Introduction to Graphical User Interface (GUI) for Applications of Indiana NRCS Unit Hydrograph (Finlay Unit Hydrograph)

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1. Introduction

This document is associated with the technique report "*Developing Customized NRCS Unit Hydrographs for Ungauged Watersheds in Indiana*" and works as a general guide for the applications of Finlay Unit Hydrograph (UH) by using the graphical user interface (GUI) developed based on Excel VBA or Python. To simplify the application process, 2052 watersheds with a mean area of 17.3 mile^2 are delineated for the whole state of Indiana using the Arc Hydro tools in ArcGIS. Then the UH parameters (Peak Rate Factor (PRF) and Lag Time) of each delineated watershed are estimated based on the regional regression equations presented in the report mentioned above. Therefore, the UH parameters given a specific point within Indiana are obtained from the values corresponding to the nearest drainage point of the delineated watershed. The following sections will describe the features of these two GUIs in detail.

2. GUI based on Excel VBA for applications of Finlay Unit Hydrograph

This version of GUI is an Excel file that contains three spreadsheets (see Figure A-1), which are "Welcome", "Finlay UH Parameters" (see Table A-1), and "Finlay UH". The tool is designed for estimating the parameters (PRF and Lag Time) of Finlay UH and generating the coordinates of dimensionless UH based on the estimated parameters. It is developed based on Excel VBA and saved as a macro-enabled worksheet (*.xlsm). Interested users can press "Alt+F11" to view the Basic code in the Excel file.

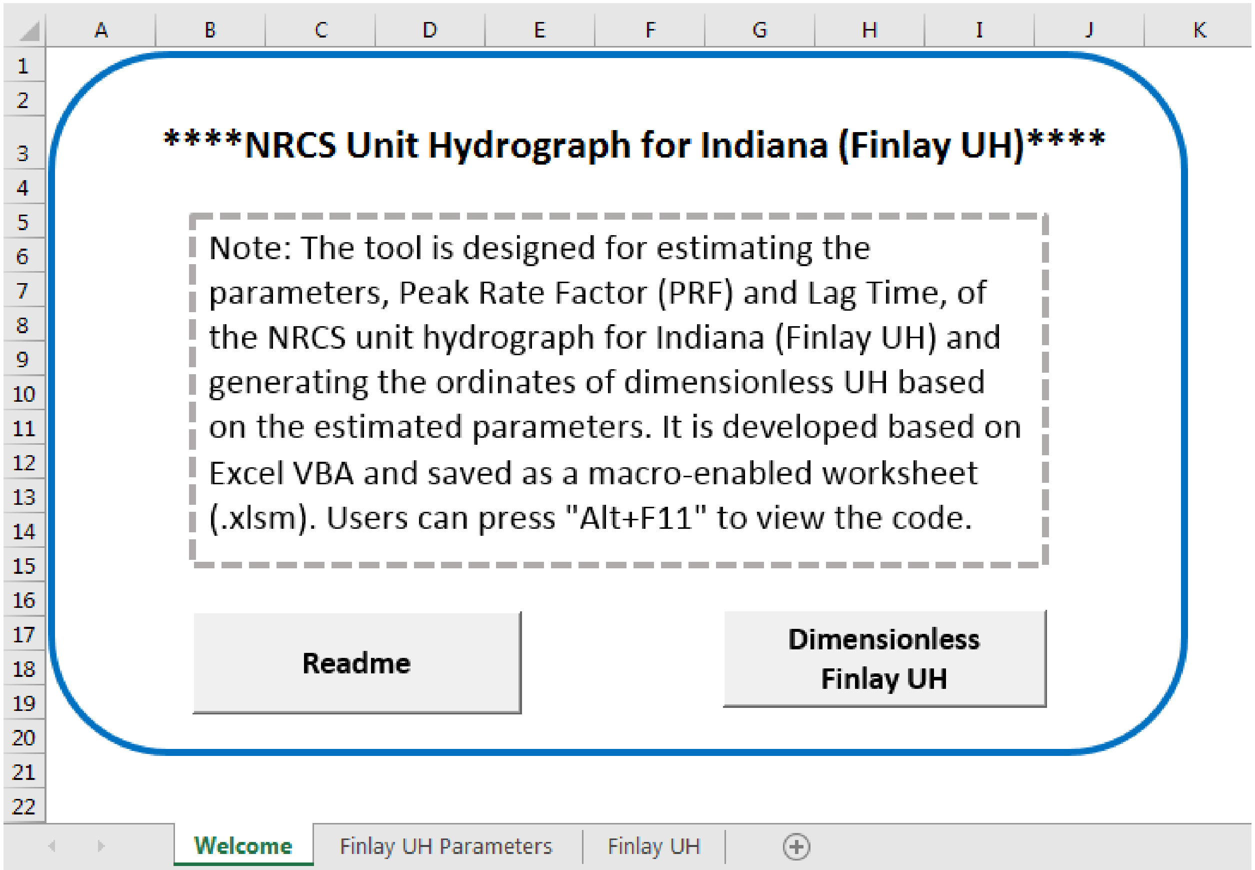


Figure A-1. Excel spreadsheets for applications of Finlay UH.

Table A-1. Data structure in the spreadsheet "Finlay UH Parameters".

North Latitude (°)	West Longitude (°)	PRF	Lag Time (hours)	Variable (1)	Variable (2)	Variable (…)
41.7655	86.6564	327	5.21	…	…	…
41.6865	86.8439	313	6.85	…	…	…
41.7290	86.9141	286	7.41	…	…	…
41.6865	86.8442	751	4.83	…	…	…
41.6788	87.0634	324	4.44	…	…	…
…	…	…	…	…	…	…

There are two buttons in the "Welcome" spreadsheet, namely, "Readme" and "Dimensionless Finlay UH". Once users click on the left button, an interface (see Figure A-2) will pop up to show a brief introduction to the tool. It stated that the parameters (PRF and Lag Time) of Finlay UH are estimated based on the observed hydrographs of 30 small study watersheds in Indiana. If the watershed characteristics are outside the applicable range of the variables in the regression equations, the values of the parameters may not be reliable. For example, the applicable drainage area of a watershed is 3 ~ 40 mile^2. The Finlay UH parameters of a specific point are obtained from the values of the nearest drainage point of the delineated watershed as highlighted in the spreadsheet, " Finlay UH Parameters". Given the values of PRF and nondimensional time interval, the coordinates of the dimensionless Finlay UH are calculated based on the Gamma function and then written to the spreadsheet, " Finlay UH", and the contact email. After clicking on the right button in the “Welcome” spreadsheet, an interface (see Figure A-3) will pop up for the input of the location of a site of interest and the nondimensional time interval, and then the Finlay UH parameters of the given point are obtained from the values of the nearest drainage point of the delineated watershed, which will be highlighted in red in the spreadsheet “Finlay UH Parameters”. And then users can get the coordinates of a dimensionless Finlay UH based on the estimated parameters through the GUI as well as in a new TR-20 input file under the working directory and the spreadsheet “Finlay UH” for further applications.

Additionally, this GUI includes some basic error-checking features. For example, after clicking on the “Run” button, if the given latitude or longitude of an outlet is falling outside of Indiana or users did not enter anything or accidentally entered the non-numerical characters, the GUI will pop up a message window to remind users to reenter the correct information.

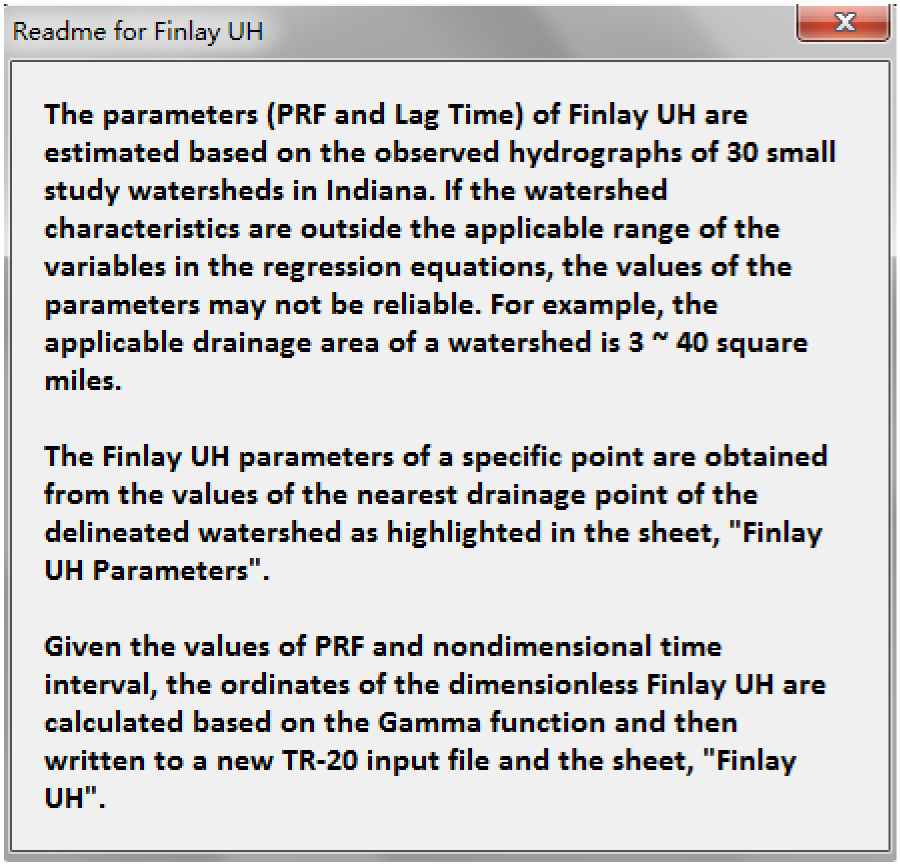
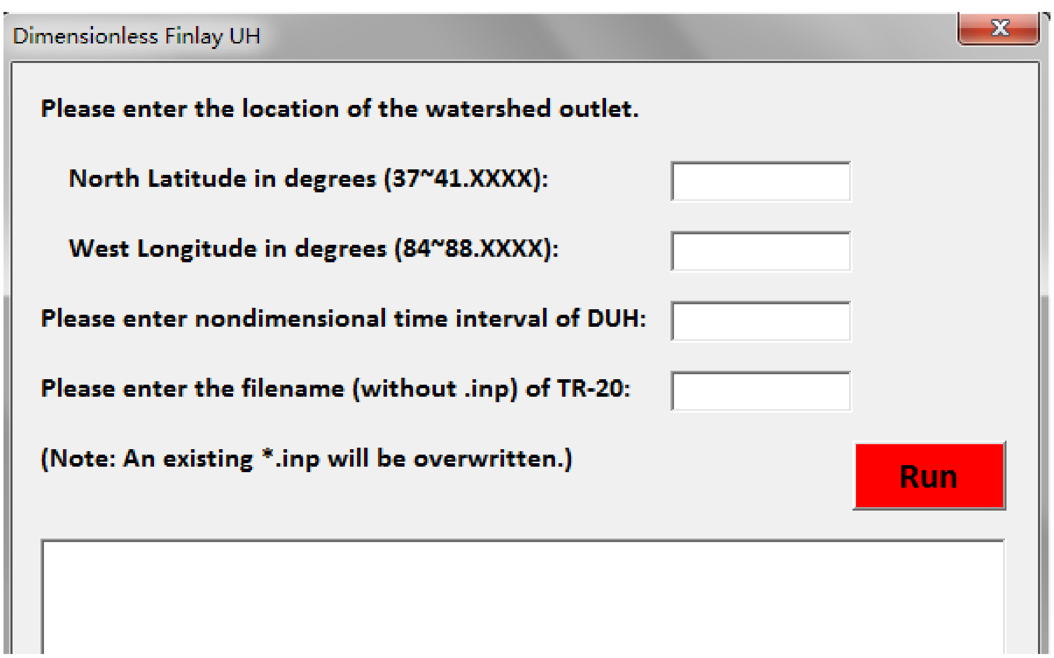
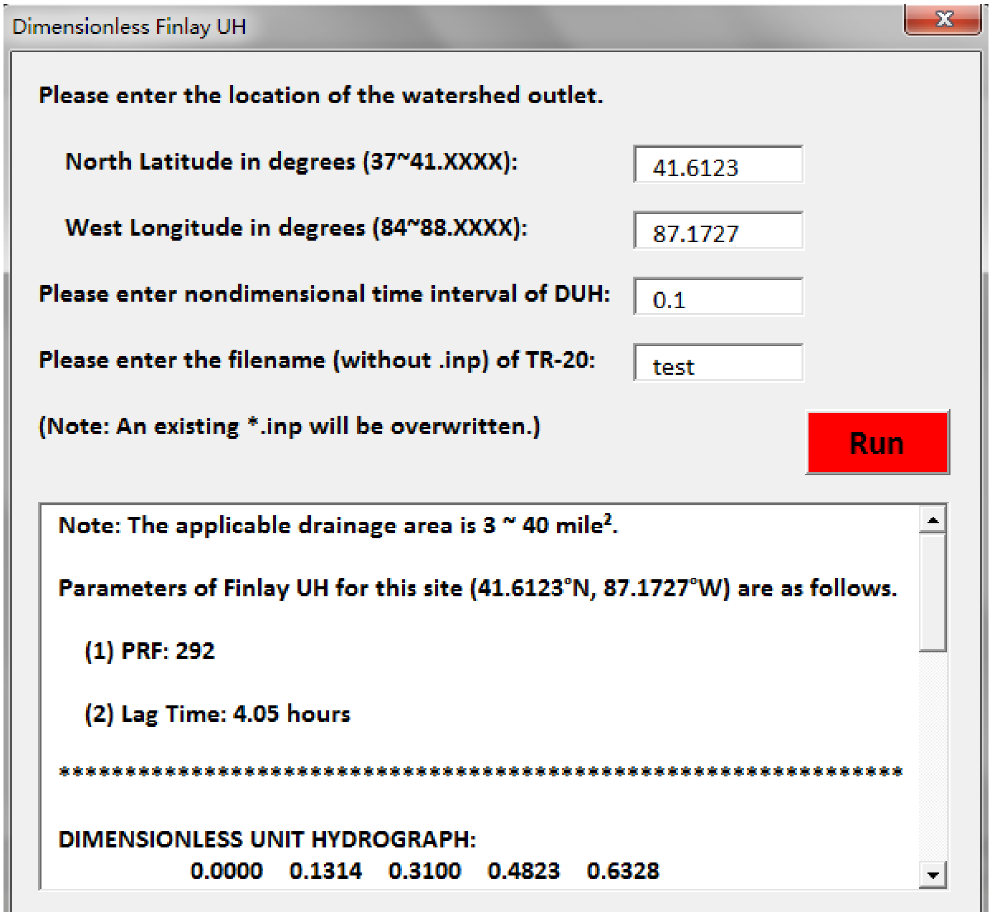


Figure A-2. Readme interface of GUI based on Excel VBA.



(a) GUI based on Excel VBA for estimation of Finlay UH parameters and ordinates.



(b) Example results obtained in the GUI based on Excel VBA.

	A	B	C	D	E	F	G	H	I
1	North Latitude (degrees)	West Longitude (degrees)	PRF	Lag Time (hours)		Cs	Area (mile^2)	Lp (m)	Lb (m)
2	41.7655	86.6564	328	5.21		0.0018	30.16496	59760	17764
3	41.6865	86.8439	314	6.85		0.0014	24.99639	66840	19475
4	41.7290	86.9141	288	7.41		0.0007	18.33847	59340	17129
5	41.6865	86.8442	751	4.83		0.0019	21.99963	50520	14404
6	41.6788	87.0634	325	4.44		0.0017	14.43337	56340	14133
7	41.6161	87.0479	566	4.89		0.0006	18.43854	46320	13423
8	41.6285	86.9510	268	5.08		0.0001	9.692554	34320	9594
9	41.6282	86.9510	320	3.93		0.0016	18.10287	48840	14400
10	41.6111	87.1627	294	4.05		0.0008	6.054328	31800	11851
11	41.5000	86.6776	326	12.32		0.0017	38.25975	80940	27956
12	41.6739	87.4422	278	13.43		0.0004	32.66203	78840	24339

(c) Highlights in red in the spreadsheet “Finlay UH Parameters”.

	A	B	C	D	E	F	G	H	I
1	DUH with PRF=294 and nondimensional time interval=0.1 for this site (41.6123°N, 87.1727°W)								
2									
3	DIMENSIONLESS UNIT HYDROGRAPH:								
4	0.0000	0.1282	0.3056	0.4780	0.6292				
5	0.7536	0.8502	0.9203	0.9667	0.9922				
6	1.0000	0.9932	0.9744	0.9464	0.9112				
7	0.8707	0.8266	0.7803	0.7329	0.6852				
8	0.6380	0.5919	0.5473	0.5046	0.4638				
9	0.4253	0.3891	0.3552	0.3236	0.2942				
10	0.2671	0.2421	0.2190	0.1979	0.1786				
11	0.1609	0.1449	0.1303	0.1170	0.1050				
12	0.0941	0.0843	0.0754	0.0674	0.0602				

(d) Output ordinates of dimensionless UH in spreadsheet "Finlay UH".

Figure A-3. GUI based on Excel VBA for generating dimensionless Finlay UH.

3. GUI based on Python for applications of Finlay UH in TR-20

This version of GUI is an executable file (*.exe) developed based on Python and can be used with the TR-20 software. This software is a surface hydrologic model applied for single storm events at a watershed scale and the WinTR-20 (hereinafter referred to as TR-20) is developed for running in the Windows system of a personal computer. The main window of TR-20 is shown in Figure A-4 and the features related to the applications of NRCS UH are shown in Figure A-5.

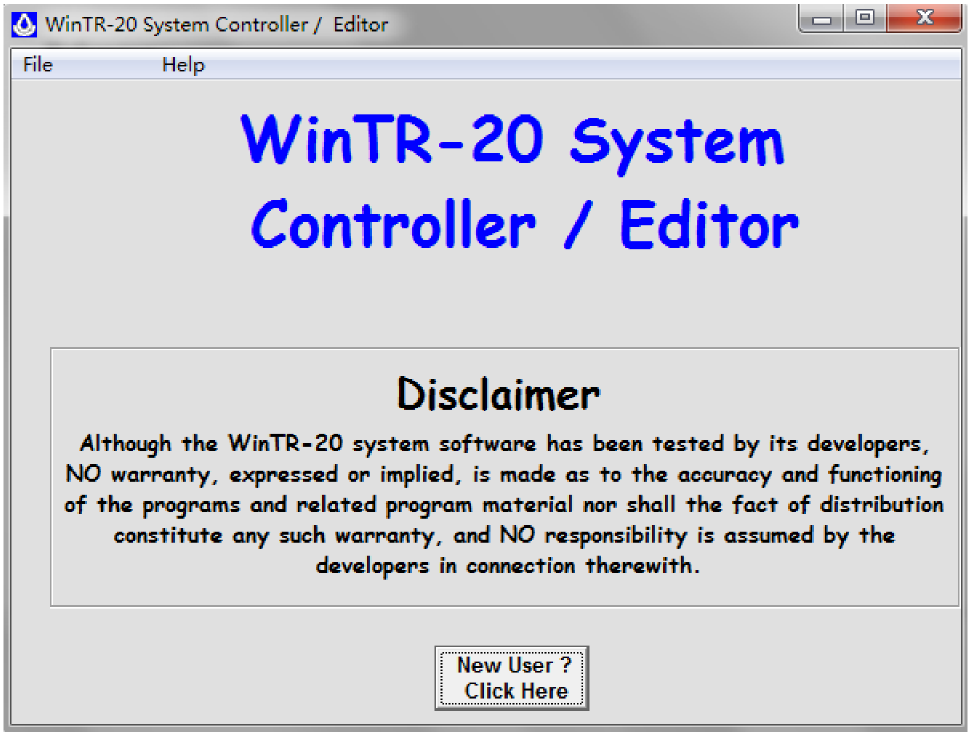
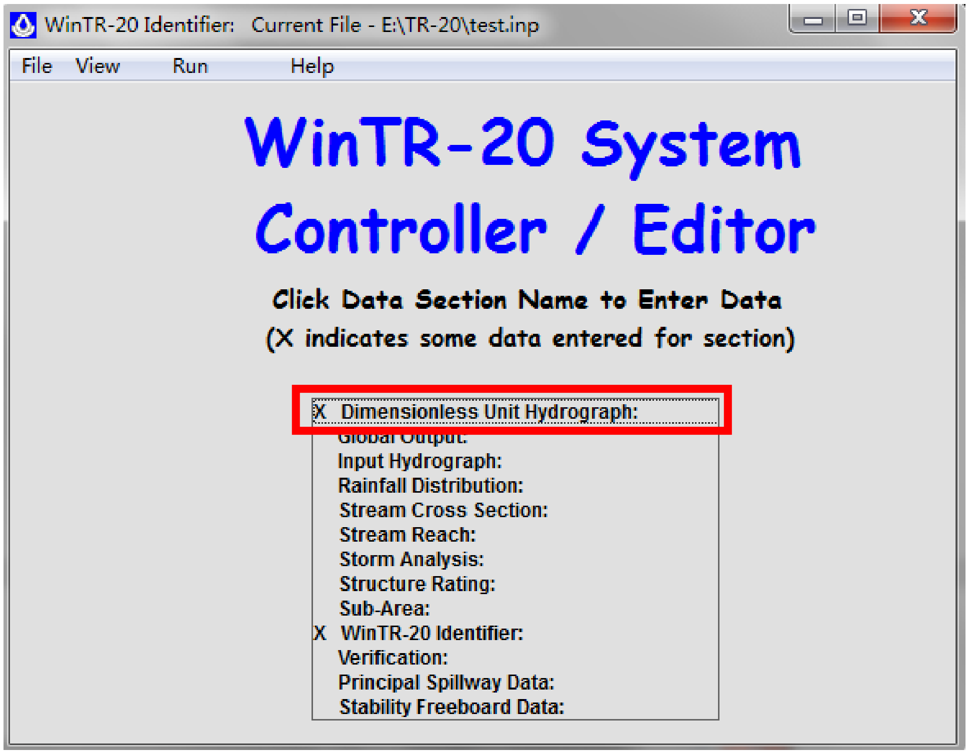
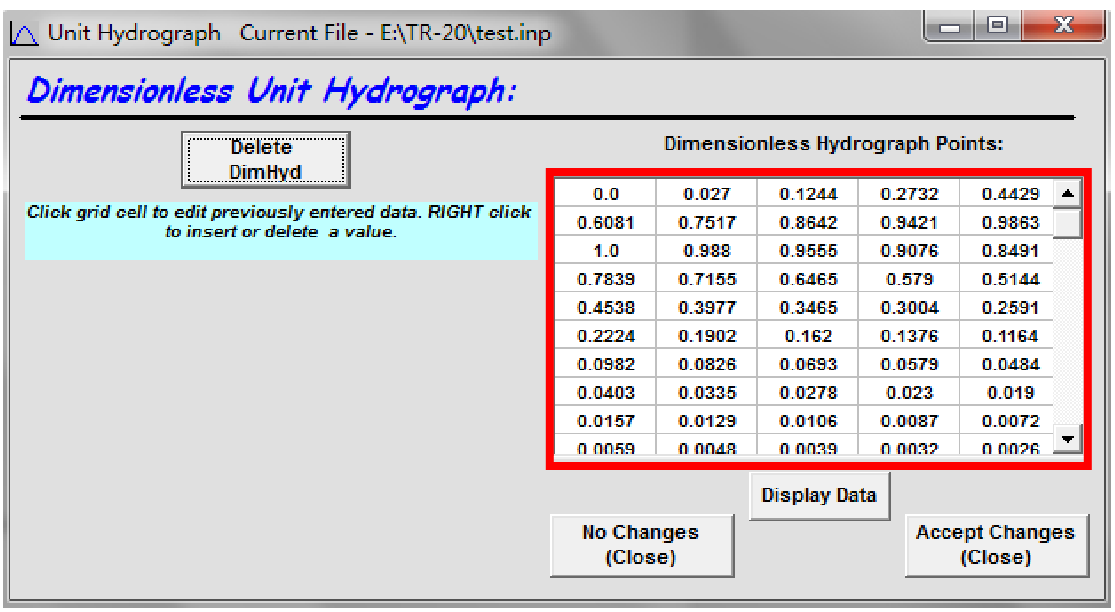


Figure A-4. Main window of TR-20.

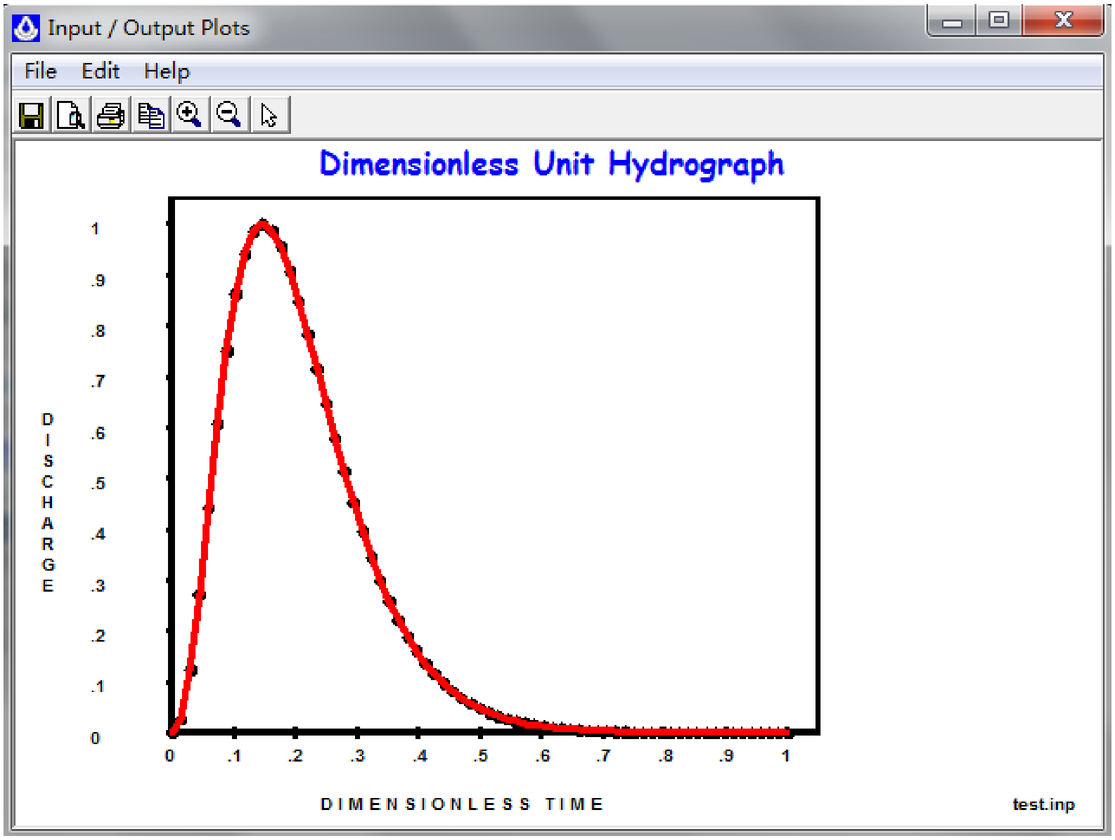
After a new TR-20 file is created, the dimensionless UH section in the main menu (see Figure A-5(a)) is used to edit or enter information for a dimensionless UH. Any data entered here will be used in lieu of the standard dimensionless unit hydrograph with PRF = 484. If the NRCS standard dimensionless UH is desired, then no data should be entered through this window. Otherwise, the sequential dimensionless UH points with a customized PRF should be filled in the cells in the red box manually (see Figure A-5(b)) after clicking on the first section in the main menu. The updated dimensionless UH can be displayed as shown in Figure A-5(c).



(a) Main menu of controller / editor of TR-20.



(b) Coordinates of dimensionless UH with a customized PRF.



(c) Plot of dimensionless UH.

Figure A-5. Features related to NRCS UH in TR-20.

It is suggested to use the GUI with the TR-20 input files from the INDOT, namely, 96 *.inp template files (see Figure A-6), which are used for the 100-year peak flow calculation and include the 100-year precipitation data from the NOAA website for a location at the center of each county in Indiana (These files can be downloaded from https://www.in.gov/indot/engineering/files/TR-20-Input-Files.zip). The GUI and these input files are intended as tools to provide convenience in the hydraulic design of hydrographs.

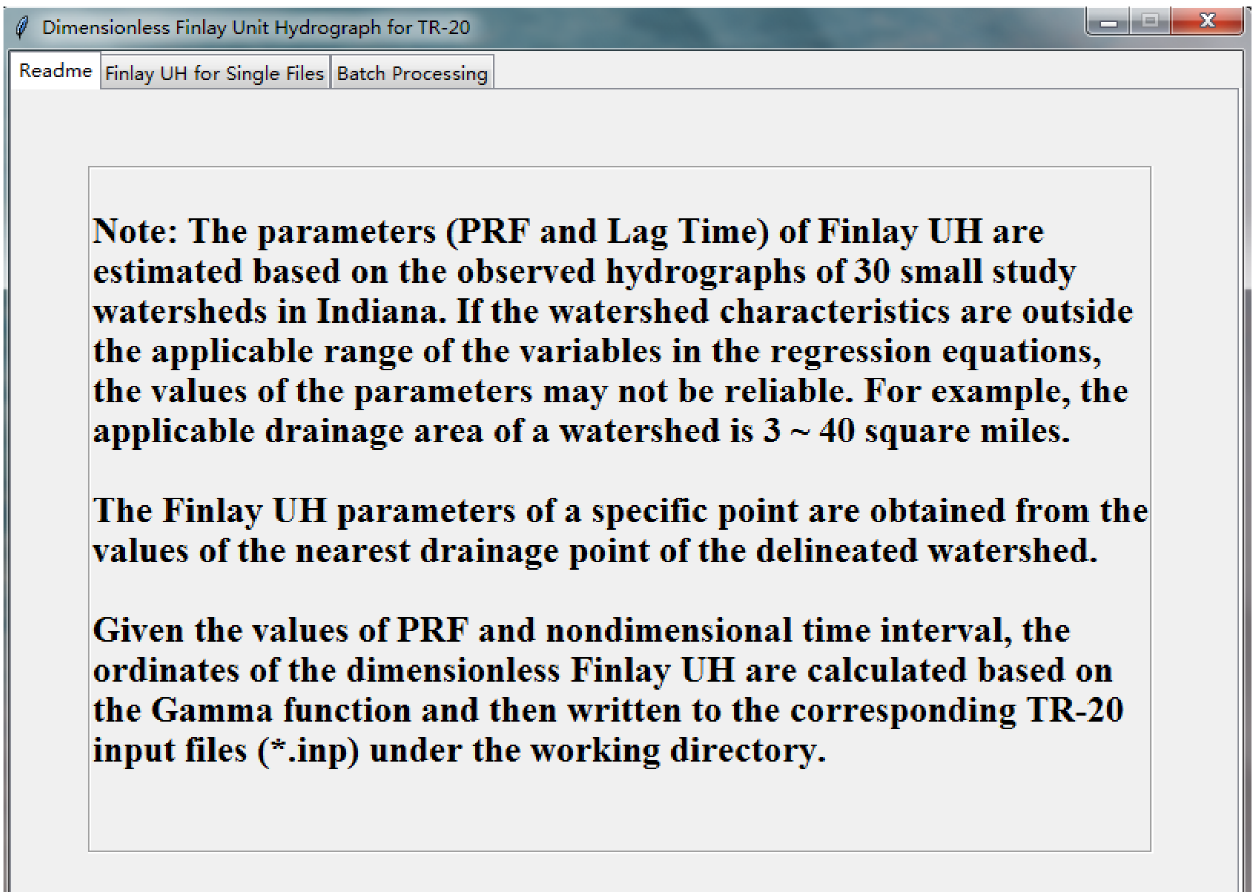

```
WinTR-20: version 3.20           0      0      0.001
Adams County 100 year

SUB-AREA:
        Name Creekoutlet          2.33    70.0    2.83

STORM ANALYSIS:
        15 minute            1.42     Huff.25   2
        30-minute            2.06     Huff.50   2
        60-minute            2.75     Huff1.0   2
        120-minute           3.31     Huff2.0   2
        3-hr                3.56     Huff3.0   2
        6-hr                4.26     Huff6.0   2
        12-hr               4.88     Huff12.0  2
        24-hr               5.50     Huff24.0  2

RAINFALL DISTRIBUTION:
        Huff.25         0.0125
                0.      0.100    0.200    0.306    0.411
```

(a) TR-20 input files for each county in Indiana.

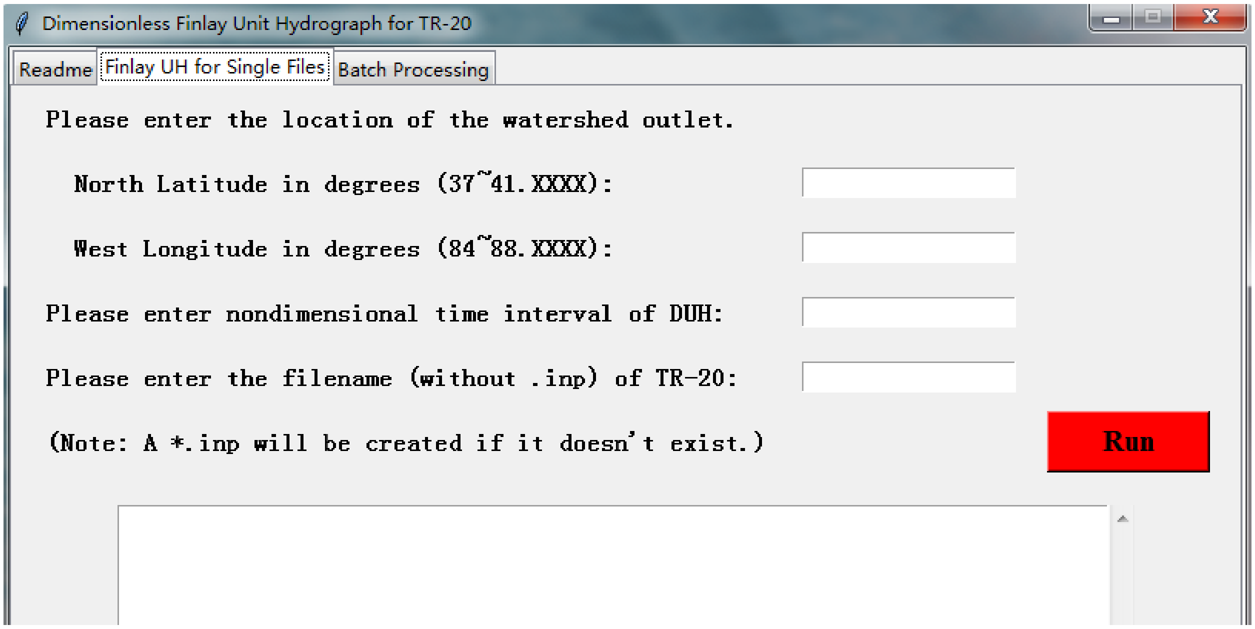
(b) File contents.

Figure A-6. Screenshots of TR-20 input files of INDOT.

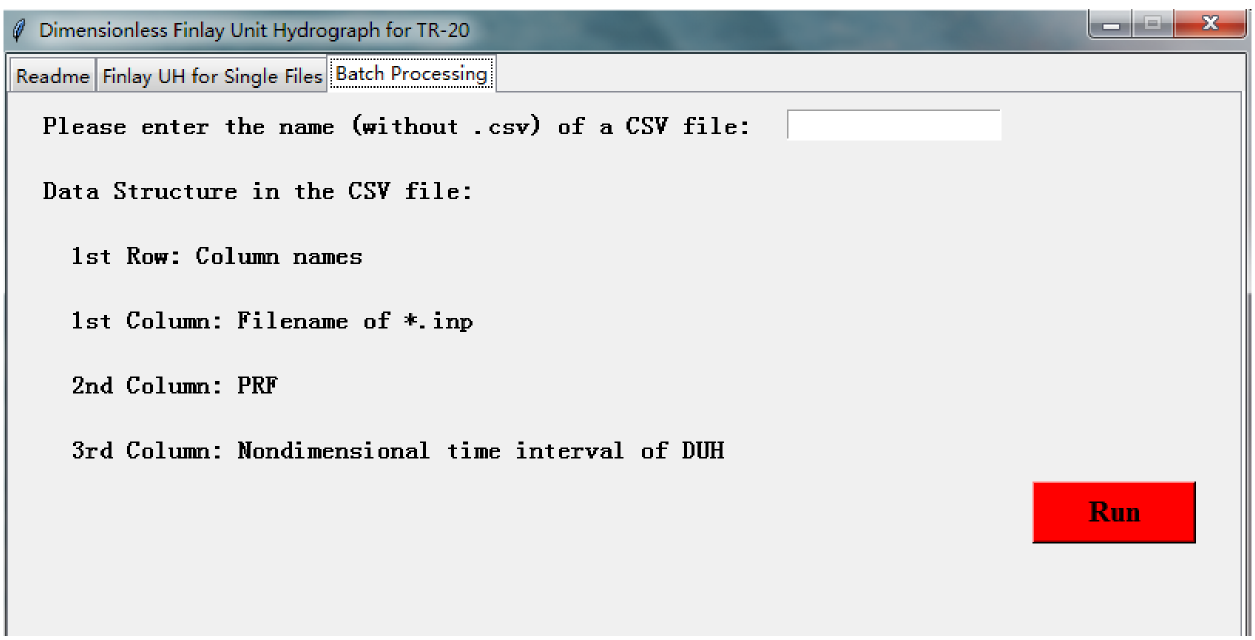
The GUI based on Python is a one-stop tool that consists of three tabs (see Figure A-7). In Tab 1, it is a Readme interface which is the same as that in the GUI based on Excel VBA. In Tab 2 (“Finlay UH for Single Files”) and Tab 3 (“Batch Processing”), users can estimate the Finlay UH parameters by entering the latitude and longitude of watershed outlets. And then users can get the ordinates of a dimensionless UH for one single TR-20 file and multiple files in Tabs 2 and 3, respectively, based on the estimated parameters and the given TR-20 filenames. A new TR-20 input file will be created if it does not exist in the working directory. Different from the GUI based on Excel VBA, users also need to enter the filename of a TR-20 file for single-file processing (see Figure A-7(b)) or the filename of a CSV file for batch (multiple-file) processing (see Figure 7(c)). After clicking on the “Run” button in Tab 2 or Tab 3, the GUI can help to insert the customized dimensionless UH coordinates into the TR-20 input files automatically rather than typing them into the cells manually (see Figure A-5(b)). Similarly, if users did not enter anything or the TR-20 file or the CSV file is not existing in the working directory, the GUI will pop up a message window to remind users to reenter the filename. If the input information is reasonable, the GUI will output the dimensionless UH coordinates in the scrolled text window in Tab 2 as well as inserting into the TR-20 input files under the current directory. An example of processing a single TR-20 input file (*Adams.inp*) by using the GUI is shown in Figure A-8 and an example for batch processing is shown in Figure A-9.



(a) Tab 1 for readme interface.

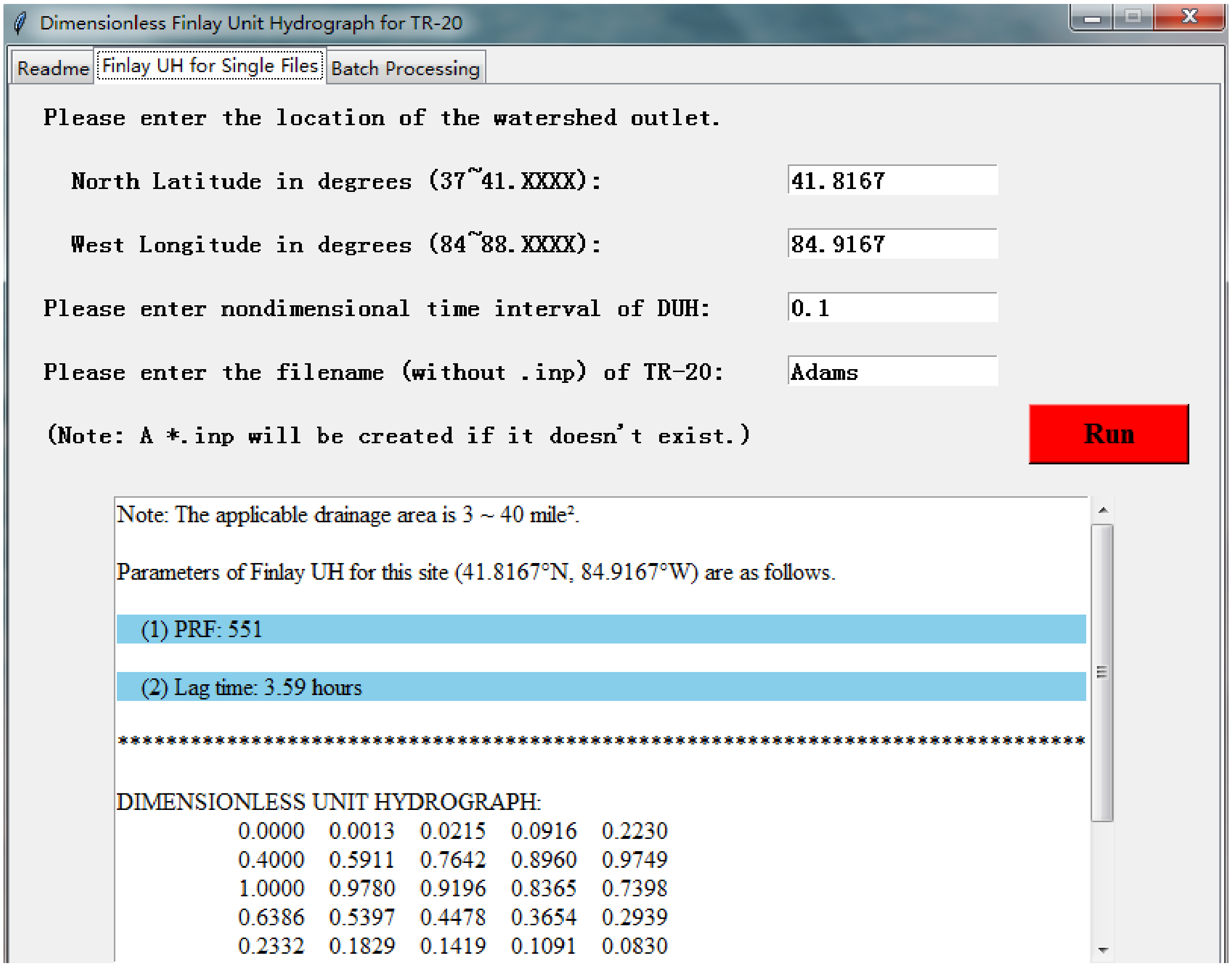


(b) Tab 2 for single-file processing.

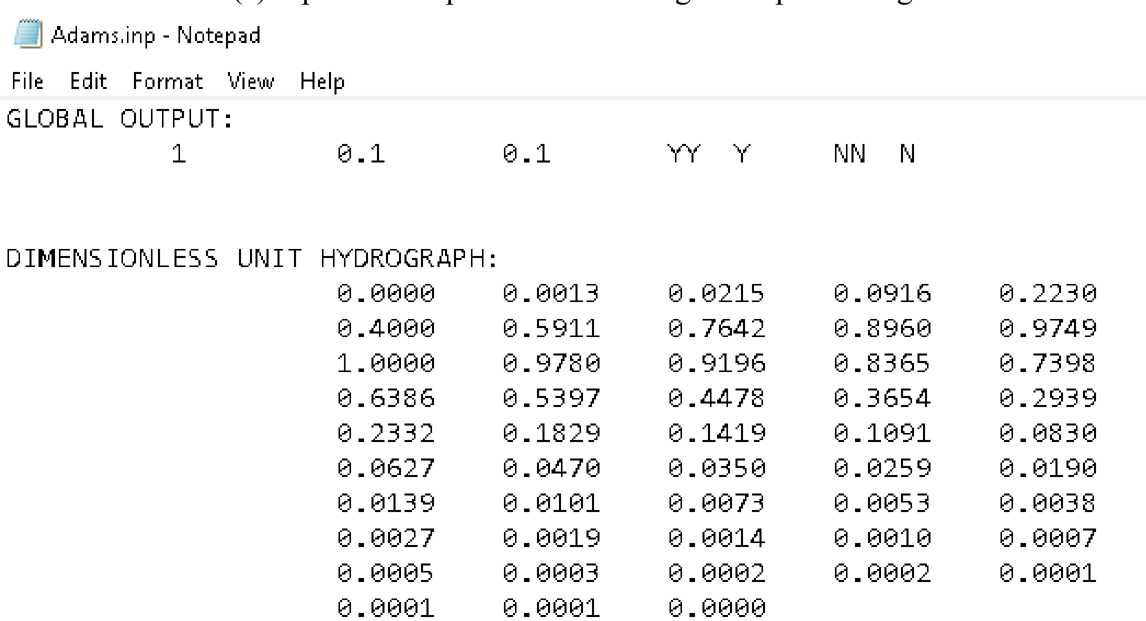


(c) Tab 3 for batch processing.

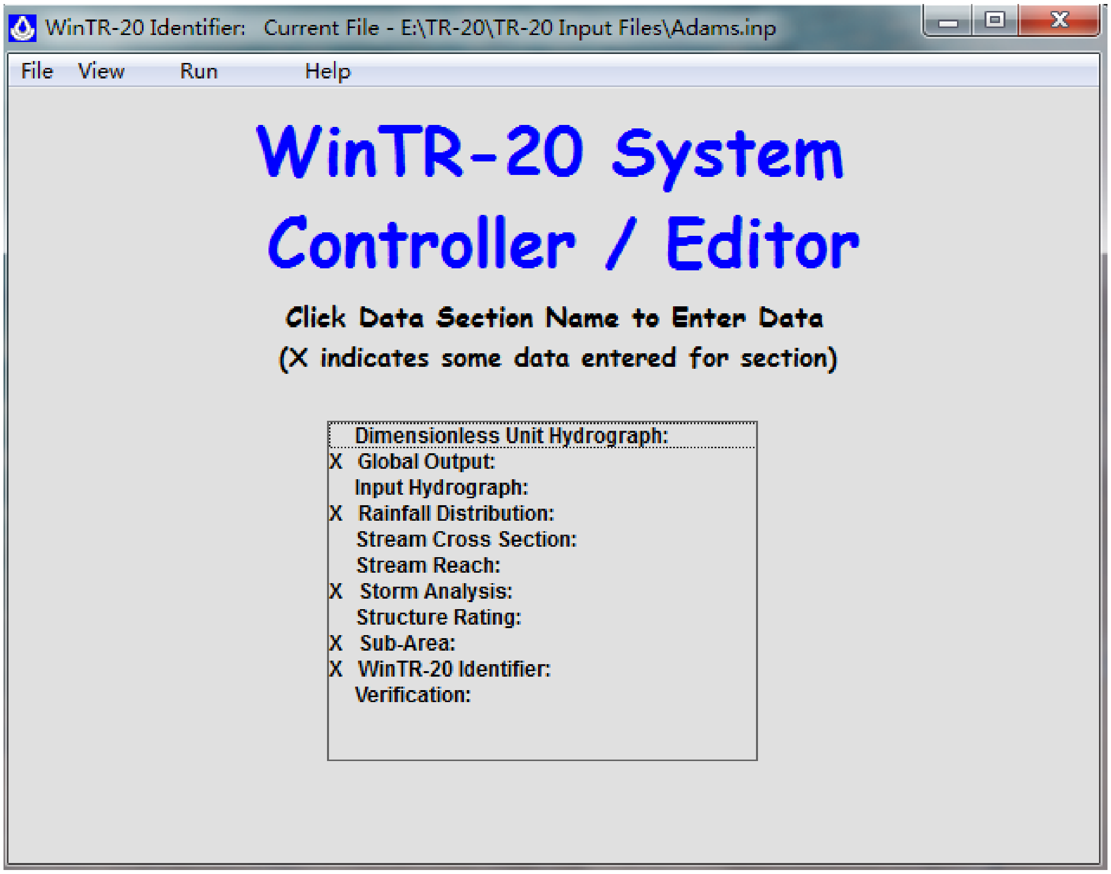
Figure A-7. GUI based on Python for generating dimensionless Finlay UH for TR-20 file.



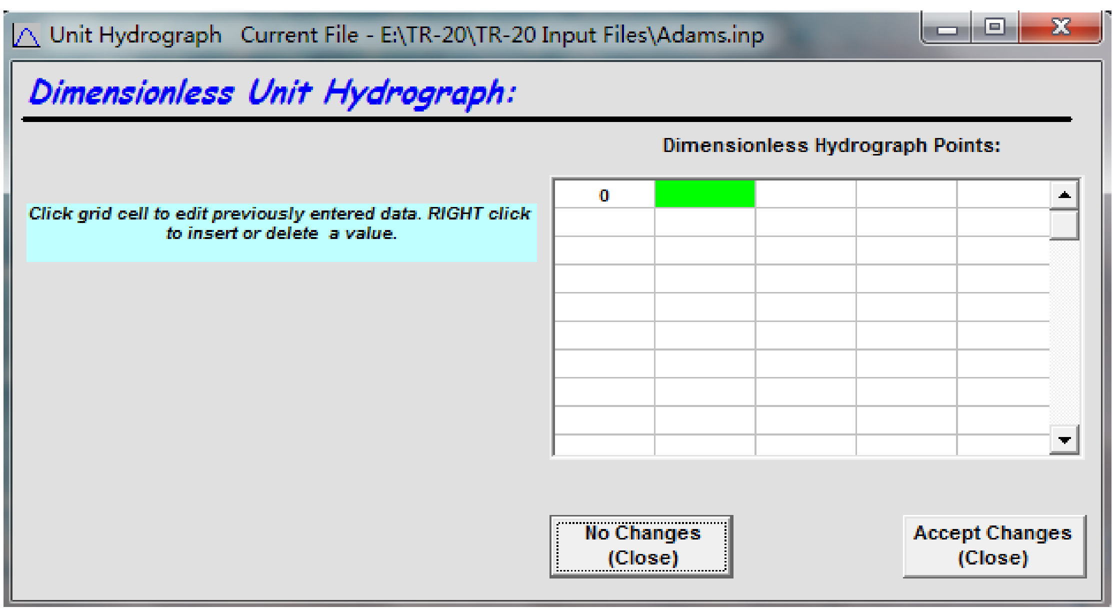
(a) Input and output in GUI for single-file processing.



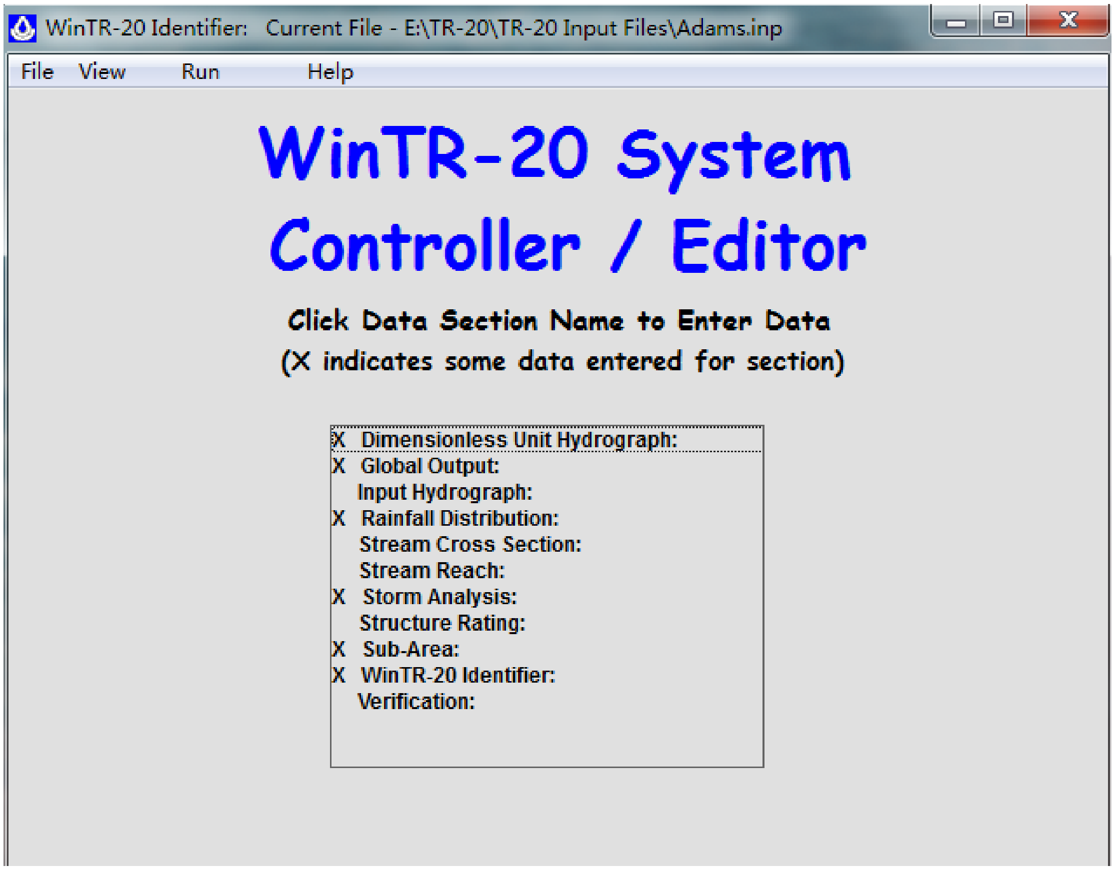
(b) Output of dimensionless UH coordinates in the TR-20 input file.



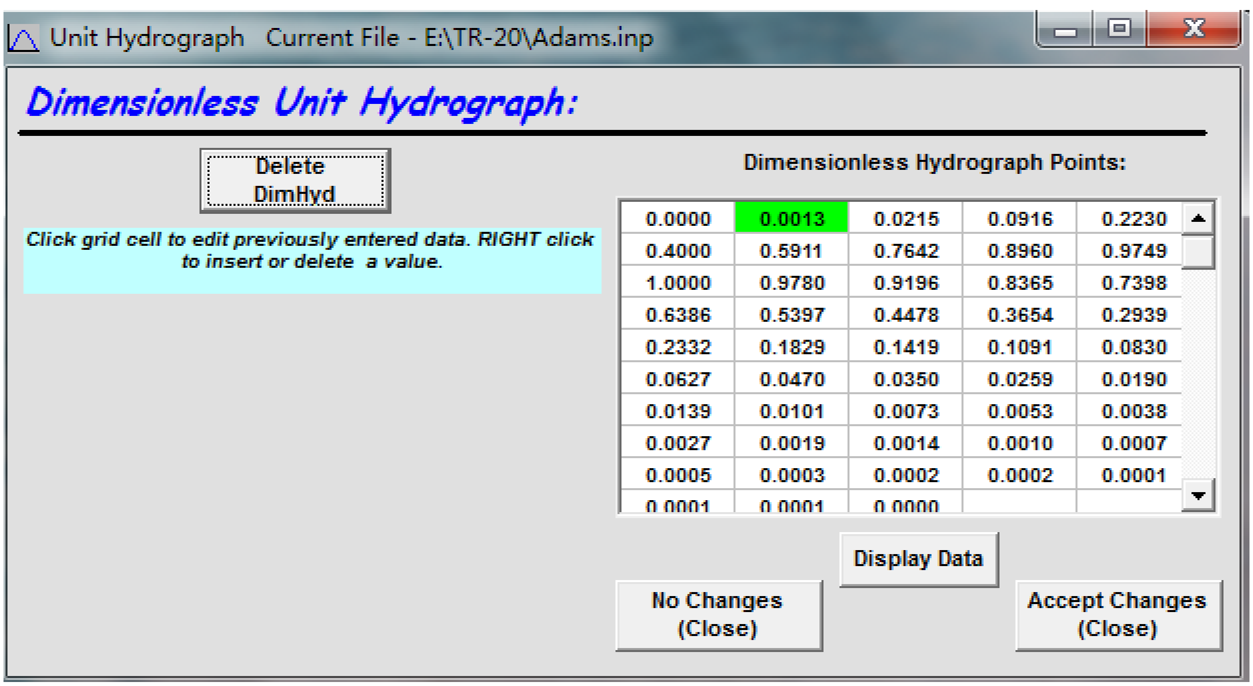
(c) Main menu of the original TR-20 file.



(d) Dimensionless UH window of the original TR-20 input file.

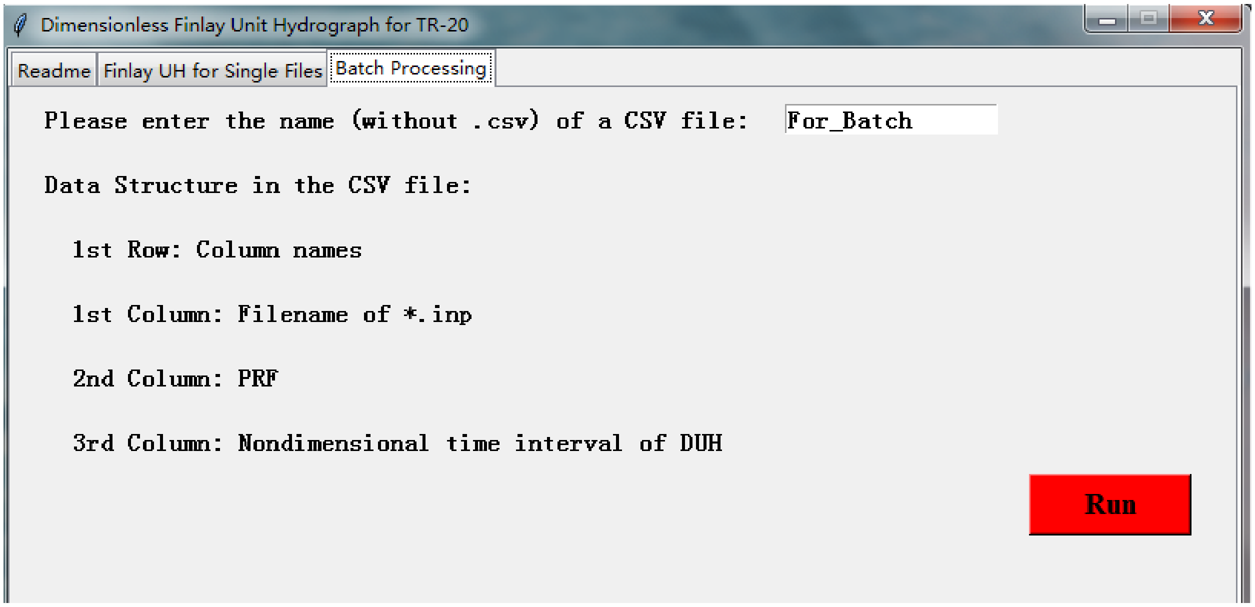


(e) Main menu of the modified TR-20 input file.



(f) Dimensionless UH window of the modified TR-20 input file.

Figure A-8. Example-1 for single-file processing (*Adams.inp*).



(a) Input in GUI for batch processing.

	A	B	C
1	**FileName (*.inp)**	**PRF**	**nondimensional time interval of DUH**
2	Adams	600	0.2
3	Allen	550	0.1
4	Bartholomew	500	0.05
5	Benton	450	0.1
6	Blackford	400	0.2

(b) Data structure of the CSV file (*For_Batch.csv*).

Figure A-9. Example-2 for batch processing.