Visual OTTHYMO

Visual OTTHYMO is a comprehensive single event hydrologic modelling and simulation software used by municipalities and engineers to calculate stormwater runoff, peak flows, and volume measurements for flood mapping and stormwater management by modelling rainfall, infiltration, runoff and routing through a watershed.

Visual OTTHYMO is useful for routing a specific design storm or storm event (e.g. the 100-year storm), but provide less capacity to quantify the effects of or “fine-tune” model inputs for antecedent soil moisture, evapotranspiration, and other more complex hydrologic situations. The accuracy of the hydrologic simulation model is defined by the quality of the coefficients these hydrologic simulation models use.

Visual OTTHYMO hydrologic simulation models are suitable for stormwater volume estimation, inflow- to outflow-discharge rate comparison, device size estimation, device performance evaluation for initial design investigation, approximate setting of elevations within hydraulic system, “simple” models – ones with simple inflow and outflow devices and field or rapid evaluation assessment of anticipated stormwater performance

Visual OTTHYMO has been accepted by the Ministry of the Environment and Climate Change, the Ministry of Natural Resources and Forestry, the Ministry of Transportation, the Ministry of Municipal Affairs And Housing, the Association of Conservation Authorities of Ontario, and most municipalities in Ontario as a valid hydrologic simulation model.

Visual OTTHYMO employs graphical drainage schematic interface to set up and run models that simulate the flow of stormwater from a variety of catchments. Visual OTTHYMO program requires the user to develop the watershed by placing an assortment of hydrologic "objects" on a project "canvas" thereby creating a visual representation of the system. When each hydrologic object is selected the user inputs various parameters, as required, to define the objects site specific variables. The simulation is then run for the desired design storm. Model output is available in text and graphical formats.

The visual nature of the model makes Visual OTTHYMO quite user friendly, as the watershed is built on the screen using the various icons provided. Anyone familiar with using the Microsoft toolbox/toolbar format will be comfortable with the layout of Visual OTTHYMO interface.

The building blocks of the Visual OTTHYMO program are hydrologic objects selected by the user to represent the study watershed. These objects are divided into four colour coded categories and grouped in the Visual OTTHYMO program's toolbox in the following categories:

- Watershed Commands,
- Routing Commands,
- Operational Commands, and
- Utility Commands.

Visual OTTHYMO Watershed Commands (Generate Hydrograph Objects)

Depending on the characteristics of the area being modelled four unit hydrograph options are available. Each hydrograph object represents a catchment in the model area.

STANDHYD - Uses parallel instantaneous unit hydrographs for impervious and pervious areas of the catchment. Infiltration is calculated using one of several methods, Horton's infiltration equation, the SCS modified CN method, or the proportional loss method. This method is recommended for modelling urban watersheds with greater than 20% impervious areas.

NASHYD - Uses the Nash instantaneous unit hydrograph method. The hydrograph is calculated based on a series of N reservoirs. Infiltration is calculated using the SCS modified CN method, or the proportional loss method. The Nash method is recommended for rural areas but can also be applied to large urban areas and to simulate infiltration in a stormsewer.

WILHYD - Uses the Williams and Hann (HYMO) unit hydrograph method. Infiltration is calculated using the SCS modified CN method. This method is recommended for rural watersheds with long recession periods.

SCSHYD - Uses the Nash hydrograph method based on SCS parameters and with N= five reservoirs. Similar to NASHYD it is recommended for rural areas

Visual OTTHYMO Routing Commands

Channel routing calculations are used to estimate the transformation of a streamflow hydrograph as a storm event moves through the drainage system. There are four hydrologic routing methods available in Visual OTTHYMO, and all are based on the continuity equation and a storage discharge relation.

ROUTE CHANNEL - Uses the variable storage coefficient method to calculate channel storage based on average channel characteristics and travel time based on Manning's equation. The channel cross section geometry is defined by a series of up to 20 X and Y coordinates entered by the user. The channel width can be divided into up to six segments with varying Manning's n values.

ROUTE PIPE - Applies variable storage coefficient method to circular and rectangular pipes. Allows only one value of Manning’s n. The pipe dimension is automatically re-sized if the values entered are not sufficient to pass the peak flow.

ROUTE MUSKCUNG - Applies the Muskingum-Cunge channel routing method. The channel cross section geometry is defined by a series of up to 20 X and Y coordinates entered by the user. The channel width can be divided into up to 6 segments with varying

Visual OTTHYMO Operational Commands (Modify Hydrograph Objects)

ADD HYD - Adds two hydrographs.

SHIFT HYD - Translation of the hydrograph by a specified time step.

DIVERT HYD - Splits a single hydrograph into up to five hydrographs**.**

DUHYD - Used to separate major and minor hydrographs from a total hydrograph.

Visual OTTHYMO Utility Commands (Manual Input Hydrograph Objects)

READ HYD - Reads a saved hydrograph file.

STORE HYD - Allows the user to enter the ordinates of a known hydrograph**.**

Visual OTTHYMO Rainfall/Storm Information

Rainfall data is entered through the raingauge form. The model can handle up to four raingauges, each with up to ten storm simulations. The user specifies which hydrograph each rainguage pertains to.

There are three model storms available, they are: Chicago Storm, Mass Storm, and Read Storm. Data for the Mass Storm and Read Storm options are read into the model from a properly formatted external text file. The Chicago storm distribution is calculated from user entered values for the time to peak ratio and either the regression constants A, B and C, or time/intensity pairs. Visual OTTHYMO program also allows the variation of the design storm to account for aerial reduction and movement of the storm system through the watershed.

Visual OTTHYMO File Management

In Visual OTTHYMO a collection of files is saved as a "project" in a master file with a *.vop extension. A project is launched by opening the main project file.
Some of the files that may be included in a project are:

- Scenario file (*.sce, contains input data for each object in the model)
- Connectivity file (*.mdr, information to run the model)
- Database file (vo.mdb, contains output information)
- Detailed Output file (*.out, the detailed output file in ASCII)
- Summary Output file (**.sum, the summary output file in ASCII)
- Storm file (*.stm, ASCII file hyetograph input into model)
- Mass Storm file (*.mst, ASCII file mass curve input into model)
- Hydrograph file (*.hyd, ASCII file hydrograph input into model)

There are two options for saving files:

- Save Project (saves all scenarios in a project)
- Save Scenario (saves only the current scenario)

Individual scenarios can be closed independent of the project, allowing the user to have only the scenario(s) of interest running.

Visual OTTHYMO Output Options

There are five options available for output generation:

- Summary Data - output from selected locations within the model.
- Hydrograph Data - Table of hydrograph points
- Hydrograph Plot - Hydrograph Plot - plot of hydrologic data
- Detailed Output File - detailed text file containing all output data for each object
- Summary Output File - summary text file containing key output data for each object.

The user's guide recommends that the project schematic be exported to third party word processing software to be printed. There is no option to print input parameters separately from output files.

Using Visual OTTHYMO

The Visual OTTHYMO interface has been designed to provide plenty of working space for the model schematic while maintaining easy access to the hydrologic objects and their associated parameters. Error and warning messages appear on the model screen and in the output files. A program help file can be searched via an index or through the help search menu for key words or topics. Additionally, help on specific areas of the program is available by pressing F1 while in the relevant dialogue box without having to go through the help menu.

Toolbox: The Toolbox gives the user access to all of Visual OTTHYMO's hydrologic objects (e.g. unit hydrograph, routing routines). Each object is represented by an icon in the Toolbox.

Toolbar: The Toolbar provides easy access to common program features found in all Windows programs (e.g. New, Open, Save) as well as some of Visual OTTHYMO's own program features (e.g. Assign Raingauge, Run Control).

Project Explorer: The Project Explorer shows the user the names of all the hydrologic scenarios within the open project. This window also provides a simple way of modify those scenarios (e.g. Delete, Copy, Insert).

Parameters Window: The Parameters Window provides the user with the main form for inputting hydrologic object parameters (e.g. catchment area, slope, length). Within this window is where the bulk of the data entry takes place.

Model Canvas: The Model Canvas is where the user builds their model schematic from the hydrologic objects in the Toolbox. Objects are dragged from the Toolbox and dropped on the Model Canvas and linked via a linking tool in the Toolbox.

Visual OTTHYMO has two options for both saving and closing files: the Save Project option which saves all scenarios in a project; and the Save Scenario option which only saves the current scenario (i.e. scenario that is bold in the Project Explorer). Visual OTTHYMO can open one project at a time. Therefore, if you wish to open another project (i.e. another *.vop file), then you must first close the existing project.

Closing a scenario is different than closing a project. By default when Visual OTTHYMO loads a project, it loads all scenarios associated with that project. If a project is being executed on a slower computer or one of the scenarios has a large number of objects (say > 200) then it may be more efficient to close one of the scenarios. Closing a scenario unloads it from memory, thereby speeding up processing of the remaining open scenarios. The only downside is that if the user wants to see the closed scenario, it will have to be re-loaded by double clicking the scenario name in the Project Explorer.

A hydrologic model can be quickly and efficiently created by Visual OTTHYMO with a few clicks of the mouse and some keystrokes for the input data. The following are the main steps involved in creating a Visual OTTHYMO model:

- Start a new project by clicking the New Project button in the Toolbar.
- Save the project and name it by clicking the Save Project icon in the Toolbar.
- This will also prompt to name the 1st Scenario.
- Create the model from scratch or import an existing model. This defines the hydrologic objects and the linkages among them.
- Alter the default parameters as required by the particular model by selecting individual objects and then their parameter values, shown in the Parameters Window.
- Select and enter the rainfall events to simulate from the Assign Raingauge button on the Toolbar.
- Run the simulation from the Run Simulation button on the Toolbar.
- View the output with the program's various output control features
- Save the project by clicking the Save Project button on the Toolbar. This will ensure that we can view the output at start-up without having to re-run the model.

Although we can change the model once it is constructed, it is wiser to set the units (metric or imperial units). at the beginning.

The hydrologic objects in Visual OTTHYMO have been separated into four categories. These objects are grouped on the Toolbox according to colour, as follows:

- Generate hydrograph objects (Green-Grey);
- Route hydrograph objects (Purple);
- Modify hydrograph objects (Red); and,
- Manual input hydrograph objects (Blue).

To get the specific object name (i.e. command name) simply move the cursor over the object and the Tip text will display it.

Generate Hydrograph Objects

Visual OTTHYMO generates hydrographs based on unit hydrograph theory. There are four unit hydrographs available: STANDHYD, NASHYD, WILHYD, and SCSHYD. Each unit hydrograph object represents a catchment. Therefore, catchments, and their corresponding runoff parameters, are defined through the generate hydrograph objects.

Route Hydrograph Objects

Route hydrograph objects are used to simulate the routing effects of channels, pipes, and reservoirs. There are two channel routing commands (ROUTE CHANNEL and ROUTE MUSKCUNG). The single pipe routing routine is ROUTE PIPE and the reservoir routing routine is ROUTE RESERVOIR.

Modify Hydrograph Objects

Modify hydrograph objects are used to simulate any form of a modification (e.g. splitting, adding, and shifting) to a hydrograph. The modification commands are: ADDHYD, HIFTHYD, DIVERT HYD, and DUHYD.

Manual Input Hydrograph Objects

Manual input hydrograph objects are used in cases where the user knows the hydrograph but does not have the catchment or routing parameters used to calculate the hydrograph. There are two manual input hydrographs in VO2: READHYD and STOREHYD.

Placing Objects on the Canvas

A hydrologic object is placed on the canvas by selecting it from the Toolbox and then clicking on the canvas where you would like the object to be placed. Once an object is on the canvas it can be moved by selecting it and holding the left mouse button while dragging it to the desired location.

Before placing an object of the same type on the canvas users should be aware of each object's default parameters. While the program has default parameters associated with each command, these may be altered on a project basis once the first object of a type is entered and edited.

Visual OTTHYMO Input Parameters - Watershed Commands

Parameter	Description
STANHYD	
NHYD	Object number between 1 and 9999.
DT	Simulation time step (min).
AREA	Watershed area, ha.
XIMP	Ratio of directly connected impervious areas, between 0 and 1.
TIMP	Ratio of total impervious area, must be greater than or equal to XIMP.
DWF	Base flow, m3/s
LOSS	Determines the loss method to be applied. 1=Horton's equation, 2=SCS modified CN, 3=Proportional Loss method.
SLPP	Slope of pervious area, %.
LGP	Length of overland flow path pervious area, m.
MNP	Manning's n for pervious surface.
SCP	Storage coefficient for the linear reservoir of the pervious areas, hr.
DPSI	Depression storage for impervious area, mm.
SLPI	Slope of impervious area, %.
LGI	Length of overland flow path impervious area, m. LGI=1 manually input LGI=2 calculated by A=1.5*L^2
MNI	Manning's n for impervious surface.
SCI	Storage coefficient for the linear reservoir of the impervious areas, hr.
RAIN	Option for user to enter rainfall data directly into hydrograph, mm/hr at DT intervals.
LABEL	Option to add a label to the hydrologic object.
NASHYD	
NHYD	Object number between 1 and 9999.
DT	Simulation time step (min).
AREA	Watershed area, ha.
DWF	Base flow, m3/s
CN	SCS curve number or Proportional loss coefficient (if -ve).
IA	Initial abstraction, mm. If IA<0 program uses SCS method to calculate losses.
N	Number of linear reservoirs.
TP	Time to peak, hr.
RAIN	Option for user to enter rainfall data directly into hydrograph, mm/hr at DT intervals.
LABEL	Option to add a label to the hydrologic object.

WILLHYD	
NHYD	Object number between 1 and 9999.
DT	Simulation time step (min).
AREA	Watershed area, ha.
AA/DWF	Base flow, m3/s
BB	Printing option. 0=print rainfall excess ordinates, 1=do not print same.
CN	Curve number.
IA	Initial abstraction, mm.
K	Recession constant, hr.
TP	Time to peak, hr.
RAIN	Option for user to enter rainfall data directly into hydrograph, mm/hr at DT intervals.
LABEL	Option to add a label to the hydrologic object.
SCSHYD	
NHYD	Object number between 1 and 9999.
DT	Simulation time step (min).
AREA	Watershed area, ha.
DWF	Base flow, m3/s.
CN	Curve number.
TP	Time to peak, hr.
RAIN	Option for user to enter rainfall data directly into hydrograph, mm/hr at DT intervals.
LABEL	Option to add a label to the hydrologic object.

Visual OTTHYMO Input Parameters - Infiltration Loss Methods for STANHYD

Parameter	Description
Horton's Method	
Fo	Initial infiltration rate, mm/hr.
Fc	Final infiltration rate, mm/hr
DCAY	Decay constant, /hr.
F	Moisture in soil at beginning of storm, mm.
DPSP	Depression storage for pervious area, mm.
SCS Modified CN Method	
CN	Curve number.
IA	Initial Abstraction, mm.
Proportional Loss Coefficient Method	
C	Proportional Los Coefficient ratio, 0-1.
IA	Initial Abstraction, mm.

Visual OTTHYMO - Input Parameters - Routing Commands

Parameter	Description
ROUTE CHANNEL	
NHYD	Object number between 1 and 9999.
DT	Time step, min.
CHLGTH	Length of channel, m.
CHSLOPE	Channel slope, %.
FPSLOPE	Flood plain slope, %.
VSN	Valley section number, a reference number between 1 and 9999.
NSEG	Number of segments in channel cross section, max 6.
ROUGH, SEGDIST	Roughness over the segment width, m
DIST, ELEV	Channel cross section shape co-ordinates.
LABEL	Option to add a label to the hydrologic object.
ROUTE MUSKCUNG	
NHYD	Object number between 1 and 9999.
DT	Time step, min.
CHLGTH	Length of channel, m.
CHSLOPE	Channel slope, %.
FPSLOPE	Flood plain slope, %.
VSN	Valley section number, 1 to 9999.
BETA	Constant for stage-discharge curve. Between 1 and 1.67.
NSEG	Number of segments in channel cross section, max 6.
ROUGH, SEGDIST	Roughness over the segment width, m
DIST, ELEV	Channel cross section shape co-ordinates.
LABEL	Option to add a label to the hydrologic object.
ROUTE PIPE	
ITYPE	Pipe shape. 1=circular, 2=rectangular
DIAM	Diameter of circular pipe, mm.
Width, Height	Dimensions of rectangular pipe, mm.
NHYD	Object number between 1 and 9999.
PIPE	Pipe number between 1 and 9999.
PLNGTH	Pipe length, m.
ROUGH	Manning's n.
SLOPE	Slope of pipe, m/m.
DT	Time step, min.
LABEL	Option to add a label to the hydrologic object.

ROUTE RESERVOIR	
NHYD	Object number between 1 and 9999.
DT	Time step, min.
RATING CURVE	Allows input discharge-storage curve.
DISCHARGE, STORAGE	Pairs of values to describe discharge-storage relationship, m3/s & ha/m.
LABEL	Option to add a label to the hydrologic object.

Visual OTTHYMO - Input parameters - Operational Commands

Parameter	Description
ADD HYD	
NHYD	Object number between 1 and 9999.
LABEL	Option to add a label to the hydrologic object.
SHIFT HYD	
NHYD	Object number between 1 and 9999.
TLAG	Lag time for the hydrograph, min.
LABEL	Option to add a label to the hydrologic object.
DIVERT HYD	
NHYD	Object number between 1 and 9999.
FLOW table	Specify flow split between up to 5 hydrographs.
NHYD1…NHYD5	Object number for outlet hydrographs no. 1-5.
Q1(n)..Q5(n)	Hydrograph outflow when the inflow is QTOTAL(n), m3/s. n=1-20.
LABEL	Option to add a label to the hydrologic object.
DUHYD	
NHYD	Object number between 1 and 9999.
CINLET	Peak flow capture rate, m3/s.
NINLET	Number of inlets in the drainage system with capture rate of CINLET.
FLOW table	Connection to downstream NHYD's.
MAJID	NHYD of major system connection.
MINID	NHYD of minor system connection.
LABEL	Option to add a label to the hydrologic object.
READ HYD	
NHYD	Object number between 1 and 9999.
FILEPN	Filepath of hydrograph.
LABEL	Option to add a label to the hydrologic object.
STORE HYD	
NHYD	Object number between 1 and 9999.

DT	Time step, min.
AREA	Watershed area, ha.
HYD POINTS	Hydrograph ordinates, m3/s. Up to 2000 pairs.
LABEL	Option to add a label to the hydrologic object.

Visual OTTHYMO Input Parameters - Assign Rain Gauge

Parameter	Description
Chicago Storm	
IUNITS	SI or metric.
TD	Duration of storm, hr.
R	Ratio of time to peak to total duration.
SDT	Storm's time increment, min.
ICASE	Method for IDF curve calculation. 1=Regression Equation (User specifies constants A,B&C), 2=Manually entered Time/Intensity Pairs.
Mass Storm	
PTOT	Total precipitation, mm.
SDT	Storm's time increment, min.
CRV Name	Mass curve file path.
Read Storm	
STMFNAME	Storm file path.

Visual OTTHYMO - Input Parameters - Modify Storm

Parameter	Description
Modify Storm 1=R Fact Factor	
NSHIFT	Time step.
RFACT	Factor to adjust rainfall increments.
Modify Storm 2=R Fact=XK*XLXM**	
NSHIFT	Time step.
XK	Constant.
XL	Distance from the epicentre of storm to centre of watershed, km.
XM	Exponent used in equation.

Prepared by Meghal M Raval, Joomin Park & Charles Aaron Jayakar

Building Experts Canada
Professional Engineers Ontario - Certificate of Authorization # 100205934
5215 Finch Avenue East Toronto ON M1S 0C2 (416) 332 1743
www.buildingexpertscanada.com