Field data analysis
La Corona NCSU

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Members
MSc. Eliana Nervi
MSc. Agustín Menta
PhD. George Chescheir
PhD. Francois Birgand

Contents

This document describes the workflow of field data analysis from La Corona during the visit to NCSU, having done interviews with Chip and Francois.

In Figure 1 is showed the catchment areas and equipment installed. In Figure 2 is showed the actual workflow of the data process.

1 Study area

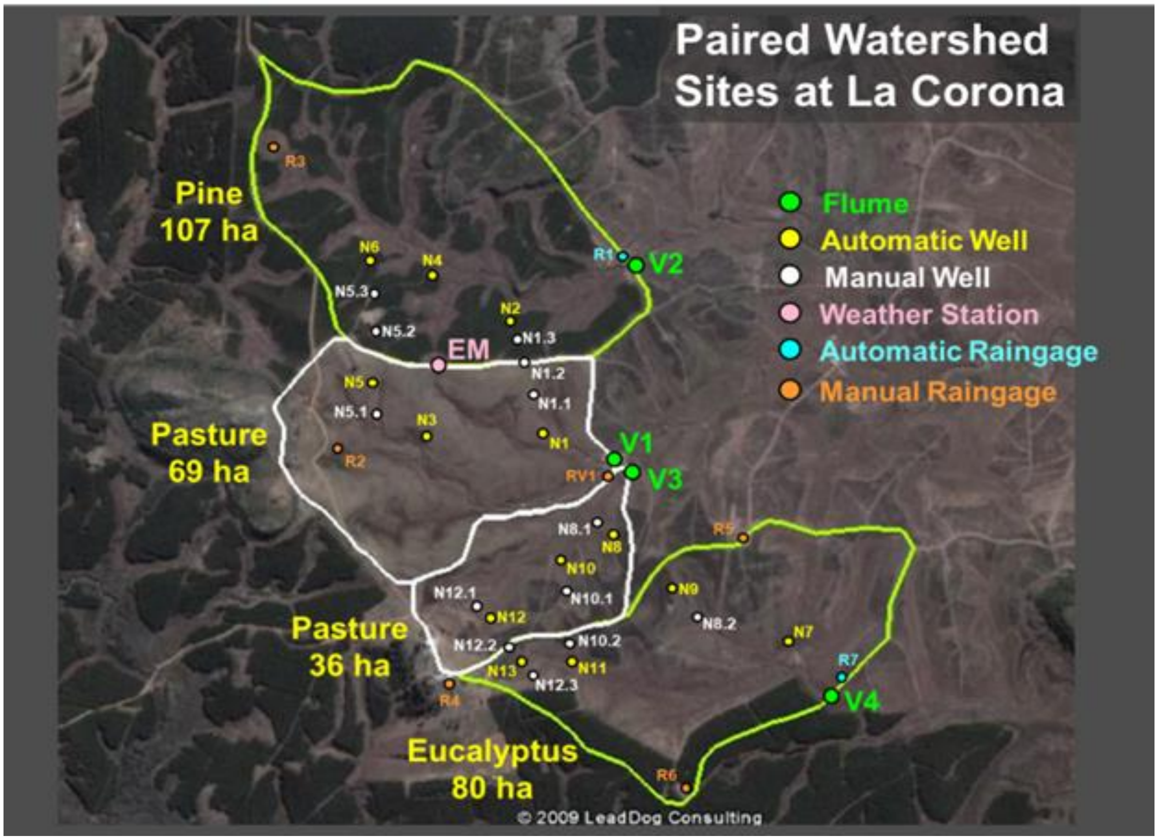


Figure 1: Catchment and equipment of La Corona

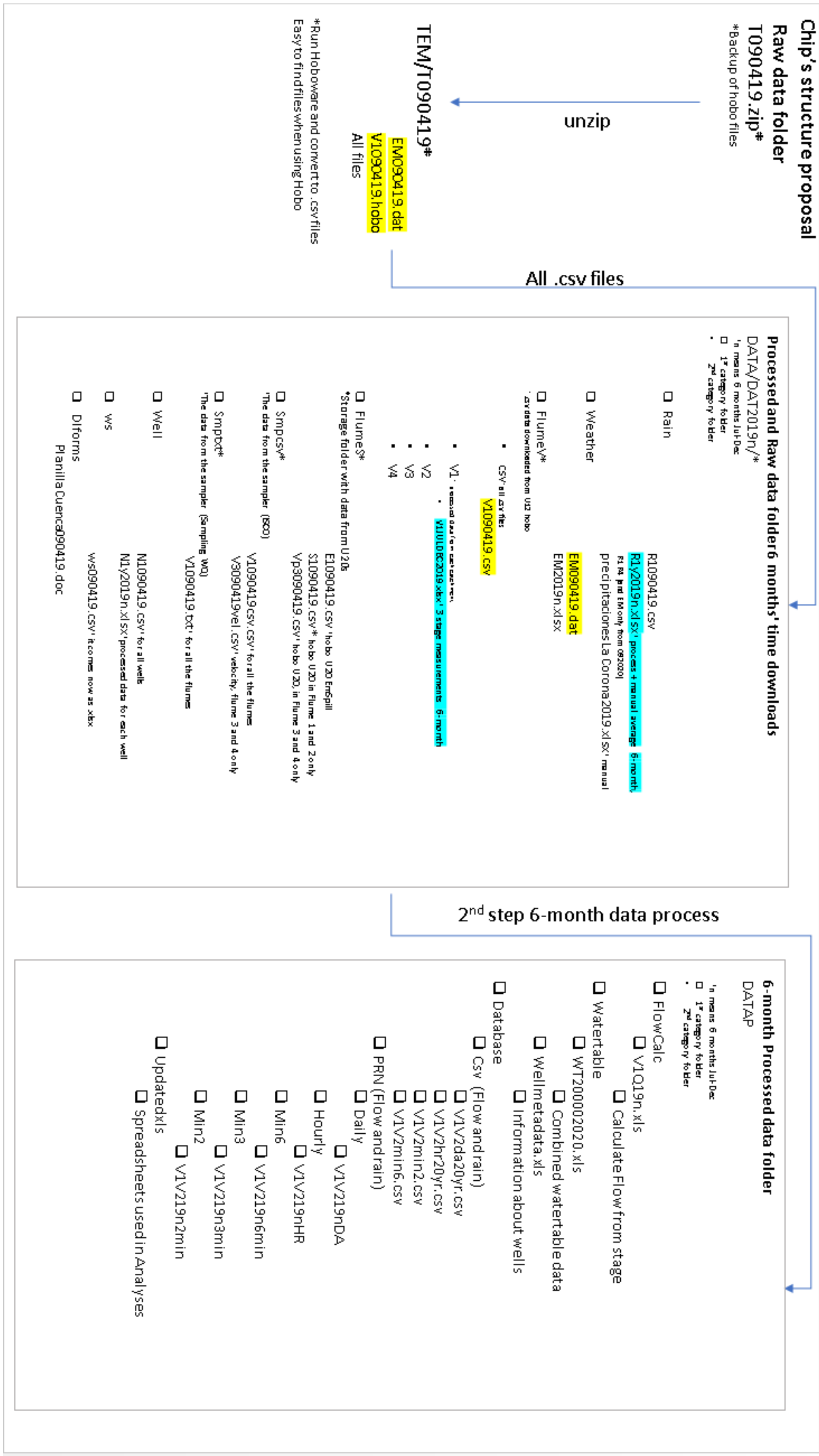


Figure 2: Actual Workflow of data process

All the information included in this document is in the folder where is included the raw data and processed data of each variable. It is also included an example document of Juliana field data survey

2 Rainfall data

2.1 General information

The first dataset to analyse is rain data. Automatic data is analysed first in a plot using Hoboware, and manual data is used only for checking.

At the moment, the EM has the most reliable rainfall data recorded every tip as a brake point logger. This logger changed in Sept 2020. Before this time, the main automatic pluviometers were R1 (Pine, catch 1) and R7 (Euca, catch 4) because the rainfall in EM was recorded by the WS every 15 min. Originally the automatic data from R7 was labelled as R4 (because it is located in catchment 4). Automatic data from R7 has been labelled as R7 since March 2023. If everything works well now, it is used the EM data. If not, separate datasets for catch 1&2 and catch 3&4 are used (see Figure 3).

In this analysis rain data is not corrected by wind.

For data filling, it is used 1:1 relationship between the raingauges. Every tip in R1 and R7 it counts as 0.254 mm and in the EM station it counts as 0.1 mm. Manual rain is recorded when the people go to field and R4 (casco) is recorded more frequently with the rain event because people are living there.

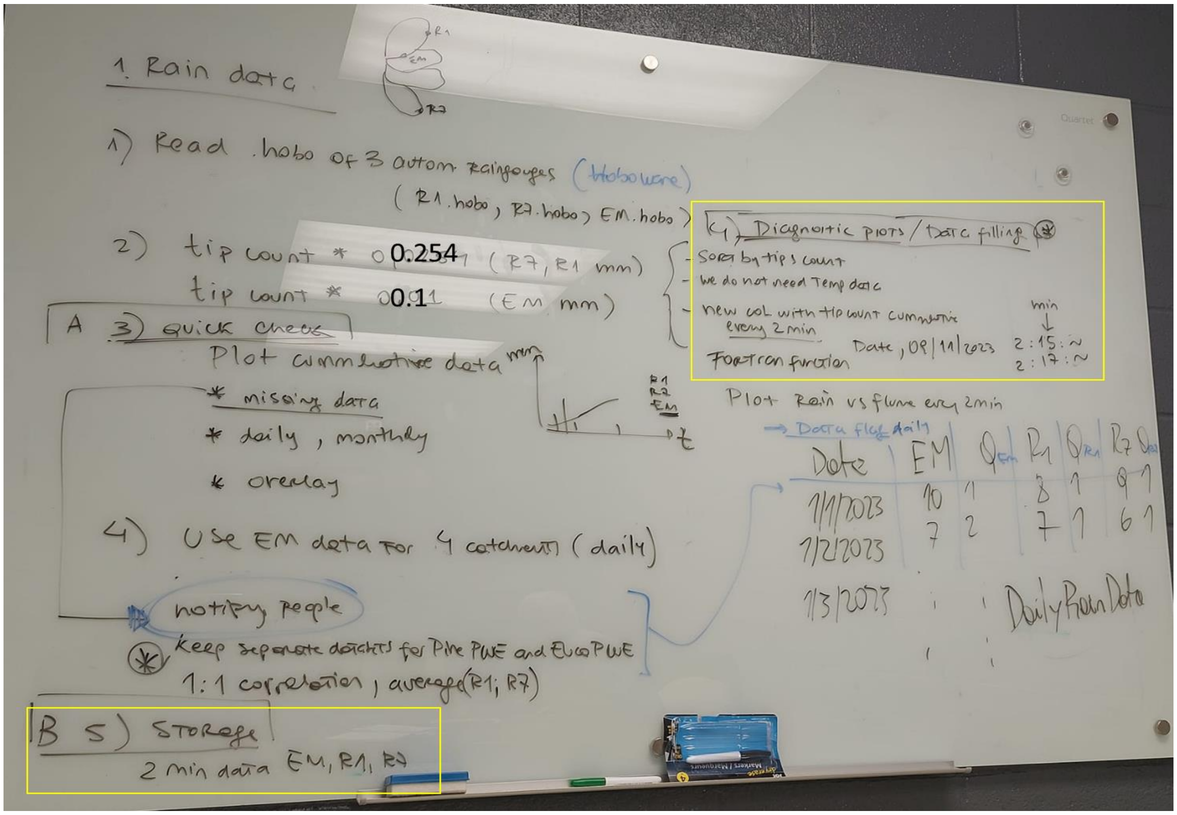


Figure 3: Step-by-step read, quick check, storage and diagnostic plots

2.2 Input files and format

Automatic rainfall input files, R4 (named R7 in Figure 1), R1 and EM input files, from here this is EM (only rainfall EM data).

- EM061523.csv
- R7061523.csv
- R1061523.csv
- EM061523.hobo
- R1061523.hobo
- R7061523.hobo

Manual rainfall*

- precipitaciones La Corona 2018A.xlsx

*There is one spreadsheet per year and monthly data is added in different sheets. There is a last sheet called total that adds manual rainfall monthly per station.

An example of these input files for rainfall analysis can be found in the folder.

2.3 Data read and conversion

The following section describes the step-by-step with comments and useful details:

1. Open R1, R7 and EM in Hoboware. Save the data in .csv format.
2. CSV files are put into an excel spreadsheet and sorted by event to separate the tips from the temperature. The temperature column is deleted. The date in time column and the evet column are copied to **R1y2019n.xlsx**
3. Excel file **R1y2019n.xlsx** convert cumulative tips into individual tips It contains information from R1, R7 and EM. Also allows us to convert the Date Time column into Jday in decimal format. The main objective of this is to create a 2 min dataset to compare with Flume data. Every file and folder that ends with 'n' determines that is the final part of the year (last 6 months)

E.g. spreadsheet R1y2019n.xlsx where pre-process is done. Another example of this file is R1y2023.xlsx.

R1			#convert to individual tips		
Time	Rain	Jday	Rain	Cum Rain	Cum Rain
	1/100 inch	12/31/2018	1/100 inch	1/100 inch	(mm)
7/1/19 0:00	0	182.00000	0.00	0.00	0
7/2/19 14:30	0	183.60420	0.00	0.00	0
7/2/19 14:46	0	183.61528	0.00	0.00	0
7/12/19 9:25	1	193.39251	1.00	1.00	0.254
7/12/19 9:26	2	193.39361	1.00	2.00	0.508

R4					
Time	Rain	Jday	Rain	Cum Rain	Cum Rain
	1/100 inch	12/31/2018	1/100 inch	1/100 inch	(mm)
7/1/19 0:00	0	182.00000	0.00	0.00	0
7/2/19 12:05	0	183.50374	0.00	0.00	0
7/12/19 9:19	1	193.38843	1.00	1.00	0.254
7/12/19 9:21	2	193.38988	1.00	2.00	0.508
7/12/19 9:28	3	193.39481	1.00	3.00	0.762

Figure 4: Spreadsheet of R1y2019n.xls

4. Create a text file with Jday (6 decimals) in the first column and rain in tip count in the second column (decimals are not relevant). This file is saved from an .xls sheet. R1 data example R1y2017n.prn. Rainfall data from the weather station is EMy2023n.prn

E.g. .prn file, 2 cols: julian day in decimal format and individual rainfall tips. This is the same for the three .prn files generated up to this point.

```
145.596516     0.00
146.512870     1.00
146.513715     1.00
146.514769     1.00
146.515972     1.00
146.516944     1.00
146.518403     1.00
146.519502     1.00
146.520359     1.00
146.521146     1.00
146.521979     1.00
146.523137     1.00
```

5. Use Fortran program from [RAINMIN.exe]() to create 2 min data output.

This program runs with the inputs in Table 1.

Table 1: RAINMIN.exe inputs to obtain 2 min rainfall dataset.

Input	E.g.	Comments
INPUT FILE NAME: YEAR	R1y2019n.prn	Important: The Fortran program now is using 0.254 per tip and this cannot be used for the EM data after Sep 2020. A new input should be added to the source code.
OUTPUT FILE NAME:	R1y2019n0.prn	The output is the 2 min data in this example
DAY OUTPUT FILE NAME:	R1y2019n0D.prn	Daily file (rain from the beginning to the end of the day)
JDAY (INITIAL) JDAY(END) INTERVAL(OUT)	2019 182 366 2	

This program was used to process R1 and R4 before Sept 2020, using separate rainfall series for the two PWE experiments (R1 for the Pine PWE and R4 for Eucalyptus PWE). In Figure 5 is shown the executable interface for the inputs and outputs.

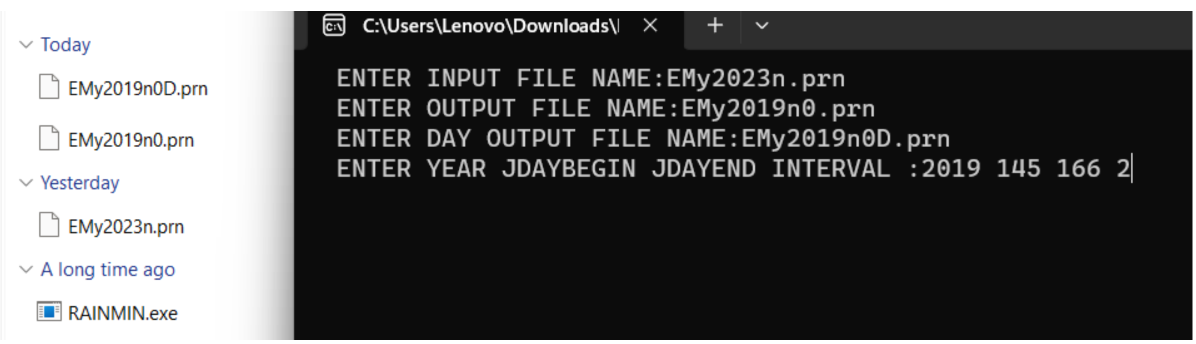


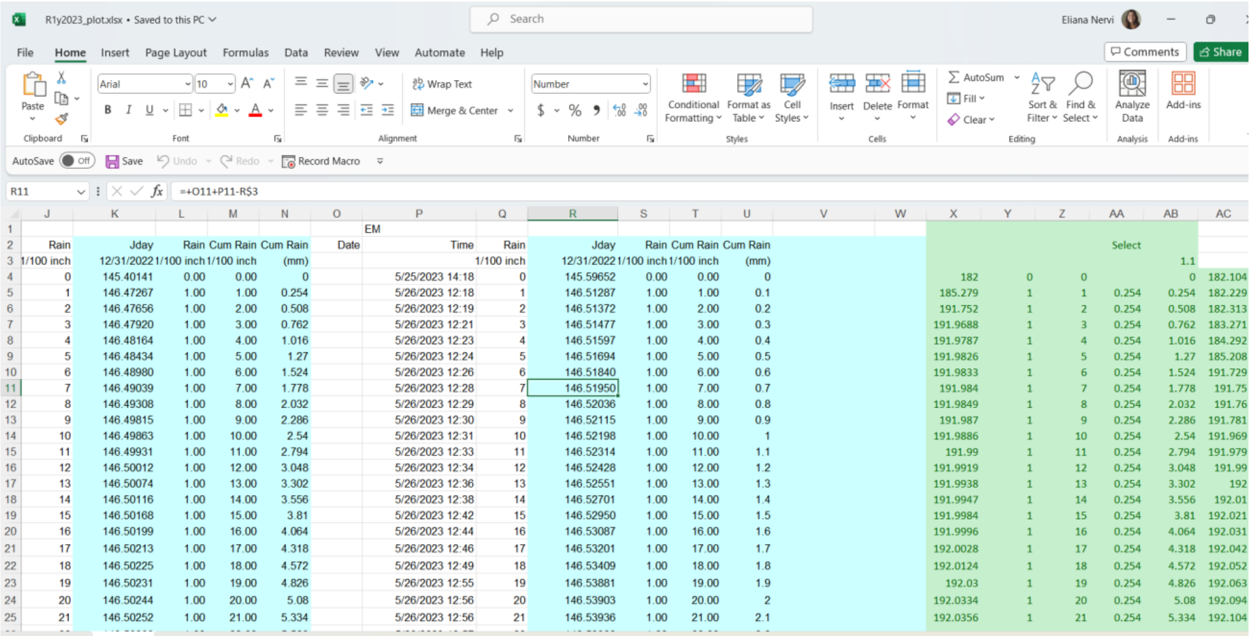
Figure 5: Fortran RAINMIN interface

Examples of these processed files for rainfall analysis can be found in the [folder]()

2.4 Quick Check:

This step allows to compare the three rain time series and notify problems to people in the field in the short term. This data check does not include the use of manual data, as this is added when a larger dataset is plotted, as manual observations are taken every 15 to 30 days.

1. Open R1y2023.xlsx (see Figure 6) file and select cumulative rainfall data in mm. In case of R1 in the following figure, the columns to plot would be K and N.



	J	K	L	M	N	O	P	Q	R	S	T	U	X	Y	Z	AA	AB	AC
1							EM											
2	Rain	Jday	Rain	Cum Rain	Cum Rain	Date	Time	Rain	Jday	Rain	Cum Rain	Cum Rain				Select		
3	1/100 inch	12/31/2022	1/100 inch	1/100 inch	(mm)			1/100 inch	12/31/2022	1/100 inch	1/100 inch	(mm)					1.1	
4	0	145.40141	0.00	0.00	0		5/25/2023 14:18	0	145.59652	0.00	0.00	0	182	0	0		0	182.104
5	1	146.47267	1.00	1.00	0.254		5/26/2023 12:18	1	146.51287	1.00	1.00	0.1	185.279	1	1	0.254	0.254	182.229
6	2	146.47656	1.00	2.00	0.508		5/26/2023 12:19	2	146.51372	1.00	2.00	0.2	191.752	1	2	0.254	0.508	182.313
7	3	146.47920	1.00	3.00	0.762		5/26/2023 12:21	3	146.51477	1.00	3.00	0.3	191.9688	1	3	0.254	0.762	183.271
8	4	146.48164	1.00	4.00	1.016		5/26/2023 12:23	4	146.51597	1.00	4.00	0.4	191.9787	1	4	0.254	1.016	184.292
9	5	146.48434	1.00	5.00	1.27		5/26/2023 12:24	5	146.51694	1.00	5.00	0.5	191.9826	1	5	0.254	1.27	185.208
10	6	146.48980	1.00	6.00	1.524		5/26/2023 12:26	6	146.51840	1.00	6.00	0.6	191.9833	1	6	0.254	1.524	191.729
11	7	146.49039	1.00	7.00	1.778		5/26/2023 12:28	7	146.51950	1.00	7.00	0.7	191.984	1	7	0.254	1.778	191.75
12	8	146.49308	1.00	8.00	2.032		5/26/2023 12:29	8	146.52036	1.00	8.00	0.8	191.9849	1	8	0.254	2.032	191.76
13	9	146.49815	1.00	9.00	2.286		5/26/2023 12:30	9	146.52115	1.00	9.00	0.9	191.987	1	9	0.254	2.286	191.781
14	10	146.49863	1.00	10.00	2.54		5/26/2023 12:31	10	146.52198	1.00	10.00	1	191.9886	1	10	0.254	2.54	191.969
15	11	146.49931	1.00	11.00	2.794		5/26/2023 12:33	11	146.52314	1.00	11.00	1.1	191.99	1	11	0.254	2.794	191.979
16	12	146.50012	1.00	12.00	3.048		5/26/2023 12:34	12	146.52428	1.00	12.00	1.2	191.9919	1	12	0.254	3.048	191.99
17	13	146.50074	1.00	13.00	3.302		5/26/2023 12:36	13	146.52551	1.00	13.00	1.3	191.9938	1	13	0.254	3.302	192
18	14	146.50116	1.00	14.00	3.556		5/26/2023 12:38	14	146.52701	1.00	14.00	1.4	191.9947	1	14	0.254	3.556	192.01
19	15	146.50168	1.00	15.00	3.81		5/26/2023 12:42	15	146.52950	1.00	15.00	1.5	191.9984	1	15	0.254	3.81	192.021
20	16	146.50199	1.00	16.00	4.064		5/26/2023 12:44	16	146.53087	1.00	16.00	1.6	191.9996	1	16	0.254	4.064	192.031
21	17	146.50213	1.00	17.00	4.318		5/26/2023 12:46	17	146.53201	1.00	17.00	1.7	192.0028	1	17	0.254	4.318	192.042
22	18	146.50225	1.00	18.00	4.572		5/26/2023 12:49	18	146.53409	1.00	18.00	1.8	192.0124	1	18	0.254	4.572	192.052
23	19	146.50231	1.00	19.00	4.826		5/26/2023 12:55	19	146.53881	1.00	19.00	1.9	192.03	1	19	0.254	4.826	192.063
24	20	146.50244	1.00	20.00	5.08		5/26/2023 12:56	20	146.53903	1.00	20.00	2	192.0334	1	20	0.254	5.08	192.094
25	21	146.50252	1.00	21.00	5.334		5/26/2023 12:56	21	146.53936	1.00	21.00	2.1	192.0356	1	21	0.254	5.334	192.104

Figure 6: Example of processing spreadsheet of rainfall data

E.g of processing a spreadsheet of rainfall data

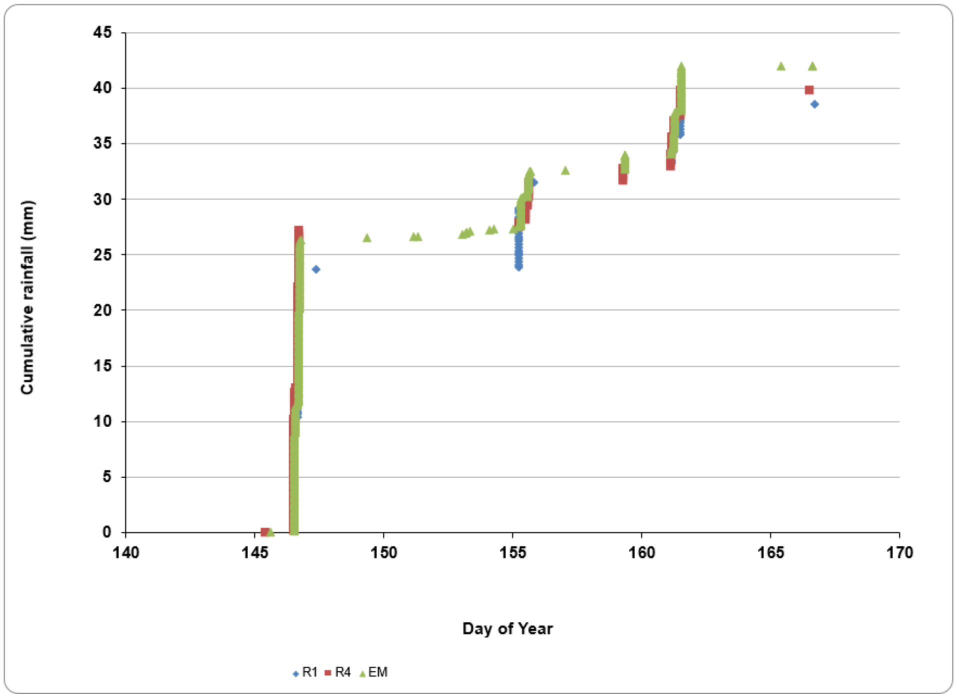
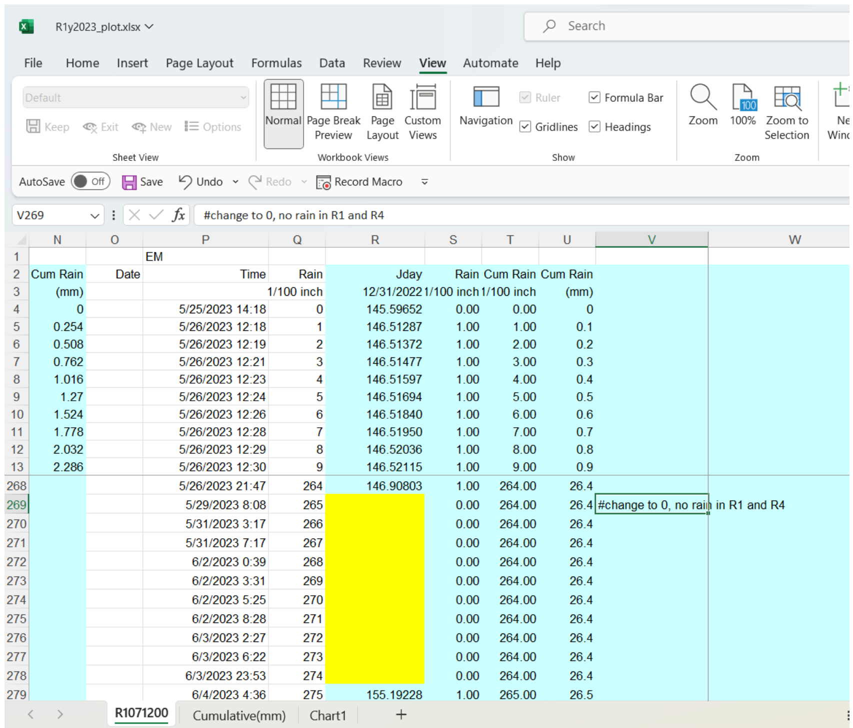


Figure 7: Cumulative of the rainfall of the three raingauges

In this case, the pluviometers data looks OK. However, the EM has tip counts in a period when R1 and R4 have no read. It should be a good strategy to look at the other variables of the weather station (Solar radiation, RH) before delete tips. In the same spreadsheet, the reads are changed to 0 to correct the dataset and a comment was added in the next column. This ensures the traceability of the analysis process. This results in a change of 1 mm in the total rain registered by the EM.



	N	O	P	Q	R	S	T	U	V	W
1			EM							
2	Cum Rain	Date	Time	Rain	Jday	Rain	Cum Rain	Cum Rain		
3	(mm)			1/100 inch	12/31/2022	1/100 inch	1/100 inch	(mm)		
4	0		5/25/2023 14:18	0	145.59652	0.00	0.00	0		
5	0.254		5/26/2023 12:18	1	146.51287	1.00	1.00	0.1		
6	0.508		5/26/2023 12:19	2	146.51372	1.00	2.00	0.2		
7	0.762		5/26/2023 12:21	3	146.51477	1.00	3.00	0.3		
8	1.016		5/26/2023 12:23	4	146.51597	1.00	4.00	0.4		
9	1.27		5/26/2023 12:24	5	146.51694	1.00	5.00	0.5		
10	1.524		5/26/2023 12:26	6	146.51840	1.00	6.00	0.6		
11	1.778		5/26/2023 12:28	7	146.51950	1.00	7.00	0.7		
12	2.032		5/26/2023 12:29	8	146.52036	1.00	8.00	0.8		
13	2.286		5/26/2023 12:30	9	146.52115	1.00	9.00	0.9		
268			5/26/2023 21:47	264	146.90803	1.00	264.00	26.4		
269			5/29/2023 8:08	265		0.00	264.00	26.4	#change to 0, no rain in R1 and R4	
270			5/31/2023 3:17	266		0.00	264.00	26.4		
271			5/31/2023 7:17	267		0.00	264.00	26.4		
272			6/2/2023 0:39	268		0.00	264.00	26.4		
273			6/2/2023 3:31	269		0.00	264.00	26.4		
274			6/2/2023 5:25	270		0.00	264.00	26.4		
275			6/2/2023 8:28	271		0.00	264.00	26.4		
276			6/3/2023 2:27	272		0.00	264.00	26.4		
277			6/3/2023 6:22	273		0.00	264.00	26.4		
278			6/3/2023 23:53	274		0.00	264.00	26.4		
279			6/4/2023 4:36	275	155.19228	1.00	265.00	26.5		

Figure 8: Changes in the spreadsheet while processing information

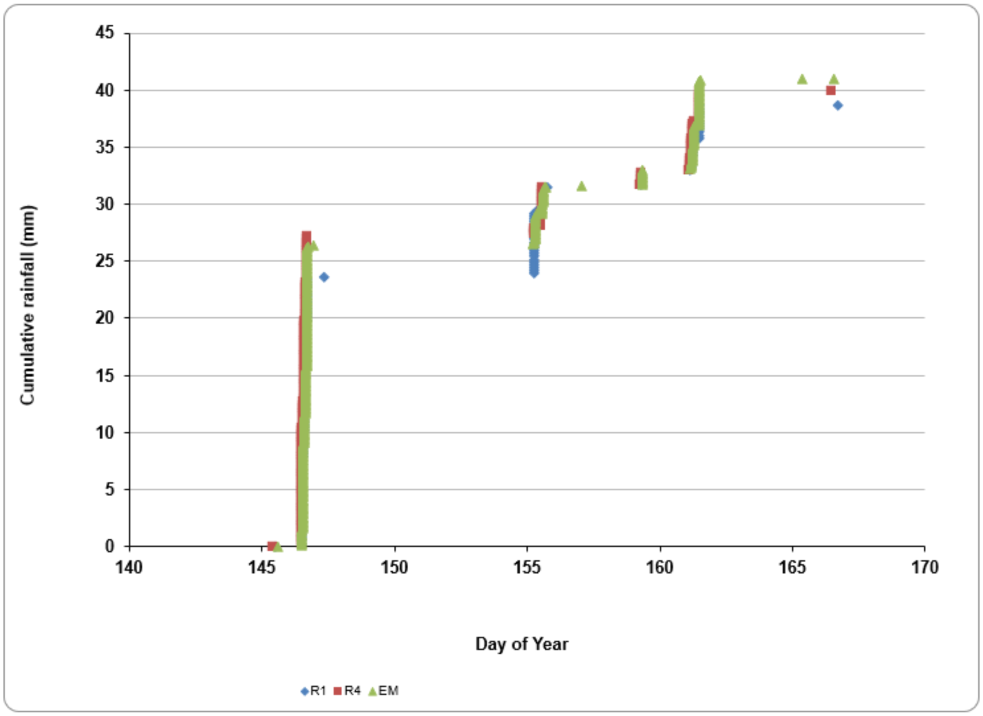


Figure 9: Changes in the plot while processing information.

Add manual data as the average of manual measurements from every dataset in [precipitaciones corona](). R4 pluviometer gets measured more frequently. This is important when putting all the data stacked by year.

Fecha	R1 (cuenca forestada)	R2	R3	R4 (casco)	RV1 (cuenca ganadera)	R5 (corrales)	R6	Vertedero Nuevo R7	EM (estación meteorologica)	Observaciones
enero	53,4	49,8	55,2	113	59,6	61	67,2	64,2	51,8	
febrero	70,8	14	166,8	89	160,6	148,3	151	155,4	155,8	
marzo	173,6	153,4	190,3	158	162,8	164,6	192,4	189,2	153,2	
abril	58,6	54,2	59,6	52	52	54,8	53,2	51,8	55,6	
mayo	71	75,8	84,8	47	78,2	73,8	76,2	74,6	60,6	
junio	38,7	35,4	43,4	0	39,5	39,4	39,4	38,6	39,8	
julio	191,8	162,4	235,8	125	207	164,8	196,2	179,8	171,5	
agosto	78,6	72,4	85,2	53	78,5	72,8	73,8	74,2	77,8	
septiembre	143,8	144,2	147,2	140	142,4	140,6	142,2	0	140,4	
octubre										
noviembre										
diciembre										
total	880,3	761,6	1068,3	777	980,6	920,1	991,6	827,8	906,5	900,9125

Figure 10: Spreadsheet of precipitaciones corona

Work in [Precipitaciones_La_Corona_2019_actualizada_completo.xls]() Data comes from ([precipitaciones corona]())

Average Manual						
12/31/2018						
7/2/19 0:00	183	0.0	0.0			
7/19/19 0:00	200	9.0	9.0		9.0	9.0
7/24/19 0:00	205	9.0	9.0		0.0	0.0
7/25/19 0:00	206	9.0	9.0		0.0	0.0
7/26/19 0:00	207	9.0	9.0		0.0	0.0
8/1/19 0:00	213	180.0	179.6		171.0	170.6
8/10/19 0:00	222	180.0	179.6		0.0	0.0
8/21/19 0:00	233	180.0	179.6		0.0	0.0
8/30/19 0:00	242	236.2	234.5		56.2	54.9
8/31/19 0:00	243	236.2	234.5		0.0	0.0
9/2/19 0:00	245	236.2	234.5		0.0	0.0
9/4/19 0:00	247	236.2	234.5		0.0	0.0
9/9/19 0:00	252	286.8	284.0		50.6	49.6
9/11/19 0:00	254	286.8	284.0		0.0	0.0
9/12/19 0:00	255	286.8	284.0		0.0	0.0
9/16/19 0:00	259	286.8	284.0		0.0	0.0
9/18/19 0:00	261	286.8	284.0		0.0	0.0
10/2/19 0:00	275	368.9	365.1		82.1	81.1
10/3/19 0:00	276	368.9	365.1		0.0	0.0
10/4/19 0:00	277	479.6	472.4		110.7	107.3
10/14/19 0:00	287	479.6	472.4		0.0	0.0
10/15/19 0:00	288	479.6	472.4		0.0	0.0
10/17/19 0:00	290	479.6	472.4		0.0	0.0
10/18/19 0:00	291	479.6	472.4		0.0	0.0
10/28/19 0:00	301	662.3	655.8		182.6	183.4
10/29/19 0:00	302	662.3	655.8		0.0	0.0
10/30/19 0:00	303	662.3	655.8		0.0	0.0

Figure 11: Example of manual data in R1y2019n.xls

2.5 Diagnostic plots (6 months of data)

1. Stack the datasets in one spreadsheet named with n at the end. E.g R1y2019n.xls*

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1		R1			#convert to individual tips				R4						
2		Time	Rain	Jday	Rain	Cum Rain	Cum Rain		Time	Rain	Jday	Rain	Cum Rain	Cum Rain	
3			1/100 inch	12/31/2018	1/100 inch	1/100 inch	(mm)			1/100 inch	12/31/2018	1/100 inch	1/100 inch	(mm)	
4		7/1/2019 0:00	0	182.00000	0.00	0.00	0		7/1/2019 0:00	0	182.00000	0.00	0.00	0	
5		7/2/2019 14:30	0	183.60420	0.00	0.00	0		7/2/2019 12:05	0	183.50374	0.00	0.00	0	
575		1/15/2020 14:48	312	380.61682	1.00	4547.00	1154.94		1/15/2020 14:44	381	380.61436	1.00	4548.00	1155.19	
576		1/15/2020 14:55	313	380.62216	1.00	4548.00	1155.19		1/15/2020 14:49	382	380.61795	1.00	4549.00	1155.45	
577		1/15/2020 15:05	314	380.62850	1.00	4549.00	1155.45		1/15/2020 14:56	383	380.62251	1.00	4550.00	1155.7	
578		1/16/2020 11:37	314	381.48448	0.00	4549.00	1155.45		1/15/2020 15:01	384	380.62630	1.00	4551.00	1155.95	
579									1/15/2020 18:05	385	380.75407	1.00	4552.00	1156.21	
580									1/16/2020 12:38	385	381.52705	0.00	4552.00	1156.21	
581															

Figure 12: Spreadsheet R1y2019n.xlsx

*Note that this period does not include EM data as it previous to Sept 2020

2. Plot the Average Manual section. This data should be added as the average of manual measurements from every dataset in precipitaciones corona**.** E.g from another period precipitaciones corona 2023.

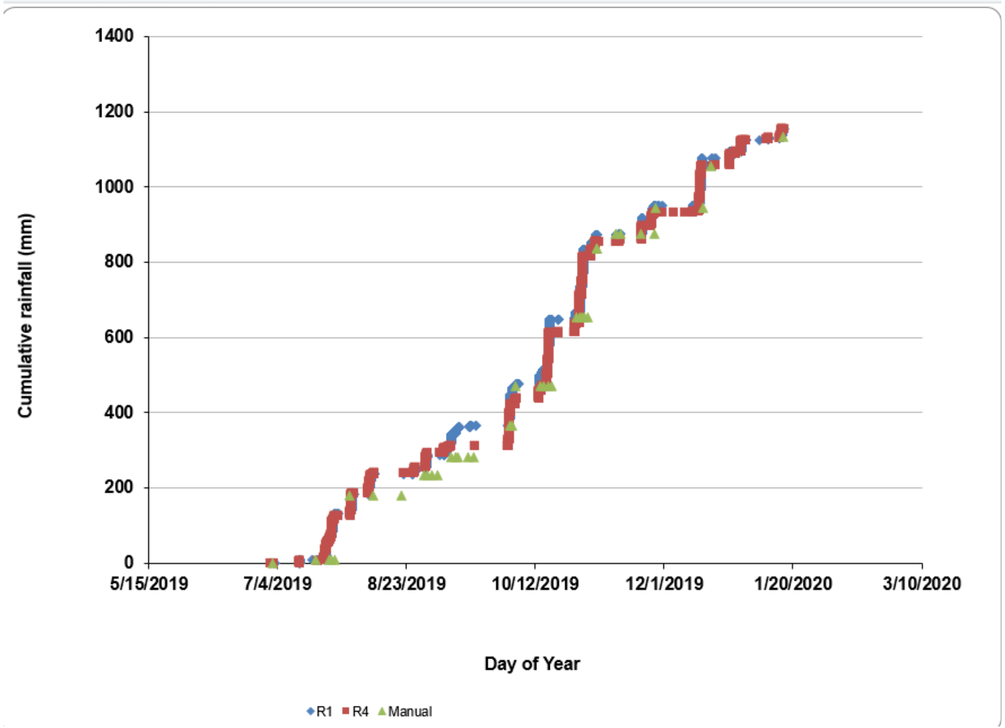


Figure 13: Cumulative rainfall for 6 months for the three raingauges

2.6 Storage. Final Plots and spreadsheets

- Daily rainfall of every rain gauge.
- Spreadsheets with processed data and cumulative rainfall every 6 months with the manual data. ScatterPlots with cumulative and simply data at daily scale.
- Rainfall data and flume data every 2 minutes in txt file (.prn) are in the folder.

3 Weather data

The second dataset is weather data. It includes in the EM: Temperature, Relative Humidity, Wind velocity, Solar radiation, and Net Solar Radiation. The backup station is the WS, it records Temperature and Relative Humidity. Both recordings are in a 15-minute timestep. The Figure 14 describes the steps of the basic data processing:

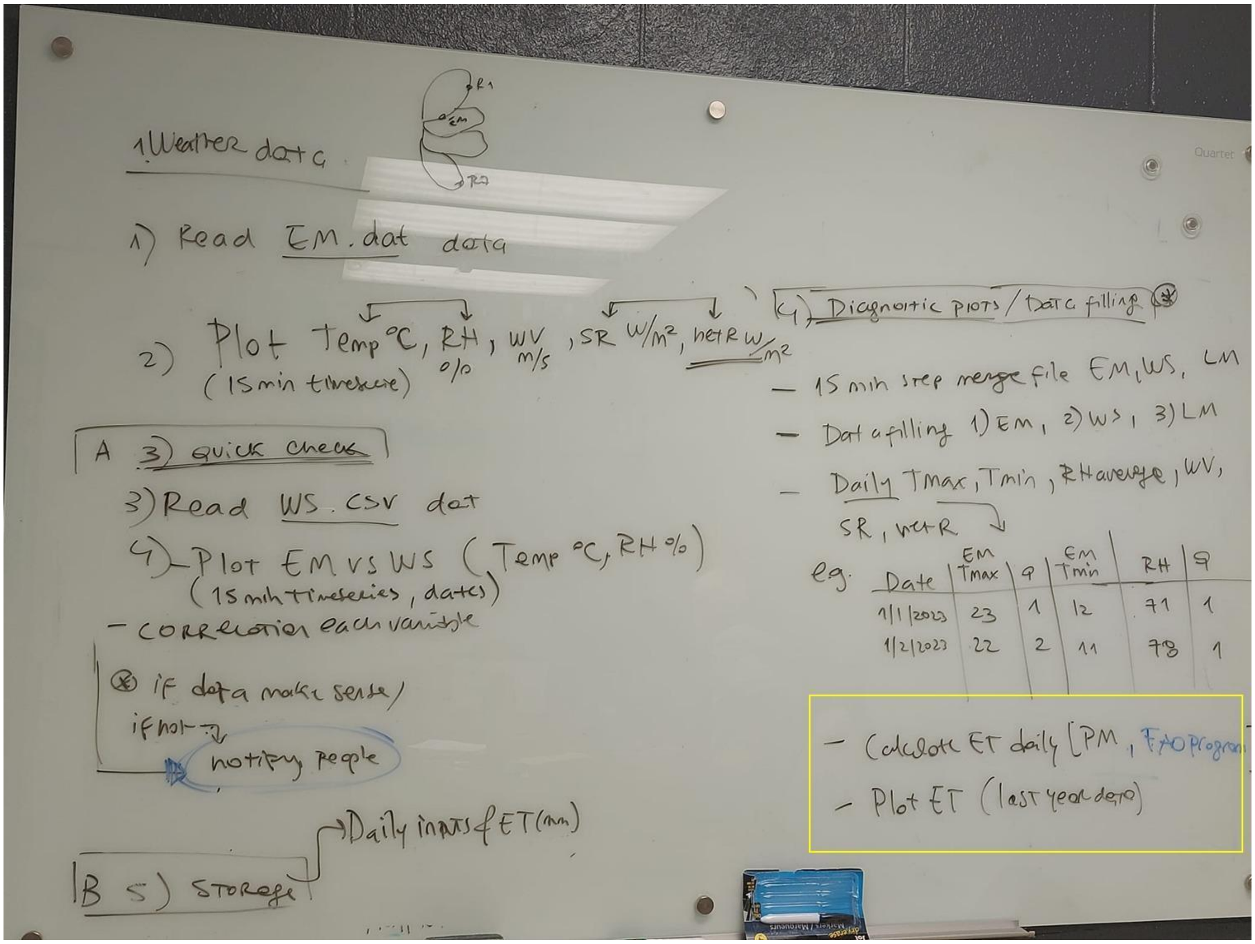


Figure 14: Step-by-step read, quick check, storage, and further diagnostic plots

3.1 Input files and format

The input files are EM042223.dat (.txt comma-separated file). Put the information in EM2019n.xlsx
WS091123.csv (from .hobo file)

3.2 Data read and conversion

The objective of this step is to accumulate all the variables daily and calculate daily reference evapotranspiration using Penman-Monteith equation (ETo).

From the EM weather station EM2019n.xlsx it determines MaxTemp, MinTemp, Max and Min RH, Average wind speed, Net Radiation in a daily step. The day is considered from the data of 00:00 to 23:45 of this day. This information is put in FAO executable reference ETo.
To run the executable ETo program we need to create a txt file with Max Temp, Min Temp, Max RH, Min RH, Wind Speed, Net Radiation in daily scale. Then is necessary to import the Cxt file (Import data from file). Put the station information (Name, Lat, Long; Figure 15). After that we have to select the period and timestep (see in Figure 16).

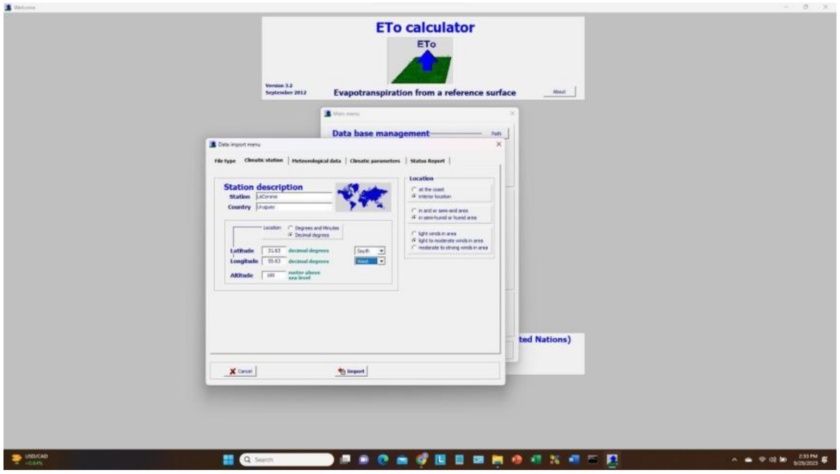


Figure 15: Information about the station in FAO executable

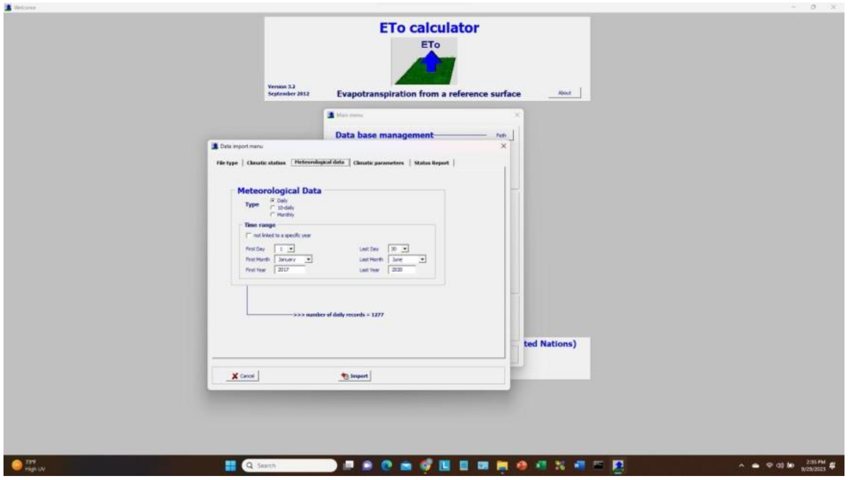


Figure 16: Meteorological data in FAO executable

After this step in Climatic parameters (see Figure 17), it is necessary to select what information we introduced in each column.

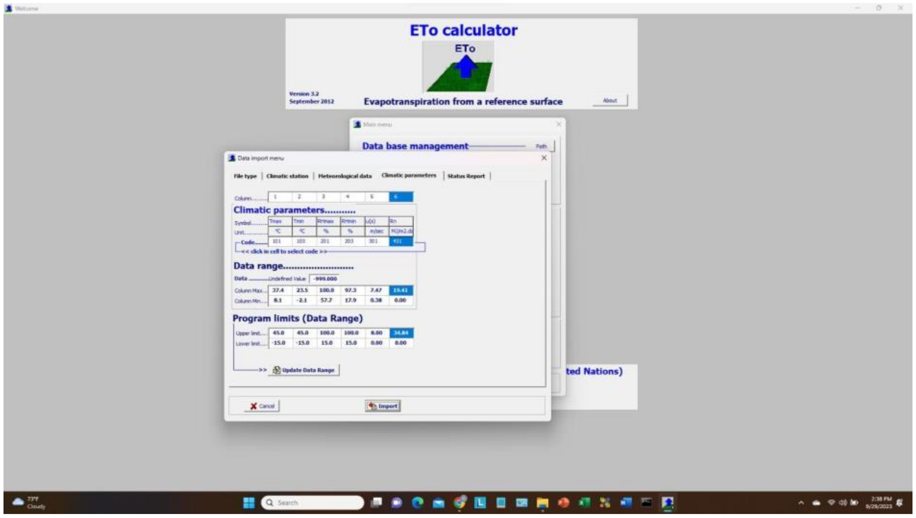


Figure 17: Climatic parameters in FAO executable

In Status Report (Figure 18) we put the name of the output files.

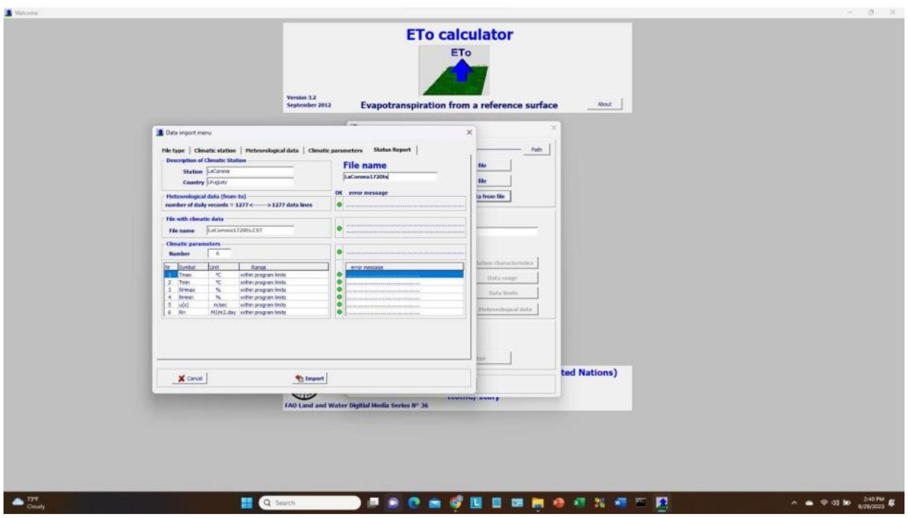


Figure 18: Status reprt in FAO executable

After that it is necessary to import the file from the button of *select a data file* which is the same information as the beginning but with another format and create another column with -9999.0 which is the Eto column with no information yet.
Select *ETo calculator*
Export results as Climate results and creates a DAT file which has the ETo data.

The information is included in a spreadsheet with daily rainfall MonthlyDailySummary.xlsx

3.3 Quick Check

1. The quick check includes two main plots:
1. Plot EM vs WS Temp and RH
2. Plots from EM2019n.xlsx

3. If something is not correct with the weather station EM
    a) The first option is to use the WS for data filling of temperature and RH.
    b) The second (last) option is to download La Magnolia daily time series for data filling considering a 1:1 correlation

3.4 Diagnostic plots

Plot ET from the EM daily in mm, verify the values are in a reasonable range, and add to a longer dataset.

4 Wells data

There are 13 wells with continuous monitoring in the four catchments. The manual wells are not used for the analysis. There is no document of the construct and litologic profile of the wells.
The time step of each measure is every 1 hour and the barometer every 2 minutes because it is also used in the flumes.
There is a WellMetaData.xlsx spreadsheet where it has the information of all the wells in mm. Height is wellhead (mm). WTD is the measure of water table depth from ground (mm). Length is the depth of the well from the wellhead and Max depth is the depth of the well (mm) from ground (see Figure 19)

Well ID	Meas	Height	WTD	Length	Max Dep	
N1	Dry	547	1483	2030	1483	11:01
N1.1	Dry	400	1220	1620	1220	11:00
N1.2	Dry	1190	1590	2780	1590	10:58

Figure 19: Example of spreadsheet WellMetaData

4.1 Input files and format

1. Read the data of 13 automatic wells and plot them together in Hoboware and save them as N1111219.csv after compensation with barometer.

N1091123.hobo
N2091123.hobo
N3091123.hobo
n4091123.hobo
N5091123.hobo
n6091123.hobo
n7091123.hobo
N8091123.hobo
n9091123.hobo
n10091123.hobo
n11091123.hobo
n12091123.hobo
n13091123.hobo

4.2 Data read and conversion

Compensation process:

1. Open data in Hoboware with the well we want to evaluate
2. Process

3. Reference water level (is always put 0). But it is possible to put the manual measure as negative from the ground instead of doing it in a spreadsheet (as it shows in the Figure 20). Important: the moment of the manual measure has to be inside of the barometric period. So it is necessary to select at least the last measure (could be before).
4. Barometric compensation
5. Create time series (see Figure 21)

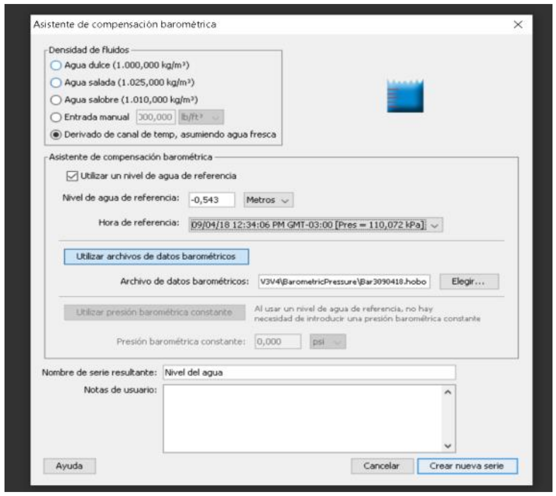


Figure 20: Compensation and Manual data includes in the process of well data in HOBOWARE

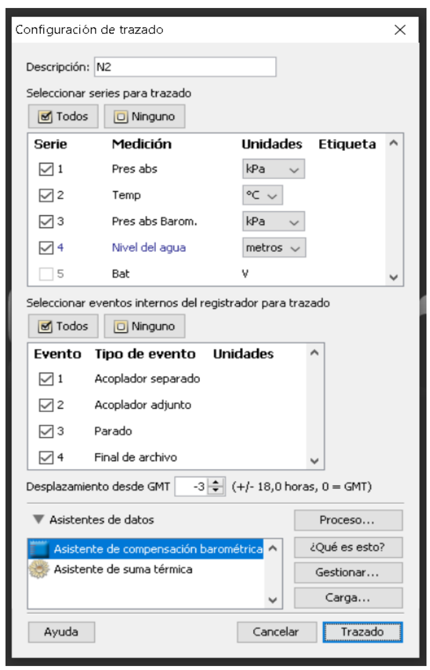


Figure 21: Trace of well processed data

6. Compensation (select option 2 in Figure 22 to compensate all the period of measure even though the barometric finish before).

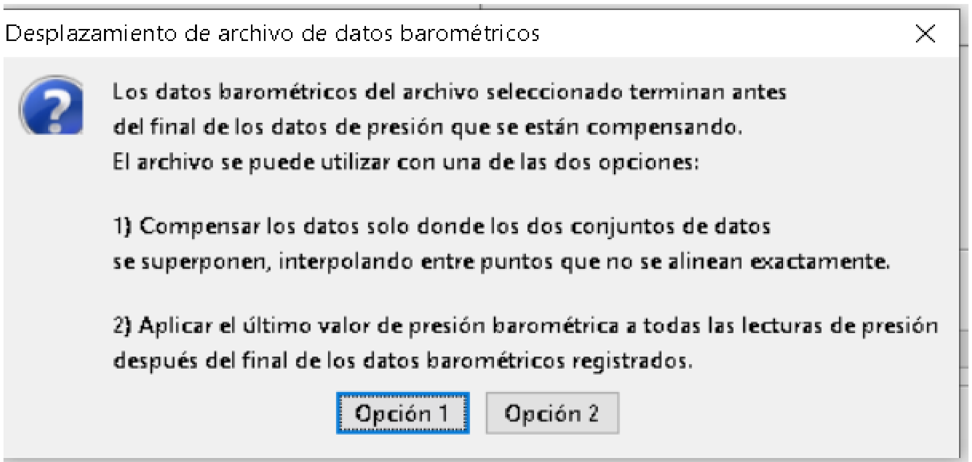


Figure 22: Time barometric compensation

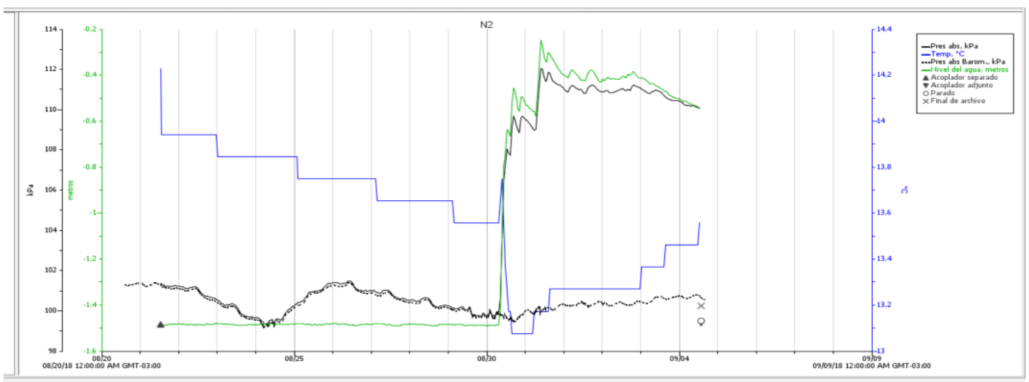


Figure 23: Results of well process data in HOBOWARE

7. The green plot is the height water level in meters
8. Export table data as csv selecting only water level (see Figure 24).

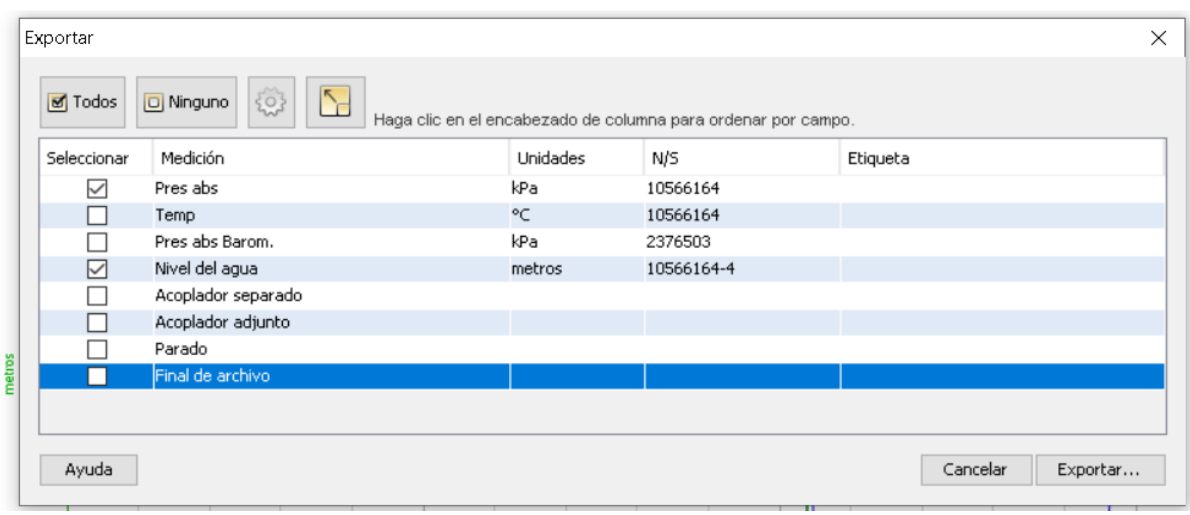


Figure 24: Export water table depth information from HOBOWARE

Oftentime it is use a dry well (N9) to compensate

4.3 Quick Check

To analyse the data of N1111219.csv is copied to the spreadsheet called N1y2019n.xlsx. Temperature is not used in evaluation.

The manual measurement from wellhead is introduced into the spreadsheet and is used to transform to measurement from the ground (If it is introduced in the software is not necessary to do this).

4.4 Storage. Final Plots and spreadsheets:

The water table variations are used to select the hydrologic balance period between no variations. To analyse data, it is used an average between the two downstream piezometer (N1-N3 and N2 and N4) and Plot with the rain.

5 Flumes data

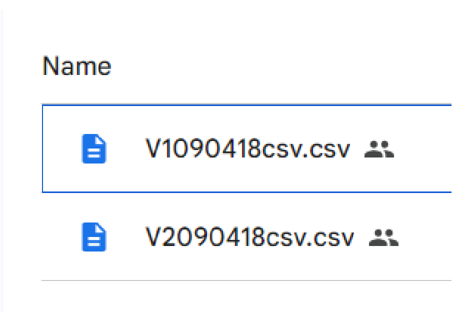
There are different loggers in each PWE. For example, there are 3 ways of measuring the flume in each catchment, and 4 in V1 and V2 because of the emergency spillway. Particularly, the HOBO U20 was installed upstream because the measurements in the HOBO U12 were often incorrect due to the accumulation of sediments in the logger pipe.
Also, the emergency spillway was built in V1 and V2 because of structural problems in the flumes that cause problems, especially after heavy rainfall.

The principal ways of estimation of discharge is firstly the Sampler (ISCO), secondly the HOBO U12, and thirdly the HOBO U20, as this latter is not able to measure low flows. The HOBO U12 is connected to the Stevens (is often good in low flows, but it does not drift (overestimate flow)).
In Eucalyptus catchments the ISCO measure stage and velocity and in Pines catchments the stage is only recorded. Velocity is only to check.

5.1 Input files and format

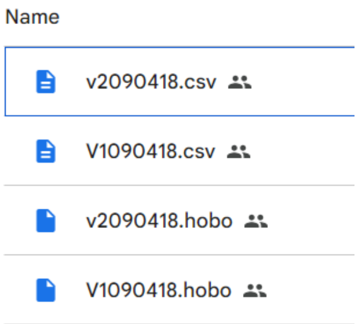
The inputs files are in the folder.

Sampler ISCO
E.g V2091123.csv



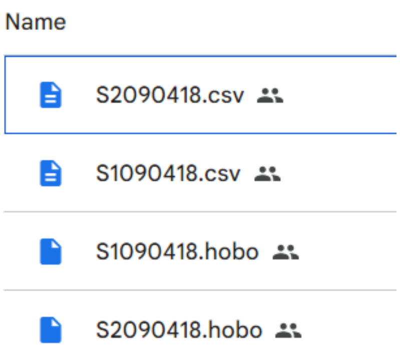
Stevens (HOBO U12)

E.g V1091123.hobo



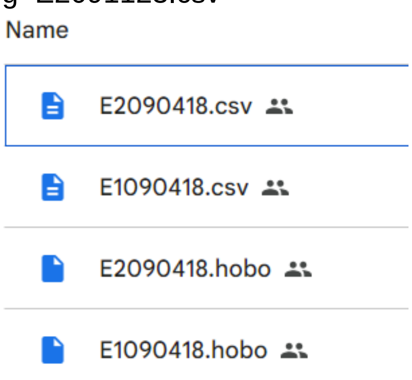
HOBO U20 OutsideWell

E.g S1091123.hobo



HOBO U20 Emergency Spillway

E.g E2091123.csv



5.2 Data read and conversion

1. Open and convert the two HOBO datasets. Open the U12 file in Hoboware and export the data in .csv format. The U20 data is open in Hoboware (see Figure 25) and needs to be compensated (Figure 26) by the barometric pressure and exported as .csv file. V1 and V2 and V3 are compensated with the barometer of catchment 3. V4 is compensated with the barometer of catchment 4.

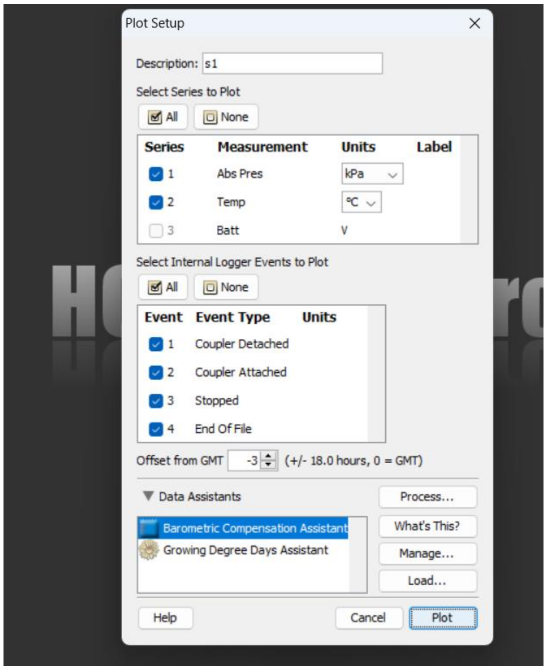


Figure 25: Example of HOBOU20 compensation

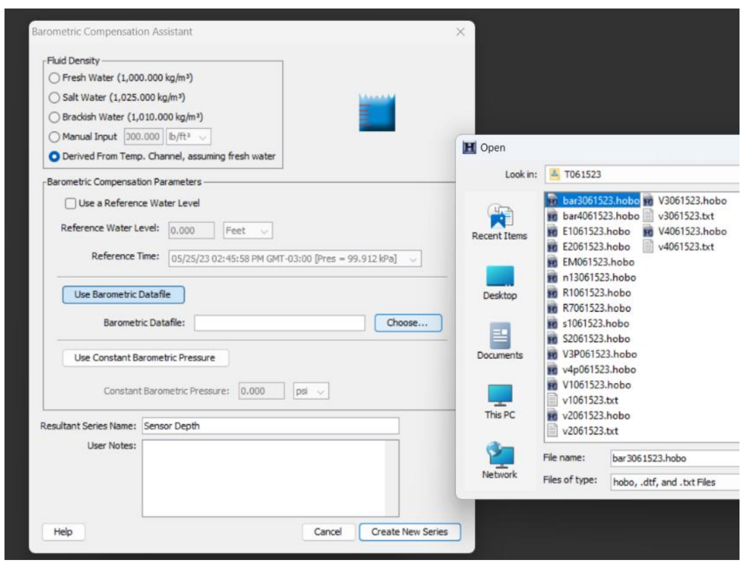


Figure 26: HOBOU20 compensation with bar3

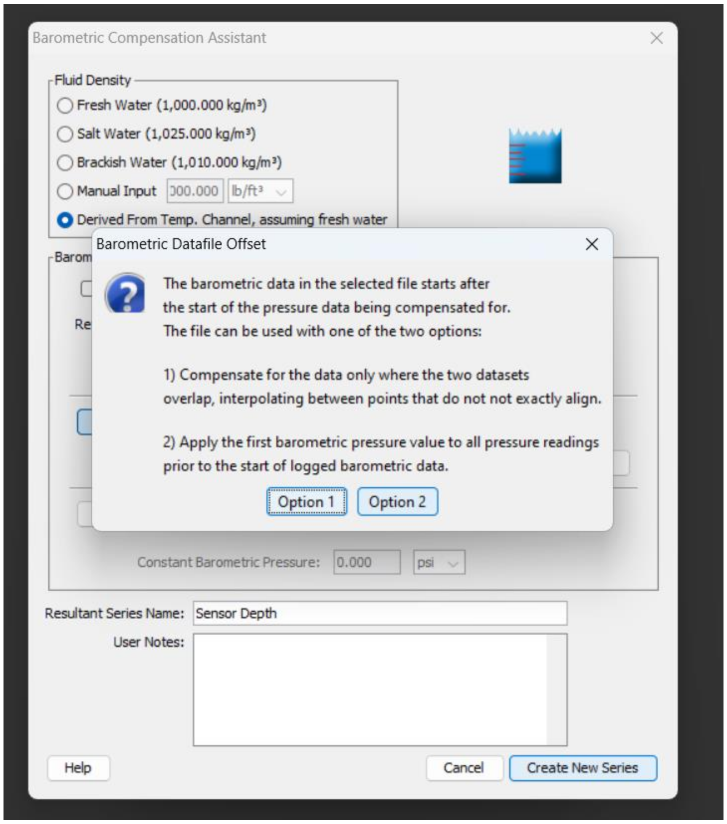


Figure 27: Select of time period for compensation

2. ISCO Sampler is already in .csv format
3. The data is open in Excel, separated by quotes, and paste the values in V1JulDec19n.xlsx in columns B and C (Date time and value respectively). There are two columns per dataset (3 datasets in total, ISCO Sampler, U12 and U20)
4. After copying the three datasets in the spreadsheet V1JulDec19n.xlsx (the first data to copy and paste is the U12 data in columns B and C)
5. To process the data from U12, use a linear transformation to convert volts in water height in meters. The sampler is also pasted in this spreadsheet and needs to be converted from feet to meters. It is necessary to add the manual measure from the field in the spreadsheet to adjust the level. In column O it is selected the most reliable measurement.
6. After reading and pre-processing the three datasets in V1JulDec19n.xlsx, copy and paste the values in V1Q19n.xlsx. This spreadsheet calculates the discharge in mm with the flume equation every 2 minutes. In this spreadsheet add the emergency spillway data, only when stage above 0.
7. Save the V1Q19n.xlsx and paste the data in V1V2y2019n.xlsx (Jday, V1Q, V2Q and rain every 2 minutes) and then is saved to a .prn file named V1V2n2min.prn to run Fortran program (FlowAn.exe) to accumulate in daily and hourly and every 6 minutes flow for the period.
8. The two minutes data is put in V1V2min2y20.csv
9. Daily information is in V1V2day20yr.csv

5.3 Quick Check:

Plot water stage in meters in 2 min timestep of three discharge loggers and select the most reliable measurement (often reliability order: Sampler, U12, U20) (see Figure 28).

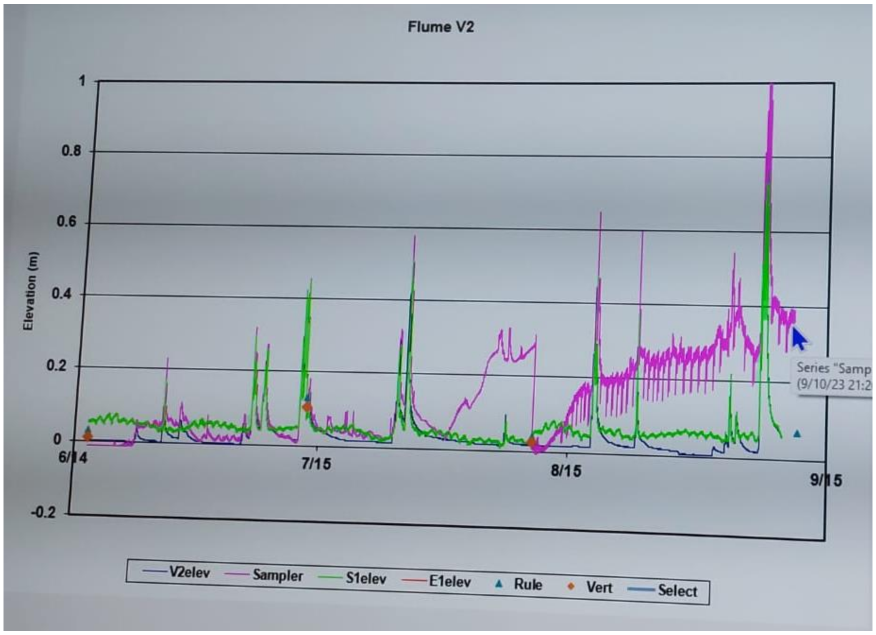


Figure 28: Plot of the three flumes every 2 minutes

Here it is able to see that the sampler is getting old because it is drifting. If the problem were sediments it should be seen the same behaviour in the U12 because the sensors are in the same place. If U12 and Sampler are full of sediment it is necessary to use the S1 (hobo 20) and make some estimates in low flows. In this plot, there is a daily fluctuation (green plot) that could be corrected with temperature, as the sensor could be reacting to the temperature. It is a very small change. The sampler is also the same, they are both affected by temperature.

Figure 29: Zoom to the three flumes data

In Figure 29 V2elev looks pretty reasonable. The two manual measurements are Rule and Vertical, Vertical should be more accurate because it is measured in the flume and the scale of the rule is not so good.

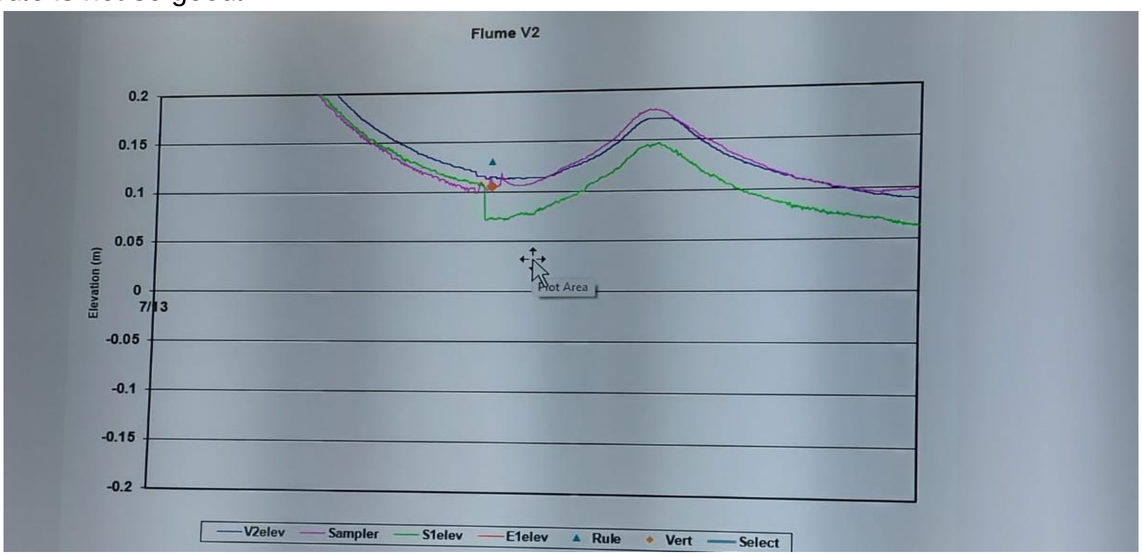


Figure 30: Problems in S1 elev

Every field visit the sampler is reseted when the level difference is too high. .
The S1 elev is a Floating pole system, probably the error of S1 of 0.5 cm before 9/2 (see Figure 30) is due to the buoy was stucked and the fall down. So it is necessary to do a correction.
At the beginning of the experiment (both pasture), the peak flows occurs more fast than after that the pines were planted.

5.4 Diagnostic plots

Plot rainfall and flow 2 minutes data to calculate the time response of the catchment (is very stable and the forestry catchment takes more time. Here we can see that the pasture catchment has higher peak flows.

Compare two watersheds monthly and yearly based.

6 Water Balance

The water balance is done with the daily data. The period is selected with a similar water table level between almost 6 months.
Equation:

$$\mathbf{ETR=P-Q}$$

$$\mathbf{ETR=Transpiration+Evaporation\ (Interception)}$$

7 Actual progress analysis

The Pine watersheds are processed until today but the eucalyptus catchments are only 3 or 4 years of processed.

All the raw data is less than 55 GB.

Until end 2022 Chip analysed the data himself.

Next thing to do is the Eucalyptus analysis. INIA would need someone that will work at least 50% on only this. High level person to be in charge on this.