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P2P Modeling System

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Xuefeng Chu (PI)

CAREER: Microtopography-Controlled Puddle-filling to Puddle-merging (P2P) Overland Flow Mechanism: Discontinuity, Variability, and Hierarchy

March 1, 2007 – May 31, 2013

P2P Modeling System
User's Manual

Version 1.50

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June 17, 2013

North Dakota State University

Introduction to the P2P Modeling System

This Windows-based software is a comprehensive hydrologic modeling package. It consists of four major components: (1) microtopography-controlled puddle-to-puddle (P2P) overland flow modeling system (P2P-Model), (2) P2P educational system (P2P-Education), (3) 2D/3D visualization and hydrotopographic analysis tools (P2P-Tool), and (4) HYDROL-INF modeling system.

P2P-Model is the key component of this P2P software. It includes three fundamental models (P2P Model-1, P2P Model-2, and P2P Model-3) and two multiscale models (Multiscale Model-1 and Multiscale Model-2). Based on surface puddle delineation, P2P-Model simulates the dynamic P2P filling, spilling, merging, and splitting overland flow processes on either impervious or infiltrating topographic surfaces. The Windows interface allows users to prepare their input data, run the models (both puddle delineation and P2P modeling), and visualize simulation results in formats of tables, graphs (2D and 3D), and animations. Particularly, the wizard facilitates computer-guided, step-by-step P2P overland flow modeling.

P2P-Education is an teaching-learning system. The software, with enhanced visualization capabilities, integrates the new modeling techniques, computer-guided learning processes, and education-oriented tools in a user-friendly Windows-based interface (A web-based version of P2P-Education also is available). P2P-Education is specially designed for three major user levels: elementary level (Level 1: K-12 and outreach education), medium level (Level 2: undergraduate education), and advanced level (Level 3: graduate education). Depending on the levels, users are guided to different educational systems. Each system consists of a series of mini "libraries" featuring movies, pictures, and documentation related to fundamental theories, varying scale experiments, and computer modeling of overland flow generation, surface runoff, and infiltration processes.

P2P-Tool consists of a series of stand-alone tools for visualization and hydrotopographic analysis, including (1) 2D and 3D visualization and animation tools, (2) puddle delineation tool (PD), (3) scanned data combination tool (S-C), (4) image-based depression storage computation tool (IDS), (5) image correction tool (IC), (6) coordinate transformation tool (XYT), (7) slope removal tool (SR), (8) fractal analysis tool (FA), (9) object-based image segmentation tool (OBIS), and (10) surface topographic parameters tool (STP). The PD tool also is an essential part of P2P modeling used for characterizing surface microtopography, delineating puddles and their relationships, determining flow directions and accumulations, and precisely computing maximum depression storage (MDS) and maximum ponding area (MPA).

HYDROL-INF is an independent hydrologic modeling system. A modified Green-Ampt infiltration-runoff model is the central part of the HYDROL-INF system. The model is capable of determining the ponding condition, simulating infiltration into a layered soil profile of arbitrary initial water distributions under unsteady rainfall, and partitioning the rainfall input into infiltration and surface runoff. Two distinct periods, pre-ponding and post-ponding, are taken into account. The model tracks the movement of the wetting front along the soil profile, checks the ponding status, and, in particular, handles the shift between ponding and non-ponding conditions. The model also is able to continuously simulate the rainfall-infiltration-runoff processes and soil water drainage and redistribution for complex rainfall patterns that include both wet time periods with unsteady rainfall and dry time periods without rainfall. In addition, the HYDROL-INF system includes the SCS-CN model and several useful hydrologic tools such as measured streamflow computation tool, time of concentration calculator, and 24-hr rainfall generator.

Acknowledgements

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1 Installation of the P2P Modeling System

Double-click the file named "Setup.exe" on the DVD drive and then just follow the instructions. After the installation, the P2P software can be started from "Start" and "Programs." A set of example data are included in the package for testing the software.

2 Instructions for Using the P2P Modeling System

A beginner may use the wizard, which provides computer-guided, step-by-step P2P modeling, including creating a new project, inputting all required data, running the models, and visualizing outputs. Generally, four major steps are required for modeling:

<u>Step 1</u>: Create a new project and select a working directory. Then, all input data and modeling output files will be automatically saved to this directory. Users may open an existing project.

<u>Step 2</u>: Select a P2P model from the main menu (e.g., P2P Model-1). Prepare all input data via submenu "Data." All temporally and/or spatially distributed data, such as rainfall intensity, evaporation rate, DEM, initial ponding depths can be input manually or imported from an existing text or Excel file. The data can also be exported to a file.

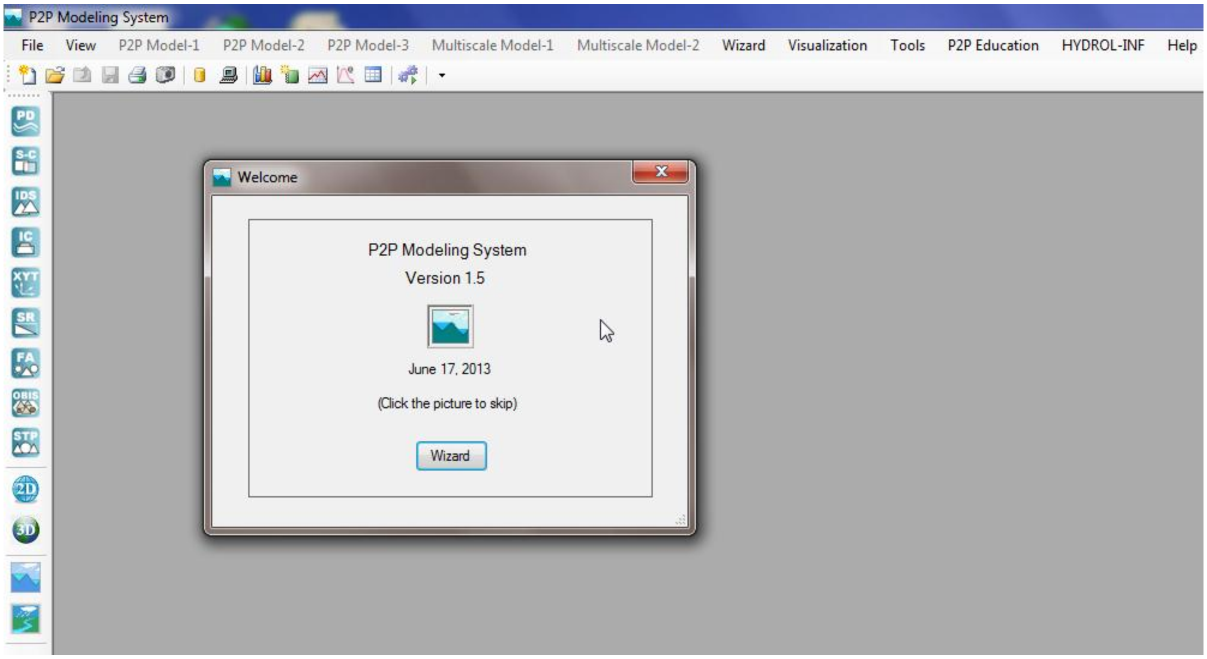
<u>Step 3</u>: Run the models via buttons or menus "Run Puddle Delineation" and "Run P2P Model." The completeness of input data will be automatically checked. Note that the puddle delineation (PD) program should be run prior to the P2P model.

<u>Step 4</u>: Conduct post-processing via submenu "Outputs." The PD results can be shown in both 3D visualization and tabular formats. The PD program provides the detailed results, such as the centers and thresholds of puddles for each level, maximum depression storage (MDS) and maximum ponding area (MPA) at each level, puddle relationships, and flow directions and accumulations for all DEM cells. The water mass balance table for each cell/puddle/basin or the entire surface can be shown via submenu "Mass Balance." The button "Mass Balance Table" shows the mass balance for basins and the entire surface. The ponded water depths for cells and puddles can be displayed in a table format. In addition, 3D animations of ponded water distribution in puddles can be visualized via submenu or button "3D Animation." The hydrograph of each basin or the entire surface can be shown through submenu or button "Hydrograph." The graphs of cumulative rainfall, evaporation, infiltration, depression storage, and surface runoff can be accessed through menu "2D Time Series Graphs" (or button 2D Graph). The information on hydrologic connectivity also is available, including functional hydrologic connectivity, structural hydrologic connectivity, hydrologic connectivity statistics summary, hydrologic connectivity statistics, and hydrologic connectivity to outlets. Both tables and graphs can be printed out using menu "Print" (or button Print). Additionally, a graph on the screen can be captured and copied to Clipboard.

3 Overview of the P2P Modeling System Interface

3.1 Main Interface

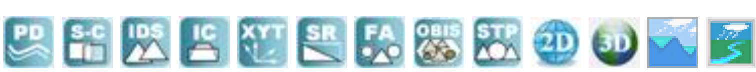
From the main interface of the Windows-based P2P system, users can access the five P2P models, wizard, visualization tools, hydrotopographic tools, P2P education software, HYDROL-INF software, and Help (including the P2P website, software documentation, and demonstration videos). The menus for each P2P model are organized according to three fundamental modeling steps: Data, Model, and Output.



3.2 Menu Bar and Tool Bar

The buttons in the menu bar (from left to right) are New Project, Open Project, Close Project, Save Project, Print, Screen Shot, Run Puddle Delineation, Run P2P Model, 3D Surface, 3D Animation, 2D Graph, Hydrograph, Mass Balance Table, and Wizard.

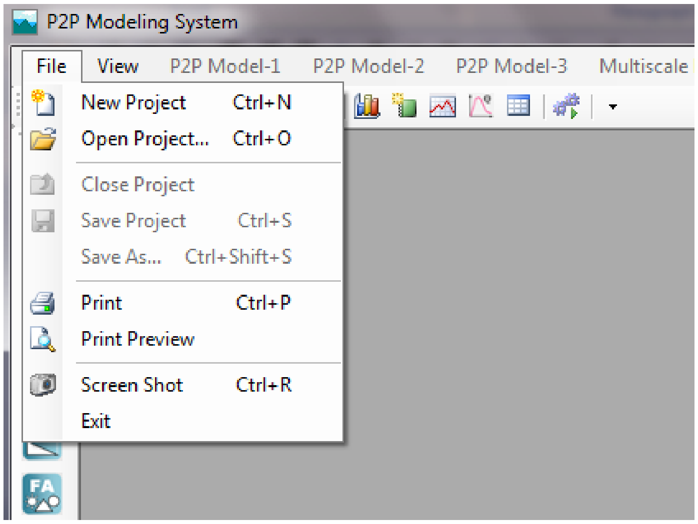
The buttons in the tool bar (from top to bottom) are puddle delineation (PD), scanned data combination (S-C), image-based depression storage computation (IDS), image correction (IC), coordinate transformation (XYT), surface slope removal (SR), fractal analysis (FA), object-based image segmentation (OBIS), surface topographic parameters (STP), 2D visualization, 3D visualization, P2P Education, and HYDROL-INF.



3.3 File

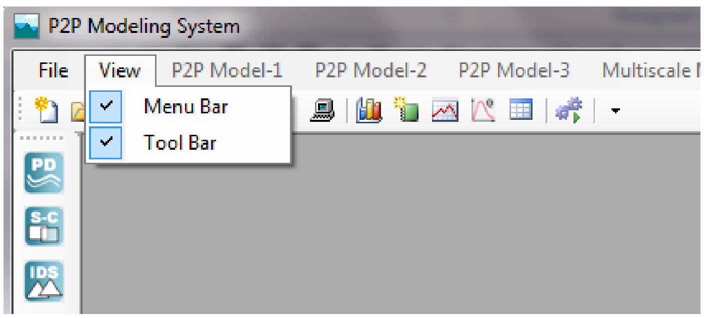
<u>New Project (button New Project)</u>: Setup a new project and specify a working directory
<u>Open Project (button Open Project)</u>: Open an existing project
<u>Close Project (button Close Project)</u>: Close the current project
<u>Save Project (button Save Project)</u>: Save the current project

Save As: Save the current project to a user-specified directory
Print (button Print): Print the current graph or a text-formatted input/output data
Print Preview: Preview the print settings
Screen Shot (button Screen Shot): Copy a screen image, such as a graph to Clipboard
Exit: Exit the P2P System



3.4 View

Menu Bar: Show/hide the menubar.
Tool Bar: Show/hide the toolbar.



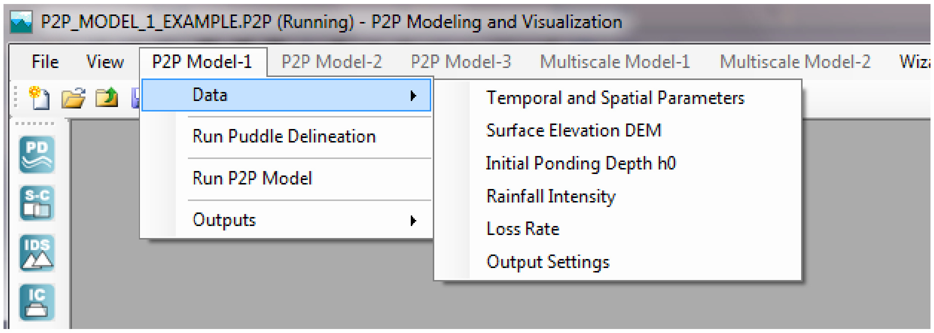
3.5 P2P Model-1

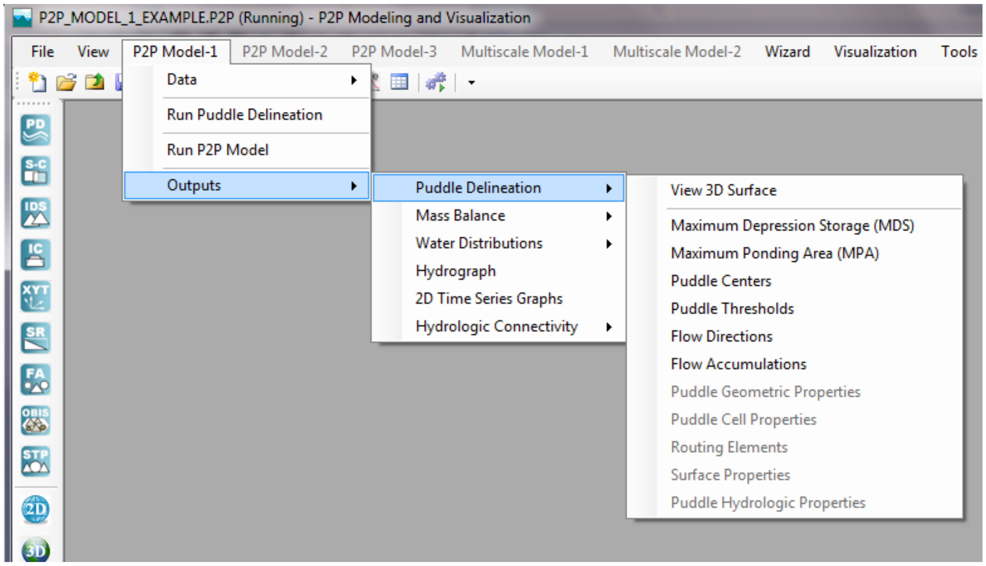
Data: Input all required data for modeling
- Temporal and Spatial Parameters
- Surface DEM
- Initial Ponding Depth h0
- Rainfall Intensity
- Loss Rate
- Output Settings

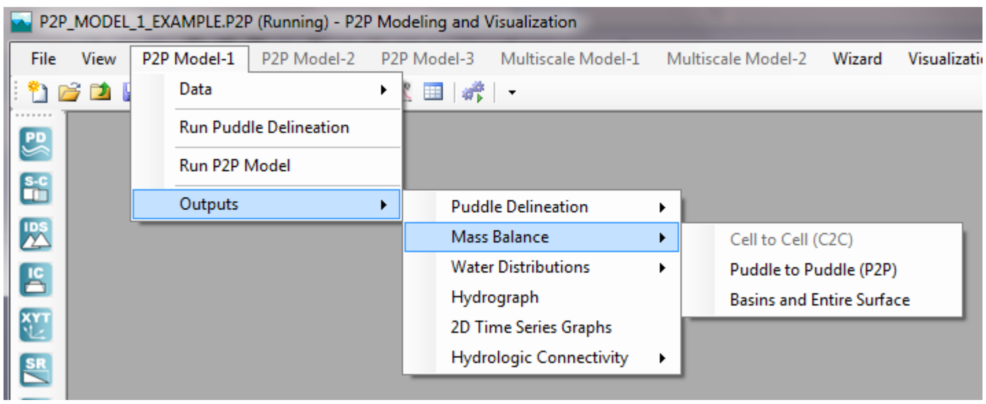
Run Puddle Delineation (button Run Puddle Delineation): Run the puddle delineation program. The outputs from the PD program will be used for the P2P modeling

Run P2P Model (button Run P2P Model): Execute the P2P modeling

Outputs: Visualize simulation results in tables, 2D/3D graphs, and 3D animations
- Surface Delineation
  - View 3D Surface
  - Maximum Depression Storage (MDS)
  - Maximum Ponding Area (MPA)
  - Puddle Centers
  - Puddle Thresholds
  - Flow Directions
  - Flow Accumulations
  - Puddle Geometric Properties
  - Puddle Cell Properties
  - Routing Elements
  - Surface Properties
  - Puddle Hydrologic Properties
- Mass Balance
  - Cell to Cell (C2C)
  - Puddle to Puddle (P2P)
  - Basins and Entire Surface
- Water Distributions
  - 3D Animations
  - Tables
    - All Cells
    - Puddle Cells
- Hydrograph
- 2D Time Series Graphs
- Hydrologic Connectivity
  - Functional Hydrologic Connectivity
  - Structural Hydrologic Connectivity
  - Hydrologic Connectivity Statistics Summary
  - Hydrologic Connectivity Statistics
  - Hydrologic Connectivity to Outlets




P2P_MODEL_1_EXAMPLE.P2P (Running) - P2P Modeling and Visualization
File View P2P Model-1 P2P Model-2 P2P Model-3 Multiscale Model-1 Multiscale Model-2 Wizard Visualization Tools
Data
Run Puddle Delineation
Run P2P Model
Outputs
Puddle Delineation
Mass Balance
Water Distributions
Hydrograph
2D Time Series Graphs
Hydrologic Connectivity
View 3D Surface
Maximum Depression Storage (MDS)
Maximum Ponding Area (MPA)
Puddle Centers
Puddle Thresholds
Flow Directions
Flow Accumulations
Puddle Geometric Properties
Puddle Cell Properties
Routing Elements
Surface Properties
Puddle Hydrologic Properties


P2P_MODEL_1_EXAMPLE.P2P (Running) - P2P Modeling and Visualization
File View P2P Model-1 P2P Model-2 P2P Model-3 Multiscale Model-1 Multiscale Model-2 Wizard
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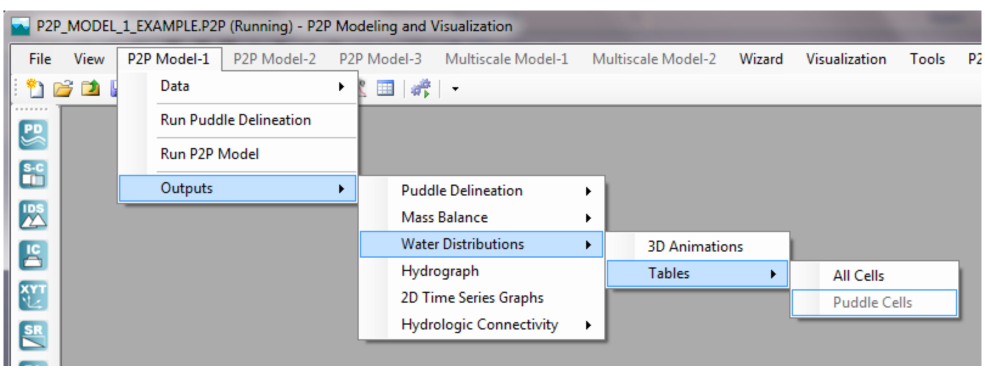
Puddle Delineation
Mass Balance
Water Distributions
Hydrograph
2D Time Series Graphs
Hydrologic Connectivity
Cell to Cell (C2C)
Puddle to Puddle (P2P)
Basins and Entire Surface


P2P_MODEL_1_EXAMPLE.P2P (Running) - P2P Modeling and Visualization
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Puddle Delineation
Mass Balance
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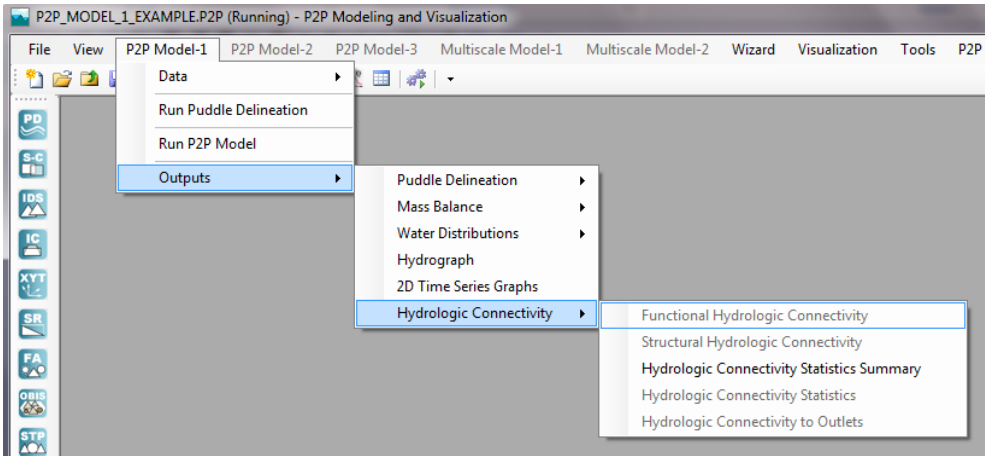


3.6 P2P Model-2

Data: Input all required data for modeling

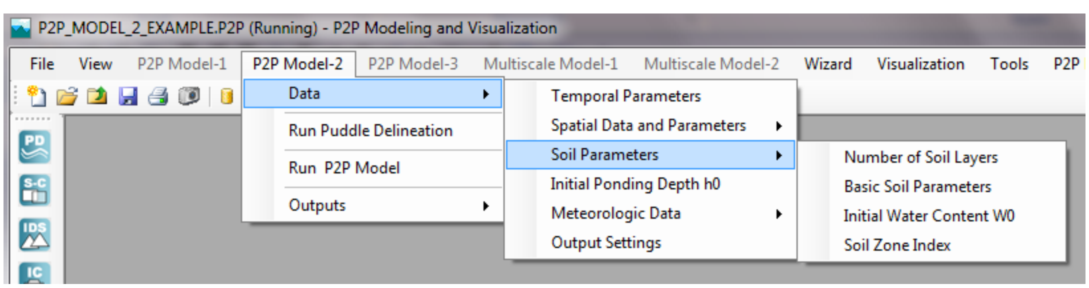
- Temporal Parameters
- Spatial Data and Parameters
  - Basic Parameters
  - Surface DEM
- Soil Parameters
  - Number of Soil Layers
  - Basic Soil Parameters
  - Initial Water Content W0
  - Soil Zone Index
- Initial Ponding Depth h0
- Meteorologic Data
  - Meteorologic Zones
  - Rainfall Intensity
  - ET Data
  - ET Zone Index of Grids
- Output Settings

Run Puddle Delineation (button Run Puddle Delineation): Run the puddle delineation program. The outputs are used for the P2P model

Run P2P Model (button Run P2P Model): Execute P2P modeling

Outputs: View the modeling results in tables, 2D/3D graphs, and 3D animations

- Surface Delineation
  - View 3D Surface
  - Maximum Depression Storage (MDS)
  - Maximum Ponding Area (MPA)
  - Puddle Centers
  - Puddle Thresholds



P2P_MODEL_2_EXAMPLE.P2P (Running) - P2P Modeling and Visualization
File
View
P2P Model-1
P2P Model-2
P2P Model-3
Multiscale Model-1
Multiscale Model-2
Wizard
Visualization
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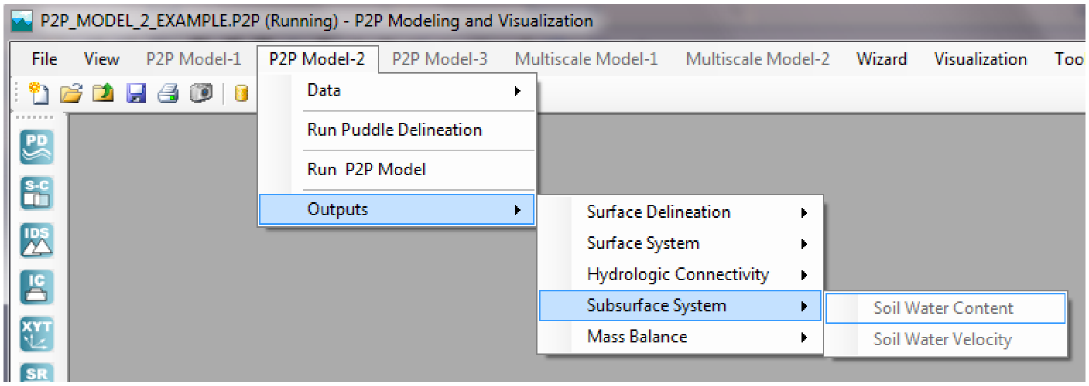
P2P
Data
Run Puddle Delineation
Run P2P Model
Outputs
Temporal Parameters
Spatial Data and Parameters
Soil Parameters
Initial Ponding Depth h0
Meteorologic Data
Output Settings
Number of Soil Layers
Basic Soil Parameters
Initial Water Content W0
Soil Zone Index



3.7 P2P Model-3

Data: Input all required data for modeling
- Temporal Parameters
- Spatial Data and Parameters
  - Basic Parameters
  - Surface DEM
  - Manning's Coefficient
- Soil Parameters
  - Number of Soil Layers
  - Basic soil Parameters
  - Initial Water Content W0
  - Soil Zone Index
- Initial Ponding Depth h0
- Meteorologic Data
  - Meteorologic Zones
  - Rainfall Intensity
  - ET Data
  - ET Zone Index of Grids
- Output Settings

Run Puddle Delineation (button Run Puddle Delineation): Run the puddle delineation program. The outputs are used for the P2P model

Run P2P Model (button Run P2P Model): Execute P2P modeling

Outputs: Output the results in text-format, 2D graph, or 3D animation
- Surface Delineation
  - View 3D Surface
  - Maximum Depression Storage (MDS)
  - Maximum Ponding Area (MPA)
  - Puddle Centers
  - Puddle Thresholds
  - Flow Directions
  - Flow Accumulations

Puddle Geometric Properties
Puddle Cell Properties
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Surface Properties
Puddle Hydrologic Properties
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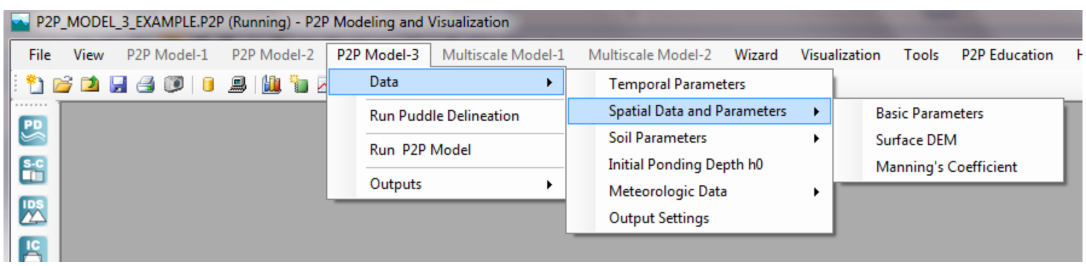
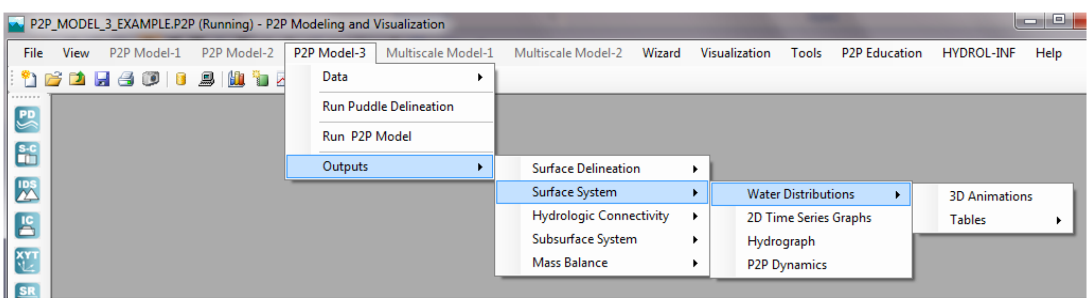
Functional Hydrologic Connectivity
Structural Hydrologic Connectivity
Hydrologic Connectivity Statistics Summary
Hydrologic Connectivity Statistics
Subsurface System
Soil Water Content
Soil Water Velocity
Mass Balance
Surface Mass Balance
Subsurface Mass Balance





3.8 Multiscale Model-1

Data: Input all required data for modeling

Temporal Parameters
Spatial Data and Parameters
    Basic Parameters
    Surface DEM
    Manning's Coefficient
Soil Parameters
    Number of Soil Layers
    Basic Soil Parameters
    Initial Water Content W0
    Soil Zone Index
Initial Ponding Depth h0
Meteorologic Data
    Meteorologic Zones
    Rainfall Intensity
    ET Data
    ET Zone Index of Grids
Output Settings

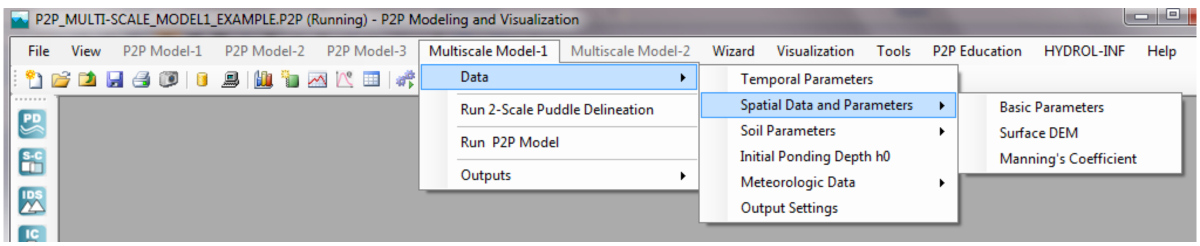
Run 2-Scale Puddle Delineation (button Run Puddle Delineation): Run the puddle delineation program for two different scales. The outputs are used for the multiscale P2P model

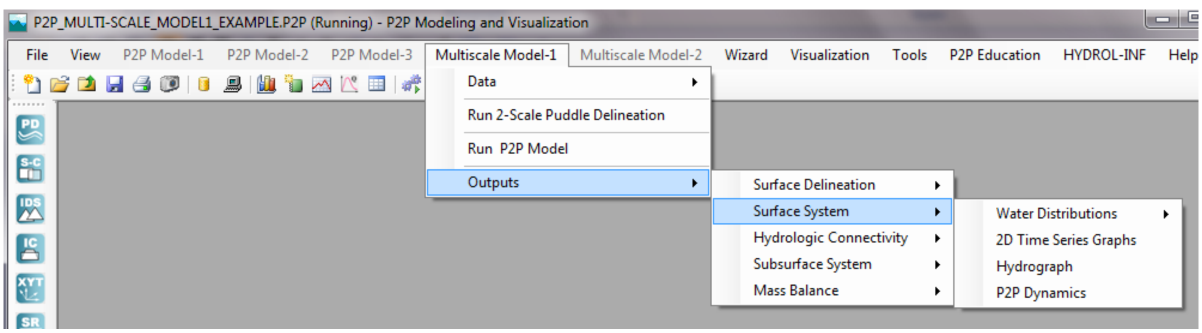
Run P2P Model (button Run P2P Model): Execute P2P modeling

Outputs: View the modeling results in tables, 2D/3D graphs, and 3D animations. Note that some outputs are optional (controlled by certain output indices)

- Surface Delineation
    - View 3D Surface
    - Maximum Depression Storage (MDS)
    - Maximum Ponding Area (MPA)
    - Puddle Centers
    - Puddle Thresholds
    - Flow Directions
    - Flow Accumulations
    - Puddle Geometric Properties
    - Puddle Cell Properties
    - Routing Elements
    - Surface Properties
    - Puddle Hydrologic Properties
- Surface System
    - Water Distributions
        - 3D Animations
        - Tables
            - All Cells
            - Puddle Cells
    - 2D Time Series Graphs

- Hydrograph
- P2P Dynamics
- Hydrologic Connectivity
  - Functional Hydrologic Connectivity
  - Structural Hydrologic Connectivity
  - Hydrologic Connectivity Statistics Summary
  - Hydrologic Connectivity Statistics
  - Hydrologic Connectivity Statistics
- Subsurface System
  - Soil Water Content
  - Soil Water Velocity
- Mass Balance
  - Surface Mass Balance
  - Subsurface Mass Balance





3.9 Multiscale Model-2

Data: Input all required data for modeling
- Temporal Parameters
- Spatial Data and Parameters
  - Basic Parameters
  - Surface DEM
- Soil Parameters
  - Number of Soil Layers
  - Basic Soil Parameters
  - Initial Water Content W0
  - Soil Zone Index
- Initial Ponding Depth h0

Meteorologic Data
- Meteorologic Zones
- Rainfall Intensity
- ET Data
- ET Zone Index of Grids

Output Settings

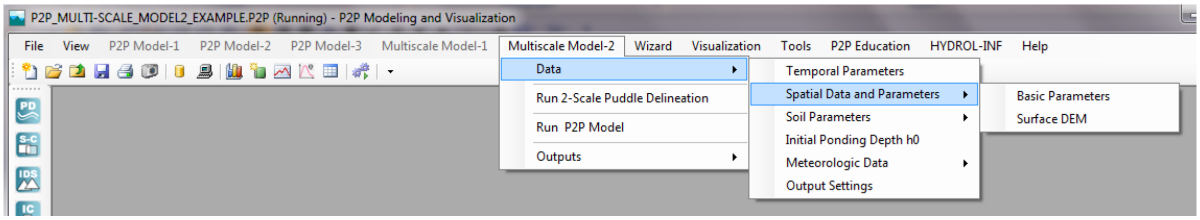
Run 2-Scale Puddle Delineation (button Run Puddle Delineation): Run the puddle delineation program for two different scales. The outputs are used for the multiscale P2P model

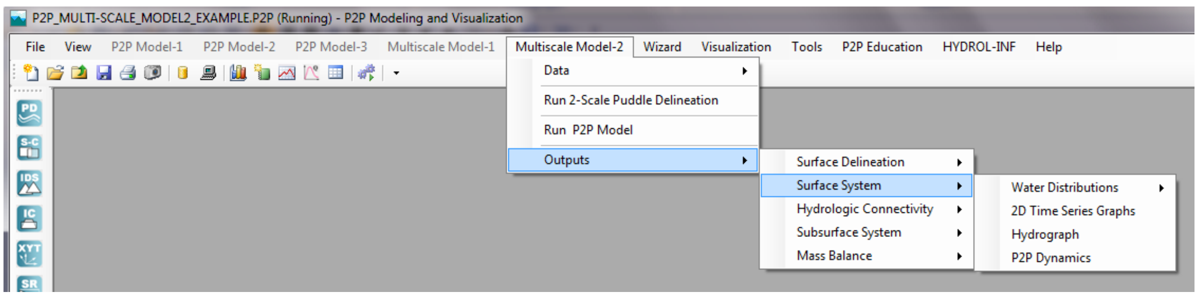
Run P2P Model (button Run P2P Model): Execute P2P modeling

Outputs: View the modeling results in tables, 2D/3D graphs, and 3D animations. Note that some outputs are optional (controlled by certain output indices)

- Surface Delineation
  - View 3D Surface
  - Maximum Depression Storage (MDS)
  - Maximum Ponding Area (MPA)
  - Puddle Centers
  - Puddle Thresholds
  - Flow Directions
  - Flow Accumulations
  - Puddle Geometric Properties
  - Puddle Cell Properties
  - Routing Elements
  - Surface Properties
  - Puddle Hydrologic Properties
- Surface System
  - Water Distributions
    - 3D Animations
    - Tables
      - All Cells
      - Puddle Cells
  - 2D Time Series Graphs
  - Hydrograph
  - P2P Dynamics
- Hydrologic Connectivity
  - Functional Hydrologic Connectivity
  - Structural Hydrologic Connectivity
  - Hydrologic Connectivity Statistics Summary
  - Hydrologic Connectivity Statistics
  - Hydrologic Connectivity Statistics
- Subsurface System
  - Soil Water Content
  - Soil Water Velocity

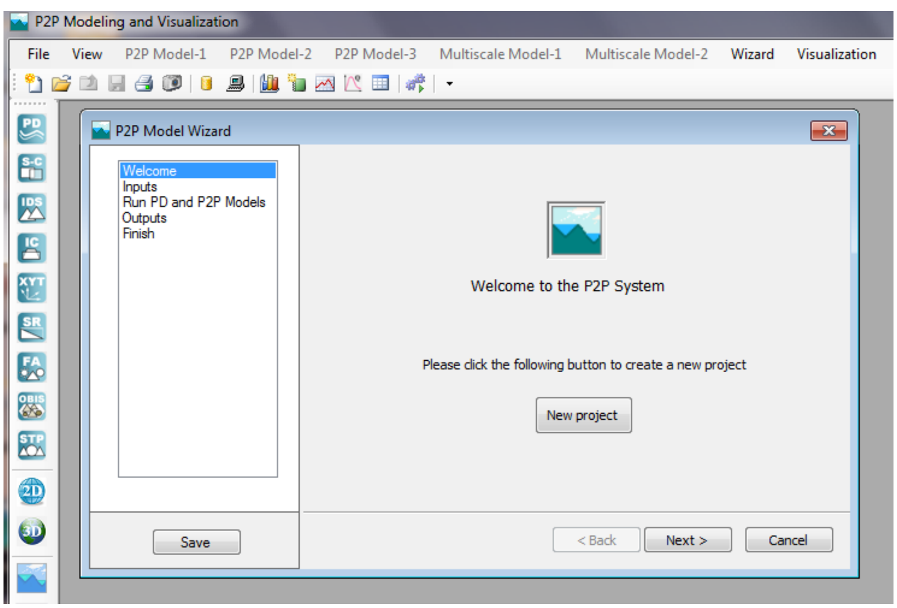
Mass Balance
  Surface Mass Balance
  Subsurface Mass Balance





3.10 Wizard

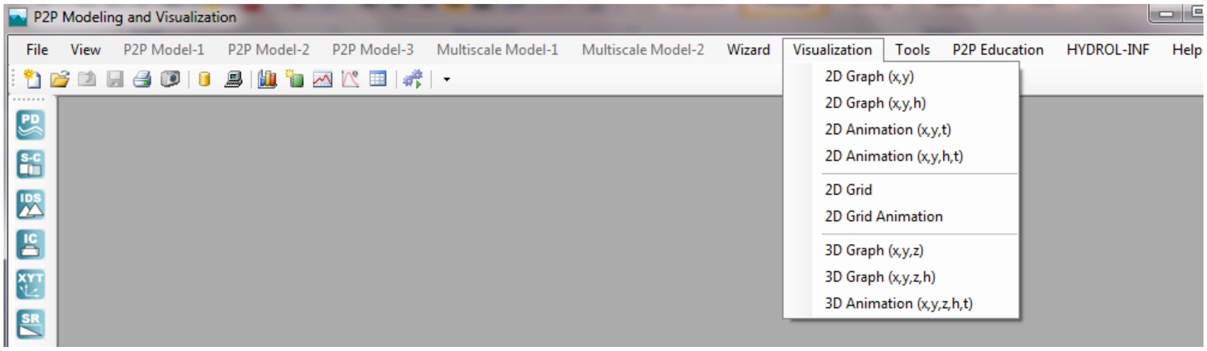
Set up a new project step by step using the wizard.



3.11 Visualization

2D Graph (x, y): Any (x, y) data.
2D Graph (x, y, h): Distribution of h over the (x, y) domain.

2D Animation (x, y, t): Changes in (x, y) data with time (t).
2D Animation (x, y, h, t): Changes in h with (x, y) and time (t).
2D Grid: Grids in a (x, y) plane view.
2D Grid Animation: Changes in grids (grid properties) with time (t).
3D Graph (x, y, z): Any (x, y, z) data.
3D Graph (x, y, z, h): Distribution of h over the (x, y, z) domain.
3D Animation (x, y, z, h, t): Changes in h with (x, y, z) and time (t).



3.12 Tools

A set of tools for analyzing surface topography are incorporated in the P2P system. These tools include:

Delineation Tools:

Puddle Delineation (PD): The PD program is capable of importing DEM data, implementing puddle delineation for fully-filled and unfilled conditions, determining flow directions and accumulations, computing contributing areas, calculating terrain parameters, displaying the results, and visualizing the puddle searching process.

Image Processing Tools:

Scanned Data Combination Tool (SC): The SC program is designed to combine two data sets (scanned DEMs) into one file. These two data sets should have an overlapping area in order to be successfully combined.

Image-based Depression Storage Computation Tool (IDS): The IDS program is designed to calculate depression storage from an experimental image. The calculated depression storage can be the maximum depression storage (MDS) of a puddle, or the depression storage at any level. Besides the image, an original DEM file is required.

Image Correction Tool (IC): The IC program is designed to process a distorted surface image and convert it to its actual surface. This program also provides the functions to transform the original image to grayscale, add neon/emboss/smooth/sharp effects to the picture, obtain the pixel value of any point, change the brightness of the picture, move/zoom/rotate the picture, and flip the picture horizontally or vertically.

Object-based Image Segmentation Tool (OBIS): The OBIS program is designed for image processing and clustering.

Topographic Tools:

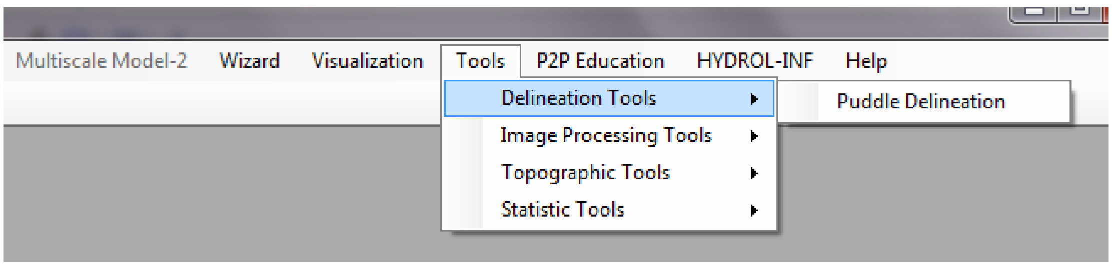
Coordinate Transformation Tool (XYT): The XYT program is designed to perform 3D rotation of a surface and create a series of surfaces with varying slopes.

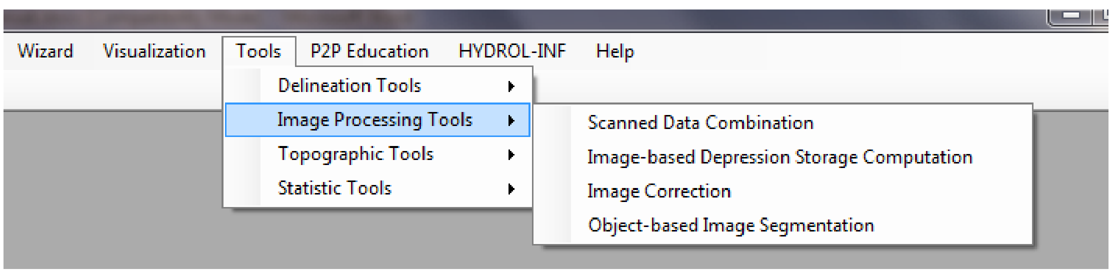
Surface Slope Removal Tool (SR): The SR program is designed to remove the overall slope of a topographic surface using the linear, quadratic, or cubic plane fitting method.

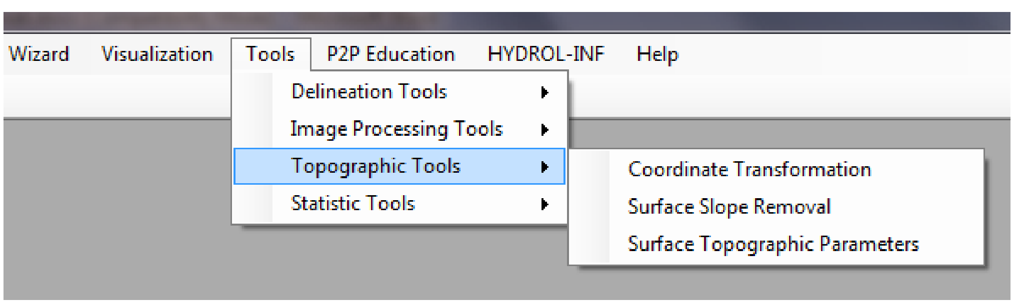
Surface Topographic Parameters Tool (STP): The STP program is designed to compute a set of commonly used surface topographic parameters, including slope, aspect, profile curvature, plan curvature, tangential curvature, and mean curvature.

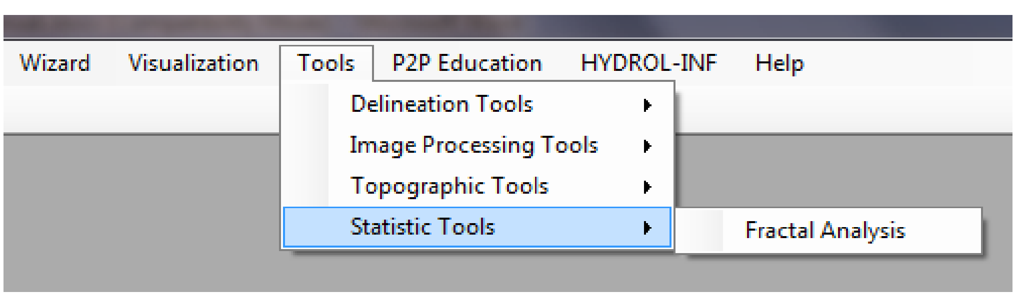
Statistic Tools:

Fractal Analysis Tool (FA): The FA program is designed to compute the omni and directional semivariograms $\gamma(h)$, fractal dimension D, and intercept I_c.



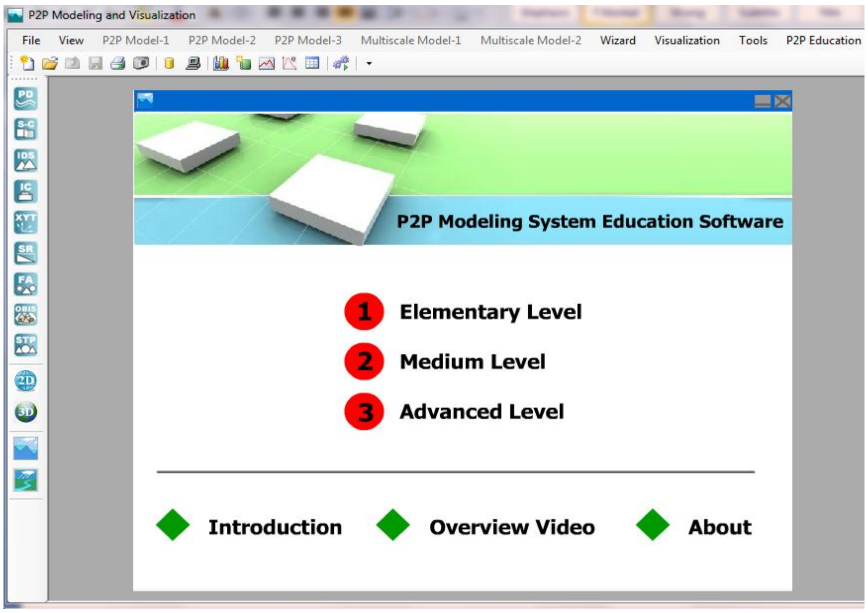






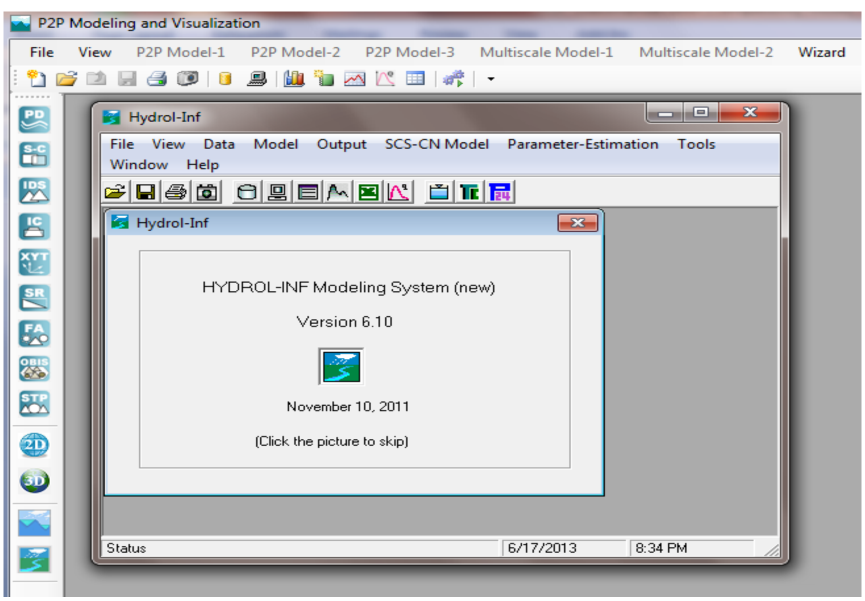
3.13 P2P Education

The P2P education software is incorporated into the P2P system. This educational software is featured with a series of documentation, pictures, and videos, as well as demonstration videos of both overland flow experiments and the P2P models. It is specially designed for users at three different levels: (1) Elementary Level, (2) Medium Level, and (3) Advanced Level.



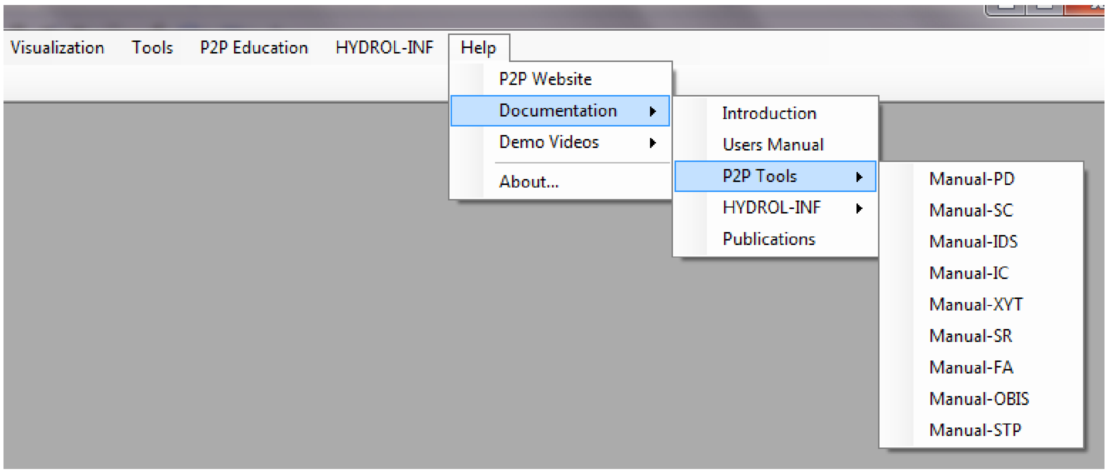
3.14 HYDROL-INF

HYDROL-INF is a research-teaching hydrologic modeling system, which is also incorporated into the P2P system.



3.15 Help

P2P Website
Documentation
Demo Videos
About



4 File Management

4.1 New Project

For the P2P modeling, users need to set up a new project through the menu File-New Project or button "New Project" in the menu bar before inputting any data. A working directory needs to be specified.

4.2 Open an Existing Project

If a project already exists, the user can open the project through the menu File-Open Project or button "Open Project" in the menu bar. All input data in the project will then be imported. When the user opens a project from a directory, that directory will be automatically set as the working directory.

4.3 Close the Current Project

The user can close a project at anytime through the menu File-Close Project or button "Close Project" in the menu bar. The user will be asked to save the current project when choosing to close the project. All the data that have been input will be saved to the working directory. Note that to open a different project the user should close the current project first.

4.4 Save the Current Project

The user can save the current project by using the menu File-Save Project or button "Save Project" in the menu bar. The project file is saved with the extension name ".P2P" to the specified directory. Whenever the user modifies the model input data, they must save the project before running the model. The current project can also be saved to another user-specified directory and file name by using the menu File-Save As. Then, the new directory will be set as the working directory.

4.5 Print a Graph/Text File

The user can print any text or graph through the menu File-Print or button “Print” in the menu bar. The user can also select a printer and specify its properties, including paper size and orientation. Note that this menu works only for the active window.

4.6 Capture a Screen Picture and Copy it to Clipboard

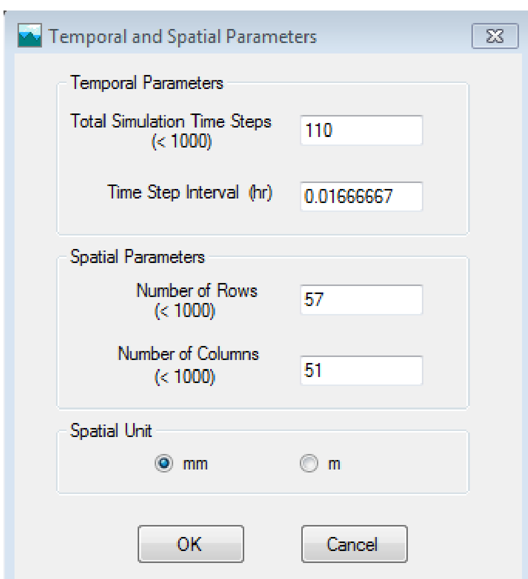
The user can utilize screen capture and copy the graph/text image to clipboard, which then can be pasted to a Word document or Powerpoint presentation.

5 P2P Modeling (P2P Model-1)

5.1 Input Data

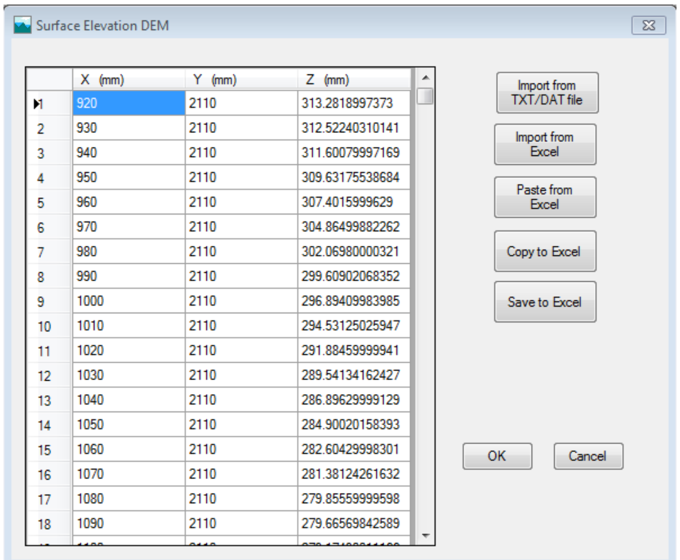
5.1.1 Temporal and Spatial Parameters

Total simulation time steps: NT (In the current program, NT_{max}=1000)
Size of a time step (hr): DT
Number of rows: RowNum (In the current program, $RowNum_{max}$=1000)
Number of columns: ColNum (In the current program, $ColNum_{max}$=1000)
Spatial Unit: mm or m



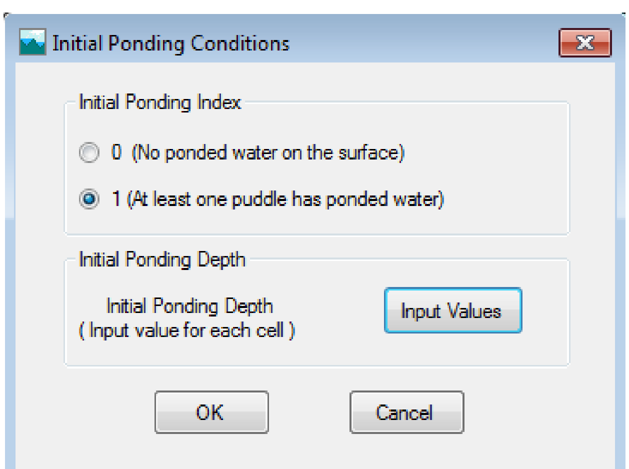
5.1.2 Surface Elevation Data (DEM)

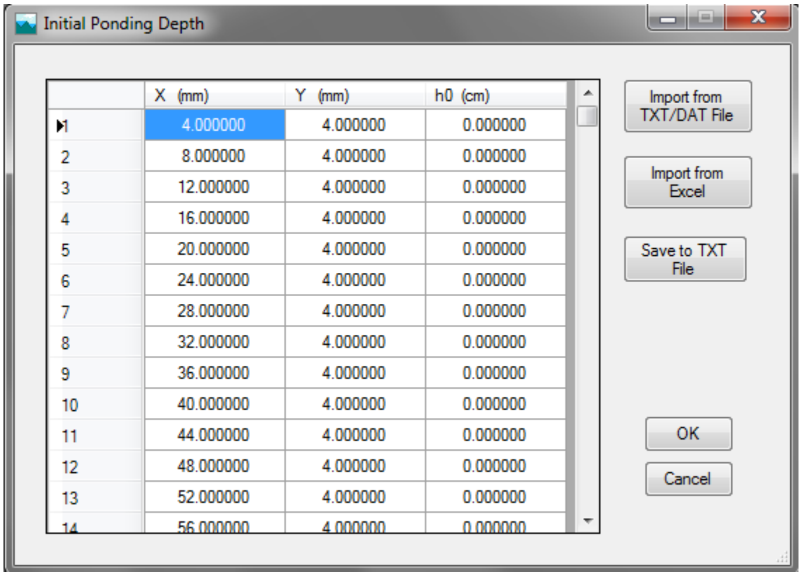
The DEM data are organized in three columns: x, y, and z. The user can import the DEM data from an Excel or txt file, or directly paste the DEM data from the clipboard. The user also can manually input the data and save them to an Excel file.



5.1.3 Initial Ponding Conditions

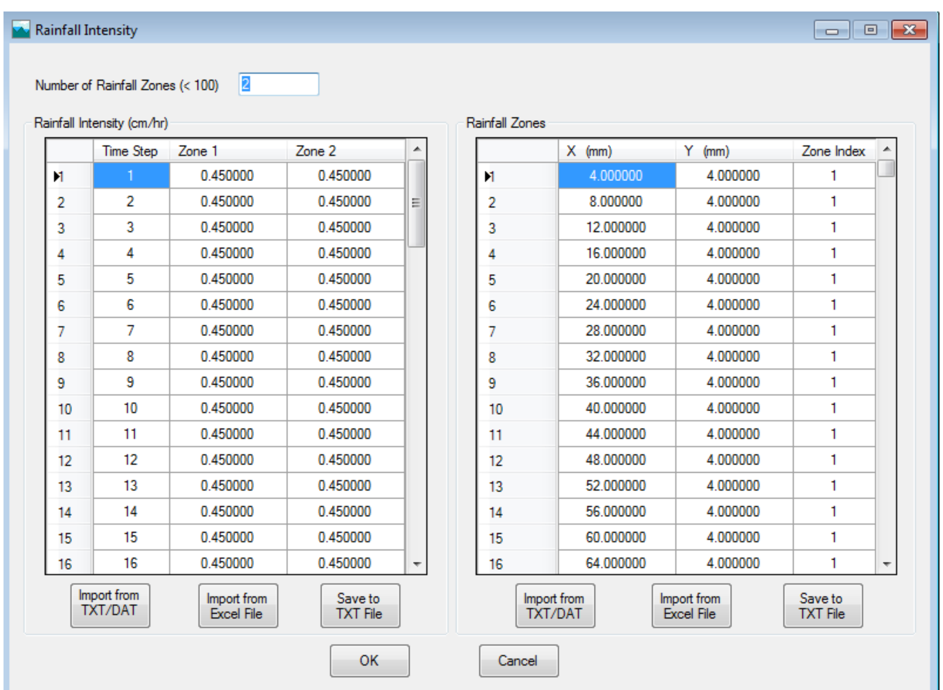
The user first needs to select initial ponding index. Index “0” indicates that there is no ponded water on the surface, while “1” indicates that at least one puddle has ponded water. If index “1” is selected, the user needs to input initial ponding depth (h0) for each cell. Similar to the DEM data table, the user can import h0 data from an Excel or txt file, or copy and paste them from the clipboard. The user also can manually input the data and save them to a txt file.





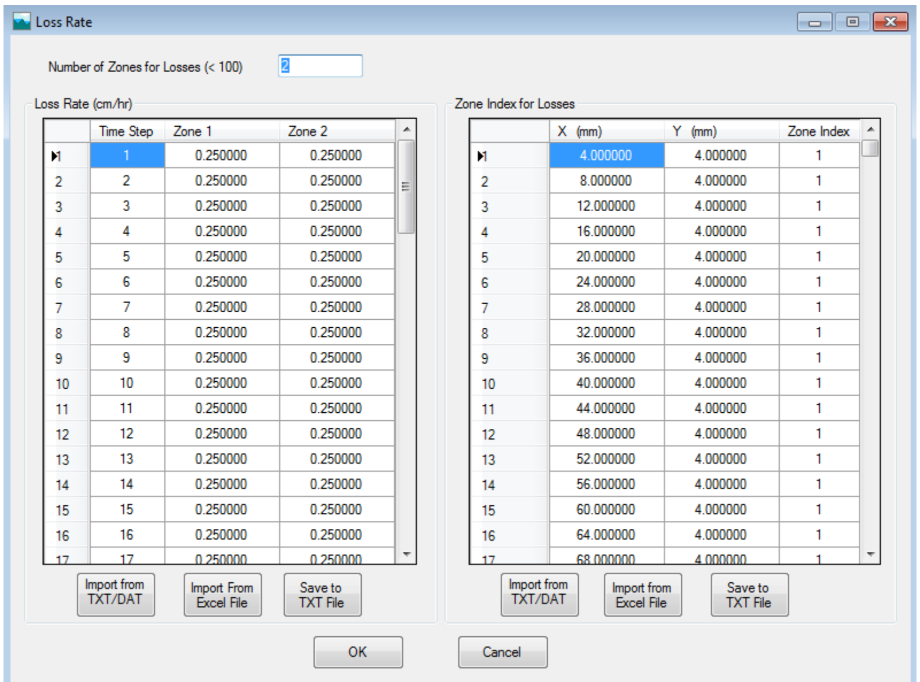
5.1.4 Rainfall Intensity

The user should specify the number of rainfall zones (RZone). In the current program, $RZone_{max}$ = 100. The rainfall intensity (cm/hr) table will be automatically created based on the RZone. Then, the user need to input the rainfall intensity for each zone at each time step. In the rainfall zone table, the user should assign a zone index for each cell. For both tables, the user can import the data from an Excel or txt file, or copy and paste them from the clipboard. The user also can manually input the data and save them to a txt file. Rainfall intensity can be zero if no rain occurs at certain time steps. The zone index starts from 1.



5.1.5 Loss Rate

The user needs to specify the number of zones for water losses. In the current program, the maximum number is 100. The loss rate (cm/hr) table will be automatically created based on the number of zones. The user then input the loss rate for each zone and each time step. In the zone table, the user should assign a zone index for each cell. For both tables, the user can import the data from an Excel or txt file, or copy and paste them from the clipboard. The user also can manually input the data and save them to a txt file. Loss rate can be zero if no loss occurs at certain times. The zone index starts from 1.



5.2 Run Puddle Delineation

The completion of input data will be automatically checked before running the puddle delineation program. Once all data is checked, the puddle delineation program can be executed by clicking P2P Model-1 - Run puddle delineation or the button “Run puddle delineation” in the menu bar. Running the puddle delineation program is required before running the P2P Model.

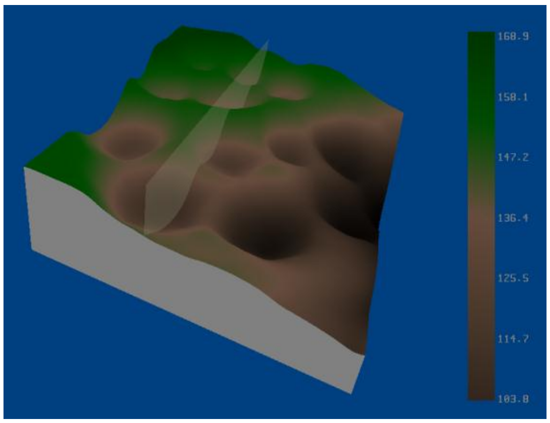
5.3 Run P2P Model

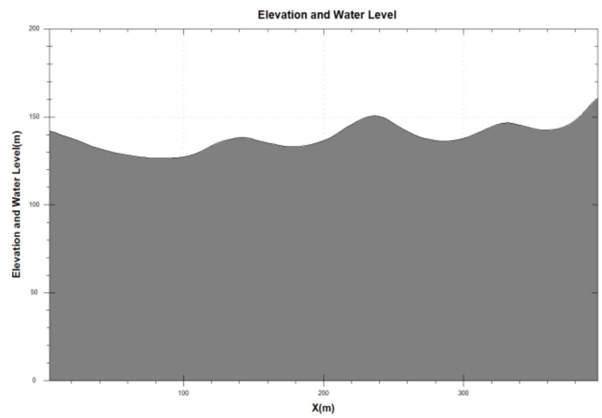
The P2P Model can be executed by clicking P2P Model-1-Run P2P Model or the button “Run P2P Model” in the menu bar. Note that running the model may take some time, depending on the modeling problem.

5.4 Outputs

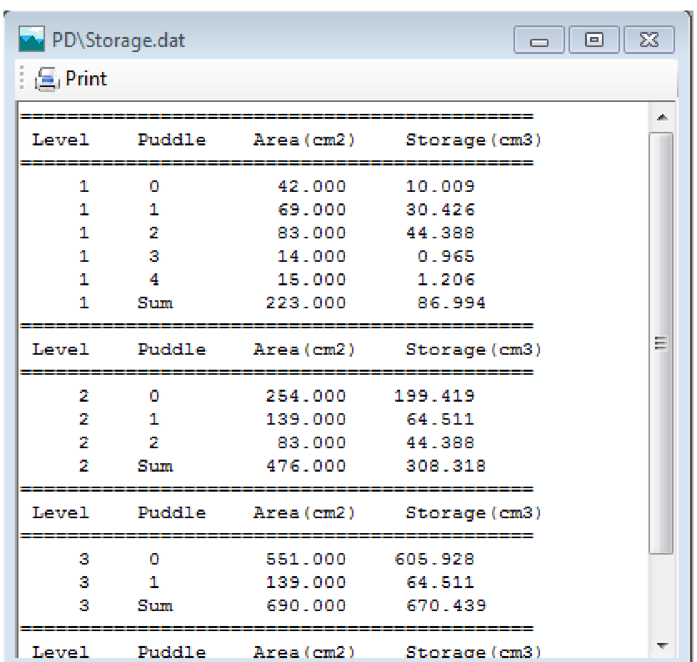
5.4.1 Puddle Delineation

1) View 3D Surface
   The surface DEM data can be viewed in a 3D graph through the submenu "View 3D Surface" or the menu button "3D Surface." The 3D surface can be moved, rotated, and zoomed in/out. The color of the legend can be changed and then the colors of the 3D surface change accordingly. A cross sectional view of the surface also can be viewed by specifying the desired location.





2) Maximum Depression Storage (MDS)
3) Maximum Ponding Area (MPA)
   The MDS and MPA for each puddle and the entire surface at each level are summarized, and can be accessed via the submenu "Maximum Depression Storage (MDS)" or "Maximum Ponding Area (MPA)."



PD\Storage.dat

Print

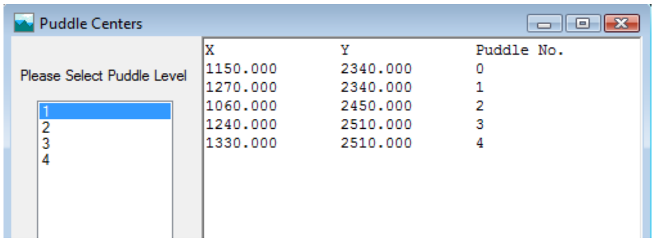
Level	Puddle	Area(cm2)	Storage(cm3)
1	0	42.000	10.009
1	1	69.000	30.426
1	2	83.000	44.388
1	3	14.000	0.965
1	4	15.000	1.206
1	Sum	223.000	86.994

Level	Puddle	Area(cm2)	Storage(cm3)
2	0	254.000	199.419
2	1	139.000	64.511
2	2	83.000	44.388
2	Sum	476.000	308.318

Level	Puddle	Area(cm2)	Storage(cm3)
3	0	551.000	605.928
3	1	139.000	64.511
3	Sum	690.000	670.439

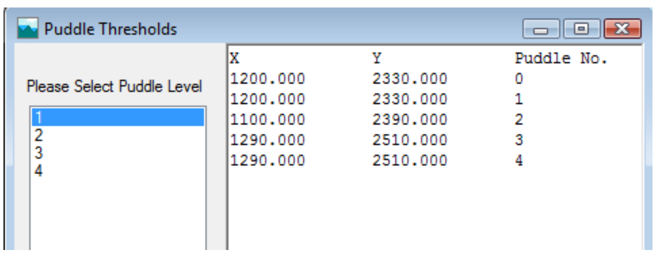
Level	Puddle	Area(cm2)	Storage(cm3)

4) Puddle Centers
   The coordinates (x and y) of puddle centers at each level can be shown using the submenu “Puddle Centers.”



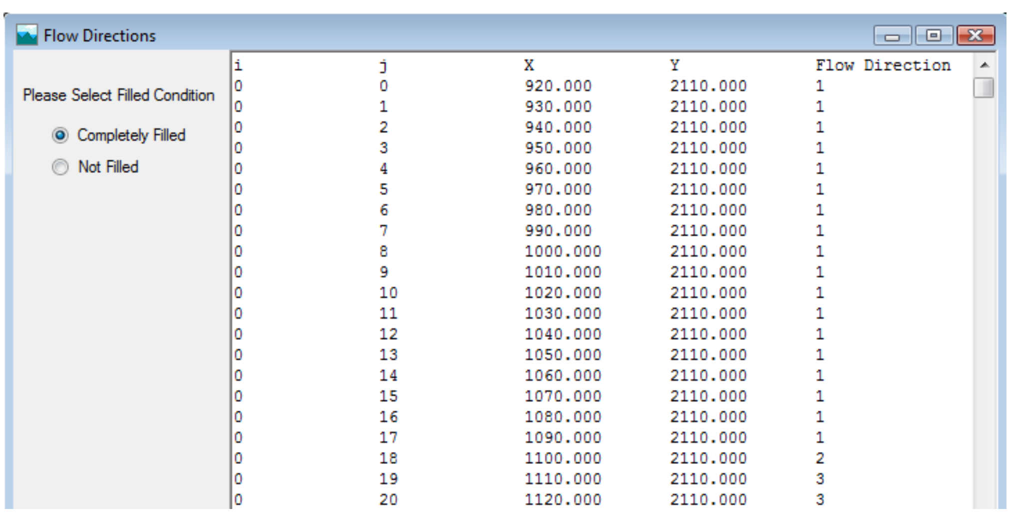
X	Y	Puddle No.
1150.000	2340.000	0
1270.000	2340.000	1
1060.000	2450.000	2
1240.000	2510.000	3
1330.000	2510.000	4

5) Puddle Thresholds
   The coordinates (x and y) of puddle thresholds at each level can be shown through the submenu “Puddle Thresholds.”



X	Y	Puddle No.
1200.000	2330.000	0
1200.000	2330.000	1
1100.000	2390.000	2
1290.000	2510.000	3
1290.000	2510.000	4

6) Flow Directions
   Flow directions for each cell under fully-filled and unfilled conditions are calculated. The directions are shown in 9 numbers ranging from 0 to 8. For both conditions, 1 to 8 represent the east, south, west, north, southeast, southwest, northwest, and northeast directions. Under a fully-filled condition, all cells within puddles have no flow direction, which is represented by “0,” while under an unfilled condition, only the puddle centers are indicated by “0.”



i	j	X	Y	Flow Direction
0	0	920.000	2110.000	1
0	1	930.000	2110.000	1
0	2	940.000	2110.000	1
0	3	950.000	2110.000	1
0	4	960.000	2110.000	1
0	5	970.000	2110.000	1
0	6	980.000	2110.000	1
0	7	990.000	2110.000	1
0	8	1000.000	2110.000	1
0	9	1010.000	2110.000	1
0	10	1020.000	2110.000	1
0	11	1030.000	2110.000	1
0	12	1040.000	2110.000	1
0	13	1050.000	2110.000	1
0	14	1060.000	2110.000	1
0	15	1070.000	2110.000	1
0	16	1080.000	2110.000	1
0	17	1090.000	2110.000	1
0	18	1100.000	2110.000	2
0	19	1110.000	2110.000	3
0	20	1120.000	2110.000	3

7) Flow Accumulations
The flow accumulation of a cell is determined by the number of cells that make water contributions to it.

PD\FlowAccum_All.dat

Print

X	Y	Flow Accumulation
920	2110	0
930	2110	2
940	2110	5
950	2110	9
960	2110	14
970	2110	20
980	2110	37
990	2110	48
1000	2110	55
1010	2110	63
1020	2110	72
1030	2110	82
1040	2110	93
1050	2110	105
1060	2110	147
1070	2110	148
1080	2110	171
1090	2110	179
1100	2110	2885

8) Puddle Geometric Properties (optional output)
Puddle geometric properties refer to the relationships and properties of puddles, such as puddle ID, basin ID of each puddle, number of cells in each puddle, and combination of puddles.

Puddle_Geo_property.OUT

Print

Puddle Relationship and Property Table

PID	BASIN	LEVEL	HLP	NCP	P1F	P2F	FLAT	NBC	NTH	THN	X(cm)	Y(cm)	PDS	NCCP	NCCO
1	2	4	1	1590	2	3	0	690	1	1	111.000	211.000	0	958	338
2	2	3	0	552	4	5	0	337	1	1	127.000	244.000	3	0	338
3	2	3	0	140	8	9	0	29	1	1	127.000	244.000	2	0	338
4	2	2	0	255	6	7	0	111	1	1	110.000	239.000	5	0	338
5	2	2	0	84	-1	-1	0	0	1	1	110.000	239.000	4	0	338
6	2	1	0	43	-1	-1	0	0	1	1	120.000	233.000	7	0	338
7	2	1	0	70	-1	-1	0	0	1	1	120.000	233.000	6	0	338
8	2	1	0	15	-1	-1	0	0	1	1	129.000	251.000	9	0	338
9	2	1	0	16	-1	-1	0	0	1	1	129.000	251.000	8	0	338

Notes:
PID = puddle ID;
BASIN = basin in which this puddle is located;
LEVEL = the level of this puddle;
HLP = highest level puddle index (1: highest levelpuddle; 0:not highest level puddle);
NCP = number of cells in a puddle;
P1F = ID of a lower level combined puddle 1;
P2F = ID of a lower level combined puddle 2(if PID is a single puddle, P1F = P2F = -1);
FLAT= flat index (1: flat; 0: not flat);
NBC = number of bottom cells for a puddle;
NTH = number of thresholds for a puddle;
THN = puddle threshold(s) list;
X, Y = coordinates of puddle thresholds;
DSP = downstream puddle for highest level puddle (0: this threshold contributes water to outlet;n: downstream puddle ID);
NCCP = number of contributing cells contributes water to PID;
NCCO = number of contributing cells contributes water to the outlet of BASIN.

9) Puddle Cell Properties (optional output)
The puddle cell properties include the relationship between the elevation and capacity/volume of water for each cell, the puddle basin ID of each cell, and the location of each cell.

Puddle_Cell.OUT

Print

Puddle Cells and Elevation-Volume (Z-V) Table

N	BASIN	PID	I	J	POND	FDR	X(cm)	Y(cm)	Z(cm)	Volume(cm3)
1	2	1	8	20	0	2	111.000	218.000	29.812	2200.252
2	2	1	50	8	0	5	99.000	260.000	29.812	2199.835
3	2	1	36	4	0	1	95.000	246.000	29.811	2199.571
4	2	1	50	42	0	2	133.000	260.000	29.811	2199.433
5	2	1	50	15	0	6	106.000	260.000	29.811	2199.432
6	2	1	9	21	0	4	112.000	219.000	29.811	2199.051
7	2	1	10	27	0	4	118.000	220.000	29.811	2199.047
8	2	1	40	5	0	1	96.000	250.000	29.807	2192.182
9	2	1	49	16	0	6	107.000	259.000	29.804	2188.281
10	2	1	27	5	0	8	96.000	237.000	29.804	2188.242
11	2	1	48	7	0	5	98.000	258.000	29.804	2188.152
12	2	1	29	48	0	6	139.000	239.000	29.803	2185.853
13	2	1	9	20	0	4	111.000	219.000	29.799	2179.849
14	2	1	10	26	0	4	117.000	220.000	29.797	2176.331
15	2	1	18	49	0	3	140.000	228.000	29.795	2173.858
16	2	1	43	23	0	6	114.000	253.000	29.795	2172.815
17	2	1	10	34	0	4	125.000	220.000	29.791	2167.855

10) Routing Elements (optional output)

The routing element list shows the basin ID of a cell (Basin) and the indicator of a puddle cell (REI). If REI equals "-1," the cell is not a part of any puddle. A REI greater than "0" represents the puddle ID of the cell.

RElist.OUT

Print

Puddle Routing Elements List Table

REID	Basin	REI	I	J	X(cm)	Y(cm)
1	1	-1	1	50	141.000	211.000
2	1	-1	2	51	142.000	212.000
3	1	-1	1	49	140.000	211.000
4	1	-1	2	50	141.000	212.000
5	1	-1	3	51	142.000	213.000
6	1	-1	1	48	139.000	211.000
7	1	-1	2	49	140.000	212.000
8	1	-1	3	50	141.000	213.000
9	1	-1	4	51	142.000	214.000
10	1	-1	2	48	139.000	212.000
11	1	-1	3	49	140.000	213.000
12	1	-1	4	50	141.000	214.000
13	1	-1	5	51	142.000	215.000
14	1	-1	3	48	139.000	213.000
15	1	-1	4	49	140.000	214.000

11) Surface Properties (optional output)

Surface properties summarize the surface area, mean slope, MDS, MPA, the maximum and mean water depths, the number of puddles, and other information on the surface.

Surface_Property.OUT

Print

Surface Properties

Area of the surface (cm2) A = 2907.000

Maximum Depression Storage (cm3) MDS = 2870.691

Maximum Ponding Area (cm2) MPA = 1589.000

Mean Contributing Area (cm2) CA = 1402.444

Mean Slope (%) = 27.515

Mean maximum water depth (cm) = 4.552

Mean average water depth (cm) = 1.805

Number of Puddle Levels = 4

Number of Puddles = 9

Number of Highest Level Puddles = 1

Number of First Level Puddles = 5

Number of Basins = 2

12) Puddle Hydrologic Properties (optional output)

Puddle hydrologic properties include the basin ID and the level of each puddle, the MDS and MPA of each puddle, contributing area of each puddle, and the maximum depth of each puddle.

Puddle_Hydro_property.OUT

Print

Puddle Hydrologic Properties Table

PID	BASIN	LEVEL	HLP	MH(cm)	EH(cm)	MDS(cm3)	MPA(cm2)	CA(cm2)	CA2(cm2)
1	2	4	1	4.552	1.805	2870.691	1590.000	2547.000	2547.000
2	2	3	0	2.571	1.098	605.928	552.000	2547.000	551.000
3	2	3	0	.890	.461	64.511	140.000	2547.000	139.000
4	2	2	0	1.760	.782	199.419	255.000	2547.000	254.000
5	2	2	0	1.169	.528	44.388	84.000	2547.000	83.000
6	2	1	0	.514	.233	10.009	43.000	2547.000	42.000
7	2	1	0	.905	.435	30.426	70.000	2547.000	69.000
8	2	1	0	.145	.064	.965	15.000	2547.000	14.000
9	2	1	0	.158	.075	1.206	16.000	2547.000	15.000

Notes:
PID = puddle ID;
BASIN = basin in which this puddle is located;
LEVEL = the level of this puddle;
HLP = highest level puddle index (1: highest levelpuddle; 0:not highest level puddle);
MH = maximum depth;
EH = average depth;
MDS = maximum depression storage;
MPA = maximum ponding area;
CA = contributing area;
CA2 = contributing area without the contribution from the upstream puddle;

5.4.2 Mass Balance

The mass balance tables are shown in a table format and can be printed. Three different mass balance tables are created for all time steps.

1) Cell to Cell (C2C) (optional output)
The cell mass balance table shows the incremental depths of rainfall (RAIN), inflow (INFLOW), outflow to the downstream cells and puddles (OUTF2C, OUTF2P), and loss (LOSS) from the surface water storage for each time step. This table also shows the ponded water depths of each cell at the beginning and end of each time step (H0, H).

MassB_CC.OUT

Print

Mass Balance Table for Contributing Cells

STEP	BASIN	REID	I	J	H0(cm)	RAIN(cm)	INFLOW(cm)	H(cm)	OUTF2C(cm)	OUTF2P(cm)	INFIL(cm)	EVAP(cm)	DIFF(cm)	I0	J0
0	2	0	1	1	.000	.000	.000	.000	.000	.000	.000	.000	.000	1	0
0	2	0	1	2	.000	.000	.000	.000	.000	.000	.000	.000	.000	1	0
0	2	0	1	3	.000	.000	.000	.000	.000	.000	.000	.000	.000	1	0
0	2	0	1	4	.000	.000	.000	.000	.000	.000	.000	.000	.000	1	0
0	2	0	1	5	.000	.000	.000	.000	.000	.000	.000	.000	.000	1	0
0	2	0	1	6	.000	.000	.000	.000	.000	.000	.000	.000	.000	1	0
0	2	0	1	7	.000	.000	.000	.000	.000	.000	.000	.000	.000	1	0
0	2	0	1	8	.000	.000	.000	.000	.000	.000	.000	.000	.000	1	0
0	2	0	1	9	.000	.000	.000	.000	.000	.000	.000	.000	.000	1	0
0	2	0	1	10	.000	.000	.000	.000	.000	.000	.000	.000	.000	1	0
0	2	0	1	11	.000	.000	.000	.000	.000	.000	.000	.000	.000	1	0
0	2	0	1	12	.000	.000	.000	.000	.000	.000	.000	.000	.000	1	0
0	2	0	1	13	.000	.000	.000	.000	.000	.000	.000	.000	.000	1	0
0	2	0	1	14	.000	.000	.000	.000	.000	.000	.000	.000	.000	1	0
0	2	0	1	15	.000	.000	.000	.000	.000	.000	.000	.000	.000	1	0
0	2	0	1	16	.000	.000	.000	.000	.000	.000	.000	.000	.000	1	0
0	2	0	1	17	.000	.000	.000	.000	.000	.000	.000	.000	.000	1	0
0	2	0	1	18	.000	.000	.000	.000	.000	.000	.000	.000	.000	1	0
0	2	0	1	19	.000	.000	.000	.000	.000	.000	.000	.000	.000	1	0

2) Puddle to Puddle (P2P)
The puddle mass balance table shows the incremental volumes of rainfall (RAIN), inflow (INFL), outflow (SPILL), loss (LOSS) from the surface water storage for each time step. In addition, this table shows the P2P processes at each time step (e.g., filling, spilling, merging, and splitting/separating) and the cumulative ponded water volumes of each basin at the beginning and end of each time step (VF0, VF).

MassB_P.OUT

Print

Mass Balance Table for Puddles

STEP	BASIN	PID	P2P-PROCESS	VF0(cm3)	RAIN(cm3)	INFL(cm3)	VF(cm3)	INFIL(cm3)	EVAP(cm3)	SPILL(cm3)	DIFF(cm3)	NSPC	P1	P2
0	2	9	Spilling	.000	.000	299.809	1.206	.000	.000	298.604	.000	1	8	0
0	2	8	Combining	.000	.000	563.577	.965	.000	.000	562.612	.000	0	9	3
0	2	7	Spilling	.000	.000	905.746	30.426	.000	.000	875.321	.000	1	6	0
0	2	6	Combining	.000	.000	1609.253	10.009	.000	.000	1599.244	.000	0	7	4
0	2	5	Spilling	.000	.000	666.228	44.388	.000	.000	621.840	.000	1	4	0
0	2	4	Combining	.000	.000	2221.084	158.984	.000	.000	2062.100	.000	0	5	2
0	2	3	Spilling	.000	.000	562.612	62.340	.000	.000	500.272	.000	1	2	0
0	2	2	Combining	.000	.000	2562.372	362.121	.000	.000	2200.251	.000	0	3	1
0	2	1	Filling	.000	.000	2200.251	2200.251	.000	.000	.000	.000	0	0	0
1	2	1	Filling	2200.251	2.648	.000	2124.334	.000	78.565	.000	.000	0	0	0
2	2	1	Filling	2124.334	2.593	.000	2049.681	.000	77.246	.000	.000	0	0	0

3) Basins and Entire Surface
The mass balance table for basins and the entire surface shows the incremental volumes of rainfall (RAIN), outflow (OUTF), and loss (LOSS) from the surface water storage for each time step. In addition, this table shows the cumulative ponded water volumes for each basin at the beginning and end of each time step (VF0, VF).

MassB.OUT

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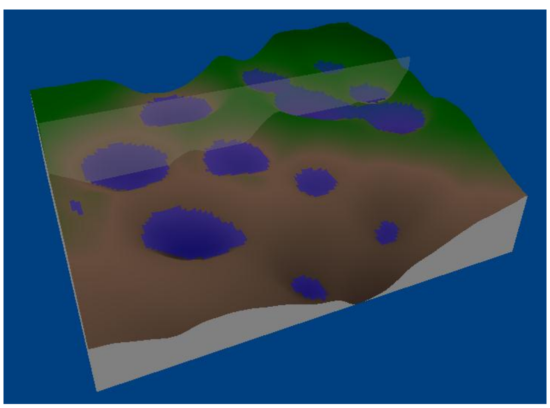
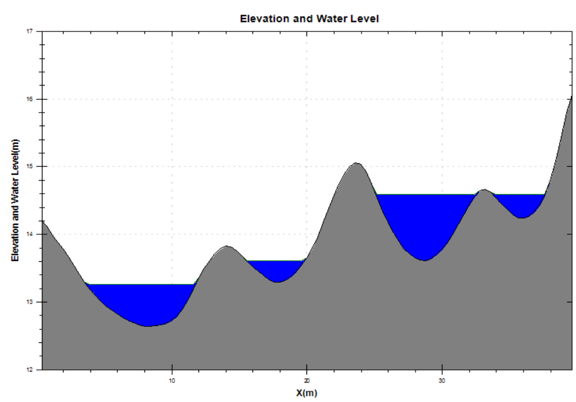
```
Mass Balance Table for Basins and Entire Surface

STEP BASIN      VF0(cm3)     RAIN(cm3)      VF(cm3)    INFIL(cm3)     EVAP(cm3)     OUTF(cm3)     DIFF(cm3)
   0     1          .000          .000         .000          .000          .000          .000          .000
   0     2      2870.690          .000     2870.690          .000          .000          .000          .000
   0 ---------------------------------------------------------------------------------------------------------
   0 Total      2870.690          .000     2870.690          .000          .000          .000          .000

   1     1          .000          .035         .000          .000          .035          .000          .000
   1     2      2870.690         4.810     2794.773          .000        80.727          .000          .000
   1 ---------------------------------------------------------------------------------------------------------
   1 Total      2870.690         4.845     2794.773          .000        80.762          .000          .000

   2     1          .000          .035         .000          .000          .035          .000          .000
   2     2      2794.773         4.810     2720.121          .000        79.462          .000          .000
   2 ---------------------------------------------------------------------------------------------------------
   2 Total      2794.773         4.845     2720.121          .000        79.497          .000          .000
```

5.4.3 Water Distributions

1) 3D Animations
The distribution of water in puddles can be viewed in a 3D graph through the submenu "3D Animations" or the menu button "3D Animation." The 3D graph can be moved, rotated, and zoomed in/out. The color of legend can be changed and then the colors of the 3D surface change accordingly. A cross section view of the surface with ponded water also can be shown by specifying the desired location.

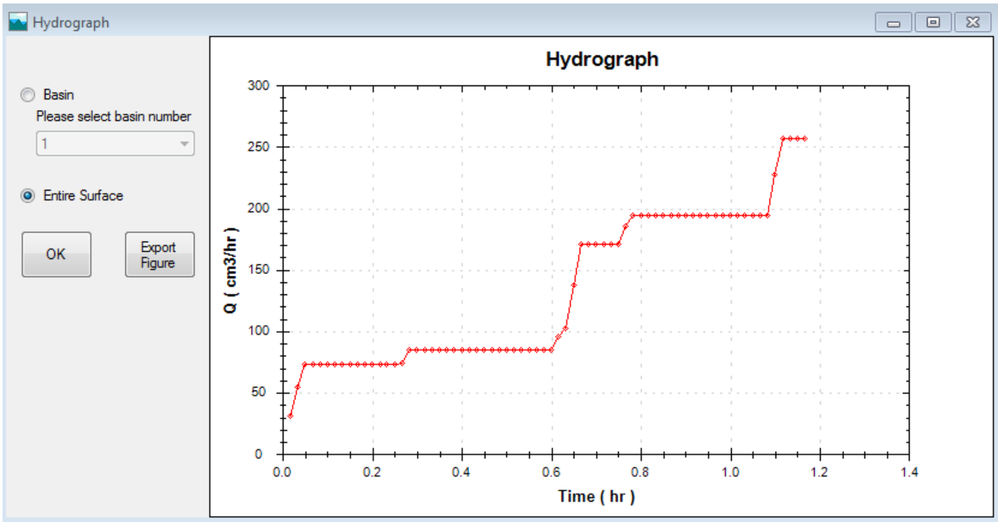




2) Tables
The depth and elevation of ponded water for each cell at each time step can be displayed by the submenu "All Cells." The submenu "Puddle Cells" is an optional output, which lists the puddle ID and the depth and volume of ponded water for each cell. In addition, the ponding index of each cell indicates the ponding status of the cell (1: with ponded water; 0: without ponded water). Similarly, a ponding index is used to indicate the ponding status of a puddle (1: with partially filled water; 0: without ponded water; and 100: fully filled).

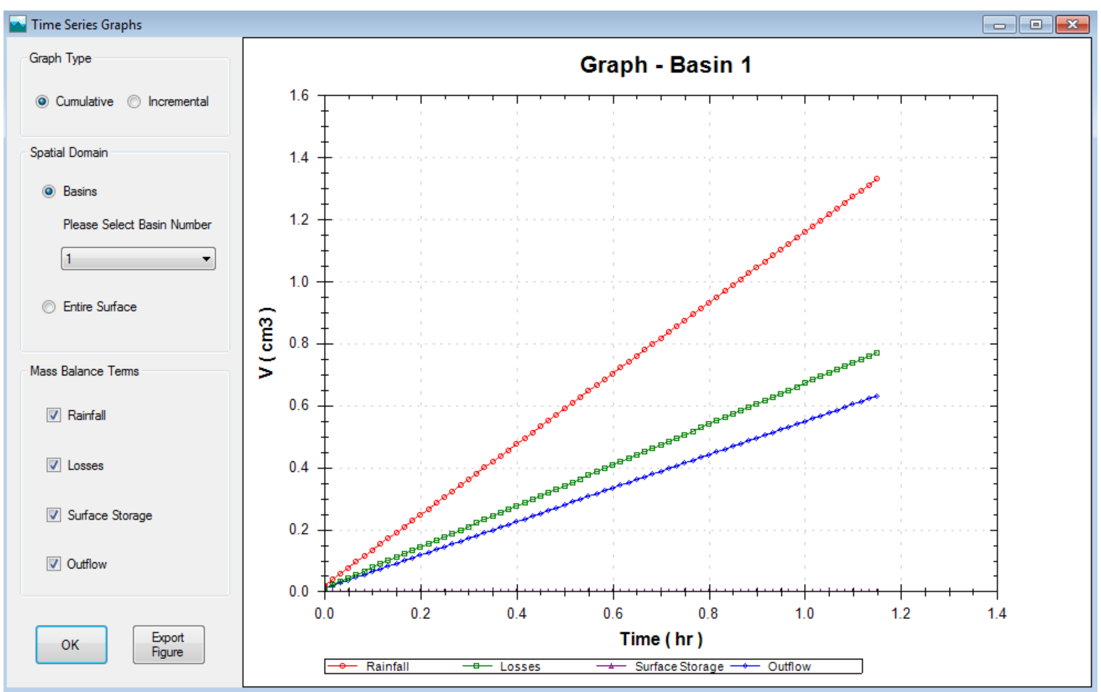
5.4.4 Hydrograph

The hydrograph can be shown through the submenu "Hydrograph" or the menu button "Hydrograph." The user can select the hydrograph for each basin or the entire surface. The hydrograph can be exported and saved as a picture (different formats).



5.4.5 2D Time Series Graphs

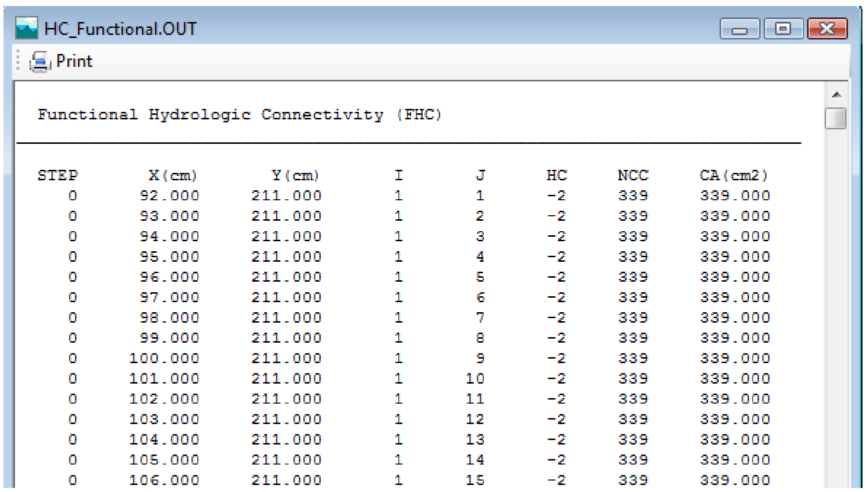
The cumulative or incremental rainfall, loss, surface storage, and outflow can be shown in a graphic format through the submenu "2D Time Series Graph" or the menu button "2D Graph." The user can select the graph for any basin or the entire surface. The graph can be exported and saved as a picture (different formats).



5.4.6 Hydrologic Connectivity

The hydrologic connectivity submenu includes functional hydrologic connectivity, structural hydrologic connectivity, hydrologic connectivity statistics summary, hydrologic connectivity statistics, and hydrologic connectivity to outlets, which are all shown in a text format and can be printed.

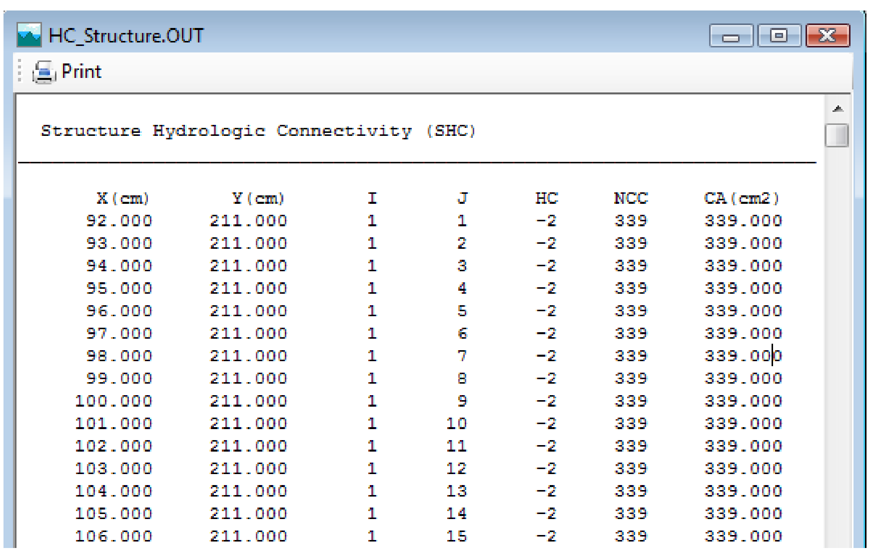
1) Functional Hydrologic Connectivity (optional output)
Functional hydrologic connectivity is calculated for each cell at each time step. The table shows the puddle or outlet ID of the cell (a positive integer for puddle ID and a negative integer for outlet ID). It also displays the number and area of cells that connect to the puddle or outlet.



Functional Hydrologic Connectivity (FHC)

STEP	X(cm)	Y(cm)	I	J	HC	NCC	CA(cm2)
0	92.000	211.000	1	1	-2	339	339.000
0	93.000	211.000	1	2	-2	339	339.000
0	94.000	211.000	1	3	-2	339	339.000
0	95.000	211.000	1	4	-2	339	339.000
0	96.000	211.000	1	5	-2	339	339.000
0	97.000	211.000	1	6	-2	339	339.000
0	98.000	211.000	1	7	-2	339	339.000
0	99.000	211.000	1	8	-2	339	339.000
0	100.000	211.000	1	9	-2	339	339.000
0	101.000	211.000	1	10	-2	339	339.000
0	102.000	211.000	1	11	-2	339	339.000
0	103.000	211.000	1	12	-2	339	339.000
0	104.000	211.000	1	13	-2	339	339.000
0	105.000	211.000	1	14	-2	339	339.000
0	106.000	211.000	1	15	-2	339	339.000

2) Structural Hydrologic Connectivity (optional output)
Structural hydrologic connectivity is calculated for each cell based on the DEM data. The table is similar the one for functional hydrologic connectivity at time step = 0.



Structure Hydrologic Connectivity (SHC)

X(cm)	Y(cm)	I	J	HC	NCC	CA(cm2)
92.000	211.000	1	1	-2	339	339.000
93.000	211.000	1	2	-2	339	339.000
94.000	211.000	1	3	-2	339	339.000
95.000	211.000	1	4	-2	339	339.000
96.000	211.000	1	5	-2	339	339.000
97.000	211.000	1	6	-2	339	339.000
98.000	211.000	1	7	-2	339	339.000
99.000	211.000	1	8	-2	339	339.000
100.000	211.000	1	9	-2	339	339.000
101.000	211.000	1	10	-2	339	339.000
102.000	211.000	1	11	-2	339	339.000
103.000	211.000	1	12	-2	339	339.000
104.000	211.000	1	13	-2	339	339.000
105.000	211.000	1	14	-2	339	339.000
106.000	211.000	1	15	-2	339	339.000

3) Hydrologic Connectivity Statistics Summary

The hydrologic connectivity statistics summary submenu shows a statistical summary of hydrologic connectivity for each time step (time step = 0 for structural hydrologic connectivity; other time steps for functional hydrologic connectivity). The table includes the number of connected areas, the mean number of the connected cells for each connected area, the mean area of each connected area, normalized discharge by rainfall input, normalized connected area to the outlet by the entire surface, normalized depression storage by maximum depression storage, cumulative storage, cumulative rainfall input, and the ratio of cumulative rainfall input to MDS.

HC_Statistics_Summary.OUT

Print

Summary of the Hydrologic Connectivity

STEP	NPC	MNCC	MCA(cm2)	NLQ	NLCA	NLDS	CS(cm3)	QIN(cm3)	QINMDS
0	7	415.286	415.286						
0	6	484.500	484.500		.124		.000	.000	.000
1	6	484.500	484.500	.115	.124	.010	90.644	33.915	.012
2	4	726.750	726.750	.115	.124	.019	118.236	67.830	.024
3	4	726.750	726.750	.115	.124	.029	145.829	101.745	.035
4	4	726.750	726.750	.115	.124	.038	173.421	135.660	.047
5	3	969.000	969.000	.115	.124	.048	201.014	169.575	.059
6	3	969.000	969.000	.115	.124	.058	228.606	203.490	.071
7	3	969.000	969.000	.115	.124	.067	256.199	237.405	.083
8	3	969.000	969.000	.115	.124	.077	283.791	271.320	.095
9	3	969.000	969.000	.115	.124	.087	311.384	305.235	.106
10	3	969.000	969.000	.115	.124	.096	338.976	339.150	.118
11	3	969.000	969.000	.115	.124	.106	366.569	373.065	.130
12	3	969.000	969.000	.115	.124	.115	394.161	406.980	.142
13	3	969.000	969.000	.115	.124	.125	421.754	440.895	.154
14	3	969.000	969.000	.115	.124	.135	449.346	474.810	.165
15	3	969.000	969.000	.115	.124	.144	476.939	508.725	.177

4) Hydrologic Connectivity Statistics (optional output)

This table of hydrologic connectivity statistics shows the number and area of connected cells for each puddle or outlet at each time step.

HC_Statistics.OUT

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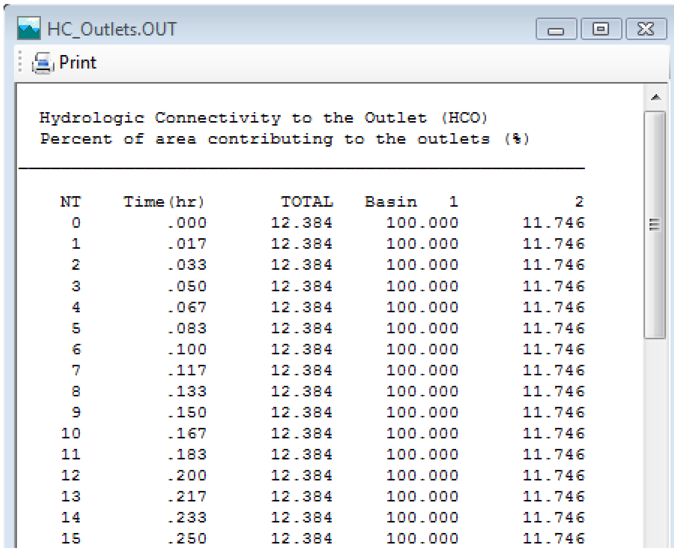
Statistics of the Hydrologic Connectivity

STEP	HC	NCC	CA(cm2)
DEM	7	617	617.000
DEM	6	475	475.000
DEM	5	783	783.000
DEM	9	351	351.000
DEM	8	321	321.000
DEM	-1	21	21.000
DEM	-2	339	339.000
0	7	617	617.000
0	6	475	475.000
0	5	783	783.000
0	3	672	672.000
0	-1	21	21.000
0	-2	339	339.000
1	7	617	617.000

5) Hydrologic Connectivity to Outlets (optional output)
Hydrologic connectivity to the outlet of a basin is expressed as the percentage of area connecting to the outlet at each time step.


HC_Outlets.OUT

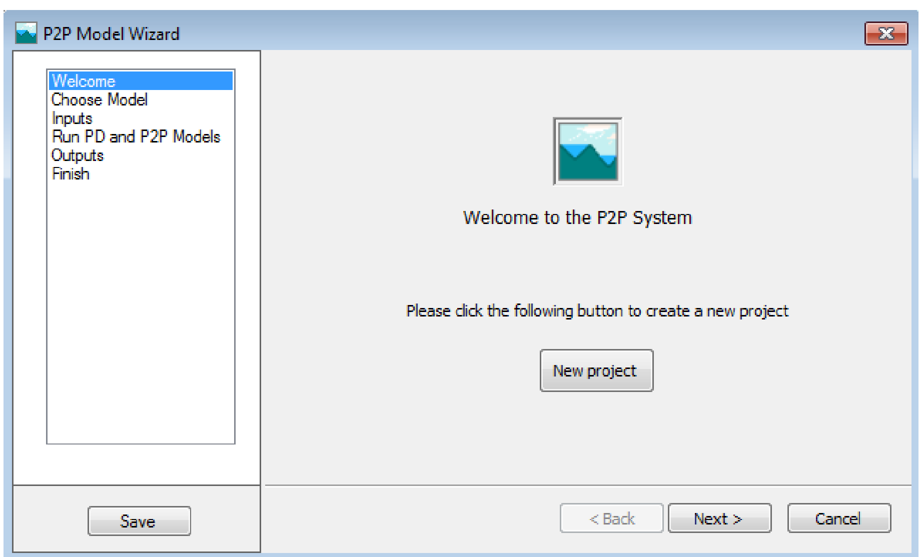
Print

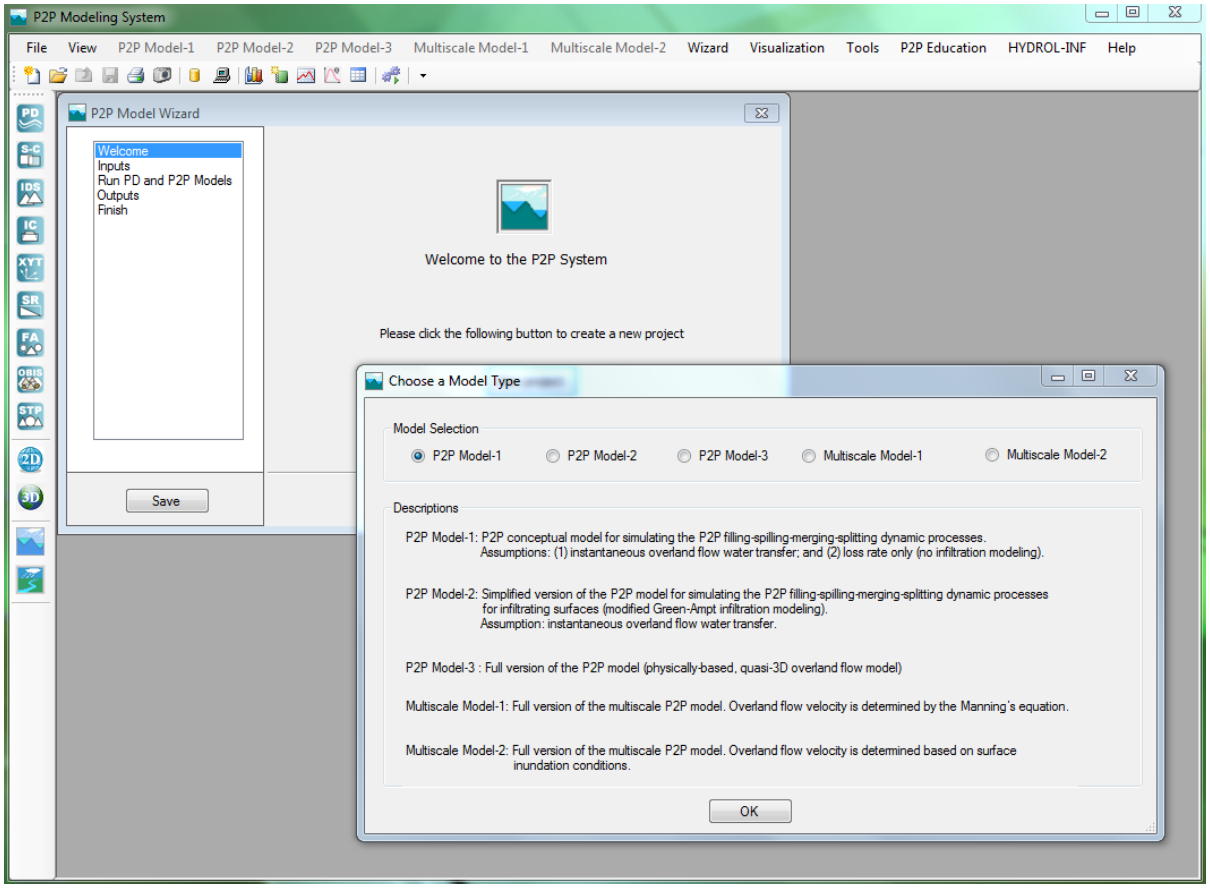
Hydrologic Connectivity to the Outlet (HCO)
Percent of area contributing to the outlets (%)

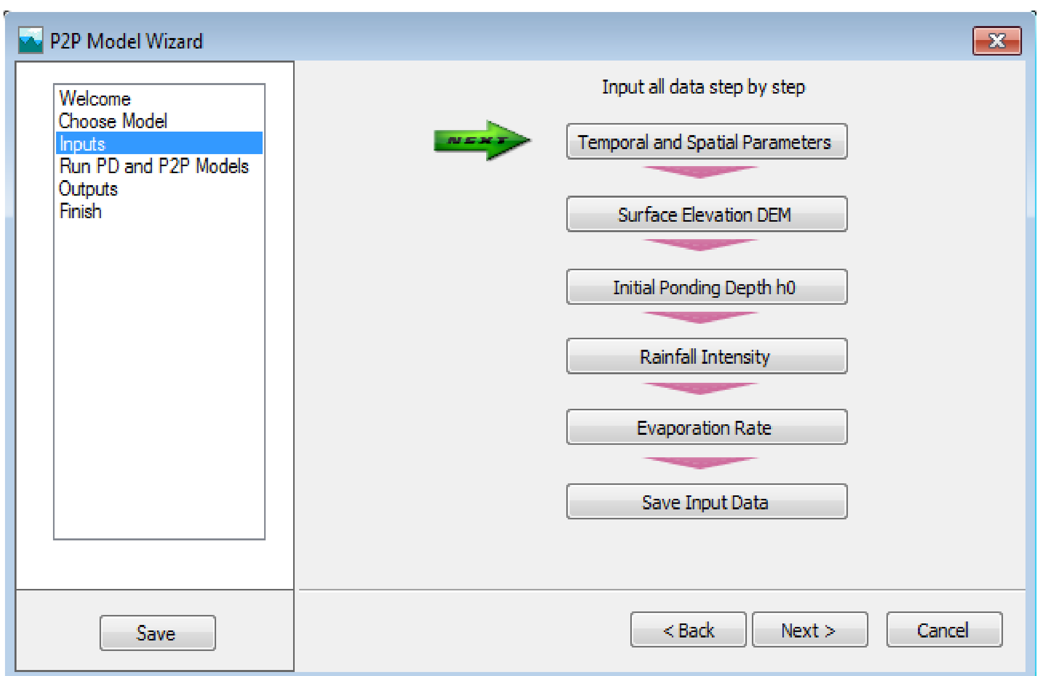
NT	Time(hr)	TOTAL	Basin 1	2
0	.000	12.384	100.000	11.746
1	.017	12.384	100.000	11.746
2	.033	12.384	100.000	11.746
3	.050	12.384	100.000	11.746
4	.067	12.384	100.000	11.746
5	.083	12.384	100.000	11.746
6	.100	12.384	100.000	11.746
7	.117	12.384	100.000	11.746
8	.133	12.384	100.000	11.746
9	.150	12.384	100.000	11.746
10	.167	12.384	100.000	11.746
11	.183	12.384	100.000	11.746
12	.200	12.384	100.000	11.746
13	.217	12.384	100.000	11.746
14	.233	12.384	100.000	11.746
15	.250	12.384	100.000	11.746

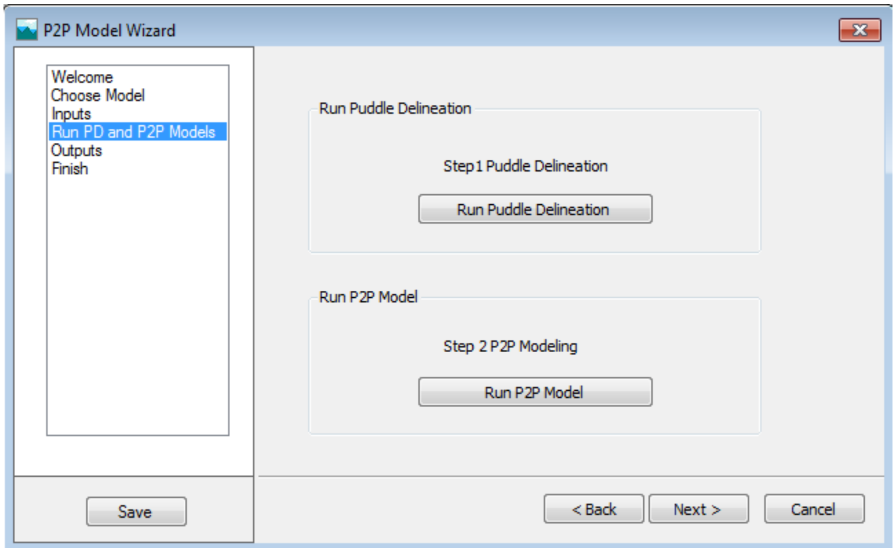
6 Wizard

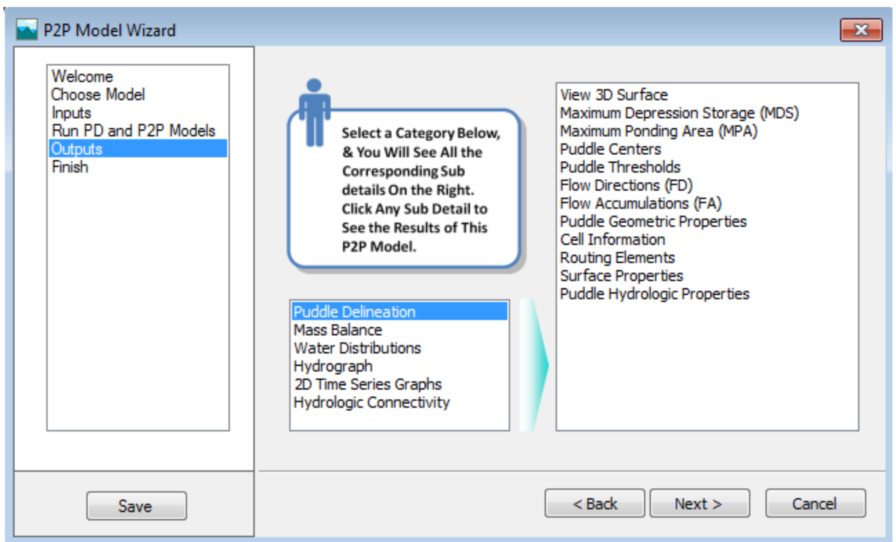
The wizard provides an easy way to do the P2P modeling. It guides the users to go through all modeling steps, including setting up a new project, inputting all required data, running the model, and visualizing the modeling outputs.

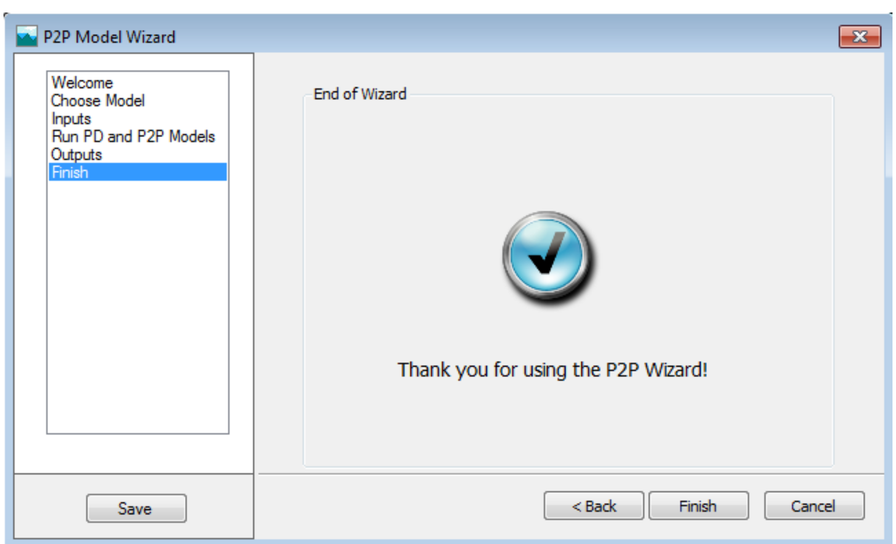



P2P Modeling System
File
View
P2P Model-1
P2P Model-2
P2P Model-3
Multiscale Model-1
Multiscale Model-2
Wizard
Visualization
Tools
P2P Education
HYDROL-INF
Help
P2P Model Wizard
Welcome
Inputs
Run PD and P2P Models
Outputs
Finish
Save
Welcome to the P2P System
Please click the following button to create a new project
Choose a Model Type
Model Selection
P2P Model-1
P2P Model-2
P2P Model-3
Multiscale Model-1
Multiscale Model-2
Descriptions
P2P Model-1: P2P conceptual model for simulating the P2P filling-spilling-merging-splitting dynamic processes.
Assumptions: (1) instantaneous overland flow water transfer; and (2) loss rate only (no infiltration modeling).
P2P Model-2: Simplified version of the P2P model for simulating the P2P filling-spilling-merging-splitting dynamic processes
for infiltrating surfaces (modified Green-Ampt infiltration modeling).
Assumption: instantaneous overland flow water transfer.
P2P Model-3 : Full version of the P2P model (physically-based, quasi-3D overland flow model)
Multiscale Model-1: Full version of the multiscale P2P model. Overland flow velocity is determined by the Manning's equation.
Multiscale Model-2: Full version of the multiscale P2P model. Overland flow velocity is determined based on surface
inundation conditions.
OK


P2P Model Wizard
Welcome
Choose Model
Inputs
Run PD and P2P Models
Outputs
Finish
Save
Input all data step by step
NEXT
Temporal and Spatial Parameters
Surface Elevation DEM
Initial Ponding Depth h0
Rainfall Intensity
Evaporation Rate
Save Input Data
< Back
Next >
Cancel


P2P Model Wizard
Welcome
Choose Model
Inputs
Run PD and P2P Models
Outputs
Finish
Run Puddle Delineation
Step1 Puddle Delineation
Run Puddle Delineation
Run P2P Model
Step 2 P2P Modeling
Run P2P Model
Save
< Back
Next >
Cancel


P2P Model Wizard
Welcome
Choose Model
Inputs
Run PD and P2P Models
Outputs
Finish
Select a Category Below, & You Will See All the Corresponding Sub details On the Right. Click Any Sub Detail to See the Results of This P2P Model.
Puddle Delineation
Mass Balance
Water Distributions
Hydrograph
2D Time Series Graphs
Hydrologic Connectivity
View 3D Surface
Maximum Depression Storage (MDS)
Maximum Ponding Area (MPA)
Puddle Centers
Puddle Thresholds
Flow Directions (FD)
Flow Accumulations (FA)
Puddle Geometric Properties
Cell Information
Routing Elements
Surface Properties
Puddle Hydrologic Properties
Save
< Back
Next >
Cancel

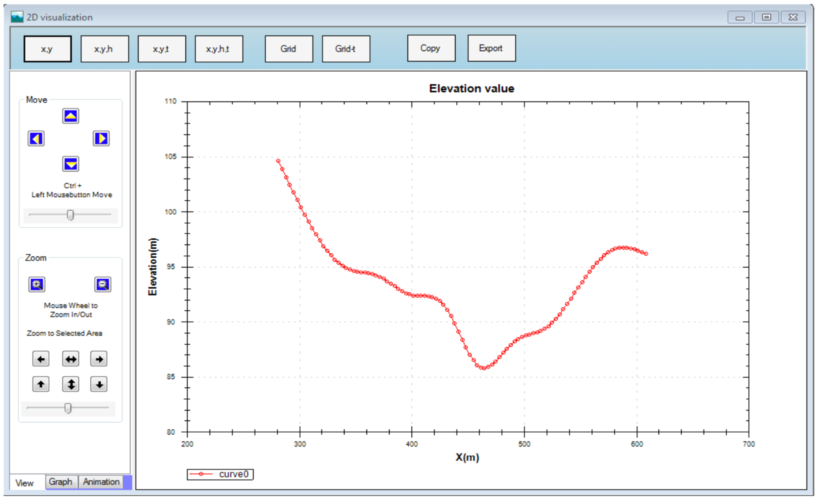

P2P Model Wizard
Welcome
Choose Model
Inputs
Run PD and P2P Models
Outputs
Finish
End of Wizard
Thank you for using the P2P Wizard!
Save
< Back
Finish
Cancel

7 Visualization

Visualization includes a set of independent tools in the P2P system. The data can be visualized in the following forms: 2D graph for x-y or x-y-h data; 2D animation for x-y-t or x-y-h-t data; 2D grid; 2D grid animation; 3D graph for x-y-z or x-y-z-h data; and 3D animation for x-y-z-h-t data. A variety of visualization functions (e.g., moving, rotating, and zooming in/out) are available for the created figures.

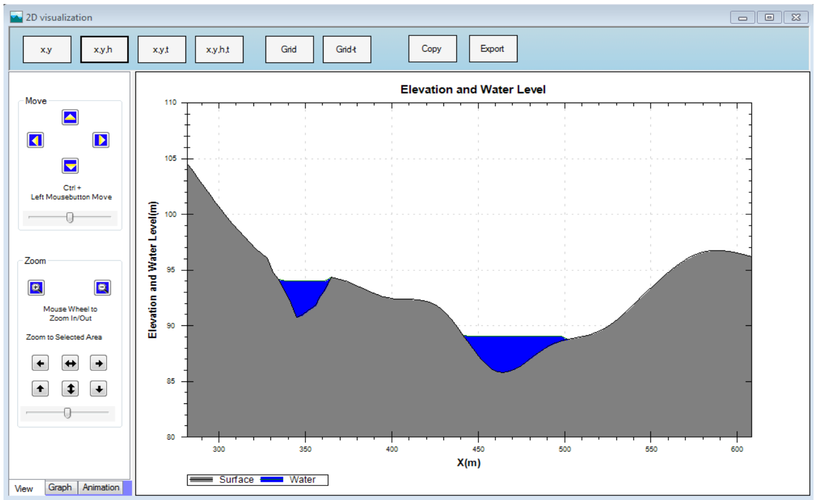
7.1 2D Graph (x, y)

Any paired data (x, y), (x, z), or (y, z) can be shown in a 2D graph (e.g., surface profile).



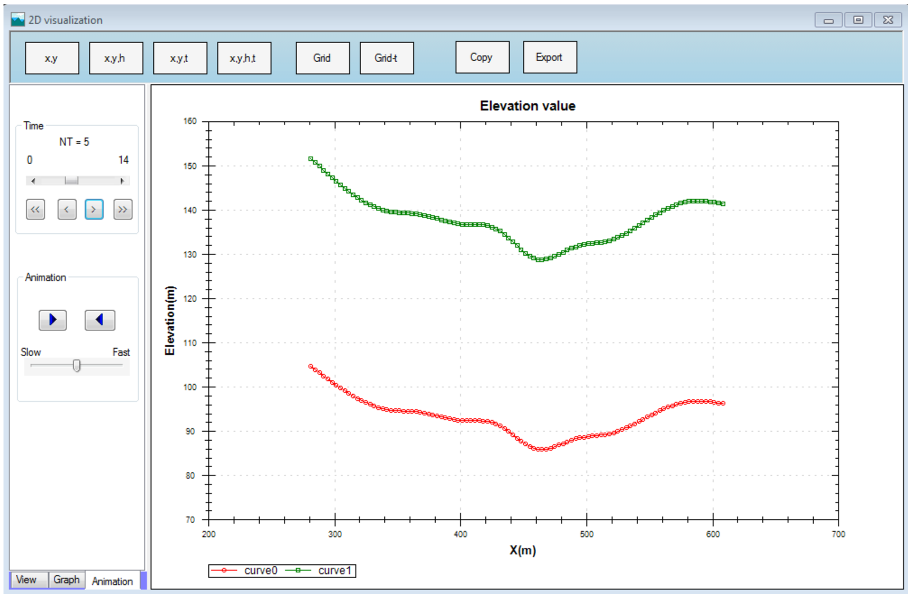
7.2 2D Graph (x, y, h)

A set of (x, y) data with ponded water depth (h) can be displayed in a 2D graph (e.g., surface profile with ponded water in puddles).



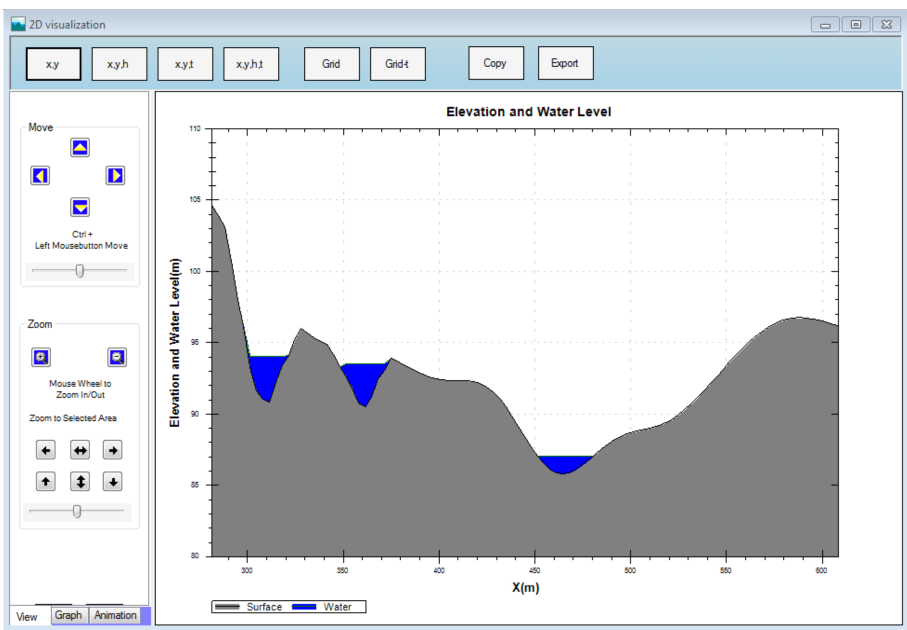
7.3 2D Animation (x, y, t)

The changes of any x-y curves with time can be shown by using a 2D animation.



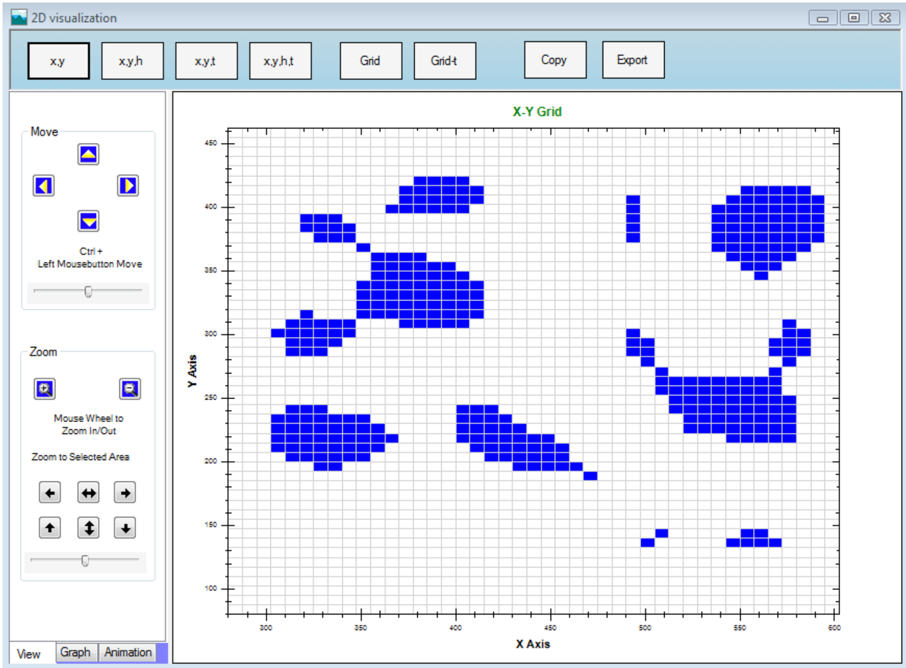
7.4 2D Animation (x, y, h, t)

The changes in ponded water depths (h) with time over the x-y domain can be shown by using a 2D animation.



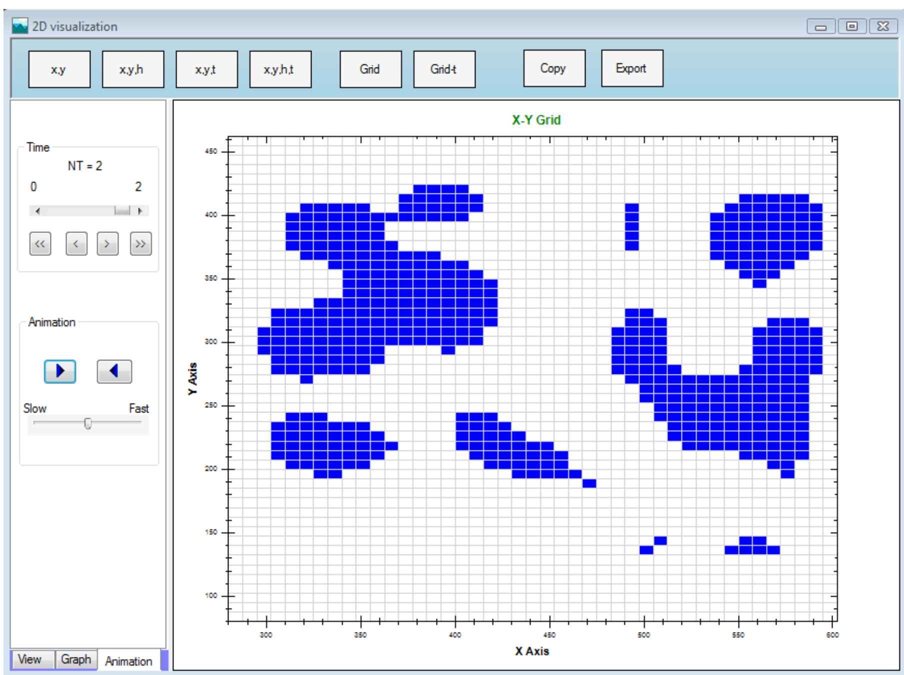
7.5 2D Grid

The spatial distribution of puddles at a specific level can be shown in a 2D grid view.



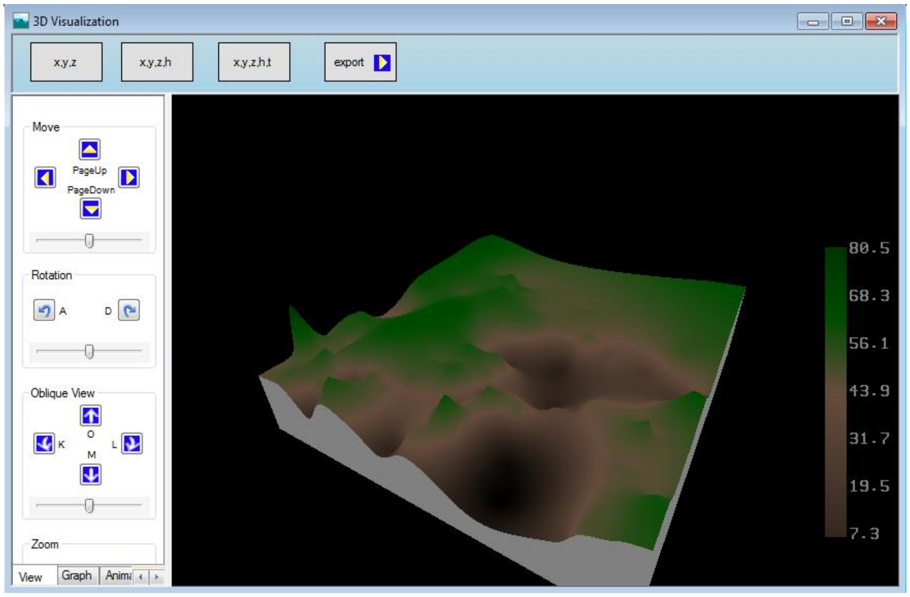
7.6 2D Grid Animation

The changes in puddles distributions with time can be shown by using a 2D grid animation.



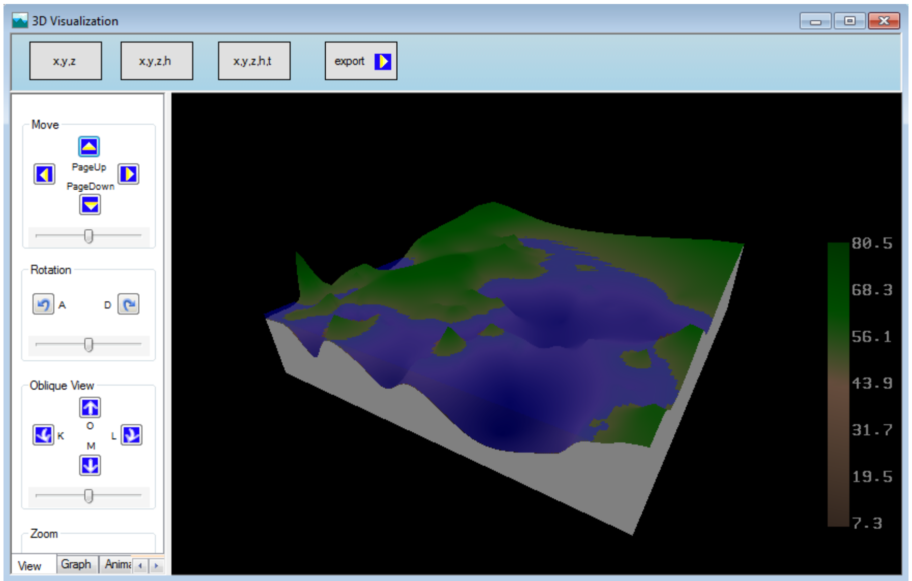
7.7 3D Graph (x, y, z)

The topography of a surface can be shown in a 3D graph.



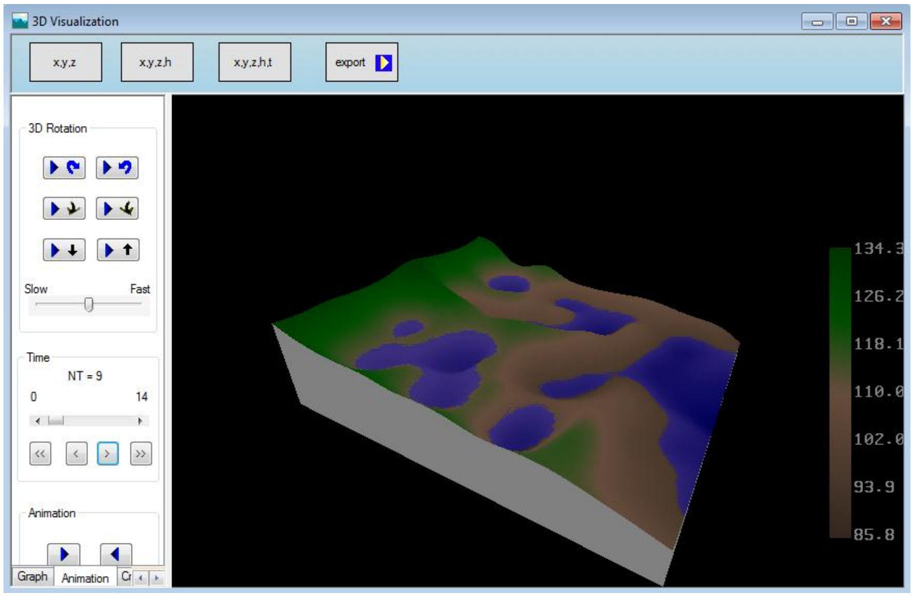
7.8 3D Graph (x, y, z, h)

A surface with ponded water can be displayed in a 3D graph.



7.9 3D Animation (x, y, z, h, t)

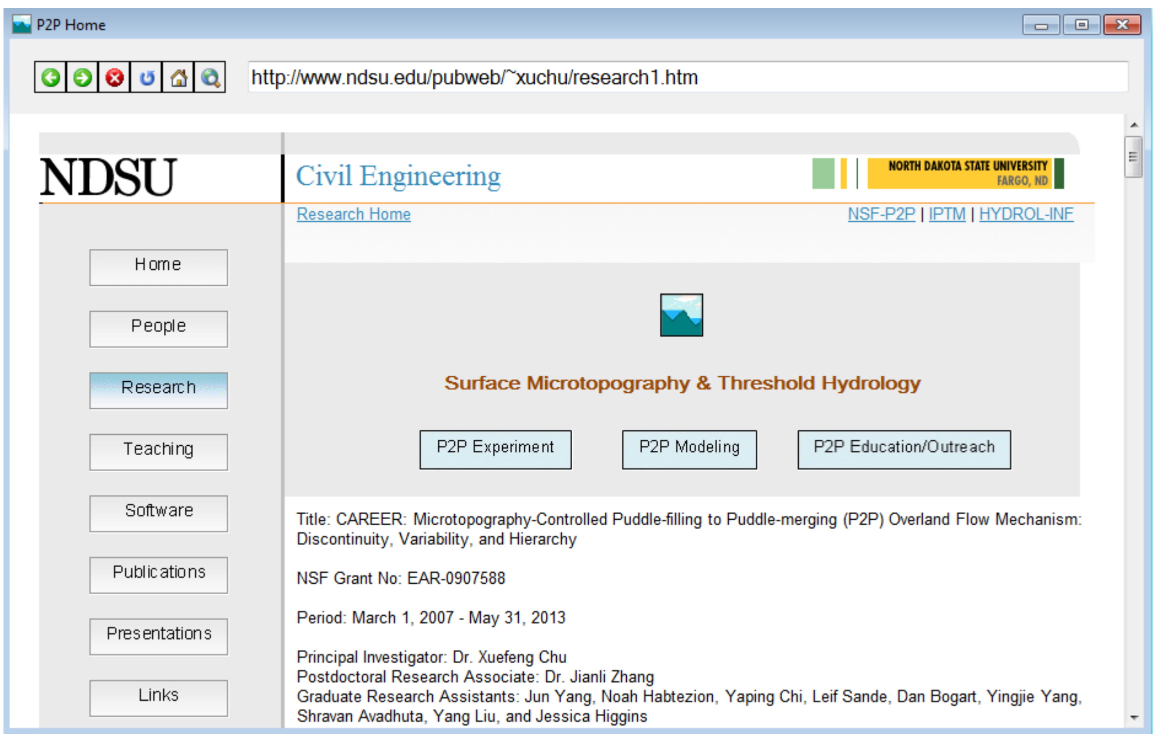
The changes in ponded water depths with time across a 3D surface can be visualized by using a 3D animation.



8 Help

8.1 P2P Website

The submenu "P2P Website" provides the link to the P2P website where more information on this NSF funded project and the P2P modeling system is available.



8.2 Documentation

The submenu "Documentation" provides an access to a series of software documents, including the introduction and user's manual for the P2P system, user's manuals for all hydrotopographic tools, the introduction and user's manual for the HYDROL-INF modeling system, and the related publications (peer-reviewed journal papers, book chapters, and proceeding papers).

8.3 Demo Videos

From the submenu "Demo Videos," users are able to access a series of demonstration videos, including an overview of the P2P system, P2P models, an overview of the P2P education software, an overview of the P2P tools, individual P2P tools, and 2D/3D visualization tools.

8.4 About

The information on the current version of the P2P modeling system, contact address, and acknowledgements can be viewed via the submenu "About."