AutoRAS1Du Module

User's Manual

(Version 0.1)

May 2021

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Introduction

A python module/package, ***AutoRAS1Du***, which is created based on the HEC-RAS API (RAS507.HECRASController and RAS507.HECRASGeometry), includes several functions that can automate a HEC-RAS 1D unsteady flow simulation:

1) ***Py2HecRas_1DU_Flow()*:** create a 1D unsteady flow data file based on the given HEC-RAS geometry data and boundary data (upstream streamflow data and downstream friction slope which are stored in separate CSV files for each reach);

2) ***Py2HecRas_1DU_Geo()*:** modify the Manning's n (given multiply factor) in the original geometry file and create a new geometry file with new Manning's n;

3) ***Py2HecRas_1DU_Plan()*:** create a HEC-RAS 1D unsteady flow plan file based on a template list in the script;

4) ***Py2HecRas_1DU_Project()*:** modify the original HEC-RAS project file;

5) ***Py2HecRas_1DU_Run()*:** run HEC-RAS 1D unsteady flow analysis and extract unsteady results (WSE, flow, average velocity of flow in main channel, and average velocity of flow in total cross section) from the HEC-RAS HDF file, and save as separate CSV files.

The sketch flowchart for the module code is shown in Figure 1.

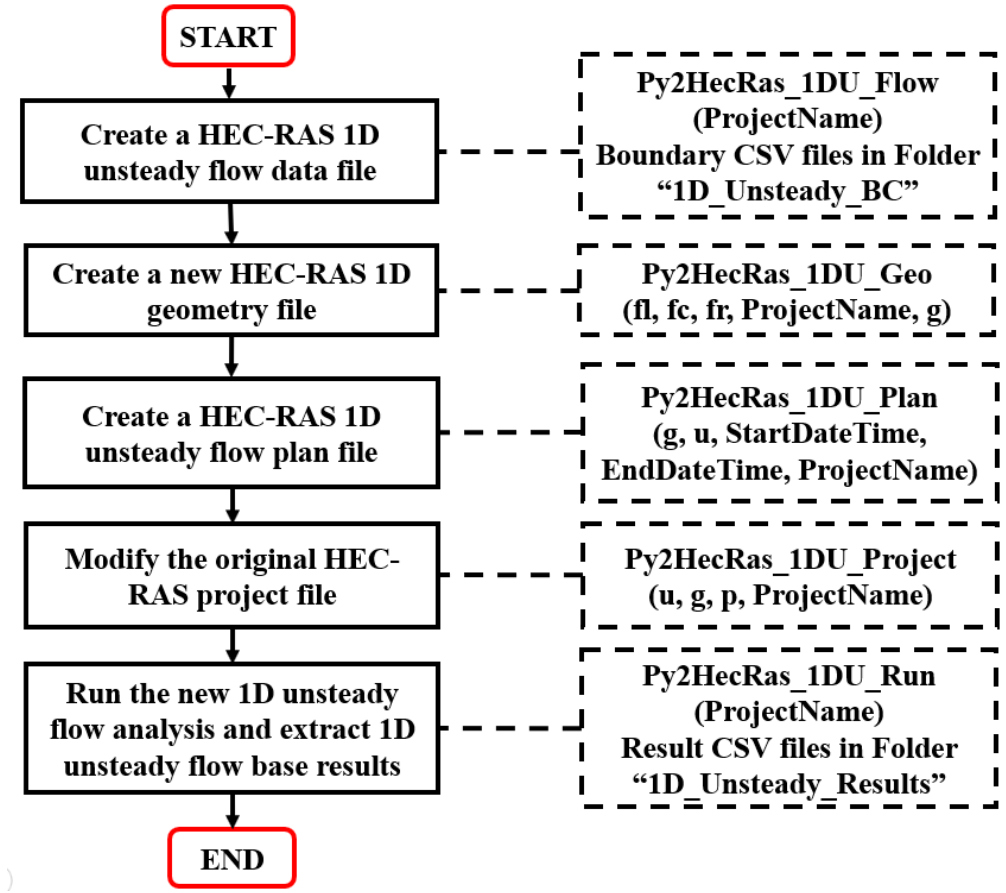

Figure 1. Flowchart for automating HEC-RAS 1D unsteady flow simulations using Python.

The sketch data structure of a HEC-RAS plan HDF5 file for the datasets of flow, water surface elevation, average velocity of flow in main channel, and average velocity of flow in total cross section is shown in Figure 2.

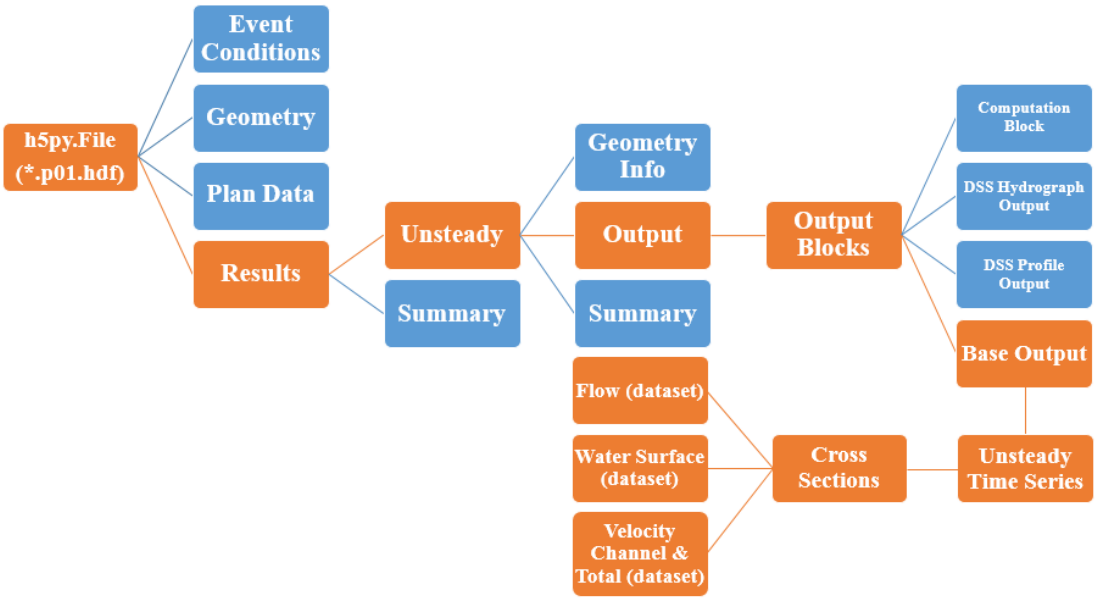

Figure 2. Sketch data structure of HDF5 file for base results of a plan file in HEC-RAS.

The module also has a timed rotating file feature for the error handling, and it could generate a log file named *AutoRAS-Msg.log*, in which some common errors would be raised, and all the logging events and the corresponding date and time would be recorded while a user is running the module. The log file would be generated in the user's current working directory with the backup count as 1. The system will save the back-up log files by appending extensions to the filename. The extensions are date based, using the date format %YYYY-%MM-%DD. If the time interval between two uses of the module is greater than one day, the oldest backup log file would be deleted. The detailed output of the log file is shown in Figure 3 and some common errors are presented in Table 1.


AutoRAS-Msg - Notepad

File Edit Format View Help

```
2021-05-18 21:53:37,044 - **********
2021-05-18 21:53:37,044 - ERROR: Flow files for TrialProject were not generated, because the project file does not exist.
2021-05-18 21:53:37,044 - **********

2021-05-18 21:53:50,429 - **********
2021-05-18 21:53:50,429 - INFO: HEC-RAS 1D unsteady flow data file for WabashAndTributarie is created successfully!
2021-05-18 21:53:50,429 - **********

2021-05-18 21:53:58,067 - **********
2021-05-18 21:53:58,067 - ERROR: Geometry files for TrialProject were not modified, because the project file does not exist.
2021-05-18 21:53:58,067 - **********

2021-05-18 21:53:58,069 - **********
2021-05-18 21:53:58,069 - ERROR: Geometry files for TrialProject were not generated, because the template geometry file does not exist.
2021-05-18 21:53:58,069 - **********

2021-05-18 21:54:47,820 - **********
2021-05-18 21:54:47,820 - ERROR: Plan files for TrialProject were not created, because the project file does not exist.
2021-05-18 21:54:47,820 - **********

2021-05-18 21:55:11,369 - **********
2021-05-18 21:55:11,369 - ERROR: For TrialProject: Computations were not performed, there must have been some missing data in the input files
2021-05-18 21:55:11,369 - **********

2021-05-18 21:55:44,202 - **********
2021-05-18 21:55:44,202 - INFO: Starting Unsteady Computations for WabashAndTributarie
2021-05-18 21:55:44,202 - INFO: Computing successfully!
2021-05-18 21:55:44,202 - **********
```

Figure 3. Example of logging events recorded in a log file.

Table 1. Exception and Error Handling in *AutoRAS1Du.*

No.	Error Type	Notes
1	FileNotFound Error	FileNotFound Error is raised when a HEC-RAS project file or a HEC-RAS template geometry file is not found in the working directory.
2	Not-Implemented Error	Not-Implemented Error is raised when simulations in HEC-RAS were not performed due to some missing data in the input files.

Installation

```
import AutoRAS1Du as Au
```

User Guide to Functions

Flow data file for a 1D unsteady flow analysis

Py2HecRas_1DU_Flow (*ProjectName****)*****:** create a 1D unsteady flow data file based on the given HEC-RAS geometry data and boundary data (upstream streamflow data and downstream friction slope which are stored in separate CSV files for each reach).

Parameters:
ProjectName is the name (without ".prj") of a HEC-RAS project.

Input:
Given HEC-RAS geometry data and boundary data (CSV files for each reach).

Output:
Creating a new 1D unsteady flow data file.

Geometry file for a 1D unsteady flow analysis

Py2HecRas_1DU_Geo (*fl, fc, fr, ProjectName, g****)*****:** modify the Manning's n (given multiply factor) in the original geometry file and create a new geometry file with new Manning's n.

Parameters:
fl is the multiply factor for the LOB Manning's n.
fc is the multiply factor for the LOB Manning's n.
fr is the multiply factor for the LOB Manning's n.
ProjectName is the name (without ".prj") of a HEC-RAS project.
g is the new number of geometry files.

Input:
Given HEC-RAS geometry data.

Output:
Creating one or more new 1D geometry files.

Plan file for a 1D unsteady flow analysis

Py2HecRas_1DU_Plan (*g, u, StartDateTime, EndDateTime, CI="1HOUR", HI="1DAY", MI="1DAY", DI="1DAY", ProjectName="test"****):*** create a HEC-RAS 1D unsteady flow plan file based on a template list in the script.

Parameters:
g is the number of geometry data files.
u is the number of unsteady flow data files.
StartDateTime is the starting simulation datetime(YYYY-MM-DD,HH:mm).
EndDateTime is the ending simulation datetime(YYYY-MM-DD,HH:mm).
CI is computation interval.
HI is hydrograph output interval.
MI is mapping output interval.
DI is detailed output interval.
ProjectName is the name (without ".prj") of a HEC-RAS project.

Input:
None.

Output:
Creating a new plan file for the 1D unsteady flow analysis.

Project file for a 1D unsteady flow analysis

Py2HecRas_1DU_Project (*u, g, p, ProjectName****)*:** modify the original HEC-RAS project file.

Parameters:
u is the added number of unsteady flow data files.
g is the added number of geometry files.
p is the added number of plan files
ProjectName is the name (without ".prj") of a HEC-RAS project.

Input:
None.

Output:
Adding new content to the original project file for the 1D unsteady flow analysis.

Running a 1D unsteady flow analysis and post-processing

Py2HecRas_1DU_Run (*ProjectName****)*:** run HEC-RAS 1D unsteady flow analysis and extract unsteady results (WSE, flow, average velocity of flow in main channel, and average velocity of flow in total cross section) from the HEC-RAS HDF file, and save as separate CSV files.

Parameters:
ProjectName is the name (without ".prj") of a HEC-RAS project.

Input:
Given a HEC-RAS flow data file, a geometry file, and a plan file for the 1D unsteady flow analysis.

Output:
Extracting the basic unsteady results (WSE, flow, average velocity of flow in main channel, and average velocity of flow in total cross section) of all the cross sections from the plan HDF file. These results are saved as CSV files in the results folder - '*1D_Unsteady_Results*'.

Application

Example 1

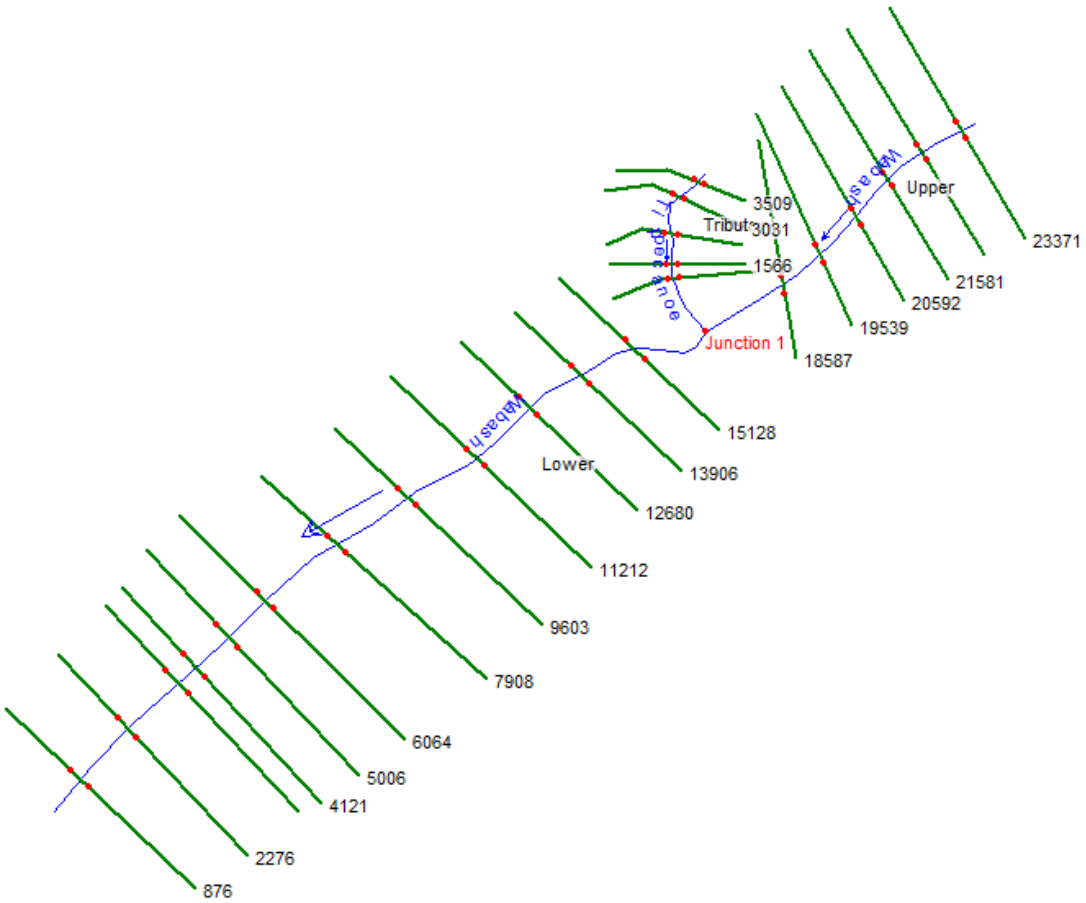

Figure 4. River network of HEC-RAS model-1.

```
>>> import AutoRAS1Du as Au

>>> # Create a 1D unsteady flow data file based on given boundary data
>>> Au.Py2HecRas_1DU_Flow(ProjectName="Wabash")

>>> # Create a HEC-RAS 1D unsteady flow plan file
>>> Au.Py2HecRas_1DU_Plan(g=1,u=1,
                          StartDateTime="2008-01-21 00:00",
                          EndDateTime="2008-02-21 00:00",
                          ProjectName="Wabash")

>>> # Run HEC-RAS 1D unsteady flow analysis and get results (WSE, flow, velocity)
>>> Au.Py2HecRas_1DU_Run(ProjectName="Wabash")
```

Example 2

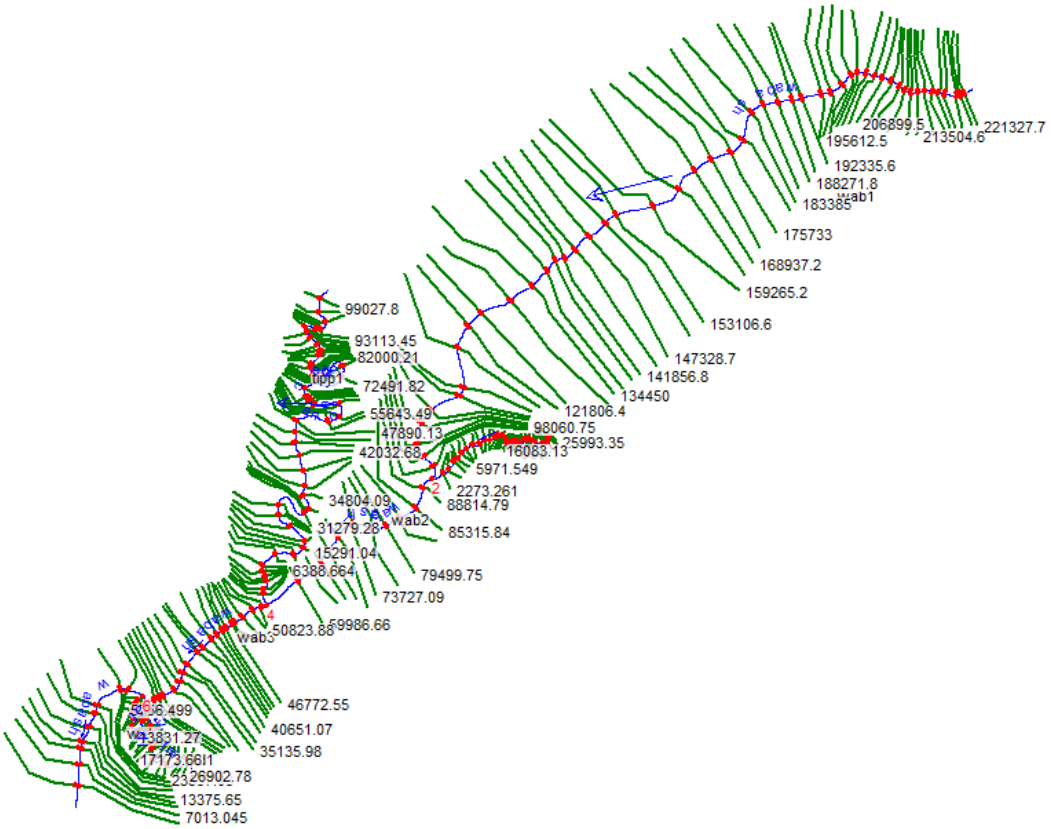

Figure 5. River network of HEC-RAS model-2.

```
>>> import AutoRAS1Du as Au

>>> # Create a 1D unsteady flow data file based on given boundary data
>>> Au.Py2HecRas_1DU_Flow(ProjectName="WabashAndTributarie")

>>> # Create a HEC-RAS 1D unsteady flow plan file
>>> Au.Py2HecRas_1DU_Plan(g=1,u=1,
                          StartDateTime="2008-01-21 00:00",
                          EndDateTime="2008-02-21 00:00",
                          ProjectName="WabashAndTributarie")

>>> # Run HEC-RAS 1D unsteady flow analysis and get results (WSE, flow, velocity)
>>> Au.Py2HecRas_1DU_Run(ProjectName="WabashAndTributarie")
```

Issues of Current Version

1) Name the boundary data files (CSV): "BC_RiverID_ReachID".csv in the Folder "1D_Unsteady_BC".

2) Results named as "Variable of ProjectName".csv are stored in the Folder "1D_Unsteady_Results"

References