Strengthening Flood Forecasting in ASEAN Member States through Regional Trainings and Coordination

(Aug.31th,2026)

RRI MODEL TRAINING

— CASE STUDY ABE RIVER BASIN IN JAPAN —

International Center for Water Hazards and Risk Management (ICHARM)
Under the auspices of UNESCO hosted by Public Works Research Institute（PWRI）

UNESCO
United Nations Educational, Scientific and Cultural Organization

ICHARM
International Centre for Water Hazard and Risk Management under the auspices of UNESCO

PWRI
Public Works Research Institute, National Research and Development Agency, Japan

RRI Model Implementation and WMO's Flood Forecasting Framework (FFF)

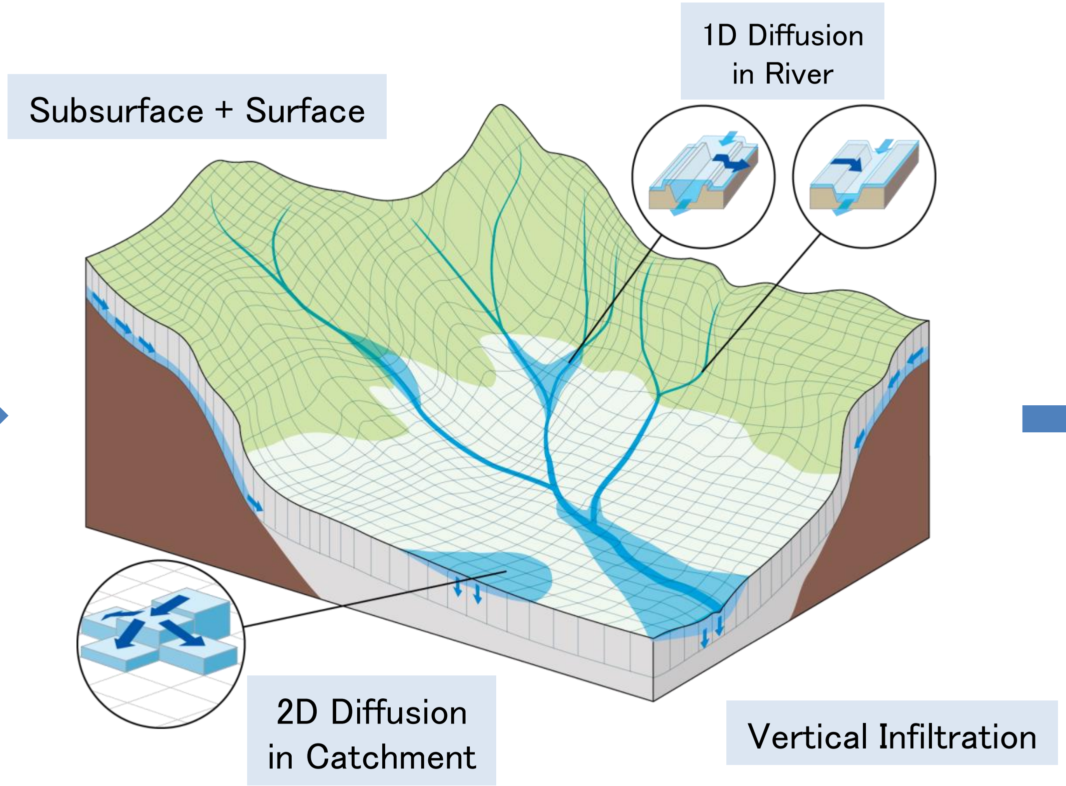
RRI is formally listed in the WMO Inventory of Interoperable Models & Platforms for Flood Forecasting (Hydrological Models category), alongside HEC-HMS, and other models.

→ RRI model implementation complies with the FFF.

WMO FFF Core Requirement	How RRI Delivers
Open, modular & interoperable models	WMO Inventory-vetted (WMO-No.1345 criteria); GIS/text I/O, integrates with IFAS and other FFF-compatible platforms
Multi-hazard coverage beyond flash floods (riverine, urban, coastal)	Simulates rainfall-runoff, river routing AND flood inundation simultaneously in one integrated model
Advanced processing: data assimilation, calibration, near-real-time use	Built-in particle-filter data assimilation (advanced application); proven near-real-time flood prediction & climate-scenario analysis
Screening criteria: institutional support, training, sustainability, peer review	Backed by ICHARM/PWRI & Kyoto University; free (registration-based), documented, award-winning, case-study proven
Scalable to LDCs/SIDS with modest infrastructure	Runs on Windows & Linux with reasonable hardware needs; GUI version lowers the entry barrier for NMHSs

RRI model; Rainfall Runoff Inundation

Input
- Rainfall
- DEM
- Land Cover
- Cross Sec.



Output
- Discharge
- W. Level
- Inundation

- Two-dimensional model capable of simulating rainfall-runoff and flood inundation simultaneously
- The model deals with slopes and river channels separately
- At a grid cell in which a river channel is located, the model assumes that both slope and river are positioned within the same grid cell

Sayama, T. et al.: Rainfall–Runoff–Inundation Analysis of Pakistan Flood 2010 at the Kabul River Basin, *Hydrological Sciences Journal*, 57(2), pp. 298–312, 2012.

2

Overview

In this seminar, exercise from RRI model construction to model validation with shown below.

1. Presetting
2. Introduction of target field
3. New create project
4. Make topographic data
   -DEM, DIR, ACC (Digital Elevation Mapping, Flow Direction, Accumulation)
5. Set River
6. Make Rainfall files by ground gauged data
7. Set parameters for calculation of RRI
8. Execute RRI model
9. Validation
10. Experiment of flood simulation

1-1. Download RRI folder

Please download “RRI_1_4_2_7_GUI_Beta.zip” from ICHARM website and “TutorialData.zip” from the WMO ETRP Moodle Platform and save them directly under the “C:¥”.

RRI_1_4_2_7_GUI_Beta.zip

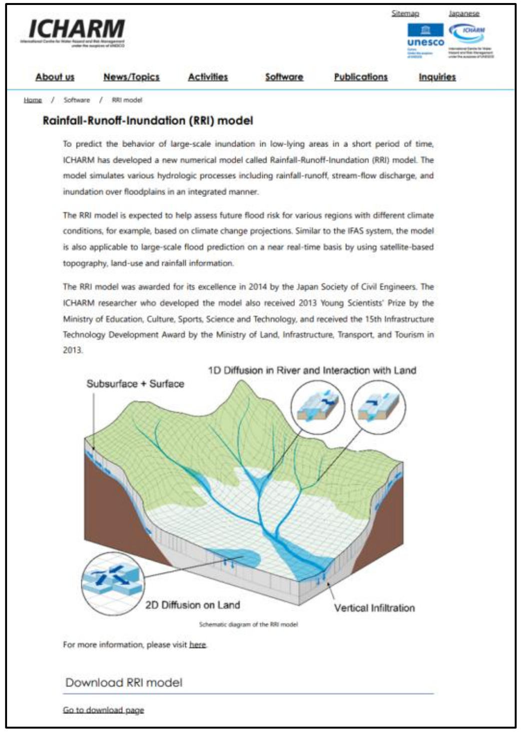
TutorialData.zip

WMO ETRP Moodle Platform

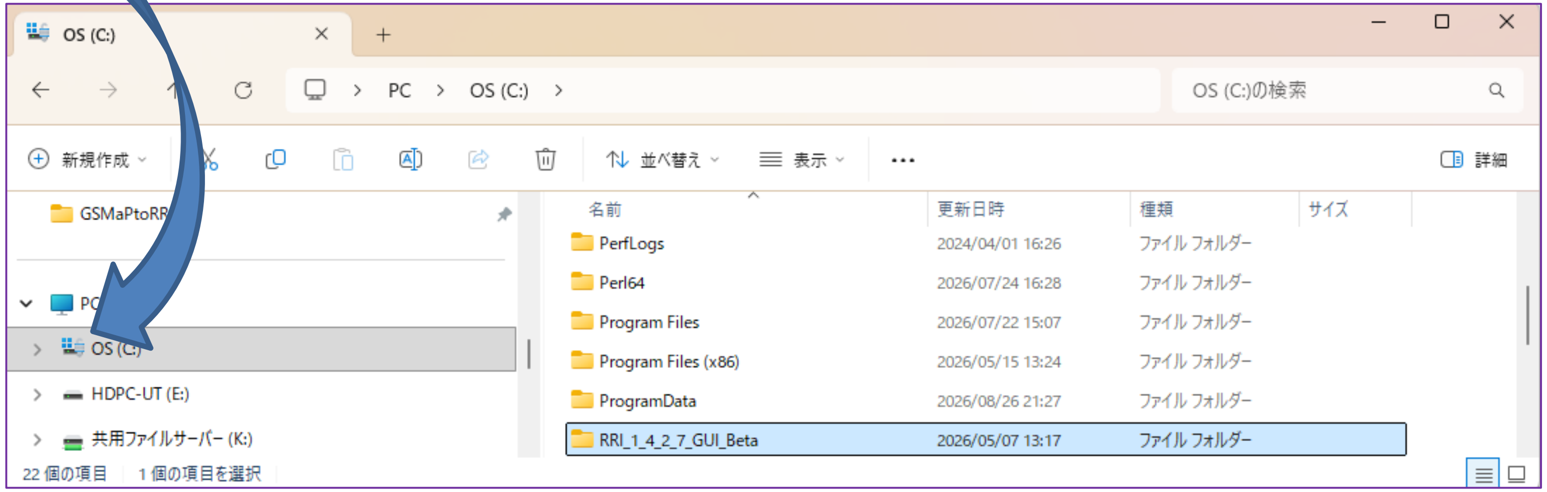
Tutorial dataset ZIP

RRI modelling tutorial dataset.

606.3 KB



ICHARM website
(https://www.pwri.go.jp/icharm/research/rri/index.html)



A long file path can sometimes cause errors.
Please locate your RRI folder directly under the “C: drive”.

1-2. Folder Structure

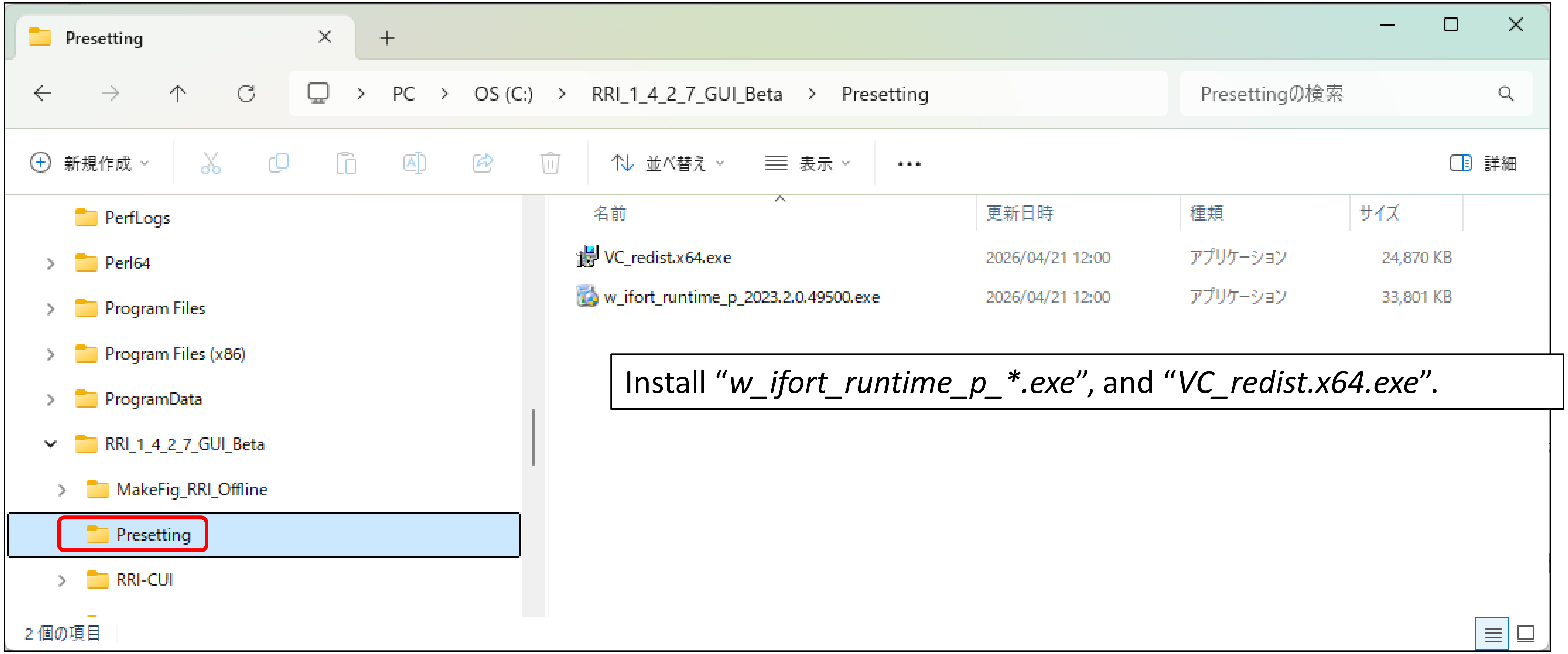
A long file path can sometimes cause errors.
Please locate your RRI folder directly under the “C: drive”.

```
C:
┣ RRI_1_4_2_7_GUI_Beta
┃  ┣ Presetting          ･･･Installer for configuration
┃  ┣ RRI-CUI             ･･･RRI model with Command Prompt (For advanced user)
┃  ┣ RRI-GUI_v5.0.6_P    ･･･RRI-Model with GUI (Graphical User Interface)
┃  ┣ 00_Readme.txt       ･･･For presetting
┃  ┗ RRI_Manual.pdf      ･･･Rainfall-Runoff-Inundation Model User’s Manual
┃
┗ TutrialData
   ┣ Discharge_WaterLevel_TEGOSHI   ･･･ Observation data from water level monitoring stations
   ┣ HydroSHEDS_USGS_3sec           ･･･ Topographic data by USGS (3 seconds)
   ┣ Rain_GroundGauge               ･･･ Ground gauged rainfall
   ┗ Validation_discharge           ･･･ Hydrograph for validation (*.xlsx)
```

1-3. Install libraries by Intel

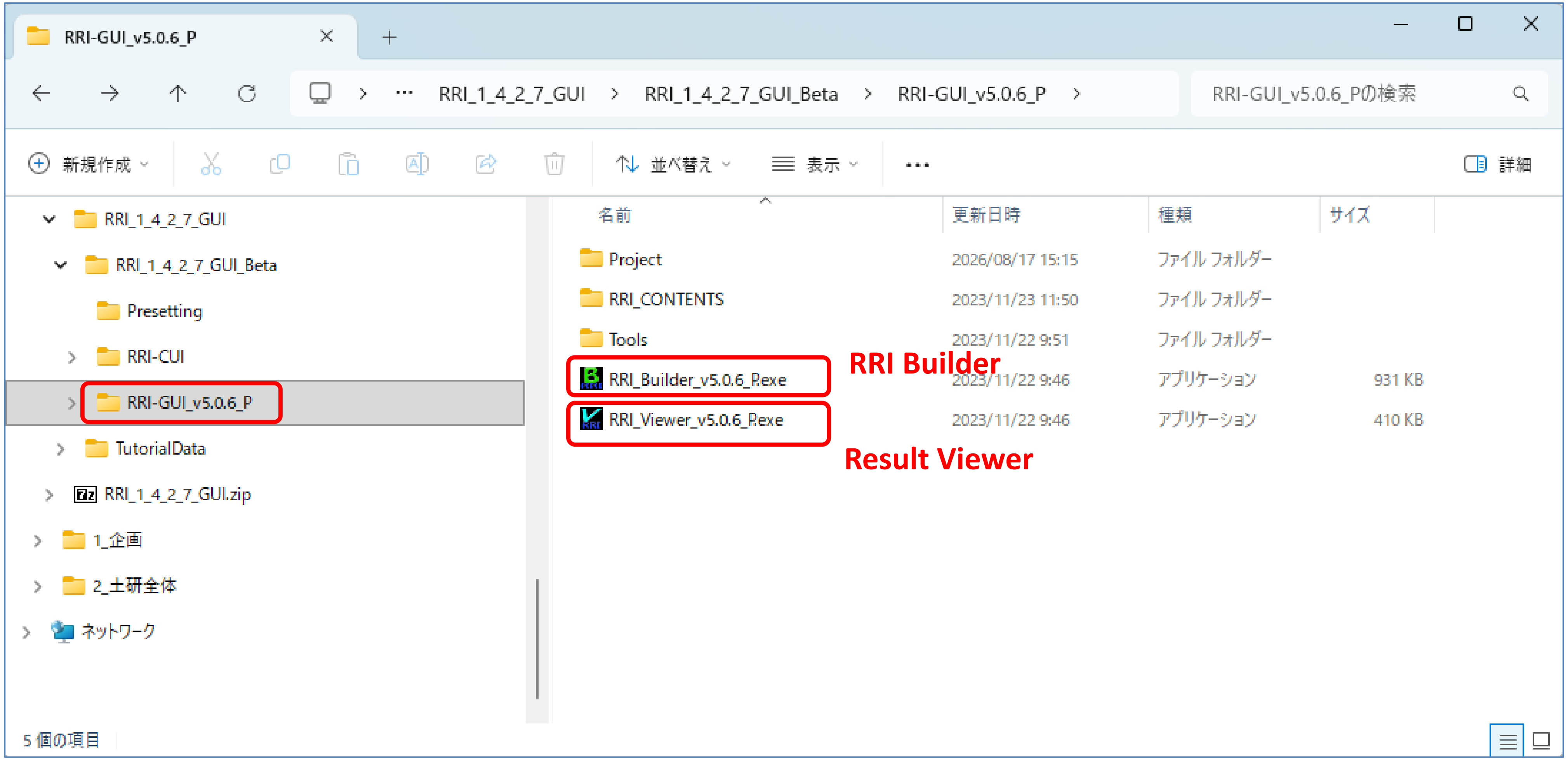
Before execute RRI-GUI, install two programs saved in “presetting” folder.

1. Intel Fortran Redistributable Library Packages (w_ifort_runtime_p_*.exe)
2. Visual C++ Redistributable Packages (VC_redist.x64.exe)



1-4.Execute RRI_Builder.exe

- “*RRI_Builder_v5.0.6_P*” : Exe file for building the model.
- “*RRI_Viewer_v5.0.6_P*“ : Exe file for displaying the calculation results.



2-1. Target of Basin in seminar

- Target basin : Abe river basin in Shizuoka Pref.
- Catchment area : 567km^2
- River length : 51km
- Land use : Mountain 93%, Farmland 3%, Urban 4%

In this training, we will develop a model based on a single type of land use in a mountainous area.

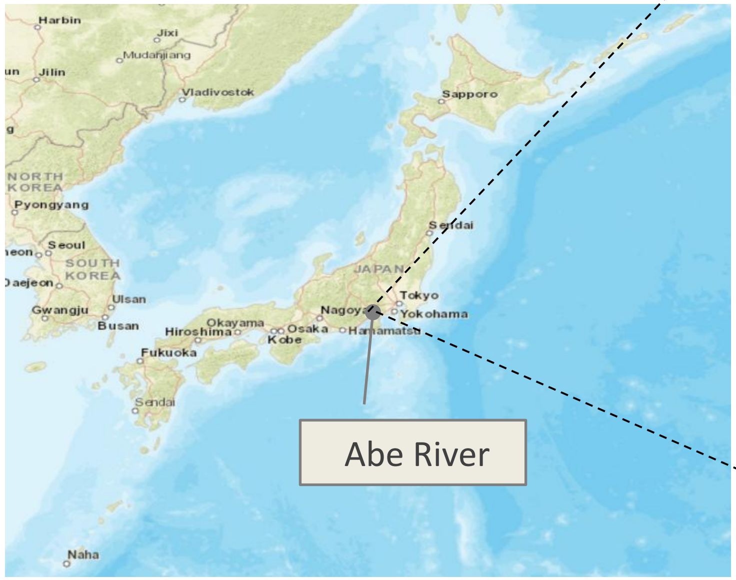


Fig. Abe river position diagram

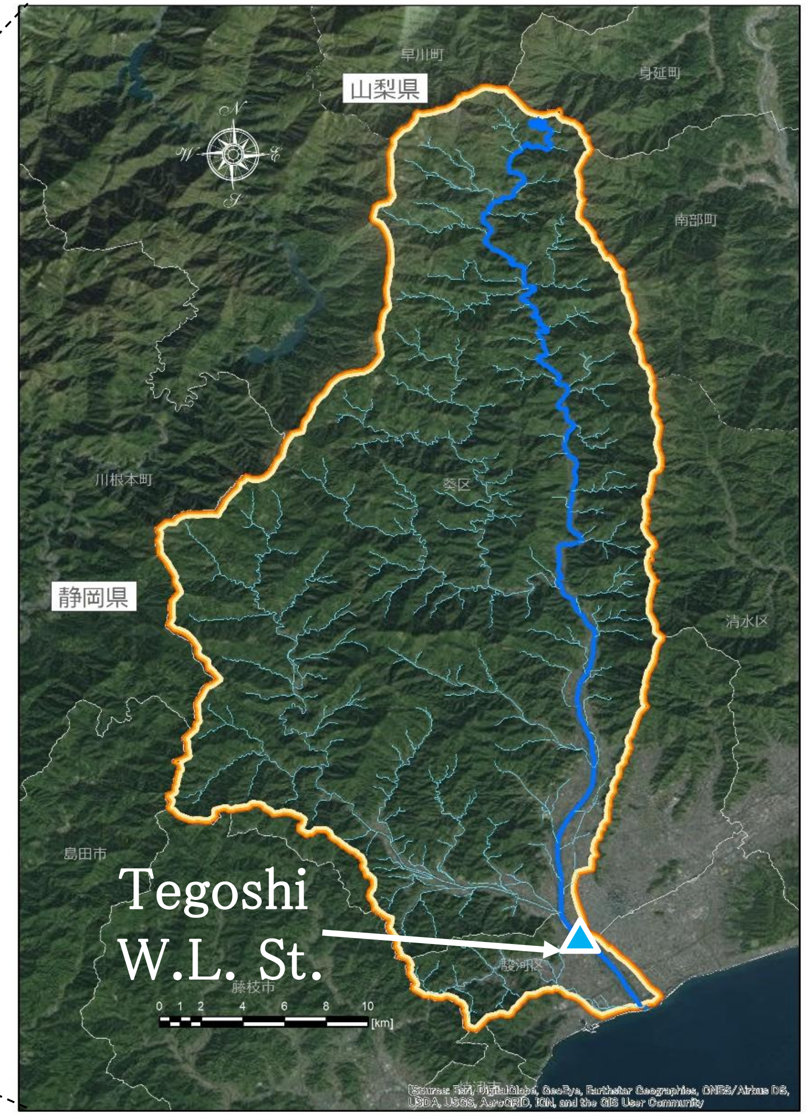


Fig. Abe river basin

2-2. Target of Flood

- Target Rain : September 2011 Typhoon
- No flooding from the Abe River
- Peak discharge : 3,500m^3/s（Design discharge : 5,500m^3/s）

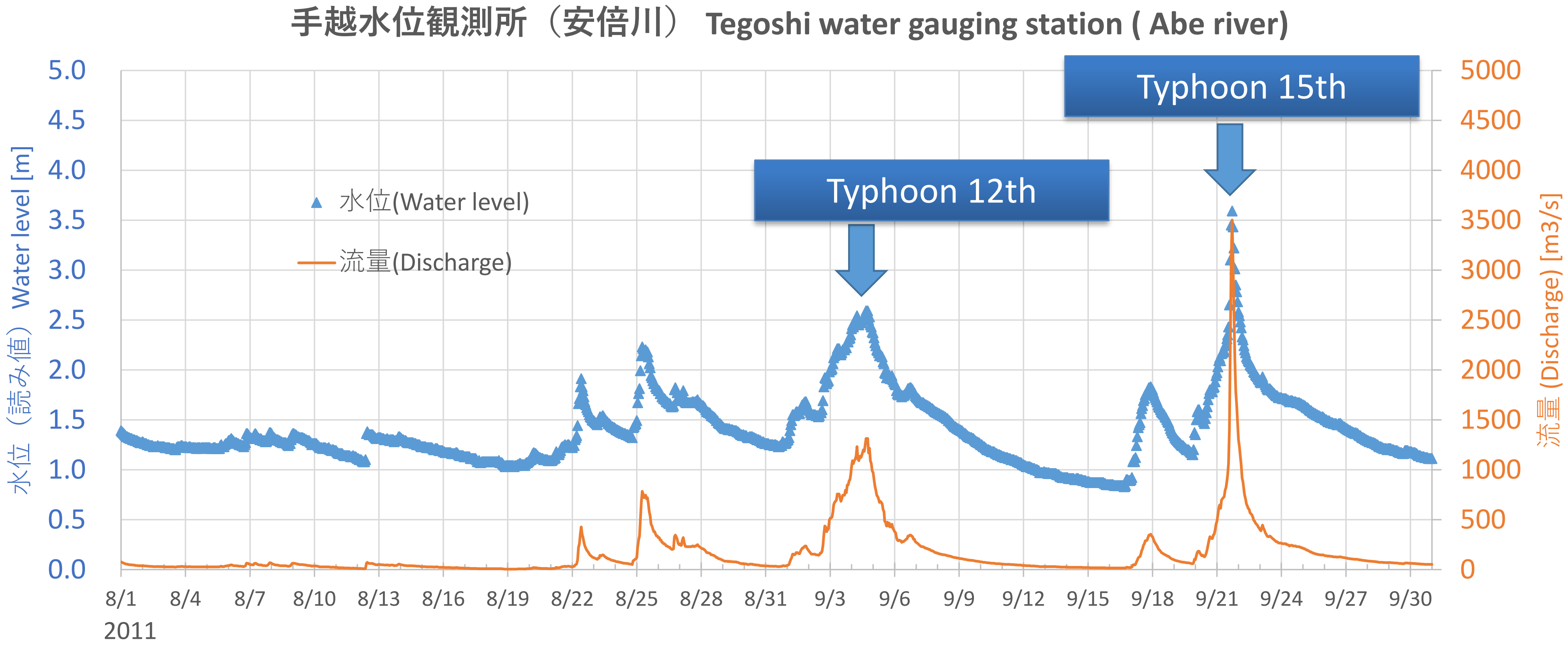
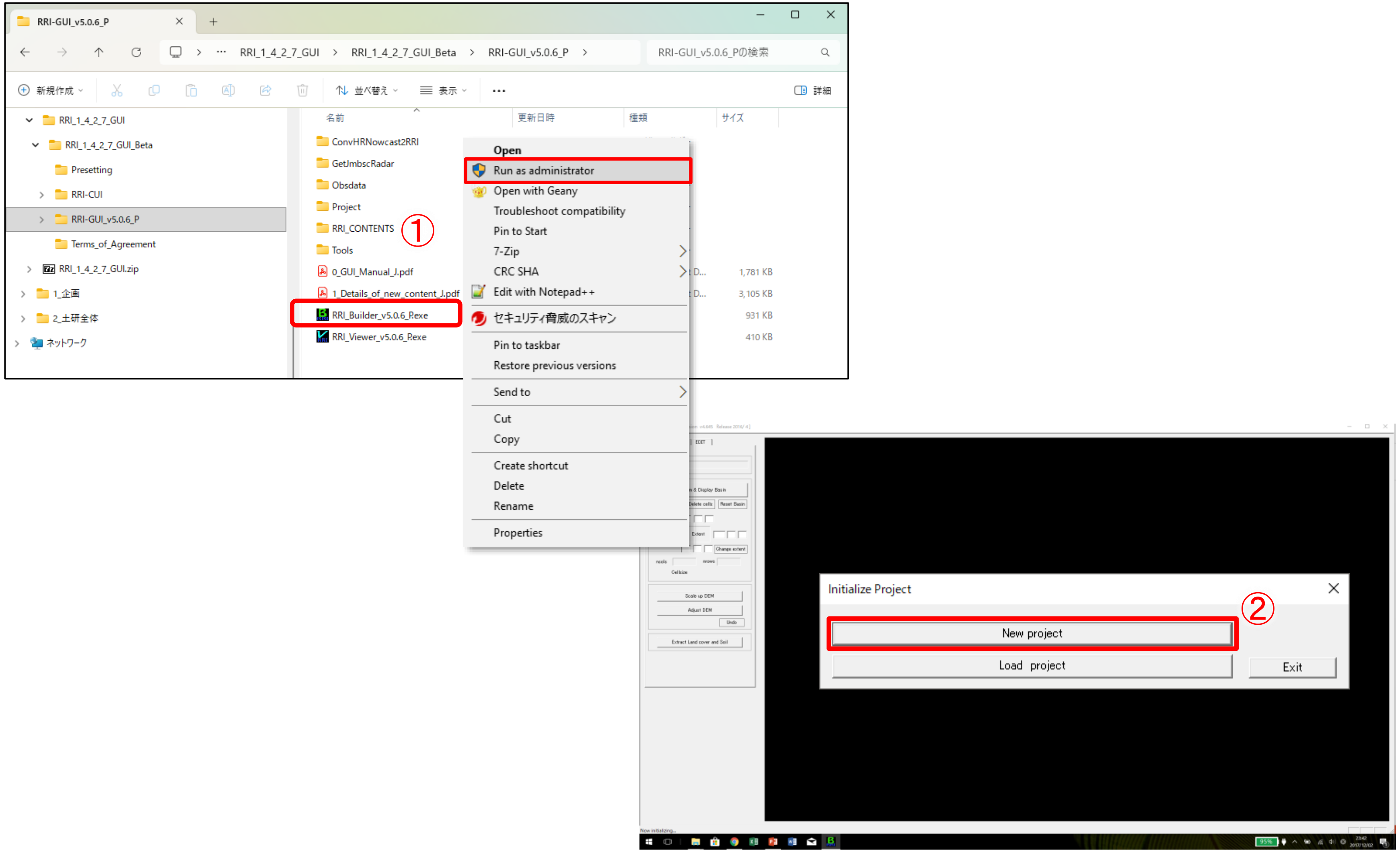


Fig. Hydrograph of water level at Tegoshi St.

3. New create project

3-1. Launch RRI-GUI

■Start up RRI-GUI



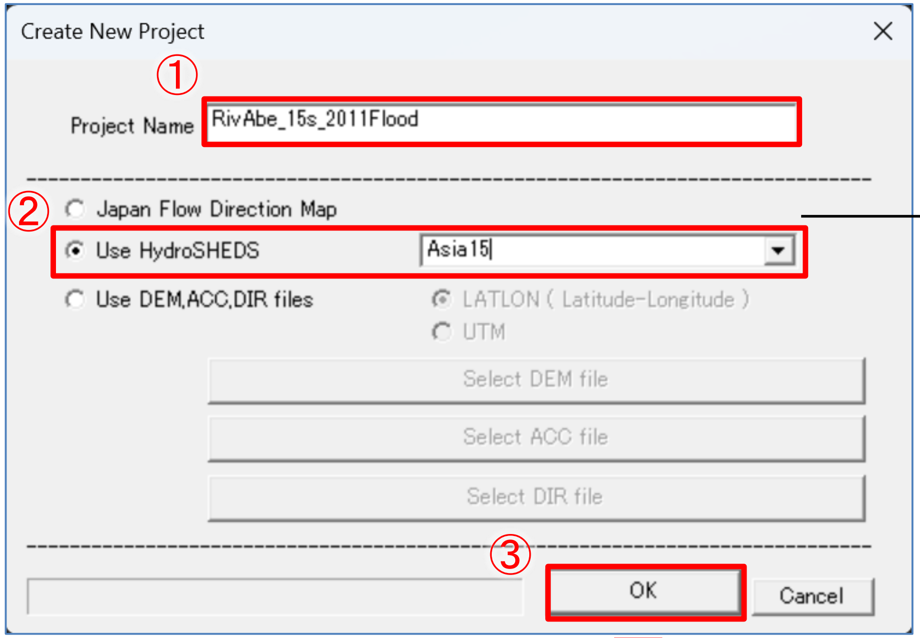
①Launch RRI-GUI Double click *RRI_BUILDER_*.exe*
Run as administrator

②Click "*New project* "

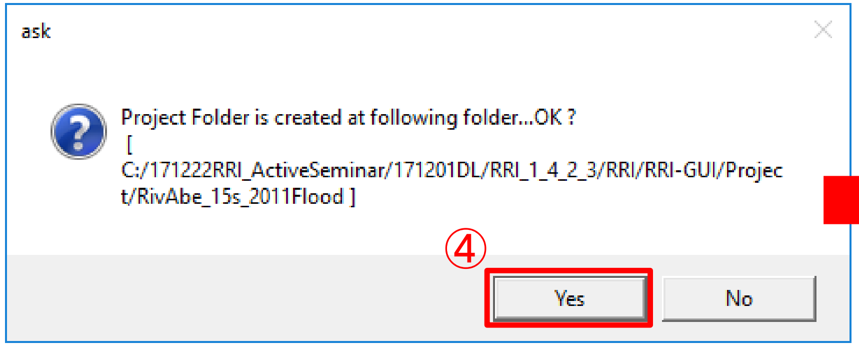
〔Note〕
If you have an existing project, click on "*Load project*", then select "*RRI_input.txt*".

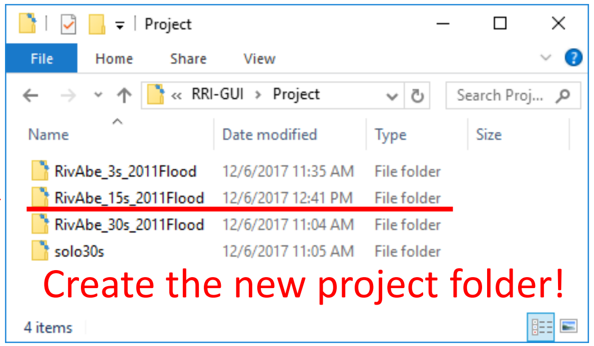
3-2. New create project

■Create New Project



〔Others〕
-*Asia30*
-*Asia15*
-*Africa30*
-*Africa15*
-*Australia30*
-*Australia15*
-*CentralAmerica30*
-*CentralAmerica15*
-*Europe30*
-*Europe15*
-*NorthAmerica30*
-*NorthAmerica15*
-*SouthAmerica30*
-*SouthAmerica15*





①Project Name:
Type a new project name to create a new project folder
e.g. *"RivAbe_15s_2011Flood"*

②Use HydroSHEDS:
Choose "*Use HydroSHEDS* ".
In this seminar, choose "*Asia15* ".

③Click "*OK* "

④Click "*YES*"

⑤Confirm the new project folder.

4-1. Introduction of Terrain data

■Download of Terrain data from HydroSHEDS by USGS

※Satellite observation

-3seconds (Appt.100m)

-15seconds (Appt.500m)

-30seconds (Appt.1km)

Already Downloaded

or

■Use the DEM prepared in your country.

※ Pre-processing with GIS software required.

Extent	Resolution	File size	Link
Africa	3s	3525MB	Download
Asia	3s	4800MB	Download
Australasia	3s	1587MB	Download
Europe and Middle East	3s	2448MB	Download
North and Central America	3s	2847MB	Download
South America	3s	2478MB	Download
Africa	15s	171MB	Download
Arctic (northern Canada)	15s	76MB	Download
Asia	15s	171MB	Download
Australasia	15s	74MB	Download
Europe and Middle East	15s	153MB	Download
Greenland	15s	31MB	Download
North and Central America	15s	133MB	Download
South America	15s	116MB	Download
Siberia	15s	143MB	Download
Global	15s	1048MB	Download
Arctic (northern Canada)	30s	25MB	Download
Africa	30s	48MB	Download
Asia	30s	47MB	Download
Australasia	30s	21MB	Download
Europe and Middle East	30s	44MB	Download
Greenland	30s	11MB	Download
North and Central America	30s	37MB	Download
South America	30s	32MB	Download
Siberia	30s	45MB	Download
Global	30s	306MB	Download

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HydroRIVERS HydroLAKES GLWD HydroWASTE GloRiC
HydroFALLS LakeTEMP

HydroSHEDS Core Data Downloads

This page provides downloads for HydroSHEDS core data products. More information about the HydroSHEDS data products can be found on our products page.

This page currently provides downloads for the latest **version 1.1 of HydroSHEDS.**

> Please note that a HydroSHEDS v2 data is now available for download <

Data format and layers

HydroSHEDS core layers are distributed in GeoTIFF format in resolutions from 3 arc-seconds to 6 arc-minutes. For details regarding the HydroSHEDS core products, please consult the HydroSHEDS Technical Documentation.

All products at a resolution of 15 arc-seconds or coarser are available either as continental tiles or in full global coverage.

The 3 arc-second layers are available as 10x10 degree tiles or as continental tiles. All 10x10 degree tiles are named with a 7-digit identifier based on the coordinates of their lower-left (southwest) corner.

Note for users of version 1.0 (now obsolete): legacy users requiring HydroSHEDS data in the former BIL or GRID formats offered in version 1.0 can access our legacy archive here.

Downloads

The following tabs provide data downloads for the different HydroSHEDS core layers at resolutions of 3, 15, or 30 arc-seconds (3s, 15s, 30s), or at 5 or 6 arc-minutes (5m, 6m).

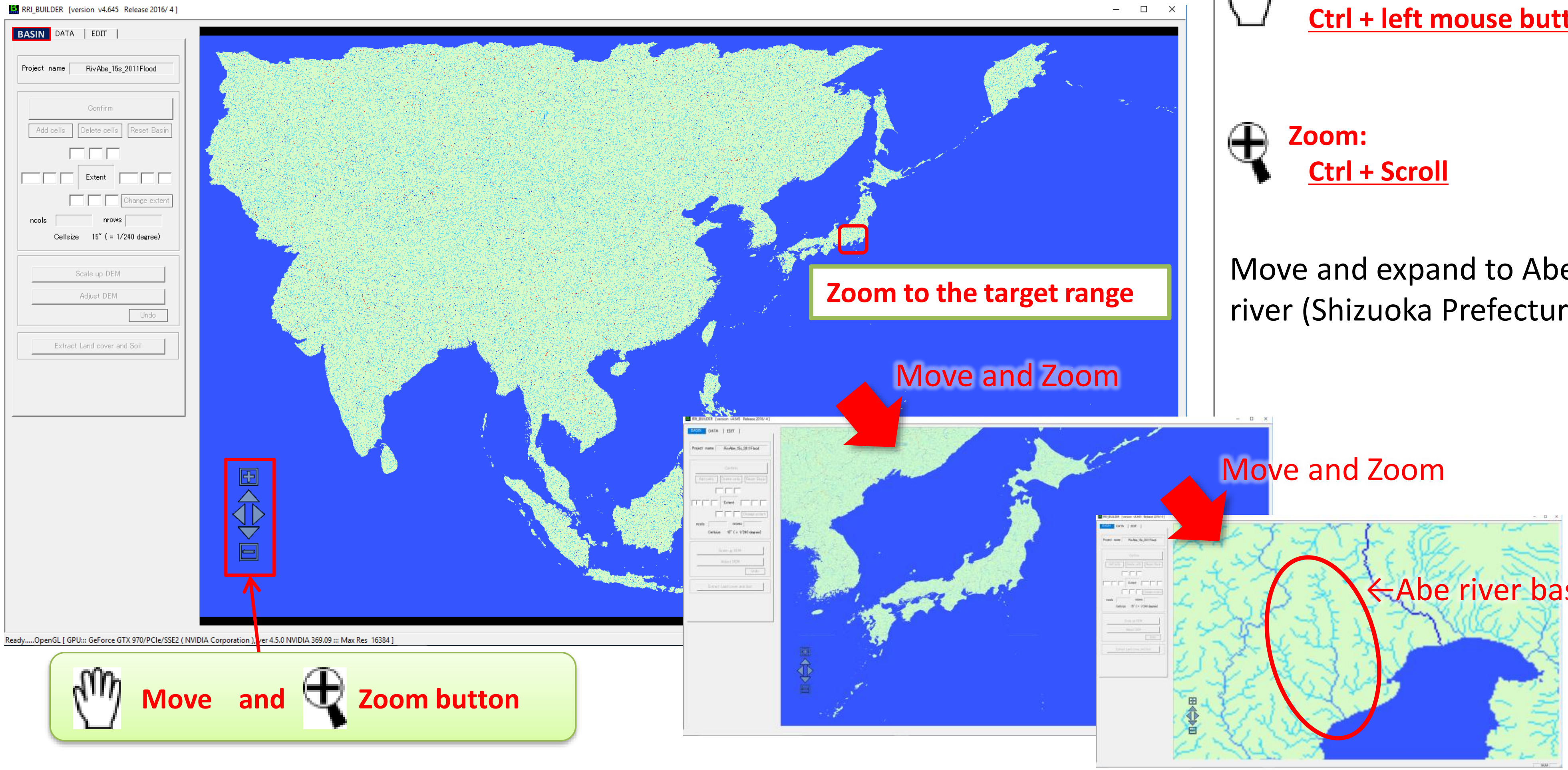
Void-filled DEM | Conditioned DEM | Flow Direction | Flow Accumulation | Flow Length | Land Mask

https://www.hydrosheds.org/hydrosheds-core-downloads

4-2. Select target basin

■Select target basin from river map by HydroSHEDS

The displayed map is automatically uploaded from HydroSHEDS data.



〔GUI Operation〕

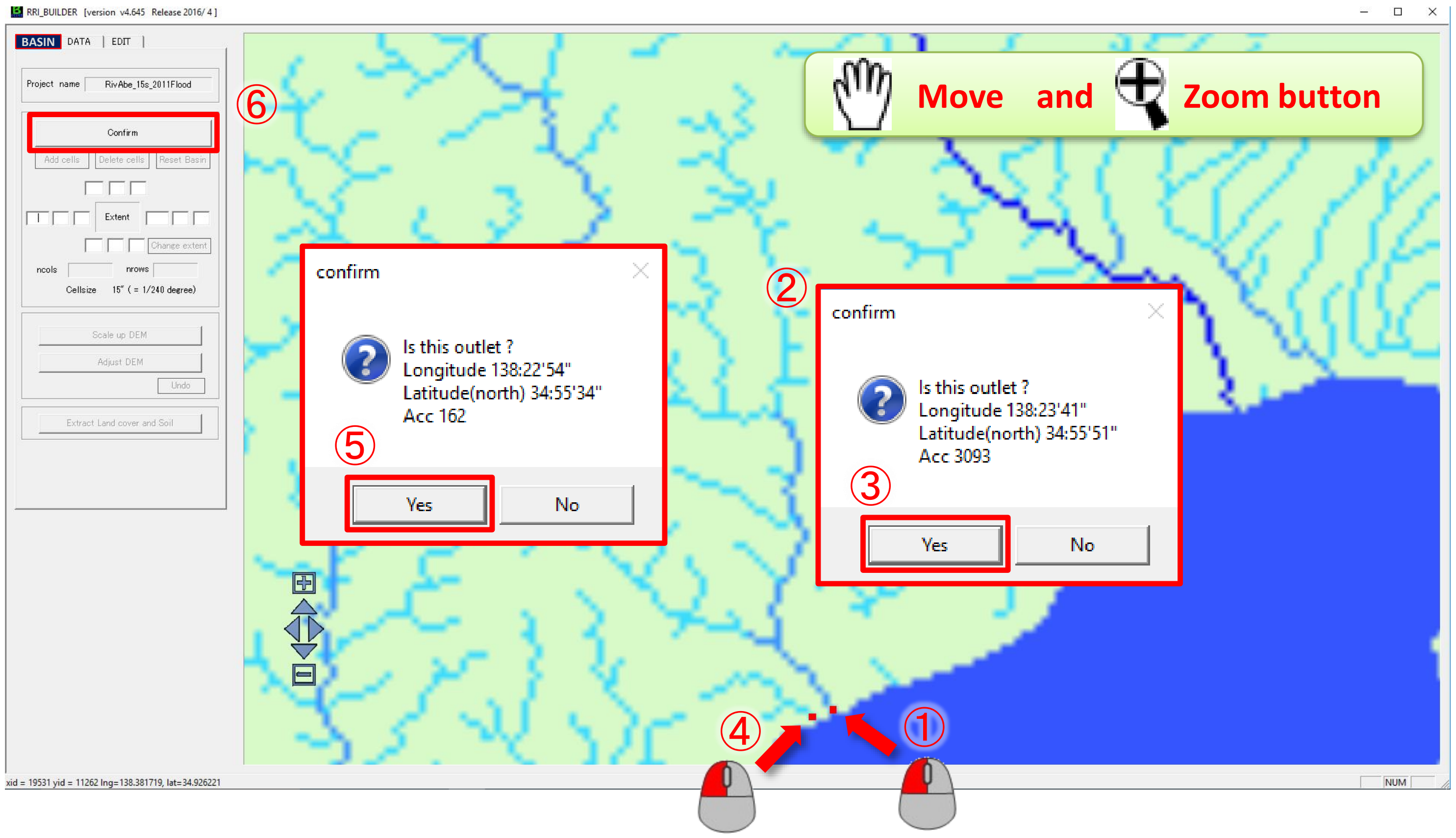
Move :
Ctrl + left mouse button

Zoom:
Ctrl + Scroll

Move and expand to Abe river (Shizuoka Prefecture)

4-3. Select outlet of target rivers

If you want to target multiple river, you can select multiple outlet.
※*SHIFT key + Click the outlet of other river*



①*Click* the outlet of the river

②Check the outlet
-Longitude(Deg:Min:Sec)
-Latitude(Deg:Min:Sec)
-Acc (Accurate cell number)

③Click "*Yes*"

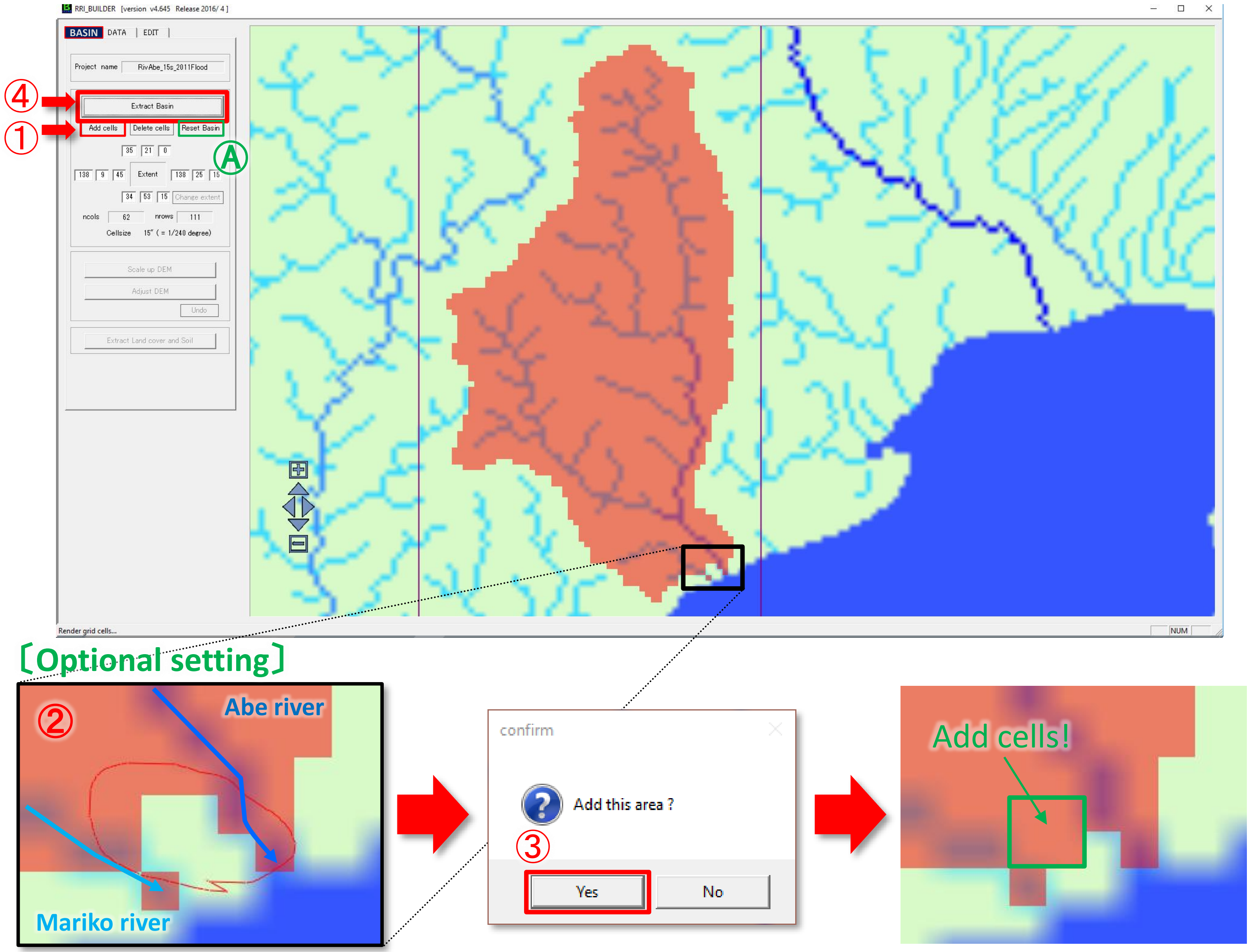
④Holding *SHIFT* key, *click* the outlet of other river.

⑤Click "*Yes*"

⑥Click "*Confirm*"

4-4. Extract target river basin

■Add cells and extract target river basin



①Click “*Add cells*”

②Surround any area by mouse.
In this seminar, add area between Abe river and Mariko river.

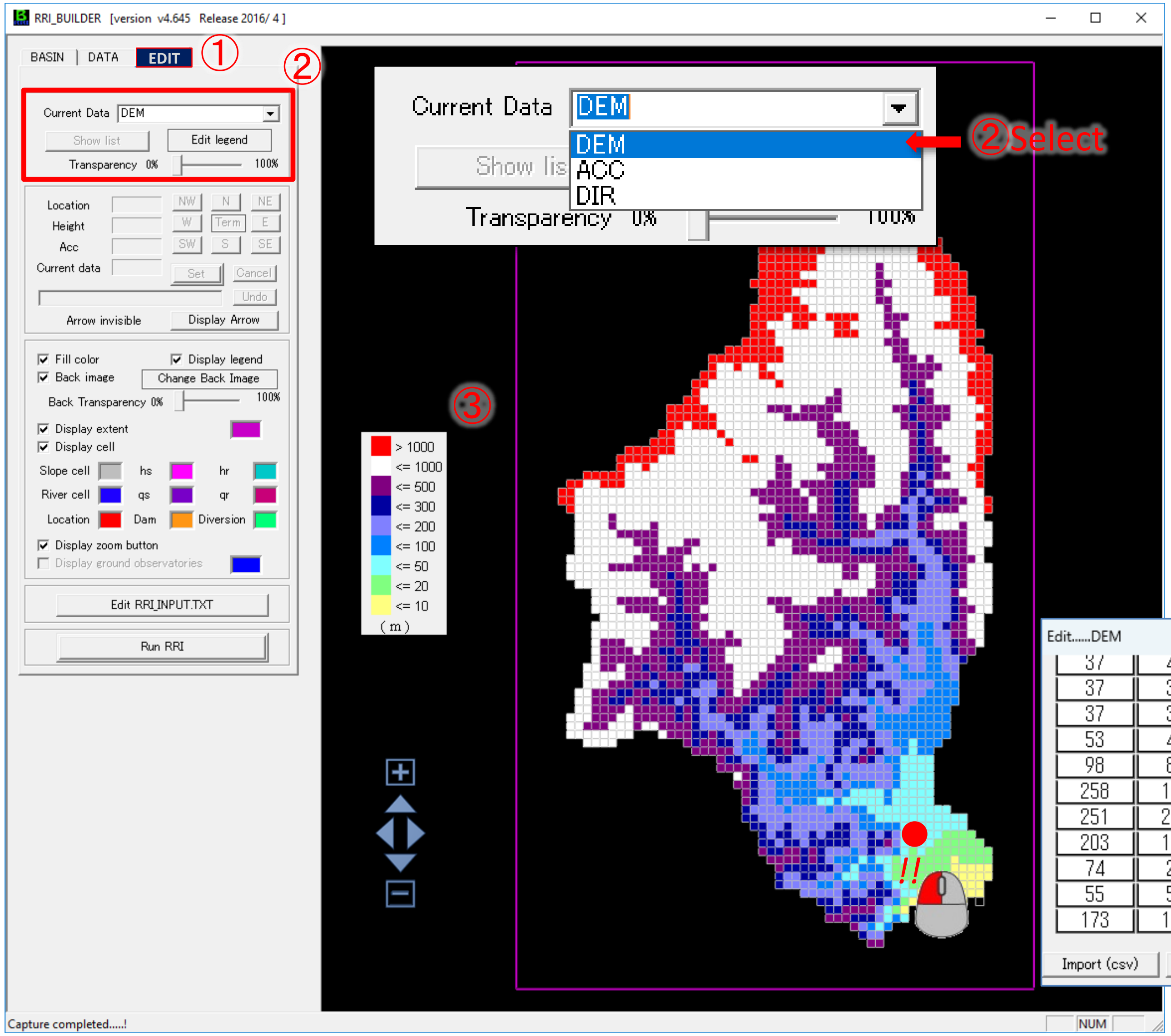
③Click “*Yes*”

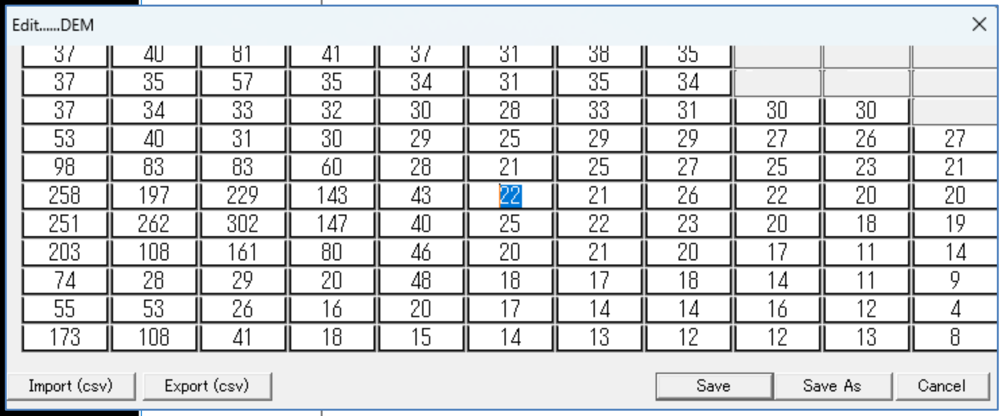
④Click “*Extract Basin*”

〈If the selected area is incorrect〉
ⒶIf you missed to select the model area, please click “*Reset Basin*” and restart “4-3 Select target basin”.

4-5. Check extracted data

◆ Check DEM(Digital Elevation Model) data





①Select “*EDIT*” tab.

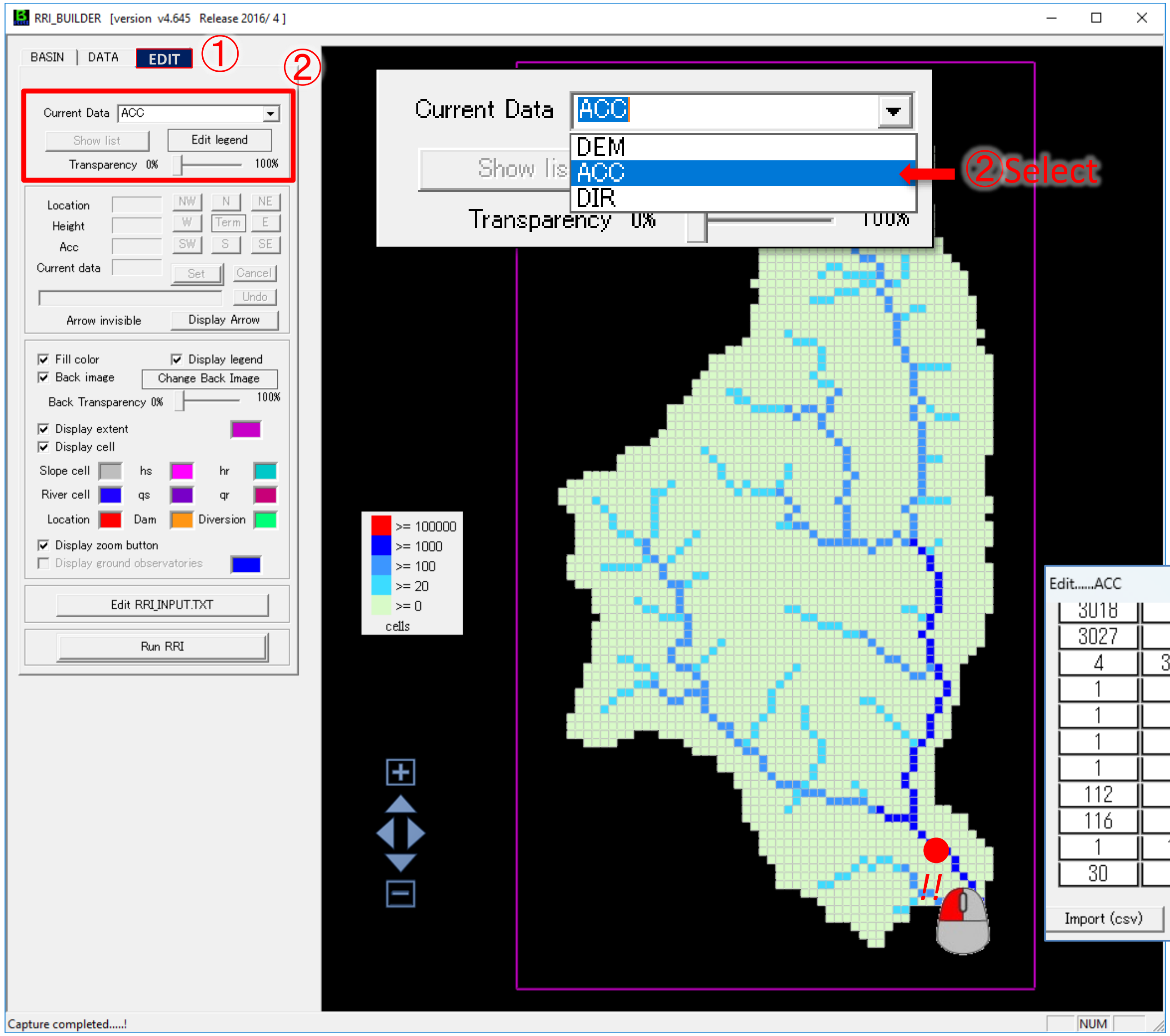
②Choose “*DEM*” from “*Current Data*” pulldown.

③display distribution of “*DEM*” data.

Double click on the map, you can modify “*DEM*” data.

4-5. Check extracted data

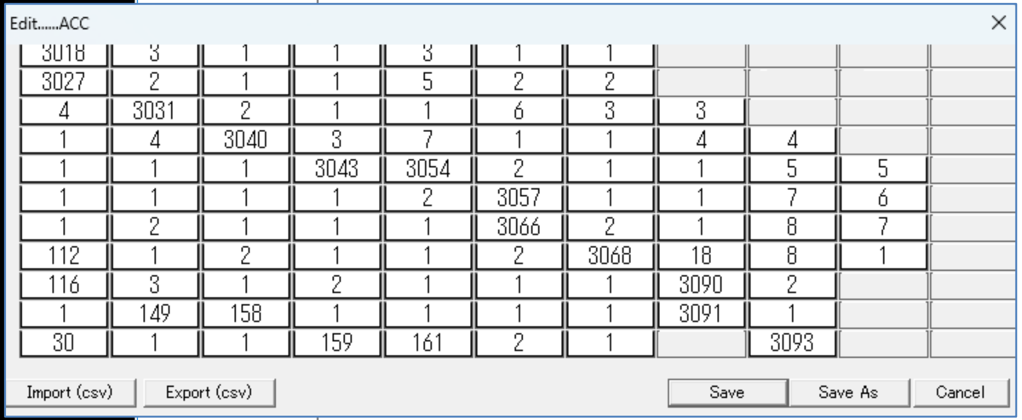
◆ Check ACC (Flow Accumulation) data



①Select "*EDIT*" tab.

②Choose "*ACC*" from "*Current Data*" pulldown.

display distribution of "*ACC*" data.



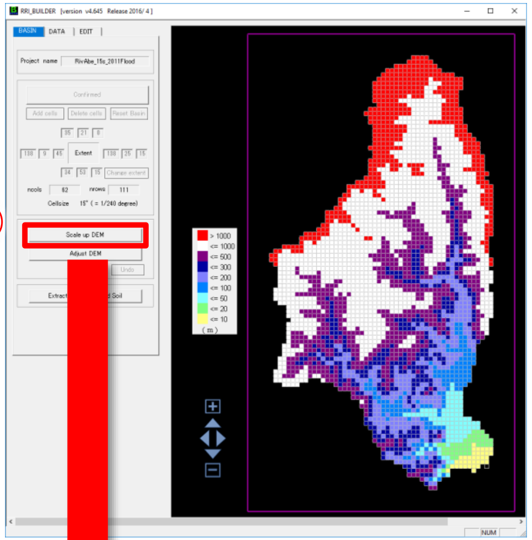
3018	3	1	1	3	1	1			
3027	2	1	1	5	2	2			
4	3031	2	1	1	6	3	3		
1	4	3040	3	7	1	1	4	4	
1	1	1	3043	3054	2	1	1	5	5
1	1	1	1	2	3057	1	1	7	6
1	2	1	1	1	3066	2	1	8	7
112	1	2	1	1	2	3068	18	8	1
116	3	1	2	1	1	1	3090	2	
1	149	158	1	1	1	1	3091	1	
30	1	1	159	161	2	1		3093	

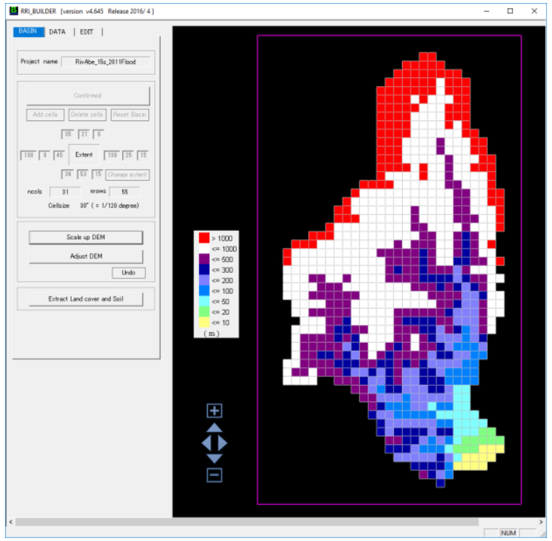
4. Make topographic data

Scale-up (Optional)

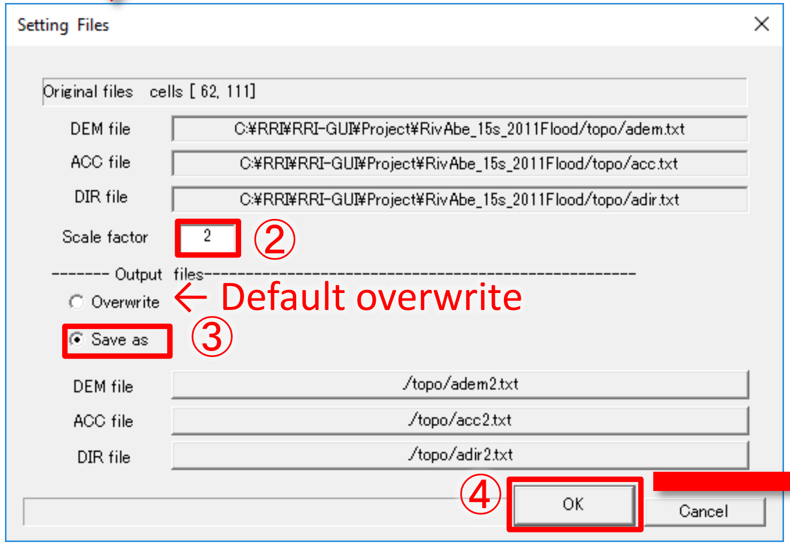
■Change spatial resolution from high's to low's

①





Result of "*Scale factor = 2*"



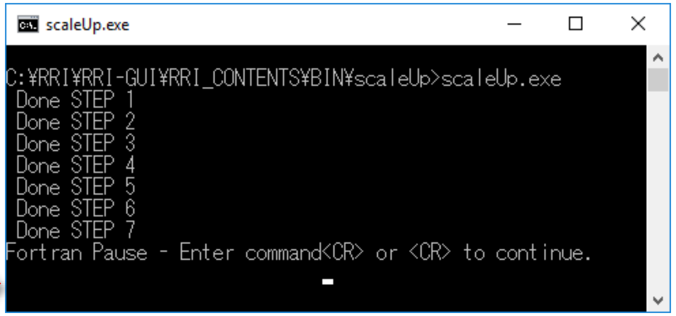
②

← Default overwrite

③

④

⑤Press "*Enter*" key



①Click "*Scale up DEM*" to open "*Setting Files*" window

②Set "*Scale factor*" = *2*
Set the cell size to twice its original value.

③Choose "*Save as*", then type in a file name for each.

④Click "*OK*"

⑤Press "*Enter*" key on command prompt

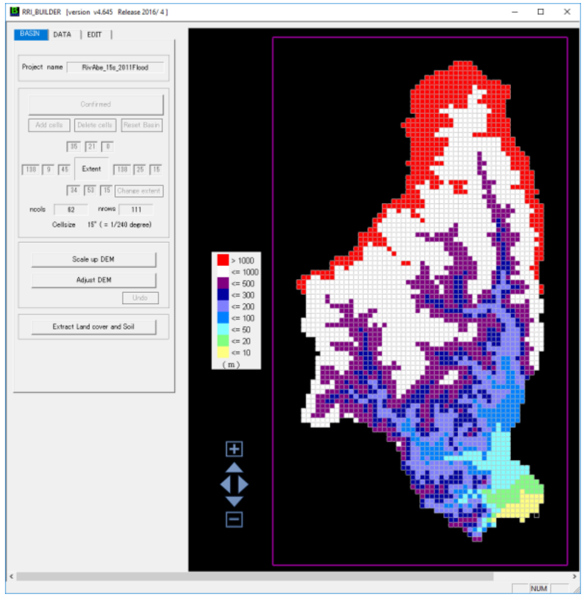
⑥Check result scale-up DEM

Scale-up (Optional)

Why Scale-up?

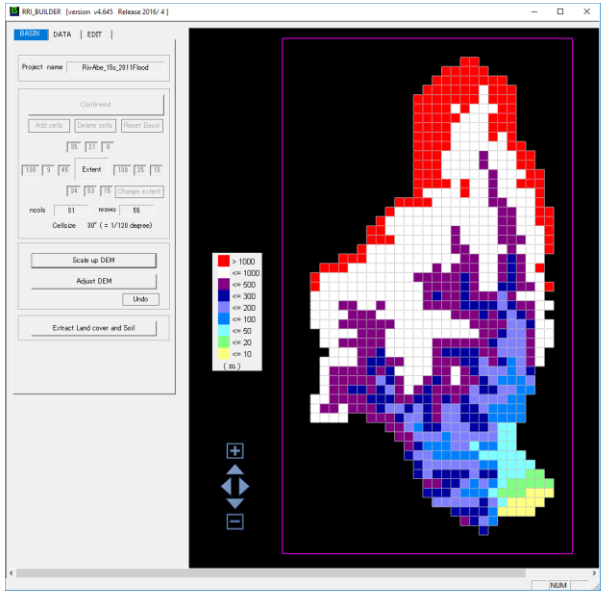
The computation time becomes shorter after scale up.
However, the accuracy of the simulation may become lower.

High resolution



x2 →

Low resolution



Computation time

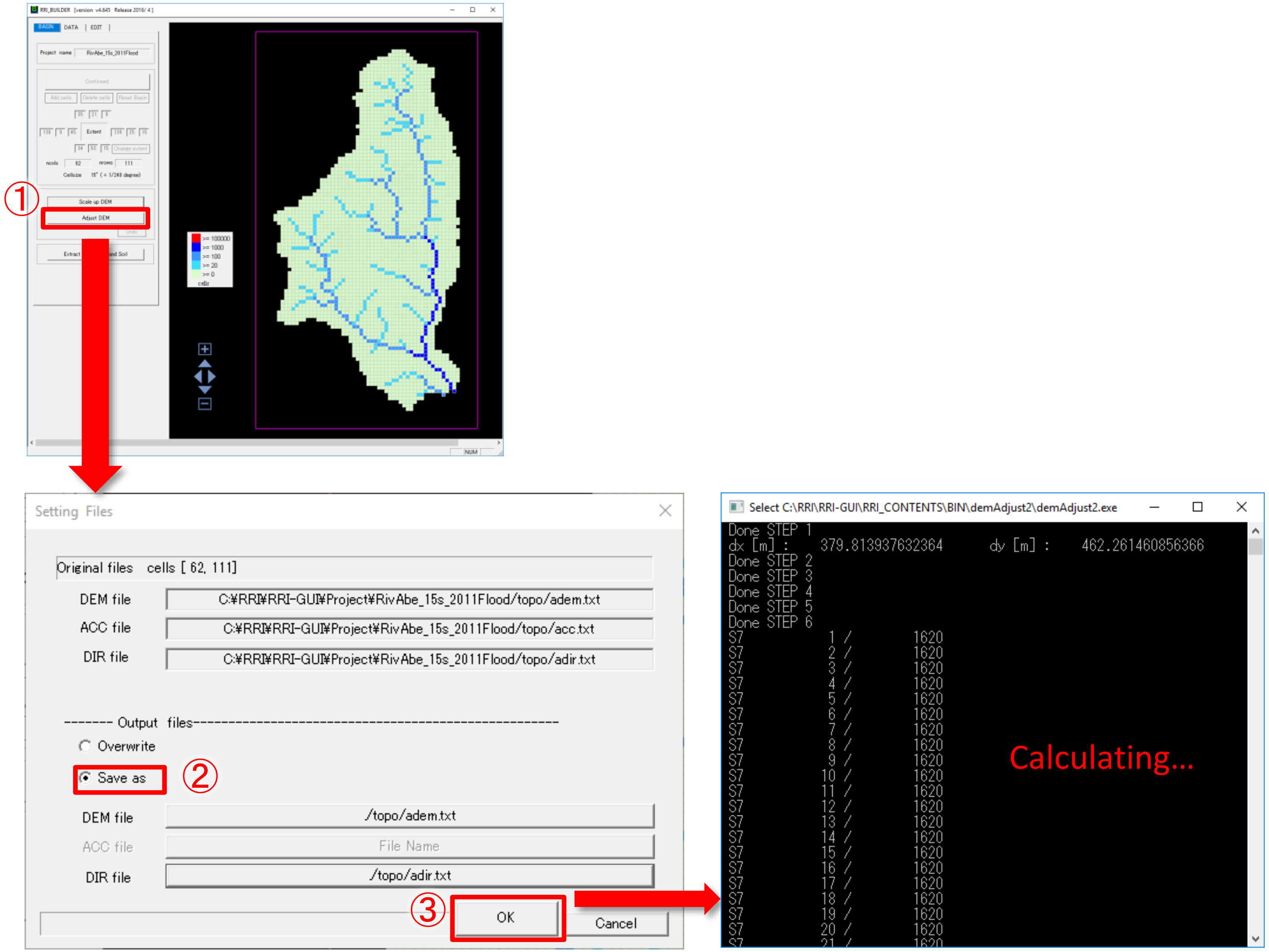
Long ⟷ Short

Accuracy

High ⟷ Low

4-6. Adjust DEM

■Create “aDEM.txt” file from “dem.txt” and “dir.txt”.



①Click “*Adjust DEM*” to open “*Setting Files*” window

②Choose “*Save as*”, then type in a file name for each.

③Click “*OK*”

④Calculation start (auto)

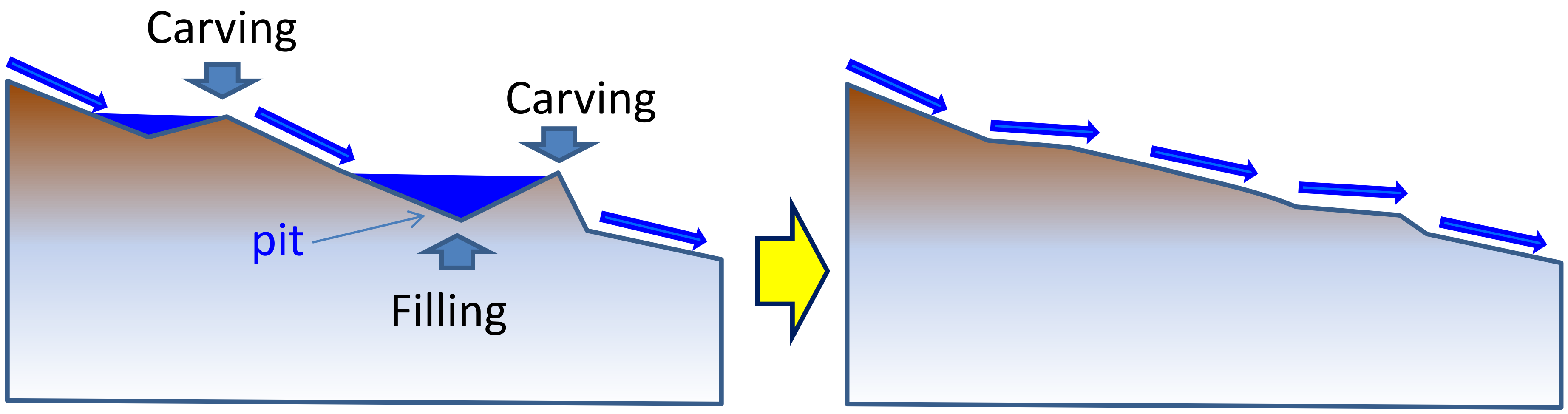
4-6. Adjust DEM (Required)

Why Adjust DEM?

Purpose 1) DEM adjustment by carving and filling
2) Zero setting of flow direction at outlet cells

<u>DEM adjustment</u>

This program adjusts DEM by carving and filling to remove pits along flow line.
This DEM adjustment is necessary to avoid unrealistic discontinuity of flow.

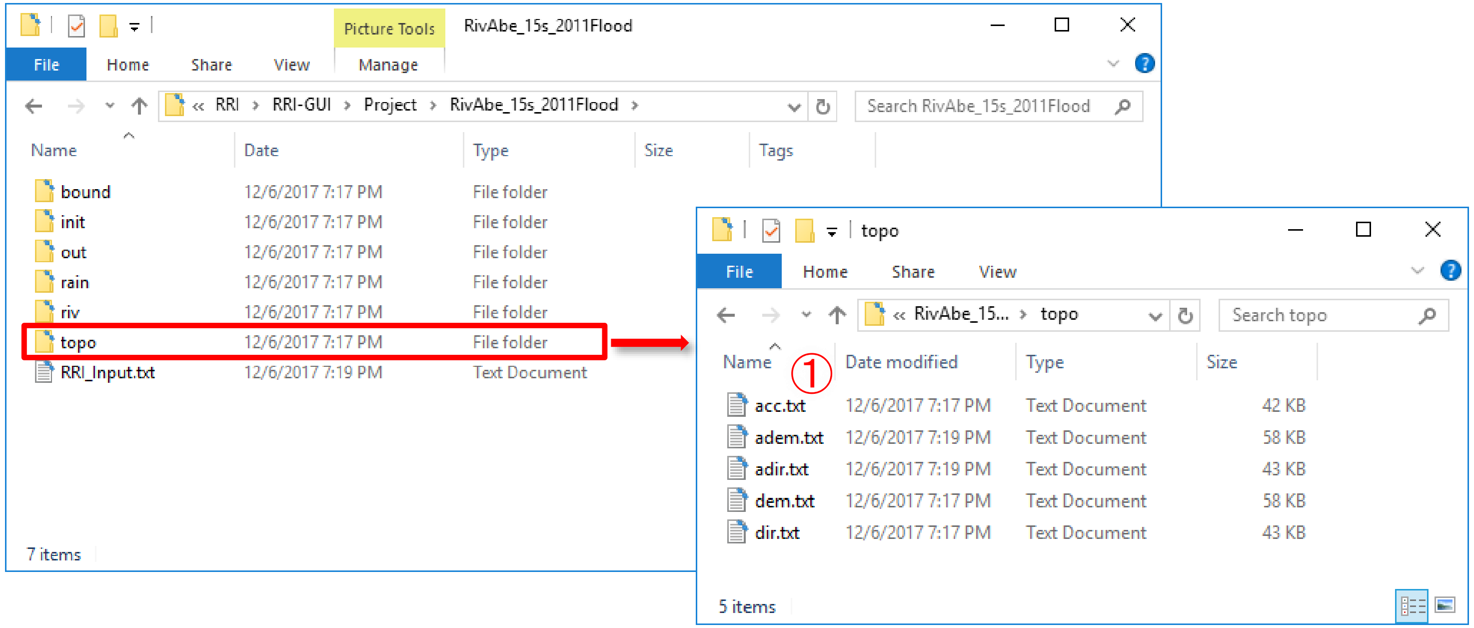


Before DEM adjustment
“DEM.txt”

After DEM adjustment
“aDEM.txt”

4-7. Check topographic files

■Check topographic data



Topographic files are created in "topo" folder for each project.

①Check following files in “topo” folder.
- dem.txt, dir.txt, acc.txt, adem.txt, adir.txt

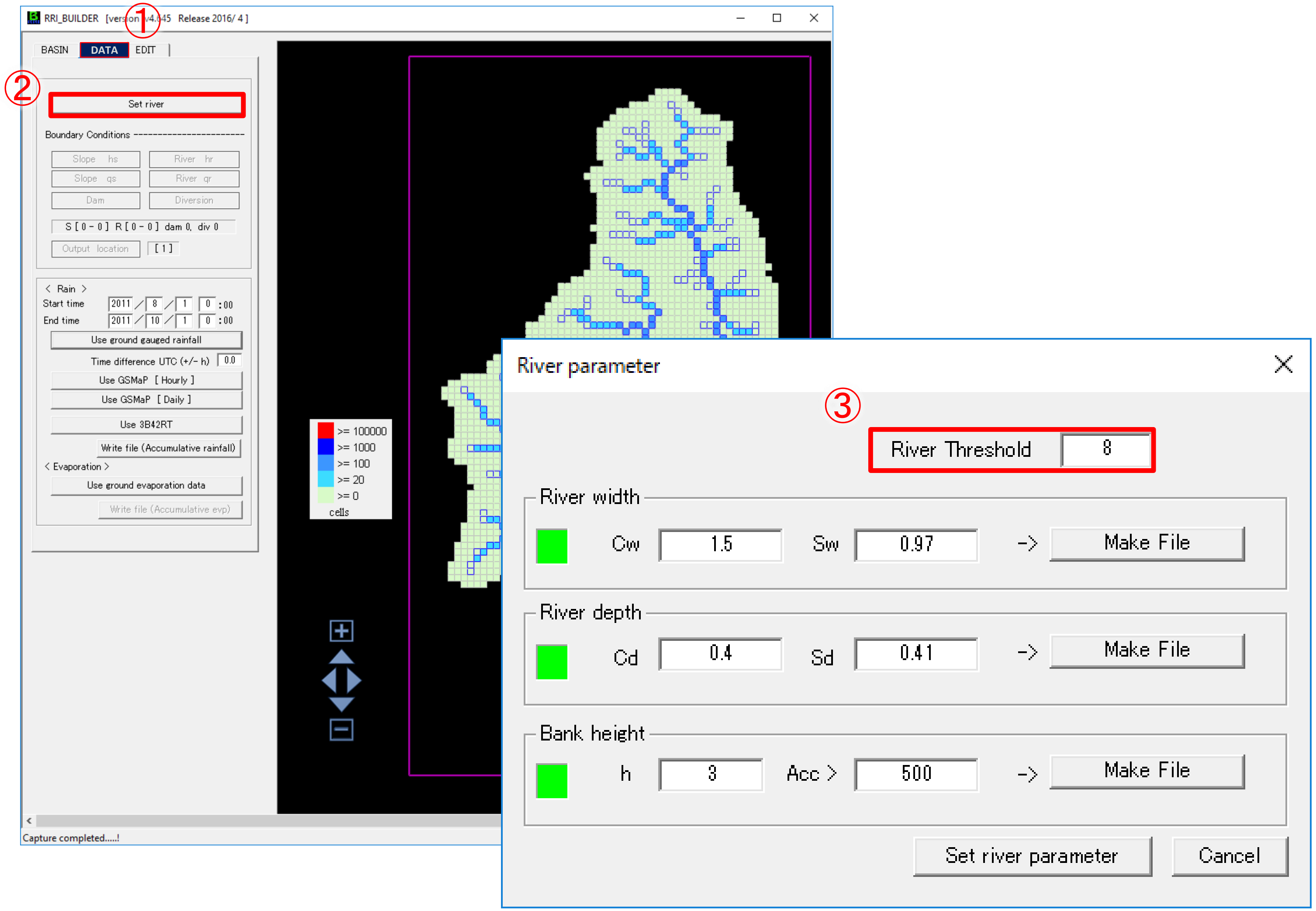
〔File information〕

Each file is stored in ASCII format.

- dem.txt : Elevation data *before* adjustment
- dir.txt : Flow direction data
- acc.txt : Flow accumulative data
- adem.txt : Elevation data *after* adjustment
- adir.txt : Zero setting of flow direction at outlet cells

Required for RRI model

5-1. Setting of "River cell"



Attention! Set value of *Case 15s*

$$width = c_w A^{S_w}$$
$$depth = c_d A^{S_d}$$

where A is the upstream catchment area in [km^2] for each river grid-cell.
Note that the units of width and depth are in [m].

①Select "*DATA*" tab.

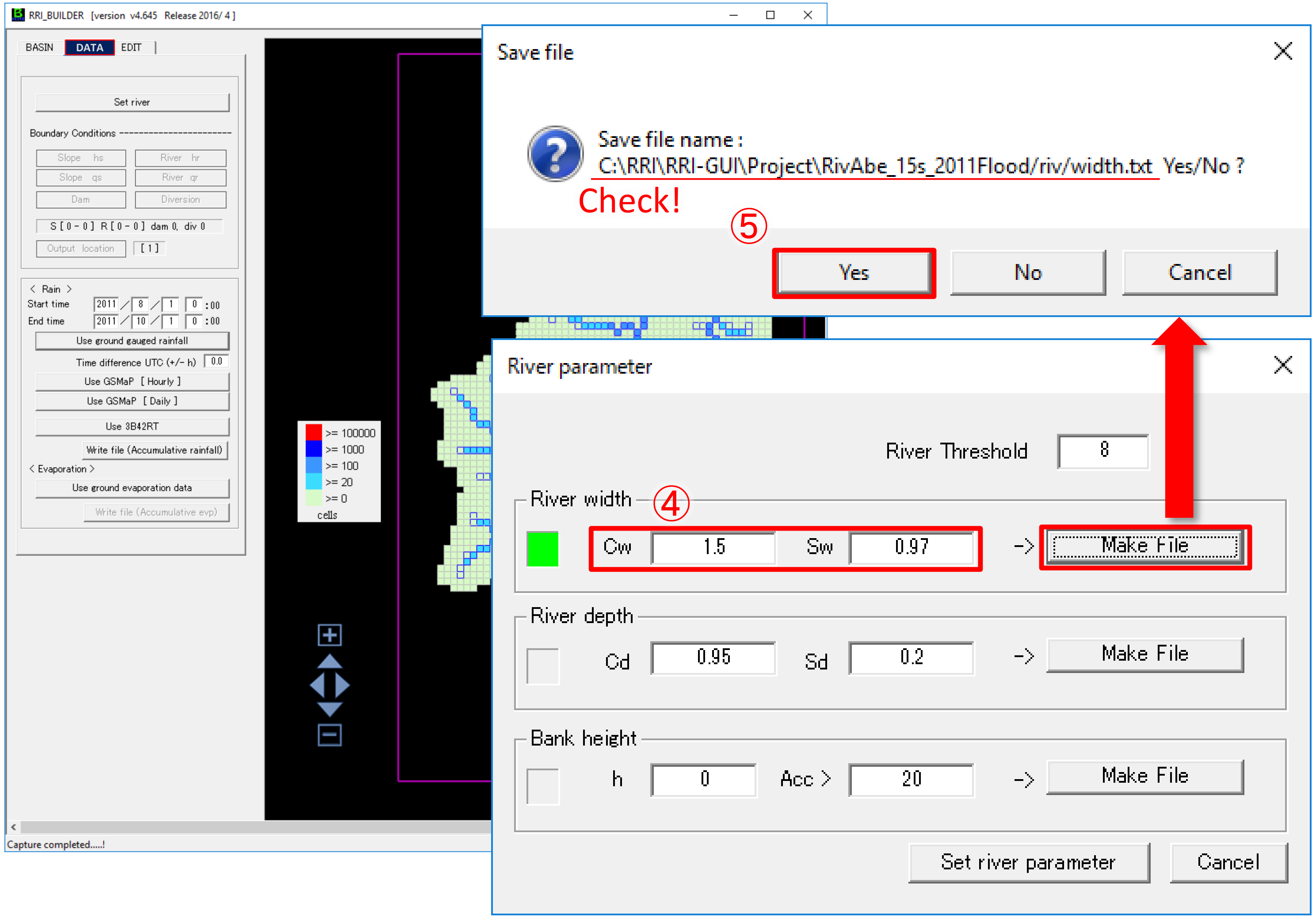
②Click "*Set river*" to open "*River parameter*" window.

③Set "*River Threshold*"=「*8*」

e.g. "*River Threshold*"
- 3s⇒200
- 15s⇒8
- 30s⇒5

The RRI model uses different calculation methods for river cells and slope cells. Therefore, it is necessary to distinguish between river and slope. This threshold should be adjusted according to the DEM resolution.

5-1. Setting of “River width”



Attention! Set value of *Case 15s*

④Set “*Cw*” = *1.5*, “*Sw*” = *0.97*, then click “*Make File*” to open “*Save file*” window.

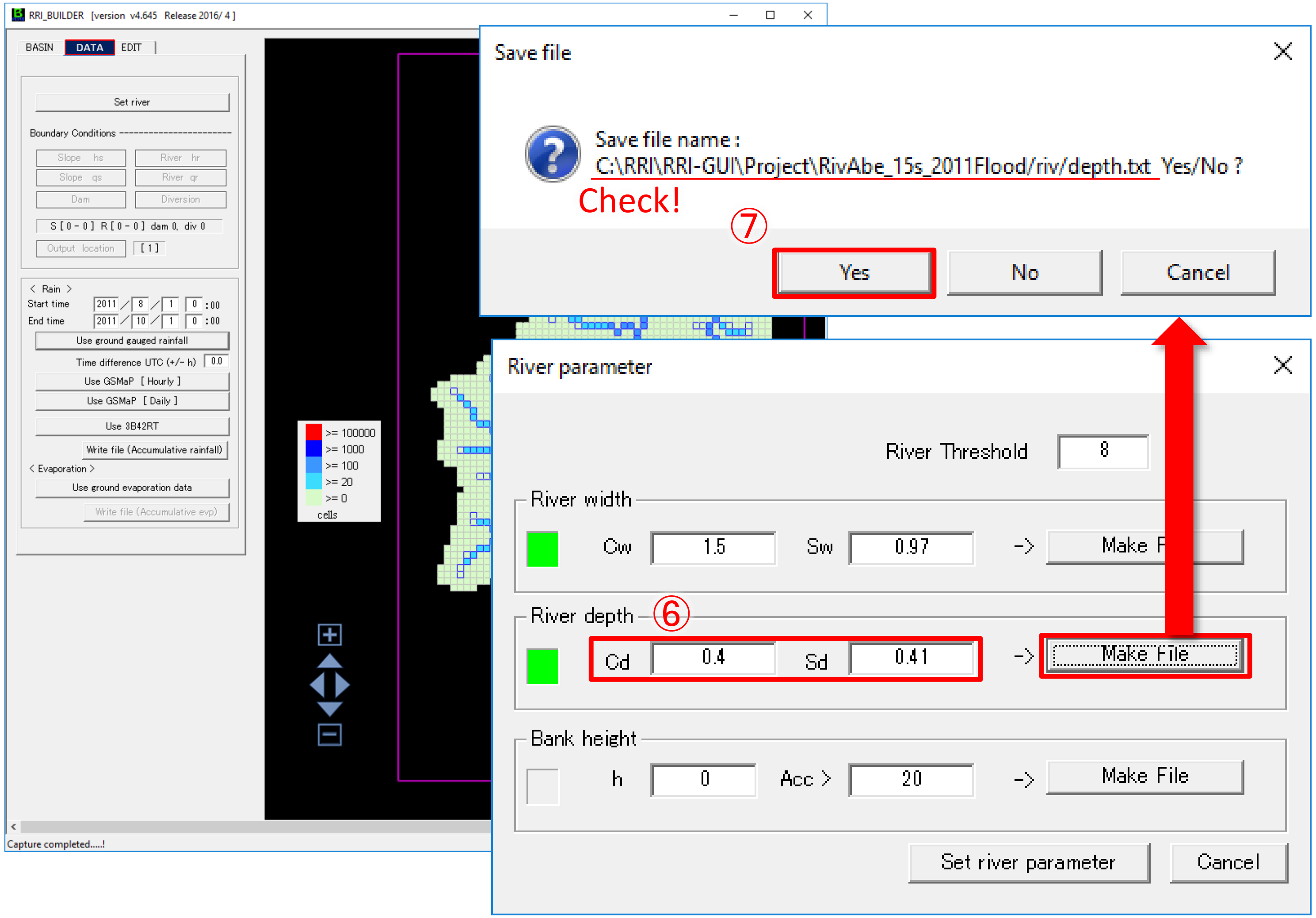
⑤Check “*Save file name*”, then Click “*Yes*”.

$$width = c_w A^{S_w}$$

$$depth = c_d A^{S_d}$$

where A is the upstream catchment area in [km^2] for each river grid-cell. Note that the units of width and depth are in [m].

5-2. Setting of “*River depth*”



Attention! Set value of *Case 15s*

$$width = c_w A^{S_w}$$

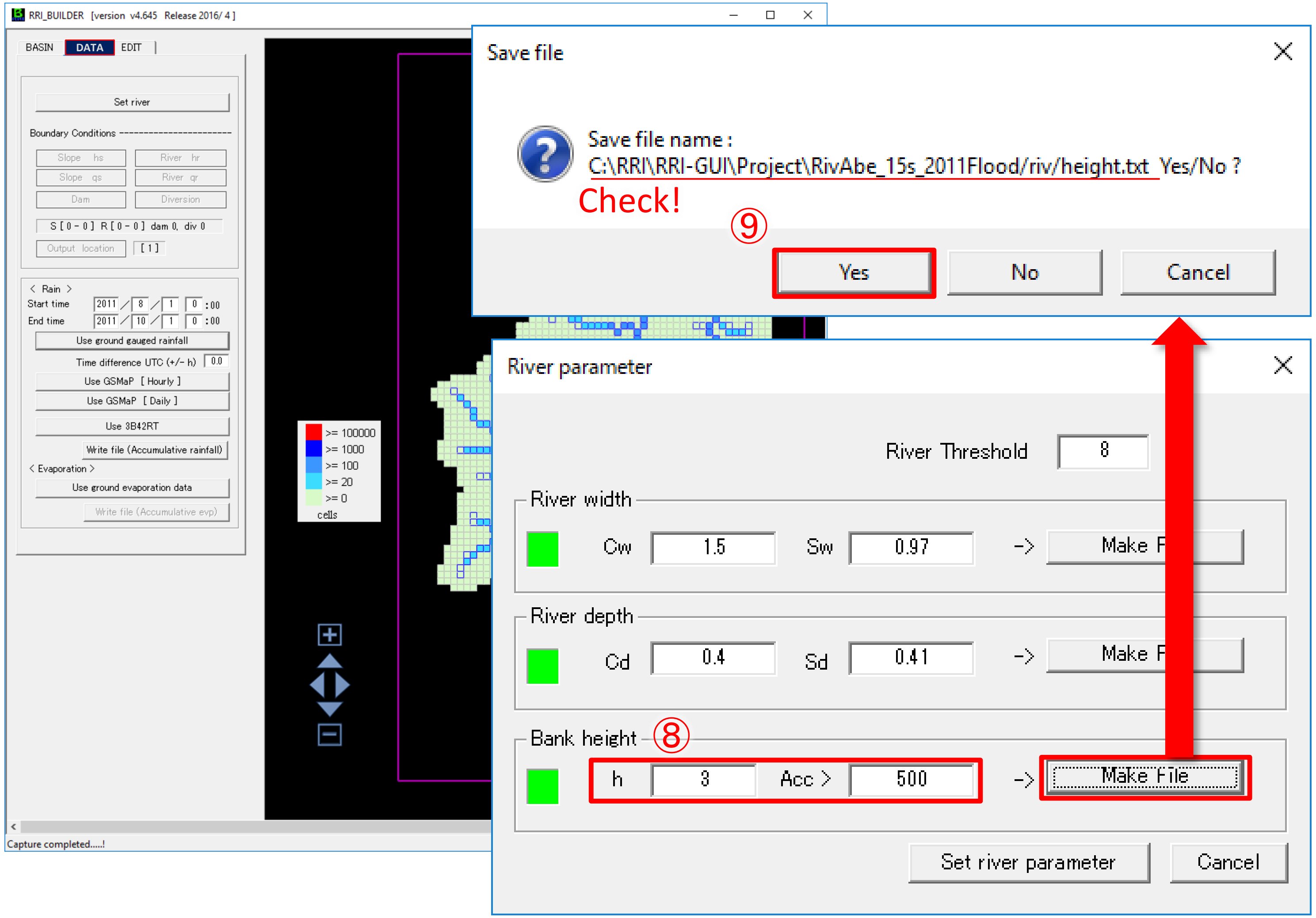
$$depth = c_d A^{S_d}$$

where A is the upstream catchment area in [km^2] for each river grid-cell.
Note that the units of width and depth are in [m].

⑥Set “*Cd*” = *0.4*, “*Sd*” = *0.41*, then click “*Make File*” to open “*Save file*” window.

⑦Check “*Save file name*”, then Click “*Yes*”.

5-3. Setting of "Bank height"



Attention! Set value of *Case 15s*

⑧Set "*h*" = *3*, "*Acc >*" *500*, then click "*Make File*" to open "*Save file*" window.

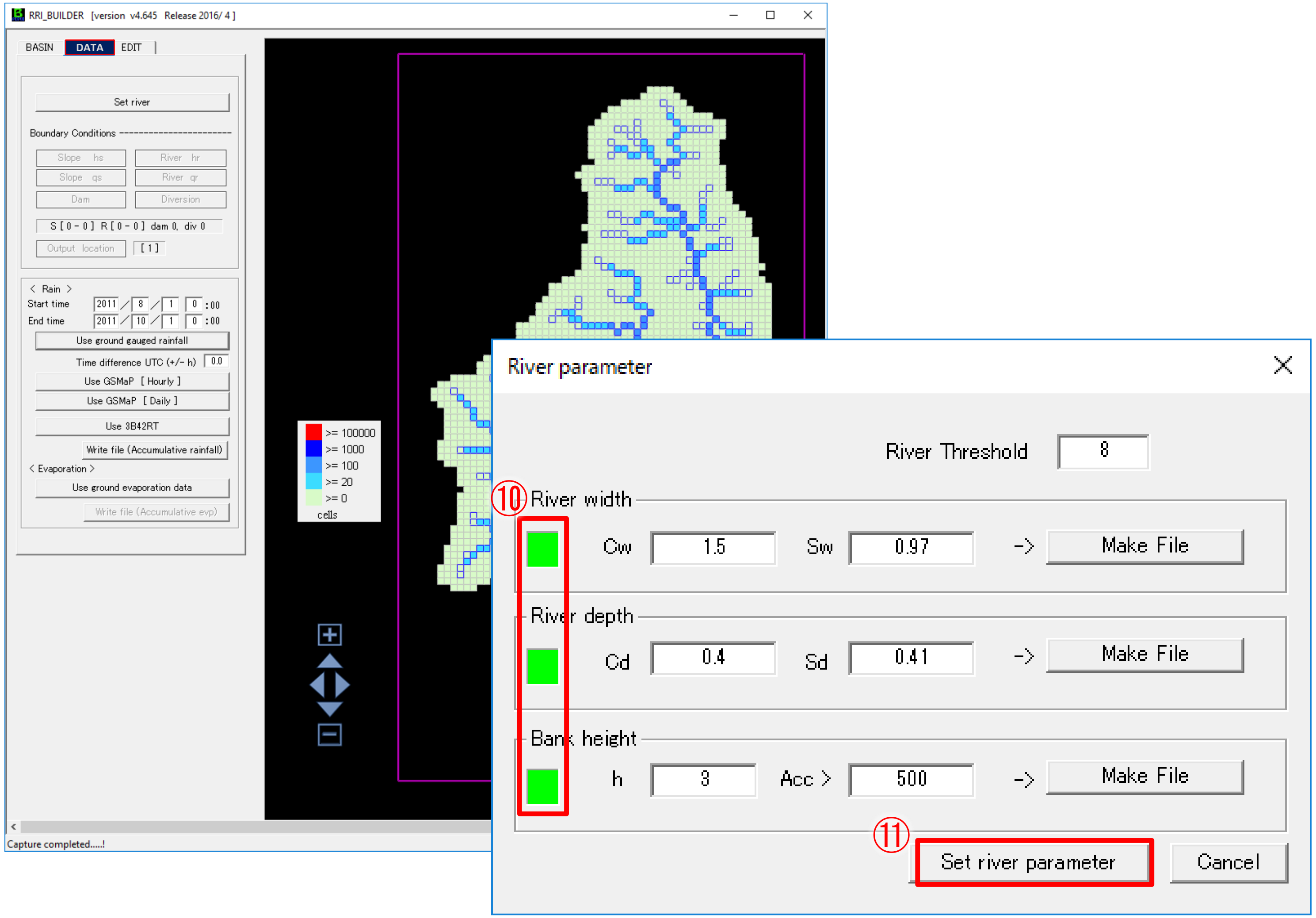
⑨Check a "*Save file name*", then Click "*Yes*".

Attention!
Even if the bank height is Zero, this process should be done.

$$width = c_w A^{S_w}$$
$$depth = c_d A^{S_d}$$

where A is the upstream catchment area in [km^2] for each river grid-cell.
Note that the units of width and depth are in [m].

5-4. Setting of river channel parameters



Attention! Set value of *Case 15s*

$$width = c_w A^{S_w}$$

$$depth = c_d A^{S_d}$$

⑩
Confirm the three green signs.

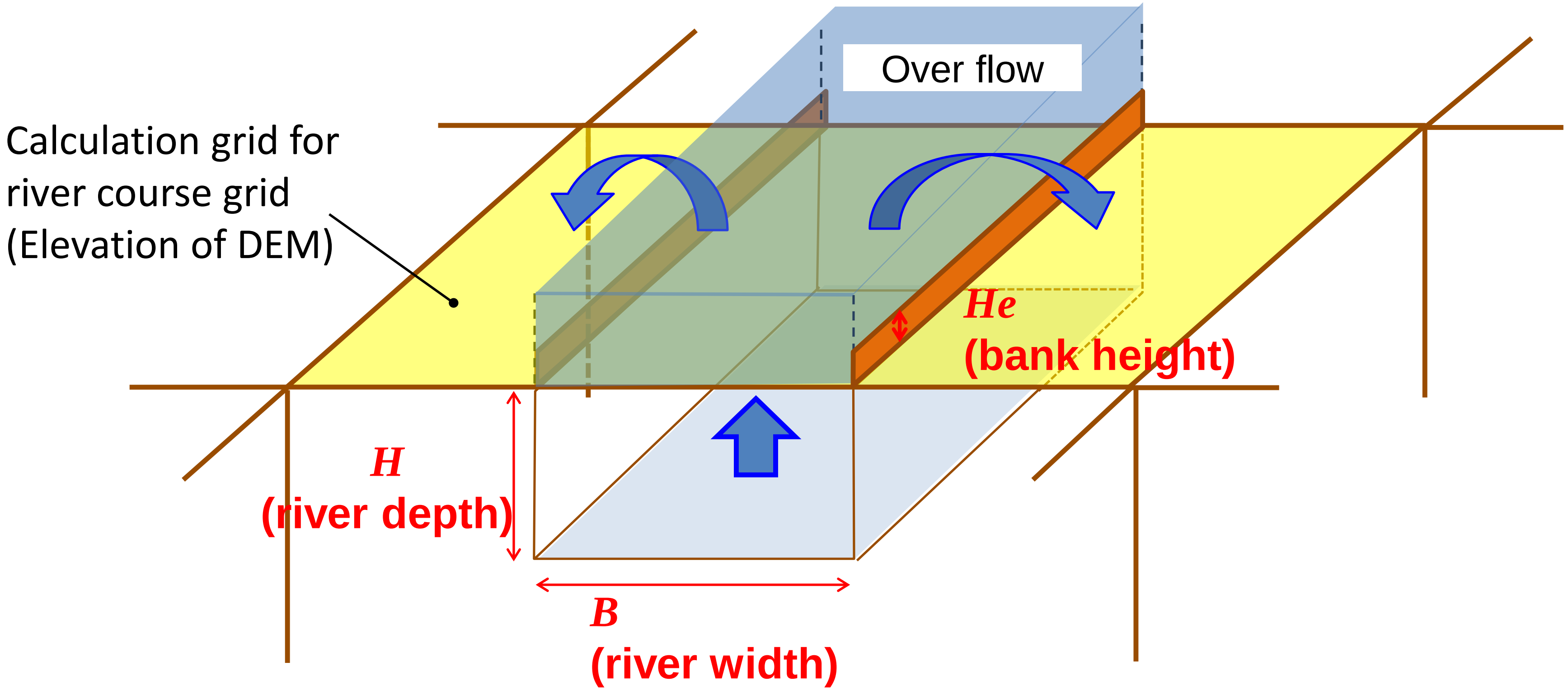
⑪Click "*Set river parameter*"

Done the setting of river channel.

Overview of river channel parameters

◆River parameters

To apply 1-dimentional river calculation, river depth, river width, bank height should be set.



Cross section information may not be available in data limited regions ….

Overview of river channel parameters

◆Empirical equations

For the first order estimation,
the following empirical equations can be used to represent river width and depths for each river grid-cell.

$$width = c_w A^{s_w}$$

$$depth = c_d A^{s_d}$$

where *A* is the upstream catchment area in [km^2] for each river grid-cell.
Note that the units of width and depth are in [m].

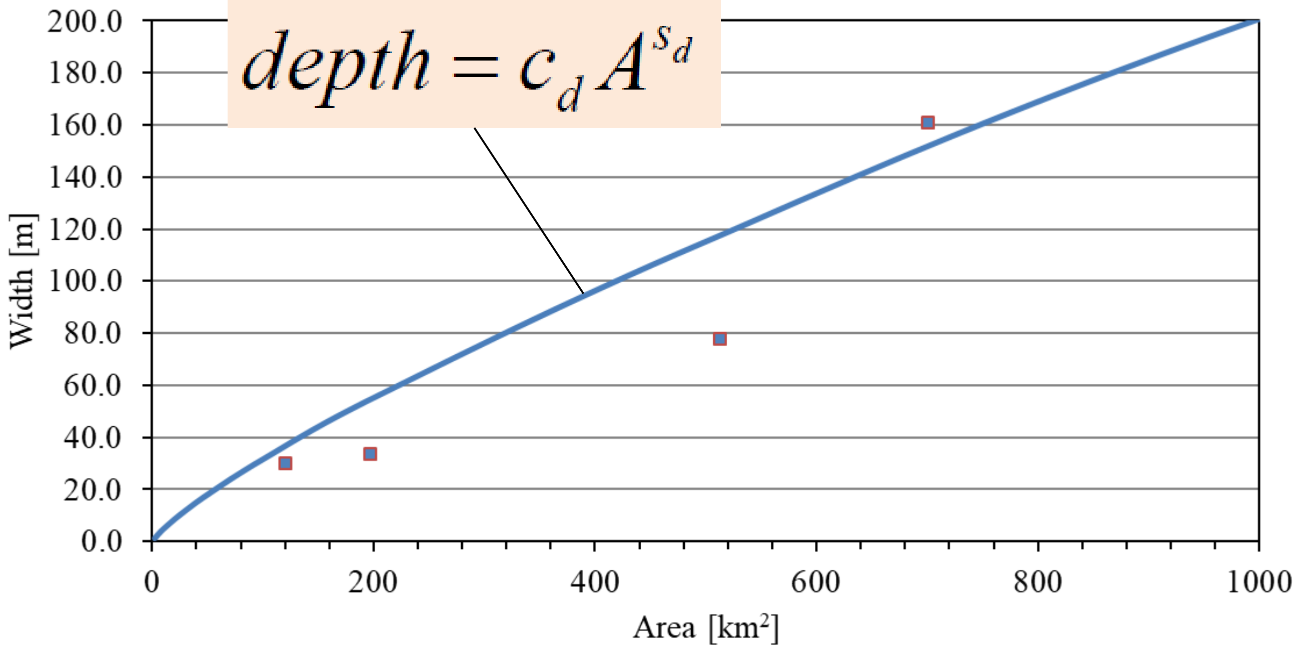
Overview of river channel parameters

◆How to Set River Channel Parameters?

The parameters are determined using cross-section data, satellite imagery (e.g., Google), and other relevant data sources so that they cover the range of those values.

$$width = c_w A^{s_w}$$

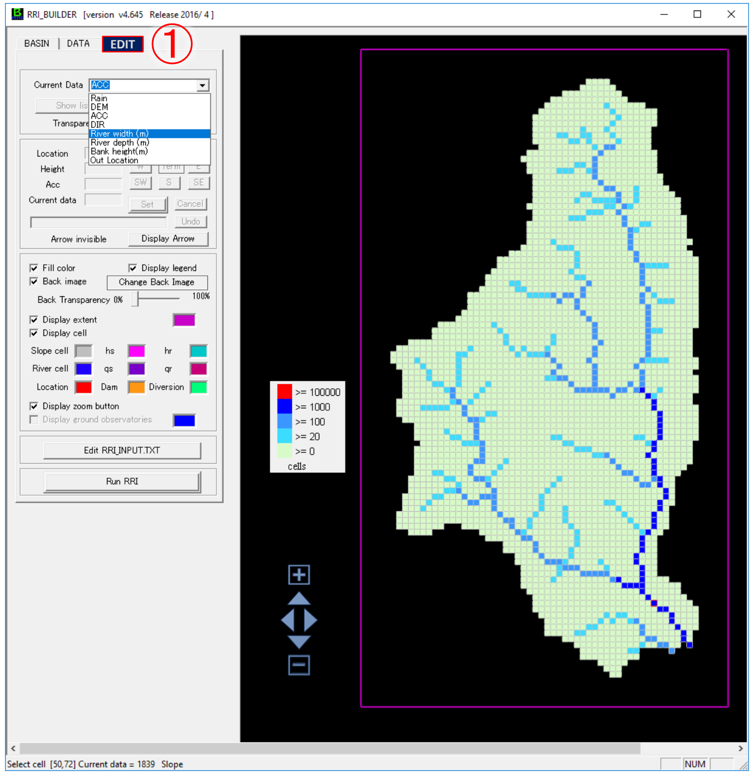
$$depth = c_d A^{s_d}$$

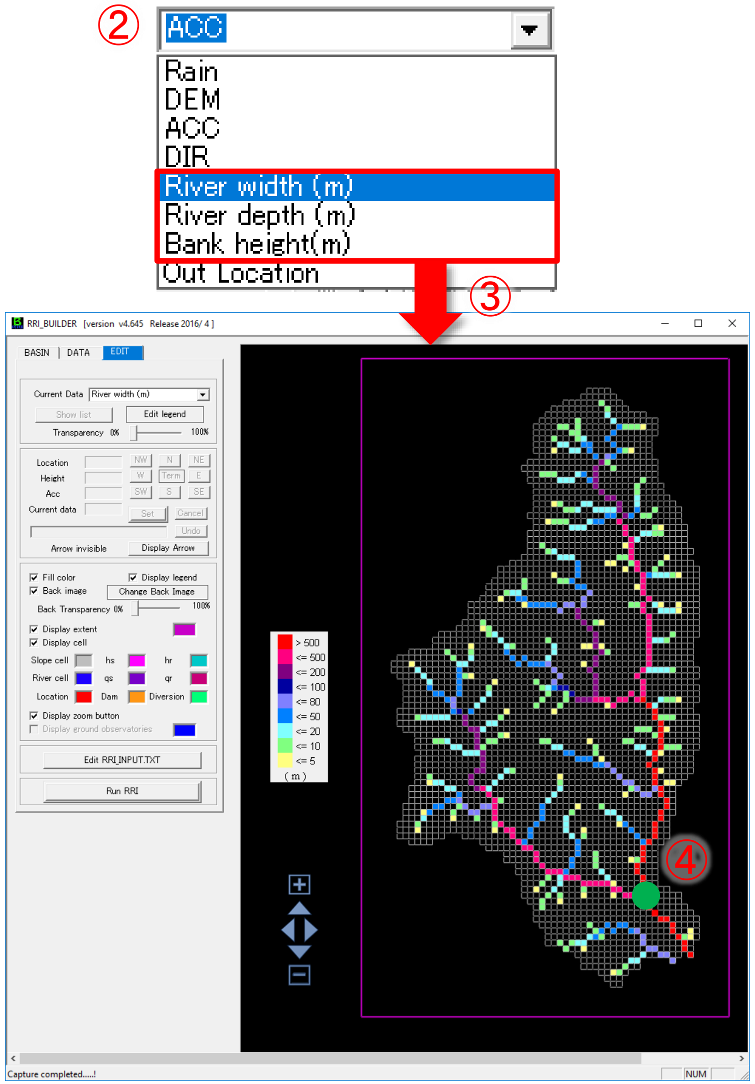


Measure Distance tool in Google Maps

Modification of river channel parameters

■You can modify river channel parameters in mesh units using RRI-GUI.





①Select “*EDIT*” tab.

②Choose the river channel parameters you want to modify in “*Current Data*”.
e.g. “*River width(m)*”

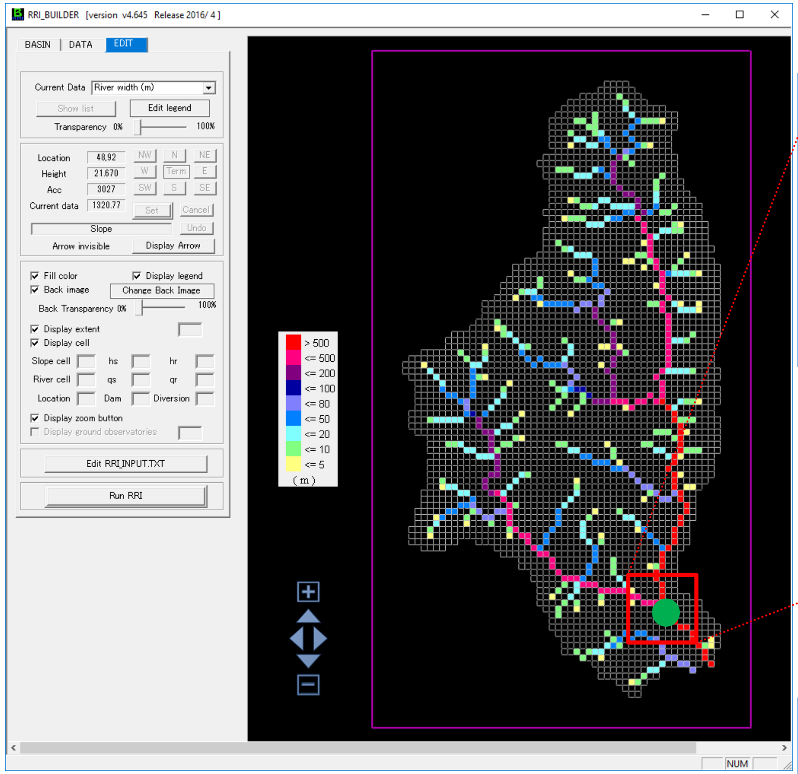
③Setting data is displayed.

④Double click a modification cell(● in figure).

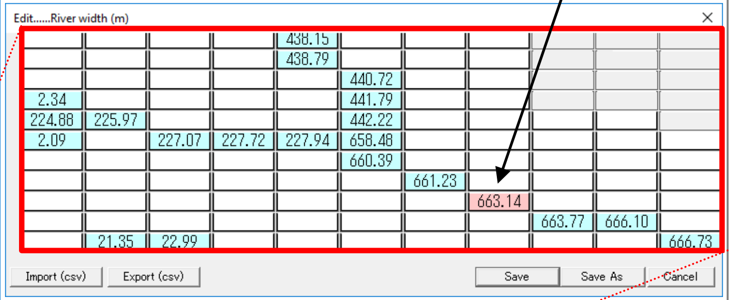
(Continue to next slide…)

Modification of river channel parameters

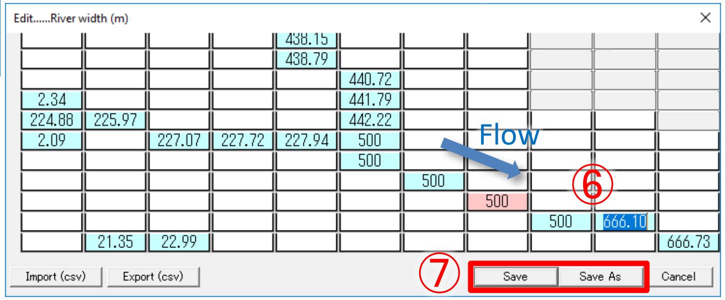
■You can modify river channel parameters in mesh units using RRI-GUI.



⑤ ● in figure



For example, to modify the river width after confluence river uniformly to “500m”.



Modify the value from “666.10” to “500”

⑤The current setting value is displayed as a table.
The red cell in the table shows the point double clicked.

⑥Choose a cell in the table and modify the current value.

⑦“*Save*” or “*Save As*”

Done

6-1. Presetting for rainfall data : CSV file

■Presetting for rainfall data by ground gauging data

Number of stations

Station name

Latitude(degree)

Longitude (degree)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	14	湯の島	大谷	梅ヶ島	戸持	玉川	安倍川島	大川	牛妻	奈良間	静岡	笹間	小河内	上川根	井川	
2	lat	35.308056	35.305	35.279722	35.258611	35.145556	35.144167	35.118333	35.07[illegible]111	35.015556	34.970278	35.031111	35.305833	35.110278	35.208333	
3	lon	138.33806	138.31306	138.33528	138.34889	138.33	138.29583	138.21833	138.37	138.26917	138.36417	138.16139	138.27417	138.16028	138.19722	
4	2011/8/1 0:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5	2011/8/1 1:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
6	2011/8/1 2:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
7	2011/8/1 3:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
8	2011/8/1 4:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
9	2011/8/1 5:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
10	2011/8/1 6:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1222	2011/9/20 18:00	5	0	10	17	6	6	9	1	1	0	6	0	3	1	
1223	2011/9/20 19:00	15	5	12	5	5	3	3	1	7	0	3	4	10	7	
1224	2011/9/20 20:00	12	5	16	28	6	15	2	4	2	2	0	7	6	12	
1225	2011/9/20 21:00	15	8	12	7	6	2	1	0	0	0	1	2	1	1	
1226	2011/9/20 22:00	5	8	4	7	8	6	6	6	9	2	1	5	1	1	
1227	2011/9/20 23:00	13	21	11	7	4	7	10	7	2	4	1	10	5	3	
1228	2011/9/21 0:00	30	20	33	13	10	20	9	3	8	1	3	3	6	6	
1229	2011/9/21 1:00	8	6	6	4	7	3	1	1	4	0	2	8	3	6	
1230	2011/9/21 2:00	22	7	22	7	3	11	11	1	1	0	6	7	5	3	
1231	2011/9/21 3:00	7	6	6	8	4	1	10	4	0	3	5	15	10	22	
1232	2011/9/21 4:00	14	4	13	14	5	2	2	3	2	0	0	6	3	7	
1233	2011/9/21 5:00	14	13	15	7	8	4	4	0	1	0	7	14	5	8	
1234	2011/9/21 6:00	22	34	24	15	10	16	16	11	4	2	15	19	15	17	
1235	2011/9/21 7:00	12	11	9	9	0	8	2	2	0	0	2	18	8	12	
1236	2011/9/21 8:00	13	5	9	11	10	8	6	2	2	1	7	11	14	15	
1237	2011/9/21 9:00	12	8	9	10	0	9	9	2	1	0	3	7	8	14	
1238	2011/9/21 10:00	19	11	13	16	5	11	10	1	8	1	21	10	19	16	
1239	2011/9/21 11:00	35	34	38	35	31	27	12	25	7	15	24	28	27	24	
1240	2011/9/21 12:00	33	29	32	33	15	19	12	10	16	6	38	20	33	15	
1241	2011/9/21 13:00	44	43	48	48	37	49	24	18	20	12	48	38	55	28	
1242	2011/9/21 14:00	48	43	46	48	37	53	31	23	31	17	64	57	69	36	
1243	2011/9/21 15:00	68	57	62	47	62	62	31	32	30	17	55	82	57	46	
1244	2011/9/21 16:00	52	63	59	44	32	41	22	8	10	8	26	73	64	40	
1245	2011/9/21 17:00	17	18	18	14	5	7	5	4	4	3	3	15	3	7	

Date & Time

Rain data is CSV file format.

Data list

-1st line : Number of stations & Station name

-2nd line : Latitude (degree)

-3rd line : Longitude (degree)

-4th line after : Date time & rainfall data (mm/h)

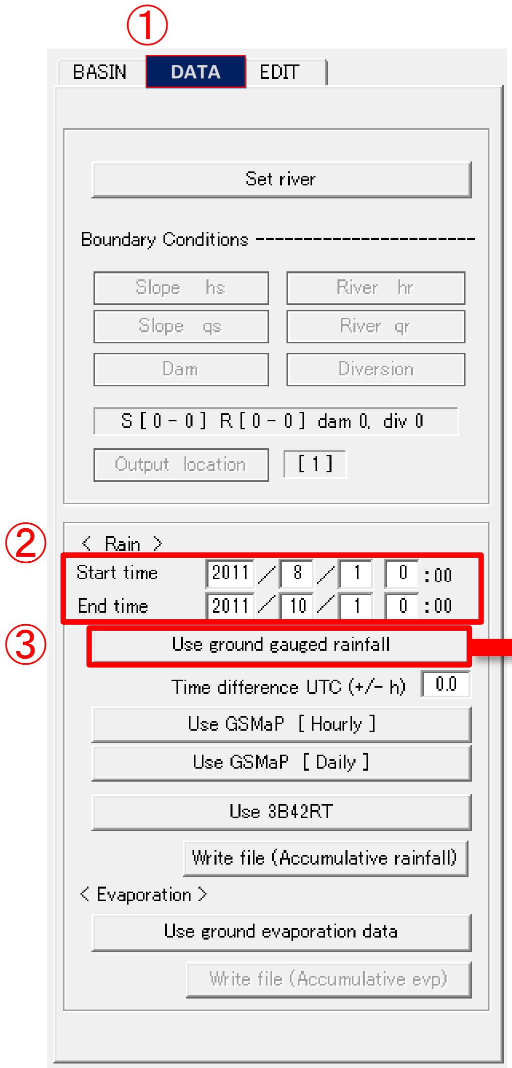
In this seminar, please use to the created rainfall file shown below.

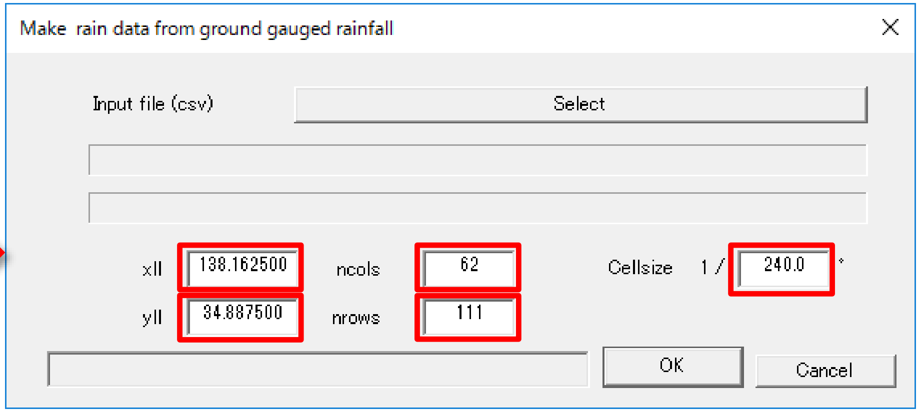
¥RRI_1_4_2_7_GUI¥TutorialData¥Rain_GroundGauge¥

Rain_ground.csv

6-2. Make rainfall files

■Setting of rainfall information





Default value is the value automatically acquired from the terrain file.

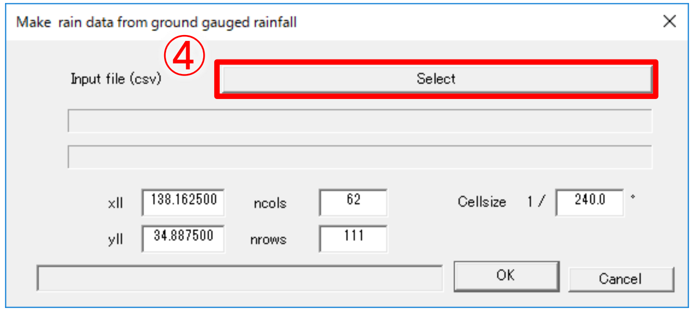
①Select "*DATA*" tab.

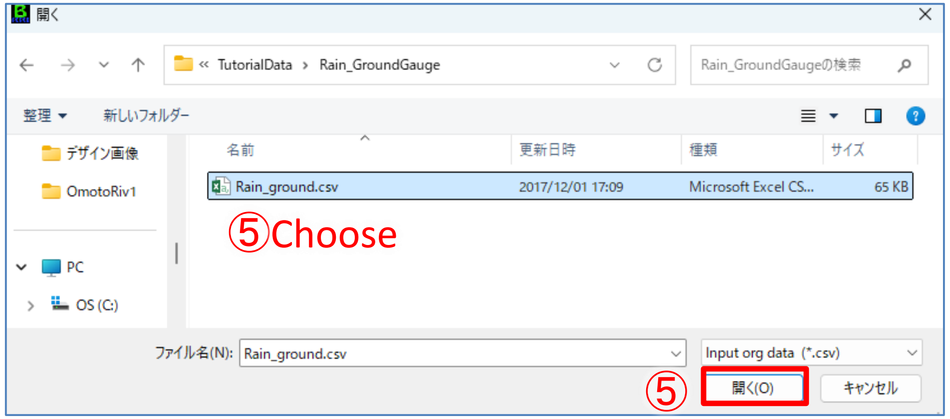
②Set "*Start time*" and "*End time*" shown blow.
Start time:*2011*/*08*/*01* *0*:00
End time :*2011*/*10*/*01* *0*:00

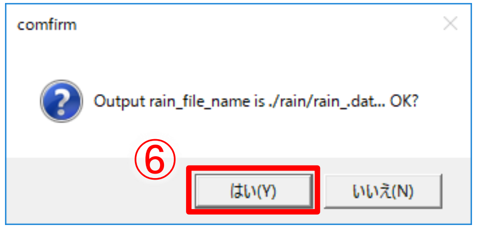
③Click "*Use ground gauged rainfall*" to open "*Make rain data from ground gauged rainfall*".

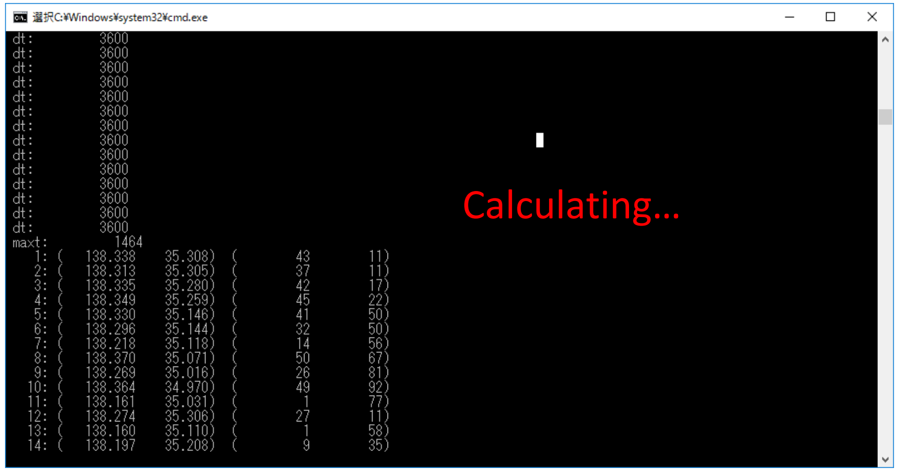
6-2. Make rainfall files

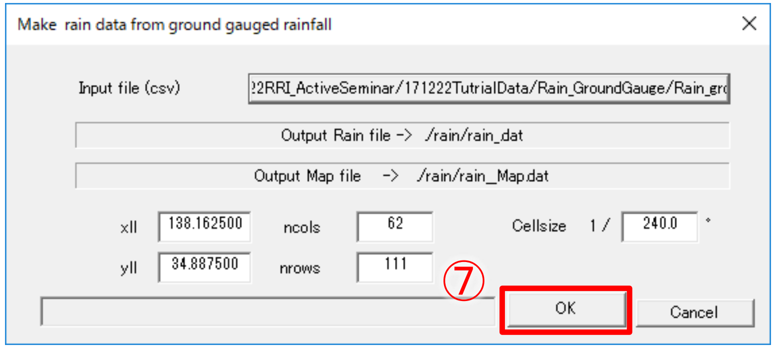
■Choice of file by ground gauged data and calculating











④Select "*Select*" of "*Input file (csv)*".

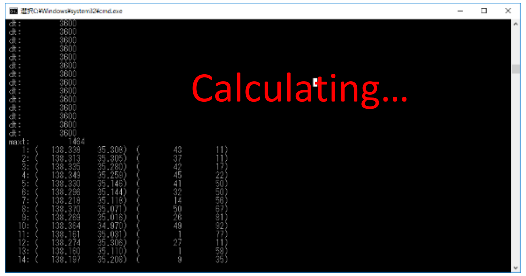
⑤Choose "*Rain_ground.csv*", and click "*Open(O)*".

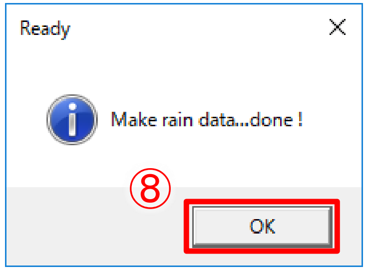
⑥Show "*Confirm*" window, then click "*はい(Y)*".

⑦Click "*OK*" : Command prompt is displayed, and calculation is started…

6-2. Make rainfall files

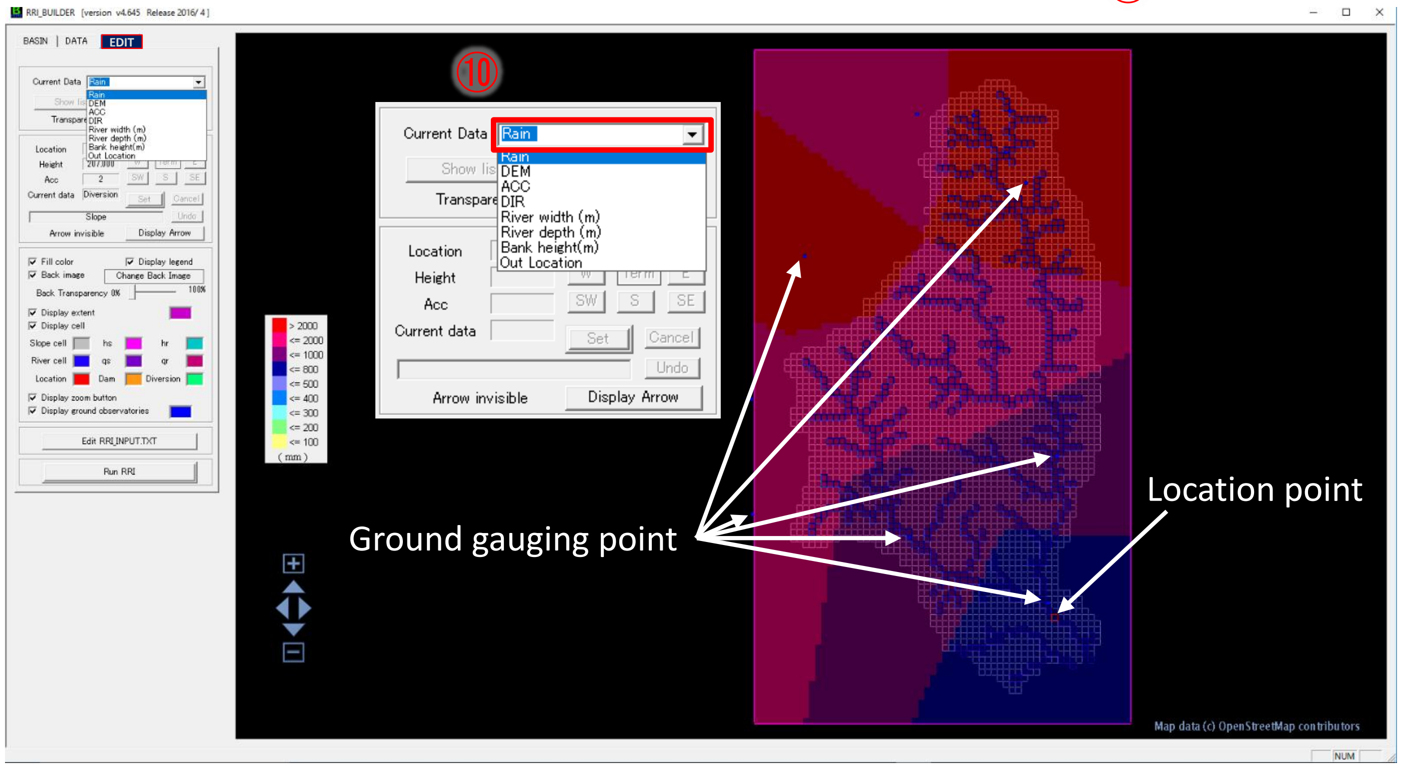
■Confirming of distribution of rainfall data





⑪

⑨



⑧Click "*OK*"
The process is complete when "*Make rain data... done !*" appears.

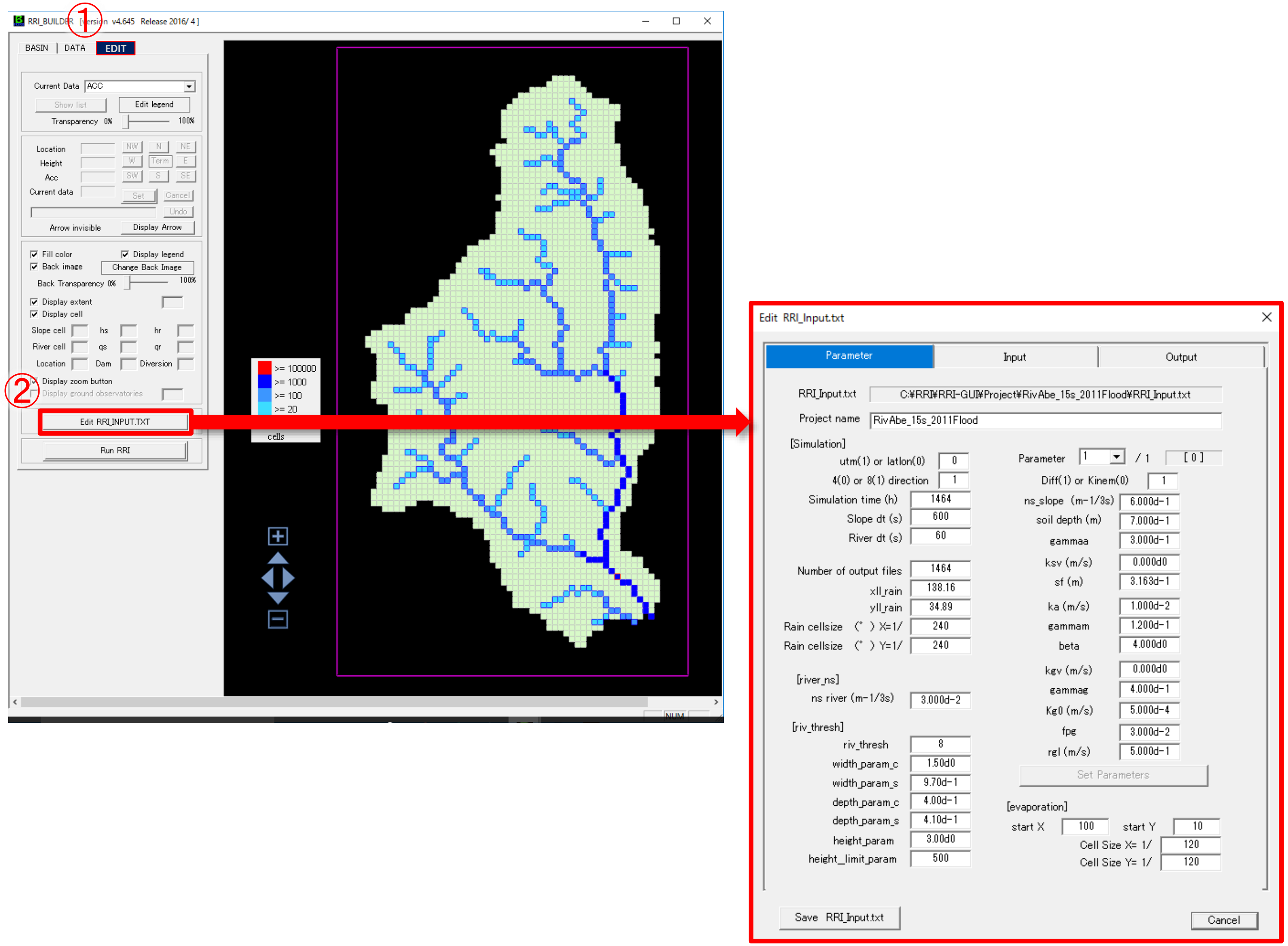
⑩Choose "*Rain*" from pulldown in "*Current Data*" .

⑪Displayed distribution of rainfall by Thiessen division.

The Thiessen polygon division is used to calculate areal rainfall from ground gauging points.

7.Set parameters for calculation of RRI

7-1. Set parameters

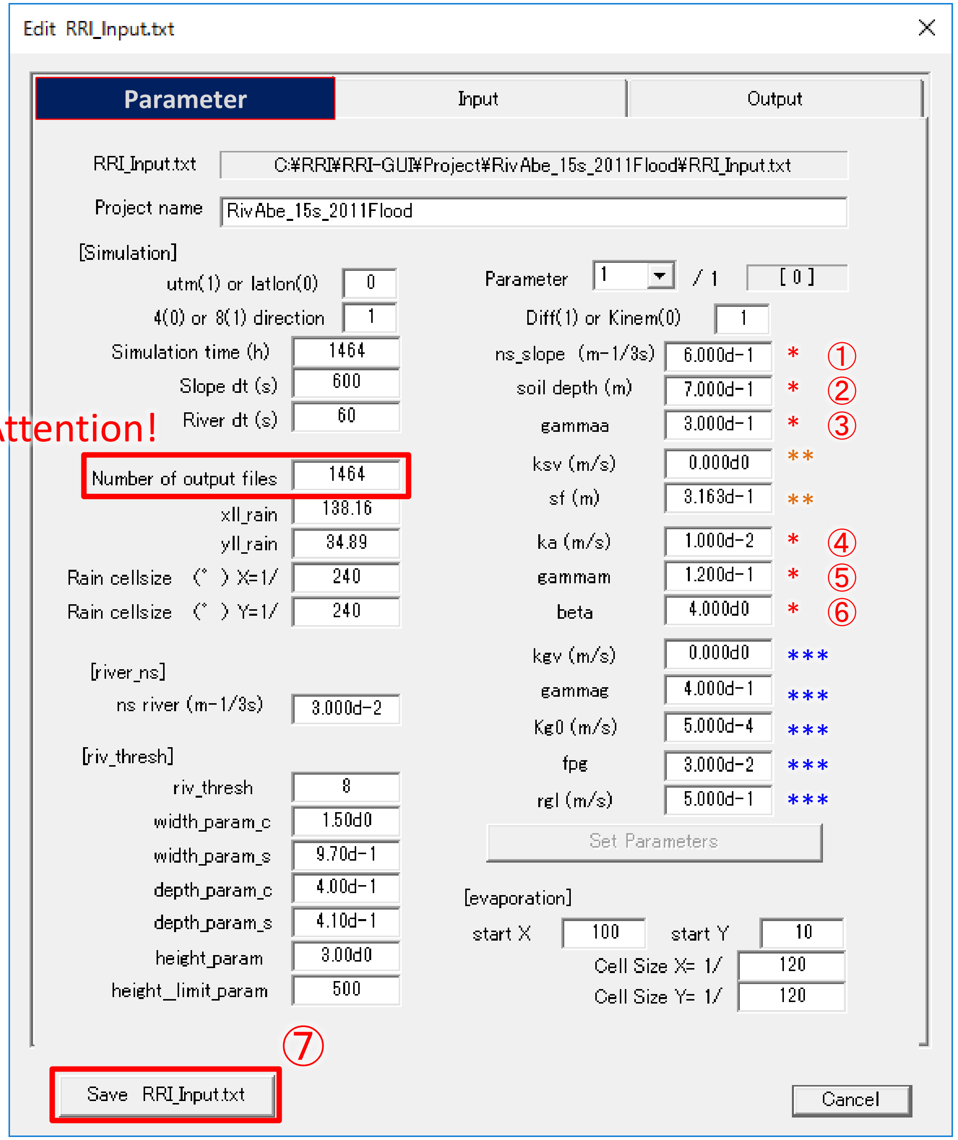


①Select “*EDIT*” tab.

②Click “*Edit RRI_INPUT.TXT*” to open “*Edit RRI_Input.txt*”.

7-1. Set parameters

Attention!



〔Setting parameters〕

* Lateral flow
Subsurface and surface model parameters

** Infiltration flow
Green-Ampt model parameters

*** Groundwater flow
Groundwater component

Set each parameter as shown on the left.
In this seminar, Lateral flow as shown below.

① Roughness on slope : *0.6*
"*ns_slope(m$^{-1/3}$/s)*"
② Soil depth : *0.7* [m]
"*Soil depth(m)*"
③Saturated effective porosity : *0.3*
"gammaa"
④Saturated hydraulic conductivity : *0.01*
"ka(m/s)"
⑤Unsaturated effective porosity : *0.12*
"gammam"
⑥Hydraulic conductivity rate : *4*
"beta"
(Saturated – Unsaturated)

⑦Click "*Save RRI_Input.txt*"

7-1. Set parameters

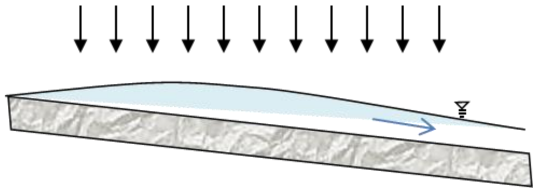
RRI model three conditions of Surface / Subsurface Flow

Surface / subsurface flow conditions

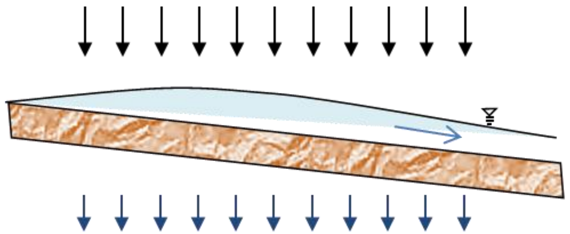
(A) Only overland flow (no infiltration loss, no subsurface flow)

(B) Vertical infiltration + Infiltration excess overland flow

(C) Saturated subsurface + Saturation excess overland flow

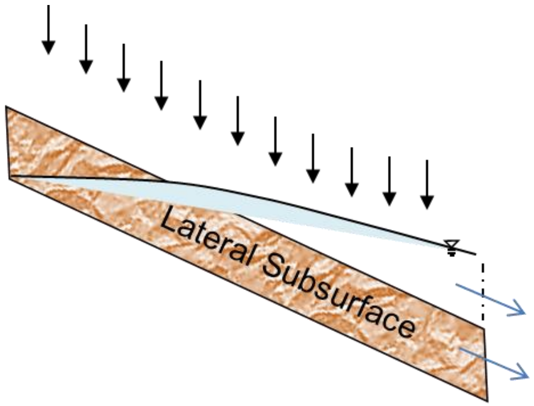


e.g., urban area



Infiltration : Green Ampt Model

e.g., paddy field, cropland

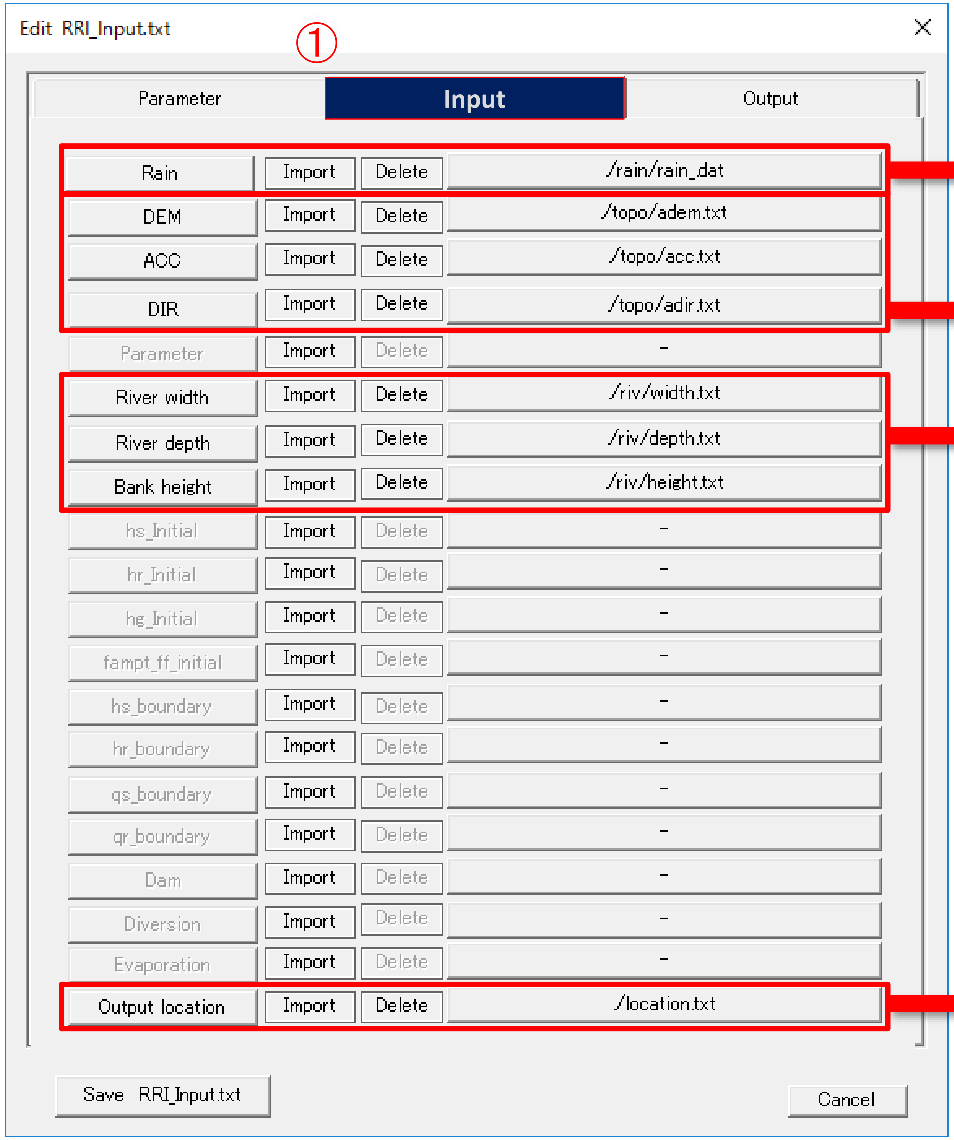


e.g., mountainous area

Users can set the appropriate type for each individual cell.

7.Set parameters for calculation of RRI

7-1. Set parameters



②

Rainfall data file

Terrain data files

River channel data files

Location file

①Select "*Input*" tab.

②Confirm files link.

-Rainfall data file

-Terrain data files

-River channel data files

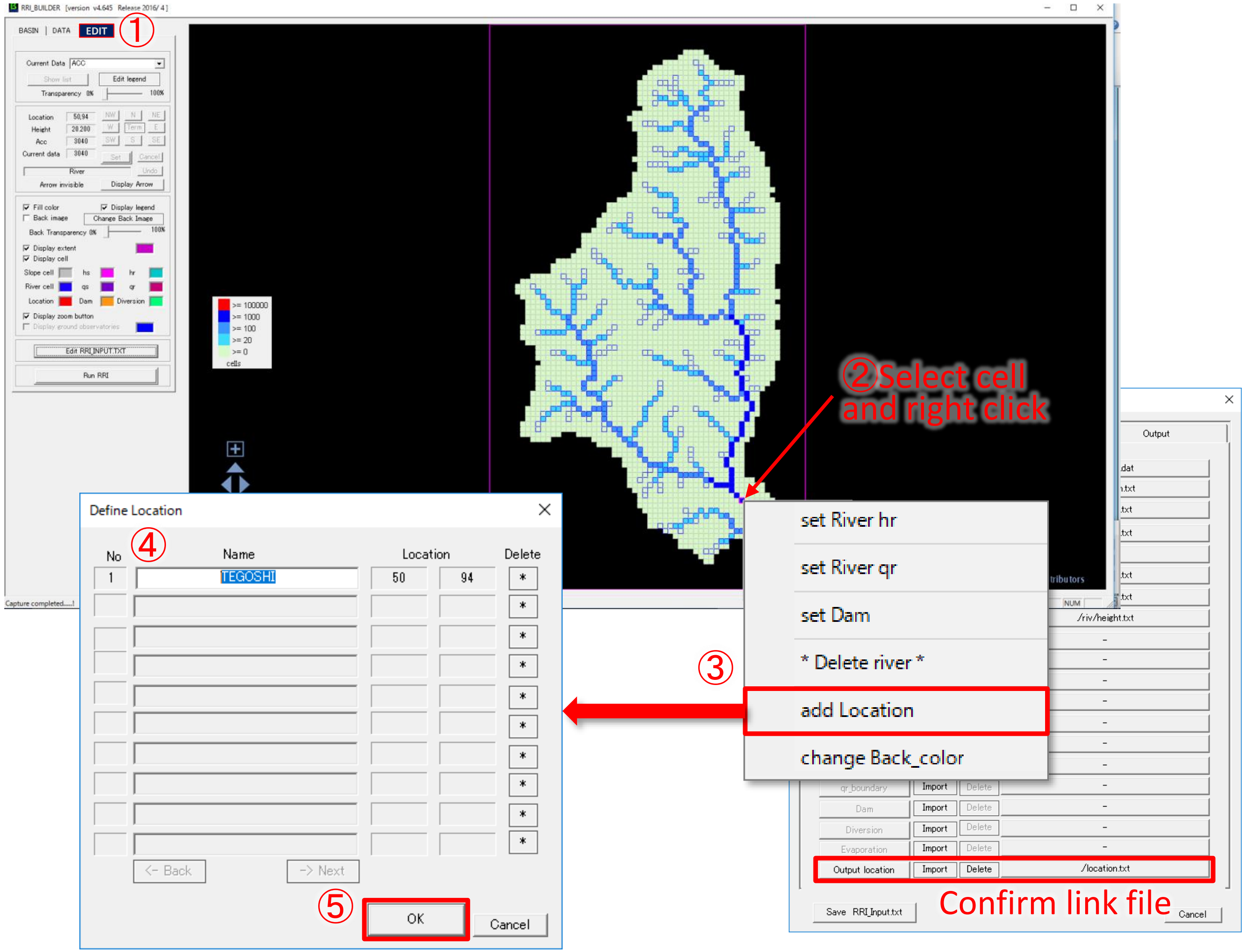
-<u>Location file</u>

↓

If "*location.txt*" does not exist, please refer to next slide.

Setting of "location.txt"

■Setting of output location file



①Select "*EDIT*" tab.

②Select cell at output point, and right click.

③Select of "*add Location*", displayed "*Define Location*" window.

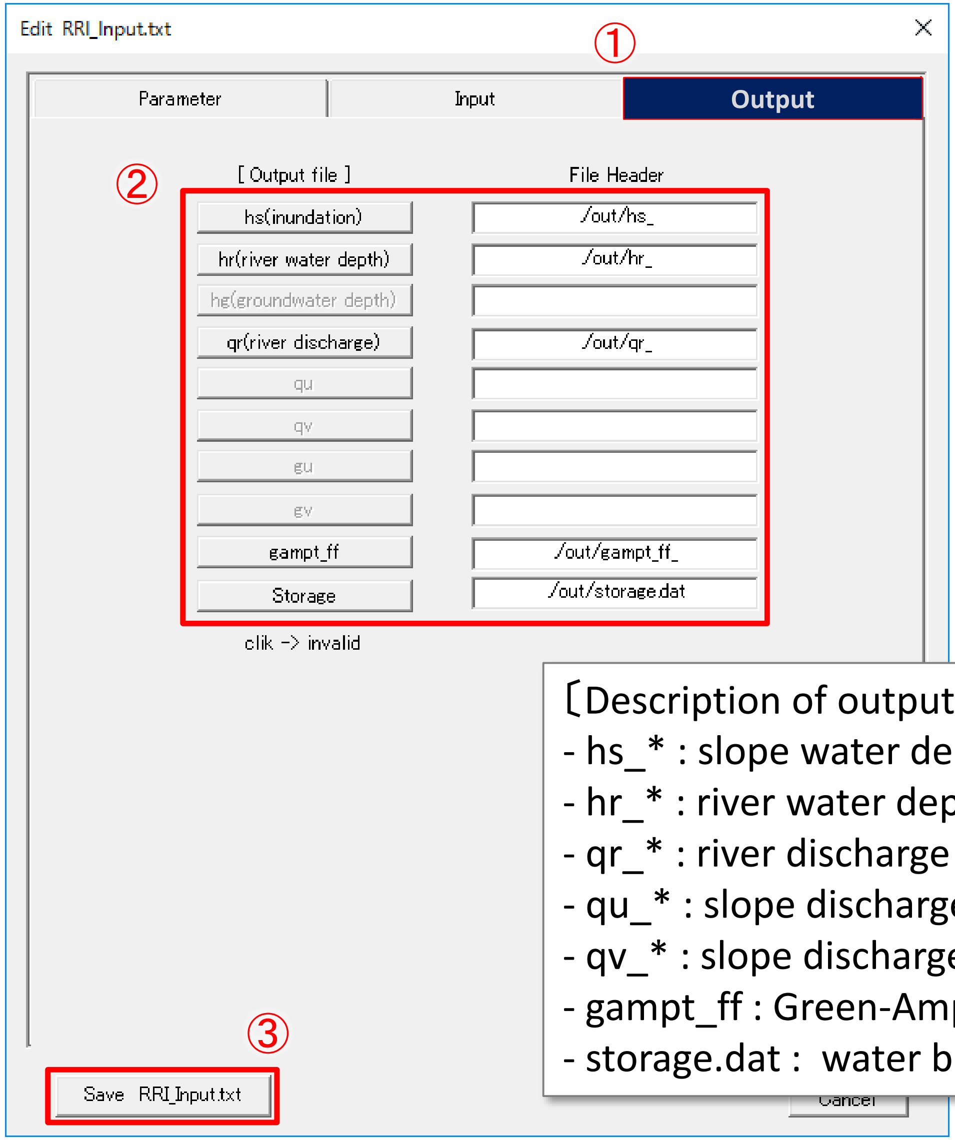
④Type point name.
e.g. "*TEGOSHI*"

⑤Click "*OK*"

Confirm link file in "*Output location*".

7.Set parameters for calculation of RRI

7-1. Set parameters



〔Description of output files〕
- hs_* : slope water depth(inundation)
- hr_* : river water depth
- qr_* : river discharge
- qu_* : slope discharge for x direction (longitude)
- qv_* : slope discharge for y direction (latitude)
- gampt_ff : Green-Ampt cumulative water depth
- storage.dat : water balance checking file

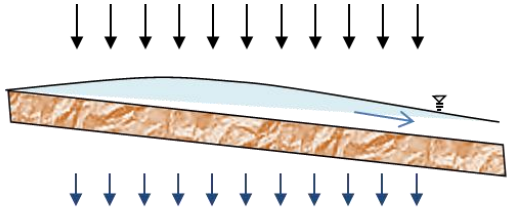
①Select “*Output*” tab.

②Check output file
- hs_* : slope water depth (inundation)
- qr_* : river discharge

③Click “*Save RRI_Input.txt*”

Set Green-Ampt parameters

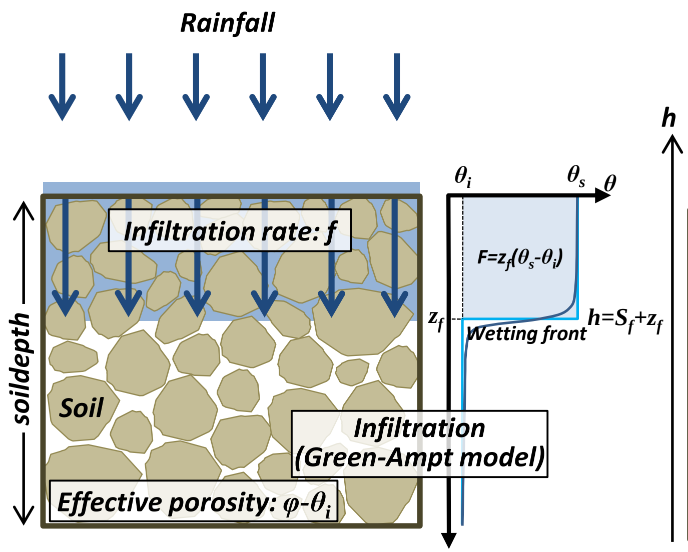
◆Vertical infiltration + Infiltration excess overland flow



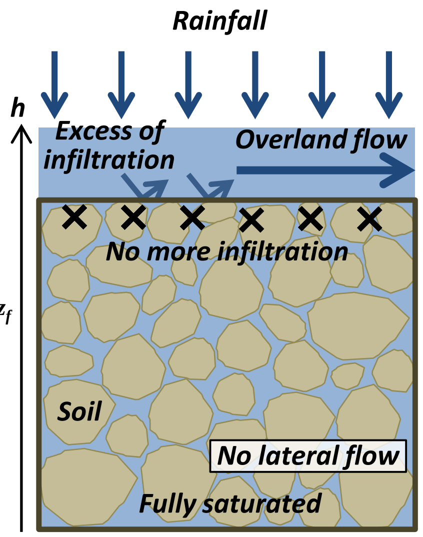
Infiltration : Green Ampt Model

- ✓ ***For relatively flat area***
- ✓ ***Only vertical infiltration is considered in the subsurface.***
- ✓ ***Apply Green-Ampt infiltration model (Raws et al., 1992).***
- ✓ ***No lateral subsurface flow is assumed.***
- ✓ ***Overland flow due to excess of infiltration***
- ✓ ***Adjustable parameters as below***

Before infiltration excess



After infiltration excess



- ✓ ***Hydraulic conductivity: k_{sv}***
- ✓ ***Suction head at wetting front: S_f***
- ✓ ***Depth of soil layer: soildepth***
- ✓ ***Effective porosity: gammaa (=$\varphi-\theta_i$)***

$$f = k_{sv}\left[1+\frac{(\phi-\theta_i)S_f}{F}\right]$$

Set Green-Ampt parameters

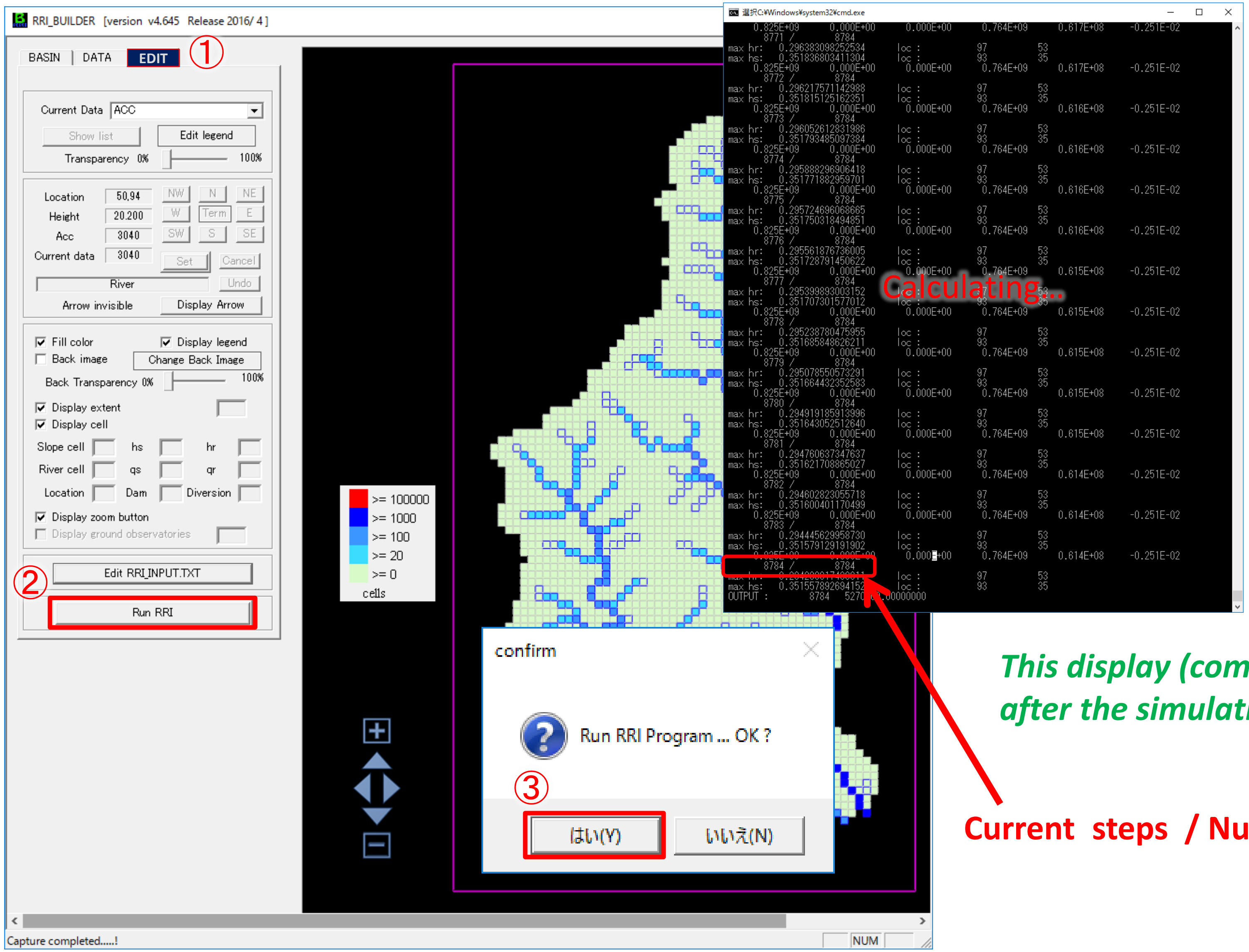
On the Green-Ampt infiltration

Reference Table : Green-Ampt Infiltration Parameters for different soil texture

Soil texture class	k_{sv} (m/s)	ϕ [gammaa]	S_f (m) [faif]
Sand	6.54E-05	0.437	0.0495
Loamy sand	1.66E-05	0.437	0.0613
Sandy loam	6.06E-06	0.453	0.1101
Loam	3.67E-06	0.463	0.0889
Silt loam	1.89E-06	0.501	0.1668
Sandy clay loam	8.33E-07	0.398	0.2185
Clay loam	5.56E-07	0.464	0.2088
Silty clay loam	5.56E-07	0.471	0.273
Sandy clay	3.33E-07	0.43	0.239
Silty clay	2.78E-07	0.479	0.2922
Clay	1.67E-07	0.475	0.3163

From Rawls, W. J. et al.., 1992. Infiltration and soil water movement. In: Handbook of hydrology, New York: McGrow-Hill Inc., 5.1-5.51. (Units are converted for RRI Model)

8-1. Run RRI model



①Select "*EDIT*" tab.

②Click "*Run RRI*", then display "confirm" window.

③Click "*はい(Y)*"

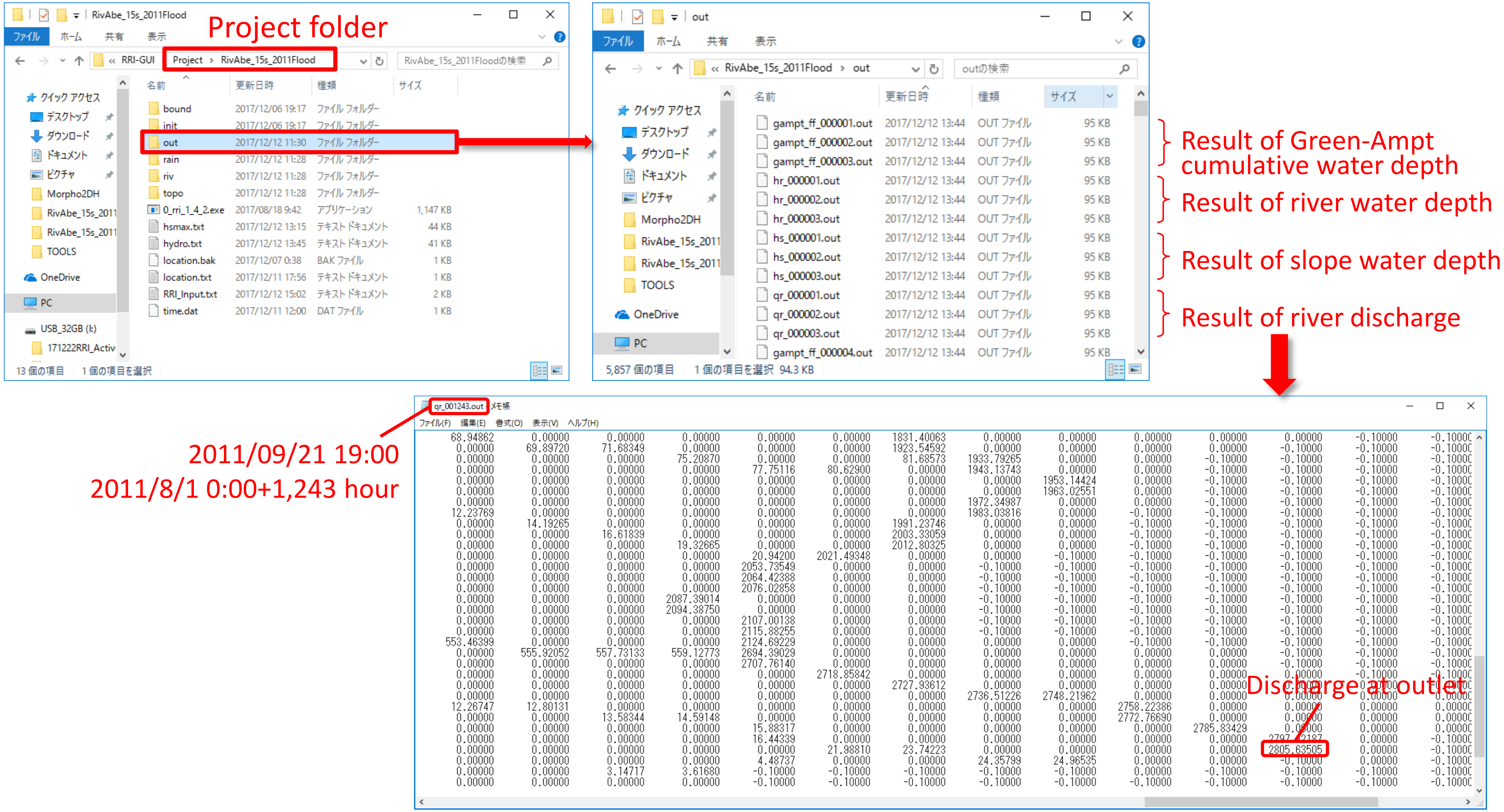
④Run (Command prompt displays the process during calculation)

This display (command prompt) will disappear after the simulation finished.

Current steps / Number of all simulation steps

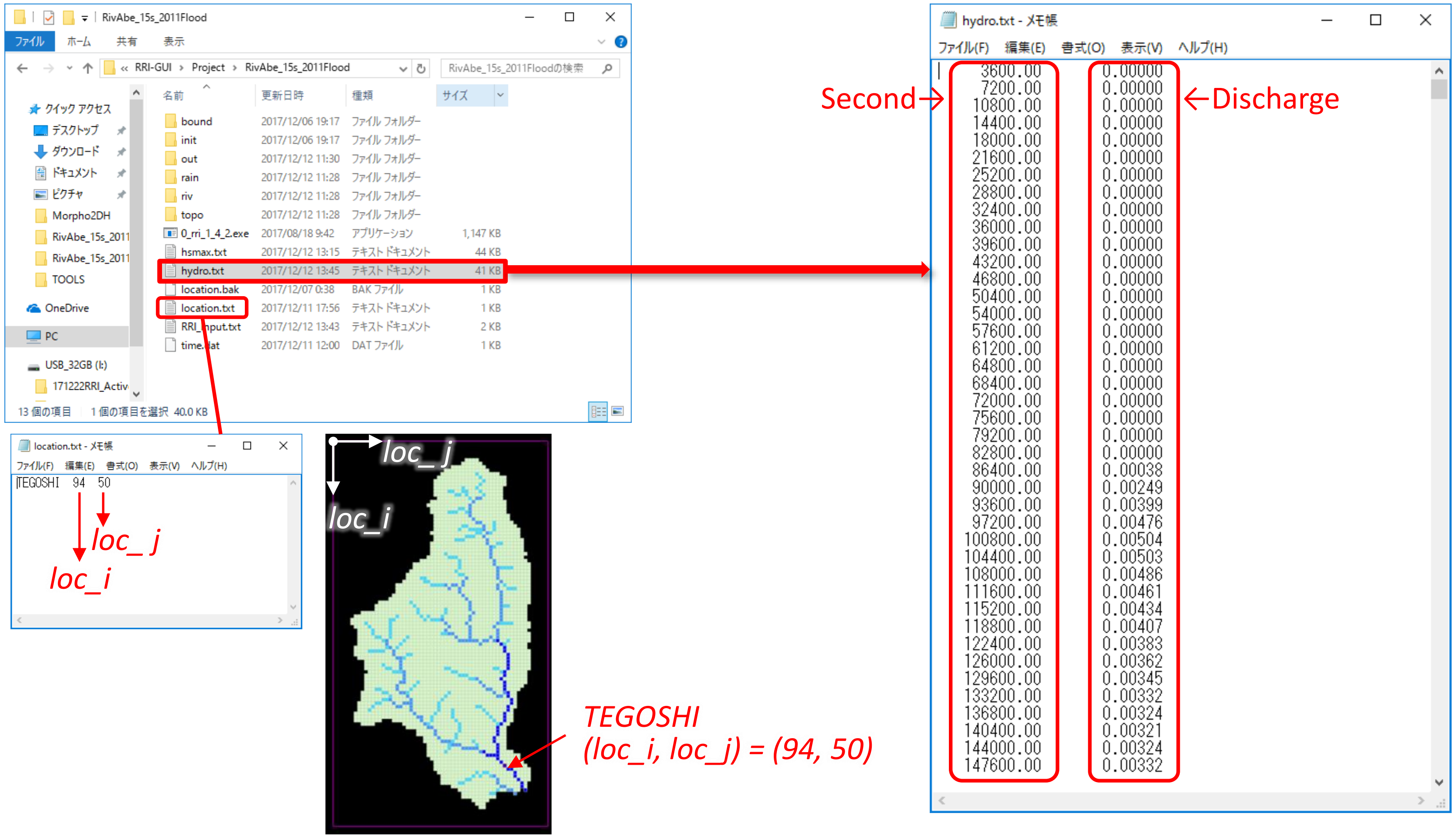
8-2. Files of calculation result

The calculation result is written to “Out” folder of each project.



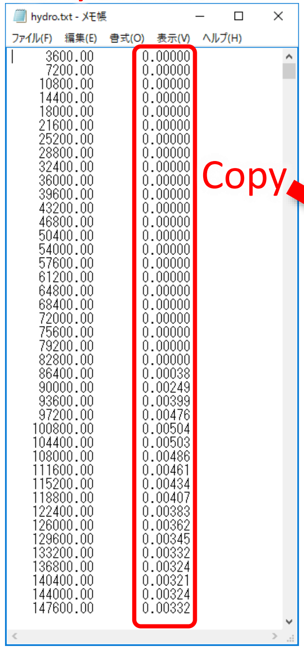
8-3. hydoro.txt

If you set the “location.txt”, time-series data of discharge is output as "hydro.txt".



9-1. Comparison with actual discharge

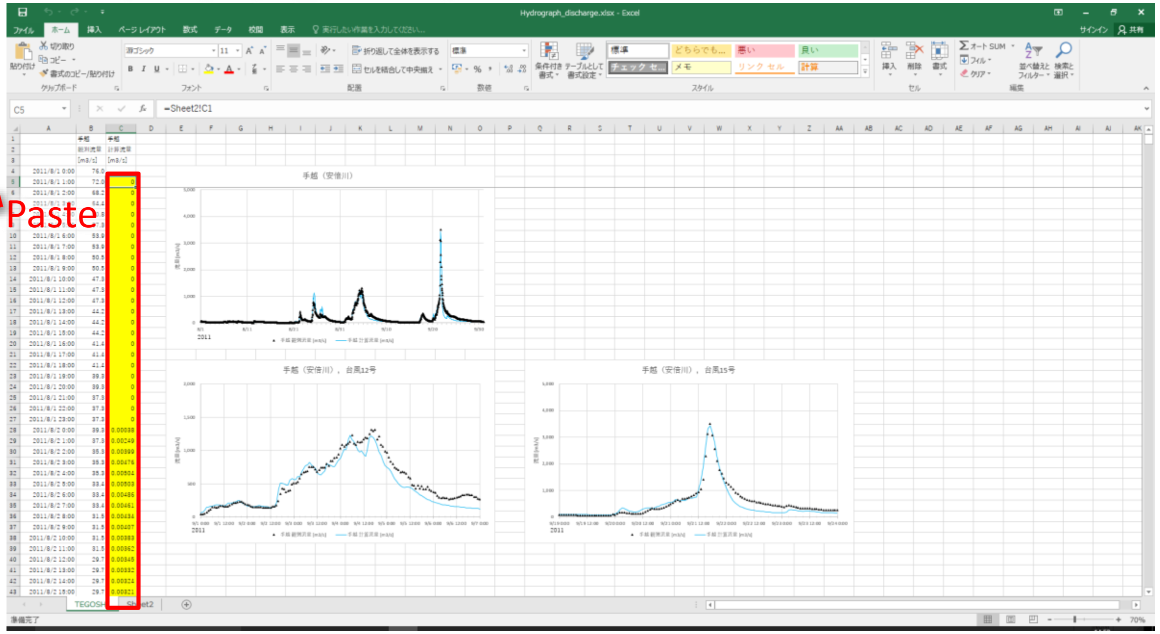
①hydro.txt



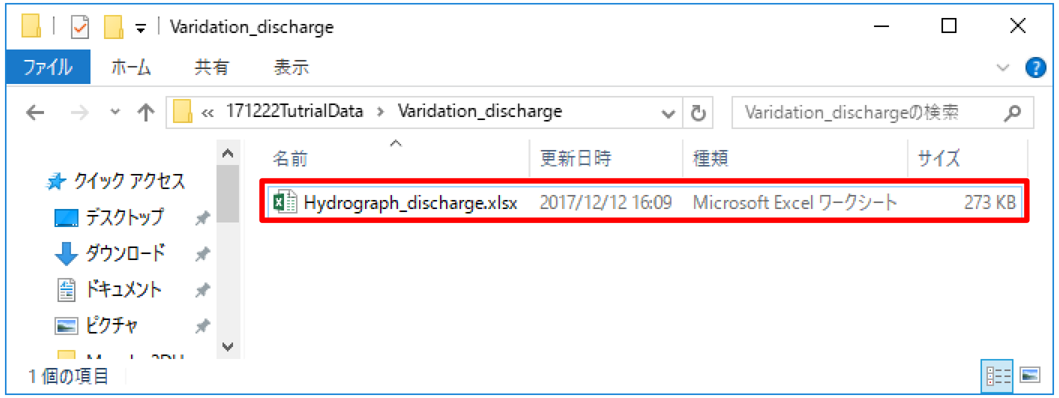
Copy

Paste

②Hydrograph_discharge.xlsx



¥¥RRI_1_4_2_7_GUI¥TutorialData¥Validation_discharge¥



①Open “*hydro.txt*”, and copy 2nd column.

②Open “*Hydrograph_discharge.xlsx*”, paste calculation discharge to the cell of “*C5*”.

Not “*C4*”

9-2. Comparison of results due to difference in spatial resolution

Spatial resolution	3s	15s	30s
Number of meshes	82,501	3,259	819
Computation time*	28min	3min	1min

*Intel Core i7-6850K CPU 3.6GHz, RAM 32GB

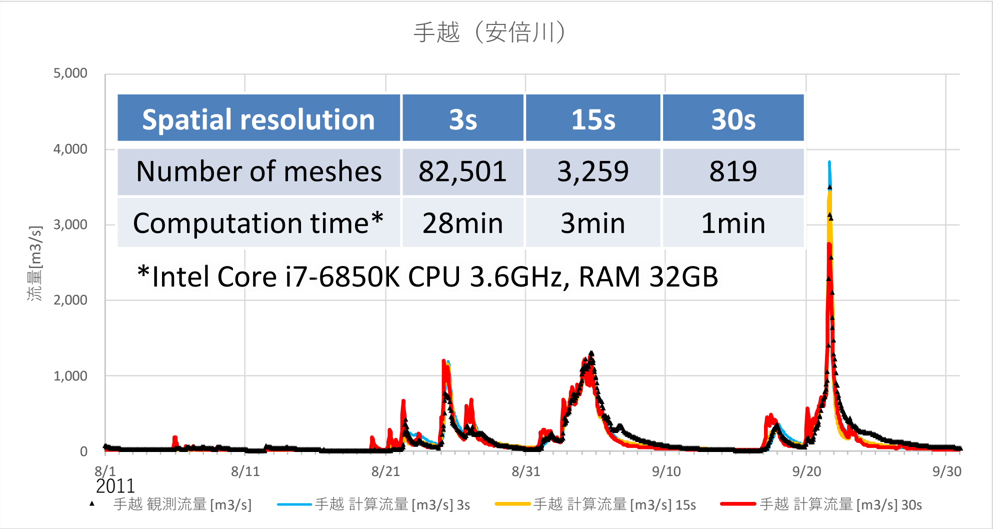


Fig. All simulation period(2011.8.1 0:00-2011.10.1 0:00)

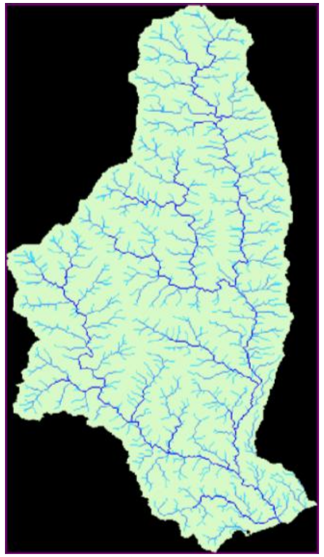


Fig. 3s

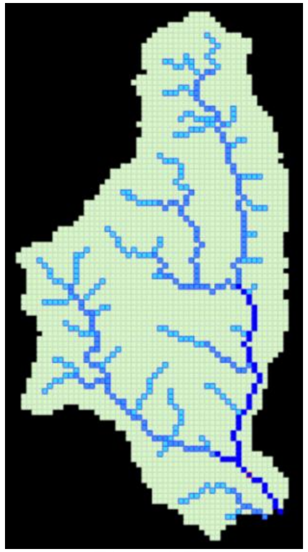


Fig. 15s

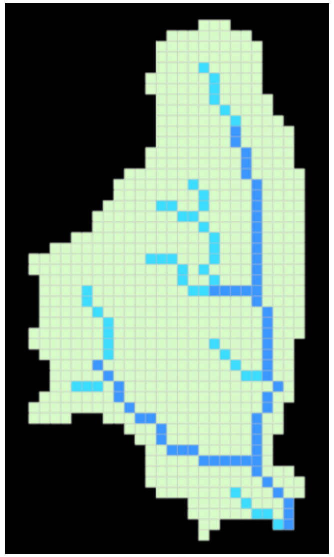


Fig. 30s

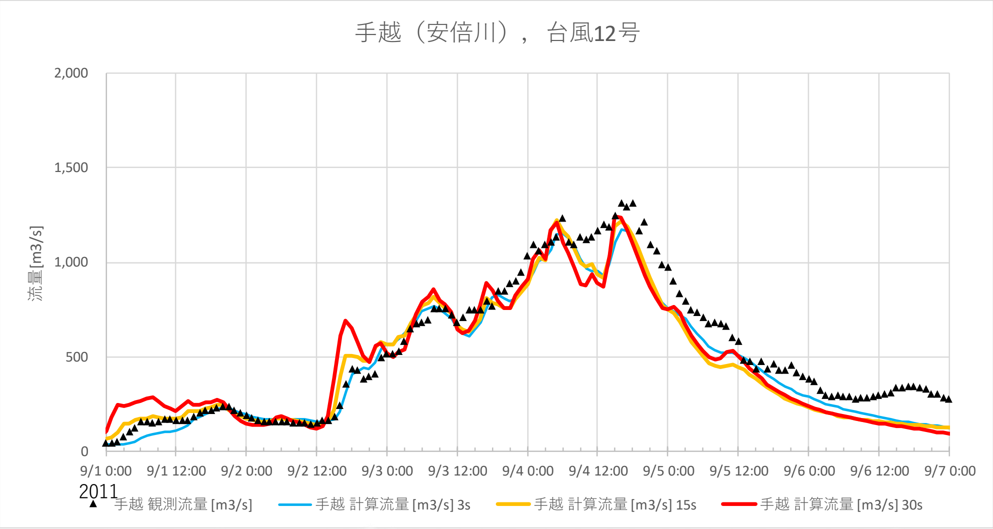


Fig. Typhoon 12th(2011.9.1 0:00-2011.9.7 0:00)

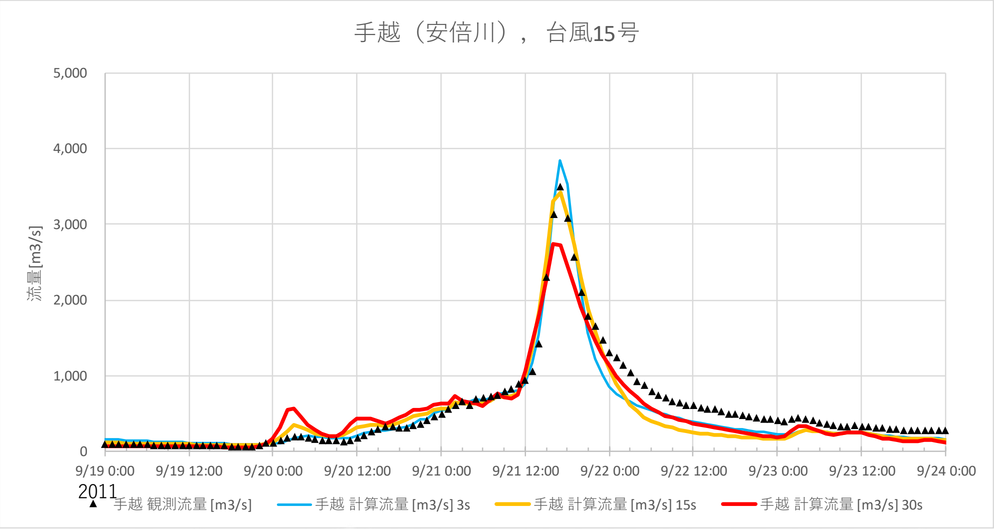
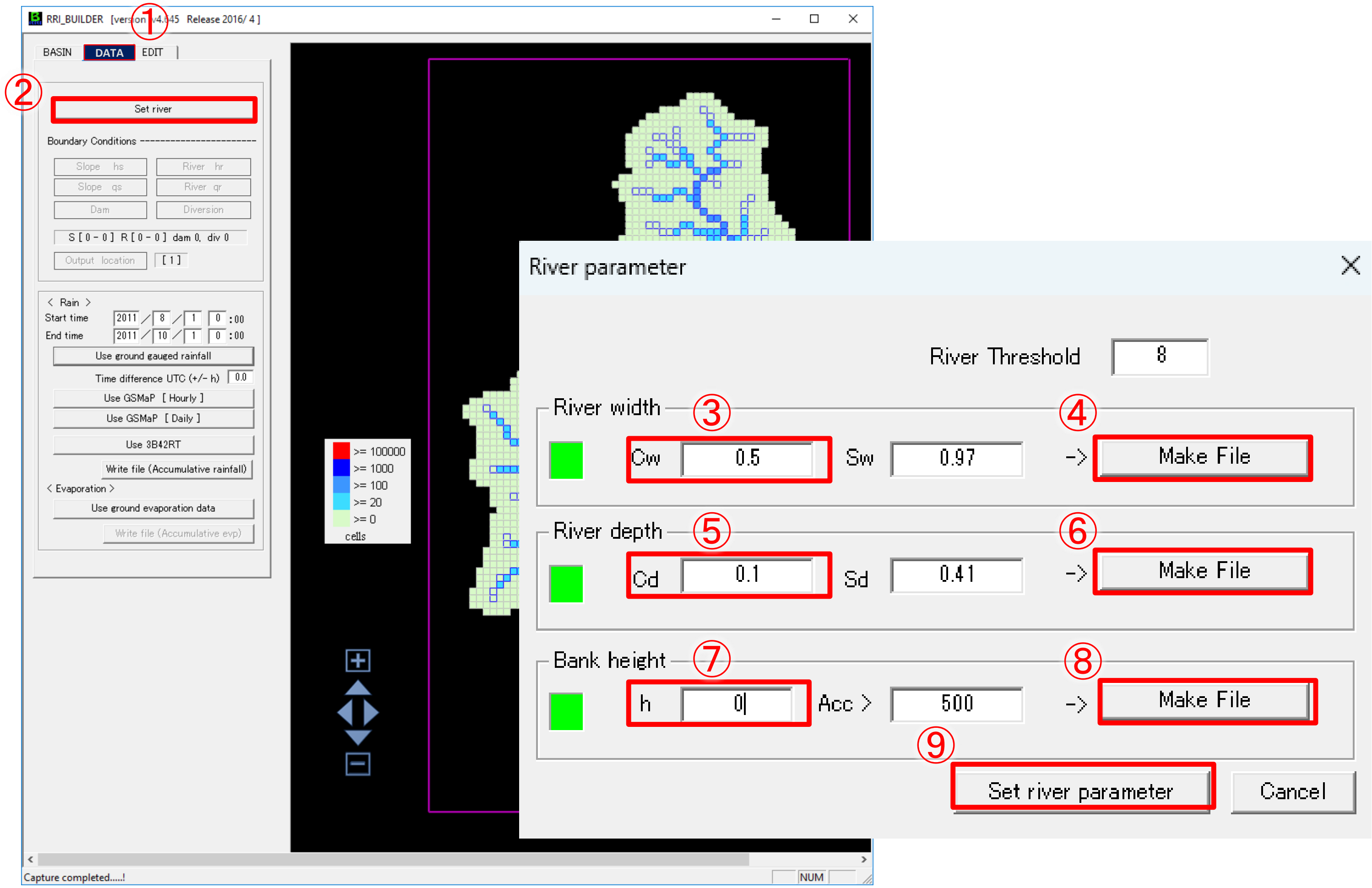


Fig. Typhoon 15th(2011.9.19 0:00-2011.9.24 0:00)

10-1. Modification of RRI model parameter

Modify the river channel model to study flood phenomena, and reanalysis of flood simulation.



①Select "*DATA*" tab.

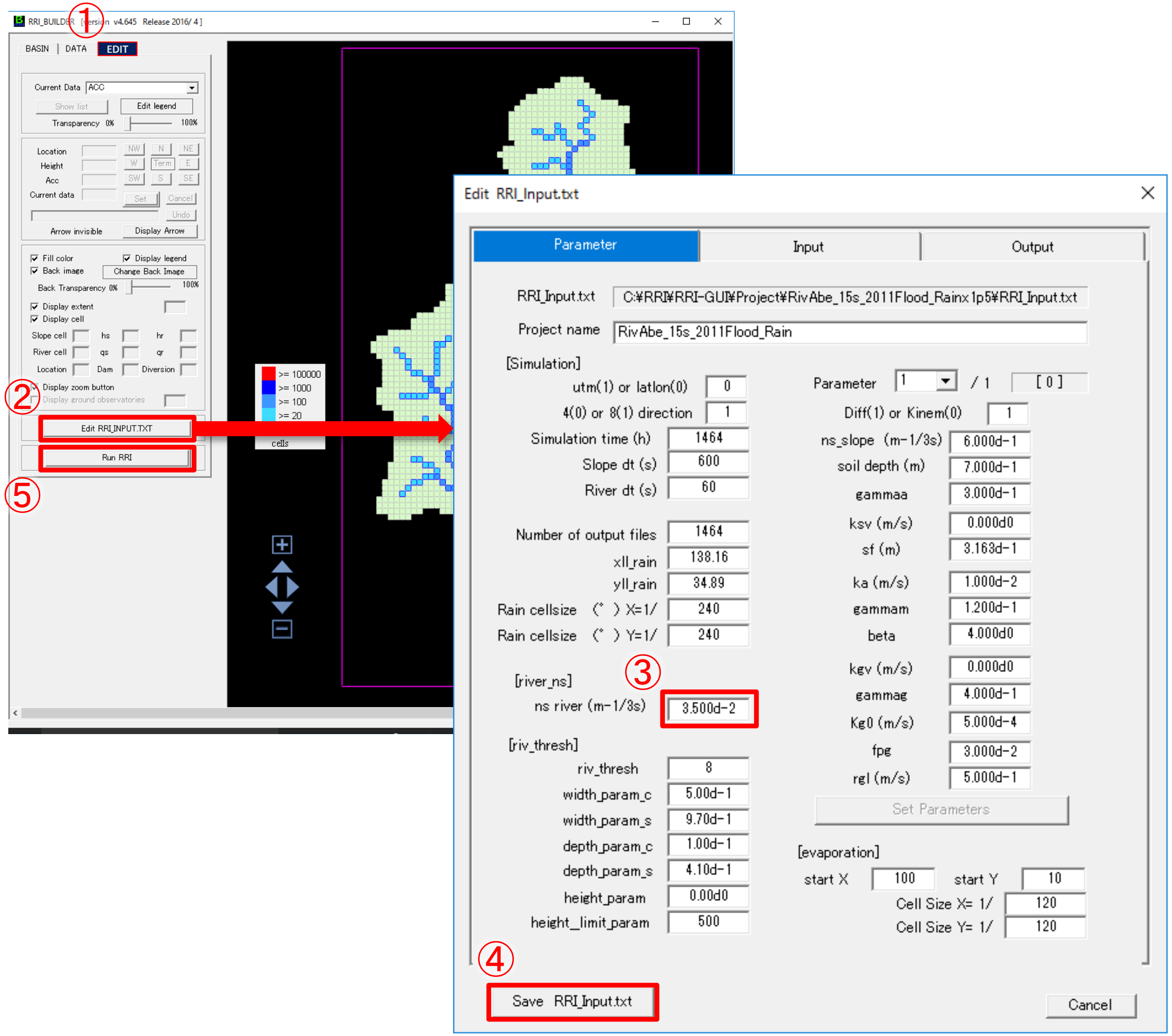
②Click "*Set river*" to open "*River parameter*" window.

③～⑧Modify as shown below.
"*Cw*"：「1.5」→「0.5」
"*Cd*"：「0.4」→「0.1」
"*h*"：「3」→「0」

Reduce the river's depth and width, and also set the levee height to zero.

⑨Click "*Set river parameter*"

10-1. Modification of RRI model parameter



①Select “*EDIT*” tab.

②Click “*Edit RRI_INPUT.TXT*” to open “*Edit RRI_Input.txt*”.

③“*ns river (m-1/3s)*” : 「*3.000d-2*」→「*3.500d-2*」

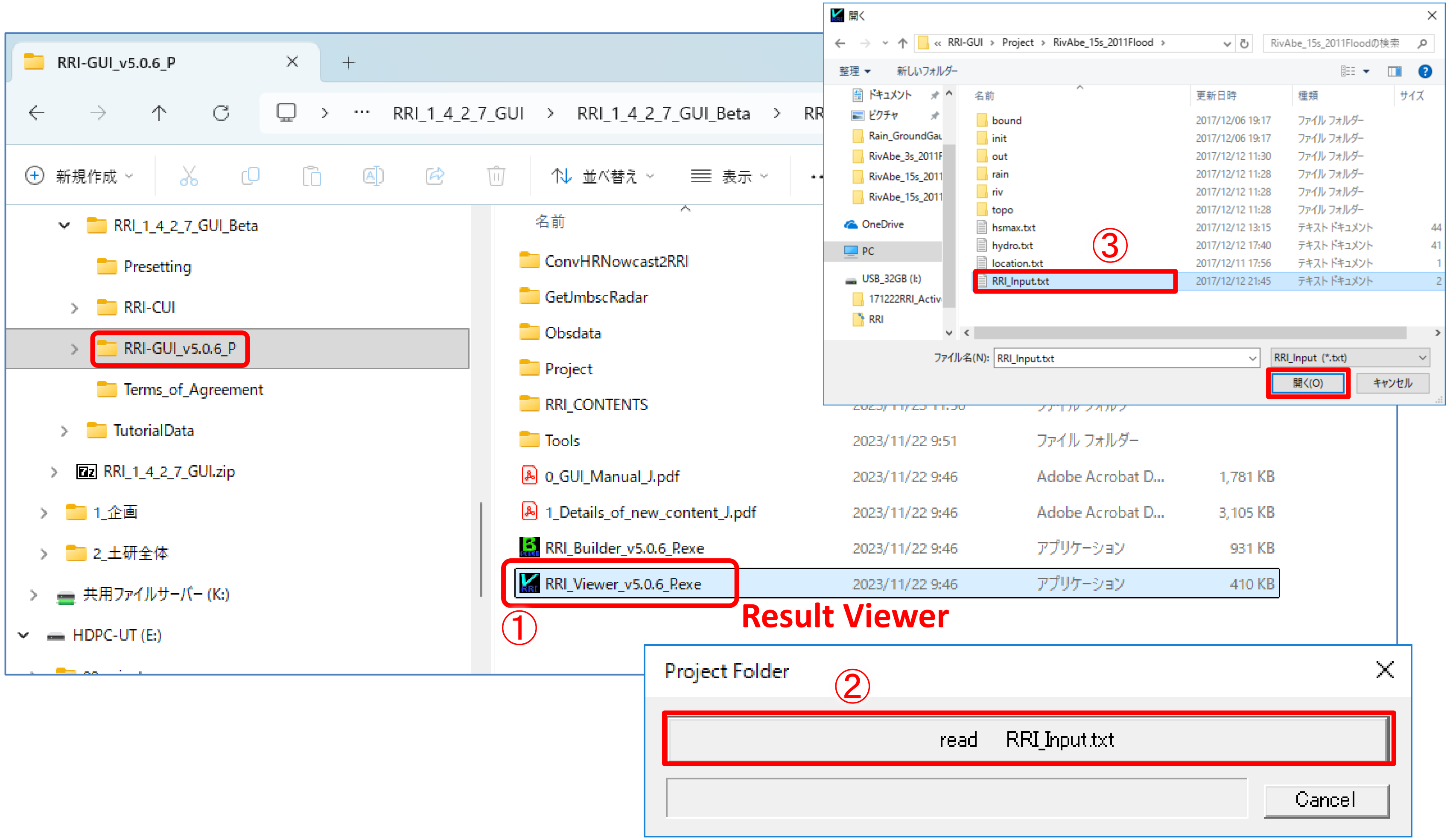
Increase the river’s roughness coefficient to make the water flow more slowly.

④Click “*Save RRI_Input.txt*”

⑤Click “*Run RRI*”

10-2. Utilization of RRI_VIEWER

Execute RRI_VIEWER_v*.exe.

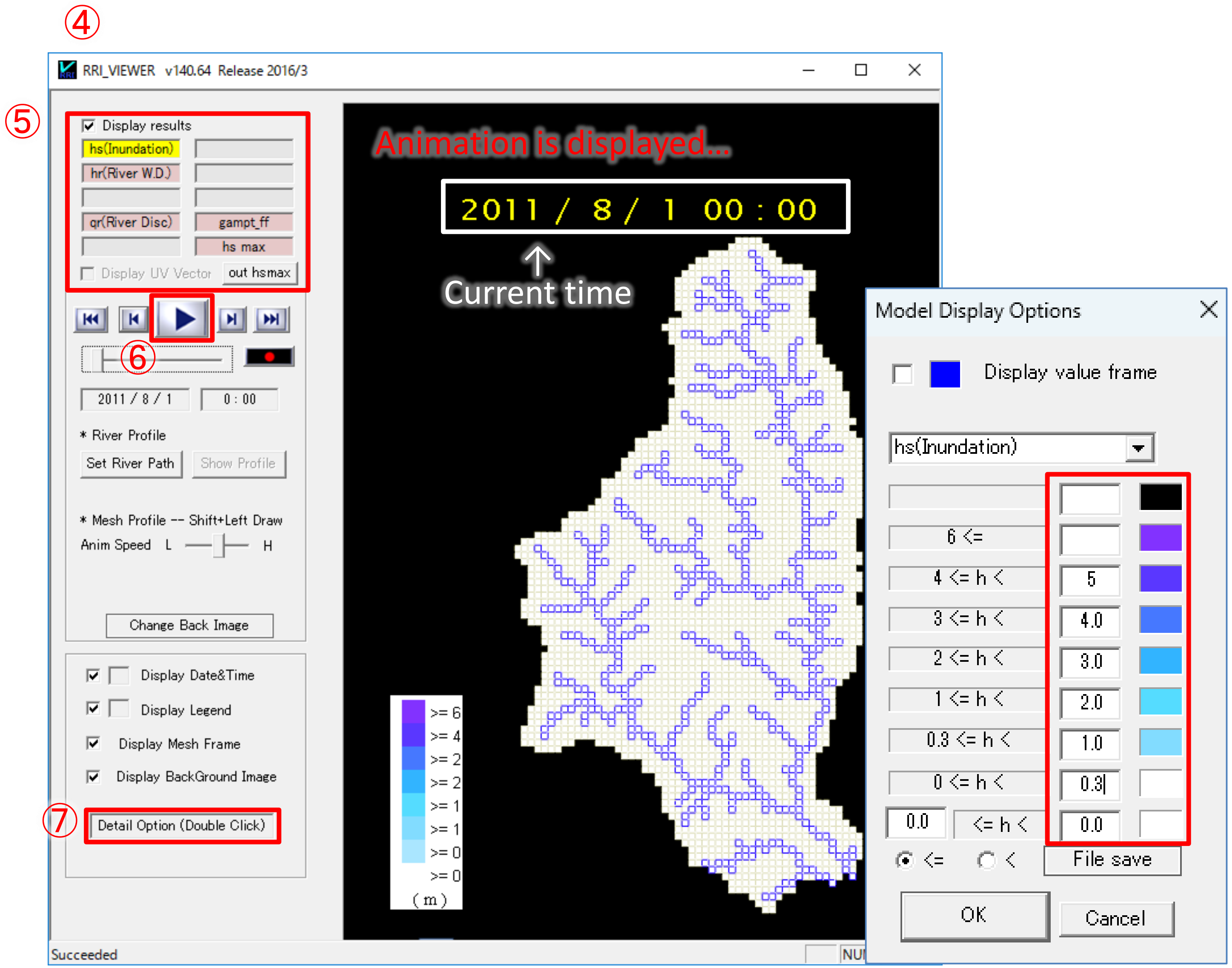


①Execute "*RRI_VIEWER_*.exe*".

②Open "*Project Folder*" window, click "*read RRI_Input.txt*".

③Choose "*RRI_Input.txt*", and click "*Open(O)*".

10-2. Utilization of RRI_VIEWER



④Open “*RRI_VIEWER*”.

⑤Target component can be selected.

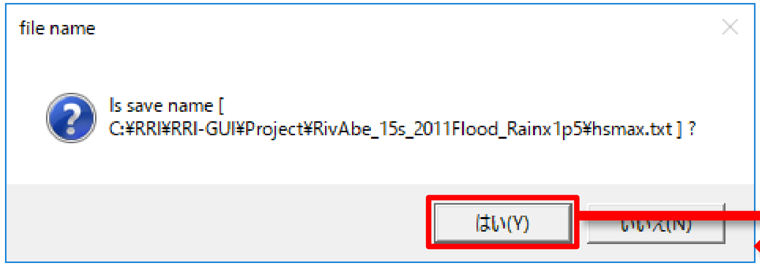
⑥Click

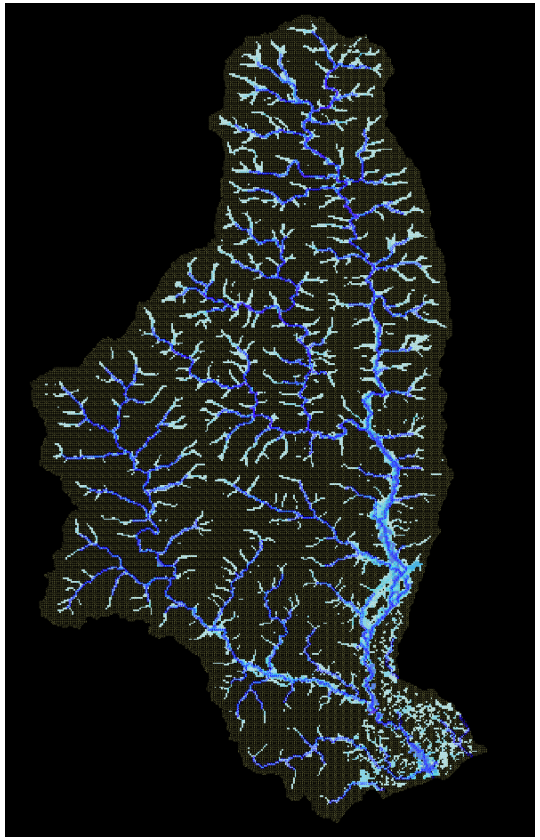
Animation is displayed…

⑦Double Click “*Detail Option*” to Open “*Model Display Options*” window.

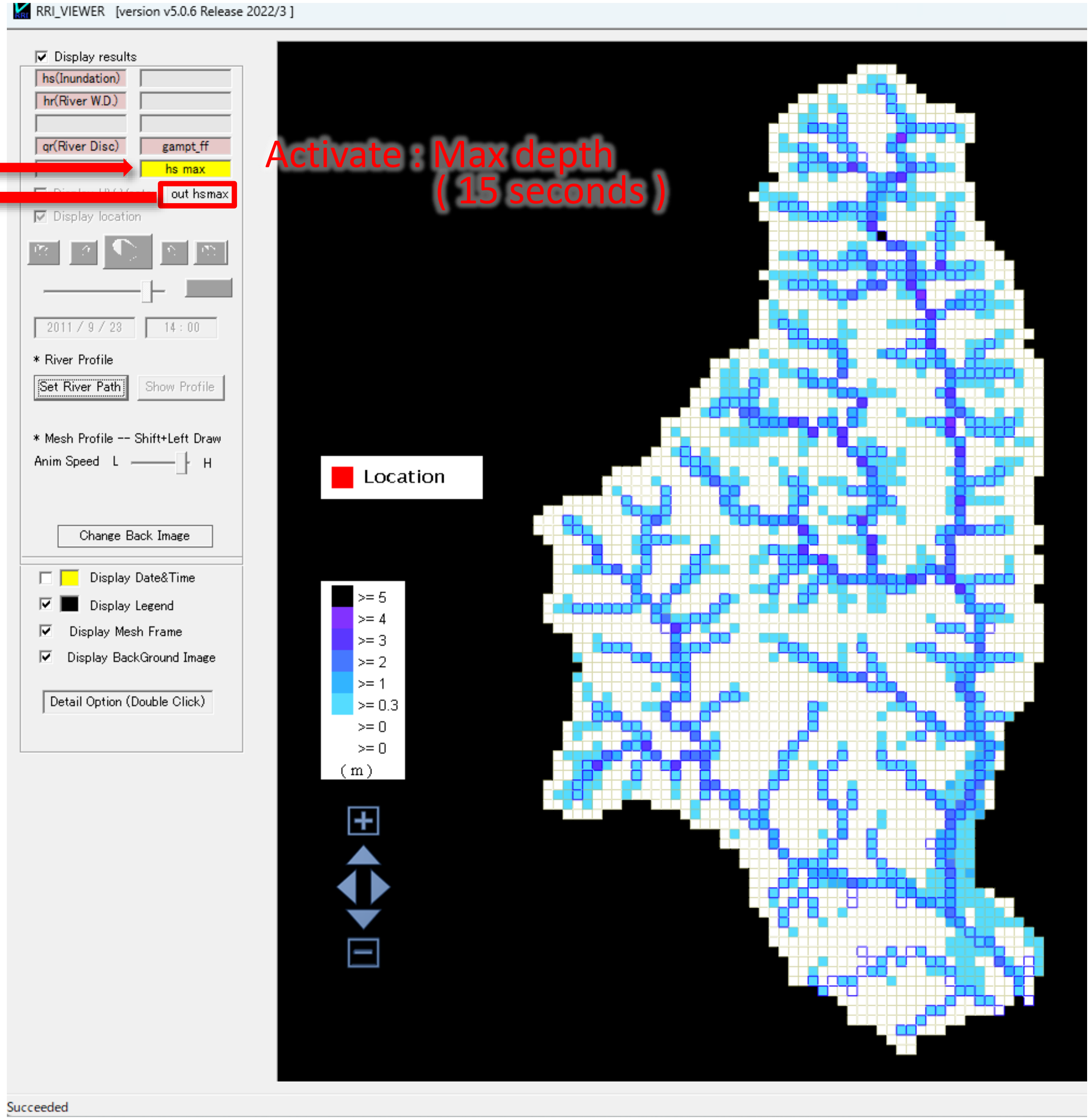
⑧Color legend is editable.

10-2. Utilization of RRI_VIEWER



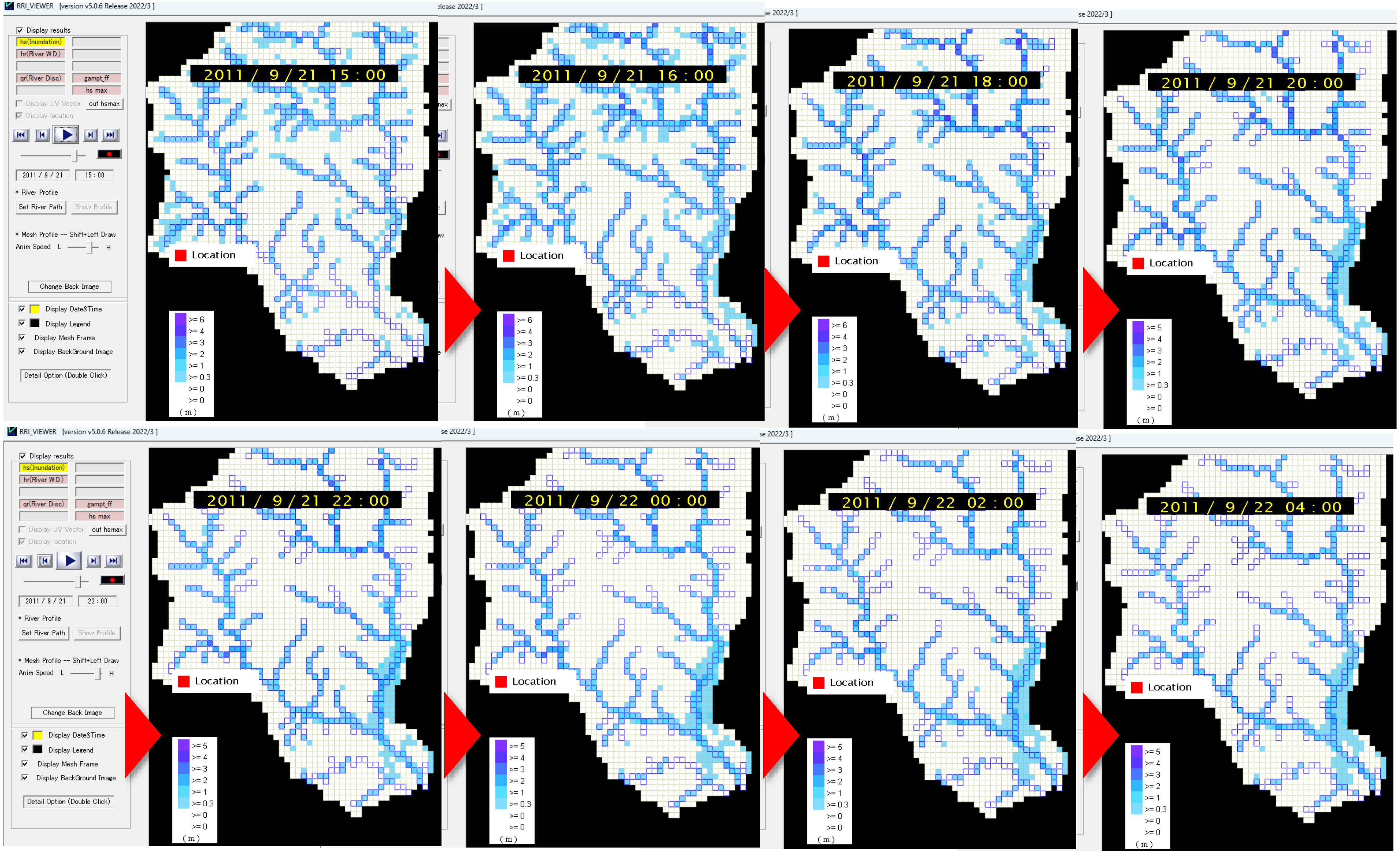


Result of max depth in 3 seconds



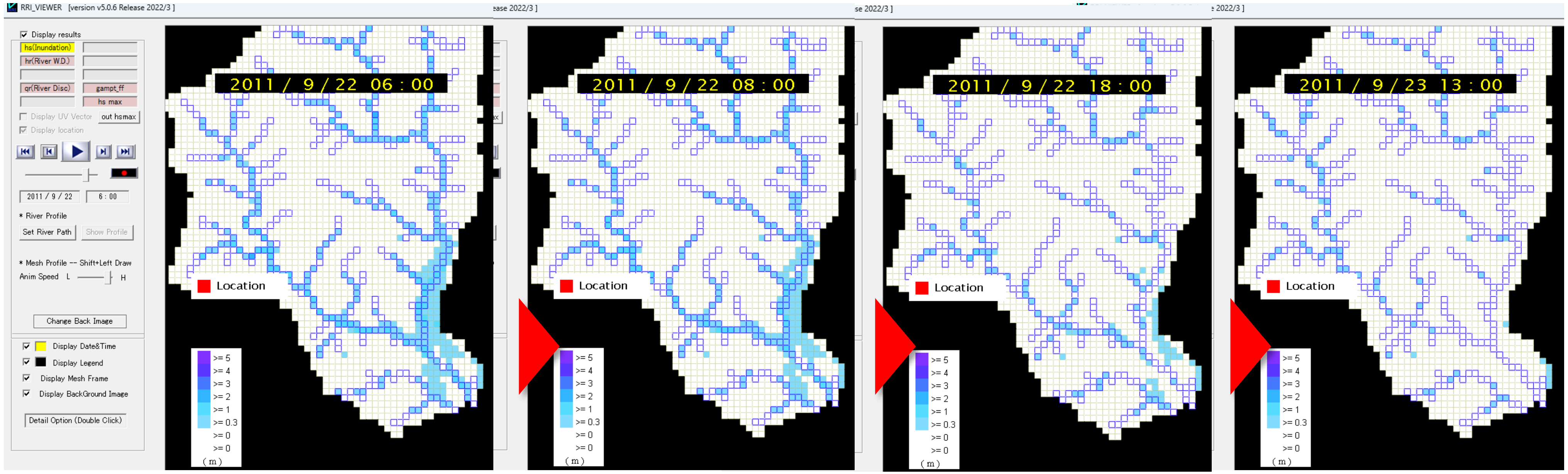
10.Experiment of flood simulation

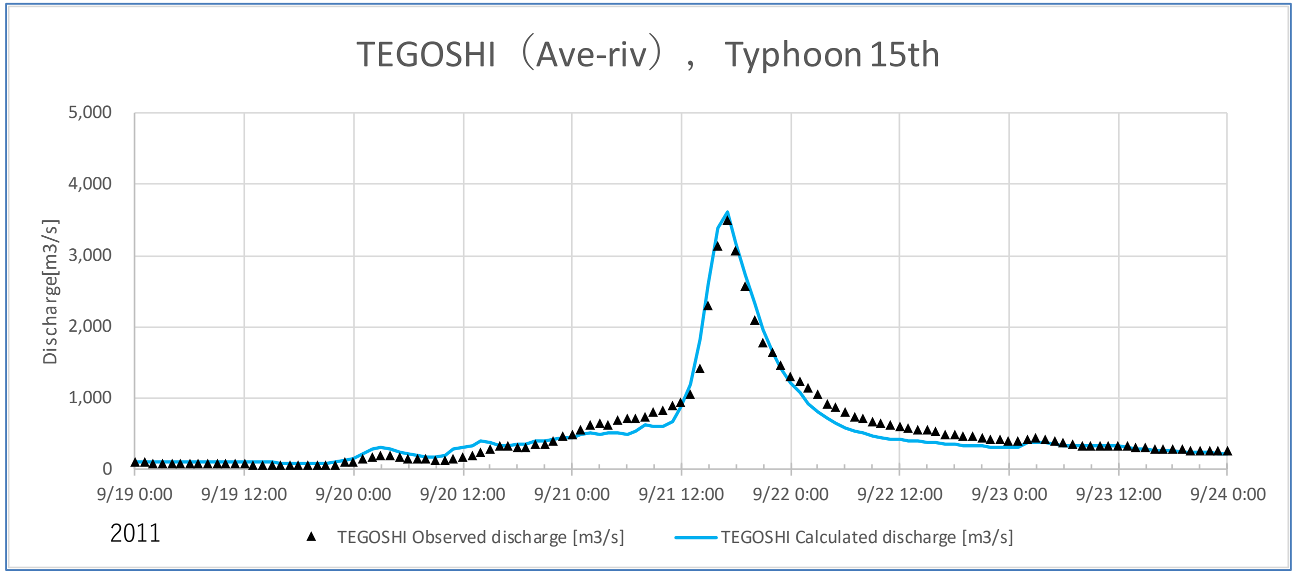
10-3. View Animation



10.Experiment of flood simulation

10-3. View Animation





Contact

If you have any questions or experience any issues regarding the RRI model, please feel free to contact us.

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miyamoto@icharm.org