WaterScope documentation

Version: 2.3
Author : Francis Pantus © 2024-2025
Latest edits: 16/07/2025

Scientific Modelling

Department of the environment
Tourism, Science and Innovation
Queensland Government

Table of Contents

Introduction and overview

The Ecosystem Health Monitoring Program

The South-East Queensland, Australia EHMP is a unique monitoring program, running for over 24 years (and already about 5 years before that with a limited number of locations) and taking water samples monthly at about 75 locations in Moreton bay, and 191 along the major river/estuarine systems. Followed by laboratory analysis and data entry, the program has already amassed a major data set on water quality over space and time in South-East Queensland.

It also contains 138 freshwater sampling sites with its own set of indicators. Table 2 and Table 3 show the indicators as recorded on the database. Currently there is also a test page for the third part of the EHMP program: the Water Quality

This dataset ranks in the top of its kind in the world. By making the data available in a structured way it invites us to turn this unique data into invaluable information used to improve our understanding and management of these crucial ecosystems and their services to us.

The aim is to turn the water sample collection by the Ecosystem Health Monitoring Program (EHMP) into a tool for learning and decision making. To reach its full potential, this dataset is to be made readily accessible for visualisation, and analyses. It should also be easily combined with other, non-EHMP, data. Currently rainfall, river discharge at 6 stations each and SOI (Southern Oscillation Index) are also accessible through the website. The results should be presented in a concise and easy to understand way. These goals are the foundation of the *Waterscope* website.

The website is in a pilot project/proof of concept phase to show the potential for making the EHMP estuarine, marine and freshwater data sets accessible in a more structured way to all involved in the resource management and research process, including the broader public. Universal access is facilitated by using a web-based application (website) as the main mode of access.

The set of indicators is restricted to a subset of the existing indicators but available between mid-2000 and the end of 2023, see the Data Availability table on Data availability. The vision is to open all datasets in the near future, if support for further development can be found.

Overview of current functions implemented.

The Waterscope website contains a broader range of data, analysis tools and information, but this manual concentrates on the *Estuarine and Bay* data. The website can be accessed using the https://www.waterscope.info address. A fallback server can be found on http://www.ehmpscope.net . Note that the fallback website is slower to respond.

The two main functional areas in the *Estuarine and Bay* data section of the website are a map section to allow the selection of sample locations and a chart section to visualise and analyse the data.

There are a (growing) range of visualisation and analysis functions available. These functions are implemented around charts as to visualise results. Options to export results into other formats are available for some results and are expected to be extended in the future. The user interface the between *Estuarine and Bay* (Figure 1), *Freshwater* (Figure 2) and

WQI (Figure 3) differs only in the choices available the for the locations and indicators. This document focusses on the *Estuarine and Bay* user interface.

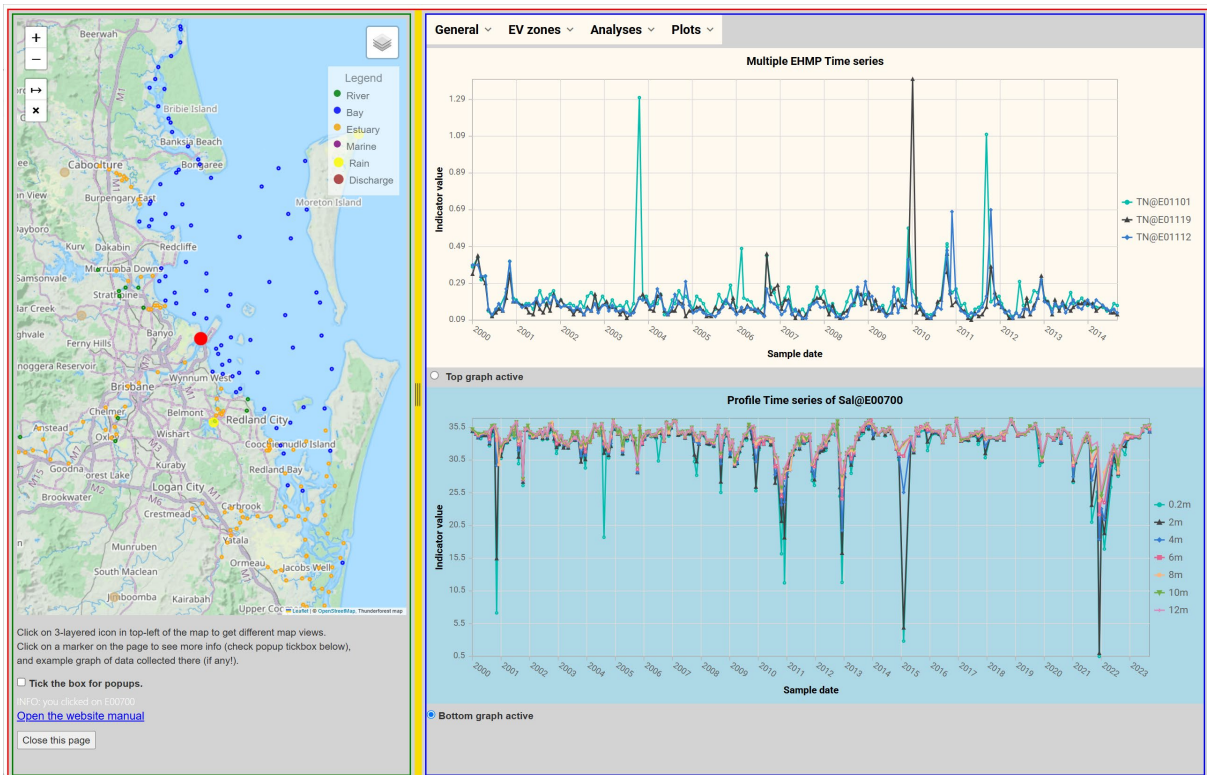


Figure 1 Overview of the user interface of the Estuarine and Bay data part of the Waterscope website.

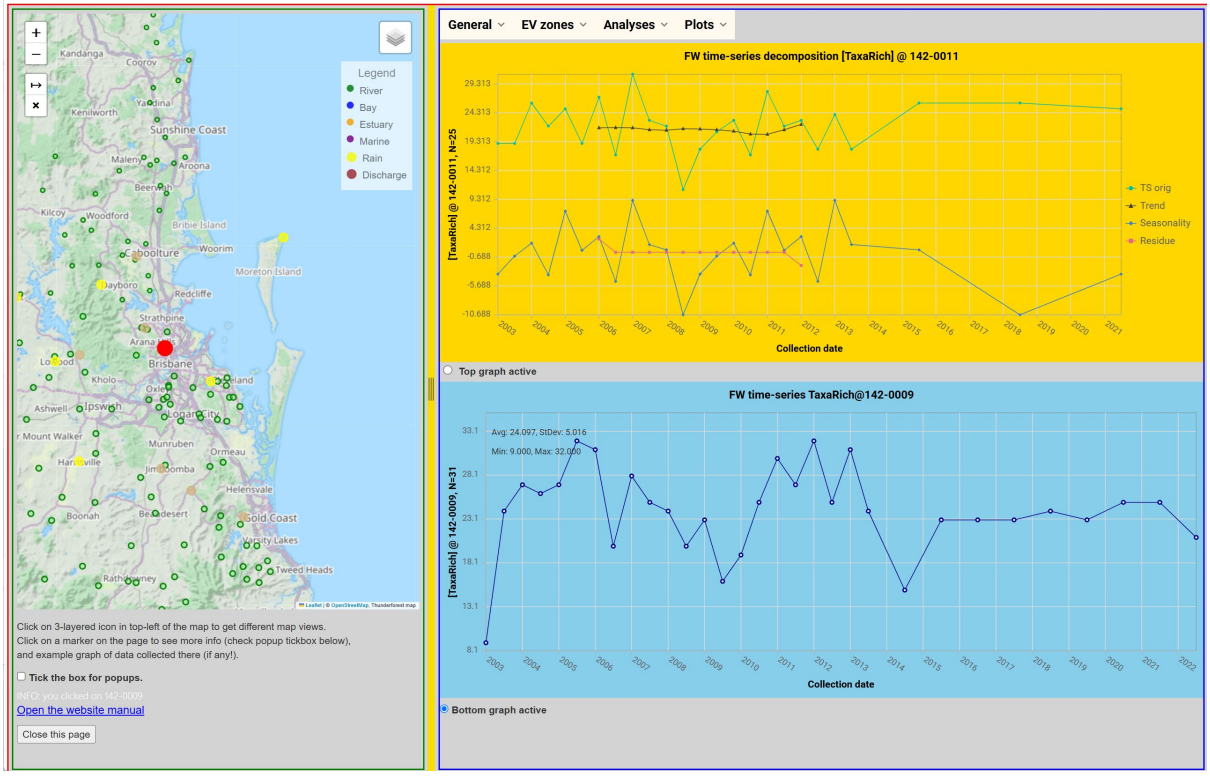


Figure 2 Overview of the user interface of the Freshwater data part of the Waterscope website.

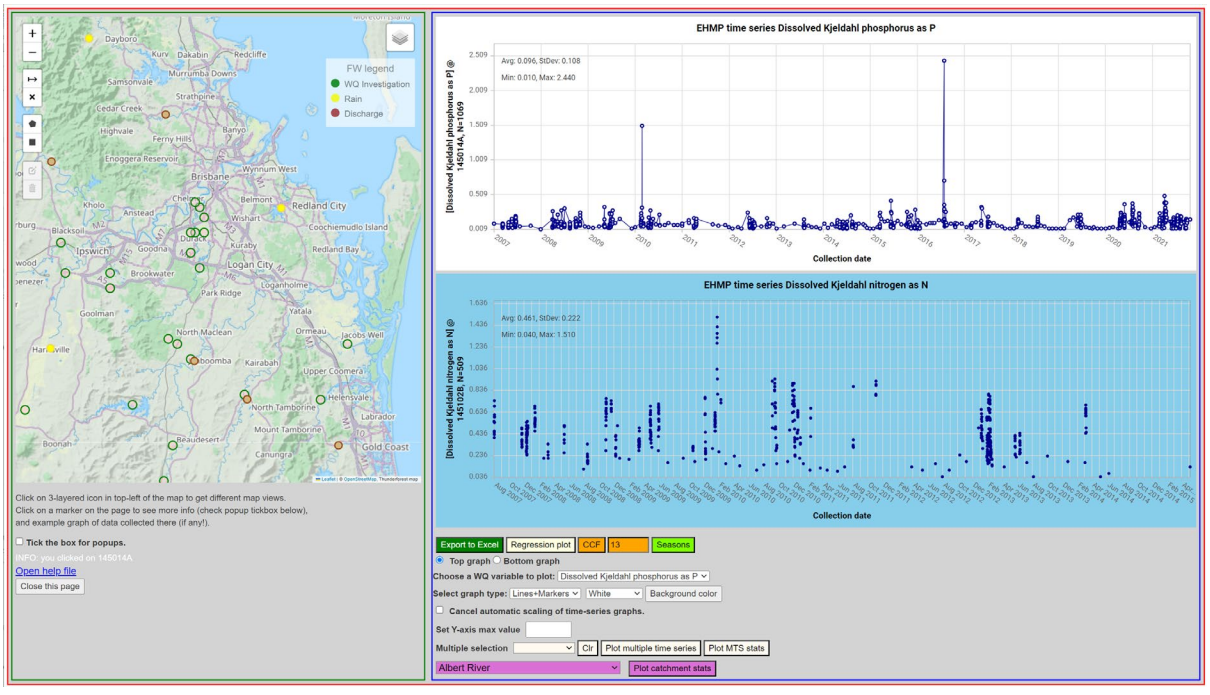


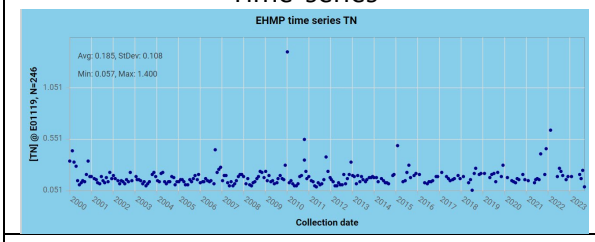
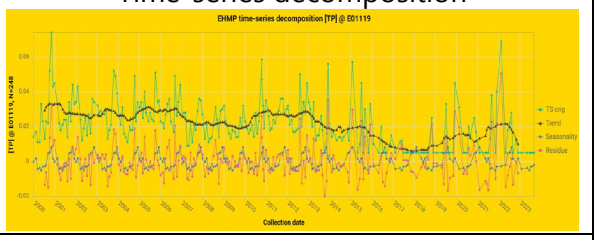
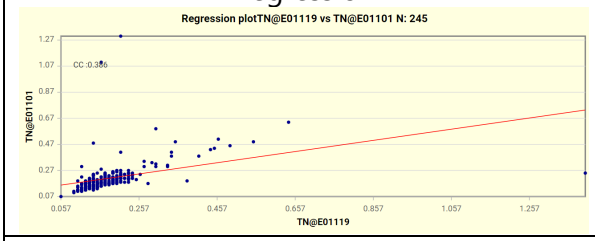
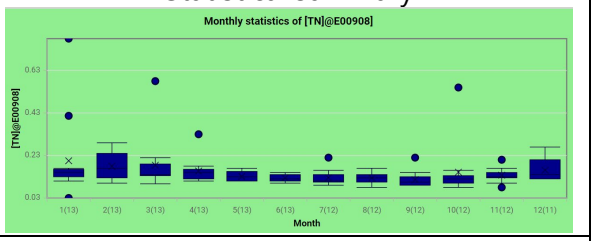
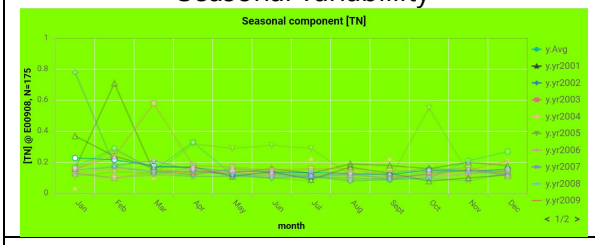
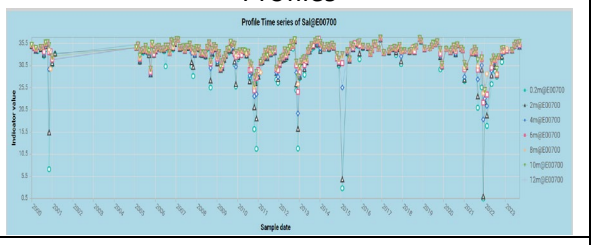
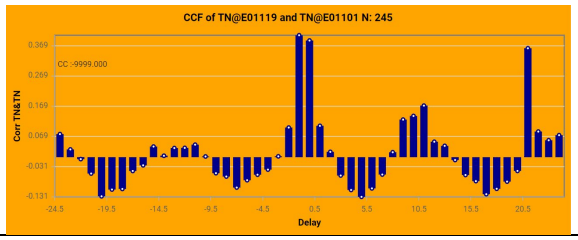
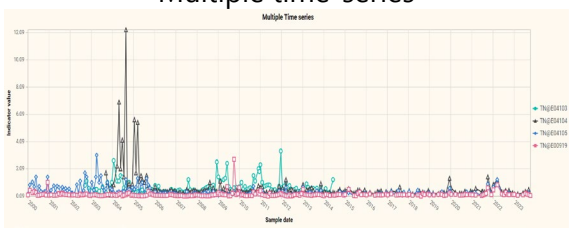
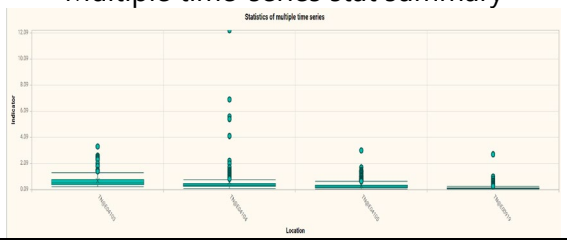
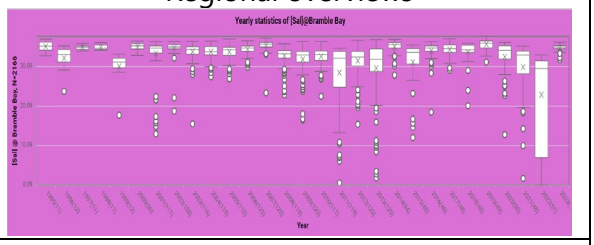
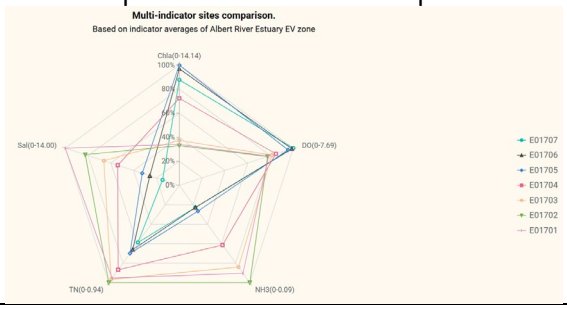
Figure 3 Overview of the user interface of the WQI data part of the Waterscope website.

Visualisation and analysis functions

This section summarises the main visualisation and analysis tool currently available, exemplified by a series of charts. Combining in different ways the various indicators from the many sample locations opens up a very rich and easy to obtain learning about the rivers, estuaries and bays in SE-Qld. See the Multi-time-series example that was created within minutes.

- Single time-series of water quality indicators from a selected sampling location
- Time-series decomposition gives an instant insight into the time-series components
- Regression of two time-series
- Multiple time-series from multiple sampling locations
- Seasonality contributions within one time-series
- Box-Whisker chart from a single sampling location and WQ indicator.
- Depth profile time-series for selected (physical) indicators
- Reporting regions temporal statistics (Box-Whisker charts)
- Auto- and cross-correlation function (ACF/CCF) between two time-series

Table 1 The charts in this table show the current stage of play of the Waterscope Estuarine and Bay section with their standard background colour. Background colours can be changed via the UI.

Time-series 	Time-series decomposition 
Regression 	Statistical summary 
Seasonal variablility 	Profiles 
Correlation function 	Multiple time-series 
Multiple time-series stat summary 	Regional overviews 
Multiple-indicator sites comparison 	

Data availability

The *Estuarine and Bay* dataset currently consists of 19 indicators of which eight are currently available via the *Waterscope* website. This data set consists of almost 2 million records of measurements since 1995.

The *Freshwater* dataset consists of 22 indicators of which six are currently available. The *Freshwater* dataset currently contains over 52,000 records of indicator values. Both data sets also include rain, river discharge and SOI time-series.

Table 2 The Waterscope Estuarine and Bay data set of potentially available indicators. The red text indicates the ones already available.

Indicator	Comments	Units
Chl_a	Chlorophyll-a	µg/L
Conductivity	Electrical conductivity	mS/cm
DO	Dissolved oxygen	mg/L
DOsat	% DO saturation	%
FRP	Filterable Reactive Phosphorus	mg/L
NH3	Ammonia	mg/L
Norg	Organic nitrogen	mg/L
NOx	Nitrogen oxides	mg/L
pH	Acidity	unitless
PheoPigm	Phaeopigment	microgr/L
Ptot	Total phosphorous	mg/L
Sal	Salinity	g/L
Secchi	Secchi depth	m
Temp*	Temperature	°C
TN	Total nitrogen	mg/L
Turb	Turbidity	NTU
Rain	Rainfall at station	mm/month
River Discharge*	River discharge at station	ML/month
SOI	Southern Oscillation Index	unitless

Table 3 The Waterscope Freshwater data set of potentially available indicators. The red text indicates the ones already available.

Indicator	Comments	Units
Chl_a	Chlorophyll-a	mg Chl_a/m2/day
Cond	Electrical conductivity	mS/cm
DelC	Ratio of the stable carbon isotopes 13C and 12C	delta units
DelN	Ratio of the stable carbon isotopes 14C and 15C	delta units
DOMin	Dissolved oxygen minimum	mg/L
DORange	Dissolved oxygen max-min	mg/L
GPP	Gross primary production	gC/m2/day
NPtoC	Non Purgeable Total Organic Carbon	mg/L?
OE50	The ratio species found to the expected number of species at a given probability 50%	ratio
PET	Aquatic insects species richness of three orders	number
pH	Acidity	N/A
PONSE	Percent of native species expected	%
PropAlien	The proportion of non-endemic fish individuals in a river reach	%
R24	Respirtion rate	gC/m2/day
SIGNAL	Stream invertebrate grade number average level	number
TaxaRich	Family richness	number
TempMax	Max temperature	°C
TempRange	Max-min temperature	N/A
Rain	Rainfall at station	mm/month
River Discharge*	River discharge at station	ML/month
SOI	Southern Oscillation Index	unitless

WaterScope website manual

This pdf demonstrates the main features of the website, focussed on the *Estuarine and Bay Data* section. The Freshwater and Water Quality Investigations functionality mirror many of these functions and their implementations.

To ensure the latest version of Waterscope, try Ctrl-F5 within the login screen.
The website login page url: http://www.waterscope.info/.

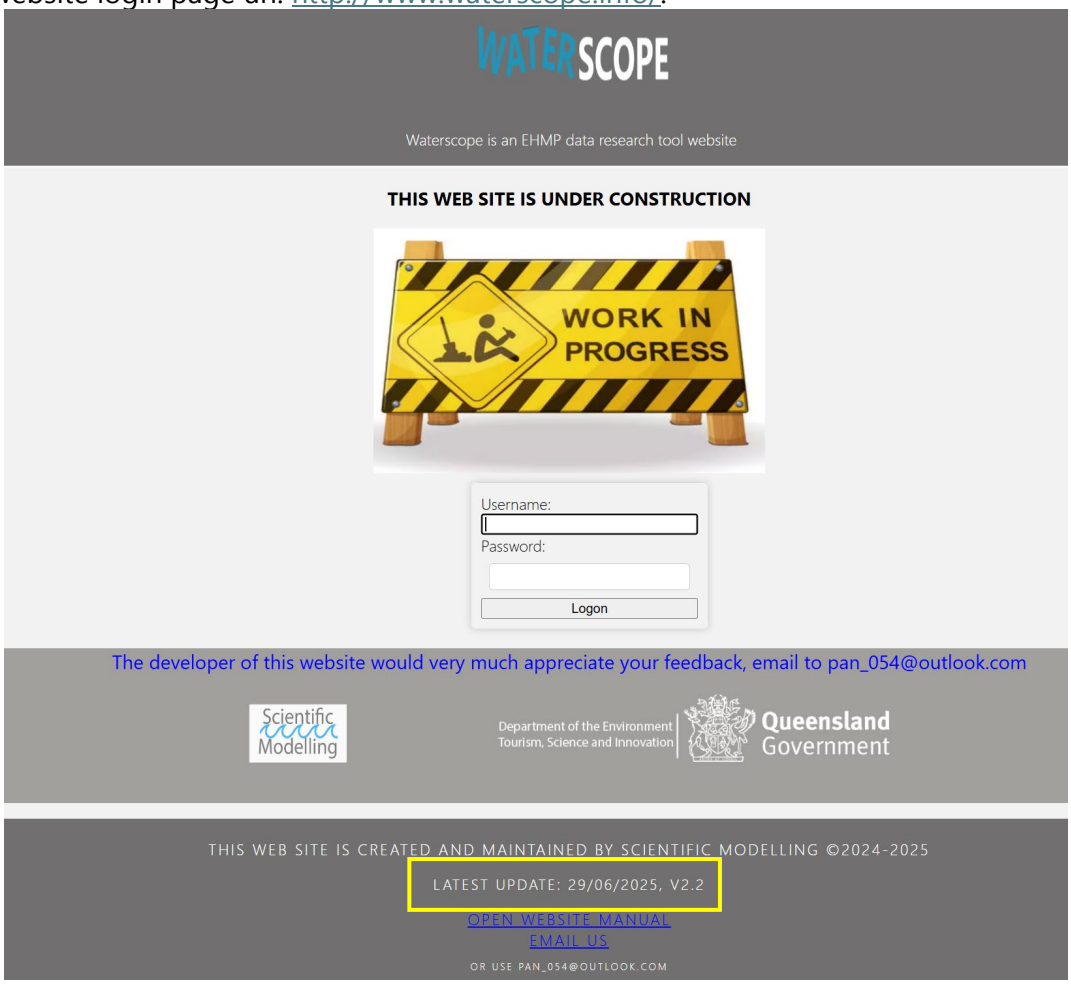


Figure 4 The login page of the Waterscope website. Please note the latest update date and version.

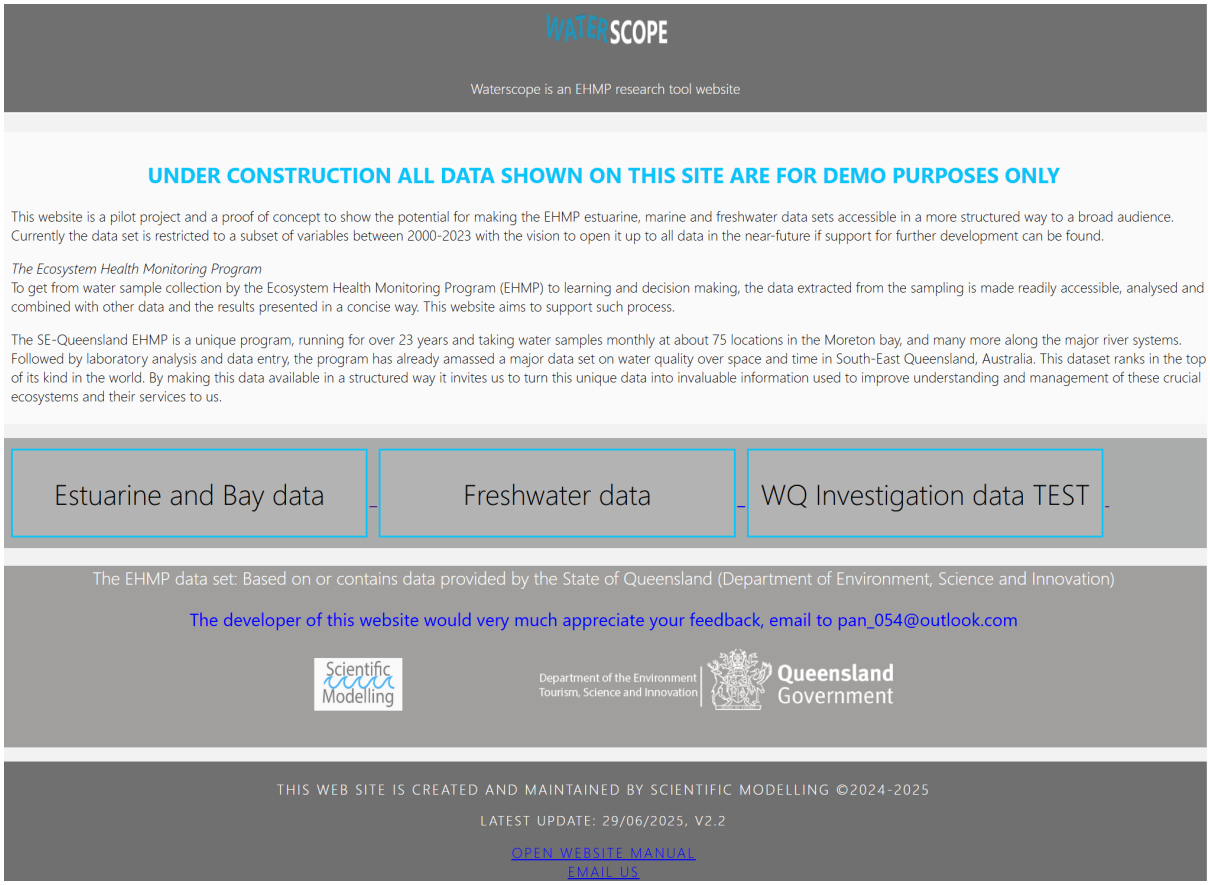


Figure 5 The home page of the website.

The login page asks for a *username* and a *password*; both need to be presented to get access. Currently, the username is just a name or ident that the user chooses. It needs to be at least five characters long, excluding leading or trailing spaces. Once a username is filled in, it will be automatically recalled after the first login.

After login, the home page opens, and the main menu will be represented by the blue-edged buttons on the middle of the page. The *Estuarine and Bay data* button opens the page that gives you access to a map with estuarine and bay EHMP registered sample locations and a variety of options to view and analyse the water quality data as collected by the EHMP program. See for EHMP program details: https://www.hlw.org.au/portfolio/ecosystem-health-monitoring-program#gsc.tab=0.

The yellow slider between the map and graph section allows changing how much width is used for either section.

The next section explains how to use the *Estuarine and Bay data* access and analysis web page.

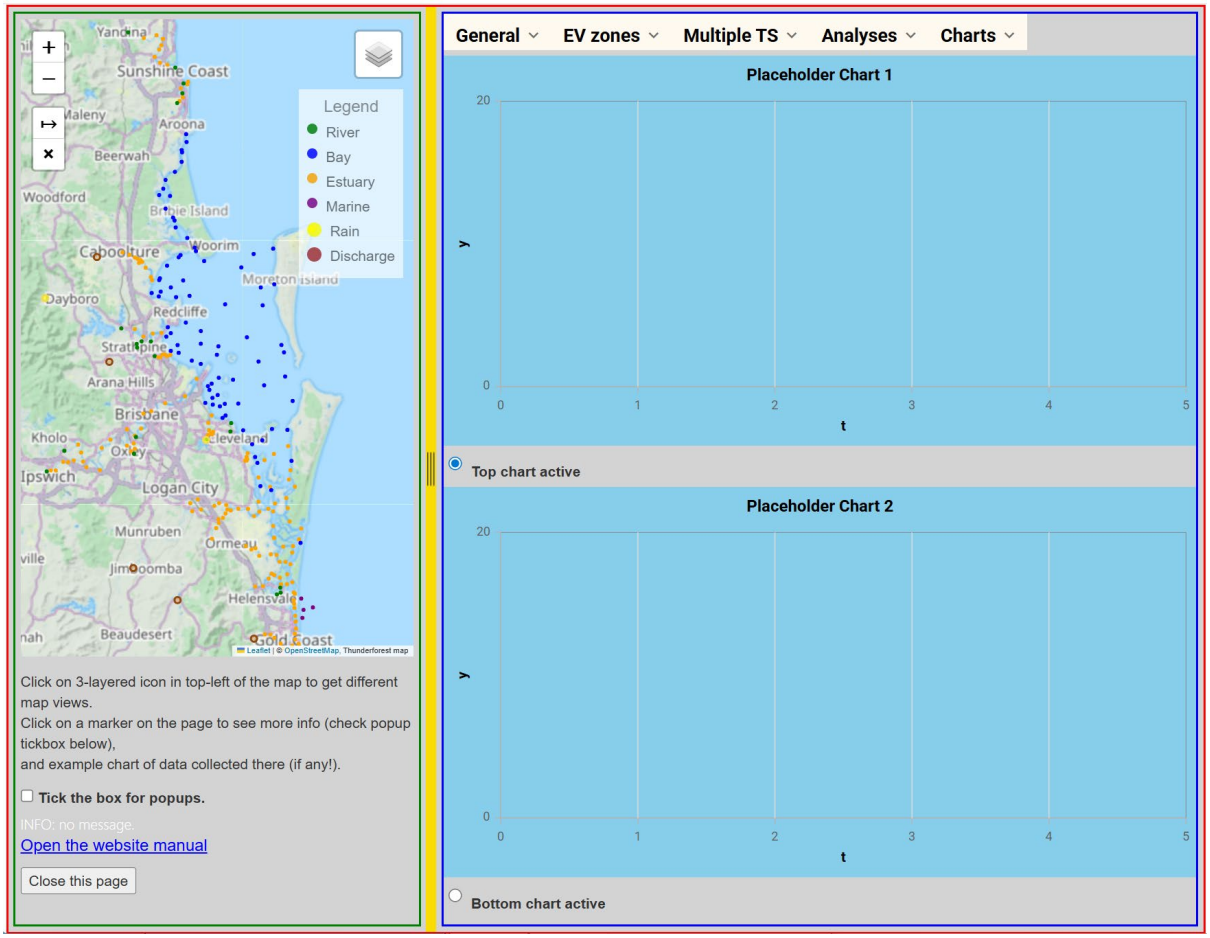


Figure 6 The Estuarine and Bay data initial screen is the main access and analysis area of the website. Most user interface elements (e.g. buttons, dropdown lists) show some explanatory text (tooltip) when hovering over them with your mouse pointer.

Estuarine and Bay Data access section

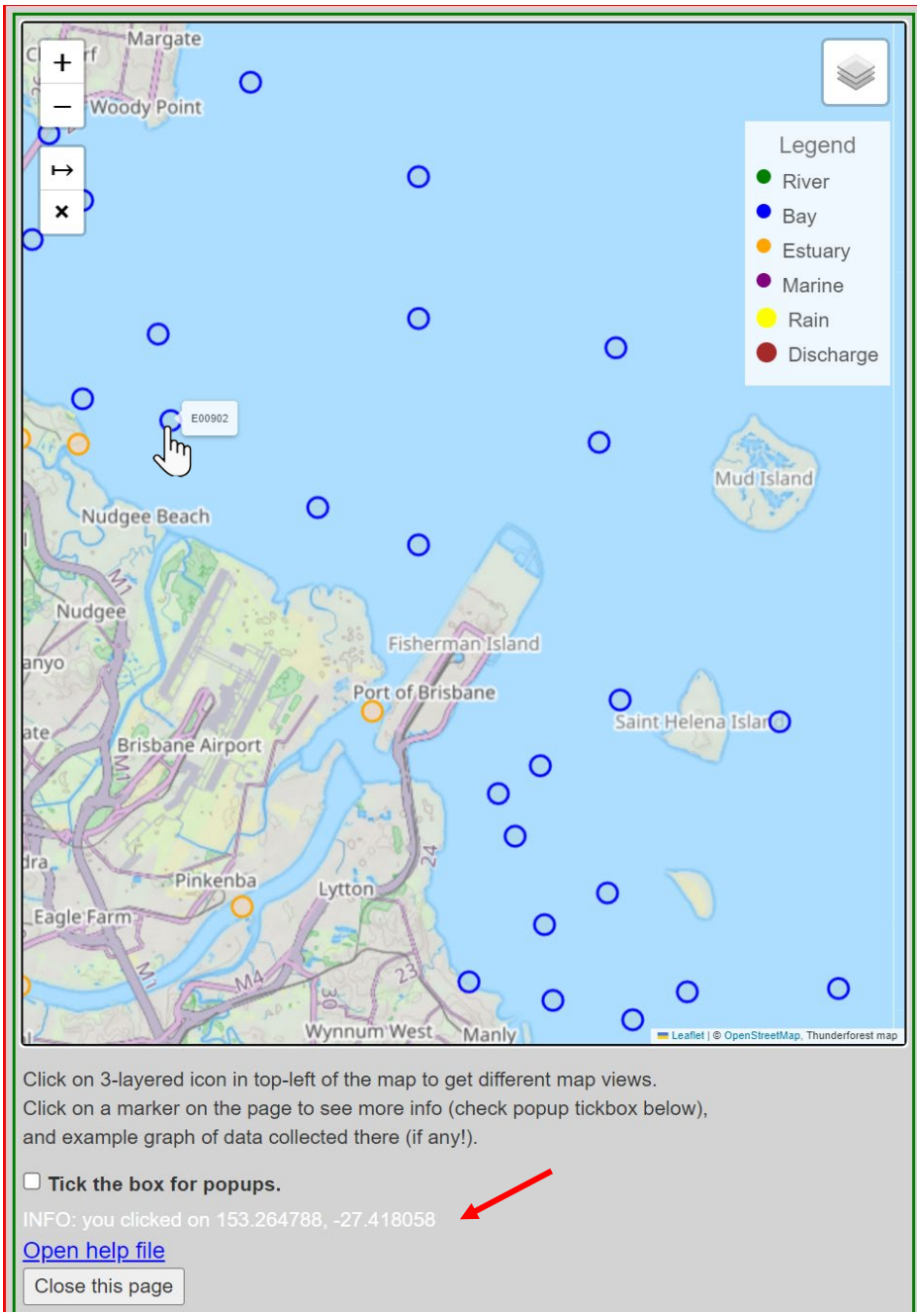
The map part of the user interface (UI)

The two main parts of the data access page are a *map* and an *analysis/ charting* area (see Figure 7 for an overview of the UI).

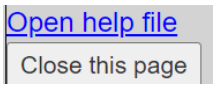
The map section is intuitive as its main function is to allow users 'on-the-fly' access to the Marine and Freshwater part of the EHMP water quality data set.

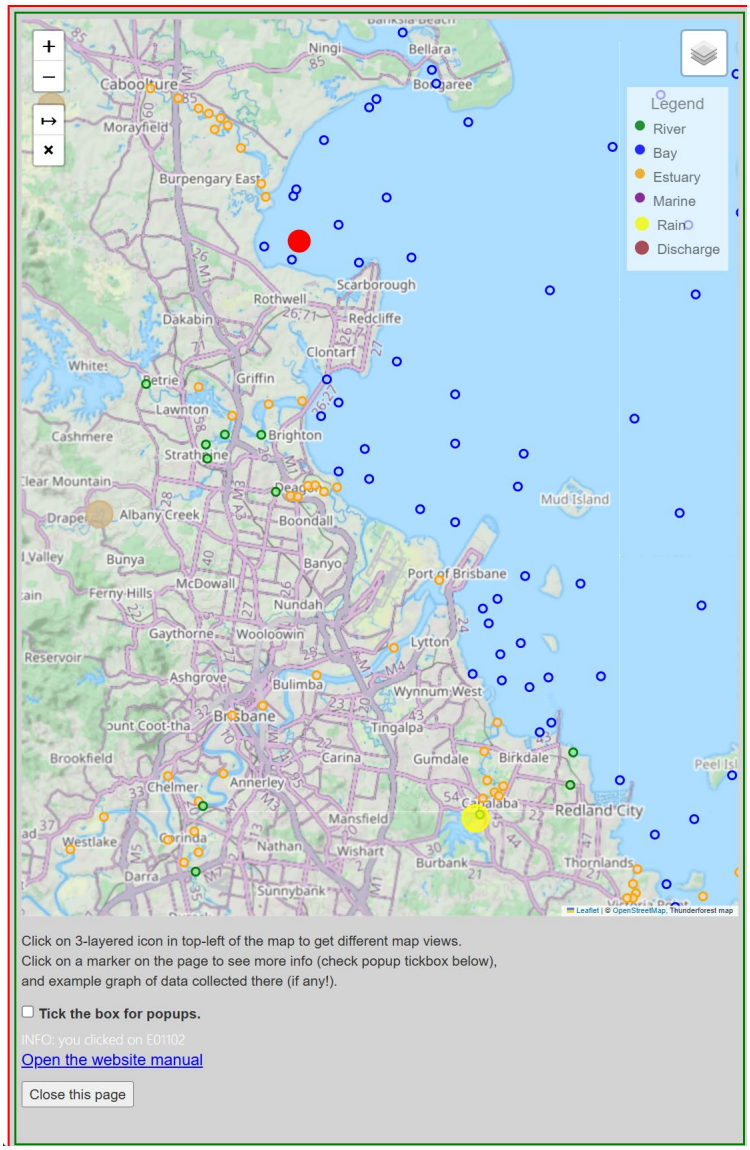
- Zooming with the mouse wheel (or the +/- box at the top left of the map), panning is done by dragging with the left mouse pointer pressed. TIP: zoom into an area of interest before trying to select a location when working on a tablet of phone without a mouse or stylus pen.
- Selecting an EHMP sample location: when hovering with a mouse pointer over one of the locations (zoom in for easier selections), two things happen:
    - 1: the mouse pointer changes to a hand, and

- 2: a label with the location ID appears.



- Clicking on a location while the pointer looks like a hand should result in a graph on the graph section and some info in the INFO box. TIP: not all locations have a full set of water quality indicators. If the requested indicator is missing, it will say so in the info box. It also marks the position on the map.
- Clicking anywhere else on the map will show the geographic position in latitudes and longitudes. INFO: you clicked on 153.226089, -27.252595
- ☐ **Tick the box for popups.** allows popup with more info to appear when a location is selected. As the popups are bulky, they are switched off by default.

- **Open help file** opens this pdf. Some browser pdf reader plugins (e.g. Chrome) may turn the text into gibberish and downloading the file would be the way around it.
- **Close this page** will open the previous web page.
- The  icon on the map shows different maps, e.g.  Google earth maps, hybrid maps.
- The  allows to measure poly-line distances on the map. Clicking the arrow box activates the distance measuring feature, indicated by its green colour  . Double-clicking the last point of the polyline stops the further addition of points. Selecting the X-icon clears the polyline. Selecting the arrow again and deactivates the distance-measuring activity and the box turns white again.
- Selecting (clicking on) a location, also changes the size and colour of the marker to red.



Instructional videos

There are a couple short (1-3 minutes) instructional videos available showing the website's use. More to come if there is a need.

Starting from scratch

Select chart types and colours

Selected locations spatial and temporal stats

Selected Multi Time Series

Radarplots

Menu

All settings and functions are accessible using the menu above the charts in the Estuarine/Bay and Freshwater windows. Figure 7 shows an overview of the available choices.

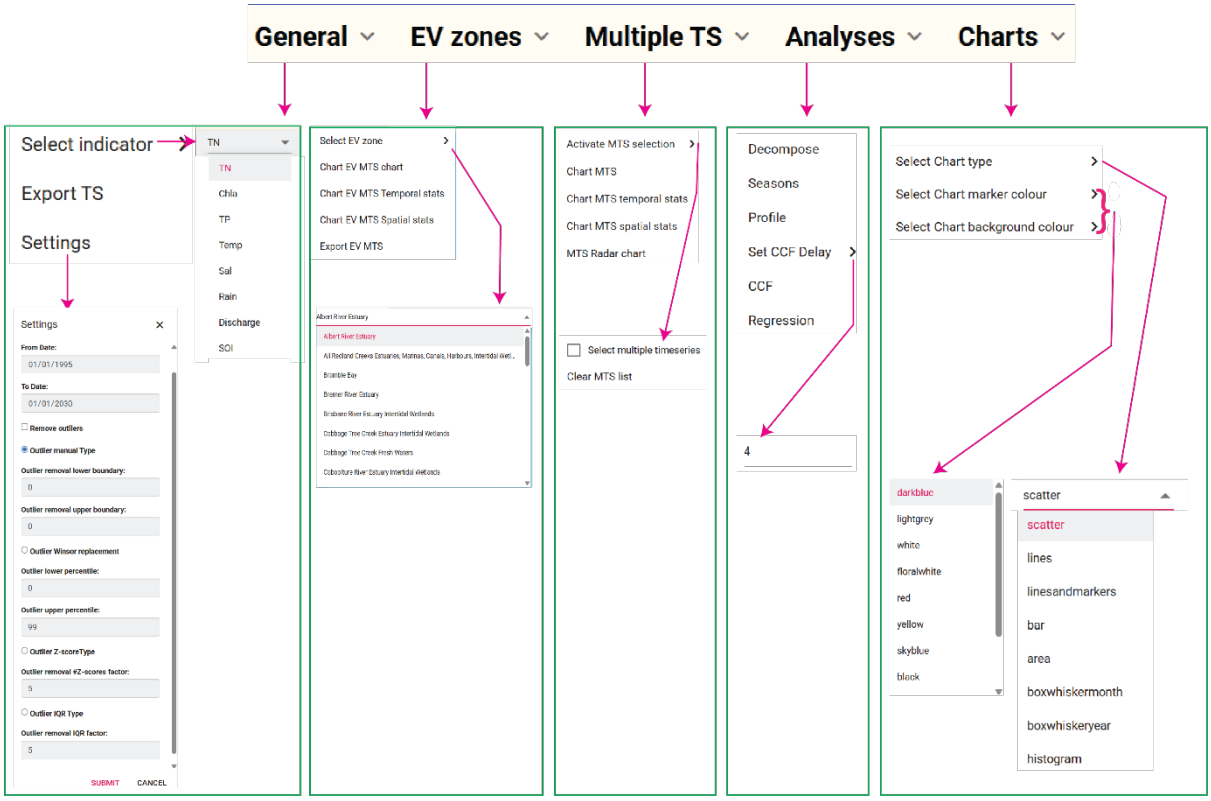


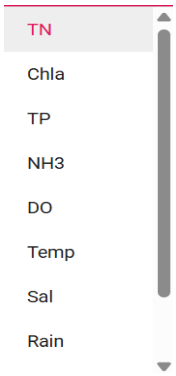
Figure 7 Overview of WaterScope menu structure. Abbreviations: TS: Time-series, MTS: Multiple time-series, EV Environmental Value, CCF: Cross Correlation Function.

Using the Estuarine and Bay Data

Single Time-series charts

This section allows access to water quality date collected for almost 23 years in bays and rivers in SE-Queensland, Australia. As the main measurements are monthly, all the data shown here has a resolution of one month.

How to select the spatial (location) aspect of the data was already explained in the previous section. This section gives an overview of what can be done with the selected data.



There are a (currently limited) range of water quality indicators available and can be selected from a dropdown list labelled ***Choose an indicator** to chart*. The default value is TN.

External drivers such as rain, river discharge can are also available as monthly totals of daily data. The SOI (Southern Oscillation Index) has already been reported as a monthly value, see http://www.bom.gov.au/climate/enso/soi/ for the whole of Australia.

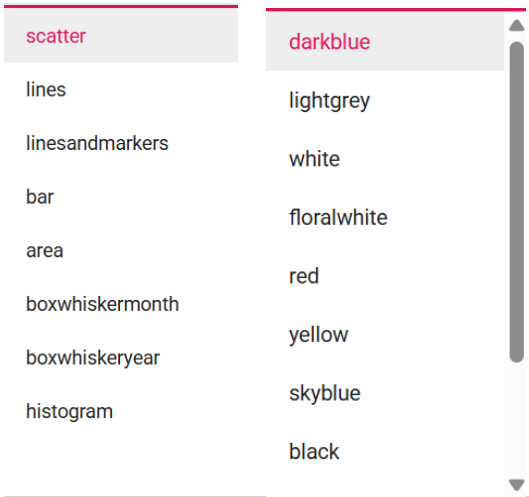
There are eight options for charts showing the same single Time-series

Table 4 There are eight options to visualise single time-series.

To chart time-series data, the following steps are recommended:

1 Activate the top or bottom graph using the radio buttons underneath the graphs
2 Select the water quality indicator to chart from the ***General/Select Indicator*** dropdown list
3 Select the type of graph and the colour used for the markers and lines from the ***Charts*** menu (***Select Chart type, Select Chart marker colour, Select Chart background colour,***
4 Click on the sample location on the map resulting in the time-series being charted.
5 The default way to visualise the time-series of data measured at a location is to chart the selected water quality indicator against the collection date.

After a graph has been produced, its appearance can be altered by using the graph type drop-list again without having to re-select the time-series on the map.



Note that the Box-Whisker charts and histogram charts do not result in a simple time-series chart.

Depending on the choice of graph type and colour from the dropdown lists, the graphs can be customised to an extent. Once a selection of marker and background colour has been made, the subsequent graphs will be shown with those settings.

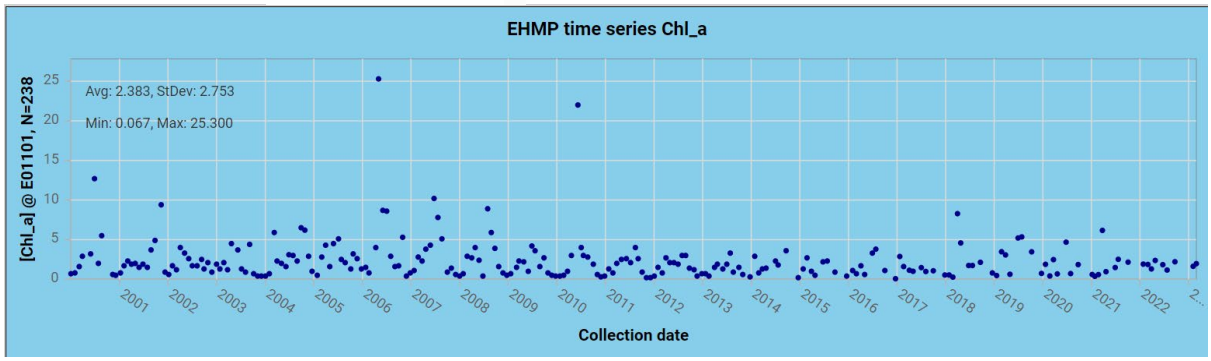
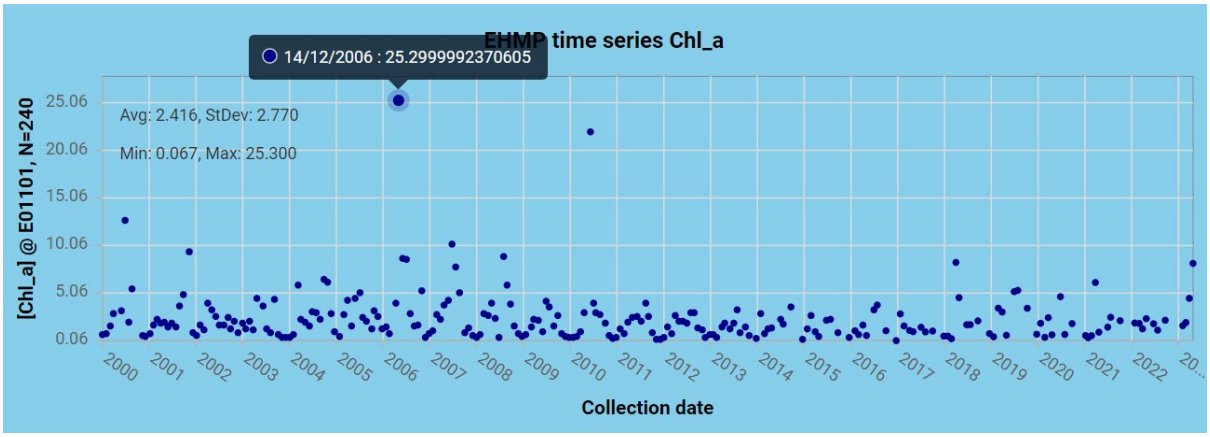


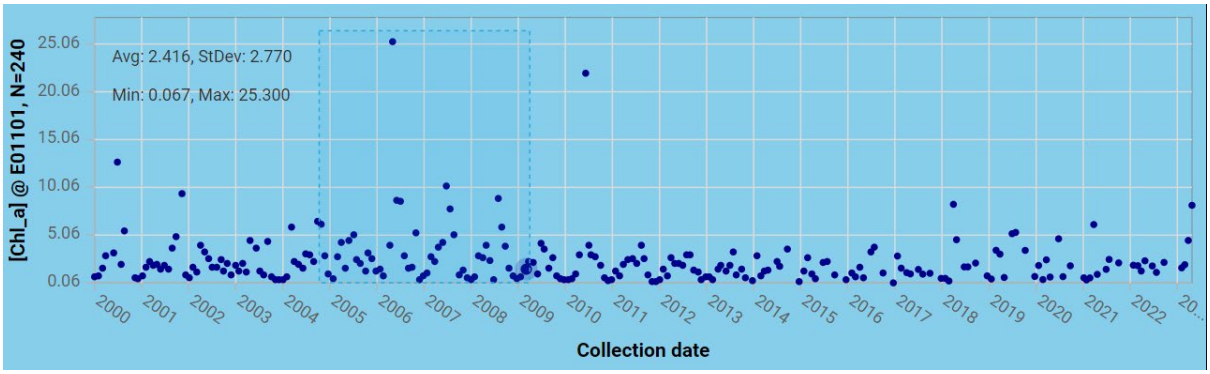
Figure 15 shows some examples of the various ways time-series charts can be formatted. Hovering over a value on the graph **shows details** of a single sample. The graphs also allow **zooming** (drag with mouse cursor, left button pressed and released) and **panning** by dragging the mouse pointer left button pressed. Time-series graphs show some **basic stats** in the top-right corner.

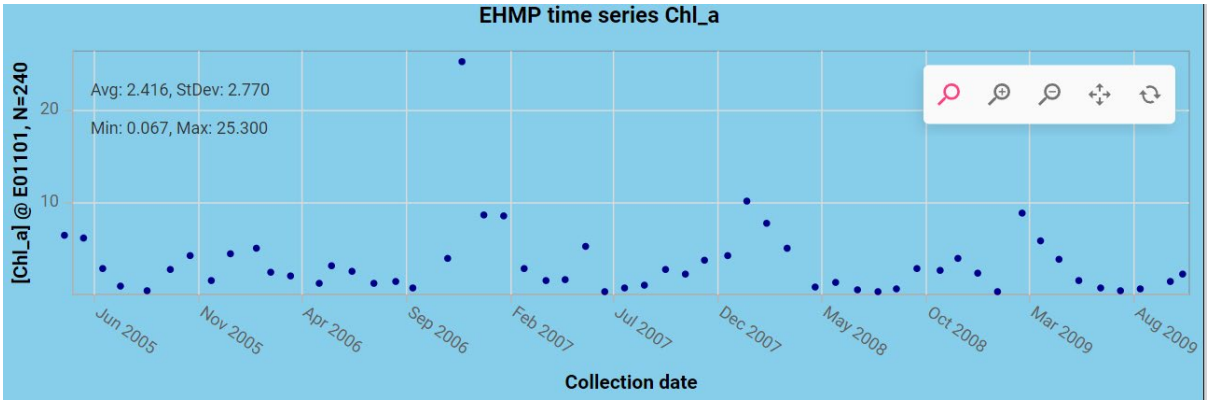
Interacting with graphs

Show value of a measurement: Hover cursor over the measurement and the date and measurement value is shown on the graph.



Zooming in/out and panning left-to-right (v.v.): Dragging the mouse pointer over the area of interest on the graph while pressing the left mouse button creates a rectangle indicating the area of interest (first graph below). Releasing the mouse button shows the actual zoomed-in area (second graph below). A little menu appears on the graph with tooltips explaining the various buttons.





When a multi-line is used, such as the season chart, a legend will appear on the right-hand side of the chart allowing more graphing options.

Dates filter

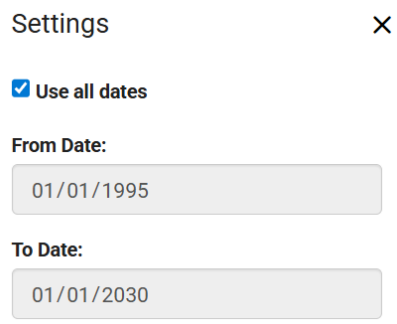
Menu: General>Settings> Use all dates

Menu: General>Settings> From Date

Menu: General>Settings> To Date:

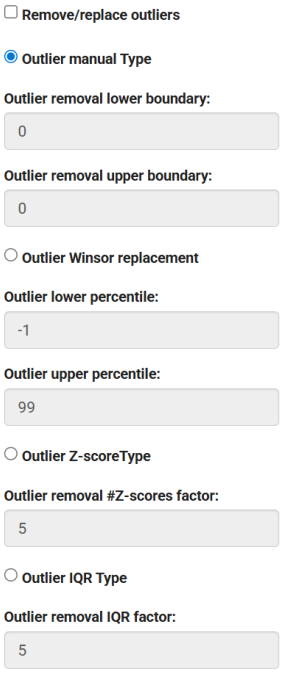
These menu options allow time-series to be filtered using a dates interval. Selecting the *From date* field you want to change and start typing the start day, month or year. Use the tab key or your mouse pointer to jump to the *To date* field.

The *Use all dates* checkbox will override the *from/to date* fields. If ticked, it disables the from and to date text boxes.



Removing *Outliers*

Menu: General>Settings> Remove/replace outliers



There are four outlier methods implemented: Manual, Winsor, Z-scores, and Inter-Quartile Range IQR.

To apply any of the methods, the *Remove Outliers* checkbox on the settings menu needs to be checked.

Only if the ***Remove outliers*** checkbox is checked, will the input text boxes be enabled, otherwise they will be greyed out.

Outlier methods only apply to single time-series (including Box-Whisker and Histogram representations of the data). The charts will contain an annotation if an outlier procedure has been applied. The Winsor method is the only method that does not remove sample values, it just replaces them.

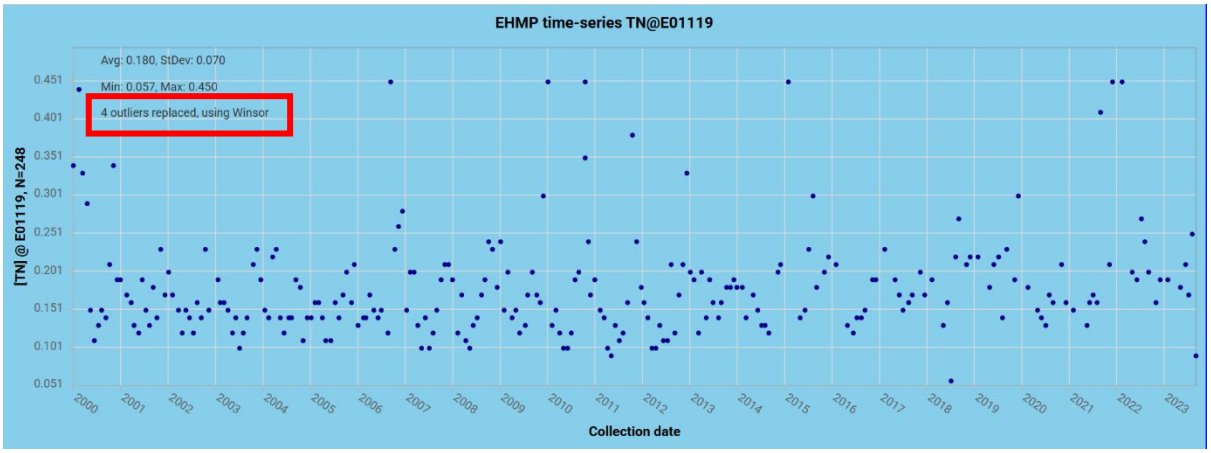


Figure 8 The single timeseries chart will show in an annotation if an outlier procedure has been applies and how many samples have been affected.

Manual boundary removal method

Menu: General>Settings> Remove outliers

Menu: General>Settings> **Outlier manual Type:**

Menu: General>Settings> **Outlier removal manual lower boundary**

Menu: General>Settings> **Outlier removal manual upper boundary**

This is the easiest to understand method. The manual max value is the value above which the time-series values are deemed to be outliers. For instance, Figure 9 top chart shows an unusually high value of around 1.45. Using the manual removal method with a lower boundary set to 0 and a upper boundary set to 1 would remove that value from the time-series, as shown in the bottom graph.

Note that the 248 values in the top graph is 1 less than in the bottom graph.

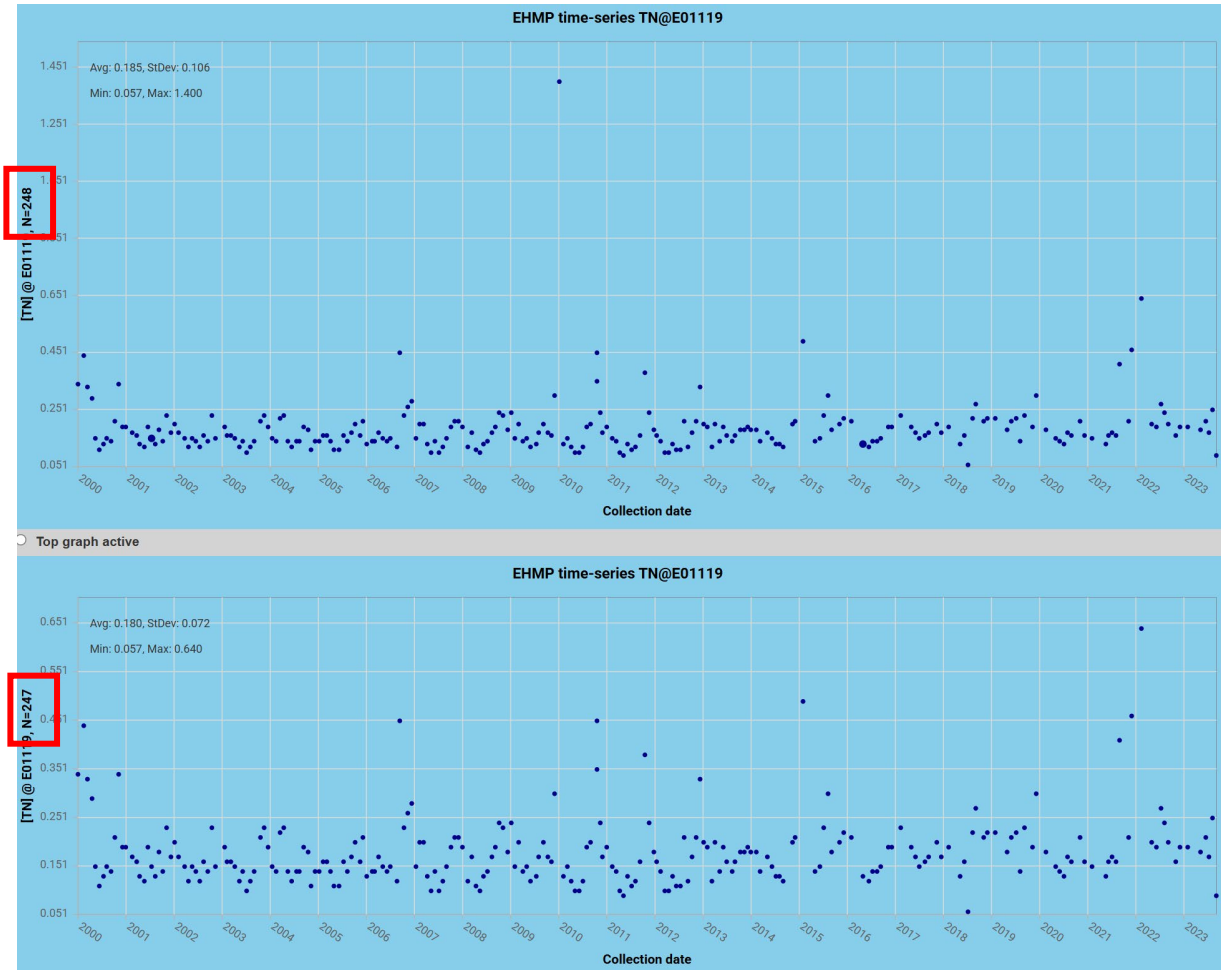


Figure 9 The top graph shows a time-series with an unusually high value of around 1.45. The bottom graph is the result of applying the manual outlier method with max value of 1. The red rectangles show the number of values in the time-series.

Winsor outlier replacement

Menu: General>Settings> Remove outliers

Menu: General>Settings> **Outlier Winsor Replacement:**

Menu: General>Settings> **Outlier lower percentile**

Menu: General>Settings> **Outlier upper percentile**

This outlier method does not delete values, but replaces outliers with percentile values.

If for instance the ***Outlier Upper percentile*** is set to 95, and the 95th percentile of the active (single) timeseries has the value of ***x***, all values above the value ***x*** in the time series will be replaced by ***x***.

Percentile 0 will delete all values smaller than the smallest value, resulting in no replacement. The same goes for the 100 percentile, taking on the highest value in the timeseries.

If the upper or lower percentage fields contain a negative number, that the percentile value will not be applied. Often the lower percentile value is set to **-1** as low value outliers are less common. If real number percentage values will be used, they will be rounded down to integer values when submitting the new settings.

The Winsor is the only outlier method available in this application where the timeseries end up with the same number of values as the original timeseries.

Z-score removal

Menu: General>Settings> Remove outliers

Menu: General>Settings> **Outlier Z-score Type:**

Menu: General>Settings> **Outlier removal #Z-scores factor:**

The outlier algorithm implemented is based on Z-score, basically a number of standard deviations of data still included after the application of the filter.

A common threshold for identifying outliers is ±3 standard deviation, but the current default is set to ±5 standard deviation to make removal of sample values even less likely. The settings allow this value to be changed (for one session).

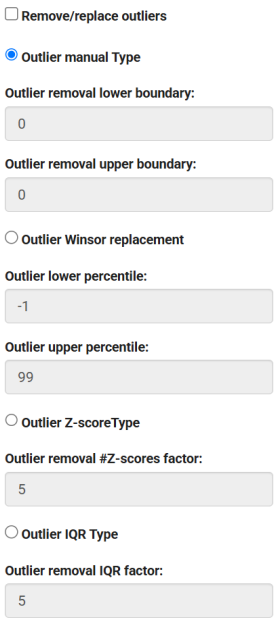
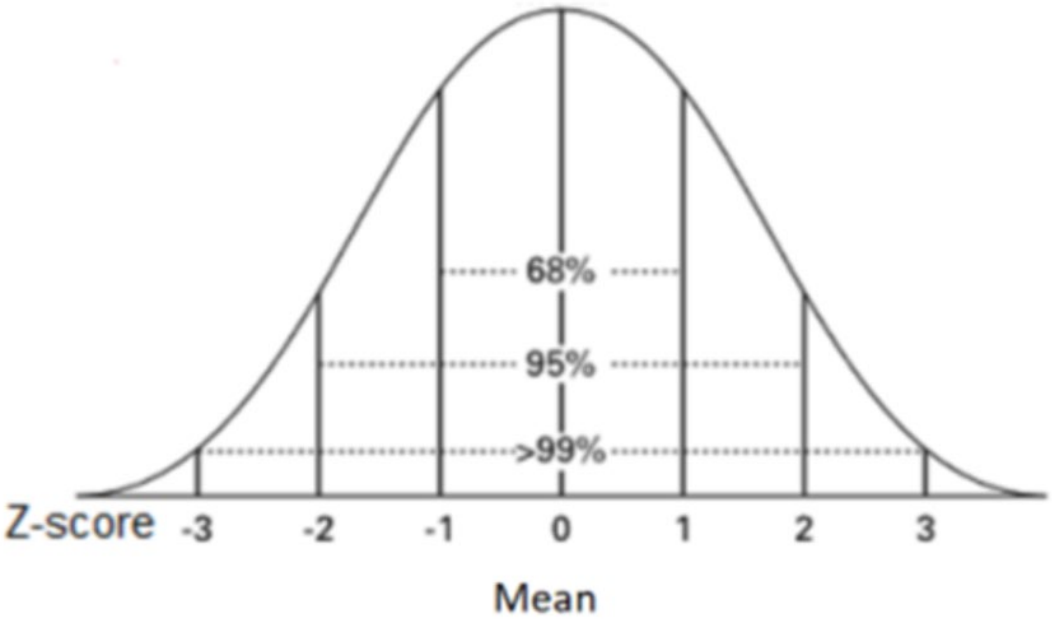


Figure 10 The outlier part of the Settings menu allows to choose between several methods.

Note: the removal of outliers is a very controversial issue. Best practice is to only remove outliers if you have a good reason to do so, often based on some context knowledge like faulty equipment of 'impossible' values e.g. a temperature of 100C.

Also note that the Z-score approach is based on the sample values to be 'normally' distributed (which they rarely, if ever, are).

To activate it, tick the *Remove outliers* checkbox in the Settings window. Please experiment with the number of StdDevs using the *Outlier removal #Z* textbox. The higher the number, the further a value must be from the average of the time-series before it would be removed.


68%
95%
>99%
Z-score
-3
-2
-1
0
1
2
3
Mean

Inter-quartile range (IQR)-based outlier removal

Menu: General>Settings> Remove outliers

Menu: General>Settings> Outlier IQR Type:

Menu: General>Settings> Outlier removal IQR factor:

Quartiles divide the (sorted) data points into four parts of (about) equal sizes, or *quarters*. The Interquartile Range method uses the first quartile (Q_1) and third quartile (Q_3) of the time-series values to set the upper and lower boundaries that determine which values are deemed to be 'outliers'.

All values smaller than Q_1 or greater than Q_3 will be deleted from the time-series.

The IRQ factor on the setting menu allows users to influence the upper and lower boundary values, i.e.

lower bound = Q_1- factor * iqr

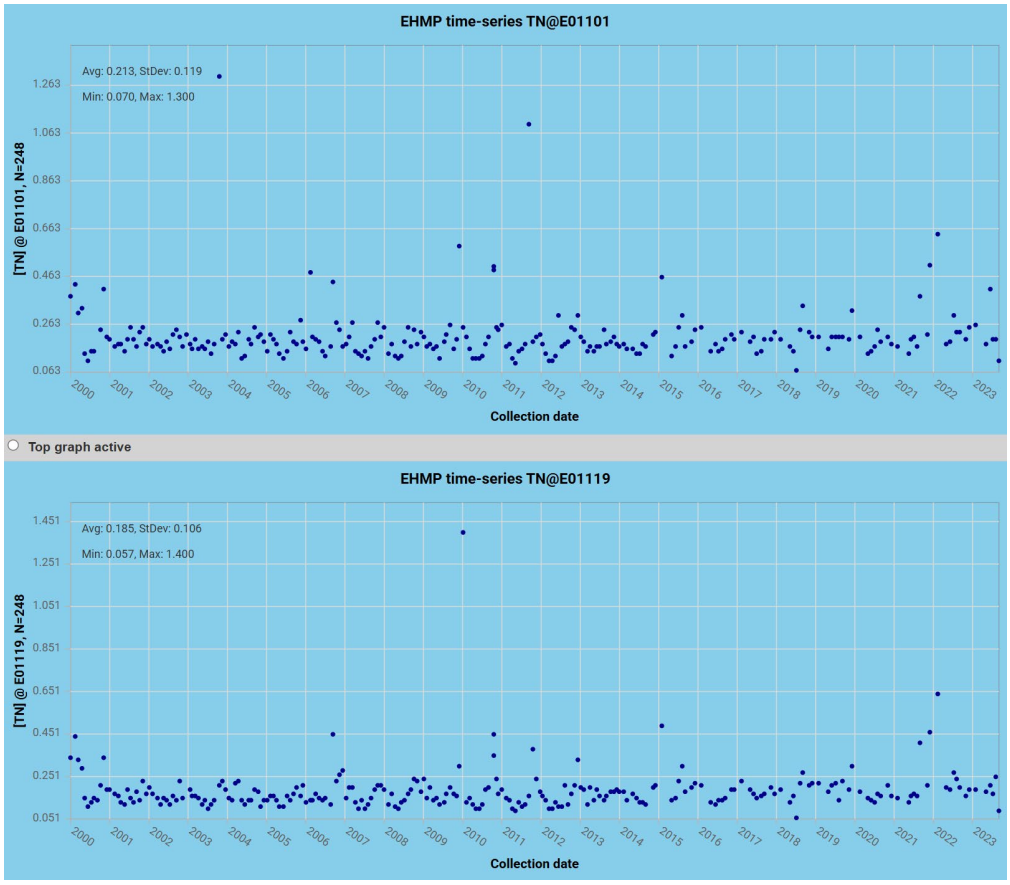
upper bound = Q_3 - factor *IQR

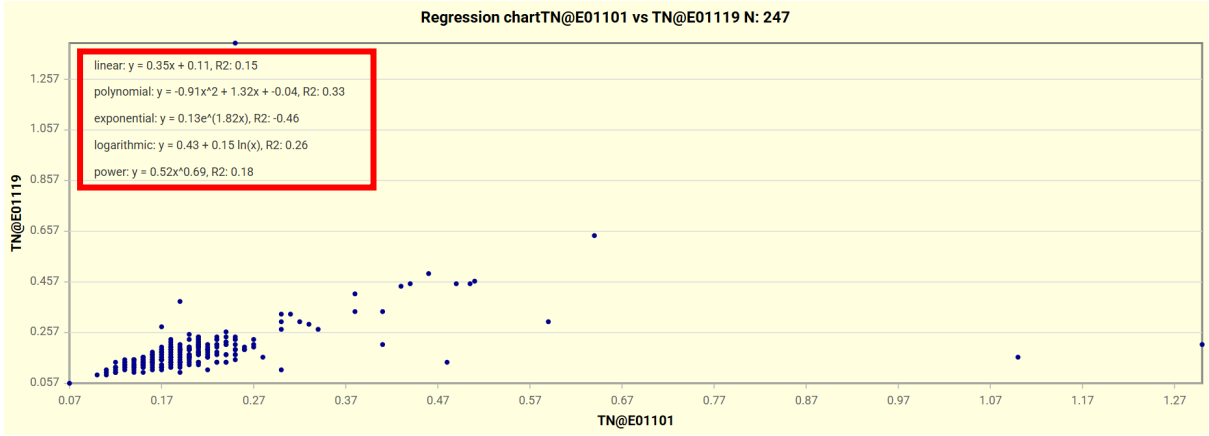
where IQR is the inter-quartile range Q3-Q1.

Example of outlier removal using Z-score

Before outlier removal

Time-series from location E01101 and E01119 as shown in the two charts below, no outlier removal applied. Applying a linear regression to the two shown in the third chart results in a correlation coefficient of around 0.38.





After removing outliers

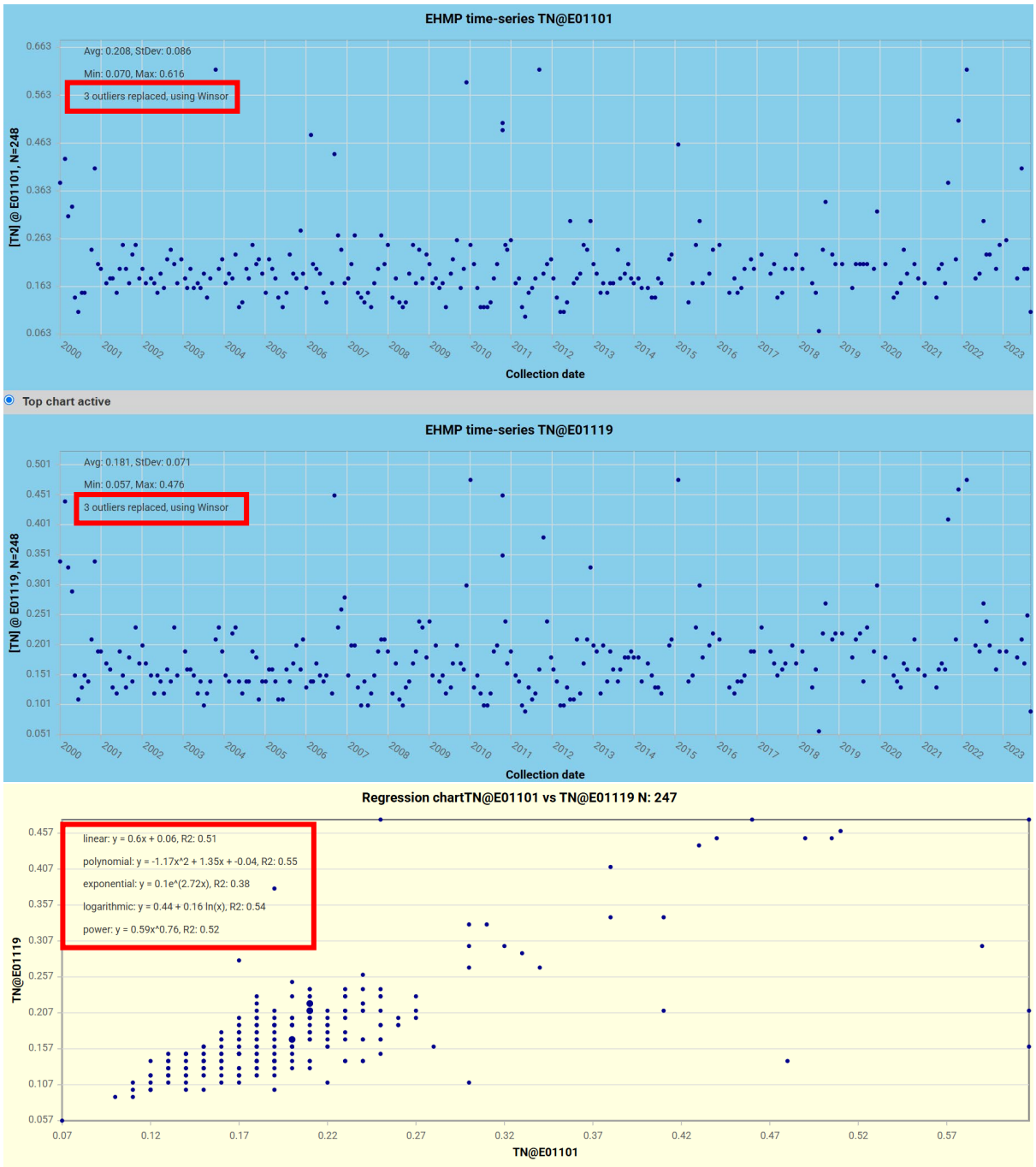
Using Winsor outlier replacement with lower bound of -1 (inactive) and upper bound of 99 percentile, replaces 3 outlier in each timeseries.:

The two charts below show the results. Note the different Y-axis scaling when comparing with the two charts of the unaltered time-series above.

If we now apply the regression function, the R^2 for the linear regression has changed from 0.15 to 0.51. The R^2 value is a measure of how well the model fits the data, with a higher R^2 value indicating a better fit.

Two conclusions:

1. Even a couple of 'outliers' can be very influential with respect to finding relationships between indicators.
2. Be careful with selecting regression models without some measure of goodness of fit (e.g. R^2) and preferably some measure considering the number of parameters modelled such as AIC or BIC when choosing which regression model to accept (see https://medium.com/@jshaik2452/choosing-the-best-model-a-friendly-guide-to-aic-and-bic-af220b33255f)



Time-series decomposition

Menu: Analyses>Decompose

To better understand the information 'hidden' within a time-series, it helps to decompose the time-series into a couple of fundamental parts: trend, seasonality (cyclic) and residuals (random) components.

The decomposition analysis overlaps with the season charts. The season charts are better in showing the year-to-year variation.

The decomposition is implemented in the EHMP website by links to R-'system', a very powerful open-source programming language for statistical software and data analysis tools. This means that the first time the analysis is used during a session, the delay is a bit longer due to the download time for the R-system and the packages needed to do the analysis.

Trend

A *trend* represents is a long-term change in the data. The trend time-series is generated by filtering out the higher-frequency components of the data using a moving-average algorithm. This results in data loss for 6 time points at the start and the end of the trend time-series.

Seasonality

Trends in the data that return to about the same values after the length of a seasonal pattern, in our case 12 months indicate that there are seasonal patterns driving that data.

Residual

After subtracting the trend and seasonality influences, we are left with a residual, often also named 'random', component. The term 'random' is here used loosely to indicate 'not seasonal or trend'.

The temporal decomposition is implemented within the EHMP website using R stats packages connected directly to the EHMP tools website. Currently there is no imputation of absent data implemented, so the accuracy it decomposition results depend on (almost) gap-less time-series.

Decomposition examples

As the trend, seasonality and residue components add up to the original time-series, the values of each of the series also indicates the importance of the component.

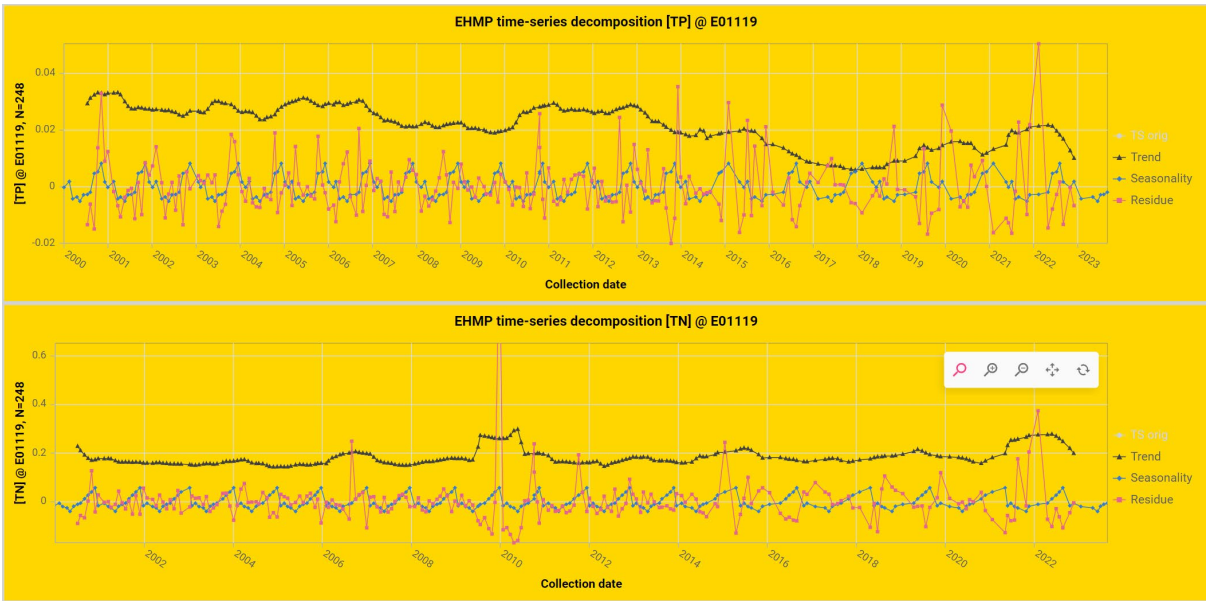


Figure 11 Examples of time-series decomposition. The top graph indicates a decreasing long-term trend of total phosphate concentration, at location E01119. The lower graph of total nitrogen concentration does not show a clear trend.

Some more info re time-series analysis, see also:

https://otexts.com/fpp2/tspatterns.html

Regression chart

Menu: Analyses>Regression

After having selected two time-series, the regression chart (light-yellow background) shows the two time-series charted against each other to reveal any if all relationships between the indicators. The top chart is represented on the x-axis, bottom chart on the y axis.

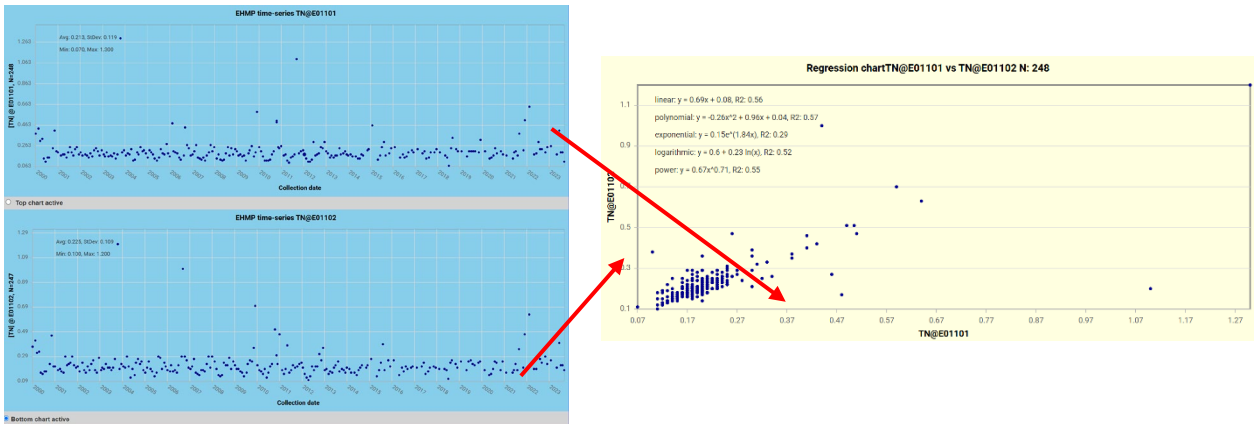


Figure 12 Creating a regression chart based on two time-series.

To create a regression chart, the sample collection months for each sample have line up. That means that the samples in the two time-series that are not collected in the same month will not be represented in the regression chart. The number of samples in the regression chart can be found as N in the chart title. In the example above, the TN indicator at side E01102 and at location E01102 were consistently sampled over the years. Both time-series contain 248 samples, and the regression chart also contains 248 samples.

The results of the five most-used regression models are plotted in the left-top corner of the regression chart, together with their respective R^2 value, an 'explained variance' measure.

Note that the X-axis variable (e.g. TN@E01101) represents the x variable and the Y-axis the y-variable (i.e. TN@E01102) in the regression equations.

A quick check of the linear regression results of Figure 12 against the

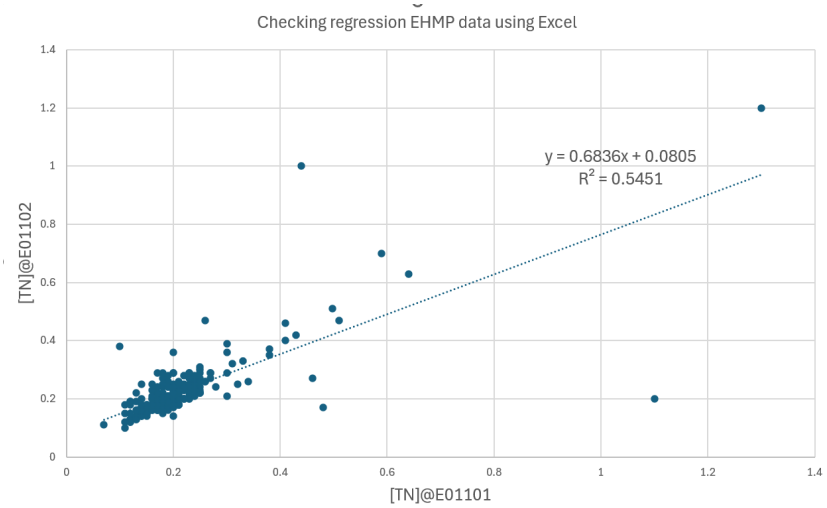
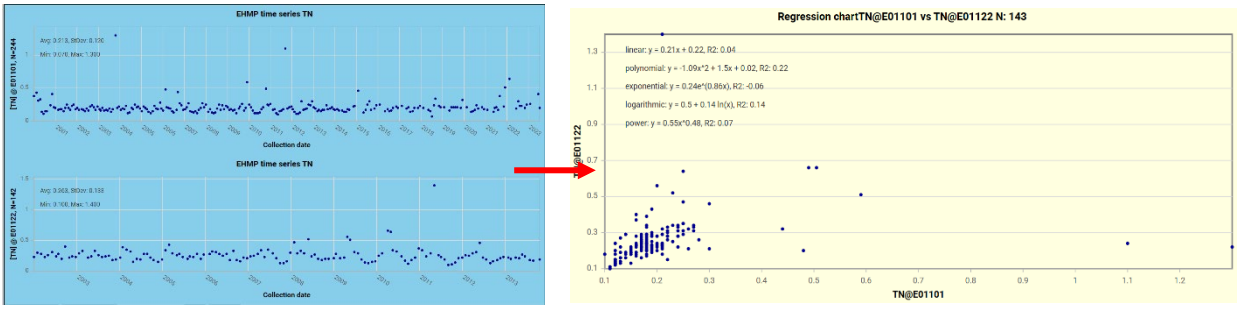


Figure 13 Checking results shown in Figure 12 against Excel regression results.

Sampling at location E01122 was discontinued after 2014, so if we were to chart location E01101 against location E01122 with only 143 samples, the regression chart would only show 143 points.



Exporting using a grid

Menu: General>Export TS

Selecting the ***Export TS*** option in the ***General*** menu shows the numeric data in a grid. The grid can be copies to the clipboard and pasted into other applications (e.g. Excel). <u>NOTE: this function works only for single time-series charts.</u>

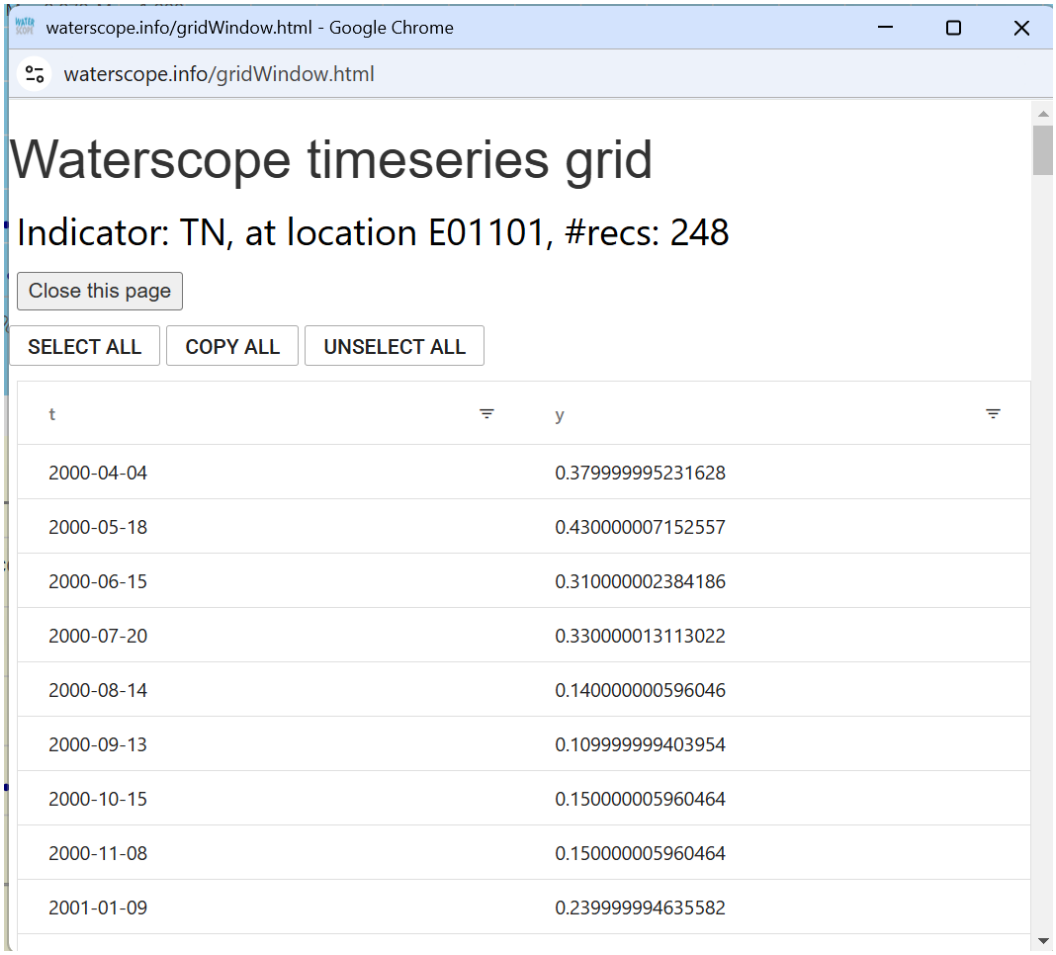
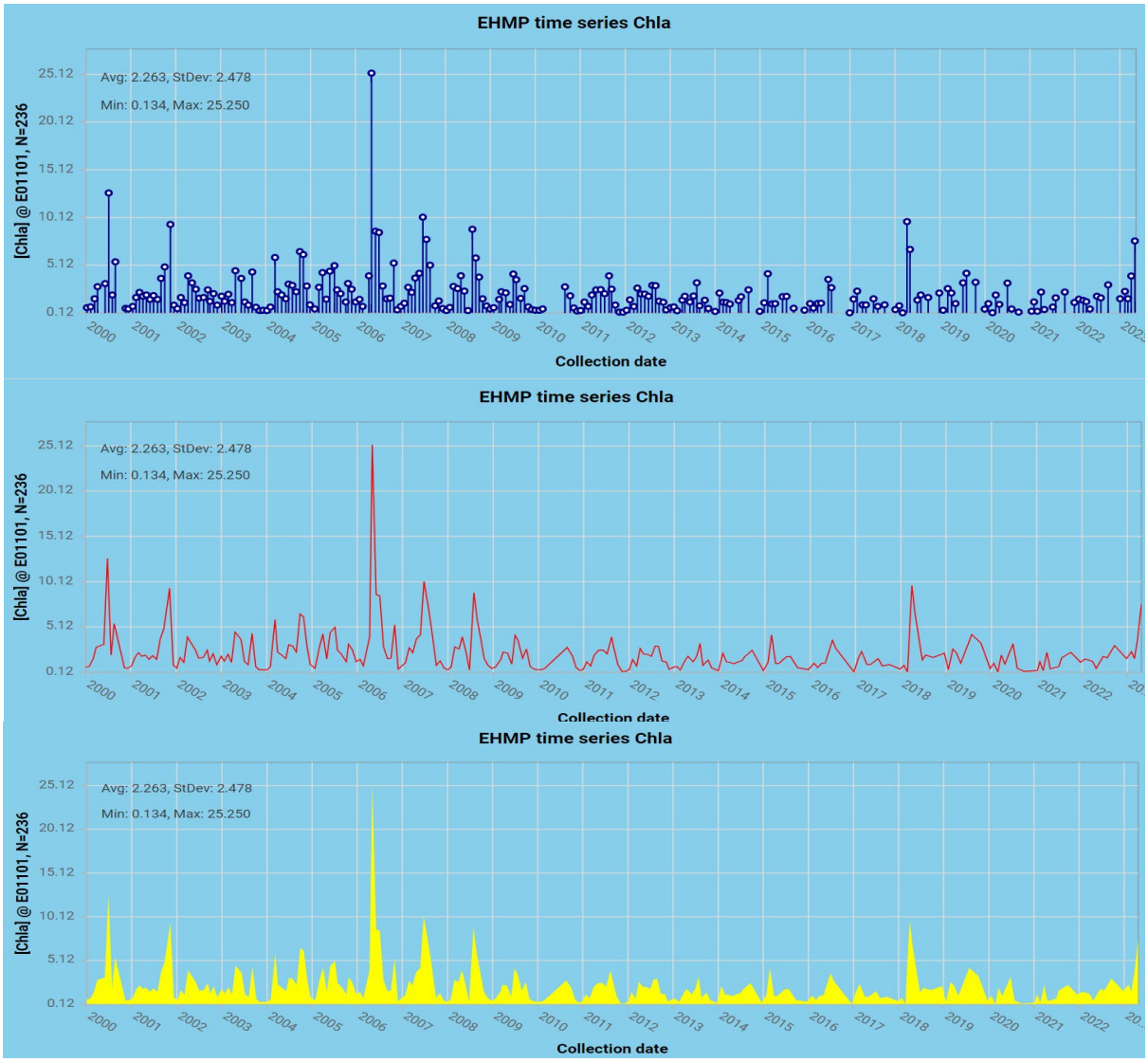


Figure 14 Grid-view of time-series data

Some examples of time-series graphing options.

Menu: Charts>Select Chart type



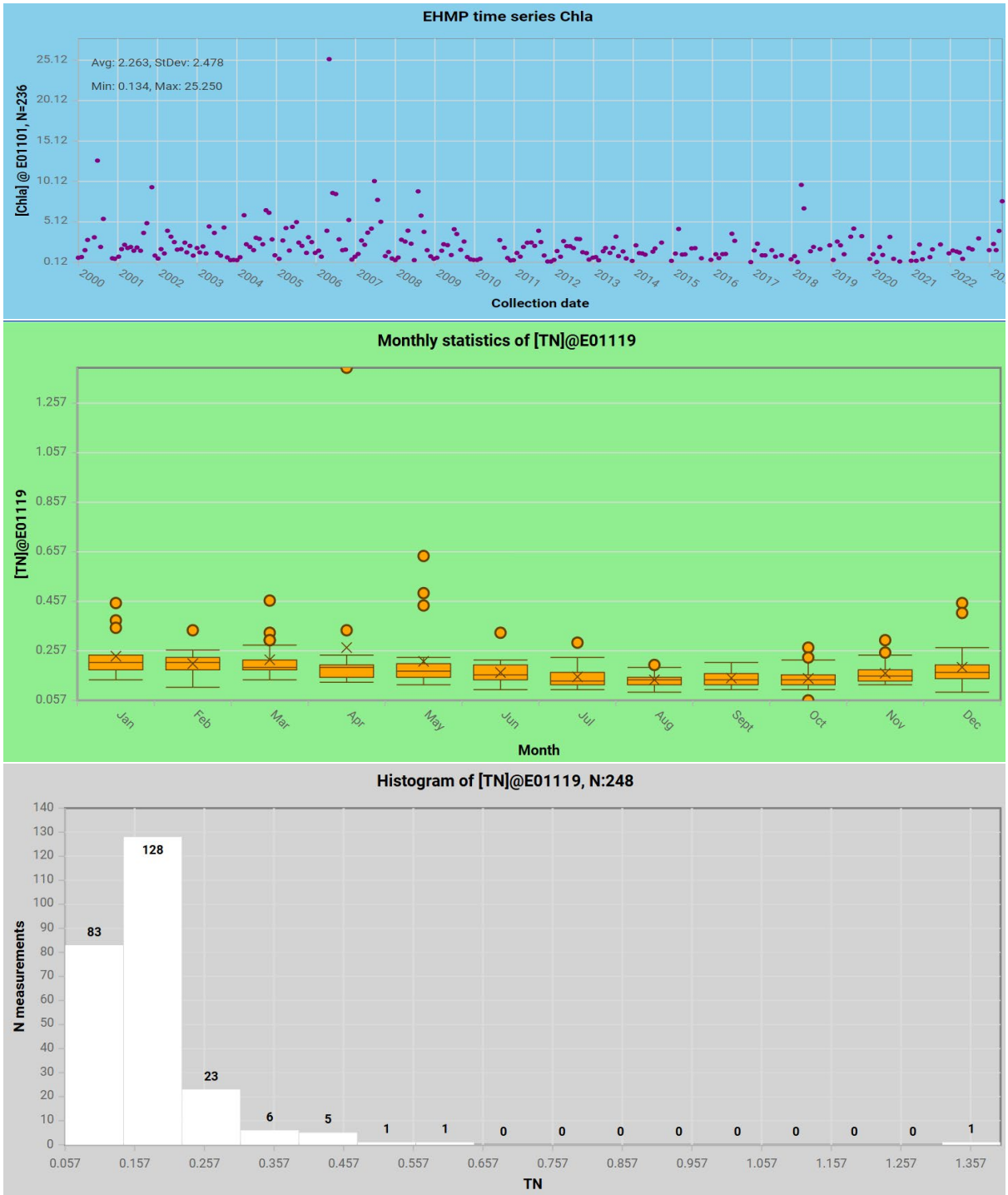


Figure 15 Various time-series graphing options

Multi-series charts

Menu: General>Settings> Multiple time-series select mode

Menu: Charts>Chart MTS

Menu: Charts> Clear MTS list

Adding sample locations to the multiple selection, the *Multiple time-series select mode* in the General>Settings menu must be checked.

The multiple time-series array can be cleared using the *Clear MTS list* option in the *Charts* menu. More details in the example below.

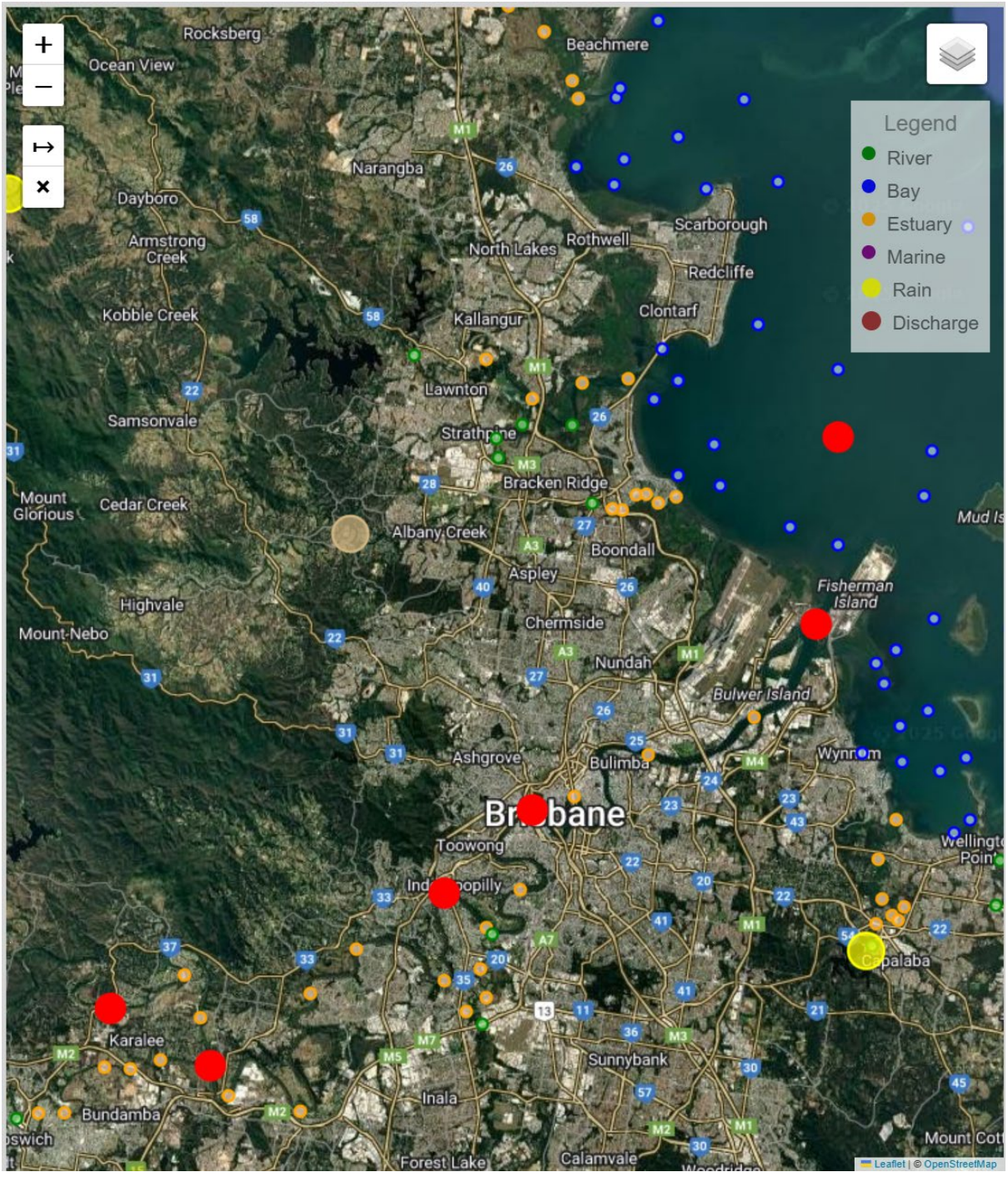
Multi-time-series example

For this example, we select six locations along the Brisbane River from College Crossing, the upper-most EHMP sample location in the Brisbane River, to a sampling location in Moreton Bay, about 9 km from the Brisbane River mouth.

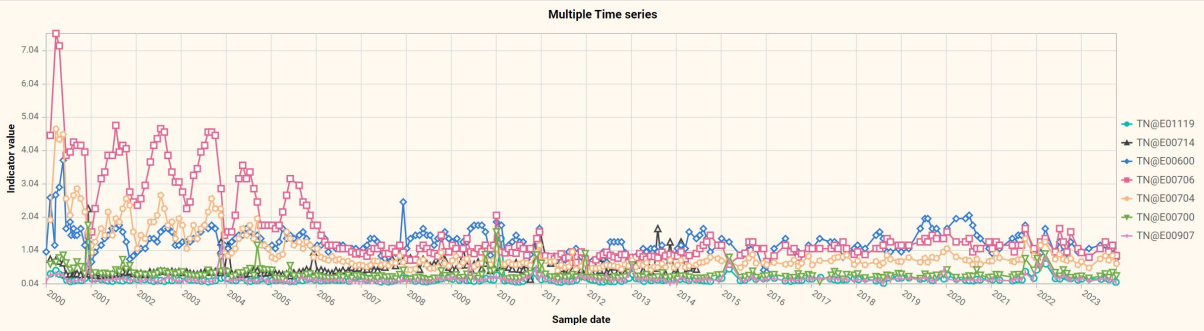
A location can be added to the time-series by clicking on a location on the map, the selected location markers are automatically enlarged and turn to red. Clicking an already selected site will deselect it (toggles it).

Try selecting these sites:

(E00)714=College Crossing, 600=Bremer River inflow, 706=Indooroopilly,704=central Brisbane, 700 = Port of Brisbane, 907= Moreton Bay.


Legend
River
Bay
Estuary
Marine
Rain
Discharge
Rocksberg
Ocean View
Beachmere
Narangba
Dayboro
Armstrong Creek
North Lakes
Rothwell
Scarborough
Redcliffe
Kobble Creek
Kallangur
Clontarf
Lawnton
Samsonvale
Strathpine
Bracken Ridge
Mount Glorious
Cedar Creek
Albany Creek
Boondall
Aspley
Fisherman Island
Highvale
Mount Nebo
Chermside
Nundah
Bulwer Island
Ashgrove
Bulimba
Toowong
Karalee
Sunnybank
Inala
Bundamba
Forest Lake
Calamvale
Leaflet | © OpenStreetMap

Clicking the *Chart multiple locations* button results in the chart below:



The location IDs on the legend are sorted in the order of adding the sample locations.

A quick run with the mouse pointer over the location ids in the legend gives an instant story of 23 years of total nitrogen concentration along the Brisbane River. Figure 16 tables the results of this example.

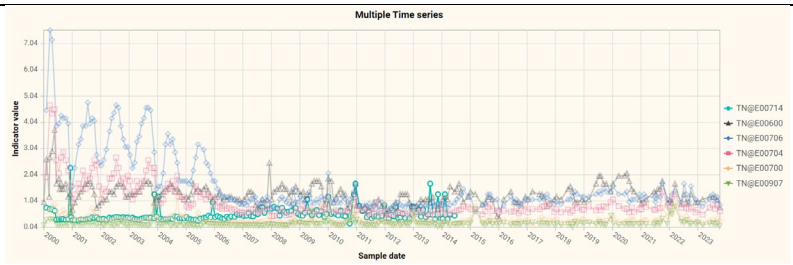
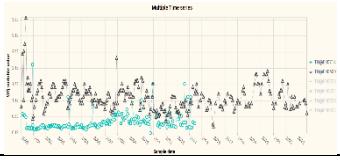
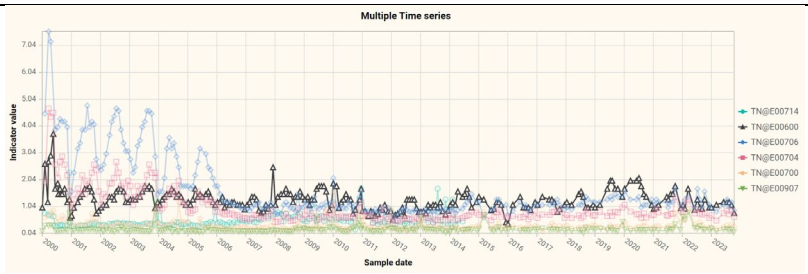
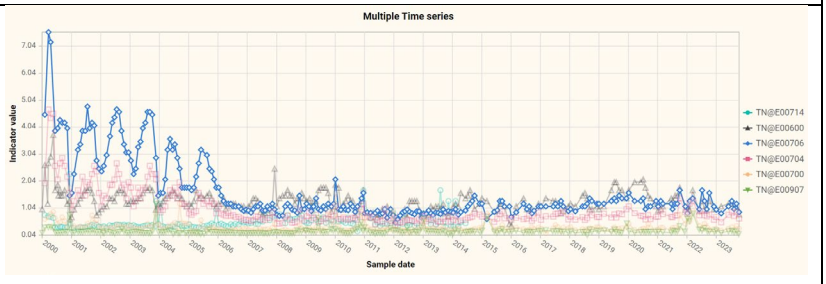
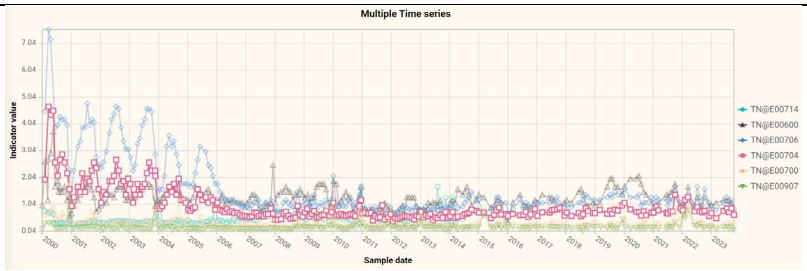
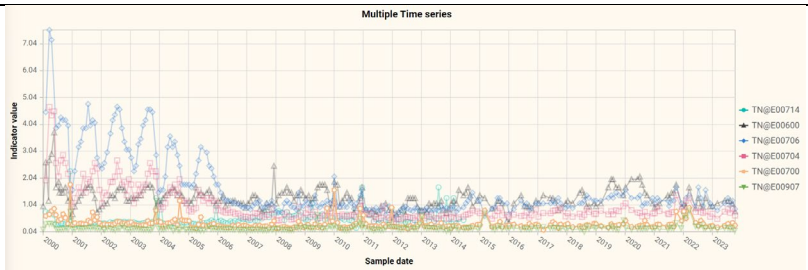
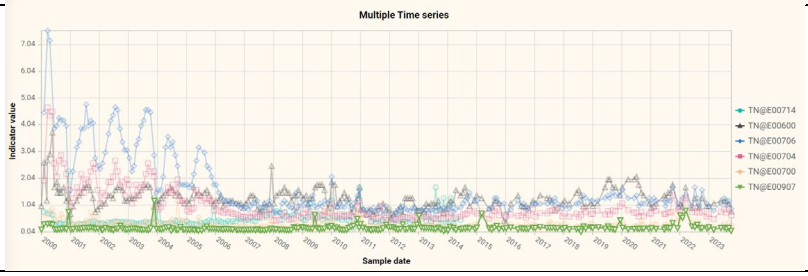
714=College Crossing. [TN] rises after ca. 2007. Unfortunately EHMP sampling stopped after 2014.	
600=Bremer river inflow. Big step-up in [TN] from College Crossing 	
706=Indooroopilly. The very large fluctuations in the data from 2000-2006 needs more investigation.	
704=central Brisbane.	
700 = Port of Brisbane. Daily tides flush these regions.	
907= Moreton Bay. Low concentrations due to dilution, ecological cycling, and export.	

Figure 16 Multi-time-series charts often give insights of spatio-temporal dynamics.

Multiple timeseries Spatial Box-Whisker chart

Menu: General>Settings> Multiple time-series select mode

Menu: Charts>Chart MTS Spatial stats

Menu: Charts> Clear MTS list

Alternatively, the stats of each location for a selected indicator can be chart as a Box-Whisker chart by selecting the *Menu: Charts>Chart MTS* ***Spatial stats*** option.

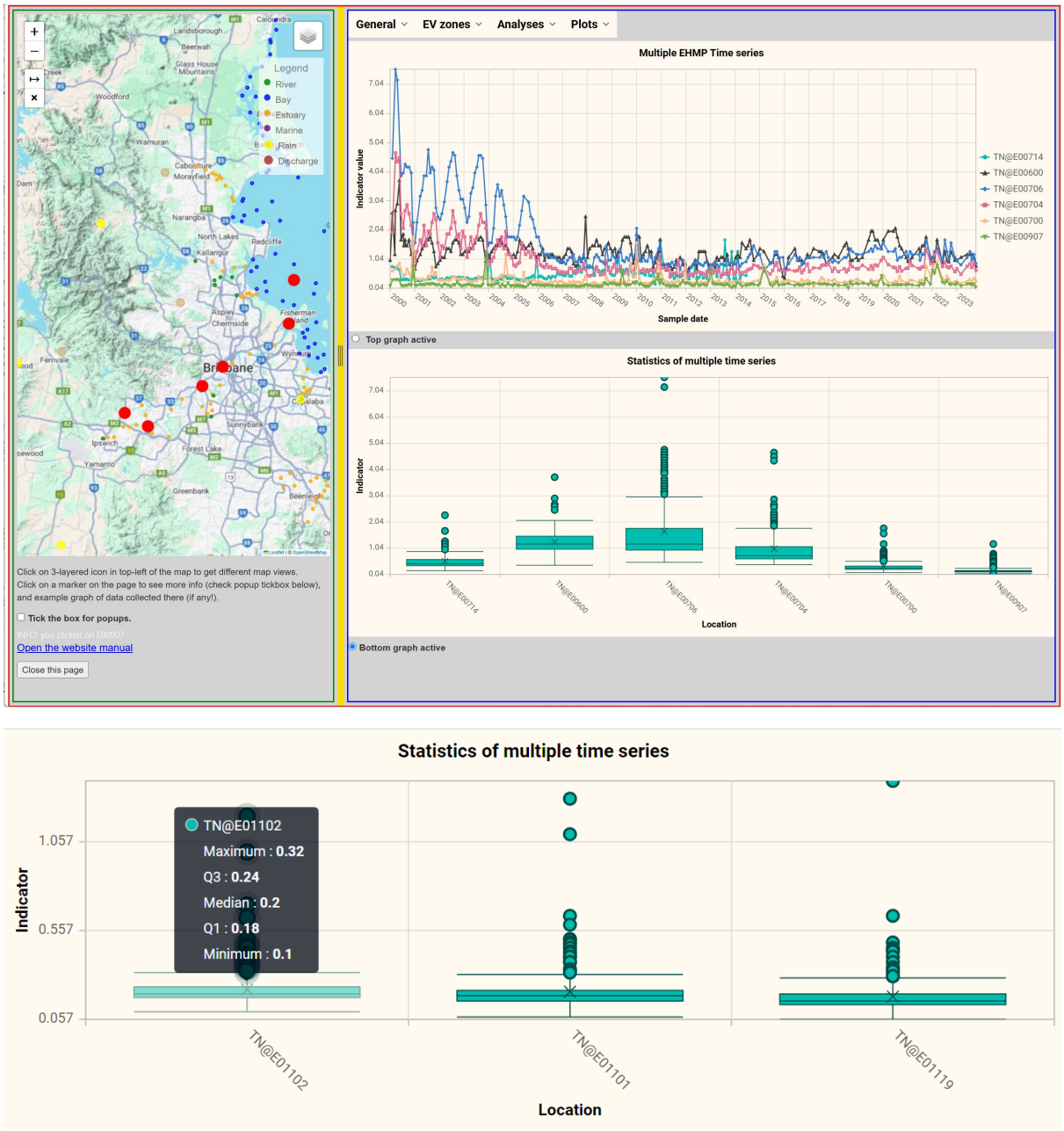


Figure 17 More details of Box-Whisker Spatial stats chart statistics pop up when the cursor hovers over an element.

Multiple timeseries Temporal Box-Whisker chart

Menu: General>Settings> Multiple time-series select mode

Menu: Charts>Chart MTS Temporal stats

Menu: Charts> Clear MTS list

The stats of all samples per year for a selected indicator can be chart as a Box-Whisker chart by selecting the *Menu: Charts>Chart MTS* ***Temporal stats*** option.

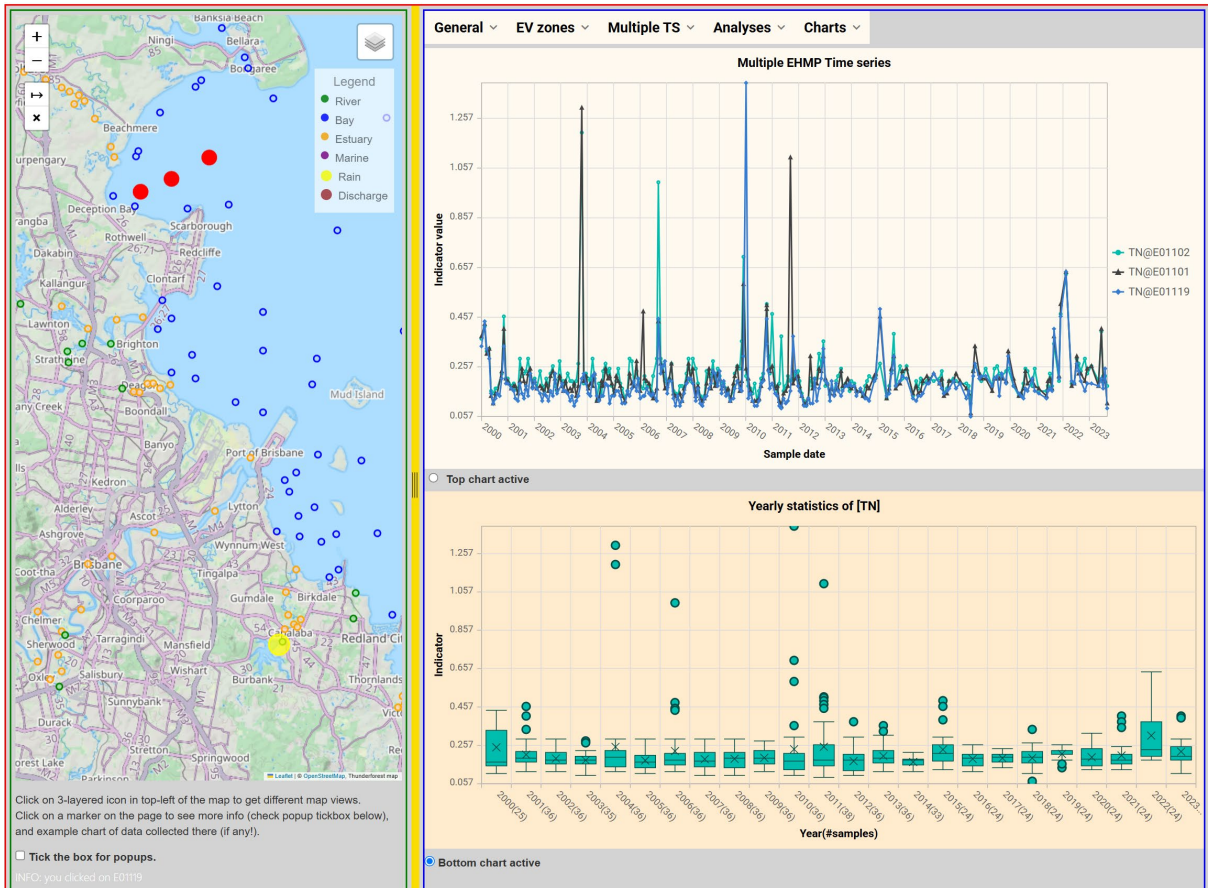


Figure 18 More details of Box-Whisker Temporal stats chart statistics pop up when the cursor hovers over an element.

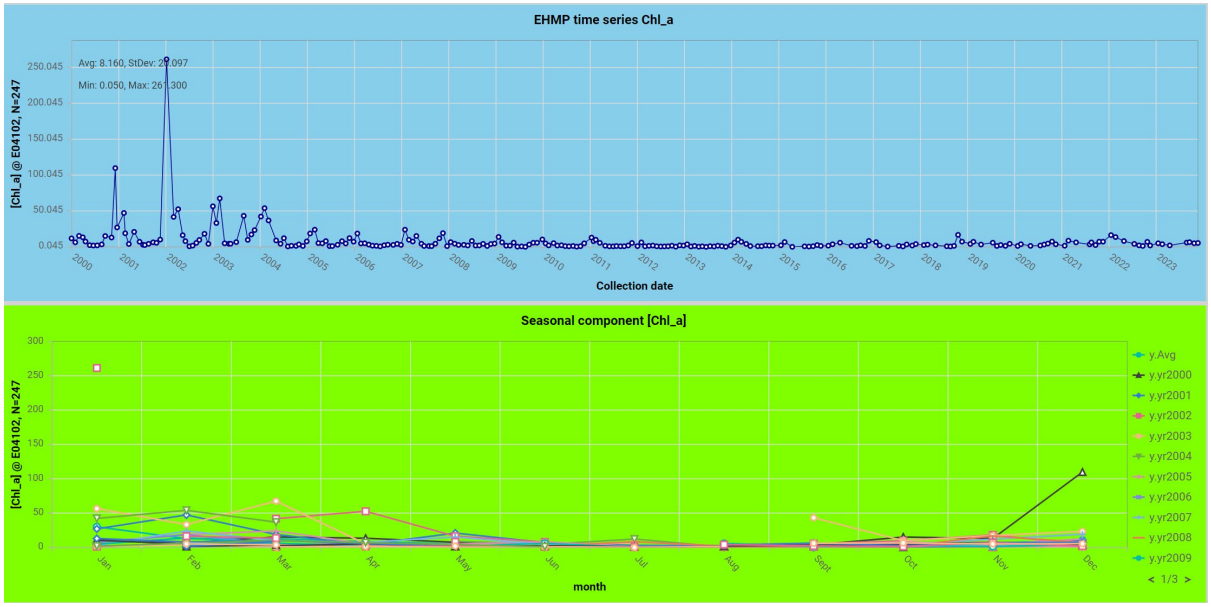
Seasons or epoch chart

Menu: Analyses>Seasons

To examine inter-annual variation, the seasons-chart is an alternative to the ACF chart. The seasons chart cuts a time-series chart (first graph below) into year segments and charts each segment separately on a graph (second graph below).

Seasons charts are just a different way to look at a time-series and can inform us about the variation of an indicator over the year and are akin to Box-Whisker charts.

See also the time-series decomposition section for more information.



The trace at the top of the legend of the *Seasonal Component* chart is the monthly average. For this location and this indicator, it shows very low variability between July and October, but it is not easy to see.

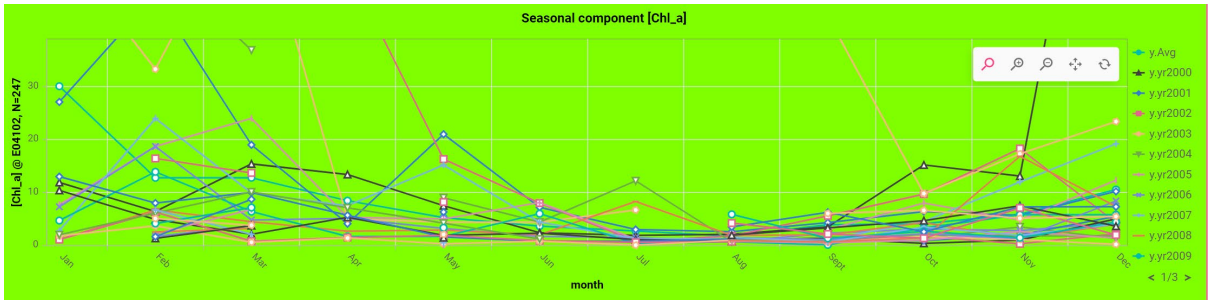
Multi-trace graphs can get cluttered very easily, so there are a couple of options to deal with it:

- Zooming in/out/panning.
- Highlighting one trace.
- Switching some of the traces off.

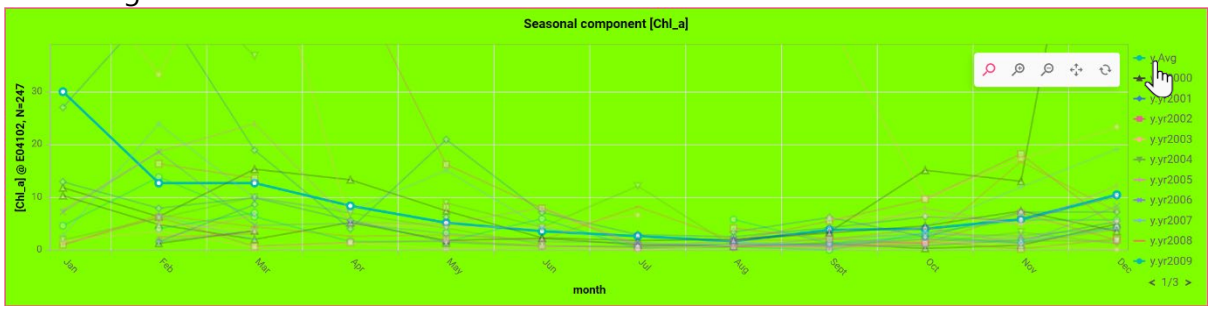
Example

The top (blue) graph shows the Chl_a trace at Cabbage Tree Creek close to the Gateway Motorway (location E04102) between 01/2000 and 12/2023. The bottom (green) shows *Seasonal Component* chart for that time-series. In this form it is very hard to interpret.

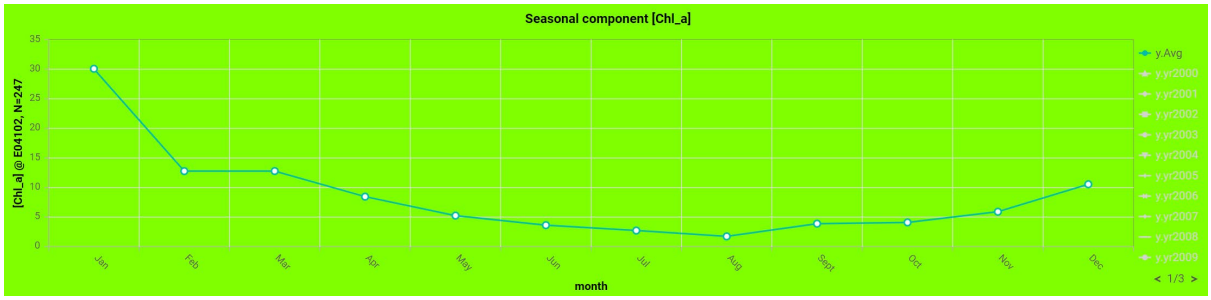
Zooming into the lower part of the graph results in:



Hovering the mouse icon over the legend, highlights the trace of a specific year, in this case the average trace:



Switching off the other traces is complete 'decluttering'.



Box-Whisker chart

Menu: Charts> Select Chart type>boxwhisker

A Box-Whisker chart can be created following the same steps as creating a time-series chart by selecting the Box-Whisker option in the dropdown box labelled **Select graph type**, indicator and a EHMP location on the map.

Box-Whisker charts provide a summary of the distribution of the data, showing the central tendency (median and average), spread (Q1, median and Q3), extremes (whiskers), and potential outliers as circles, see Figure 19.

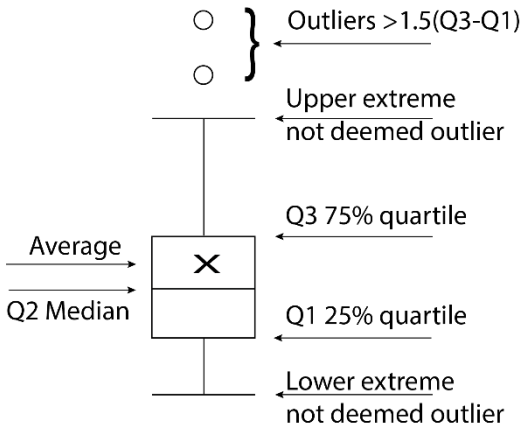
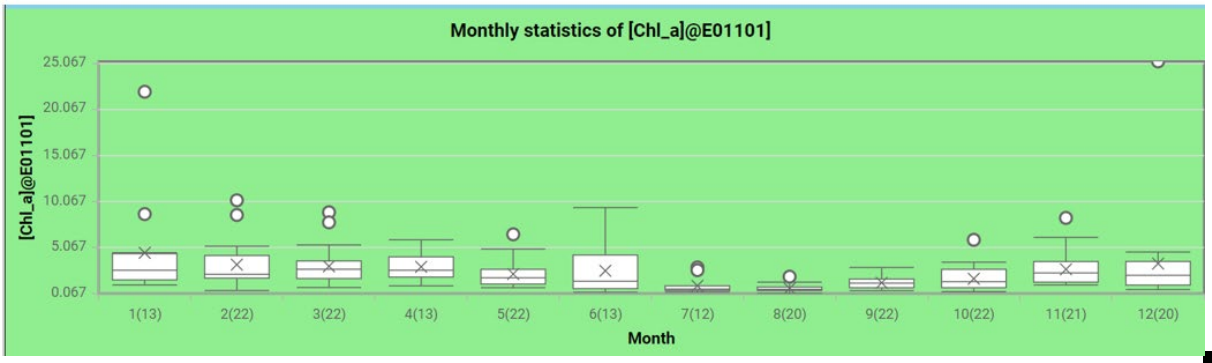


Figure 19 The Box-Whisker symbol summarises a range of statistical characteristics of a set of numbers, e.g. a timeseries.

Box-Whisker charts show these statistics derived from grouping by month the time-series of each year, resulting in several samples per month (numbers in parentheses after month label). Overlaying the annual time-series allows to draw some descriptive statistics for each month and charting those descriptive statistics on a graph. The number of samples the statistic is based on can be seen between brackets on the x-axis labels. Note that some months (Jan, April, June, July) are based on less samples due to the EHMP program sampling effort reduction since 2015.

More detailed information on Box-Whisker charts and outliers can be found here:



https://www.tableau.com/data-insights/reference-library/visual-analytics/charts/box-whisker

https://www.ncl.ac.uk/webtemplate/ask-assets/external/maths-resources/statistics/descriptive-statistics/other-measures-of-dispersion.html#Outliers

Currently, no outlier analysis has been implemented (yet).

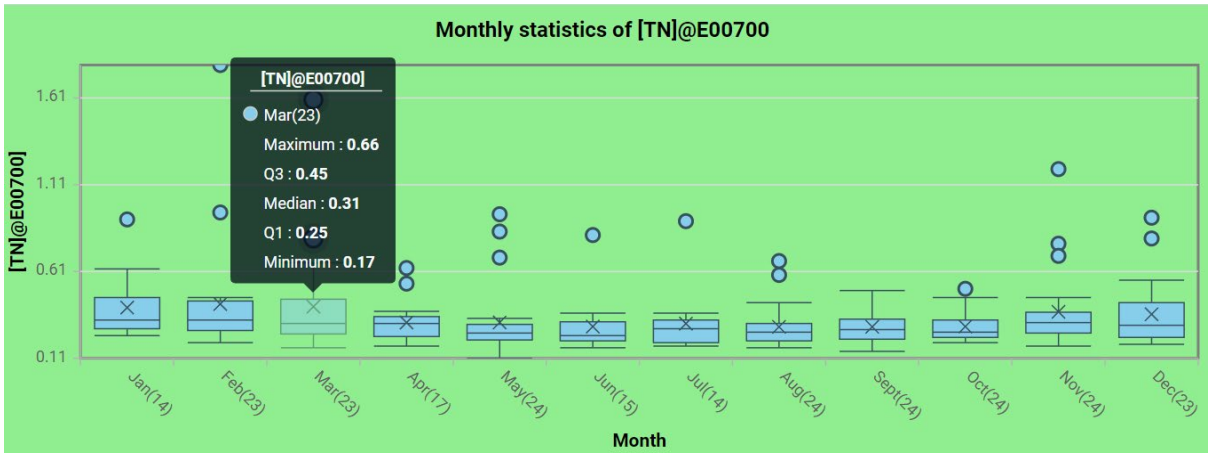


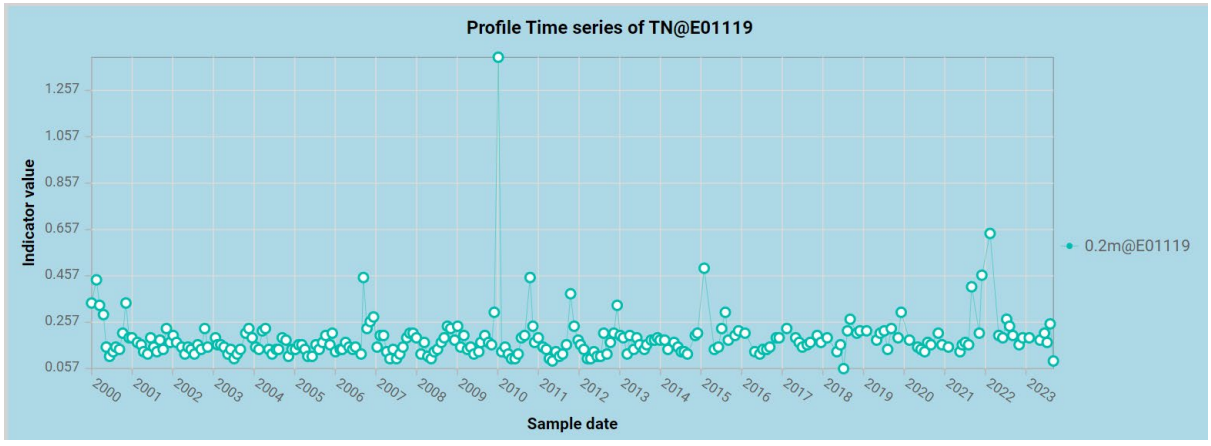
Figure 21 More details of Box-Whisker chart statistics pop up when the cursor hovers over an element.

Depth Profile time-series charts

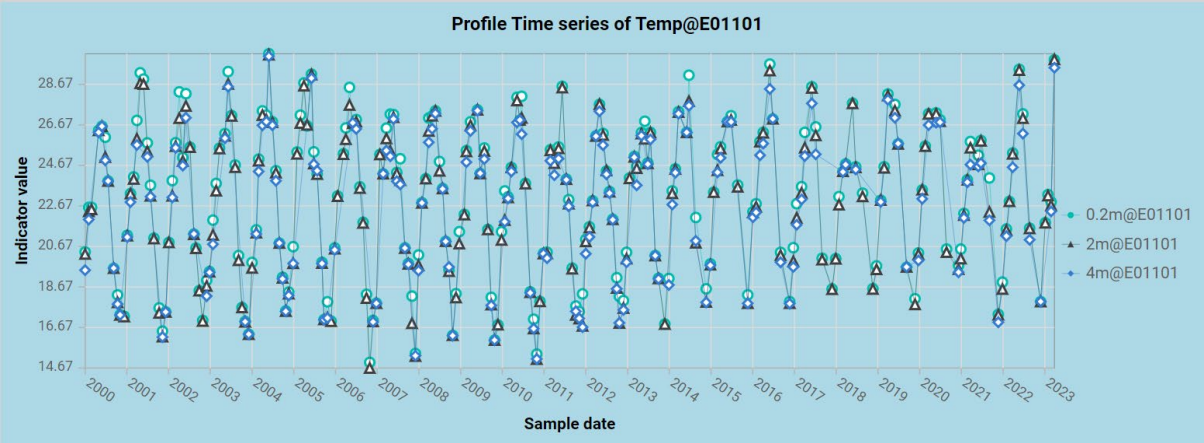
Menu: Analyses>Profile

Apart from the many samples that were collected at the water's surface (20 cm depth), for some of the indicators, mainly the physical indicators (e.g. temperature, and salinity etc.), data has been collected at a range of depths, often at 2, 4 and 6 m. These are called *depth-profiles* and are also accessible via the Waterscope website. Not all locations have profiles.

Charting the profile time-series s quite simple: just chart a 'normal' time-series as described in the previous section and select the ***Profile*** option in the ***Analyses*** menu. If there is no profile data available, only the 0.2m chart (same as the normal time-series chart, with different background colour) will be shown, see graph below.

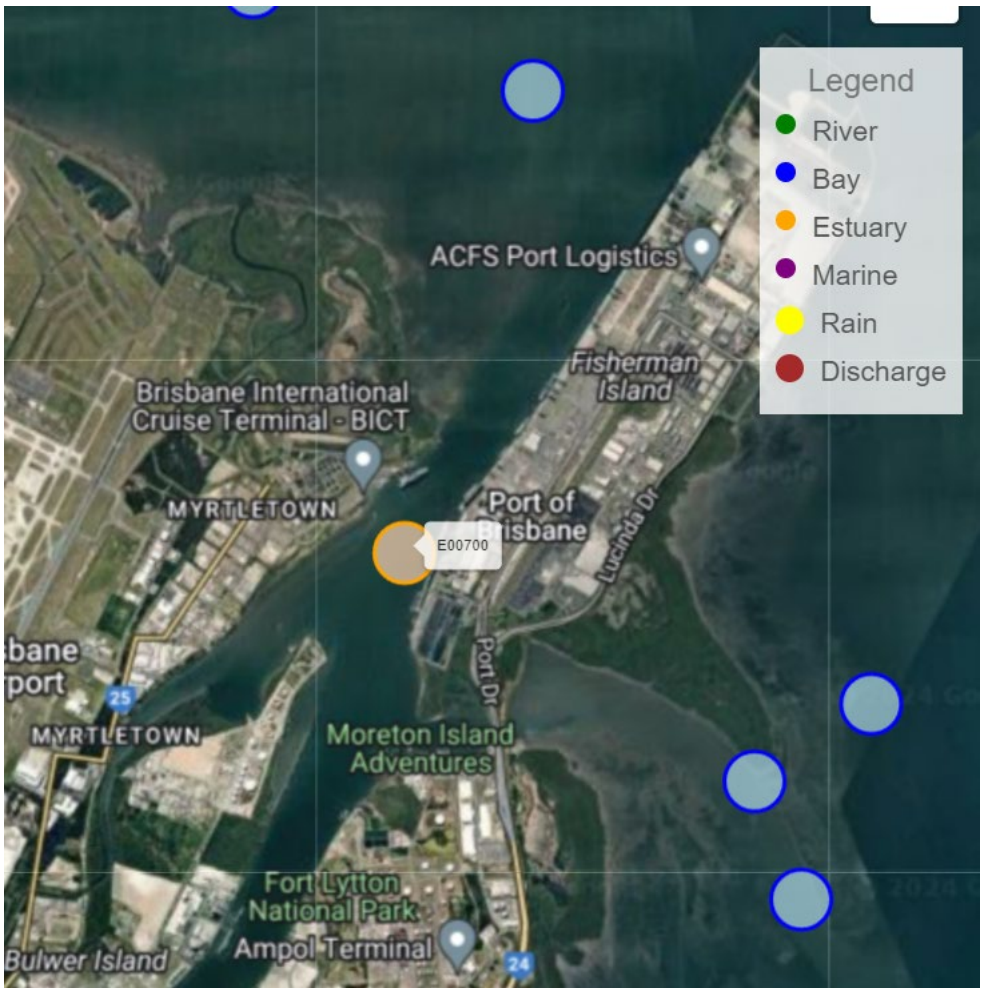


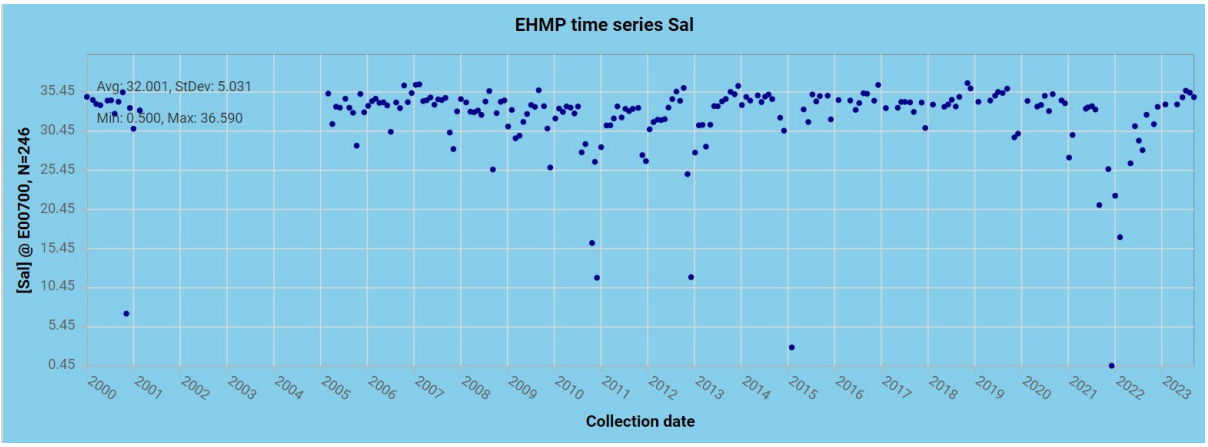
If profiling data is available, the chart will show a set of time-series at the various depths, as shown in the graph below.



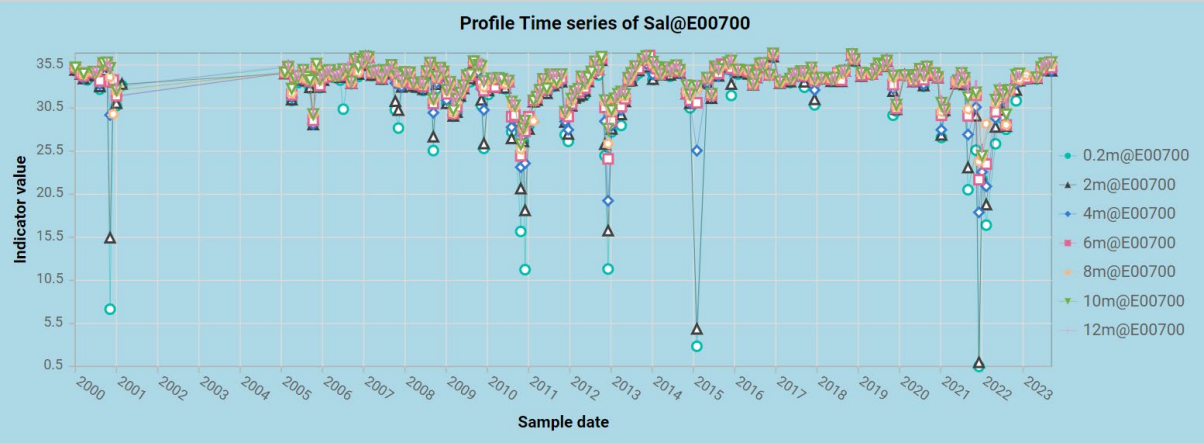
Profile chart example

The profiling data can show the salinity gradient at the Brisbane River mouth. Selecting the salinity (Sal) indicator and chart its time-series for location E00700 (see map below) will result in a normal time-series graph

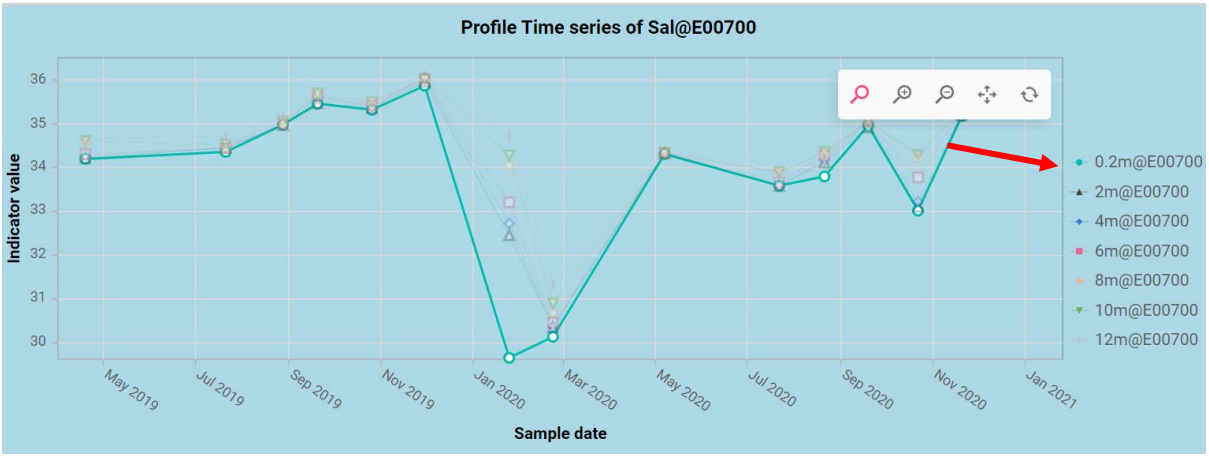




Selecting the Profile option in the Analysis menu results in the following chart:



Zooming into some area of the chart (anywhere) and hovering the mouse over the legend of the right (see below), a very clear salinity gradient can be visualised, thus confirming that the freshwater flowing down the Brisbane River stays at the top while the saltwater influx from the Bay (heavier specific gravity) stays at the bottom.



EV zone charts

Menu: EV zones>Select EV zone

Menu: EV zones>Chart EV MTS

Menu: EV zones>Chart EV MTS stats

Menu: EV zones>Chart EV Radar chart

Menu: EV zones>Export EV MTS

The water bodies in SE-Queensland are divided into E(nvironmental) V(alue) zones to allow summaries of results over parts of a bay or rivers to be assessed and reported on. Figure 22 Overview of reporting regions in SE-Queensland, Australia, as published by the Queensland Department of Environment, Tourism, Science and Innovation (DETSI).Figure 22 shows the EV-zones The pdf can be downloaded here.

Figure 30 and Figure 31 show the sample locations that make up each of the EV zones in the Estuarine/Bay and Freshwater sample programs.

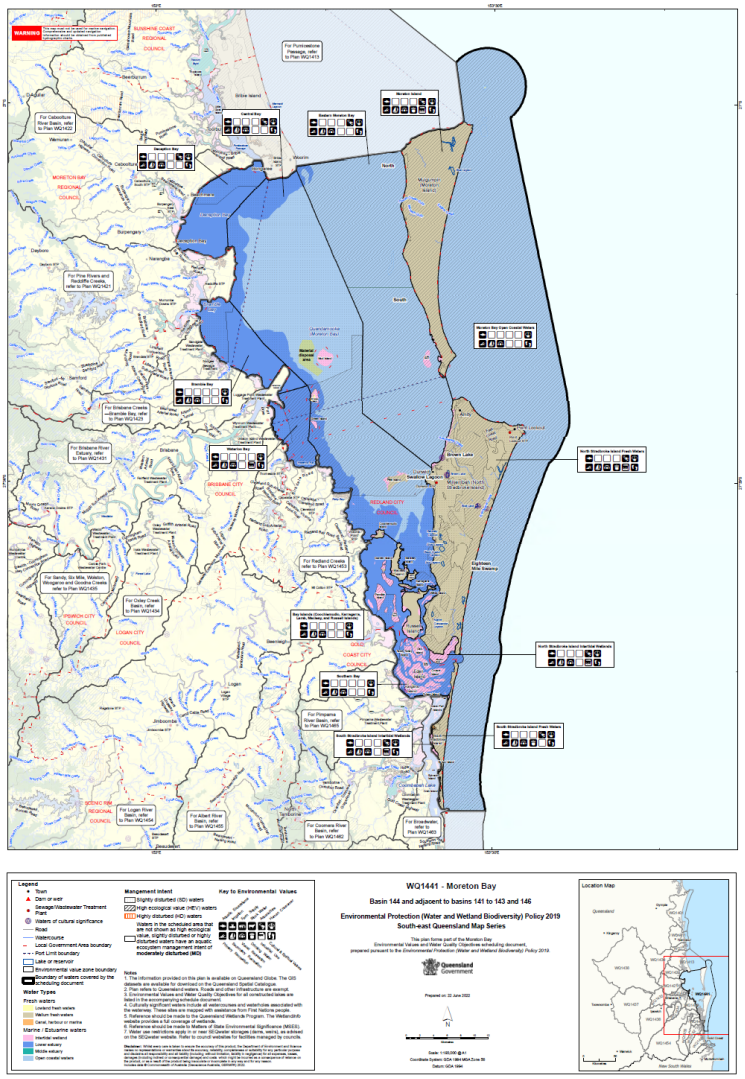


Figure 22 Overview of reporting regions in SE-Queensland, Australia, as published by the Queensland Department of Environment, Tourism, Science and Innovation (DETSI).

To create an annual Box/Whisker stats chart for an EV-zones first select which EV zone you're interested in via the menu: ***Menu: EV zones>Select EV zone.***

To chart the box-whisker chart, use ***Menu: EV zones>Chart EV MTS Temporal stats*** or ***Menu: EV zones>Chart EV MTS Spatial stats***

Example: the graph below shows the results of annual stats for the Brisbane River.

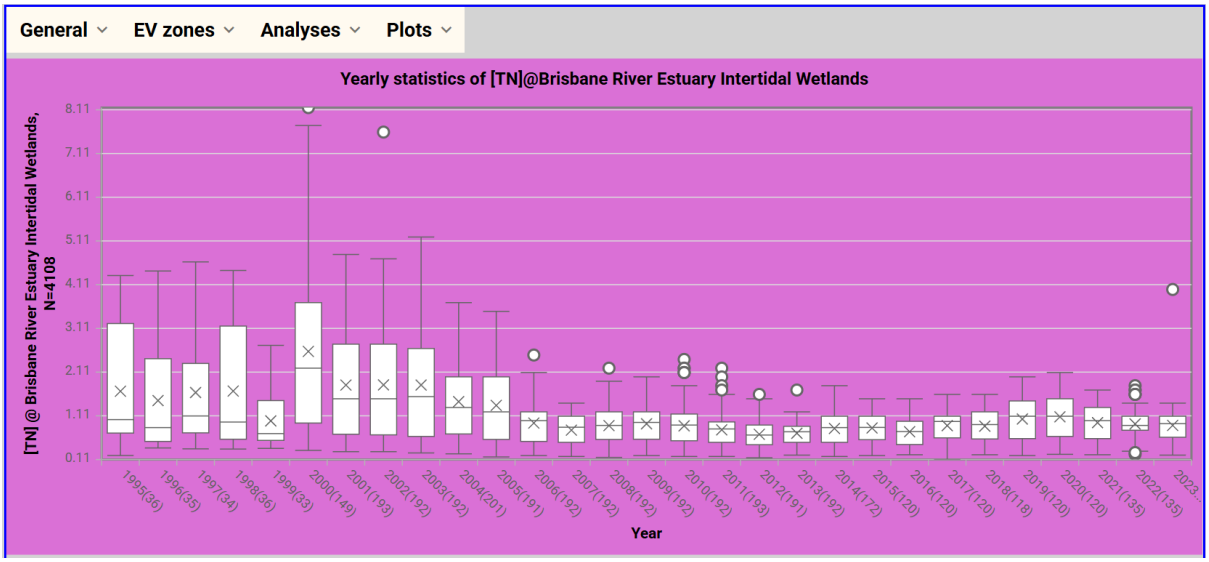


Figure 23 The annual trend of TN for the Brisbane River

Each Box-Whisker symbol represents the statistical description grouping (e.g. total nitrogen, TN) samples taken at all locations within an EV-zone (e.g. Brisbane River) for each calendar year.

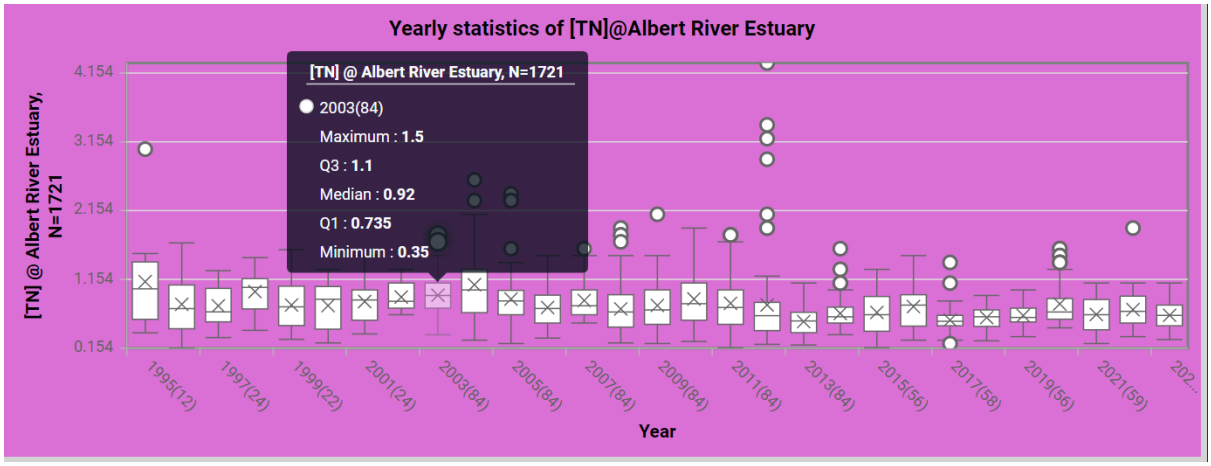


Figure 24 More details of Box-Whisker chart statistics pop up when the cursor hovers over an element.

NOTE: for the profiled indicators, this based on the 0.2m data only.

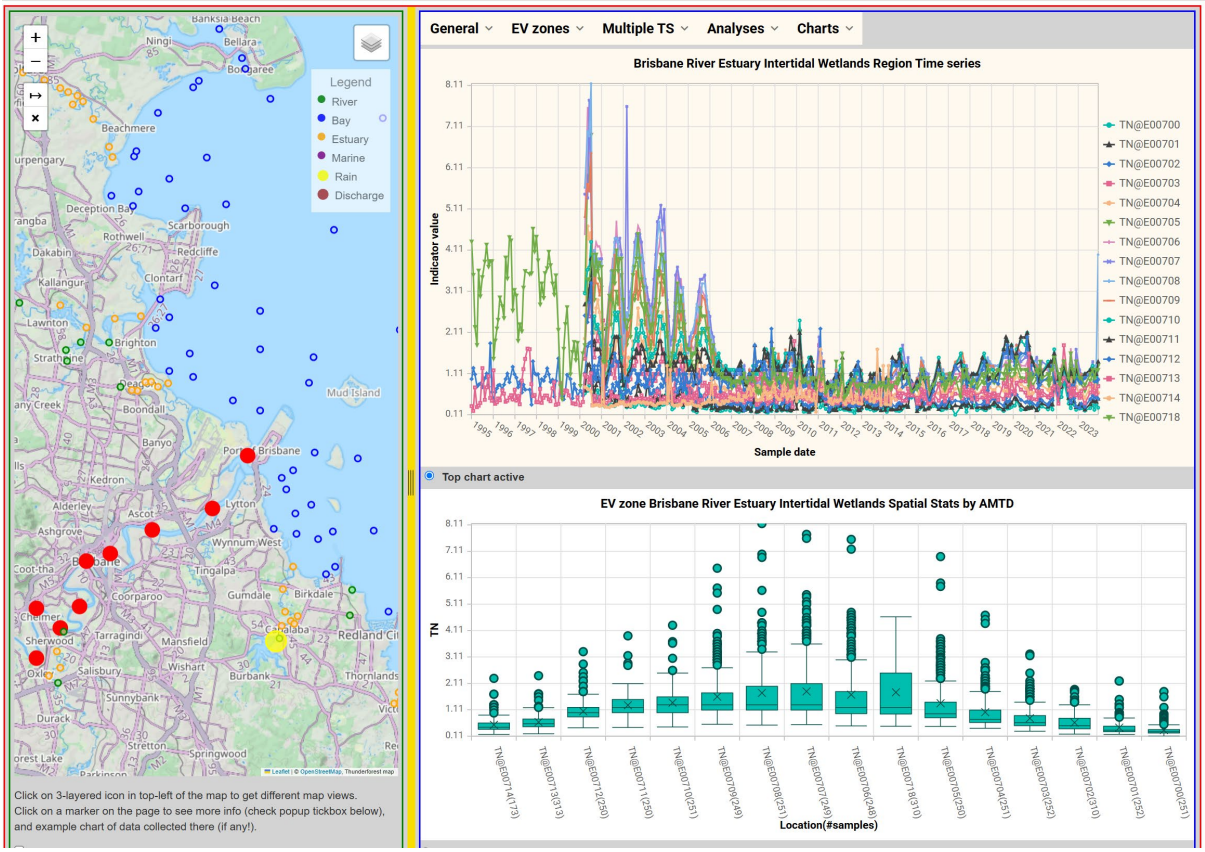


Figure 25 The timeseries (top chart) and spatial trend stats (bottom chart) of TN along the Brisbane River

See the Box-Whisker chart section for details regarding the meaning of the symbols.

The red markers on the map show which sites are part of the selected EV zone.

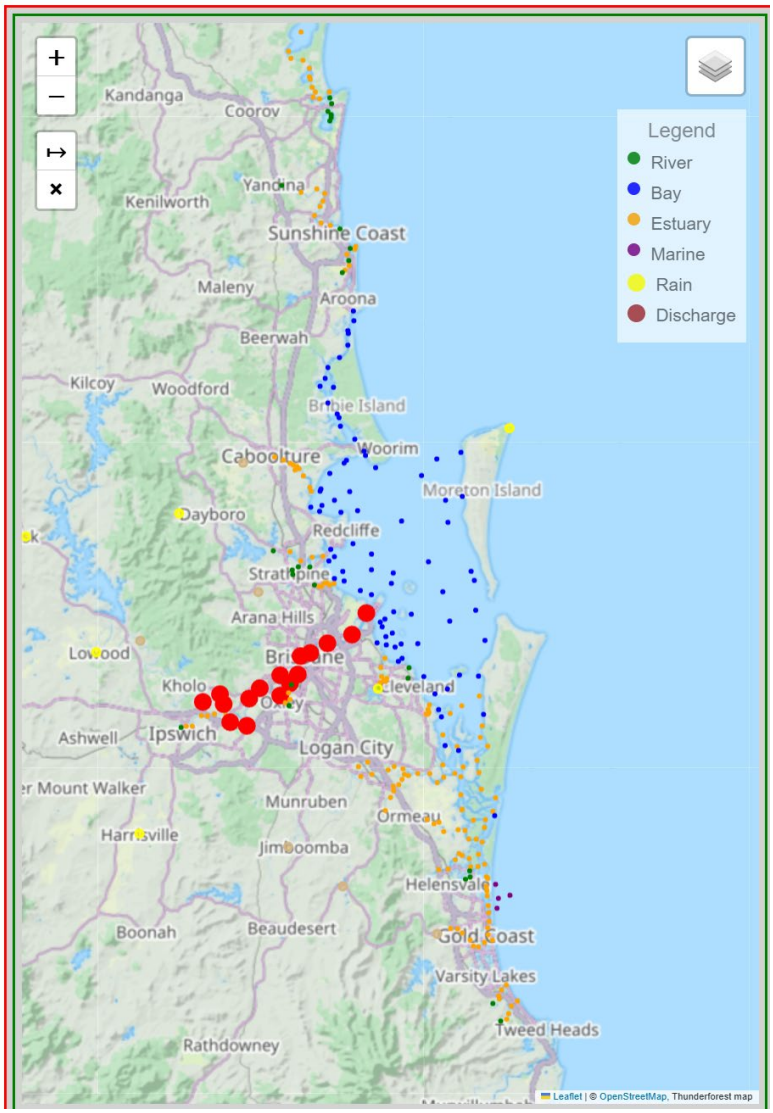


Figure 26 When charting time-series or Box-Whisker stats, the sites included in the EV zone are marked in red on the map.

When selecting the multiple time-series chart (***Menu: EV zones>Chart EV MTS***), the time-series for each sample location will be charted. Figure 27 shows an example of the result.

Note that there are a limited number of sites that can be shown in the legend at one time.

The text in the lower right (i.e. <1/2> in the red box) indicates that there are more sites to be shown in the legend. Using the < and > characters, the previous or next page of the legend will be shown. This only pertains to the legend, all time-series are already charted.

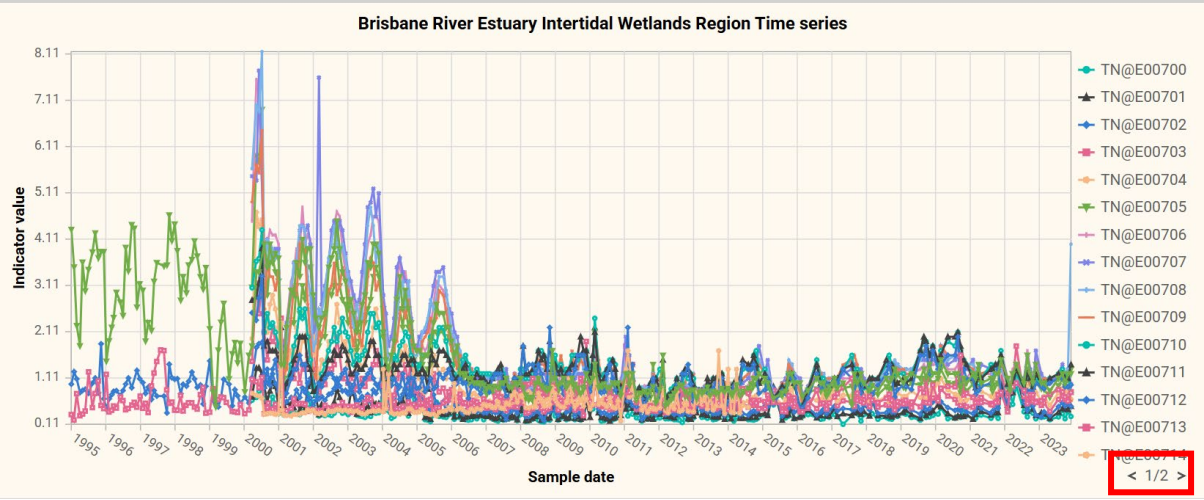


Figure 27 When selecting an EV-zone chart, the locations that comprise that zone will automatically be highlighted

Multi-indicator site comparisons with radar charts

Menu: EV zones>EV Radar chart

or

Menu: Multiple TS>MTS Radar chart

NOTES: *Currently only implemented for EV zones and user-selected locations using the Estuarine and Bay data.*
Some EV zones may fail if one or more locations have no data for one or more indicators (e.g. Easter Bay).

A quick comparison between sites using a range of indicators can be achieved using a radar or spider web chart. The current implementation is using the EV zones as the way to group locations.

For EV zones

Select an EV zone first (***Menu: EV zones>Select EV zone***). Then select the ***EV Radar chart*** option in the ***EV Zones*** menu. For example, using the (default) EV zone of the Albert River Estuary would result in the radar chart below.

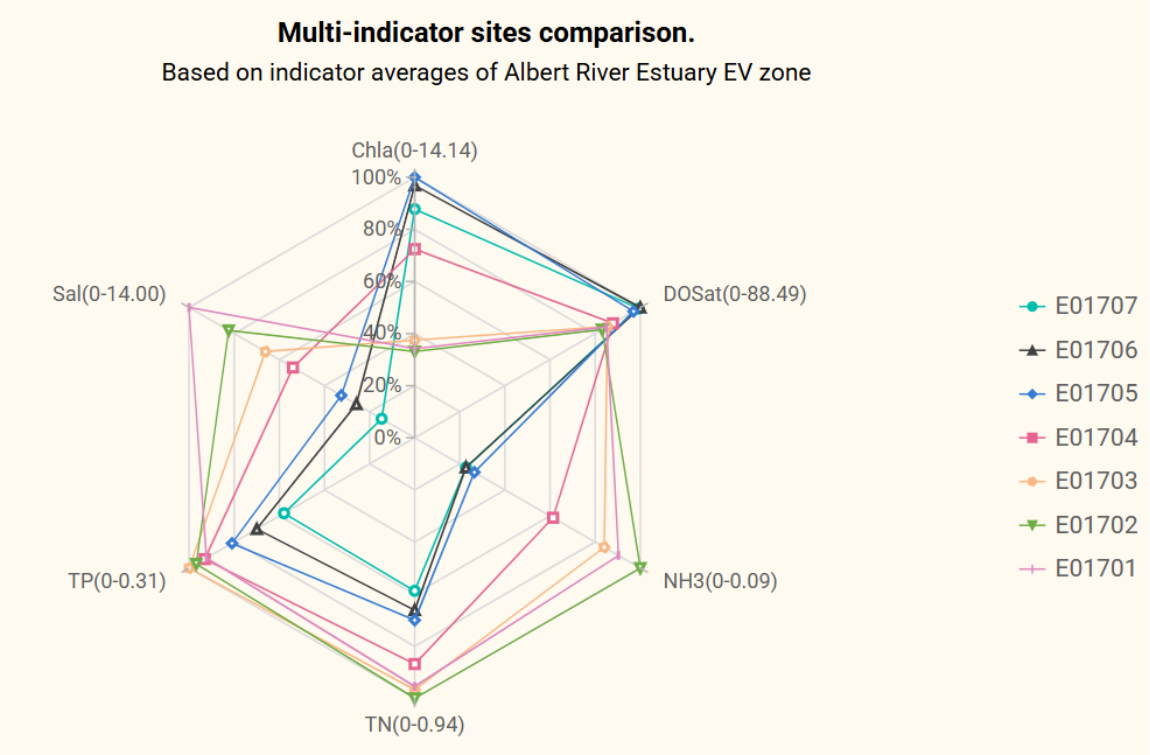
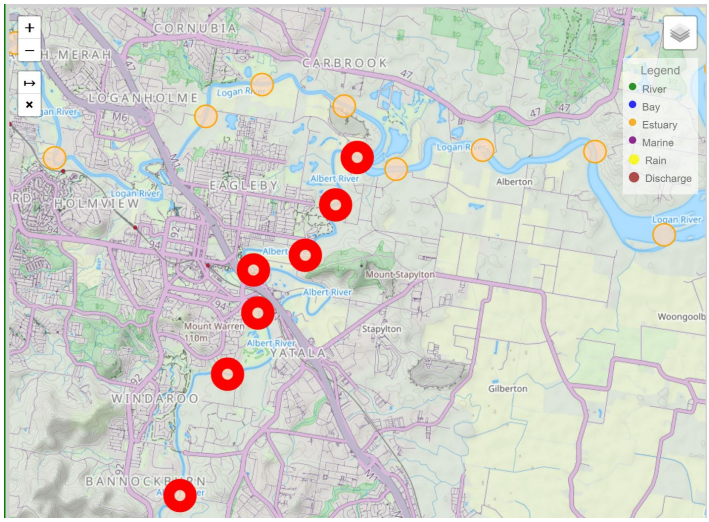


Figure 28 A radar or spider web chart allows for a quick comparison between sites using a range of indicators.

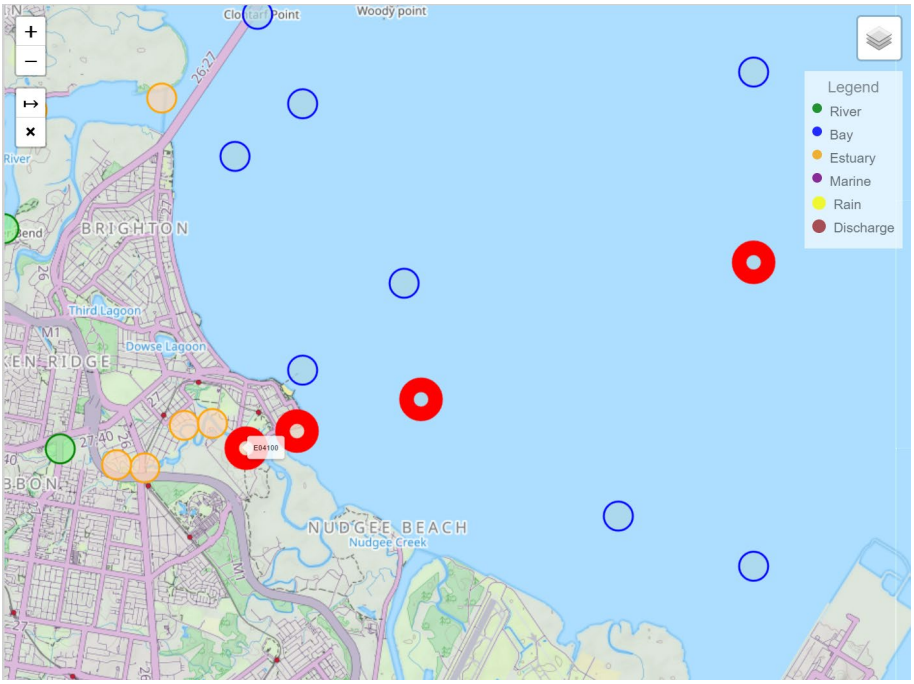
The map will show which sites are included.



For user-selected locations

Select one or more locations first: ***Menu: Multiple TS>Select multiple time series***.

Then select one or more sites on the map.



Selecting locations using *Menu: Multiple TS>MTS Radar chart* results in the chart as shown below.

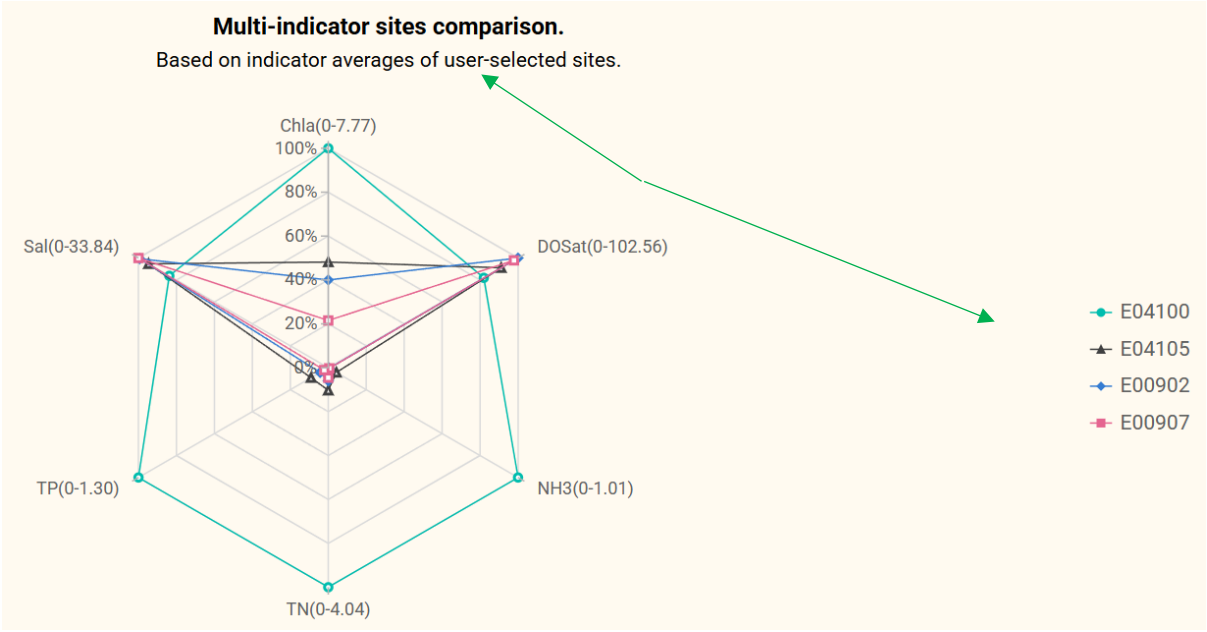


Figure 29 Radar charts based on user-selected locations give a quick impression about the selected locations. For example: site E04100 distinguishes itself by having such high nutrient components relative to its neighbour locations.

How to interpret the numbers on the radar charts

The numbers are the percentages of the maximum average value for that indicator and that location. For instance, hovering over a marker on the chart shows that the Chlorophyll a

level at the E01703 location (orange line) is 37.43% of the maximum average level for Chl-a of 14.14 in the Albert Estuary zone.

For example, the average Chl-a level at location E01703 is 14.14*37.43/100=5.29 µg/L.

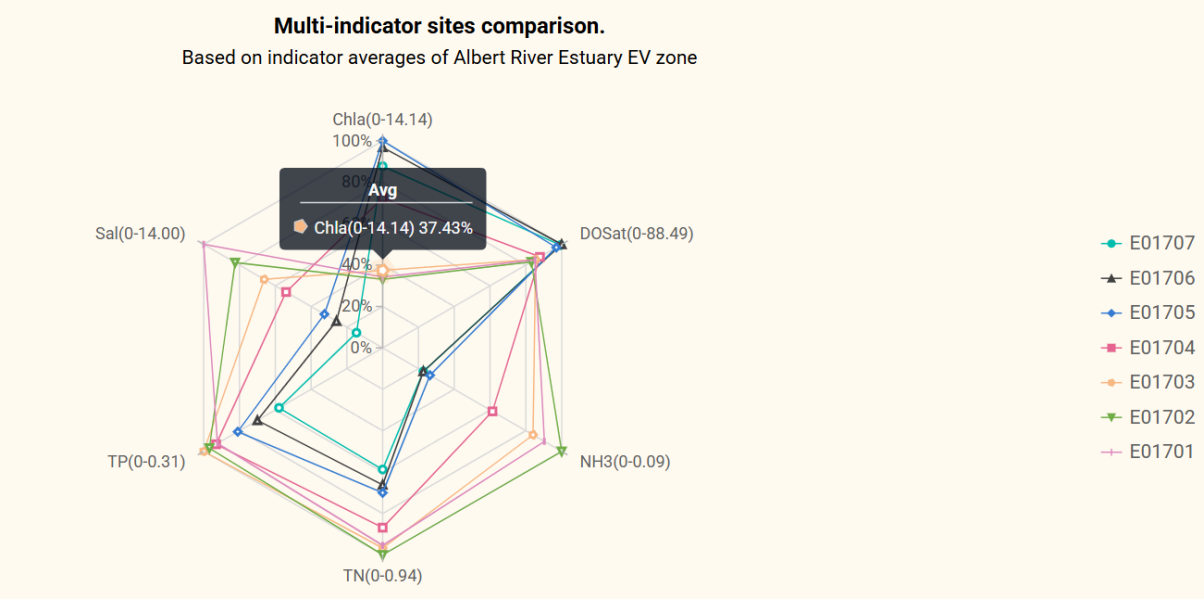


Figure 30 The numbers at the end of the radar chart 'spokes' indicate the maximum of the time-averaged indicator values over all selected locations.

Hovering over a location on the legend will highlight the trace belonging to the location. As locations for rivers are sorted from upper to lower catchment, running the mouse pointer over the legend gives a rapid visual impression of changes along the river.

Date-filtered radar plots

By using the settings and select a date interval, the radar plots will take that into account.

General>Settings>Use All dates and deselect the checkbox. Fill the required From- and To dates and press Submit. Then request the radar plot as previously described.

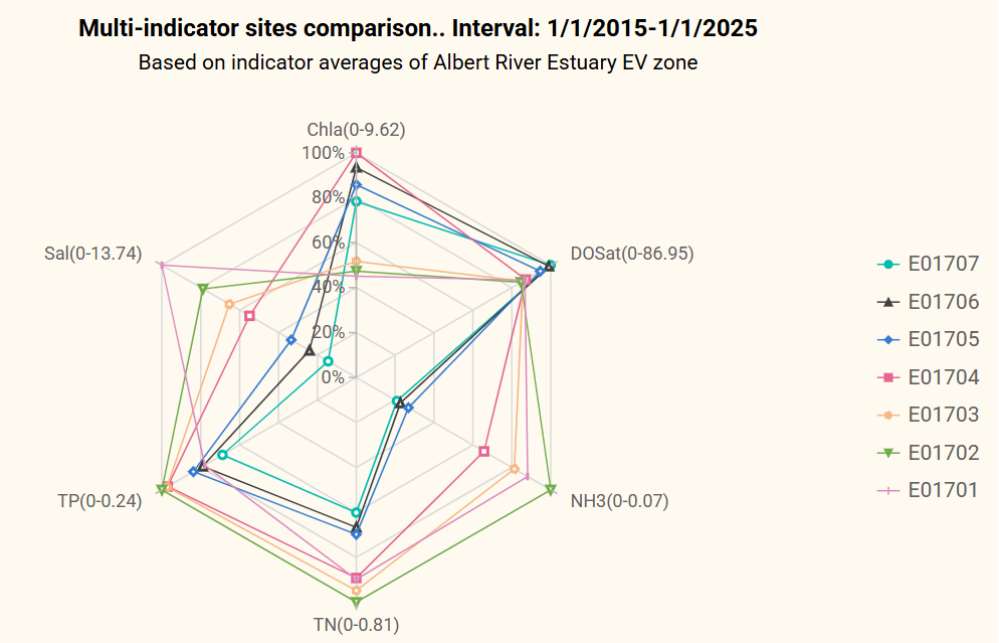


Figure 31 Setting a date interval will be included in the radar plot.

Exporting EV-zone values

Menu: EV zones>Export EV MTS

By selecting Export EV MTS , the values of the selected indicator from the sample locations in an EV-zone can also be visualised in a pivot table and copied to the clipboard, see Figure 28 to be transferred files that can be imported into other programs e.g. Excel sheets, text files etc..

Please not that only the time-series can be exported, not the Box-Whisker charts.

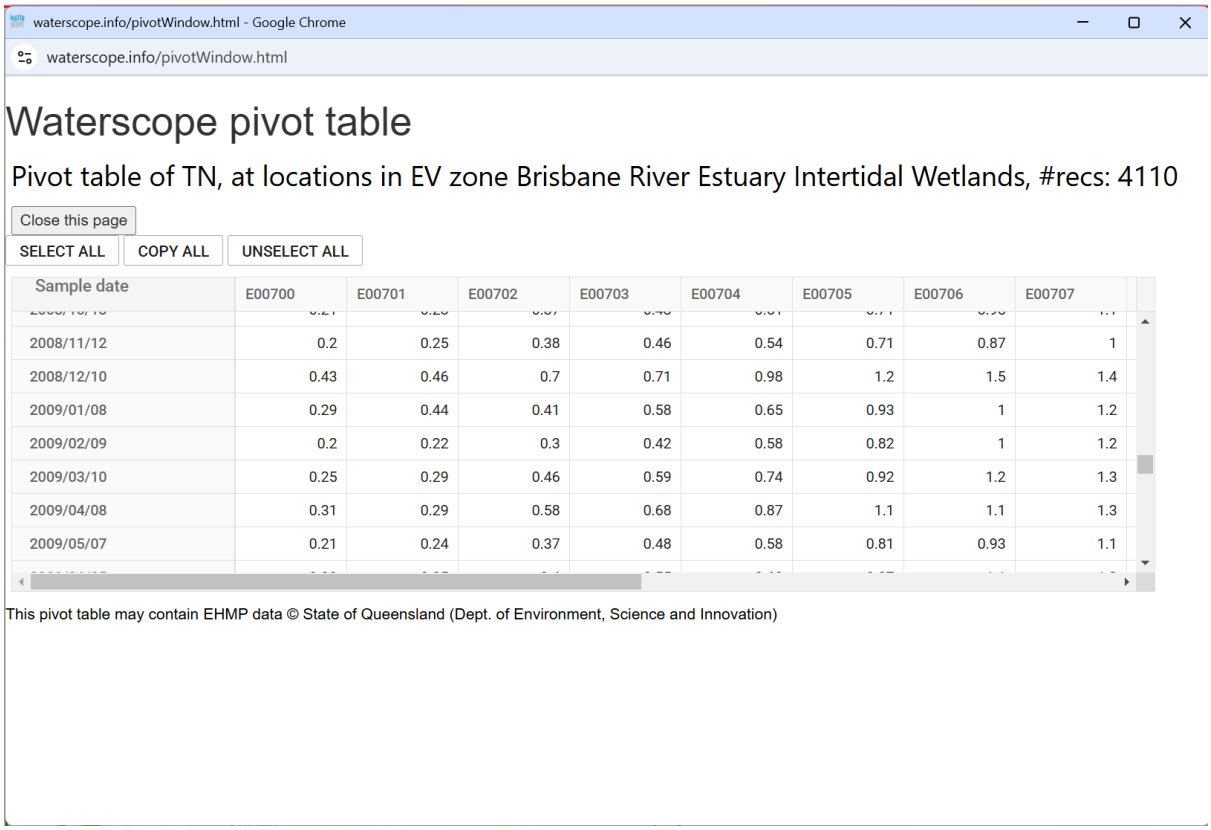


Figure 32 The indicator values at the locations within the selected EV-zone can be shown in a pivot table and copies to the clipboard for further analysis.

EV regions maps and legends

The two Figures below serve as a lookup table to find which sample locations fall within

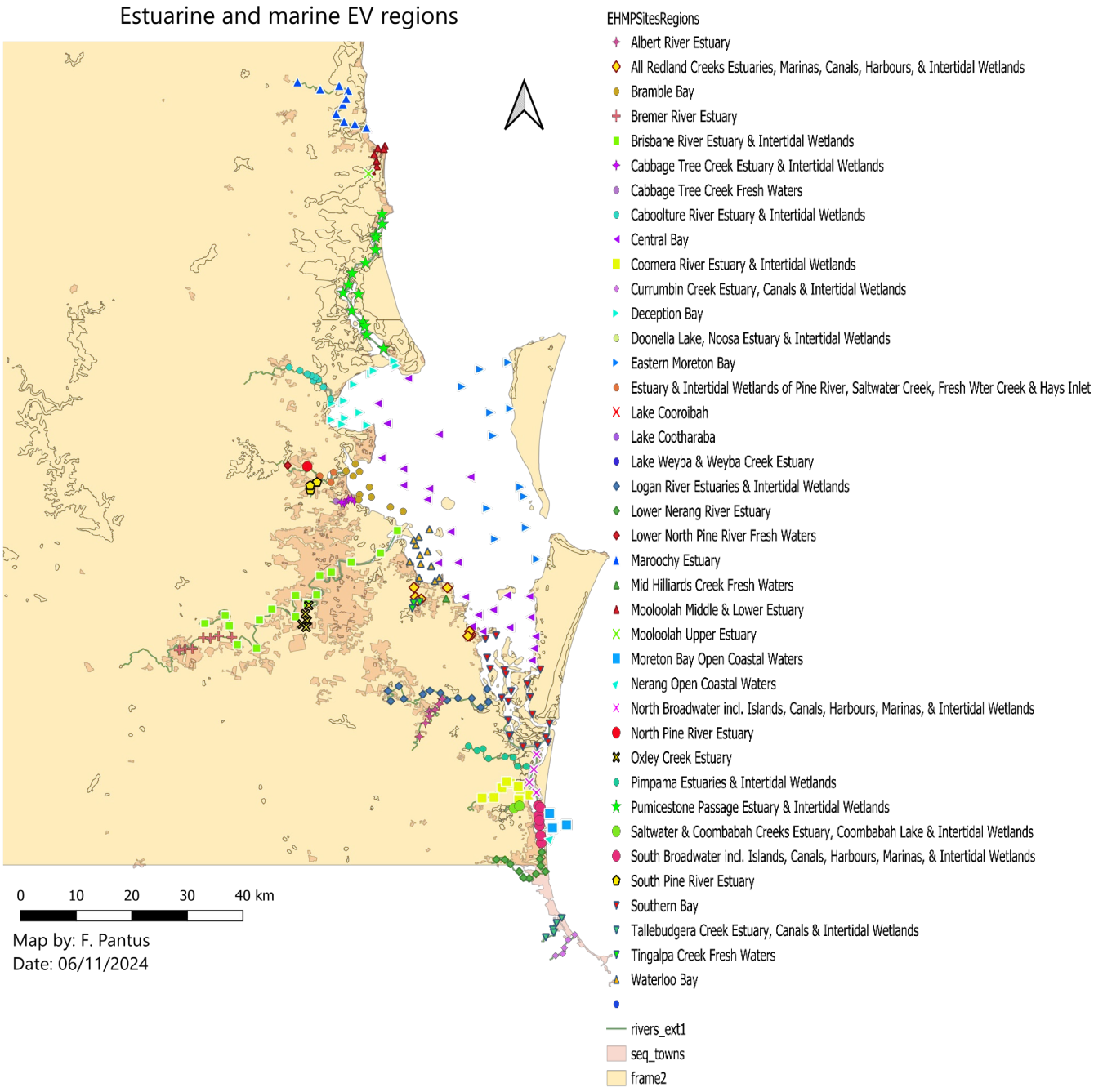


Figure 33 Map of Estuarine/Marine sample locations, grouped in EV regions.

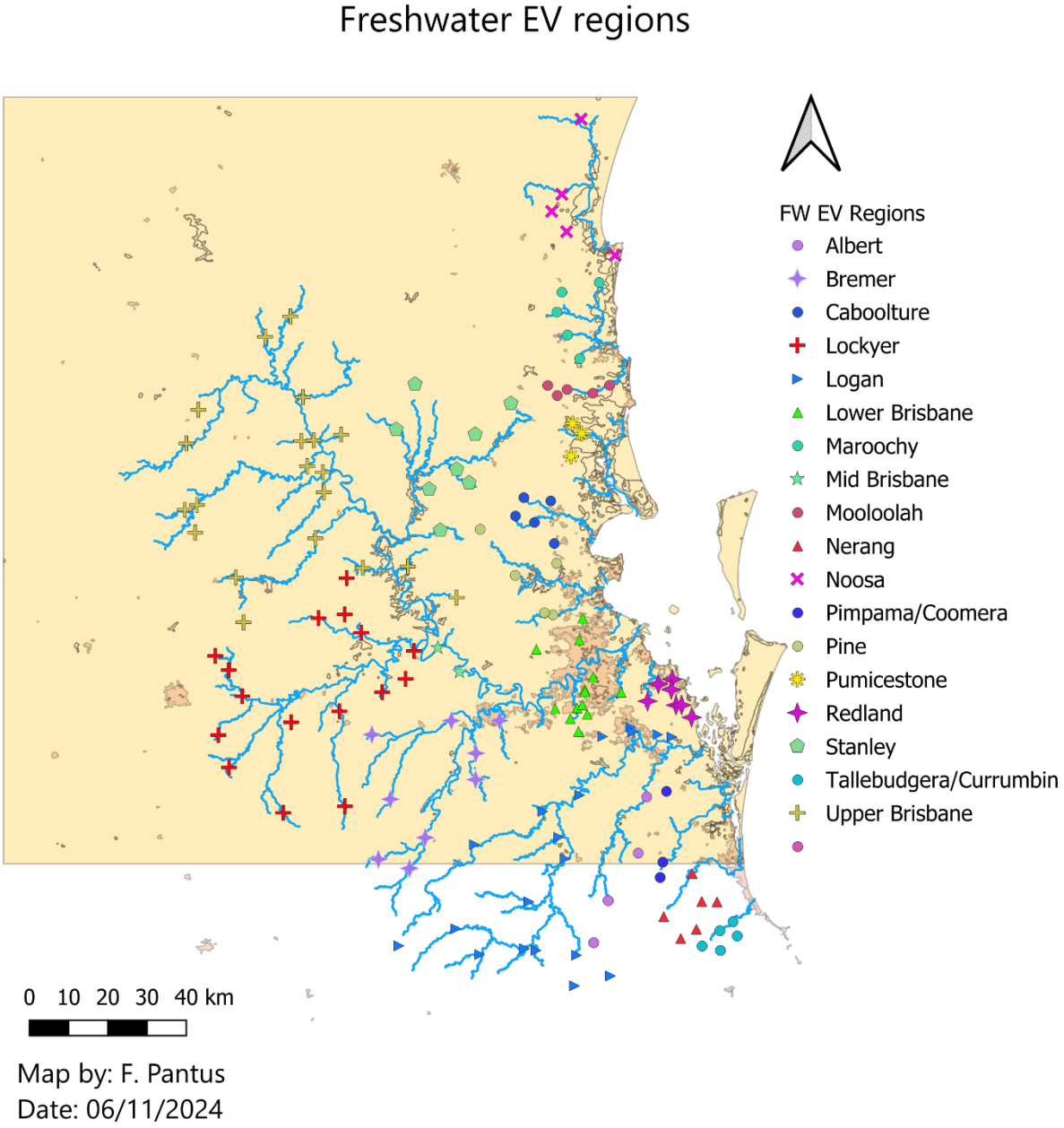


Figure 34 Map of Freshwater sample locations, grouped in EV regions.

Appendix A: Image gallery of graphs and charts

Cross/auto correlation function

We expect the processes that generate the EHMP data not to be in sync. For instance: an increase in nutrients is not expected to have an instantaneous effect on the growth of algae. A rain event in the upper catchments may cause delayed increase in river flows, nutrients or water turbidity. The **CCF** (cross-correlation function) is created by shifting two time-series in one months steps and calculates the cross correlation at each step. Peakes (+ or -) in the CCF chart other than at zero-delay may indicate that the underlying processes cause time-shifted responses. But it also may mean periodicity (e.g. seasonal) in the (underlying) processes. These delays may cause totally wrong conclusions about the underlying processes when based on 'normal' regression analysis only, so CCF is a powerful tool to examine relationships within the spatio-temporal EHMP and other data set. Calculating the CCF bases on the same time-series is named ACF (Auto-Correlation Function) and tells us something about the periodic (e.g. seasonal) behaviour of an underlying process.

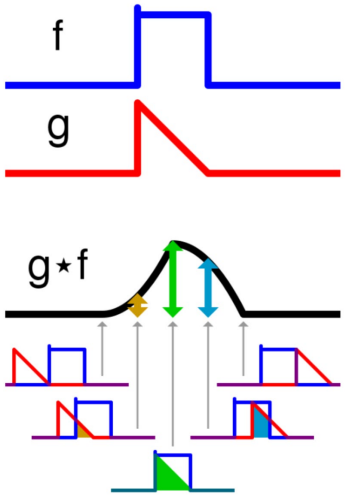


Figure 35 Diagram explaining the basics of the cross-correlation function.

The application of the CCF algorithm shifts the top chart time-series along the bottom chart time-series from minus-NDelay to plus-NDelays. NDelays is the number of shifts to the right of the CCF-button. Together with the zero delay, there will be 2*NDelay +1 points in the CCF graph.

Peak (+/-) in the negative delay portion (left side) of the graph indicate that the time-series in the top graph is delayed (occurs later in time) with respect to the time-series in the bottom graph. Visa verse, peaks on the left-side of the CCF graph indicates that the bottom graph time-series is delayed with respect to the top graph time-series. A peak at zero delay can be interpreted that the two time-series are in sync.

Example of a cross-correlation function

To create a cross- or auto-correlation function, both graphs must contain data. For a cross-correlation function, the date in the two graphs must be from different time-series, for an auto-correlation function, both graphs must contain the same time-series.

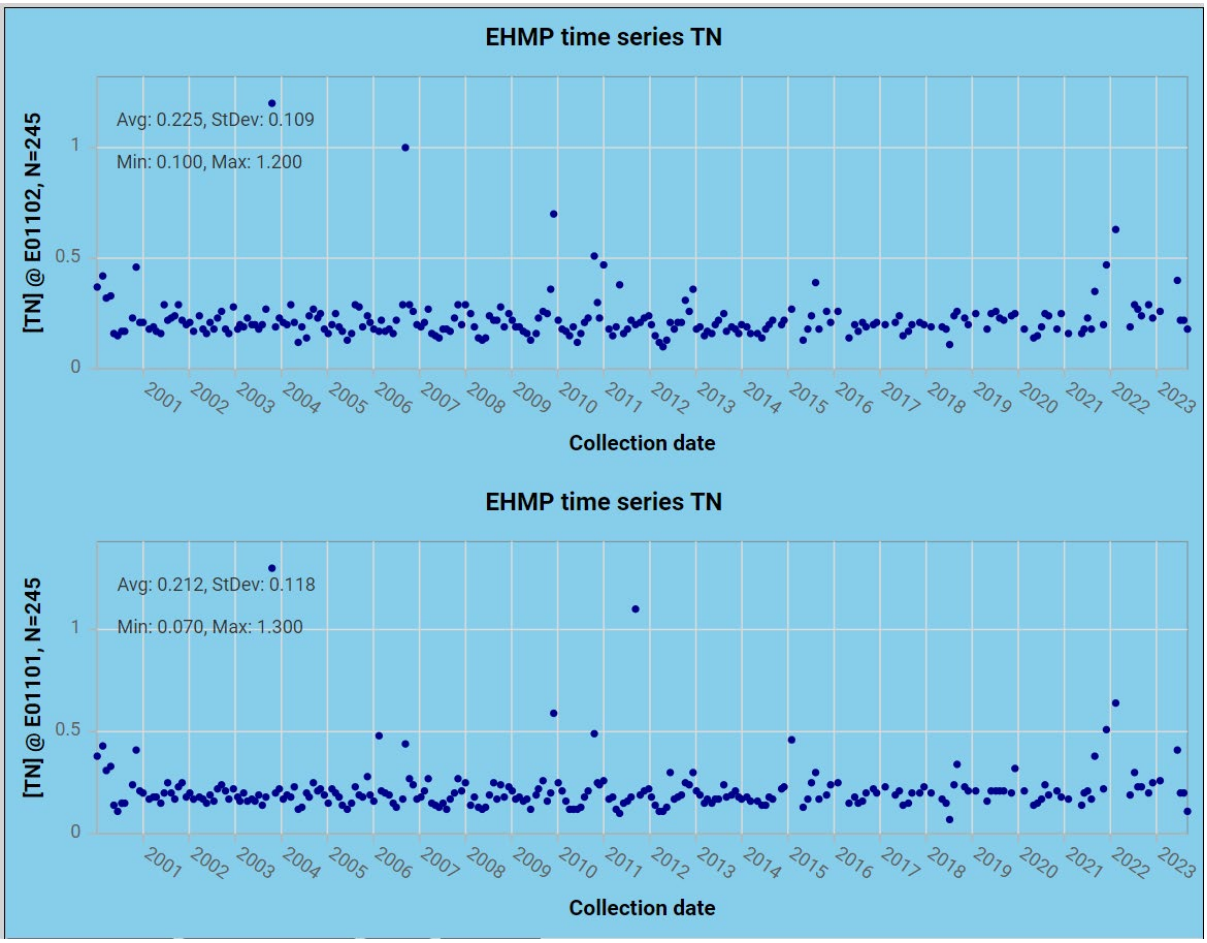


Figure 36 For a cross-correlation function, both graphs should contain a different time-series

The number of delays are set to 4 by default but can be changed in the Settings: ***Menu: General>Settings>CCF delay***.

Depending which graph is active (top or bottom), the CCF (or ACF) function is calculated and charted there.

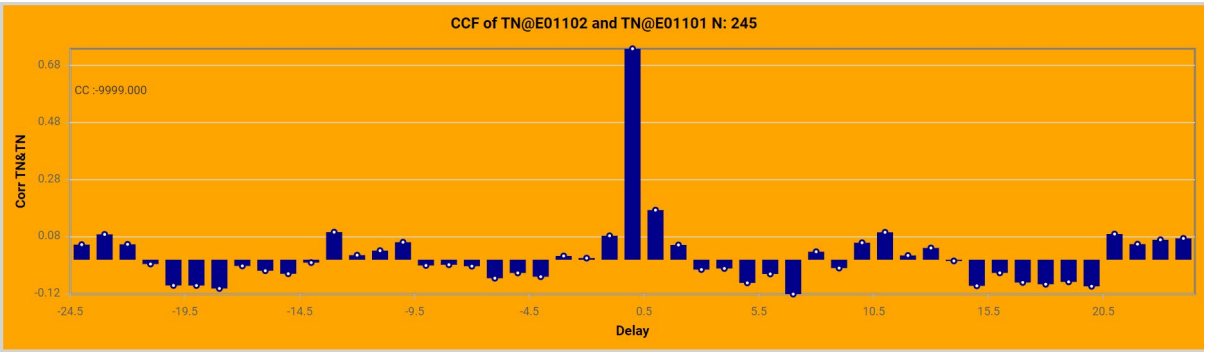


Figure 37A cross-correlation function shows the correlation between two time-series that are shifted N delay steps relative to each other. It allows us to examine the strength of the relationship of two time-series that may be delayed with respect to each other.

Example of auto-correlation functions (ACF).

After loading two time-series (same location, same indicator), and setting the number of delays to 24 (two years) and selecting the CCF button, the result is charted on the active (top or bottom) graph.

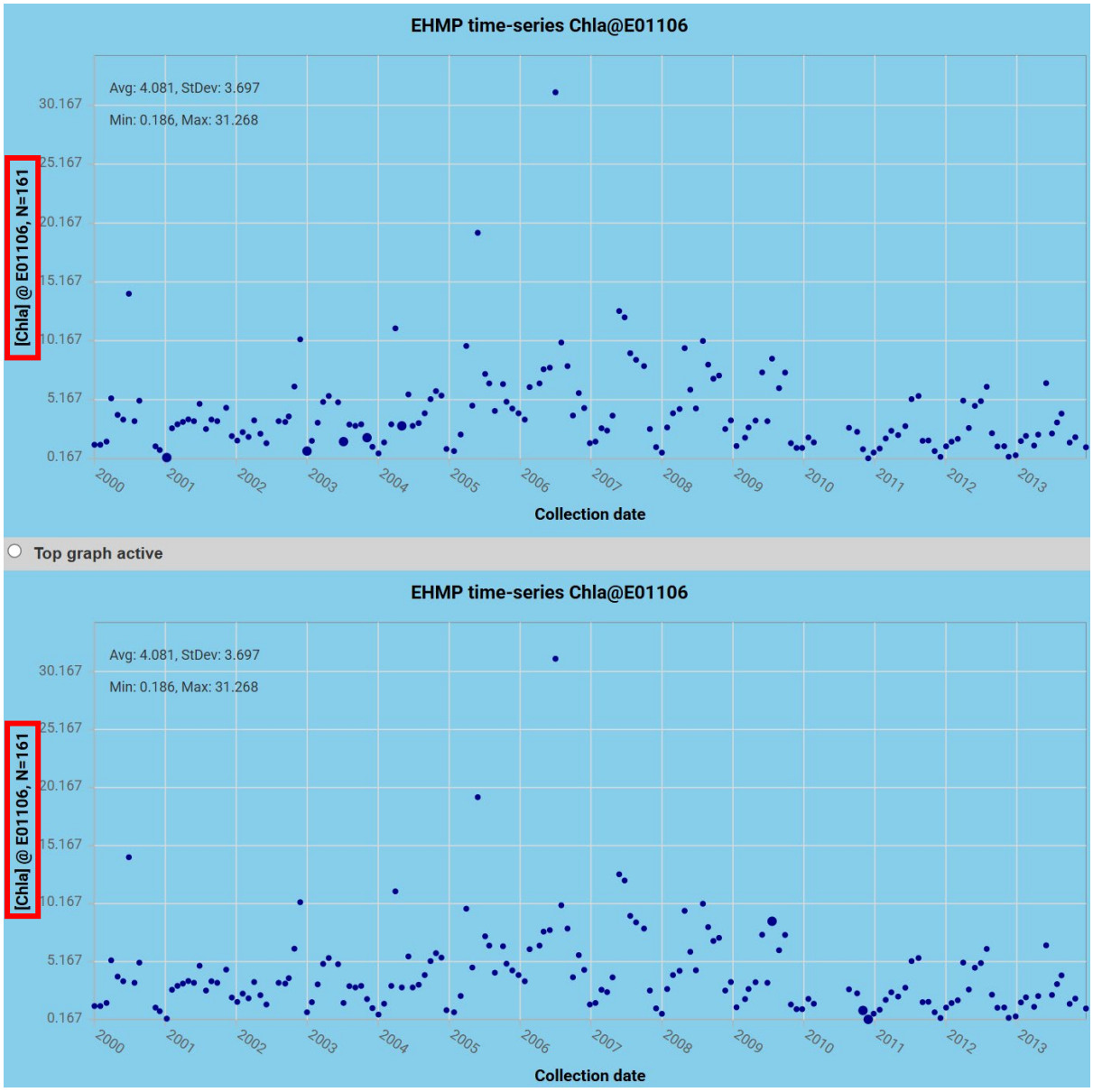


Figure 38 To calculate an auto-correlation function, both graphs must contain the same time-series.

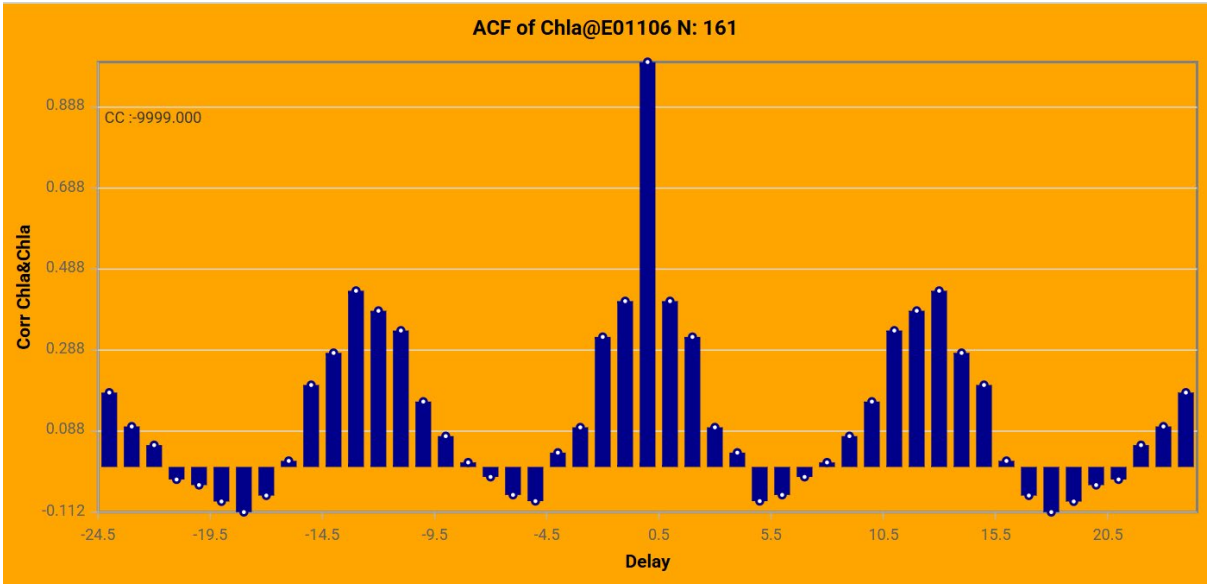


Figure 39 An auto-correlation function reveals the presence (or absence) of periodicity in a time-series. This Chl_a time-series near the mouth of the Caboolture River (location E1106) shows a clear annual (+/- 12-13 months, +/- 25 months) periodicity, reminiscent of a biological boom/bust cycle based on available light and water temperature. Currently the X-axis labels are a bit confusing and should have integer values, subtract 0.5 from all x-axis values.

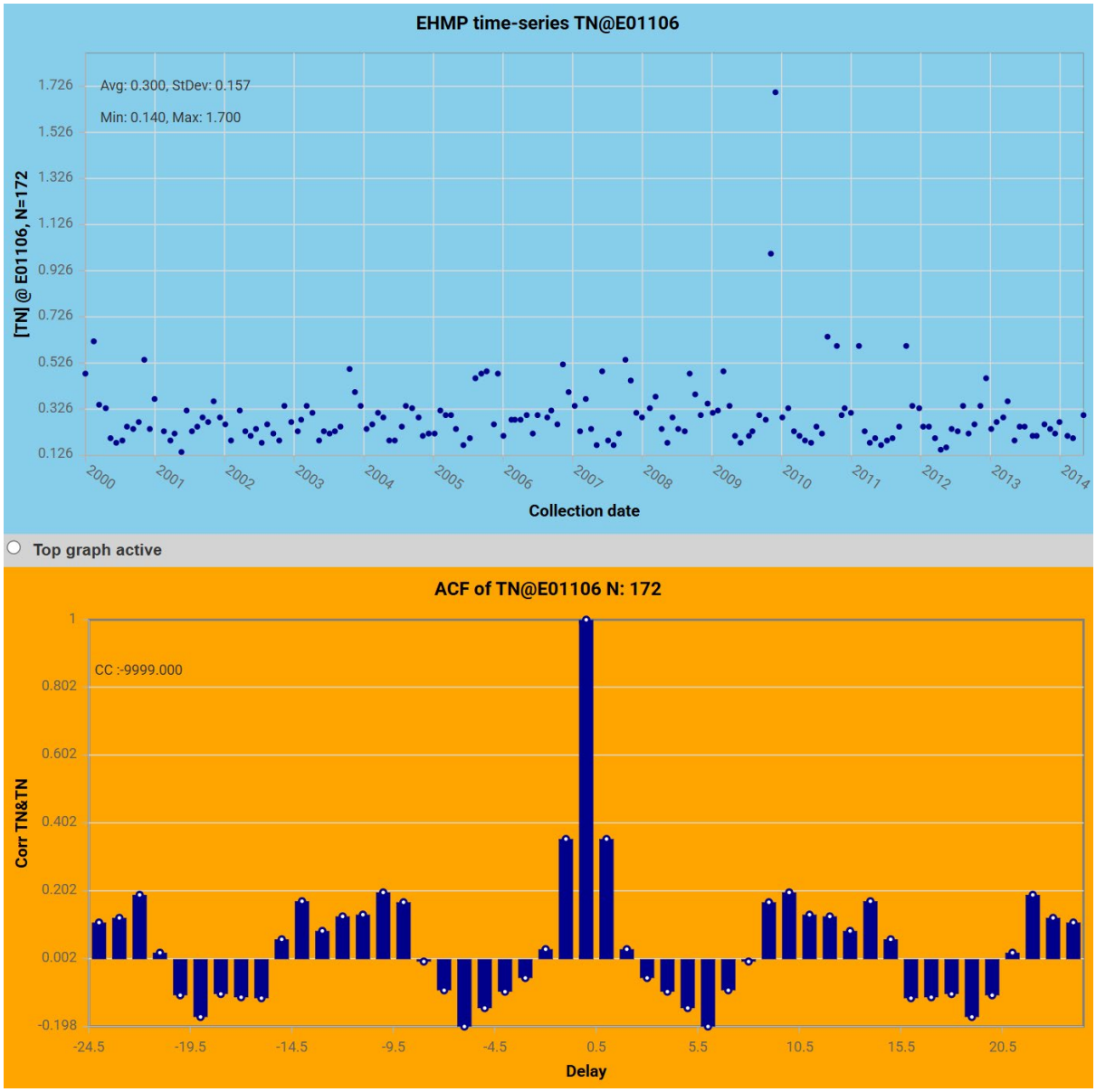


Figure 40 The ACF of TN at the Caboolture River mouth (location E1106) shows a more 'smeared' correlation function annual cycle, possibly driven by the inter-annual variation of rainfall and river discharge.

The ACF reveals recurrent dynamics (periodicity) in a time-series, e.g. seasonality, regular man-made disturbances etc..

This is a simple replacement of more detailed frequency domain analysis such as discrete Fourier transforms.

Appendix: Some comments wrt the data

Temporal granularity

The temporal granularity of the sampling intervals of the EHMP data is in months.

To keep data in some kind of sync, daily data such as rain and river discharges are represented as monthly sums. To keep things simple, the representation date is the 28th of each month as all month, including February, will contain that date.

Spatial granularity

The spatial granularity is at the EHMP sample sites, both for the river/estuarine/bay as well as the freshwater programs. Except for the Southern Oscillation Index (SOI) data which is only available for the whole of Australia. Selecting any site will access the same SOI data.

Detection level

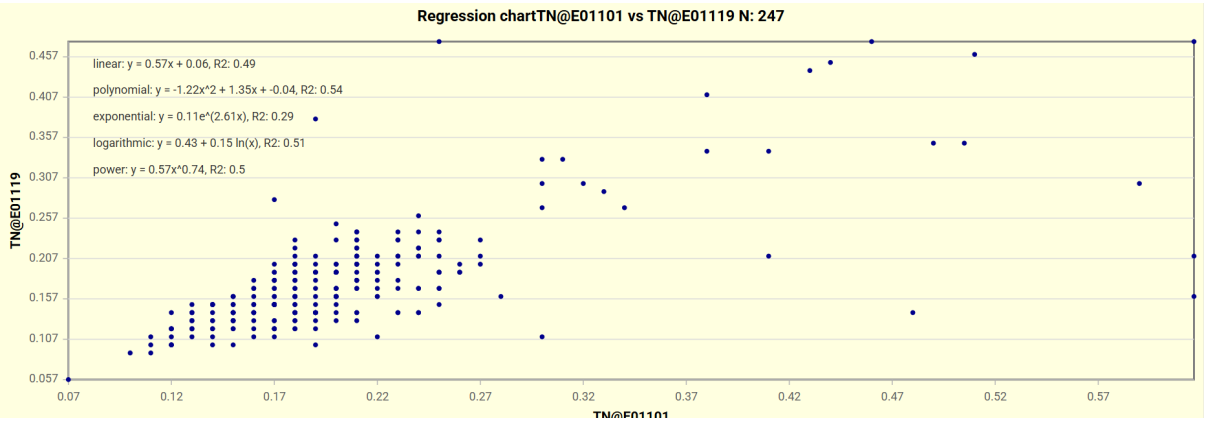
All indicators that are found to be below the detection level, are represented at half that detection level.

Secchi depth

Secchi depth found to be more than the available depth at a station are represented as NODATA.

Apparent discrete classes in data

Notably the Total N data shows up in graphs as discrete classes (columns in the graph below). The reason is that the laboratory supplies that data with two decimal precision only.



Appendix: Maps and Charts Gallery

Maps

Various ways to view the selection map

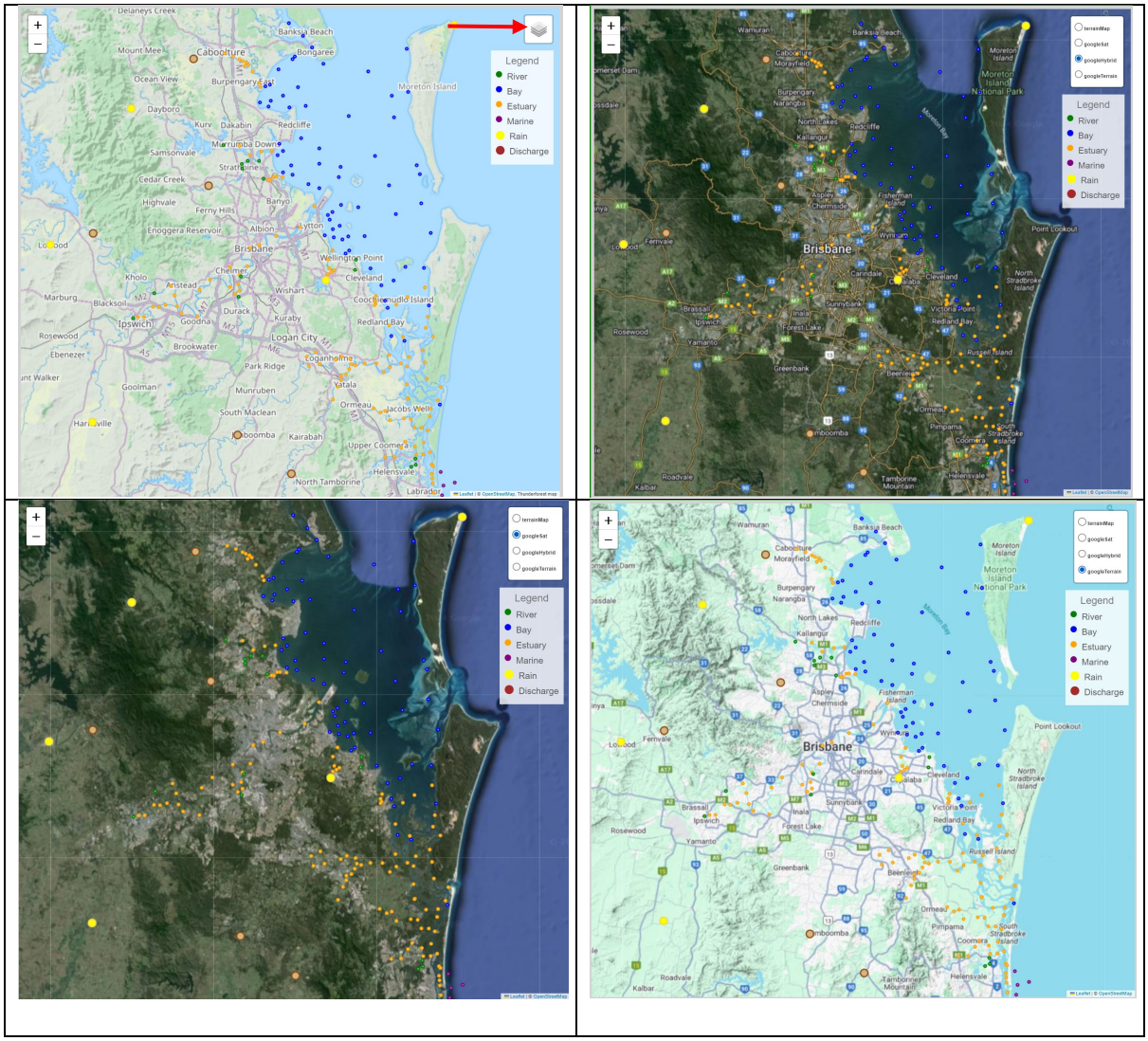
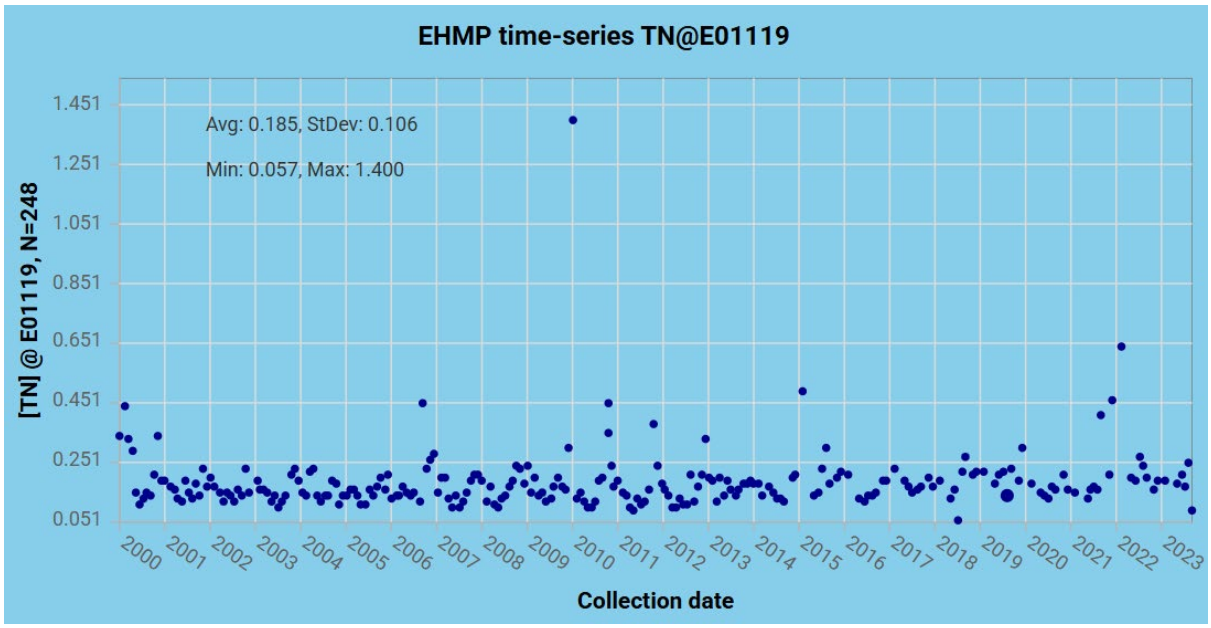


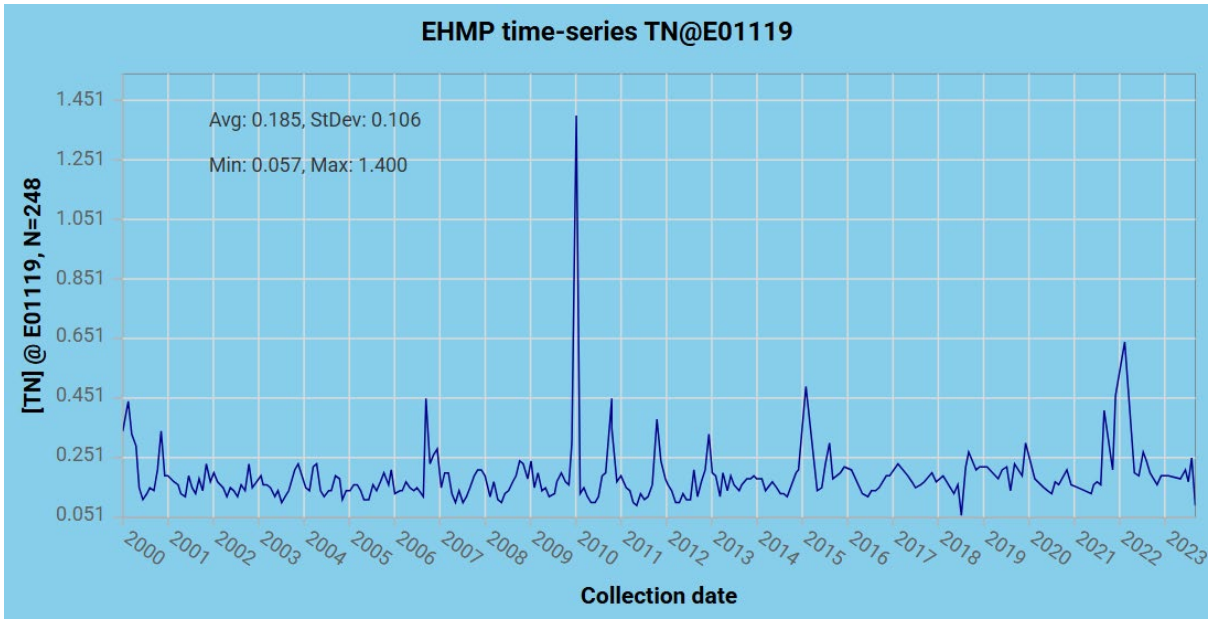
Chart types

Time-series

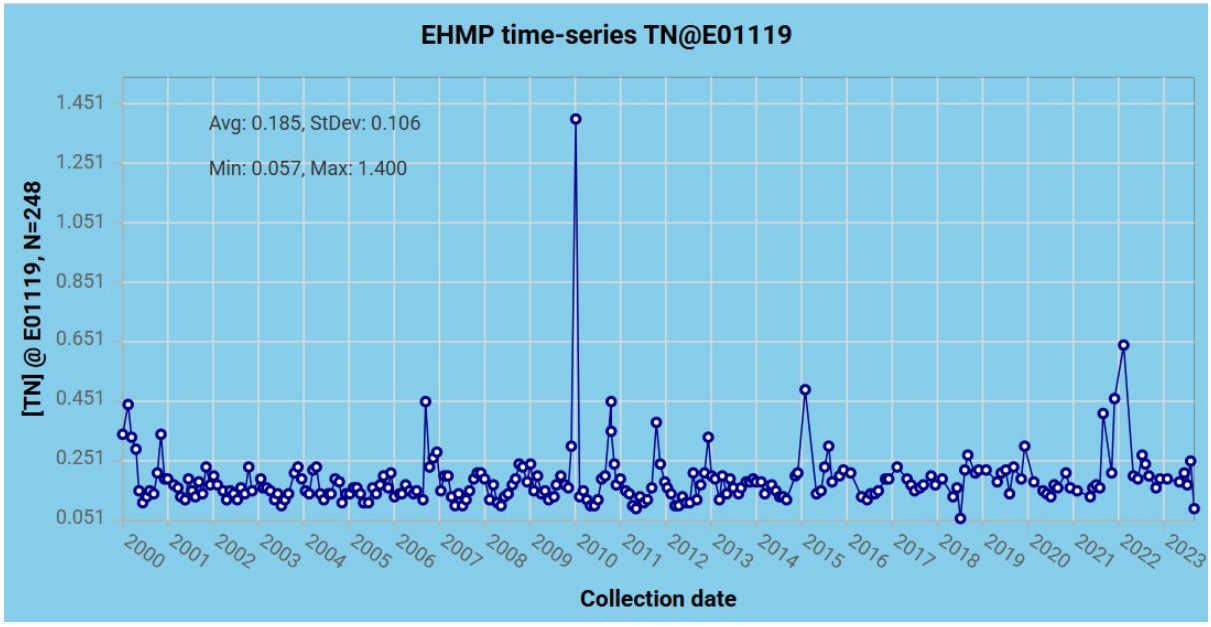
Scatter



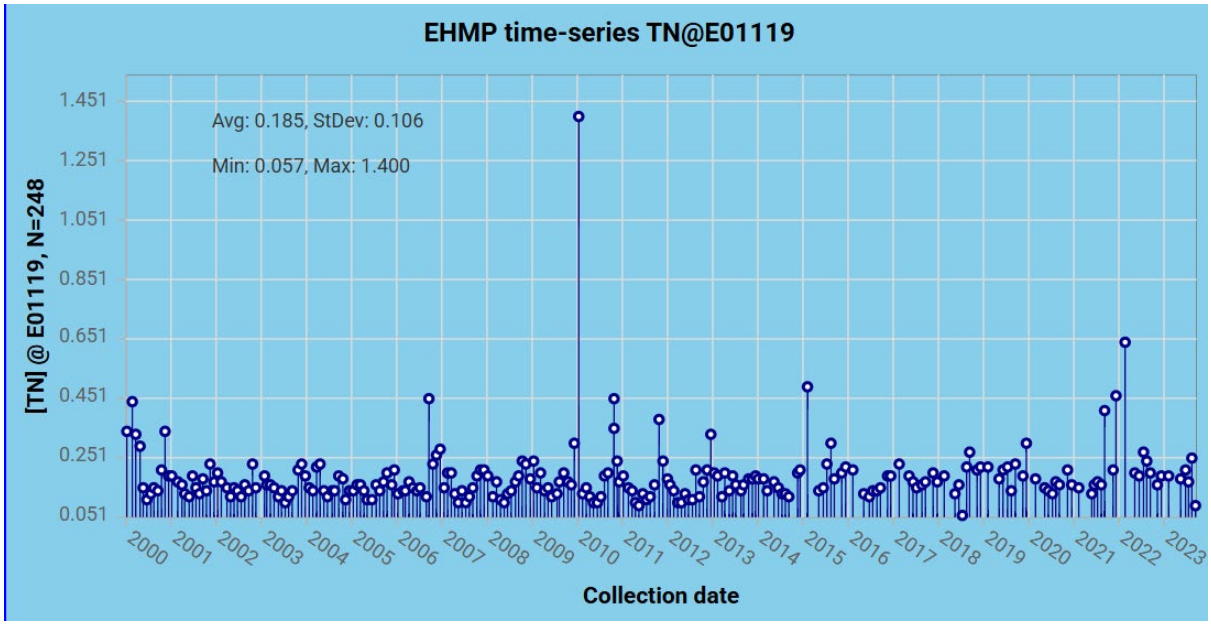
Line



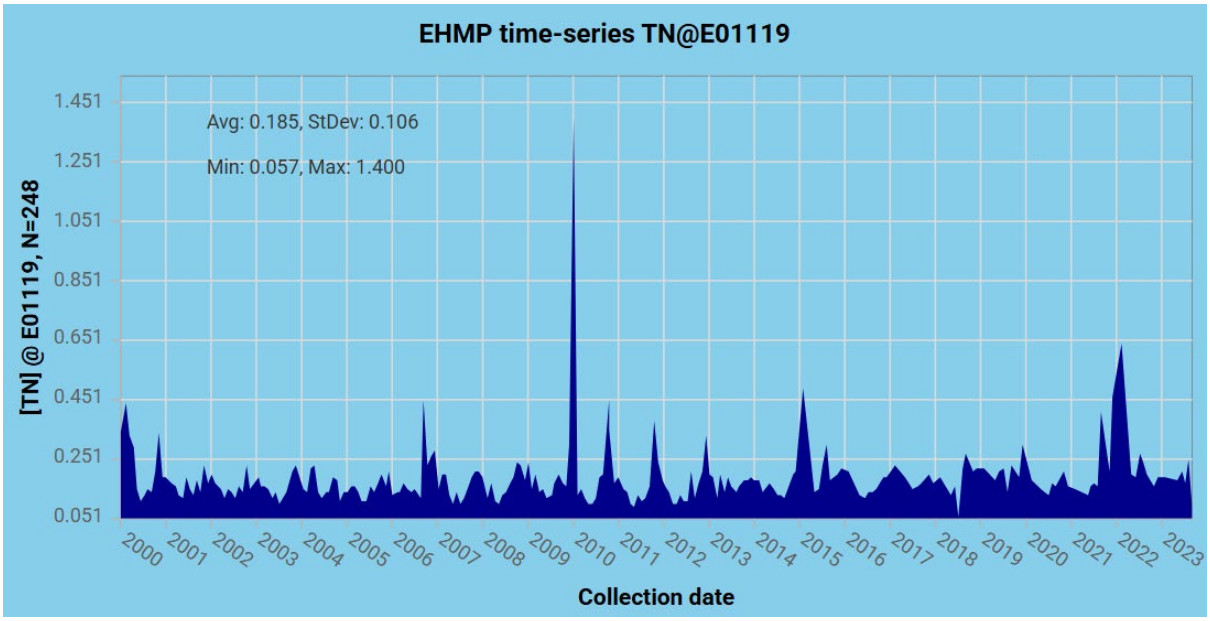
Line with markers



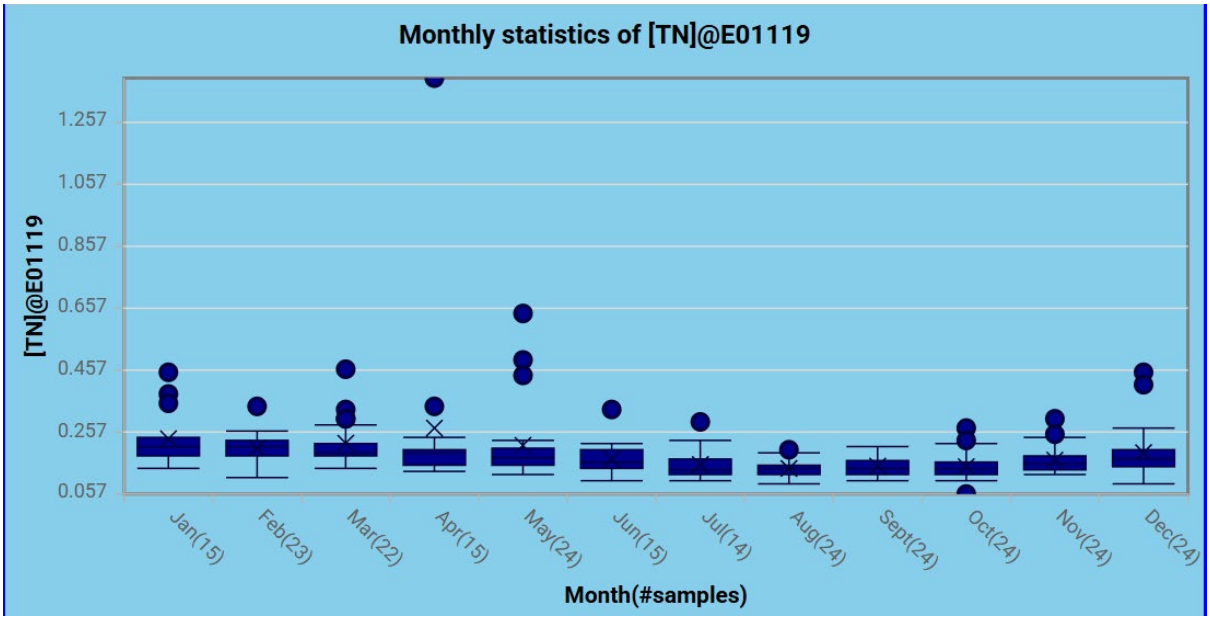
Bar



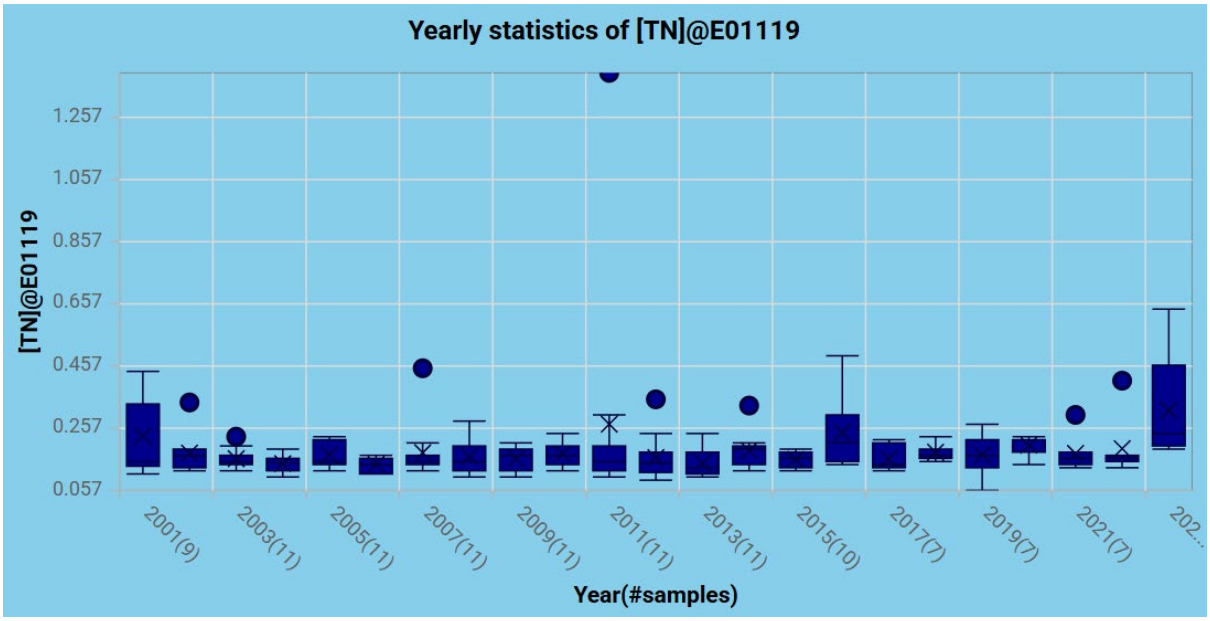
Area



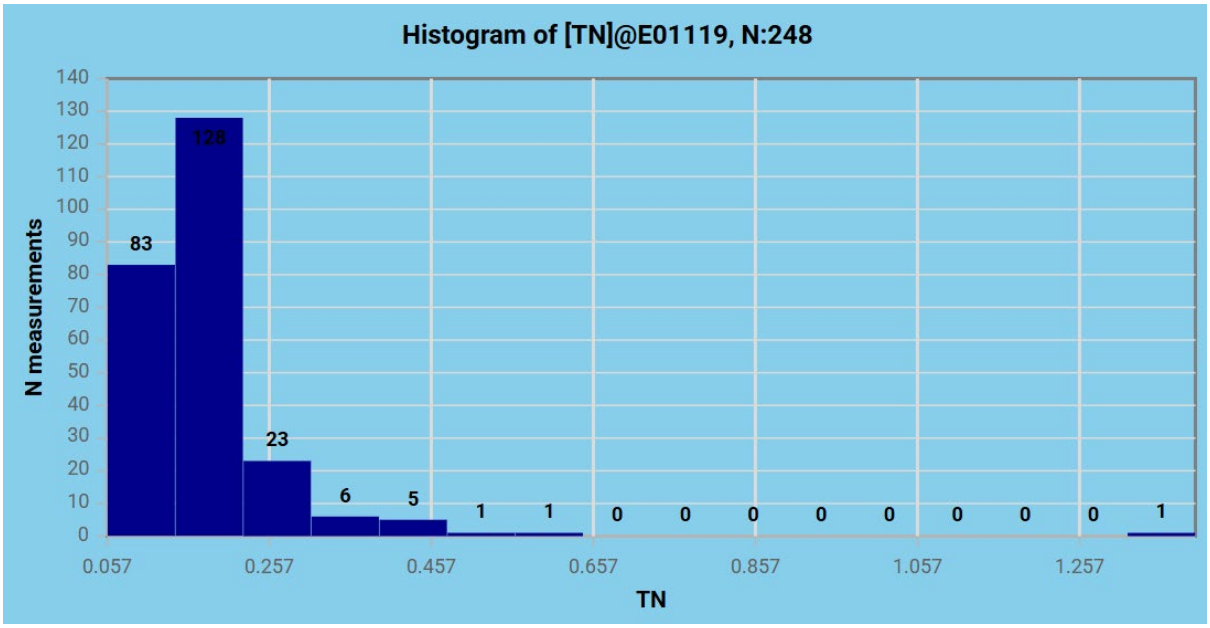
Box and Whisker per month



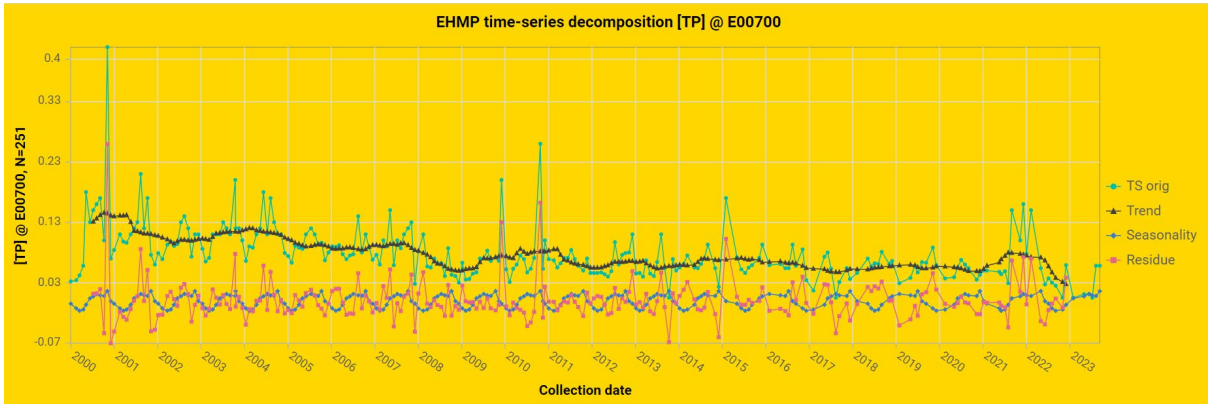
Box and Whisker per year

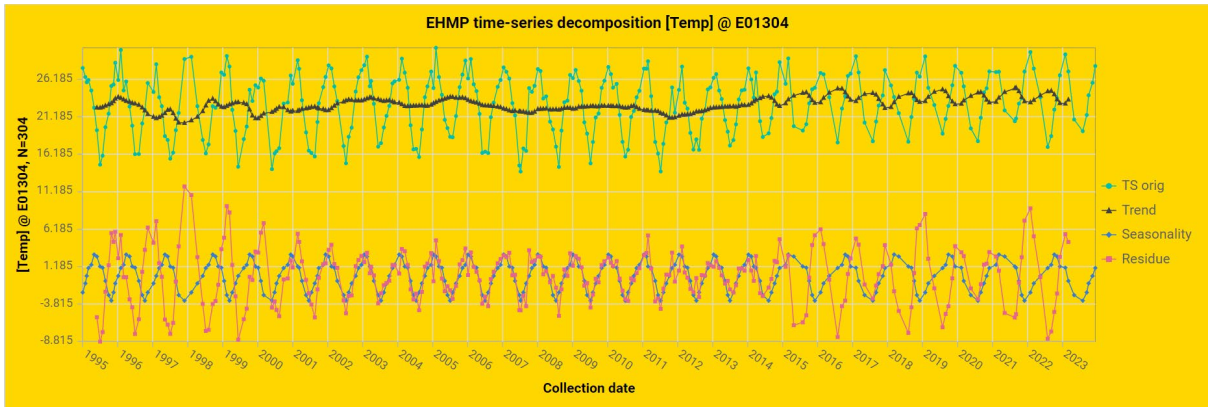

Yearly statistics of [TN]@E01119
[TN]@E01119
1.257
1.057
0.857
0.657
0.457
0.257
0.057
2001(9)
2003(11)
2005(11)
2007(11)
2009(11)
2011(11)
2013(11)
2015(10)
2017(7)
2019(7)
2021(7)
Year(#samples)

Histogram

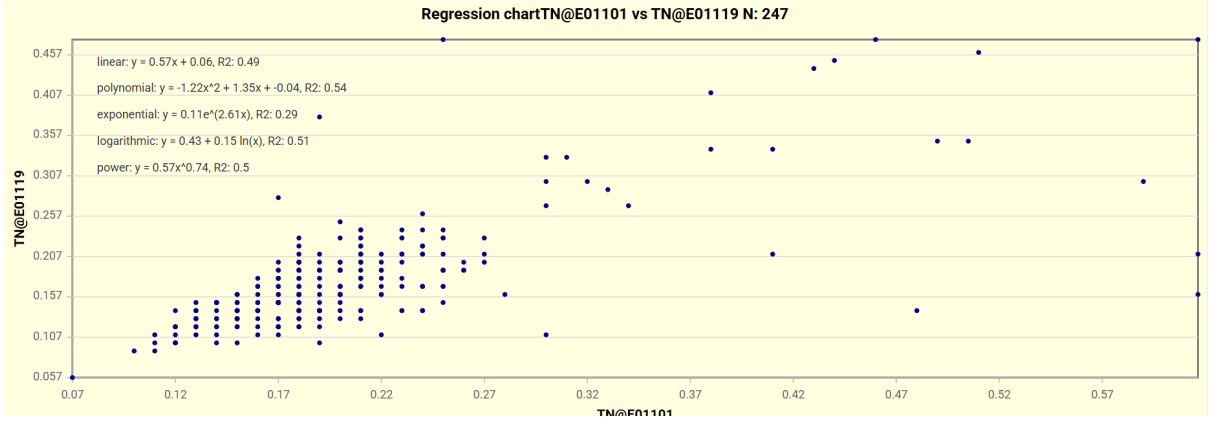

Histogram of [TN]@E01119, N:248
N measurements
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
83
128
23
6
5
1
1
0
0
0
0
0
0
0
0
1
0.057
0.257
0.457
0.657
0.857
1.057
1.257
TN

Time-series decomposition

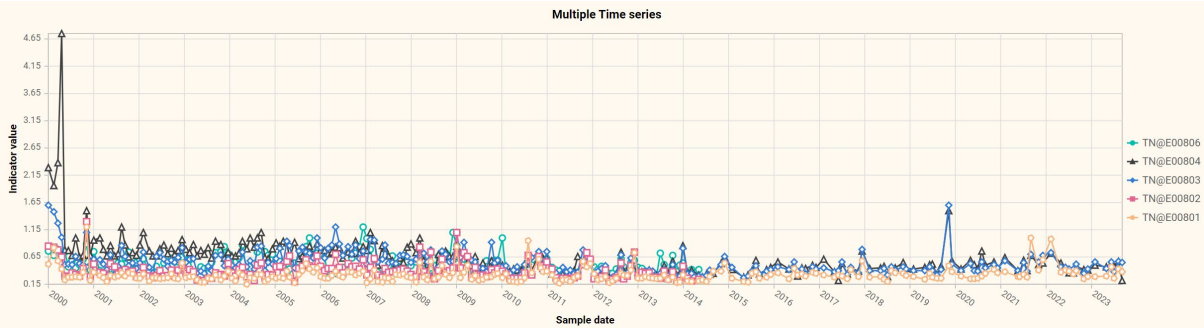




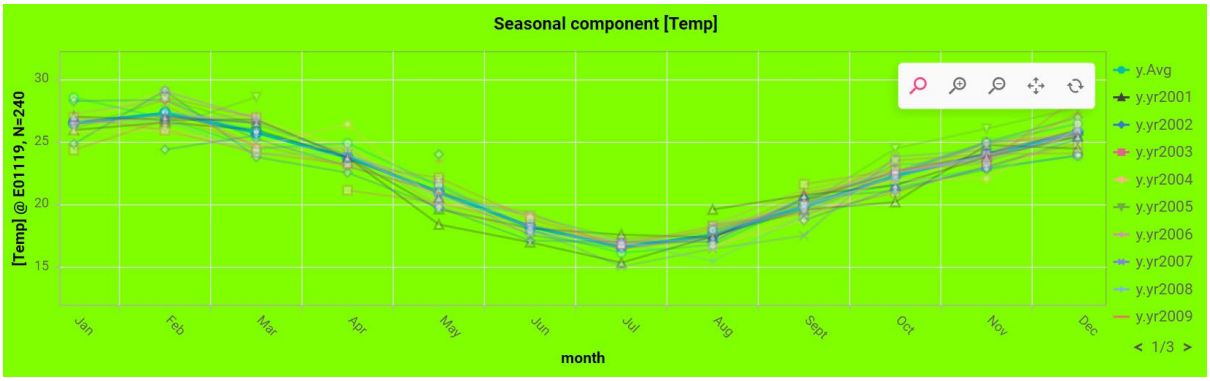
Regressions



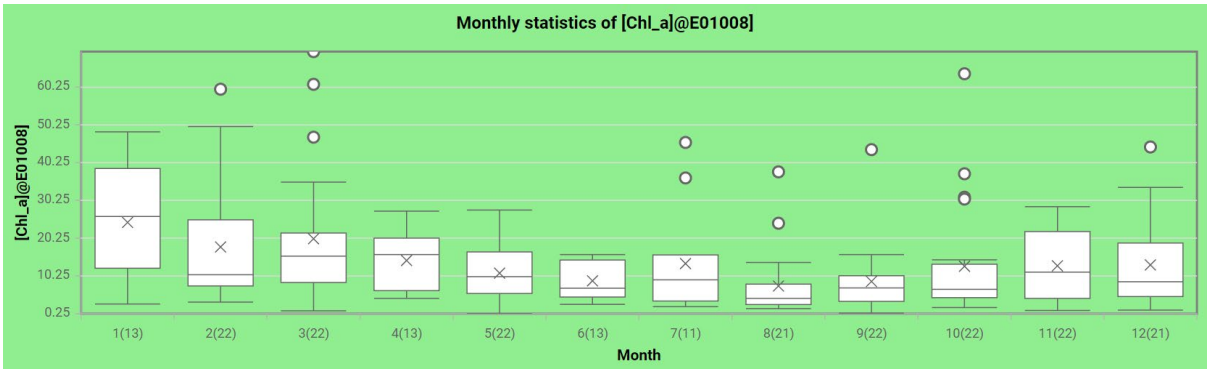
Multiple time-series



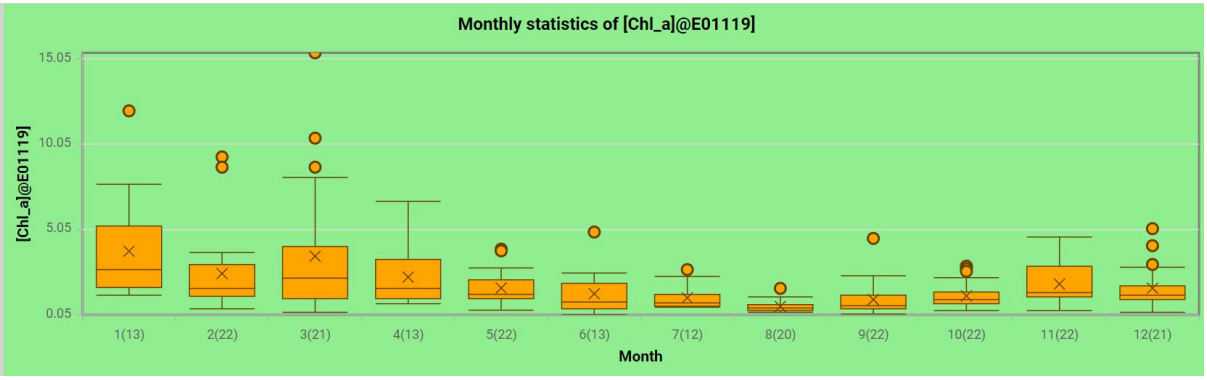
Seasonality component



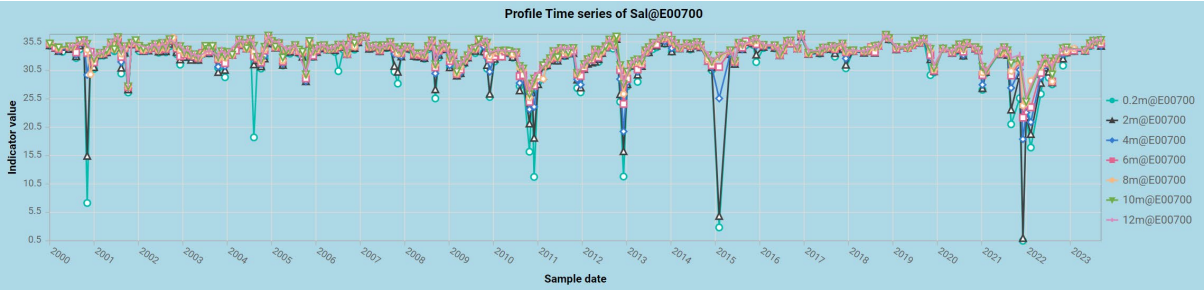
Box-Whisker



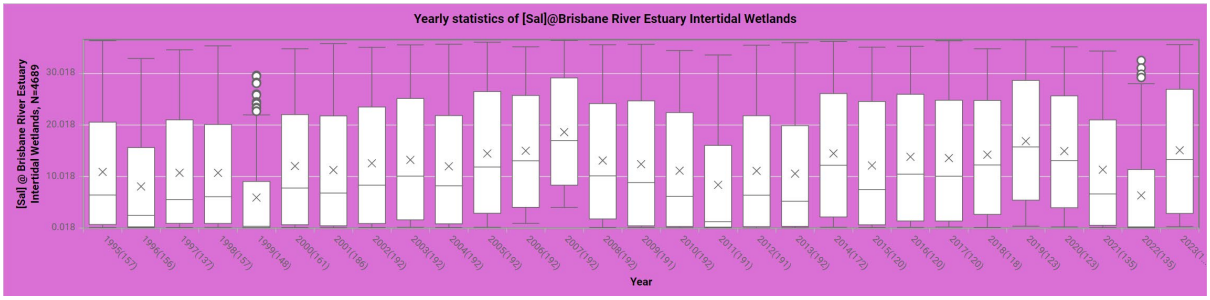
Box-Whisker, different colours



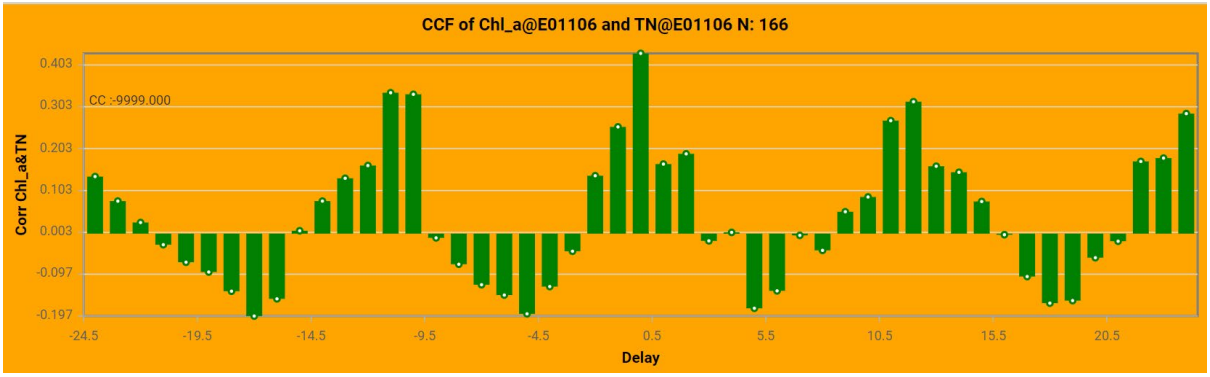
Depth profile



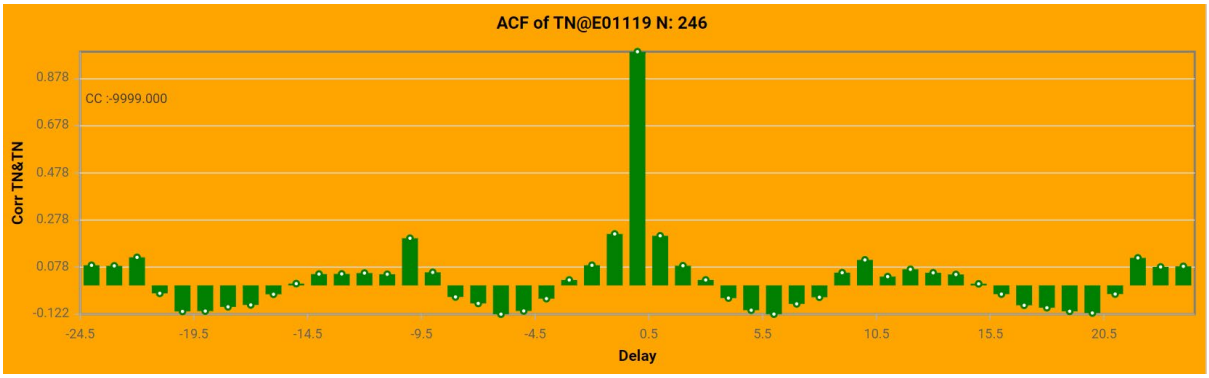
Reporting Regions



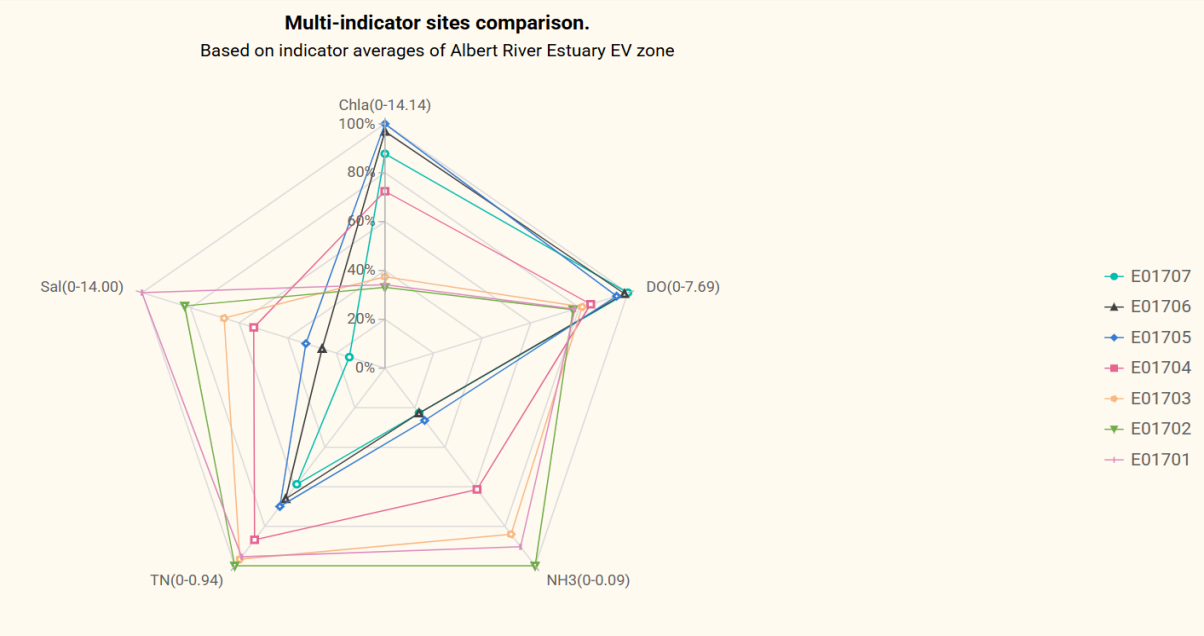
Correlation function



Autocorrelation function



Multi-indicator comparisons between EV zone or user-selected locations: the radar plot



Appendix: Environmental Values

Links to key documents:

https://environment.desi.qld.gov.au/management/water/policy

FOR DB MANAGERS ONLY

EVZones

DESI Environmental Value (EV) Zones field in the locations table is being used to delineate the various reporting zones.

To allow the reporting zone names as part of SQL queries, the '&' character must be removed with the following query:

UPDATE `ehmplocations` SET `EVZone` = Replace(`EVZone`," &","");

Depth values

The Depth value in the web-based *ehmpindicators* table in the mySQL DB is set to 0.200000002980232 (due to some formatting problems during transfer) and must be updated to 0.2:

UPDATE `ehmpindicators` SET `Depth`= 0.2 WHERE `Depth`=0.200000002980232

Table of Figures

Table of Tables