

2011

Automating Hydraulic Analysis v 1.0.

Basic tutorial and introduction

Automating Hydraulic Analysis (AHYDRA) is a freeware application that automates some specific features of HEC RAS or other hydraulic software. It is intended to ease the task of sensitivity and uncertainty analysis in water related studies. It is under constant improvement. For comments and suggestions feel free to contact us.

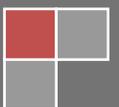


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AHYDRA

Introduction

The basic data needed to calculate hydraulic profiles of a channel are the discharge, channel geometry, water elevation at a control section and channel roughness. Discharge is a given data and the channel geometry is obtained by measurements. Usually the water elevation at control section (boundary condition) and channel roughness are unknown and have to be estimated by indirect ways (Chow 1959).

Although there are different approaches and recommendations for those data, they are just suggestions and incorporate an error to the vicinity of the boundary station and cross sections. The best approach is to perform a sensitivity analysis of such values, and if needed to perform an uncertainty analysis. Although the task of updating either the boundary condition or Manning roughness are simple ones, when repeating many times (sensitivity and uncertainty analysis) it may become a tedious and time consuming task; besides, the possibility of accidental errors when typing values increase. Automating Hydraulic Analysis (AHYDRA) automates some features of HEC RAS and other hydraulic software in order to ease the task of sensitivity and uncertainty analysis.

The current version was successfully tested in:

64 bit computer running Windows 7

32 bit computer running Windows Vista.

Requirements

If you have trouble installing or executing it, it is suggested to download and install the latest windows updates. If you still have problems, please contact us and report them so that we can improve the application. In order to run AHYDRA you need:

- HEC-RAS version 4.1. Any other version may give errors. You can download from its website
- Windows operating system with .NET Framework v 4.0.30319. You can download it from the Microsoft windows update website

<http://www.microsoft.com/isapi/redir.dll?prd=Win2000&ar=WinUpdate>.

Updating Boundary Condition

Introduction

Boundary condition defines the starting water level at the end of the river, which is needed so that the program can begin the calculations. HEC-RAS allows specifying boundary condition in one of the following options (Brunner 2001):

Known water surface: This is the known water surface for the given profile. This option applies for cases where the water level was measured for a given discharge

Critical depth: With this option the program calculates the critical depth for the section and uses it as boundary condition. This option applies for cases where there is a control structure such as weir, gate or drop that controls and forces the critical depth

Rating Curve: In this option the water level is interpolated from the given rating curve. Usually this case applies for control station where water levels and discharges are measured constantly.

Normal depth: In this option the program uses the energy slope to calculate the normal depth with Manning's equation.

The most used boundary condition is the normal depth. Although the normal depth is unknown, usually it is approximated either by using the channel slope or the water surface slope near the boundary station. Nevertheless, these are just approximations that incorporates an error to the vicinity of the boundary station; thus, is suggested to increase the cross sections and channel length (Brunner 2010) (which increases the topographical data required) so that these errors do not affect the study area. Figure 1 shows a river hydraulic profile under different downstream boundary condition and its influence area that covers around 1500 m.

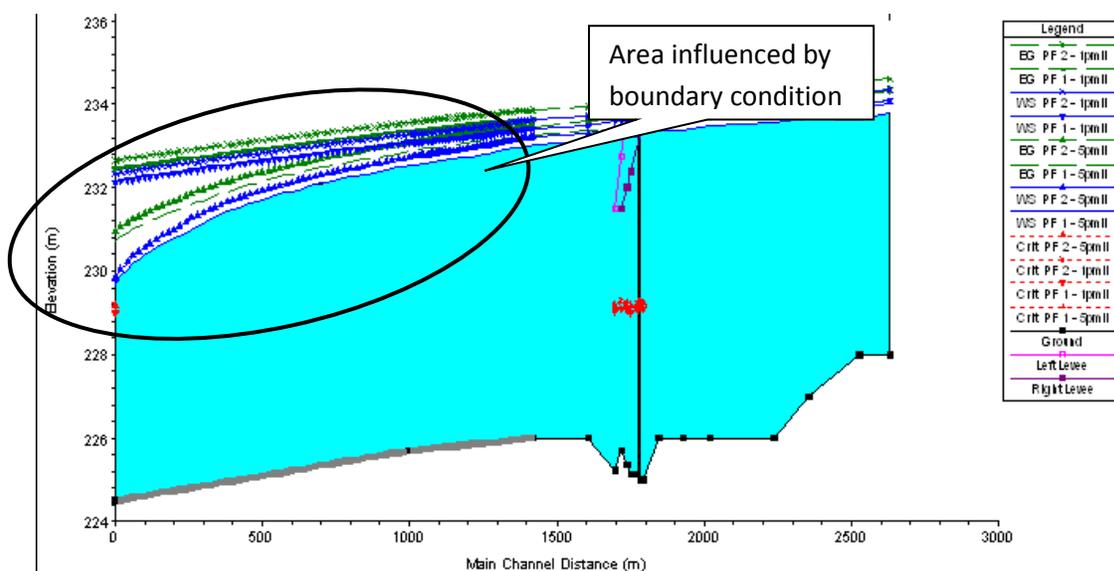


Figure 1 Influence of boundary conditions

The best approach is to perform a sensitivity analysis of the boundary conditions, and if needed to perform an uncertainty analysis. Although the task of updating the boundary condition is a simple one, when repeating many times (sensitivity and uncertainty analysis) it may become a tedious and time consuming task. Automating Hydraulic Analysis (AHYDRA) allows updating boundary condition, executing the simulation and viewing the results from a single screen and a single instruction (button click)

Updating Boundary Condition

Install AHYDRA

AHYDRA is a freeware application that can be downloaded from its website

<http://ahydra.yolasite.com>

It comes in a compressed .rar file. Just decompress it in the path "C" so that it will create a folder with the path "C:\AHYDRA" and launch it by double clicking the AHYDRA.exe icon. Before executing it, be sure that you have HEC-RAS version 4.1 installed. If you have a previous version the AHYDRA will not work.

NOTE: It is important to have the "C:\AHYDRA" path in order to overcome accessibility limitation with the "C:" and "Program Files" folder.

If you have trouble installing or executing it, it is suggested to download and install the latest windows updates. If you still have problems, please contact us and report them so that we can improve the application.

Using AHYDRA to update boundary condition

Once AHYDRA is launched, you will get the main window with a help menu and two (2) tabs, one for boundary condition and one for roughness. The boundary condition tab is the main one by default. The help menu links to the AHYDRA website.

Before using AHYDRA, a HEC RAS projects has to be ready to use; it means, one geometry file, one flow data file and one plan created, like the examples that can be downloaded from the website. The HEC-RAS project to be used must have normal depth as boundary condition.

The boundary condition tab has the following components (figure 2)

1. Open RAS project. This button will open a dialog menu, in order to navigate and select the path and the HEC RAS file project (*.prj).
2. Select flow file. This button will open a dialog menu, in order to navigate and select the path and the HEC RAS file with the flow data (*.sXX).
3. River. In this text box you have to specify the name of the river where the boundary condition is located. By default it has the name "river" which is the name of the example file.
4. Reach. In this text box you have to specify the name of the reach where the boundary condition is located. By default it has the name "reach" which is the name of the example file.

5. Boundary condition. This section consists of two (2) radial buttons and text boxes. The radial buttons are to select whether the boundary condition is located upstream (supercritical flow) or downstream (subcritical flow). The text boxes are to specify the new energy slope boundary condition to be simulated.
6. Results radial buttons. Those radial buttons are to select how the results will be presented once the simulation is over. There are three (3) options: show the results in a 2D profile plot show them in a 3D plot or show them as a table.
7. Run model. With this button the program will simulate the river with the new boundary condition and once it has finished will show the results in the selected option.

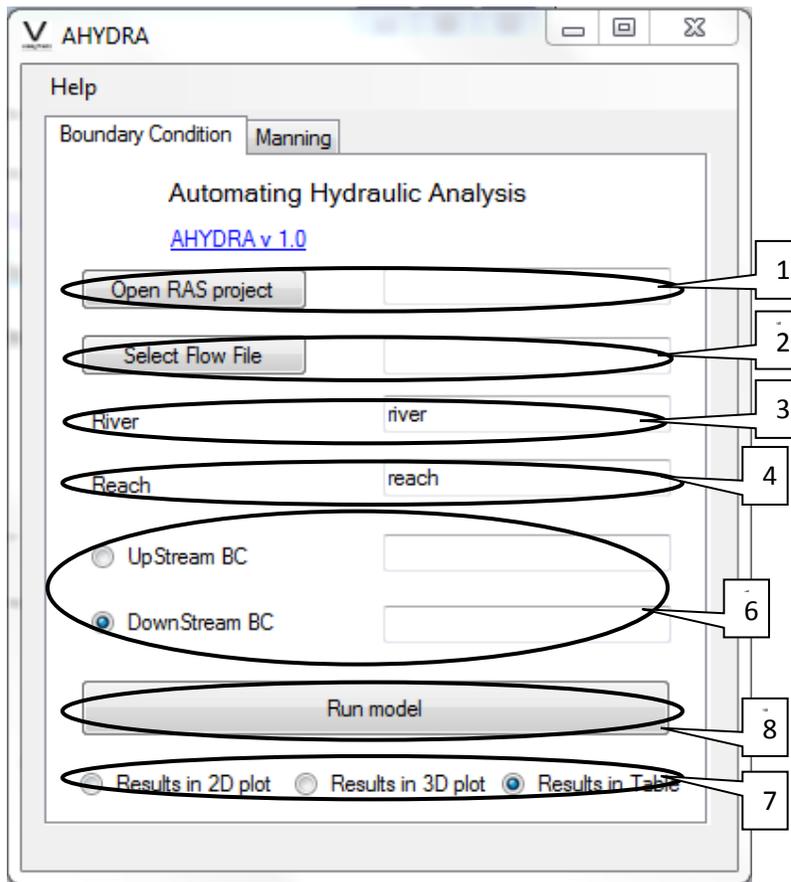


Figure 2 Updating Boundary condition screen

Channel Roughness

Introduction

There are many formulas for estimating roughness coefficient according to the material, discharge and shape of section. Cowan (Cowan 1956) developed an approach to estimate such value considering irregularities, shape, vegetation and material. There are also tables with suggested values according to the channel and material (Chow, 1959). Nevertheless, all those criteria's suggest a value within a given range. The best approach is to perform a sensitivity analysis of the roughness range, and if needed to perform an uncertainty analysis. Although the task of updating the roughness value is a simple one, when repeating many times (sensitivity and uncertainty analysis) it may become a tedious and time consuming task. Thus, Automating Hydraulic Analysis (AHYDRA) allows updating boundary condition, executing the simulation and viewing the results from a single screen and a single instruction (button click)

Updating Roughness Coefficient

Once AHYDRA is launched, you will get the main window with a help menu and two (2) tabs, one for boundary condition and one for roughness. The boundary condition tab is the main one by default, so change to the Manning tab. The help menu has link to the AHYDRA website.

Before using AHYDRA, a HEC RAS projects has to be ready to use; it means, one geometry file, one flow data file and one plan created, like the examples that can be downloaded from the website.

NOTE. In the current version, the all the cross sections have to be integer numbers in consecutive order. The higher numbers are upstream.

The boundary condition tab has the following components (figure 3)

1. Open RAS project. This button will open a dialog menu, in order to navigate and select the path and the HEC RAS file project (*.prj).
2. River name and reach name. This text boxes are to specify the name of the river and reach where the manning roughness will be changed.
3. Overbank and channel roughness. Those text boxes are to specify the new manning roughness. There are tree text boxes, one to specify the new roughness of the left channel overbank, one to specify the new roughness of the main channel and the other to specify the new roughness of the right overbank.
4. Upstream and downstream cross sections. Those text boxes are to specify the range of cross sections where the manning roughness is to be updated. The cross sections have to be integer numbers and the higher number is the upstream.
5. Results radial buttons. Those radial buttons are to select how the results will be presented once the simulation is over. There are three (3) options: show the results in a 2D profile plot show them in a 3D plot or show them as a table.
6. Run model. With this button the program will simulate the river with the new boundary condition and once it has finished will show the results in the selected option.

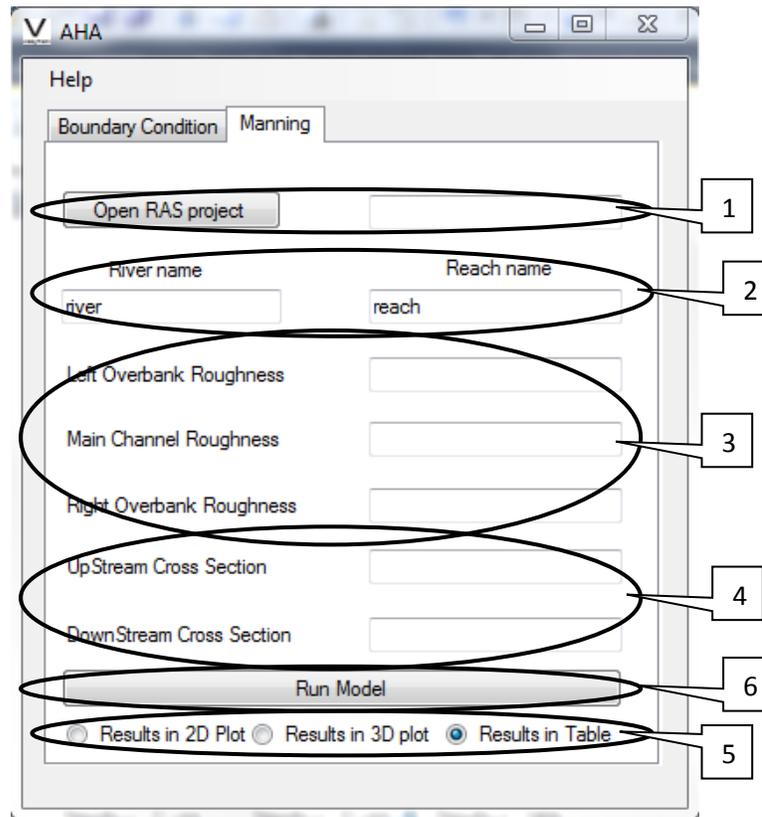


Figure 3 Updating roughness screen

Examples

The compressed file examples.rar contains a HEC-RAS project that can be used with the application. It is a very simple model with a constant slope and a regular shape. As already said, it is just for demonstration of the application. You can try both functionalities of AHYDRA; updating boundary condition and updating roughness. The AHYDRA website also has videos showing the use of AHYDRA with the example project.

Updating boundary condition. The project has an initial boundary condition of normal depth 0.1. The profile shows that such value influence the results over a certain distance. You can use AHYDRA to easily test different values of the boundary condition

Roughness. The file has one main channel and two overbanks. You can use AHYDRA to easily change and try different roughness values.

Comments and / or suggestion

AHYDRA is under constant development and improvement.

On the website you can watch some tutorial videos showing the use of AHYDRA.

If you have any question, suggestion or requirement, just contact us either via mail or via AHYDRA web site.

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<http://ahydra.yolasite.com>

References

Brunner, G. W. (2001). HEC-RAS river analysis system : user's manual. Davis, CA, US Army Corps of Engineers, Institute for Water Resources, Hydrologic Engineering Center.

Brunner, G. W. (2010). HEC-RAS river analysis system : hydraulic reference manual Version 4.1. Davis, CA, US Army Corps of Engineers, Institute for Water Resources, Hydrologic Engineering Center.

Chow, V. T. (1959). Open channel hydraulics. Tokyo, McGraw-Hill.

Cowan, W. L. (1956). "Estimating hydraulic roughness." Agricultural engineering **37**(7): 473-475.