WaterScope documentation



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Scientific Modelling

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Tourism, Science and Innovation
Queensland Government

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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 2025, 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.

Artificial Intelligence (AI)

NOTE: Artificial Intelligence (AI) is bringing a revolution to many areas, including computer programming and web-design. The Waterscope website development has jumped onto this wagon with staggering results. Development of utilities that may take days or even weeks, are now done in minutes or hours. It also makes "on-demand' development a more realistic proposition.

To demonstrate the results, there now is a "Utilities" button on the main page of the Waterscope website that gives access to a range of utilities based on AI generated software modules. Have a look at Appendix A too for some screenshot images.

The WQ (Estuarine/Bay) menu now includes General, EV zones, MTS, Analyses, AI, Spatial/Temporal and Reporting categories. The AI category provides the following tools:

- Random Forest: uses random forest machine learning to find predictors for selected indicators.

- Clustering: applies clustering analyses (k-means and hierarchical) to the estuarine and bay data.

- Graph Neural Networks: network-based pattern analysis.

- Hotspot analysis: Getis-Ord spatial statistics to identify concentration hotspots.

- Time-Shifted Patterns: DTW, LSTM and CNN analysis of shifted time-series patterns.

- 3D Data Cube: interactive 3-D visualisation (time x location x indicator) with rotation, cutting and slicing.

- Trend and forecast: time-series decomposition, trend regression and multi-indicator forecasting.

- PCA is available from the Analyses category, while Spatial/Temporal video workflows and Reporting tools are available from their own menu categories.

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.

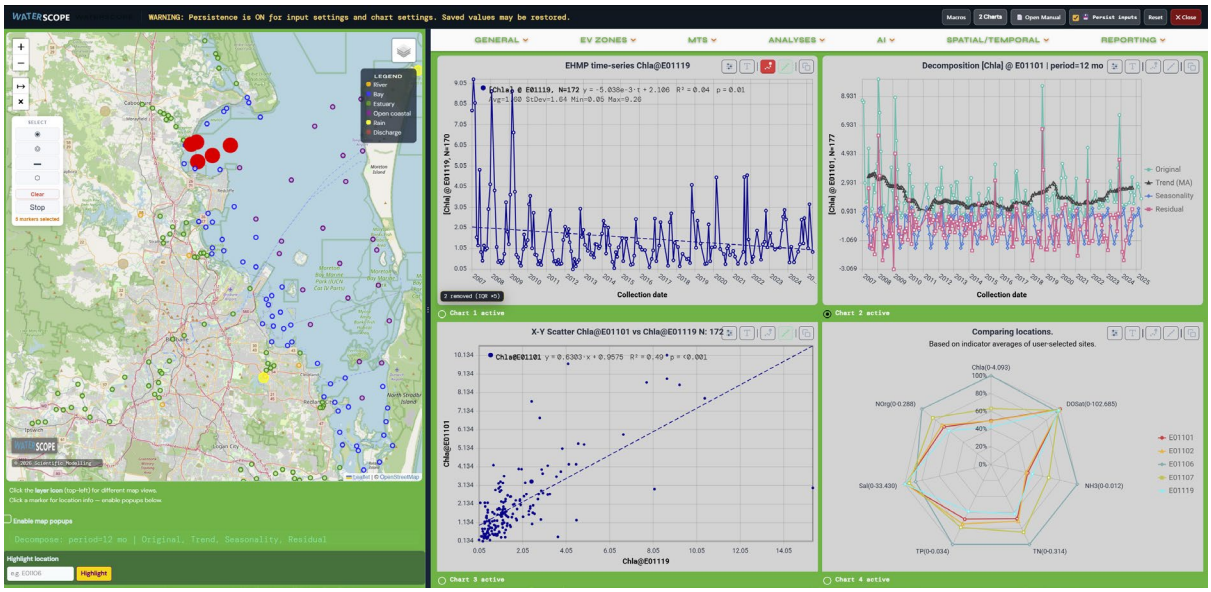


Figure 1 Overview of the user interface of the Estuarine and Bay data part of the Waterscope website.

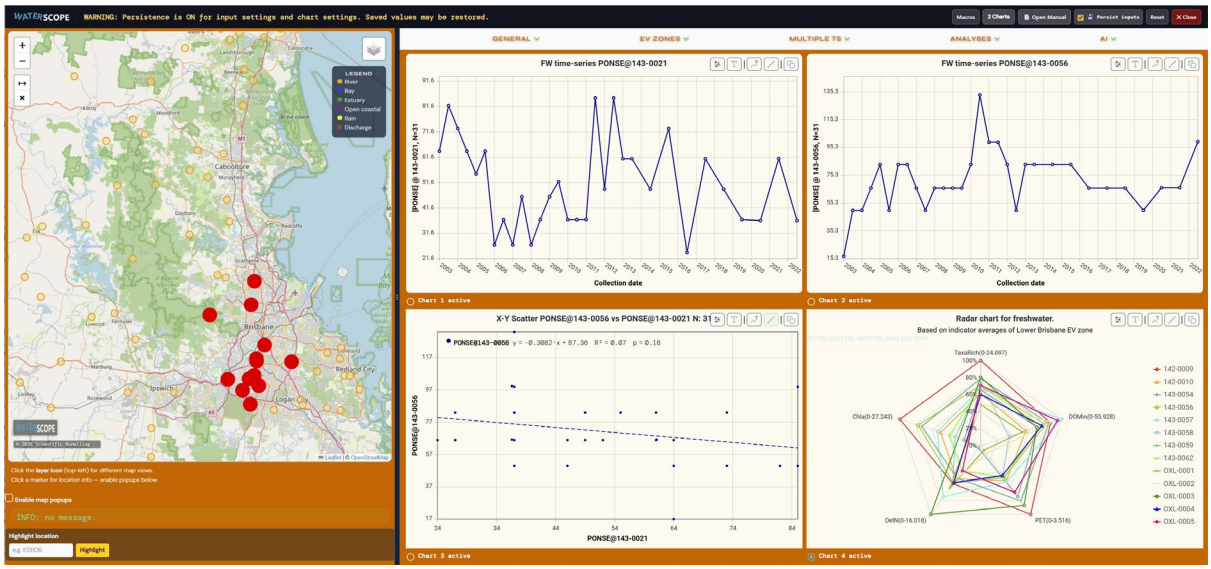


Figure 2 Overview of the user interface of the Freshwater data part of the Waterscope website.

Visualisation and analysis functions

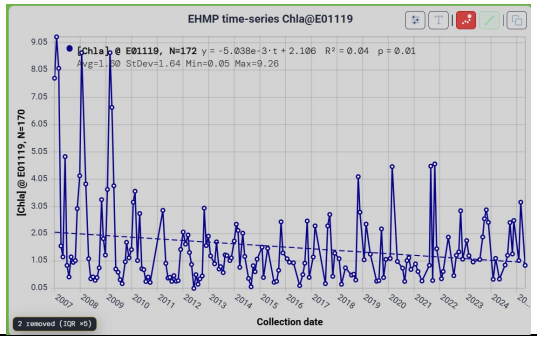
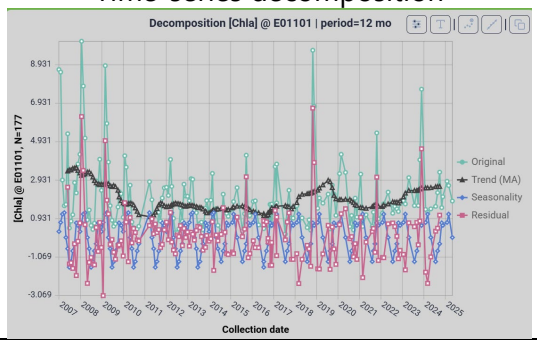
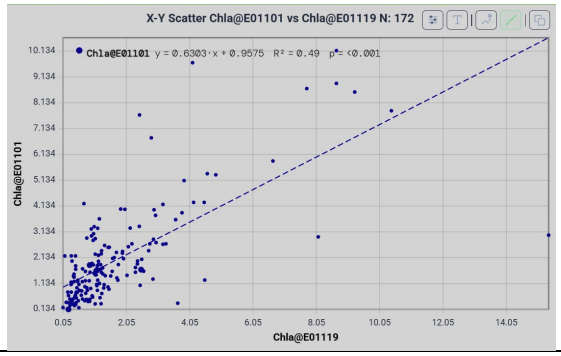
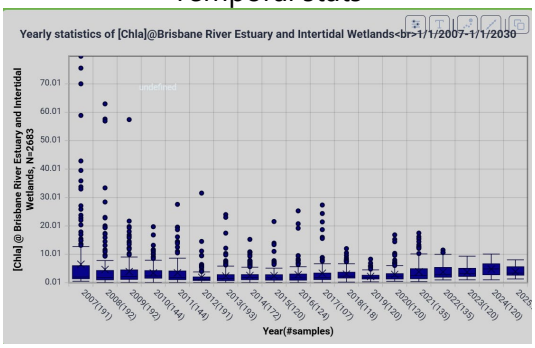
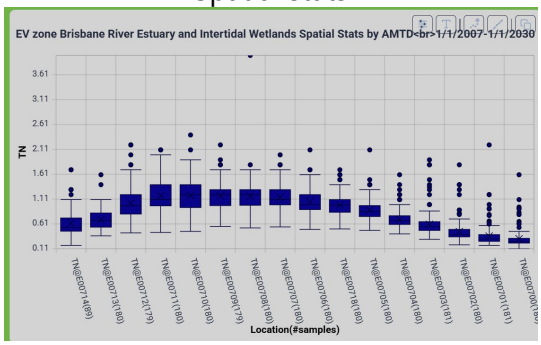
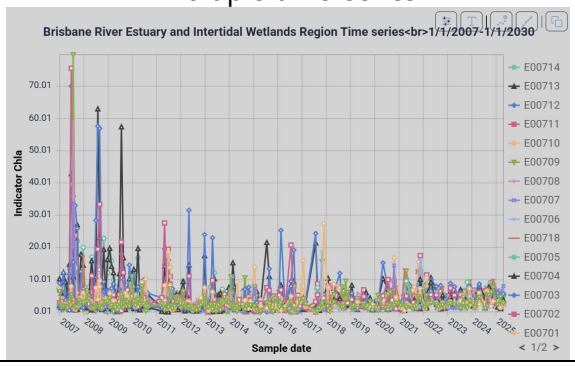
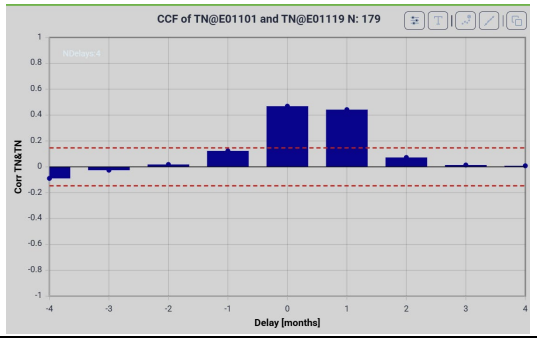
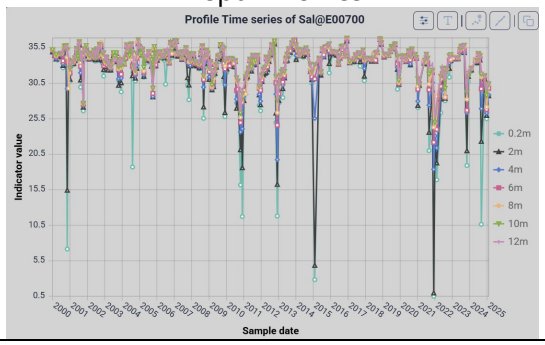
This section summarises the main visualisation and analysis tool currently available, exemplified by a series of charts. Combining in different ways the various indicators from the many sample locations opens up a very rich and easy to obtain learning about the rivers, estuaries and bays in SE-Qld. See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

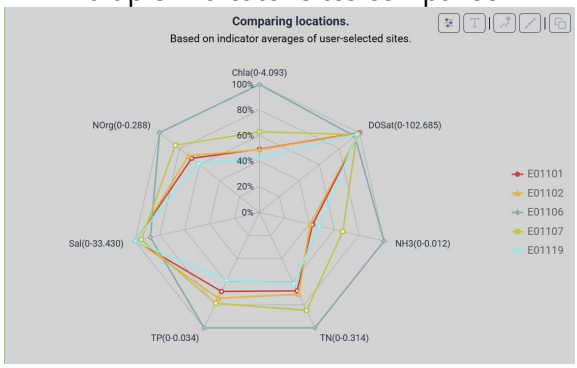
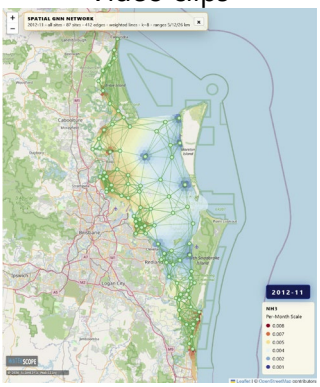
- Single time-series of water quality indicators from a selected sampling location
- Time-series decomposition gives an instant insight into the time-series components
- X-Y Scatter plot of two time-series, plus per-chart toolbar regression overlays for individual time-series charts
- Multiple time-series 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

There are also a range of modern-stats based analyses pages:

- Clustering with PCA
- Random Forest method to find optimal predictor functions
- Graph neural networks
- Neural network spatial prediction
- Principal Component Analysis (PCA) across multiple indicators and locations
- Hotspot analysis (Getis-Ord spatial statistics)
- Time-Shifted Pattern analysis (DTW, LSTM, CNN)
- 3D Data Cube (interactive time x location x indicator visualisation)
- Trend detection and forecasting across multiple indicators and locations

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
	
X-Y Scatter	Temporal stats
	
Spatial stats	Multiple time-series
	
Correlation function	Depth Profiles
	
Multiple time-series stat summary	Regional overviews

Multiple-indicator sites comparison	Spatio-temporal dynamics Video clips
	

Data availability

The *Estuarine and Bay* dataset currently consists of 19 indicators 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. 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.

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..

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/.

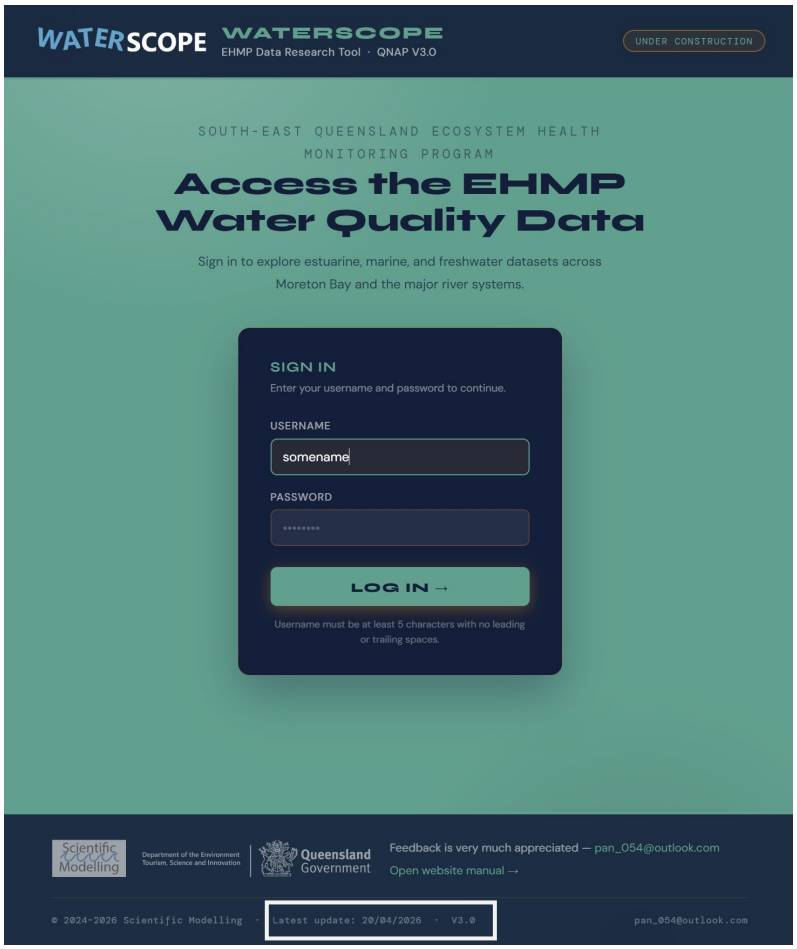


Figure 3 The login page of the Waterscope website. Please note the latest update date and version.

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.



Figure 4 The home page of the website.

After login, the home page opens, and the main menu will be represented by three big buttons on the middle of the page. The *Waterscope Navigator* is an instructional overview of what the website has to offer.

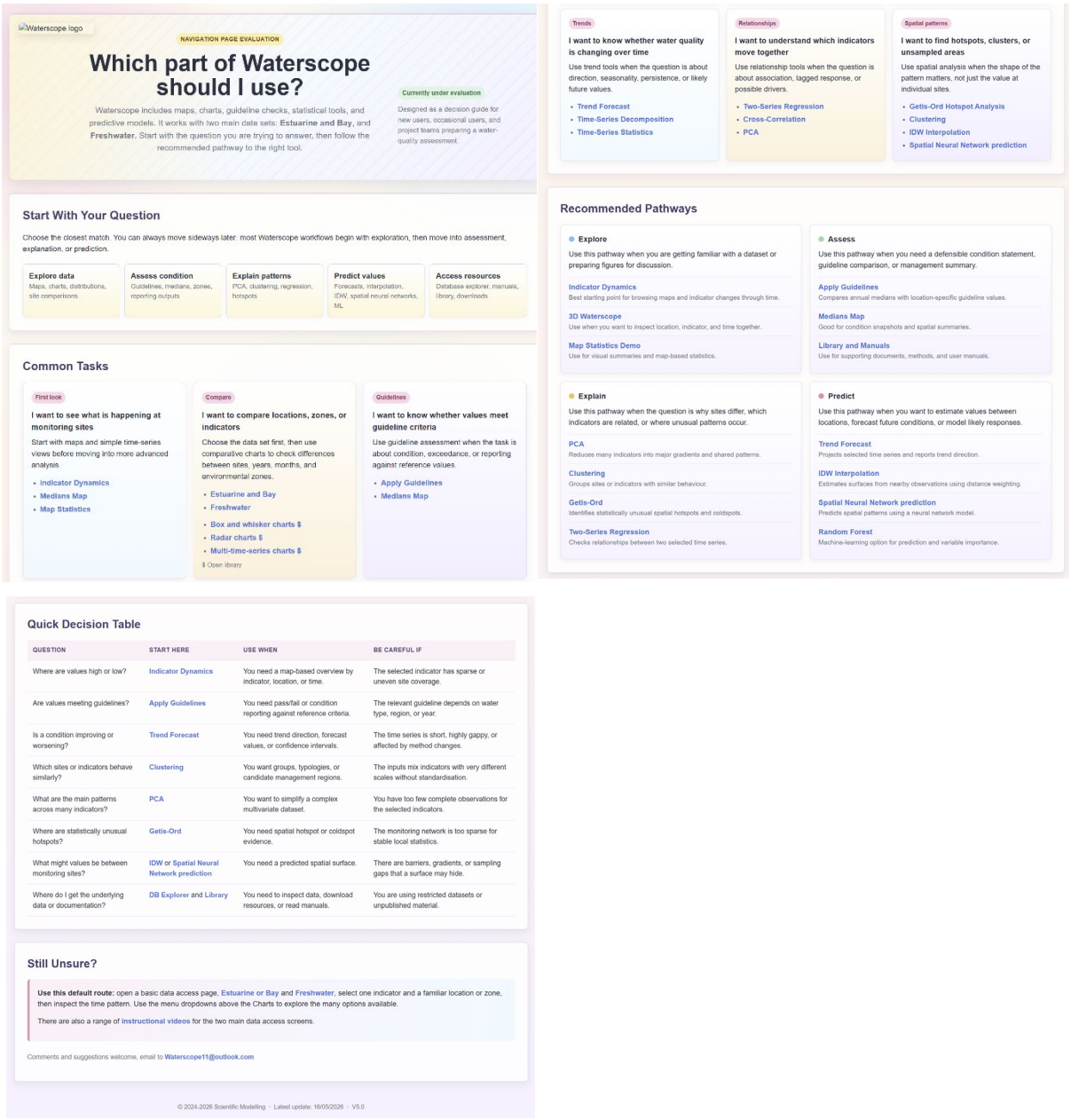


Figure 5 The Waterscope Navigator aims to offer some guidance of that is on offer

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.

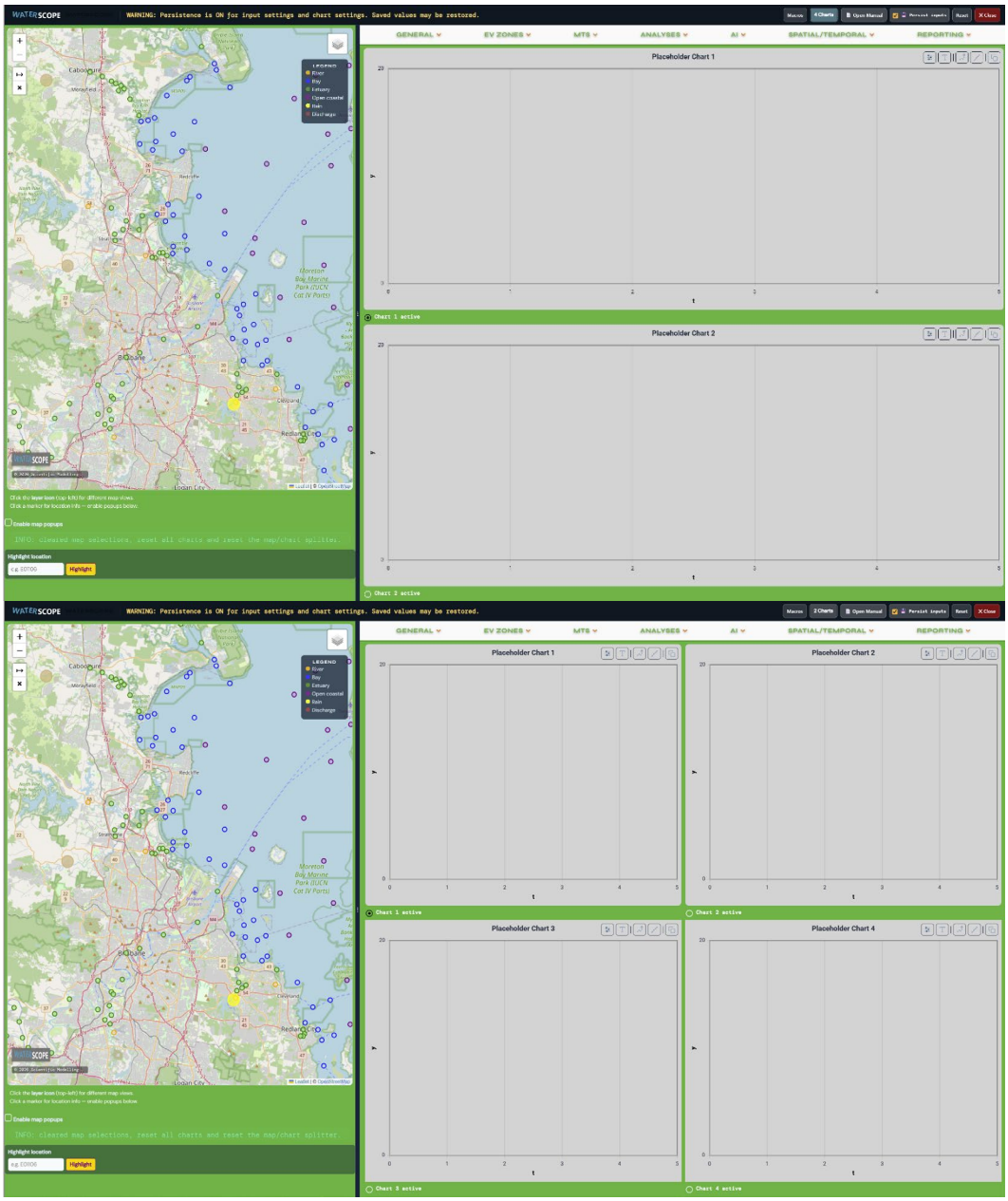


Figure 6 The Estuarine and Bay data initial screen is the main access and analysis area of the website. There is a two chart and a four chart variant to choose from. Most user interface elements (e.g. buttons, dropdown lists) show some explanatory text (tooltip) when hovering over them with your mouse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

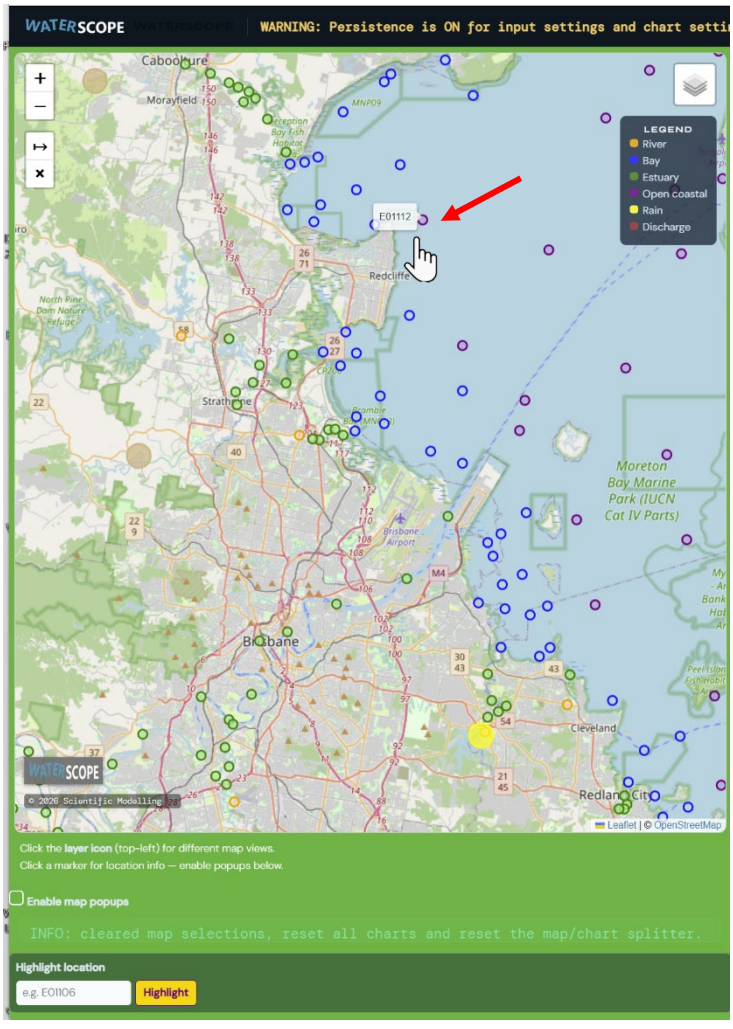
Estuarine and Bay Data access section

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.

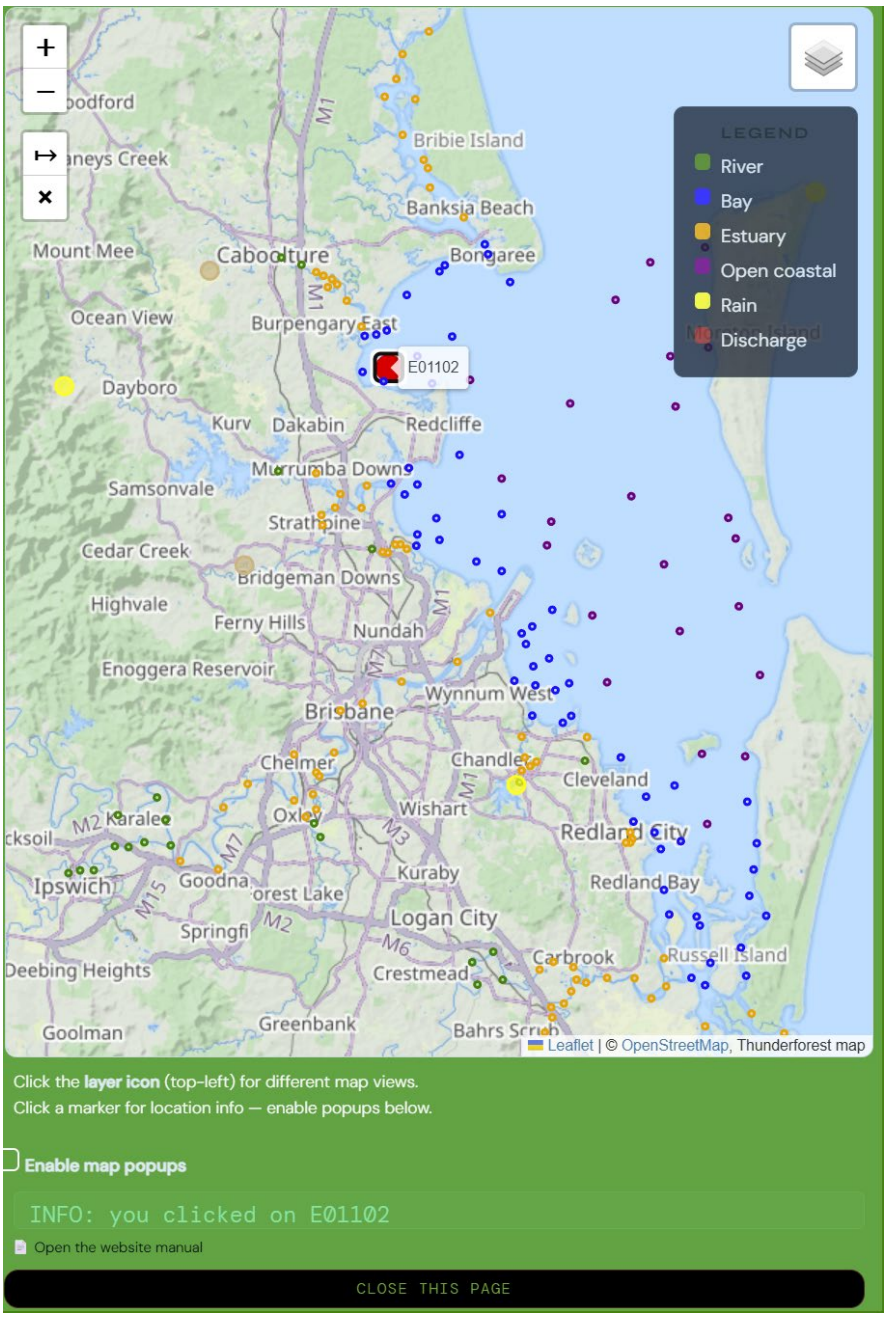
- Zooming with the mouse wheel (or the +/- box at the top left of the map), panning is done by dragging with the left mouse pointer pressed. TIP: zoom into an area of interest before trying to select a location when working on a tablet of phone without a mouse or stylus pen.
- Selecting an EHMP sample 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.

- 

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.
- The Info box below the map also includes a Highlight location control on the Estuarine and Bay, Freshwater and WQI data access pages. Type a location ID, for example E01106, and click Highlight or press Enter. If that location is present on the map, its marker is shown larger with a yellow fill and a purple outline. This visual highlight is only a lookup aid: it does not recenter the map, does not load a time-series, and does not replace any existing active or multi-selected red markers. The temporary highlight is cleared when another marker action changes the map markers.
-


LEGEND
River
Bay
Estuary
Open coastal
Rain
Discharge
E01102
Bribie Island
Banksia Beach
Mount Mee
Caboolture
Bongaree
Ocean View
Burpengary East
Dayboro
Kurv
Dakabin
Redcliffe
Murrumba Downs
Samsonvale
Strathpine
Cedar Creek
Bridgeman Downs
Highvale
Ferny Hills
Nundah
Enoggera Reservoir
Wynnum West
Brisbane
Chelmer
Chandler
Cleveland
Wishart
Redland City
Karalee
Ipswich
Goodna
Kuraby
Redland Bay
Springfield
Logan City
Carbrook
Russell Island
Crestmead
Greenbank
Goolman
Leaflet | © OpenStreetMap, Thunderforest map
Click the layer icon (top-left) for different map views.
Click a marker for location info — enable popups below.
Enable map popups
INFO: you clicked on E01102
Open the website manual
CLOSE THIS PAGE

Instructional videos

There are a couple short (1-3 minutes) instructional videos available showing the website's use. They can be access through the Library option in the General menu category. 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

All settings and functions are accessible using the menu above the charts in the Estuarine/Bay and Freshwater windows. The current WQ menu categories are General, EV zones, MTS, Analyses, AI, Spatial/Temporal and Reporting. Figure 7 shows an overview of the available choices.
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.

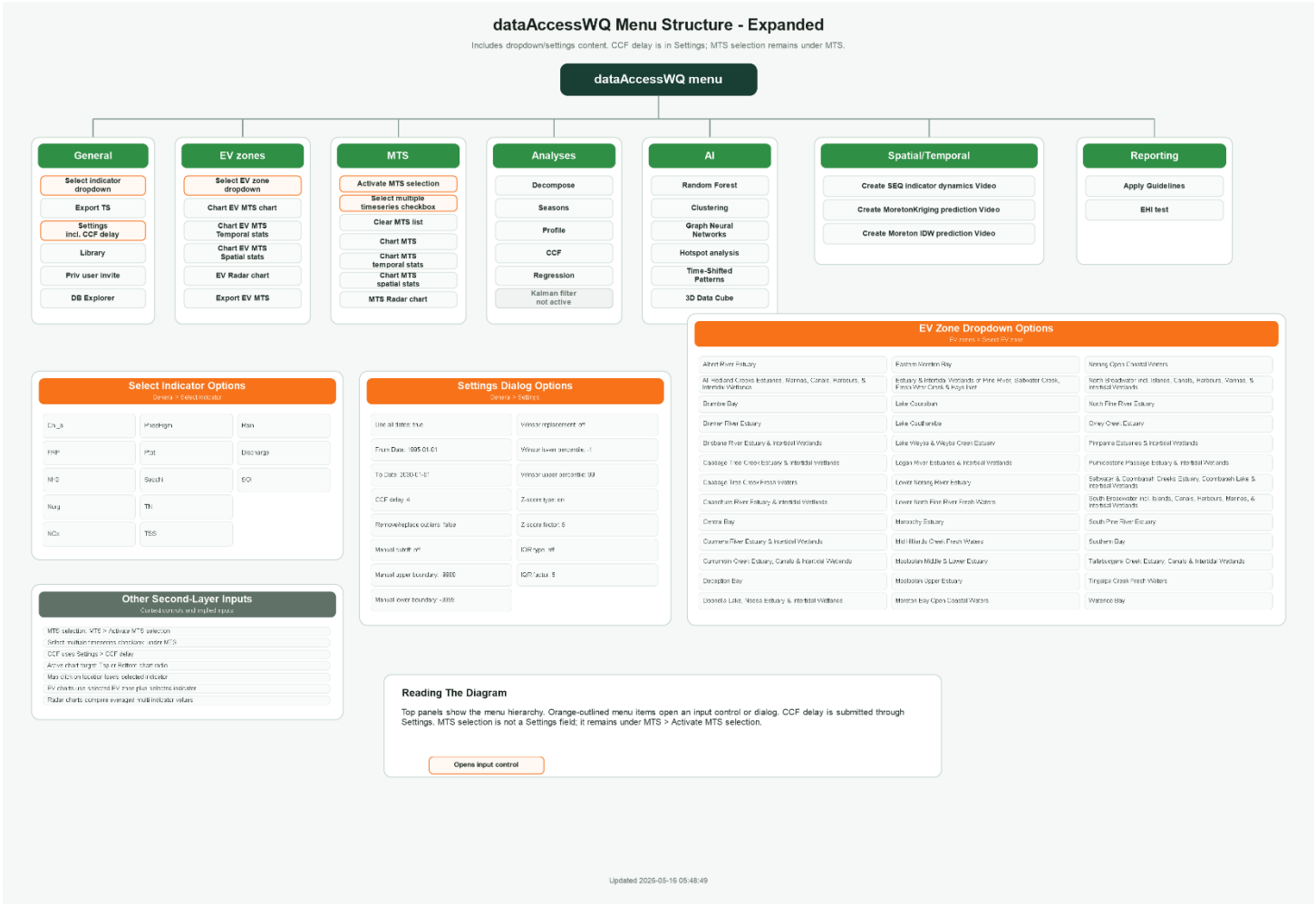


Figure 7 Overview of WaterScope menu structure.

Macro recorder

WARNING: If the browser window changes shape between recording and replay, the replay cursor may not be represented accurately. The cursor shown during replay is a visual guide, while the macro actions themselves are replayed from the recorded page controls, map view state, chart zoom state and element-relative positions.

The Macro controls in the top bar can record and replay routine Waterscope workflows. Click Macros, choose Record, perform the required page actions, then click Stop and name the macro. Saved macros can be selected and replayed later from the same controls.

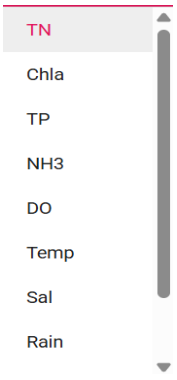
Macro recording captures menu selections, form changes, map pan and zoom state, chart pan and zoom state, and a visual cursor trail including left and right mouse-button positions. For the most reliable replay, record fresh macros after major layout changes and treat the replay cursor as an aid rather than an exact browser pointer.

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.



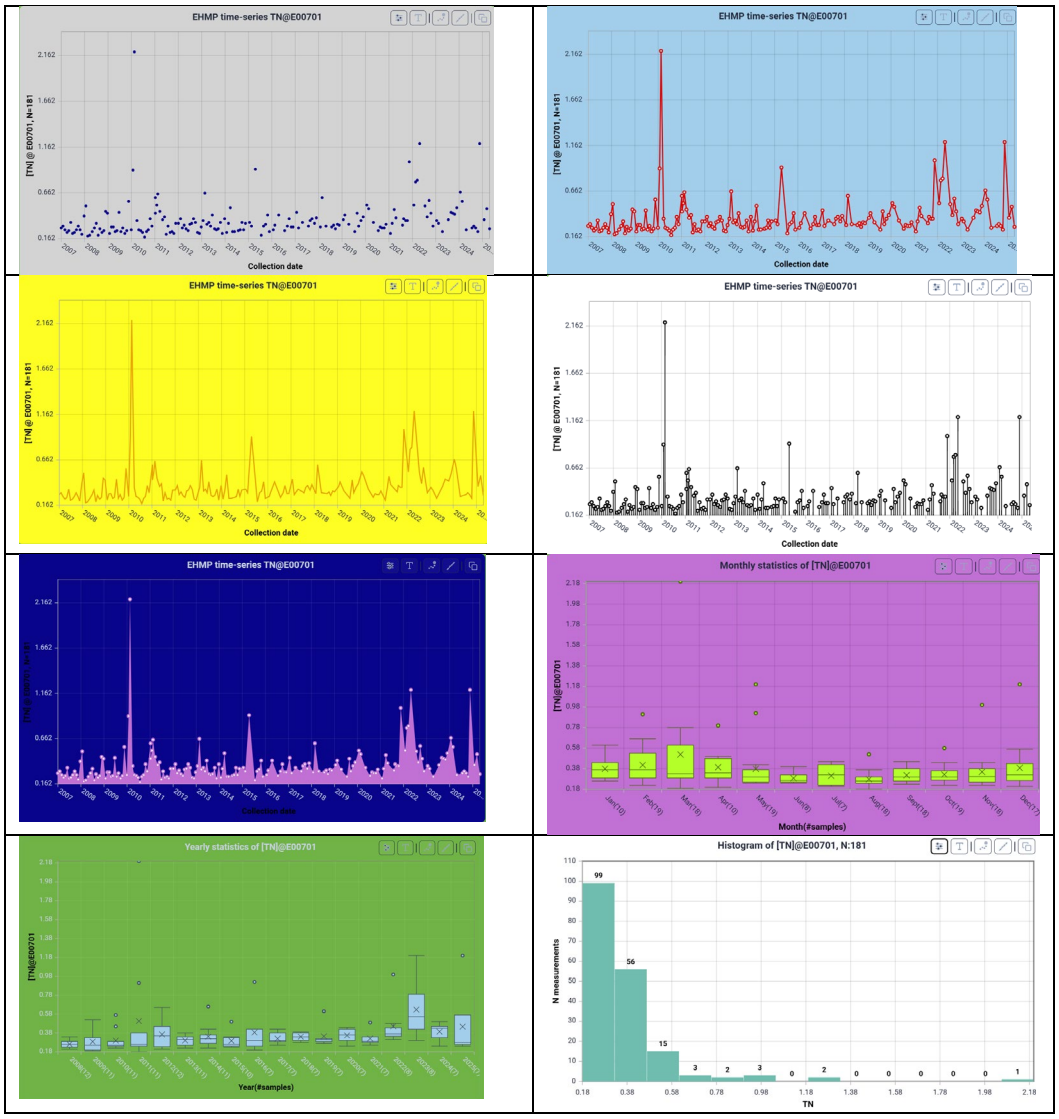
There are a (currently limited) range of water quality indicators available and can be selected from a dropdown list labelled ***Choose an indicator*** *to chart*. The default value is TN.

One of the buttons on the chart toolbar allows selecting various chart forms and colours, see the *Chart Toolbar* section below.

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. But in many different colour-schemes.



Using two or four chart panels

The Estuarine/Bay and Freshwater data access pages can be used in either a two-chart or four-chart layout. The button in the top bar switches between the layouts: when the page is showing two charts the button offers 4 Charts, and when the page is showing four charts it offers 2 Charts. The four-chart layout is useful when comparing several related outputs at the same time, for example two source time-series, a CCF or ACF result, and a seasonal, regression or box-whisker view.

Only one chart is active at a time. The active chart is the destination for the next map selection or analysis result. Select it with the radio button underneath the chart panel. In the four-chart layout the active chart can be Chart 1, Chart 2, Chart 3 or Chart 4; in the two-chart layout it is limited to Chart 1 and Chart 2.

The active chart can also be advanced in a round-robin sequence from the keyboard. Press either the backquote key (`) on the left-hand side of the keyboard or the right bracket key (]) on the right-hand side. Each press moves the active chart to the next available chart and

wraps back to Chart 1 after the last visible chart. These shortcuts are ignored while typing in text boxes or while menu/dialog fields are active.

A typical four-chart workflow is:

Load a first time-series into Chart 1 and a second time-series into Chart 2.
Switch the active chart to Chart 3 or Chart 4 before running an analysis, so the original source charts remain visible.
Use the per-chart toolbar on each panel to adjust chart type, background colour, series colour, regression overlays, outlier handling, labels, copy/export actions and persistence settings independently.
Return to the two-chart layout when more map space is needed or when only the two source time-series need to be inspected.

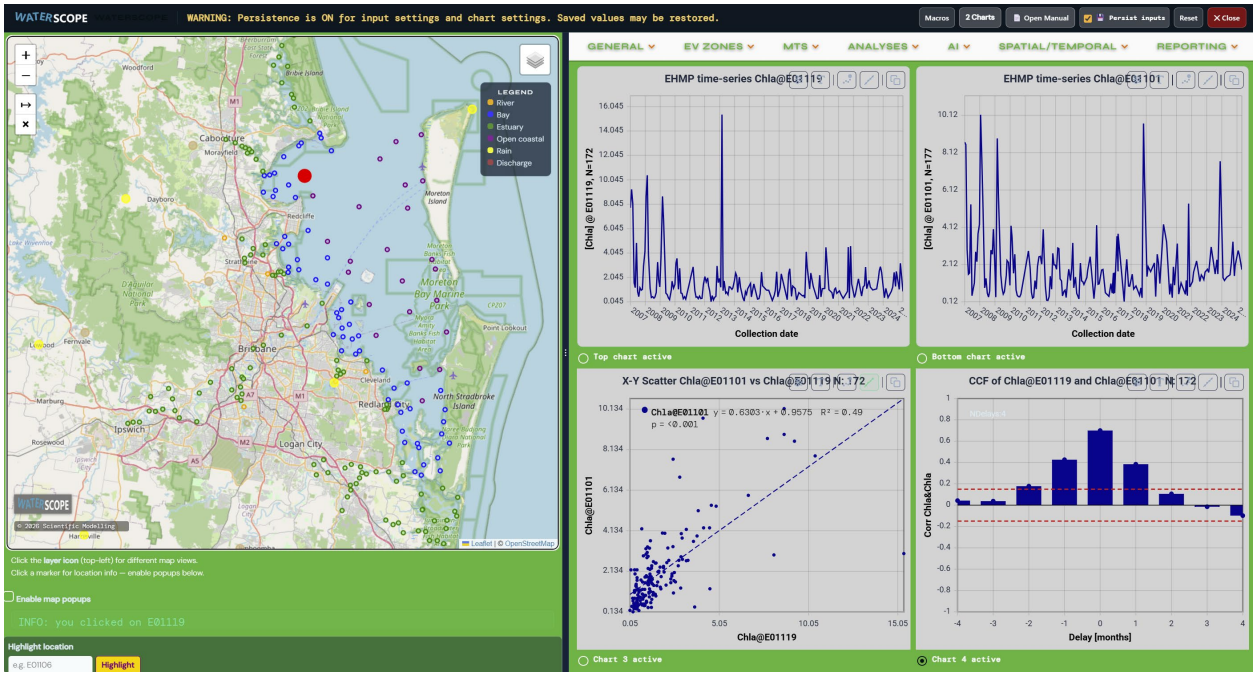


Figure 8 Four-chart layout showing multiple analysis outputs side by side.

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.

Chart toolbar

Each chart panel has its own toolbar. The toolbar controls apply to that chart only, which is especially useful in the four-chart layout where different panels may be used for source time-series, CCF or ACF output, regression checks, seasonal views, box-whisker summaries, histograms or EV-zone comparisons.

The toolbar is designed for common chart-editing tasks that previously required changing global menu settings. It makes chart-specific adjustments faster and reduces the risk of changing the appearance of other charts by accident.

The main toolbar actions are:

Open the chart editor/settings panel to change chart type, background colour, series colour, line width, marker size and persistence mode.
Copy the chart image to the clipboard for reports, presentations or emails.
Open label and axis controls to edit the chart title, X-axis title, Y-axis title and optional Y-axis minimum/maximum.



Figure 9 Chart toolbar buttons attached to each chart panel.

Toggle a regression overlay for suitable single time-series or scatter-style views.
Apply, restore or configure outlier handling for the current chart.

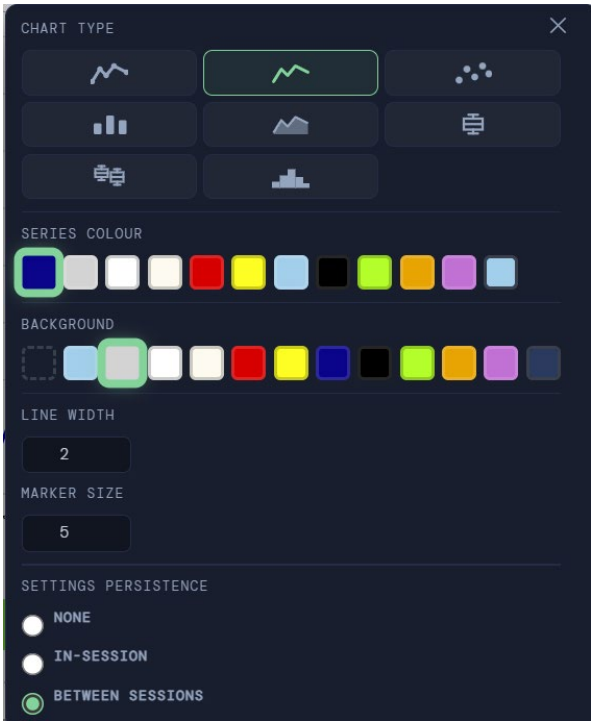


Figure 10 Chart editor panel for chart appearance, labels and persistence settings

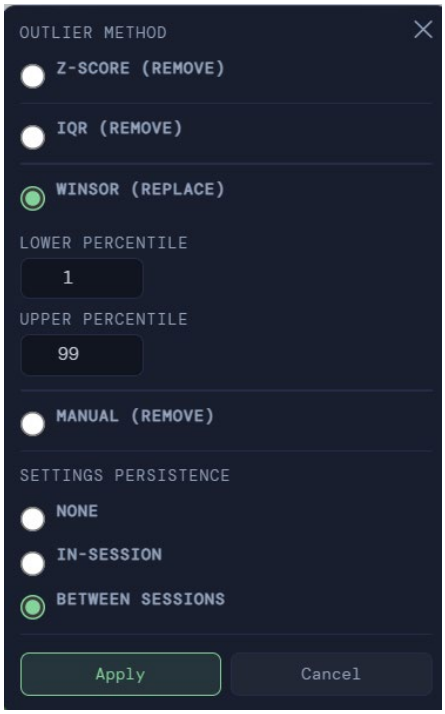


Figure 11 Outlier settings opened from the chart toolbar.

In the chart editor, the persistence options determine whether the selected appearance settings are used only for the current chart, reused during the current browser session, or saved between sessions. The series colour setting also controls the fill colour of column-style analysis outputs such as CCF/ACF bars.

The outlier button has two behaviours. A single click applies or restores the currently selected outlier method. A double-click opens the outlier settings panel. When an outlier filter is active, the toolbar button is highlighted and the chart displays an annotation indicating that an outlier procedure has been applied.

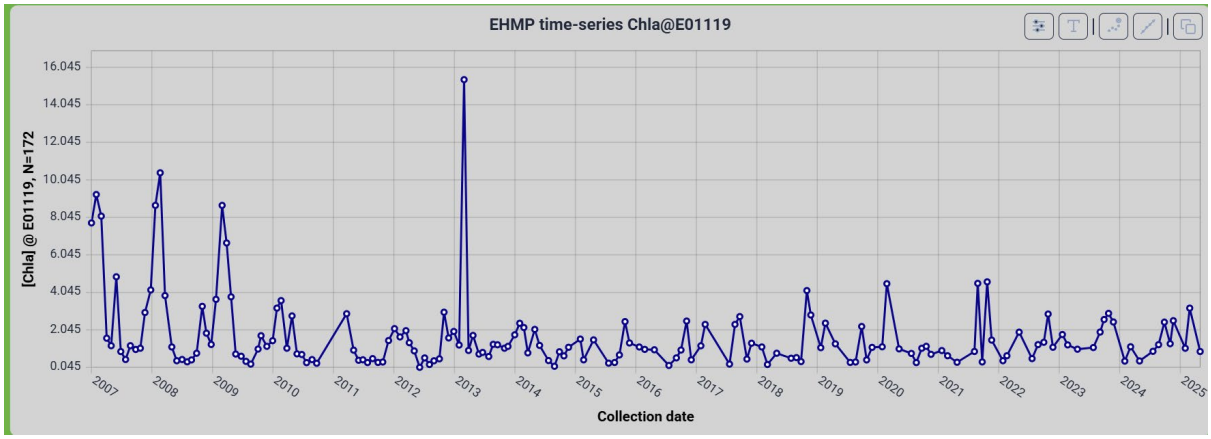


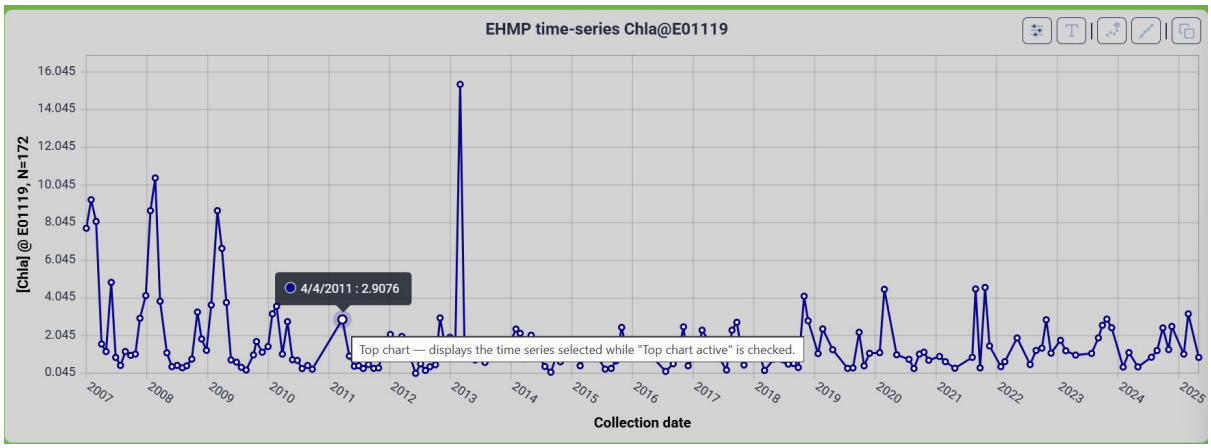
Figure 15 shows some examples of the various ways time-series charts can be formatted. Hovering over a value on the graph **shows details** of a single sample. The graphs also allow **zooming** (drag with mouse cursor, left button pressed and released) and **panning** by

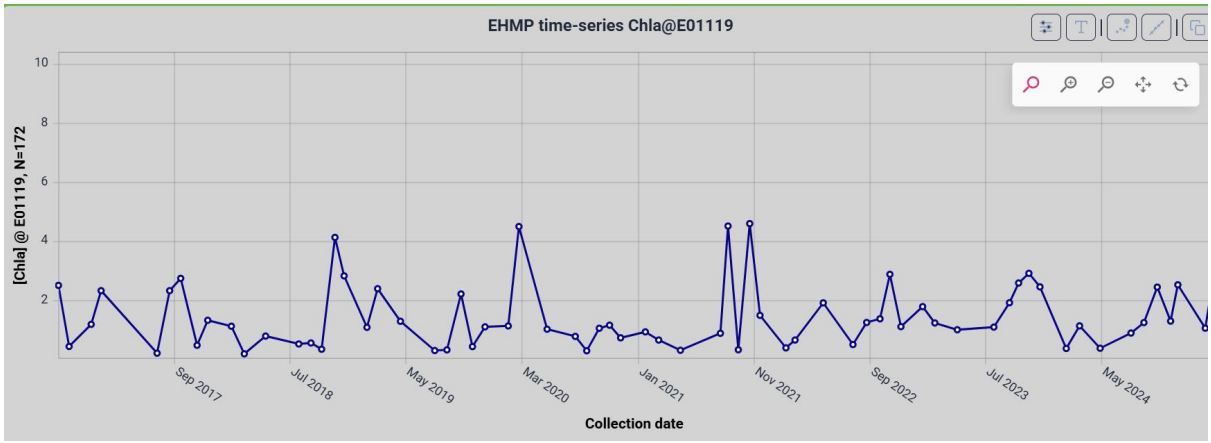
dragging the mouse pointer left button pressed. Time-series graphs show some **basic stats** in the top-right corner.

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

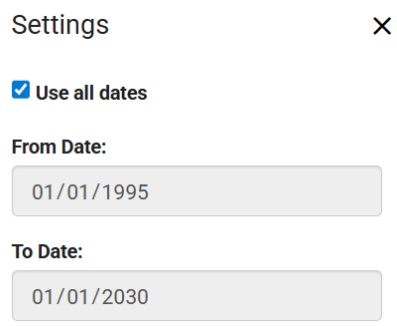
Menu: General>Settings>To Date

Menu: General>Settings>CCF delay

From version 5.0 onwards the General>Settings dialog contains the date range controls, the CCF delay value, and related persistence/reset controls. Outlier removal is now handled from each chart toolbar. Multiple time-series activation is now handled from the MTS menu category.

These menu options allow time-series, radar plots and related analyses to be filtered using a date interval. Select the From date or To date field and type the required date, or use the picker controls where available.

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*

Chart toolbar: Outlier button

Outlier removal is accessed via the Outlier button on the chart toolbar (single-click applies or restores; double-click opens the settings panel). There are four outlier methods implemented: Manual, Winsor, Z-scores, and Inter-Quartile Range (IQR). The outlier settings panel also contains a persistence option (None, In-session, or Between sessions).

To apply a method: double-click the Outlier toolbar button to open the settings panel, select the desired method and set its parameters, then single-click the button to apply. The button turns red when an outlier filter is active. Single-clicking again restores the original data.

The chart toolbar now contains a dedicated Outlier button and a Regression button. Single-click the Outlier button to apply or restore the current outlier method; double-click it to open the outlier settings panel. Click the Regression button to toggle a linear regression overlay for the current chart.

The outlier methods apply to single time-series charts, including Box-Whisker and Histogram representations where supported. The charts include an annotation if an outlier procedure has been applied. The Winsor method is the only method that replaces sample values rather than removing them.

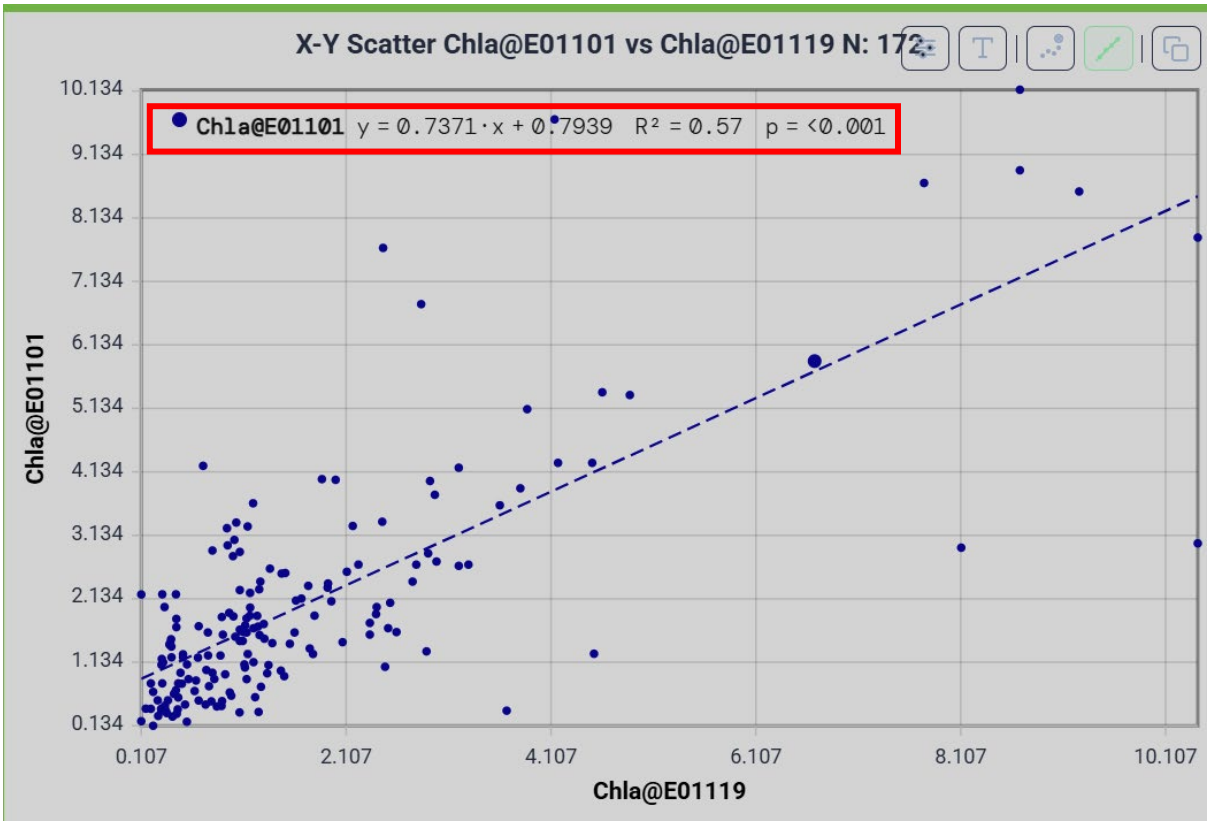


Figure 12 The single timeseries chart will show in an annotation if an outlier procedure has been applies and how many samples have been affected.

Manual boundary removal method

Chart toolbar: Outlier button (double-click) > Manual

Chart toolbar: Outlier button (double-click) > Manual

Chart toolbar: Outlier button (double-click) > Manual > Min value

Chart toolbar: Outlier button (double-click) > Manual > Max value

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.

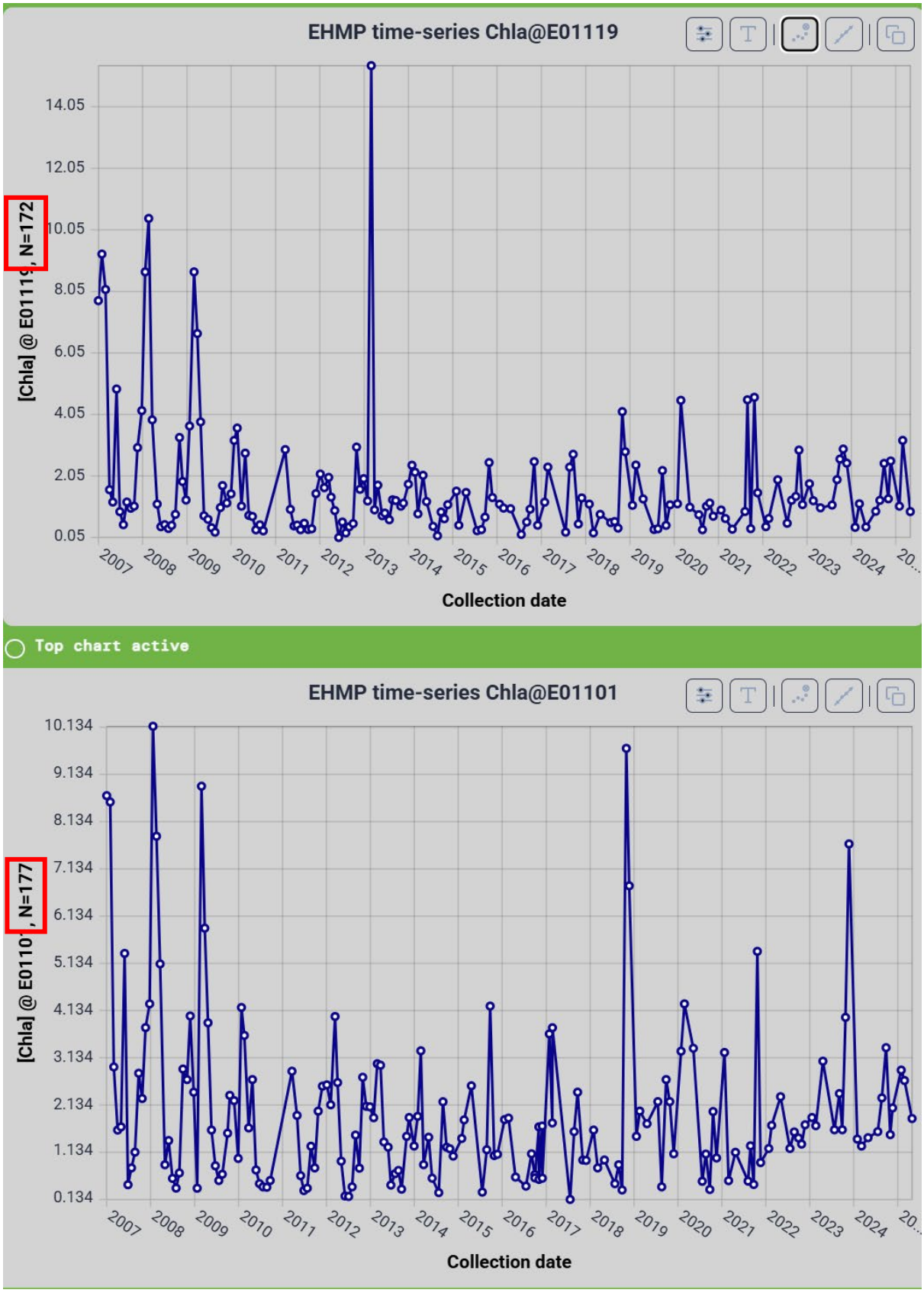


Figure 13 The top graph shows a time-series with an unusually high value of around 1.45. The bottom graph is the result of applying the manual outlier method with max value of 1. The red rectangles show the number of values in the time-series.

Winsor outlier replacement

Chart toolbar: Outlier button (double-click) > Winsor

Chart toolbar: Outlier button (double-click) > Winsor

Chart toolbar: Outlier button (double-click) > Winsor > Lower percentile

Chart toolbar: Outlier button (double-click) > Winsor > 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 invalid values, the relevant percentile setting is not applied. Percentage values are entered as real numbers but are treated as percentile cut-offs when the settings are applied.

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

Figure 10 The outlier settings panel allows users to choose between Manual, Winsor, Z-score and IQR methods.

Chart toolbar: Outlier button (double-click) > Z-Score

Chart toolbar: Outlier button (double-click) > Z-Score > Threshold (σ)

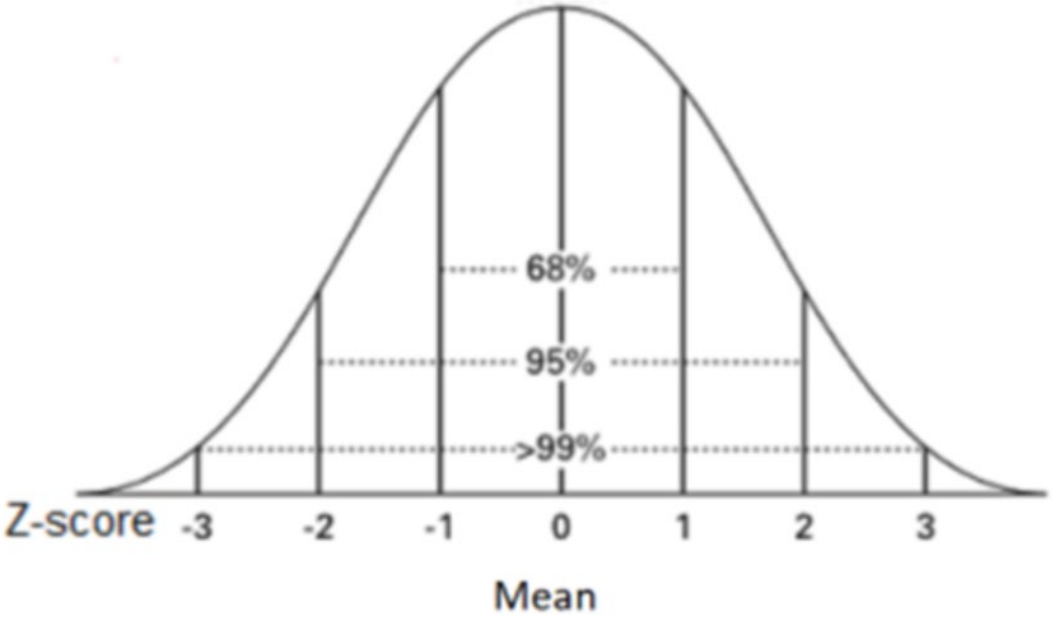
The outlier algorithm implemented is based on Z-score, basically a number of standard deviations of data still included after the application of the filter.

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).

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.



Inter-quartile range (IQR)-based outlier removal

Chart toolbar: Outlier button (double-click)

Chart toolbar: Outlier button (double-click) > IQR

Chart toolbar: Outlier button (double-click) > IQR

Quartiles divide the (sorted) data points into four parts of (about) equal sizes, or quarters. The Interquartile Range method uses the first quartile (Q1) and third quartile (Q3) 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

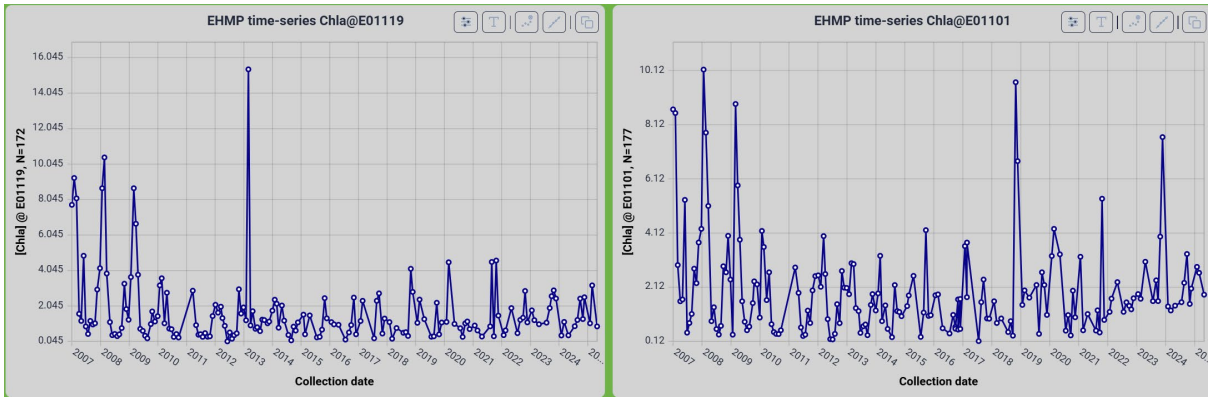
upper bound = Q_3 - factor *IQR

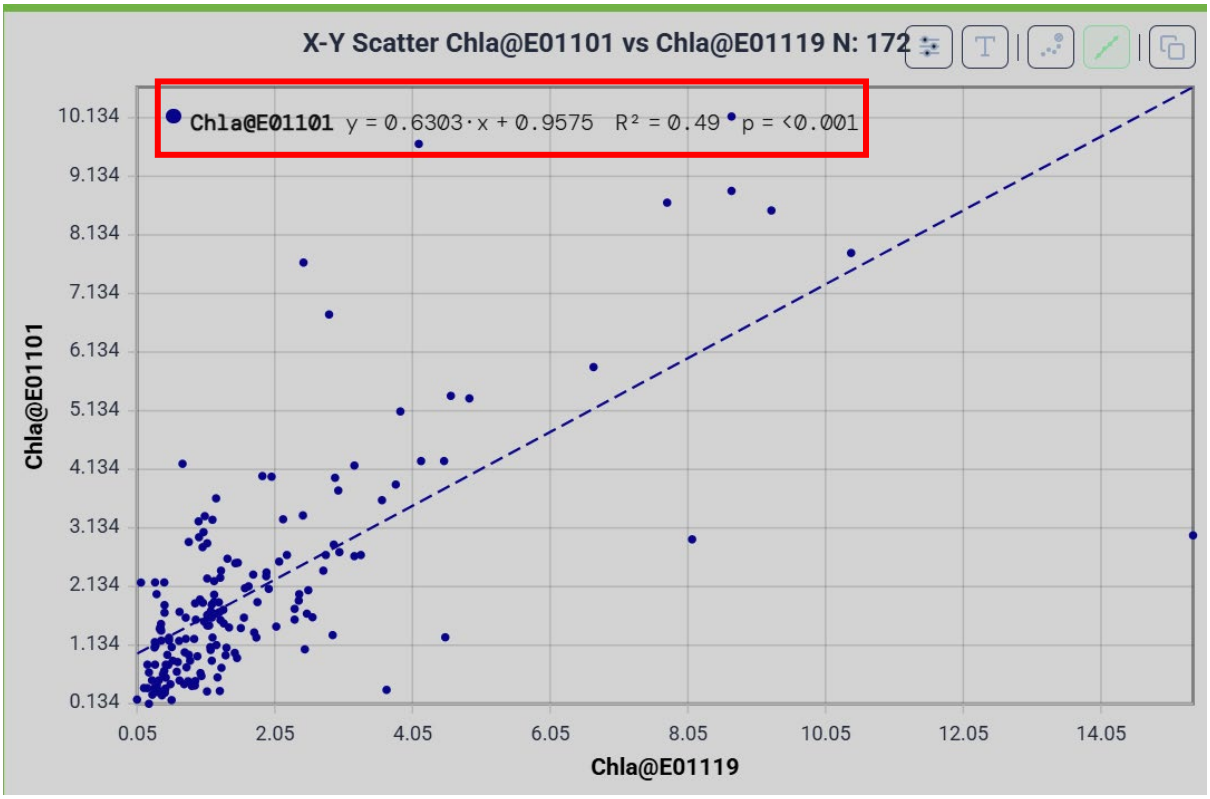
where IQR is the inter-quartile range Q3-Q1.

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 1 percentile and upper bound 99 percentile replaces 3 outliers 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)

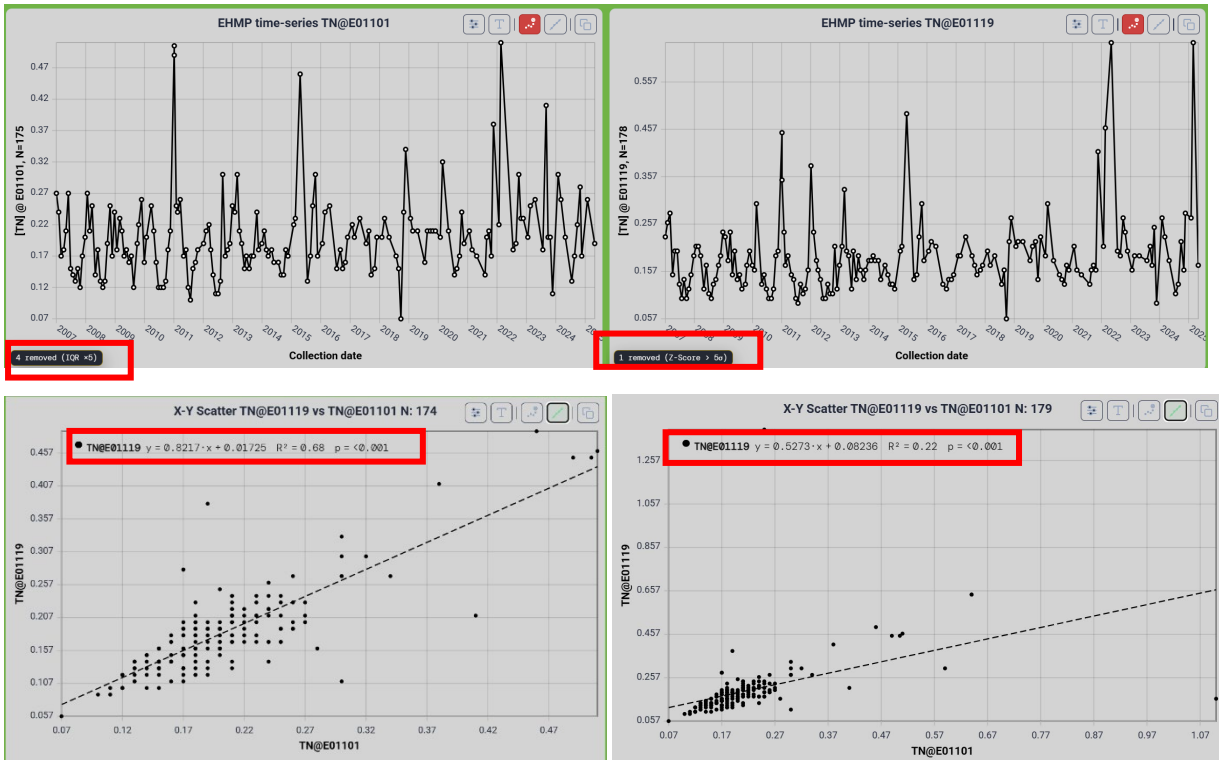


Figure 14 The top two charts show two timeseries with just five outlier measurements removed out of nearly 360 measurements. The bottom two charts show how that alters the regression outcomes, left is with outlier removal and R^2 of 0.68, right no outlier removal resulting in a regression outcome with R^2 of 0.22.

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 , 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.

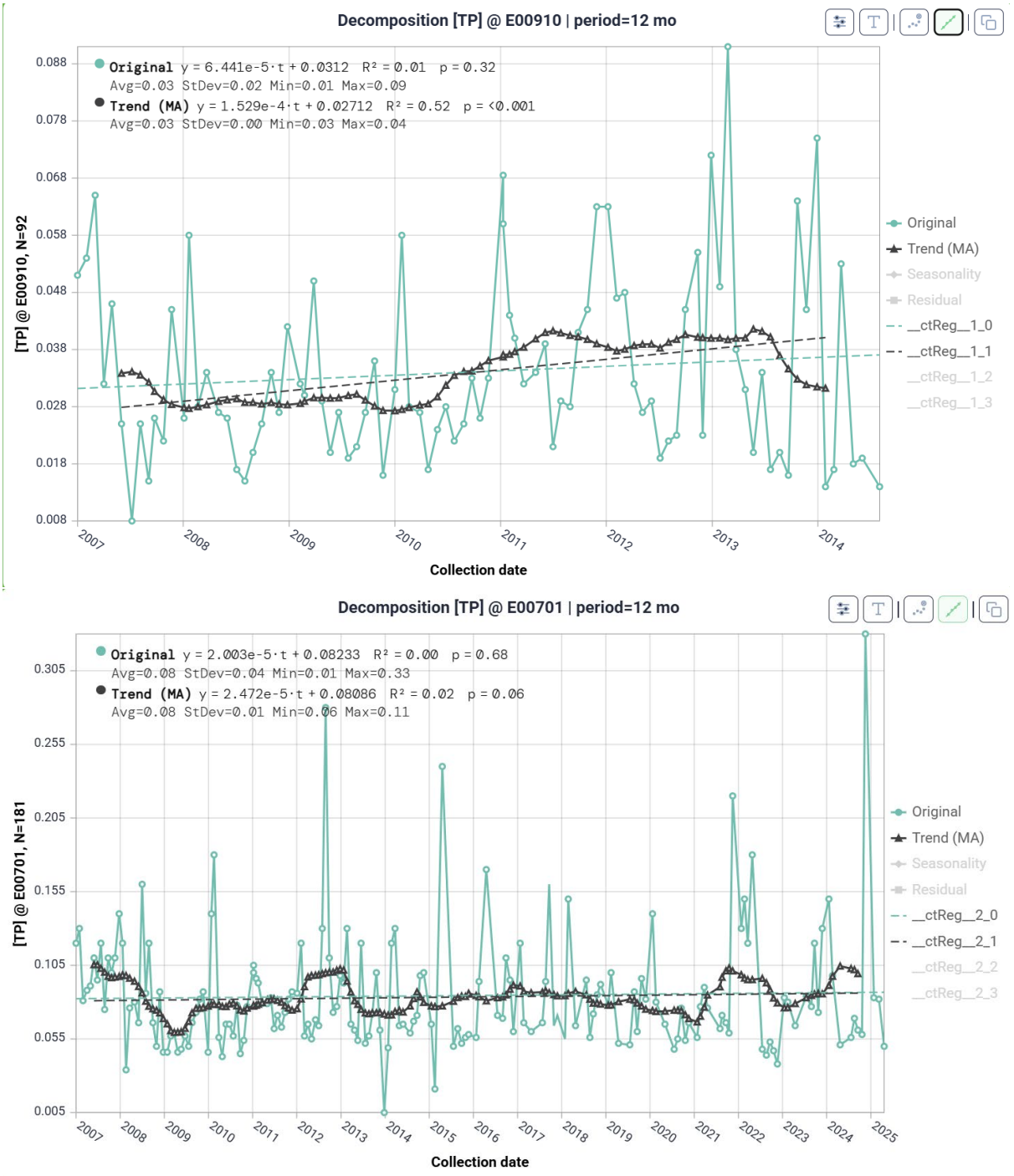


Figure 15 Examples of time-series decomposition. The top graph indicates an increasing long-term trend of total phosphate concentration, at location E00910. The lower graph of total nitrogen concentration does not show a clear trend.

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

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

X-Y Scatter chart

Menu: Analyses>X-Y Scatter

After two single time-series have been selected in the top and bottom charts, the X-Y Scatter chart plots one series against the other to reveal relationships between indicators or locations. The active chart is used as the Y axis and the inactive chart as the X axis. The tool uses overlapping months only and respects any active outlier-filtered chart data.

The older Regression menu label has been replaced by X-Y Scatter. Regression has not disappeared: a linear regression overlay can now be toggled from the Regression button on each chart toolbar, and decomposition still fits a regression to the trend component.

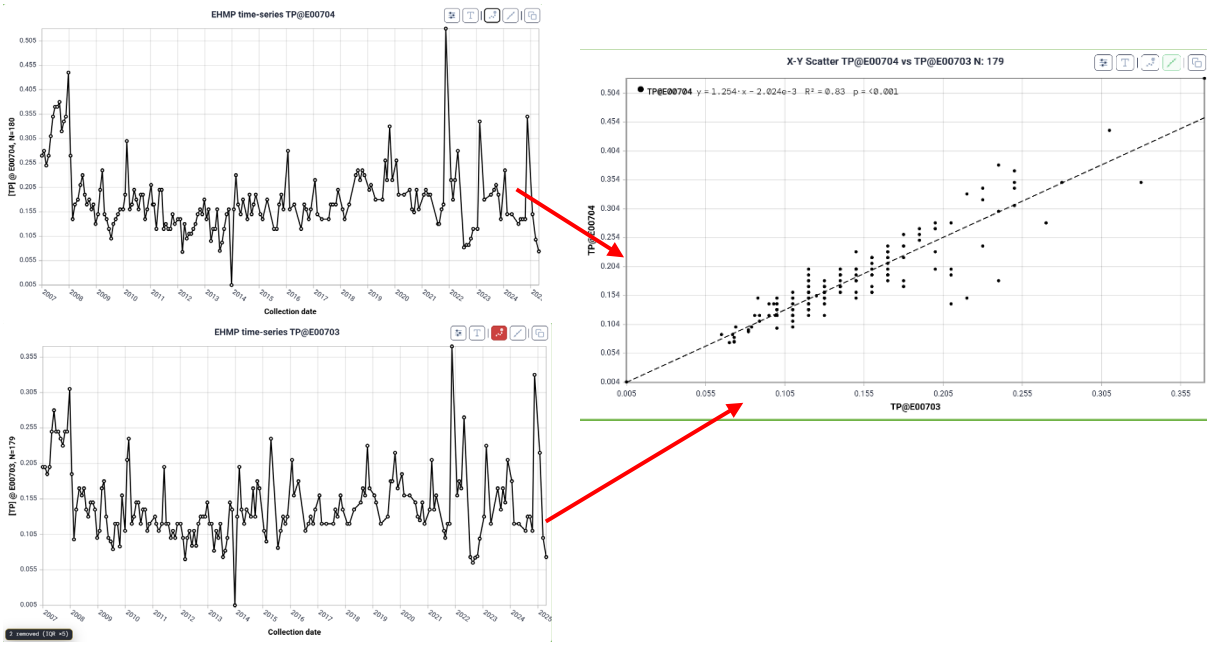


Figure 12 Creating an X-Y Scatter chart based on two time-series.

To create an X-Y Scatter chart, the sample collection months for each time-series have to line up. Samples that are not collected in the same month in both time-series are not represented. The number of matched samples is shown as N in the chart title.

The X-Y Scatter chart also calculates common fitted models and shows their equations and R2 values in an overlay. This makes it possible to inspect the relationship while keeping the menu label focused on the chart type.

Figure 13 compares the fitted-model output against Excel as a quick validation check.

Regression overlay on time-series charts: A separate Regression button on the chart toolbar toggles a linear regression line directly on the active time-series chart. When active the button is highlighted, and the chart shows a dashed regression line with R2, p-value, and equation displayed in an overlay box inside the plot area. The button can be toggled independently on each of the two chart slots.

Figure 16 Checking results shown in Figure 12 against Excel regression results.

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). NOTE: this function works only for single time-series charts.

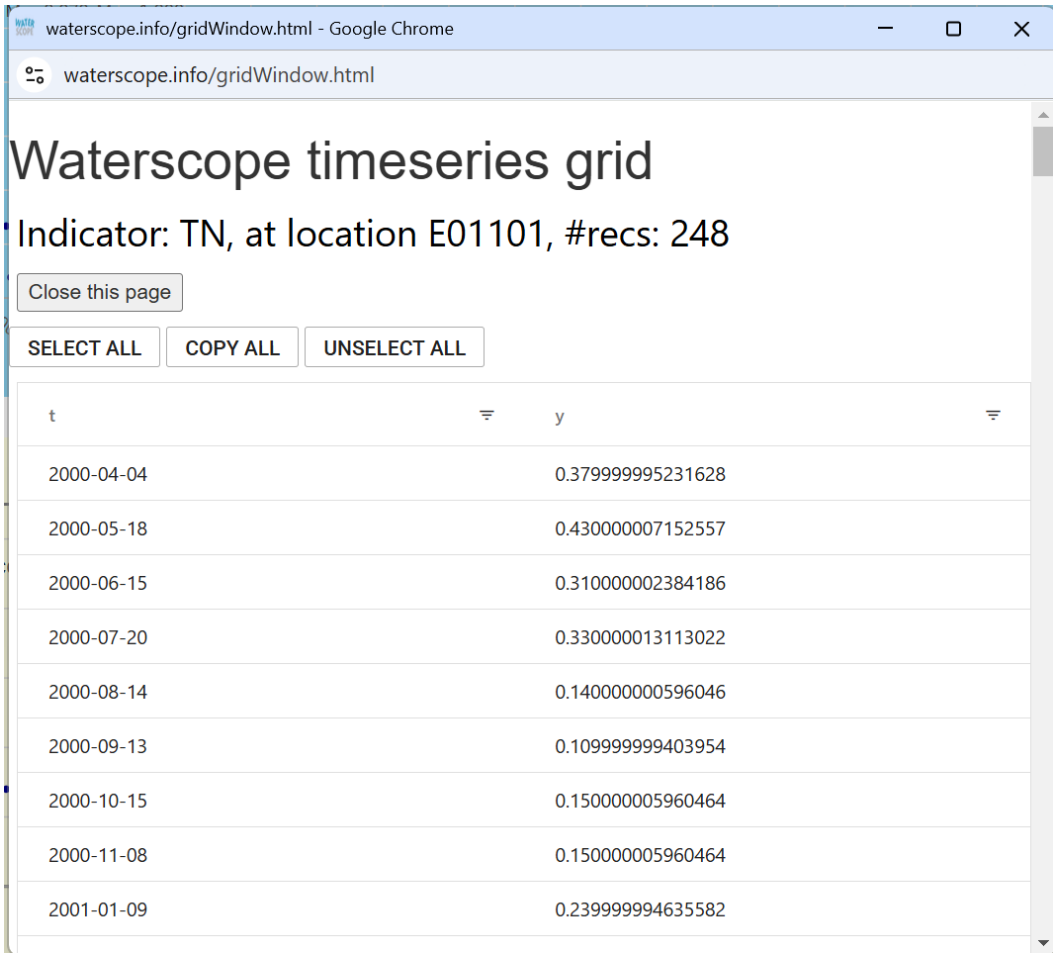


Figure 17 Grid-view of time-series data

Multi-series charts

Menu: MTS>Activate MTS selection

Menu: MTS>Chart MTS

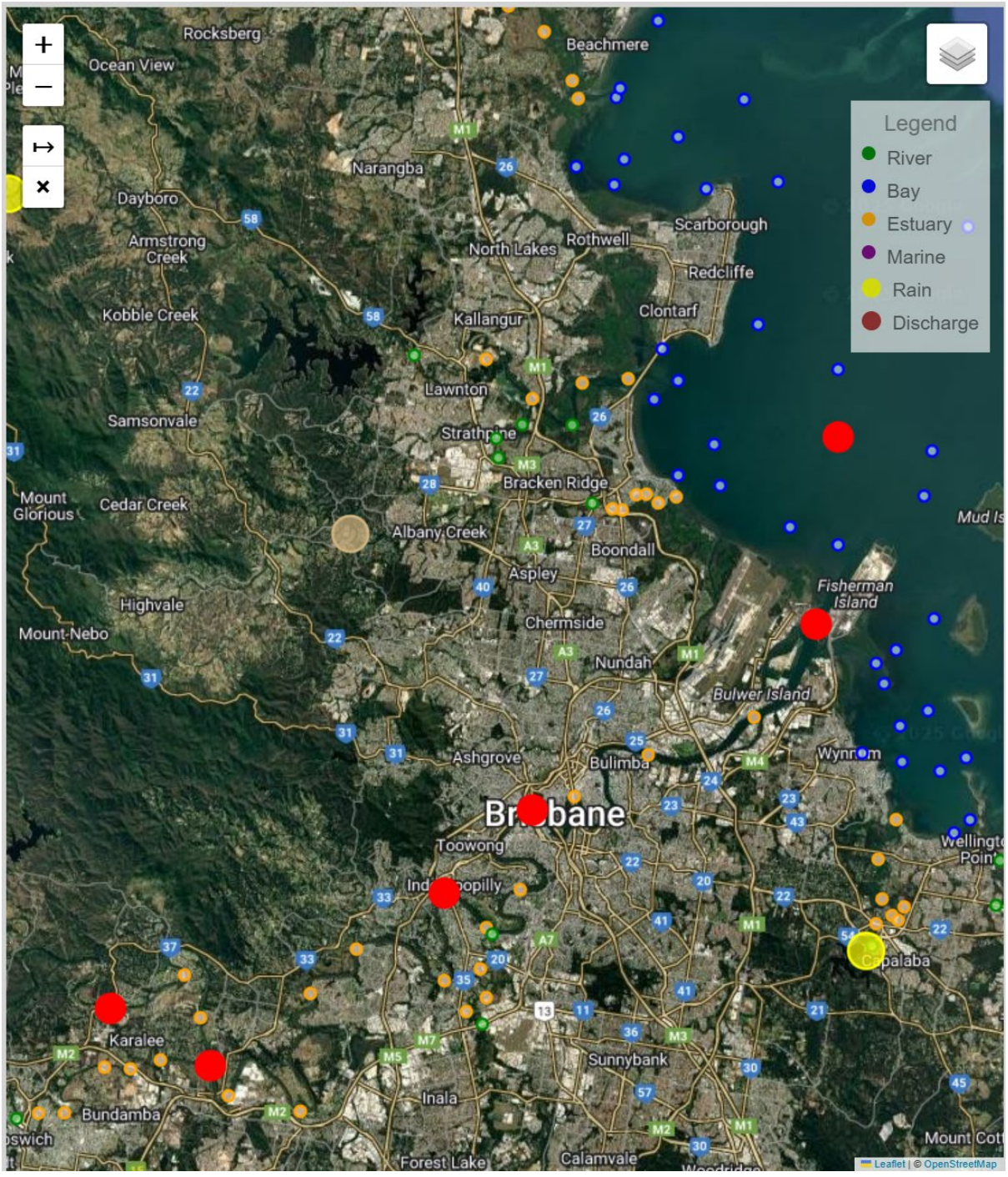
Menu: MTS>Activate MTS selection>Clear MTS list

To add sample locations to the multiple selection list, use Menu: MTS>Activate MTS selection and tick Select multiple timeseries. While active, clicking markers adds or removes locations and the map selection toolbar can be used for area-based selections.

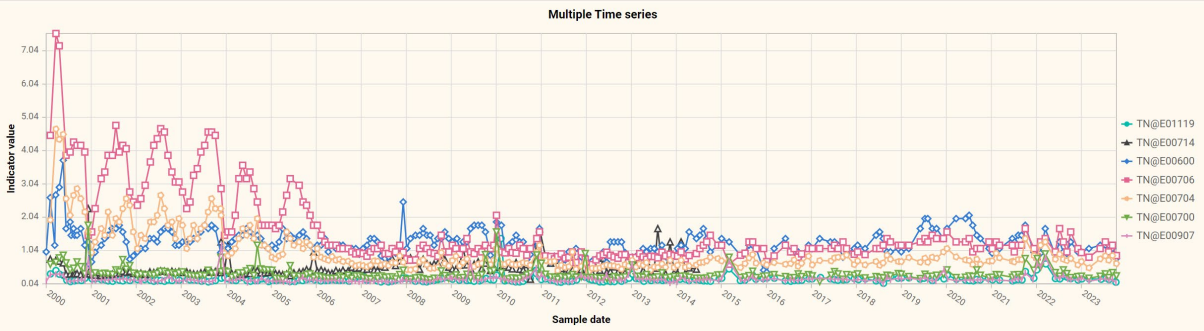
The multiple time-series array can be cleared using Clear MTS list under the MTS activation menu. More details are given in the example below.

An added feature is the selection tool that appears on the map when Menu: MTS>Activate MTS selection is active.

(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.

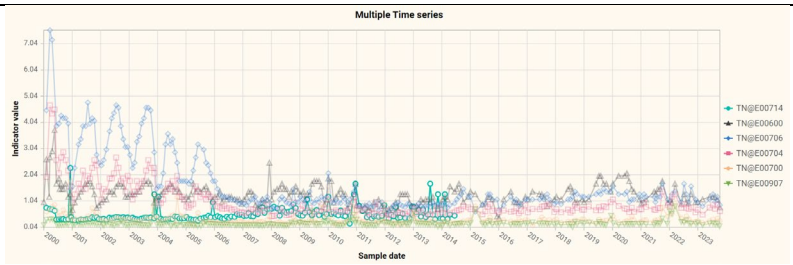
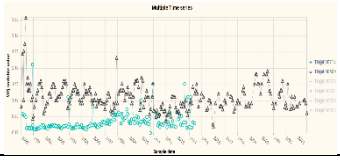
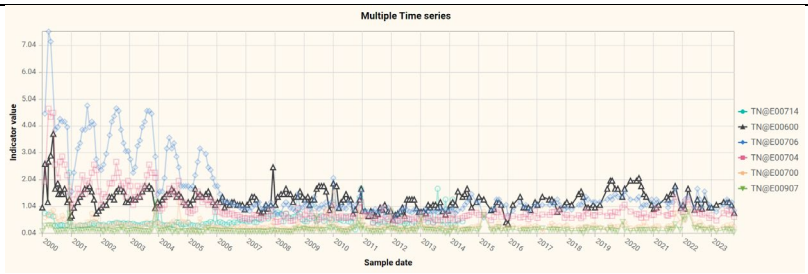
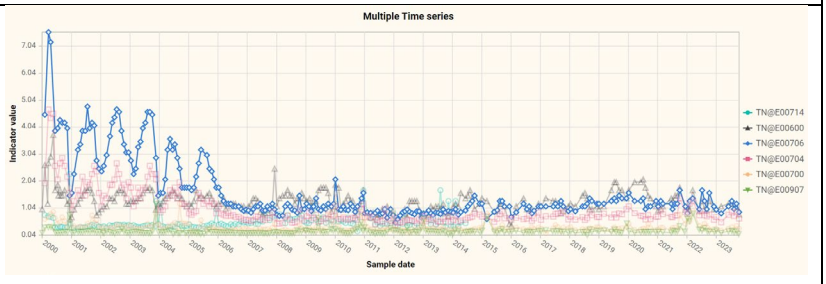
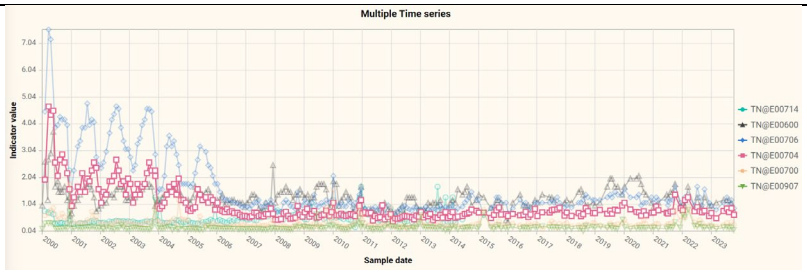
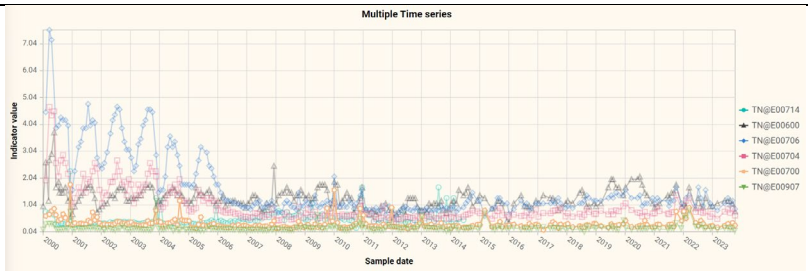
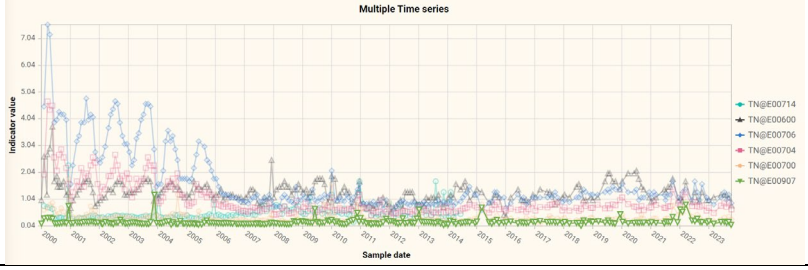
714=College Crossing. [TN] rises after ca. 2007. Unfortunately EHMP sampling stopped after 2014.	
600=Bremer river inflow. Big step-up in [TN] from College Crossing 	
706=Indooroopilly. The very large fluctuations in the data from 2000-2006 needs more investigation.	
704=central Brisbane.	
700 = Port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

Figure 18 Multi-time-series charts often give insights of spatio-temporal dynamics.

Multiple timeseries Spatial Box-Whisker chart

Menu: MTS>Activate MTS selection

Menu: MTS>Chart MTS spatial stats

Menu: MTS>Activate MTS selection

Menu: MTS>Activate MTS selection

Menu: MTS>Chart MTS spatial stats

Menu: MTS>Activate MTS selection>Clear MTS list

Alternatively, the statistics of each selected location for the selected indicator can be charted as a Box-Whisker chart by selecting Menu: MTS>Chart MTS spatial stats.

Figure 19 More details of Box-Whisker Spatial stats chart statistics pop up when the cursor hovers over an element.

Multiple timeseries Temporal Box-Whisker chart

Alternatively, the statistics of each selected location for the selected indicator can be charted as a Box-Whisker chart by selecting Menu: MTS>Chart MTS spatial stats.

Menu: MTS>Chart MTS temporal stats

Menu: MTS>Activate MTS selection

Menu: MTS>Activate MTS selection

Menu: MTS>Chart MTS temporal stats

Menu: MTS>Activate MTS selection>Clear MTS list

The statistics of all samples per year for a selected indicator can be charted as a Box-Whisker chart by selecting Menu: MTS>Chart MTS temporal stats.

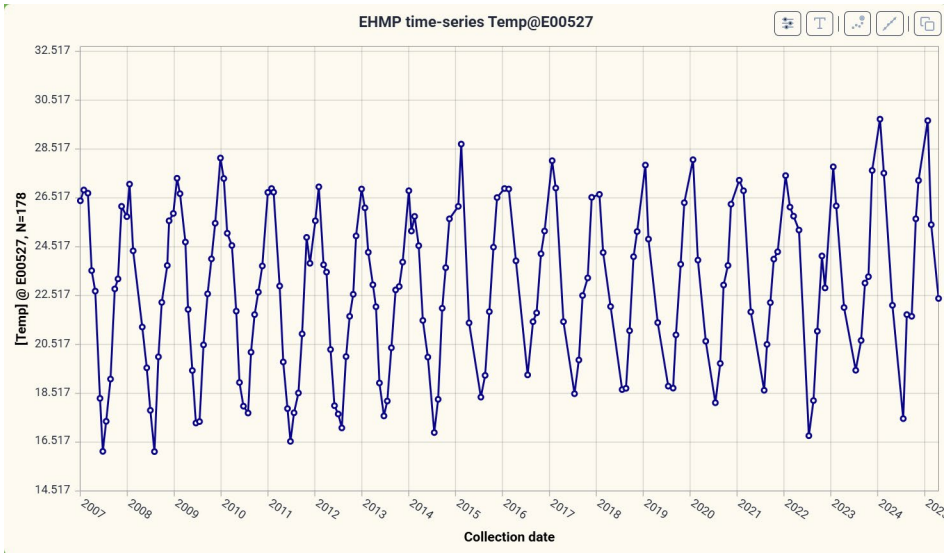
Seasons or epoch chart

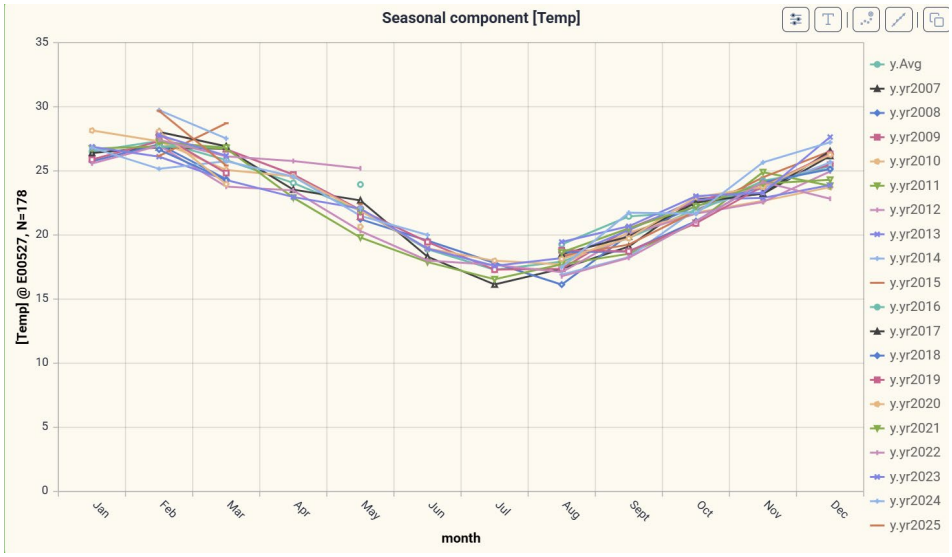
Menu: Analyses>Seasons

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:

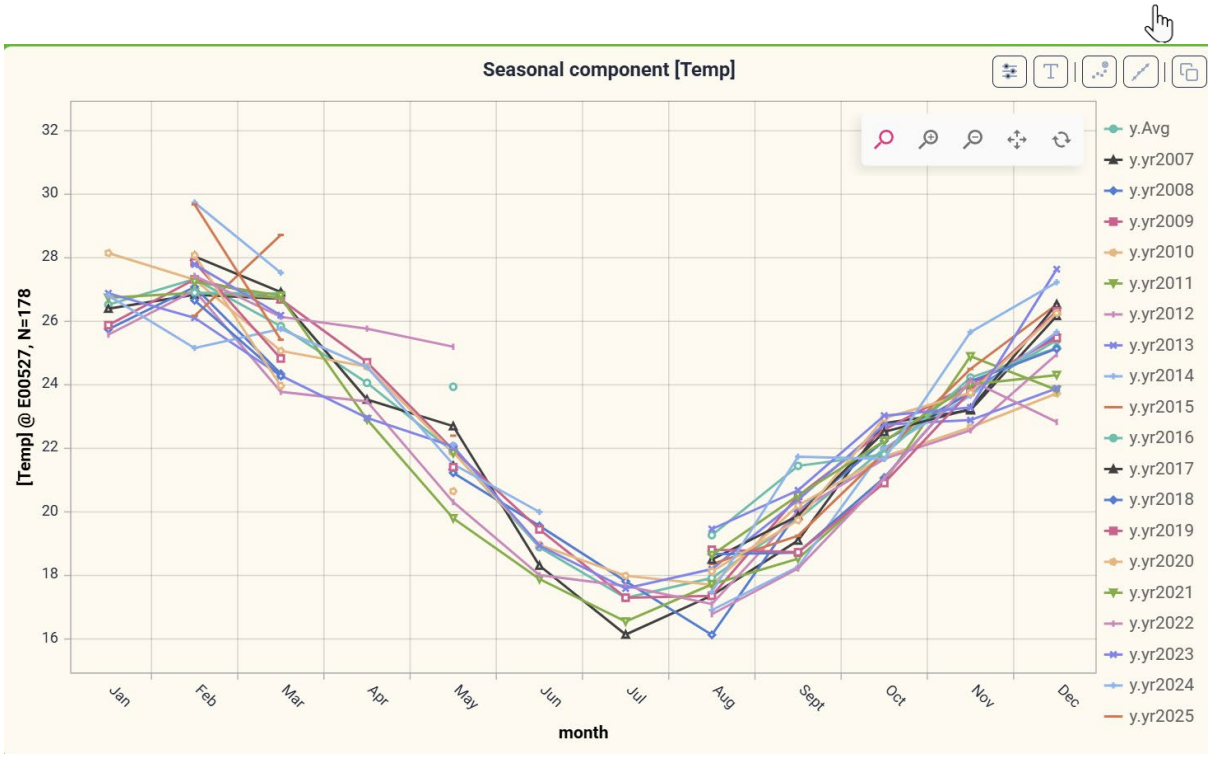
- Zooming in/out/panning.
- Highlighting one trace.
- Switching some of the traces off.

Example

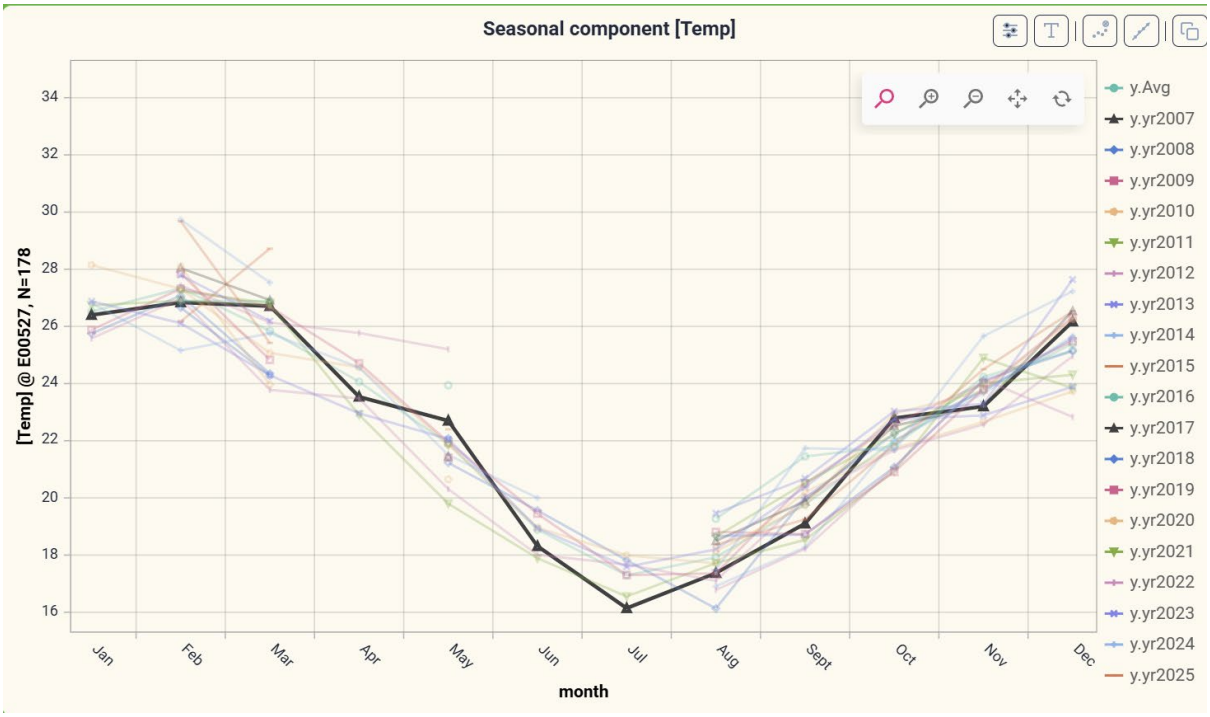
The top (blue) graph shows the temperature chart. The bottom (green) shows *Seasonal Component* chart for that time-series. In this form it is very hard to interpret.

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'.


Seasonal component [Temp]
[Temp] @ E00527, N=178
month
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct
Nov
Dec
y.Avg
y.yr2007
y.yr2008
y.yr2009
y.yr2010
y.yr2011
y.yr2012
y.yr2013
y.yr2014
y.yr2015
y.yr2016
y.yr2017
y.yr2018
y.yr2019
y.yr2020
y.yr2021
y.yr2022
y.yr2023
y.yr2024
y.yr2025


Seasonal component [Temp]
[Temp] @ E00527, N=178
month
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct
Nov
Dec
y.Avg
y.yr2007
y.yr2008
y.yr2009
y.yr2010
y.yr2011
y.yr2012
y.yr2013
y.yr2014
y.yr2015
y.yr2016
y.yr2017
y.yr2018
y.yr2019
y.yr2020
y.yr2021
y.yr2022
y.yr2023
y.yr2024
y.yr2025

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.

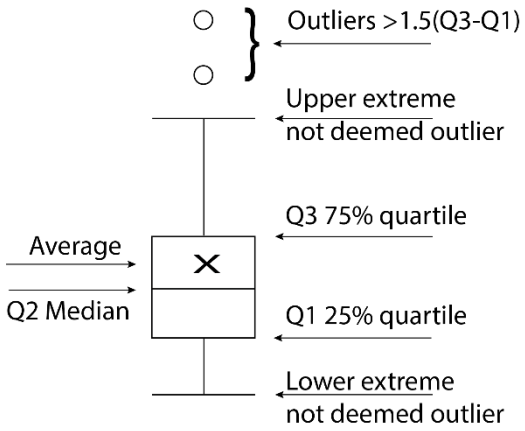
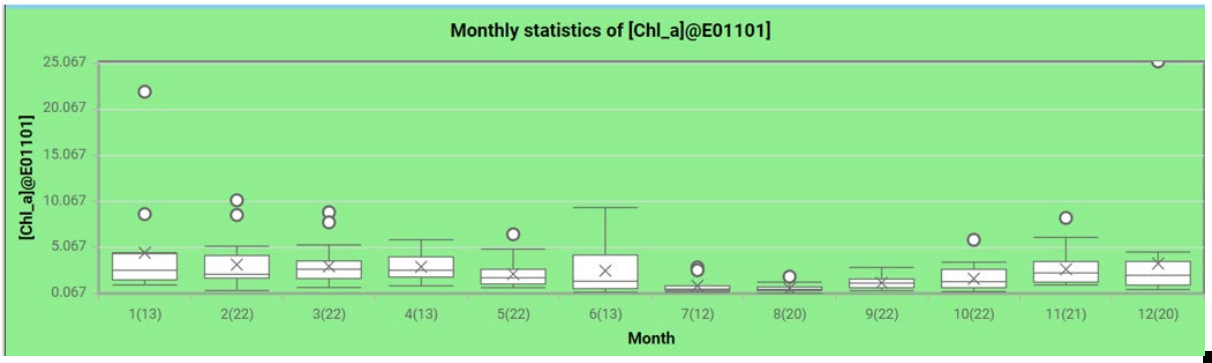


Figure 20 The Box-Whisker symbol summarises a range of statistical characteristics of a set of numbers, e.g. a timeseries.

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

Outlier handling is now implemented through the chart toolbar. Box-Whisker charts still display their distributional outlier points, while the toolbar outlier methods are used to filter or replace values in supported single-series chart views.

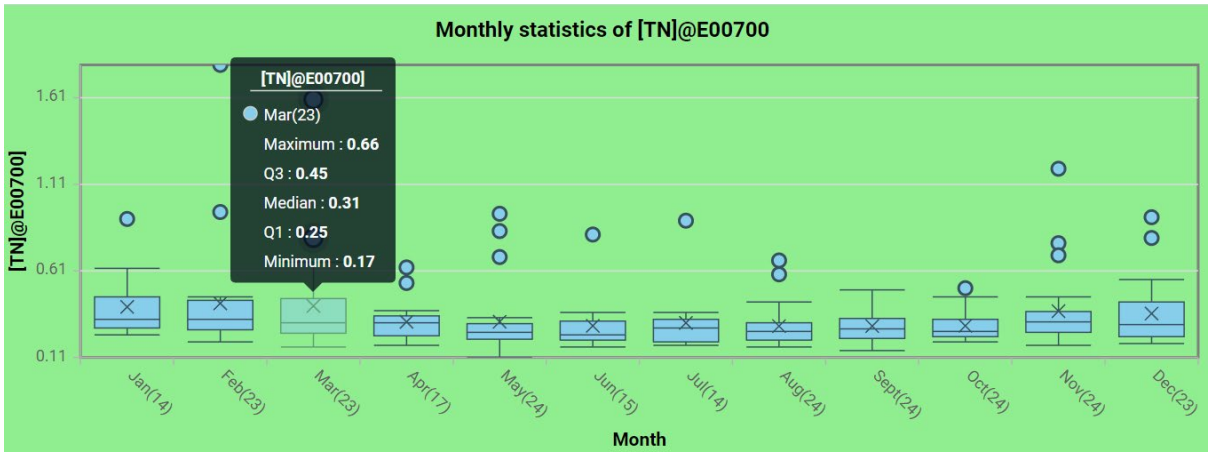


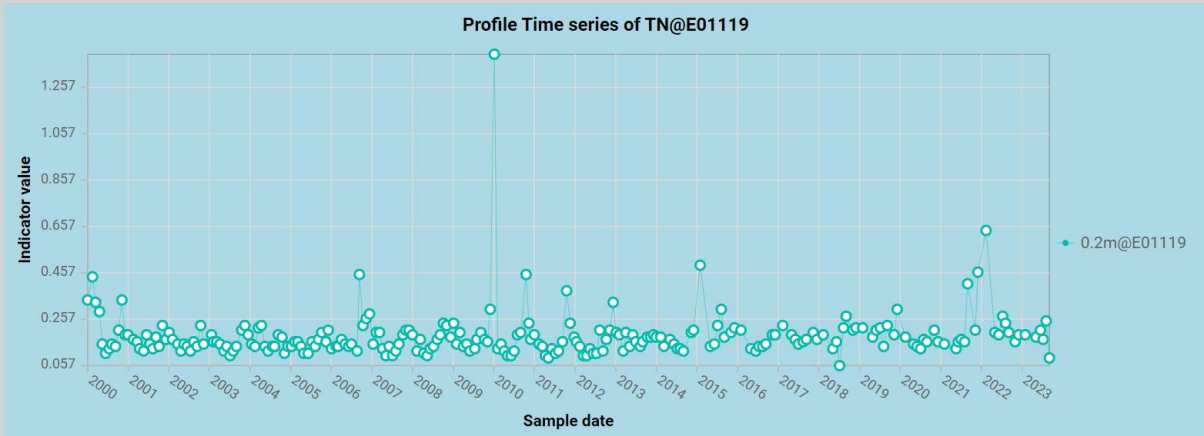
Figure 22 More details of Box-Whisker chart statistics pop up when the cursor hovers over an element.

Depth Profile time-series charts

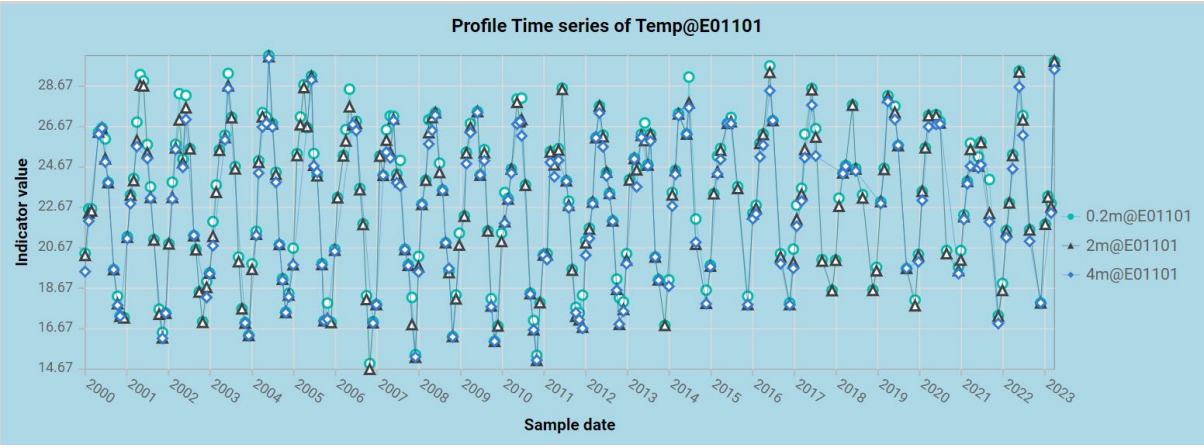
Menu: Analyses>Profile

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.

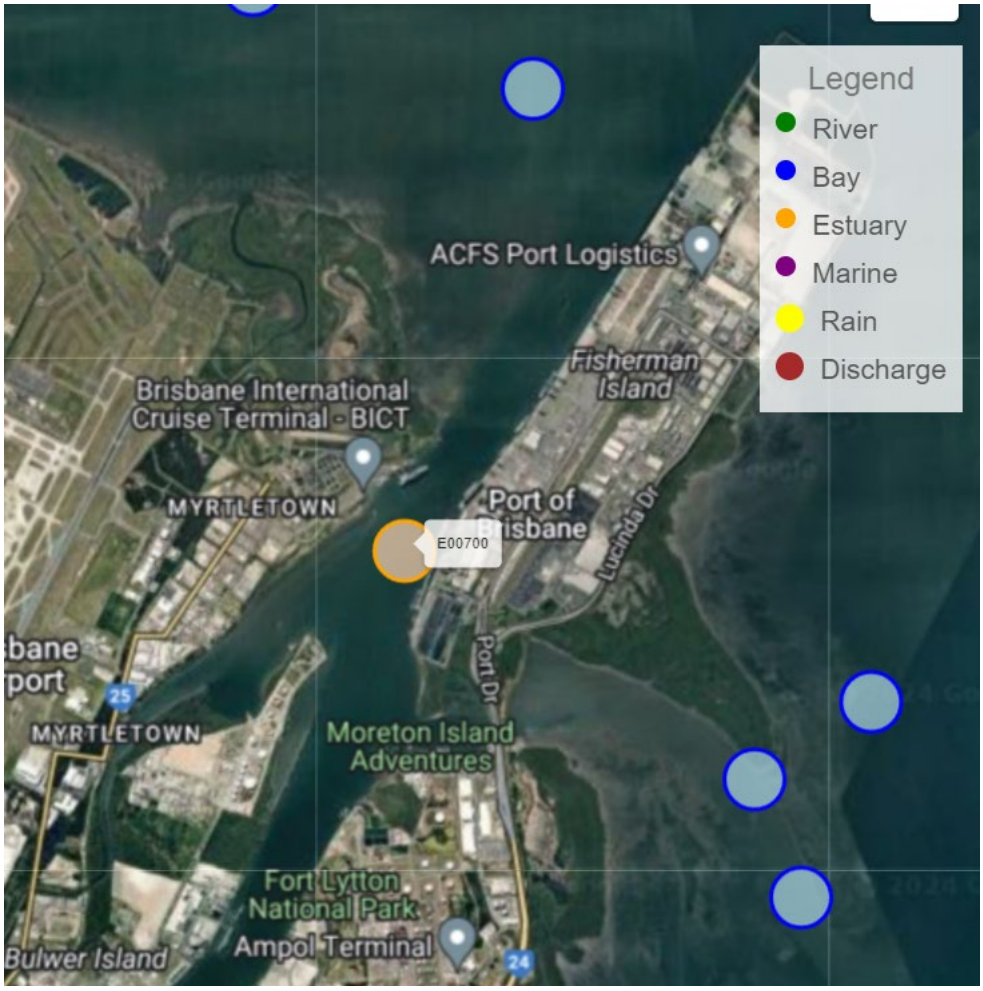


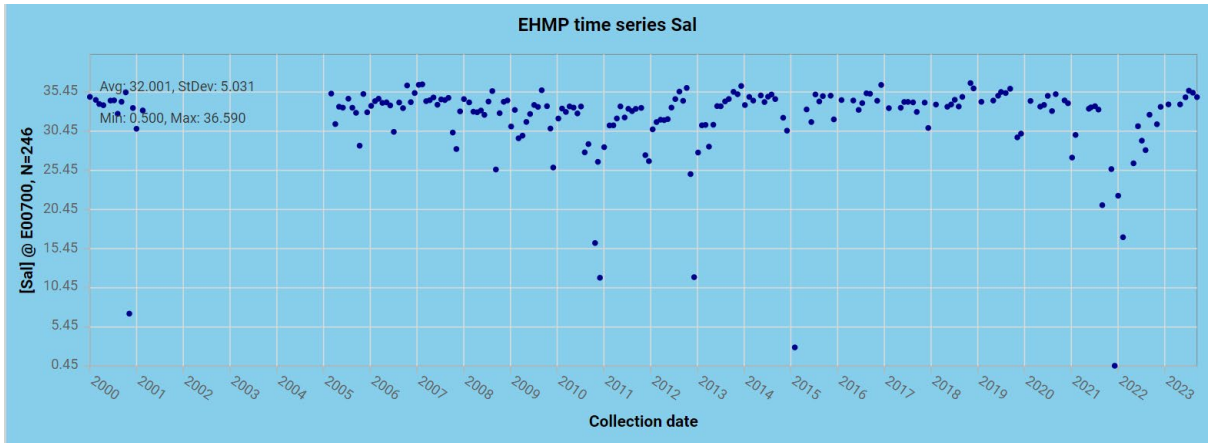
If profiling data is available, the chart will show a set of time-series at the various depths, as shown in the graph below.



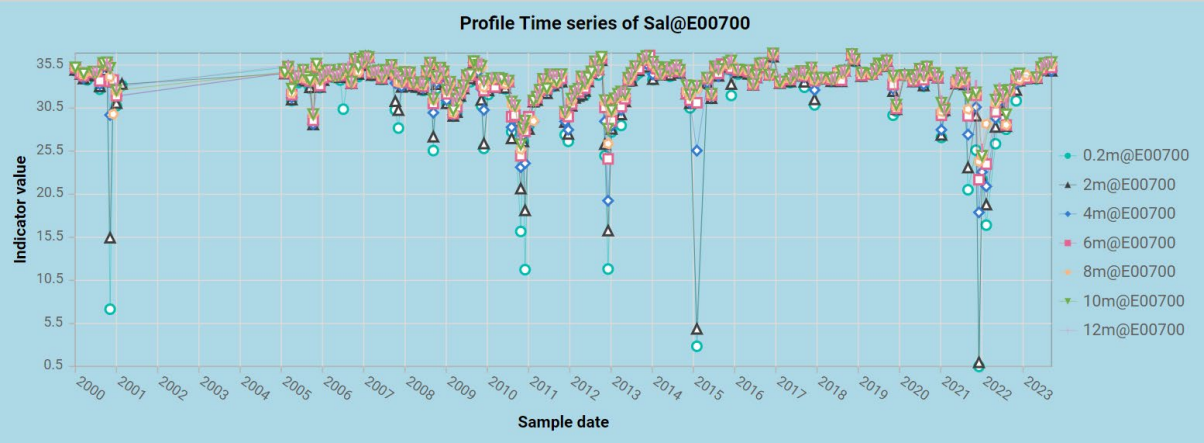
Profile chart example

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

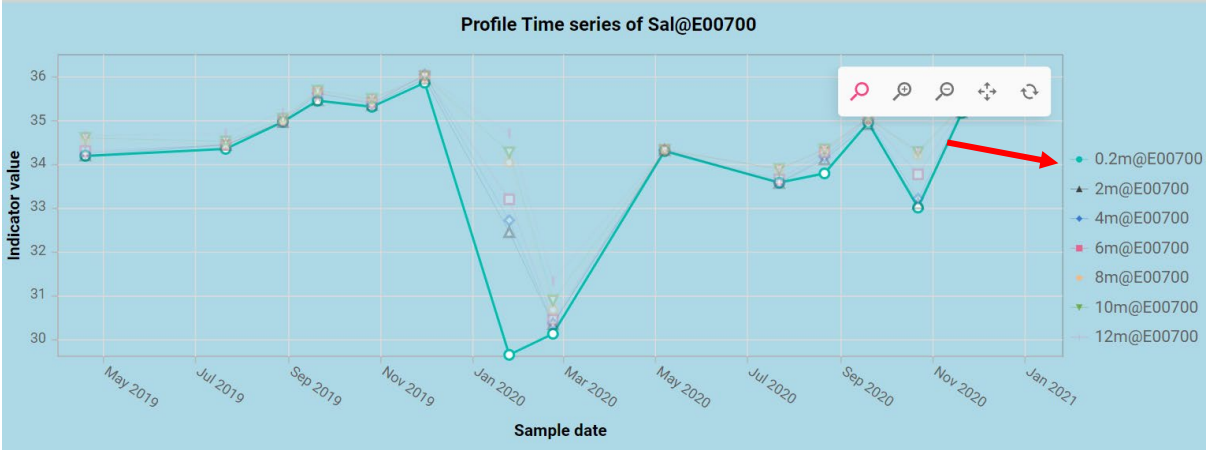




Selecting the Profile option in the Analysis menu results in the following chart:



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

Using EV Zones

EV zones are a convenient grouping and filtering mechanism for monitoring locations. They let you work with locations that belong to the same Environmental Values zone, rather than selecting each location individually.

Use the EV zones menu when you want to inspect, summarise, compare, or export data for the locations in a selected zone. Start by selecting the EV zone, then use the EV MTS chart to inspect the time series for sites in that zone. Use the temporal and spatial statistics options when you need summaries through time or across locations. Use the EV radar chart when you want a compact comparison of indicators or summary values. Use Export EV MTS when the zone-level data need to be copied to another program for reporting or further analysis.

EV zone summaries do not create new measurements. They reorganise and summarise the selected monitoring data by reporting area, so the result still depends on the selected indicator, date range, sites available in the zone, and any gaps in sampling.

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.

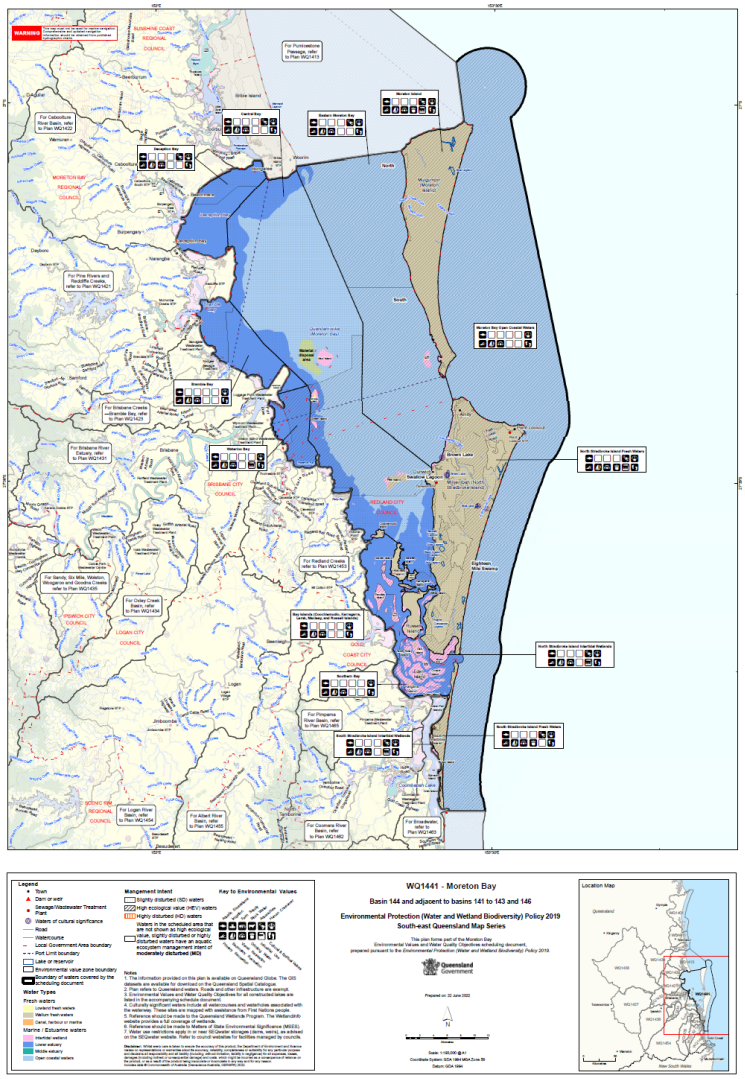


Figure 23 Overview of reporting regions in SE-Queensland, Australia, as published by the Queensland Department of Environment, Tourism, Science and Innovation (DETSI).

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.

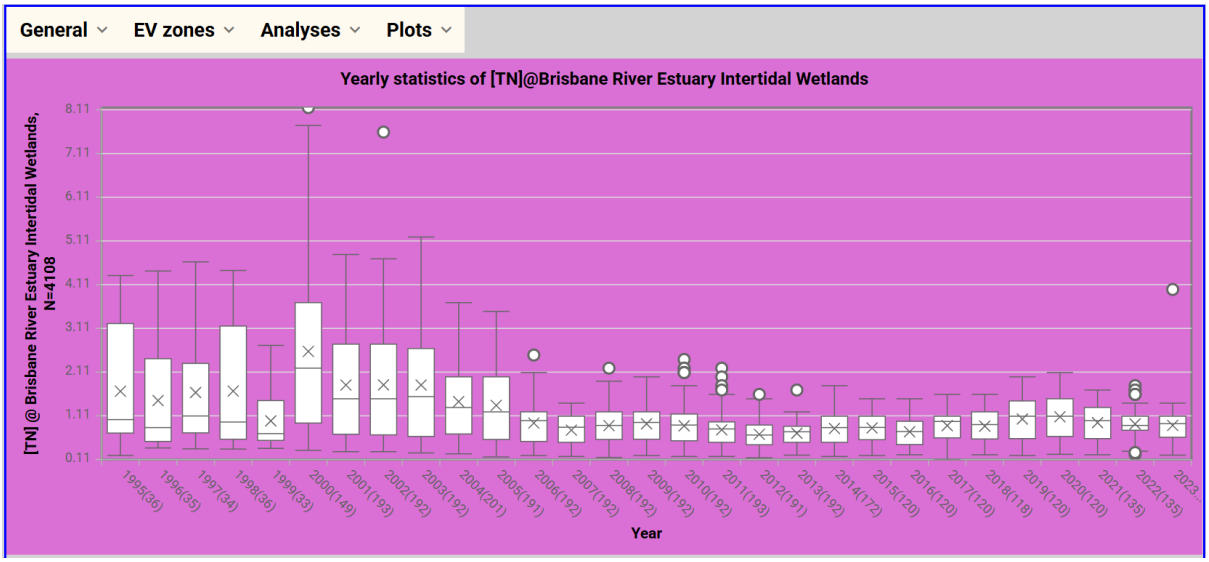


Figure 24 The annual trend of TN for the Brisbane River

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.

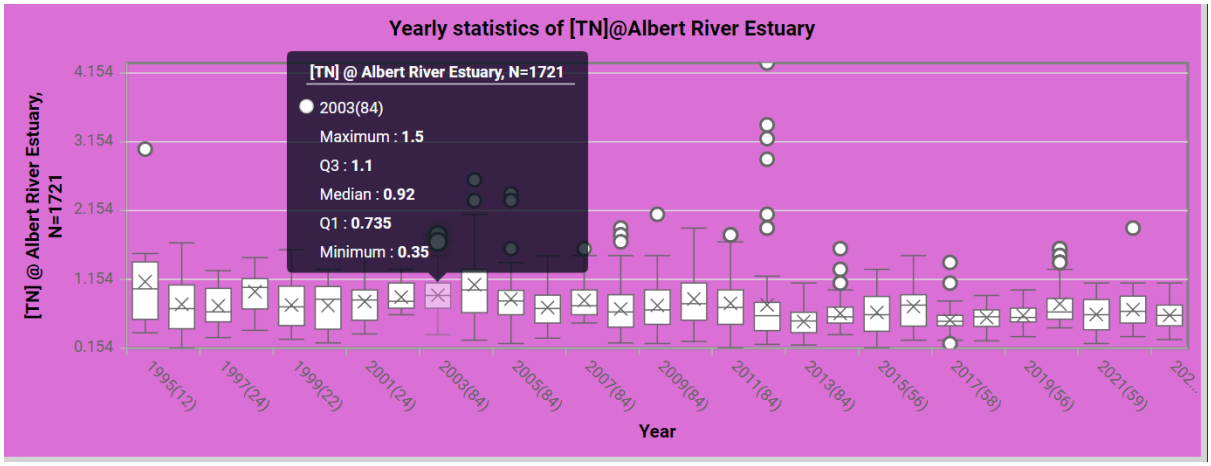


Figure 25 More details of Box-Whisker chart statistics pop up when the cursor hovers over an element.

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

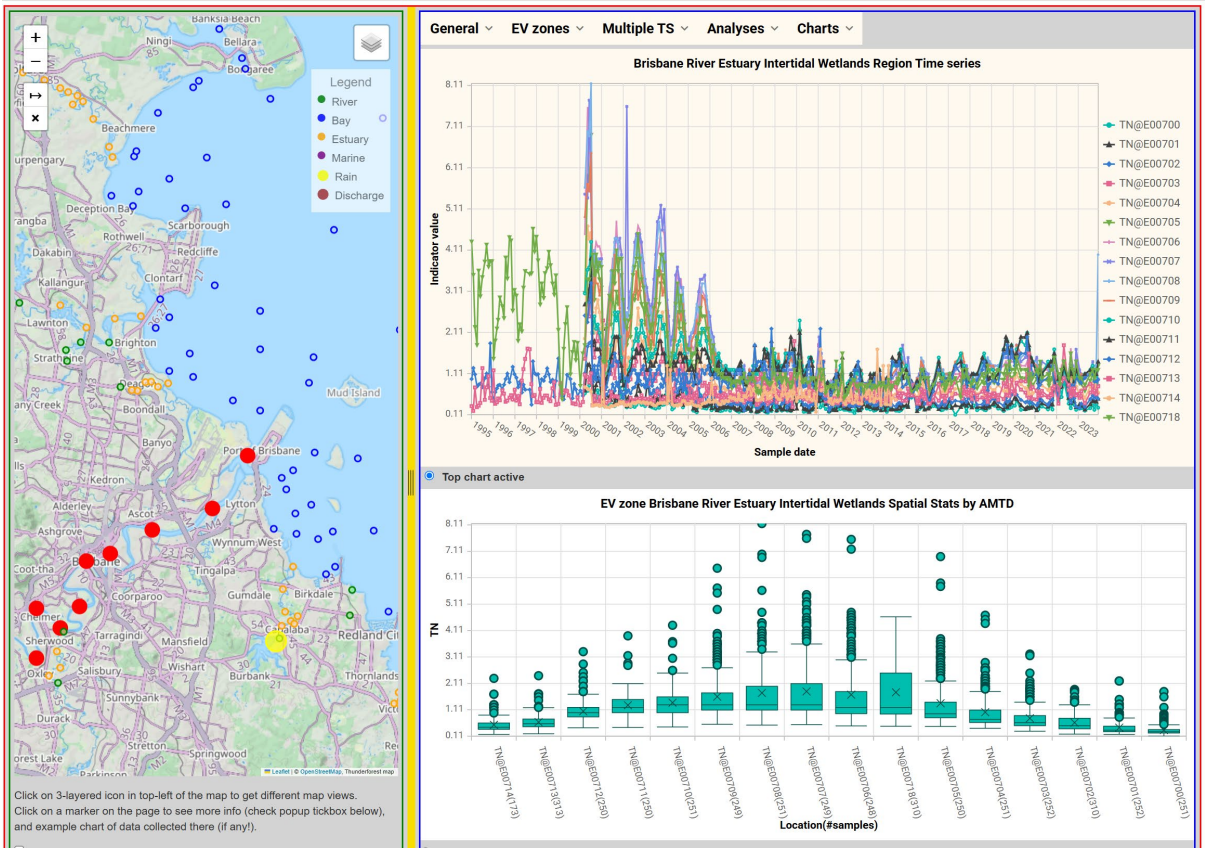


Figure 26 The timeseries (top chart) and spatial trend stats (bottom chart) of TN along the Brisbane River

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.

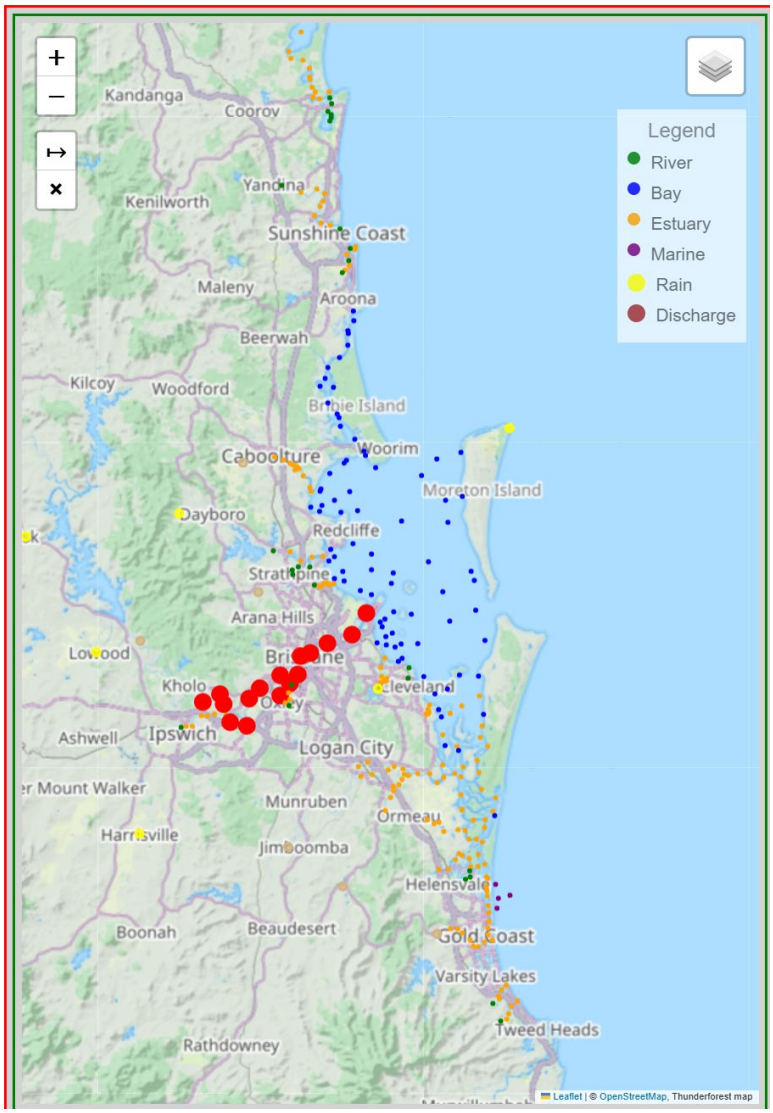


Figure 27 When charting time-series or Box-Whisker stats, the sites included in the EV zone are marked in red on the map.

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.

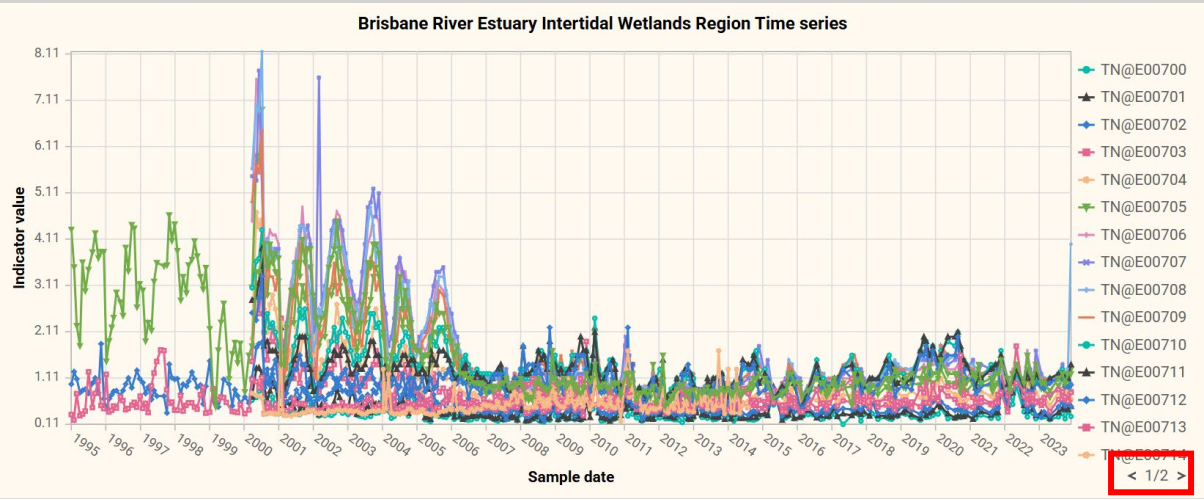


Figure 28 When selecting an EV-zone chart, the locations that comprise that zone will automatically be highlighted

Multi-indicator site comparisons with radar charts

Menu: EV zones>EV Radar chart

or

Menu: MTS>MTS Radar chart

Menu: MTS>MTS Radar chart
Menu: MTS>MTS Radar chart

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.

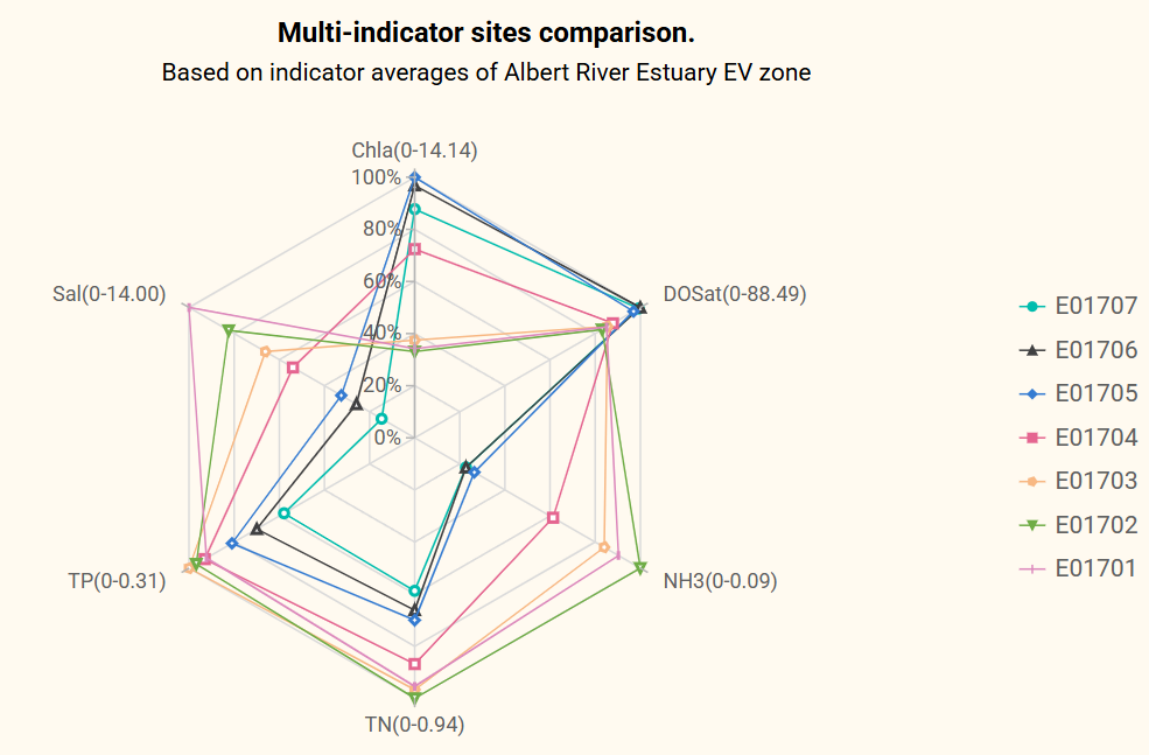
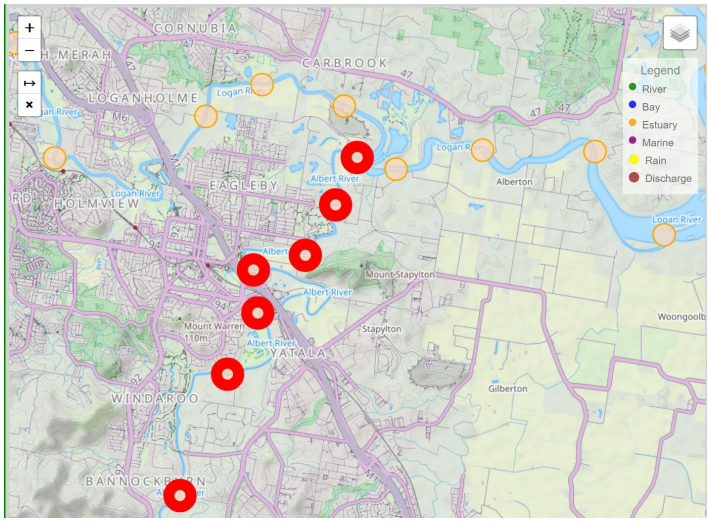


Figure 29 A radar or spider web chart allows for a quick comparison between sites using a range of indicators.

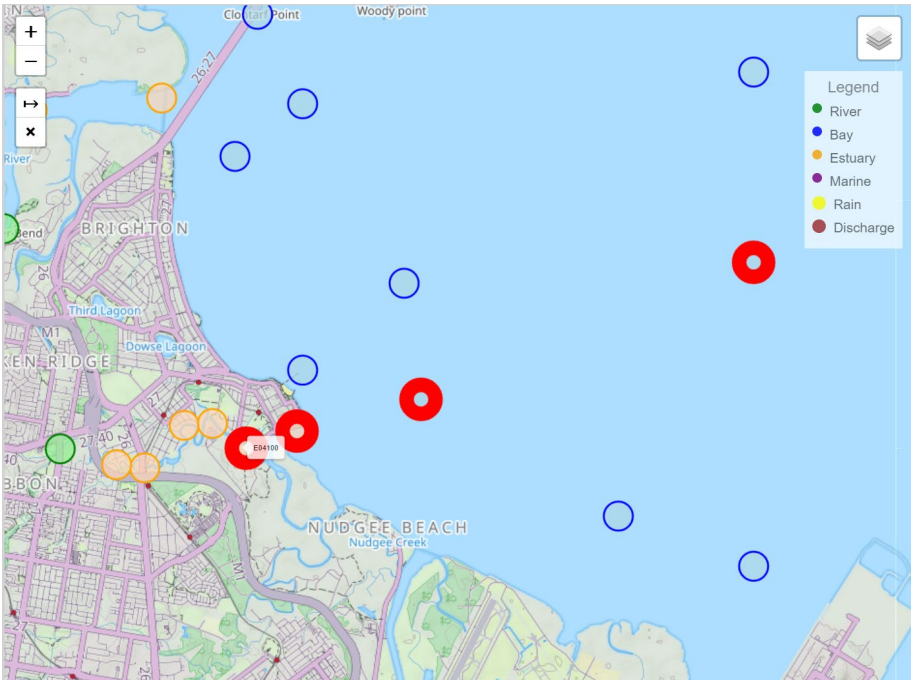
The map will show which sites are included.



For user-selected locations

Select one or more locations first: Menu: MTS>Activate MTS selection. When this mode is active, a map selection toolbar is shown, allowing point, rectangle and polygon-style selection of multiple locations. Click individual markers or use the selection tools to build the MTS list.

Then select one or more sites on the map.



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

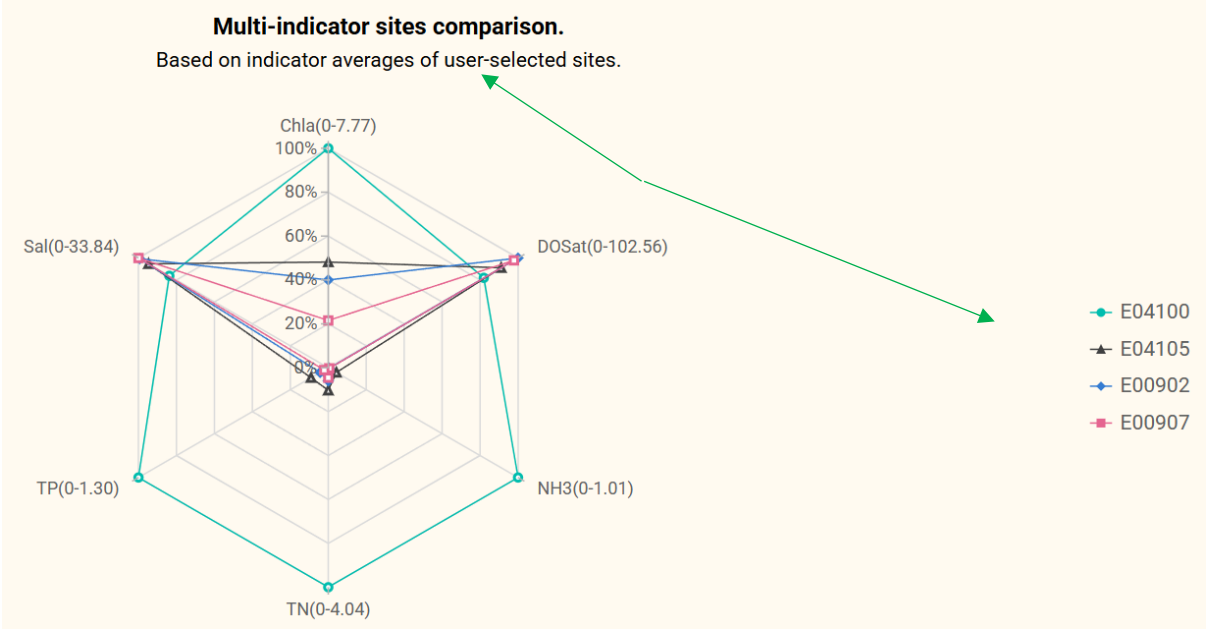


Figure 30 Radar charts based on user-selected locations give a quick impression about the selected locations. For example: site E04100 distinguishes itself by having such high nutrient components relative to its neighbour locations.

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.

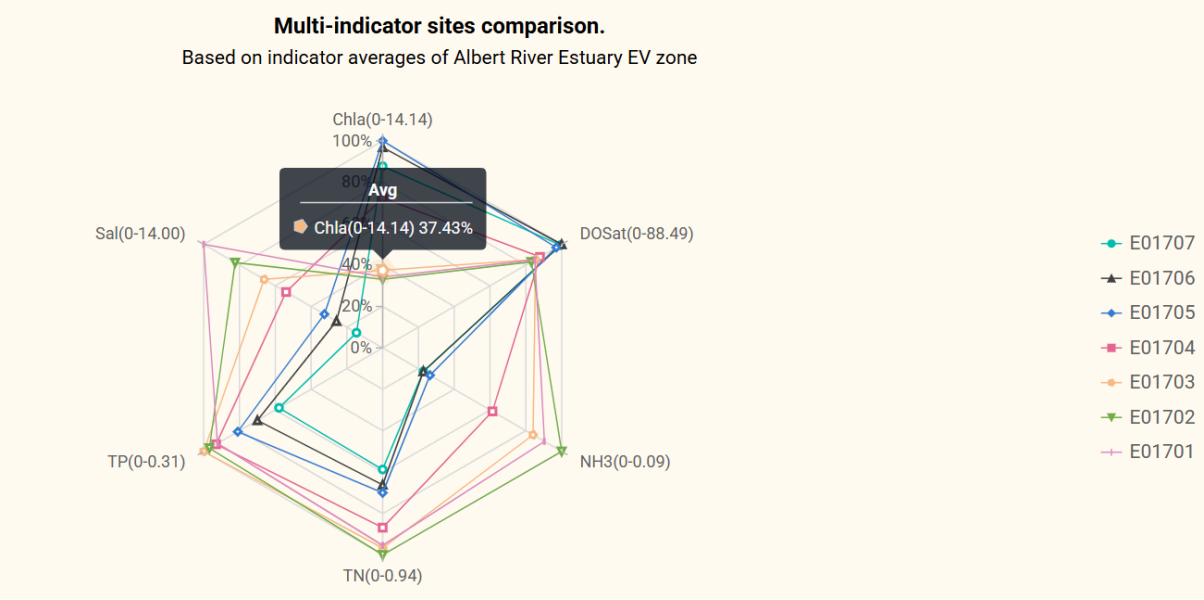


Figure 31 The numbers at the end of the radar chart 'spokes' indicate the maximum of the time-averaged indicator values over all selected locations.

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.

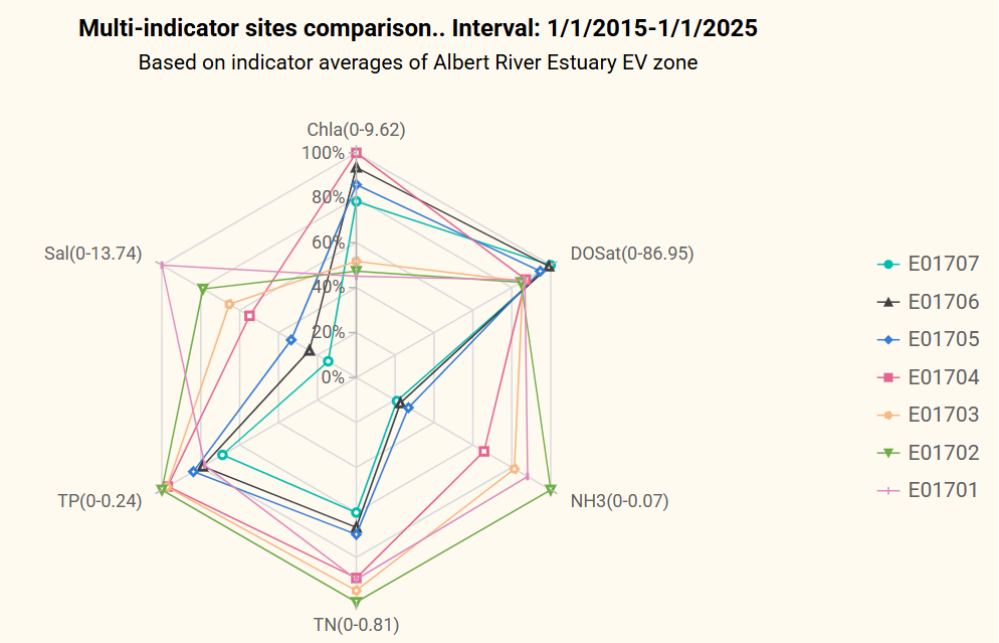


Figure 32 Setting a date interval will be included in the radar plot.

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.

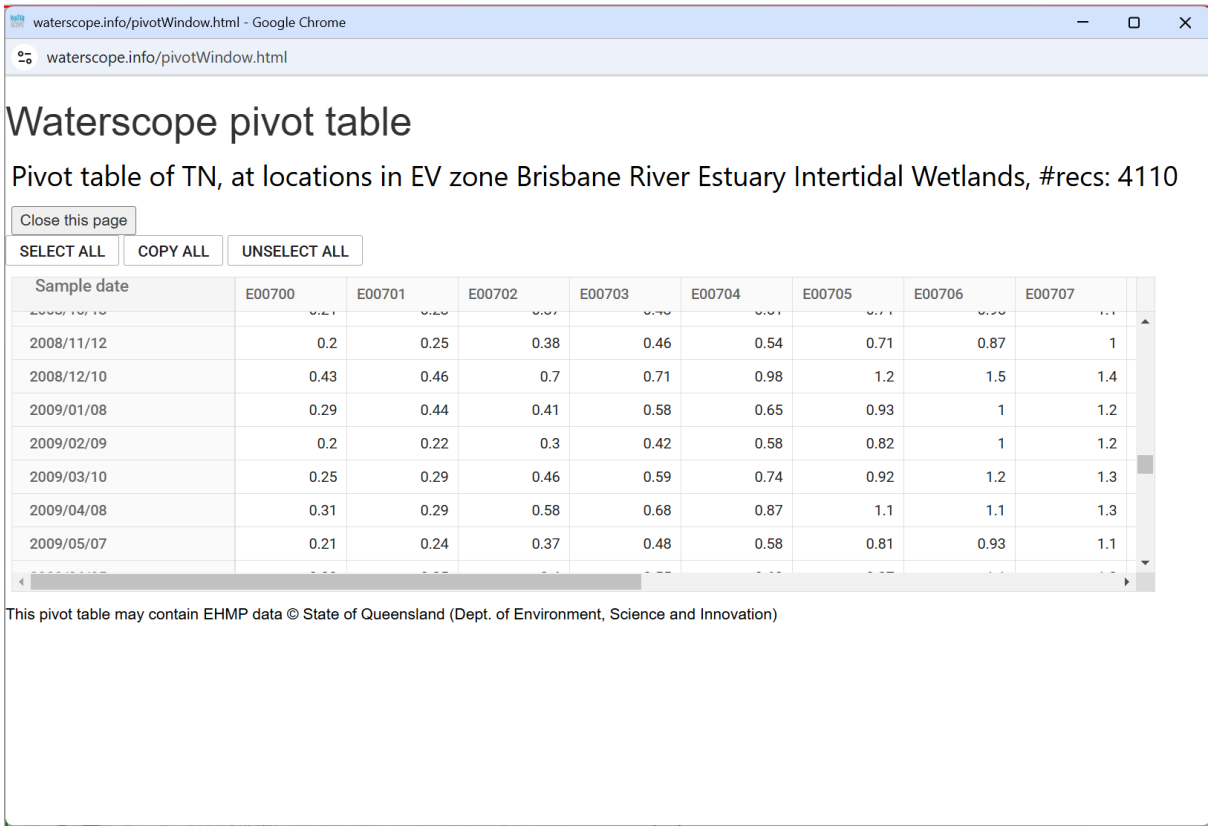


Figure 33 The indicator values at the locations within the selected EV-zone can be shown in a pivot table and copies to the clipboard for further analysis.

EV regions maps and legends

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

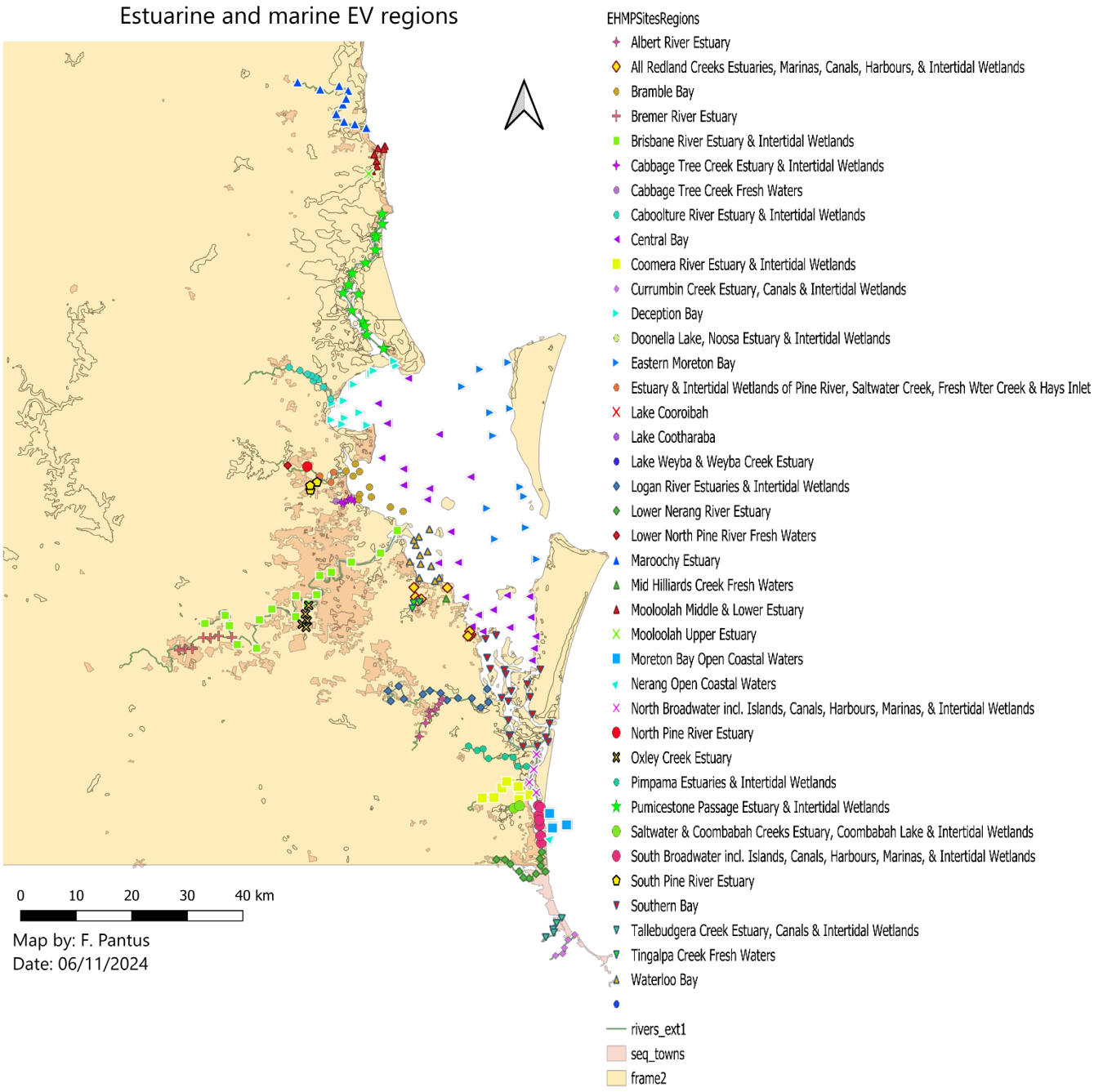


Figure 34 Map of Estuarine/Marine sample locations, grouped in EV regions.

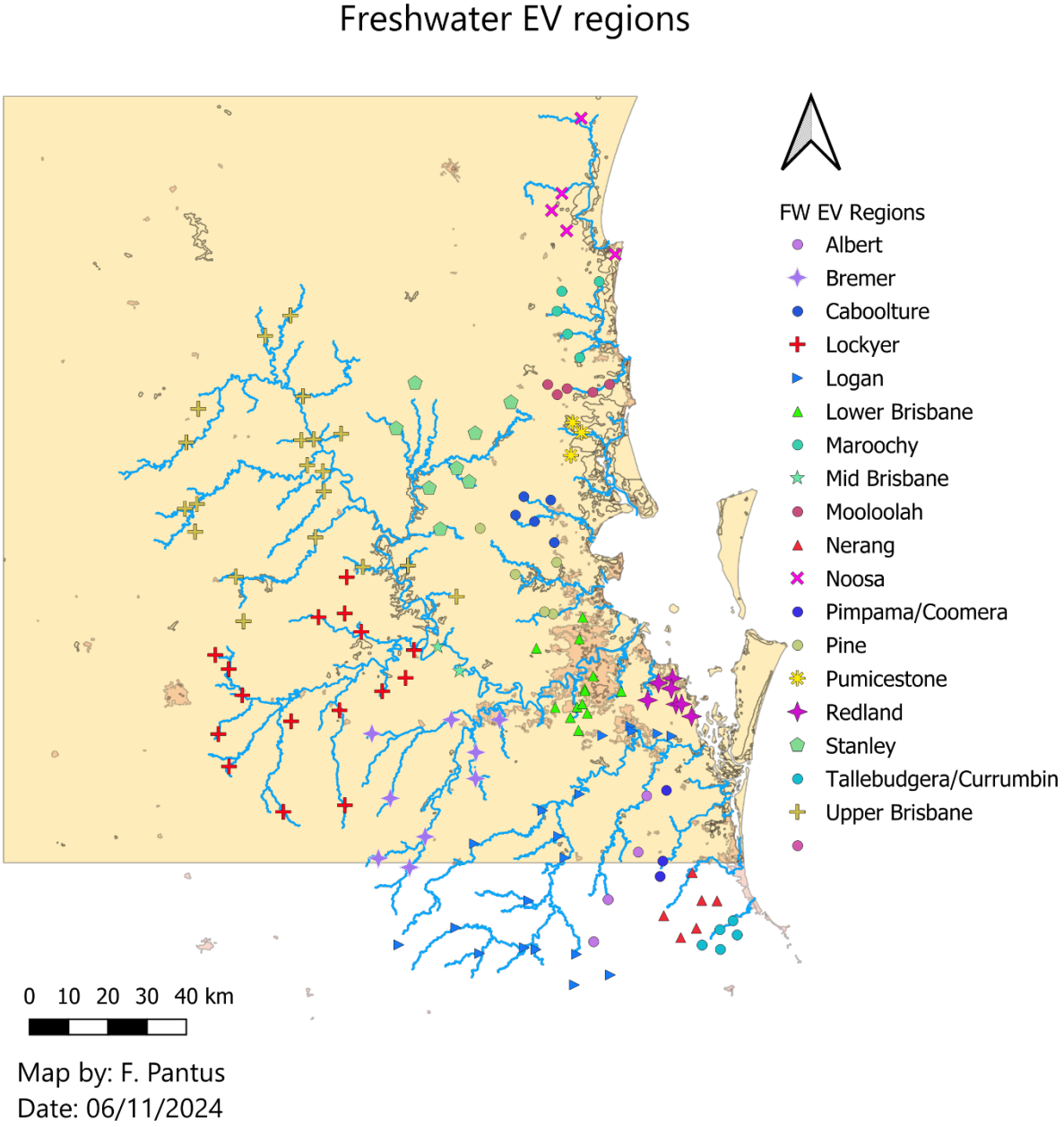
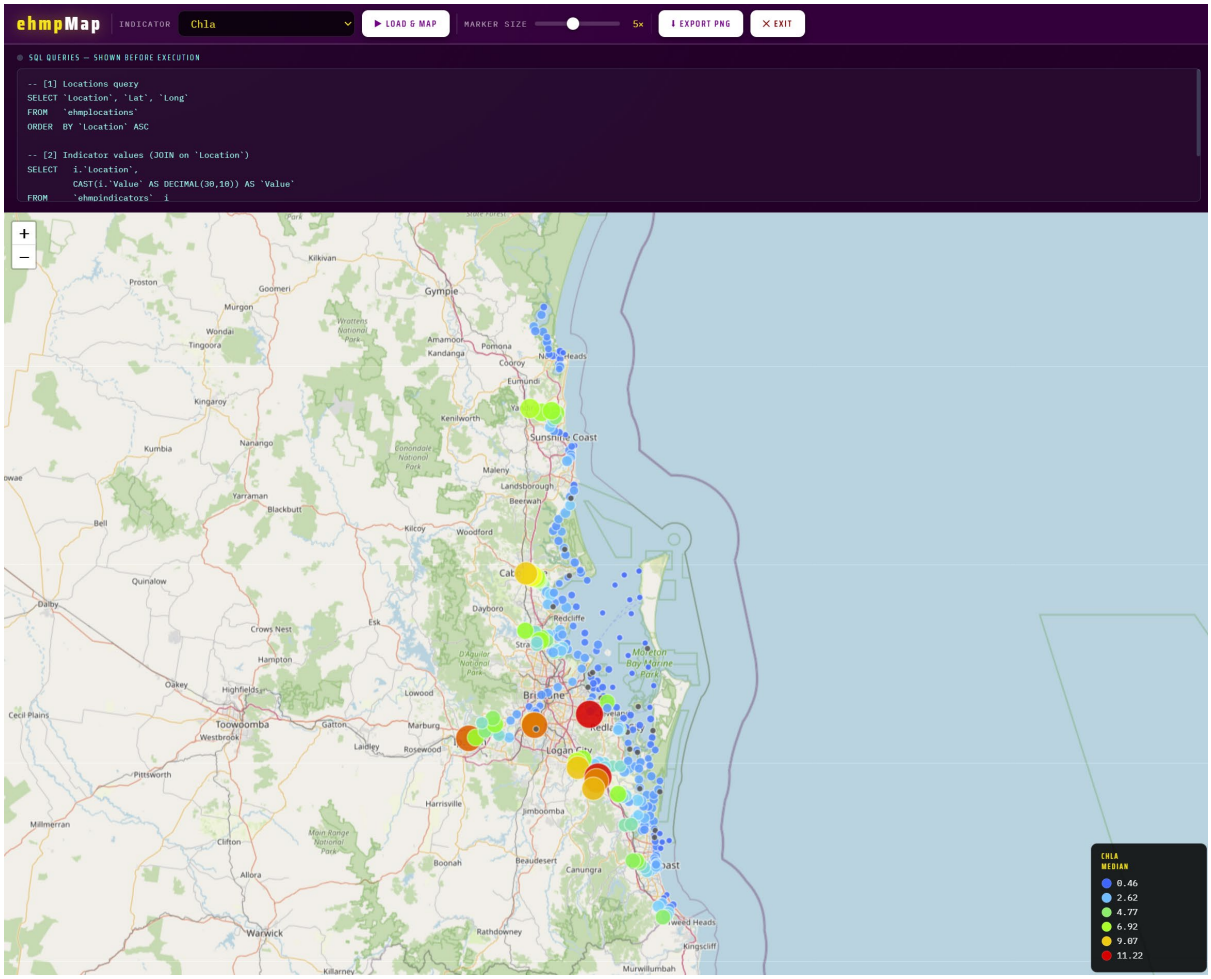


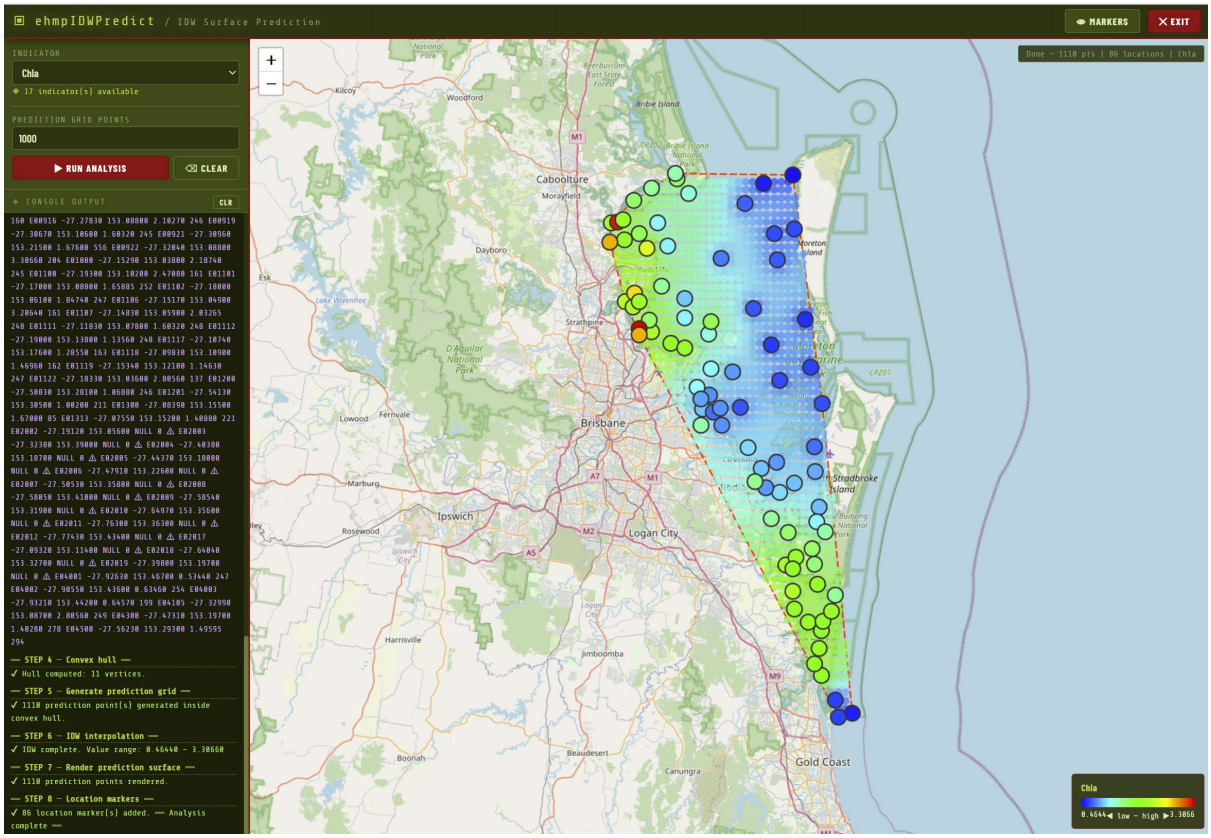
Figure 35 Map of Freshwater sample locations, grouped in EV regions.

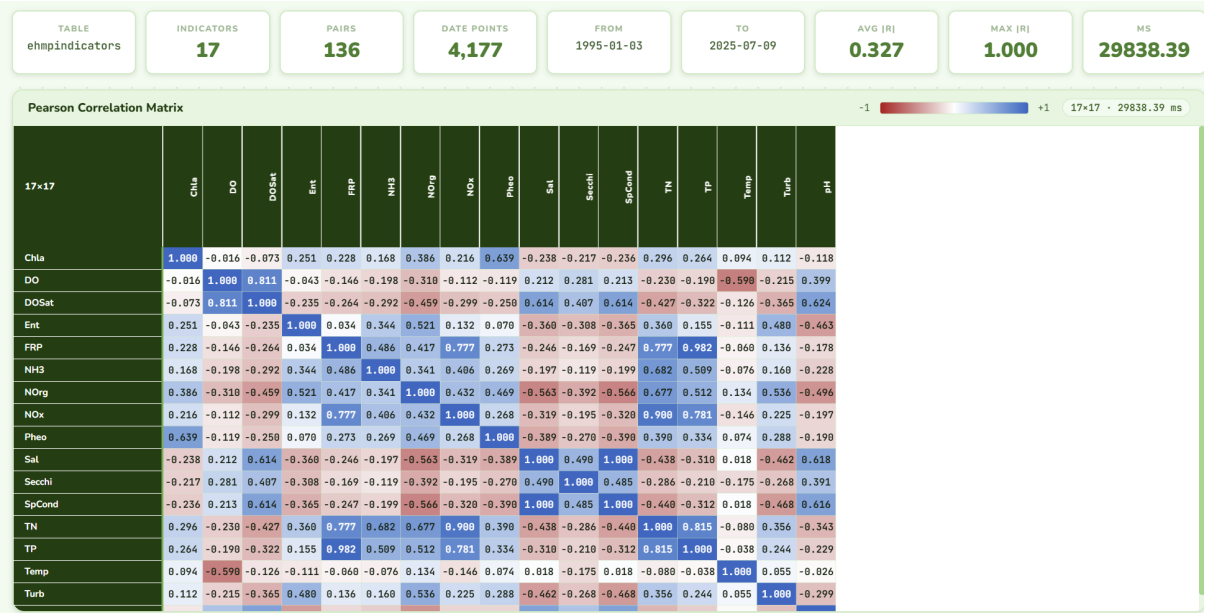
Appendix A: AI-generated Utils

There are now a range of new demonstration utilities available using the Waterscope website.

- Instant overview: shows hotspots in the SE-Qld region instantly
- IDW-based prediction NOW: create inverse-distance weighted prediction for Moreton Bay
- Numeric insights of relationships: Correlation matrix of selected indicator
- Shifted relationships: Cross-correlation function for time-delayed relationships
- Trends with statistical significance: Decomposes a time series. Show the temporal trend at a location for a selected indicator. Comes with statistical significance measures.
- Spatial coherence, or not: Semi-variogram for Moreton Bay for a selected indicator + model. Expressing a distance-based cohesion in the bay. Not for beginners 😉.
- EHMP DB explorer: shows the EHMP Database tables, allows non-destructive queries and the calculation of the major statistics of a selected indicator over all data.

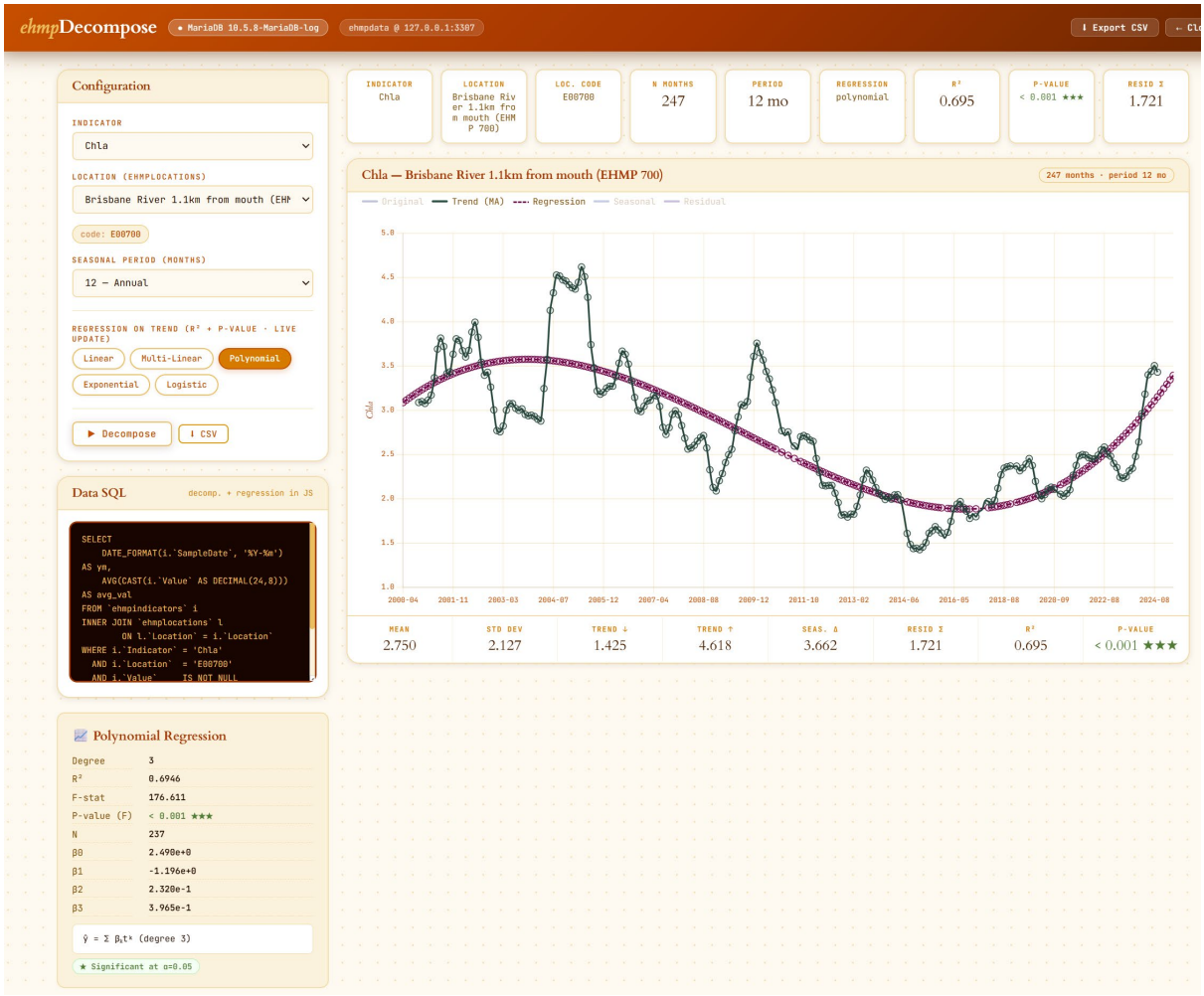

ehmpMap
INDICATOR
Chla
LOAD & MAP
MARKER SIZE
5×
EXPORT PNG
EXIT
SQL QUERIES — SHOWN BEFORE EXECUTION
-- [1] Locations query
SELECT `Location`, `Lat`, `Long`
FROM `ehmplocations`
ORDER BY `Location` ASC
-- [2] Indicator values (JOIN on `Location`)
SELECT i.`Location`,
CAST(i.`Value` AS DECIMAL(30,10)) AS `Value`
FROM `ehmpindicators` i
Gympie
Sunshine Coast
Brisbane
Logan City
Toowoomba
Warwick
CHLA MEDIAN
0.46
2.62
4.77
6.92
9.07
11.22


ehmpIDWPredict / IDW Surface Prediction
MARKERS
EXIT
INDICATOR
Chla
17 indicator(s) available
PREDICTION GRID POINTS
1000
RUN ANALYSIS
CLEAR
CONSOLE OUTPUT
CLR
160 E00916 -27.27830 153.08800 2.10270 246 E00919
-27.30670 153.10600 1.60320 245 E00921 -27.30960
153.21500 1.67600 556 E00922 -27.32040 153.08800
3.30660 204 E01000 -27.15290 153.03800 2.18740
245 E01100 -27.19300 153.10200 2.47080 161 E01101
-27.17000 153.08800 1.65085 252 E01102 -27.18000
153.06100 1.84740 247 E01106 -27.15170 153.04900
3.20640 161 E01107 -27.14030 153.05900 2.03265
248 E01111 -27.11830 153.07800 1.60320 248 E01112
-27.19000 153.13800 1.13560 248 E01117 -27.10740
153.17600 1.28550 163 E01118 -27.09830 153.10900
1.46960 162 E01119 -27.15340 153.12100 1.14630
247 E01122 -27.18330 153.03600 2.80560 137 E01200
-27.50030 153.28100 1.06880 246 E01201 -27.54130
153.30500 1.00200 211 E01300 -27.08390 153.15500
1.67000 85 E01313 -27.07550 153.15200 1.40880 221
E02002 -27.19120 153.05600 NULL 0 ⚠ E02003
-27.32380 153.39000 NULL 0 ⚠ E02004 -27.40380
153.18700 NULL 0 ⚠ E02005 -27.44370 153.18000
NULL 0 ⚠ E02006 -27.47910 153.22600 NULL 0 ⚠
E02007 -27.50530 153.35800 NULL 0 ⚠ E02008
-27.58050 153.41000 NULL 0 ⚠ E02009 -27.58540
153.31900 NULL 0 ⚠ E02010 -27.64970 153.35600
NULL 0 ⚠ E02011 -27.76300 153.36300 NULL 0 ⚠
E02012 -27.77430 153.43400 NULL 0 ⚠ E02017
-27.09320 153.11400 NULL 0 ⚠ E02018 -27.64040
153.32700 NULL 0 ⚠ E02019 -27.39800 153.19700
NULL 0 ⚠ E04001 -27.92630 153.46700 0.53440 247
E04002 -27.90550 153.43600 0.63460 254 E04003
-27.93210 153.44200 0.64570 199 E04105 -27.32990
153.08700 2.80560 249 E04300 -27.47310 153.19700
1.40280 278 E04500 -27.56230 153.29300 1.49595
294
STEP 4 — Convex hull
✓ Hull computed: 11 vertices.
STEP 5 — Generate prediction grid
✓ 1110 prediction point(s) generated inside convex hull.
STEP 6 — IDW interpolation
✓ IDW complete. Value range: 0.46440 - 3.30660
STEP 7 — Render prediction surface
✓ 1110 prediction points rendered.
STEP 8 — Location markers
✓ 86 location marker(s) added. Analysis complete
Done — 1110 pts | 86 locations | Chla
Caboolture
Morayfield
Dayboro
Strathpine
Brisbane
Ipswich
Logan City
Gold Coast
Marburg
Rosewood
Harrisville
Jimboomba
Beaudesert
Boonah
Canungra
Kilcoy
Woodford
Esk
Lowood
Fernvale
Moreton Island
Stradbroke Island
Chla
0.4644 low - high 3.3066

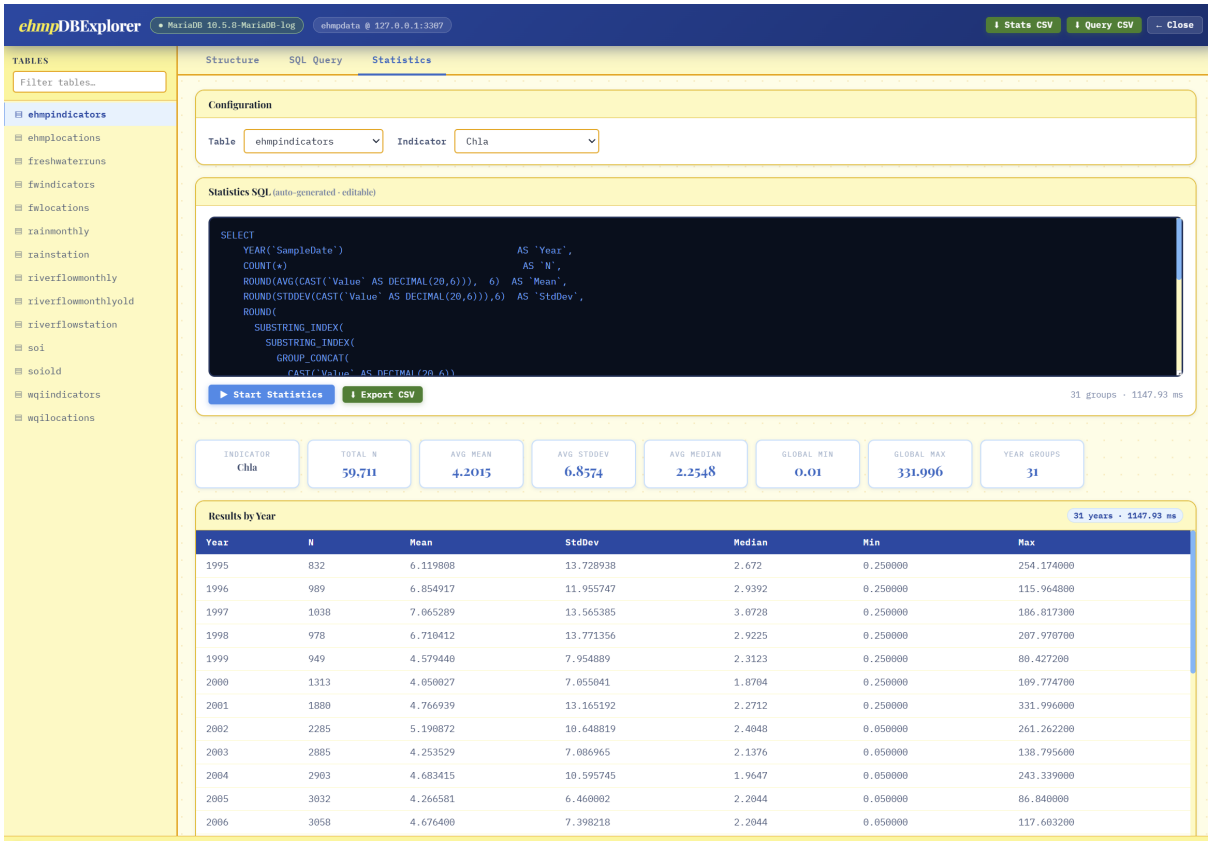


17×17	Chla	DO	DOSat	Ent	FRP	NH3	NOrg	NOx	Pheo	Sal	Secchi	SpCond	TN	TP	Temp	Turb	pH
Chla	1.000	-0.016	-0.073	0.251	0.228	0.168	0.386	0.216	0.639	-0.238	-0.217	-0.236	0.296	0.264	0.094	0.112	-0.118
DO	-0.016	1.000	0.811	-0.043	-0.146	-0.198	-0.310	-0.112	-0.119	0.212	0.281	0.213	-0.230	-0.190	-0.590	-0.215	0.399
DOSat	-0.073	0.811	1.000	-0.235	-0.264	-0.292	-0.459	-0.299	-0.250	0.614	0.407	0.614	-0.427	-0.322	-0.126	-0.365	0.624
Ent	0.251	-0.043	-0.235	1.000	0.034	0.344	0.521	0.132	0.070	-0.360	-0.308	-0.365	0.360	0.155	-0.111	0.480	-0.463
FRP	0.228	-0.146	-0.264	0.034	1.000	0.486	0.417	0.777	0.273	-0.246	-0.169	-0.247	0.777	0.982	-0.060	0.136	-0.178
NH3	0.168	-0.198	-0.292	0.344	0.486	1.000	0.341	0.406	0.269	-0.197	-0.119	-0.199	0.682	0.509	-0.076	0.160	-0.228
NOrg	0.386	-0.310	-0.459	0.521	0.417	0.341	1.000	0.432	0.469	-0.563	-0.392	-0.566	0.677	0.512	0.134	0.536	-0.496
NOx	0.216	-0.112	-0.299	0.132	0.777	0.406	0.432	1.000	0.268	-0.319	-0.195	-0.320	0.900	0.781	-0.146	0.225	-0.197
Pheo	0.639	-0.119	-0.250	0.070	0.273	0.269	0.469	0.268	1.000	-0.389	-0.270	-0.390	0.390	0.334	0.074	0.288	-0.190
Sal	-0.238	0.212	0.614	-0.360	-0.246	-0.197	-0.563	-0.319	-0.389	1.000	0.498	1.000	-0.438	-0.310	0.018	-0.462	0.618
Secchi	-0.217	0.281	0.407	-0.308	-0.169	-0.119	-0.392	-0.195	-0.270	0.498	1.000	0.485	-0.286	-0.210	-0.175	-0.268	0.391
SpCond	-0.236	0.213	0.614	-0.365	-0.247	-0.199	-0.566	-0.320	-0.390	1.000	0.485	1.000	-0.440	-0.312	0.018	-0.468	0.616
TN	0.296	-0.230	-0.427	0.360	0.777	0.682	0.677	0.900	0.390	-0.438	-0.286	-0.440	1.000	0.815	-0.080	0.356	-0.343
TP	0.264	-0.190	-0.322	0.155	0.982	0.509	0.512	0.781	0.334	-0.310	-0.210	-0.312	0.815	1.000	-0.038	0.244	-0.229
Temp	0.094	-0.590	-0.126	-0.111	-0.060	-0.076	0.134	-0.146	0.074	0.018	-0.175	0.018	-0.080	-0.038	1.000	0.055	-0.026
Turb	0.112	-0.215	-0.365	0.480	0.136	0.160	0.536	0.225	0.288	-0.462	-0.268	-0.468	0.356	0.244	0.055	1.000	-0.299




ehmpDecompose
MariaDB 10.5.8-MariaDB-log
ehmpdata @ 127.0.0.1:3307
Export CSV
Configuration
INDICATOR
Chla
LOCATION (EHMPLOCATIONS)
Brisbane River 1.1km from mouth (EHM
code: E00700
SEASONAL PERIOD (MONTHS)
12 — Annual
REGRESSION ON TREND (R² + P-VALUE · LIVE UPDATE)
Linear
Multi-Linear
Polynomial
Exponential
Logistic
▶ Decompose
CSV
Data SQL
decomp. + regression in JS
SELECT
DATE_FORMAT(i.`SampleDate`, '%Y-%m')
AS ym,
AVG(CAST(i.`Value` AS DECIMAL(24,8)))
AS avg_val
FROM `ehmpindicators` i
INNER JOIN `ehmplocations` l
ON l.`Location` = i.`Location`
WHERE i.`Indicator` = 'Chla'
AND i.`Location` = 'E00700'
AND i.`Value` IS NOT NULL
INDICATOR
Chla
LOCATION
Brisbane Riv
er 1.1km fro
m mouth (EHM
P 700)
LOC. CODE
E00700
N MONTHS
247
PERIOD
12 mo
REGRESSION
polynomial
R²
0.695
P-VALUE
< 0.001 ★★★
RESID Σ
1.721
Chla — Brisbane River 1.1km from mouth (EHMP 700)
247 months · period 12 mo
Original
Trend (MA)
Regression
Seasonal
Residual
Chla
MEAN
2.750
STD DEV
2.127
TREND ↓
1.425
TREND ↑
4.618
SEAS. Δ
3.662
RESID Σ
1.721
R²
0.695
P-VALUE
< 0.001 ★★★
Polynomial Regression
Degree 3
R² 0.6946
F-stat 176.611
P-value (F) < 0.001 ★★★
N 237
β0 2.490e+0
β1 -1.196e+0
β2 2.320e-1
β3 3.965e-1
ŷ = Σ βⱼtʲ (degree 3)
★ Significant at α=0.05


4 SEMI-VARIOGRAM & MODEL FIT
Model
Spherical
Nugget (C₀)
0.0000
Sill (C₀+C)
0.5311
Range (km)
28.63
SSE
1.745e-1
Pairs
3655
Semi-Variogram — Chla · Moreton Bay
Spherical Model (nugget=0.000, sill=0.531, range=28.6 km)
Empirical Semi-variogram (Chla)
Semi-variance γ(h)
Lag Distance h (km)



Year	N	Mean	StdDev	Median	Min	Max
1995	832	6.119808	13.728938	2.672	0.250000	254.174000
1996	989	6.854917	11.955747	2.9392	0.250000	115.964800
1997	1038	7.065289	13.565385	3.0728	0.250000	186.817300
1998	978	6.710412	13.771356	2.9225	0.250000	207.970700
1999	949	4.579440	7.954889	2.3123	0.250000	80.427200
2000	1313	4.050027	7.055041	1.8704	0.250000	109.774700
2001	1880	4.766939	13.165192	2.2712	0.250000	331.996000
2002	2285	5.190872	10.648819	2.4048	0.050000	261.262200
2003	2885	4.253529	7.086965	2.1376	0.050000	138.795600
2004	2903	4.683415	10.595745	1.9647	0.050000	243.339000
2005	3032	4.266581	6.460002	2.2044	0.050000	86.840000
2006	3058	4.676400	7.398218	2.2044	0.050000	117.603200

Appendix B: 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.

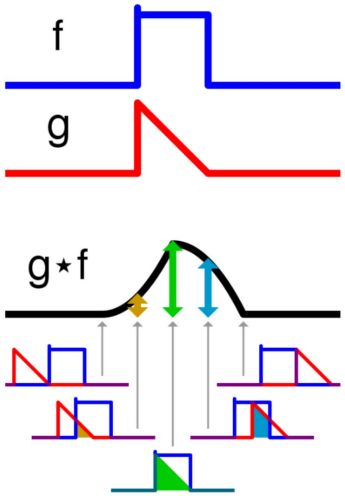


Figure 36 Diagram explaining the basics of the cross-correlation function.

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.

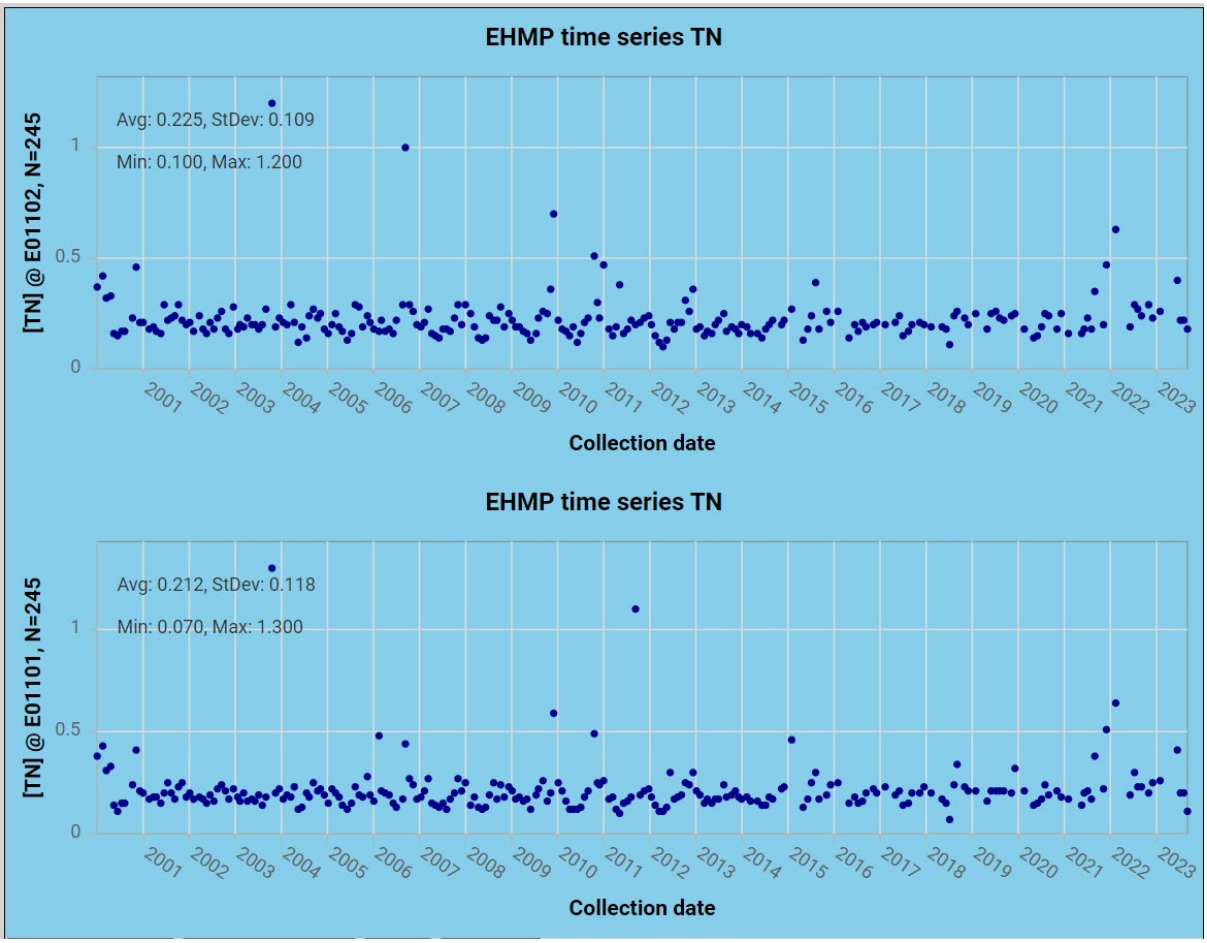


Figure 37 For a cross-correlation function, both graphs should contain a different time-series

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.

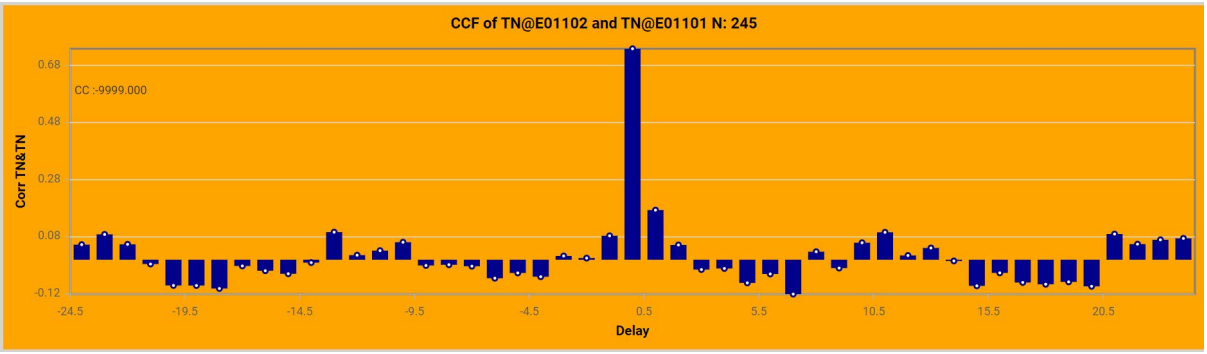


Figure 38A cross-correlation function shows the correlation between two time-series that are shifted N delay steps relative to each other. It allows us to examine the strength of the relationship of two time-series that may be delayed with respect to each other.

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.

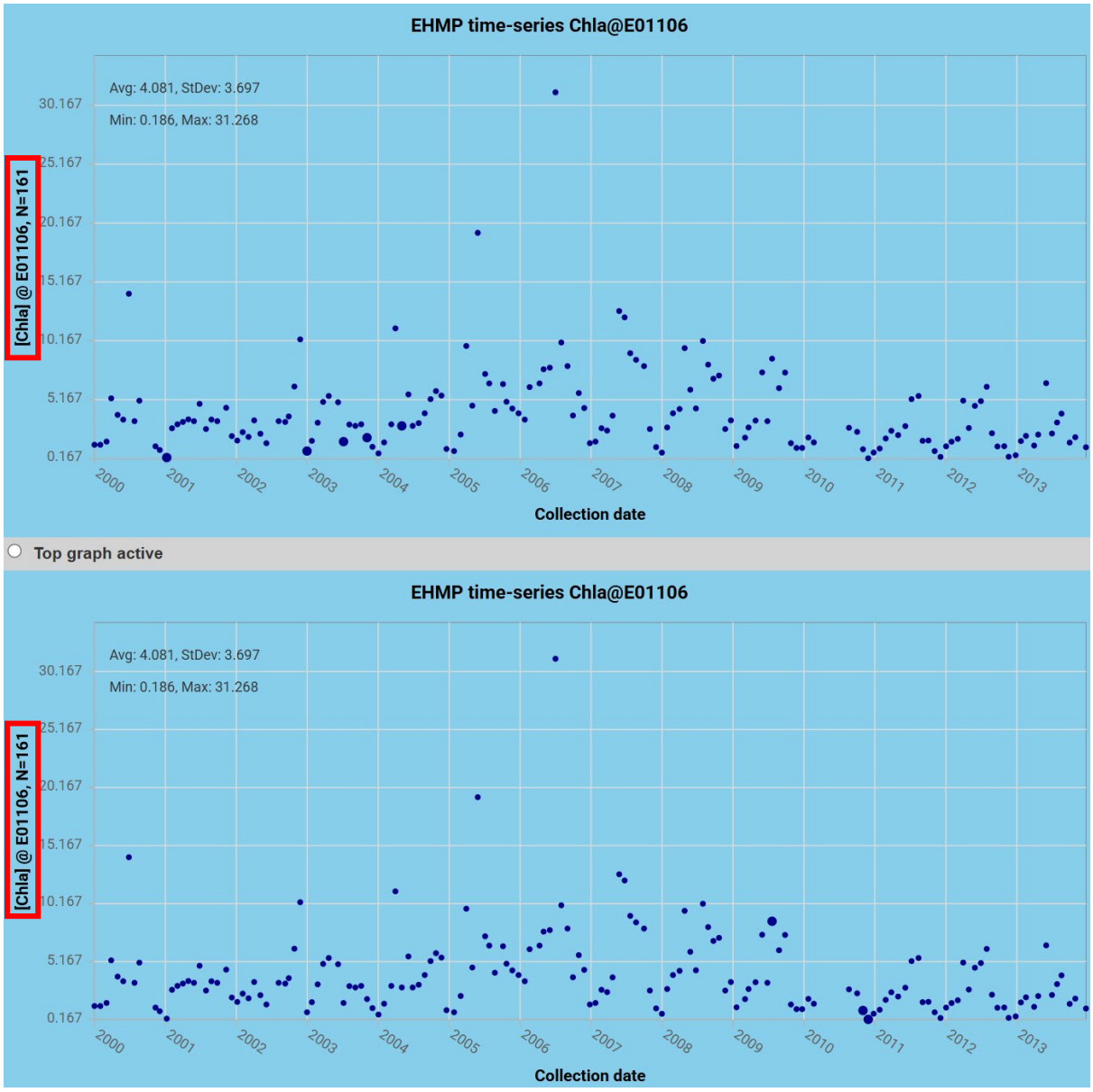


Figure 39 To calculate an auto-correlation function, both graphs must contain the same time-series.

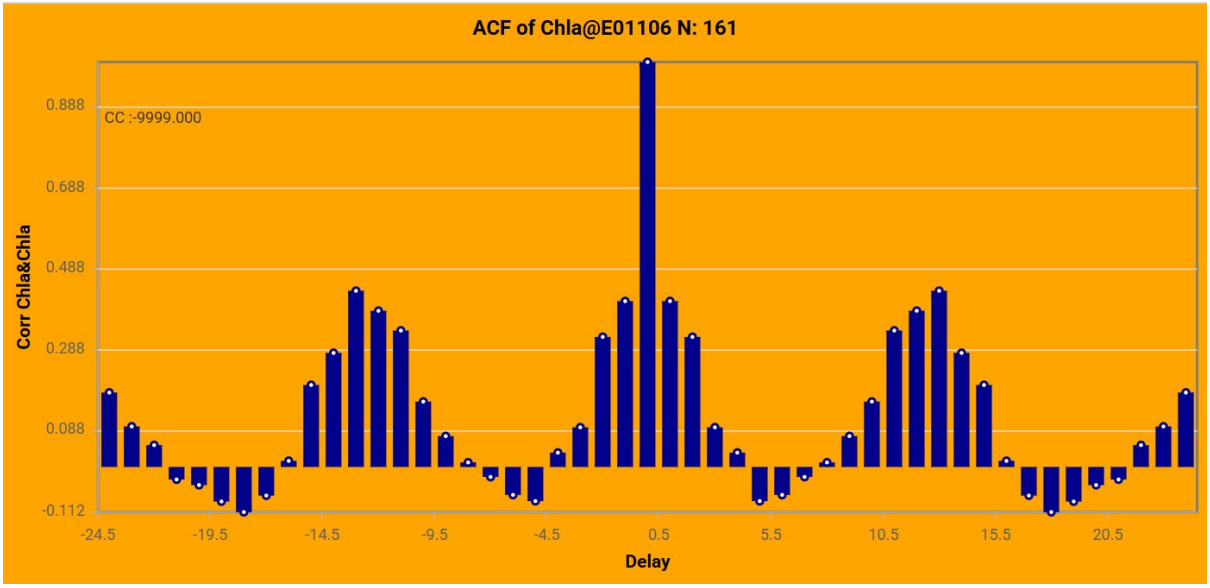


Figure 39 An auto-correlation function reveals the presence (or absence) of periodicity in a time-series. This Chl_a time-series near the mouth of the Caboolture River (location E01106) shows a clear annual (+/- 12 months, +/- 25 months) periodicity, reminiscent of a biological boom/bust cycle based on available light and water temperature.

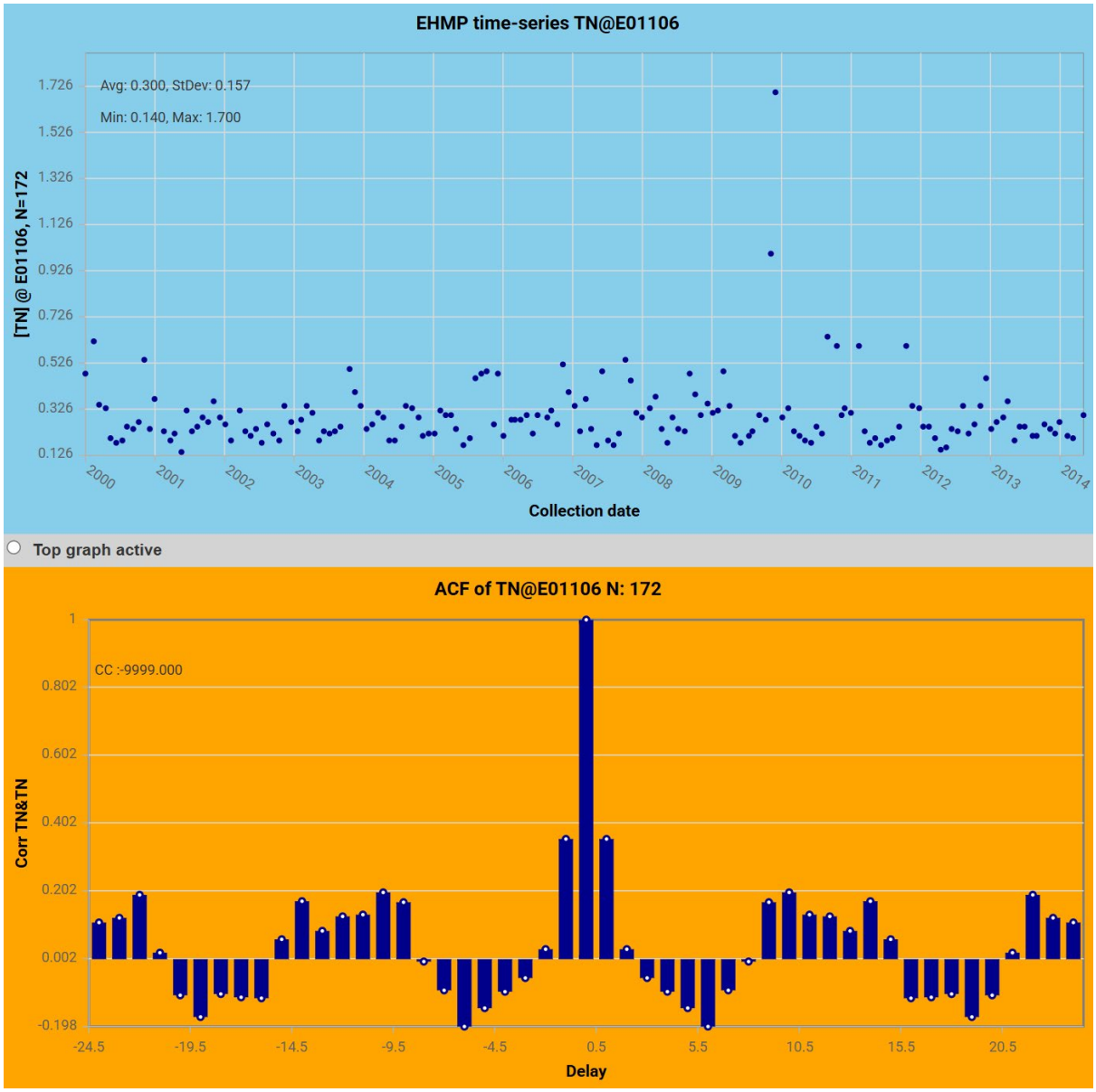


Figure 40 The ACF of TN at the Caboolture River mouth (location E1106) shows a more 'smeared' correlation function annual cycle, possibly driven by the inter-annual variation of rainfall and river discharge.

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.

Reporting

Menu: Reporting>Apply Guidelines

This option performs a map-based assessment comparing annual median indicator values against water quality guidelines for all sampled locations. Results are colour-coded on the map.

Menu: Reporting>EHI test

Opens the EHMP MapStats Ecosystem Health Index (EHI) test workflow in a separate window. This workflow requires privileged user or administrator access.

Spatial/Temporal menu options open the SEQ indicator dynamics video, Moreton Bay Kriging prediction video, and Moreton Bay IDW prediction video workflows in separate windows.

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

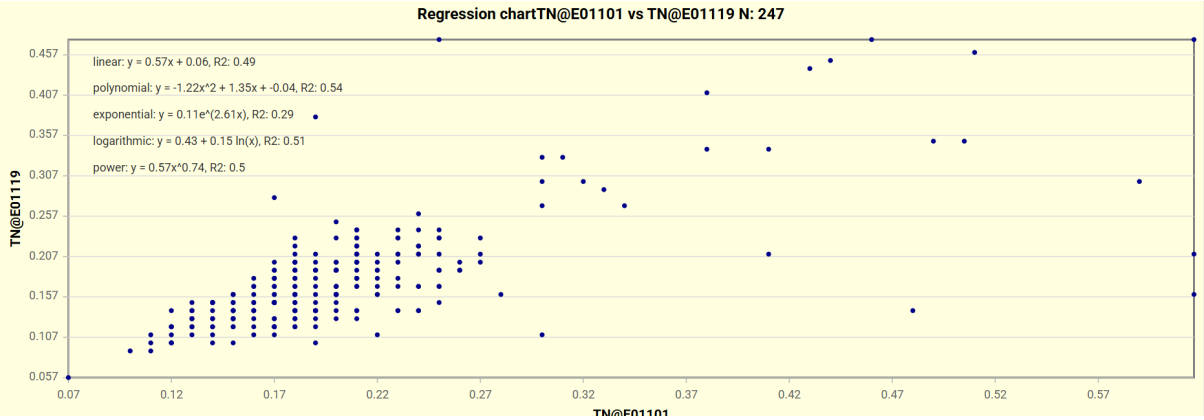
All indicators that are found to be below the detection level, are represented at half that detection level.

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

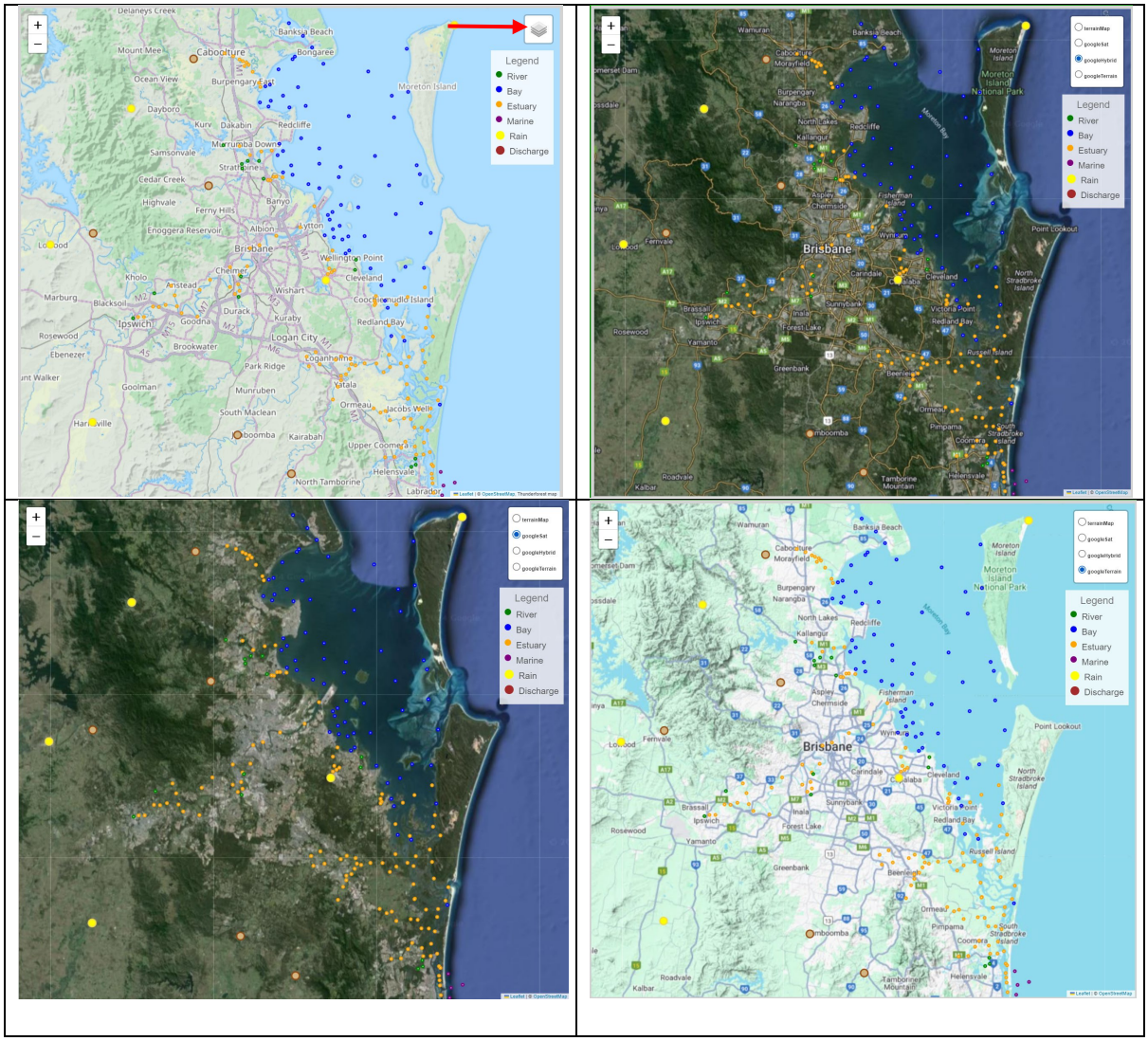
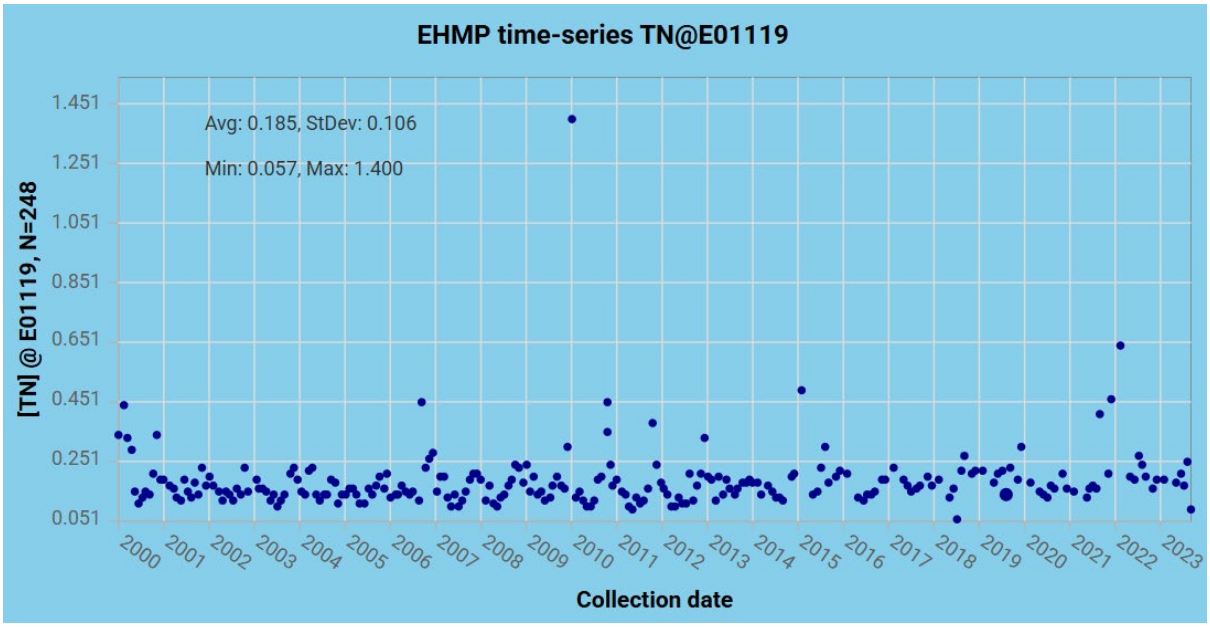


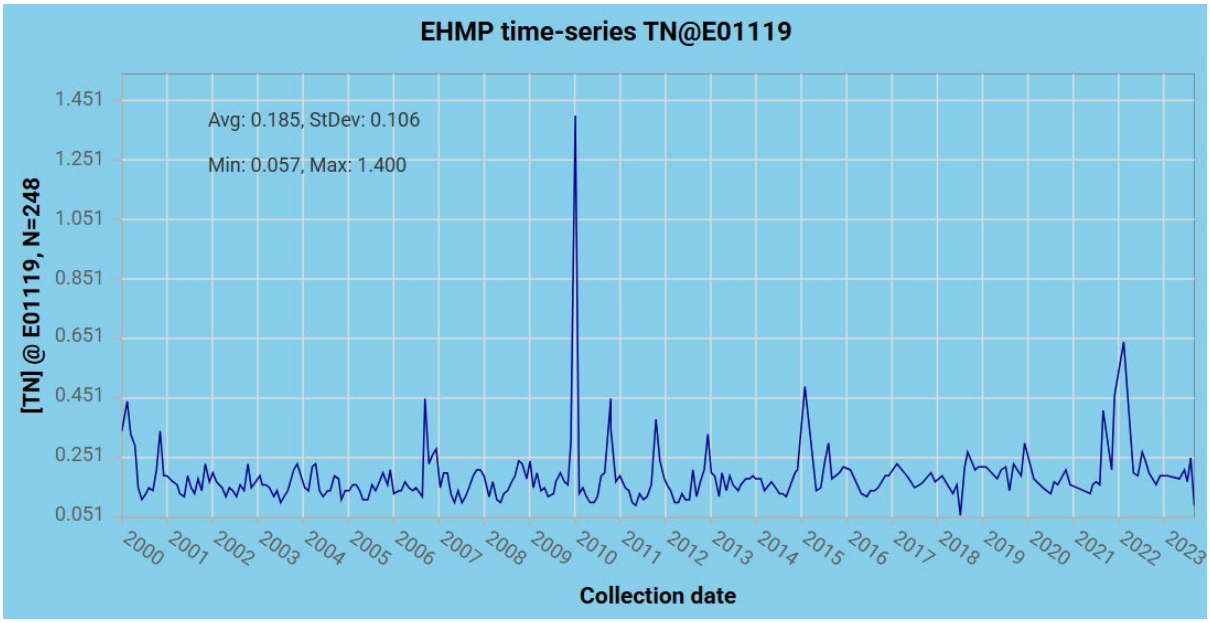
Chart types

Time-series

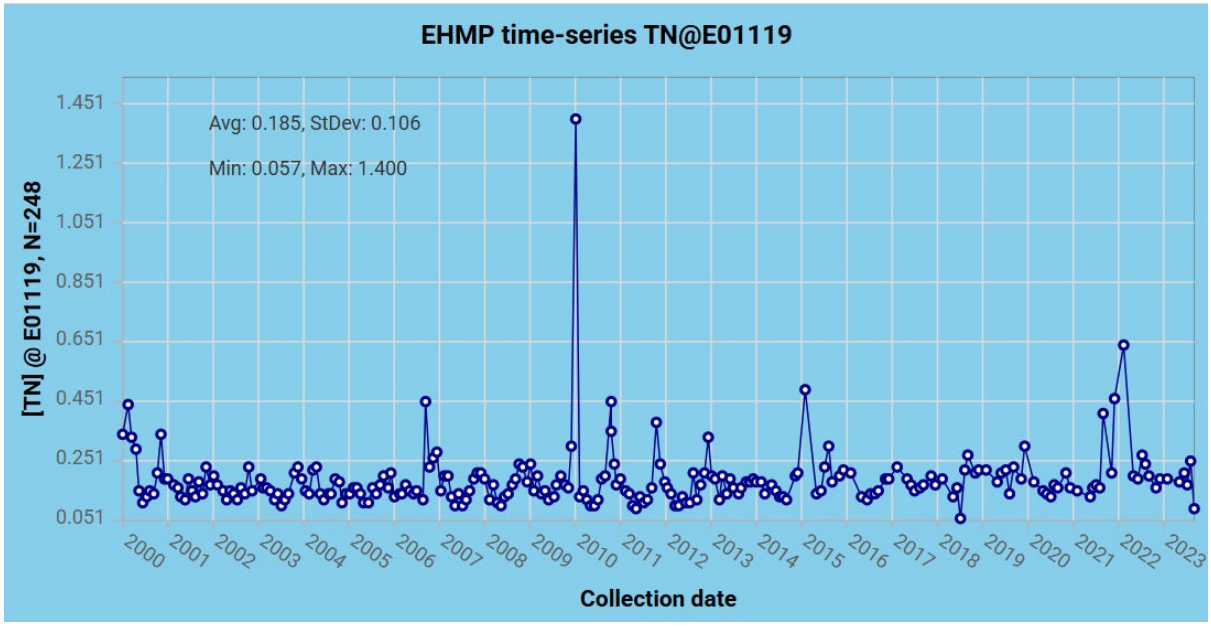
Scatter



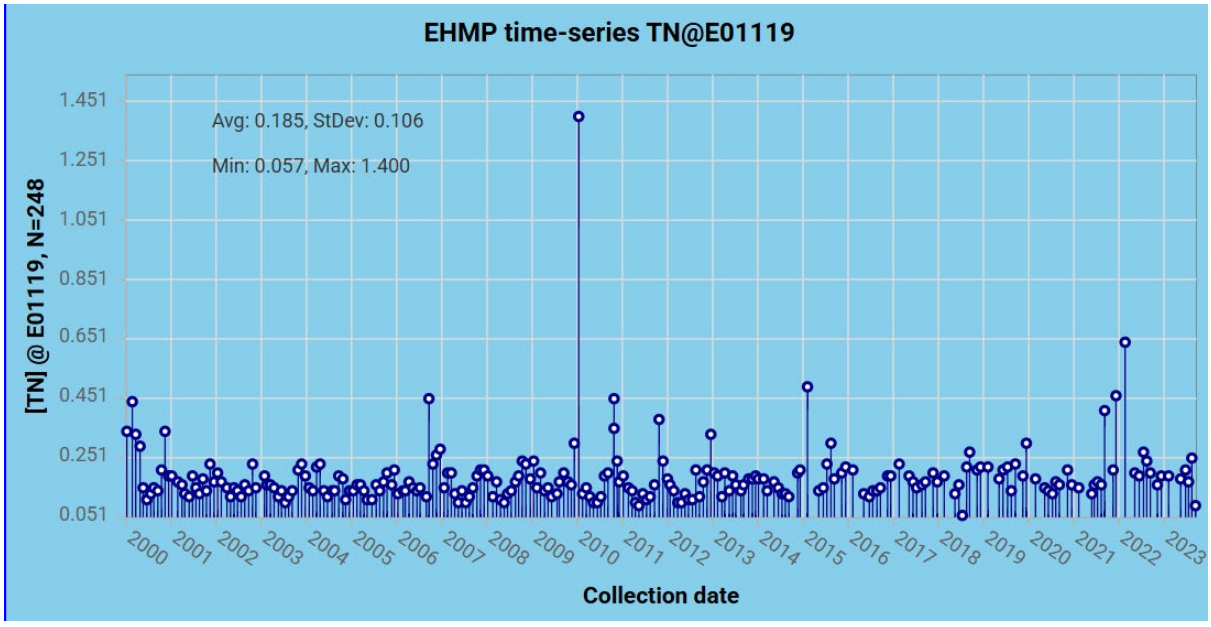
Line



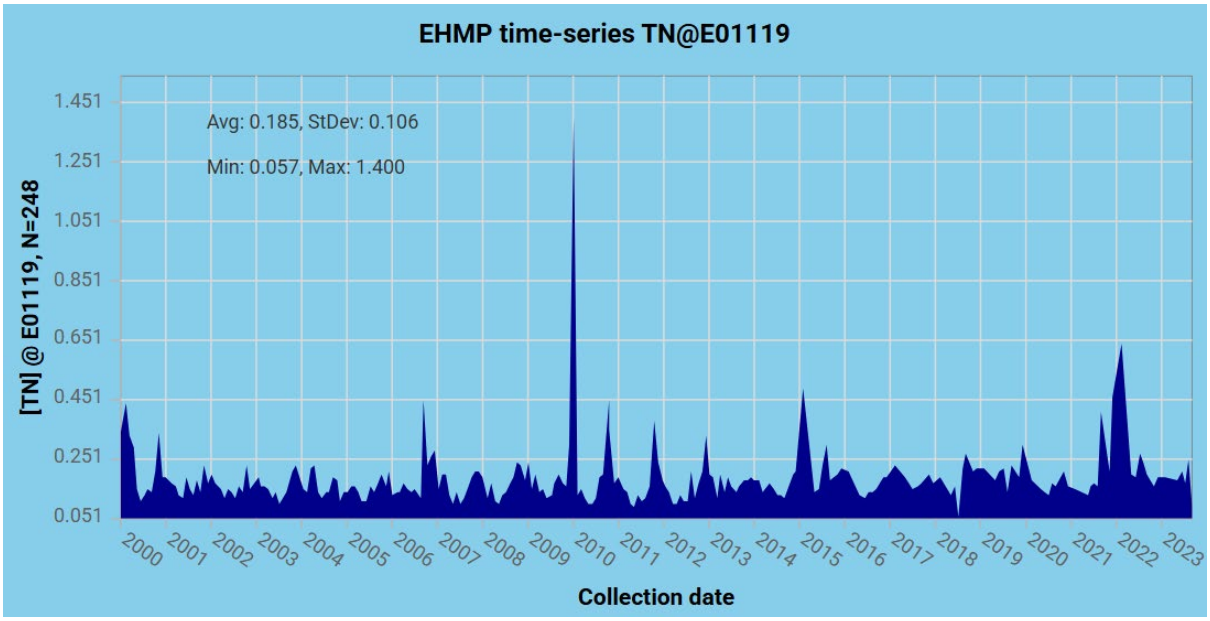
Line with markers



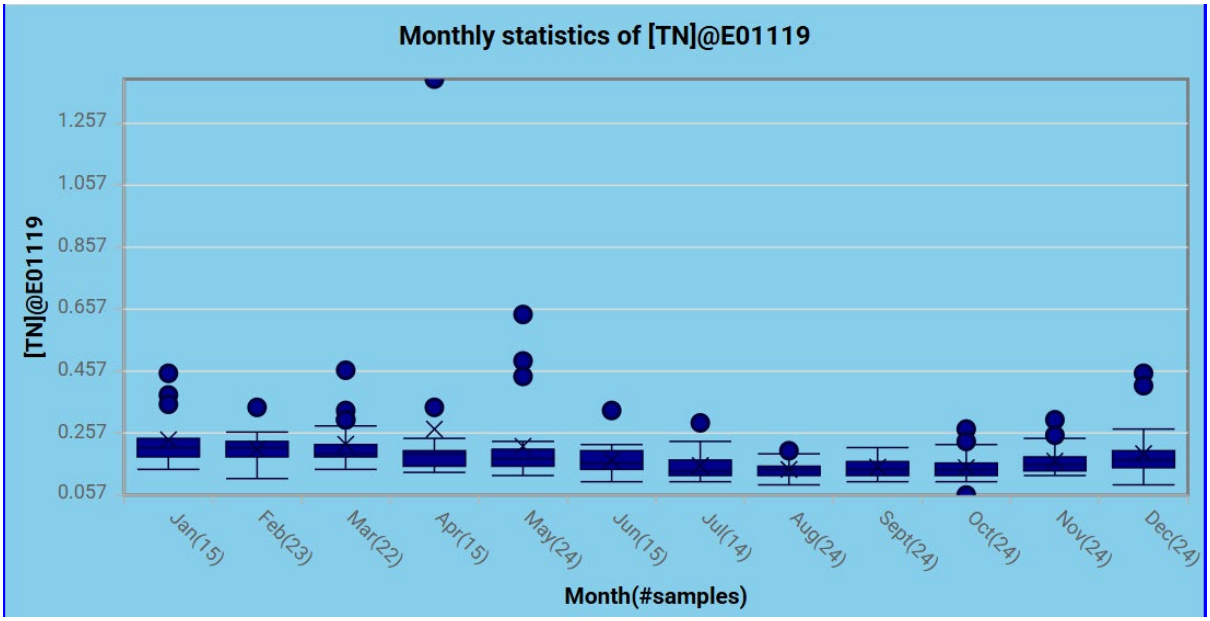
Bar



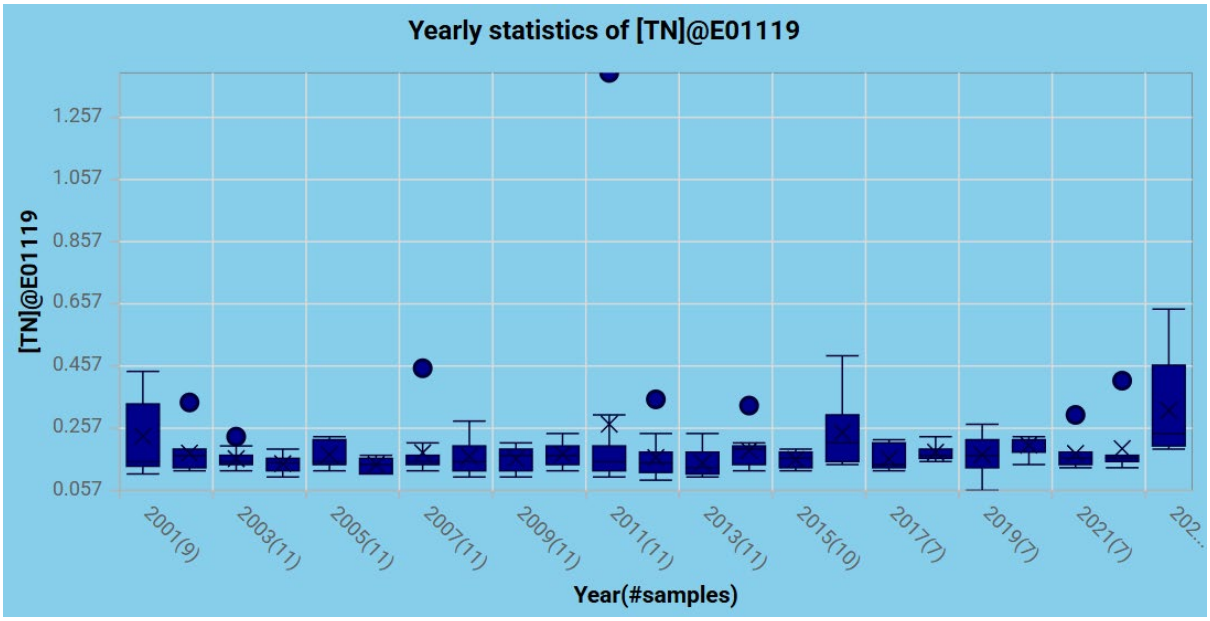
Area



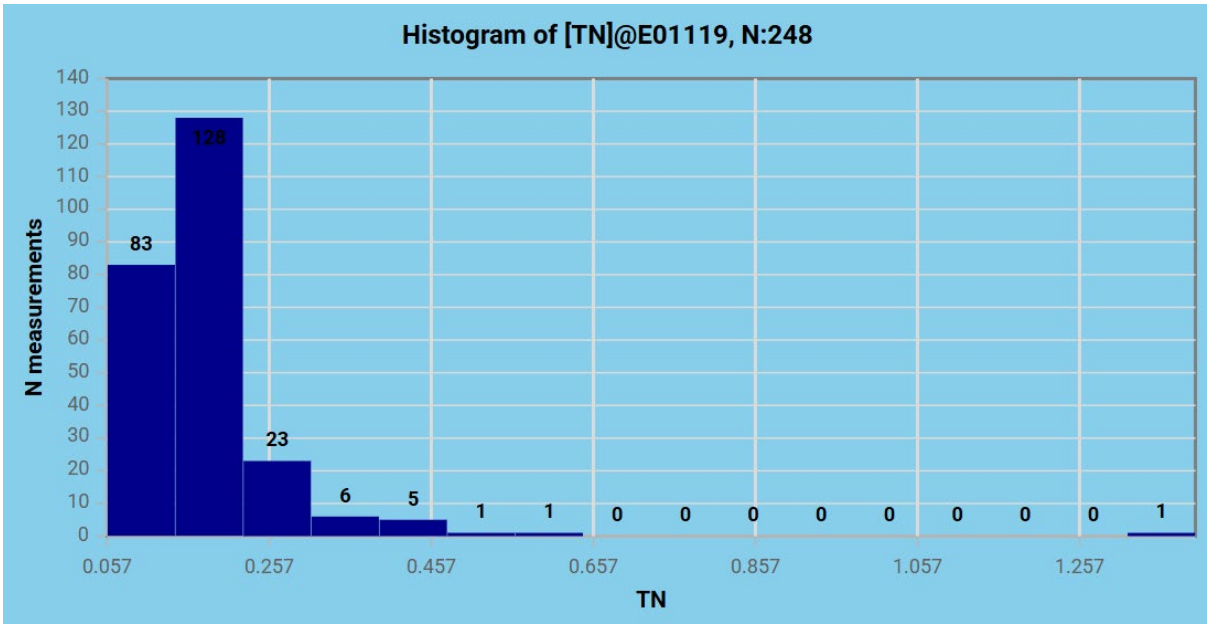
Box and Whisker per month



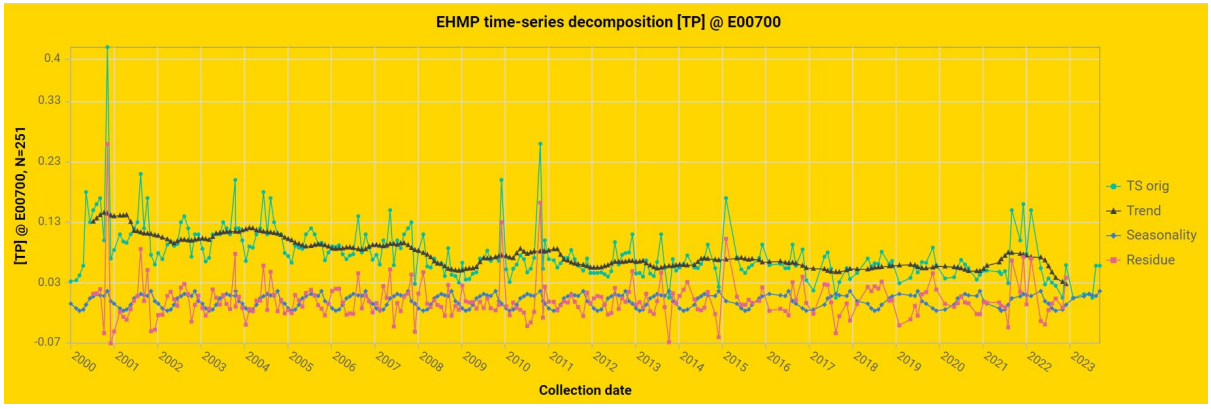
Box and Whisker per year

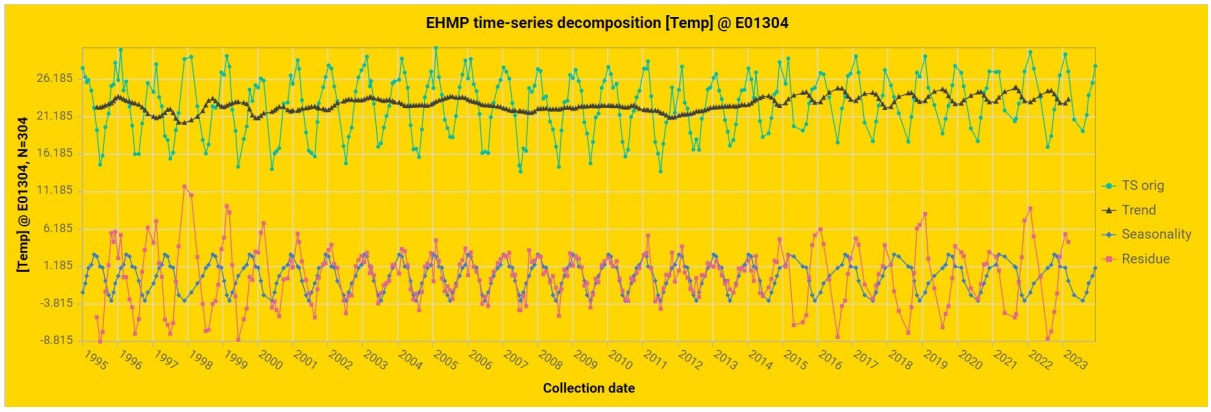

Yearly statistics of [TN]@E01119
[TN]@E01119
1.257
1.057
0.857
0.657
0.457
0.257
0.057
2001(9)
2003(11)
2005(11)
2007(11)
2009(11)
2011(11)
2013(11)
2015(10)
2017(7)
2019(7)
2021(7)
Year(#samples)

Histogram

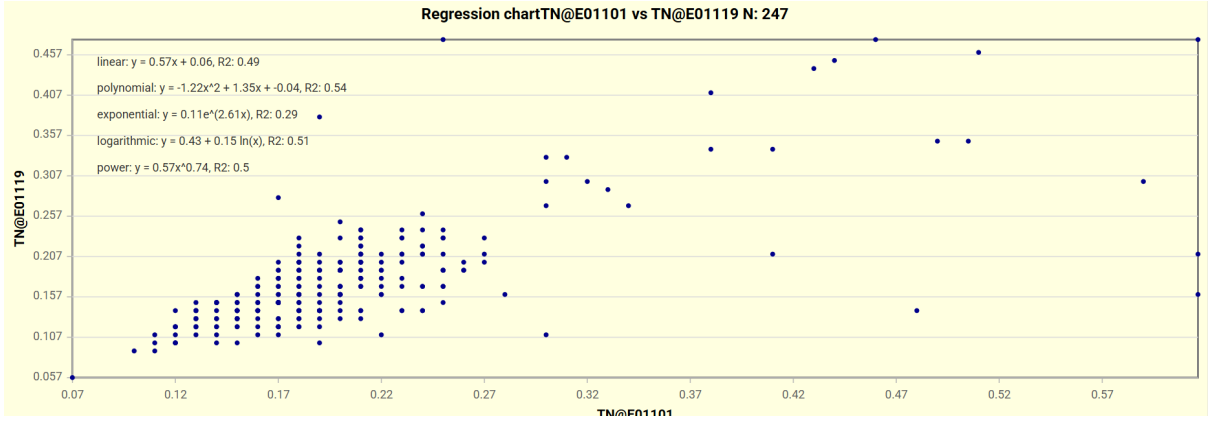

Histogram of [TN]@E01119, N:248
N measurements
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
83
128
23
6
5
1
1
0
0
0
0
0
0
0
0
1
0.057
0.257
0.457
0.657
0.857
1.057
1.257
TN

Time-series decomposition

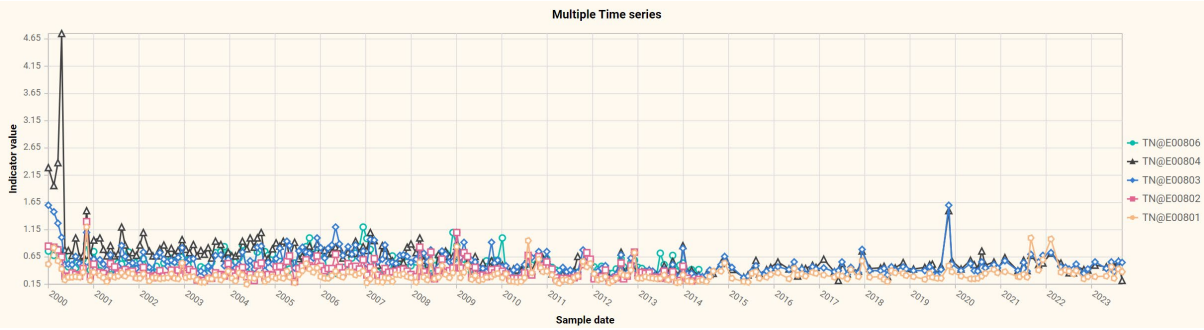




Regressions

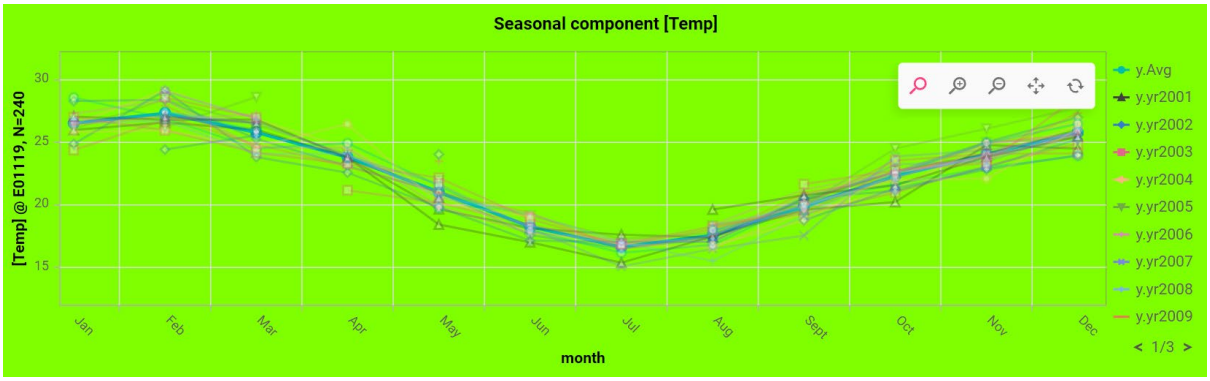


Multiple time-series

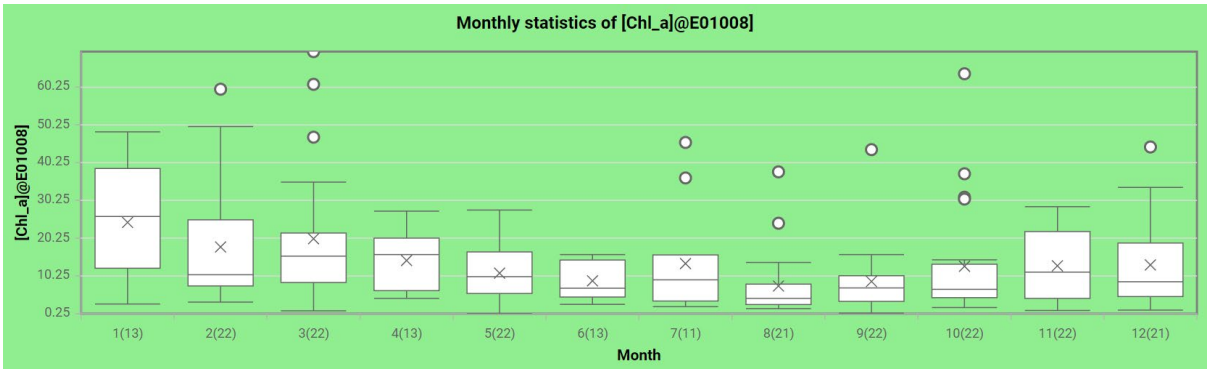




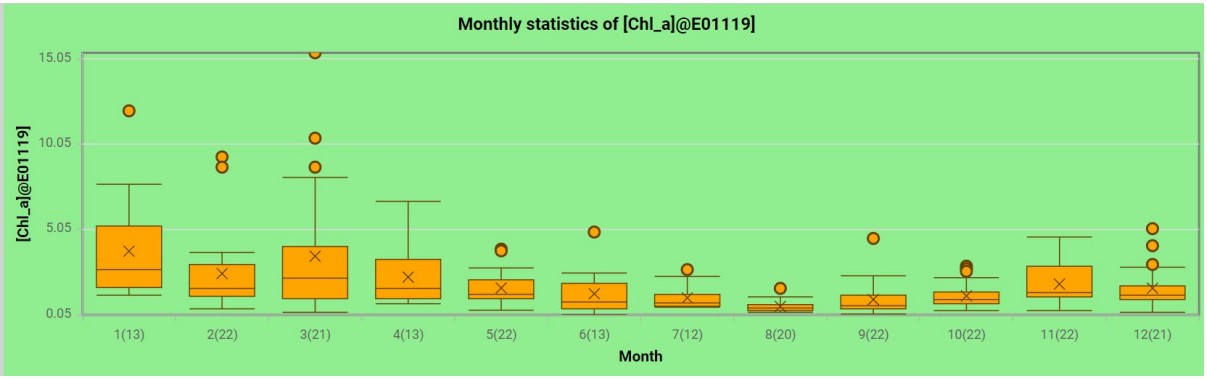
Seasonality component



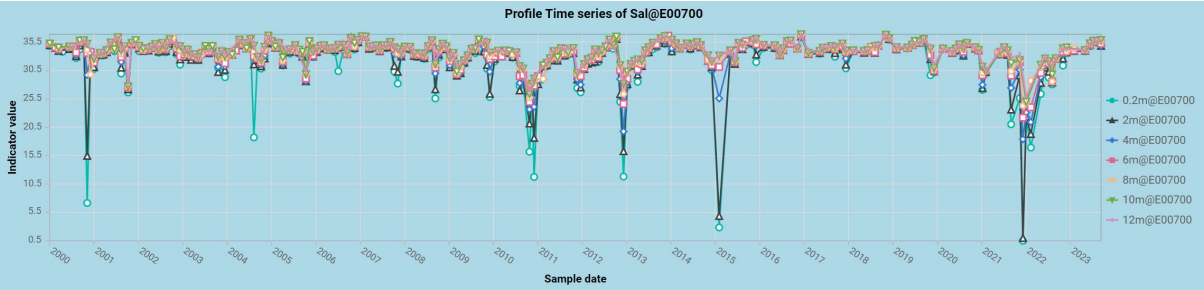
Box-Whisker



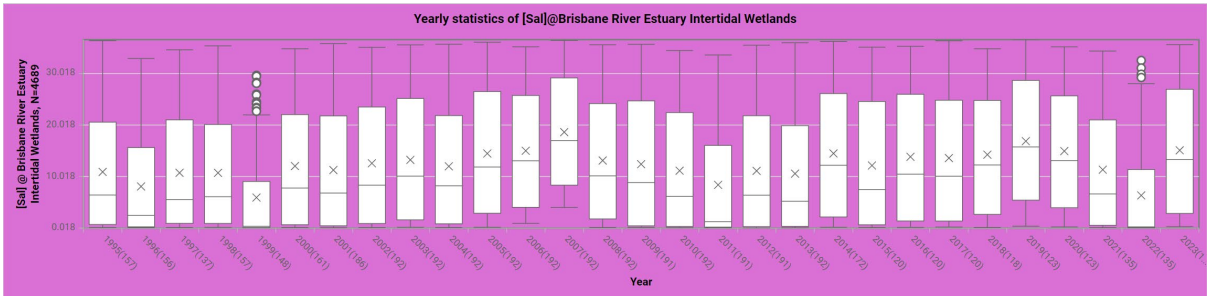
Box-Whisker, different colours



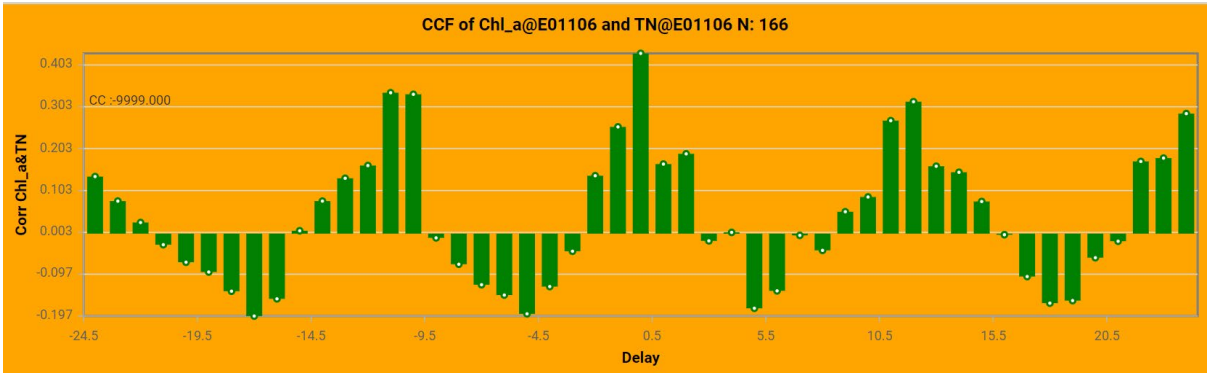
Depth profile



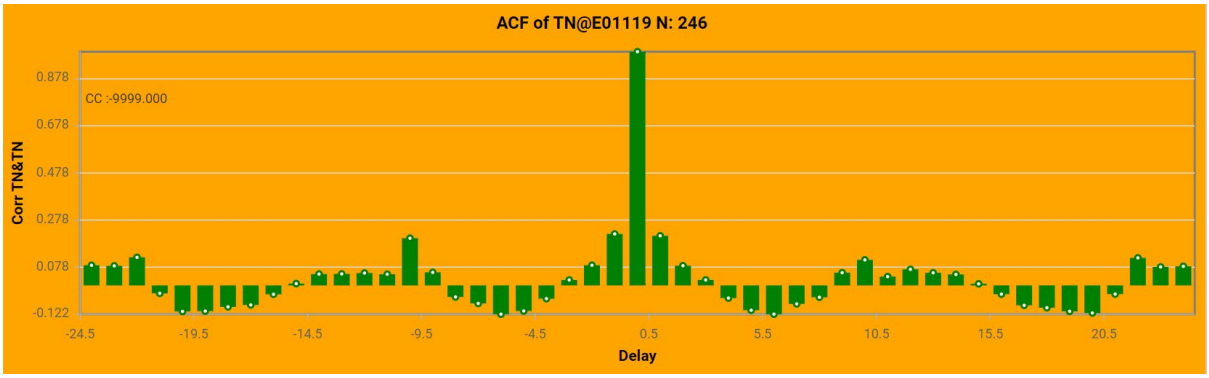
Reporting Regions



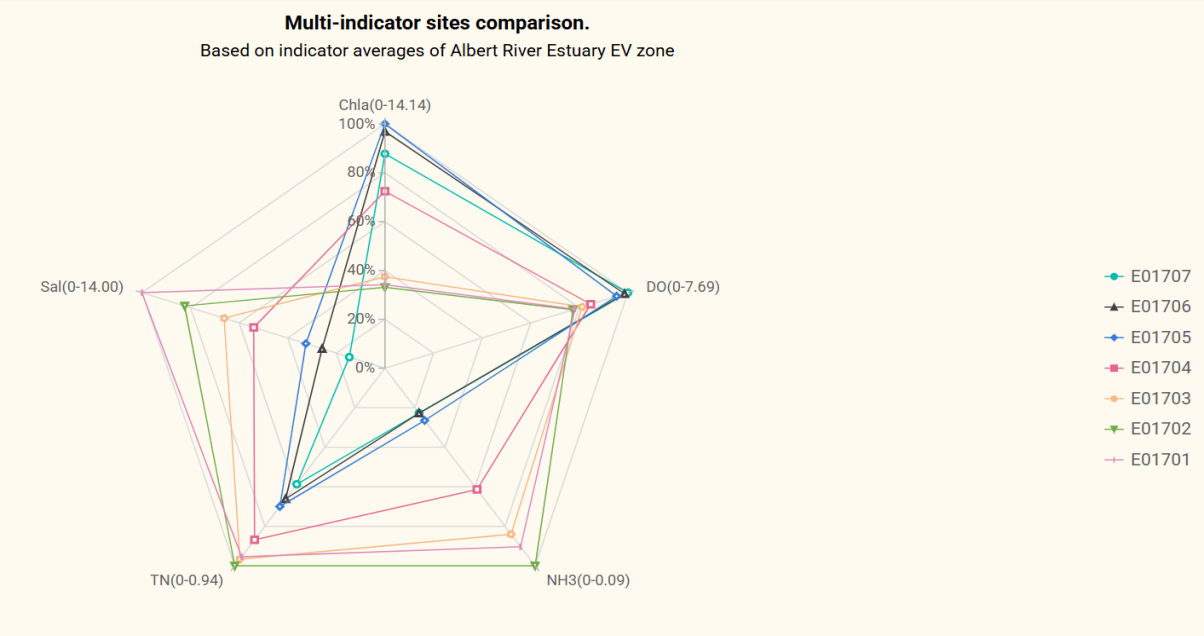
Correlation function



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

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