

INRAE



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Getari
v. 1.0.10
User Guide

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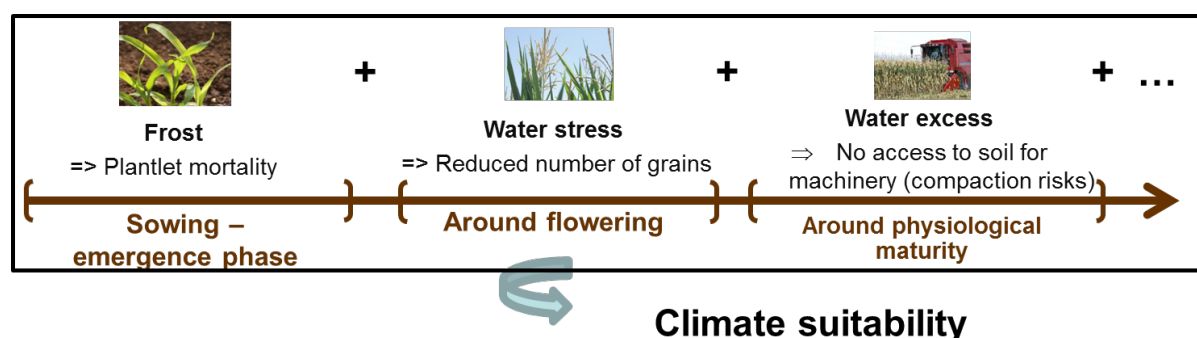
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1 What is GETARI?

Generic Evaluation Tool of Agroclimatic Indicators

GETARI is a generic evaluation tool to calculate and study climate suitability of areas for cultivation of specific crops. Crops are very dependent of the climatic effects happening during their cycle and those define climate suitability areas for cultivation. Agroclimatic indicators (i.e., heat degree days, frost days and the amount of rainfall over specific periods) are classically used providing synthetic information on the effects of climate on crop functioning. Recent studies have used agroclimatic indicators calculated over phenological periods (hereby referred to as ecoclimatic indicators) (Holzkämper et al., 2013, 2011; Caubel et al., 2015). Holzkämper et al. (2013, 2011), developed an evaluation method where several indicators are calculated over the crop cycle, normalized and aggregated to derive a global index of climate suitability. Recently, Caubel et al., 2015 develop a new assessment method of climate suitability for agriculture derived from Holzkämper et al. (2013) by improving its genericity and flexibility enough to address agronomical questions concerning climate suitability for crop cultivation according to ecophysiological criteria, days available to carry out cultural practices and yield quality.

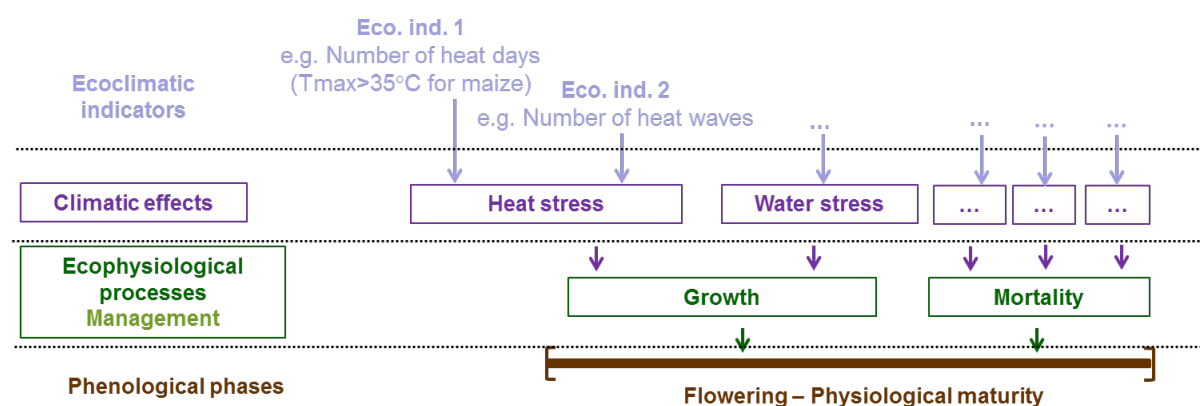
Figure 1.- More accurate information about the effects of climate on particular plant processes occurring during specific crop development phases



Evaluation method description

The generic evaluation method is described in Caubel et al., 2015. This method is based on the aggregation of ecoclimatic indicators first developed by Holzkämper et al. (2013). Ecoclimatic indicators are agroclimatic indicators that are calculated at the scale of the crop cycle. These indicators can provide information about crop response to climate through ecophysiological or agronomic thresholds. The method developed allows designing evaluation trees (Figure 2).

Figure 2.- Method description



For this, we need to identify necessary information at different levels to constitute the evaluation of climate suitability:

1. we will define the **phenological periods** affected by detrimental climate effects;
2. we will identify **ecophysiological processes** (crop growth, mortality, quality) or cultural practices (pest treatments) that take place during these phenological periods;
3. we will relate the **climatic effects** on them (i.e., heat stress, water stress...) (Figure 3);
4. we identify among the **indicators** available in a library, those that allow us to calculate the effects of climate on the crop (Figure 4).

Figure 3.- The different climatic effects considered in the evaluation method





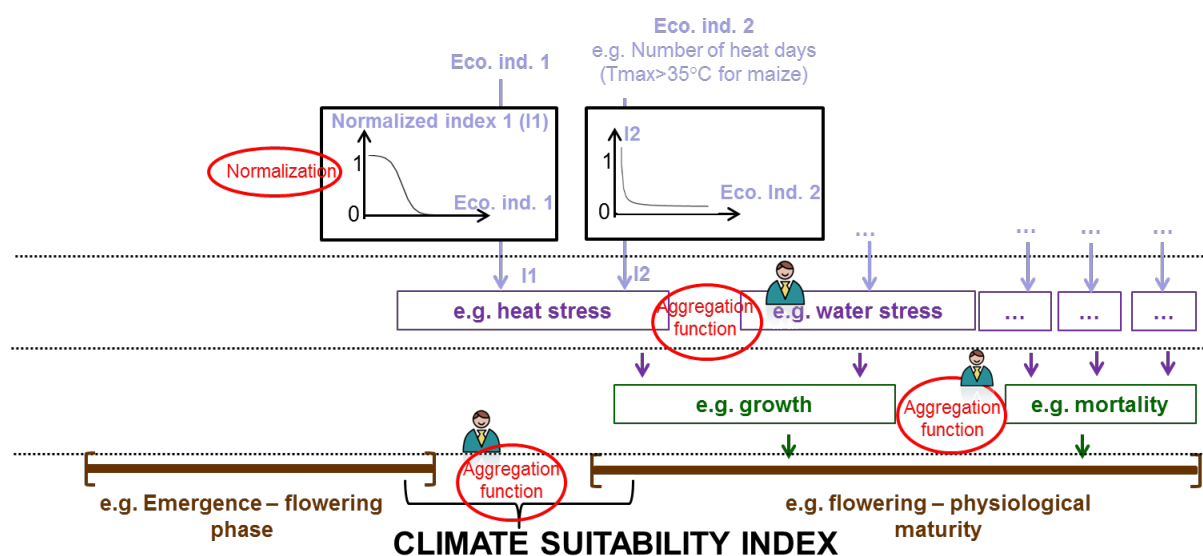
Ecophysiological processes/ Management		Climatic effects on crops
Ecophysiology	Growth	Water stress Water excess Cold Frost Heat stress Radiation deficit Mean thermal conditions 
	Yield quality	Heat stress Range temperature Nocturnal temperature Water excess Water stress 
	Mortality	Heavy rain (lodging) Heat waves/frost waves Frost Drought spell 
Number of days available for sowing, harvest, etc.		Water excess (soil compaction risks with machinery) High wind conditions (pesticides spray treatment) 

Figure 4.- Ecoclimatic indicators characterizing the different climatic effects

TEMPERATURE	T_MIN T_MAX T_MEAN T_AMP COLDTMIN_DAYS COLDTMIN_FREQUENCY FROST_SPELL COLDTMEAN_DAYS COLDTMEAN_FREQUENCY HEAT_DAYS HEAT_FREQUENCY HEAT_SPELL	Average minimal temperature per phase Average maximal temperature per phase Average mean temperature per phase Average daily range temperature per phase Number of days when the minimal temperature < threshold per phase Frequency of days when the minimal temperature < threshold per phase Number of cold waves per phase (minimal temperature < threshold during x consecutive days) Number of days when the mean temperature < threshold per phase Frequency of days when the mean temperature < threshold per phase Number of days when the maximal temperature > threshold per phase Frequency of days when the maximal temperature > threshold per phase Number of heat waves per phase (maximal temperature > threshold during x consecutive days)
RADIATION	RADIATION_AVERAGE RADIATION_SUM	Average daily radiation per phase Sum of daily radiation per phase
WIND	HIGHWIND_DAYS HIGHWIND_FREQUENCY	Number of days with wind speed > threshold per phase Frequency of days with wind speed > threshold per phase
RAIN	RAIN_SUM RAINY_DAYS RAINY_FREQUENCY HEAVYRAIN_FREQUENCY HEAVYRAIN_DAYS WATER_DEFICIT DROUGHT_SPELL	Sum of rain per phase Number of rainy days per phase Frequency of days with rain per phase Frequency of days with heavy rain (rain > threshold) Number of days with heavy rain (rain > threshold) Sum of daily rain – daily reference evapotranspiration per phase Number of drought spell per phase (rain = 0 during x consecutive days)
SOIL WATER	WATERSTRESS_FREQUENCY WATERSTRESS_DAYS WETSOIL_FREQUENCY WETSOIL_DAYS	Frequency of days with soil water content < threshold per phase Number of days with soil water content < threshold per phase Frequency of days with soil water content > SWCfc (soil water content at field capacity) per phase Number of days with soil water content > SWCfc (soil water content at field capacity) per phase
COMPOSITE INDICATOR	DECISIONSOW_FREQUENCY	Frequency of days for which conditions on minimal temperature, mean temperature, soil water content and rain after sowing are respected during the sowing period

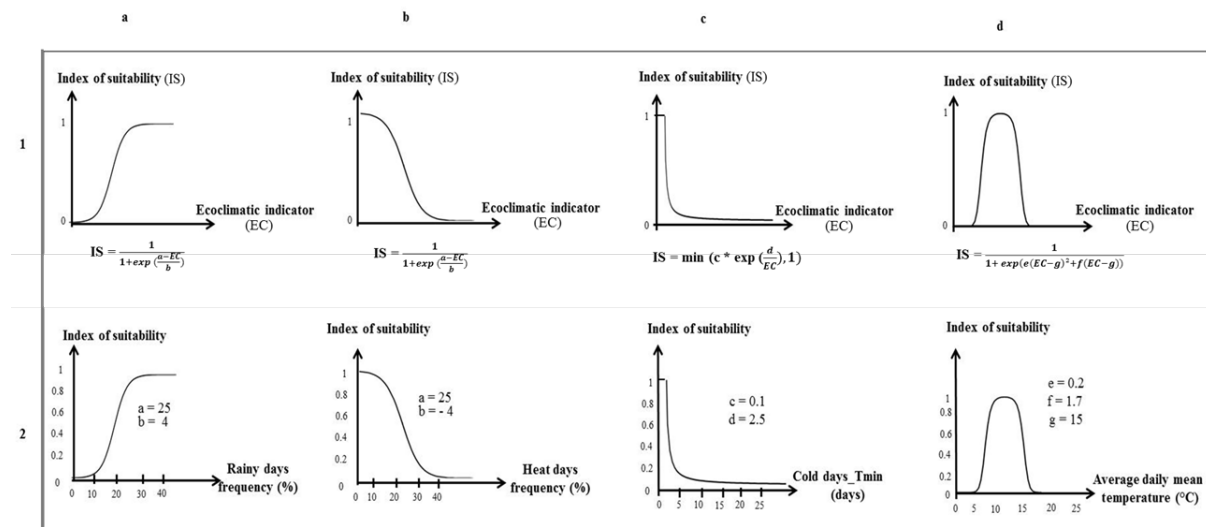
Therefore we will normalize and aggregate the information to compute a Global Index of Climate Suitability (GICS).

Figure 5.- Normalization and aggregation method



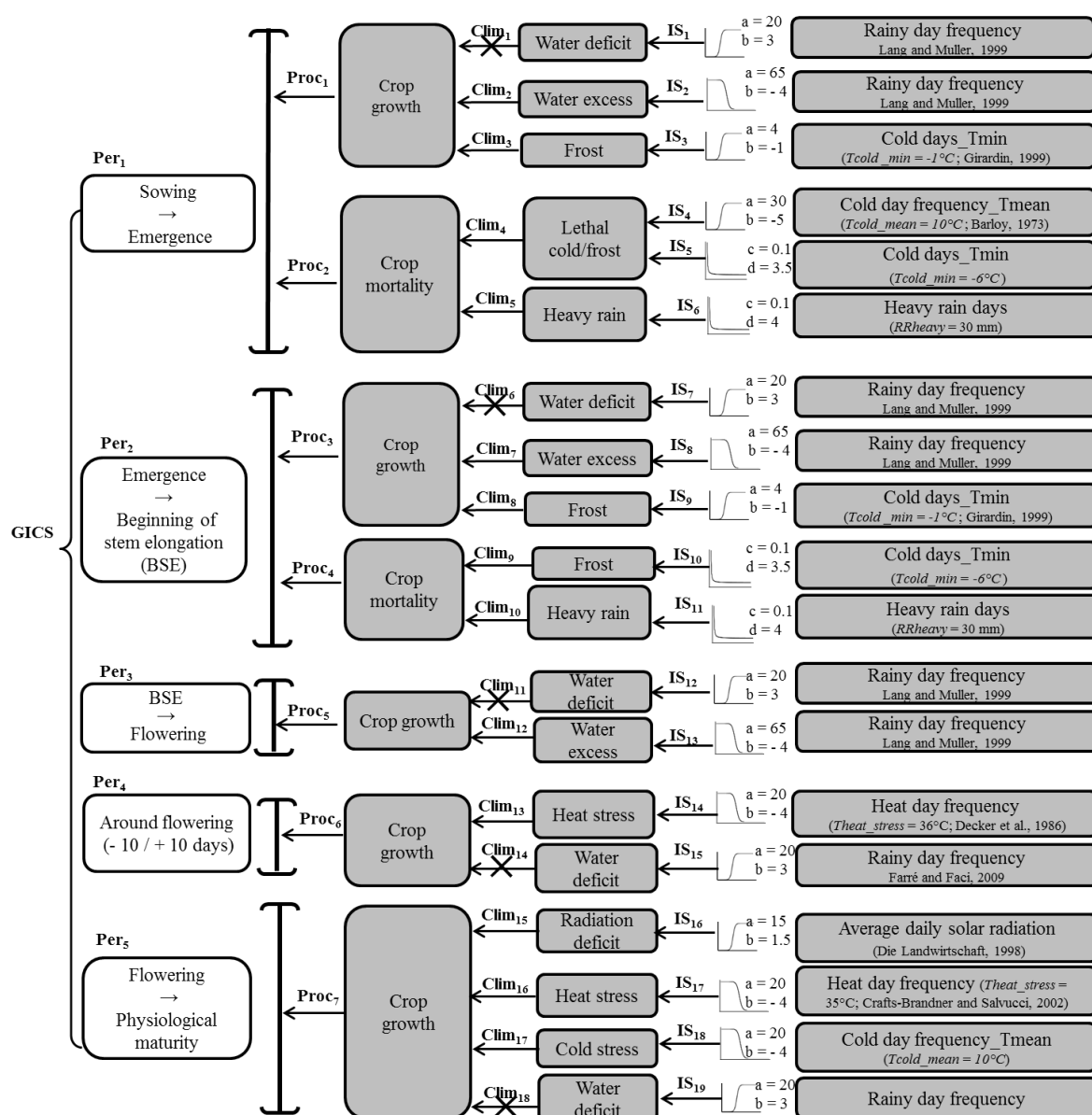
This normalization will allow getting normalized indices of climate suitability ranging from 0 to 1. These normalized indices (Figure 6) are then aggregated using pre-defined rules (Holzkämper et al., 2013, Caubel et al., 2015).

Figure 6.- Normalization functions available in GETARI



Successive aggregations will be performed at different levels (at climatic effect level, at ecophysiological processes level, and between phenological phases) in order to get a final Global Index of Climate Suitability (GICS) (Figure 7).

Figure 7.- Example of the evaluation tree of the climate suitability for maize in terms of crop ecophysiology (from Caubel et al., 2015)



1.1 References

- Garcia De Cortazar Atauri, Inaki; Maury, Olivier, 2019, "GETARI : Generic Evaluation Tool of AgRoclimatic Indicators", <https://doi.org/10.15454/IZUFAP>, Portail Data INRAE, V1
- Caubel, J., Garcia de Cortazar-Atauri, I., Launay, M., De Noblet-Ducoudré, N., Huard, F., Bertuzzi, P., Graux, A-I. (2015). Broadening the scope for ecoclimatic indicators to assess crop climate suitability according to ecophysiological, technical and quality criteria. DOI [10.1016/j.agrformet.2015.02.005](https://doi.org/10.1016/j.agrformet.2015.02.005).
- Holzkämper, A., Calanca, P., Fuhrer, J., 2013. Identifying climatic limitations to grain maize yield potentials using a suitability evaluation approach. Agricultural and forest meteorology 168, 149–159. DOI [10.1016/j.agrformet.2012.09.004](https://doi.org/10.1016/j.agrformet.2012.09.004).
- Holzkämper, A., Calanca, P., Fuhrer, J., 2011. Analyzing climate effects on agriculture in time and space. Procedia Environmental Sciences 3, 58–62. DOI [10.1016/j.proenv.2011.02.011](https://doi.org/10.1016/j.proenv.2011.02.011).

David Delannoy, Julie Caubel, Iñaki Garcia de Cortazar Atauri 16/06/2015

2 How to use GETARI?

Generic Evaluation Tool of AgRoclimatic Indicators

2.1 What do you need to run GETARI?

In order to use GETARI, you need two informations:

- Daily weather data from one point
- Phenological data or calendar dates to calculate indicators

2.1.1 Weather data

Getari uses daily weather data. Files should have a defined structure that you can create in different software as Excel or LibreOffice. Data can be in a CSV or txt format. Data have to be structured by columns: year, month, day and after weather variables.

	A	B	C	D	E	F	G	H	I	J	K	L
1	AN	MOIS	JOUR	ETPP	RG	RR	TMC	TN	TX	UM	V	
2	1990	1	1	0.3	380	0	7	3.2	10.9	84	0.9	
3	1990	1	2	0.3	700	0	9.4	4.1	14.8	82	2.6	
4	1990	1	3	0.3	270	0	9.1	4.2	14	85	2.7	
5	1990	1	4	0.4	650	0	8.6	4.7	12.5	79	1.7	
6	1990	1	5	0.1	630	0	5.9	1.1	10.7	90	1	
7	1990	1	6	0.2	290	0.5	5.7	1.9	9.5	94	1	
8	1990	1	7	0	40	4	6.8	5.1	8.5	88	1.8	
9	1990	1	8	0.5	620	1	10.8	7.5	14	86	1.9	
10	1990	1	9	0.6	440	10	9.6	7.3	11.8	86	1.8	
11	1990	1	10	0.4	200	0	7.6	5.9	9.3	91	2.3	
12	1990	1	11	0.4	490	0	7.1	3.4	10.8	86	1.3	
13	1990	1	12	0.4	380	0	7.8	4.1	11.4	80	1.3	
14	1990	1	13	0.2	720	0	8.3	4.9	11.6	89	0.9	
15	1990	1	14	0.6	680	0	8.5	4.1	12.9	77	2.8	
16	1990	1	15	0.8	870	0	10.7	8	13.4	80	3.2	
17	1990	1	16	0.7	780	0	10.2	5.2	15.2	79	2.2	
18	1990	1	17	0.5	470	0	7.8	2.8	12.9	88	1.3	
19	1990	1	18	0.5	870	0	7.8	2.6	12.9	82	3.2	
20	1990	1	19	1.5	910	0	8	4.4	11.6	59	4.2	
21	1990	1	20	0.7	960	0	7.7	1.4	14	60	1.7	
22	1990	1	21	1.4	990	0	9.8	2.9	16.8	34	2.1	
23	1990	1	22	1.6	990	0	9.6	3.1	16.1	37	2.7	
24	1990	1	23	0.9	940	0	7.3	2.3	12.2	55	1.7	
25	1990	1	24	0.3	400	0	8.3	1.6	14.9	78	1.9	
26	1990	1	25	0.7	770	0	12.4	7.8	16.9	83	1.2	
27	1990	1	26	1	750	0	10.5	7.5	13.5	75	2.9	
28	1990	1	27	0.7	320	0	8.9	3.4	14.5	86	2.2	
29	1990	1	28	1.2	280	0	10.9	8.5	13.3	80	3.7	
30	1990	1	29	0.9	1000	1.5	10	6.1	13.9	77	2.3	
31	1990	1	30	1	960	0	11.9	7	16.9	79	1.7	

Getari includes a tool allowing you to put your data in the correct format. You can use this tool to identify which are the different variables you will use to compute indicators.

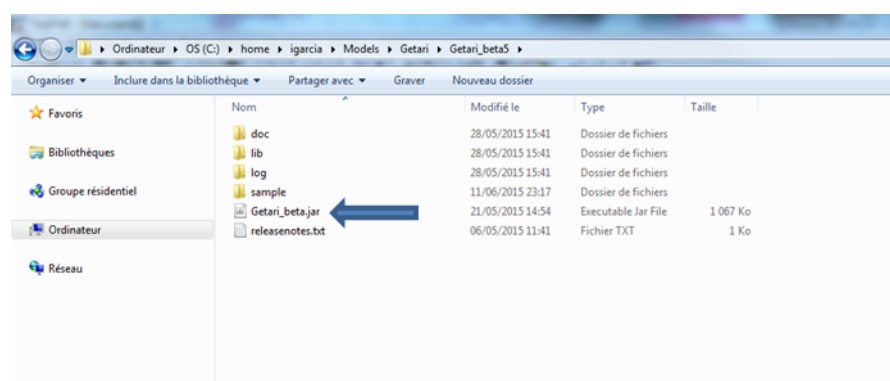
2.1.2 Phases data

In this file you will include information of the different phases that you want to use to calculate indicators. You must create one file by site. However in this file you can identify all the years you need. First column identify harvest year.

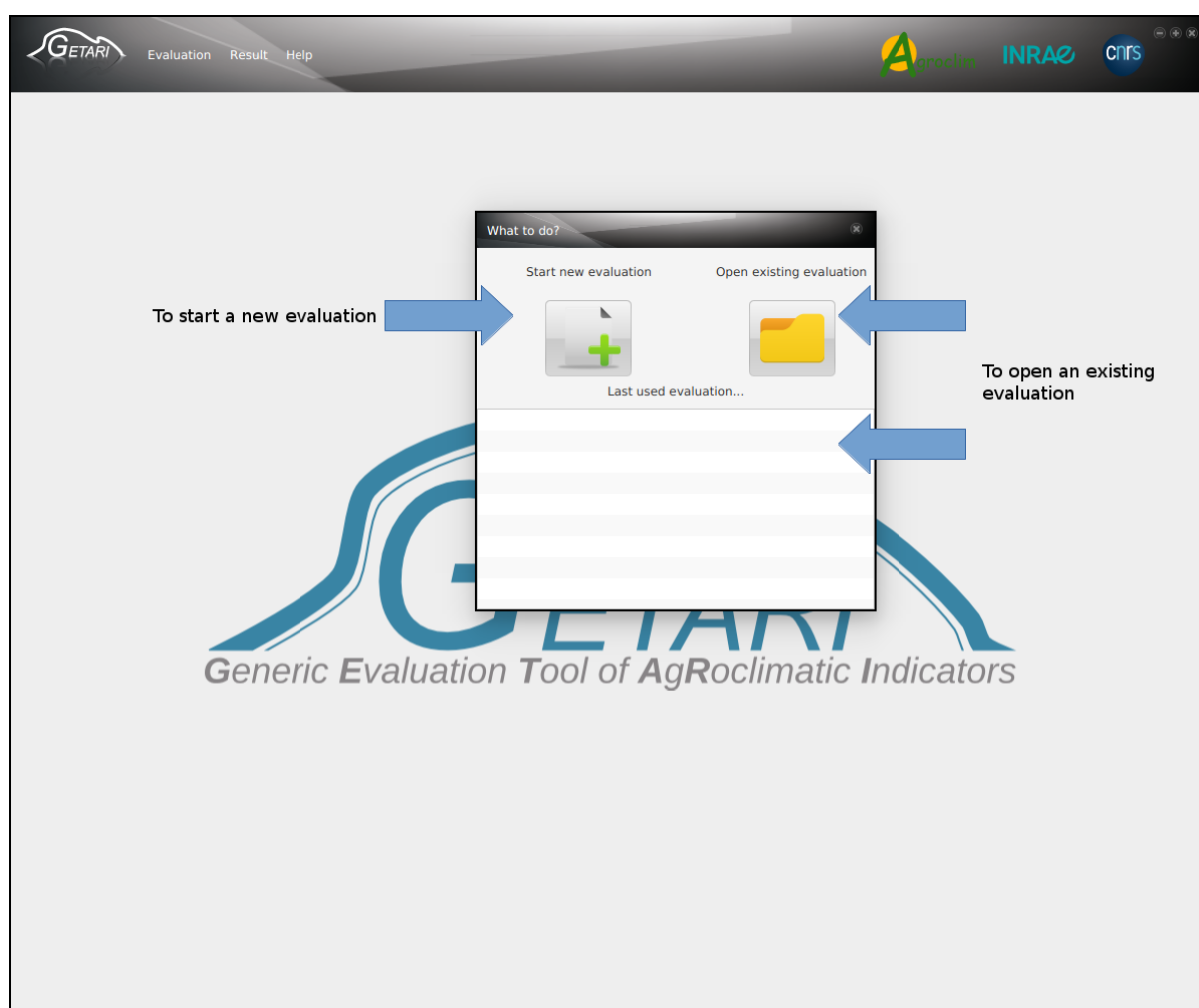
	A	B	C	D	E	F	G	H	I	J
1	year	S0	S1	S2	S6	S3	S7	S4	S5	
2	1990	59	74	86	117	127	137	144	166	
3	1991	59	72	82	114	124	134	145	167	
4	1992	59	75	87	118	128	138	146	169	
5	1993	59	78	91	119	129	139	147	168	
6	1994	59	73	83	114	124	134	144	166	
7	1995	59	77	91	118	128	138	148	169	
8	1996	59	79	93	120	130	140	149	169	
9	1997	59	74	84	111	121	131	141	163	
10	1998	59	75	87	118	128	138	145	167	
11	1999	59	75	88	115	125	135	144	165	
12	2000	59	74	87	117	127	137	145	167	
13	2001	59	74	85	114	124	134	143	163	
14	2002	59	75	85	112	122	132	142	166	
15	2003	59	77	89	117	127	137	146	166	
16	2004	59	80	94	125	135	145	153	173	
17	2005	59	84	94	122	132	142	151	171	
18	2006	59	80	90	116	126	136	145	166	
19	2007	59	73	87	113	123	133	141	163	
20	2008	59	75	89	119	129	139	148	171	
21	2009	59	77	92	120	130	140	149	170	
22	2010	59	83	96	125	135	145	153	175	
23	2011	59	78	91	116	126	136	144	167	
24	2012	59	76	89	119	129	139	149	170	
25	2013	59	80	94	124	134	144	156	178	
26	2014	59	75	87	112	122	132	141	163	
27										
28										
29										

2.2 How to start with GETARI?

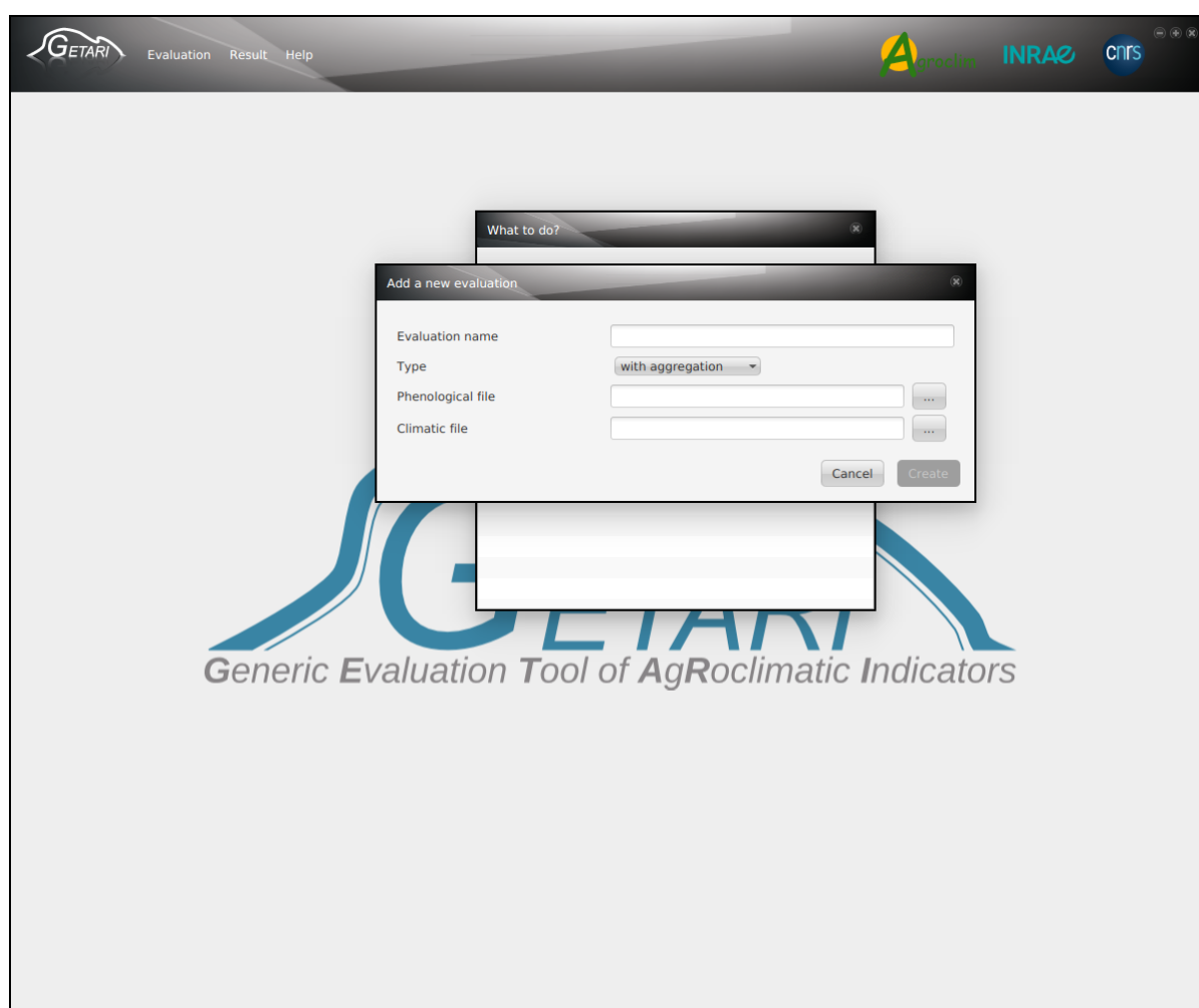
After you have [downloaded GETARI](#), you can install directly in your computer. If you choose the JAR archive, in order to run GETARI you need to verify that you **have at least Java version 8**. To run GETARI, you have to execute **Getari.jar**. Otherwise, simply click on the desktop icon or search GETARI in the Windows menu.



You will find this window



You can open an existing evaluation (*.gri files) or to start a new evaluation. If you want to create a new evaluation, you will open this window



You can name your evaluation as you want (in this case – “evaluation-test”). After you have to choose different files: a) phenological file (with calendar data) and b) weather data file.

a) Phenological file format setting

The phenological file will ask you to identify year column (information described in the “Columns to drag”). All the other columns are after the “year column” and must be in increasing order.

Import data helper

Separators: ☒ Semicolon, ☐ Tabulation, ☐ Comma

Columns to drag: year

Drag the names of the columns above onto the headers below. Right click to clear a header.

year	s0	s1	s2	s3	s4
1980	120	140	160	180	200
1981	120	140	160	180	200
1982	120	140	160	180	200
1983	120	140	160	180	200
1984	120	140	160	180	200

Import Cancel

b) Climatic file format setting

The climatic file needs to identify several columns. The header of different columns are available at the “Columns to drag” box. If headers of your original file do not have the same names that climatic variables described in GETARI, program will ask you to identify them (? red values). When you have identified all the columns you need in the file you can “Create” it.

Import data helper

Separators: ☐ Semicolon, ☒ Tabulation, ☐ Comma

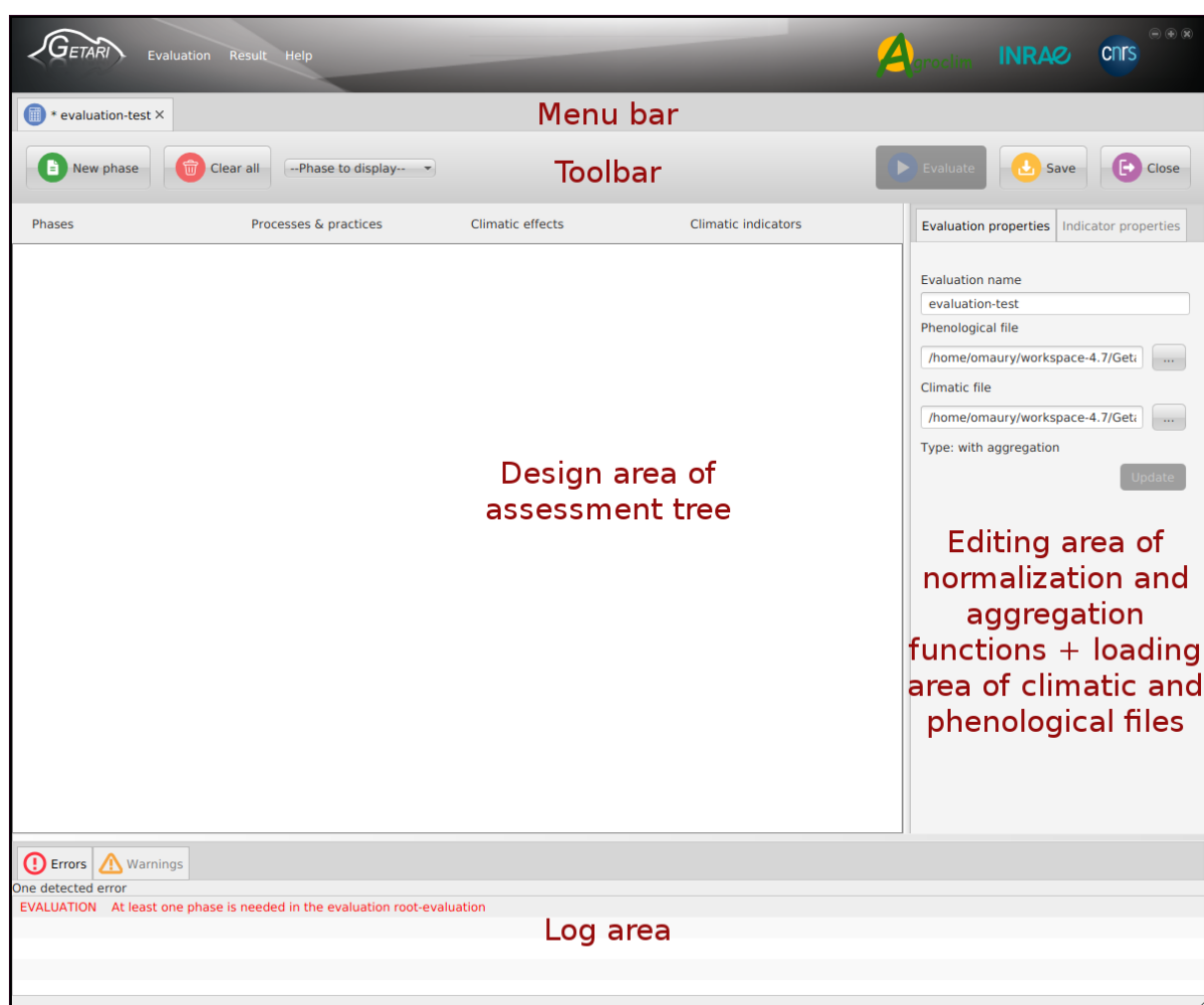
Columns to drag: year, month, day, tmin, tmax, tmean, radiation, rain, wind, co2, etp, rh, soilwat...

Drag the names of the columns above onto the headers below. Right click to clear a header.

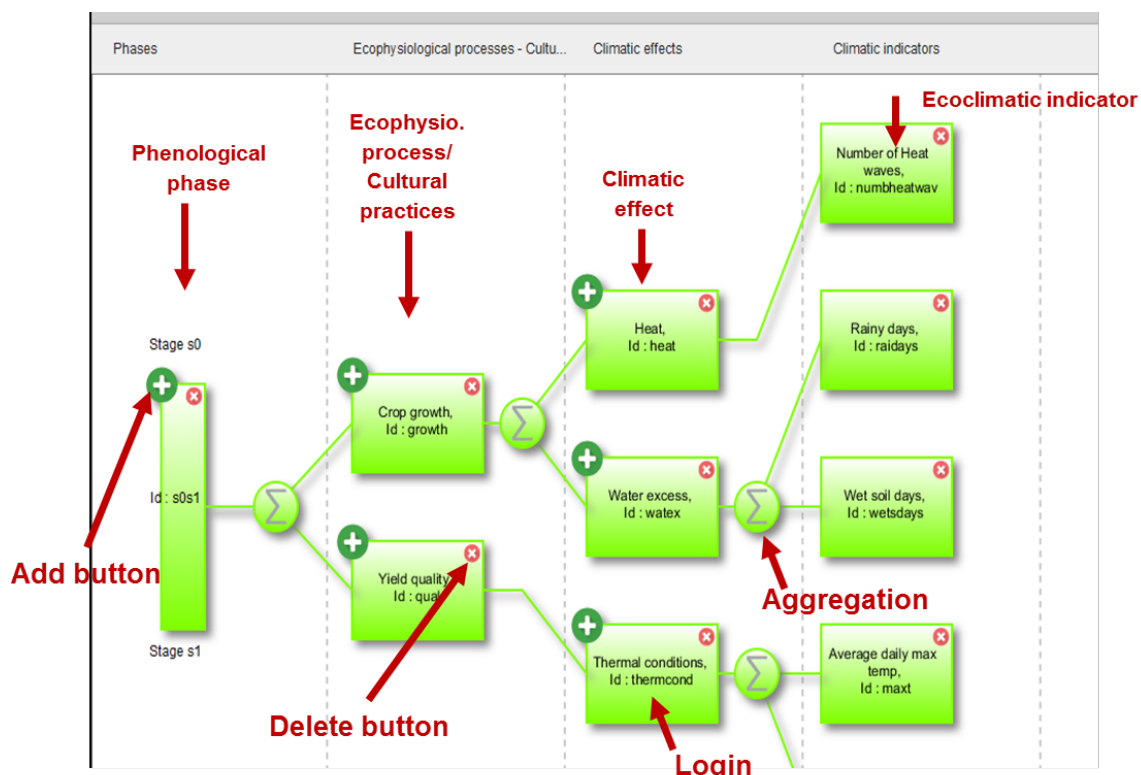
year	month	day	tmin	tmax	radiation	rain	?	wind	?	?	co2	etp
1980	1	1	1.3	9.4	211	22	-999	2.3	-999	-999	-999	0.9
1980	1	2	2.1	4.3	792	5	-999	2.2	-999	-999	-999	0
1980	1	3	-3	5	844	0	-999	0.4	-999	-999	-999	0
1980	1	4	-2	7.8	445	0	-999	1	-999	-999	-999	0.4
1980	1	5	1.3	9.7	604	11	-999	3	-999	-999	-999	0

Import Cancel

Once you have chosen your climatic and phase files, you can create your evaluation. A new window appears allowing you to create a new evaluation tree.



When you create a tree, firstly you have to choose the phase that you want to evaluate, after the processes (growth, mortality and management), the climatic effect and finally the indicator you want to calculate.



For each indicator you can edit normalization function and when necessary you can also write different aggregation functions (mean, min, max... values). To calculate aggregation functions you must use the Id value which is identified in each box.

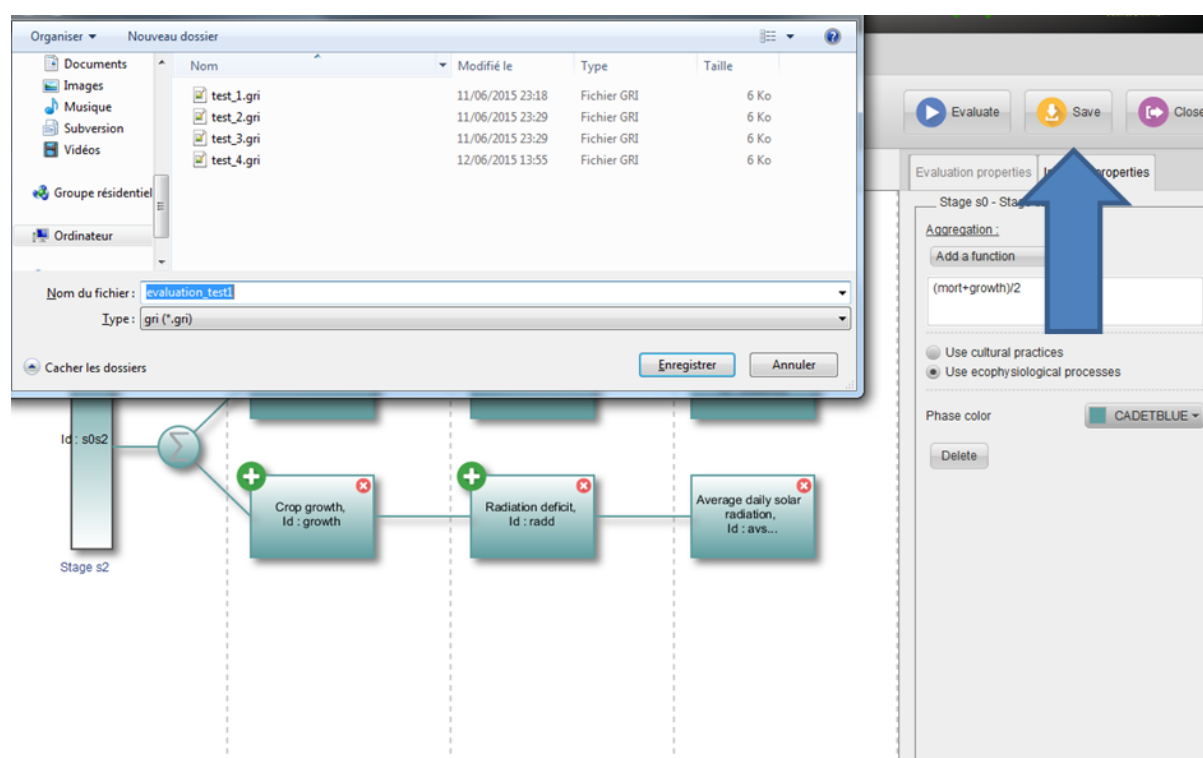
Editing area of normalization function

This screenshot shows the 'Indicator properties' tab for 'Heat stress days (hsdays)'. It includes a 'Criteria' section with a 'Threshold' of 35. The 'Normalization' section shows a 'Sigmoid' function selected, with parameters 'Sigmoid a' set to 20 and 'Sigmoid b' set to 0. A graph displays the Sigmoid curve. Red arrows point to the 'Definition of threshold value (for ecoclimatic indicator needing threshold to be defined)', the 'Selection of normalization function', and the 'Selection of appropriate parameter values'.

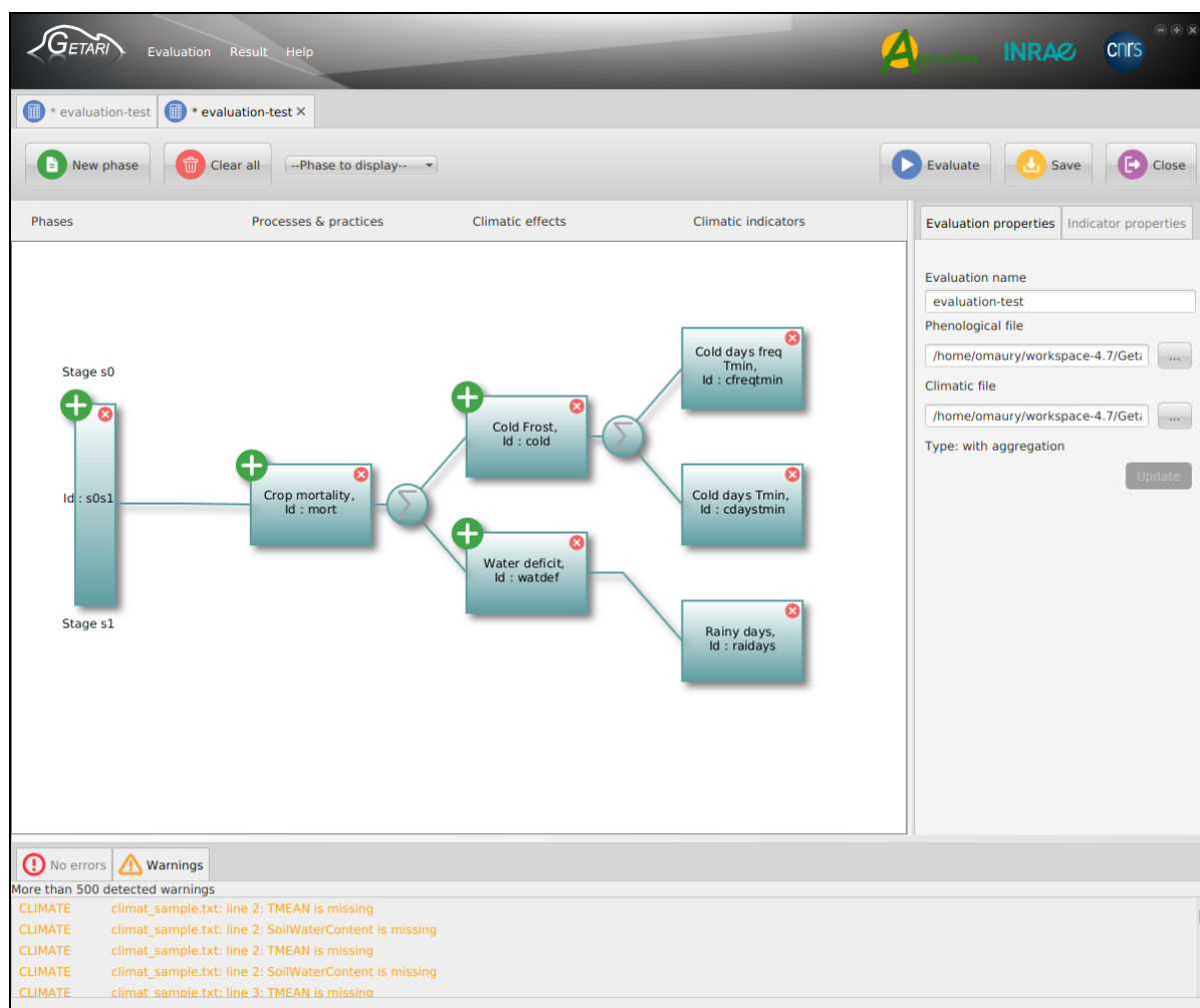
Editing area of aggregation function

This screenshot shows the 'Indicator properties' tab for 'Heat (heat)'. It includes an 'Aggregation' section with a dropdown menu set to 'Add a function'. A red arrow points to the 'Choose between available functions' dropdown. Below, the 'Usable variable for the aggregation function' is listed as 'hsdays' and 'hsfreq'. A red arrow points to the 'Edition of aggregation function' area, which includes a 'Delete' button.

If you want to save the evaluation tree, you can use the “Save” button.



If you have chosen one indicator which is missing in the climatic file, an error will appear in the “Problem tab”. If you have forgotten to define the aggregation function, an error will also appear.



Once, you have finalized to prepare your evaluation tree (define normalization functions, thresholds, aggregation functions) and you do not have any error (only warnings), you can run the evaluation.

A new tab will open with results for each indicator, climatic effect, ecophysiological processes and phase. Raw data represents absolute values of the indicator. You can save our results as an *.out file. You can also copy your results ("Copy to clipboard button") to be used in other programs as Excel or LibreOffice.

Year	Phase s0s1	Crop mortality	Cold Frost	Water deficit	Cold days freq Tmin Parent: Cold Frost Normalized data	Raw data	Cold days Tmin Parent: Cold Frost Normalized data	Raw data	Rainy days Parent: Water deficit Normalized data	Raw data
2009	0.7503	0.7503								
2010	0.6587	0.6587								
1980	0.7313	0.7313	0.5000	0.9626	0.0001	55.0000	1.0000	0.0000	0.9626	7.0000
1981	0.7262	0.7262	0.5000	0.9525	0.0000	75.0000	1.0000	0.0000	0.9525	8.0000
1982	0.7410	0.7410	0.5000	0.9820	0.0000	65.0000	1.0000	0.0000	0.9820	4.0000
1983	0.7353	0.7353	0.5000	0.9706	0.0000	65.0000	1.0000	0.0000	0.9706	6.0000
1984	0.7262	0.7262	0.5000	0.9525	0.0000	75.0000	1.0000	0.0000	0.9525	8.0000
1985	0.7262	0.7262	0.5000	0.9525	0.0000	85.0000	1.0000	0.0000	0.9525	8.0000
1986	0.7410	0.7410	0.5000	0.9820	0.0001	55.0000	1.0000	0.0000	0.9820	4.0000
1987	0.7262	0.7262	0.5000	0.9525	0.0000	90.0000	1.0000	0.0000	0.9525	8.0000
1988	0.7580	0.7580	0.6113	0.9046	0.2227	25.0000	1.0000	0.0000	0.9046	11.0000
1989	0.7434	0.7434	0.5009	0.9859	0.0019	45.0000	1.0000	0.0000	0.9859	3.0000
1990	0.7370	0.7370	0.5114	0.9626	0.0229	35.0000	1.0000	0.0000	0.9626	7.0000
1991	0.7023	0.7023	0.5000	0.9046	0.0000	80.0000	1.0000	0.0000	0.9046	11.0000
1992	0.7410	0.7410	0.5000	0.9820	0.0001	55.0000	1.0000	0.0000	0.9820	4.0000
1993	0.7756	0.7756	0.6113	0.9399	0.2227	25.0000	1.0000	0.0000	0.9399	9.0000
1994	0.7120	0.7120	0.5000	0.9241	0.0000	60.0000	1.0000	0.0000	0.9241	10.0000
1995	0.7330	0.7330	0.5033	0.9626	0.0066	40.0000	1.0000	0.0000	0.9626	7.0000
1996	0.7122	0.7122	0.5002	0.9241	0.0005	50.0000	1.0000	0.0000	0.9241	10.0000
1997	0.7137	0.7137	0.5033	0.9241	0.0066	40.0000	1.0000	0.0000	0.9241	10.0000
1998	0.7503	0.7503	0.5379	0.9626	0.0758	30.0000	1.0000	0.0000	0.9626	7.0000
1999	0.9431	0.9431	0.9620	0.9241	0.9241	10.0000	1.0000	0.0000	0.9241	10.0000
2000	0.9256	0.9256	0.8886	0.9626	0.7772	15.0000	1.0000	0.0000	0.9626	7.0000
2001	0.6904	0.6904	0.5000	0.8807	0.0000	60.0000	1.0000	0.0000	0.8807	12.0000
2002	0.7199	0.7199	0.5000	0.9399	0.0000	60.0000	1.0000	0.0000	0.9399	9.0000
2003	0.7330	0.7330	0.5033	0.9626	0.0066	40.0000	1.0000	0.0000	0.9626	7.0000
2004	0.6903	0.6903	0.5000	0.8807	0.0000	70.0000	1.0000	0.0000	0.8807	12.0000
2005	0.7389	0.7389	0.5379	0.9399	0.0758	30.0000	1.0000	0.0000	0.9399	9.0000
2006	0.7452	0.7452	0.5379	0.9525	0.0758	30.0000	1.0000	0.0000	0.9525	8.0000
2007	0.7460	0.7460	0.6113	0.8807	0.2227	25.0000	1.0000	0.0000	0.8807	12.0000
2008	0.7257	0.7257	0.5114	0.9399	0.0229	35.0000	1.0000	0.0000	0.9399	9.0000

2.3 How to get support?

Support for GETARI is available in a variety of different forms:

- using the form in the GETARI application (preferred method),
- using the [Redmine forge](#),
- using the [contact form](#) on this web site.

2.4 References

- Garcia De Cortazar Atauri, Inaki; Maury, Olivier, 2019, "GETARI : Generic Evaluation Tool of AgRoclimatic Indicators", <https://doi.org/10.15454/IZUFAP>, Portail Data INRAE, V1
- Caubel, J., Garcia de Cortazar-Atauri, I., Launay, M., De Noblet-Ducoudré, N., Huard, F., Bertuzzi, P., Graux, A-I. (2015). Broadening the scope for ecoclimatic indicators to assess crop climate suitability according to ecophysiological, technical and quality criteria. DOI [10.1016/j.agrformet.2015.02.005](https://doi.org/10.1016/j.agrformet.2015.02.005).

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