



HYDROGNOMON – OPEN SOURCE SOFTWARE FOR THE ANALYSIS OF HYDROLOGICAL DATA



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processes: from point to global spatial scales and from minute to
climatic time scales***

**Stefanos Kozanis, Antonis Christofides, Nikos Mamassis, Andreas
Efstratiadis, and Demetris Koutsoyiannis**

**Department of Water Resources and Environmental Engineering,
School of Civil Engineering, National Technical University of Athens,
Greece**

1. Hydrognomon — Introduction

Hydrognomon is a software tool for the processing of hydrological data. Data are imported through standard text files, spreadsheets or by typing. Available processing techniques include time step aggregation and regularization, interpolation, regression analysis and infilling of missing values, consistency tests, data filtering, graphical and tabular visualisation of time series, and more. Hydrognomon is free software licensed under the GPLv3.

It supports several time steps, from the finest minute scales up to decades; specific cases of irregular time steps and offsets are also supported. The program also includes common hydrological applications, such as evapotranspiration modelling, stage-discharge analysis, homogeneity tests, areal integration of point data series, processing of hydrometric data, as well as lumped hydrological modelling with automatic calibration facilities.

Here the emphasis is given on the statistical module of Hydrognomon, which provides tools for data exploration, fitting of distribution functions, statistical prediction, Monte-Carlo simulation, determination of confidence limits, analysis of extremes, and construction of ombrian (IDF) curves.

2. User interface

The screenshot shows the Hydrognomon software interface. The main window displays a data table with columns for time stamps and various data series. A 'Time series data' callout points to the data columns. A 'Time series graphs' callout points to a bar chart window showing data from 1975 to 1978. A 'Flags - highlighting' callout points to a cell containing 'INFILLING'. A 'Special functions - filtering' callout points to a 'Define Filter' dialog box with options for filtering by value or flag.

Time stamp	Series 1	Series 2	Series 3	Series 4	Flags
1975/06	57,30			6,10	
1975/07	4,00			0,00	
1975/08	20,00			2,80	
1975/09	10,20			2,50	
1975/10	18,60			0,00	
1975/11	70,70			84,60	
1975/12	169,40			99,20	
1976/01	78,60			58,50	
1976/02				135,20	
1976/03				119,80	
1976/04				81,50	
1976/05				25,70	
1976/06	7,20	39,20	28,70	0,00	INFILLING
1976/07	2,30	21,40	0,00		
1976/08	14,50	10,70	0,00		
1976/09	0,20	33,30	0,00		
1976/10	75,50	132,00	73,80		
1976/11	59,20	178,20	28,40		
1976/12	59,60	164,80	22,50		
1977/01	13,00	63,90	10,10		INFILLING
1977/02	7,30	43,20	24,90		
1977/03	22,00	51,00	23,10		
1977/04	39,70	72,90			
1977/05	1,10	30,00			
1977/06	33,70	23,00			
1977/07	0,00	0,00			
1977/08	1,40	8,00			
1977/09	21,10	65,20	32,90		
1977/10	27,00	14,00	0,00		
1977/11	49,10	219,80	52,90		
1977/12	178,40	88,80	137,10		
1978/01	145,30	198,00	389,60		

The screenshot shows a tabular view of time series data in Hydrognomon. The table has columns for years and multiple data series.

Year	10	11	12	1	2	3
1952-53	27,00	141,00	174,00	171,00	30,00	55,00
1953-54	160,20	136,10	58,00	155,20	95,10	67,30
1954-55	65,90	147,50	144,90	82,90	19,20	72,80
1955-56	201,30	160,40	50,10	67,50	181,40	108,60
1956-57	18,20	62,70	35,90	118,10	22,60	54,40
1957-58	206,00	75,80	97,40	85,90	3,00	91,20
1958-59	67,30	127,70	25,60	76,60	24,50	61,40
1959-60	91,80	79,70	47,50	126,40	71,40	66,40
1960-61	13,60	43,90	194,30	95,50	50,90	154,20
1961-62	37,70	60,70	139,50	37,00	117,00	156,00
1962-63	174,00	159,00	155,00	38,30	70,40	72,20
1963-64	234,00	52,10	38,10	162,70	43,50	60,50
1964-65	20,50	6,50	86,00	125,00	110,00	87,80
1965-66	37,10	31,60	55,20	109,30	11,50	152,20
1966-67	20,10	120,90	101,50	38,50	57,80	83,00
1967-68	137,20	67,10	124,30	81,10	82,70	69,00
1968-69	164,90	113,30	216,90	80,60	20,80	94,30
1969-70	1,50	40,60	192,60	43,10	41,50	84,80
1970-71	85,70	12,00	76,00	52,00	84,30	98,70
1971-72	112,50	61,30	69,70	181,40	82,20	24,50
1972-73	111,10	25,70	33,70	123,30	53,20	35,50

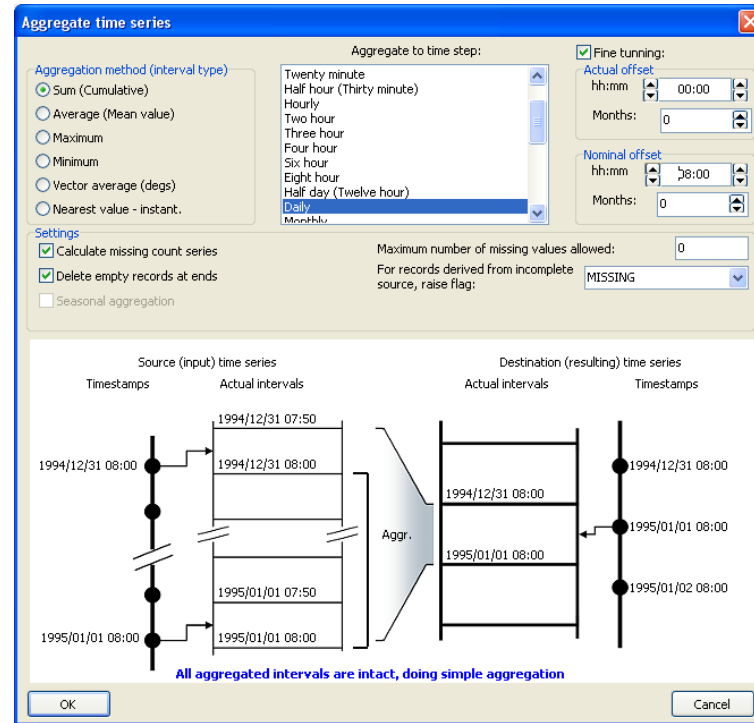
Conventional view (multi time series display)

Tabular view (single time series)

3. Time integration of series

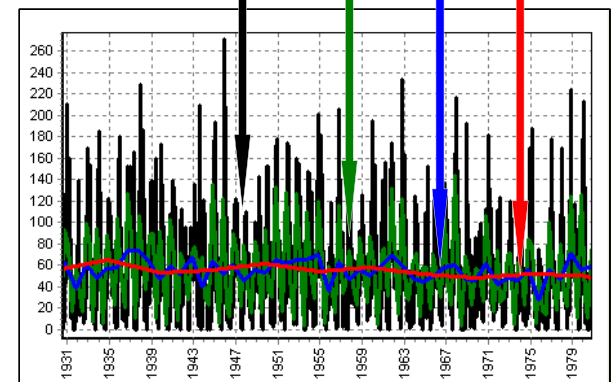
Hydrognomon's time integration algorithms can handle from minute time steps of automatic gauging stations, up to daily / monthly / seasonal / annual or over-year time steps.

Any transformation is allowed between different time steps, with features such as time offsets, interpolated values for shifted time intervals, hydrological year scales with adjusted origin, seasonal aggregation, and more.



Interface – Aggregation parameters

1954/10 - 1955/01		110,30	
1955/02	19,20		
1955/03	72,80		
1955/04	128,40		
1955/05	2,00		
1955/02 - 1955/05		55,60	
1955/06	12,70		
1955/07	4,80		
1955/08	21,00		
1955/09	76,80		
1955/06 - 1955/09		28,83	
1954-55			64,91
1950/10 - 1955/09			62,28



Average values from 1 month to a term period (4 months), annual, 5-year

4. Time series regression and infilling

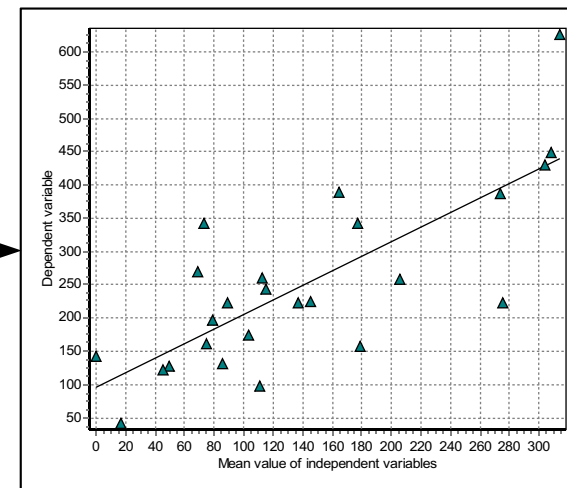
The time series regression and infilling tool can determine the correlation between different time series. A linear combination relating several independent variables to a dependent variable can be established using optimization routines. This can work seasonally, if needed, and several constraints can be defined.

	Variable: 1	Variable: 2	Variable: 3	Variable: 4	Variable: 5	Variable: 6	Max time series	Only Positives
1	Automatic	Always used	Automatic	Automatic	Not used	Automatic	2	True
2	Automatic	Always used	Automatic	Automatic	Not used	Automatic	2	True
3	Automatic	Automatic	Automatic	Automatic	Not used	Automatic	2	True
4	Automatic	Automatic	Automatic	Automatic	Not used	Automatic	1	True
5	Automatic	Automatic	Automatic	Automatic	Not used	Automatic	1	True
6	Automatic	Automatic	Not used	Automatic	Not used	Automatic	1	True
7	Automatic	Automatic	Not used	Automatic	Not used	Automatic	1	True
8	Automatic	Automatic	Automatic	Automatic	Not used	Automatic	1	True
9	Automatic	Automatic	Automatic	Automatic	Automatic	Automatic	1	True
10	Automatic	Automatic	Automatic	Automatic	Automatic	Automatic	2	True
11	Automatic	Automatic	Automatic	Automatic	Not used	Automatic	2	True
12	Automatic	Automatic	Always used	Automatic	Not used	Automatic	3	True

Model constraints, individually for each month

	N	D=R ²	R	Dcr.	a0	a1	a2	a3	a4	a5	a6
10	25	0,508	0,713	0,160	36,279		0,403	0,892			
11	25	0,528	0,726	0,160	66,687			1,358			
12	25	0,590	0,768	0,160	96,702			1,091			
1	24	0,056	0,236	0,167	139,670		0,563				
2	24	0,038	0,194	0,167	135,364		0,141		0,131		
3	24	0,362	0,601	0,167	40,135			0,767	0,071		
4	25	0,643	0,802	0,160	43,064				1,032		
5	25	0,168	0,410	0,160	74,001				0,287		
6	22	0,313	0,559	0,182	37,233	1,045					
7	17	0,609	0,781	0,235	26,290	1,662					
8	24	0,350	0,592	0,167	20,083						0,562
9	22	0,438	0,662	0,182	17,797			1,095			

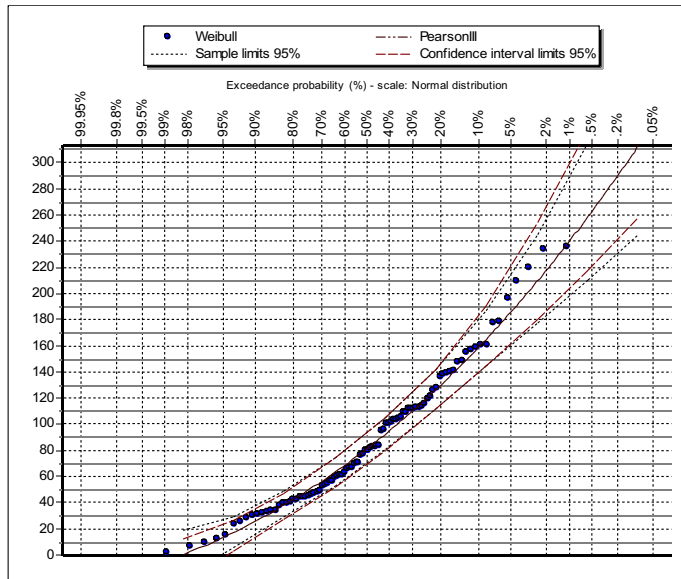
Model output – regression parameters for each month



December variogram – Dependent variable vs independent vars

5. Statistical analysis of time series — “Pythia”

Hydrognomon's module for statistical time series analysis, called “Pythia”, can estimate properties of samples and parameters of distribution functions; includes 27 statistical distributions for data fitting; provides statistical forecasts and tests (χ^2 and Kolmogorov – Smirnov); and can determine confidence intervals of any distribution function using an original Monte-Carlo algorithm.



Confidence zones for December precipitation on Pearson III CDF

	October	November	December	January	February	March	April
Data count	93	94	94	94	94	94	94
Mean value	72.19	88.06	106.27	94.88	79.85	70.51	40.5
Standard deviation	59.99	52.98	58.59	53.23	46.18	43.76	33.1
Skewness	306165.11	113556.43	98249.38	167	144	144	144
Gamma	1.42	.76	.49	1.11			42
Gamma Kappa	1.59	.2	-.44	2.97			3.37
Gamma Lambda	3.9	4.25	4.48	4.36			3.37
Gamma c	1.05	.79	.68	.71	.75	.72	.91
Thir...	-1.72	-.71	-.28	-.49	-.61	-.27	-.42
Skewnes	-1.49	-1.47	-.91	-1.4	-1.43	-.71	-.56
LogNormal n, y	4.02	4.32	4.53	4.42	4.24	4.09	3.45
LogNormal sy	.72	.56	.52	.52	.54	.57	.71
Galton my	4.82	5.33	5.88	4.95	5.06	5	4.22
Galton sy	.42	.25	.16	.34	.28	.28	.42
Galton c	-63.08	-124.46	-256.69	-55.16	-84.14	-83.47	-34.0
Exponential c	12.2	35.07	47.68	41.65	33.67	26.74	7.43
Exponential Lambda	.02	.02	.02	.02	.02	.02	.03
Gamma Lambda	1.45	2.76	3.29	3.18	2.99	2.6	1.5
Gamma Kappa	.02	.03	.03	.03	.04	.04	.04
Pearson III Kappa	1.99	6.86	16.76	3.25	5.32	5.22	1.99
Pearson III Lambda	.02	.05	.07	.03	.05	.05	.04
Pearson III c	-12.44	-50.75	-133.62	-1.11	-26.66	-29.45	-6.1
Log Pearson III Kappa	1.81	1.86	4.81	2.04	1.96	8.01	12.7
Log Pearson III Lambda	1.28	1.74	3.25	2.03	1.86	3.92	3.91

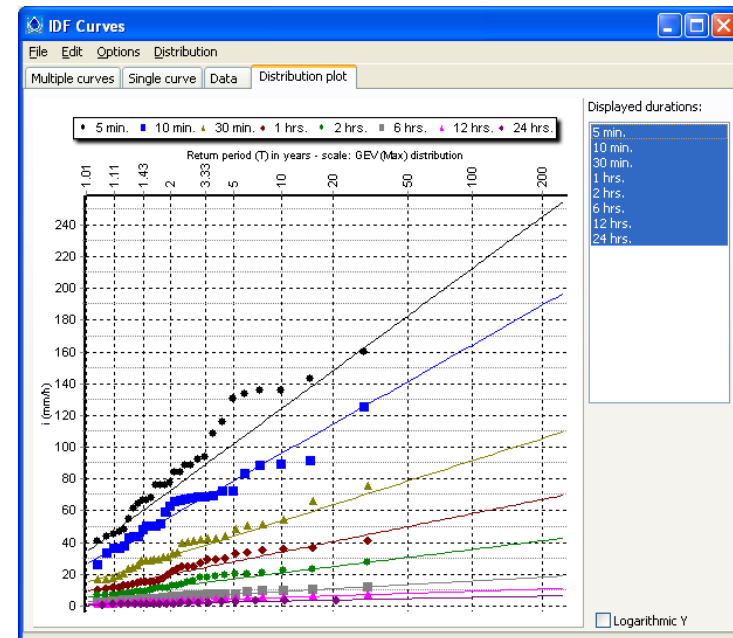
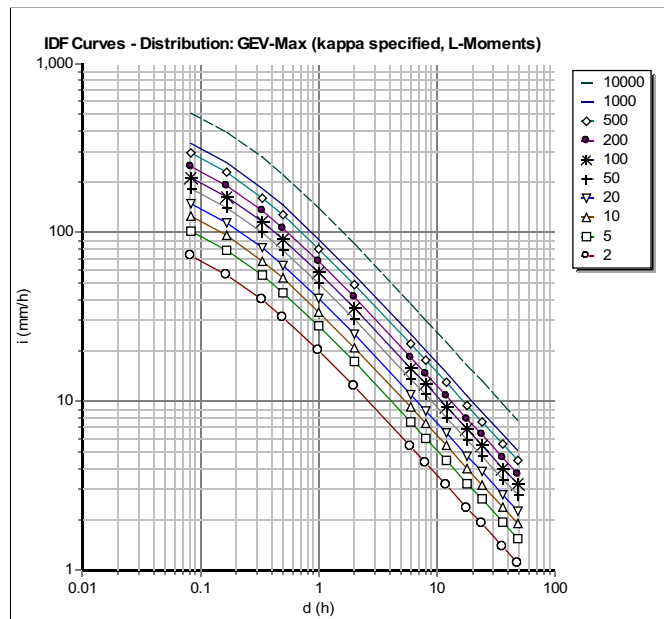
Statistical properties and distribution functions params

CDF graphs selection

6. Ombrian curves — “Ombros”

Ombrian curves (also known as IDF curves) can be constructed from annual maxima of precipitation events, which can either be provided or estimated from measurements (with a time step of 1 minute to 24 hours). Ombrian curves, that is, intensity functions of episode duration and return period, are calculated using an advanced algorithm.

“Ombros” takes advantage of “Pythia”, allowing to choose from a list of distribution functions and calculating confidence intervals with the Monte-Carlo method.



7. Create a time series database using Enhydriis



Hydrognomon is a standalone program, which stores its data in files—as simple as a word processor. But if you need to store your data centrally, we have Enhydriis: a database system with a web interface and several features:

- It can optionally work in a distributed way. Many organisations can install one instance each, but an additional instance, common to all organisations, can be setup as a common portal. This additional instance can be configured to replicate data from the other databases, but without the space-consuming time series, which it retrieves from the other databases on demand. A user can transparently use this portal to access the data of all participating organisations collectively.
- It opens downloaded timeseries directly in Hydrognomon.
- It is extensible and has an API for communication with other systems.

Written in Python/Django and using PostgreSQL, Enhydriis can be installed on every operating system on which Python runs, including GNU/Linux and Windows. It is free software, available under the GNU General Public License version 3 or any later version.

Enhydriis is still under development and needs polishing, but it is already being used operationally by the Hydroscope project in Greece.

The screenshot shows the Hydroscope web interface. The top part displays a 'Station Catalogue' with a table of 5 entries. The bottom part shows 'Station Details' for station ID 1322.

Select	ID	Name
<input type="checkbox"/>	1040	ΩΡΑΙΟΙ
<input type="checkbox"/>	1860	ΙΣΤΙΑΙΑ
<input type="checkbox"/>	1951	ΚΑΣΤΑΝΩΤΙΣΣΑ
<input type="checkbox"/>	2283	ΜΗΛΙΕΣ
<input type="checkbox"/>	2779	ΣΗΜΙΑ(ΒΟΥΤΑΣ)

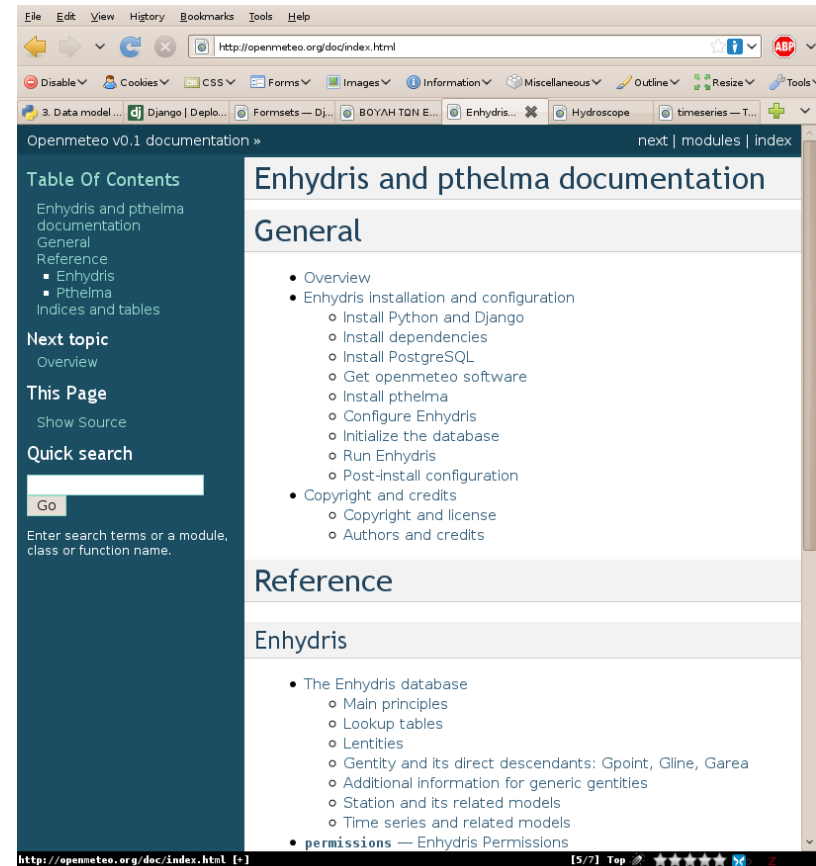
ID	Name	Variable	Unit Of Measurement	Remarks	Instrument
5456	ΘΕΡΜΟΚΡΑΣΙΑ (ΕΛΑΧΙΣΤΗ)		°C		7418
5455	ΘΕΡΜΟΚΡΑΣΙΑ (ΜΕΓΙΣΤΗ)		°C		6763
5454	ΘΕΡΜΟΚΡΑΣΙΑ (ΜΕΤΡΗ)		°C		6768
5453	ΑΝΕΜΟΣ (ΔΙΕΥΘΥΝΣΗ)		-		7453
5452	ΑΝΕΜΟΣ (ΤΑΧΥΤΗΤΑ)		m/s		6762
5451	ΕΞΑΤΜΙΣΗ (ΕΚΤΙΜΗΜΕΝΗ)		mm		6814
5450	ΧΙΟΝΙ		mm		7488
5449	ΒΡΟΧΟΠΤΩΣΗ		mm	MONAEEZ (mm)	6812
4789	ΒΡΟΧΟΠΤΩΣΗ		mm	MONAEEZ (mm)	6813

8. Support possibilities

Not only is Enhydris free software, it also has detailed documentation for administrators and developers. Therefore, your computer guy can probably install and maintain it, especially if they have a background in Python.

If you don't have such a computer guy, there are many Python specialists and companies on the market who would love to offer you commercial support. For example, indifex.com, the Greek company who created Enhydris under supervision by the NTUA, will be more than happy to take your money.

Free software also allows you to have new features developed without the need to ask us for permission; but it is still better to first consult with us.



The screenshot shows a web browser displaying the documentation for Openmeteo v0.1. The page is titled "Enhydris and pthelma documentation" and is organized into sections: "General", "Reference", and "Enhydris". The "General" section includes an "Overview" and "Enhydris installation and configuration" with sub-points like "Install Python and Django", "Install dependencies", "Install PostgreSQL", "Get openmeteo software", "Install pthelma", "Configure Enhydris", "Initialize the database", "Run Enhydris", and "Post-install configuration". The "Reference" section includes "Copyright and credits" with sub-points "Copyright and license" and "Authors and credits". The "Enhydris" section includes "The Enhydris database" with sub-points "Main principles", "Lookup tables", "Lentities", "Gentity and its direct descendants: Gpoint, Gline, Garea", "Additional information for generic gentities", "Station and its related models", and "Time series and related models". A "permissions" link is also visible under the Enhydris section. The browser's address bar shows "http://openmeteo.org/doc/index.html".

9. Data is like software: it's better when it's free

Maybe you don't need to maintain your own database, because we are creating openmeteo.org, an international, public meteorological database.

Enhydris has a security system that allows it to be used either in an organisational setting or in a public setting. In an organisational setting, there are privileged users who have write access to all the data. In a public setting, users can subscribe, create stations, and add data for them, but they are not allowed to touch stations of other users.

openmeteo.org, currently under construction, will host such a public database, where you will be able to store and manage your data, provided you make it available under a free license.

Hydrognomon on the web: <http://www.hydrognomon.org/>

Get poster: <http://www.itia.ntua.gr/en/docinfo/962/>

More information on the openmeteo.org project, as well as source code for Hydrognomon and Enhydris: <http://openmeteo.org/>