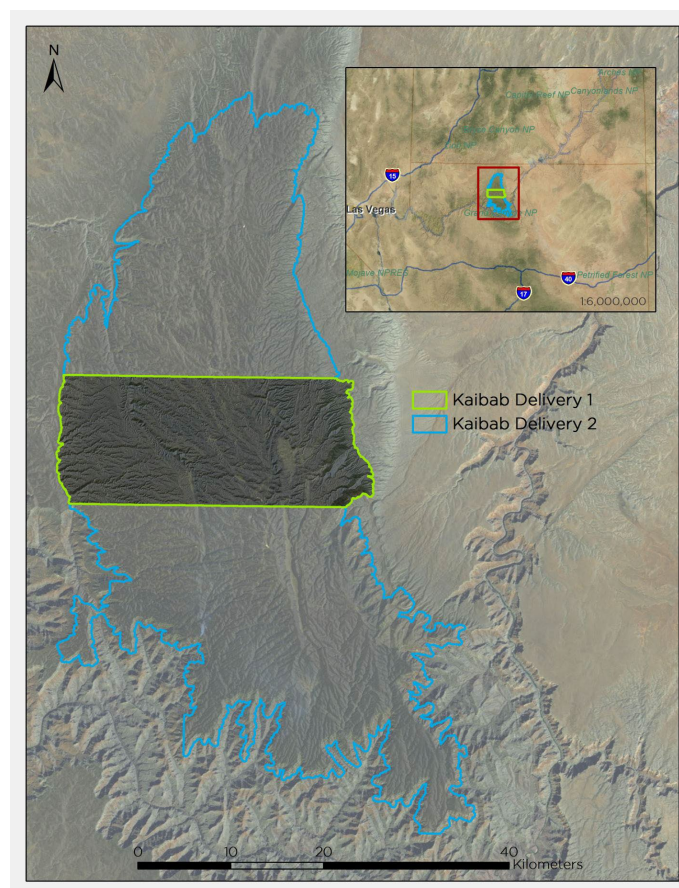


# EXERCISE 1

## Preparation for Processing Workflow



### Introduction

In this course, you will use a four-tile subset of the 1,359 lidar data tiles collected on the Kaibab National Forest, Arizona in August and September of 2012. In total, the two lidar acquisitions that comprise this area cover 457,925 acres. The goal of this course is for students to become familiar with processing lidar point cloud data in FUSION to produce common lidar derivatives such as canopy height, canopy cover and canopy density. This exercise is intended to prepare students for processing by providing detailed instructions on how to install and configure the necessary software, as well as acquainting them with the course data.

## Objectives

- The objective of this exercise is to prepare you for processing data from a large lidar acquisition. Specifically, you will download FUSION, change some settings on your computer and become familiar with the tutorial data.

## Required Data

- Project\_Home folder (~4 Gigs) -- This folder contains all the relevant data and the appropriate file structure that correlates to the processing workflow.

## Prerequisites

- It is highly recommended that you are efficient in using FUSION along with DOS to run FUSION command line executables. If you lack the recommended experience, you can access the “Introductory” FUSION tutorial at the following links:
  - Self-paced online tutorial found [here](#)
  - USDA Introduction to FUSION
    - [https://fsweb.gtac.fs.fed.us/training-site/tutorials/Introduction%20to%20FUSION/story\\_html5.html?lms=1](https://fsweb.gtac.fs.fed.us/training-site/tutorials/Introduction%20to%20FUSION/story_html5.html?lms=1)
- Required Software
  - FUSION 4.2 download from <http://forsys.sefs.uw.edu/fusion/fusionlatest.html>
    - Note: The FUSION manual will be automatically downloaded with the software (c:\FUSION\doc\FUSION\_manual.pdf)
  - ArcGIS v10.0 or later
  - Windows/DOS
  - NotePad (or your preferred text editor—we recommend Notepad++)



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## Part 1: Install FUSION

The first step of this exercise is to download and install FUSION. You will need Help Desk to download both FUSION and GDAL. You can reach Help Desk at 866-945-1354 or <https://usdacts-rsso.fed.onbmc.com/rss/start#/catalog>.

### A. Navigate to FUSION Website

1. Have Help Desk go to the following link to open “The Latest Version” Fusion webpage:  
<http://forsys.cfr.washington.edu/fusion/fusionlatest.html>
2. Have Help Desk click the **Install file** hyperlink to download **fusionlatest.exe**.
  - i. Alternatively, if you happen have run elevated options or admin privileges, open File Explorer and navigate to your **Downloads** folder. Otherwise,
  - ii. Right click **fusionlatest.exe** and select **Run Elevated**. You will then be prompted to enter a brief explanation of why you need to install this software. Running this executable elevated will avoid the need for administrative privileges.
3. Have Help Desk follow the FUSION Setup instructions to install the software.
  - i. . The first screen of the **Fusion Setup** dialog will display.
  - ii. Keep the default installation Components and click **Next >**.
  - iii. Keep the default Install Location and click **Next >**.
  - iv. And, keep the defaults for the **Start Menu Folder** and click **Install**.
  - v. After the installation completes, click **Close**.

## Part 2: Install GDAL

The Geospatial Data Abstraction Library (GDAL) is a library of software utilities for processing and translating between geospatial data types. You will not need to use GDAL for most FUSION tools, but the fourth exercise relies on GDAL for some processing tasks (converting ASCII to IMG). There are several characteristics of your computer that you need to be aware of before you can install GDAL. Section 4A provides instructions for identifying important information about your Windows 7 computer, while section 4B is for Windows 10. Help Desk will need to install GDAL.

### A. Windows 10 Instructions—Check Windows Architecture and C++ installation

1. Click the **Start** button and then click the **Settings** button at the bottom left that is marked by a gear symbol.
2. When the **Windows Settings** window opens, click **System**.
3. Next, click the **About** button at the bottom of the panel on the left.
4. In the window that opens look for **System type**. This will tell you if you have a 32 bit or 64 bit system. Make a note of this for later.
5. Next, you will want to check the latest C++ installation on your computer. In the Search dialog at the bottom left of your task bar, type in **Control Panel** and open it.
6. In the Control Panel, click **Programs** then click **Programs and Features**.

7. Scroll down in the list of installed programs that appears until you see the **Microsoft Visual C++** installations. There will likely be several of these, followed by the years the software was written. Make a note of the latest Microsoft Visual C++ you have installed.

## B. Install GDAL

1. There are a number of different places you can install GDAL from. One useful place is [gisinternals.com](http://www.gisinternals.com). Have Help Desk navigate to: <http://www.gisinternals.com/release.php>
  - i. In the webpage there will be a table with the columns Compiler and Arch. The compiler column will have a year and the Arch column will show an architecture type.
2. Click on the link in the downloads column that corresponds to the architecture type of your computer from Section A/B and the latest year that doesn't exceed the year of your latest C++ installation.
3. The image below shows the versions you should choose from if you have a 64 bit architecture and an installation of C++ from 20xx. Choose 2017 or 15 based on what you found in the previous steps.

**Stable Releases**

The following packages are compiled based on packages based on the latest official releases of MapServer and GDAL. It is recommended for production environments.

**GDAL 3.0.0 and MapServer 7.4.0**

Compiler	Arch.	Downloads	Package Info	Date	Revisions
MSVC 2015	win32	<a href="#">release-1900-gdal-3-0-0-mapserver-7-4-0</a>	<a href="#">information</a>	2019-06-03 23:50:01	<a href="#">b5c26cc b2e5f04</a>
MSVC 2015	x64	<a href="#">release-1900-x64-gdal-3-0-0-mapserver-7-4-0</a>	<a href="#">information</a>	2019-06-03 22:27:04	<a href="#">b5c26cc b2e5f04</a>
MSVC 2017	win32	<a href="#">release-1911-gdal-3-0-0-mapserver-7-4-0</a>	<a href="#">information</a>	2019-06-04 22:20:55	<a href="#">b5c26cc b2e5f04</a>
MSVC 2017	x64	<a href="#">release-1911-x64-gdal-3-0-0-mapserver-7-4-0</a>	<a href="#">information</a>	2019-06-04 22:40:36	<a href="#">b5c26cc b2e5f04</a>

4. In the page that opens there are a number of files that you can download. Find the one with the description: **Generic installer for the GDAL core components**. It will be a .MSI file. Click to download this.
5. When the file has downloaded, run the installer. If you do not have administrative privileges on your computer, navigate to your Downloads folder, have Help Desk run the installer with default settings and the **Typical** setup type.
  - i. You may keep the default settings and choose the **Typical** setup type.

## C. Connect GDAL with FUSION

1. Open **File Explorer**
2. Navigate to where your FUSION installation was saved (C:\FUSION).
3. Open the Folder **APScripts**, then **ComputerSpecific**.
4. There you will see the file **GDALconfig.bat**. Right-click on the file and click **Edit** (edit with Notepad++ if you have that installed). The file will open in notepad.
5. On line 6 you need to make sure the .bat file is pointing to the **gdal\_translate** utility. This is an executable that exists where you installed GDAL in section B. The file is commonly located at C:\Program Files\GDAL\gdal\_translate. If you don't see the .exe file there you can try searching for it in File Explorer. When you add the path to the GDALconfig.bat file, you do not need the .exe extension on the file.
6. On line 10, make sure the path to the **gdal-data** folder you installed in section C is correct. If you aren't sure where the gdal-data folder was placed, you can search for it in File Explorer.

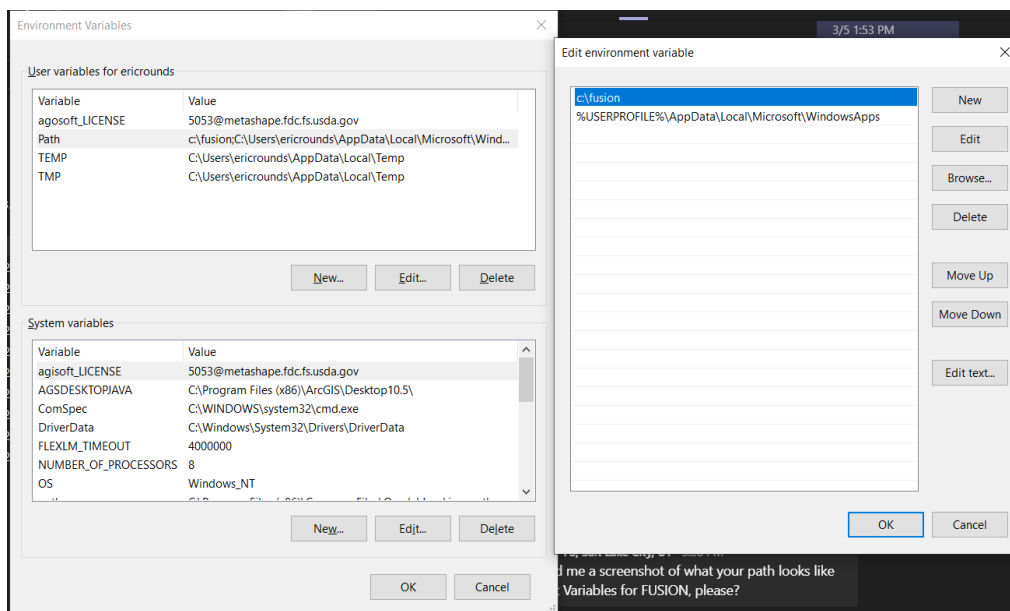
7. Click **File** then **Save**.
8. Close GDALconfig.bat. You should not need to open that file ever again!

## Part 3: Edit Environmental Variables

Once FUSION is installed, we will need to make some adjustments to our computer to make it easier to perform our analyses. When you have completed this section, you will be able to run FUSION command line functions from any directory on your computer. This is a huge advantage when processing large lidar acquisitions.

### A. Open and Edit Environmental Variables

1. In the Search bar at the bottom of your Windows 10 computer, type in **Environmental Variables** and select **Edit environmental variables for your account**.
2. In the **Environmental Variables** dialog box, click **New** under the User variables section.
3. In the **New User Variable** dialog box that opens, name the variable name **Path**, enter **C:\FUSION** as the Variable value and then click **OK** (see following graphic).
  - i. You are providing the path of the FUSION software so that your computer will know where all the FUSION executables are located.



4. Click **OK** in the remaining dialog boxes to close them and retain the edit. Now let's quickly test the new environmental variable.

### B. Test Environmental Variables

1. Now let's quickly test the new environmental variable. Open a Command Prompt by typing **Command Prompt** into the **Search** window on the taskbar at the bottom of your screen.
2. In the command prompt, type **catalog** and press **Enter**.
  - i. You should now see a description of the FUSION command line executable "catalog.exe".



```

Select Command Prompt
Microsoft Windows [Version 10.0.18362.239]
(c) 2019 Microsoft Corporation. All rights reserved.

C:\Users\ericrounds>catalog
Catalog v2.35 (FUSION v3.80) (Built on Aug  6 2018 10:55:46) DEBUG
--Robert J. McGaughey--USDA Forest Service--Pacific Northwest Research Station
Prepares a report describing a LIDAR dataset and optionally indexes all data
file for use in FUSION

Syntax: Catalog [switches] DataFile [CatalogFile]
DataFile      LIDAR data file template or name of a text file containing a list
               of file names (must have .txt extension)
CatalogFile   Base name for the output catalog file (extensions will be added)

Switches:
Switches are preceded by a "/". If a switch has multiple parameters after
the ":", they should be separated by a single comma with no spaces before
or after the comma.

interactive   Present a dialog-based interface
quiet         Suppress all output during the run
verbose       Display all status information during the run
version       Report version information and exit with no processing
newlog        Erase the existing log file and start a new log
log:name      Use the name specified for the log file
locale        Adjust program logic to input and output locale-specific numeric
               formats (e.g. use a comma for the decimal separator)
nolaszipdll   suppress the use of the LASzip dll (c) Martin Isenburg...
               removes support for compressed LAS (LAZ) files. This option
               is only useful for programs that read or write point files.
  
```

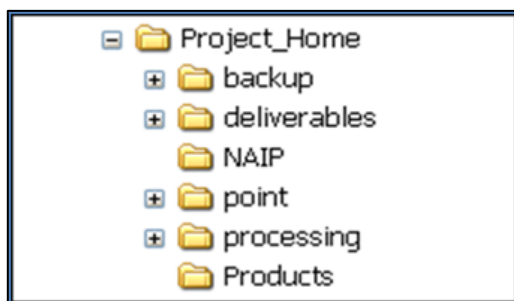
3. If the environmental variable was not set correctly, you will instead see a message saying that the command is not recognized. If this is the case, we recommend that you repeat the above steps and try again. If the issue persists, restart your computer and try again. If all else fails, contact the instructor (Shiona.howard@usda.gov).

## Part 4: Copy Tutorial Data to Your Computer

We recommend working with lidar data locally. Processing will be much quicker when you process it on a local hard drive, so we'll copy the Project\_Home folder to your C drive.

### A. Copy the Project\_Home folder to a root directory

1. Copy the Project\_Home folder to a root directory, such as C:\ or another local drive of your choice. The example scripts, provided to you in the processing batch files, will be run from C:\Project\_Home.
2. Once you have completely copied the Project\_Home folder and all its contents, open the folder in File Explorer.
3. You should now see five sub directories: **backup**, **deliverables**, **NAIP**, **point**, **processing** and **products** (see following graphic).



4. Take a few moments and explore the folders and their contents
  - i. Examine the contents of the folders in Project\_Home and become familiar with the folder structure.



5. The tutorial data folder “Project\_Home” contains approximately 4 gigabytes of data. The above file structure works well for our processing workflow. Take a moment to familiarize yourself with the folders and their content. Obviously, you can use any file structure you want to organize your lidar project data, but remember that the file paths in your batch files will need to reflect the file structure you choose.
6. The **backup** folder contains the resulting img layers from the final gridmetrics processing that you will create in exercise 4. Having this folder will allow you to explore them while you wait for the processing to complete.
7. The **deliverables** folder typically contains the point, raster and vector data you will receive from the lidar vendor. In this tutorial we have removed the point data and placed it in its own folder “point” to facilitate the workflow.
8. The **NAIP** folder contains a reference image for the study area so that you may view the data in FUSION in later exercises.
9. The **point** folder contains the raw lidar data (.las files) with index files (.ldi and .ldx) included to save you time. Generally you would have to create these with the catalog command.
10. The **processing** folder contains a batch file we will use for the processing. You will populate this folder with more batch files in later exercises.
11. The **products** folder will contain any new text files or layers that we create during the processing workflow.

## Part 5: Explore the lidar data tiling structure

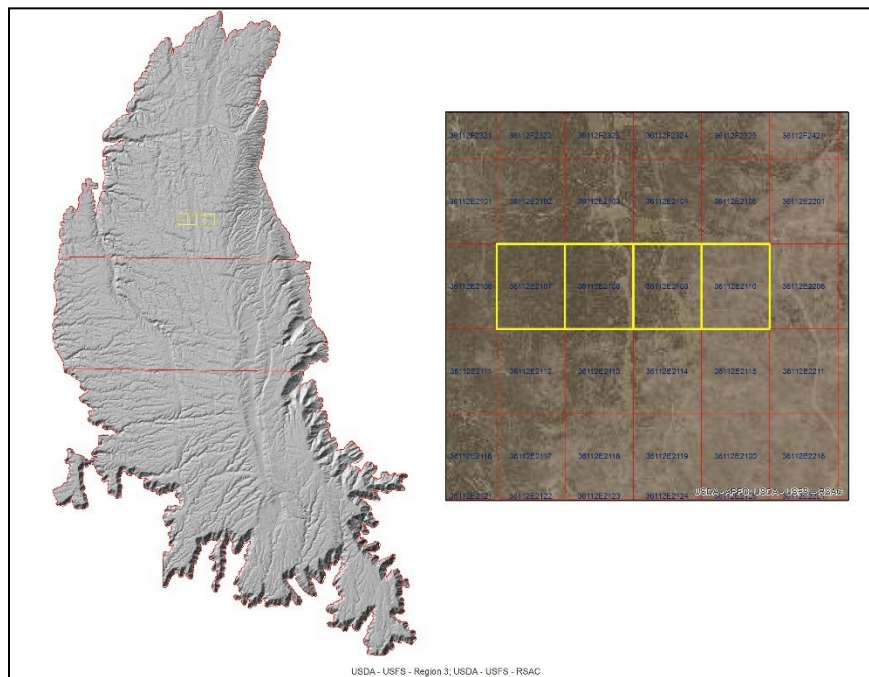
When you receive your lidar data it will most likely be provided to you in data tiles. Understanding how the lidar data tiles are organized will help you work with the data more efficiently. Let’s take a few moments and explore how the lidar data tiles are organized.

### A. View Tiling Structure in ArcMap

1. Open ArcMap.
2. Click the **Add Data** button. Then navigate to and load **tile-index.shp**. The file is included in the Project\_Home folder at the following path: `\Project_Home\deliverables\vector\tile-index.shp`.
3. Right click on **tile\_index** in the contents panel and select **Open Attribute Table**.
4. The column “**LAS\_ID**” essentially carries all the location information we need for each tile. Let’s interpret the Text value for the first tile in the attribute table. The text value in the first cell is **36112E3201**. This represents:
  - i. **36112E32** = DOQ Name (36 = latitude, 112 = longitude, and E3= Quad #)
  - ii. **E32** = Quarter Quad #
  - iii. **01** = Specific Tile (Each Quarter Quad is split into 25 tiles)
5. Close the attribute table for tile-index.shp. If you like, you can change the symbology for tile-index.shp to remove the fill color and choose a line color of your choice.
6. Navigate to and load **workshop-area.shp**. The file is included in the Project\_Home folder at the following path: `\Project_Home\deliverables\vector\workshop-area.shp`.
  - i. Workshop-area.shp denotes the area we have chosen to work with during this tutorial. You should notice it includes 4 tiles.

7. Navigate to and load **NAIP2015.tif** (C:\lidartraining\Project\_Home\NAIP). The file is a natural color NAIP image with 1/3 meter pixel resolution that covers a portion of the study area.

*We hope that by displaying this data together in ArcMAP (see examples in following graphic) you will get a better understanding for the scope of the overall acquisition and the terrain contained in the specific tiles we will work with in the subsequent exercises.*

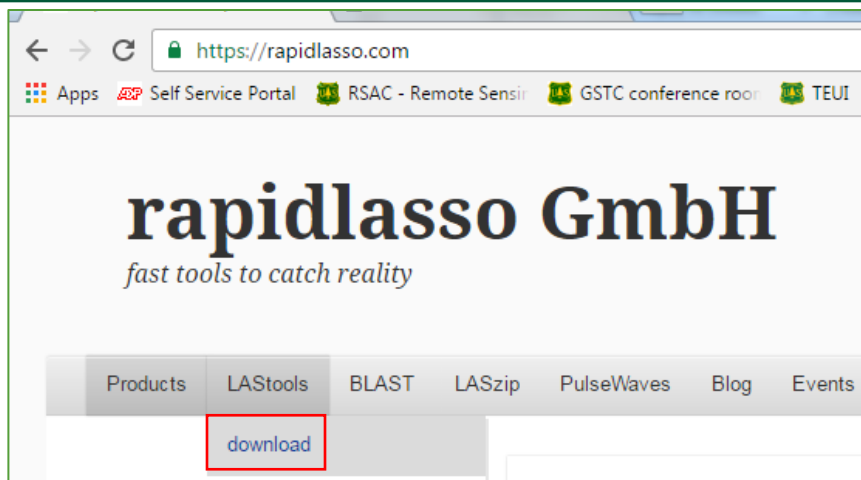


## Part 6: Download LAsTools

One great feature of FUSION and the AreaProcessor is that we can work with point cloud data in the zipped format (.laz), which conserves a lot of storage space. To take advantage of this capability, you will also need to download LAsTools and manually copy the **LASzip64.dll** file from the LAsTools folder into FUSION's install folder.

### A. Open a Browser

1. Connect to the LAsTools site: <https://rapidlasso.com>.
2. On the main menu, click **LAsTools** to open a drop down menu and then click **download** (see following graphic).



3. Unzip the downloaded file and navigate to **LAStools**, **LASzip**, and then **dll**.
4. Copy the **LASzip64.dll** file.
5. Navigate to the Fusion folder and paste the **LASzip64.dll** file in with the other executables.

> FUSION    Search FUSION

Name	Date modified	Type	Size
groundfilter64	6/16/2020 3:53 PM	Application	243 KB
Identify	6/16/2020 3:49 PM	Application	63 KB
imagecreate	6/16/2020 3:53 PM	Application	759 KB
imprtdem	1/29/2007 11:46 AM	Application	68 KB
IntensityImage	6/16/2020 3:49 PM	Application	684 KB
IntensityImage64	6/16/2020 3:49 PM	Application	793 KB
JoinDB	6/16/2020 3:49 PM	Application	67 KB
LASzip64.dll	9/29/2020 10:38 AM	Application extension	257 KB
LDA2ASCII	6/16/2020 4:06 PM	Application	95 KB
LDA2ASCII64	6/16/2020 4:06 PM	Application	114 KB
LDA2LAS	6/16/2020 3:50 PM	Application	121 KB

i.

## Part 7: Optional—Create shortcuts for FUSION executables and associated tools.

As you start to process large amounts of lidar point data you will use specific tools repeatedly. It may save you time if you create desktop shortcuts for these tools.

### A. Fusion Shortcuts

1. Navigate to the FUSION directory (most commonly C:\FUSION).
2. Copy and Paste the following executables to your desktop:
  - i. **Fusion.exe**—startup for FUSION software.
  - ii. **DTMHeader.exe**—provides a quick means to examine and modify PLANS DTM file header information.

**Note:** Some FUSION tools, such as AreaProcessor, which you will learn about in exercise 4, reference other tools in the FUSION folder in your C:\ drive. Because of this, you must copy all of the tools it references to your desktop as well, otherwise the tool will error. It is not recommended that you make a desktop shortcut for AreaProcessor.

i. Create a shortcut on your desktop for Notepad or your preferred text editor.

## B. Create a desktop shortcut for the Command Prompt by following these steps:

1. Right click on your desktop. Select **New** and then **Shortcut** from the drop-down menus.
2. In the Create Shortcut Wizard, Click the **Browse...** button.
3. Navigate thru the following directory structure: **My Computer, C:\, WINDOWS, system32, cmd.exe.**
4. Select **cmd.exe** and click **OK**.
5. Click **Next** in the Create Shortcut Wizard.
6. Type a name of your choice and click **Finish**.
7. Open the Command Prompt by right clicking the shortcut and choosing “**run as administrator**”. This should be done to ensure FUSION has the access it needs to run freely on your computer. **If you don’t have admin rights then choose “run elevated”.**

**Congratulations!** You have successfully completed this exercise. You now have your computer set up so that you can begin processing the lidar point cloud.