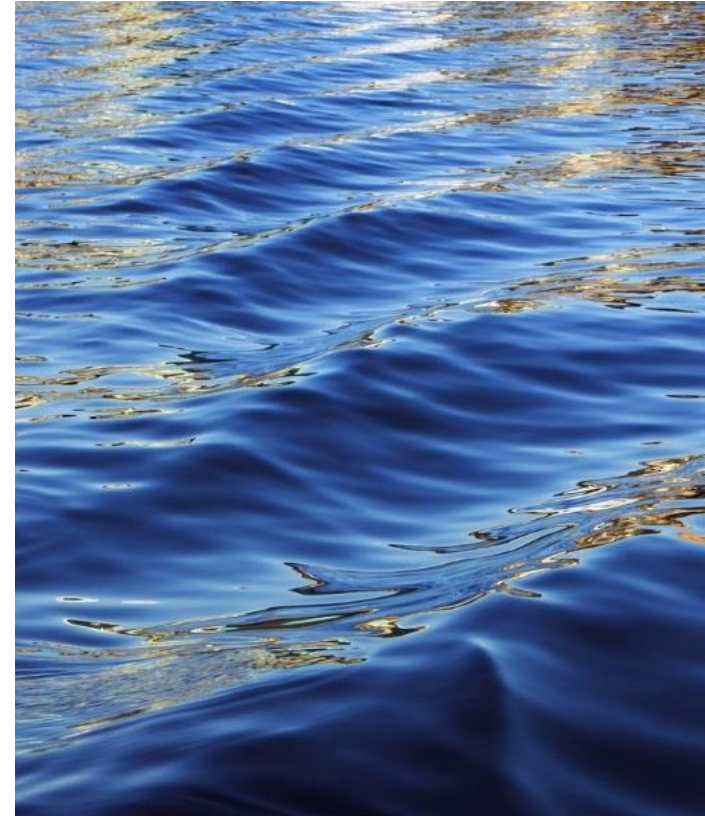


# REQUERIMIENTO DE AGUA EN CULTIVO TOMATE ROJO

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Maestría Diseño Electrónico  
Mayo, 2021

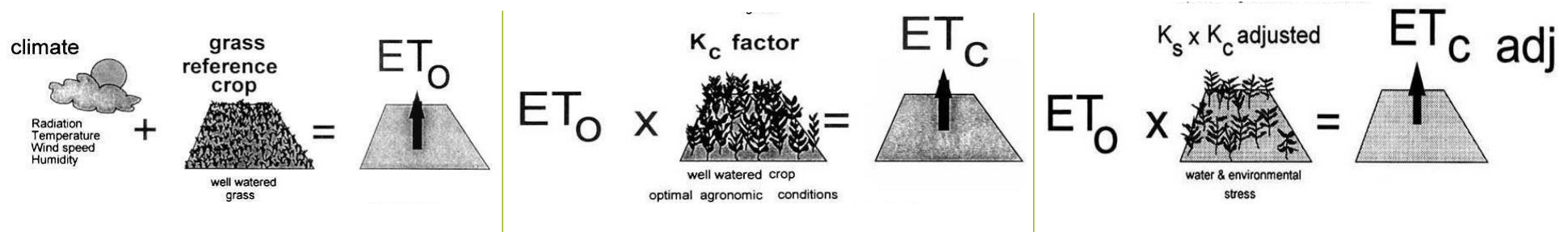


# Objetivo del Proyecto

- Crear base de datos climatológica proveniente de estación(es) Conagua referente a la región sur de Jalisco.
- Diseñar una herramienta SW para análisis y procesamiento de datos climatológicos en el cálculo de requerimiento de agua de un cultivo basado en el modelo FAO Penman-Monteith:

$$ET_o = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T + 273} u_2 (e_s - e_a)}{\Delta + (1 + 0.34u_2)}$$

- Calcular ETo/ETc en cultivo de tomate rojo en la zona sur de Jalisco



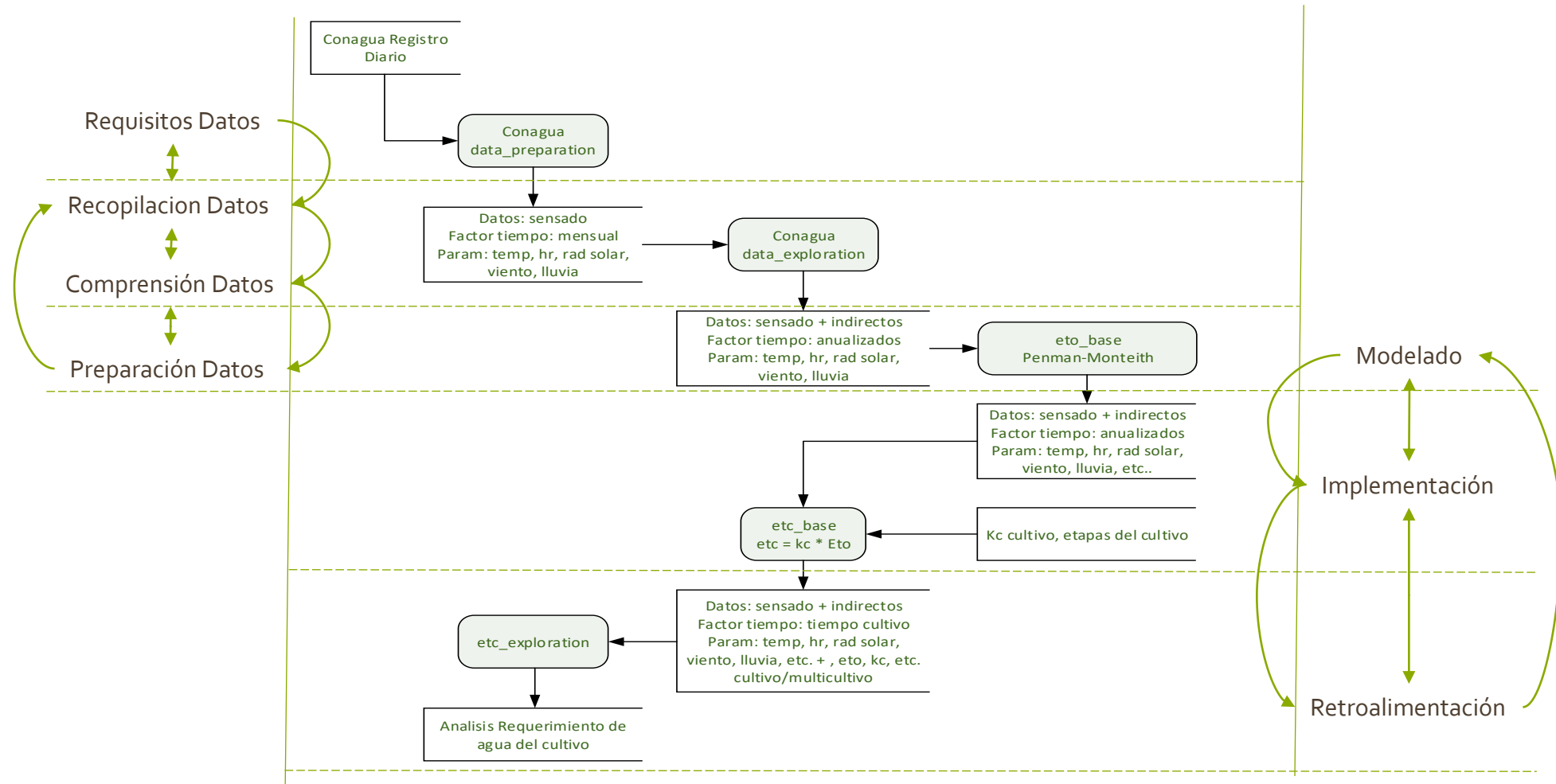
- Análisis de consumos en el uso de agua agrícola.

# Proceso para Obtención de Datos

- Fuente: Conagua Cd Guzman (Físico: <2019, Digital 2019-2020)
- Estación: Cd Guzman (lat = 19.59, lon = -103.59, msnm = 1408.99)
- Características: ~ 50 Variables Clima
- Frecuencia Registro: Diario (~ 1500 registros mensual)
- Medición Directa: Temp Aire, Hum Rel, Vel Viento, Lluvia, Horas Sol
- Medición Indirecta: Radiación Sup Cultivo, Def Saturación Vapor, Dens Flujo Suelo

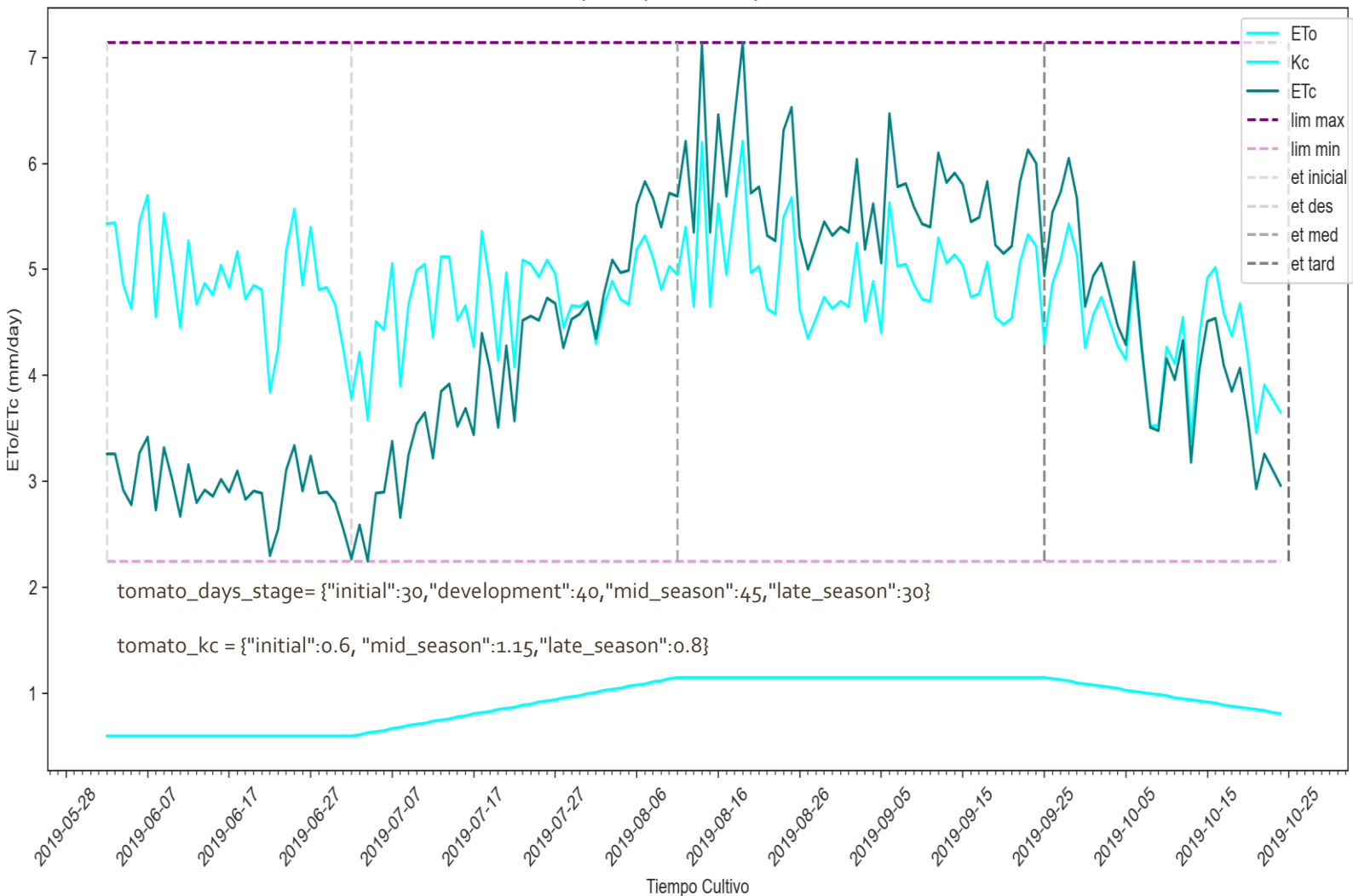
	DA	T.S	T.R	T.V	MAX	MIN	P.R	R.R	MAX	MIN	P.SEN	MAX	MIN	O.SC	P.FMM	MAX	MIN	O.SC	
1		15.5	10.1	11.2	12.3	10.6	8.6	80	90	40	850.2	850.9	848.8	2.1	1031.9	1031.2	1031.2	4.0	
	DA	T.S	T.R	T.V	MAX	MIN	P.R	R.R	MAX	MIN	P.SEN	MAX	MIN	O.SC	P.FMM	MAX	MIN	O.SC	DIREC.
1		15.4	11.5	10.5	11.6	9.3	7.6	59	90	31	850.1	853.8	850.3	3.5	1017.5	1021.1	1021.6	8.5	15W
2		15.5	11.6	10.6	11.7	9.4	7.7	60	91	32	851.2	854.9	851.4	3.6	1018.6	1022.2	1022.7	9.6	16W
3		15.6	11.7	10.7	11.8	9.5	7.8	61	92	33	852.3	856.0	852.5	3.7	1019.7	1023.3	1023.8	10.7	17W
4		15.7	11.8	10.8	11.9	9.6	7.9	62	93	34	853.4	857.1	853.6	3.8	1020.8	1024.4	1024.9	11.8	18W
5		15.8	11.9	10.9	12.0	9.7	8.0	63	94	35	854.5	858.2	854.7	3.9	1021.9	1025.5	1026.0	12.9	19W
6		15.9	12.0	11.0	12.1	9.8	8.1	64	95	36	855.6	859.3	855.8	4.0	1023.0	1026.6	1027.1	14.0	20W
7		16.0	12.1	11.1	12.2	9.9	8.2	65	96	37	856.7	860.4	856.9	4.1	1024.1	1027.7	1028.2	15.1	21W
8		16.1	12.2	11.2	12.3	10.0	8.3	66	97	38	857.8	861.5	858.0	4.2	1025.2	1028.8	1029.3	16.2	22W
9		16.2	12.3	11.3	12.4	10.1	8.4	67	98	39	858.9	862.6	859.1	4.3	1026.3	1029.9	1030.4	17.3	23W
10		16.3	12.4	11.4	12.5	10.2	8.5	68	99	40	859.0	862.7	859.2	4.4	1027.4	1031.0	1031.5	18.4	24W
11		16.4	12.5	11.5	12.6	10.3	8.6	69	100	41	860.1	863.8	860.3	4.5	1028.5	1032.1	1032.6	19.5	25W
12		16.5	12.6	11.6	12.7	10.4	8.7	70	101	42	861.2	864.9	861.4	4.6	1029.6	1033.2	1033.7	20.6	26W
13		16.6	12.7	11.7	12.8	10.5	8.8	71	102	43	862.3	866.0	862.5	4.7	1030.7	1034.3	1034.8	21.7	27W
14		16.7	12.8	11.8	12.9	10.6	8.9	72	103	44	863.4	867.1	863.6	4.8	1031.8	1035.4	1035.9	22.8	28W
15		16.8	12.9	11.9	13.0	10.7	9.0	73	104	45	864.5	868.2	864.7	4.9	1032.9	1036.5	1037.0	23.9	29W
16		16.9	13.0	12.0	13.1	10.8	9.1	74	105	46	865.6	869.3	865.8	5.0	1034.0	1037.6	1038.1	25.0	30W
17		17.0	13.1	12.1	13.2	10.9	9.2	75	106	47	866.7	870.4	866.9	5.1	1035.1	1038.7	1039.2	26.1	31W
18		17.1	13.2	12.2	13.3	11.0	9.3	76	107	48	867.8	871.5	868.0	5.2	1036.2	1039.8	1040.3	27.2	32W
19		17.2	13.3	12.3	13.4	11.1	9.4	77	108	49	868.9	872.6	869.1	5.3	1037.3	1040.9	1041.4	28.3	33W
20		17.3	13.4	12.4	13.5	11.2	9.5	78	109	50	869.0	872.7	869.2	5.4	1038.4	1042.0	1042.5	29.4	34W
21		17.4	13.5	12.5	13.6	11.3	9.6	79	110	51	870.1	873.8	870.3	5.5	1039.5	1			
22		17.5	13.6	12.6	13.7	11.4	9.7	80	111	52	871.2	874.9	871.4	5.6	1040.6	1043.1	1043.6	30.5	35W
23		17.6	13.7	12.7	13.8	11.5	9.8	81	112	53	872.3	876.0	872.5	5.7	1041.7	1044.2	1044.7	31.6	36W
24		17.7	13.8	12.8	13.9	11.6	9.9	82	113	54	873.4	877.1	873.6	5.8	1042.8	1045.3	1045.8	32.7	37W
25		17.8	13.9	12.9	14.0	11.7	10.0	83	114	55	874.5	878.2	874.7	5.9	1043.9	1046.4	1046.9	33.8	38W
26		17.9	14.0	13.0	14.1	11.8	10.1	84	115	56	875.6	879.3	875.8	6.0	1045.0	1047.5	1048.0	34.9	39W
27		18.0	14.1	13.1	14.2	11.9	10.2	85	116	57	876.7	880.4	876.9	6.1	1046.1	1048.6	1049.1	36.0	40W
28		18.1	14.2	13.2	14.3	12.0	10.3	86	117	58	877.8	881.5	878.0	6.2	1047.2	1049.7	1050.2	37.1	41W
29		18.2	14.3	13.3	14.4	12.1	10.4	87	118	59	878.9	882.6	879.1	6.3	1048.3	1050.8	1051.3	38.2	42W
30		18.3	14.4	13.4	14.5	12.2	10.5	88	119	60	879.0	882.7	879.2	6.4	1049.4	1051.9	1052.4	39.3	43W
31		18.4	14.5	13.5	14.6	12.3	10.6	89	120	61	880.1	883.8	880.3	6.5	1050.5	1053.0	1053.5	40.4	44W
32		18.5	14.6	13.6	14.7	12.4	10.7	90	121	62	881.2	884.9	881.4	6.6	1051.6	1054.1	1054.6	41.5	45W
33		18.6	14.7	13.7	14.8	12.5	10.8	91	122	63	882.3	886.0	882.5	6.7	1052.7	1055.2	1055.7	42.6	46W
34		18.7	14.8	13.8	14.9	12.6	10.9	92	123	64	883.4	887.1	883.6	6.8	1053.8	1056.3	1056.8	43.7	47W
35		18.8	14.9	13.9	15.0	12.7	11.0	93	124	65	884.5	888.2	884.7	6.9	1054.9	1057.4	1057.9	44.8	48W
36		18.9	15.0	14.0	15.1	12.8	11.1	94	125	66	885.6	889.3	885.8	7.0	1056.0	1058.5	1059.0	45.9	49W
37		19.0	15.1	14.1	15.2	12.9	11.2	95	126	67	886.7	890.4	886.9	7.1	1057.1	1059.6	1060.1	47.0	50W
38		19.1	15.2	14.2	15.3	13.0	11.3	96	127	68	887.8	891.5	888.0	7.2	1058.2	1060.7	1061.2	48.1	51W
39		19.2	15.3	14.3	15.4	13.1	11.4	97	128	69	888.9	892.6	889.1	7.3	1059.3	1061.8	1062.3	49.2	52W
40		19.3	15.4	14.4	15.5	13.2	11.5	98	129	70	889.0	892.7	889.2	7.4	1060.4	1062.9	1063.4	50.3	53W
41		19.4	15.5	14.5	15.6	13.3	11.6	99	130	71	890.1	893.8	890.3	7.5	1061.5	1064.0	1064.5	51.4	54W
42		19.5	15.6	14.6	15.7	13.4	11.7	100	131	72	891.2	894.9	891.4	7.6	1062.6	1065.1	1065.6	52.5	55W
43		19.6	15.7	14.7	15.8	13.5	11.8	101	132	73	892.3	896.0	892.5	7.7	1063.7	1066.2	1066.7	53.6	56W
44		19.7	15.8	14.8	15.9	13.6	11.9	102	133	74	893.4	897.1	893.6	7.8	1064.8	1067.3	1067.8	54.7	57W
45		19.8	15.9	14.9	16.0	13.7	12.0	103	134	75	894.5	898.2	894.7	7.9	1065.9	1068.4	1068.9	55.8	58W
46		19.9	16.0	15.0	16.1	13.8	12.1	104	135	76	895.6	899.3	895.8	8.0	1067.0	1069.5	1070.0	56.9	59W
47		20.0	16.1	15.1	16.2	13.9	12.2	105	136	77	896.7	900.4	896.9	8.1	1068.1	1070.6	1071.1	58.0	60W
48		20.1	16.2	15.2	16.3	14.0	12.3	106	137	78	897.8	901.5	898.0	8.2	1069.2	1071.7	1072.2	59.1	61W
49		20.2	16.3	15.3	16.4	14.1	12.4	107	138	79	898.9	902.6	899.1	8.3	1070.3	1072.8	1073.3	60.2	62W
50		20.3	16.4	15.4	16.5	14.2	12.5	108	139	80	899.0	902.7	899.2	8.4	1071.4	1073.9	1074.4	61.3	63W
51		20.4	16.5	15.5	16.6	14.3	12.6	109	140	81	900.1	903.8	900.3	8.5	1072.5	1075.0	1075.5	62.4	64W
52		20.5	16.6	15.6	16.7	14.4	12.7	110	141	82	901.2	904.9	901.4	8.6	1073.6	1076.1	1076.6	63.5	65W
53		20.6	16.7	15.7	16.8	14.5	12.8	111	142	83	902.3	906.0	902.5	8.7	1074.7	1077.2	1077.7	64.6	66W
54		20.7	16.8	15.8	16.9	14.6	12.9	112	143	84	903.4	907.1	903.6	8.8	1075.8	1078.3	1078.8	65.7	67W
55		20.8	16.9	15.9	17.0	14.7	13.0	113	144	85	904.5	908.2	904.7	8.9	1076.9	1079.4	1079.9	66.8	68W
56		20.9	17.0	16.0	17.1	14.8	13.1	114	145	86	905.6	909.3	905.8	9.0	1078.0	1080.5	1081.0	67.9	69W
57		21.0	17.1	16.1	17.2	14.9	13.2	115	146	87	906.7	910.4	906.9	9.1	1079.1	1081.6	1082.1	69.0	70W
58		21.1	17.2	16.2	17.3	15.0	13.3	116	147	88	907.8	911.5	908.0	9.2	1080.2	1082.7	1083.2	70.1	71W
59		21.2	17.3	16.3	17.4	15.1	13.4	117	148	89	908.9	912.6	909.1	9.3	1081.3	1083.8	1084.3	71.2	72W
60		21.3	17.4	16.4	17.5	15.2	13.5	118	149	90	909.0	912.7	909.2	9.4	1082.4	1084.9	1085.4	72.3	73W
61		21.4	17.5	16.5	17.6	15.3	13.6	119	150	91	910.1	913.8	910.3	9.5	1083.5	1086.0	1086.5	73.4	74W
62		21.5	17.6	16.6	17.7	15.4	13.7	120	151	92	911.2	914.9	911.4	9.6	1084.6	1087.1	1087.6	74.5	75W
63		21.6	17.7	16.7	17.8	15.5	13.8	121	152	93	912.3	916.0	912.5	9.7	1085.7	1088.2	1088.7	75.6	76W
64		21.7	17.8	16.8	17.9	15.6	13.9	122	153	94	913.4	917.1	913.6	9.8	1086.8	1089.3	1089.8	76.7	77W
65		21.8	17.9	16.9	18.0	15.7	14.0	123	154	95	914.5	918.2	914.7	9.9	1087.9	1090.4	1090.9	77.8	78W
66		21.9	18.0	17.0	18.1	15.8	14.1	124	155	96	915.6	919.3	915.8	10.0	1089.0	1091.5	1092.0	78.9	79W
67		22.0	18.1	17.1	18.2	15.9	14.2	125	156	97	916.7	920.4	916.9	10.1	1090.1	1092.6	1093.1	80.0	80W
68		2																	

# Metodologías Empleadas Preparación Datos



# Conclusiones

Evapotranspiracion - Etapas Cultivo



Cultivo: Tomate Rojo	
Fecha de Trasplante: 2019-06-01 00:00:00	
Agua requerida durante el cultivo:	639.70 mm (~6.4x10^6L)
Agua de lluvia durante el cultivo:	820.8 mm
Deficit agua durante el cultivo:	-181.09 mm
Temp Max durante el cultivo:	25.6 °C
Temp Min durante el cultivo:	12.2 °C
Humedad Max durante el cultivo:	98.0 %
Humedad Min durante el cultivo:	27.0 %
Vel Viento Max durante el cultivo:	4.1 m/s
Vel Viento Min durante el cultivo:	0.6 m/s
Rad Solar Max durante el cultivo:	36.8 MJ[day-1][m-2]
Rad Solar Min durante el cultivo:	23.06 MJ[day-1][m-2]

	transp_day_season	etc_crop_season	rain_crop_season	irrig_water_crop_season
0	2019-05-27	643.730042	812.6	-168.869958
1	2019-05-28	643.625212	823.2	-179.574788
2	2019-05-29	642.322771	823.2	-180.877229
3	2019-05-30	641.909063	829.5	-187.590937
4	2019-05-31	640.849346	830.0	-189.150654
5	2019-06-01	639.770587	820.8	-181.029413
6	2019-06-02	638.398858	782.4	-144.001142
7	2019-06-03	636.829037	782.3	-145.470963
8	2019-06-04	635.054604	782.3	-147.245396
9	2019-06-05	633.519283	782.3	-148.780717
10	2019-06-06	631.927321	782.3	-150.372679





+ Info:

[https://github.com/polkg6/crop\\_water\\_requirement](https://github.com/polkg6/crop_water_requirement)

