



P2P Tools

# Puddle Delineation – PD Tool

## User's Manual

Version 1.50

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## **Introduction to the Puddle Delineation Software**

This Windows-based puddle delineation (PD) software is developed for characterizing surface microtopography, delineating puddles and their hierarchical relationships, determining flow directions and accumulations, and precisely computing maximum depression storage (MDS), maximum ponding area (MPA), and contributing areas for two surface ponding conditions: fully-filled and unfilled conditions. In addition, the PD software facilitates the computation and visualization of terrain parameters including local slopes and aspects.

### **Limitations of the Current Computer Program:**

Maximum number of puddles at one level (MAXPUDDLE): 5000

Maximum number of threshold cells for each puddle (MAXTHRESH): 5000

Maximum number of cells for each puddle at one level (MAXPOINT): 2000

Maximum number of rows (MAXNI): 1000

Maximum number of columns (MAXNJ): 2000

### **Acknowledgement:**

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# 1. Windows Interface

The Windows-based PD software is developed using C#. The Windows interface facilitates importing DEM data, implementing puddle delineation for either fully-filled or unfilled condition, determining flow directions and accumulations, computing contributing areas, calculating terrain parameters, displaying the results, and visualizing the puddle searching process (Fig. 1).

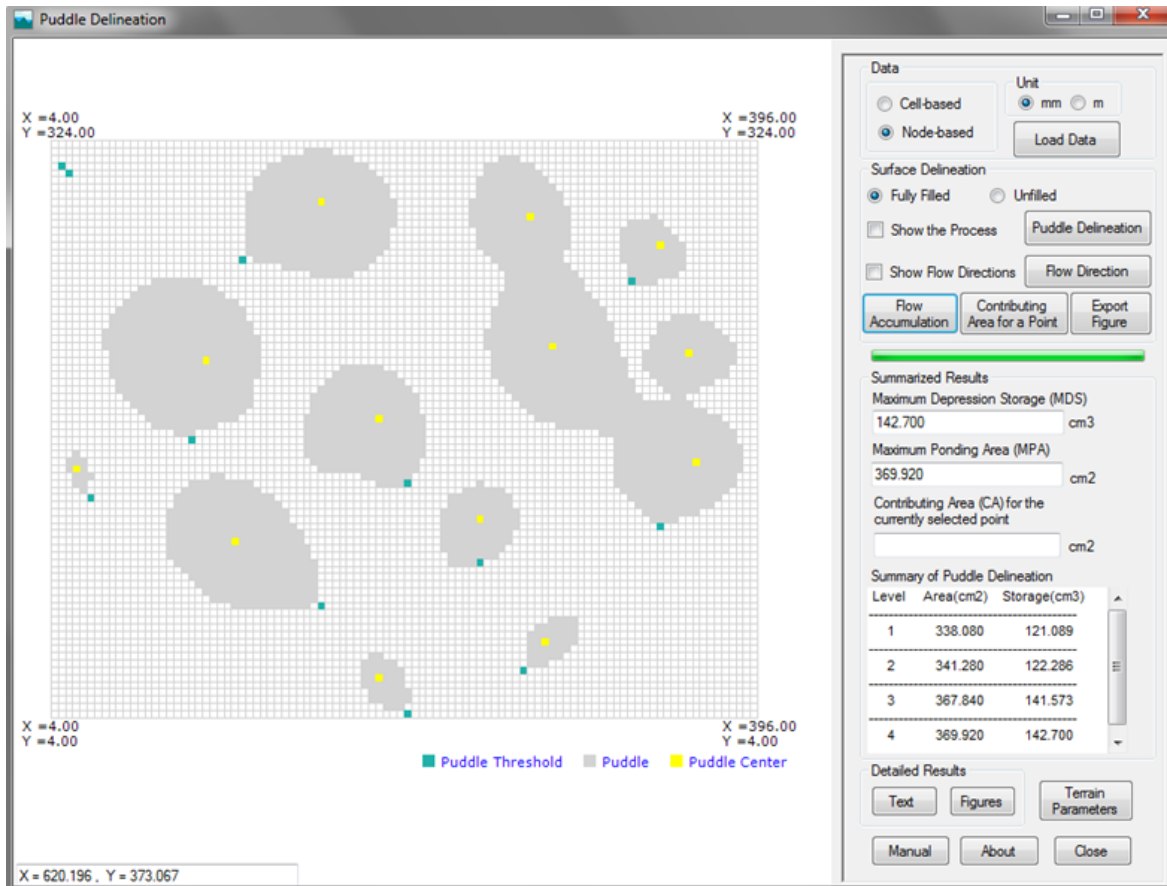


Fig. 1 Windows interface of the puddle delineation software

The main interface shows a summary of the major puddle delineation results. The detailed results in both text and figure formats can be accessed via the buttons of “Text” and “Figures” (Fig. 1). The calculated terrain parameters (local slopes and aspects) and flow directions and accumulations can be visualized through the button of “Terrain Parameters” (Fig. 1). The user’s manual and the software version information also can be accessed on the main interface.

## 2 Procedures for Puddle Delineation

### 2.1 Input Data

Surface DEM data may have two different formats: cell-based and node-based (Figs. 2a and 2b). Users are allowed to select either of them (Fig. 2c). The first line of the DEM data file should consist of the total number of rows and the total number of the columns of the DEM grids for the surface area. The remaining lines of the DEM data file include the x, y, and z coordinates. All the data on each line are separated by a comma or a space. The xyz DEM data should be sorted first by the y values of the DEM data and then by the x values of the DEM data from the smallest to the largest. Two units (mm and m) are available for selection for the DEM data (Fig. 2c). After selecting the data settings, the DEM data can be imported by clicking “Load Data.”

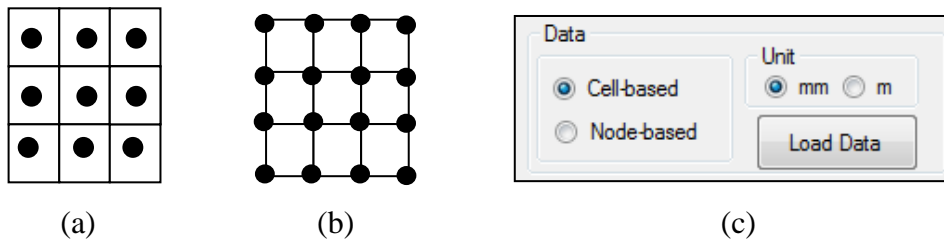


Fig. 2 DEM data and their formats: (a) cell-based and (b) node-based

### 2.2 Surface Delineation

A surface can be delineated for either a fully-filled condition (puddles at all levels reach their thresholds) or an unfilled condition by selecting “Fully Filled” or “Unfilled,” respectively (Fig. 3a). To visualize the puddle delineation process, the option of “Show the Process” should be selected (Fig. 3a). Otherwise, only the final distribution of puddles will be shown in the display window.

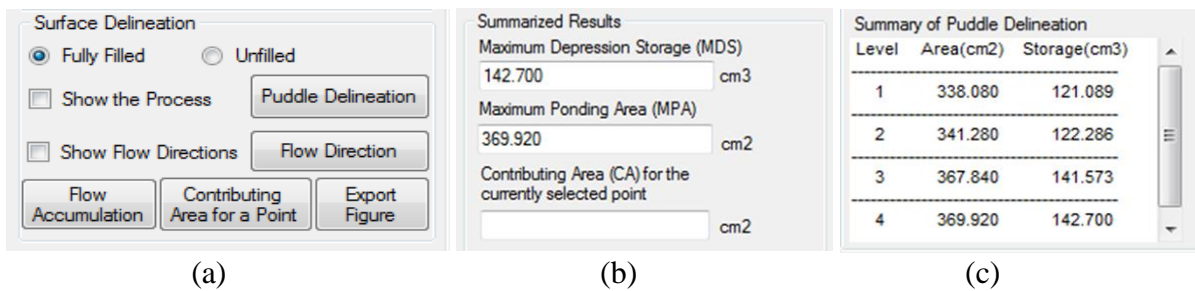


Fig. 3 Surface delineation options and summarized results

The delineation of puddles is executed by clicking the button of “Puddle Delineation” (Fig. 3a). Then, the computed maximum depression storage (MDS) and maximum ponding area (MPA) for the highest puddle level are displayed (Fig. 3b). Additionally, the MDS and MPA values for all levels are shown in a summary table (Fig. 3c).

Following puddle delineation, users should click the button of “Flow Direction” (Fig. 3a) to calculate flow directions for all DEM cells. The results will be saved to a file named “FD\_Fill.dat” for the fully-filled condition or “FD\_NoFill.dat” for the unfilled condition. If the option of “Show Flow Directions” (Fig. 3a) is selected, flow directions of all cells also will be shown in blue arrows in the display window.

Following the computation of flow directions, users should click the button of “Flow Accumulation” (Fig. 3a) to calculate flow accumulations for all DEM cells. The results will be saved to a file named “FlowAccum\_All.dat.”

The contributing area for a selected cell/point can be calculated by clicking the button of “Contributing Area for a Point” (Fig. 3a) and then clicking on any cell in the display window to select that cell/point. The selected cell will be shown in red color and the contributing area (CA) for the selected cell/point is calculated and displayed in green color. In addition, the computed CA is shown in the textbox (Fig. 3b).

Note that the x and y coordinates of the cursor are shown in the lower left textbox of the display window and they change with the mouse movement. Any image in the display window can be saved to an image file by clicking the button of “Export Figure” (Fig. 3a).

## **3 Detailed Results**

### **3.1 Results in a Text Format**

The results can be displayed in text-format tables. By clicking the button of “Text” on the main interface, users can access detailed results in a new window (Fig. 4). The available output data include the basic information (e.g., surface area, number of puddle levels, maximum depression storage, and maximum ponding area), detailed results, imported DEM data, puddle distribution, puddle properties (including puddle centers, thresholds, and cells for any puddle levels), and flow accumulations. They can be accessed by clicking the corresponding buttons.

The output data displayed on the interface can be printed or saved to a text file. Major delineation results are automatically saved to a set of output files, including puddle centers, thresholds, puddle cells, and combination relationships of puddles for all puddle levels.

Level	Puddle	Area (cm2)	Storage (cm3)
1	0	0.000	0.000
1	1	6.400	0.442
1	2	6.080	0.432
1	3	47.520	22.584
1	4	15.680	2.943
1	5	2.080	0.044
1	6	28.000	13.309
1	7	36.160	10.354
1	8	58.560	20.295
1	9	16.960	5.751
1	10	42.720	19.519
1	11	10.560	2.008
1	12	19.520	5.226
1	13	47.840	18.181
1	Sum	338.080	121.089

Level	Puddle	Area (cm2)	Storage (cm3)
2	0	65.440	25.942
2	1	0.000	0.000
2	2	6.400	0.442
2	3	6.080	0.432
2	4	47.520	22.584
2	5	15.680	2.943
2	6	2.080	0.044
2	7	28.000	13.309
2	8	36.160	10.354
2	9	58.560	20.295
2	10	16.960	5.751
2	11	10.560	2.008
2	12	47.840	18.181
2	Sum	341.280	122.286

Level	Puddle	Area (cm2)	Storage (cm3)
3	0	120.000	58.538
3	1	0.000	0.000
3	2	6.400	0.442
3	3	6.080	0.432
3	4	47.520	22.584
3	5	15.680	2.943
3	6	2.080	0.044
3	7	36.160	10.354

Fig. 4 Detailed results in a text format

### 3.2 Results in a Figure Format

Users also can visualize the results in a figure format in a new window (Fig. 5) by clicking the button of “Figures” on the main interface. Users can select different puddle levels and view the corresponding puddle distributions. This function allows users to visualize the combination and relationships of puddles. In addition, the PD software provides various visualization functions (e.g., zoom in/out and move in different directions). By selecting the tab of “Graph,”

users can change the settings of the figure, such as the title and font, the frame and filled color, as well as the x and y axes.

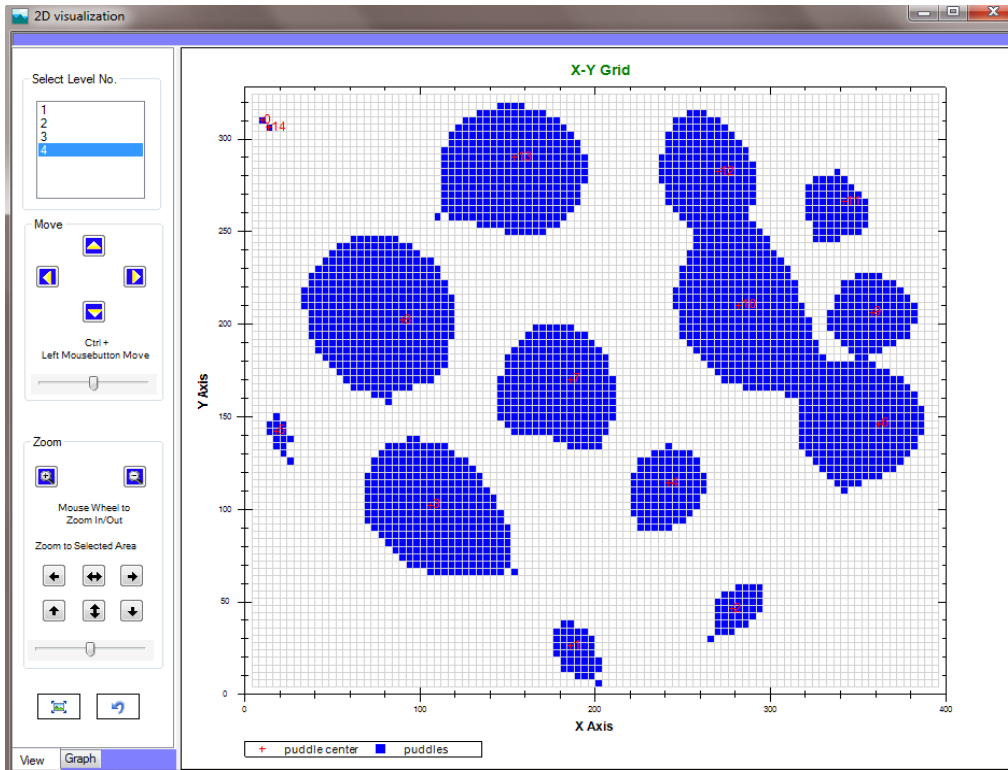


Fig. 5 Detailed results in a figure format

## 4 Terrain Parameters

In addition to flow directions and accumulations, the PD program computes two terrain parameters: local slopes and aspects for all DEM cells. These terrain parameters can be visualized in a new window by clicking the button of “Terrain Parameters” on the main interface.

The local slope of a cell is expressed as a percentage and can be shown by clicking the button of “Slope” in the new window (Fig. 6). The aspect of a cell is displayed in eight distinct colors representing eight directions (north, northeast, east, southeast, south, southwest, west, and northwest). The gray color is used to represent flat and puddle cells (Fig. 7). The flow direction of a cell is shown in a blue arrow, indicating one of the eight directions. No flow direction (white color) is assigned to any flat and puddle cells (Fig. 8). The distribution of flow accumulations for all DEM cell is shown in Fig. 9. In addition, the contributing area for a user specified cell/point can be shown on the main interface (Fig. 10).



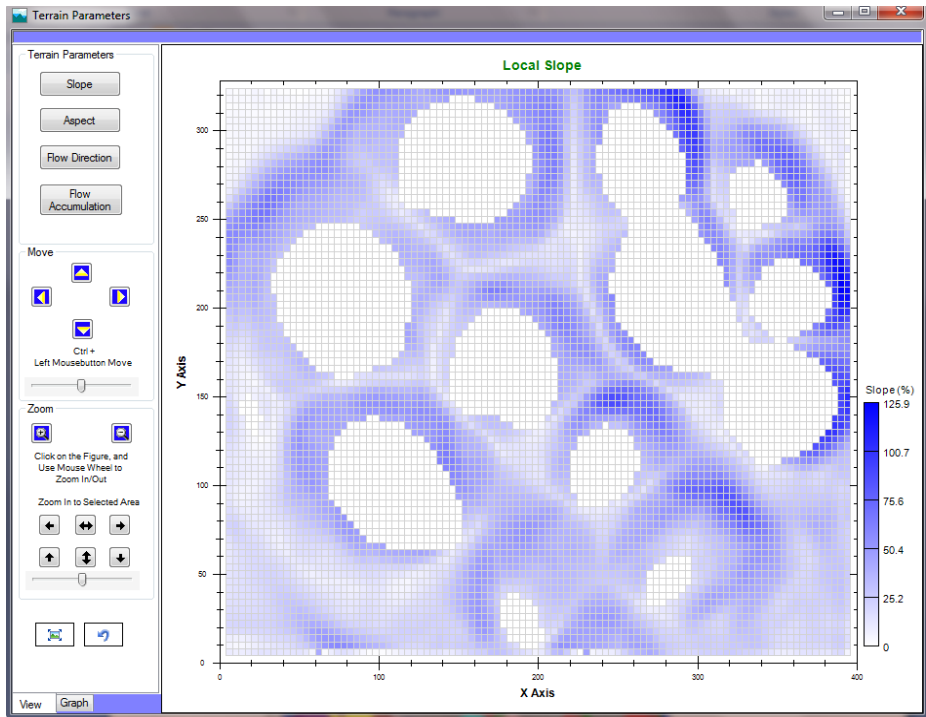


Fig. 6 Distribution of local slopes

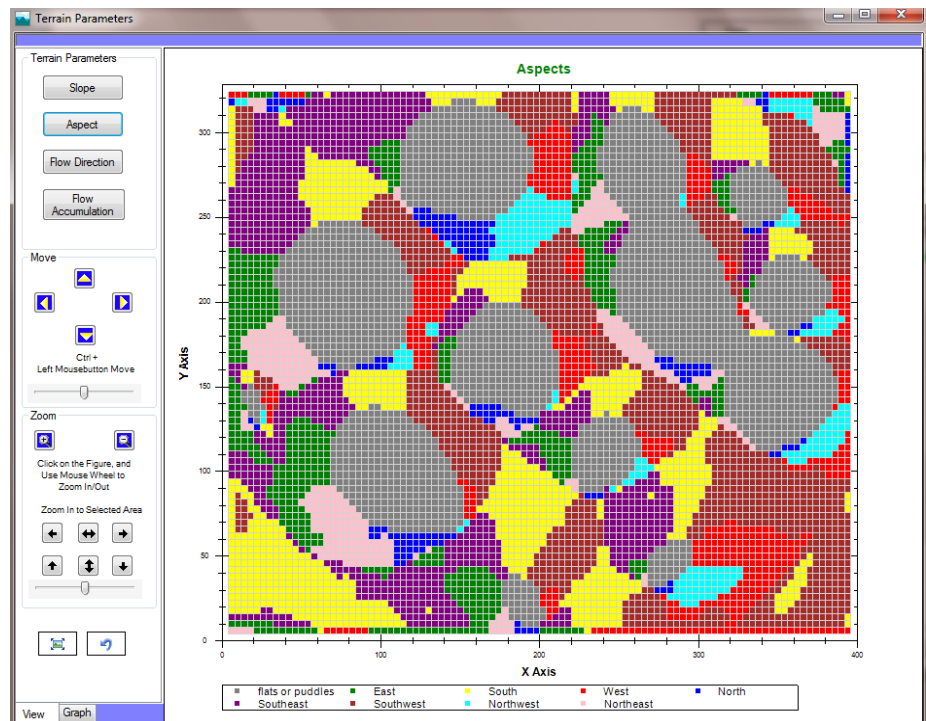


Fig. 7 Distribution of aspects

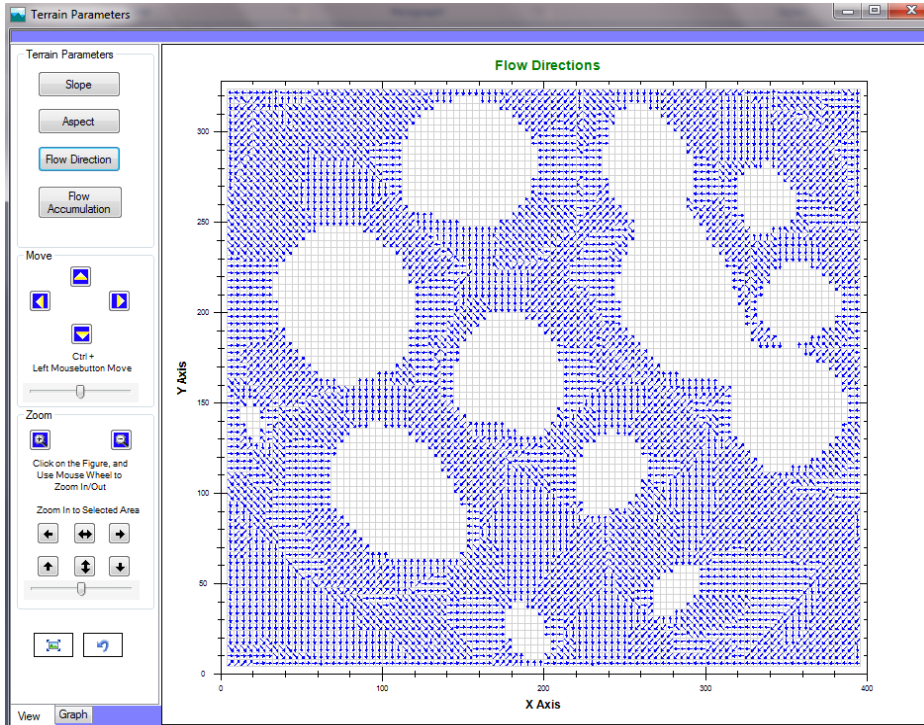


Fig. 8 Distribution of flow directions

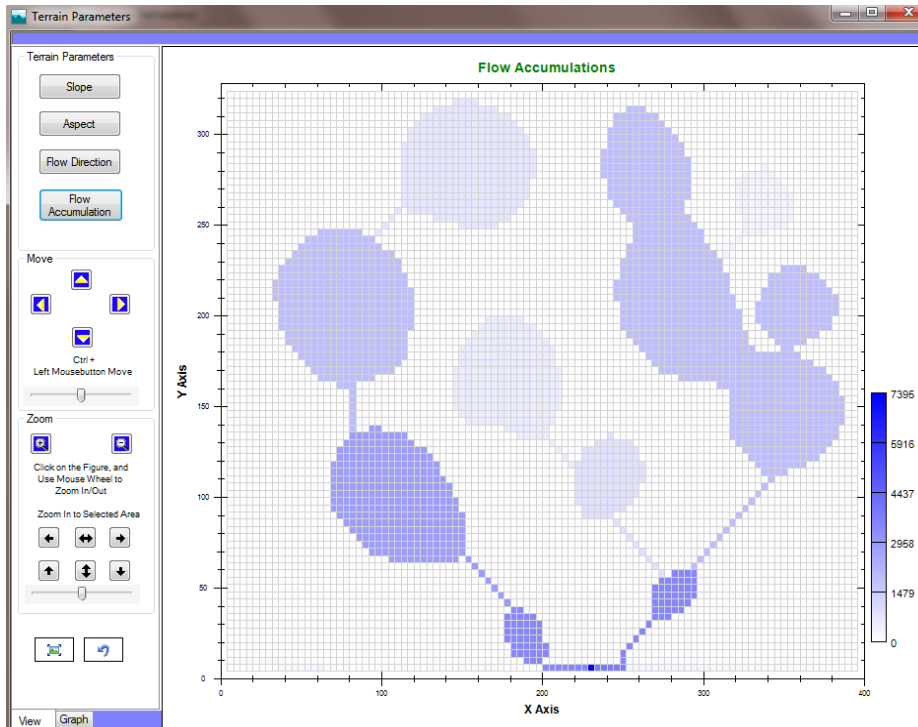


Fig. 9 Distribution of flow accumulations

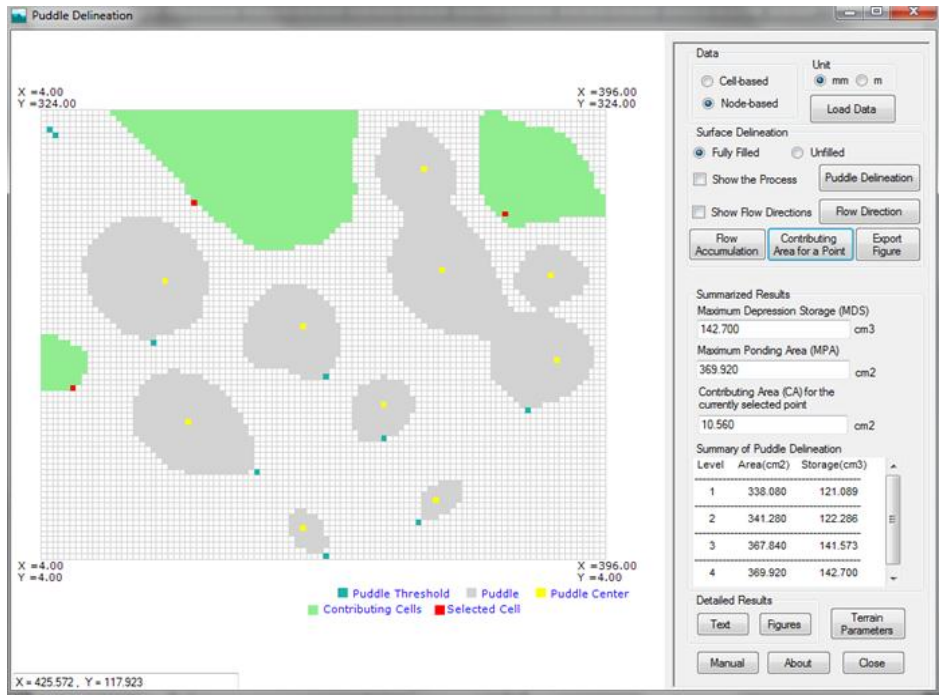


Fig. 10 Contributing areas for the selected cells/points

## 5 Helpful Information

The user's manual of the PD software can be accessed by clicking the button of "Manual" on the main interface. Users also can access the software version and contact information (Fig. 11) via the button of "About" on the main interface.

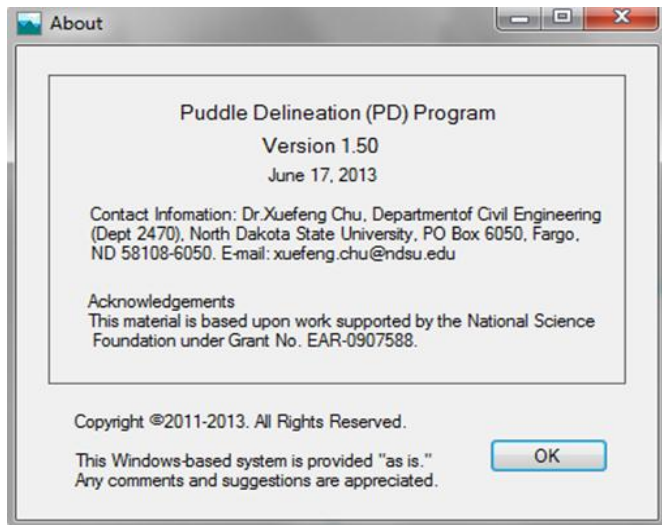


Fig. 11 Software version and contact information