The program is experimental and will be improved if found useful. In case of any issues, please contact jackurbanski@gmail.com.

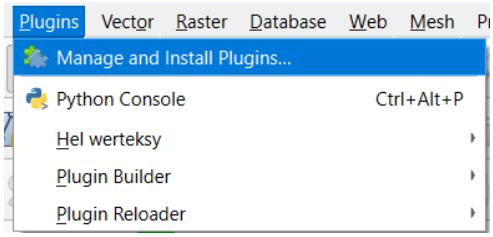
!!! The program creates temporary files (of SHP type) in the directory where it saves output files, with the main names tempfeatch00, tempfeatch11, tempfeatch22. After completion, they are automatically deleted. If the program stops working correctly during operation, these files need to be deleted manually for the program to function again.!!!

Using wind fetch tools in QGIS
Plugin Wind Fetch2
(for QGIS versions 3.n)

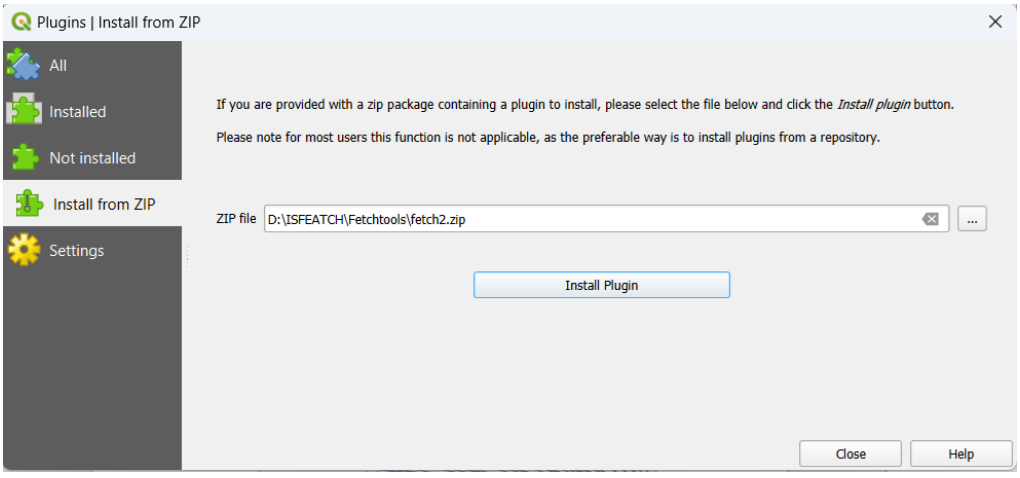
The Wind Fetch toolkit is used for calculating and analyzing a reservoir's exposure to wind-induced waves. The fetch line is the distance in meters between any point in the reservoir and the shoreline, measured in the direction from which the wind blows. This is illustrated in the diagram on page 3 (fetch type 4). In practice, the so-called effective fetch (fetch types 1, 2, and 3) is used, as it better approximates how the wind generates wave action. The tools utilize a layer of points and the reservoir's outline as a polygon.

In the first step, fetch lines required by the fetch definition are created for each point (from the point to the shore). In the second step, based on these lines, points are assigned values for effective fetch, the average fetch calculated using wind frequency from different directions, the maximum fetch, the most frequent fetch, and the REI (Relative Exposure Index). Assigning these values to points enables the creation of continuous maps for the reservoir and shoreline

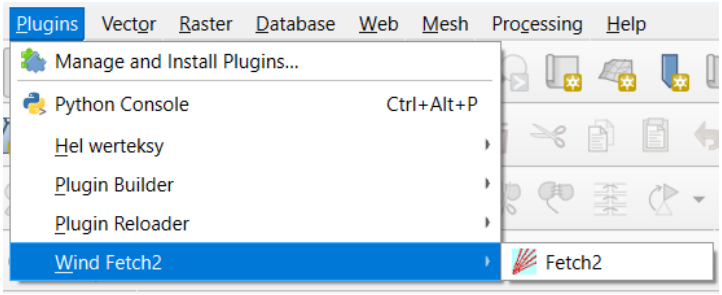
Start with adding plugin **Wind Fetch2** to QGIS:



Install the plugin from the downloaded fetch2.zip.

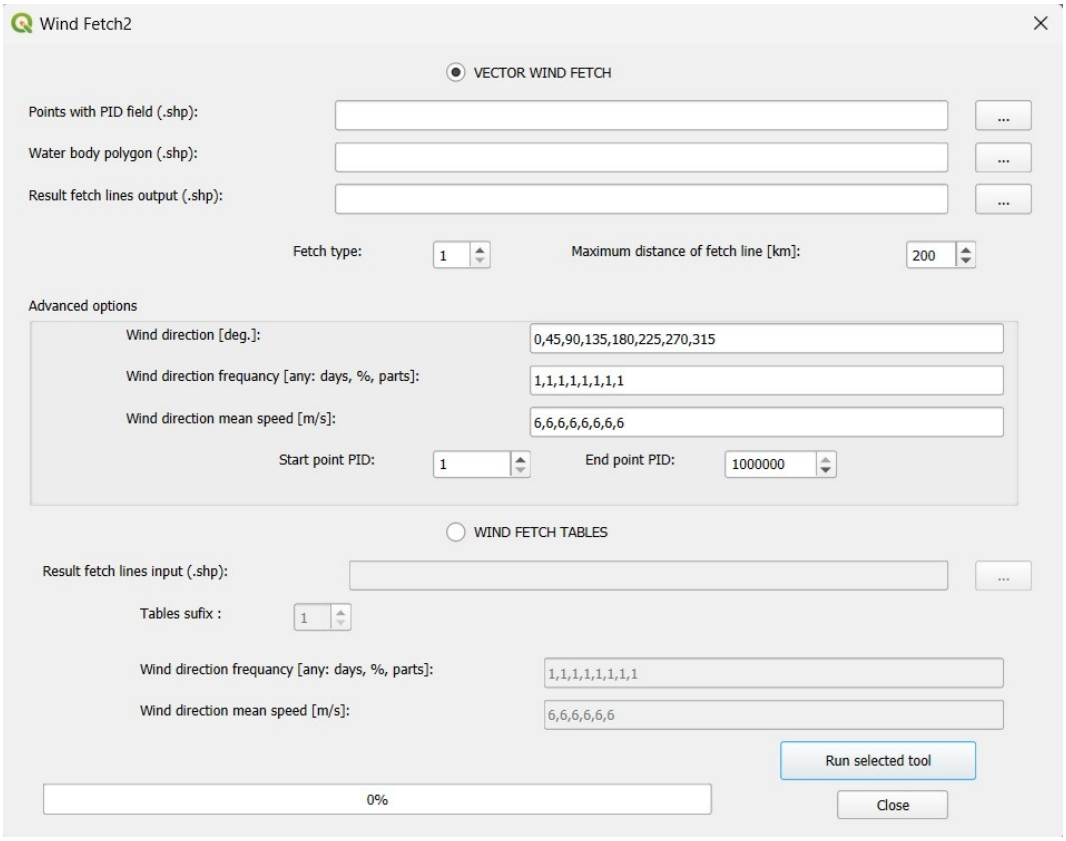


The Fetch2 plugin will be installed and can be launched by clicking its icon.



The Wind Fetch2 plugin includes two tools in a single dialog box: **Vector Wind Fetch** and **Wind Fetch Tables**, which are activated using radio buttons.

Vector Wind Fetch is the primary tool that performs the complete cycle of determining wind fetch. The tool utilizes two layers that must be in a projected coordinate system. The vertical map frame should indicate the northern direction. The first layer is a point layer (SHP) that must contain a PID field (integer type) with point numbers (identifiers). The second layer is a polygon layer that defines the water body. Points must be located within the polygon layer. When determining wind fetch for the shoreline, the points should be near the shore but not directly on it (e.g., within 20 meters). The tool first creates a layer of wind fetch lines for each point, and then generates two text files. The first file contains the effective fetch length for each wind direction, and the second provides a statistical analysis of fetch for each point. Since creating fetch lines can be a time-consuming process, an additional tool, **Wind Fetch Tables**, allows for the creation of the aforementioned text files directly from a previously generated fetch lines file for any wind frequency and speed.



PARAMETERS:

Points with PID field (.shp)

Layer of points with a PID field (Short or Long type) containing unique point identifiers as natural numbers (1, 2, 3, ...). The point layer should be in a projected coordinate system. Points should be inside the polygon, not on its boundary. The point layer should be in SHP format.

Water body polygon (.shp)

Layer of the polygon representing the water body in which the fetch is analyzed. It should be in the same coordinate system as the points. The polygon layer should be in SHP format.

Result fetch line (.shp)

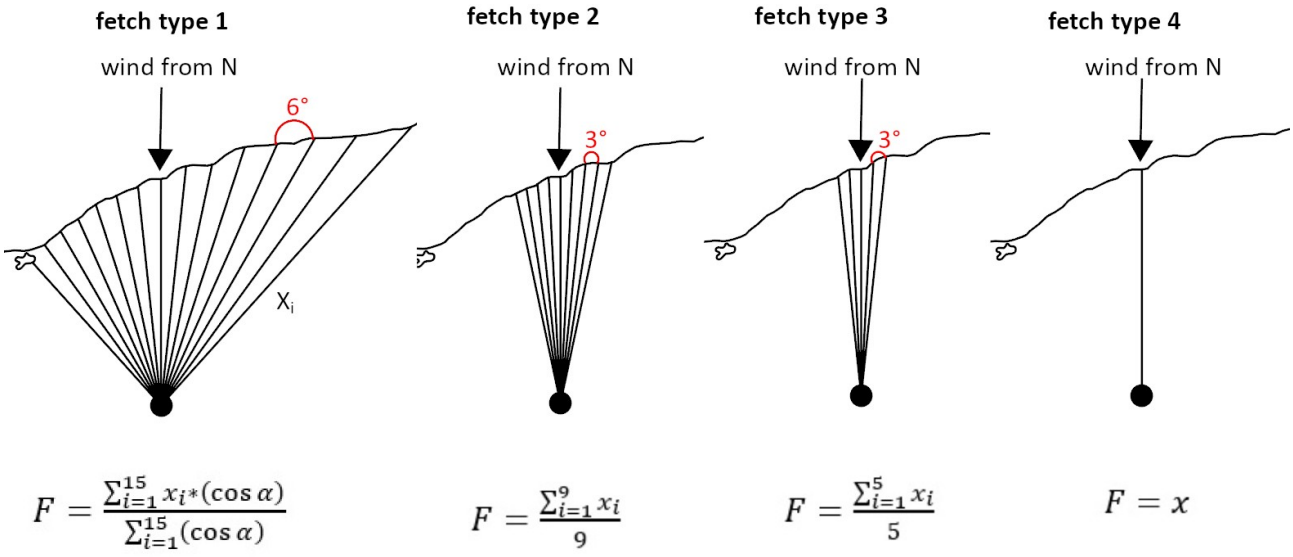
Full name with path (SHP format only), e.g., C:\project\result.shp. A line layer of individual fetch lines is created. This layer should not be overwritten. The attribute table description of the created layer is shown in the example below.

Max distance of fetch line [km]

Maximum length of the fetch line in kilometers. The default is 200 km. It should be set such that further extending it does not change the wind wave parameters or reaches the shore for each point and direction.

Fetch type [1, 2, 3, 4]

Specifies one of the four methods to determine the effective fetch F. The default type is 1.



$$F = \frac{\sum_{i=1}^{15} x_i * (\cos \alpha)}{\sum_{i=1}^{15} (\cos \alpha)} \qquad F = \frac{\sum_{i=1}^{9} x_i}{9} \qquad F = \frac{\sum_{i=1}^{5} x_i}{5} \qquad F = x$$

Wind directions [deg.]

Specifies a series of wind directions for which fetch will be determined as text. Wind direction values should be separated by commas. Default wind directions are 0, 45, 90, 135, 180, 225, 270, 315. If incorrect values are entered or the field is left blank, default values will be used.

Wind direction frequency [any; days, %, parts]

Specifies a series of wind frequencies from each direction. Values should be separated by commas and correspond to the number of wind directions. By default, all directions have equal frequency. Wind frequency can be entered in any format (days, percentages, or parts). The algorithm calculates values relative to the sum of the provided frequencies. Default values are applied in case of input errors.

Wind direction mean speed [m/s]

Specifies a series of average wind speeds from each direction. Values should be separated by commas and correspond to the number of wind directions. By default, all directions have a speed of 6 m/s. Default values are applied in case of input errors. These values are used solely for REI calculations.

Start point PID

With a large number of points, work can be divided into stages and performed for a subset of points defined by PID. This parameter defines the first point for which calculations will be performed. The default value is 1.

End point PID

With a large number of points, work can be divided into stages and performed for a subset of points defined by PID. This parameter defines the last point for which calculations will be performed. The default value is 1,000,000.

Due to the potentially lengthy process of creating fetch lines, the additional **Wind Fetch Tables** tool allows for the creation of the aforementioned text files directly from previously obtained fetch line files for any wind frequency and speed.

PARAMETERS:

Fetch lines created by Vector Wind Fetch tool (.shp)

Full name with path of fetch lines created by the Vector Wind Fetch tool.

Tables suffix (1, 2, 3...)

This tool creates tables of computed fetch values and their statistical analysis, similar to the previous tool. Names are constructed based on the fetch line name plus a natural number.

Wind direction frequency [any; days, %, parts]

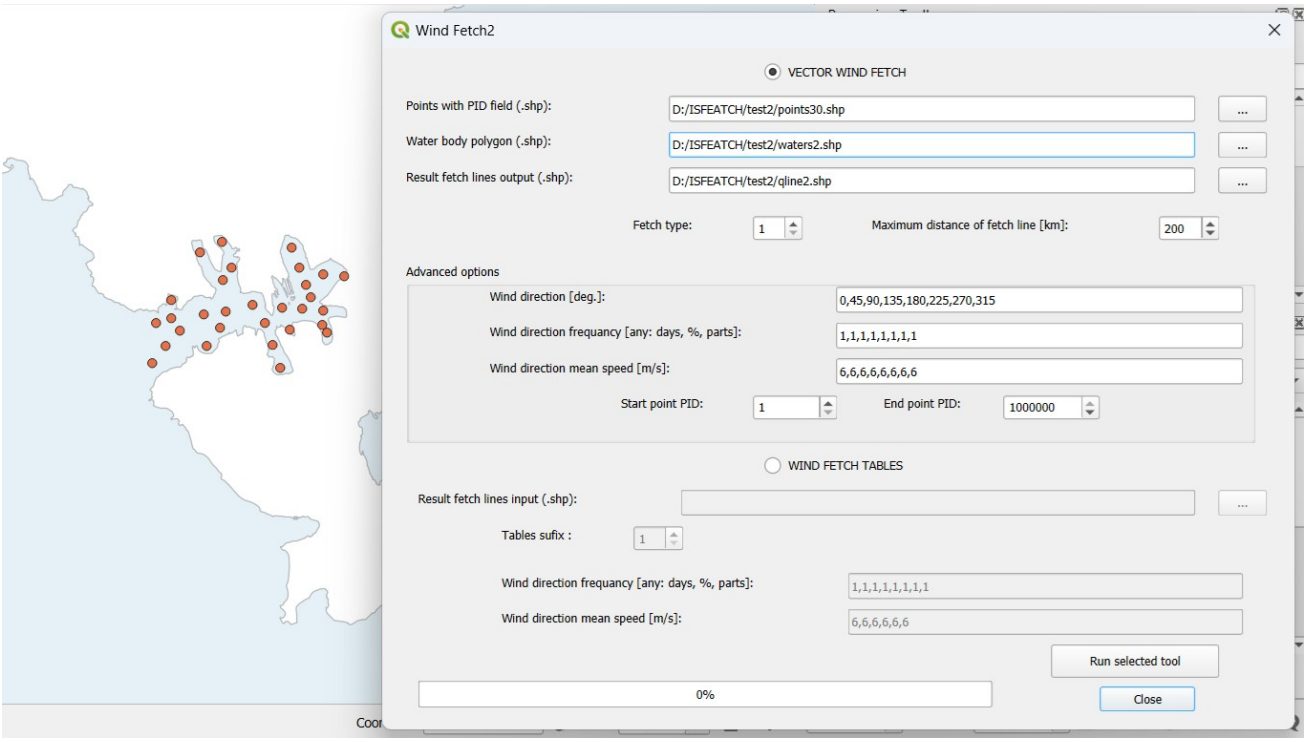
Specifies a series of wind frequencies from each direction. Values should be separated by commas and correspond to the number of wind directions. By default, all directions have equal frequency. Wind frequency can be entered in any format (days, percentages, or parts). The algorithm calculates values relative to the sum of the provided frequencies. Default values are applied in case of input errors.

Wind direction mean speed [m/s]

Specifies a series of average wind speeds from each direction. Values should be separated by commas and correspond to the number of wind directions. By default, all directions have a speed of 6 m/s. Default values are applied in case of input errors. These values are used for calculating the REI index (page 8).

Example using test data (Minimal tool execution configuration):

Test layers (test_fetch.zip) - points30 (SHP) and waters2 (SHP)



Only points, body polygon, and result fetch lines output (output data should not be overwritten) are entered. Other parameters remain as defaults.

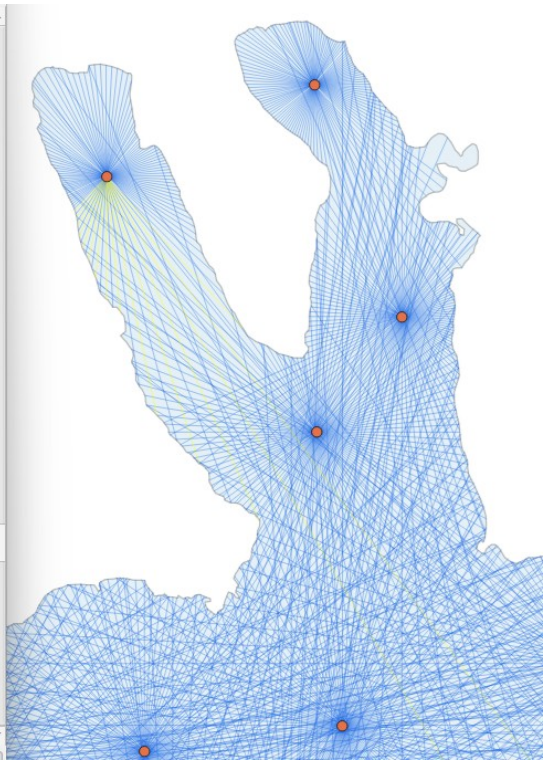
Upon clicking "Run selected tool," the tool operates in three stages, with progress displayed as a percentage completed on the progress bar (from 1% to 100%) for each stage. If QGIS reports no errors, the program will execute correctly. Additionally, the program generates a text file named "fetch lines output_rob.txt," which includes a description of all parameters used and information about success or errors.

Vector Wind Fetch parameters:
fpoint = D:/ISFEATCH/test2/points30.shp
fpol = D:/ISFEATCH/test2/waters2.shp
fetch_line = D:/ISFEATCH/test2/qline2.shp
fetchtype = 1
dd =200000.0
wind_dir =[0.0, 45.0, 90.0, 135.0, 180.0, 225.0, 270.0, 315.0]
wind_freq =[1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0]
wind_speed =[6.0, 6.0, 6.0, 6.0, 6.0, 6.0, 6.0, 6.0]
pstart =1
pend =1000000
Tool executed correctly.

The program creates a new line layer and two text files (in addition to the parameter file):

- qline2.shp - fetch layer for each point and each wind direction

	PID	lff	nrfl	SHPL
2699	23	135	14	3543.03604175...
2700	23	135	15	2186.73818169...
2701	23	180	1	3393.58222250...
2702	23	180	2	15132.1661764...
2703	23	180	3	13440.3437522...
2704	23	180	4	6263.02809354...
2705	23	180	5	5036.26225049...
2706	23	180	6	4074.30643466...
2707	23	180	7	2272.30859438...
2708	23	180	8	2047.67943468...
2709	23	180	9	1694.26517025...
2710	23	180	10	1422.50058812...
2711	23	180	11	1267.30614535...
2712	23	180	12	1102.80961011...
2713	23	180	13	947.628500534...
2714	23	180	14	838.692766817...
2715	23	180	15	776.074828115...



The attribute table contains the point number (PID), wind direction (180), line number (their count depends on the selected fetch type), and line length in meters.

The text file with effective fetch has a name format of line + _effe.csv

	PID	f0	f45	f90	f135	f180	f225	f270	f315
1	1	2554.8	7689.9	10759.6	8536.2	95325.3	188816.2	164822.9	51283.1
2	2	11430.0	11890.4	7814.1	2761.8	91674.5	188043.2	197916.6	109250.0
3	3	4741.4	9378.8	10368.6	5242.0	40058.0	152202.2	152118.7	53036.0
4	4	3469.6	6526.4	8271.4	6740.7	17019.1	125029.6	109191.7	3354.6
5	5	9468.3	8121.7	2798.9	1401.6	1283.9	1349.5	59355.9	55657.9
6	6	3801.1	3573.0	3165.8	7378.0	8437.8	4210.7	2776.5	3271.8
7	7	6129.8	5852.3	7101.4	5186.8	4836.6	96456.9	95714.8	5370.6
8	8	2076.9	2072.9	2532.9	5148.3	5517.1	71032.3	75415.1	4843.1
9	9	3706.2	5536.5	6119.4	4125.6	3522.6	12594.4	35892.3	18998.1
10	10	5078.1	2081.0	1491.6	3267.8	2983.3	1220.1	957.9	4146.4
11	11	4472.8	2020.4	1767.6	1449.8	1152.4	1228.1	1222.1	3695.9
12	12	2572.9	2910.9	4910.9	4707.8	3944.4	2986.0	1603.9	2139.8
13	13	7392.1	6520.4	5256.5	4060.4	2428.9	16699.6	4607.9	4871.7

It contains the calculated effective fetch in meters (according to the selected type) for each wind direction.

The second file (named line + _stat.csv) contains statistics of the effective fetch for each point (PID) and the REI (Relative Exposure Index).

	PID	WAFETCH	MXFETCH	MFFETCH	REI
1	1	66224	188816	188816	397341
2	2	77598	197917	197917	465585
3	3	53393	152202	152202	320359
4	4	34950	125030	125030	209702
5	5	17430	59356	59356	104578
6	6	4577	8438	8438	27461
7	7	28331	96457	96457	169987
8	8	21080	75415	75415	126479
9	9	11312	35892	35892	67871
10	10	2653	5078	5078	15920
11	11	2126	4473	4473	12757
12	12	3222	4911	4911	19332
13	13	6480	16700	16700	38878
14	14	3056	6820	6820	18334
15	15	3949	6853	6853	23694

WAFETCH - weighted average of effective wind fetch (using wind frequancy)

$$WAFETCH = \sum_{i=1}^{n(wind\,direction)} effective\,fetch\,for\,i\,direction * frequance\,of\,wind\,for\,i\,direction$$

MXFETCH - maximum efective fetch

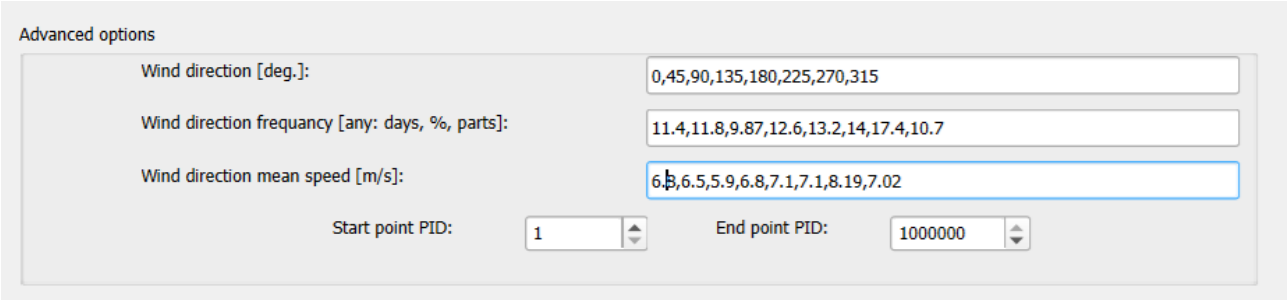
MFFETCH - most frequant effective fetch (define by wind frequance)

REI - Relative Expousure Index

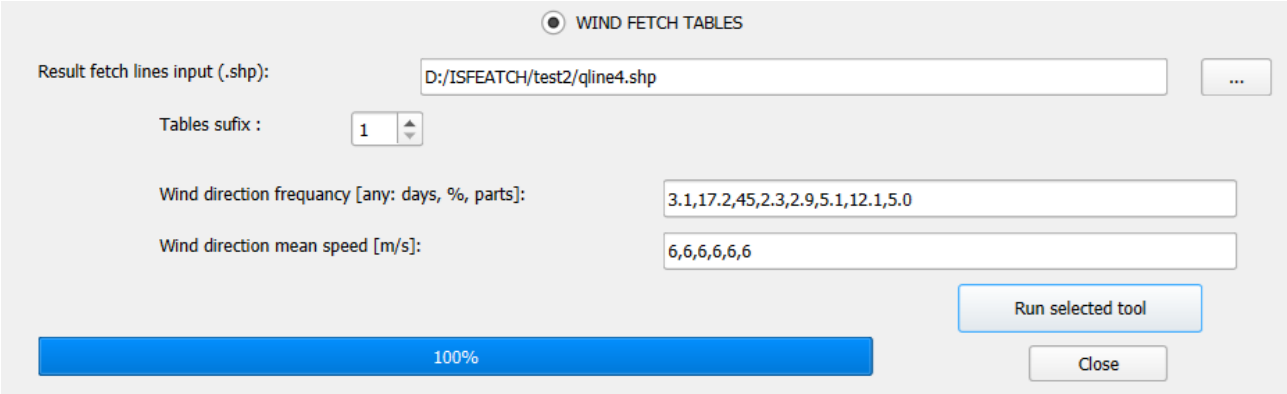
$$REI = \sum_{i=1}^{n(wind\,direction)} effective\,fetch\,for\,i\,direction * frequance\,of\ wind\,for\,i\,direction * wind\,speed\,for\,i\,direction$$

Using advanced options allows inputting different wind directions, wind frequency, and average speed values (for calculating RMI). Different types of effective fetch can also be specified using numbers (1, 2, 3, 4 as shown in the diagram above).

If advanced values are not entered, the tool will apply default parameters. T



The Wind Fetch Tables tool is used to create text files with computed values, similar to the previous tool, but based on existing fetch lines. This allows inputting different wind frequency and speed values without the need to recreate lines, which can be time-consuming. The table suffix allows creating subsequent versions of files with appended numbers.



Example conducted in QGIS (continuous map creation):

For the analyzed area, the average effective fetch (type=1) was calculated considering the wind frequency of Hornsund fjord in Svalbard. The calculated values were joined (join attributes by field value) to point data (500 points), and using methods such as IDW and Clip raster by mask layer, a spatial distribution map was created. The computation time was 24 minutes.