# Catchment Attribute Allocation and Accumulation Tool
## CA$^3$T

**Background:**

The purpose of CA$^3$T is the integration of landscape attributes with the NHDPlus Catchments. CA$^3$T has two main functions: Allocation and Accumulation. The Allocation function takes a user-supplied raster dataset of one or more landscape attributes and allocates the attribute(s) to the NHDPlus Flowlines using the NHDPlus Catchments. The Accumulation function builds, for each NHDPlus Flowline, the upstream accumulated values for the allocated attributes. An example of landscape attributes that have been allocated and accumulated are the National Land Cover Dataset (NLCD) attributes that are included in NHDPlus. The NHDPlus table called CatchmentAttributesNLCD is the result of an allocation process and contains the percent of each NLCD land cover category found in each NHDPlus Catchment. The NHDPlus table called FlowlineAttributesNLCD is the result of an accumulation process and contains the percent of each NLCD land cover category that is in the area that is upstream of (i.e. drains to) each NHDPlus Flowline.

Additional information about NHDPlus is available at http://www.horizon-systems.com\nhdplus.

**CA3T Initialization File:**

An initialization file (CA3T.ini) is used by the CA3T during processing. It is also used to save values entered by the user. Some of these parameters are set during program installation, some are set during the first execution of CA3T and still others are set each time CA3T is executed. If CA3T is not running properly, use a text editor (such as Notepad) to check that the following parameters are set properly.

ApplicationDataPath= <path to the NHDPlus Tools Application data on the local harddisk>
　　This parameter holds the location of NHDPlus Tools Application data and is required. The NHDPlus Tools Application data must be installed for CA3T to work. The data is found, along with the CA3T installation package, on the NHDPlus Tools page. The data must be downloaded and uncompressed to the local harddisk. Uncompressing the data creates a folder called "\NHDPlusAppData". This parameter in the CA3T.ini file must point to that folder on the local harddisk. Upon the first execution of CA3T, the user is prompted to point to this folder on the local harddisk. This parameter should only be changed if the NHDPlus Tools Application data is moved. **The path/folder names should not contain spaces.**

NHDPlusPath= <path to NHDPlus data on the local harddisk>
　　This parameter holds the location of NHDPlus data and is required. The NHDPlus data for each hydrologic region to be processed must be installed for CA3T to work. The data is found on the NHDPlus web page. The NHDPlus data must be downloaded and uncompressed to the local harddisk. A single folder should be created to hold all hydrologic regions of NHDPlus data (e.g. \NHDPlusData). All NHDPlus data zip files should be uncompressed into that single folder. Once the NHDPlus data is uncompressed, there will be sub-folders called "\NHDPlusrr" for each hydrologic region (rr). Upon the first execution of

CA3T, the user is prompted to high level folder that holds all the NHDPlus data (e.g. \NHDPlusData). This parameter should only be changed if the NHDPlus data is moved. **The path/folder names should not contain spaces.**This is set during installation and should only be changed if the data is moved. **The path/folder names should not contain spaces.**

TempWorkAreaPath=<path to a temporary work area on local harddisk>
This parameter points to a temporary work area on the local harddisk that CA3T will use during processing. After a successful run, CA3T deletes the potentially large amount of data placed in this folder. The user must have write privileges for this folder. It is recommended that you create a dedicated folder for this purpose rather than use one of the default system folders (e.g., C:\NHDPlusToolsWork). **The path/folder names should not contain spaces.**

**System Requirements:**
CA3T requires the following software and datasets
ArcGIS 9.2 or 9.3 and the Spatial Analyst extension, Service Pack 3 or higher
.Net Framework version 2.0 (See know issues below)

All NHDPlus datasets, except the elevation grids are required for NHDPlus region being used in CA3T.

NHDPlus Tools Application Data - this dataset is available for download from the NHDPlus web site at: http://www.horizon-systems.com/NHDPlus/tools.php. It is a self-extracting zip file.

**Navigating the CA³T User Interface:**

The main screen of CA³T presents six functions:

- **About** – contains version and other basic information about CA³T. This information is displayed when CA³T is first started and each time the "About" button is clicked.
- **Allocate** – starts the user interface for entering inputs and performing the Allocation function.
- **Append Allocations** – starts the user interface for entering inputs and performing the function to combine allocation files into a drainage area allocation file.
- **Accumulate** – starts the user interface for entering inputs and performing the Accumulation function.
- **Delete Log** – deletes the cumulative log where CA³T writes status messages. The log is stored in the directory where CA³T is installed and contains important information in the event that CA³T fails.
- **Help** – displays this help document.
- **Quit** – terminates CA³T.

**Running CA³T Allocate:**

After clicking the "Allocate" button, the user input form for the allocation function is displayed (see Figure 1).
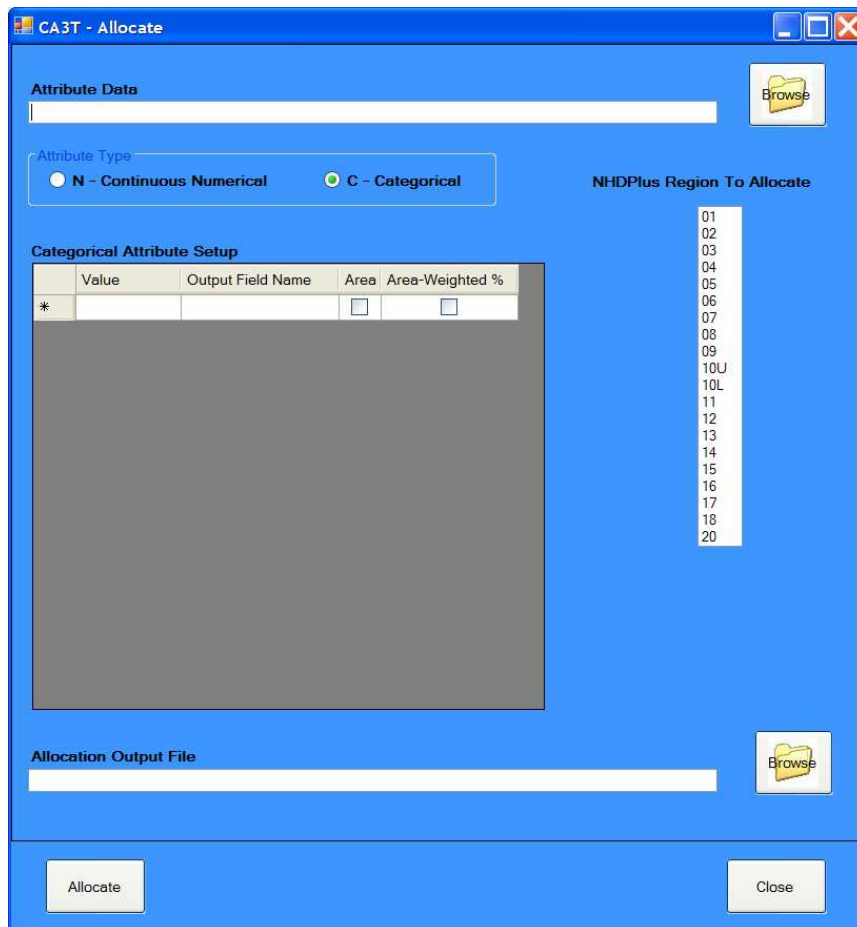
Figure 1:  Allocate Function User Interface

To perform allocation, six pieces of information must be entered for the allocation function:

- **Attribute File:**  Specify the full path and filename of the user-supplied input attribute file.  This file must be an ESRI grid in National Albers projection.  Cell size of 30 meters is recommended.  The grid should be built using a snap raster of the NHDPlus cat grid.

- **Attribute Type:**  Specify whether the grid to be allocated contains a continuous numerical attribute or a categorical attribute.  A continuous numerical attribute contains values that represent measurements of a single type of information (e.g. elevation, precipitation).  In a categorical attribute, each unique value represents a category code (e.g. land use categories or crop categories).

- **Continuous Attribute Setup:**  When the Attribute data is continuous, the setup form will look like figure 1a.  Specify an output field name of 1-to-8 characters, beginning with a letter.  These field names will be used for the attributes in the allocation output file.  Use checkmarks to choose one or more output value types:

- Average value (V)
- Maximum value (X)
- Minimum value (N)
- Simple sum of values (S)



Figure 1a

- **Categorical Attribute Setup:** When the Attribute data is categorical, the setup form will look like figure 1b. For each category, specify an output field name of 1-to-8 characters, beginning with a letter. These field names will be used for the attributes in the allocation output file. Use checkmarks to choose one or both of the output value types:
  - Area for category value (A)
  - Area-weighted percent for category value (P)

Figure 1b

- **NHDPlus Region to Allocate:** Specify the NHDPlus "region" (01, 02, 03, 04, 05, 06, 07, 08, 09, 10L, 10U, 11, 12, 13, 14, 15, 16, 17, 18, or 20) for the data contained in the Attribute File. If the intent is to perform allocation and accumulation in the Mississippi River or Colorado River drainage areas, perform the Allocate function separately for each region in the drainage area. If input attribute data is unavailable for a particular region, that region may be skipped and a missing data allocation for that region may be added with the "Append Allocations" function.

- **Allocation File:** Specify the full path and filename to hold the resulting allocated attribute values. When Allocate completes its work, this file will contain a record for each NHD Flowline (with known flow direction) in the NHDPlus Region selected. The record will contain each of the chosen allocation attribute output value types. The Allocation File obeys the format rules for "Pivoted Format with Hydroseq Numbers" provided below.

When all the inputs have been specified, click the "Run Allocation" button and the CA$^3$T allocation process will be executed.

**Running CA$^3$T Append Allocations:**

This function builds an appended allocation file from a set of regional allocation files. The purpose of Append Allocations is to create an allocation file that contains the entire upstream

drainage for an NHDPlus region to be accumulated with the CA³T Accumulation function. Appending is only required prior to performing accumulations in the two drainage areas that contain multiple NHDPlus Regions: the Mississippi River (regions 03, 05, 06, 07, 08, 10L, 10U, and 11) and the Colorado River (regions 14 and 15). The regional allocation files to be appended may be allocation files created by the CA³T Allocation function or from another source. All files to be appended must obey the format rules for "Pivoted Format with Hydroseq Numbers" provided below.

The CA³T tool comes with Missing Data allocation files for the non-terminal NHDPlus regions in the Mississippi and Colorado drainages. The non-terminal NHDPlus regions are 05, 06, 07, 10L, 10U, 11, and 14. If there is no regional allocation file for one or more of these regions <u>and</u> an accurate accumulation of missing data areas is desired, these "Missing Data" allocation files should be appended along with the available regional allocation files. For example, if there are regional allocation files for NHDPlus regions 07 and 10L, these can be appended with a "Missing Data" allocation file for region 10U, thenwhen accumulation is run for either 07 or 10L, on the resulting appended file, the Missing Data areas will be accumulated properly.

After clicking the "Append Allocations" button, the user input form for this function is displayed (see Figure 2).
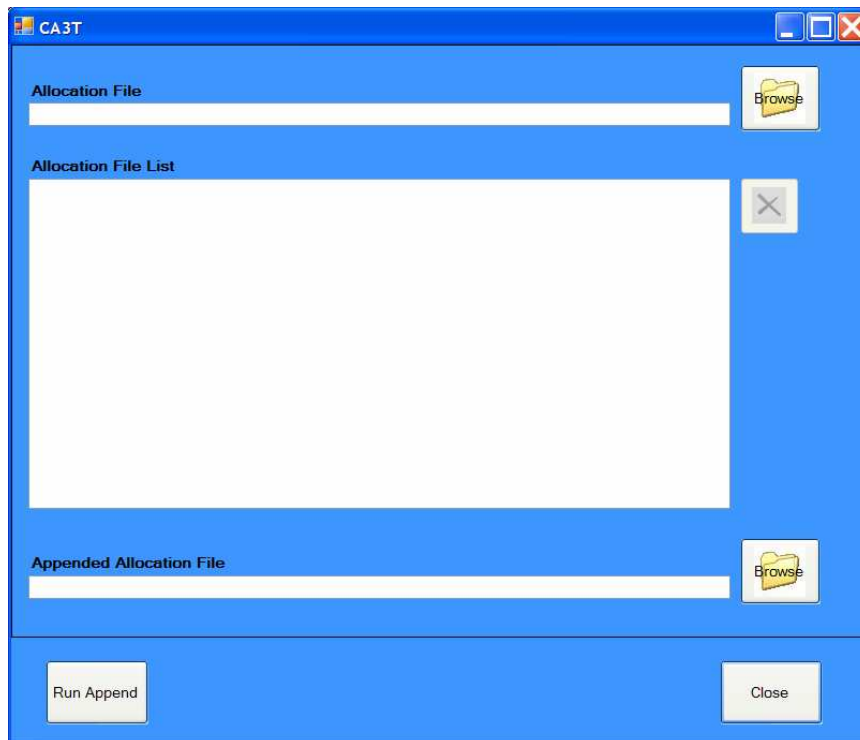


Figure 2:  Append Allocation Function User Interface

To use this function, the following must be entered:

- **Allocation File:** Specify the full path and filename of an input allocation attribute file that is to be appended. This will add the file to the **Allocation File List.** Allocation attribute files will generally be the output of the CA$^3$T Allocate function. However, a file of attributes tied to NHD Flowline/Catchment ComIDs that was created by another process may be used if it obeys the format rules for "Pivoted File Format with Hydroseq Numbers" provided below. Each file should contain the allocation attributes for one or more NHDPlus Regions. The MissingData allocation files that are distributed with CA$^3$T may be included in the file list to complete an upstream drainage area where no regional allocation files are available. The MissingData files can be found where the NHDPlus Tools Application Data is installed.

- **Appended Allocation File:** Specify the full path and filename where CA$^3$T is to place the appended output file.

When all the input files have been specified, click the **"Run Append" button** and the append process will be executed.

### Running CA$^3$T Accumulate:

After clicking the "Accumulate" button, the user input form for the accumulation function is displayed (see Figure 3).



Figure 3: Accumulate Function User Interface

To perform Accumulation, three pieces of information must be entered:

- **Allocation File:** Specify the full path and filename of the input allocated attribute file. This file will generally be the output of the CA$^3$T Allocate function. However, this file may be a file of attributes tied to NHD Flowline/Catchment ComIDs that was created by another process. If the file was not created by the CA$^3$T Allocate function, it must obey the format rules for "Pivoted Format with Hydroseq Numbers" provided below. Generally, the Allocation File should contain data for the NHDPlus Region to be

accumulated and for all NHDPlus Regions upstream. See the "Append Allocations" section.

- **NHDPlus Region:** Specify the NHDPlus region (01, 02, 03, 04, 05, 06, 07, 08, 09, 10L, 10U, 11, 12, 13, 14, 15, 16, 17, 18, or 20) for which attributes are to be accumulated. If the Allocated Attribute File does not contain complete data for this region and all upstream regions, the results of the accumulation may be incomplete. See the "Append Allocations" section.

- **Accumulation File:** Specify the full path and filename where CA³T is to place the accumulated attribute data. When CA³T completes its work, this file will contain a record for each NHD Flowline (with known flow direction) in the NHDPlus Region selected. The record will contain the attribute field for each attribute found in the Allocation File and each will be valued with an accumulation of that attribute from all upstream NHDPlus Flowlines.

When all the inputs have been specified, click the "Run Accumulation" button and the CA³T accumulation process will be executed. Accumulation can be a lengthy process and should be run on a workstation that can remain dedicated to the process until it is complete.

**Pivoted File Format with Hydroseq Numbers:**

The functions of CA³T either expect as input or create as output a file format known as "Pivoted with Hydroseq Numbers". The CA³T Allocate function creates a file in this format. The CA³T Append and Accumulate functions expect this file format as input and create a file in this format.

This format is a comma delimited text file with text data in double quotes. The file contains a header which describes the fields in the subsequent lines.

Header line will contain a list of fieldnames for the data in the file:

   ComID,MissDataA,<attrtype1>,<attrname1>,…,<attrtypeN>,<attrnameN>,hydroseq

Each line following the header line will contain actual data for a single NHDPlus Flowline/Catchment ComID:

   comid, missdataarea,attrvaltype1,attributevalue1, ..., attrvaltypeN,attributevalueN,hydroseq

The MissDataA field contains the total upstream area where there was missing data.

Attrvaltype is a coded attribute that tells what type of value is contained in the immediately following attribute. The valid codes for Attrvaltype are:

   A = value is an area in square kilometers
   P = value is an area-weighted percent
   X = value is a maximum
   N = value is a minimum

V = value is an average
S = value is a sum

Attributevalue contains the attribute value.

The Hydroseq field is the hydrologic sequence number of the NHD Flowline that can be found in the NHDFlowlineVAA field. In addition to containing this field, the records must be ordered descending by Hydroseq within each NHDPlus region. The NHDPlus regions may be in any order.