



iRIC Software
Changing River Science

Morpho2DH

Tutorial

- Debris/Mud flow -

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I. Outline

I.1 Morpho2DH

Morpho2DH is a calculation solver that a debris/mud flow model is added to Morpho2D.

Morpho2D is the unsteady horizontal two dimensional bed deformation analysis solver which is developed by Hiroshi Takebayashi, Kyoto University. The governing equations are written in boundary fitted general coordinate system. In 2009, the solver was installed to RIC-Nays Version 1.0 which is the free software developed by RIC. Some functions are added to the original version and the improved version is installed into iRIC Version2.0 on March 2011. Morpho2D was unified with Nays2D and Nays2DH was developed. Hence, the development of Morpho2D was stopped on March 2014.

Morpho2DH is the horizontal two dimensional debris/mud flow analysis solver which can reproduce the transport and deposition process of debris/mud flow due to the landslides. Structures (ex. sabo dam, weir, house and so on) and horizontal distribution of erosion depth can be considered in the analysis.

Additionally, the unsteady horizontal two dimensional bed deformation analysis which can be performed using Morpho2D can be performed as it used to be.

I.2 Morpho2DH Tutorial – Debris/Mud flow –

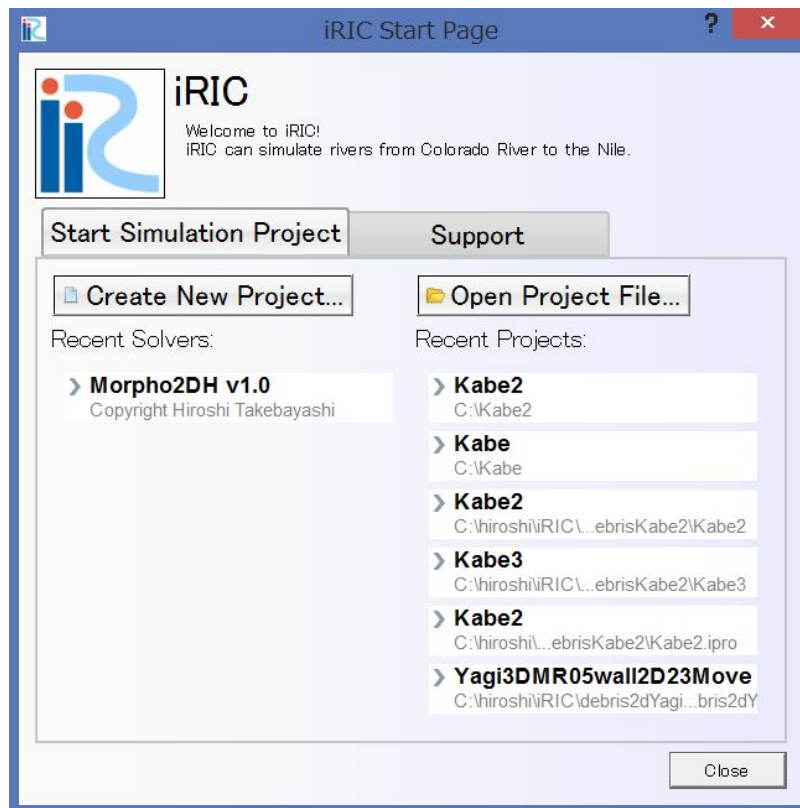
The purpose of the tutorial is to show the detailed procedure of the analysis from the beginning to end. Tutorials has enough explanations to perform analysis. However, if you cannot understand the tutorials, please refer iRIC user manual and Morpho2DH manual.

[Contents of Tutorial]

- Chapter II Transport and deposition process of debris/mud flow
- Chapter III Debris/Mud flow analysis with structures

I.3 Open Morpho2DH

1. Startup iRIC, Select [Create New Project] from [iRIC Start Page].



※Operation of Start Page
Please refer P12 in iRIC
user manual

Figure I—1(1) Start of Morpho2DH

2. Select [Morpho2DH] in [Select Solver] window and press OK.

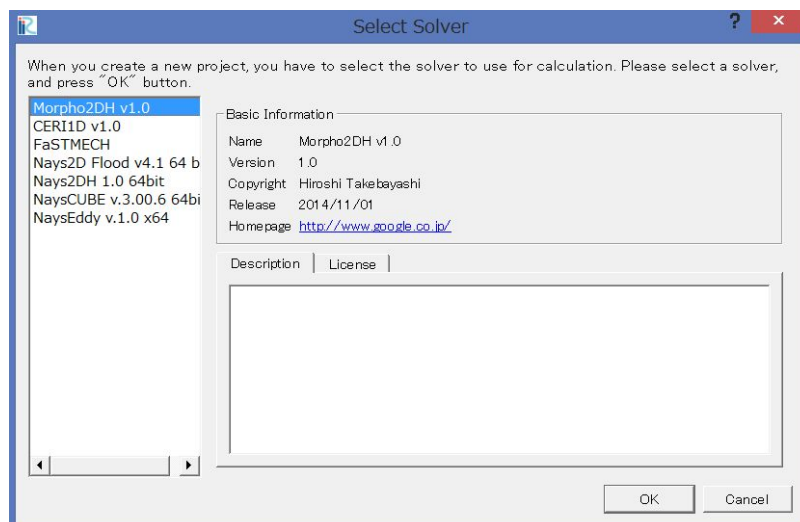


Figure I—1(1) Start of Morpho2DH

II. Transport and deposition process of debris/mud flow

◆ Purpose

The purpose of this chapter is for river engineers and university students who have no experience of bed deformation analysis to learn to perform debris/mud flow analysis by use of Morpho2DH and visualize the calculated results.

◆ Procedure

Procedure in this chapter is shown in Figure II—1.

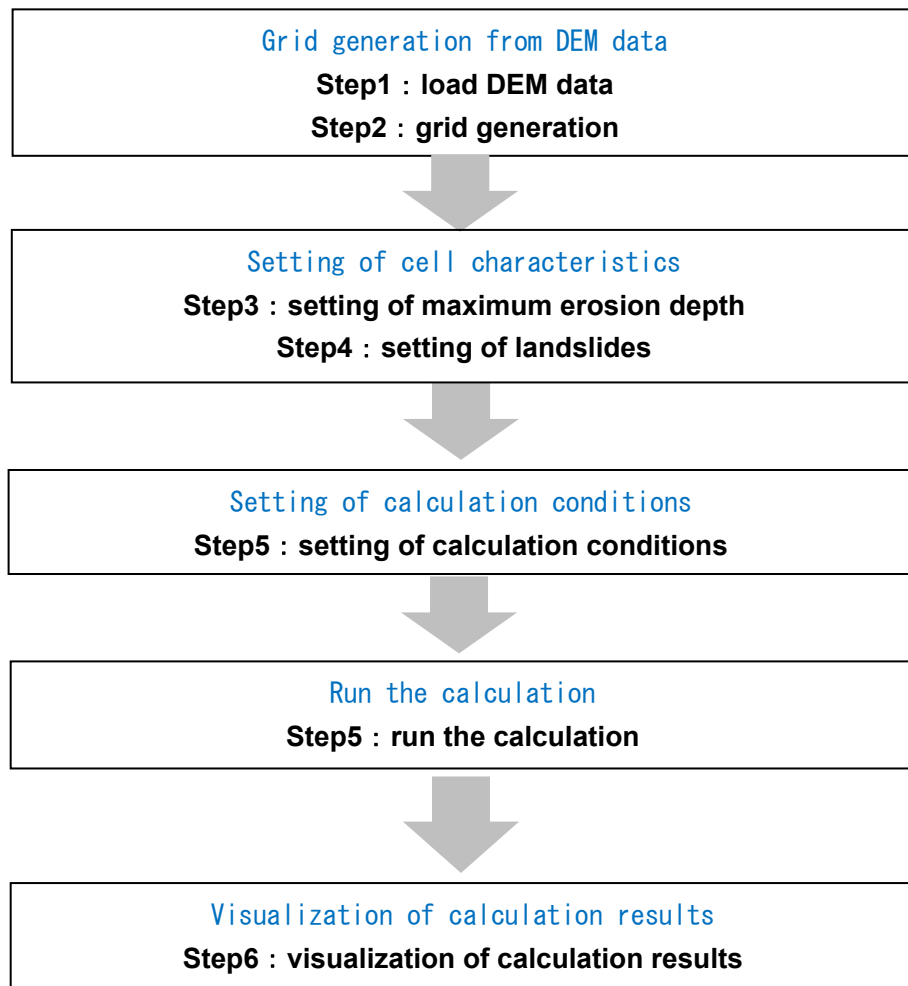
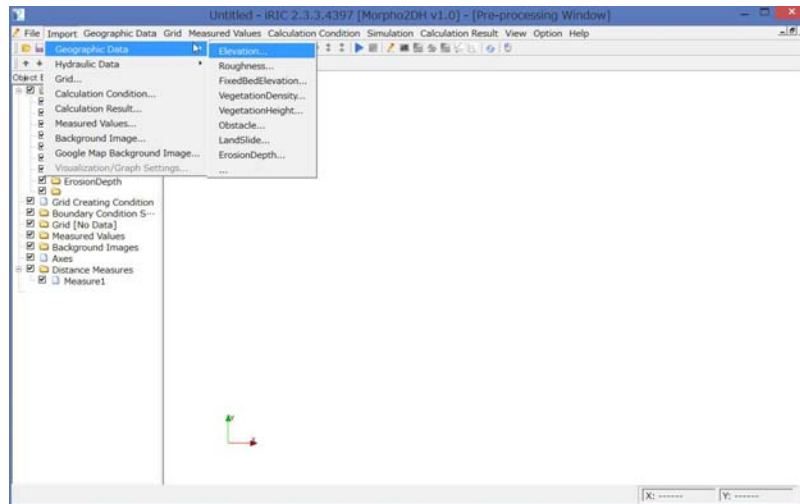


Figure II—1 Procedure in this chapter

II.1 Grid generation from DEM data

II.1.1 Load DEM data

1. Click [Geographical Data]–[Elevation] in [import].



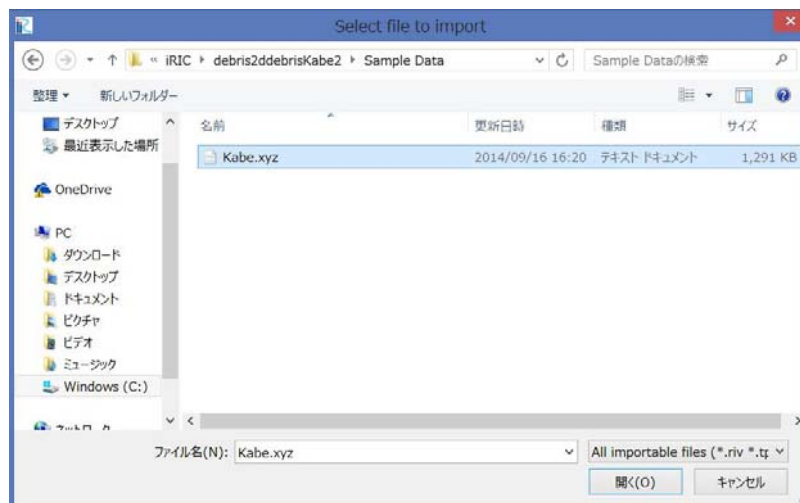
※ Grid generation method in Morpho2DH

Morpho2D can select 'Create grid from polygonal line and width', 'Create grid from river survey data', and so on.

In this chapter, 'Create grid from polygonal line and width' is described

Figure II–2(1) Load the bed elevation data

2. Select [Kabe.xyz] in [Sample Data] folder.



※DEM data file

DEM data file (*.xyz) is composed of the data number, x and y coordinate, land elevation data (z).

Format of DEM data file is explained in iRIC manual.

Figure II–2(2) Load the bed elevation data

II.1.2 Grid generation

■ Selection of the grid generation algorithm

1. Click [Select algorithm to create grid] in [Grid].

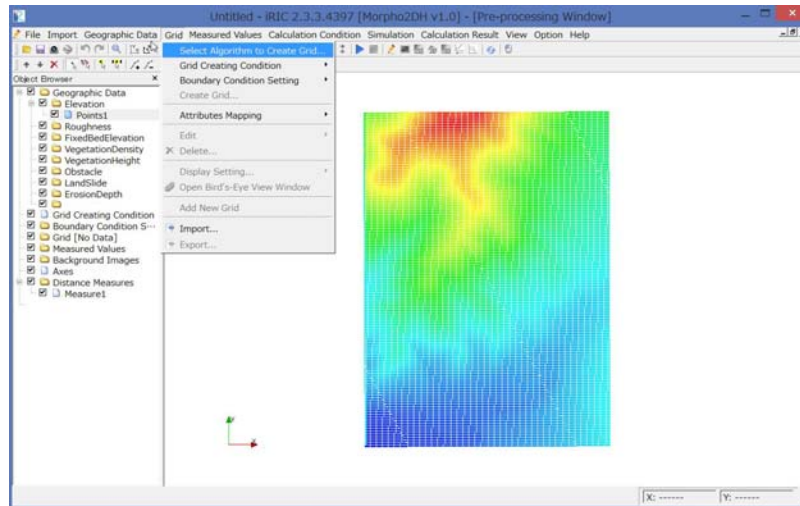


Figure II—3(1) Selection of the grid generation algorithm

2. Select [Create grid from polygonal line and width] in [Algorithm] and press OK.

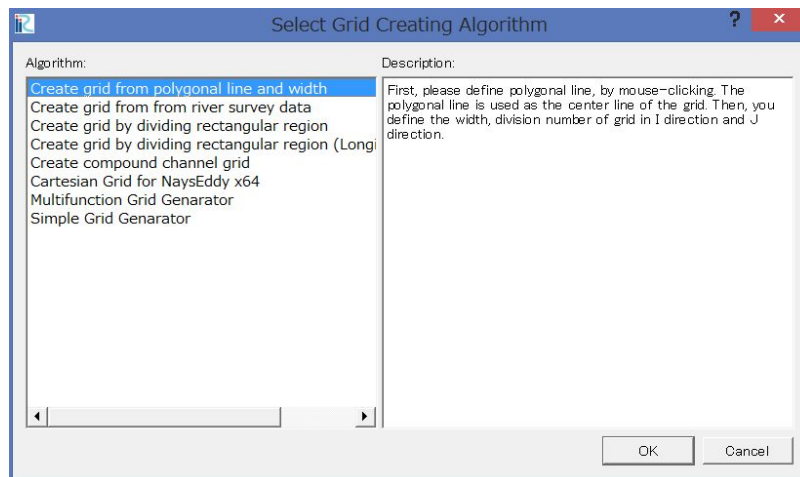


Figure II—3 (2) Selection of the grid generation algorithm

3. Small dialog is popped up and input the thinning value of the data.

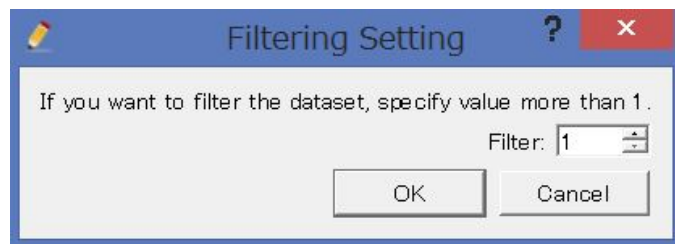


Figure II—3 (3) Input the thinning value of the data

■ Decision of number and size of grids

- 1 Click the upstream and the downstream ends of calculation region and press return to decide the centerline of the calculation domain.
- 2 The dialog as shown in the figure is popped up. Decide the number of longitudinal grids (n_I), the number of transverse grids (n_J), the width of calculation domain (W), the size of grids (d_I , d_J).
- 3 Press OK in the dialog.

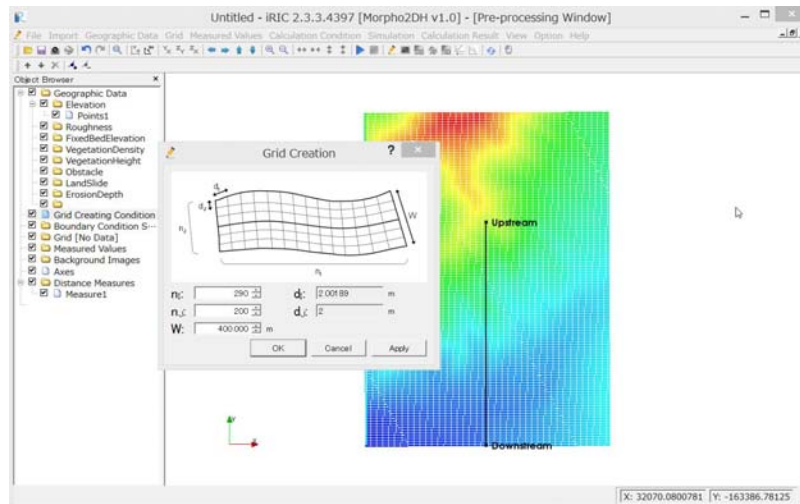


Figure II—4(1) Add division points in transvers direction

- 4 Press OK in the dialog for confirmation of mapping

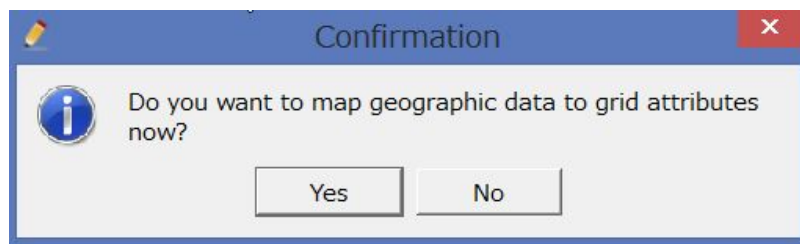


Figure II—4(2) Confirmation of mapping

5 Grids are formed.

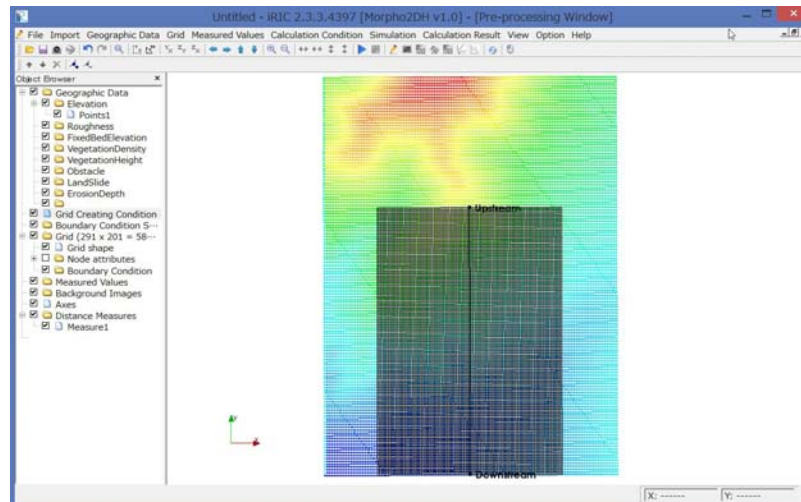


Figure II—4(3) Add division points in transvers direction

■Load background image

1. Click [Background Image] in [import].

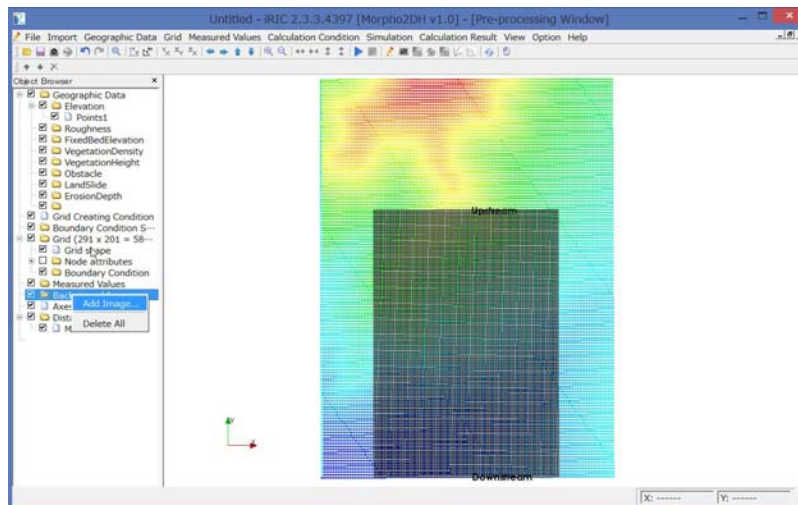


Figure II-5 (1) Load the background image

※Background image

When users create the numerical grids, background images help to decide the location of bank and so on.

2. Select [Kabe3.jpg] in [Sample Data].

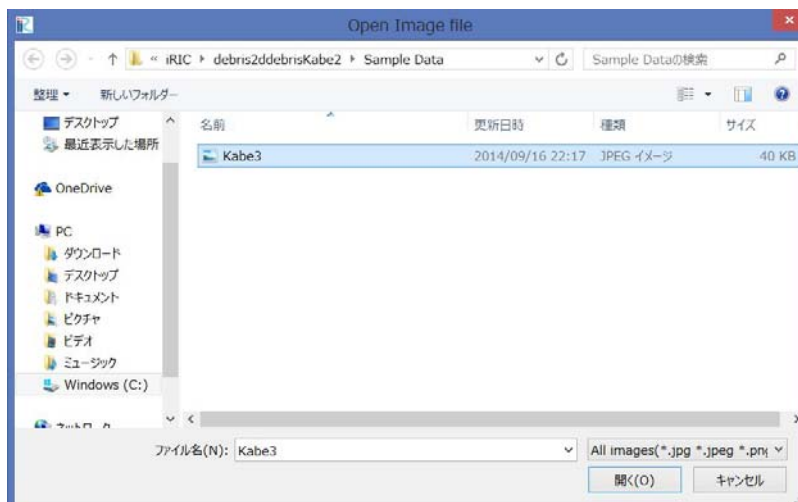


Figure II-5 (2) Load the background image

3. Background image is fitted to cross-sections by use of [Pan], [Rotate] and [Zoom]

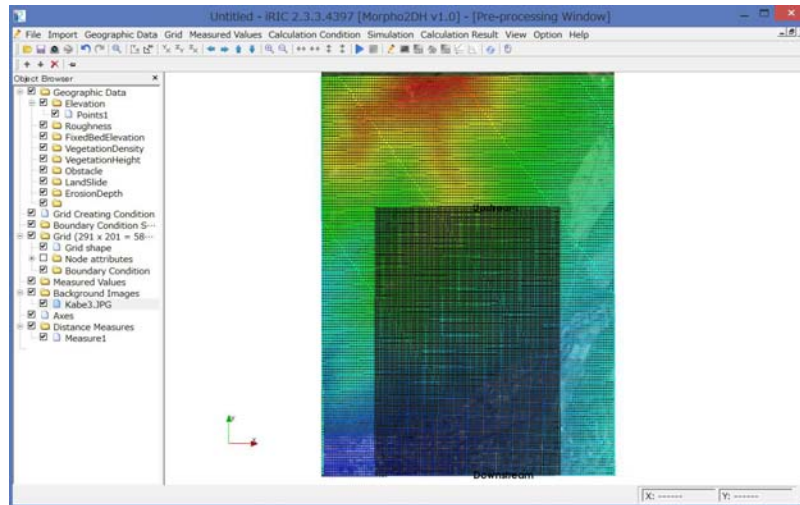
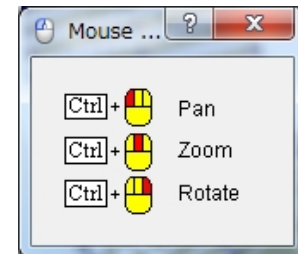


Figure II—5(3) Load the background image

※Hints for the fitting



Details are on P104 in iRIC user manual

■ Maximum erosion depth of land surface

- 1 Click [ErosionDepth] in [Object Browser] by right button and select [add] and [Polygon].

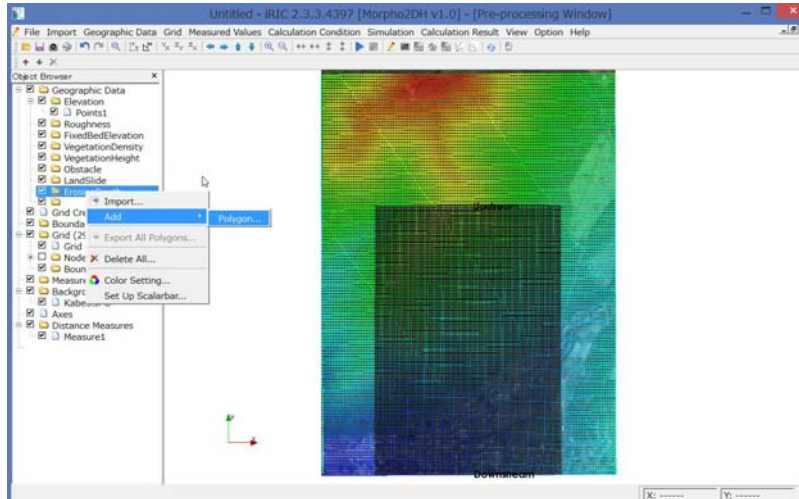


Figure II—6(1) Create polygon

- 2 Make a polygon by clicking at the corners of the polygon. The polygon should cover the whole calculation area. Double clicks stop to make the polygon.
- 3 Enter the maximum erosion depth value in the small windows.

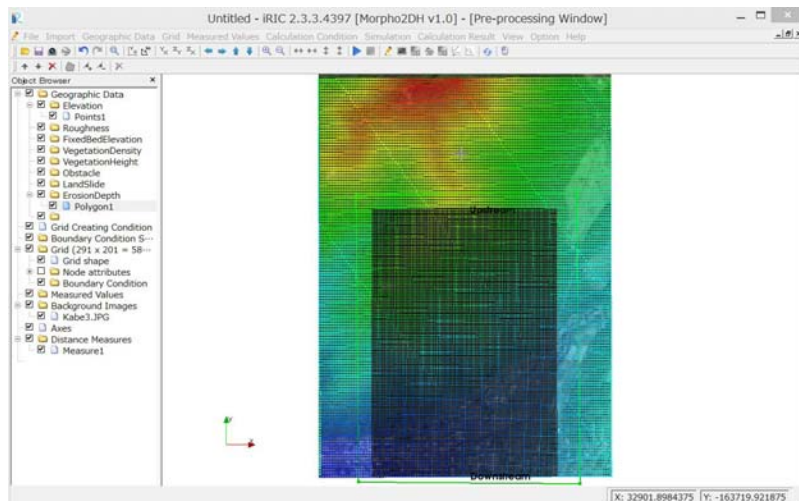
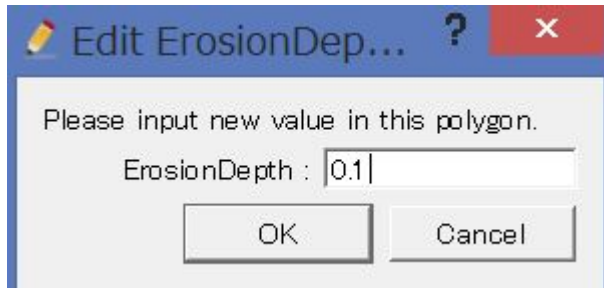


Figure II—6(2) Create polygon



Unit is m.

Figure II-6(3) Input the maximum erosion depth value

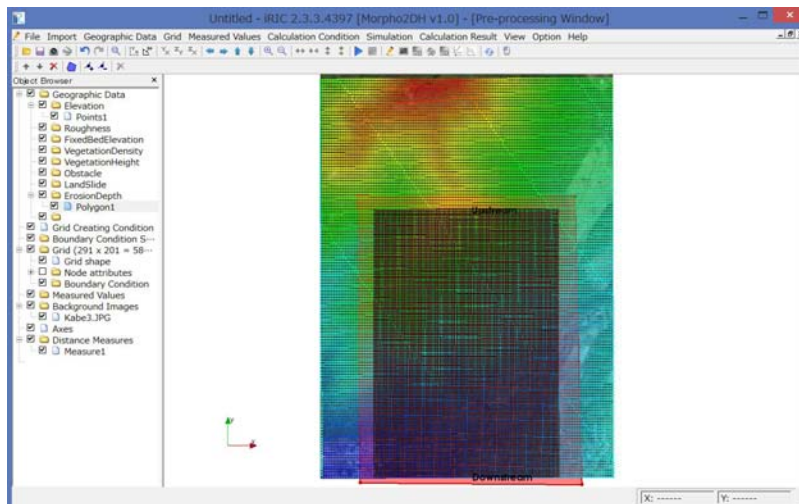


Figure II-6(4) Create polygon

■ Location and size of landslides

- 4 Click [Landslide] in [Object Browser] by right button and select [add] and [Polygon].

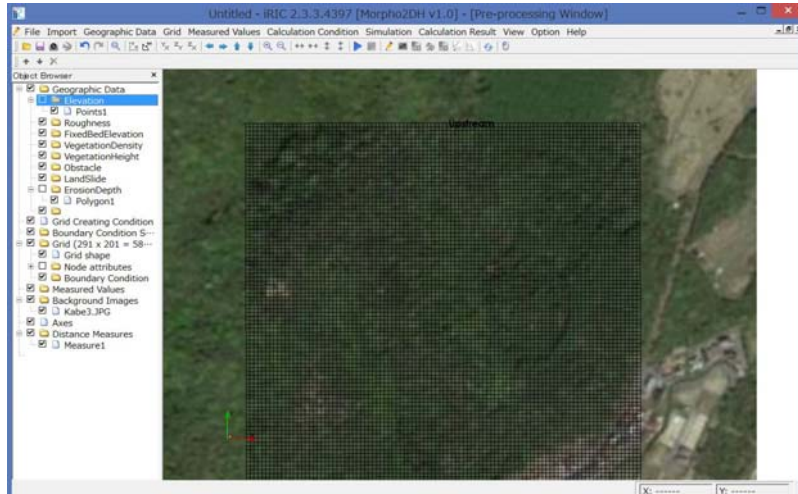


Figure II—7(1) Create polygon

- 5 Make a polygon by clicking at the corners of the polygon. The polygon should cover the whole calculation area. Double clicks stop to make the polygon.
- 6 Enter the maximum erosion depth value in the small windows.

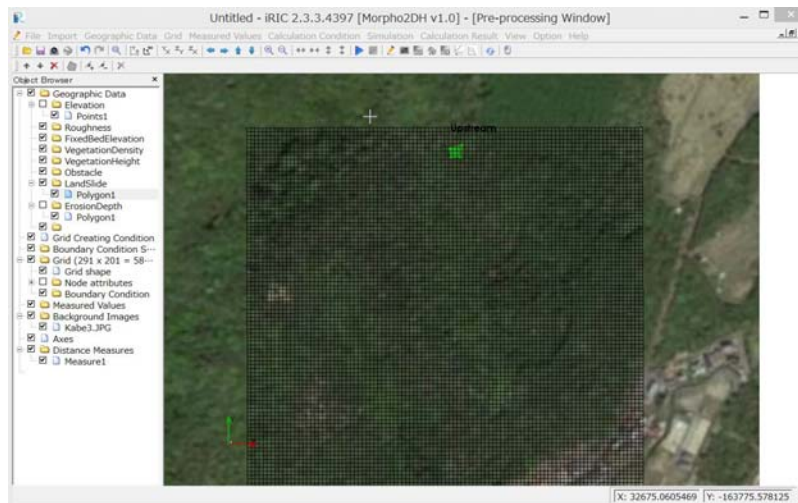
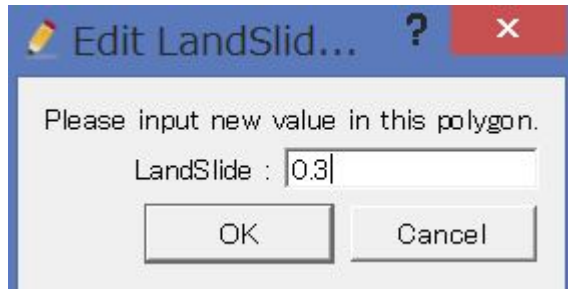


Figure II—7(2) Create polygon



Unit is m.

Figure II—7(3) Input the depth of landslides

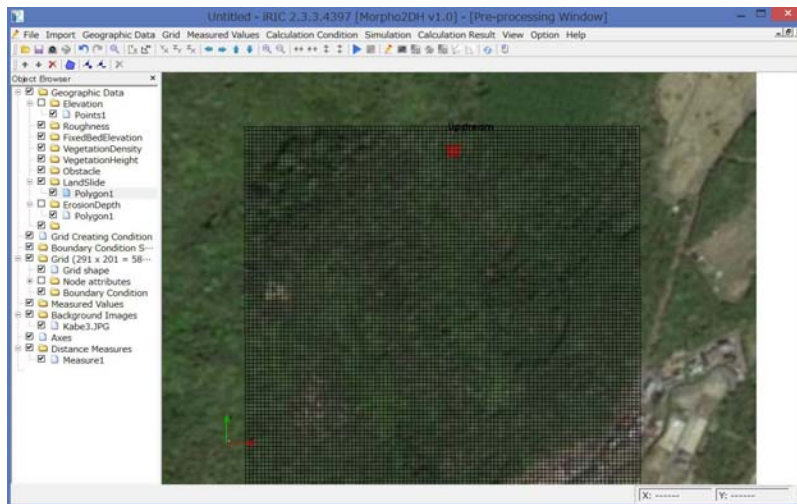


Figure II—7(4) Create polygon

II.2 Setting of calculation conditions

II.2.1 Setting of calculation conditions

■ Selection of solver type

- 1 Click [Setting] in [Calculation Condition].

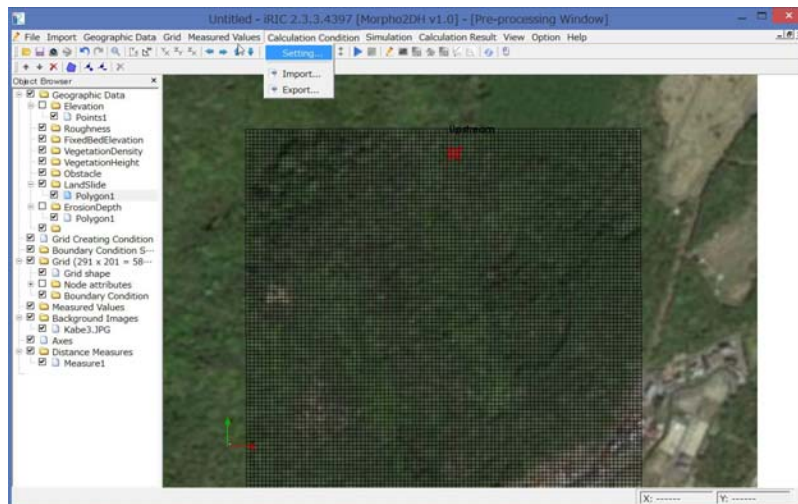


Figure II—8 Setting of calculation conditions

■ Setting of calculation parameters

- 1 Click [Parameters] in [Calculation Condition] window.
- 2 Select [Debris/Mud Flow] in [Calculation Type].
- 3 [Start Time (s)] is 0.
- 4 [End Time (s)] is 200 (s).
- 5 [Computational Time Step (s)] is 0.01 (s).
- 6 [Output Time Step for File (s)] is 1 (s).
- 7 [Output Time Step for Screen (s)] is 1 (s).
- 8 [Start Time of Bed Deformation (s)] is 0 (s).

- Select [Flow only] for flow calculation or [Bed material load] for bed deformation analysis by bed material load or [Debris/Mud flow] for bed deformation analysis by debris/mud flow.
- Start time of the calculation is set in [Start Time (s)]. Unit is second.
- End time of the calculation is set in [End Time (s)]. Unit is second.
- Time step Δt is set in [Computational Time Step (s)]. Unit is second. The time step is decided considering CFL condition.
- Output time step for file is set in [Output Time Step for File (s)]. Unit is second.
- Output Time Step of calculation condition for Screen is set in [Output Time Step for Screen (s)]. Unit is second. Short time step makes the calculation time longer.
- Start time of bed deformation is set in [Start Time of Bed Deformation (s)]. Unit is second. When the debris/mud flow calculation is performed, please input 0.

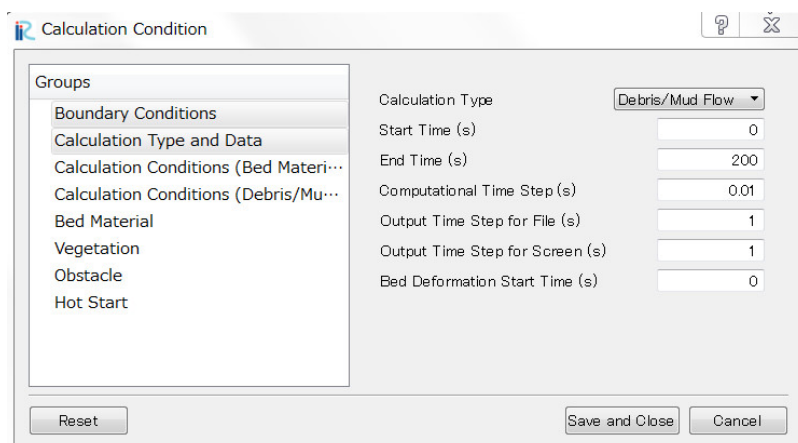


Figure II—9 Setting of calculation parameters

■ Setting of calculation conditions

- 1 Click [Calculation Conditions (Debris/Mud Flow)] window.
- 2 Select [Constant] in [Sediment Concentration], because temporal change of sediment concentration of mud flow is small.
- 3 Input 0.6 for [Static Deposition Sediment Concentration].
- 4 Input 0.2 for [Liquid Behavior Sediment Ratio].
- 5 Input 0.01 (m) for [Minimum Flow Depth].
- 6 Input 34 (degree) for [Internal Friction Angle].
- 7 Select [Constant] in [Laminar Flow Depth], because spatial change of land slope is not changed well here.
- 8 Input 0.4 for [Laminar Flow Depth Ratio].
- 9 Input [Resistance Coefficient] is set. The value is about 72.
- 10 Select [Disabled] in [Non-erodible Height].

- Please select [Change] when you want to consider the spatiotemporal change of sediment concentration.
- Static deposition sediment concentration is between 0.54 and 0.8.
- Fine material behaves as liquid phase. 0.2mm and finer diameter is rough standard to decide [Liquid Behavior Sediment Ratio].
- [Minimum Flow Depth] must be set to get stable calculation results. The unit is m.
- When the flow characteristics are debris flow, the laminar flow depth ratio is about 1. When the fine material includes in the flow well, the laminar flow depth ratio must be smaller than 1.
- Value of [Resistance Coefficient] must be set to reproduce flow depth.
- When some parts of the bed composed of rock or sabo dams is set in the calculation area, please select [Enable] in [Non-erodible Height]. When [Non-erodible Height] is [Enable], the non-erodible height area must be set using polygons.

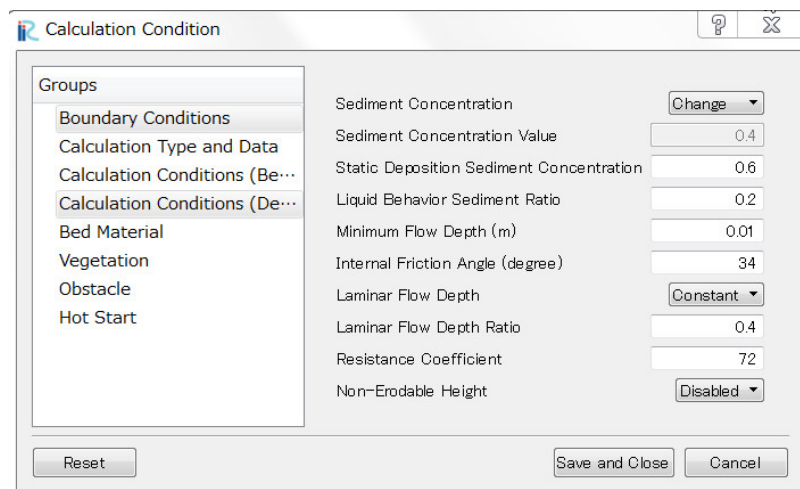
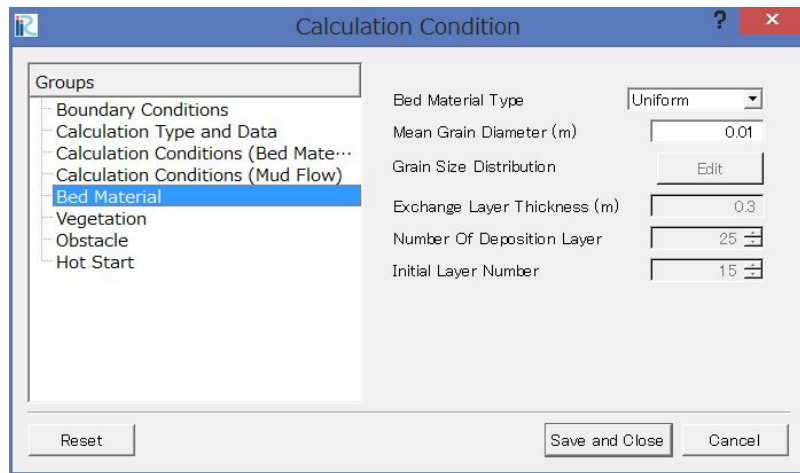


Figure II-10 Setting of calculation conditions

■ Setting of bed material conditions

- 1 Click [Bed Material] in [Calculation Condition] window.
- 2 Select [Uniform] in [Bed Material Type].
- 3 [Mean Grain Diameter (m)] is available, when [Uniform] is selected in [Bed Material Type]. Here, please input 0.01 (m).



- Input mean grain diameter in [Mean Grain Diameter (m)]. This function is available only for uniform sediment

Figure II-11 Setting of bed material conditions

■ Setting of vegetation conditions

- 1 Click [Vegetation] in [Calculation Condition] window.
- 2 Select [Don't Use Data] in [Vegetation Density Data].
- 3 Select [Don't Use Data] in [Vegetation Height Data].

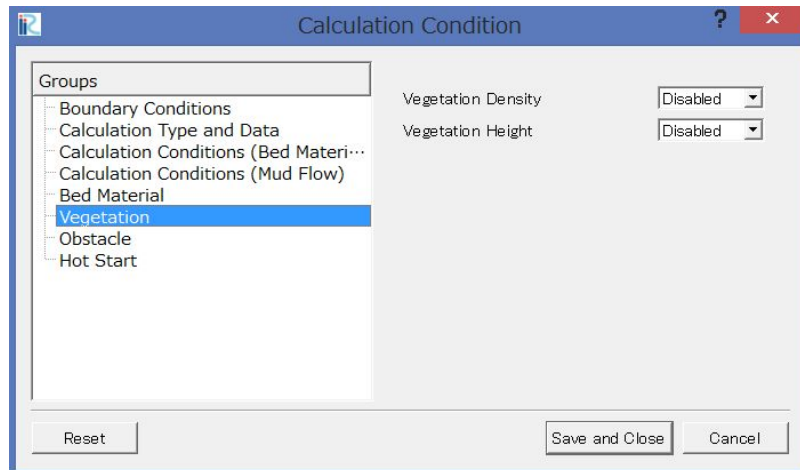


Figure II—12 Setting of vegetation conditions

- Select if vegetation density data is loaded or not in [Vegetation Density Data]. When users consider the vegetation, vegetation density data is required.
- Select if vegetation height data is loaded or not in [Vegetation Height Data]. When users have the horizontal distribution of vegetation height data, please load the data. If there is no information on the vegetation height, top of the vegetation is always higher than the water surface level.

■ Setting of obstacle

- 1 Click [Obstacle] in [Calculation Condition] window.
- 2 [Disabled] is selected in [Obstacle].

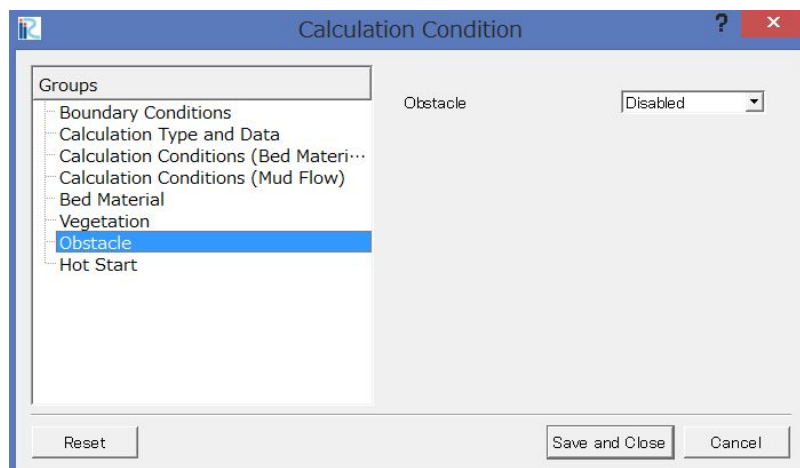
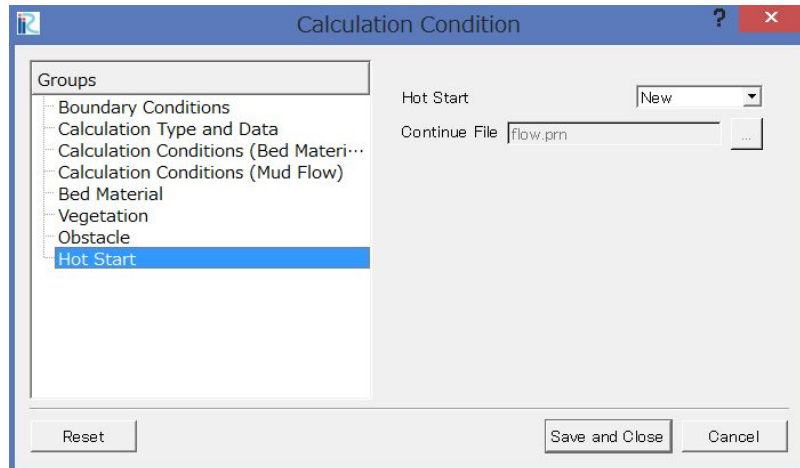


Figure II—13 Setting of obstacle conditions

- When the obstacles are considered, the polygons of obstacles must be created,

■ Setting of hot start

- 1 Click [Hot Start] in [Calculation Condition] window.
- 2 Select [New] in [Hot Start].
- 3 No need to select [Continue File].



- When users perform debris/mud flow calculation, please select [New].

Figure II-14 Setting of hot start

■ Finish of the setting of the calculation conditions

- 1 Click [Save and Close] after setting [Calculation Condition].

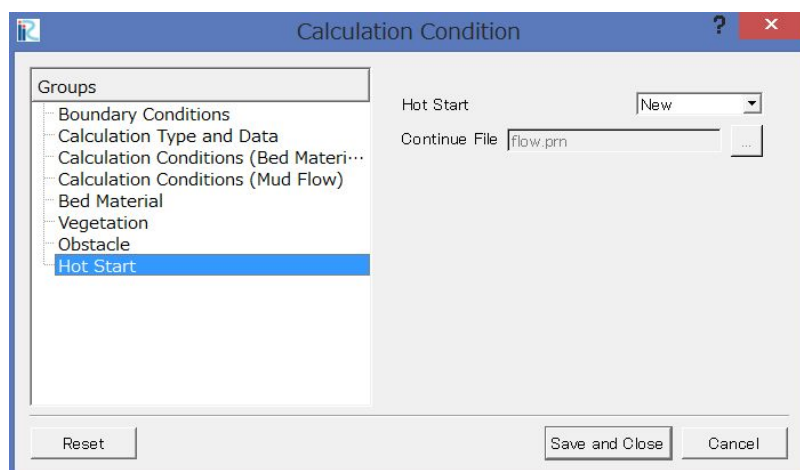


Figure II-15 Setting of calculation conditions

II.3 Run the calculation

- 1 Press [Run] on the tool bar

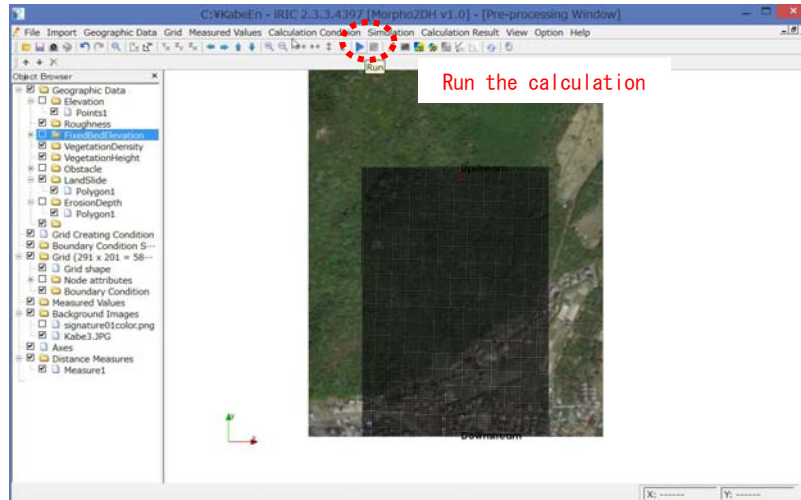


Figure II–16(1) Run the calculation

- 2 Press [Yes] for the warning of mapping.

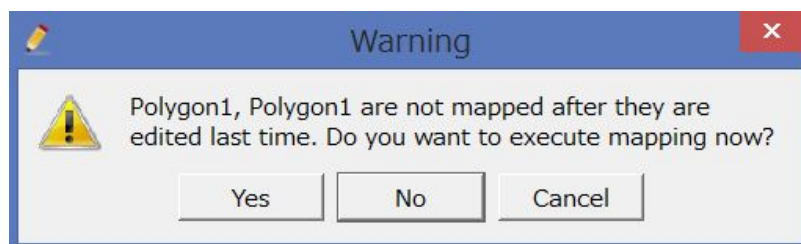


Figure II–16(2) Warning of mapping

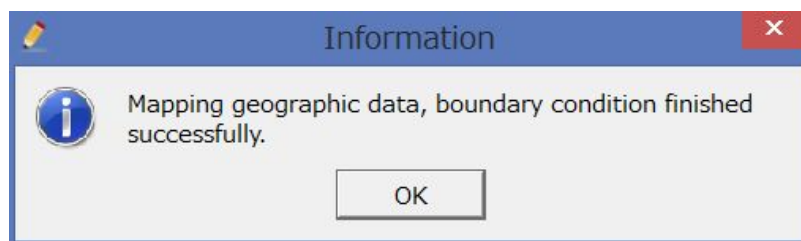


Figure II–16(3) Warning of mapping

- 3 If you press [Run] button, [Information] for save of project. Please press [Yes].
- 4 Please select [Save as Project] in the dialog [Select How to Save Project] for the calculation of debris/mud flow, because the size of file tends to be larger.
- 5 Create new folder and name the folder [KabeEn].

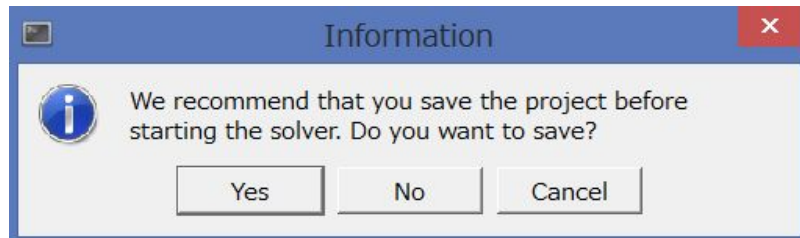


Figure II-16(4) Save the project

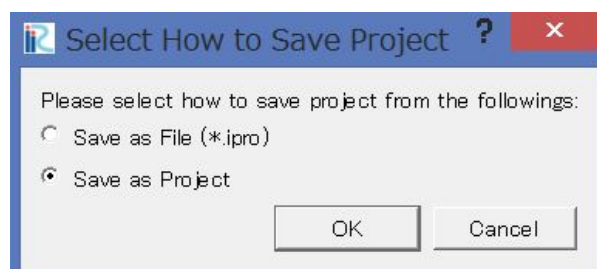


Figure II-16(5) Save the project

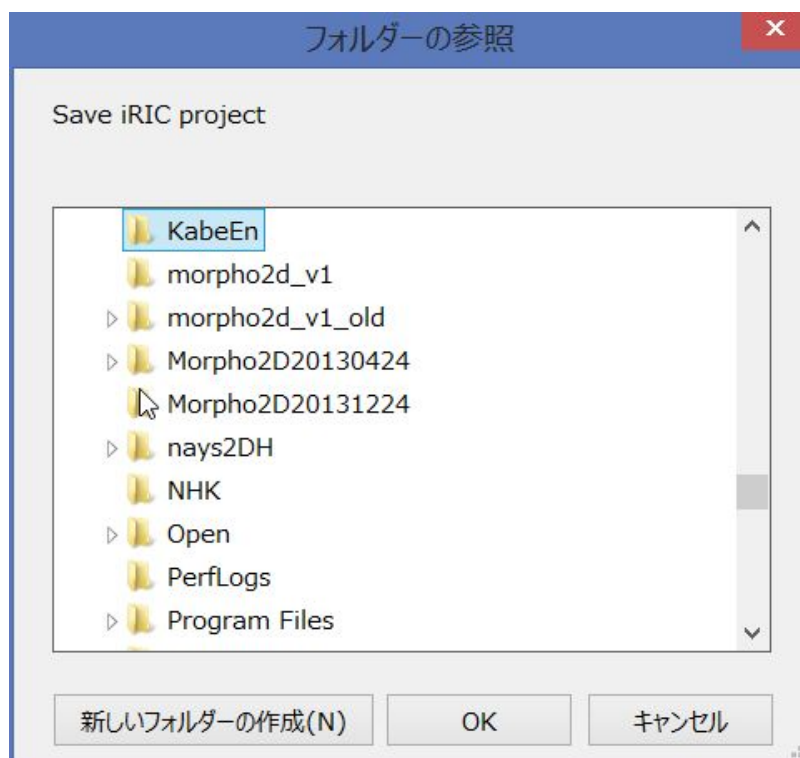
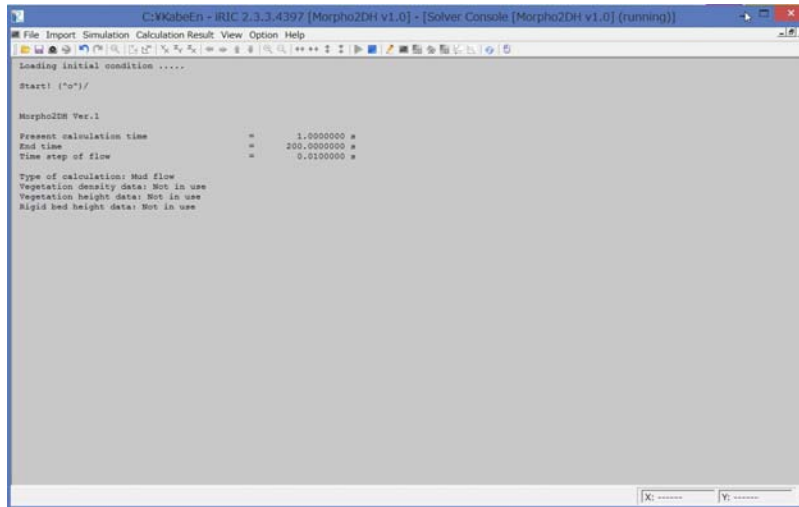


Figure II-16(6) Save the project

6 Startup the gray colored screen automatically.

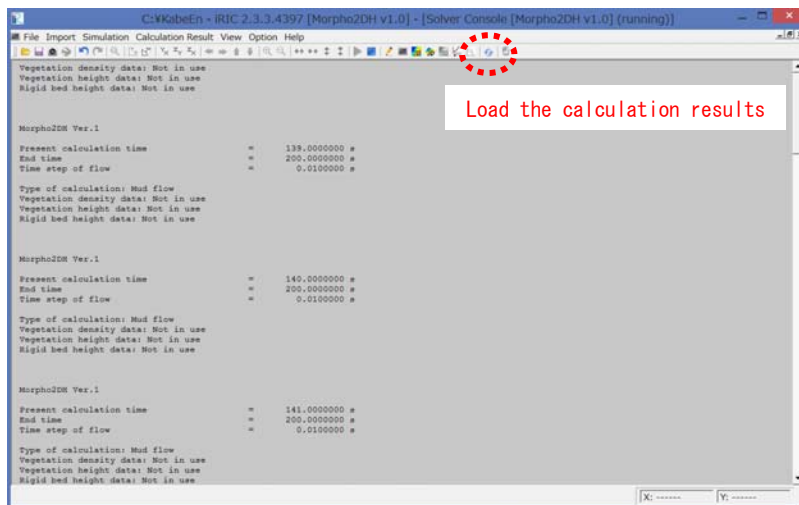


※ Information on the screen

Present calculation time (s)
End time (s)
ream end (m3/s)
Time step of flow (s)
Type of calculation,
Vegetation density data,
Vegetation height data,
Rigid bed height data

Figure II–16(7) Run the calculation

7 When you want to check the calculation results during calculation, please press [Reload the calculation results] button. The method to visualize the calculation results is explained in the next section.



※ Information on the screen

Present calculation time (s)
End time (s)
ream end (m3/s)
Time step of flow (s)
Type of calculation,
Vegetation density data,
Vegetation height data,
Rigid bed height data

Figure II–16(7) Run the calculation

8 When [Solver Finished] window is appeared on the screen, press OK.

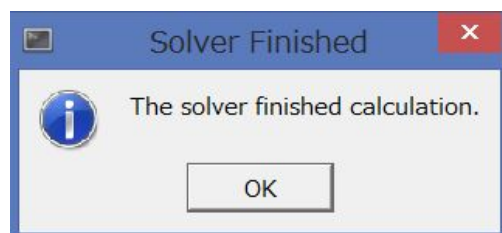


Figure II–16(8) Run the calculation

II.4 Visualization of calculation results

II.4.1 Visualization of calculation results

- 1 Click [Open New 2D Post-Processing Window] button.

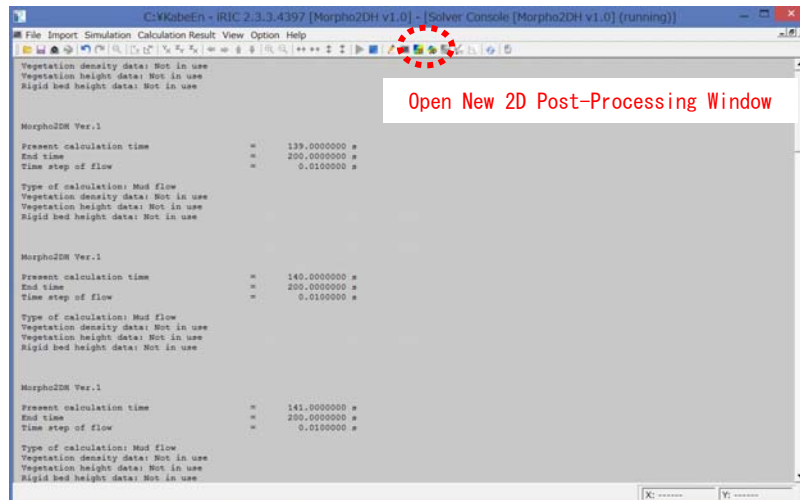


Figure II—17 Open visualization window

■ Contour

- 1 Check [Scalar] in [Object Browser].
- 2 Check [Kabe3.jpg] in [Background Images] in [Object Browser].
- 3 Horizontal distribution of flow depth is shown by checking [Depth].
- 4 By using animation tool bar, results can be checked by a movie.

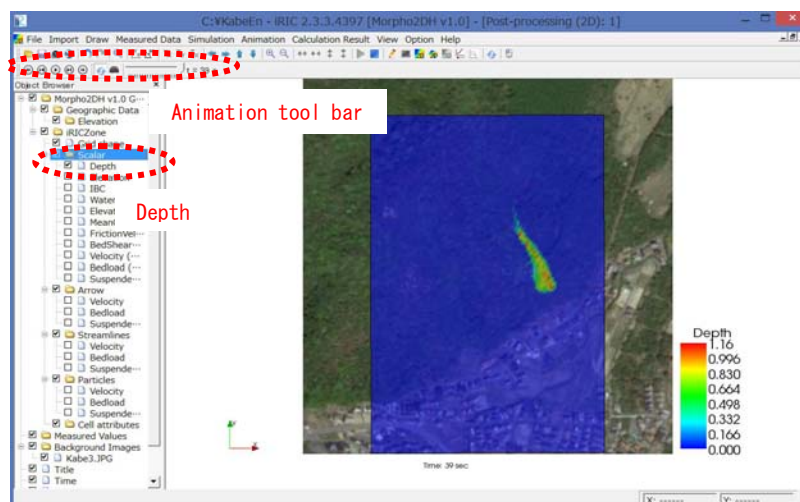


Figure II—18 (1) Make contour

- 5 When you want to modify contour, please open [Property] by clicking [Scalar] by the right button.
- 6 If you want to visualize the flow region only, the value about 0 is inputted in [Min] in [Value range] and check off [Fill lower area].
- 7 Modification of labels in the color bar can be made in [Color Bar Setting].

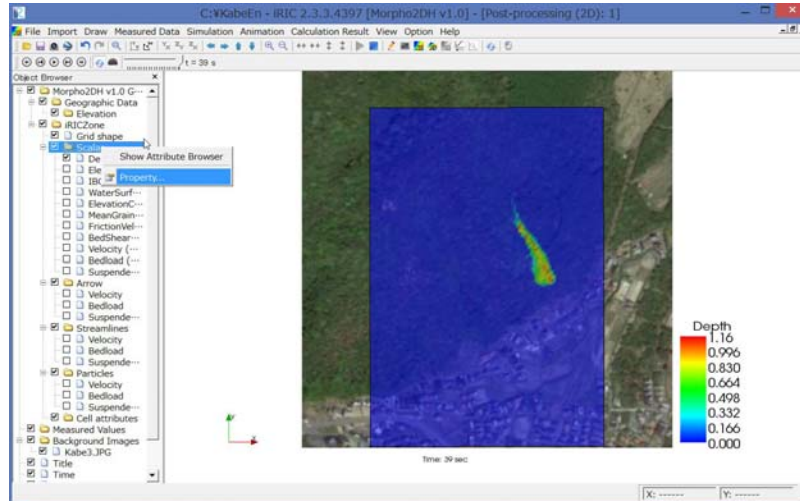


Figure II-18 (2) Select Property

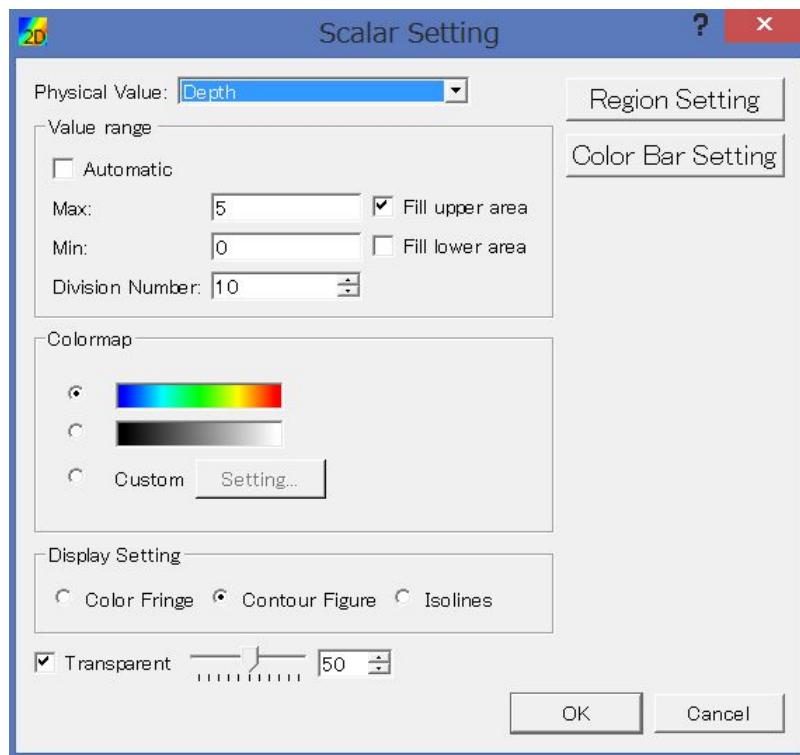


Figure II-18(3) Modification of contour

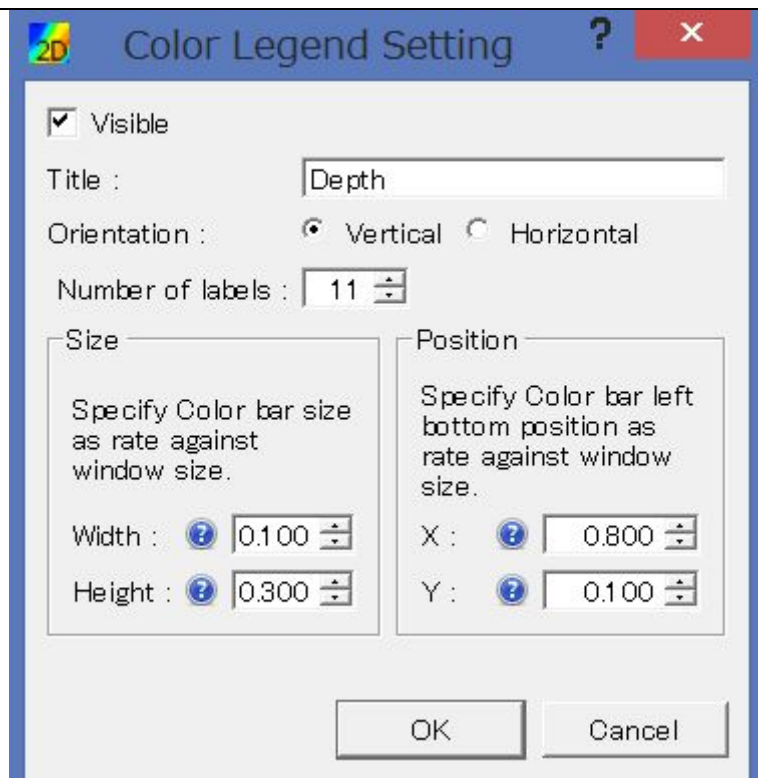


Figure II—18(4) Modification of color bar

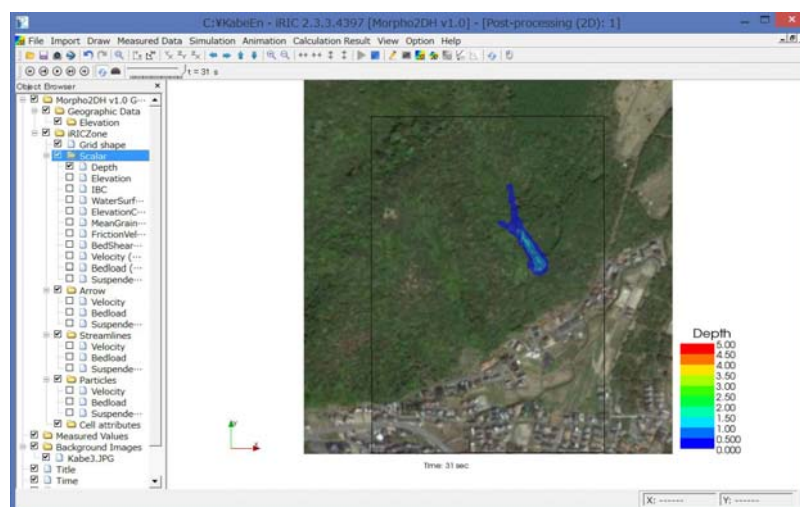


Figure II—18(5) Modification of contour

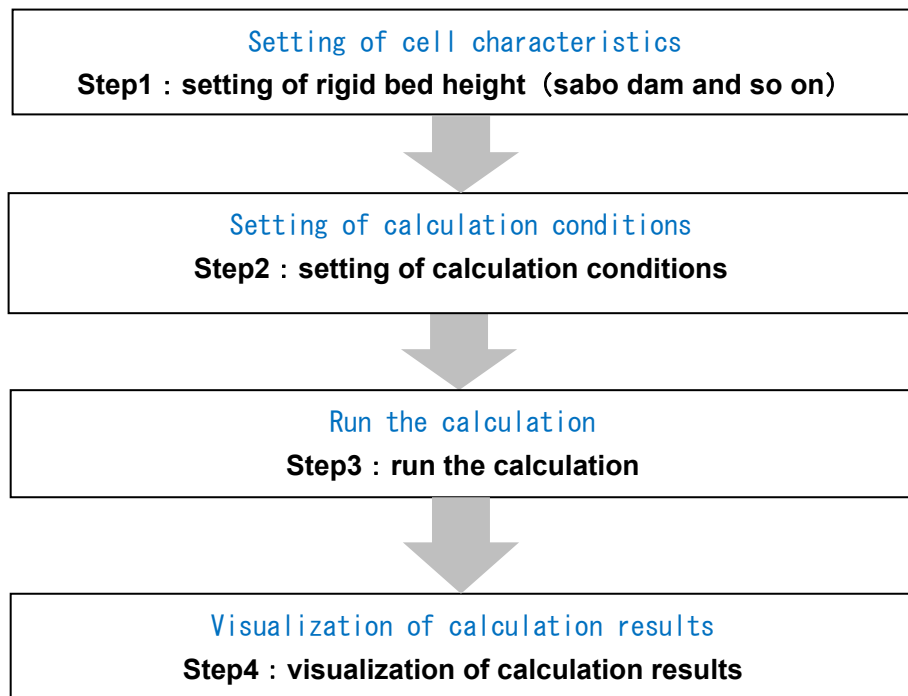
III. Debris/Mud flow analysis with structures

◆ Purpose

The purpose of this chapter is for river engineers and university students who had the experience of ‘Transport and deposition process of debris/mud flow’ to learn to perform debris/mud flow analysis by use of Morpho2DH and visualize the calculated results.

◆ Procedure

Procedure in this chapter is shown in Figure II—1.



FigureIII—1 Procedure in this chapter

III.1 Setting of rigid bed height (sabo dam and so on)

III.1.1 Setting of rigid bed height (sabo dam and so on)

■ Setting of sabo dam

- 1 Click [FixedBedElevation] in [Object Browser] by right button and select [add] and [Polygon].

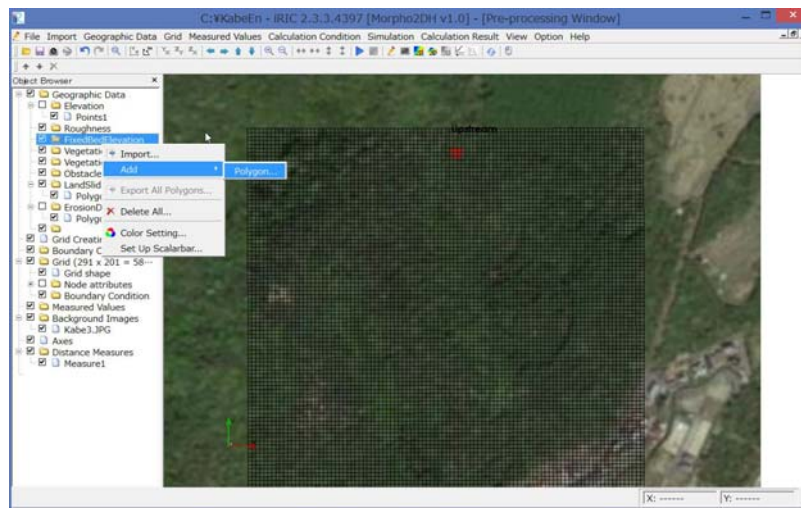


Figure III-2(1) Create polygon

- 2 Make a polygon by clicking at the corners of the polygon. Double clicks stop to make the polygon.
- 3 Enter the surface elevation value of sabo dam in the small windows.

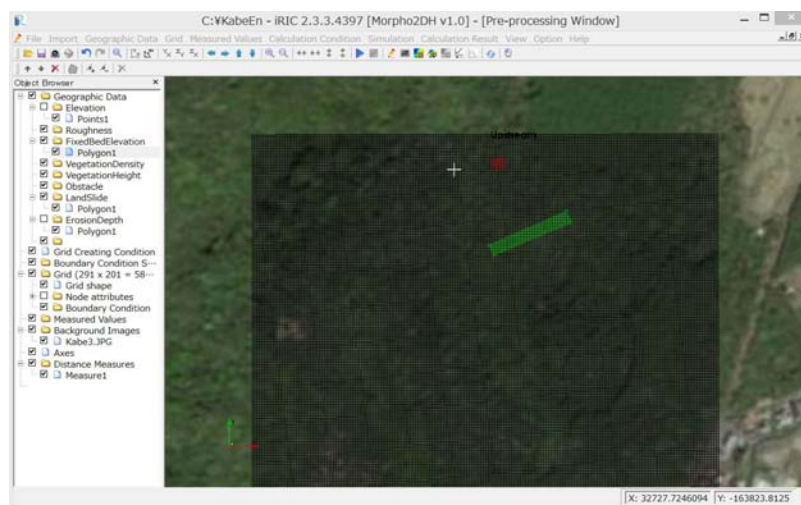
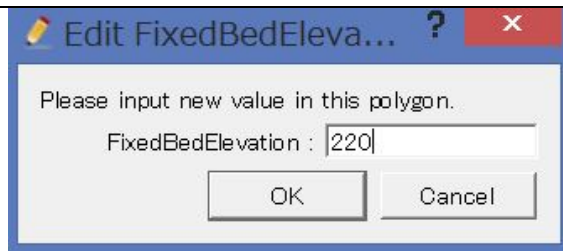


Figure III-2 (2) Create polygon



Unit is m.

Figure III-2(3) Input the surface elevation of sabo dam

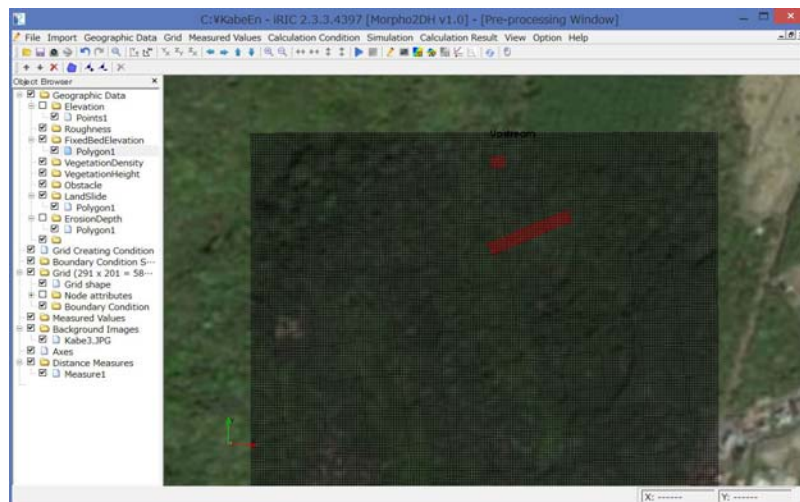


Figure III-2(4) Create polygon

III.1.2 Setting of calculation condition of rigid bed

■ Setting of rigid bed height

- 1 Click [Calculation Conditions (Debris/Mud Flow)] window.
- 2 Select [Enabled] in [Non-erodible Height].

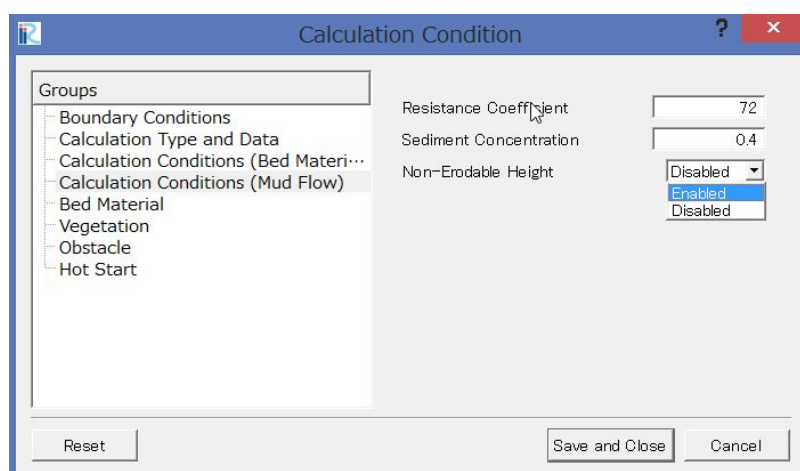


Figure III-3 Setting of rigid bed

III.2 Visualization of calculation results

III.2.1 Visualization of calculation results

■ Contour

- 1 Check [Scalar] in [Object Browser].
- 2 Check [Kabe3.jpg] in [Background Images] in [Object Browser].
- 3 Horizontal distribution of land elevation change is shown by checking [ElevationChange]. Erosion of Land in the downstream of the landslide and the sediment deposition in the upstream of sabo dam is reproduced.

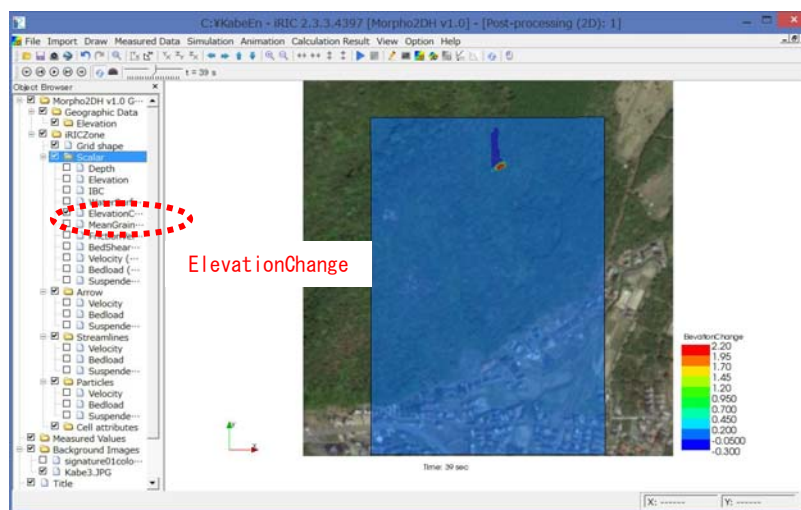


Figure III-4 Contour of land elevation change

III.3 Setting of obstacles (houses and so on)

III.3.1 Setting of obstacles(houses and so on)

■ Setting of houses

- 1 Click [Obstacle] in [Object Browser] by right button and select [add] and [Polygon].

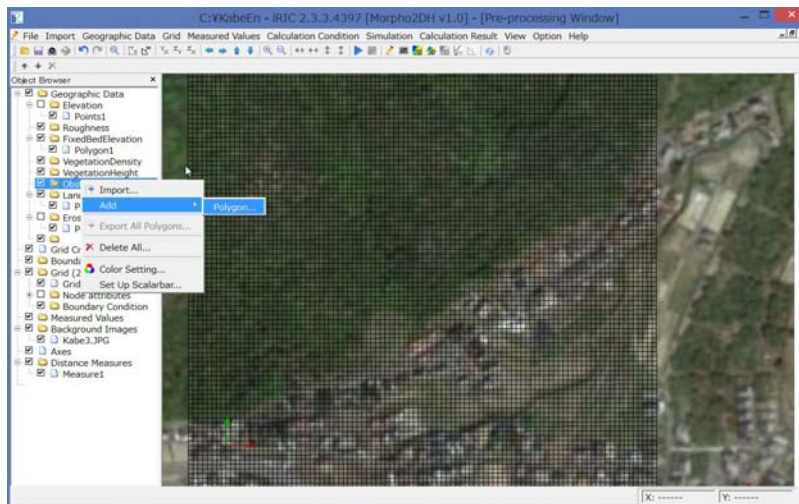


Figure III-5(1) Create polygon

- 2 Make a polygon by clicking at the corners of the polygon. Double clicks stop to make the polygon.
- 3 Select [Obstacle] in the small windows.

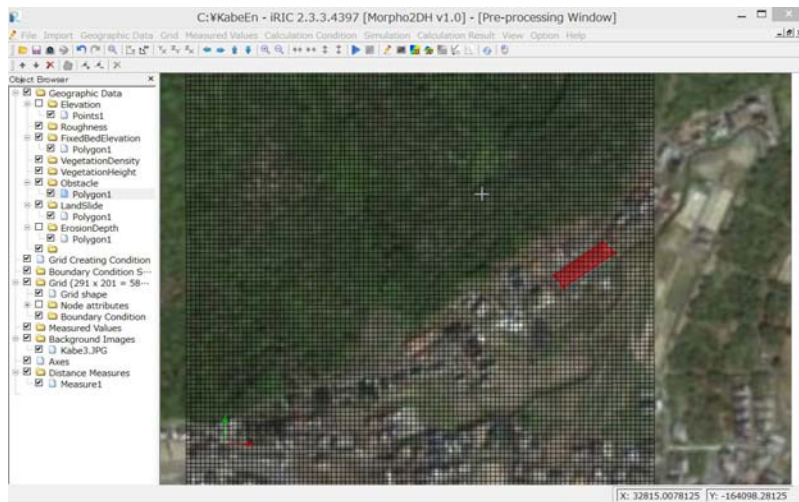


Figure III-5(2) Create polygon

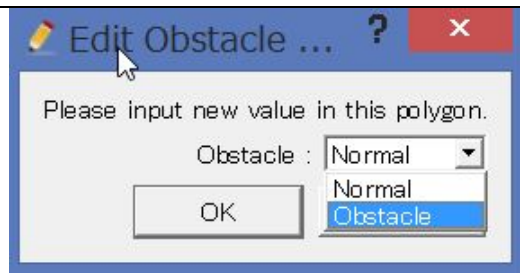


Figure III-5(3) Select [Obstacle]

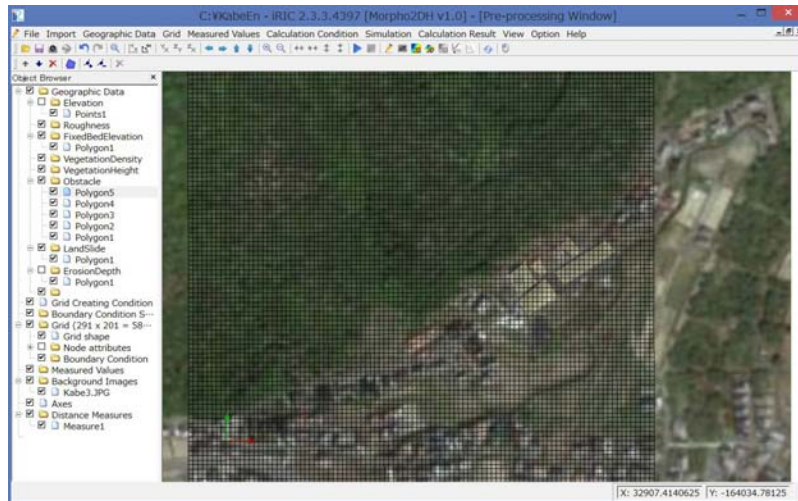


Figure III-5(4) Create polygon

III.3.2 Setting of calculation condition of obstacles

■ Setting of calculation condition of obstacles

- 1 Click [Obstacle] window.
- 2 Select [Enabled].

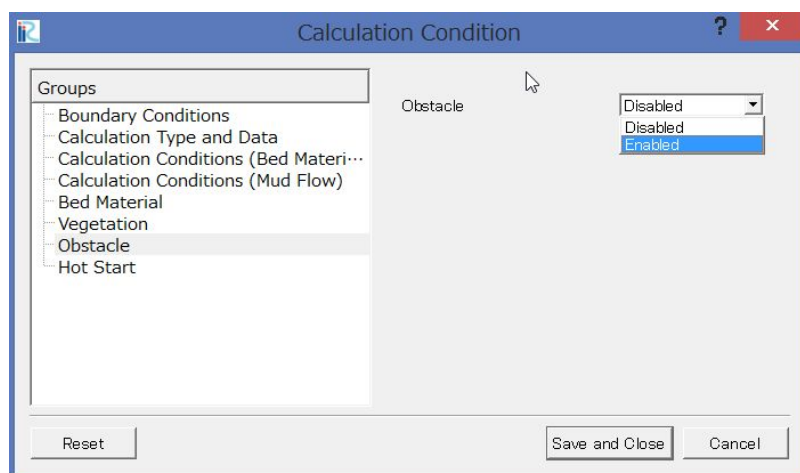


Figure III-6 Setting of obstacles

III.4 Visualization of calculation results

III.4.1 Visualization of calculation results

■ Contour

- 1 Check [Scalar] in [Object Browser].
- 2 Check [Kabe3.jpg] in [Background Images] in [Object Browser].
- 3 Horizontal distribution of flow depth is shown by checking [Depth].
Debris/Mud flow flows between houses.

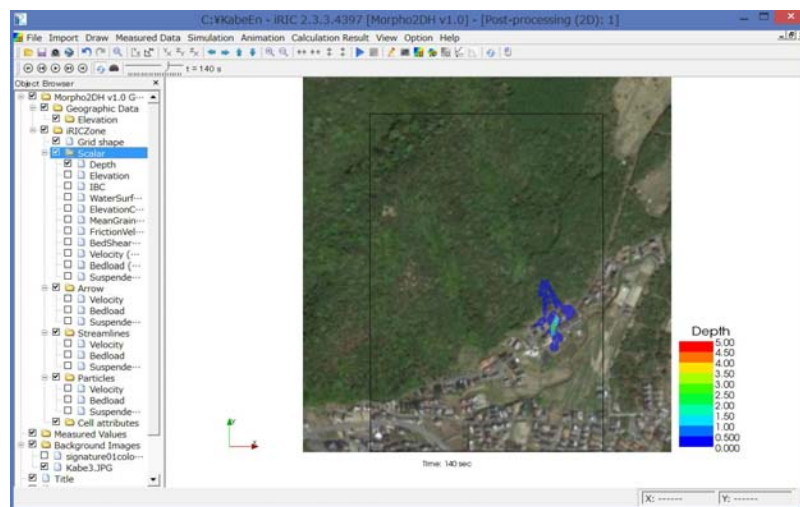


Figure III-7 Contour of flow depth