EvaTRiP Pro User's Manual

Release 2.0.0

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CONTENTS

CHAPTER

ONE

INTRODUCTION

EvaTRiP Pro is an analysis tool for calculation result of rive channgel flows, that is developed to provide a useful tool that can be used for wide variety of purposes, based on functions of EvaTRiP.

It can be used to analyse calculation results of arbitrary river channel solvers, including Nays2DH.

EvaTRiP Pro is the solver developed with Python, and the source code is available with license that allows users to modify it.

If users want to execute advanced analysis than in EvaTRiP Pro, users can edit source code of EvaTRiP pro, to add their own functions, and use them.

We hope that many users will use EvaTRiP Pro in their researches, educations, and businesses, and that will leads to the river designs considering for better environments.

Please refer to *License* (page 35) for the detail of license.

CHAPTER TWO

WORKFLOW

The workflow to use EvaTRiP pro, to analyse calculation result is as follows:

1. Run a river channel flow solver, like Nays2DH, to get calculation result.
2. Create a project for EvaTRiP Pro, and setup setting for analysis, using Pre-processing window and Calculation Condition dialog.
3. Run EvaTRiP Pro, with menu [Simulation] –> [Run].
4. Visualize analysis result using [2D Post-processing Window] and [Graph Window].

Please refer to *Functions* (page 5) for detail about how to use each function.

CHAPTER

THREE

FUNCTIONS

The list of functions of EvaTRiP Pro is shown in Table 3.1.

Table 3.1: The functions EvaTRiP Pro

Function	Description
Riffle and pool analysis	Analyze the area of riffle, pool and rapid, based on depth, velocity and Froude number.
Region statistics analysis	Calculate statistics, like average, stddev etc for regions.
Threshold Classification	Classificate calculation result values with threshold values.
Composition tool	Calculate Froude number, move critical diameter etc.
Response function tool	General purpose analysis tool based on PHABSIM.
Evaluation of Terrestrial plant growth	Tool to evaluate the region where terrestrial plants can grow.

3.1 Common Operation

3.1.1 How to use

Importing grid

When you start a project in EvaTRiP Pro, The dialog shown in Figure 3.1 will appear.

Select the CGNS file containing the calculation results to be analyzed and press the “ OK ” button.

The message “ Do you want to import a lattice from a CGNS file? ” Press the “ Yes ” button. The preprocessor will appear with the lattice imported, The preprocessor will appear with the lattice imported, as shown in Figure 3.2.

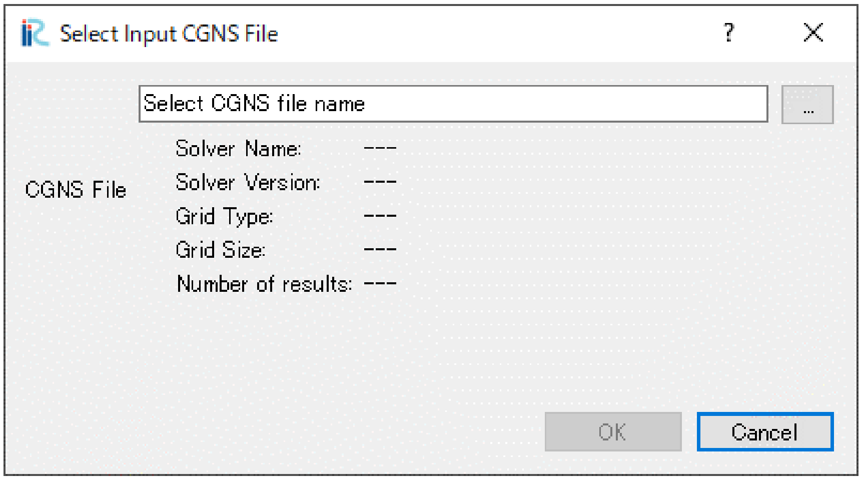

Figure 3.1: Select CGNS file for input dialog

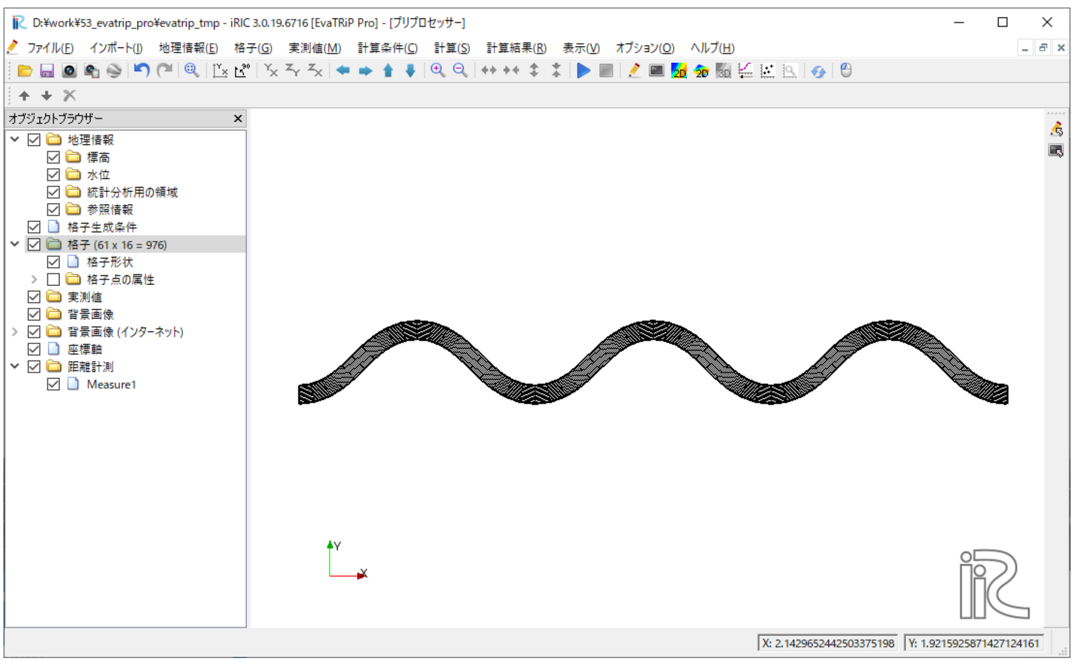

Figure 3.2: [Pre-processing Window] just after importing a grid

Editing calculation condition

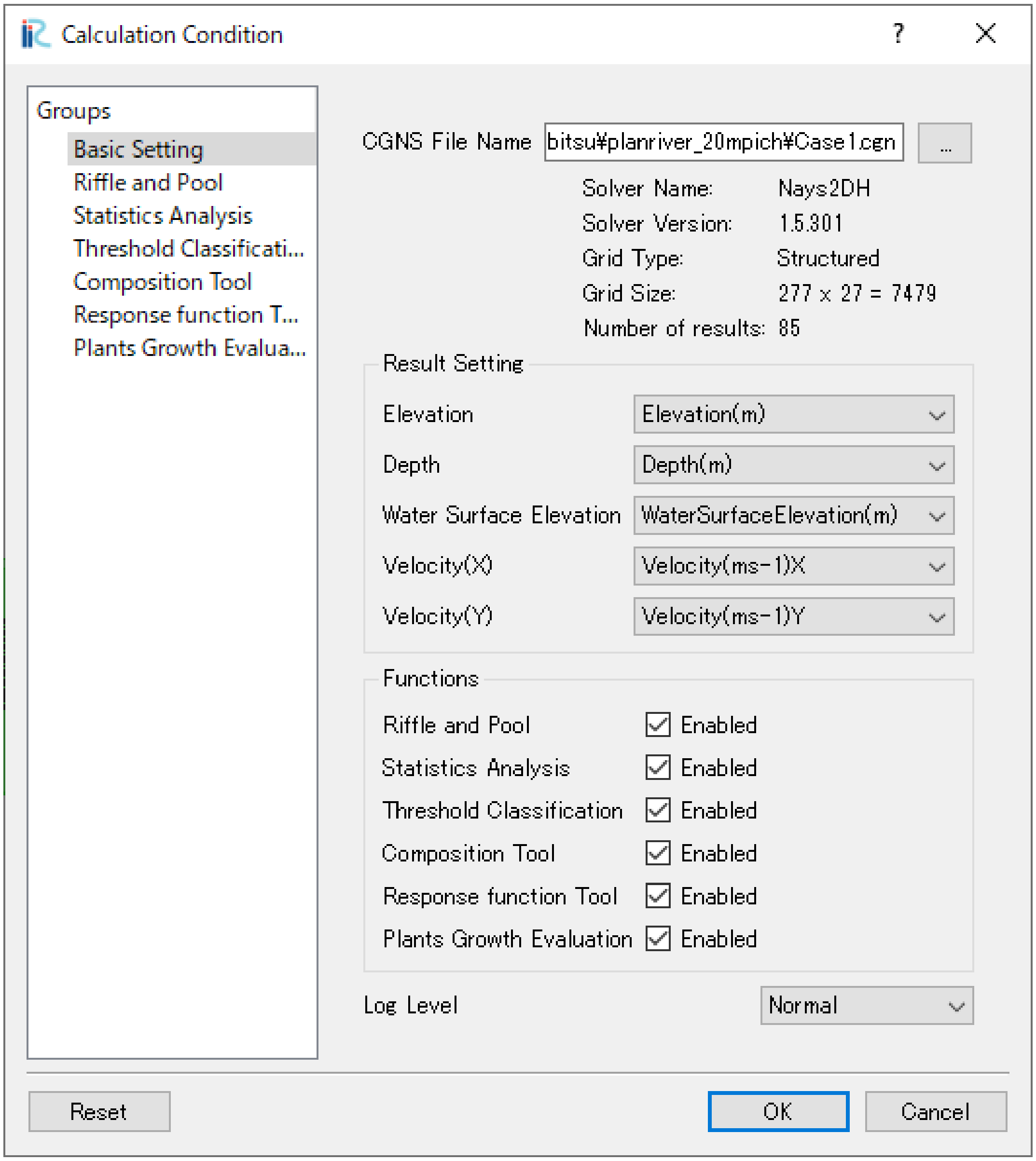

Figure 3.3: [Calculation Condition] dialog [Basic Setting] page

On [Basic Setting] page of [Calculation Condition] dialog, setup setting like below:

- **CGNS File Name**: Select the CGNS file, that contains calculation result to analyze.
- **Result Setting Elevation**: Select the calculation result that contains elevation values.
- **Result Setting Depth**: Select the calculation result that contains depth values.
- **Result Setting Water Surface Elevation**: Select the calculation result that contains water surface elevation values.
- **Result Setting Velocity(X)**: Select the calculation result that contains x component of velocity values.

- **Result Setting Velocity(Y)**: Select the calculation result that contains y component of velocity values.
- **Functions**: Check on checkbox next to the functions to use.

3.2 Riffle and pool analysis

Analyze the area of riffle, pool and rapid, based on depth, velocity and Froude number.

3.2.1 Description of functions

Riffle and pool analysis tool provides the two functions below:

- Classify area based on value of Froude number (Entwistle et al., 2018)
- Manual definition

Classify area based on value of Froude number (Entwistle et al., 2018)

Based on Froude number value calculated from depth and velocity, river channel area is classified to 5 types, including Pool, Glide etc. Detail is shown in Table 3.2.

Table 3.2: Classes based on Froude number

Class	Range of Froude number
Pool	$Fr < 0.04$
Glide	$0.04 \leqq Fr < 0.15$
Run	$0.15 \leqq Fr < 0.245$
Riffle	$0.245 \leqq Fr < 0.49$
Cascade / rapid	$0.49 \leqq Fr$

Manual definition

Classify area to pool, riffle, rapid using the threshold value of depth and velocity.

3.2.2 How to use

Editing calculation condition

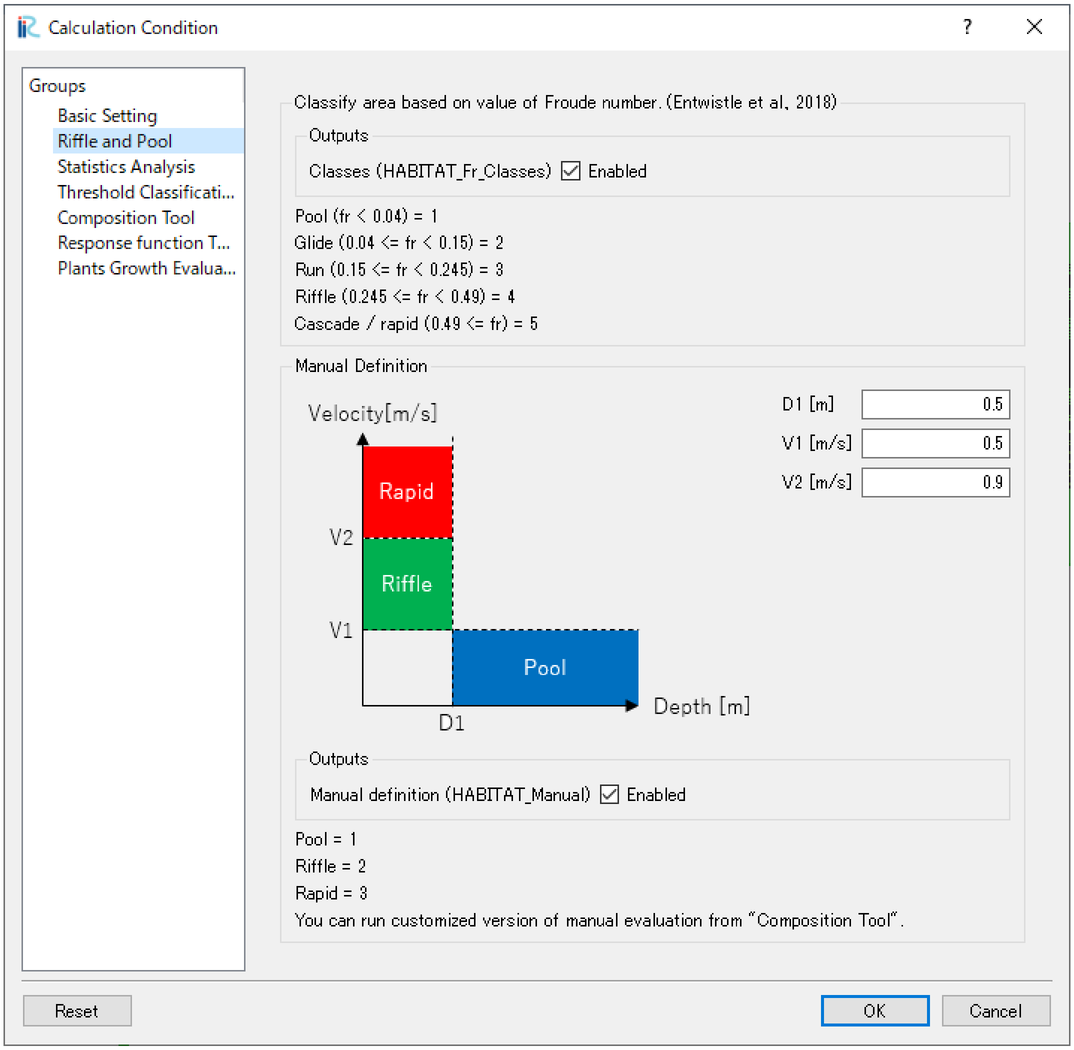

Figure 3.4: [Calculation Condition] dialog [Riffle and Pool Analysis] page

On [Riffle and Pool Analysis] page of [Calculation Condition] dialog, setup setting like below:

Classify area based on value of Froude number (Entwistle et al., 2018)

- **Classes (HABITAT_Fr_Classes)**: Check on to output results.

Manual Definition

- **D1 [m]**: Specify the threshold value of depth, refering the figure.
- **V1 [m/s]**: Specify the threshold value of velocity, refering the figure.
- **V2 [m/s]**: Specify the threshold value of velocity, refering the figure.
- **Outputs**: Check on to output results.

Visualization of analysis result

Visualize the analysis result that EvaTRiP pro outputs.

The list of output values are shown in below.

HABITAT_Fr_Classes
Pool = 1, Glide = 2, Run = 3, Riffle = 4, Cascade / rapid = 5

HABITAT_Manual
1 for Pool, 2 for Riffle, 3 for Rapid, 0 for others

3.3 Statistics Analysis

Calculate statistics, like average, stddev etc.

3.3.1 Description of functions

Calculate the statistics below:

- Maximum
- Minimum
- Average
- Standard deviation
- Coefficient of Variation

Statistics Analysis function provides the two functions below:

- Calculates statistics at each grid node
- Calculates statistics for regions

Calculates statistics at each grid node

Calculates statistics at each grid node, in the time range specified.

Calculates statistics for regions

If user defines [Areas for Statistics Analysis] in Pre-processing window, statistics for each region for each time step is output to CSV file.

If regions are not defined, statistics for whole region is calculated.

3.3.2 How to use

Define areas for Statistics Analysis

User needs to execute this step only when they wants to use [Calculates statistics for regions] multiple regions.

The steps are shown below:

1. Defining groups
2. Defining polygons
3. Mapping groups to grid

Defining groups

Select [Geographic Data] / [Area for Statistics Analysis], and Select [Edit Groups···] from right-clicking menu.

Dialog in Figure 3.5 is shown, so define the groups you need.

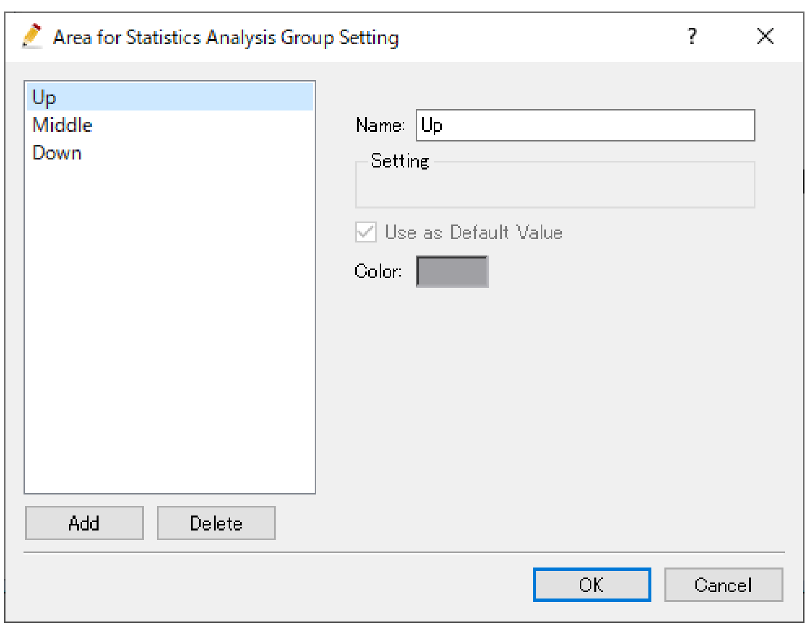

Figure 3.5: [Group Setting] dialog

Defining polygons

Select [Geographic Data] / [Area for Statistics Analysis], and Select [Add] –> [Polygons···] from right-clicking menu.

New polygon data is added, so define polygons, and link them to the groups. When you finish defining polygons by double-clicking, a dialog to select a group is shown.

Figure 3.6 shows an example of [Pre-processing Window] after defining polygons.

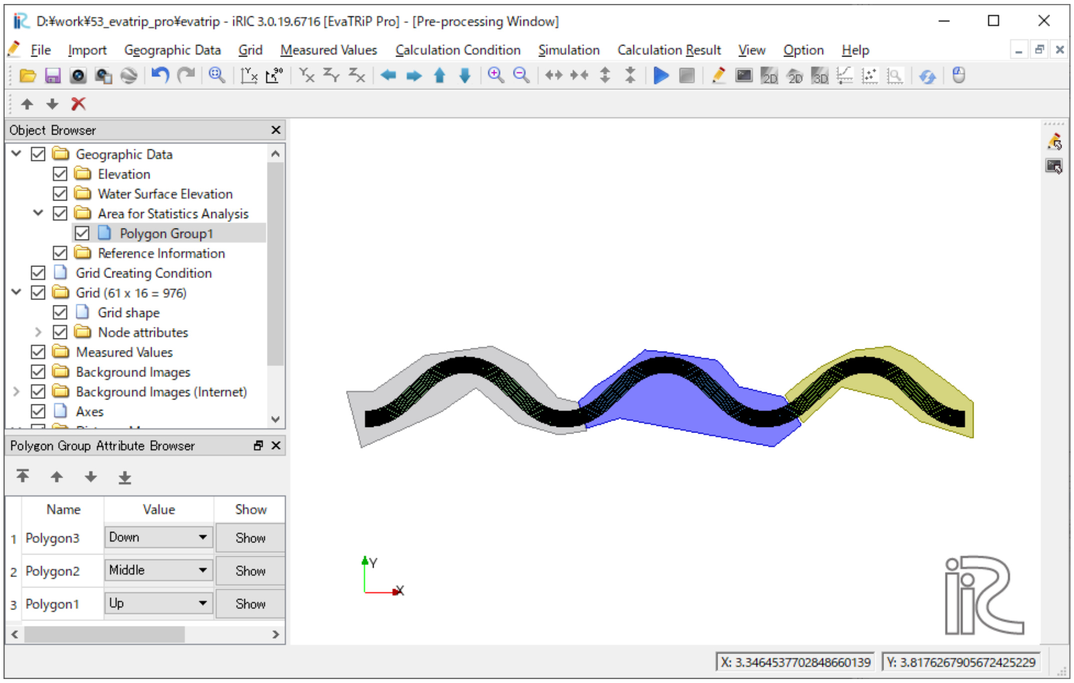

Figure 3.6: Example of defined polygons

Mapping groups to grid

Select [Grid] –> [Attribute Mapping] –> [Execute] from menu. [Attribute Mapping] dialog is shown, so check on [Area for Statistics Analysis] and click on [OK] button.

Note: When a grid node is included in multiple polygons, the group linked to the polygon on the top is mapped to the node.

Please note that it is not possible to map multiple groups to a grid node.

Note: Please note that you need to execute this step, even when you do not define groups, and calculates statistics for whole region.

Editing Calculation Condition

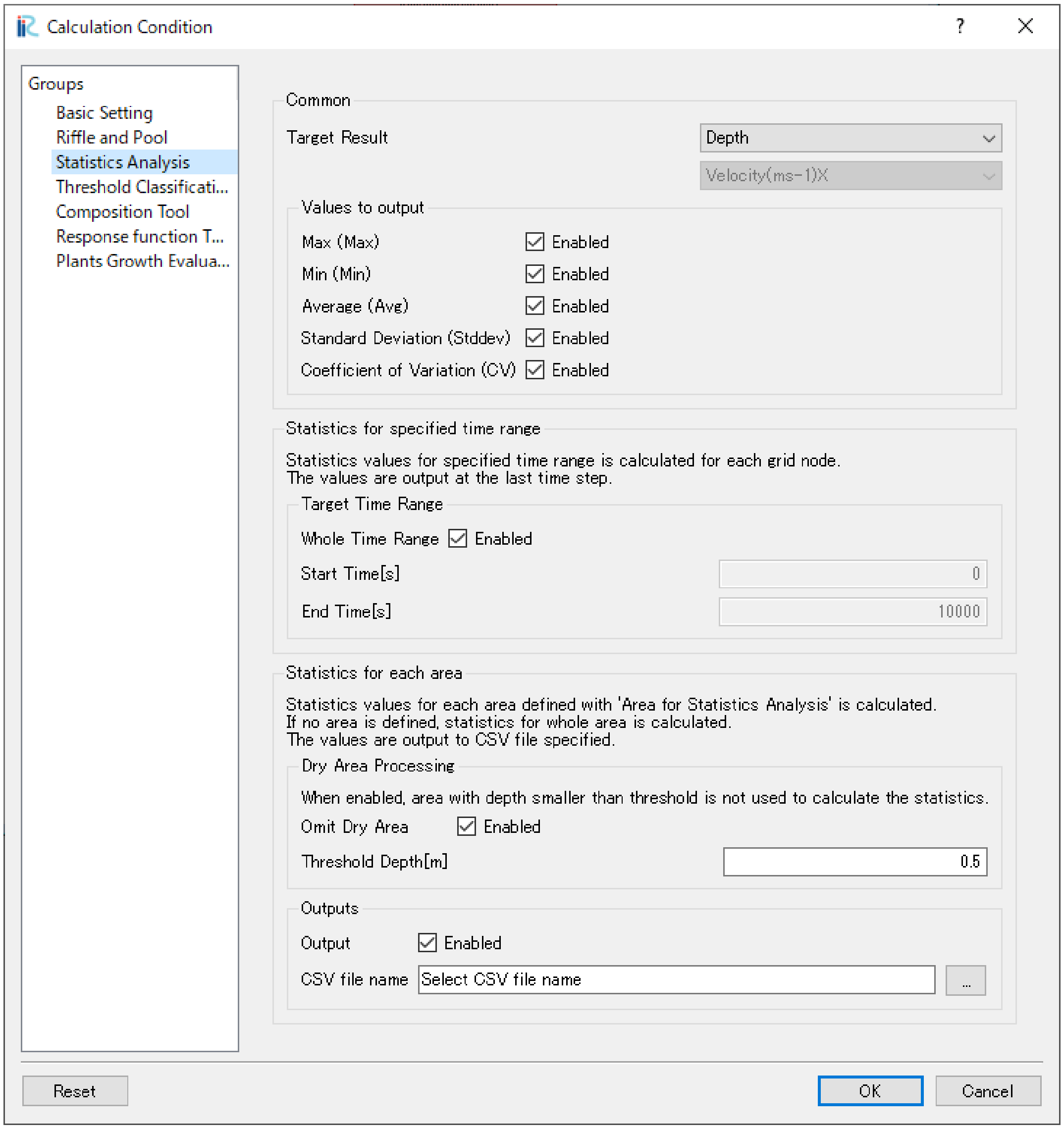

Figure 3.7: [Calculation Condition] dialog [Statistics Analysis] page

On [Statistics Analysis] page of [Calculation Condition] dialog, setup setting like below:

Common

- **Target Result**: Select the calculation result of which to calculate statistics.
- **Values to output**: Check on checkboxes that you want to output.

Statistics for each grid node

- **Target Time Range**: Specify the time range to calculate statistics.

Statics for each area

- **Dry Area Processing**: Specify setting about if the tool should use values at area with depth smaller than threshold, to calculate statistics.
- **Output**: Check on checkbox to output values.
- **CSV file name**: Specify the CSV file name to output.

Visualization of analysis result

Visualize the analysis result that EvaTRiP pro outputs.

The statistics for each grid node is output at the last time step.

The list of output values are shown below.

STAT_Max
: Maximum

STAT_Min
: Minimum

STAT_Avg
: Average

STAT_Stddev
: Standard deviation

STAT_CV
: Coefficient of variation

Checking the CSV file output

Statistics for each area is output to CSV file.

The list of output values to CSV file are shown below.

Count
: The number of nodes included in the area

Max
: Maximum

Min
: Minimum

Avg
Average

Stddev
Standard deviation

CV
Coefficient of variation

3.4 Threshold Classification

Classificate calculation result values with threshold values.

3.4.1 How to use

Editing Calculation Condition

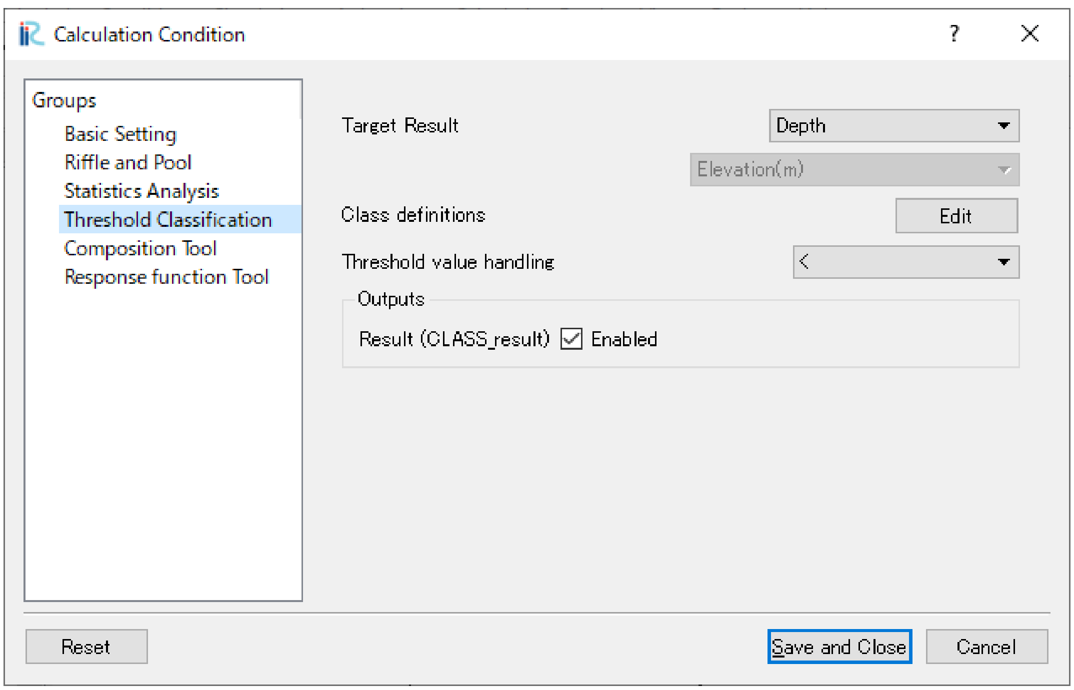

Figure 3.8: [Calculation Condition] dialog [Threshold Classification] page

On [Threshold Classification] page of [Calculation Condition] dialog, setup setting like below:

- **Target Result**: Select the calculation result to classify.
- **Class definitions**: Define the classification. Refer to Figure 3.9 for example.
- **Threshold value handling**: Select from if threshold value is included to left range or right range. if "<" is selected, threshold value is included to left range.
- **Result (CLASS_result)**: Check on the check box to output the analysis result.

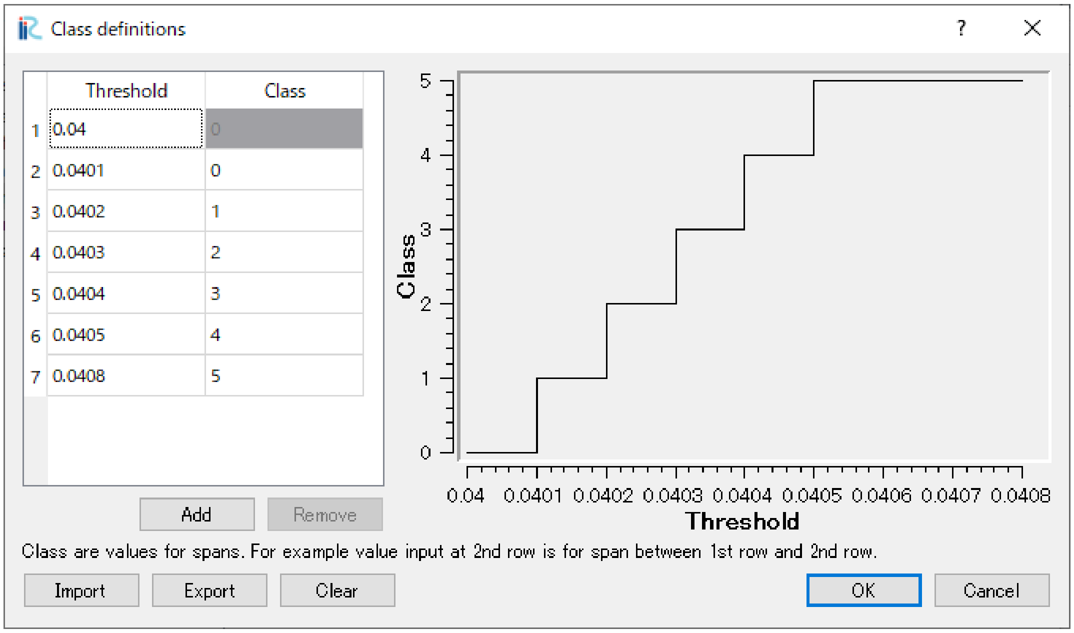

Figure 3.9: Example of classification definition

Visualization of analysis result

Visualize the analysis result that EvaTRiP pro outputs.

The list of output values are shown below.

CLASS_result
Classification result

3.5 Composition tool

Calculate Froude number, move critical diameter etc.

3.5.1 Description of functions

Composition tool provides the following five functions:

- Froude number calculation
- Move critical diameter calculation
- Fluid force calculation
- Manual formula calculation

Froude number calculation

Calculates Froude number from depth h, velocity v. Froud number is calculated with the formula below. g is the gravitational acceleration.

$$Fr = \frac{v}{\sqrt{gh}}$$

Move critical diameter calculation

Calculates move critical diameter values with the following steps:

1. Calculates water level gradient I from water surface elevation. Calculate water level gradient for both I-direction and J-direction, and then use the maximum value of them as I for each grid node.

   Level gradient in I direction I_i is calculated with formula below. x, y are coordinates of grid.

   - $i = 1$

   $$I_1 = \frac{w_{(2,j)} - w_{(1,j)}}{\sqrt{(x_{(2,j)} - x_{(1,j)})^2 + (y_{(2,j)} - y_{(1,j)})^2}}$$

   - $i = i_{max}$

   $$I_{max} = \frac{w_{(i_{max},j)} - w_{(i_{max}-1,j)}}{\sqrt{(x_{(i_{max},j)} - x_{(i_{max}-1,j)})^2 + (y_{(i_{max},j)} - y_{(i_{max}-1,j)})^2}}$$

   - else

   $$I_i = \frac{1}{2}\left(\frac{w_{(i+1,j)} - w_{(i,j)}}{\sqrt{(x_{(i+1,j)} - x_{(i,j)})^2 + (y_{(i+1,j)} - y_{(i,j)})^2}} + \frac{w_{(i,j)} - w_{(i-1,j)}}{\sqrt{(x_{(i,j)} - x_{(i-1,j)})^2 + (y_{(i,j)} - y_{(i-1,j)})^2}}\right)$$

   Similar formulas are used to calculate level gradient in J direction.

2. Calculates friction speed u_* from depth h and water level gradient I. g is the gravitational acceleration.

   $$u_* = \sqrt{ghI}$$

3. Calculates move critical diameter using Iwagaki ' s formula [Iwagaki], from u_*. The formulas are shown in Table 3.3. Please note that the unit of u_* is centimeter per second, and the unit of move critical diameter is centimeter. The unit of critical diameter values output is milimeter.

Table 3.3: Formulas to calculate move critical diameter

Condition	Formula
$24.5127 \leqq u_*^2$	$d_{max} = u_*^2/80.9$
$6.49 \leqq u_*^2 < 24.5127$	$d_{max} = (u_*^2/134.6)^{22/31}$
$3.1075 \leqq u_*^2 < 6.49$	$d_{max} = u_*^2/55.0$
$1.469 \leqq u_*^2 < 3.1075$	$d_{max} = (u_*^2/8.41)^{32/11}$
$u_*^2 < 1.469$	$d_{max} = u_*^2/226.0$

Note: Because water level gradient is needed, this function can be used for calculation results of solvers that uses structured grids.

Fluid force calculation

Calculates Fluid force F from depth h and velocity v, with the formula below:

$$F = hv^2$$

Manual formula calculation

Calculates value with formula manually defined.

You can describe formulas with Python notations. Refer to *[Manual Definition]* (page 20) for examples.

You can use the variables in Table 3.4 for Manual definition.

Table 3.4: The list of variables available in manual definition

Value	Variable name
Elevation	elevation
Depth	depth
Water surface elevation	wse
Velocity (X)	vx
Velocity (Y)	vy
Velocity (magnitude)	v
Arbitrary Variable 1	val1
Arbitrary Variable 2	val2

3.5.2 How to use

Editing calculation condition

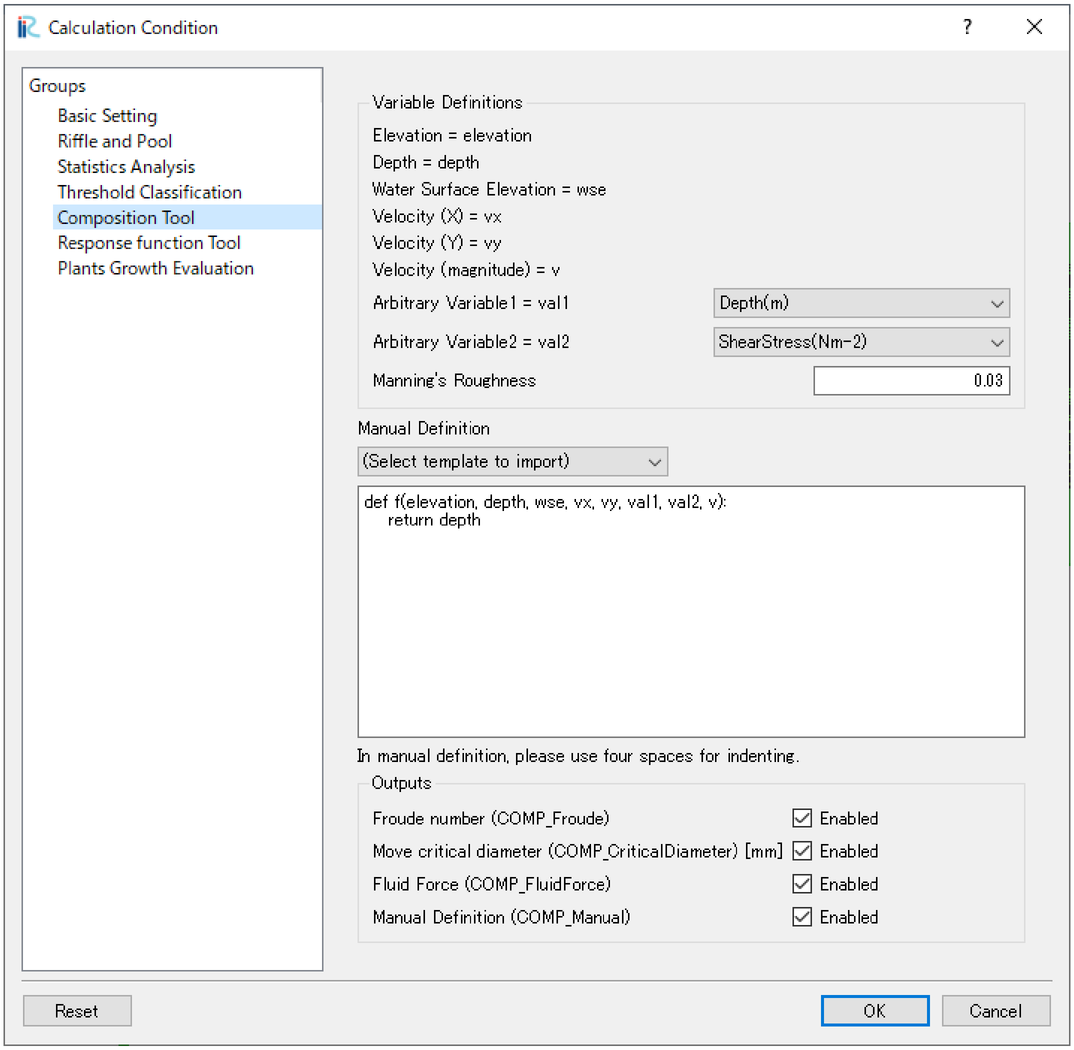

Figure 3.10: [Calculation Condition] dialog [Composition Tool] page

[Composition Tool] page of [Calculation Condition] dialog, setup setting like below:

- **Arbitrary Variable 1, 2**: Select the variable to use in [Manual Definition].
- **Manual Definition**: Define the manually defined formula
- **Outputs**: Check on values to output.

Visualization of analysis result

Visualize the analysis result that EvaTRiP pro outputs.

The list of output values are shown in below.

COMP_Froude
Froud number

COMP_CriticalDiameter
Move critical diameter

COMP_FluidForce
Fluid Force

COMP_Manual
Calculation result of manually defined formula

3.5.3 [Manual Definition]

Users can define formula with Python notations.

Please refer to the hints below:

- Variables like depth, wse are loaded as numpy.ndarray.
- Please use four spaces for indenting.
- numpy is already imported as np.
- You can use arbitrary modules, using import statement.
- You can use print() to output calculation result to [Solver Console Window].
- You can use only ASCII characters.

In [Manual Definition], define a function with name, f, that has arguments shown in Table 3.4.

Predefined examples

EvaTRiP Pro bundles several predefined examples.

You can import the predefined examples, using the combo box with message "(Select template to import)".

Default

The definition of template "Default" is shown in List 3.1.

List 3.1: Predefined example "Default"

```
def f(elevation, depth, wse, vx, vy, val1, val2, v):
    return depth
```

The function of template "Default" returns depth simply.

Please use the template in case you want to define your own function from scratch, by edit the part "return depth".

Riffle and Pool (custom thresholds)

The definition of template "Riffle and Pool (custom thresholds)" is shown in List 3.2.

List 3.2: Predefined example "Riffle and Pool (custom thresholds)"

```
import numpy as np

THRESHOLD_RIFFLE_DEPTH1 = 0.5
THRESHOLD_RIFFLE_DEPTH2 = 0.8
THRESHOLD_POOL_V1 = 0.5
THRESHOLD_POOL_V2 = 0.9


def f(elevation, depth, wse, vx, vy, val1, val2, v):
    """Calculate riffle and pool from depth, v (velocity)"""

    ret = np.zeros(depth.shape, dtype=np.uint8)
    # THRESHOLD_RIFFLE_DEPTH1 <= depth < THRESHOLD_RIFFLE_DEPTH2 and
    # v <= THRESHOLD_POOL_V1
    # -> ret = 1
    ret = np.where(
        (depth >= THRESHOLD_RIFFLE_DEPTH1) &
        (depth < THRESHOLD_RIFFLE_DEPTH2) &
        (v <= THRESHOLD_POOL_V1), 1, ret)

    # THRESHOLD_RIFFLE_DEPTH2 <= depth and
    # v <= THRESHOLD_POOL_V1
    # -> ret = 2
    ret = np.where(
        (depth >= THRESHOLD_RIFFLE_DEPTH2) &
        (v <= THRESHOLD_POOL_V1), 2, ret)

    # depth <= THRESHOLD_RIFFLE_DEPTH1 and
    # THRESHOLD_POOL_V1 <= v < THRESHOLD_POOL_V2
    # -> ret = 3
    ret = np.where(
        (depth <= THRESHOLD_RIFFLE_DEPTH1) &
        (v >= THRESHOLD_POOL_V1) &
        (v < THRESHOLD_POOL_V2), 3, ret)

    # depth <= THRESHOLD_RIFFLE_DEPTH1 and
    # THRESHOLD_POOL_V2 <= v
    # -> ret = 4
    ret = np.where(
        (depth <= THRESHOLD_RIFFLE_DEPTH1) &
        (v >= THRESHOLD_POOL_V2), 4, ret)

    return ret
```

This example is the extended version of "Manual Definition" of Riffle and Pool analysis that is introduced in *Manual definition* (page 8).

The output value is as follows:

- Depth is greater than THRESHOLD_RIFFLE_DEPTH1 and less than THRESHOLD_RIFFLE_DEPTH2 and velocity is less than THRESHOLD_POOL_V1 –> 1
- Depth is greater than THRESHOLD_RIFFLE_DEPTH2 and velocity is less than THRESHOLD_POOL_V1 –> 2
- Depth is less than THRESHOLD_RIFFLE_DEPTH1 and flow velocity is greater than THRESHOLD_POOL_V1 and less than THRESHOLD_POOL_V2 –> 3
- Depth is less than THRESHOLD_RIFFLE_DEPTH1 and flow velocity is greater than THRESHOLD_POOL_V2 –> 4
- Other -> 0

A diagram representing the relationship between threshold values and values is shown in Figure 3.11.

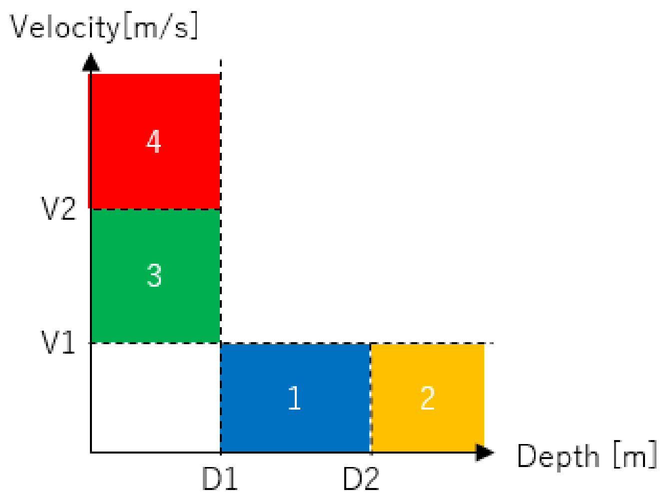

Figure 3.11: Riffle and Pool (custom thresholds) diagram

If you want to perform a complex riffle and pool analysis, please use this template and change the threshold values or increase the number of conditions.

Riffle and Pool (Hauer et al. 2009)

Riffle and Pool (Hauer et al. 2009) is based on the paper [Hauer]. The definition of template " Riffle and Pool (Hauer et al. 2009) " is shown in List 3.3.

List 3.3: Predefined example " Riffle and Pool (Hauer et al. 2009)

```
import numpy as np


def decisionNCv(vv):
    ret = np.zeros(vv.shape, dtype=np.uint8)
    ret = np.where(vv <= 0.1, 1, ret)
    ret = np.where((vv <= 0.25) & (ret == 0), 2, ret)
    ret = np.where((vv <= 0.40) & (ret == 0), 3, ret)
```

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```
    ret = np.where((vv <= 0.75) & (ret == 0), 4, ret)
    ret = np.where((ret == 0), 5, ret)
    return ret


def decisionNCd(dd):
    ret = np.zeros(dd.shape, dtype=np.uint8)
    ret = np.where((dd >= 0.01) & (dd <= 0.4), 5, ret)
    ret = np.where((dd <= 0.8) & (ret == 0), 4, ret)
    ret = np.where((dd <= 1.2) & (ret == 0), 3, ret)
    ret = np.where((dd <= 1.5) & (ret == 0), 2, ret)
    ret = np.where(ret == 0, 1, ret)
    return ret


def decisionNCval1(tt):
    ret = np.zeros(tt.shape, dtype=np.uint8)
    ret[:] = 2  # default value
    ret = np.where(tt <= 2.0, 0, ret)
    ret = np.where(tt <= 20, 1, ret)
    return ret


def decisionHC(mmh, dd):
    habitat = np.zeros(mmh.shape)
    habitat[:] = 2  # backwater
    habitat = np.where(mmh == 20, 6, habitat)  # riffle
    habitat = np.where((mmh >= 10) & (mmh <= 18) & (habitat == 2), 5, habitat)  # fast␣
↪run
    habitat = np.where((mmh >= 5) & (mmh <= 9) & (habitat == 2), 4, habitat)  # run
    habitat = np.where((mmh >= 2) & (mmh <= 4) & (habitat == 2), 3, habitat)  # pool
    habitat = np.where((dd <= 0.01) & (habitat == 2), 0, habitat)  # drywater
    habitat = np.where((dd <= 0.8) & (habitat == 2), 1, habitat)  # shallow

    return habitat


def f(elevation, depth, wse, vx, vy, val1, val2, v):
    """Calculate riffle and pool from depth, v (velocity), val1"""

    ncv = decisionNCv(v)
    ncd = decisionNCd(depth)
    ncval1 = decisionNCval1(val1)

    mh = (ncd + ncv) * ncval1
    mh = np.where(depth <= 0.01, 0, mh)

    return decisionHC(mh, depth)
```

The process details are shown below.

1. Calculates NCv based on the flow velocity v with the following conditions:

- $v \leq 0.1$ –> 1
- $0.1 < v \leq 0.25$ –> 2
- $0.25 < v \leq 0.4$ –> 3
- $0.4 < v \leq 0.75$ –> 4
- $0.75 < v$ –> 5

2. Calculates NCd based on the water depth d with the following conditions:
   - $d \leq 0.01$ –> 1
   - $0.01 \leq d \leq 0.4$ –> 5
   - $0.4 < d \leq 0.8$ –> 4
   - $0.8 < d \leq 1.2$ –> 3
   - $1.2 < d \leq 1.5$ –> 2
   - $1.5 < d$ –> 1
3. Calculates $NCval1$ based on arbitrary variable1 $val1$ with the following conditions:
   - $val1 \leq 2.0$ –> 0
   - $2.0 < val1 \leq 20$ –> 1
   - $20 < val1$ –> 2
4. Calculates $mh = (NCd + NCv) \times NCval1$.
5. If $d \leq 0.01$, overwrite mh to 0.
6. Based on the mh obtained above, the decision is made as follows:
   - $mh = 20$ –> riffle
   - $10 \leq mh \leq 18$ –> fast run
   - $5 \leq mh \leq 9$ –> run
   - $2 \leq mh \leq 4$ –> pool
   - None of the above conditions apply, and $d \leq 0.01$ –> drywater
   - None of the above conditions apply, and $0.01 < d \leq 0.8$ –> shallow
   - None of the above conditions apply –> backwater

Note: val1 should be ShearStress by default.

Adding template of Manual Definition

You can register the function you ' ve created to EvaTRiP, so that you can import the template using the combo box with message " (Import template to import) ".

The steps are as follows:

1. Save file that contains the function you created, in the folder that stores the source code of EvaTRiP Pro. We recommend that you name the file " manual_xxxxxxx.py " or something similar.

2. Modify definition.xml and add a <Source> entry the the the item named “comp_manual”. An example is shown in List 3.4, where line 6 is the line added, that make it possible to load the contents of “manual_myfunction.py” by selecting the “My function” entry.

List 3.4: Example of definition.xml (excerpt)

```
1  <Item name="comp_manual">
2    <Definition valueType="string" multiline="true">
3      <Source caption="Default" filename="manual_default.py" default="true"/>
4      <Source caption="Riffle and Pool (custom thresholds)" filename="manual_rp_custom.py" />
5      <Source caption="Riffle and Pool (Hauer et al. 2009)" filename="manual_rp_hauer.py"/>
6      <Source caption="My function" filename="manual_myfunction.py"/>
7      <Condition type="and">
8        <Condition type="isEqual" target="comp_output_manual" value="1" />
9        <Condition type="isEqual" target="f_composition" value="1" />
10     </Condition>
11  </Definition>
12 </Item>
```

3.6 Response function Tool

General purpose analysis tool based on PHABSIM.

3.6.1 How to use

Editing Calculation Condition

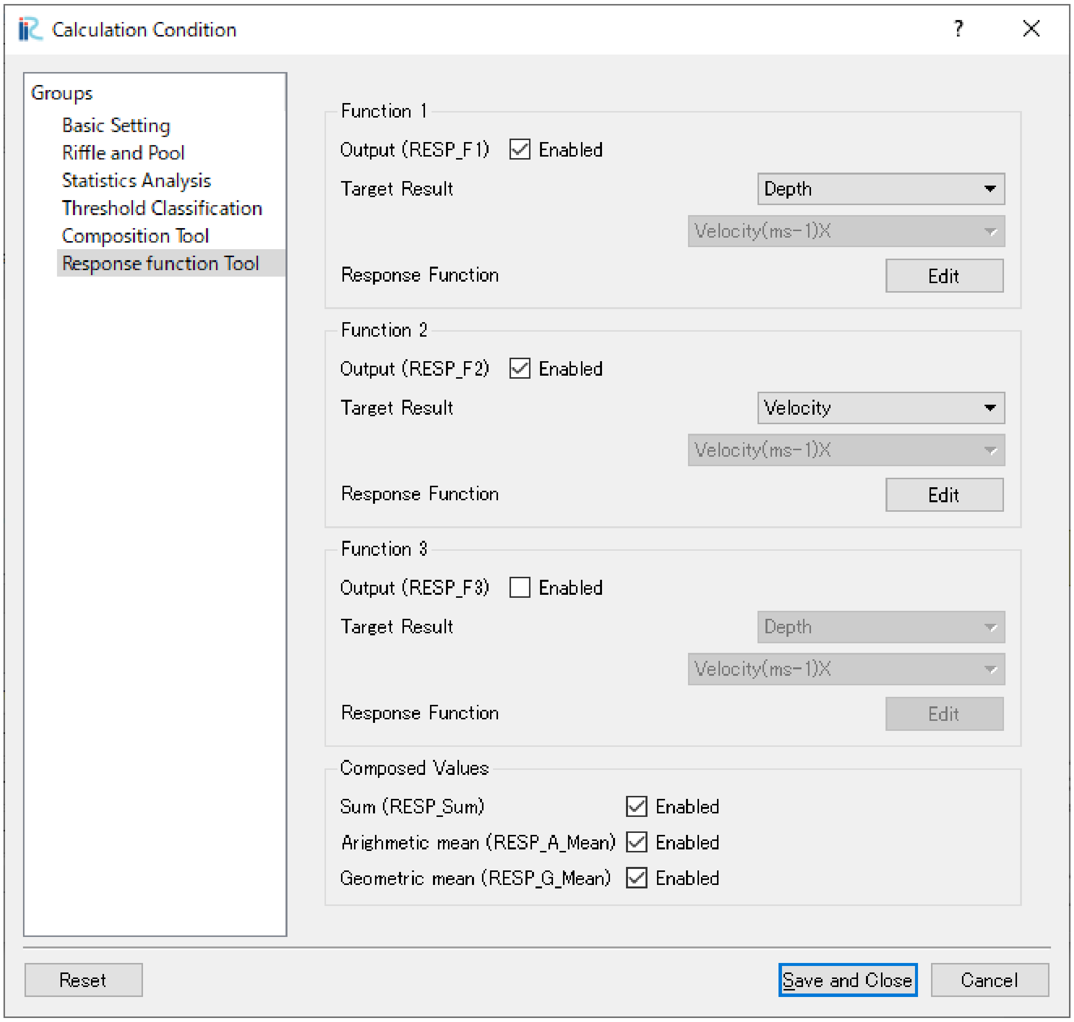

Figure 3.12: [Calculation Condition] dialog [Response function Tool] page

On [Response function Tool] page of [Calculation Condition] dialog, setup setting like below:

- **Function 1 Output (RESP_F1) etc.**: Check on the check box to output.
- **Function 1 Target Result etc.**: Select the calculation result to input to the function.
- **Function 1 Response Function etc.**: Define the fujnction. Refer to Figure 3.13 for example.
- **Sum (RESP_Sum)**: Check on check box to output the sum of functions.
- **Arighmetic mean (RESP_A_Mean)**: Check on check box to output the arighmetic mean of functions.
- **Geometric mean (RESP_G_Mean)**: Check on check box to output the geometric mean of functions.

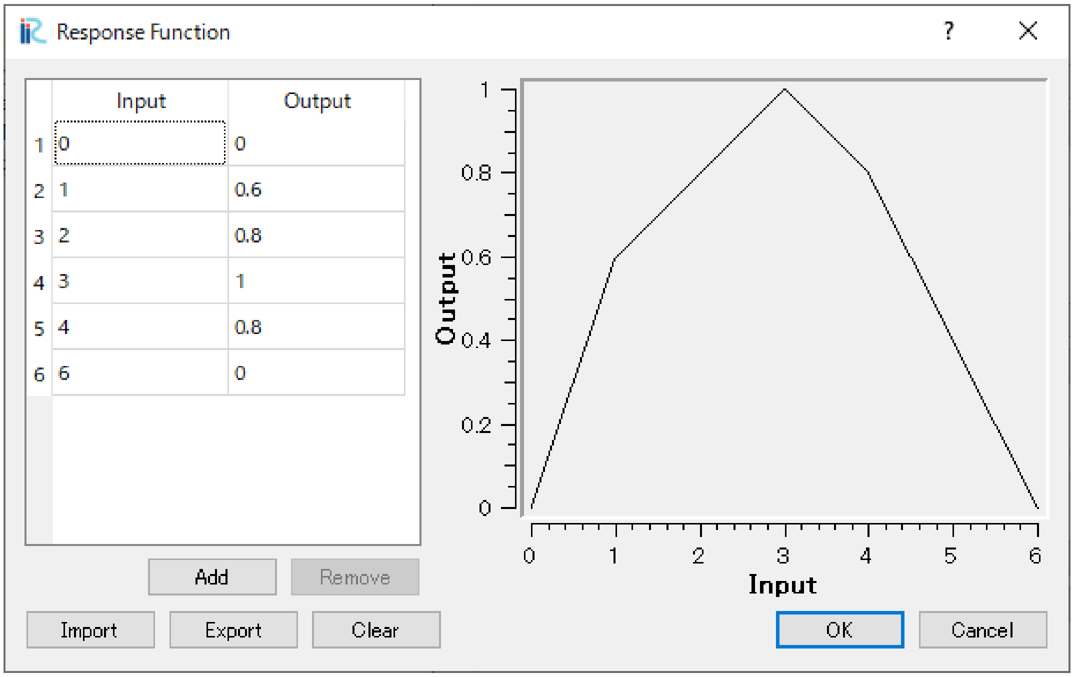

Figure 3.13: Example of function definition

Visualization of analysis result

Visualize the analysis result that EvaTRiP pro outputs.

The list of output values are shown in below.

RESP_F1
Function 1

RESP_F2
Function 2

RESP_F3
Function 3

RESP_Sum
Sum

RESP_A_Mean
Arighmetic mean

RESP_G_Mean
Geometric mean

3.7 Evaluation of Terrestrial plant growth

The water depth h(m) and depth-averaged velocity V(m/s) obtained from the flow calculations are used to evaluate the conditions for terrestrial plant growth.

3.7.1 Description of functions

Three kinds of methods to evaluate terrestrial plant growth are implemented in this tool.

Using the duration averaged depth

In this method, the duration averaged depth: (h) is used to evaluate the region where the terrestrial plants grow or not, with the formula in Table 3.5.

Table 3.5: Evaluation formula by depth

Condition	Evaluation
$h < 0.2$	Probability of terrestrial plant growth is very high
$0.2 < h \leq 0.3$	Probability of terrestrial plant growth is high
$0.3 < h \leq 0.4$	Probability of terrestrial plant growth is low
$0.4 < h$	Probability of terrestrial plant growth is very low

Using the relationship between depth and velocity

A relationship formula between depth and velocity as follow is used to evaluate terrestrial plant growth in this tool. h_{VD_est} is the threshold depth whether terrestrial plants can grow or not. Terrestrial plant growth can be evaluated comparing h_{VD_est} (m) and h (m), as shown in Table 3.6

$$h_{VD\_est} = -0.1 \log V + 0.05 \tag{3.1}$$

Table 3.6: Evaluation formula by relationship between depth and velocity

Condition	Evaluation
$h < h_{VD\_est}$	Terrestrial plants cannot grow
$h > h_{VD\_est}$	Terrestrial plants can grow

Using the Wash-Out Index (WOI)

WOI (Wash-Out Index) is used to evaluate terrestrial plant growth in this tool. WOI is defined by (3.2).

$$WOI = \frac{\tau_{*c90}}{\tau_{*90}} \tag{3.2}$$

Where τ_{*90} and τ_{*c90} are non-dimensional shear stress and non-dimensional critical shear stress for d90 respectively, that are defined by equations below.

tau_{*90} and τ_{*c90} are defined by Eqs (3.3) and (3.4) respectively.

$$\tau_{*90} = \frac{hI_e}{sd_{90}} \tag{3.3}$$

$$\frac{\tau_{*c90}}{\tau_{*c50}} = \left[\frac{\log_{10} 19}{\log_{10} 19(d_{90}/d_{50})}\right]^2 \tag{3.4}$$

Where d_{50} and d_{90} are the grain diameters (unit: meter) at which 50% and 90% volume passes through the sieve respectively, s is the specific gravity of river bed material (=1.65), h is the water depth (m), I_e is the energy gradient, d_{c*50} is the non-dimensional critical shear stress of d_{50} (=0.06).

Table 3.7: Evaluation formyla by WOI (Wash-Out Index)

Condition	Evaluation
$WOI < 1$	Terrestrial plants can grow
$WOI \geq 1$	Terrestrial plants cannot grow

3.7.2 How to use

Setting grid attributes

Setup grid attributes as follows:

- **d50 (m)**: d_{50} used in (3.4)
- **d90 (m)**: d_{90} used in (3.4)

Editing calculation condition

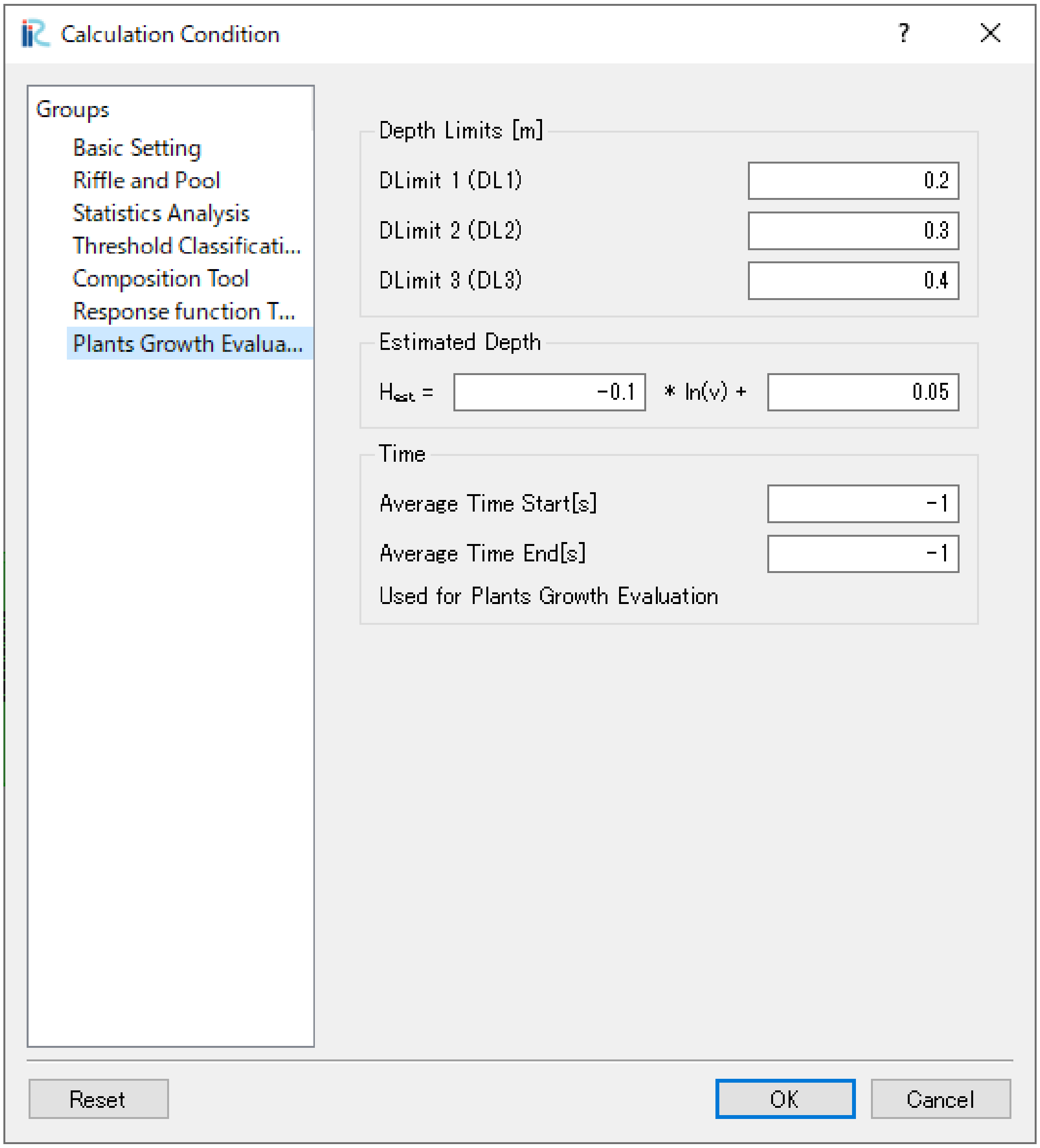

Figure 3.14: [Calculation Condition] dialog [Plants Growth Evaluation] page

In the " Plants Growth Evaluation " page of the [Calculation Conditions] dialog, setup the setting like below:

- **DLimit 1 (DL1)**: Specify the threshold depth: H1 to evaluate the region of terrestrial plant growth.
- **DLimit 2 (DL2)**: Specify the threshold depth: H2 to evaluate the region of terrestrial plant growth.
- **DLimit 3 (DL3)**: Specify the threshold depth: H3 to evaluate the region of terrestrial plant growth.
- **Estimated Depth**: Coefficient for Eq. (3.1)
- **Time Average Time Start[s]**: Specify the starting time for calculating the average depth, average velocity, maximum depth, and maximum velocity, that is used in the evaluation of terrestrial plant grow. When the value is -1, it means the first time step.

- **Time Average Time End[s]**: Specify the ending time for calculating the average depth, average velocity, maximum depth, and maximum velocity, that is used in the evaluation of terrestrial plant grow. When the value is -1, it means the last time step.

Visualization of analysis result

Visualize the analysis result that EvaTRiP pro outputs.

The list of output values are shown below.

pla_DepEstimate
Values mean followings, calculated from depth:

- In case of " 3 " , h(m) is more than 0.4m.
- In case of " 2 " , h(m) is between 0.3m and 0.4m.
- In case of " 1 " , h(m) is between 0.3m and 0.3m.
- In case of " 0 " , h(m) is less than 0.2m

pla_VelDepEstimate
This parameter means the result of comparing depth h (m) and h_{VD_est} which is estimated by (3.1) from velocity. Values mean followings.

- $h < h_{VD\_est}$: 0
- $h > h_{VD\_est}$: 1

pla_WOIEstimate
This parameter means the result of comparing τ_{*90} and τ_{*c90} which are estimated by (3.2), calculated from depth and velocity. Values mean followings.

- $WOI < 1$: 0
- $WOI \geq 1$: 1

AVG_pla_DepEstimate
Values mean followings, calculated from average depth:

- In case of " 3 " , h(m) is more than 0.4m.
- In case of " 2 " , h(m) is between 0.3m and 0.4m.
- In case of " 1 " , h(m) is between 0.3m and 0.3m.
- In case of " 0 " , h(m) is less than 0.2m

AVG_pla_VelDepEstimate
This parameter means the result of comparing average depth h (m) and h_{VD_est} which is estimated by (3.1) from average velocity. Values mean followings.

- $h < h_{VD\_est}$: 0
- $h > h_{VD\_est}$: 1

MAX_pla_WOIEstimate
This parameter means the result of comparing τ_{*90} and τ_{*c90} which are estimated by (3.2), calculated from maximum depth and maximum velocity. Values mean followings.

- $WOI < 1$: 0
- $WOI \geq 1$: 1

CHAPTER FOUR

EXAMPLES

A YouTube movie about how to use EvaTRiP is published. The movie is in Japanese.

The URL of the movie is as below.

https://www.youtube.com/watch?v=2xCdC9DmVLA&list=PLjUrUSvJNya_qvwCimGJ7EgzidDF2o4aO

CHAPTER

FIVE

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