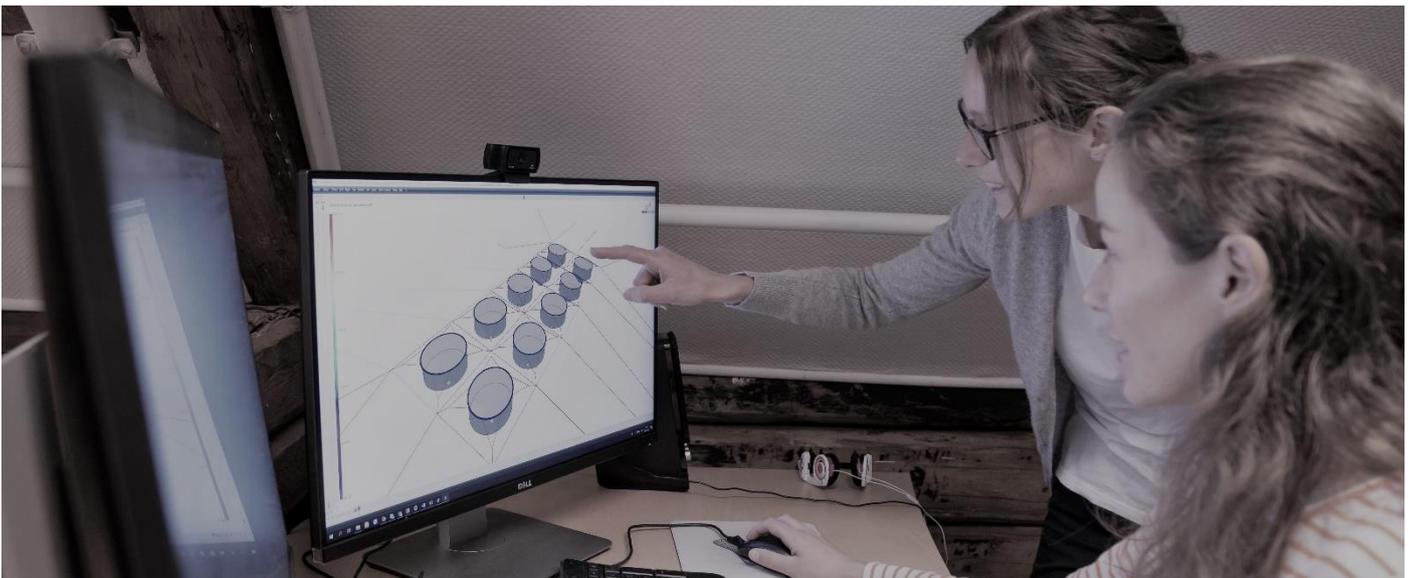


AquaSim training courses

- AquaHarmony



Revision: 1.0

AquaSim version: 2.18

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1 Prerequisites

The tutorial presents a simple case study with the purpose of demonstrating functionality in AquaSim.

It is assumed that the user is familiar with the basic principles of modelling and specifying material parameters in AquaEdit, as well as conducting analyses. If you are looking for an introduction to AquaSim we advise you to start with the Basic program tutorials.

2 Case study – AquaHarmony

2.1 Learning objectives

In this tutorial you will be introduced to:

- The fundamentals of AquaHarmony
- Input parameters to current data filtering
- View results and diagrams

2.2 Introduction

AquaHarmony is an addon program to the AquaSim package and is a data processing tool for de-noising and filtering of measurements. AquaHarmony is useful to apply when you have raw data of measurements from long periods of time. The advantage of this tool is that the mathematical approach ensures a consistent post-processing of the data. This provides a good basis for further quality assurance of your data set.

Let us say we have data of current measurements, as shown by the blue line in the figure below. These measurements can be seen as a sum of simpler harmonic functions (which is reflected in the name of this program tool). When the data is divided into harmonic functions, the AquaHarmony can filter out the parts that should be removed. Leaving us with a smoother curve, the orange one.

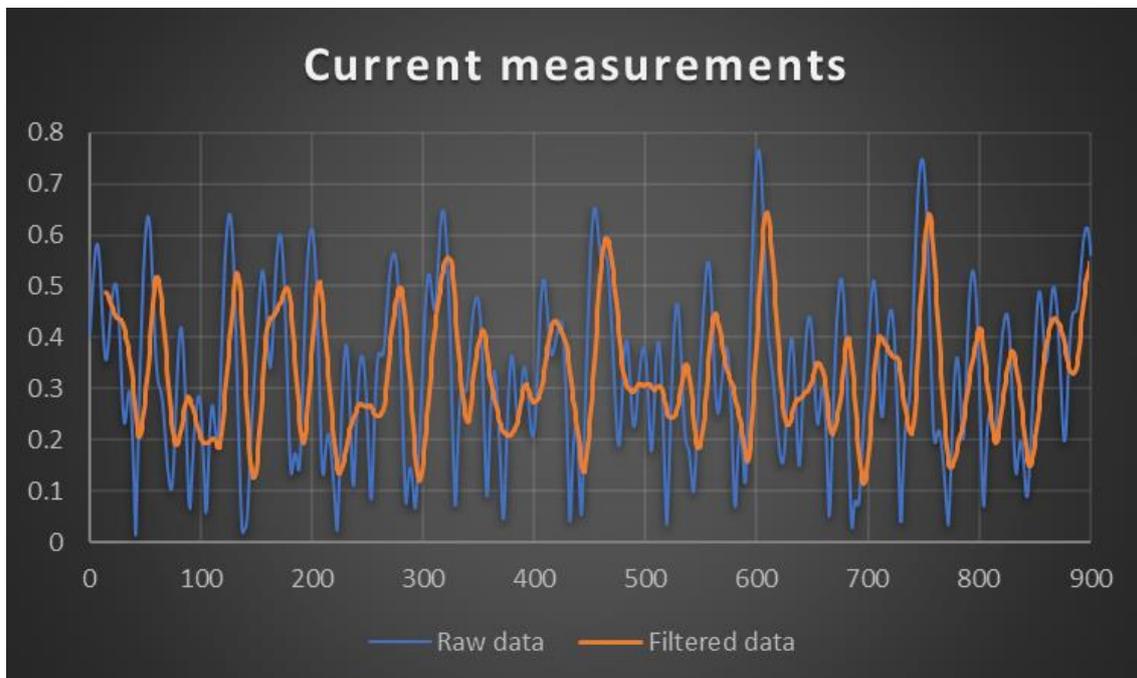


Figure 1

2.3 Interface

AquaHarmony is loaded through the Start menu on your computer.

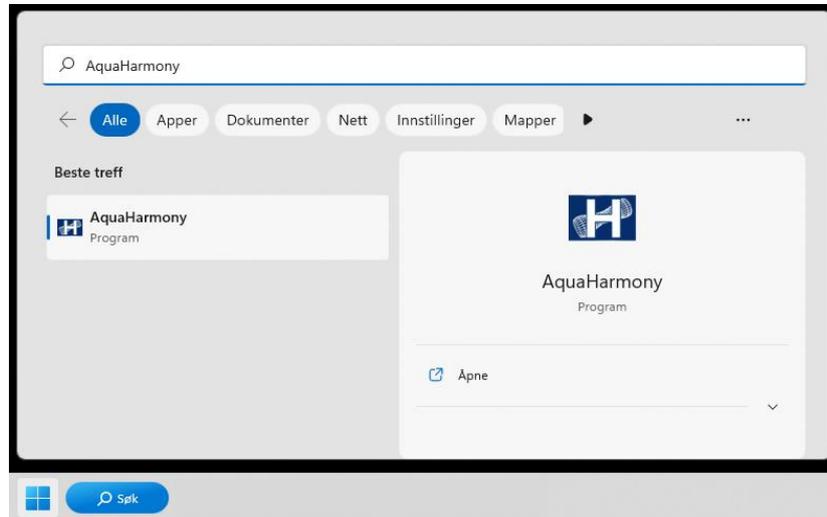


Figure 2

The interface consists of three main sections:

1. **Filter condition:** this is where you define the criteria for how data should be filtered.
2. **Raw data:** this is where your raw data appear when they are loaded into AquaHarmony.
3. **Filtered data:** when analysis has been conducted, the filtered data will appear in this section.

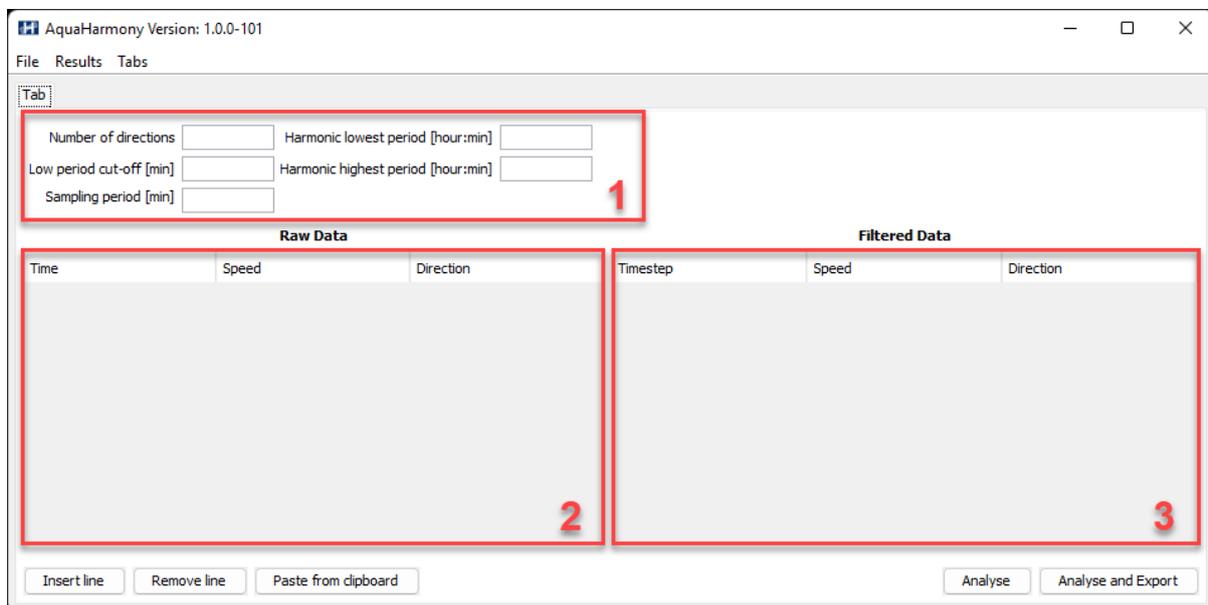


Figure 3

In the lower left part of the interface, you find options for inserting or remove lines in the Raw data section. You may also paste data from the clipboard. To the right, you find options for starting the filtering and analyse the raw data.

2.4 Import of data

Data can be imported in several ways:

- Through manually typing data line-by-line by applying the Insert line option,
- Paste it from the clipboard,
- Or, through selecting File > Import File...

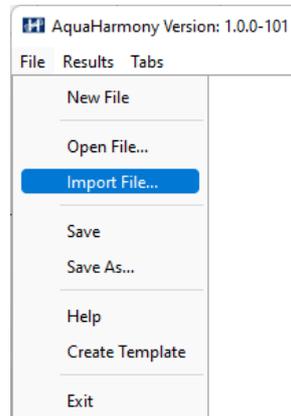


Figure 4

Following this tutorial is some example data. To import this, select **File > Import file...** Navigate to where you saved this tutorial and select *AquaHarmony_test_data.xlsx* > **Open**.

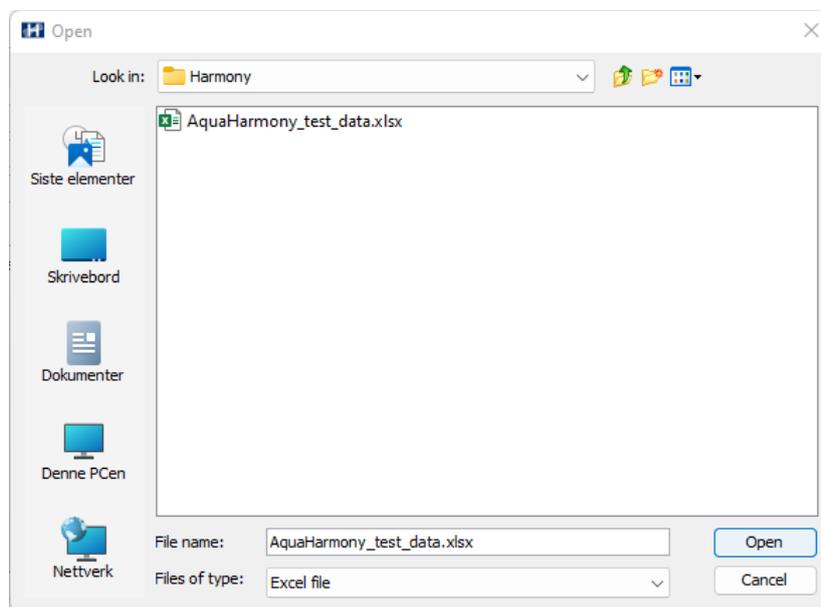


Figure 5

The progress-bar indicates that data is imported to AquaHarmony.



Figure 6

The imported data will be visible in the **Raw data**-section.

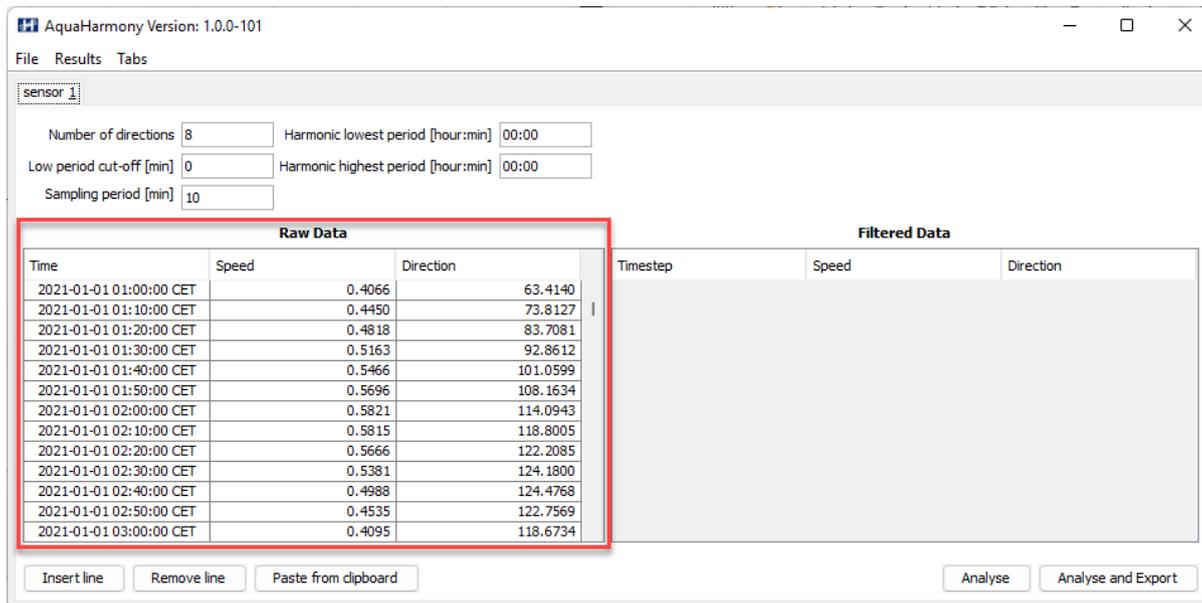


Figure 7

The Time column provides the time for when the measurement was conducted. For the current version of AquaHarmony, the input format for time must be **day.day.month.month.year.year.year hour:hour:minute:minute:second:second**. **Speed** is the measured current velocity at the given time instant. **Direction** is the direction of the current, measured in degrees.

2.5 Filter condition

Let us define the filter condition for the dataset:

- **Number of directions:** is the number of sectors one would like to present the results in. This is based on 360 degrees, such that when this is **8**, we will get sections of $360/8 = 45$ degrees.
- **Low-period cut off [min]:** this is the periods that you would like to filter out. All periods below this value will be removed from the dataset. In this tutorial we set this to **300**. Note! This may not be a representative value, but is applied in this example to show you the effect it will have on results when the analysis is conducted.
- **Sampling period [min]:** is the number of minutes between each time-step in the dataset. AquaHarmony finds this automatically. To some extent, AquaHarmony can handle some difference in the sampling period within the given dataset. But too large differences will require action from the user. In such cases, the user is notified. We leave this equal to **10** minutes.
- **Harmonic lowest and -highest period [hour:min]:** are useful in cases where you for example will remove the effect of tide.
 - o **Harmonic lowest period [hour: min]** removes all periods lower than this value. Let us remove all periods lower than **6 hours**.
 - o **Harmonic highest period [hour:min]:** removes all periods higher than this value. We choose the remove periods higher than **24 hours**.

sensor 1

Number of directions Harmonic lowest period [hour:min]

Low period cut-off [min] Harmonic highest period [hour:min]

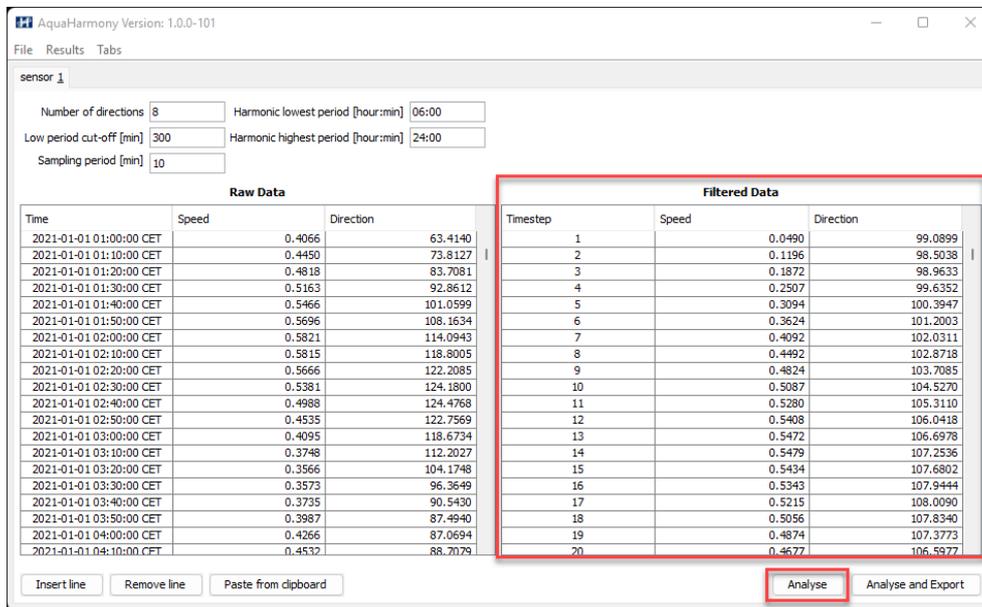
Sampling period [min]

Figure 8

2.6 Analysis

Having set the filter condition, we are ready to start an analysis. AquaHarmony is based on Fast Fourier Transform, F F T. Which means that data is transferred from time-domain to frequency domain, where the components with lower period than the cut-off period will be removed.

Select **Analyse** in the lower right corner of the AquaHarmony interface. Analyse will start the filtering immediately and view it in the Filtered Data section.



The screenshot shows the AquaHarmony software interface with the 'Analyse' button highlighted in red. The interface displays two data tables: 'Raw Data' and 'Filtered Data'.

Raw Data			
Time	Speed	Direction	
2021-01-01 01:00:00 CET	0.4066	63.4140	
2021-01-01 01:10:00 CET	0.4450	73.8127	
2021-01-01 01:20:00 CET	0.4818	83.7081	
2021-01-01 01:30:00 CET	0.5163	92.8612	
2021-01-01 01:40:00 CET	0.5466	101.0599	
2021-01-01 01:50:00 CET	0.5696	108.1634	
2021-01-01 02:00:00 CET	0.5821	114.0943	
2021-01-01 02:10:00 CET	0.5815	118.8005	
2021-01-01 02:20:00 CET	0.5666	122.2085	
2021-01-01 02:30:00 CET	0.5381	124.1800	
2021-01-01 02:40:00 CET	0.4988	124.4768	
2021-01-01 02:50:00 CET	0.4535	122.7569	
2021-01-01 03:00:00 CET	0.4095	118.6734	
2021-01-01 03:10:00 CET	0.3748	112.2027	
2021-01-01 03:20:00 CET	0.3566	104.1748	
2021-01-01 03:30:00 CET	0.3573	96.3649	
2021-01-01 03:40:00 CET	0.3735	90.5430	
2021-01-01 03:50:00 CET	0.3987	87.4940	
2021-01-01 04:00:00 CET	0.4266	87.0694	
2021-01-01 04:10:00 CET	0.4532	88.7079	

Filtered Data			
Timestep	Speed	Direction	
1	0.0490	99.0899	
2	0.1196	98.5038	
3	0.1872	98.9633	
4	0.2507	99.6352	
5	0.3094	100.3947	
6	0.3624	101.2003	
7	0.4092	102.0311	
8	0.4492	102.8718	
9	0.4824	103.7085	
10	0.5087	104.5270	
11	0.5280	105.3110	
12	0.5408	106.0418	
13	0.5472	106.6978	
14	0.5479	107.2536	
15	0.5434	107.6802	
16	0.5343	107.9444	
17	0.5215	108.0090	
18	0.5056	107.8340	
19	0.4874	107.3773	
20	0.4672	106.5977	

Figure 9

The time of day has in the Filtered Data been converted to timesteps for each filtered speed and associated direction.

2.7 Post processing

The filtered data can be viewed in terms of time series or a current rose. These options are found in the **Result** option.

File Results Tabs

View Speed/Time Graph

View Current Rose

Figure 10

We would like to first view the results in terms of time series. From the **Result** option, select **View Speed/Time Graph**.

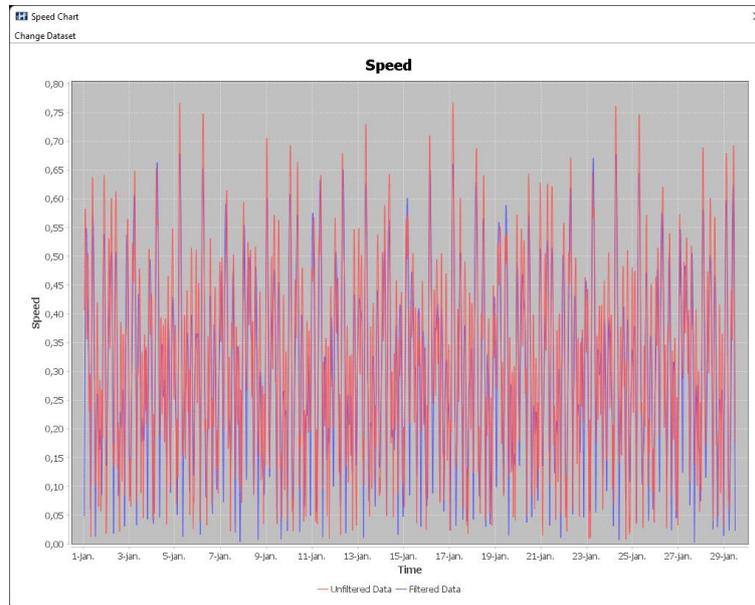


Figure 11

The red line is the unfiltered raw data, and the blue is the filtered. The view can be toggled on and off from the **Change Data** set option, in the upper left corner.

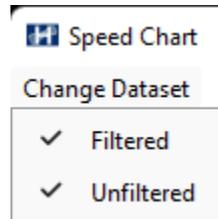


Figure 12

Plot the current rose by selecting **Result > View Current Rose**.

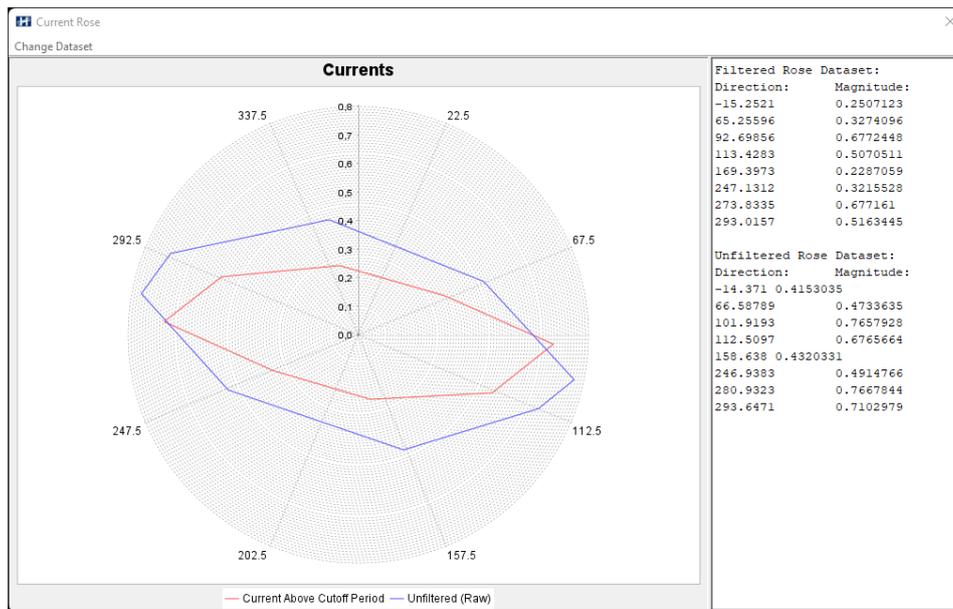


Figure 13

The diagram is divided into 8 sectors, according to what was specified in Number of directions in the filter condition section. The blue line represents unfiltered data, and the red line is the filtered data. By selecting **Change Data set > Current within Tidal Frame** one can visualize the results within Harmonic lowest- and -highest period (green line).

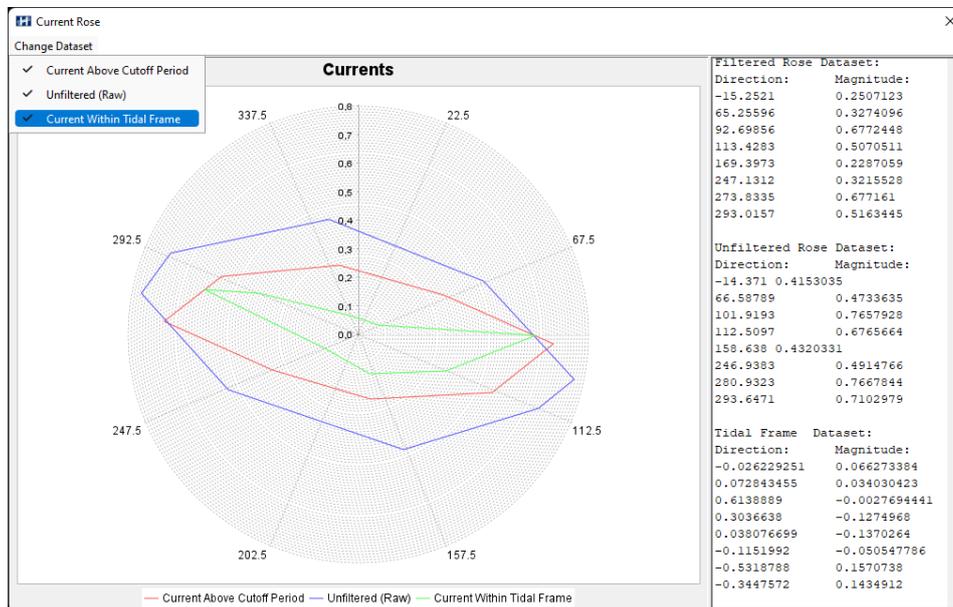


Figure 14

The table to the right in the Current Rose window can be marked and copied to the clipboard for further processing.

2.8 Analyse and Export

As an alternative to analyse the data directly in AquaHarmony, you may also export it and save the results on your computer. In the main interface window, go down to the **Analyse and Export**. Select this option and navigate to a folder you want to save the analysis.

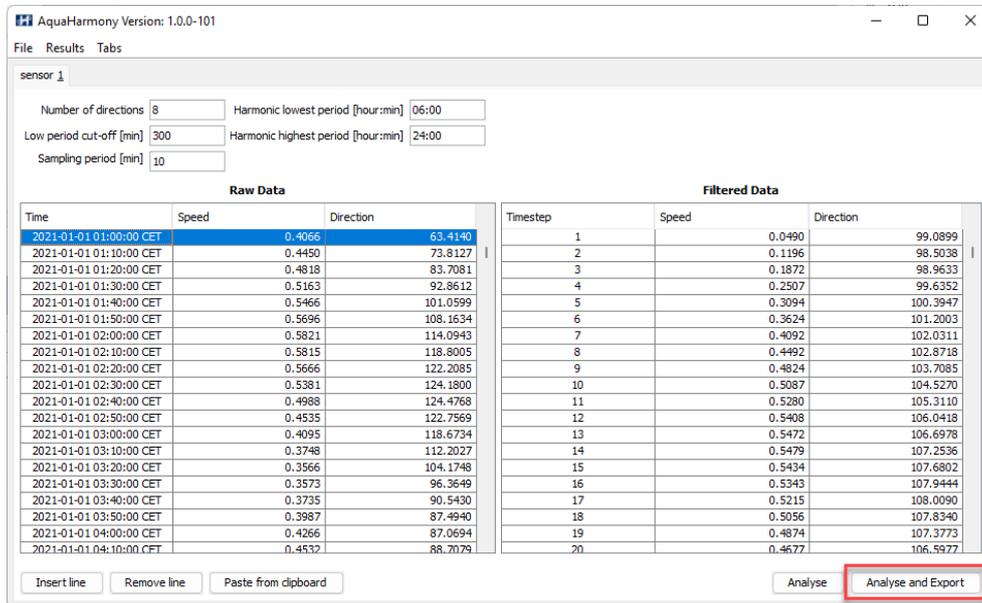


Figure 15

We have chosen to name the analysis *Example*.

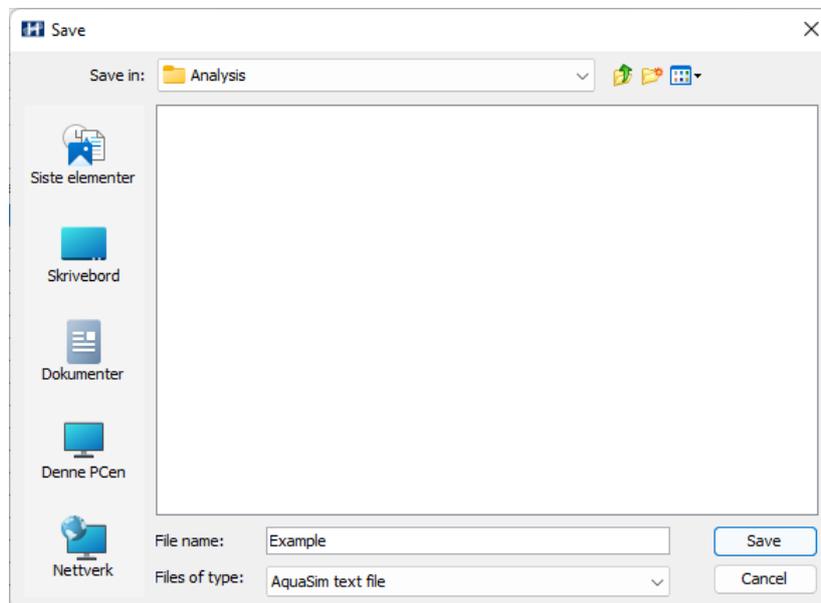


Figure 16

Select **Save**. The analysis will start immediately and be saved.

If we navigate to the folder where the analysis is saved, we see that several files have been generated from AquaHarmony.

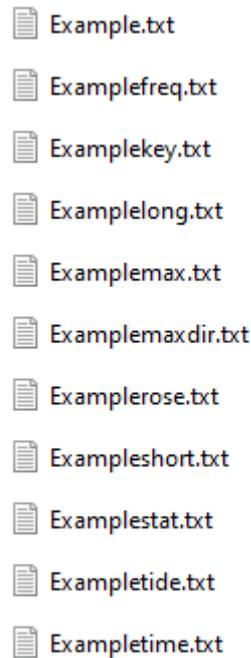


Figure 17

Example.txt contain the unfiltered data. *Examplefreq.txt* is the raw data and the filtered data transformed from time-domain to frequency domain. The *Examplekey.txt* provides information about the software version and license information. You can read more about the content of the files in the AquaHarmony User Manual from our webpage https://aquasim.no/files/documentation/User_manual_AquaHarmony.pdf.

2.9 Save files

As the last thing in this tutorial, we will mention the opportunity to save the imported Raw data and the filter condition. This is saved as a .hmodel. To save these settings, select **File > Save as...**

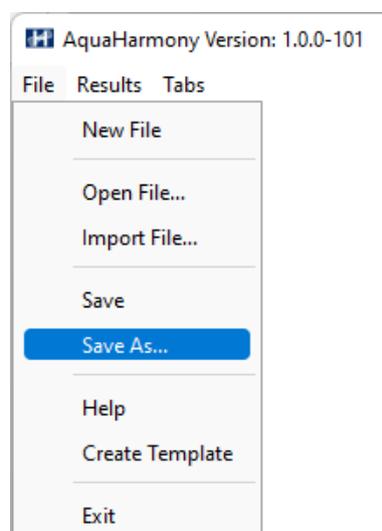


Figure 18

3 Revision comments

Revision no.	Comment
1.0	First publication

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