



**Food and Agriculture  
Organization of the  
United Nations**



# **Strengthening Agro-climatic Monitoring and Information Systems (SAMIS) to improve adaptation to climate change and food security in LAO PDR (GCP/LAO/021/LDF)**

## **ArcGIS training materials**









**Strengthening Agro-climatic Monitoring and Information Systems (SAMIS)  
to improve adaptation to climate change and food security in the Lao  
People's Democratic Republic  
(GCP/LAO/021/LDF)**

**ArcGIS training materials**

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# Introducing GIS

A first look into the concepts that comprise  
a Geographic Information System



Dr. Kavinda Gunasekara  
Frank Yrle

Strengthening Agro-climatic Monitoring and Information Systems (SAMIS)  
to improve adaptation to climate change and food security in Lao PDR

## Overview

Learning GIS Fundamentals

1. Who uses GIS?
2. How layers work in a GIS
3. GIS **features** & **surfaces**
4. Spatial relationships in GIS



# GIS – Geographic Information Systems

## Definition

(def) A geographic information system (GIS) captures, stores, analyzes, manages, and presents data that is linked to locations.

GIS is a set of tools that allow for the processing of spatial data into information.

A good GIS should answer the following questions:

**Location – *Where is it?***

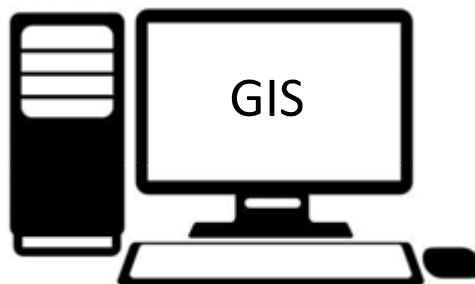
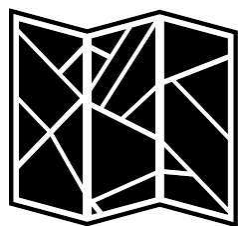
**Condition – *What if?***

**Trends – *What has changed since?***

**Relations – *Which data are related?***

## Synthesis of Different Data Sources

All exist in one system

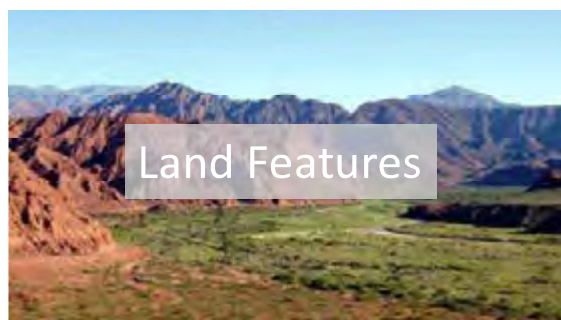
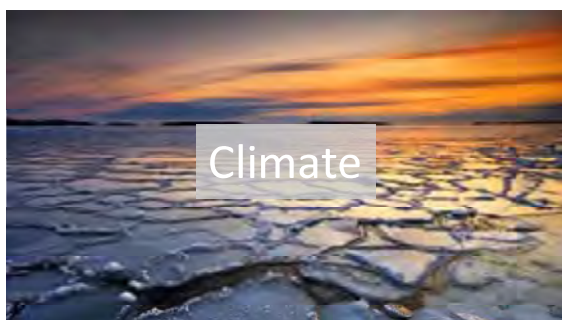


- ✓ Analysis
- ✓ Map the Results
- ✓ Store & Share Data



## Applications of GIS

Many disciplines use GIS



## Examples of Maps possible with GIS



*Analysis of the effects of land use change on protected areas in the Philippines, 2006*

### Land Use Change

- Tracking how land is used with time series image analysis

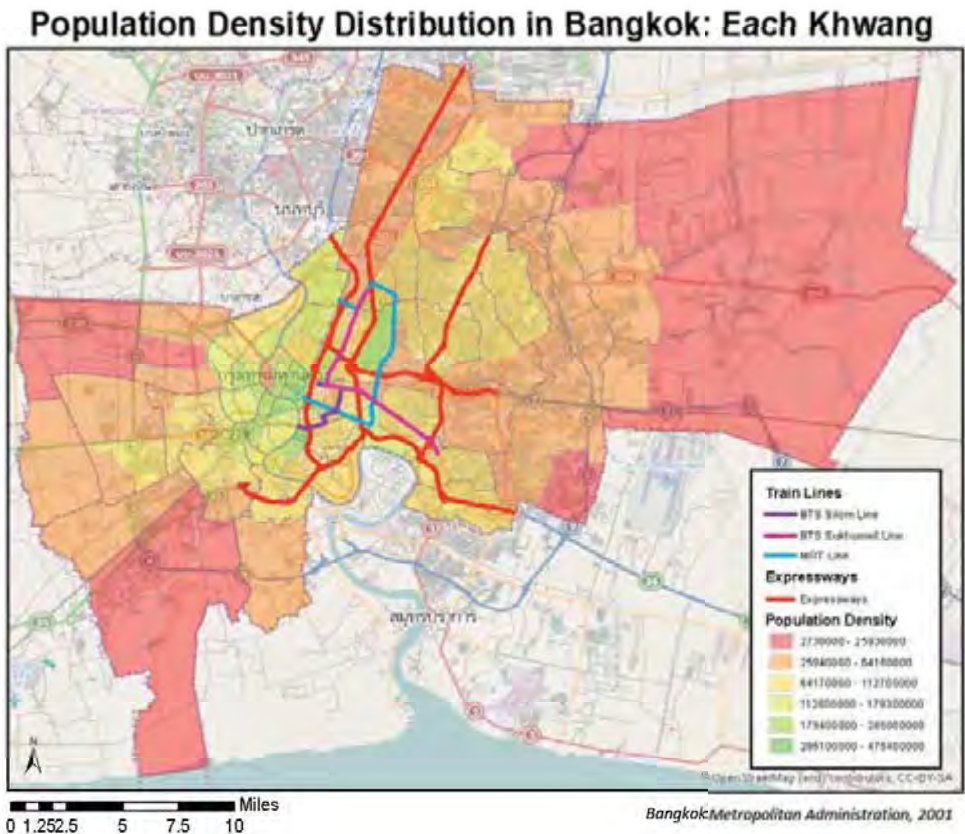




## Population Density

- Distribution of people in relation to area

Ex: Countries, provinces,  
districts, sub-districts,  
cities, etc.

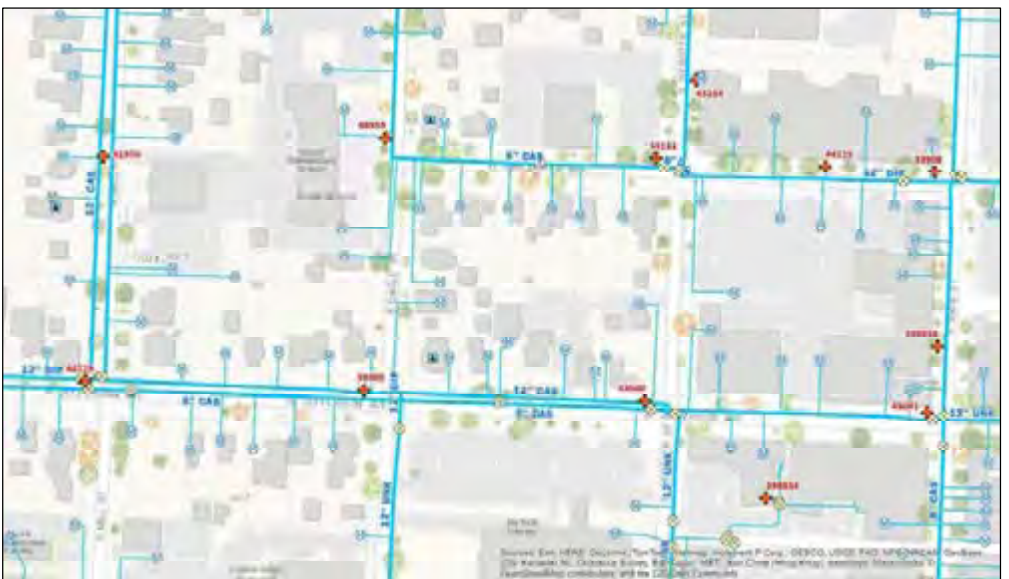


5

## Utility Management

- Coordinate, map, & manage, repairs

Ex: Water pipes,  
electricity infrastructure



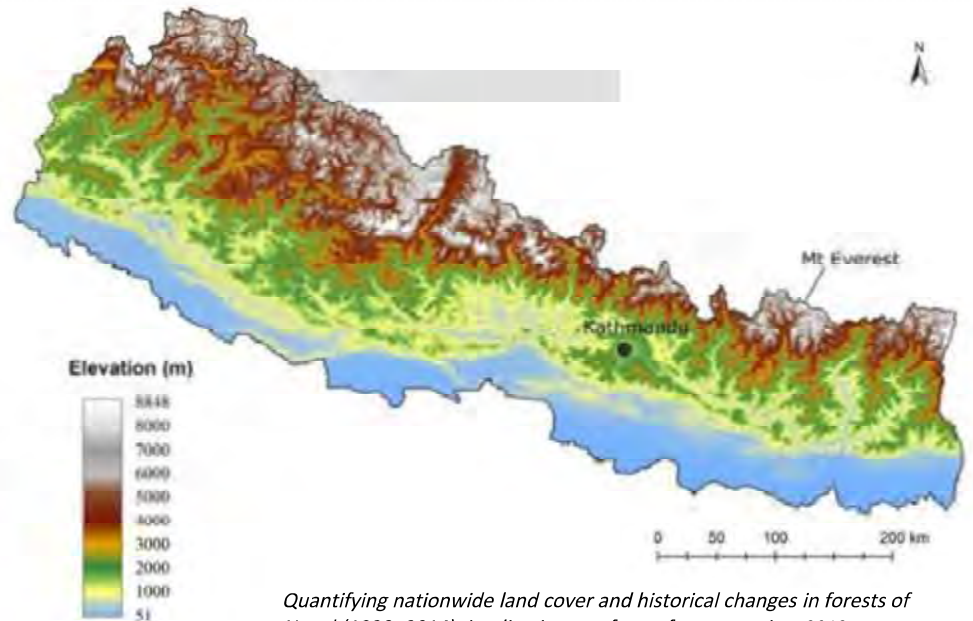
*Naperville, Illinois, United States.*  
2019



## Examples of Maps possible with GIS

### Elevation Map

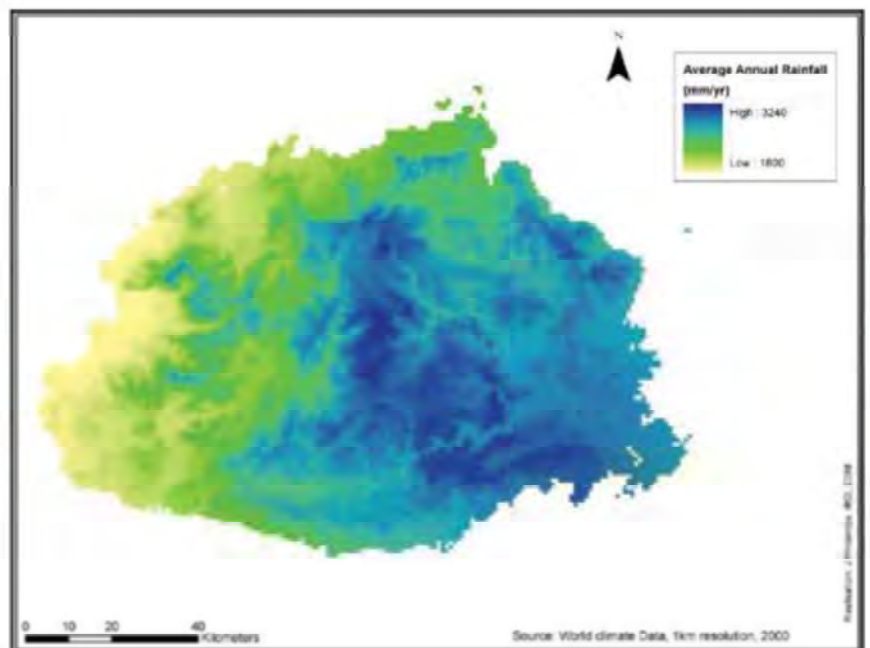
- Elevation of Earth features



## Examples of Maps possible with GIS

### Precipitation Map

- Amount of rainfall received over an area





## Examples of Maps possible with GIS

### Rescue Operations

- Planning for Thai cave rescue mission 2018



Planning for Thai cave rescue mission, 2018

ESRI Thailand

- Cave interior route & features
- Extent & direction of water flow



Figure 4. Land suitability map for ecotourism in Surat Thani province [34].

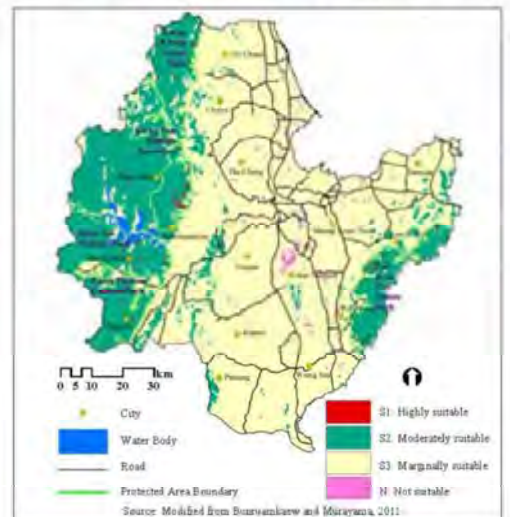


Figure 2. Classified land use/cover (LUC) map of Surat Thani province in 2007.

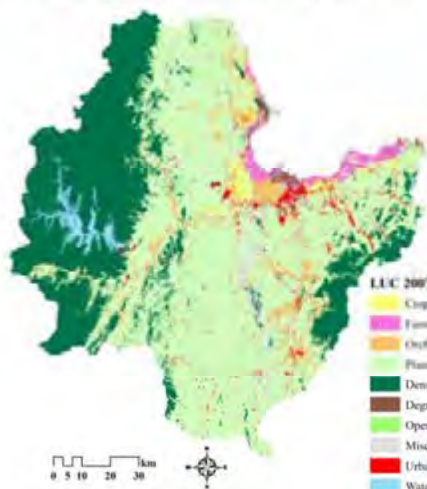


Table 1. Area coverage of land use/cover change (LUCC) classes in 2007.

LUC Type	Area (ha)	Proportion (%)
Crop Land (AC)	24,793.02	1.98
Farm Land (AF)	18,050.94	1.44
Orchard (AO)	43,688.62	3.49
Plantation (AP)	665,634.10	53.21
Dense Forest (F)	381,372.70	30.49
Degraded Forest (FD)	8,893.26	0.71
Open Forest (FO)	825.03	0.07
Miscellaneous Land (M)	45,822.42	3.66
Urban & Built-up Land (U)	33,064.38	2.64
Water Body (W)	28,813.14	2.30
<b>Total area</b>	<b>1,250,957.61</b>	<b>100.00</b>

LUC 2007  
 Crop Land (AC)  
 Farm Land (AF)  
 Orchard (AO)  
 Plantation (AP)  
 Dense Forest (F)  
 Degraded Forest (FD)  
 Open Forest (FO)  
 Miscellaneous Land (M)  
 Urban & Built-up Land (U)  
 Water Body (W)

Land Use and Natural Resources Planning  
 for Sustainable Ecotourism, 2012

Bunruamkaew & Murayama,  
 GIS in Surat Thani, Thailand

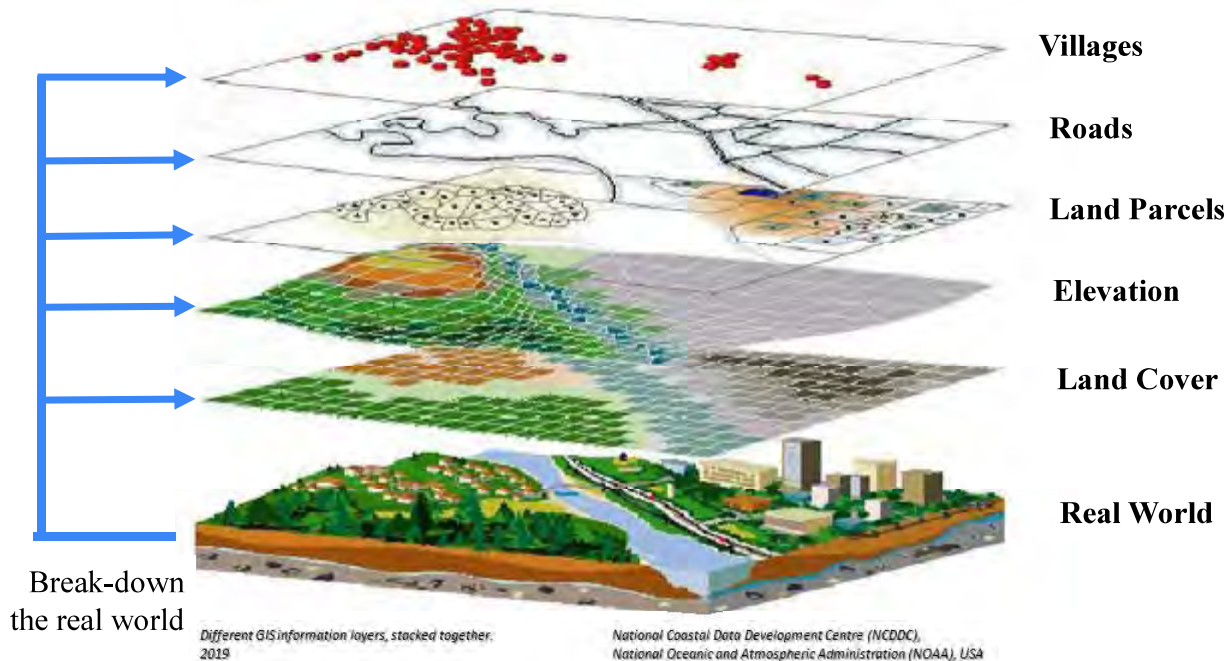
### Land Suitability

- Assessment of land cover to determine possible sites for future development



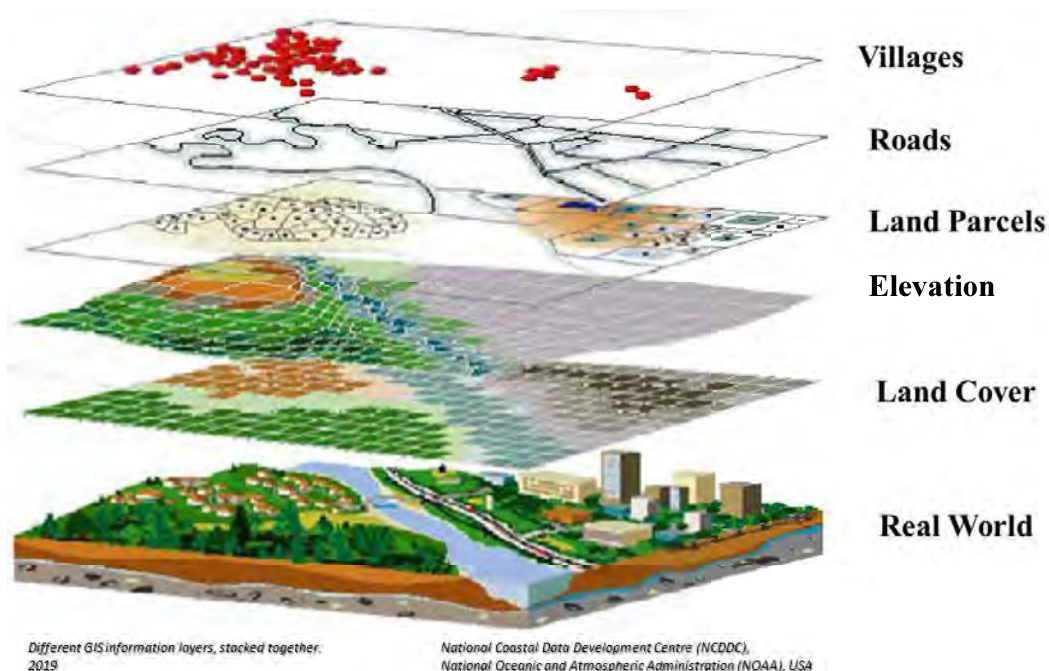
## GIS Maps Contain Layers

Interpretation of Real World in GIS



## Layers Contain Features or Surfaces

Interpretation of Real World in GIS



Some layers contain **features**

Ex. The roads layer contains many different roads

- Each road is a feature



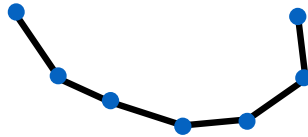
## Features

Features have shape & size

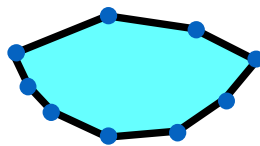
We typically represent features from the real world as three distinct spatial elements in GIS:



**Points** - simplest element



**Lines** - set of connected points



**Polygons** - set of connected lines

Points, Lines, and Polygons are referred to as **vector** data

## Examples of Features on a Map

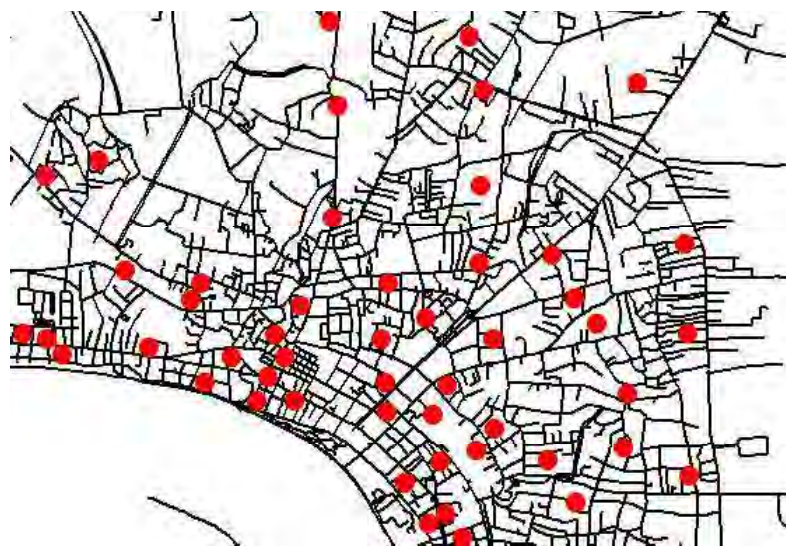
Learning GIS Fundamentals



businesses



roads



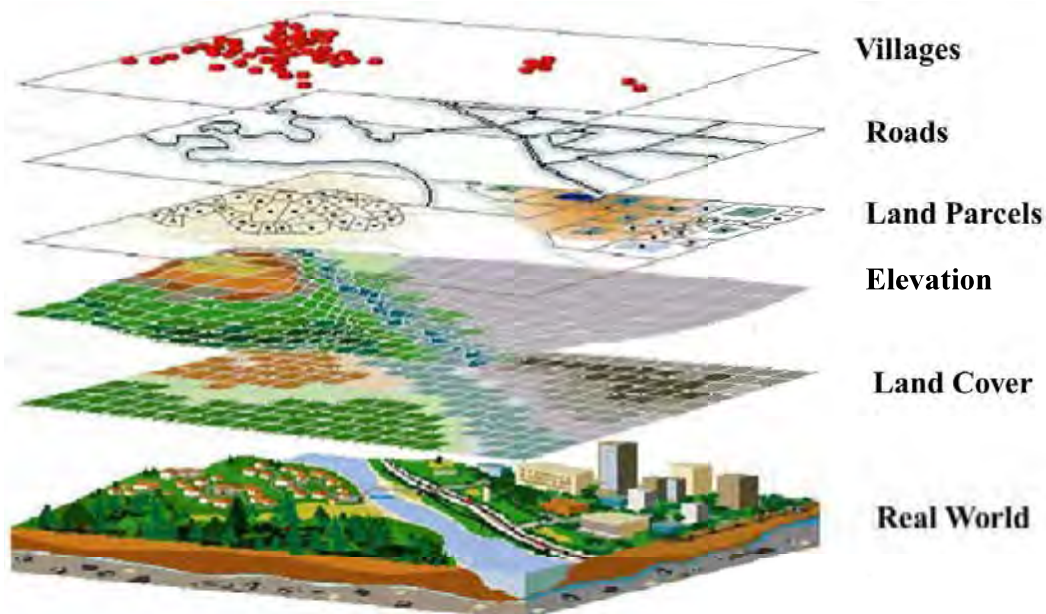
Vientiane capital, Laos map, 2019



## Layers Contain Features or Surfaces

Interpretation of Real World in GIS

Some layers are **surfaces**



*Different GIS information layers, stacked together.  
2019*

*National Coastal Data Development Centre (NCDDC),  
National Oceanic and Atmospheric Administration (NOAA), USA*

Ex. Elevation is considered a continuous property that changes from one location to another

- Each square represents an elevation value

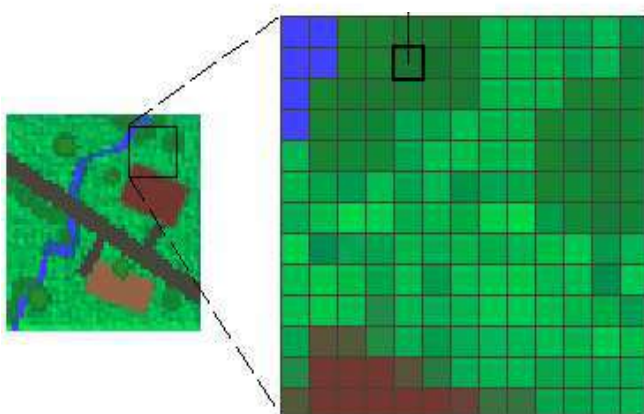
## Surfaces

Have numeric data; does not use shapes



The most common surface is a **raster**.  
It is a matrix of identically sized square cells.

Pixel



**PIXEL** (picture element)

The smallest unit in an image.  
In raster based GIS systems,  
attribute information can be  
assigned to each pixel.

ESRI

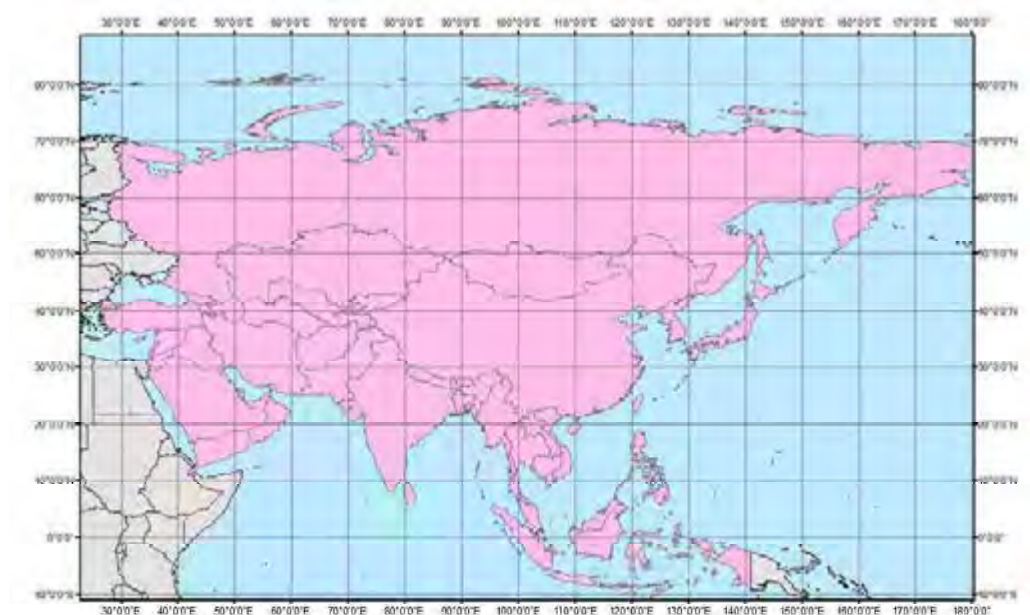


## Features have Locations

### Coordinate Systems

A **graticule** assists  
with finding  
locations on maps

Vientiane  
17° 58' **29.4780"** N  
102° 37' 51.1212" E



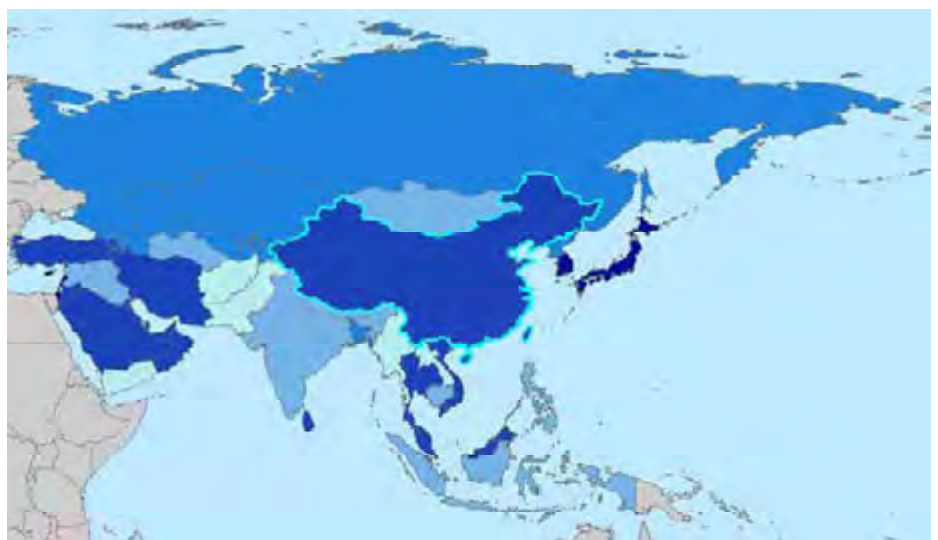
Asia map, 2019

## Features have additional information

### Learning GIS Fundamentals

- ✓ Shape      Other
- ✓ Location      Information

Table			
Life Expectancy			
	CNTRY_NAME	ISO_3DIGIT	Y2015
	Maldives	MDV	77
	Oman	OMN	77
	Bahrain	BHR	77
	China	CHN	76
	Vietnam	VNM	76
	Iran, Islamic Rep.	IRN	76
	Turkey	TUR	75
	Malaysia	MYS	75
	Thailand	THA	75
	Sri Lanka	LKA	75
	Kuwait	KWT	75
	Armenia	ARM	74



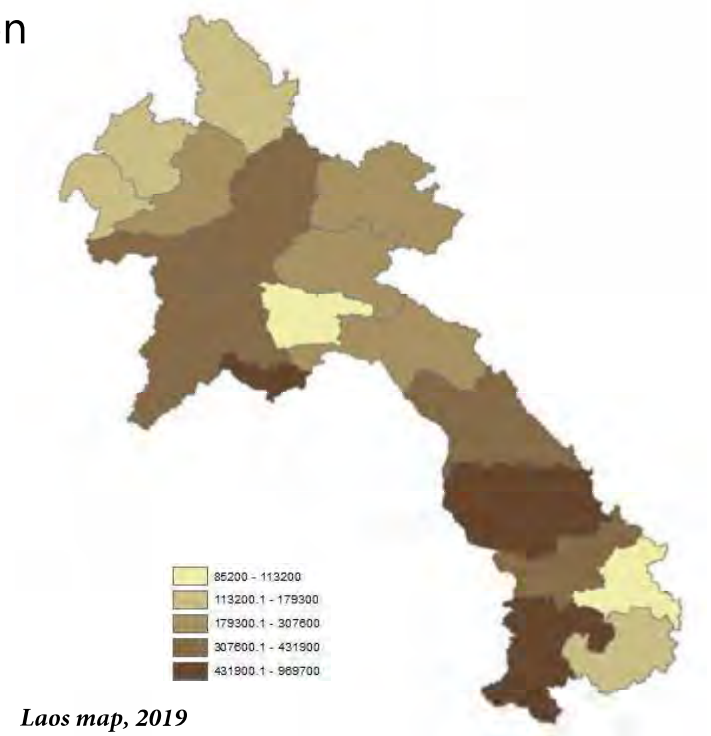
Asia map, 2019



## Features have additional information

Learning GIS Fundamentals

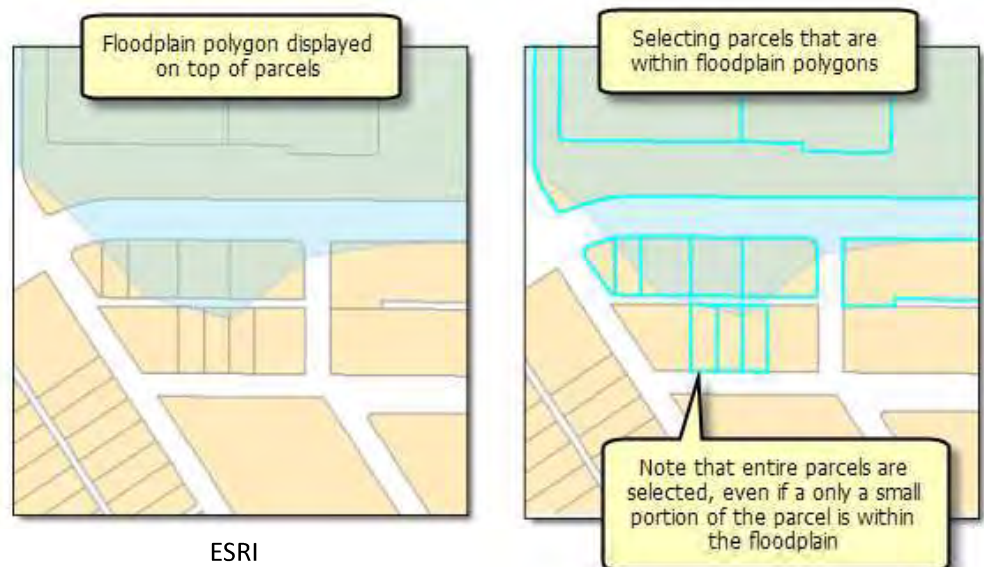
Each province corresponds to a color in the legend based on population



## Overlap of features

Finding new insights

- Example of overlay analysis
- One layer is a represents the floodplain
- The other layer contains information about parcels
- Determining which houses lie within floodplain

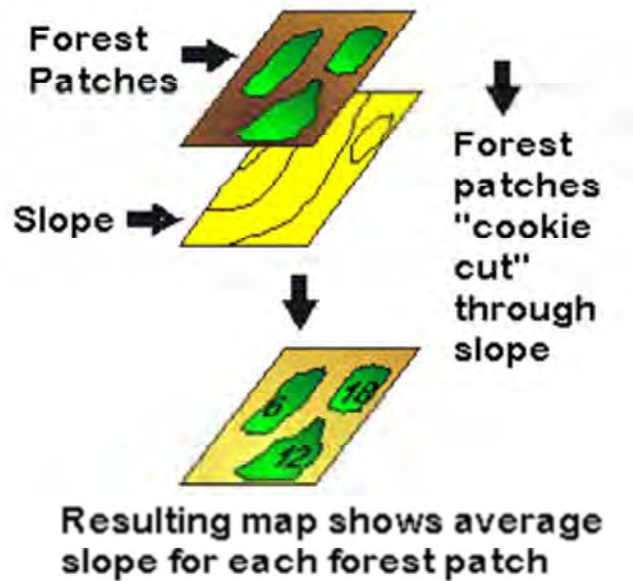




## Overlap of features

Finding new insights

- Example of Overlap between features
- Determining slope of forest patches
- One layer contains polygons of forest patches
- Another layer represents the slope of the same area
- Overlay functions reveal the slope at each of the forest patches



University of Nebraska, Omaha

## ESRI ArcGIS Environment

A first look into the concepts that comprise  
a Geographic Information System

Dr. Kavinda Gunasekara  
Frank Yrle





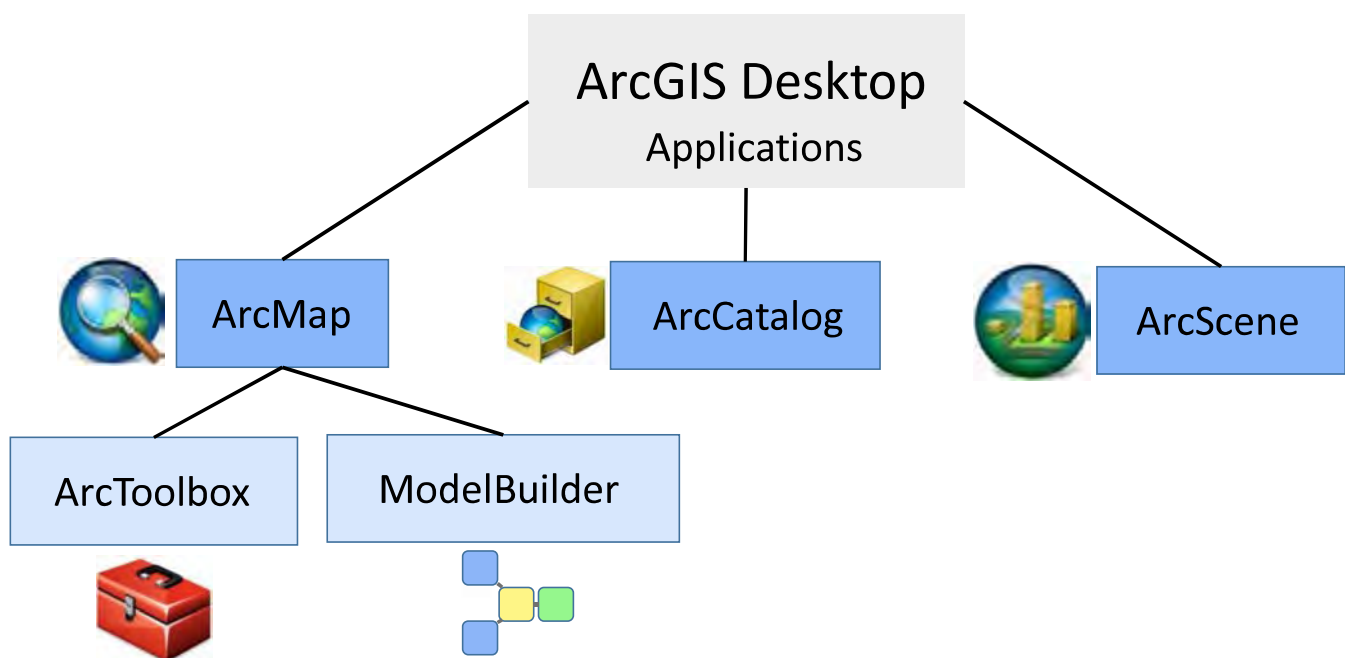
## Objectives

Day 1 Session 2

1. Introduction to the ArcGIS Desktop applications
2. Know the components of the [ArcGIS platform](#)

## ArcGIS Desktop Environment

Day 1 Session 2





# Capabilities of ArcGIS

## Definitions

### File formats compatible with ArcGIS

Query	SDC	IGDS
	SDE layers	IGES
Draw / Edit tools	<a href="#">Shapefiles (.shp)</a>	MIF
	<a href="#">Text files (.txt)</a>	MOSS
	<a href="#">Excel files (.xls)</a>	SDTS (point, raster, and vector)
Spatial Analysis tools	<a href="#">TIN</a>	SLF TIGER (through v2002)
	VPF	Sun Raster
	ADS	ADRG Image (.img)
Many spatial file formats	AGF	ArcSDE raster
	DFAD	DTED Level 0, 1, and 2 (.dt*)
	DIME	<a href="#">Esri Grid</a>
	DLG	Hierarchical Data Format (HDF)
	ETAK	LizardTech MrSID and MrSID Gen 3 (.sid)
	GIRAS	National Imagery Transmission Format (NITF) (.ntf)
		<a href="#">Tagged image file format (TIFF) (.tif)</a>

# Shapefile contents

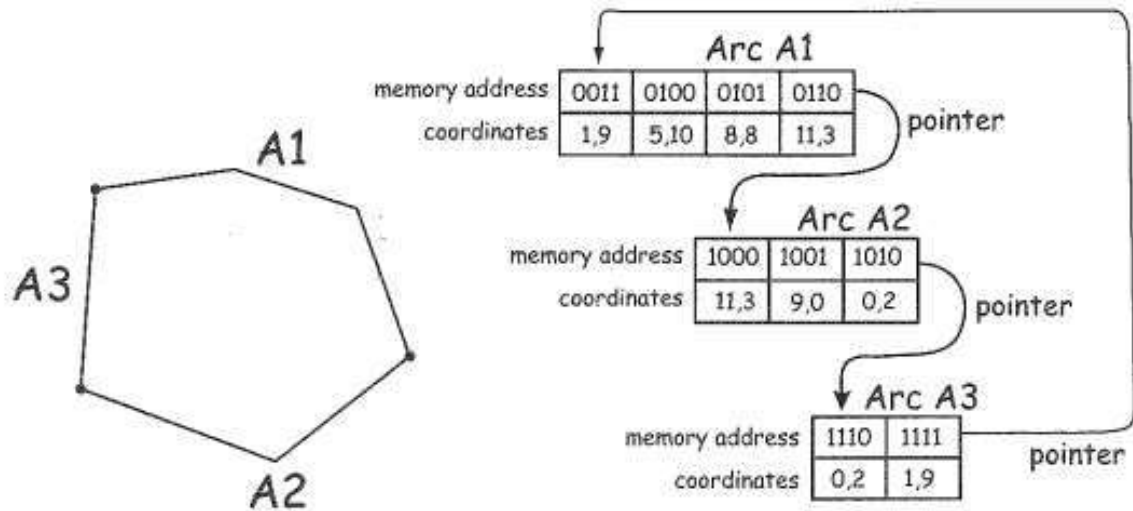
## Many file extensions

File Extension	Description
.shp	The main file that stores the feature geometry; required.
.shx	The index file that stores the index of the feature geometry; required.
.dbf	The dBASE table that stores the attribute information of features; required.
.sbn	The files that store the spatial index of the features.
.sbx	The files that store the spatial index of the features.
.prj	The file that stores the coordinate system information; used by ArcGIS.
.xml	Metadata for ArcGIS—stores information about the shapefile.
.cpg	An optional file that can be used to specify the codepage for identifying the character set to be used.



## Indexing vector files

Process of indexing



Bolstad 2012  
GIS Fundamentals

## ArcGIS Desktop

Applications

ArcMap

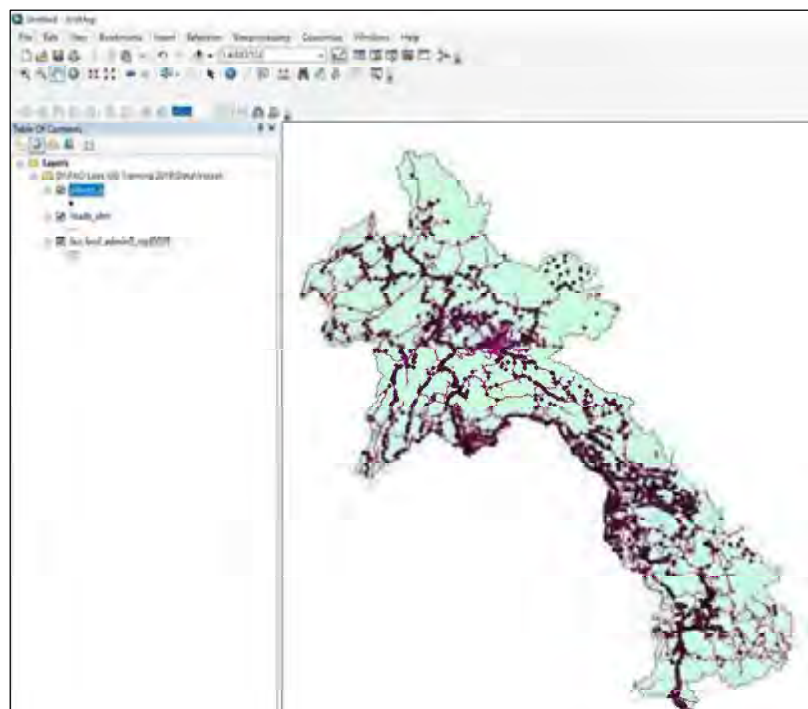
ArcCatalog

Tools

ModelBuilder

ArcScene

Extensions



Laos map, 2019



## ArcGIS Desktop

### Applications

ArcMap

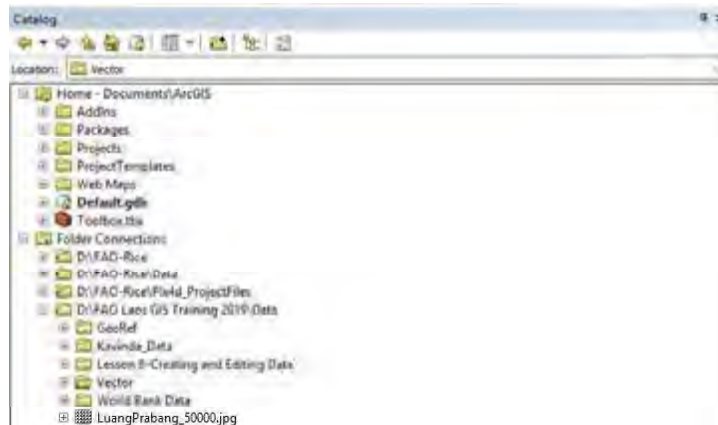
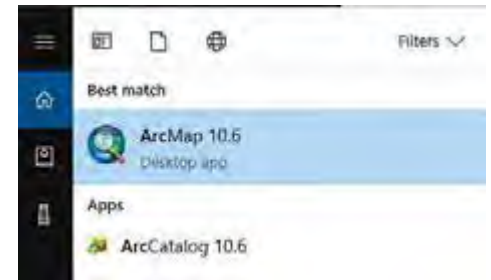
ArcCatalog

Tools

ModelBuilder

ArcScene

Extensions



## ArcGIS Desktop

### Applications

ArcMap

ArcCatalog

Tools

ModelBuilder

ArcScene

Extensions





## ArcGIS Desktop

Applications

ArcMap

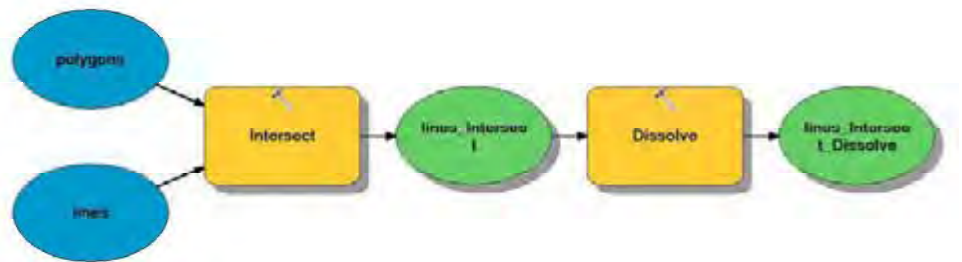
ArcCatalog

Tools

ModelBuilder

ArcScene

Extensions



Streamline geoprocessing tasks

Make your own tools

## ArcGIS Desktop

Applications

ArcMap

ArcCatalog

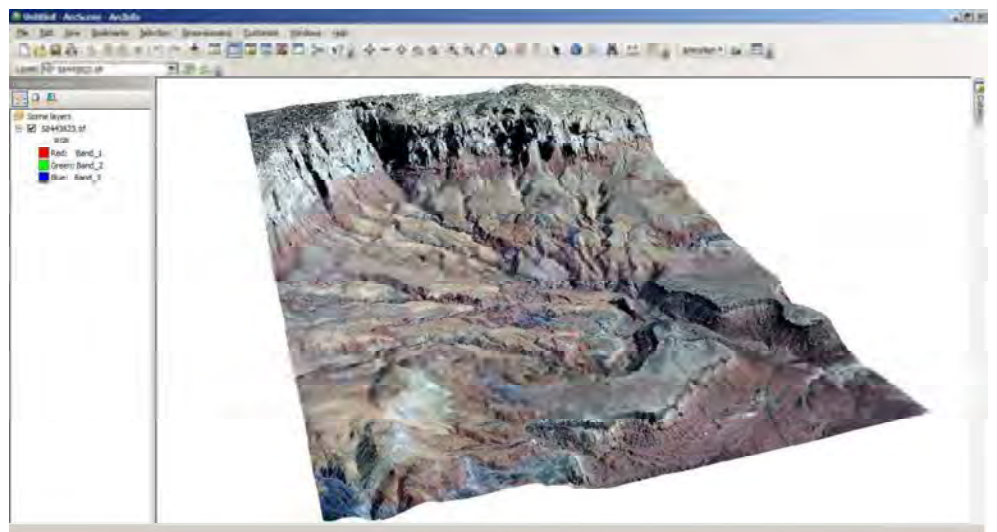
Tools

ModelBuilder

ArcScene

Extensions

3D Visualization





## ArcGIS Desktop

Applications

ArcMap

ArcCatalog

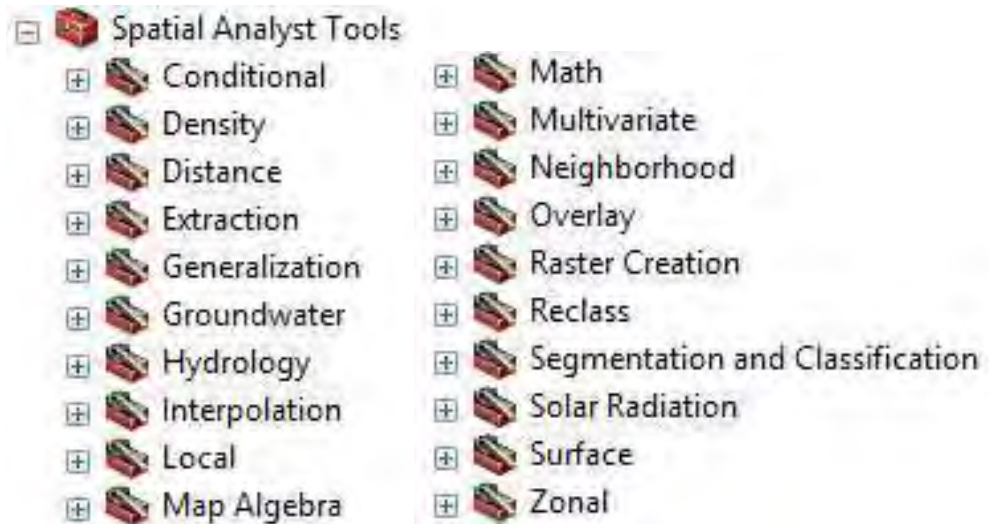
Tools

ModelBuilder

ArcScene

Extensions

## Spatial Analyst



## ArcGIS Desktop

Applications

ArcMap

ArcCatalog

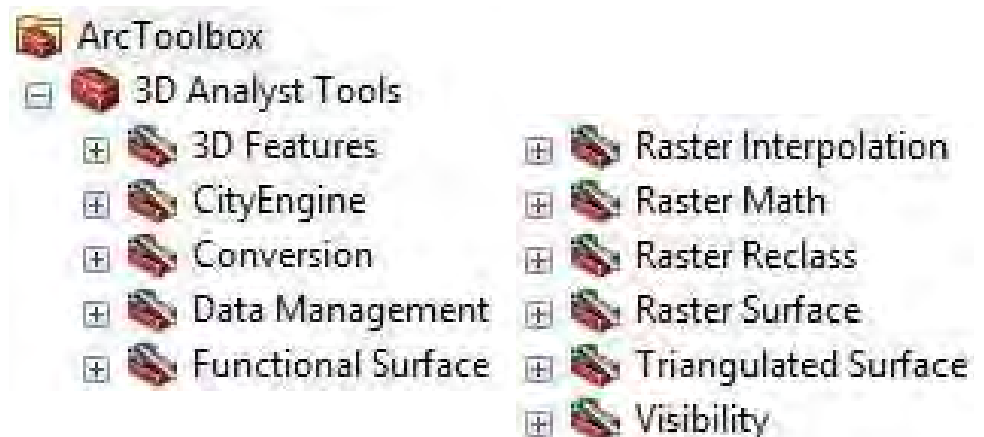
Tools

ModelBuilder

ArcScene

Extensions

## 3D Analyst





ArcMap

ArcCatalog

Tools

ModelBuilder

ArcScene

Extensions



## Getting to Know the ArcMap Interface

A first look into the concepts that comprise  
a Geographic Information System

Dr. Kavinda Gunasekara  
Frank Yrle







## Overview

Getting to know the ArcMap Interface

1. Becoming acquainted with ArcMap structure
2. Visualizing Data
3. Basic Tools for Maps
4. Additional tools



## Overview

Coordinate Systems & Projections

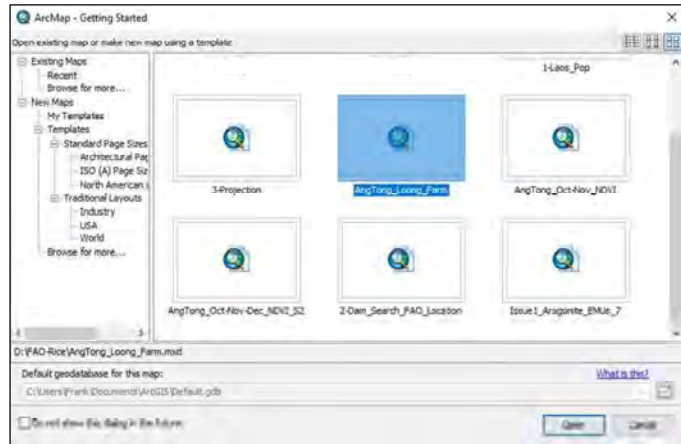
1. Examining coordinate systems
2. Projecting Data
3. Defining a map projection
4. Georeferencing a raster



## Opening ArcMap

### Getting Started

When you first open Arcmap you will be greeted by the **Getting Started** window. This is handy for loading a recent project that you were previously working on.

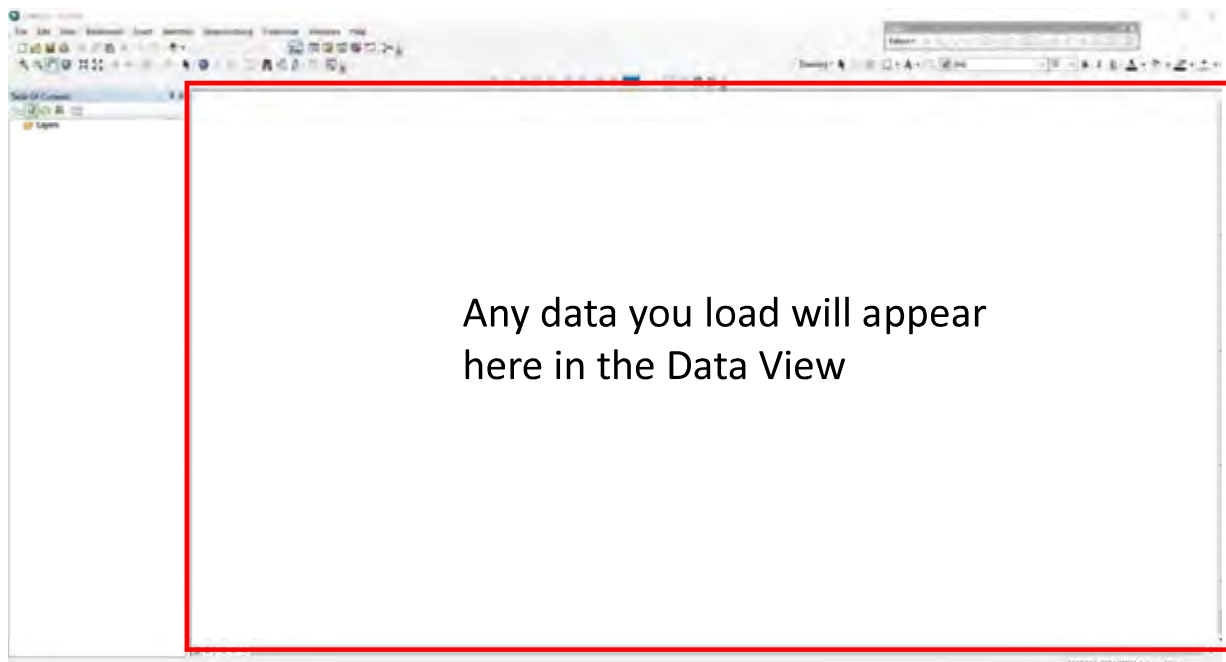


For now, click **Cancel** to start on a new project.

## Opening ArcMap

### Exploring Features Available

After clicking cancel you will be taken to the ArcMap Data View

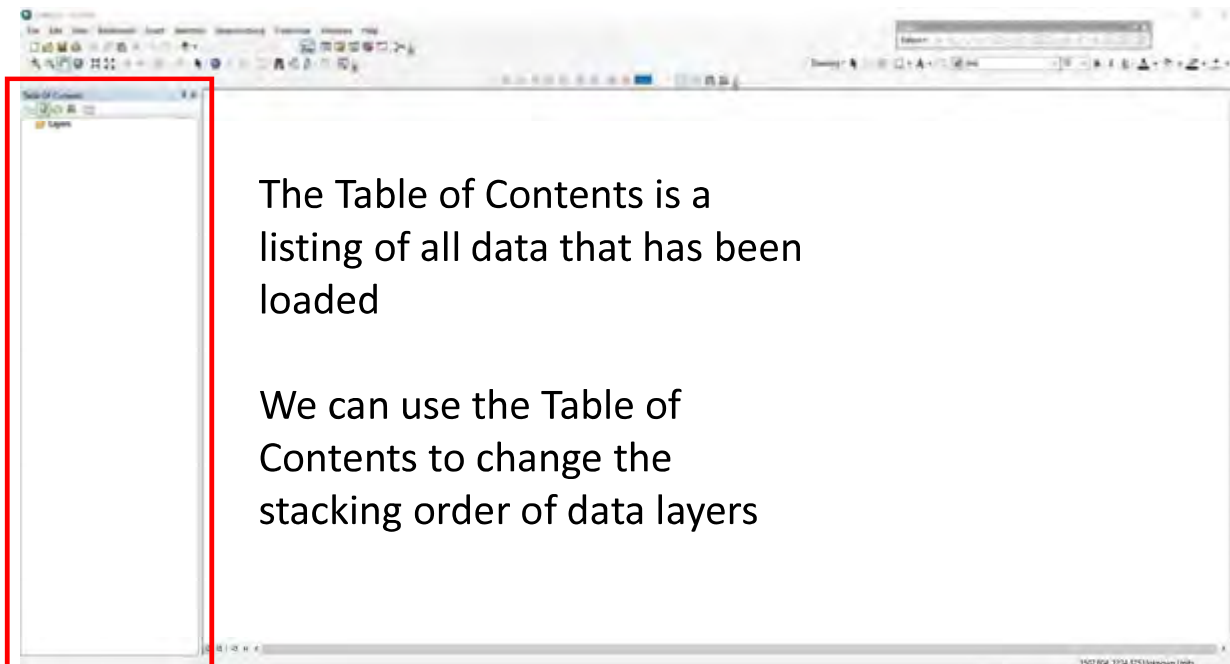




## Opening ArcMap

Exploring Features Available

After clicking cancel you will be taken to the ArcMap Data View



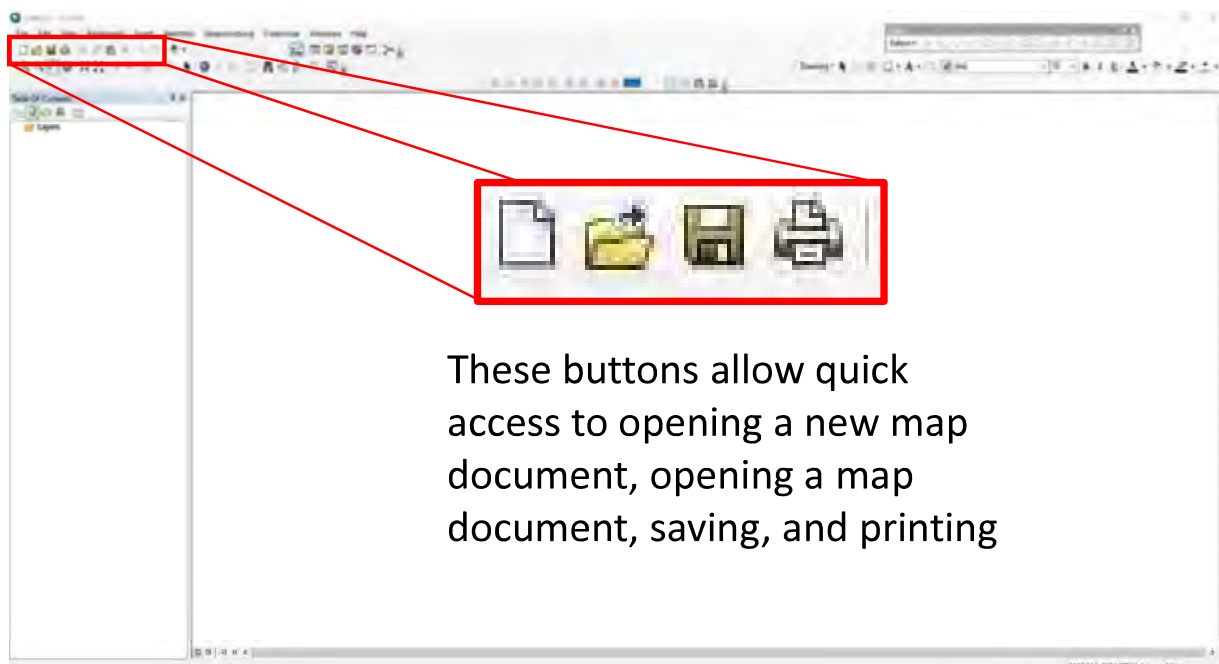
The Table of Contents is a listing of all data that has been loaded

We can use the Table of Contents to change the stacking order of data layers

## Opening ArcMap

Exploring Features Available

After clicking cancel you will be taken to the ArcMap Data View



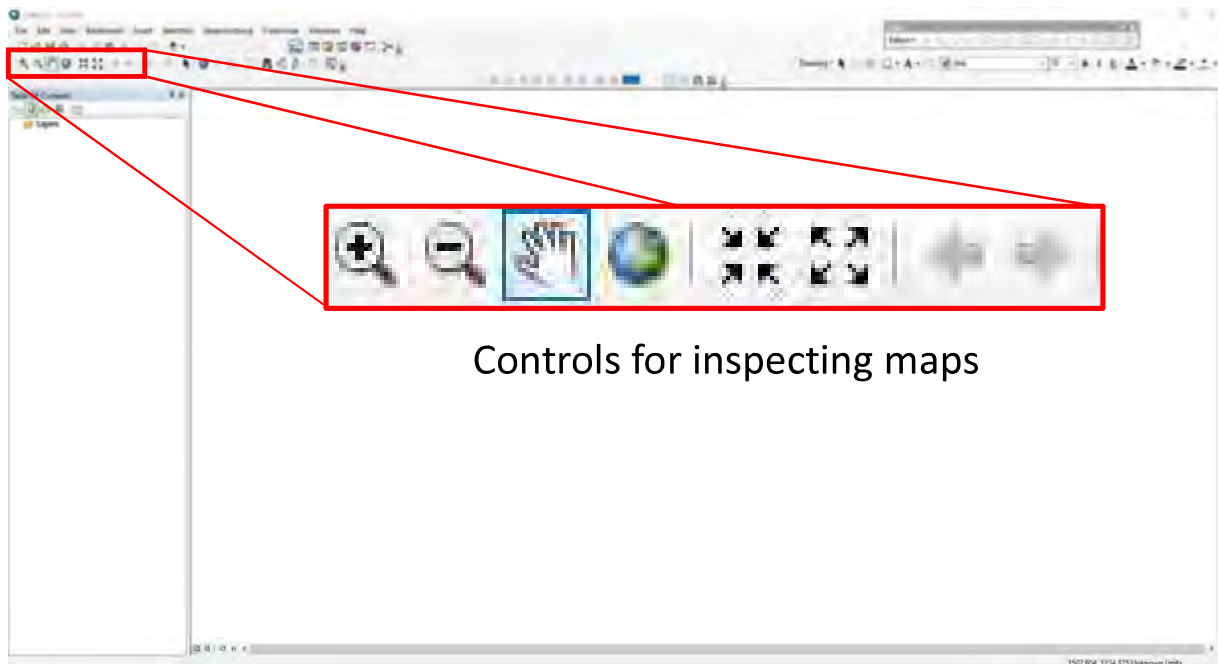
These buttons allow quick access to opening a new map document, opening a map document, saving, and printing



## Opening ArcMap

Exploring Features Available

After clicking cancel you will be taken to the ArcMap Data View

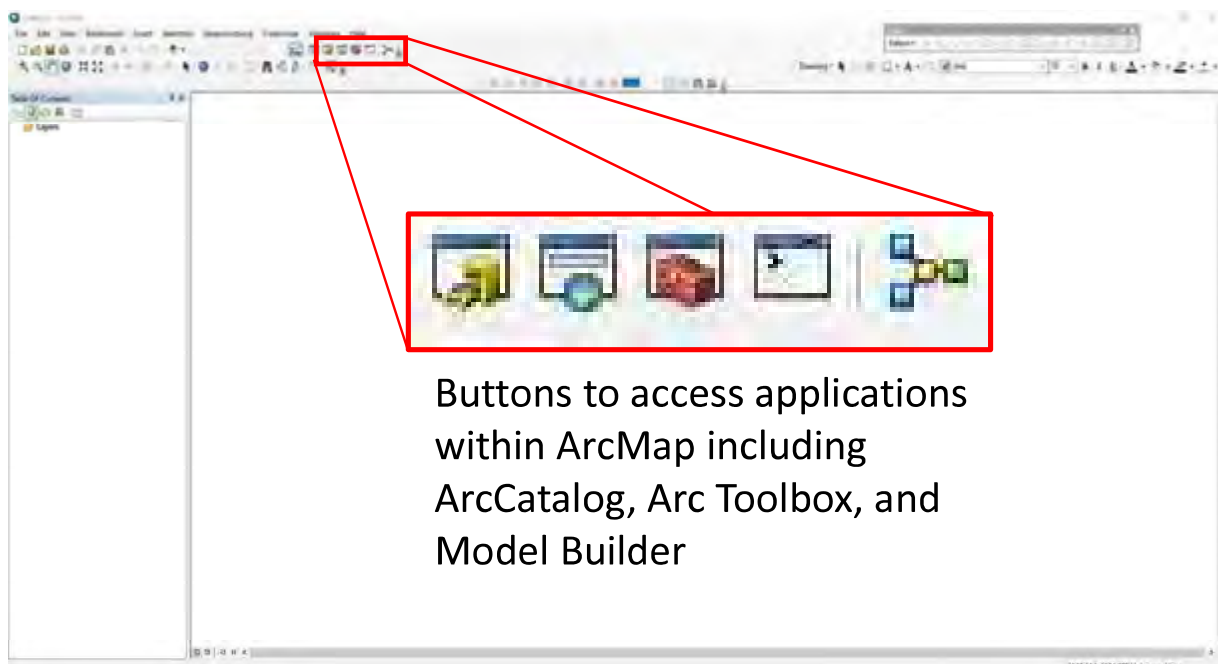


Controls for inspecting maps

## Opening ArcMap

Exploring Features Available

After clicking cancel you will be taken to the ArcMap Data View



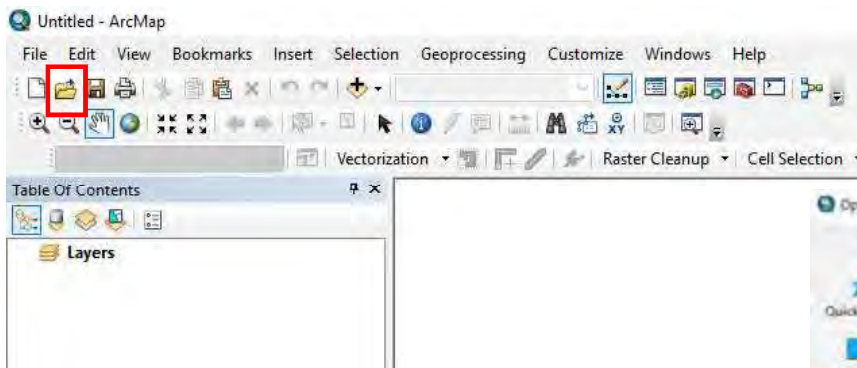
Buttons to access applications within ArcMap including ArcCatalog, Arc Toolbox, and Model Builder



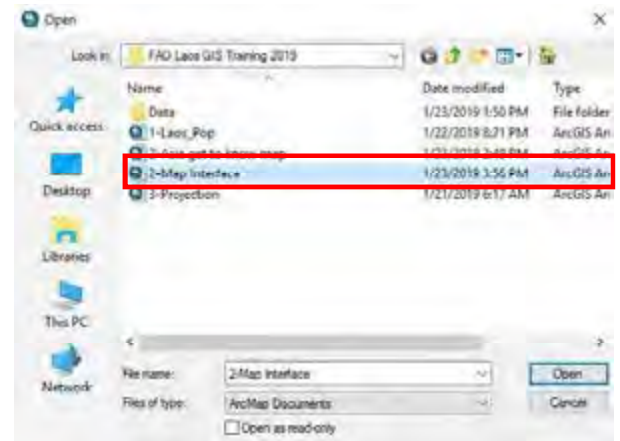
## Opening a Map Document

Exploring Features Available

.mxd is the file extension for ArcMap files



2. Open the file:  
2-Map Interface.mxd



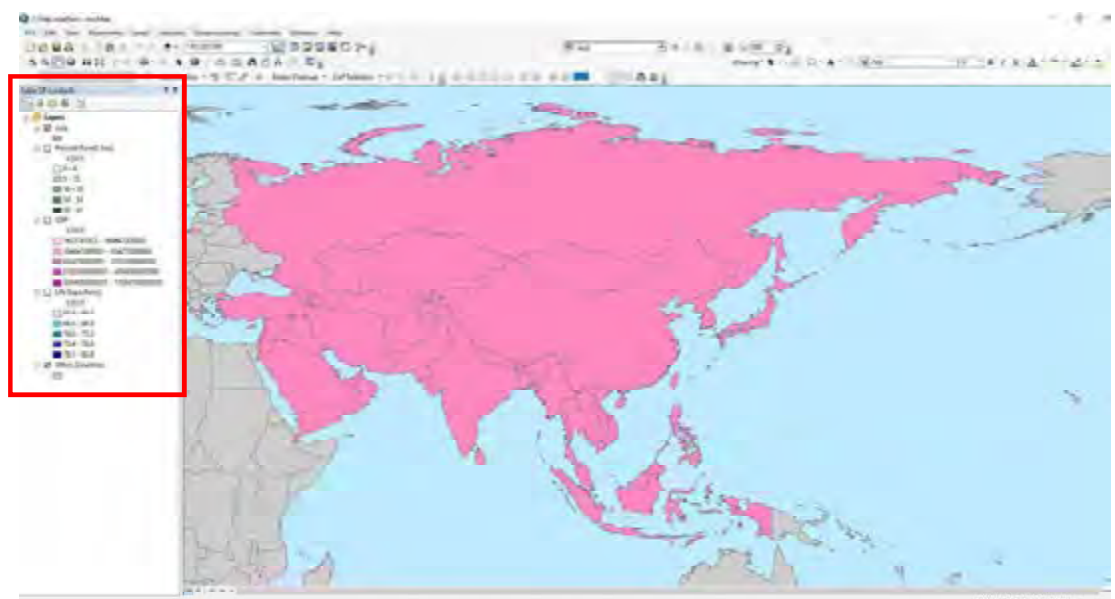
1. Press the  button to open an existing map document

## Overview

Exploring Features Available

The **Table of Contents** shows 5 files in the map document

- Asia
- Percent Forest Area
- GDP
- Life Expectancy
- Other Countries



Asia map, 2019

Country statistics data from The World Bank



## Overview

Exploring Features Available



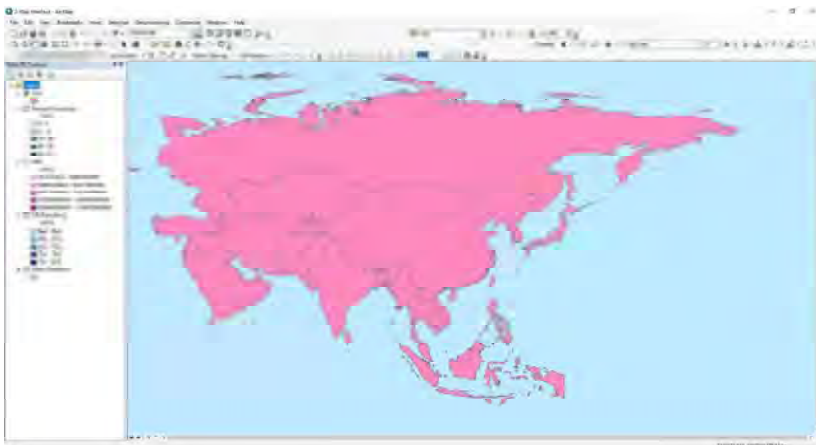
Asia map, 2019

A closer look at the Table of Contents shows us that the **Asia** and **Other Countries** layers are active

Table Of Contents	
<b>Layers</b>	
<input checked="" type="checkbox"/>	Asia
<input type="checkbox"/>	Percent Forest Area
Y2015	
<input type="checkbox"/>	0 - 4
<input type="checkbox"/>	5 - 15
<input type="checkbox"/>	16 - 33
<input type="checkbox"/>	34 - 54
<input type="checkbox"/>	55 - 81
<input type="checkbox"/>	GDP
Y2015	
<input type="checkbox"/>	1633741923 - 164641000000
<input type="checkbox"/>	164641000001 - 654270000000
<input type="checkbox"/>	654270000001 - 2102390000000
<input type="checkbox"/>	2102390000001 - 4394980000000
<input type="checkbox"/>	4394980000001 - 11064700000000
<input type="checkbox"/>	Life Expectancy
Y2015	
<input type="checkbox"/>	62.3 - 66.5
<input type="checkbox"/>	66.6 - 69.9
<input type="checkbox"/>	70.0 - 73.3
<input type="checkbox"/>	73.4 - 78.0
<input type="checkbox"/>	78.1 - 83.8
<input checked="" type="checkbox"/>	Other_Countries

## Layers can be turned on & off

Check / Uncheck



Asia map, 2019

3. Uncheck the Other Countries box in the Table of Contents

4. Try the same with the Asia Layer

5. When you're finished turn both layers back on

Table Of Contents	
<b>Layers</b>	
<input checked="" type="checkbox"/>	Asia
<input type="checkbox"/>	Percent Forest Area
Y2015	
<input type="checkbox"/>	0 - 4
<input type="checkbox"/>	5 - 15
<input type="checkbox"/>	16 - 33
<input type="checkbox"/>	34 - 54
<input type="checkbox"/>	55 - 81
<input type="checkbox"/>	GDP
Y2015	
<input type="checkbox"/>	1633741923 - 164641000000
<input type="checkbox"/>	164641000001 - 654270000000
<input type="checkbox"/>	654270000001 - 2102390000000
<input type="checkbox"/>	2102390000001 - 4394980000000
<input type="checkbox"/>	4394980000001 - 11064700000000
<input type="checkbox"/>	Life Expectancy
Y2015	
<input type="checkbox"/>	62.3 - 66.5
<input type="checkbox"/>	66.6 - 69.9
<input type="checkbox"/>	70.0 - 73.3
<input type="checkbox"/>	73.4 - 78.0
<input type="checkbox"/>	78.1 - 83.8
<input type="checkbox"/>	Other_Countries



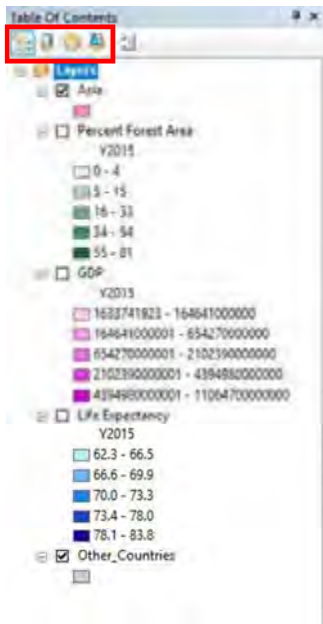
## Table of Contents

### Listing Methods

The Blue outline indicates that method is selected



There are 4 options for listing data in the Table of contents



List by Drawing Order



List by Source



List by Visibility

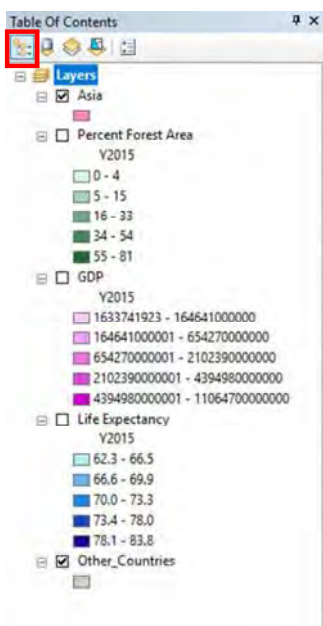


List by Selection

## Table of Contents

### Listing Methods

The Blue outline indicates that method is selected



List by Drawing Order

Drag & drop to change drawing order

6. **Try on your own:** Make the Percent Forest Area layer active and drag & drop it above the Asia layer



Asia map, 2019



Asia map, 2019



## Table of Contents

### Listing Methods

The Blue outline indicates that method is selected



Layer Name	Visibility
Percent Forest Area	Visible
Y2015	Visible
0 - 4	Visible
5 - 15	Visible
16 - 33	Visible
34 - 54	Visible
55 - 81	Visible
Asia_pc100	Visible
GDP	Not Visible
Y2015	Not Visible
1633741923 - 164641000000	Not Visible
164641000001 - 654270000000	Not Visible
654270000001 - 2102390000000	Not Visible
2102390000001 - 4394980000000	Not Visible
4394980000001 - 11064700000000	Not Visible
Life Expectancy	Not Visible
Y2015	Not Visible
62.3 - 66.5	Not Visible
66.6 - 69.9	Not Visible
70.0 - 73.3	Not Visible
73.4 - 78.0	Not Visible
78.1 - 83.8	Not Visible
Other_Countries	Not Visible
Forest Percent Cover.csv	Not Visible
Life Expectancy - Total.csv	Not Visible
GDP.csv	Not Visible



List by Source

Layers are listed by the geodatabase or folder containing the data source they reference

Also lists folders associated with the data

## Table of Contents

### Listing Methods

The Blue outline indicates that method is selected



Layer Name	Visibility
Percent Forest Area	Visible
Y2015	Visible
0 - 4	Visible
5 - 15	Visible
16 - 33	Visible
34 - 54	Visible
55 - 81	Visible
Asia_pc100	Visible
Other_Countries	Visible
GDP	Not Visible
Life Expectancy	Not Visible



List by Visibility

Layers are listed by whether they are turned on or off

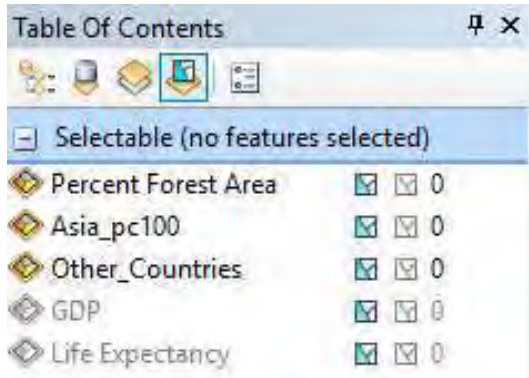
We have not turned on GDP or Life Expectancy layers, so they are listed at the bottom as **Not Visible**



## Table of Contents

Listing Methods

The **outline** indicates that method is selected



List by Selection

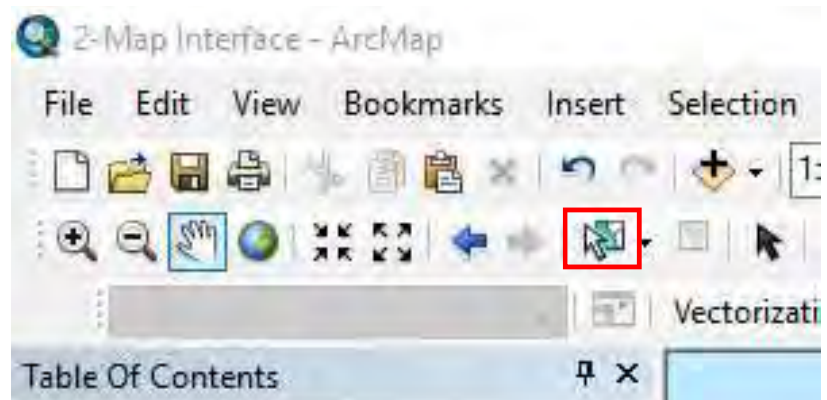
Layers are listed by whether they are selected by the interactive editing and selection tools

No layers are selected as indicated by the menu  
(no features selected)

## Table of Contents

Listing Methods

The **Select Features** tool lets us select points, line, and polygons present in the Data View

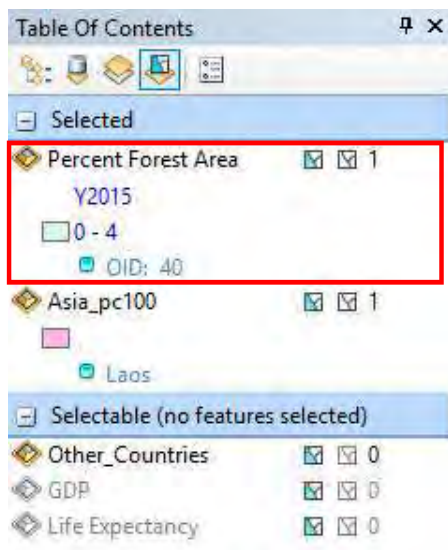


Click the Select Features tool, then select Laos in the Data View. Laos will be outlined in blue once it's selected



## Table of Contents

### Listing Methods



Laos now appears in the selected menu



Laos map, 2019

Asia layer was also activated, so Laos is selected there too

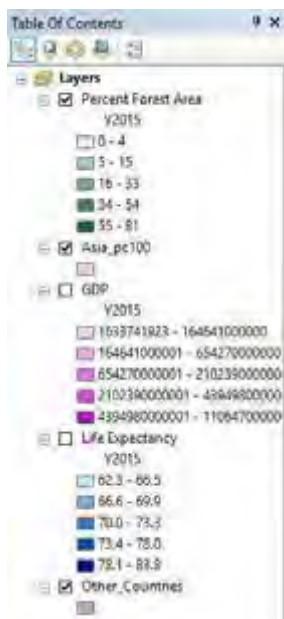


Deselect Laos by clicking the grey square for both layers

## Change Name of a Layer

### Modify Layer

Return to List by Drawing Order



Let's change the name of the Asia layer. Currently the name is Asia\_pc100  
Change the name to **Asian Countries**

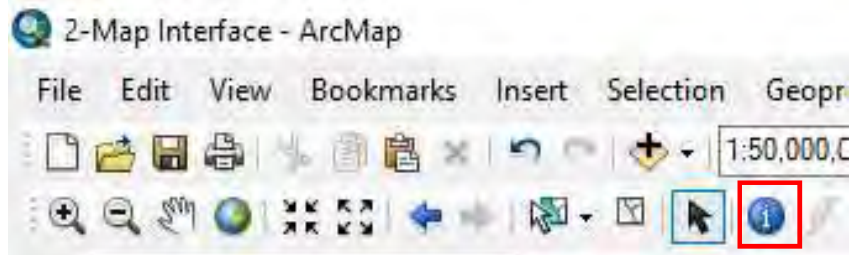
Click Asia\_pc100 2x in the Table of Contents  
The name will be highlighted in dark blue. You can then type the new name





## Identify Tool

Gain insight to map layers



The **Identify Tool** will help us discover information about features without having to open the attribute table

### On your own:

Use the Identify Tool to find the 2015 percent forest cover for Laos, Indonesia, Kazakhstan, and Tajikistan

## Tools for Exploring the Map

Gain insight to map layers



Zoom In

Press 1x to zoom in a little



Zoom Out

Click & Drag to form a zoom box



Fixed zoom in

Incremental zoom in / zoom out



Fixed zoom out

Zoom faster with mouse wheel



Previous Extent

Return to previous view prior to last zoom or movement



## Tools for Exploring the Map

Gain insight to map layers



Pan

Click and hold the left mouse button to move across the map

- Can also be achieved by clicking & holding mouse wheel



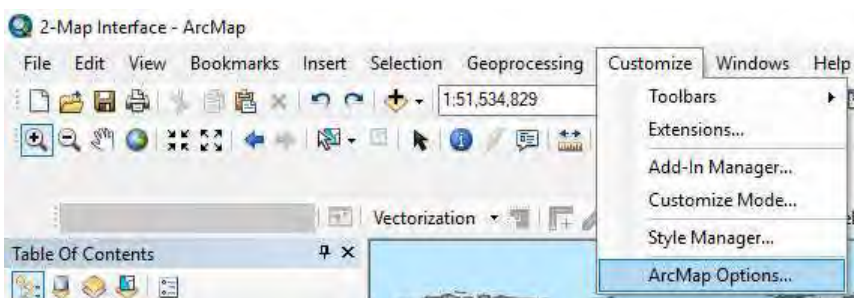
Full Extent

Returns to whole view of the map area after zooming / panning

**On your own:** Practicing zooming and panning with these tools. When you're finished return to the full extent of the map

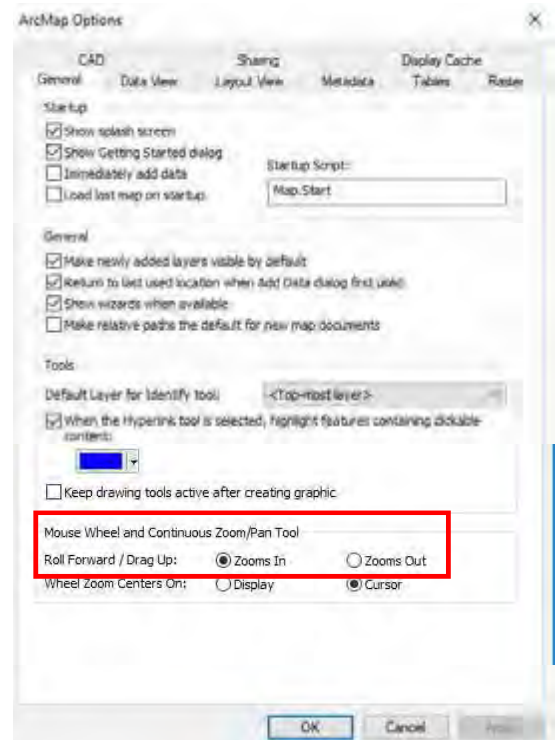
## Customizing the wheel zoom

Gain insight to map layers



Zooming with the mouse wheel is quick & convenient. However, zooming like that might feel backwards.

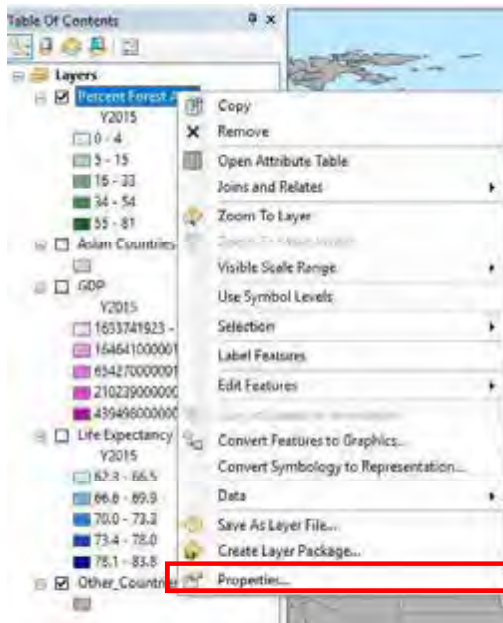
To change roll / zoom direction:  
Roll Forward  
Select **Zoom In**





## Map Tips

Gain insight to map layers

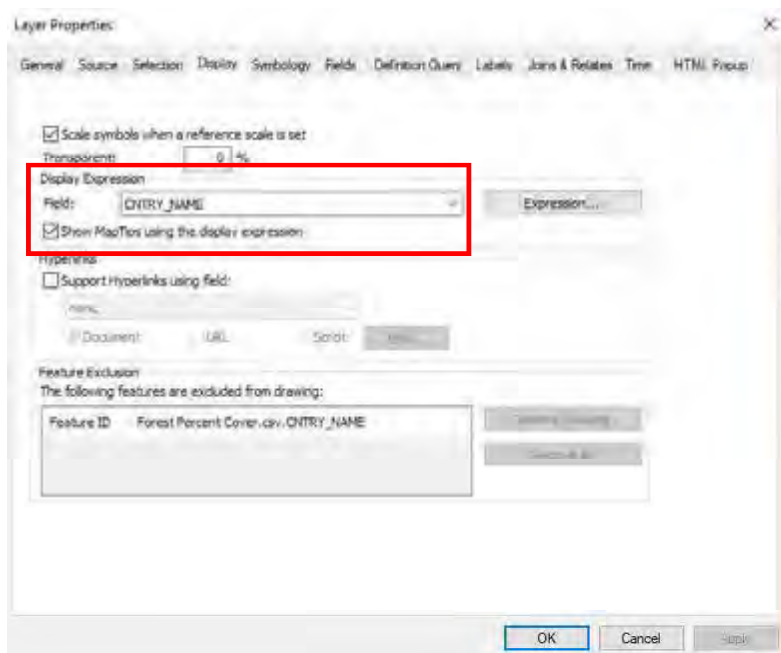


**Map Tips** – Tool that lets you hover the mouse over a feature to learn about data of your choice.

Access the Properties of Percent Forest Area: Right click the Percent Forest Area Layer and select **Properties** (or you can double-click the layer name)

## Map Tips

Gain insight to map layers



**Map Tips** – Tool that lets you hover the mouse over a feature to learn about data of your choice.

**Check the box** to turn Map Tips on for this layer

You can also select the field that will appear for the map tip. Choose **CNTRY\_NAME**





## Map Tips

Gain insight to map layers



*Laos map, 2019*

**Map Tips** – Tool that lets you hover the mouse over a feature to learn about data of your choice.

The **Map Tip** shows us the country name because we selected CNTRY\_NAME for the Map Tip field

## Create a Bookmark

Gain insight to map layers



*Laos map, 2019*

**Bookmarks** help us keep track of a place / map extent that we want to go back to.

Make a Bookmark for Laos.

Zoom to Laos

Click the **Bookmarks** tab at the top of the screen

Click Make a Bookmark

Name your bookmark: Laos



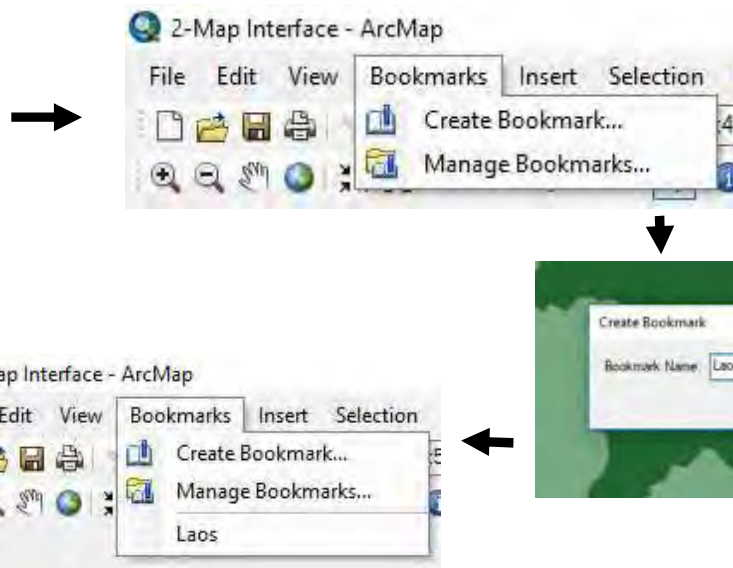
## Create a Bookmark

Gain insight to map layers



Laos map, 2019

Bookmarks help us keep track of a place / map extent that we want to go back to.



## Go to XY

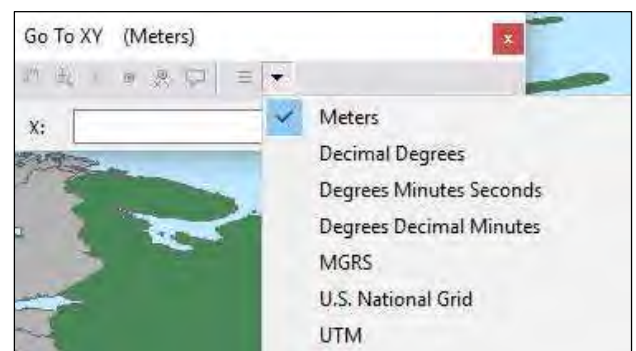
Pinpoint locations with coordinates



Use the **Go to XY** tool to mark locations on your map – provided that you know the coordinates



Choice of units





## Go to XY

Pinpoint locations with coordinates



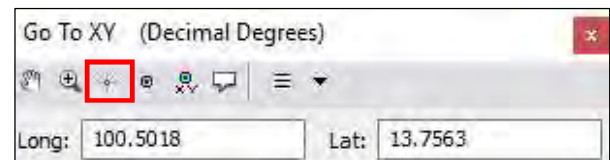
Choose [Decimal Degrees](#) for units

Enter these coordinates into the Go to XY tool

	LAT	LONG
Bangkok	13.7563°	100.5018°
Vientiane	17.9757°	102.6331°

First try Bangkok

Use [Flash](#) to determine if the coordinates are correct

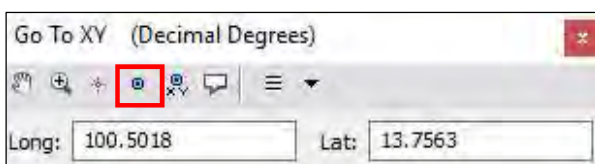


## Go to XY

Pinpoint locations with coordinates



If the coordinates are correct, click [Add Point](#) on the Go to XY tool



*Thailand map, 2019*

Next try Vientiane

	LAT	LONG
Bangkok	13.7563°	100.5018°
Vientiane	17.9757°	102.6331°



## Measure Distance

Pinpoint locations with coordinates



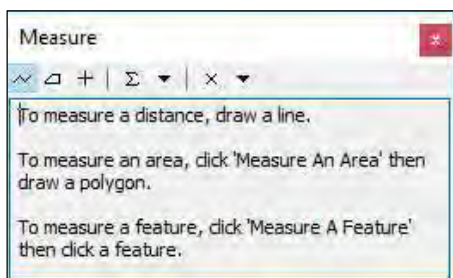
Thailand map, 2019

Now that we have two cities marked on the map, let's determine how far apart they are. We will need the [Measure Tool](#)



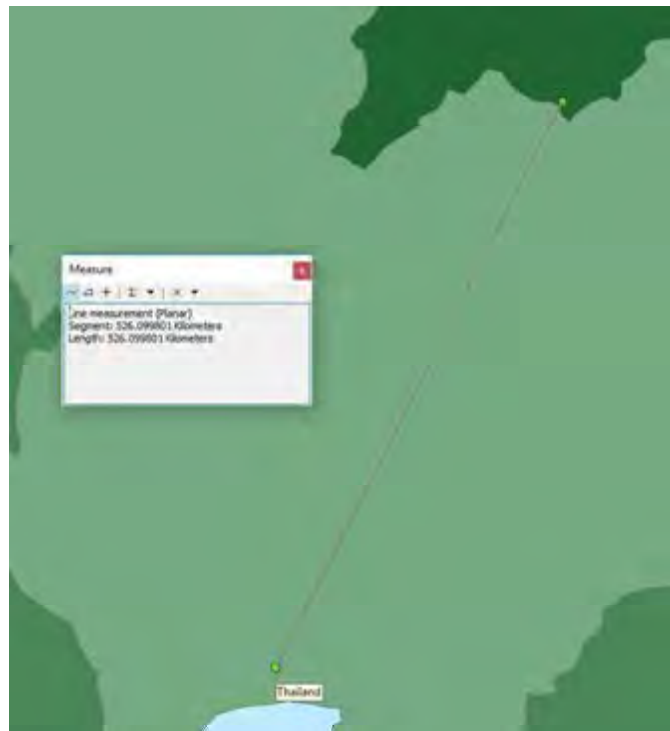
## Measure Distance

Pinpoint locations with coordinates



We found Planar Distance to be approximately 526 km

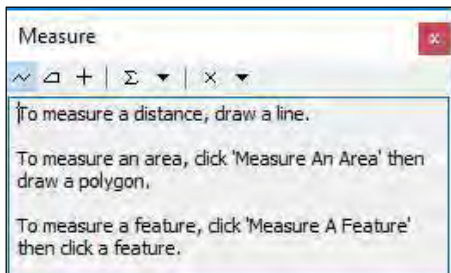
Try Geodetic distance and see if there is a difference.





## Measure Distance

Pinpoint locations with coordinates



**On your own:** Use the measure tool to find the planar distance and the geodesic distance between Vientiane and Istanbul, Turkey

## Vector & Raster Analysis Part 1

Basic useful tools in vector & raster operations  
(data use in this exercise is only for demonstration purpose only)

Dr. Kavinda Gunasekara  
Frank Yrle





## Learning topics

Overview of the exercise

1. Layer symbolizing and use predefined legend
2. Dissolve tool and options
3. Clip tool and various ways to utilize the tool
4. Importing GPS data and creating GIS layer
5. Proximity tool and options
6. Several combination of overlay operations to achieve the specific objectives
7. Field calculator
8. Intersect and union overlay operations
9. Merge and append tools

## I. Explore the data

Overview of data

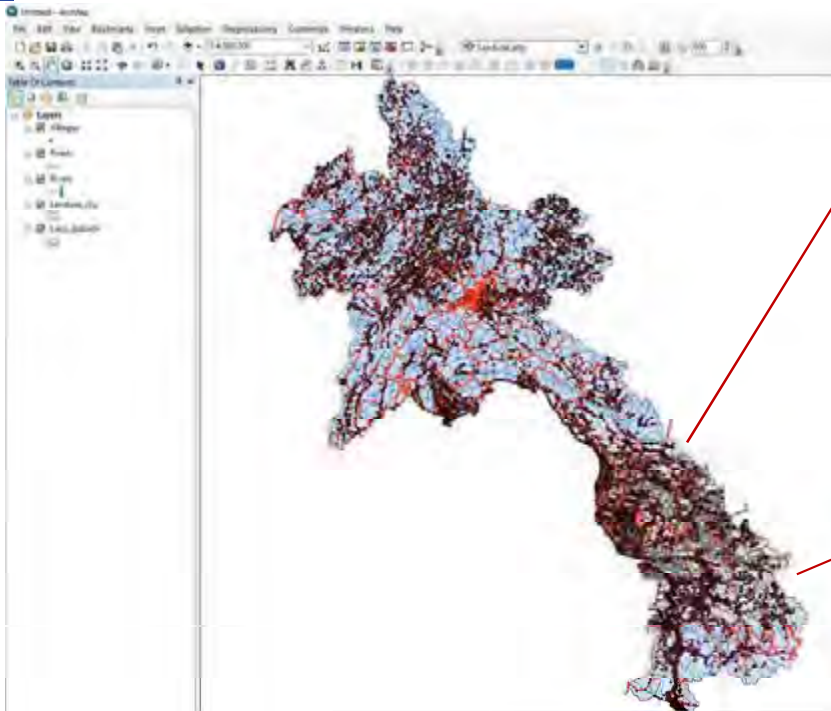
1. Shape files
  1. Administrative boundaries
  2. Road
  3. River
  4. Village
  5. Landuse\_clip
  6. .layer file: landuse legend
2. Table data
  1. Coordinates of Agro-meto stations
  2. Other attributes of Agro-meto stations





# I. Explore the data

## Overview of data

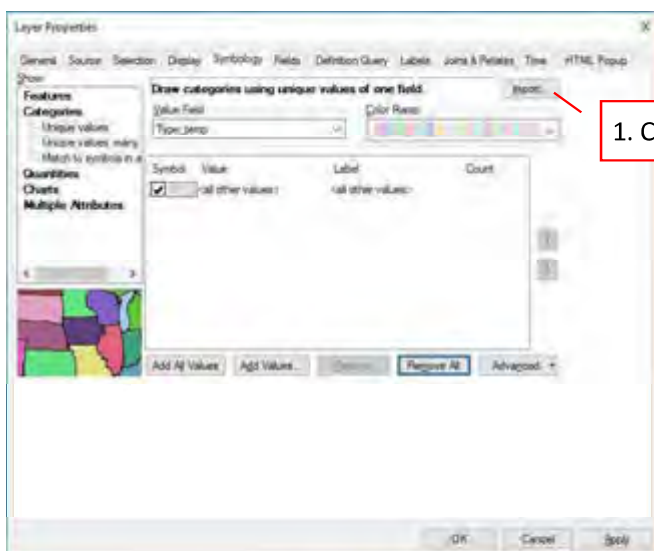


*Laos map, 2019*

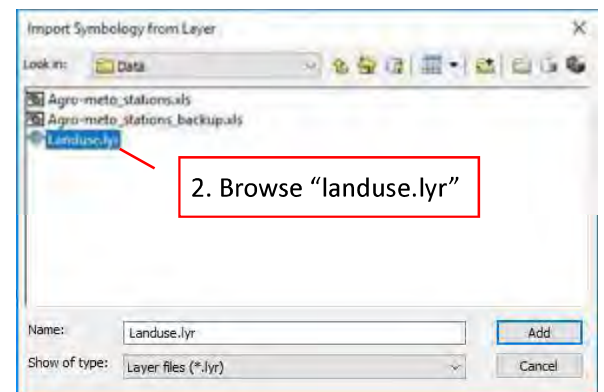
## Symbolize Layers

Assign colors based on data categories

1. Check the categories of data and assign appropriate symbols/colors
2. How to assigned predefined legend/colors based on .layer file?



1. Click Import



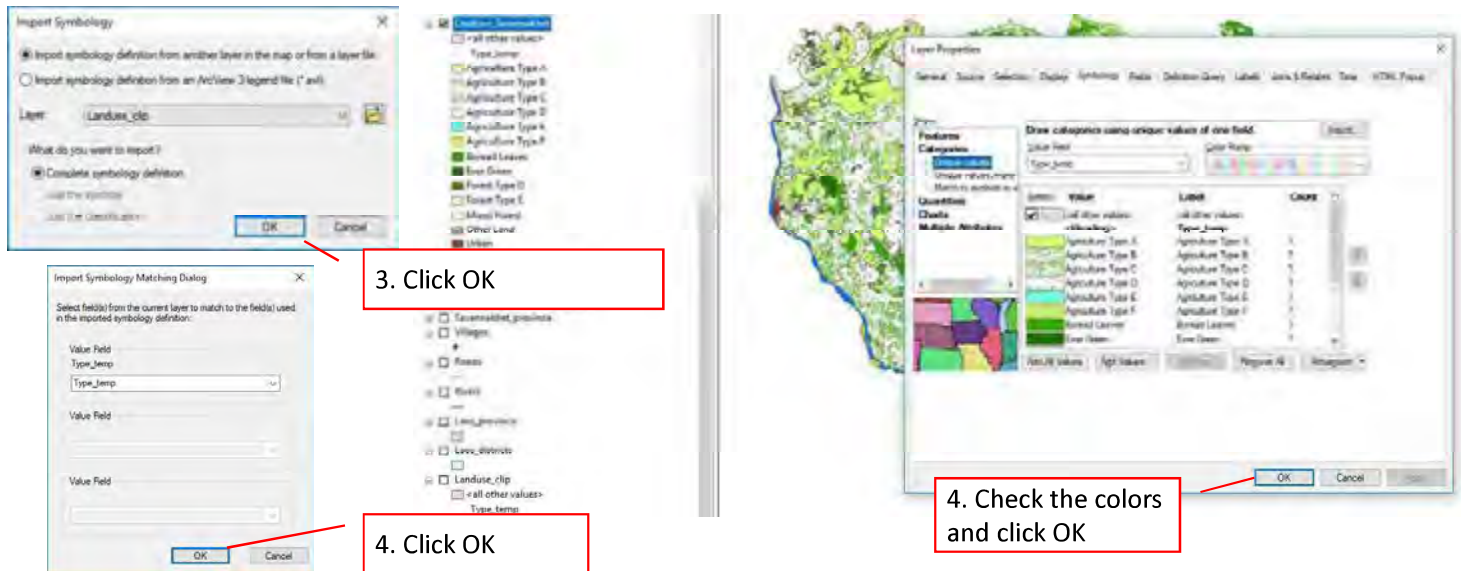
2. Browse "landuse.lyr"



# Symbolize Layers

Assign colors based on data categories

1. Check the categories of data and assign appropriate symbols/colors
2. How to assigned predefined legend/colors based on .layer file?



## How to make Level 1 Landuse level and symbolize

- Make level one field landuse



## Landuse Level 2

## Landuse Level 1



### Agriculture

### Forest

### Other Land

### Urban

### Water

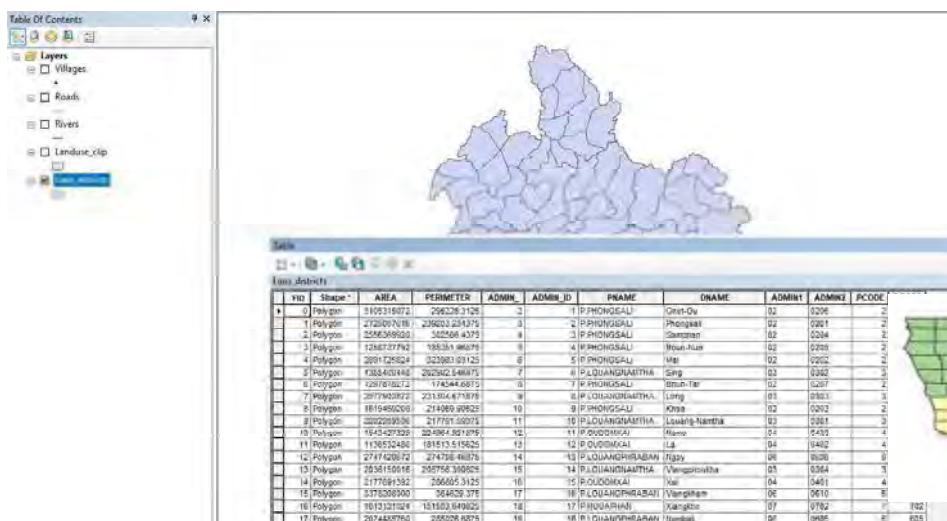
How to make Level 1 Landuse level and symbolize

[Field Name] = "Category Name" {operator} [Field Name] = "Category Name"

## Create Province Layer

Use Dissolve tool

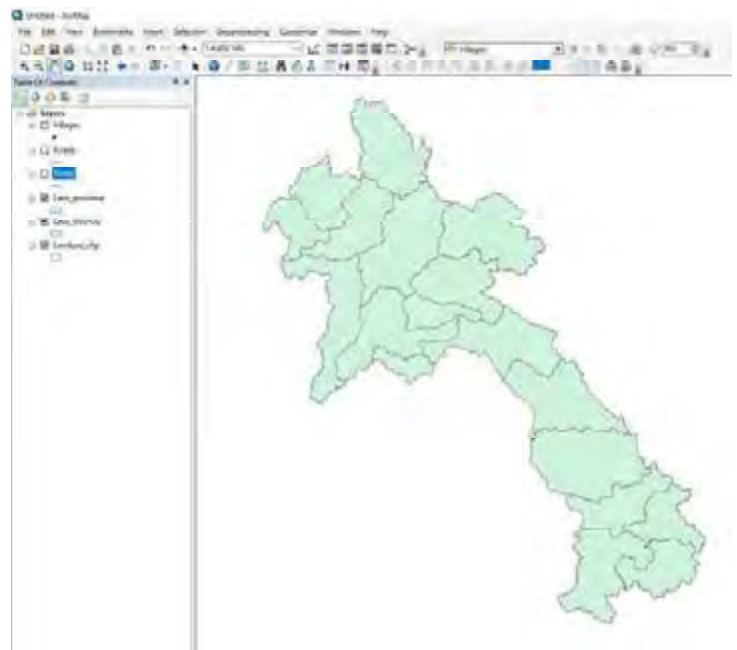
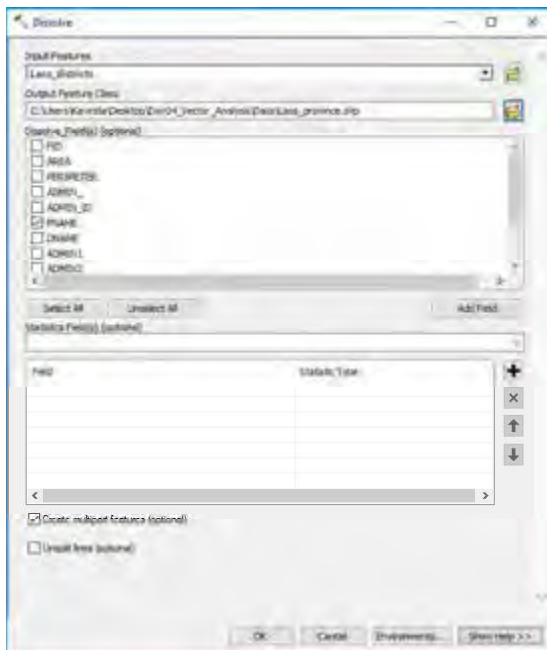
1. Open ArcTool Box
2. Data management Tools → Generalization → Dissolve





## Create Province Layer

Use Dissolve tool

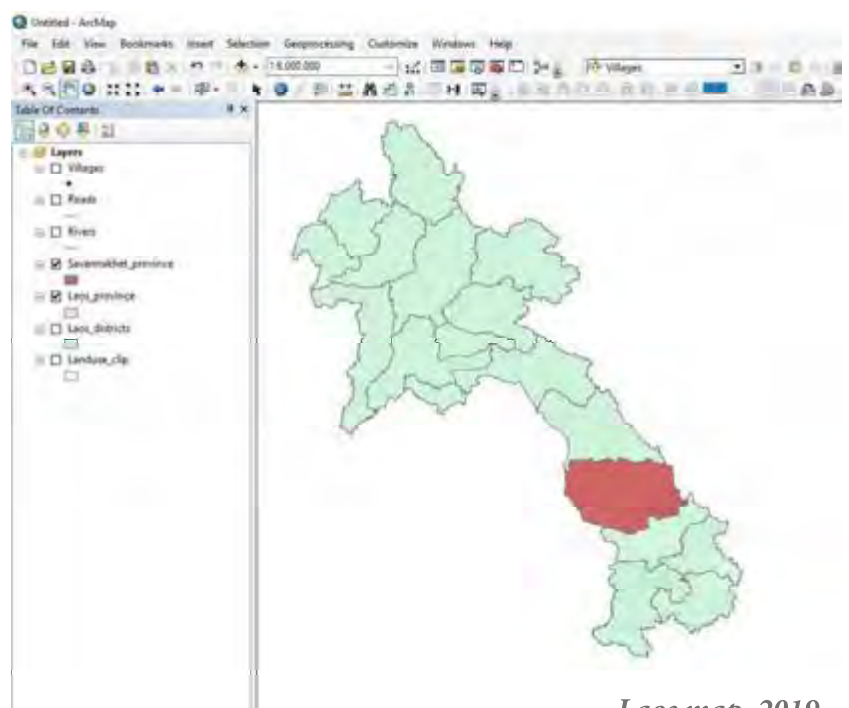


*Laos map, 2019*

## Create Savannakhet Province Layer

Export data into separate later

1. Select Savannakhet province
2. [R] click and Data ➔ Export Data



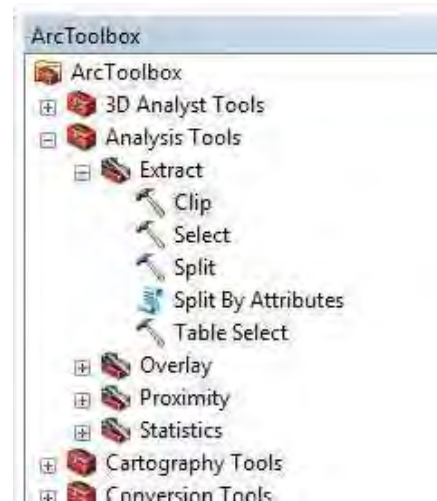
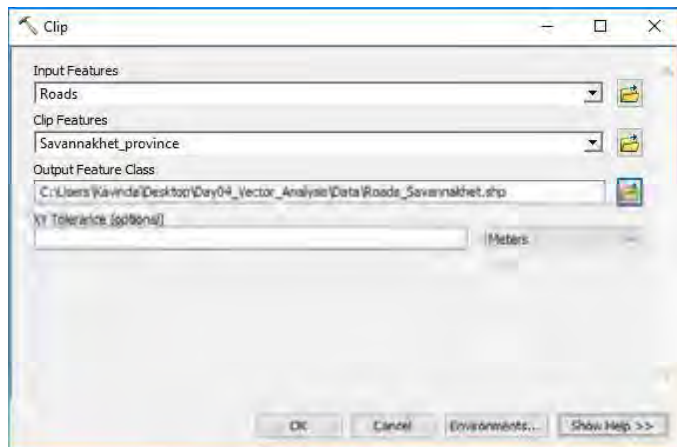
*Laos map, 2019*



## Data preparation for Savannakhet Province

- Use Clip Tool

1. Analysis Tools → Extract → Clip
2. Clip all the layers by Savannakhet province layer

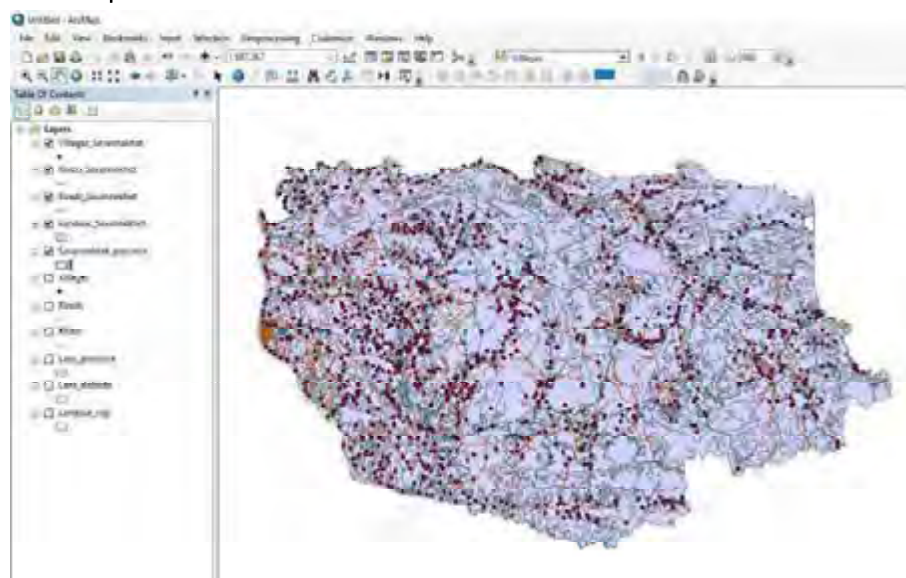


## Data preparation for Savannakhet Province

Use Clip Tool

## Use Clip Tool

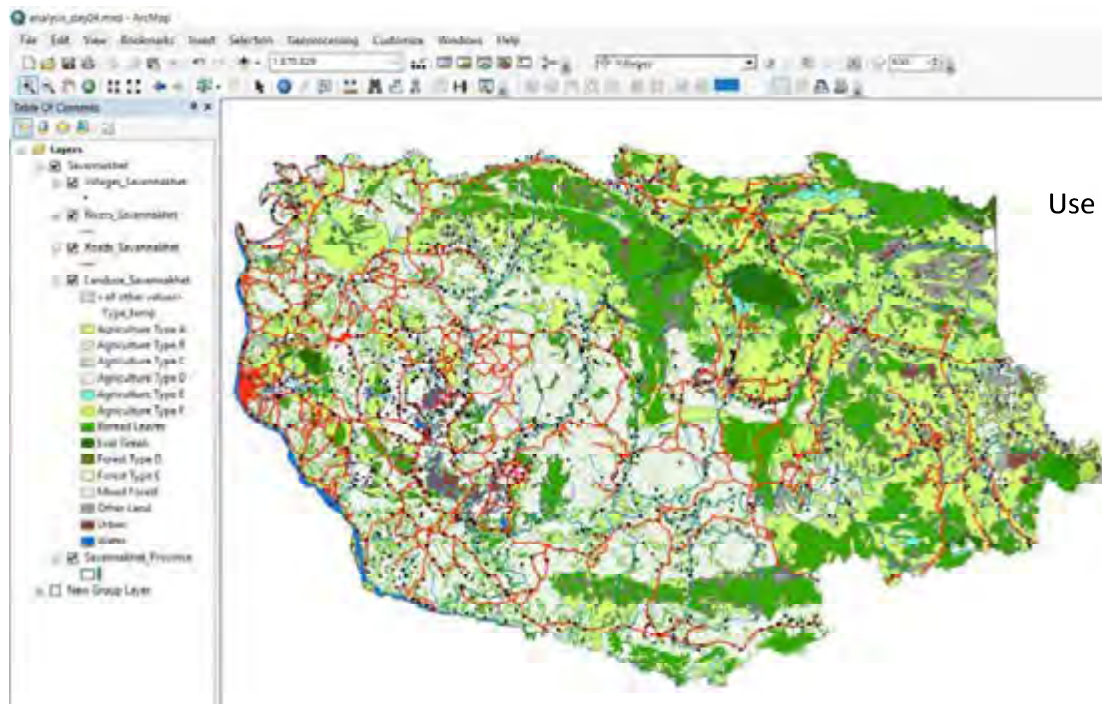
3. Clip landuse layer as well
4. Explore the dataset





## Data preparation for Savannakhet Province

Use Clip Tool



Use appropriate symbology

*Savannakhet province, Laos map, 2019*

## Adding GPS data and creating layer

Data preparation

1. Open "Agro-meto\_stations.xls" and explore the table

A screenshot of an Excel spreadsheet titled 'Agro-meto\_stations.xls'. The spreadsheet contains a table with 6 columns: CODE, TYPE\_ID, TYPE, Coverage\_KM, POINT\_X, and POINT\_Y. The data rows show various agro-meteorological stations with their respective codes, types, coverage areas, and coordinates.

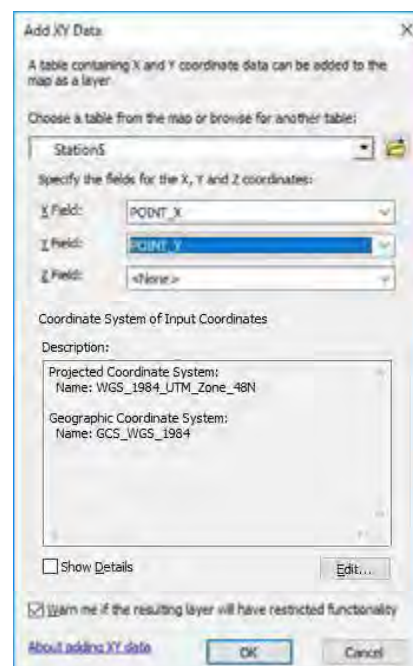
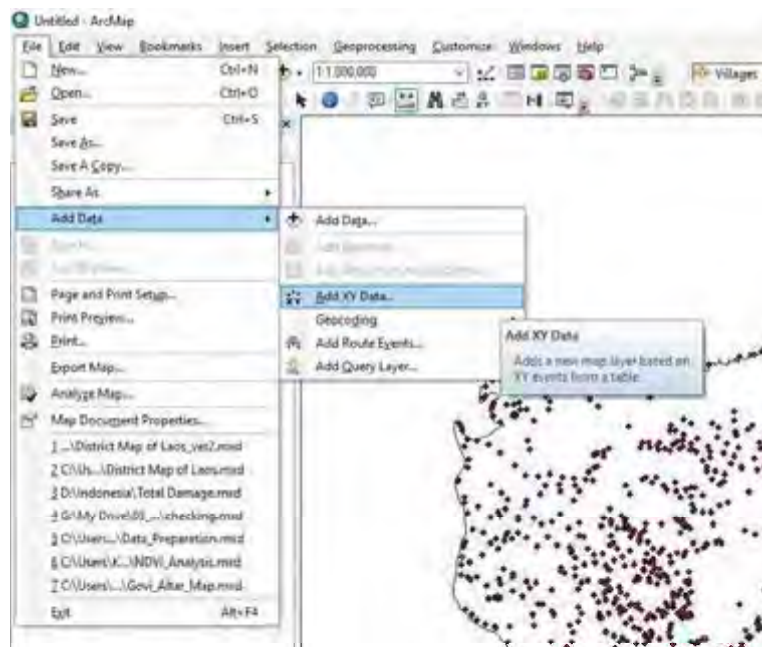
	A	B	C	D	E	F
	CODE	TYPE_ID	TYPE	Coverage_KM	POINT_X	POINT_Y
2	10001	1	Agro-met Station Type A	5	474724.198354000000	1829664.873680000000
3	10002	2	Agro-met Station Type B	3	494502.498801000000	1805445.292600000000
4	10003	2	Agro-met Station Type B	3	513892.071235000000	1819139.500230000000
5	10004	2	Agro-met Station Type B	3	536583.054955000000	1812942.618600000000
6	10005	2	Agro-met Station Type B	3	905538.306496000000	1877215.250750000000
7	10006	3	Agro-met Station Type C	2	498300.917791000000	1857323.684940000000
8	10007	3	Agro-met Station Type C	2	548279.753011000000	1846228.183400000000
9	10008	3	Agro-met Station Type C	2	527388.672447000000	1814741.371290000000
10	10009	4	Agro-met Station Type D	2	488804.827342000000	1813941.640490000000
11	10010	4	Agro-met Station Type D	2	502298.804725000000	1806444.797800000000
12	10011	4	Agro-met Station Type D	2	505397.509474000000	1807744.394120000000
13	10012	4	Agro-met Station Type D	2	506796.789341000000	1858423.157830000000
14	10013	4	Agro-met Station Type D	2	550678.626331000000	1770359.895500000000
15	10014	4	Agro-met Station Type D	2	533086.516653000000	1817540.118770000000
16	10015	4	Agro-met Station Type D	2	553877.263471000000	1822138.228580000000
17	10016	4	Agro-met Station Type D	2	479808.725912000000	1882013.272920000000
18	10017	4	Agro-met Station Type D	2	481807.645170000000	1878014.852810000000
19	10018	4	Agro-met Station Type D	2	487204.989504000000	1874916.316810000000
20	10019	4	Agro-met Station Type D	2	615451.743943000000	1871517.663420000000
21	10020	4	Agro-met Station Type D	2	577567.485524000000	1894312.322460000000



## Adding GPS data and creating layer

### Data preparation

2. Go to File → Add Data → Add XY Data

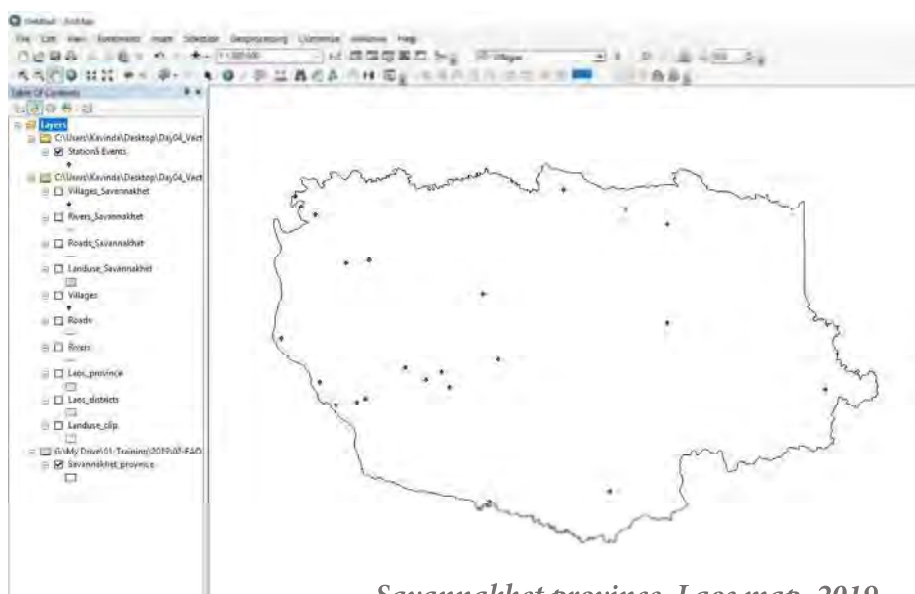


## Adding GPS data and creating layer

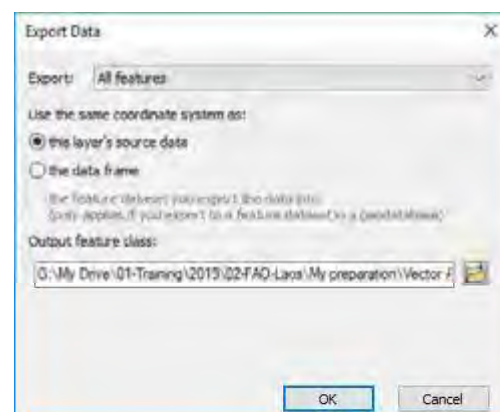
### Data preparation

2. Explore the data, this is temporary file

3. To make it permanent file; [R] click → Data → Export Data



*Savannakhet province, Laos map, 2019*

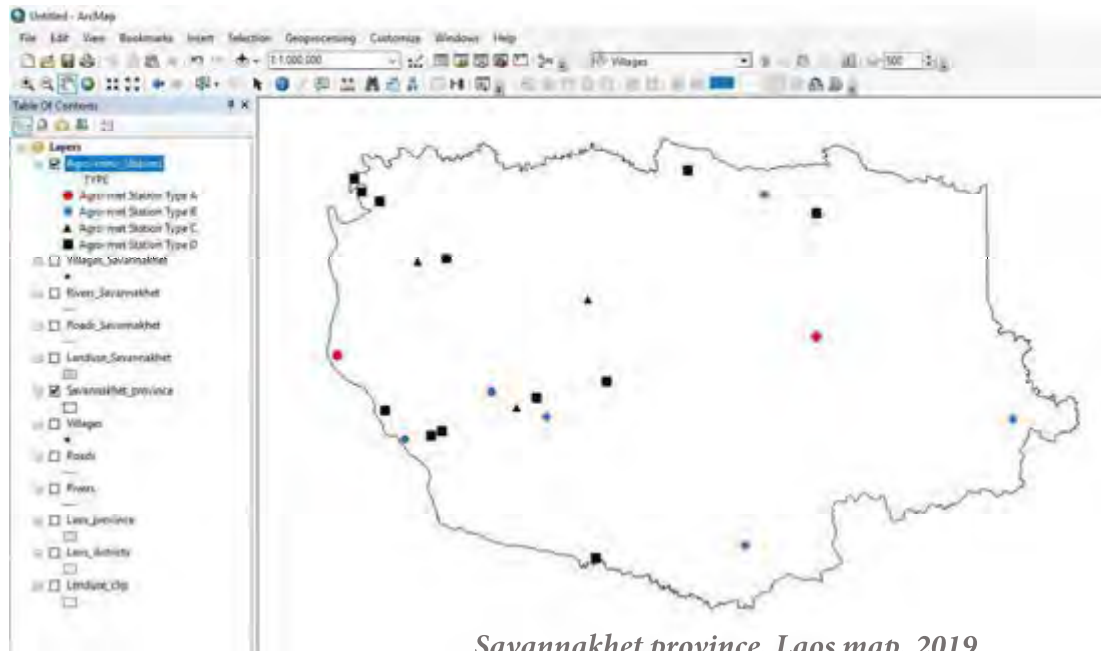




## Adding GPS data and creating layer

Data preparation

### 4. Symbolize the created later

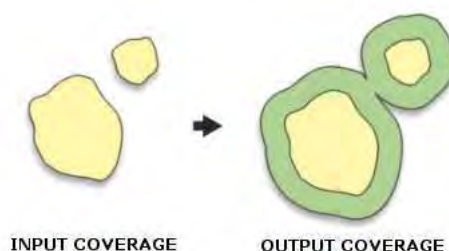
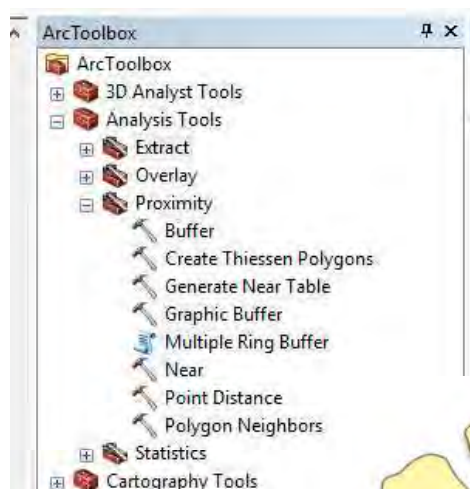


*Savannakhet province, Laos map, 2019*

## Proximity Tools

Use Buffer Tool

### 1. Analysis Tools → Proximity → Buffer

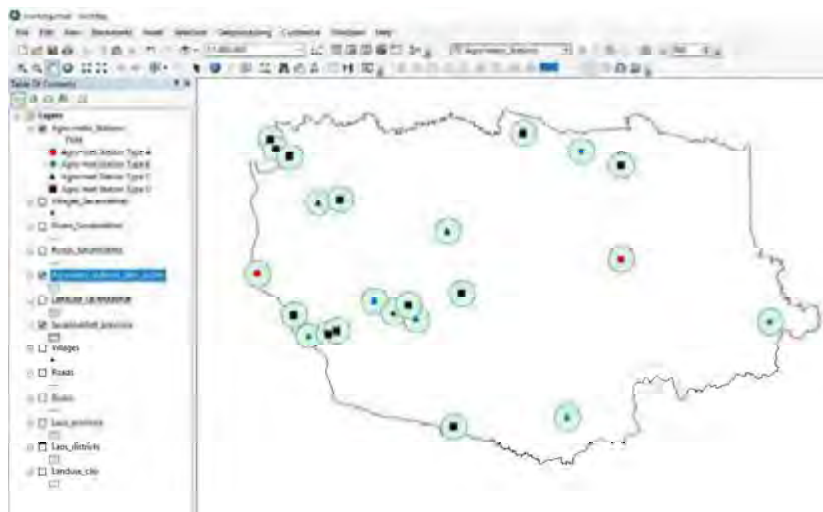




## Proximity Tools

Use Buffer Tool

### 2. Create 5km buffer for Agromet stations

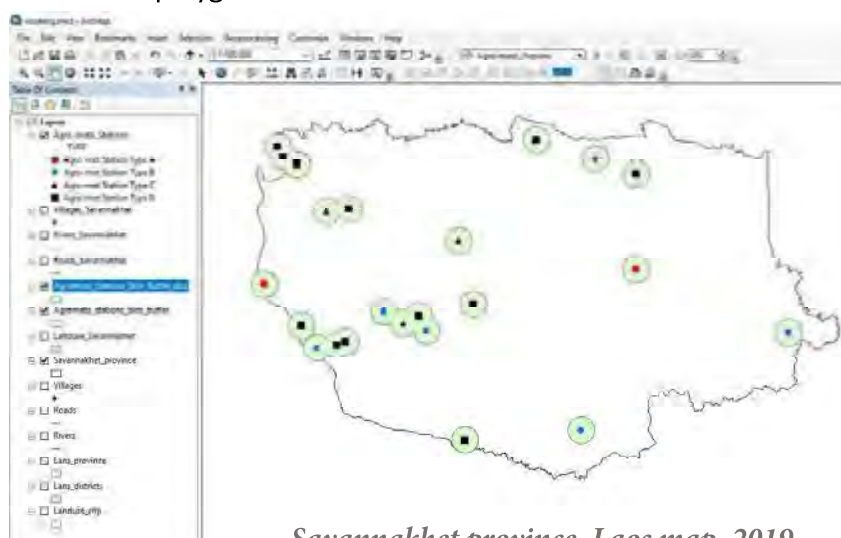
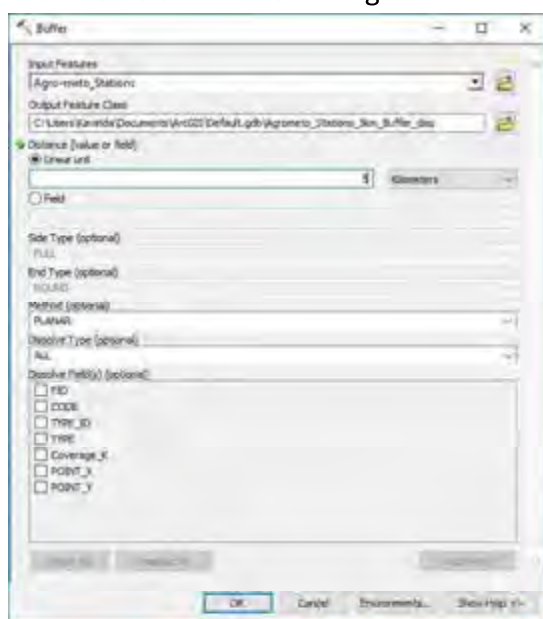


*Savannakhet province, Laos map, 2019*

## Proximity Tools

Use Buffer Tool: Try with Dissolve Type: All

### 3. Create 5km buffer for Agromet stations with dissolve polygons



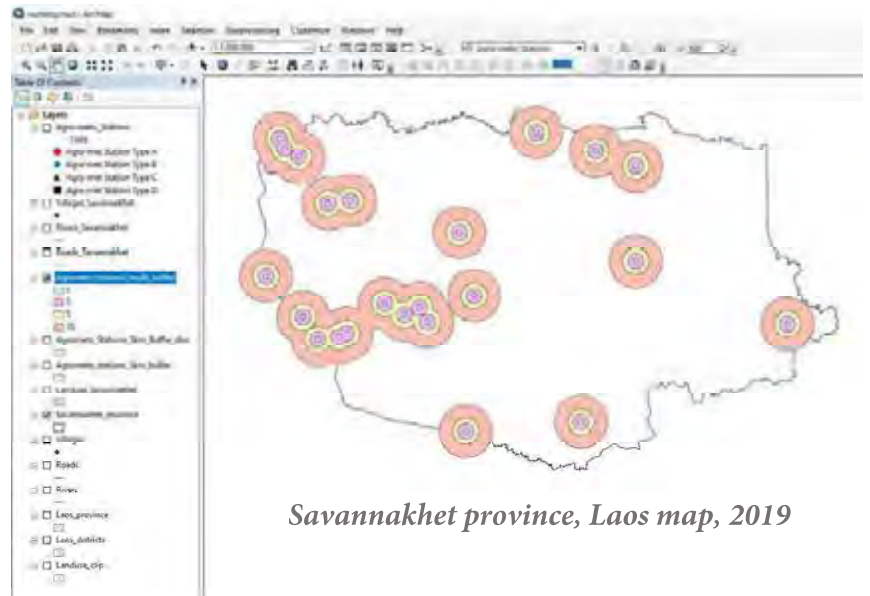
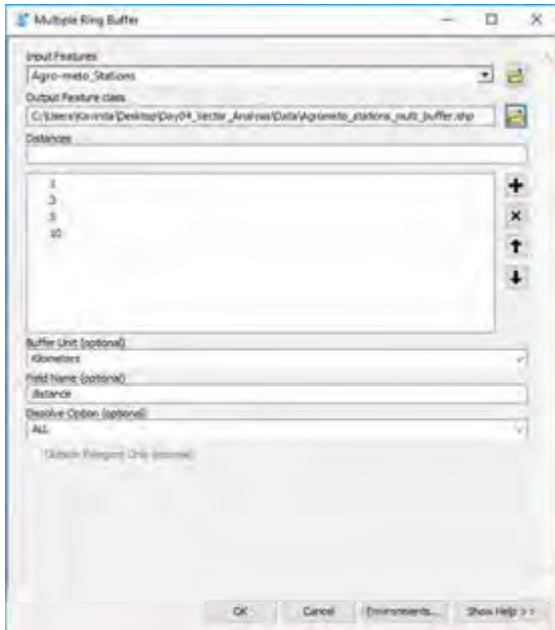
*Savannakhet province, Laos map, 2019*



## Proximity Tools

Use Buffer Tool: Try with Multiple Ring Buffer

4. Create 1, 3, 5, 10 km buffer for Agromet stations with dissolve polygons

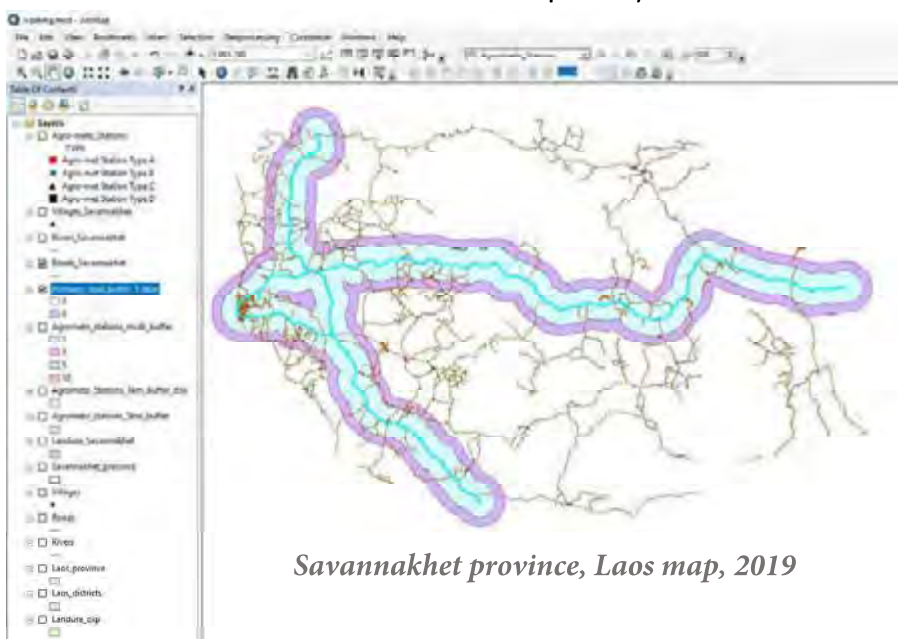


*Savannakhet province, Laos map, 2019*

## Proximity Tools: Self-task I

Use Buffer Tool: buffer for line feature

1. Create 5km and 8 km buffer zones for “primary” road in Savannakhet province



*Savannakhet province, Laos map, 2019*



How many villages within 10km distance to all agromet stations in Savannakhet Province?

Answers by Participants:

1<sup>st</sup> place: 393 villages by Natnakhone SAENGCHAN

2<sup>nd</sup> place: 393 villages by Sengduangduan

3<sup>rd</sup> place: 393 villages by Phousavanh

4<sup>th</sup> place: 393 villages by Phapasit

5<sup>th</sup> place: 393 villages by Kaemery CHAO

6<sup>TH</sup> place:

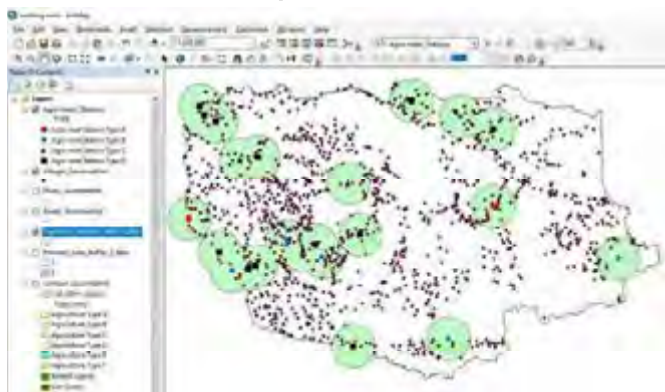
## Proximity Tools: Self-task II

Hint: You can do this several ways; buffer tools and clip or select by location tool

Identify the villages within 10km distance to agromet stations

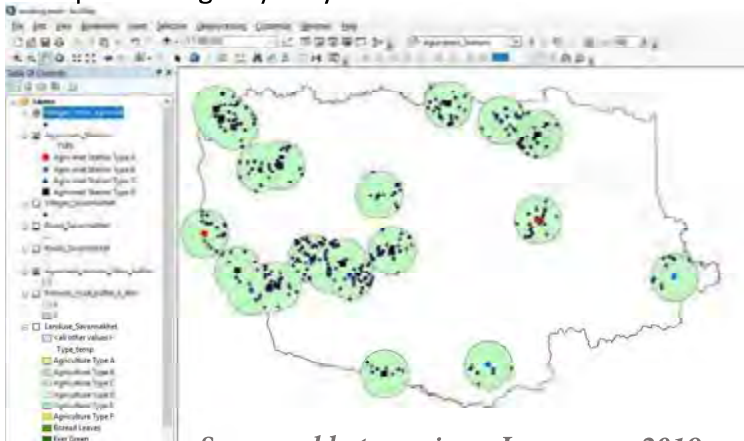
Answer: using buffer and clip tools

1. 10km buffer for Agromet Stations



*Savannakhet province, Laos map, 2019*

2. Clip the village layer by 10km buffer



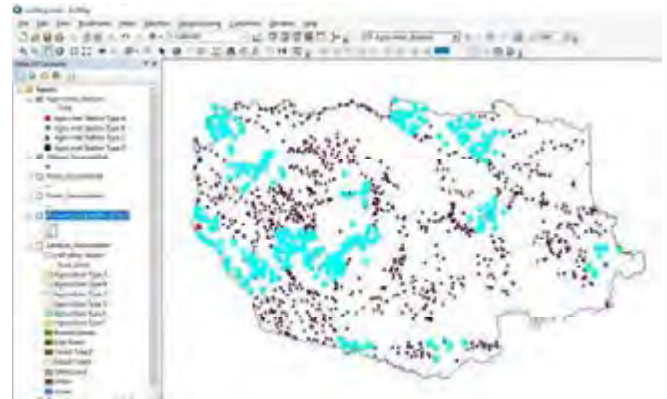
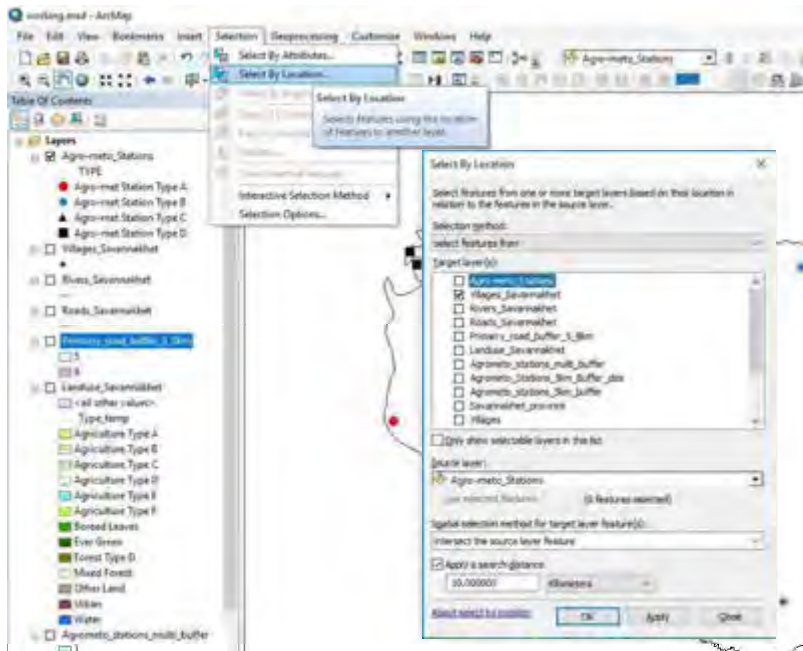
*Savannakhet province, Laos map, 2019*



## Answer: using Select By Location tool

Hint: you have to do two types of operations

1. Identify the villages within 10km distance to agromet stations



Savannakhet province, Laos map, 2019

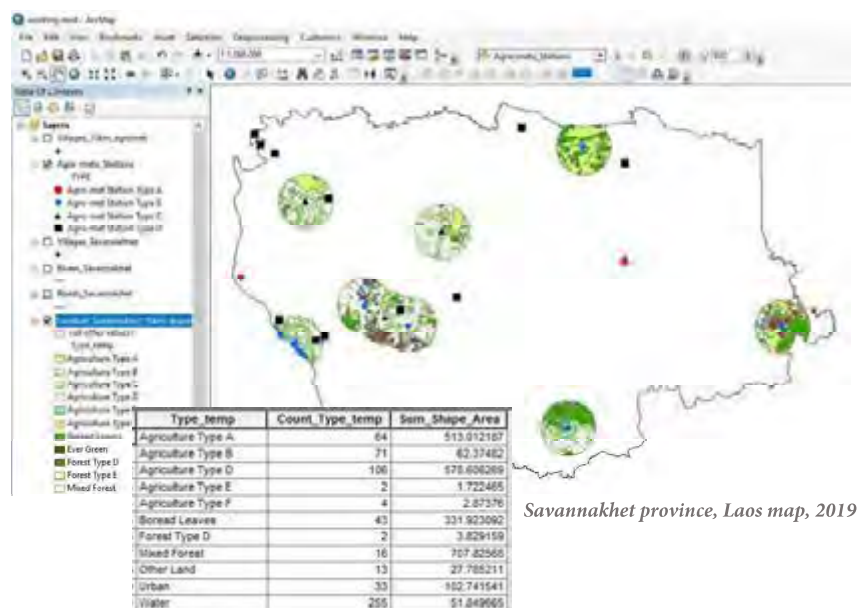
## Overlay operations: Self-task III

Hint: you have learnt all the tools to do this operation

Create a separate landuse layer within the distance of 10km from Agromet stations Type B and C. Then generate area (sqkm) vs landuse type table and area percentage

Steps:

1. Select Agromet Stations Type B and C
2. Create a new layer of Agromet stations Type B and C
3. Create a 10km buffer for above layer
4. Clip landuse layer by 10km buffer
5. Calculate area
6. Use Summarize tool



Savannakhet province, Laos map, 2019

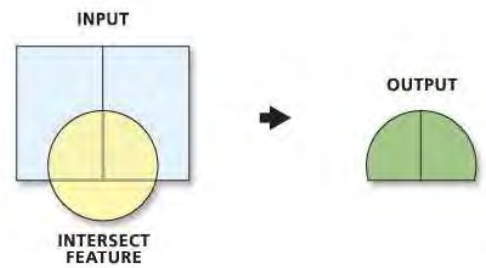


## Use of Intersect and Union tool

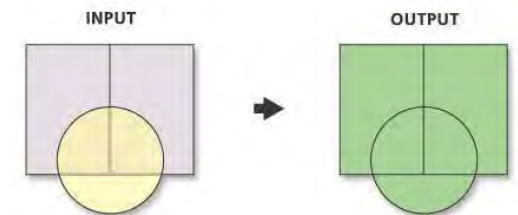
Understand the concept of these vector operations

1. Two layers use for demonstrate of these tool (Landuse and Agromet stations)
2. Make a 5km and 10km multiple ring buffer for agromet stations
3. Carefully check the attribute table of both layers before performing analysis
4. Perform Intersect operation
5. Check and understand the generated attribute table
6. Perform Union operation
7. Check and understand the generated attribute table

### Intersect

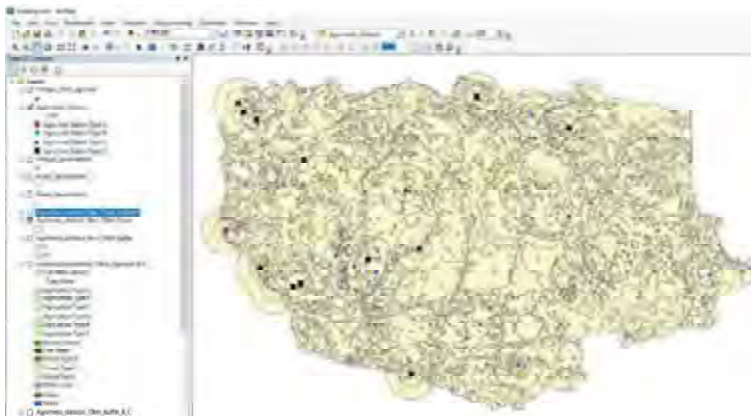


### Union

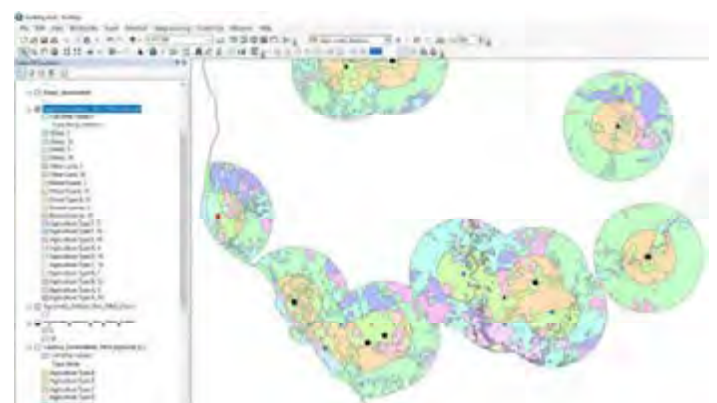


## Use of Intersect and Union tool

Understand the concept of these vector operations



Union results



Intersect results



## Merge and Append tools

How to add newly established Agromet stations

How to add newly established Agro Meteorological Stations to the existing Agromet station dataset?

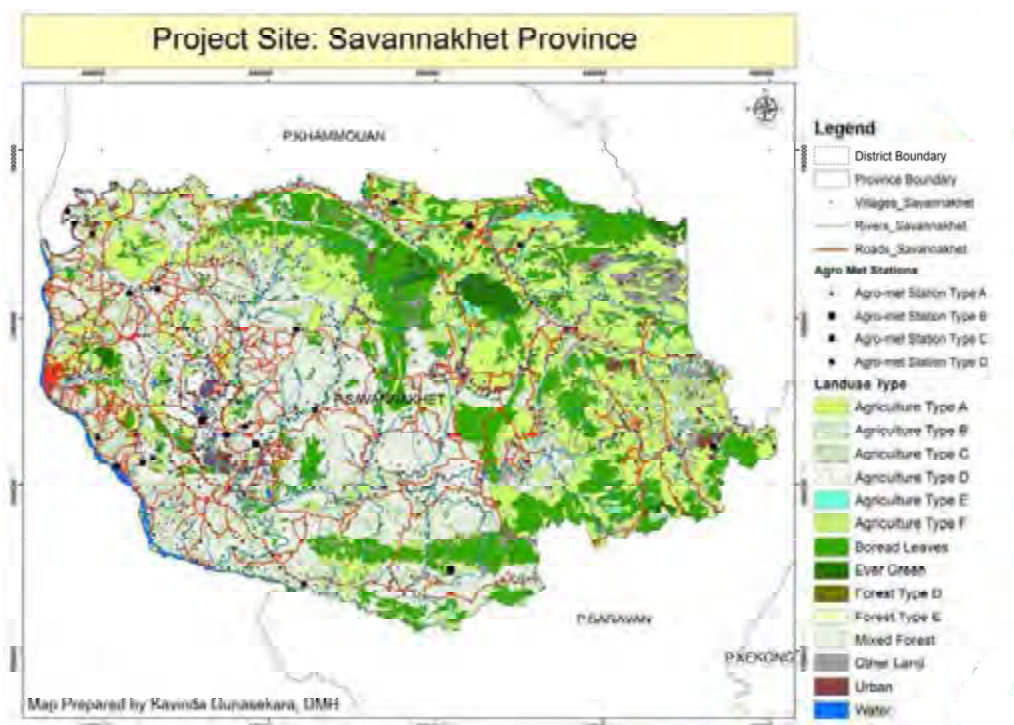
1. Right hand table shows the coordinates of new Agro Meteorological stations (coordinates in UTM 48N WGS84)
2. Make a new layer of newly established stations
3. Merge newly created stations with existing stations
4. Try append tool as well, as the second option

X Coordinate	Y Coordinate	Code
582722.43	1842666.56	10024
588543.56	1808271.36	10025
649397.34	1850869.08	10026

# Home work



Home work - make a map similar to this



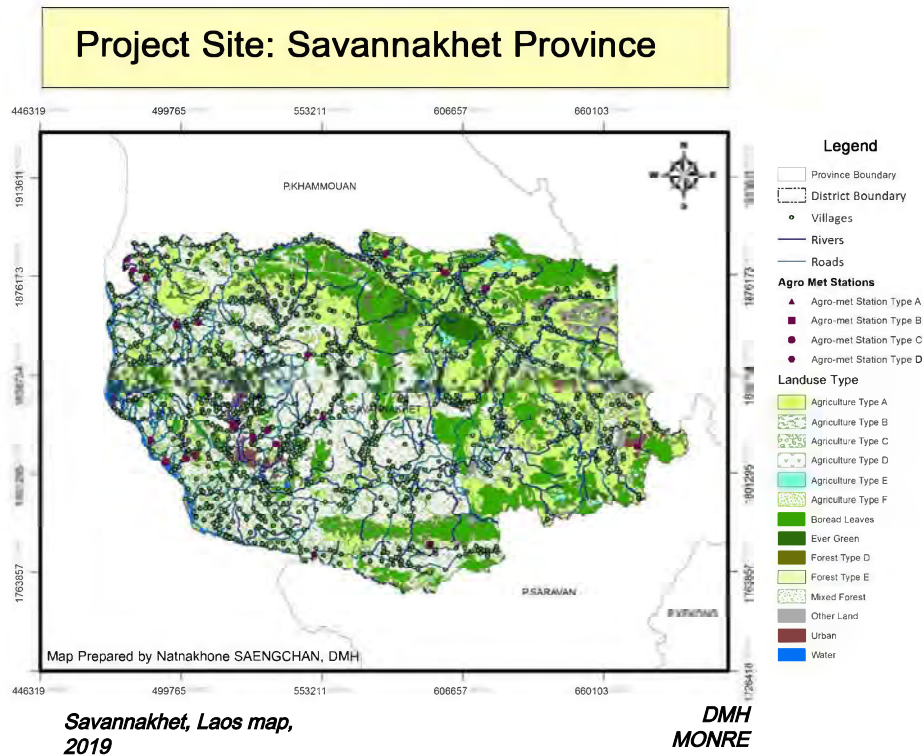
*Savannakhet, Laos map,  
2019*

*DMH  
MONRE*

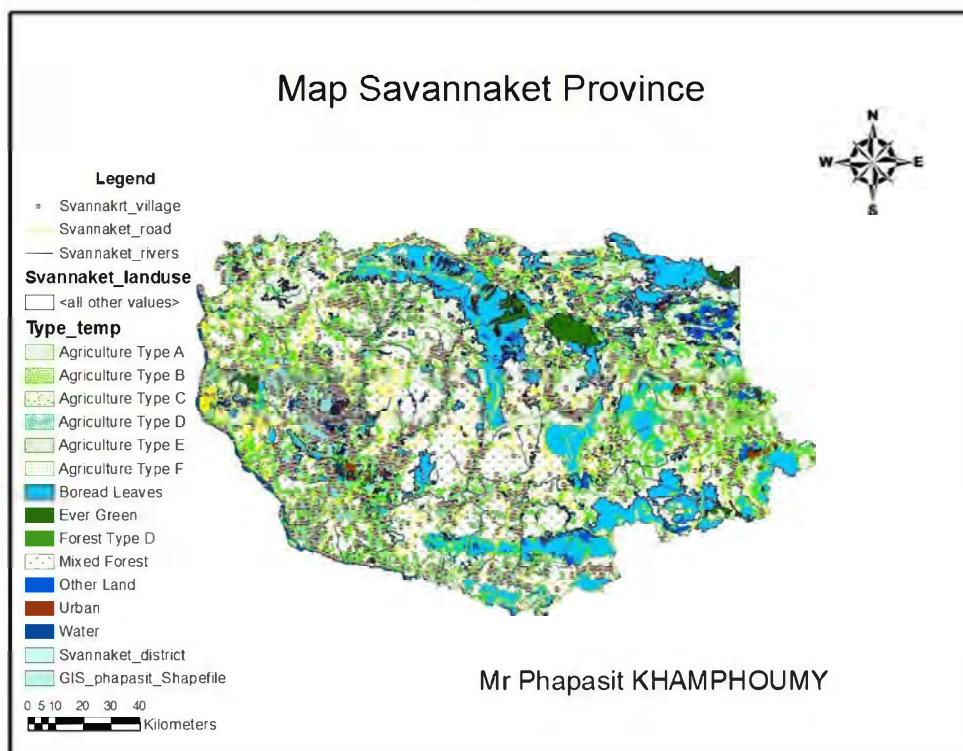
Participants Answers



## Home work - Map prepared by Natnakhone



## Home work - Map prepared by Phapasit

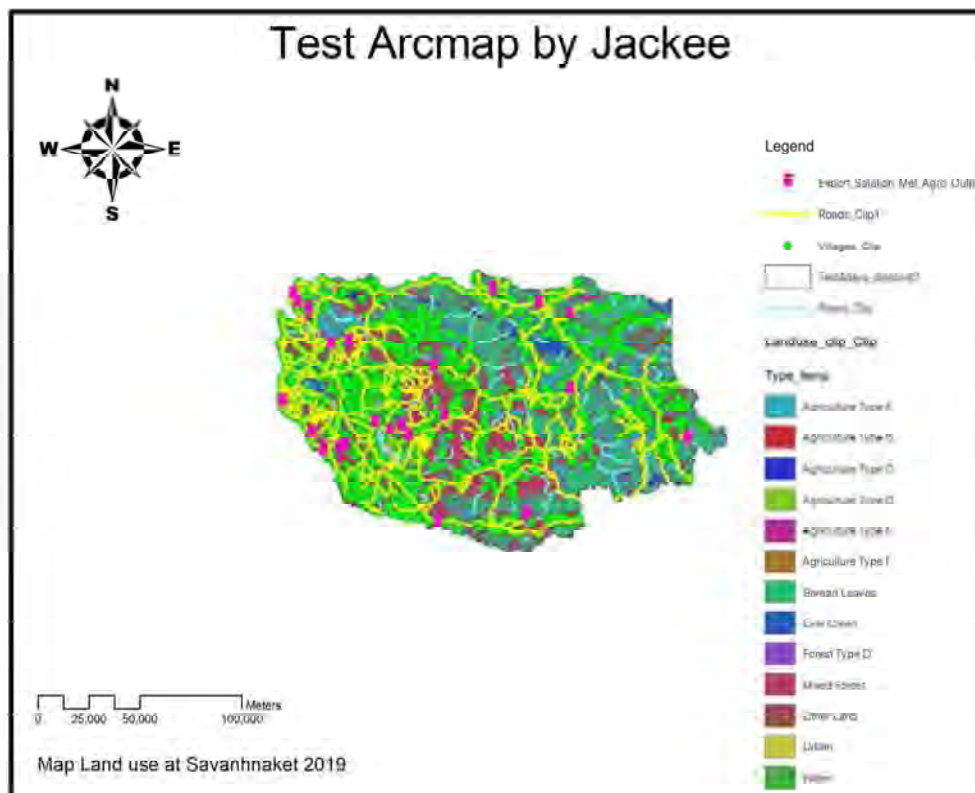
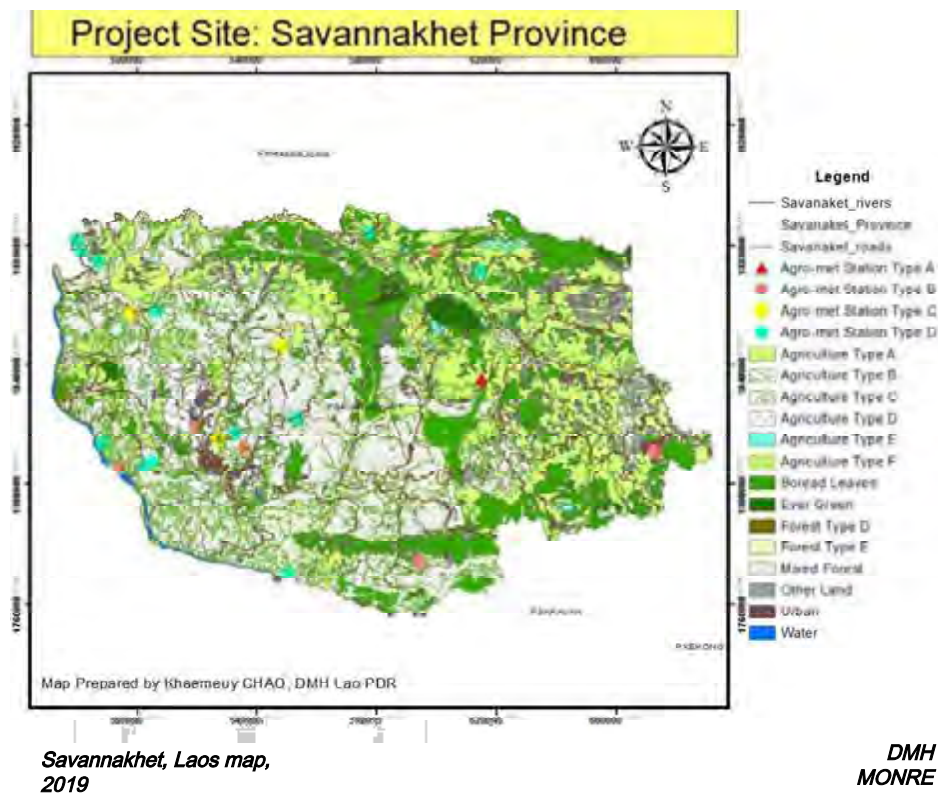


*Savannakhet, Laos map, 2019*

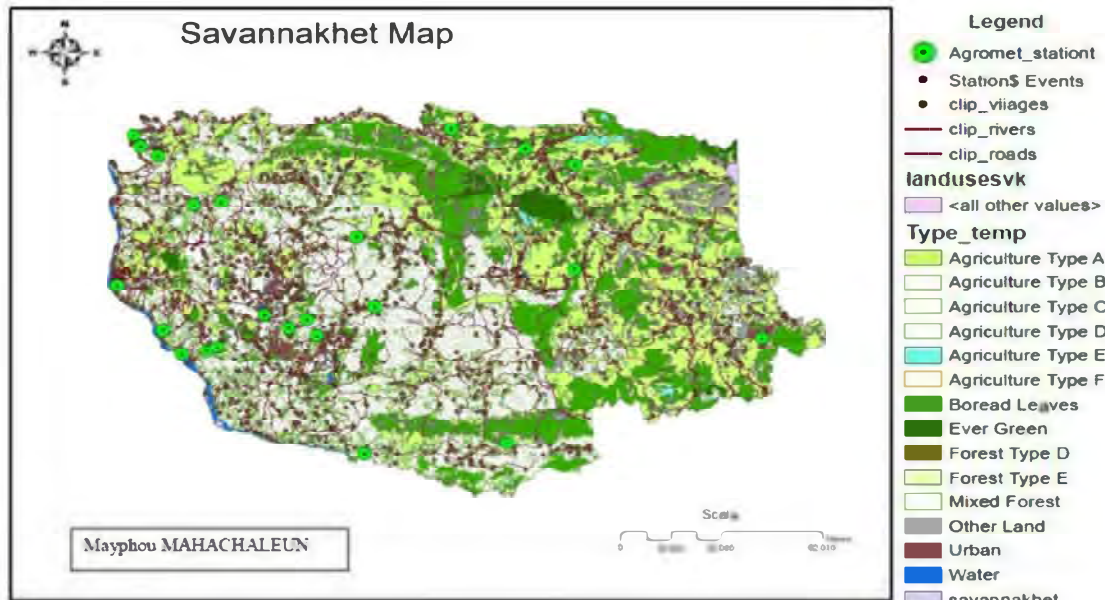
DMH  
MONRE



## Home work – Map prepared by Phapasit

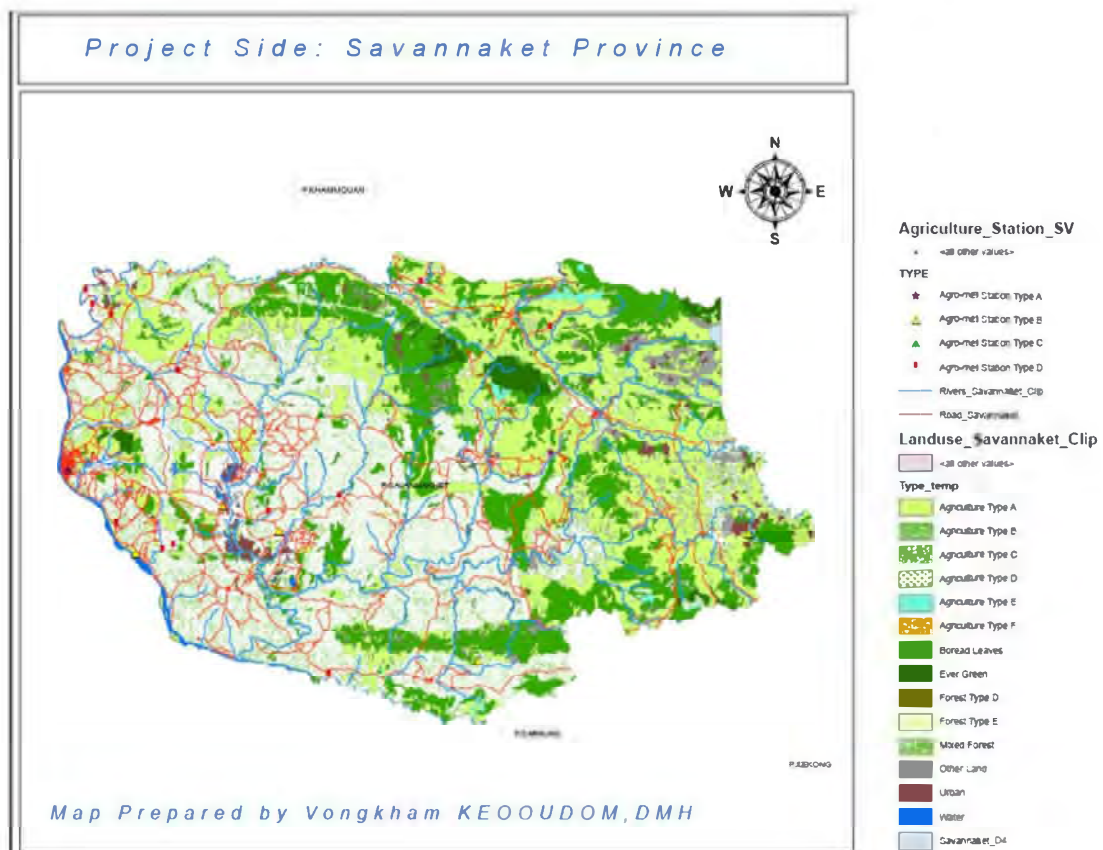






Savannakhet, Laos map,  
2019

DMH  
MONRE

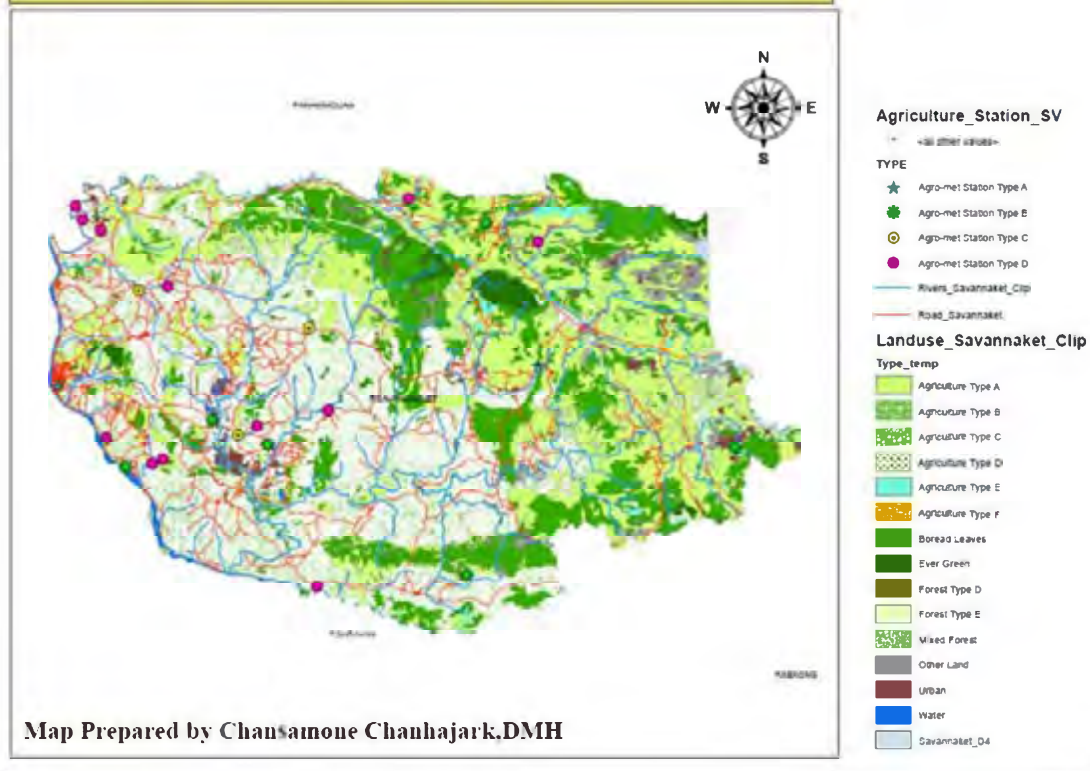


Savannakhet, Laos map,  
2019

DMH  
MONRE



## Project Side: Savannakhet Province



Savannakhet, Laos map,  
2019

DMH  
MONRE

## Home wrok: teacher vs student

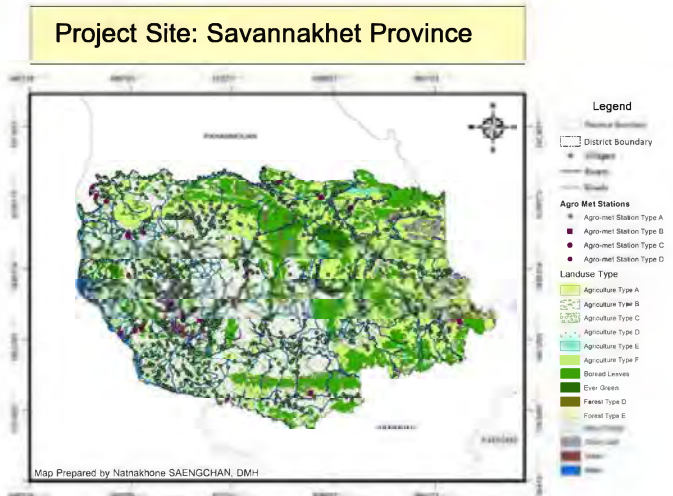
### Teachers' map



Savannakhet, Laos map,  
2019

DMH  
MONRE

### Mr. Natnakhone's Map



Savannakhet, Laos map,  
2019

DMH  
MONRE



# Vector & Raster Analysis

## Part II

Basic useful tools in vector & raster operations  
(data use in this exercise is only for demonstration purpose only)

Dr. Kavinda Gunasekara  
Frank Yrle



Strengthening Agro-climatic Monitoring and Information Systems (SAMIS)  
to improve adaptation to climate change and food security in Lao PDR

### Learning topics

Overview of the exercise

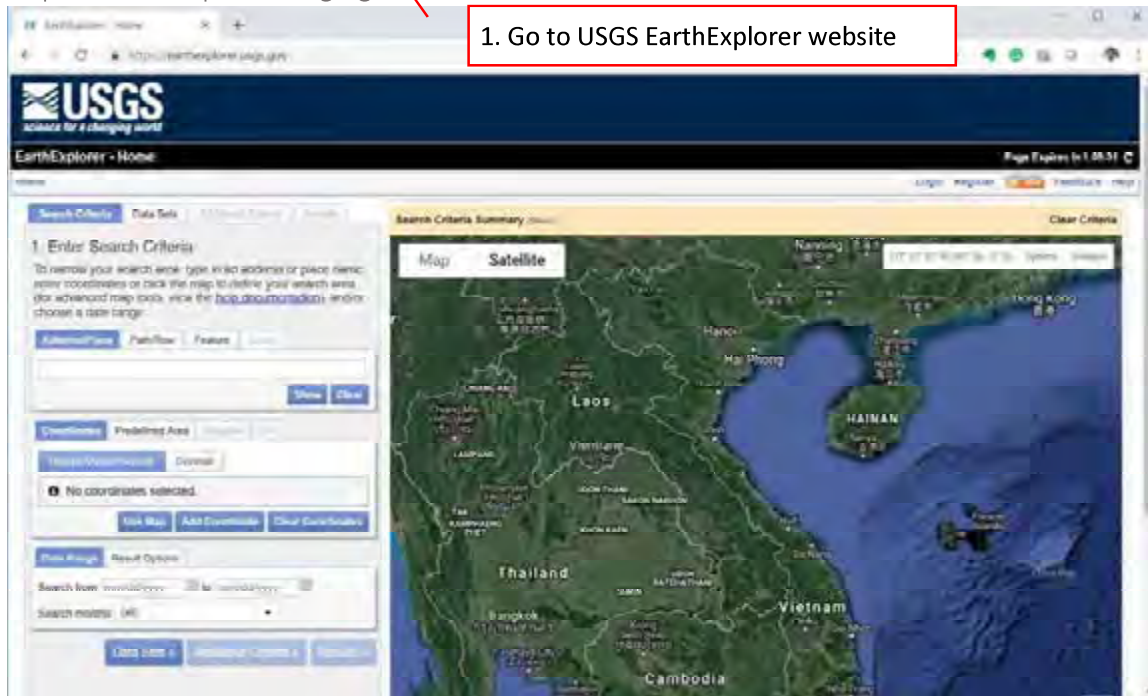
1. Adding raster data: freely downloaded SRTM30 tiles
2. Explore raster data
3. How to make mosaic raster
4. How to clip raster data by a polygon
5. How to make Slope layer
6. How to make Aspect/hillshade layer
7. How to reclassify raster data
8. How to convert in between Raster and vector
9. Final vector overlay operation: finding best locations for new Agro Meteorological stations



## How you can download free elevation data?

<https://earthexplorer.usgs.gov/>

1. Go to USGS EarthExplorer website



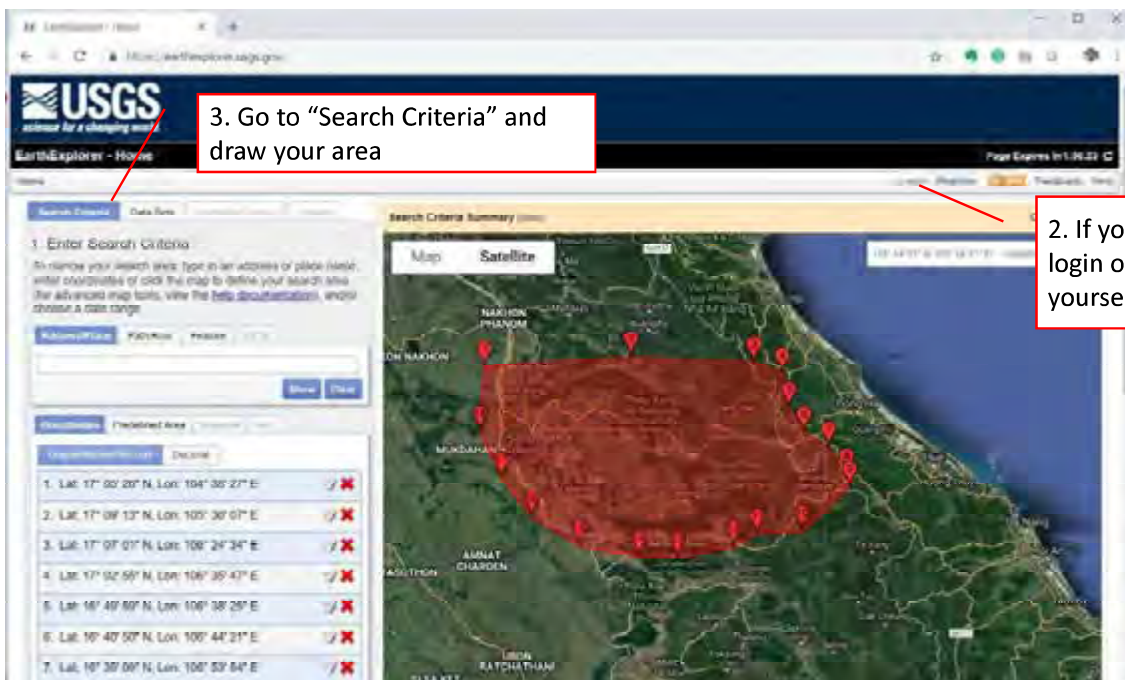
Laos map, 2019

## How you can download free elevation data?

<https://earthexplorer.usgs.gov/>

3. Go to "Search Criteria" and draw your area

2. If you have an account please login otherwise Register yourself.

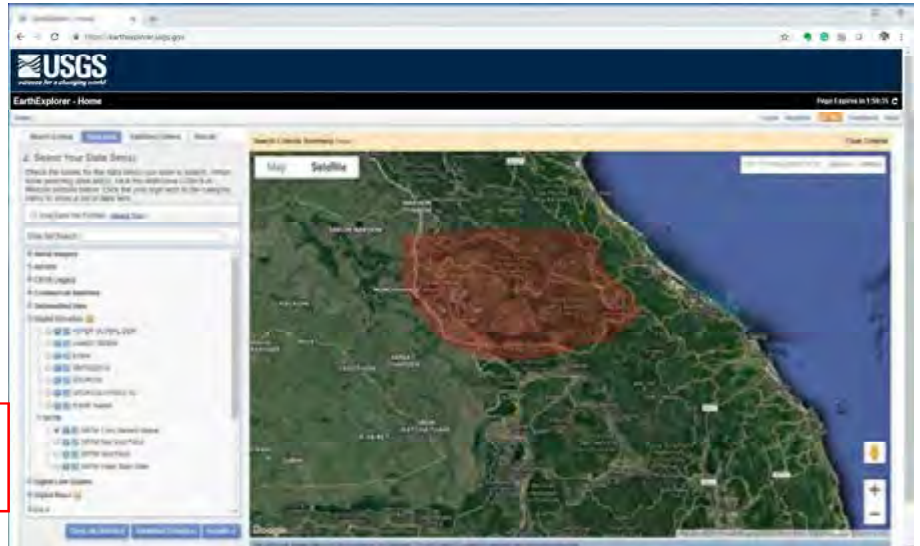
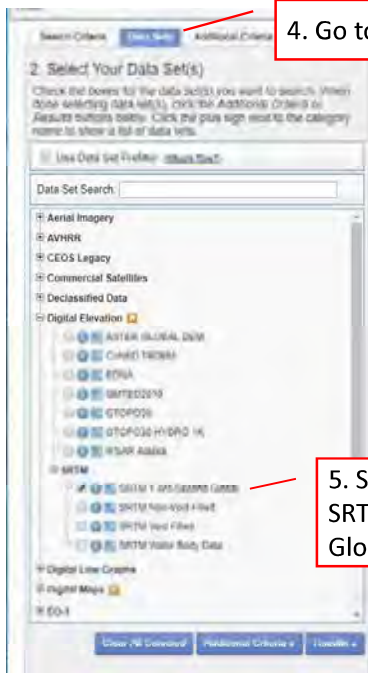


Savannakhet, Laos map, 2019



## How you can download free elevation data?

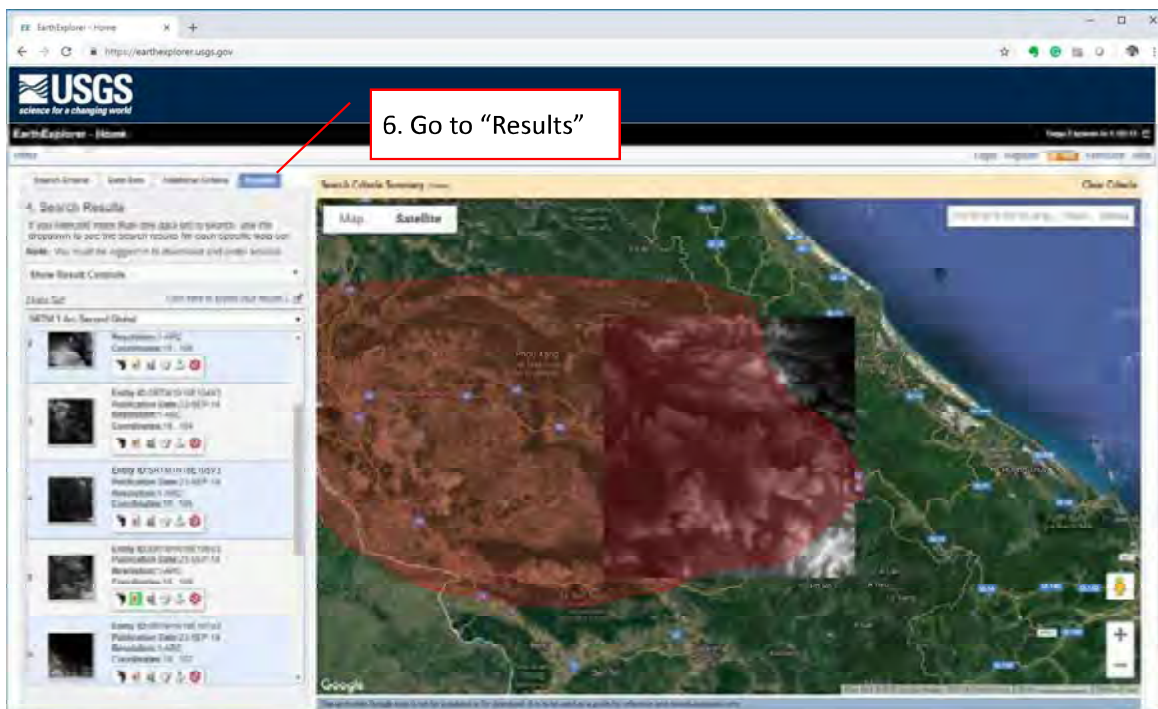
<https://earthexplorer.usgs.gov/>



Savannakhet, Laos map, 2019

## How you can download free elevation data?

<https://earthexplorer.usgs.gov/>

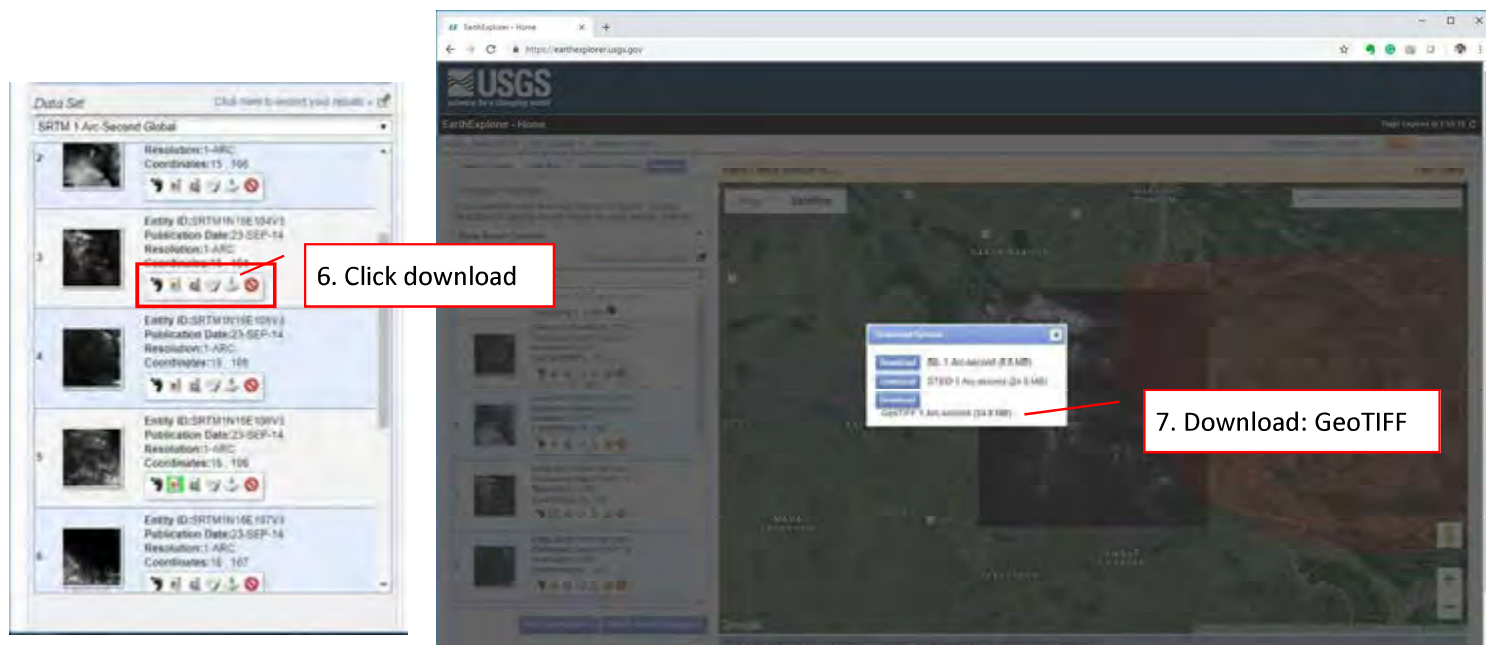


Savannakhet, Laos map, 2019



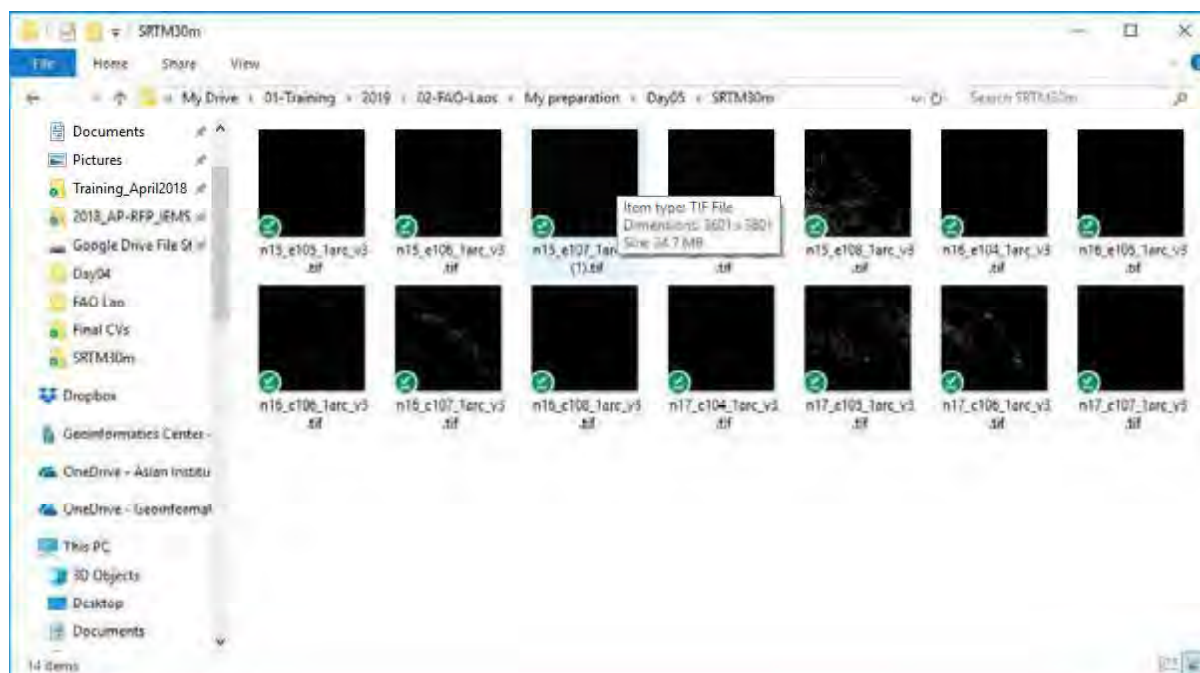
## How you can download free elevation data?

<https://earthexplorer.usgs.gov/>



## Downloaded SRTM 30m Elevation Data

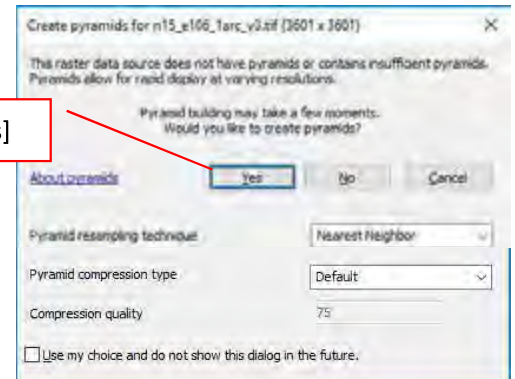
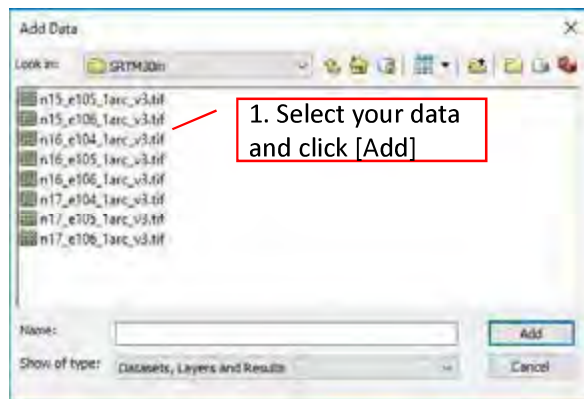
Browse the downloaded using windows explorer





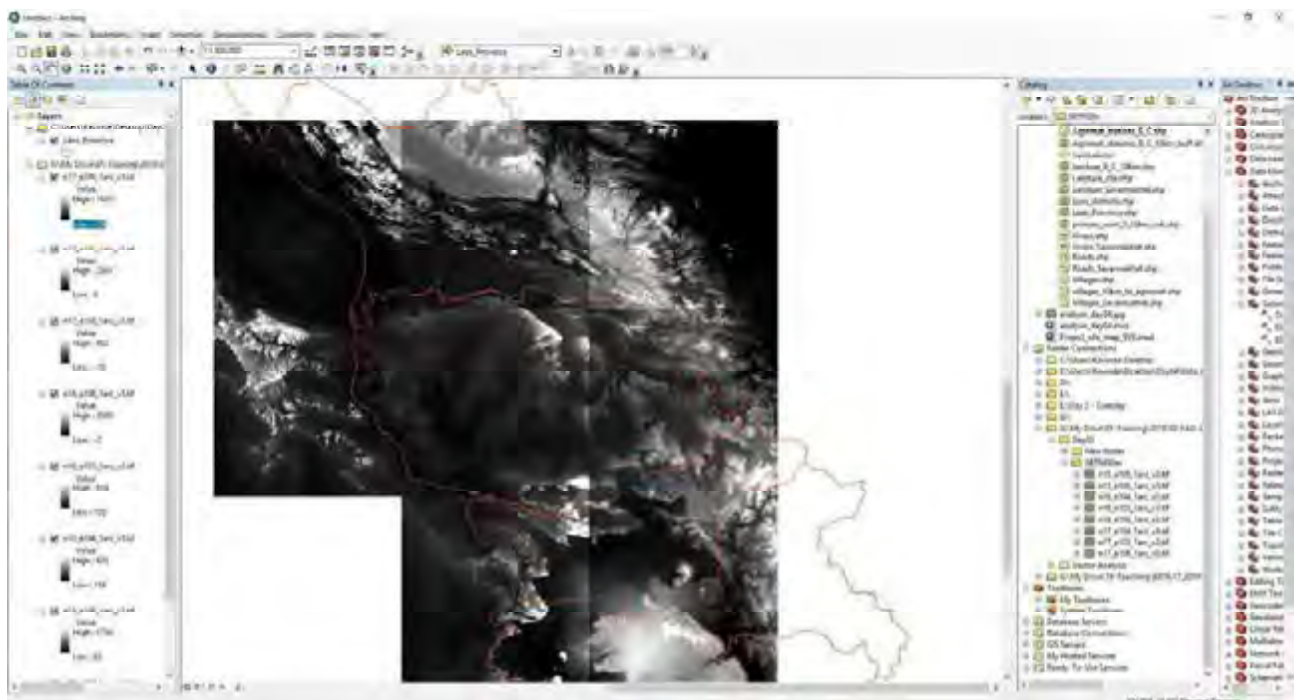
## How to open Raster data in ArcMap

Go to Add Data → browse your data folder



## How to open Raster data in ArcMap

Elevation data

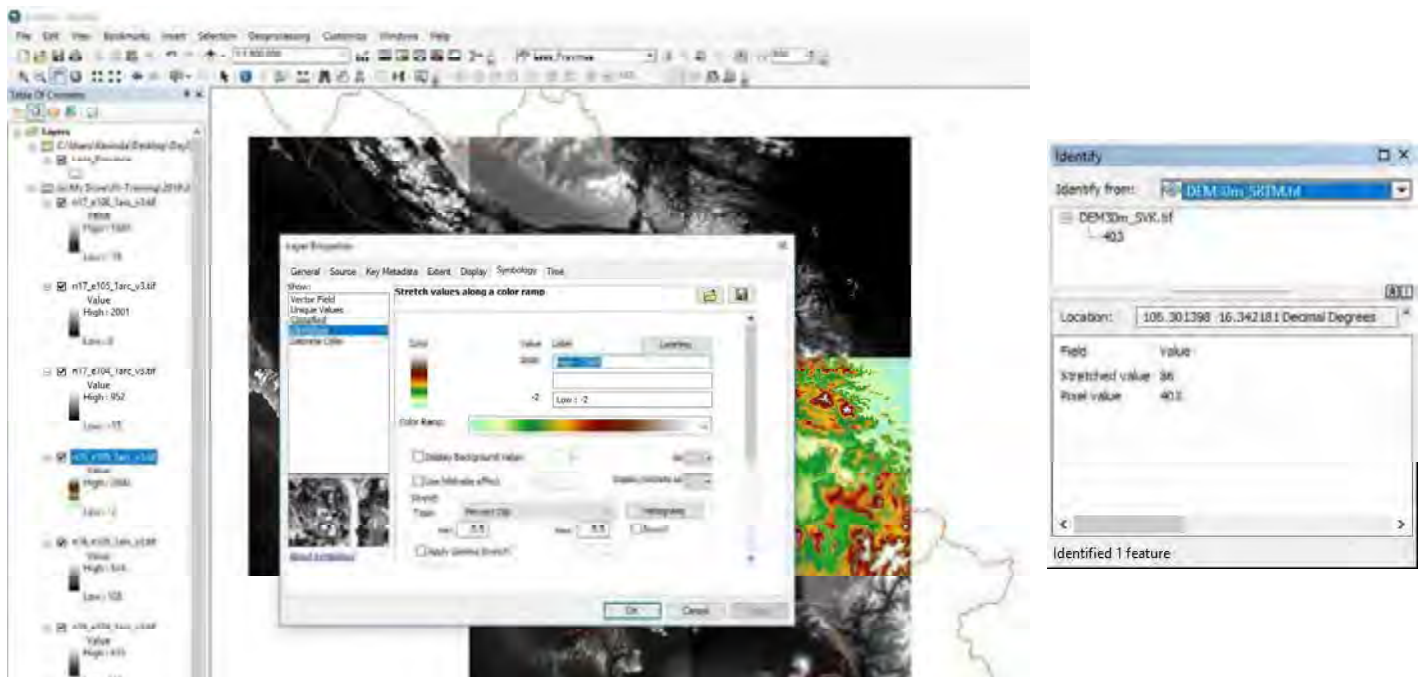


Savannakhet, Laos map, 2019



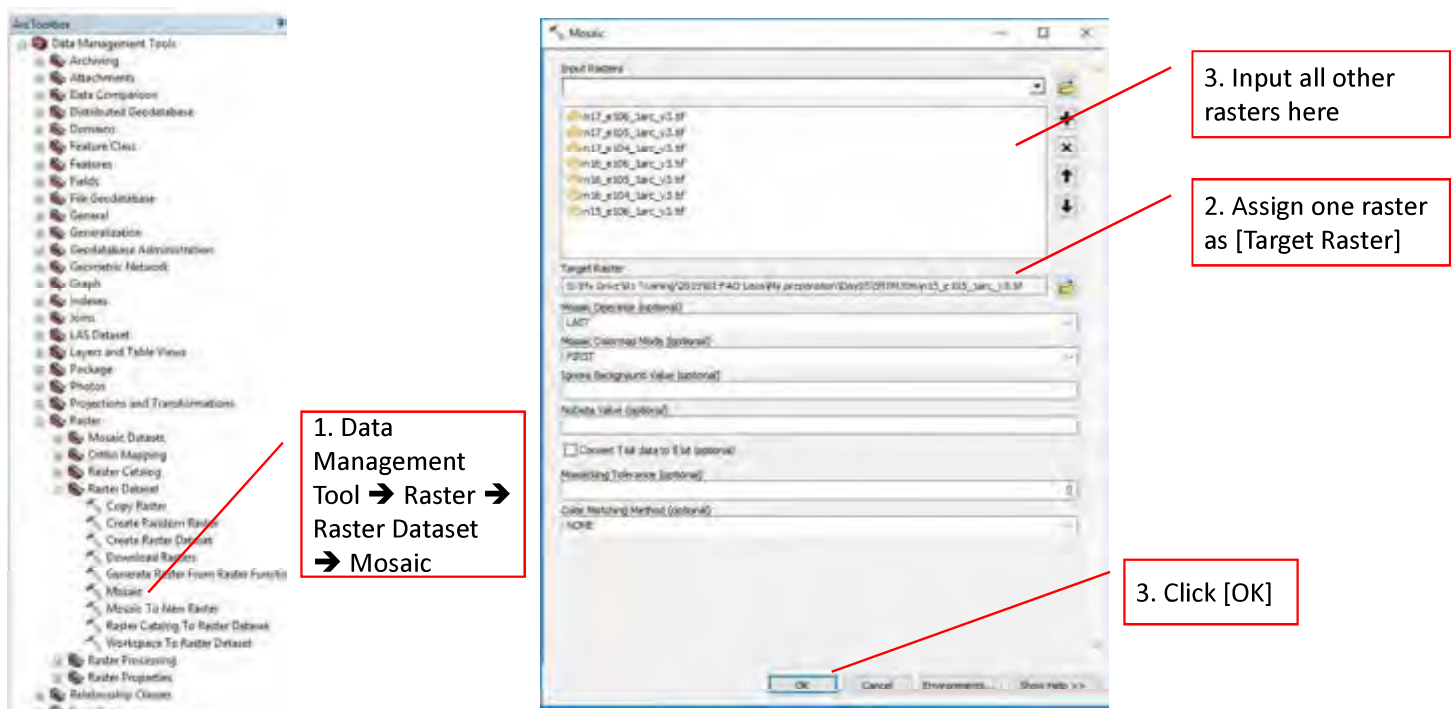
## Explore the added raster data

Use identity tool and try to change symbology



## How to mosaic raster data

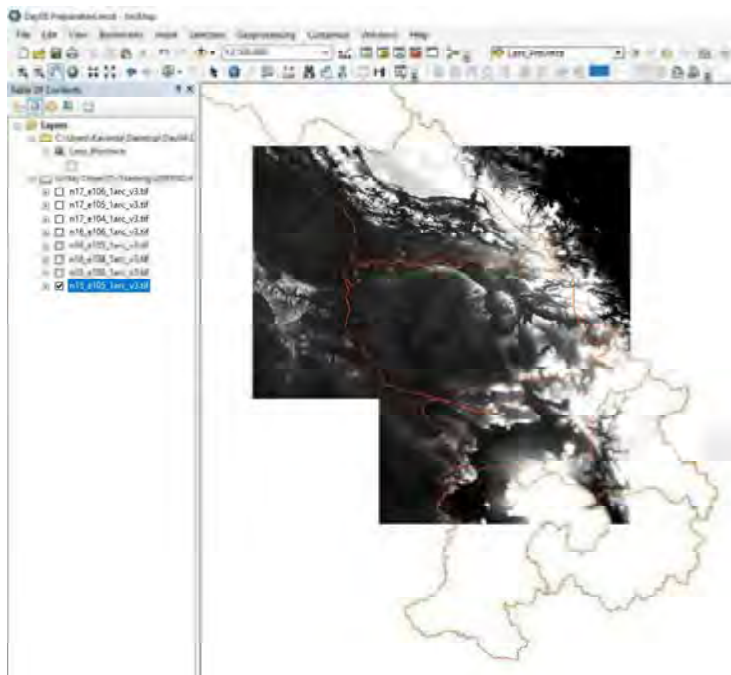
Making single raster for whole Savannakhet province



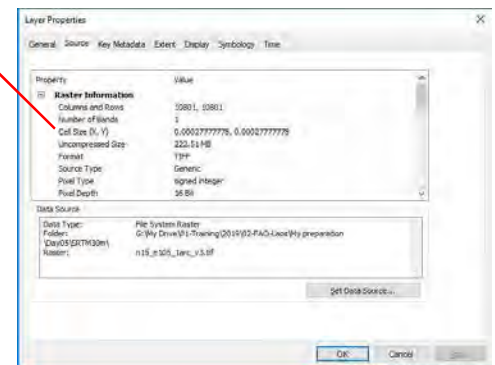


## Explore generated raster data

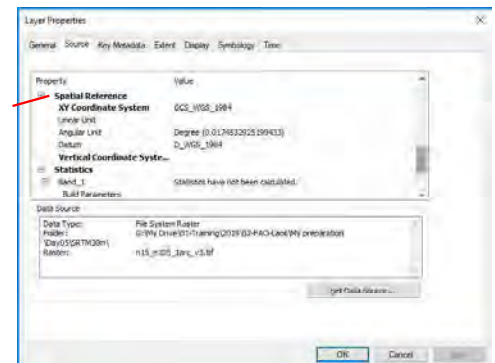
Check layer properties



Check cell size



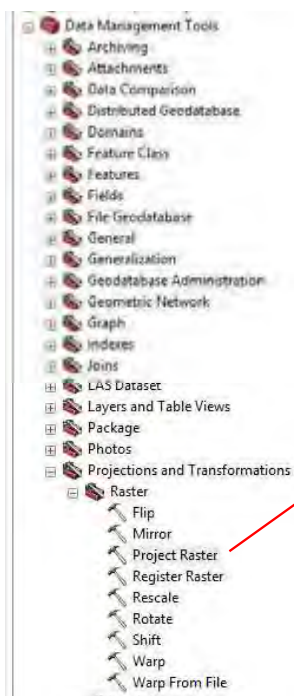
Check coordinate system



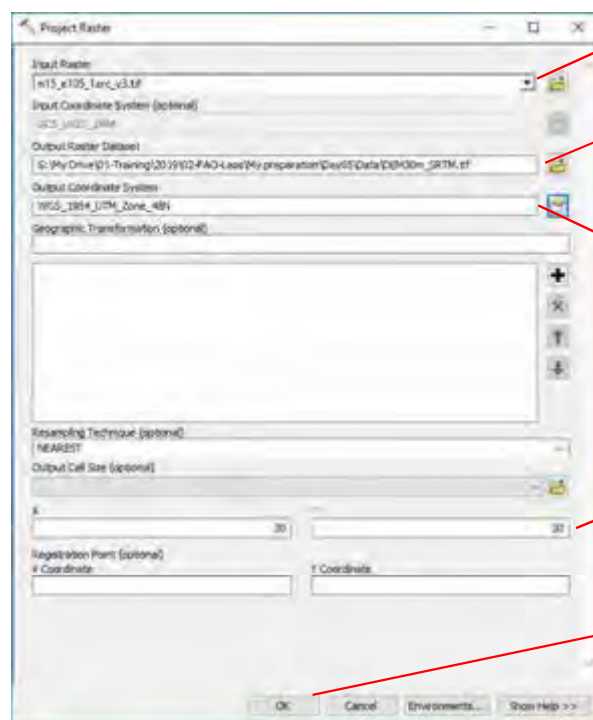
Savannakhet, Laos map, 2019

## How to reproject raster to a new coordinate system

WGS84 Lat Lon to UTM48N WGS84



1. Data Management Tool  
→ Projections and Transformations → Project Raster



2. Input Raster

3. Output Raster name

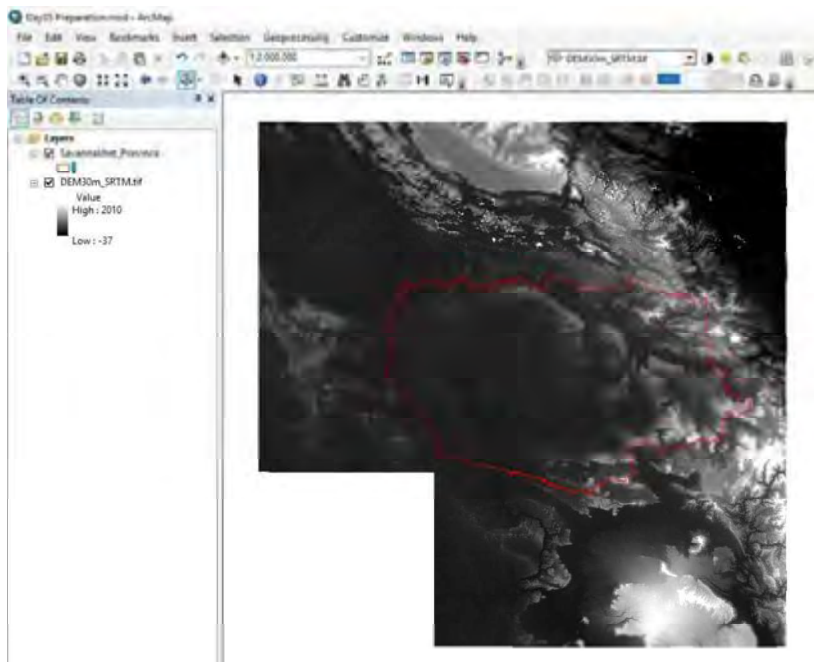
4. Output Coordinate System:  
WGS\_1984\_UTM\_Zone\_48N

5. Output Cell Size: 30m

6. Click [OK]



## Reprojected Elevation Raster



Savannakhet, Laos map, 2019

## How to clip Raster data

Clip your elevation Raster to Savannakhet Province

1. Data Management Tool → Raster → Raster Processing → Clip

2. Input DEM

3. Savannakhet province boundary

4. Click this option

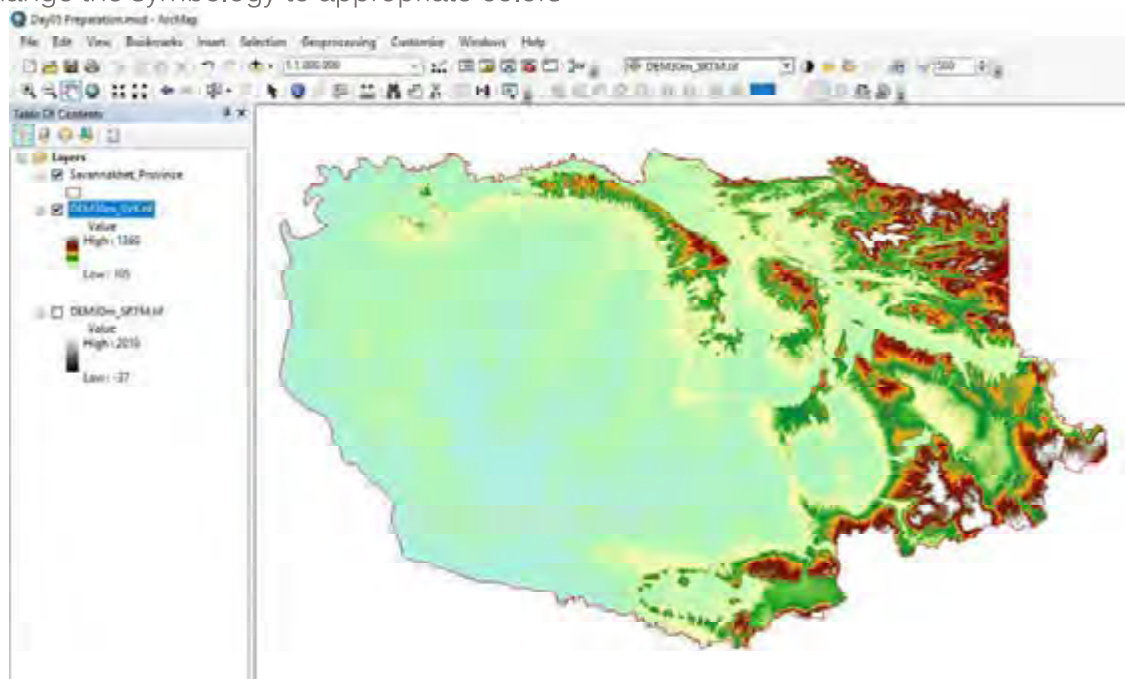
5. Output name: DEM30m\_SVK.tif

6. Click [OK]



## Elevation data – Savannakhet province

Change the symbology to appropriate colors



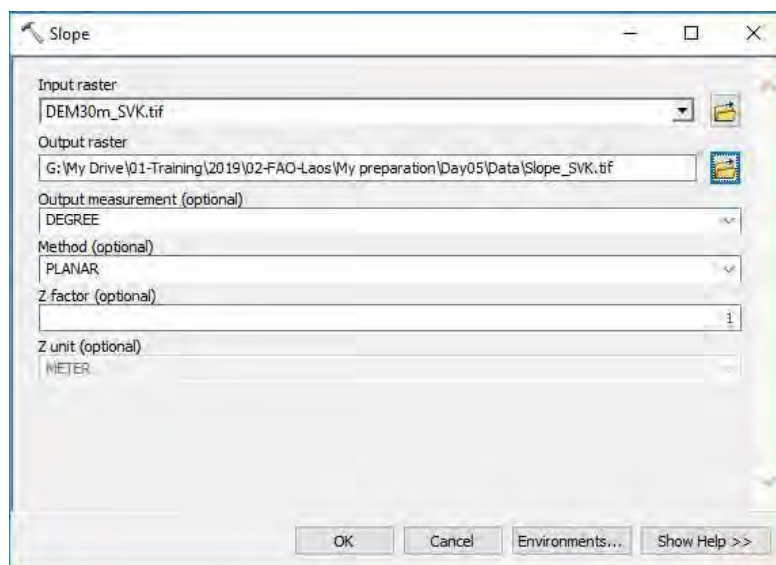
*Savannakhet, Laos map, 2019*

## How to create Slope

Slope layer of Savannakhet province



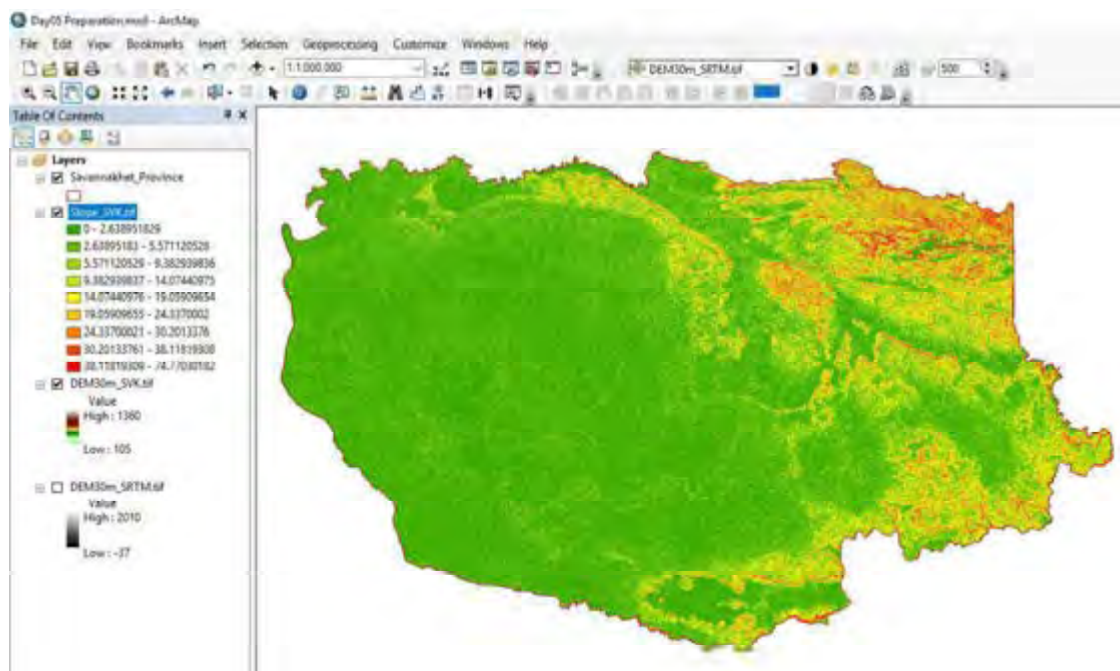
1. Spatial Analyst  
Tools → Surface  
→ Slope





## Slope Map – Savannakhet province

Slope classes in degrees



*Savannakhet, Laos map, 2019*

## How to create Aspect

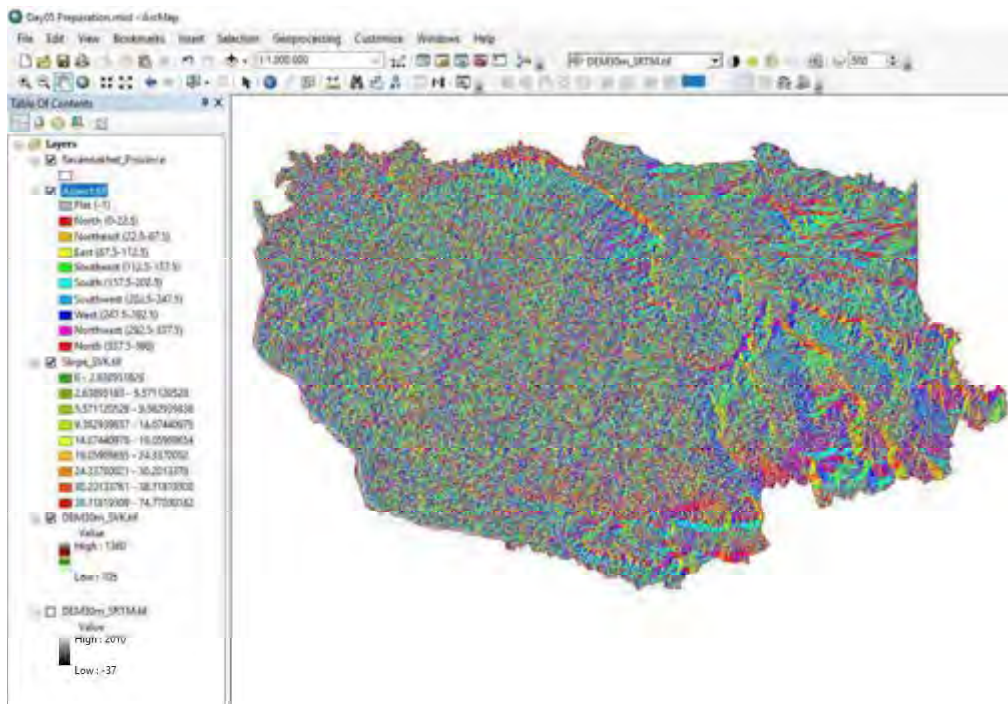
Aspect layer of Savannakhet province

1. Spatial Analyst Tools → Surface → Aspect



## Aspect Map – Savannakhet province

See the Aspect classes



Savannakhet, Laos map, 2019

## How to create Hillshade

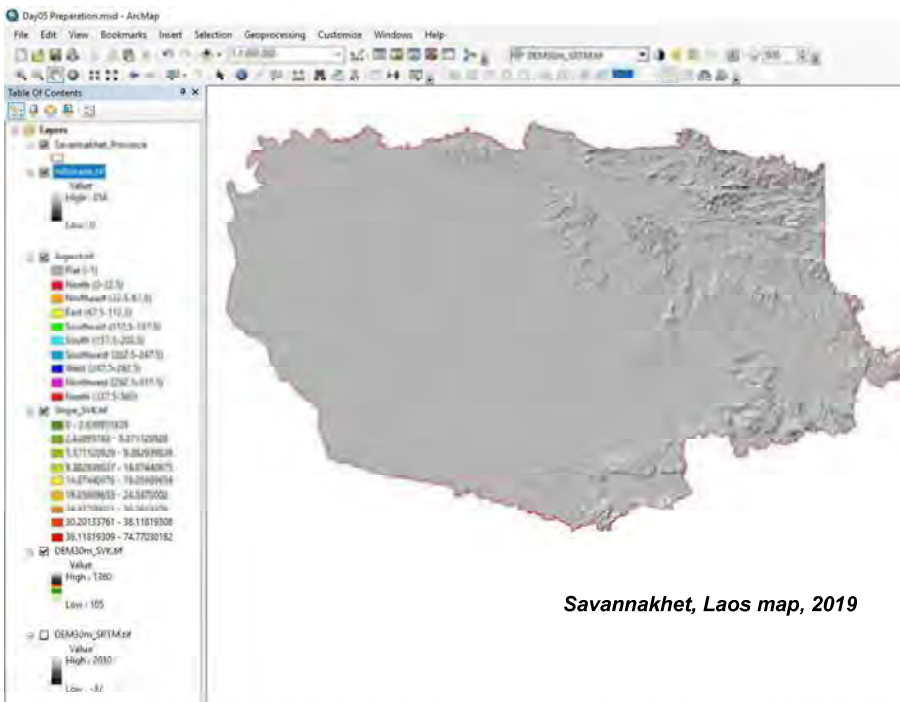
Hillshade layer of Savannakhet province

1. Spatial Analyst  
Tools → Surface  
→ Hillshade



## How you can download free elevation data?

<https://earthexplorer.usgs.gov/>



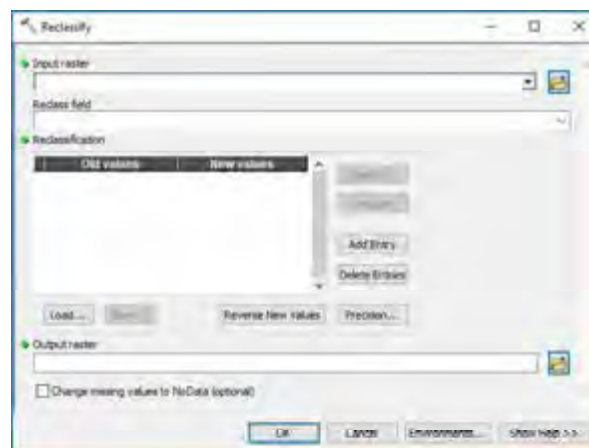
*Savannakhet, Laos map, 2019*

## How to re-class raster data

Necessary step if you want convert continuous raster data to vector

### Spatial Analyst Tools

- Conditional
- Density
- Distance
- Extraction
- Generalization
- Groundwater
- Hydrology
- Interpolation
- Local
- Map Algebra
- Math
- Multivariate
- Neighborhood
- Overlay
- Raster Creation
- Reclass
  - Lookup
  - Reclass by ASCII File
  - Reclass by Table
  - Reclassify
  - Rescale by Function
  - Slice



1. Spatial Analyst Tools →  
Reclass → Reclassify

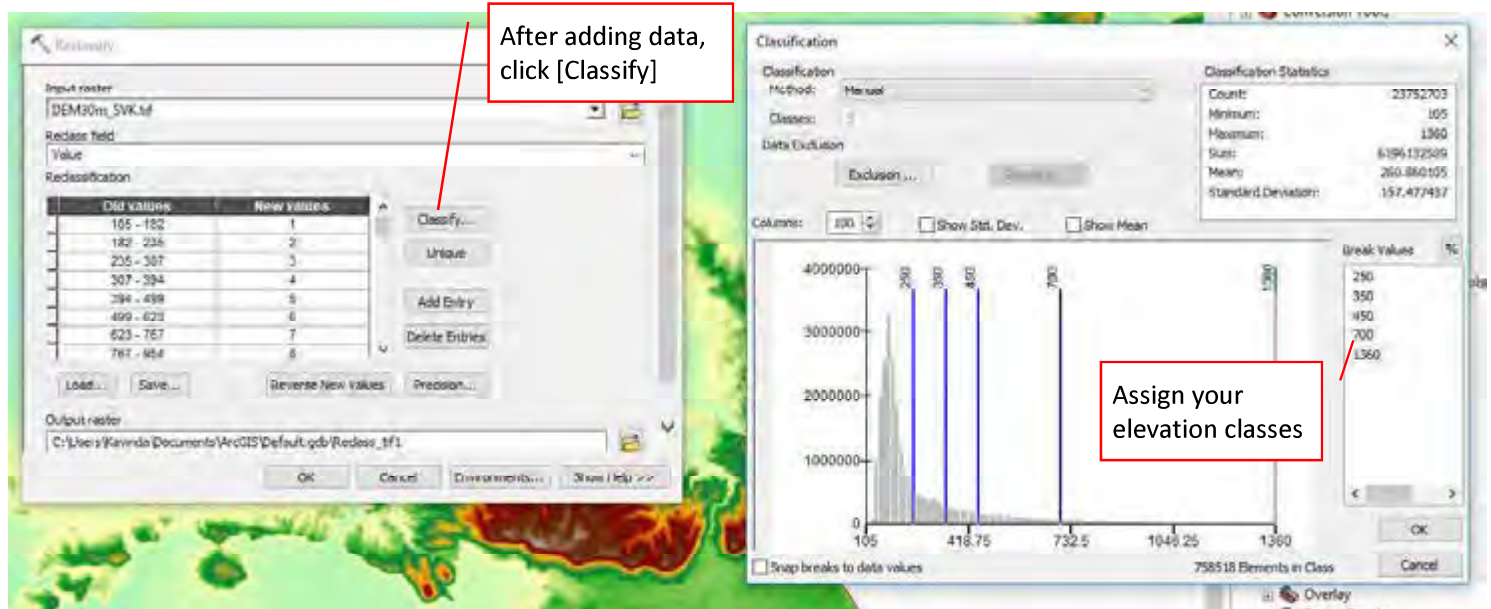
Try to reclassify your elevation to

- Min – 250m
- 250m – 350m
- 350m – 450m
- 450m – 700m
- More than 700m



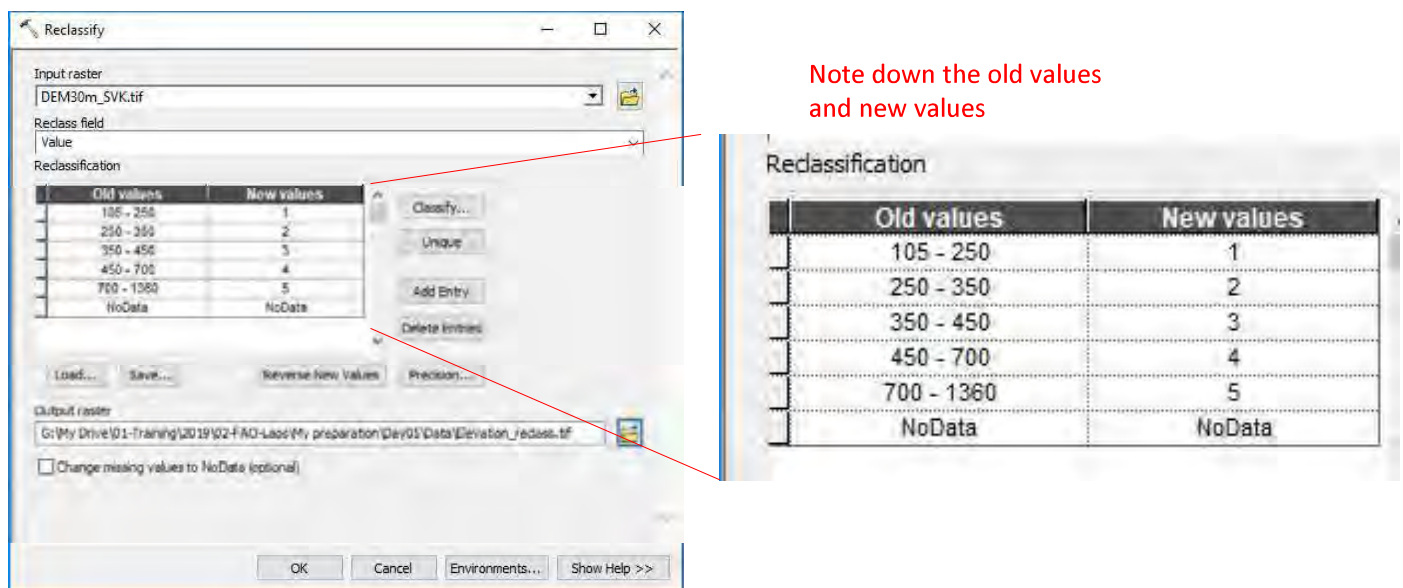
## How to re-class raster data

Raster reclassification steps



## How to re-class raster data

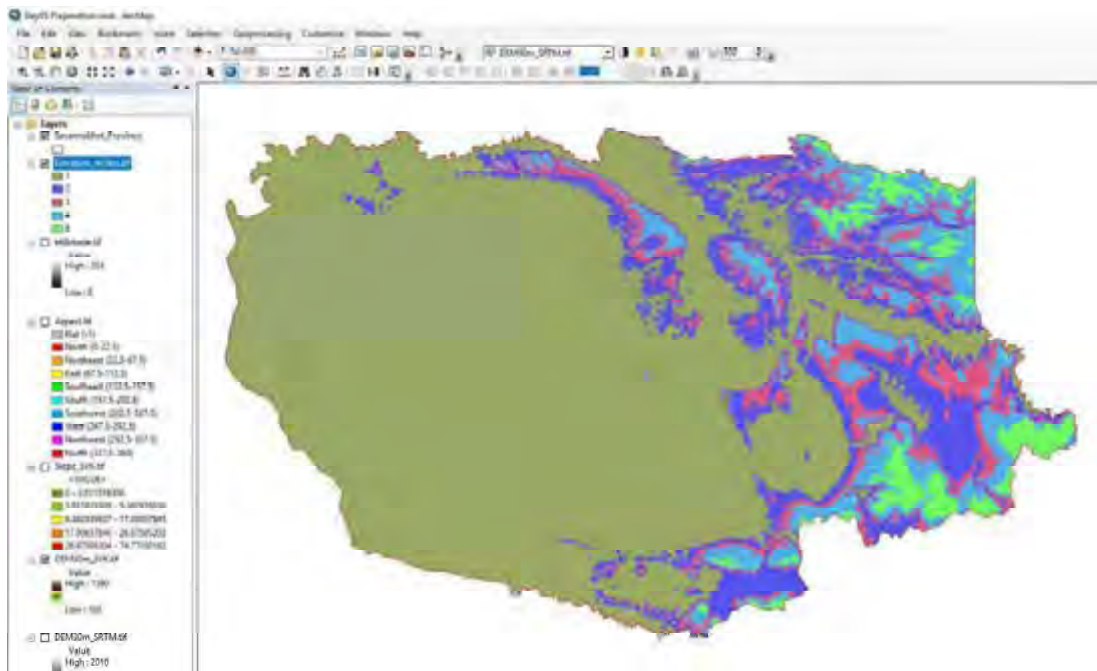
Raster reclassification steps





## How to re-class raster data

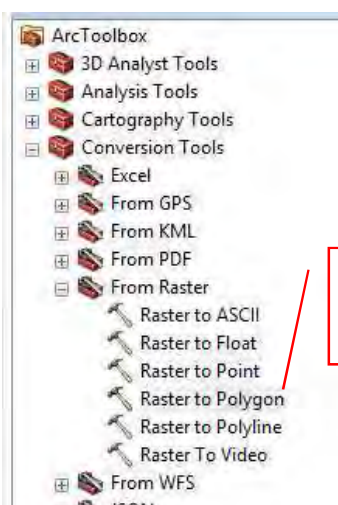
Display reclassified data



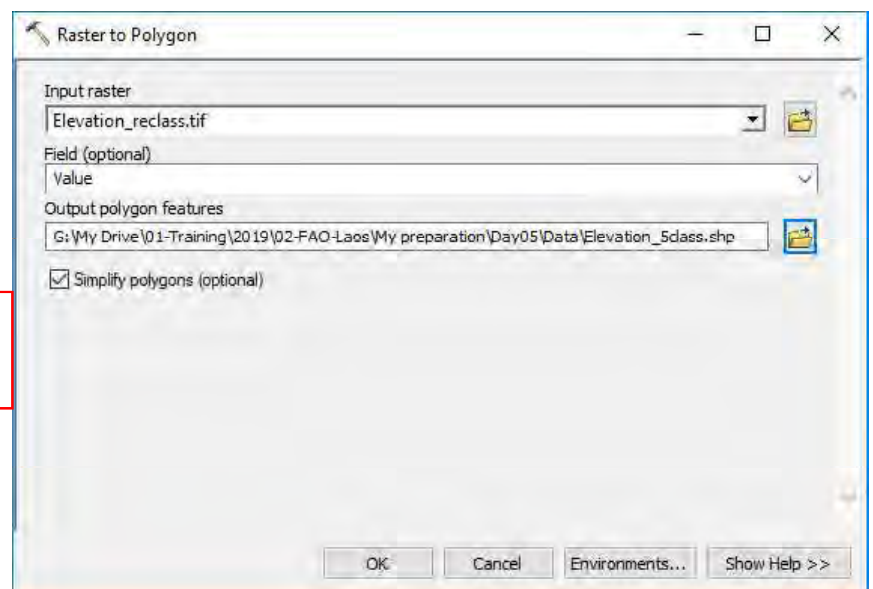
Savannakhet, Laos map, 2019

## How to convert Raster to Vector data

Data conversion



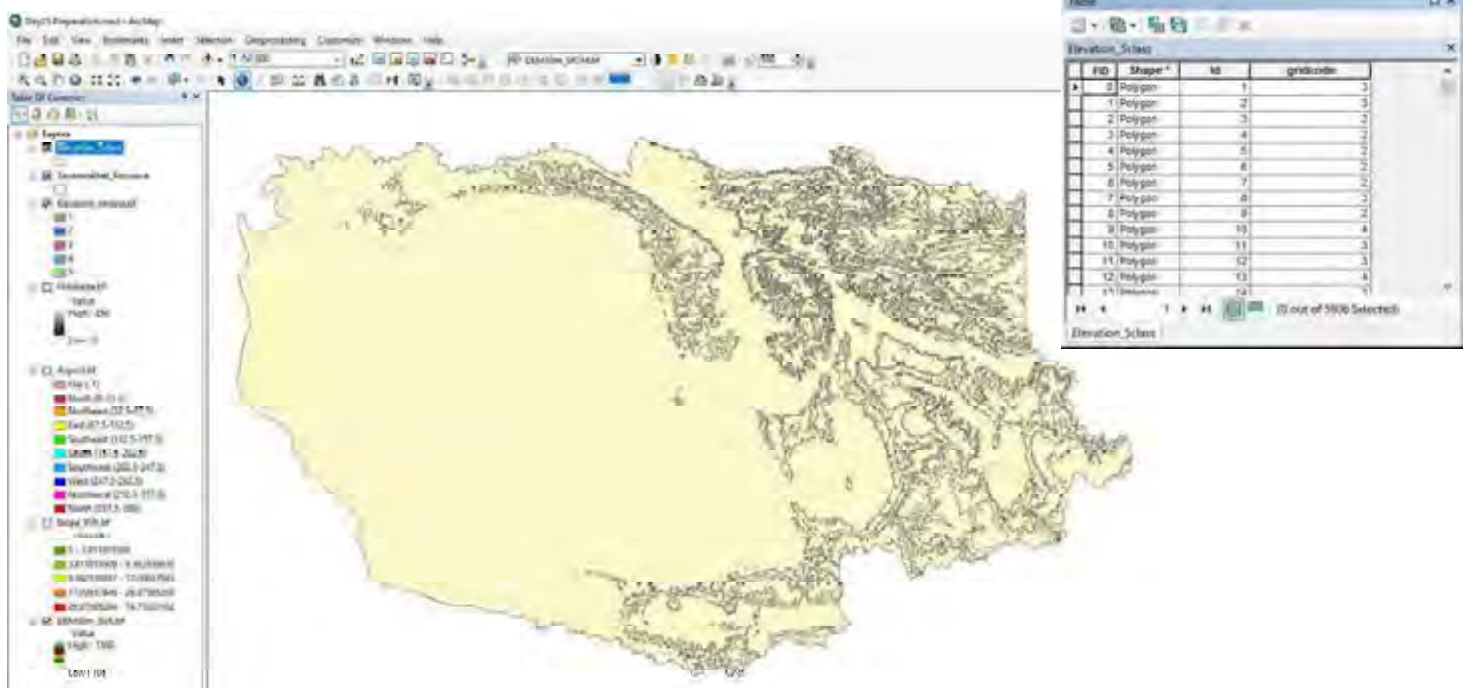
Conversion Tools  
→ From Raster →  
Raster to Polygon





## Elevation classes in vector format

Explore the attribute table



Savannakhet, Laos map, 2019

## Overlay operations: Self-task V

Hint: you have learnt all the tools to do this operation

Can you find the area (in sqkm) of

I. 0 – 20 degree slope

II. more than 20degree slope

III. Optional: how many percentage of villages in 0-20 degree slope zone



## Overlay operations: Self-task V

Hint: you have learnt all the tools to do this operation

### Find the best locations for a new Agro Meteorological Stations

Criteria:

1. 10km away from “primary” roads
2. 20km away from existing Agro Meteorological Stations
3. Elevation more than 450m

## Contact Us

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[www.ait.ac.th](http://www.ait.ac.th)  
[www.geoinfo.ait.ac.th](http://www.geoinfo.ait.ac.th) (our center)  
[www.Facebook.com/gicait](https://www.facebook.com/gicait)



# Coordinate Systems & Projections

A first look into the concepts that comprise  
a Geographic Information System

Dr. Kavinda Gunasekara  
Frank Yrle



Strengthening Agro-climatic Monitoring and Information Systems (SAMIS)  
to improve adaptation to climate change and food security in Lao PDR

## Overview

Coordinate Systems & Projections

1. Explore coordinate systems
2. Projecting Data in ArcGIS
3. Files without coordinate systems
4. Georeference a paper map



## Coordinate Systems

### Coordinate Systems & Projections

GIS are different than other data systems because they contain **spatial data**

#### Coordinates

- Location
- Shape
- Extent

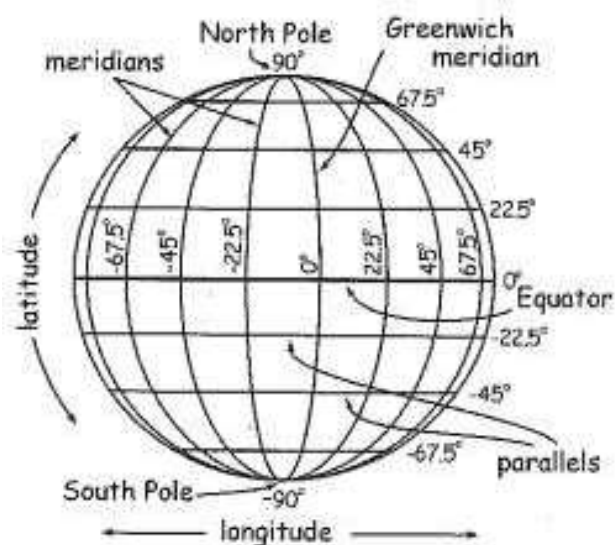
Two types of coordinate systems

## Geographic Coordinate Systems

### Coordinate Systems & Projections

#### Curved surface

Geographic coordinates systems use a 3D spherical surface to define locations on the Earth



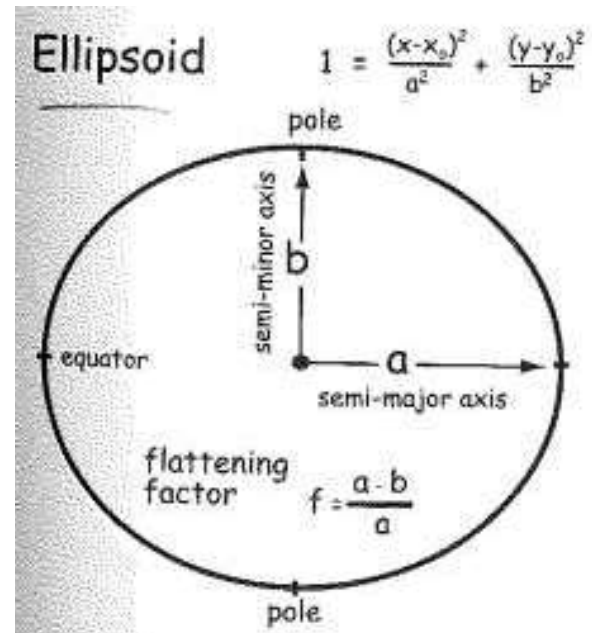


## What makes up a geographic coordinate system?

### Ellipsoid

#### Ellipsoid

- Originally measured with astronomical observations
- Measured at continental level – led to discrepancies in position
- More recently – GNSS and laser observation



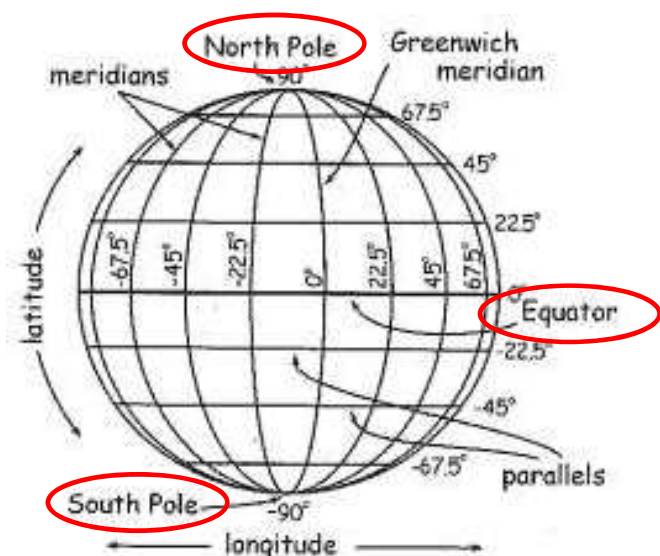
## What makes up a geographic coordinate system?

### Poles & Equator

- **Poles** – defined by the axis of revolution of the ellipsoid
- **Equator** – the circle mid-way between two poles, at a right angle to the polar axis, and spanning the widest dimension of the ellipsoid



**Coordinates can be defined**





# Geographic Coordinate Systems

## Terms

Latitude – varies from N to S

Parallel = lines of constant latitude, runs E to W

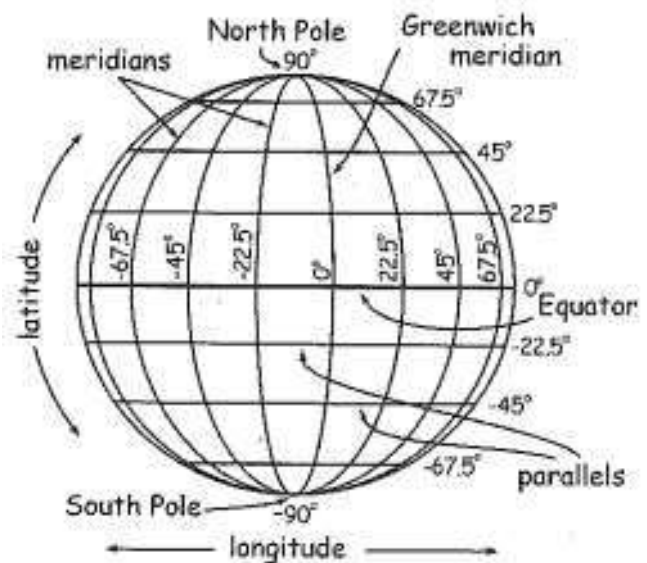
Equator is 0° latitude

Longitude – varies from E to W

Meridian = lines of constant longitude, runs N to S

Meridians converge at the poles

Prime Meridian is 0° longitude



Bolstad 2012  
Fundamentals of GIS

## An additional component of a coordinate system

### Datum

Geographic coordinate system with ellipsoid, poles, and equator specify only the position at the prime meridian

In order to know the other points on earth we must perform survey based on that

Datum is a reference surface

Datum is made up of: ellipsoid with a coordinate system & origin; set of points and lines that have been surveyed

Governments typically have a surveying department to measure & maintain these points  
The datum tells us the latitudes and longitudes of a set of points on an ellipsoid

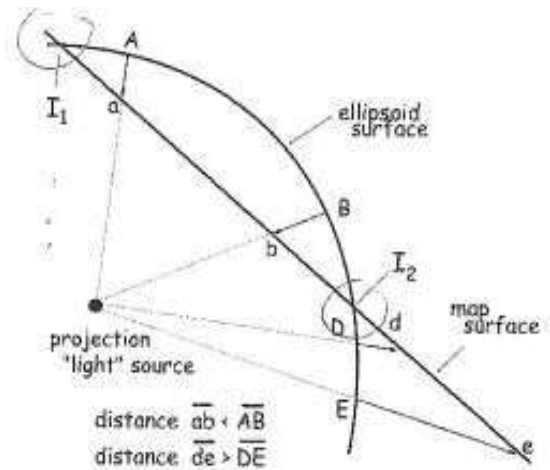
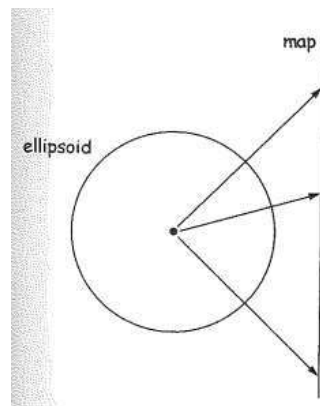
Bolstad 2012  
Fundamentals of GIS



# Map Projections

## Coordinate Systems & Projections

Map projections are necessary to transfer the measurements made on an ellipsoid onto a flat map. Those measurements, or points, are projected from the Earth surface onto a flat map.



Bolstad 2012  
Fundamentals of GIS

# Projected Coordinate Systems

## Shapes for projection

### Conic (tangent)



### Conic (secant)



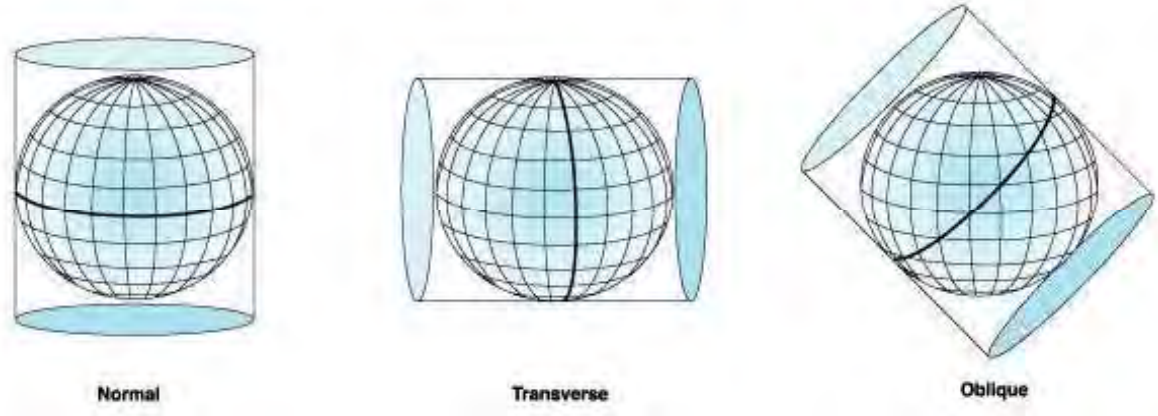
ESRI



Projected Coordinate Systems

Shapes for projection

Cylindrical aspects

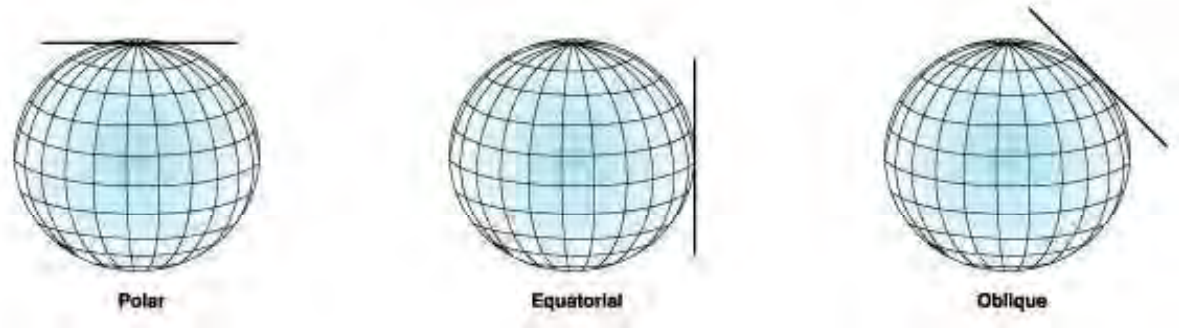


ESRI

Projected Coordinate Systems

Shapes for projection

Planar aspects



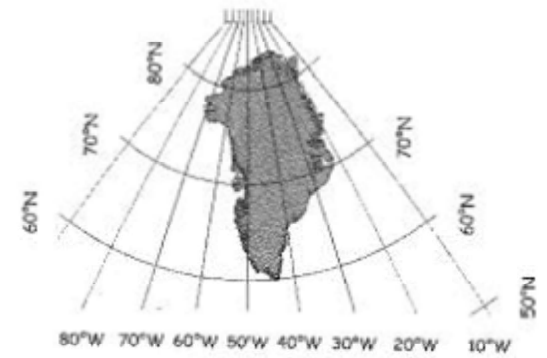
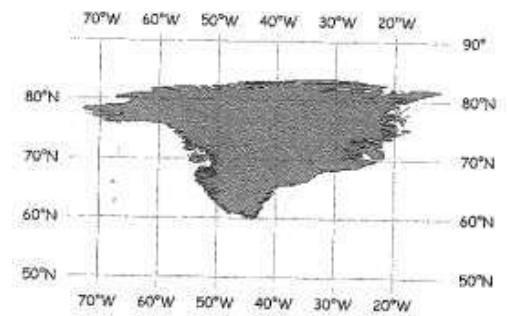
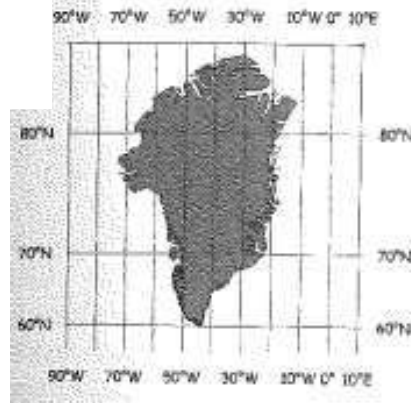
ESRI



# Distortion in Maps

Coordinate Systems & Projection

Distortion is inherent in all maps for distance, direction, shape, & area



Bolstad 2012  
Fundamentals of GIS

## Overview

Coordinate Systems & Projections

1. Explore coordinate systems
2. Projecting Data in ArcGIS
3. Files without coordinate systems
4. Georeference a paper map



## Start an ArcMap session

Blank map

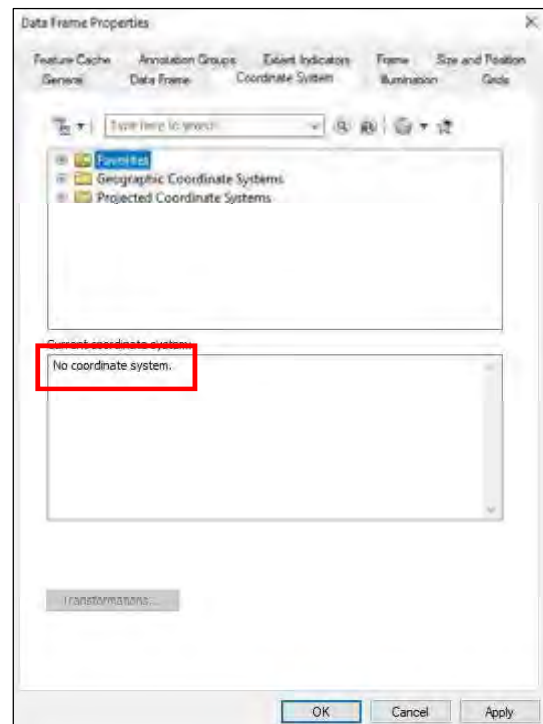
Open ArcMap

At Table of Contents right-click Layers

Properties

Also notice the units

994,062 202,494 Unknown Units



## Adding Data & Coordinate Systems

Observe coordinate system

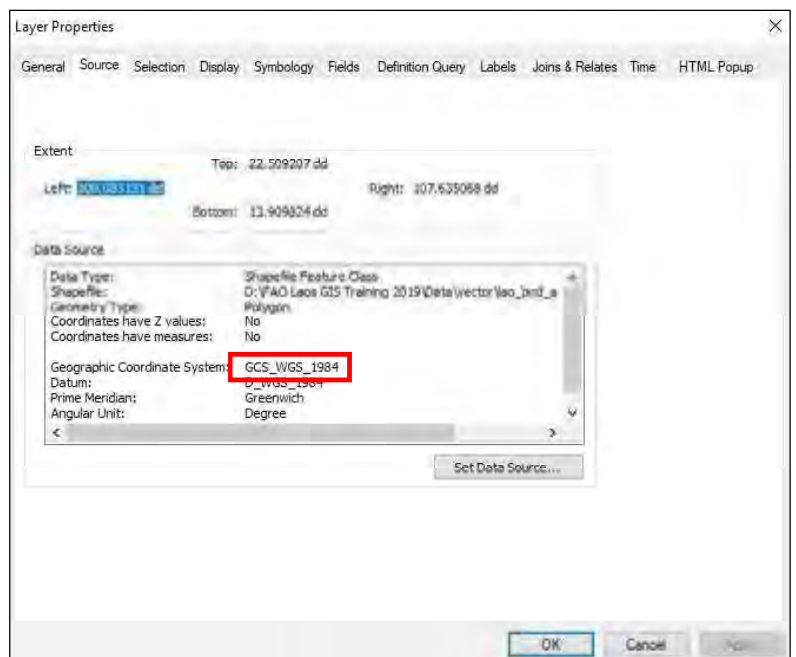
From ArcCatalog window add data:

Lao\_bnd\_admin0\_ngd2018.shp

Right-click | Properties | Source tab

108.136 19.12 Decimal Degrees

The data frame takes on the coordinates of the first file added to it





## Adding Data & Coordinate Systems

Observe coordinate system

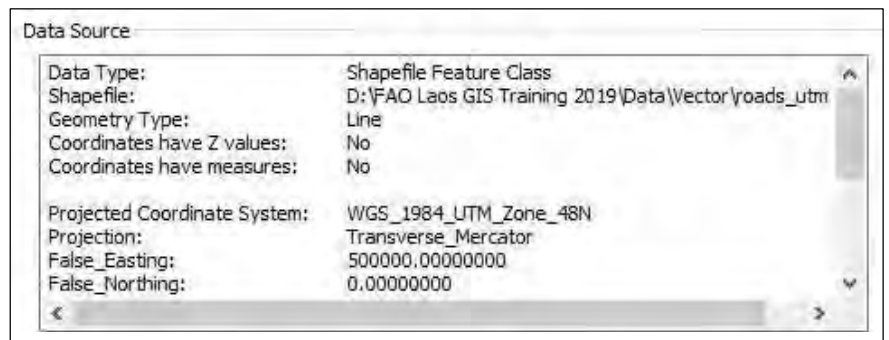
From ArcCatalog window add data:

Roads\_utm.shp

Right-click | Properties | [Source tab](#)

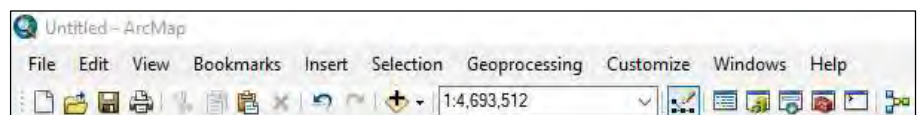


These two layers have different coordinate systems, but the data can be visualized because ArcMap is able to project [on the fly](#)



## Projecting data

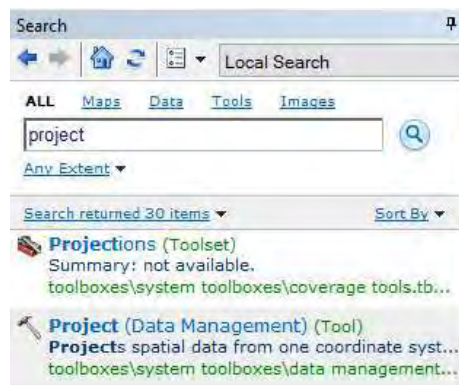
Observe coordinate system



Select the [Search](#) tool from the toolbar

Search for [project](#)

Click [Project \(Data Management\)](#)





## Adding Data & Coordinate Systems

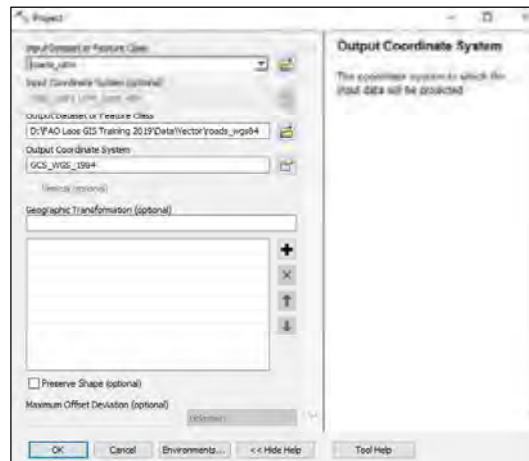
Observe coordinate system

At the Project tool  
enter roads\_utm.shp  
for the input dataset

Specify a file name and  
output folder

Finally select  
geographic coordinate  
system: WGS84  
for the output  
coordinate system

OK



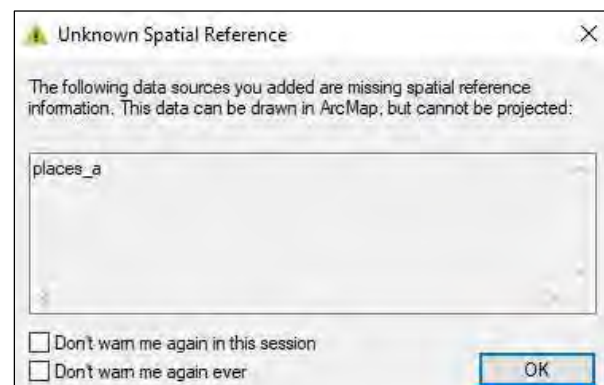
## Defining a projection

Observe coordinate system

From ArcCatalog window add data:  
places\_a.shp

You should see a warning message titled  
Unknown Spatial Reference. This means the  
places\_a shapefile doesn't have projection  
information associated with it.

We can add a projection to a file that doesn't  
have one by using the Define Projection tool;  
However, we should have some idea of what  
the projection is beforehand

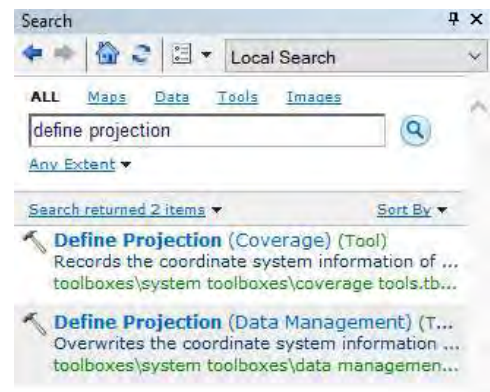




## Defining a projection

Observe coordinate system

Use the Search tool to find **Define Projection**



In this case it turns out that the projection is WGS84, so select that at the Coordinate System box

**OK**



## Overview

Coordinate Systems & Projections

1. Explore coordinate systems
2. Projecting Data in ArcGIS
3. Files without coordinate systems
4. **Georeference a paper map**

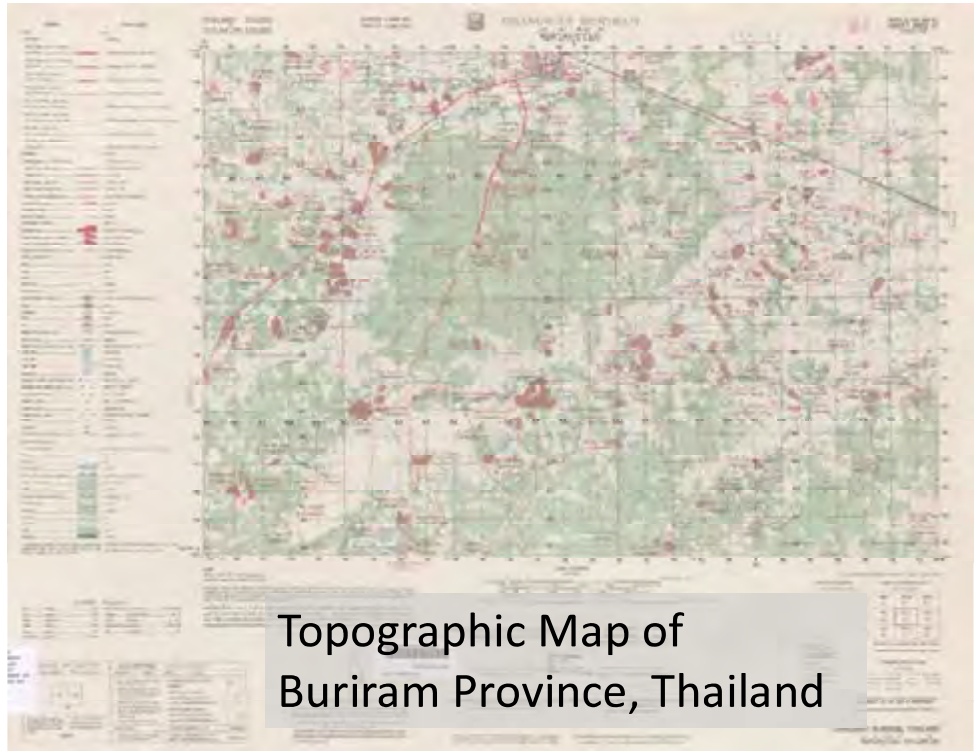


## Paper Maps

How can we integrate into a GIS?

### Georeference

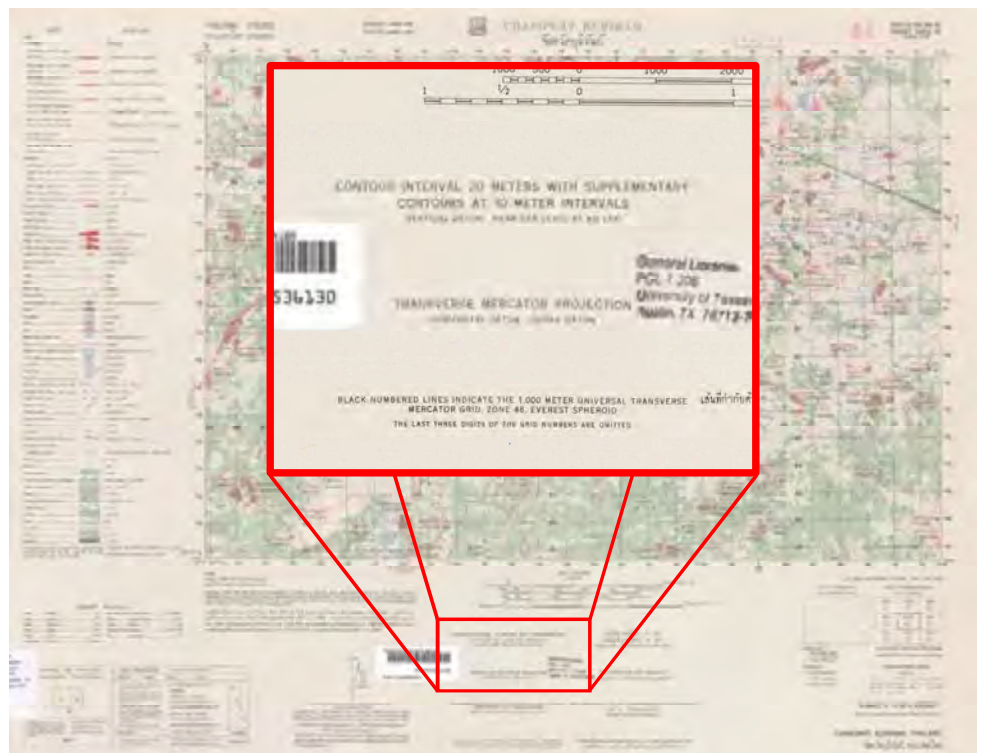
Performed on scanned paper maps to align them with a known coordinate system



## Info needed to Georeference

Two Requirements

1. **Metadata** –  
Coordinate System,  
Projection
2. Ground Control  
Points (GCP)





## Info needed to Perform Georeference

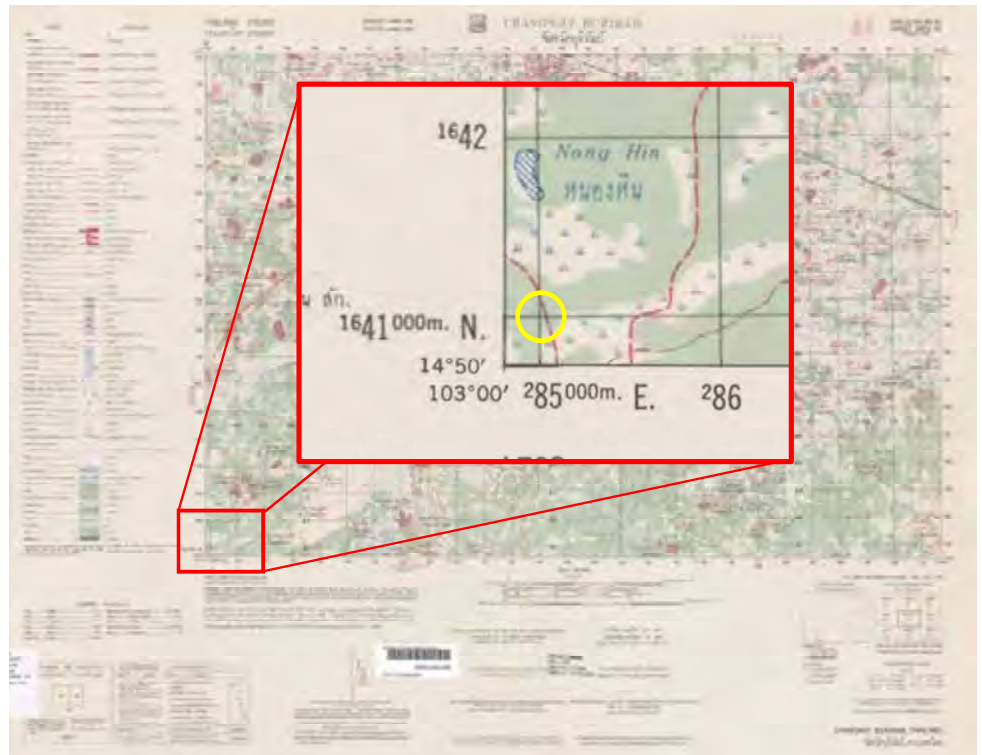
Two Requirements

1. Metadata –  
Coordinate System,  
Projection
2. **Ground Control  
Points** (GCP)

Coordinates for this GCP:

X = 285,000 m E

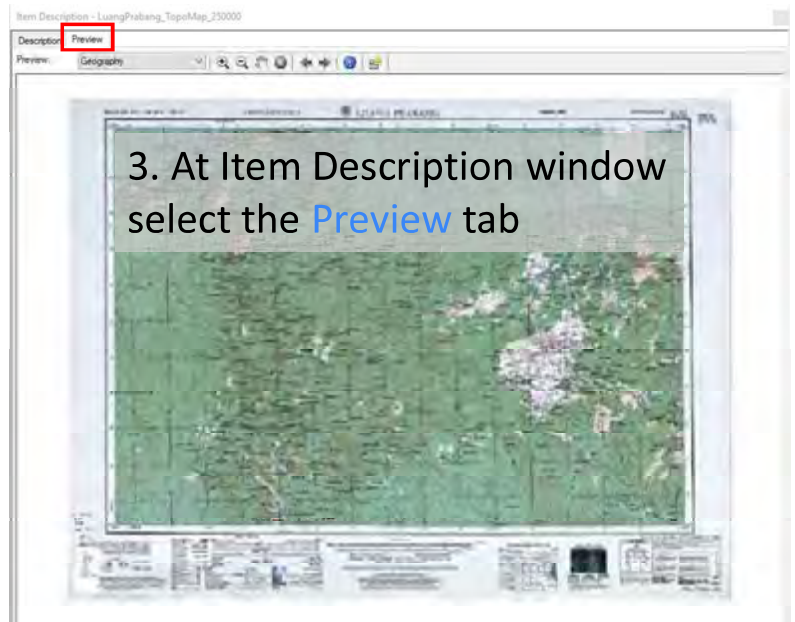
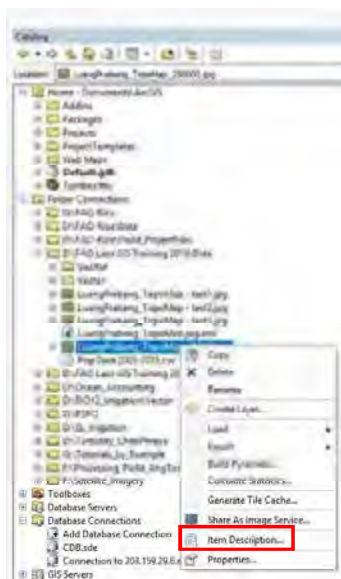
Y = 1,641,000 m N



## Applications of GIS

Many disciplines use GIS

1. Open the  
ArcCatalog  
Window in  
ArcMap

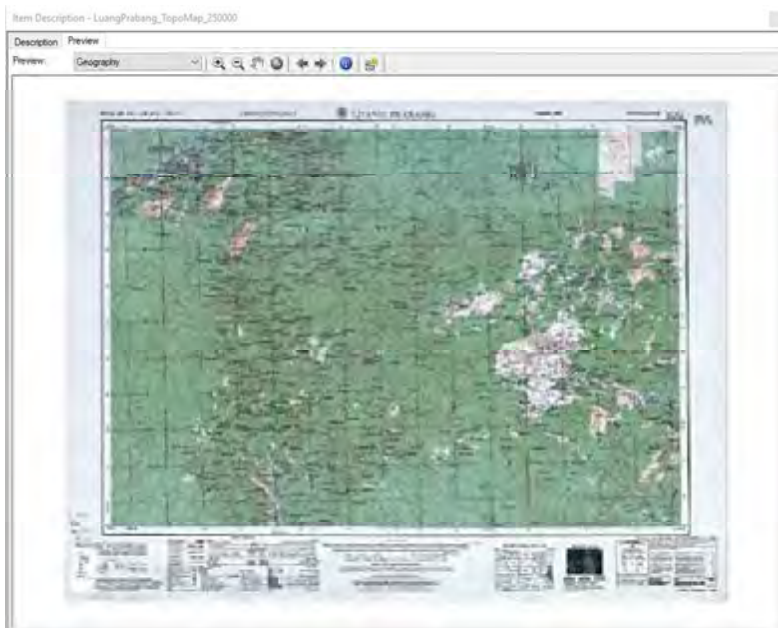


2. Find the file LuangPrabang\_TopoMap\_250000.jpg  
Right Click and select **Item Description...**



## Applications of GIS

Many disciplines use GIS



Some important info present on paper map:

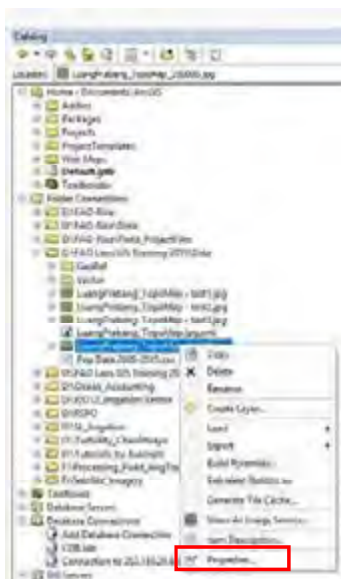
- Scale
- Year
- Creator
- Projection
- Spheroid

Activity:

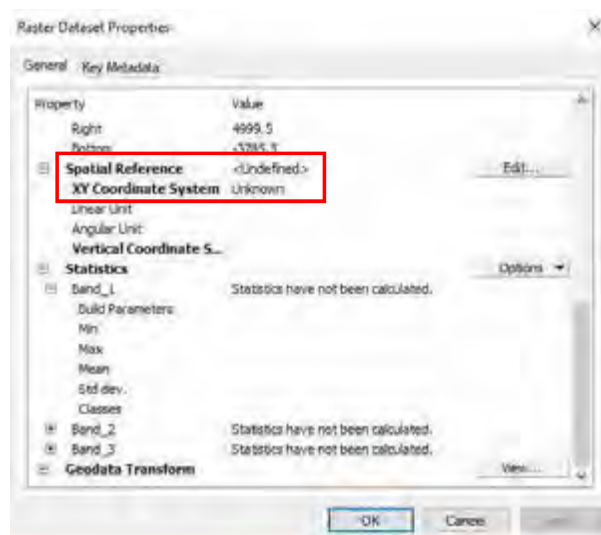
Find each one on the map

## Applications of GIS

Many disciplines use GIS



4. Open Properties for LuangPrabang\_TopoMap\_250000.jpg



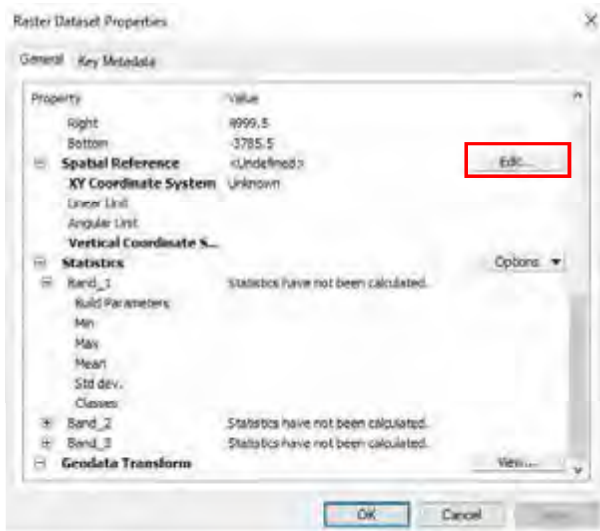
(Scroll down to find Spatial Reference Data)

5. Notice that the spatial reference is unknown. We can find this information printed on the map.

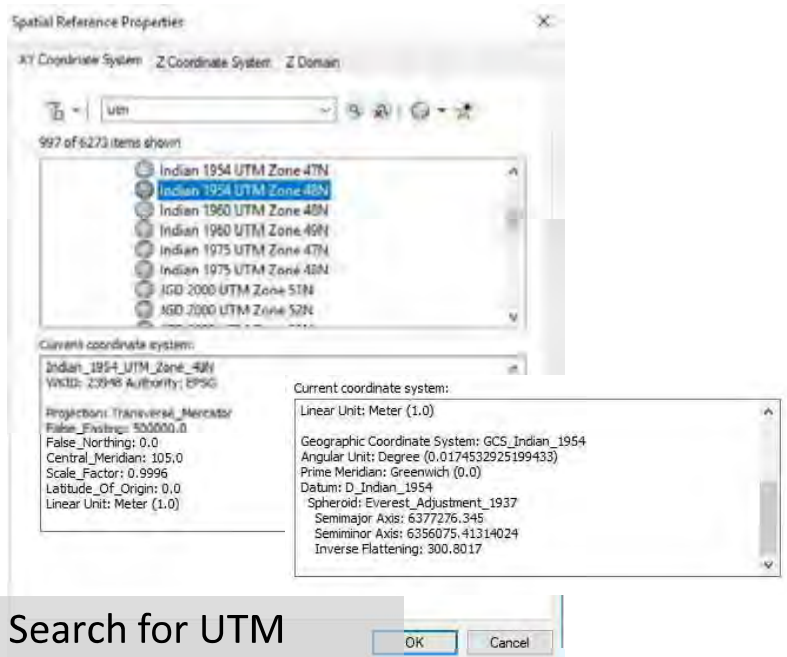


## Applications of GIS

Many disciplines use GIS



6. Click the **Edit** button

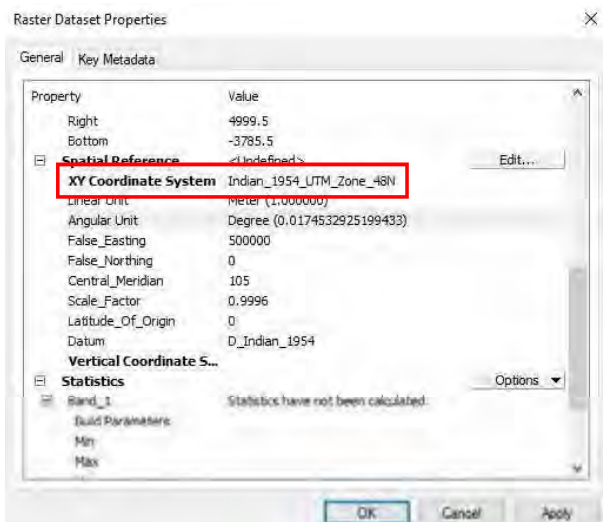


7. Search for UTM

- Navigate to Asia folder
- Find Indian 1954 UTM Zone 48

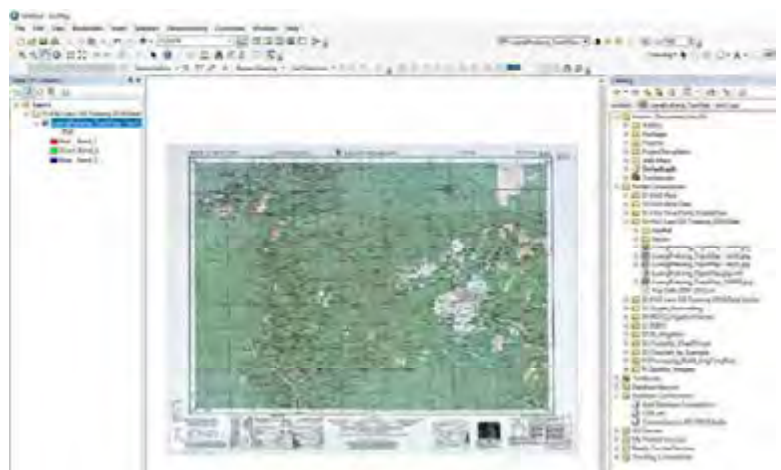
## Applications of GIS

Many disciplines use GIS



8. Click **Apply**.

The coordinate system will be updated with your selection



9. **Drag & drop**

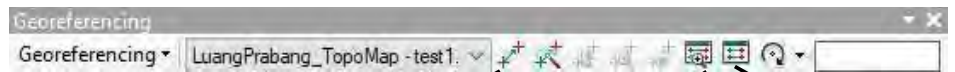
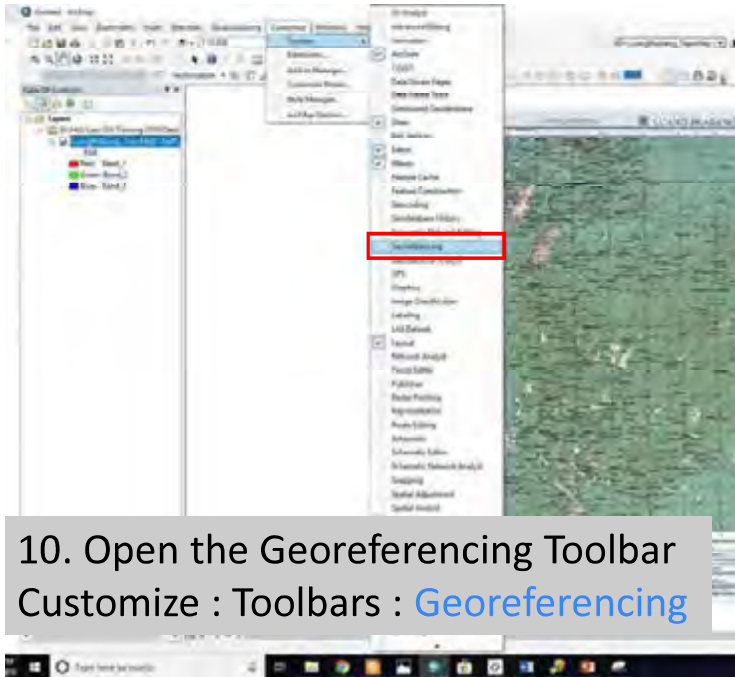
LuangPrabang\_TopoMap\_250000.jpg  
from ArcCatalog window into the ArcMap  
data view on the left.

Your Topo map will appear.



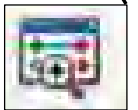


Many disciplines use GIS



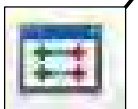
Add control  
Points

Select control points  
to adapt a  
coordinate system to  
the scanned map



Viewer

View raster layer to be referenced

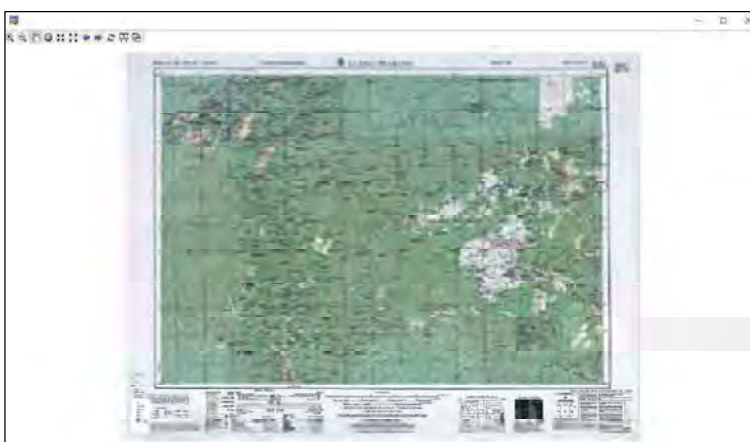


View Link Table

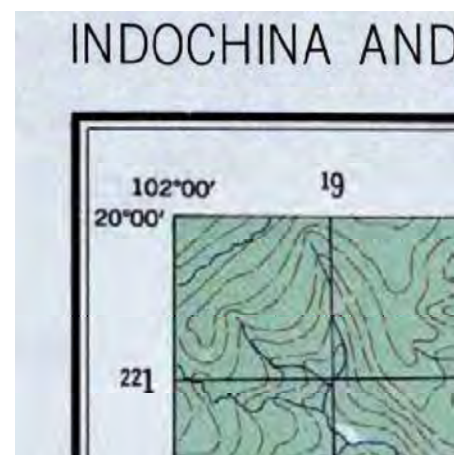
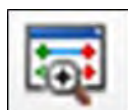
Open the Link Table to edit and  
examine the links

5

Many disciplines use GIS



11. Click the **Viewer** button. The map will appear in the viewer window.

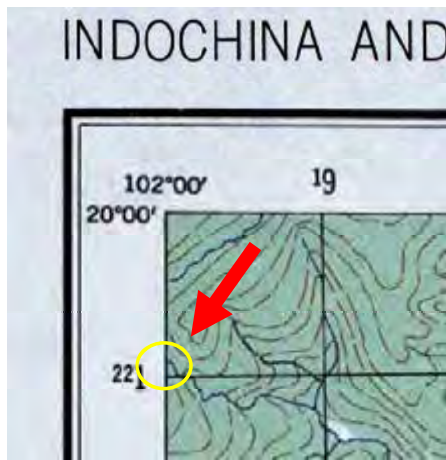



12. Zoom to the top left corner of the map



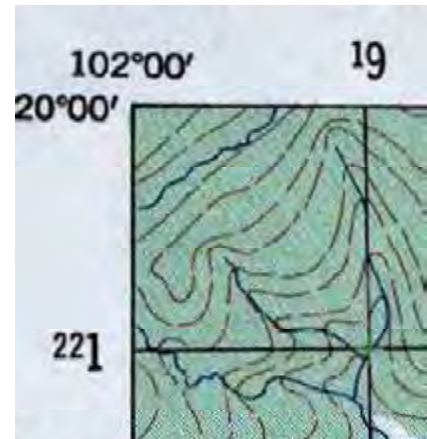
## Applications of GIS

Many disciplines use GIS



13. Press the  button. Use the cursor to select the cross where the arrow is pointing. Click 2x

Upper Left

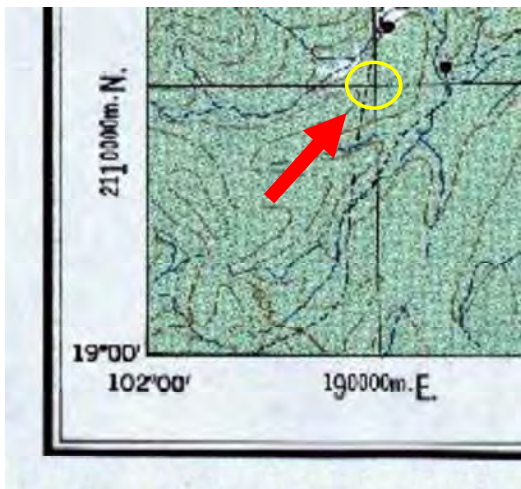


14. A green cross will appear where you clicked 2x

## Applications of GIS

Many disciplines use GIS

Lower Left



15. Repeat for the other 3 corners of the image

Upper Right



Lower Right

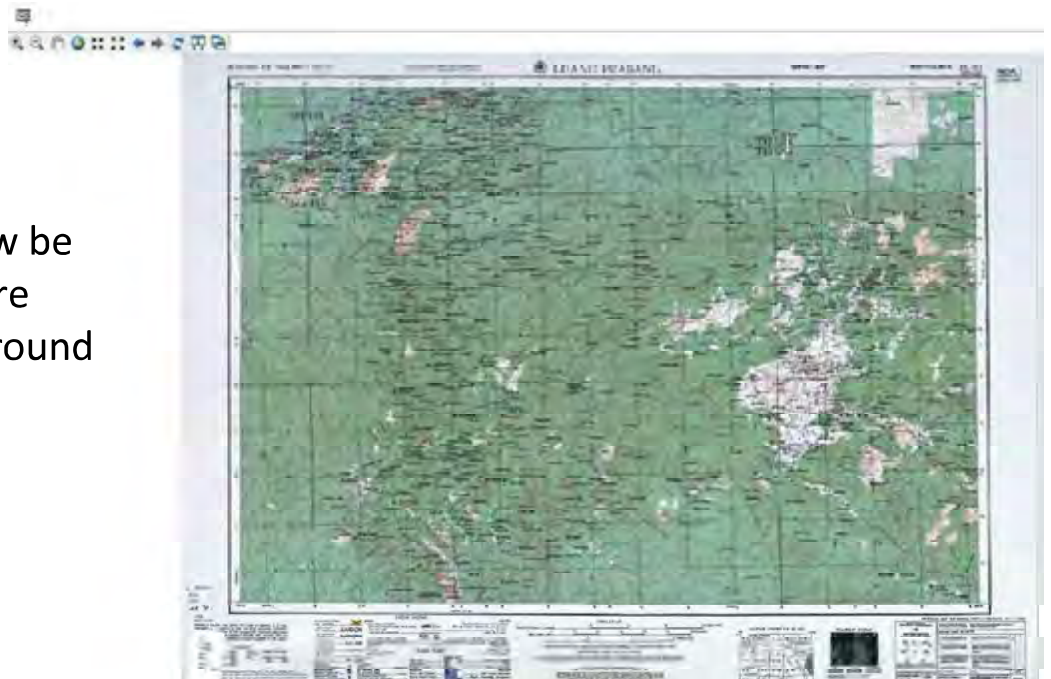




## Applications of GIS

Many disciplines use GIS

16. There should now be 4 green crosses where you 2x clicked the Ground Control Points



## Applications of GIS

Many disciplines use GIS

17. Click the View Link Table button.



Link	X Source	Y Source	X Map	Y Map	Residual_x	Residual_y	Residual
<input checked="" type="checkbox"/> 1	447.329061	-314.929584	447.329061	-314.929584	1.08002e-12	-8.54747e-13	1.17186e-12
<input checked="" type="checkbox"/> 2	499.153322	-3033.019447	499.153322	-3033.019447	1.13687e-13	0	1.13687e-13
<input checked="" type="checkbox"/> 3	4538.064085	-262.890272	4538.222835	-262.890272	9.09495e-13	-8.54747e-13	1.01605e-12
<input checked="" type="checkbox"/> 4	4589.609431	-2986.491417	4589.798160	-2986.491417	9.09495e-13	9.09495e-13	1.28622e-12

Auto Adjust ☒ Transformation: 1st Order Polynomial (Affine) Forward Residual Unit: Unknown

Enter the coordinates from the map into X Map & Y Map.

If you followed the same order as the powerpoint, Link  
1 = Upper Left  
Link 2 = Lower Left  
Link 3 = Upper Right  
Link 4 = Lower Right



## Applications of GIS

Many disciplines use GIS



Press the **Full Extent** button to if viewer loses track of the map.

Link								
			Total RMS Error:		Forward: 50.704			
Link	X Source	Y Source	X Map	Y Map	Residual_x	Residual_y	Residual	
<input checked="" type="checkbox"/> 1	447.329061	-314.929584	190000.000000	2210000.000000	3.24431	50.6493	50.7531	
<input checked="" type="checkbox"/> 2	499.153322	-3033.019447	190000.000000	2110000.000000	-3.24459	-50.6536	50.7574	
<input checked="" type="checkbox"/> 3	4538.064085	-262.890272	340000.000000	2210000.000000	-3.23775	-50.5468	50.6504	
<input checked="" type="checkbox"/> 4	4589.639431	-2986.491417	340000.000000	2110000.000000	3.23803	50.5512	50.6548	

☒ Auto Adjust

Transformation:

1st Order Polynomial (Affine)

Degrees Minutes Seconds

Forward Residual Unit : Unknown

18. Enter the following coordinates:

Link	Location	X Map	Y Map
1	Upper Left	190000	2210000
2	Lower Left	190000	2110000
3	Upper Right	340000	2210000
4	Lower Right	340000	2110000

## Residuals

Many disciplines use GIS

Residual is **very high**

Link								
			Total RMS Error:		Forward: 50.704			
Link	X Source	Y Source	X Map	Y Map	Residual_x	Residual_y	Residual	
<input checked="" type="checkbox"/> 1	447.329061	-314.929584	190000.000000	2210000.000000	3.24431	50.6493	50.7531	
<input checked="" type="checkbox"/> 2	499.153322	-3033.019447	190000.000000	2110000.000000	-3.24459	-50.6536	50.7574	
<input checked="" type="checkbox"/> 3	4538.064085	-262.890272	340000.000000	2210000.000000	-3.23775	-50.5468	50.6504	
<input checked="" type="checkbox"/> 4	4589.639431	-2986.491417	340000.000000	2110000.000000	3.23803	50.5512	50.6548	

☒ Auto Adjust

Transformation:

1st Order Polynomial (Affine)

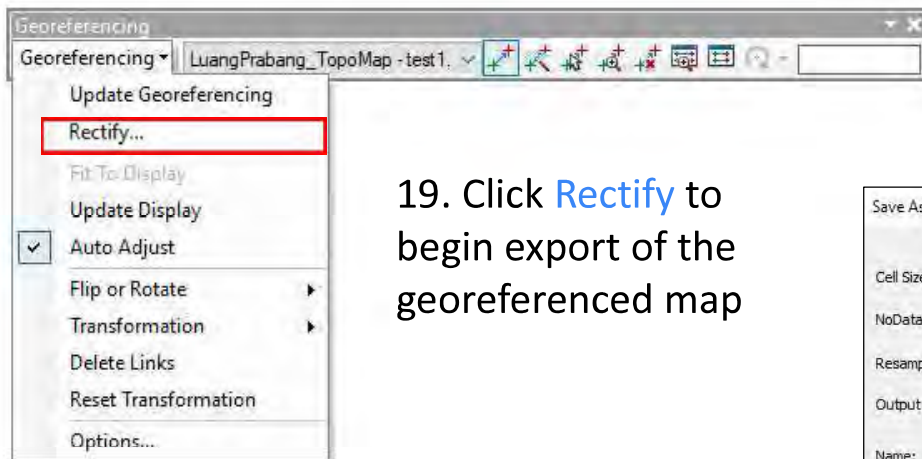
Degrees Minutes Seconds

Forward Residual Unit : Unknown



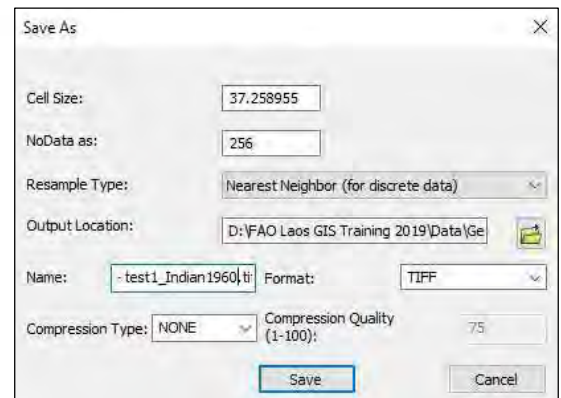
## Rectify

Export your map



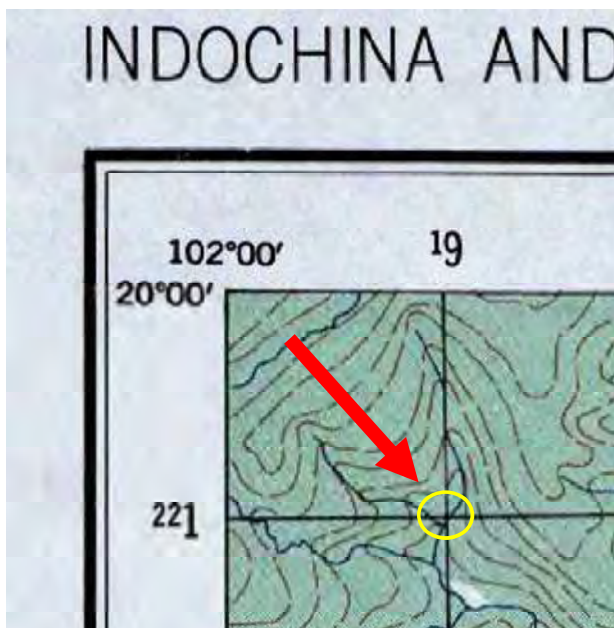
19. Click **Rectify** to begin export of the georeferenced map

20. Select a location and file name, then click **Save**



## Results of georeferencing

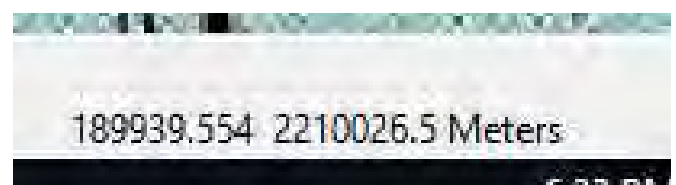
Many disciplines use GIS



**Before** georeferencing



**After** georeferencing





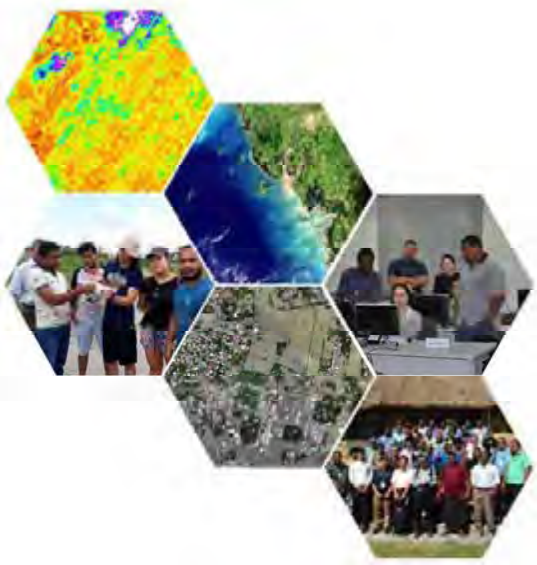
Georeference the following image:

[LuangPrabang\\_50000.jpg](#)

## Map Composition in ArcGIS

A first look into the concepts that comprise  
a Geographic Information System

Dr. Kavinda Gunasekara  
Frank Yrle





## Topics covered in this section

### Overview

1. Create new map
2. Exploring a map
3. Changing the symbol of features
4. Adding labels to a map
5. Laying out map
6. Saving map
7. Exporting map

## Opening ArcMap 10.6

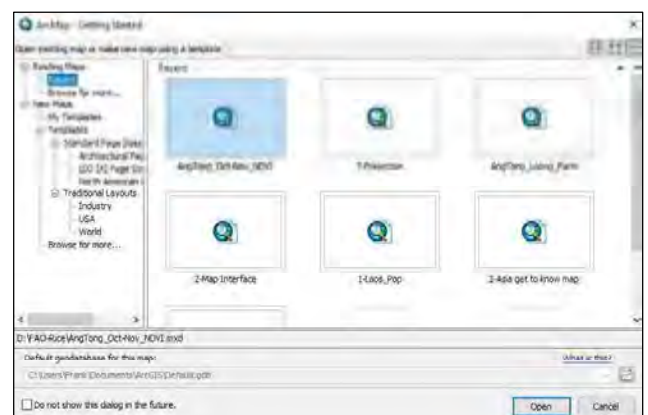
### New empty map

❖ Type Arcmap into the Windows search bar

❖ Select ArcMap 10.6



❖ Click **Cancel**  
to open a  
new, empty  
map.

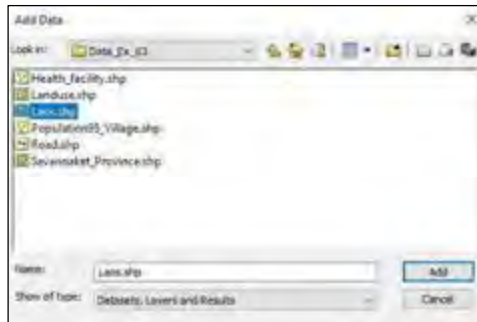




## Adding a layer to a map

Assessment of skills – Begin at conclusion of lesson

- Adding a layer to a map, click the [Add Data](#) button

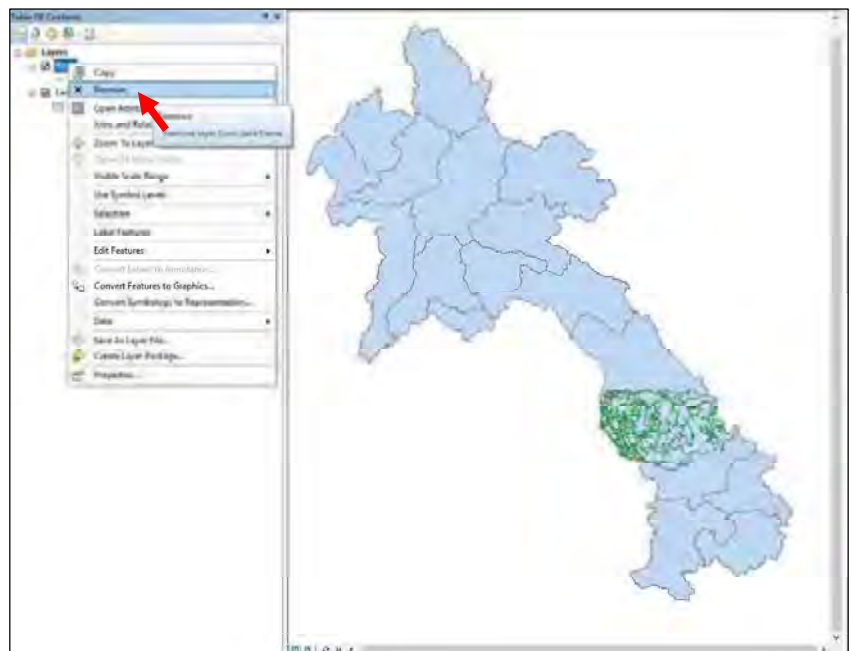


- Select a layer's name which you want to add to the map.
- Many layers could be selected as the same time (hold SHIFT on key board and click to select)
- Then click Add button

## Removing a layer from a map

Table of Contents

- To remove a layer, Right-click at the layer's name in the Table of Contents then select [Remove](#).









Laos map, 2019



## Review of map navigation tools

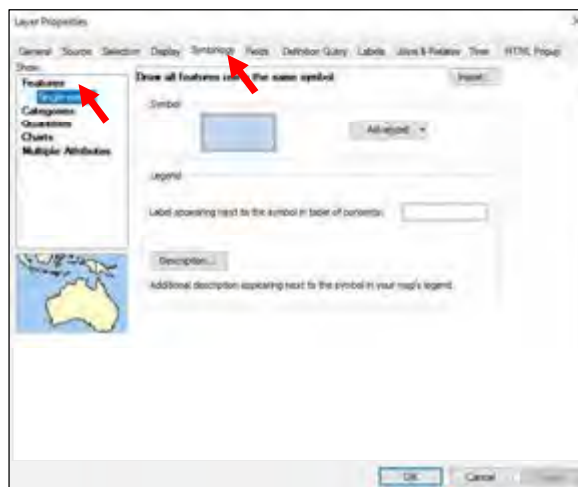
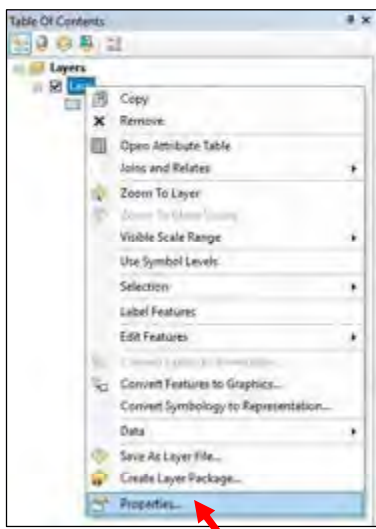
Located at toolbar

- To Zoom In click the  button and Zoom Out click the  then drag a box around the portion to Zoom.
- For Fixed Zoom In click  button and Fixed Zoom Out click at  button, the current display map will be zoomed.
- Click  button to Pan the map.
- Click  button to do quickly zoom out to the map's full extent.

## Changing the symbol of features

Changing polygon features

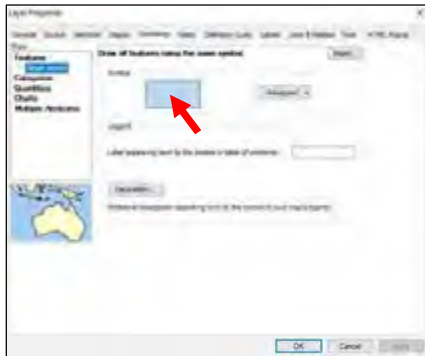
- Right-click the layer's name in the Table of Contents and click [Properties](#)
- Click the Symbology tab on the Properties dialog box, Click Features



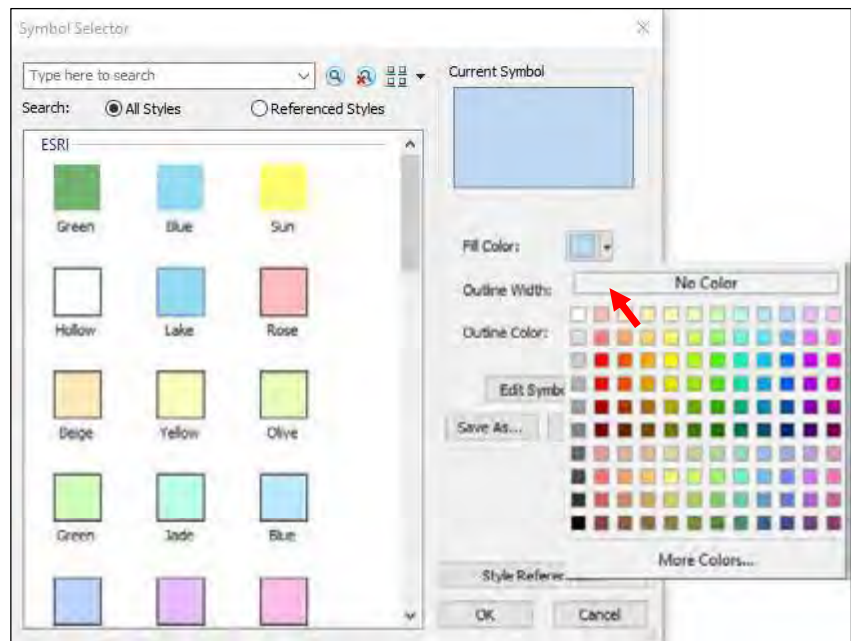


## Changing symbology

### Properties menu



- Click the Symbol button to change the symbol.

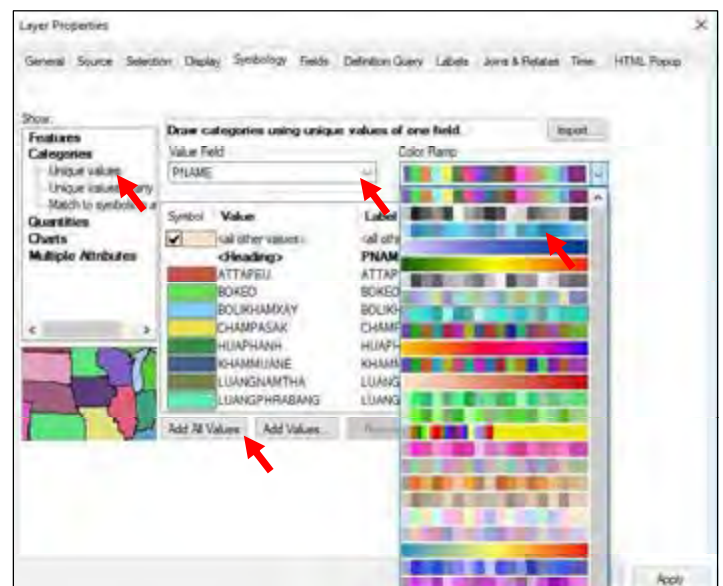


- In the Symbol Selector dialog box, click a new symbol or change specific properties of symbol. Then click OK.

## Exercises to be completed on your own

Assessment of skills – Begin at conclusion of lesson

- At Layer Properties. Click the Symbology tab, then click Categories
- Click the Value Field, dropdown arrow and click the field that contains the values we want to map.
- Click the Color Scheme dropdown arrow and click a color scheme
- Click Add All Values, Click Apply.

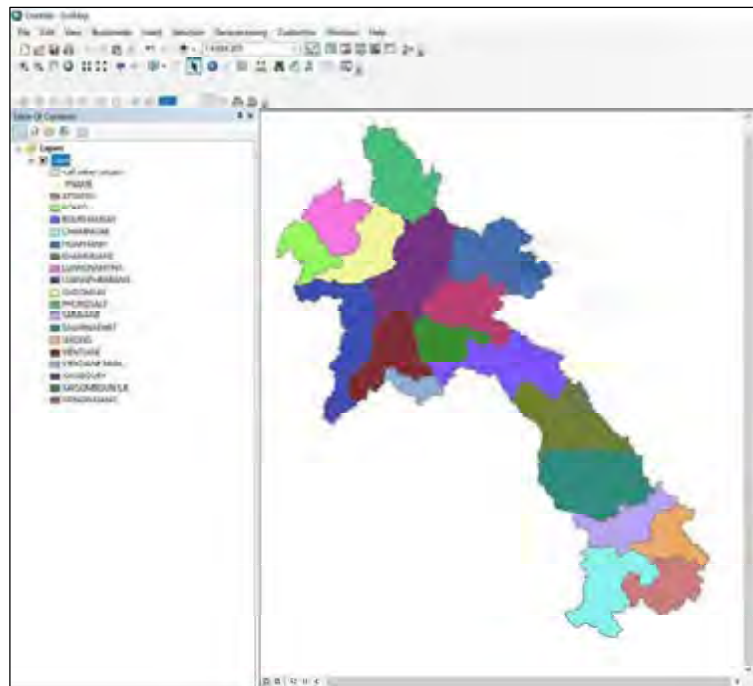




## Symbolizing Features

### Unique Values

- Examine map colors and Click **OK** button

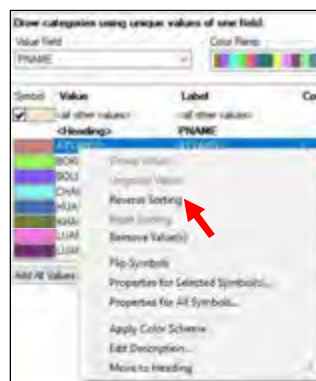


Laos map, 2019

## Symbolizing Features

### Sorting values

- To **Sort unique value**, in Layer Properties, Click the Symbology tab.
- Click the Value column
- Click Reversed Sorting. Click OK
- To **Order unique values**, Click the Symbology tab.
- Click the value you want to move up or down in the list.
- Use the up and down arrows to either promote or demote the value in the list.
- Click OK.

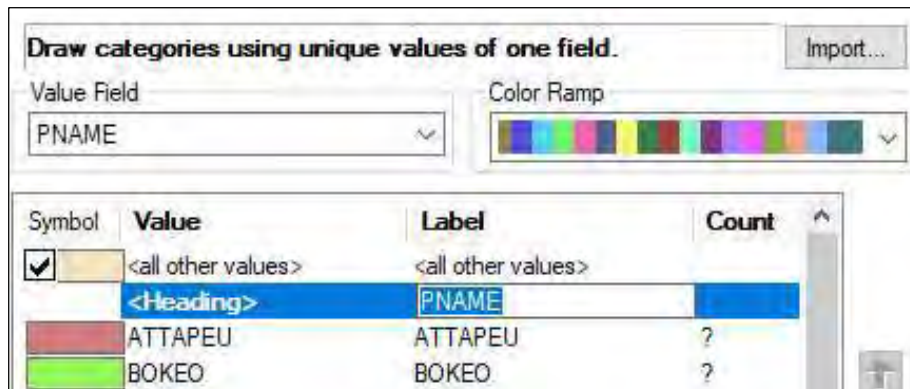




## Assigning new Label Heading

Accessed in Layer Properties Menu

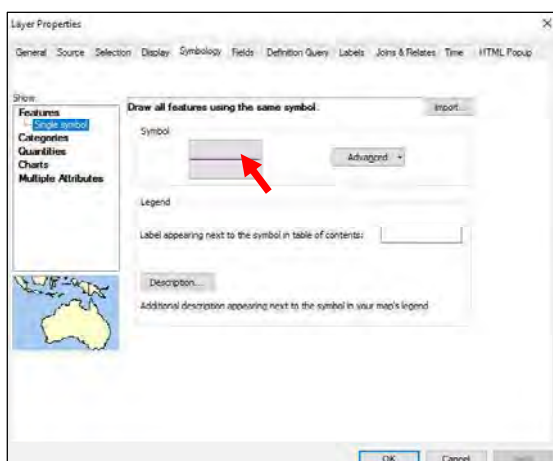
- To give a **new name for heading** of a group value  
Click the Symbology tab.
- Click at the heading in Label, and type a new heading.
- Then Click OK.



## Changing the line features symbols

Assessment of skills – Begin at conclusion of lesson

- Right-click at the layer's name of line layer in the table of contents, And click Properties.
- Click the Symbology tab on the Properties dialog box, Click Features
- Click the Symbol button to change the symbol.

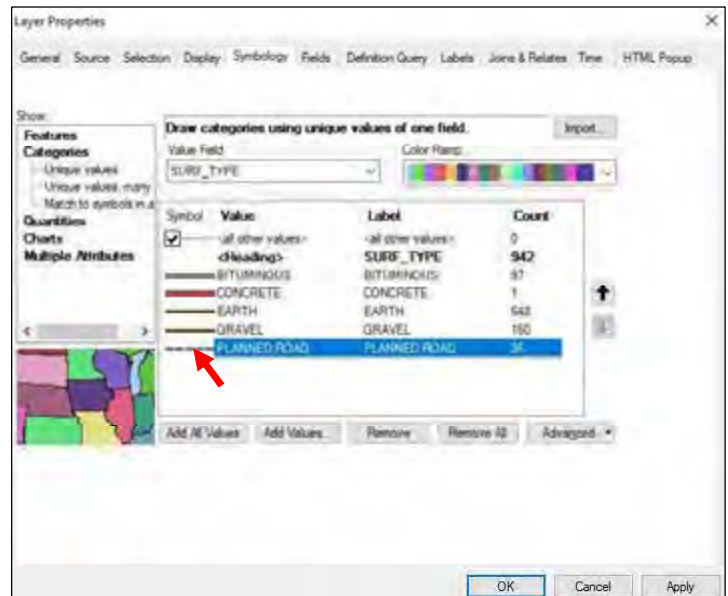




## Draw a line layer showing unique values

### Layer Properties Menu

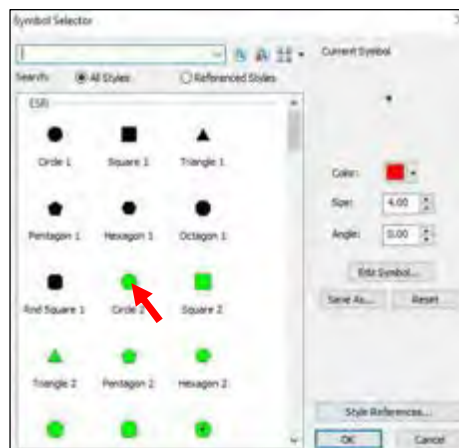
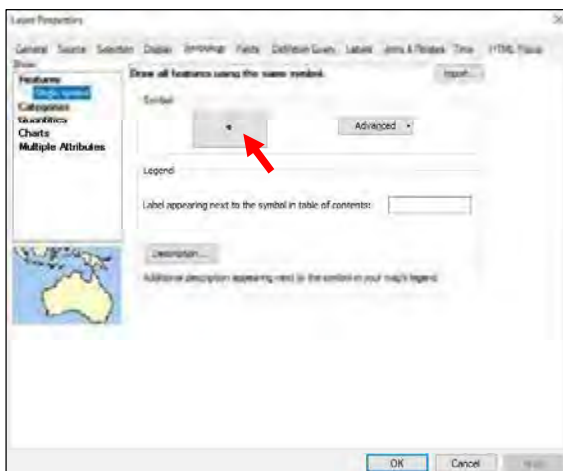
- Right-click the line layer and click Properties.
- Click the Symbology tab, then click Categories
- Click the Value Field, select the field that contains the values we want to map.
- Double-Click in each line feature value to change the line style, size and color.
- Click OK.



## Changing point features symbols

### Assessment of skills – Begin at conclusion of lesson

- Right-click at the layer's name of point layer click Properties.
- Click the Symbology tab on the Properties dialog box, Click Features
- Click the Symbol button to change the symbol.





At Table of Contents



*Laos map, 2019*

Assessment of skills – Begin at conclusion of lesson

- To change the label properties, right-click at the layer's name. Select Properties, click Label tab.
- Then change the Method, Label Field, Text Style, Text Symbol and other properties. Click OK.

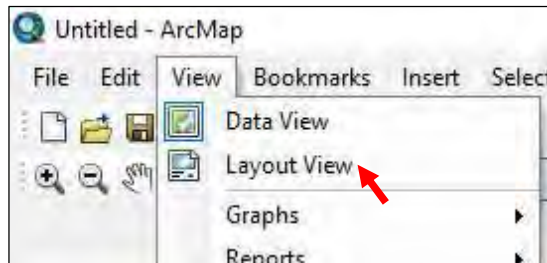




## 5. Laying out a map

### 5.1 Using an Existing template

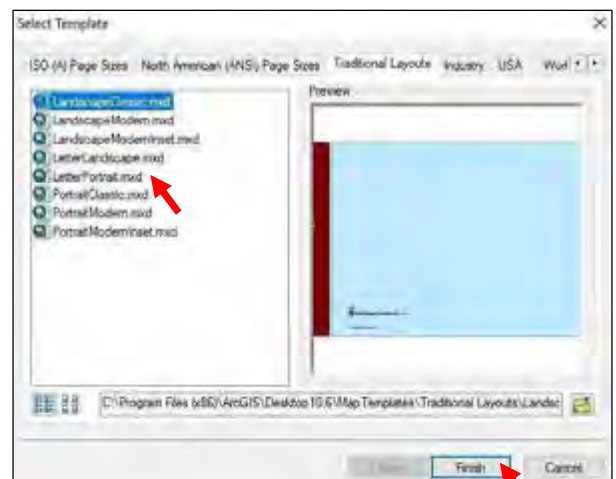
- Click View and click Layout View



- After entering Layout View the Layout toolbar will appear



- Click the **Change Layout** button to change layout and select template



- Select Template catalog tab and click a template style.

- Click Finish

## Making a map with a template

Adjust data frame

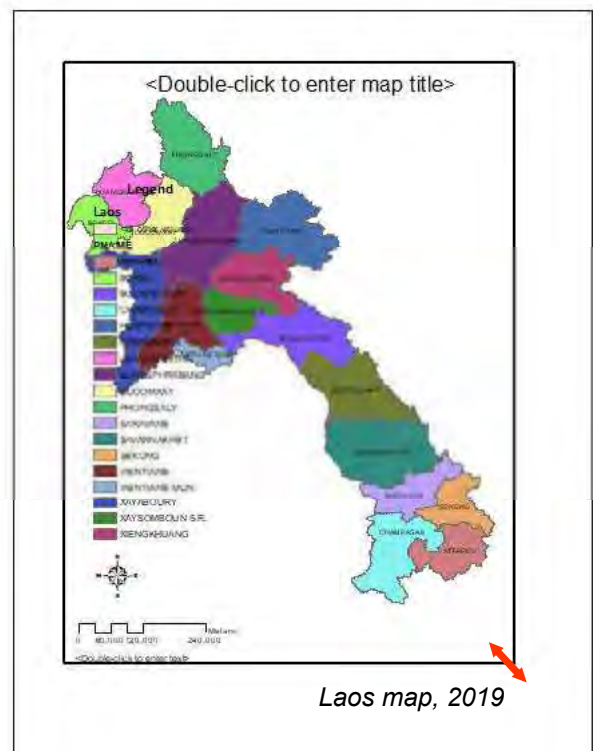
- Click the Select Elements button



Click the data frame to select it.

- The data frame is now outlined with dashed line and has selection handles at its corners and edges.

- Click the resize cursor.
- Click the corner, drag it up and to the left.





## Making a map with a template

Adjust map elements

- Move other elements;  
North Arrow, Legend frame,  
Scale Bar and Title out of  
the Data frame by clicking  
and dragging each element.

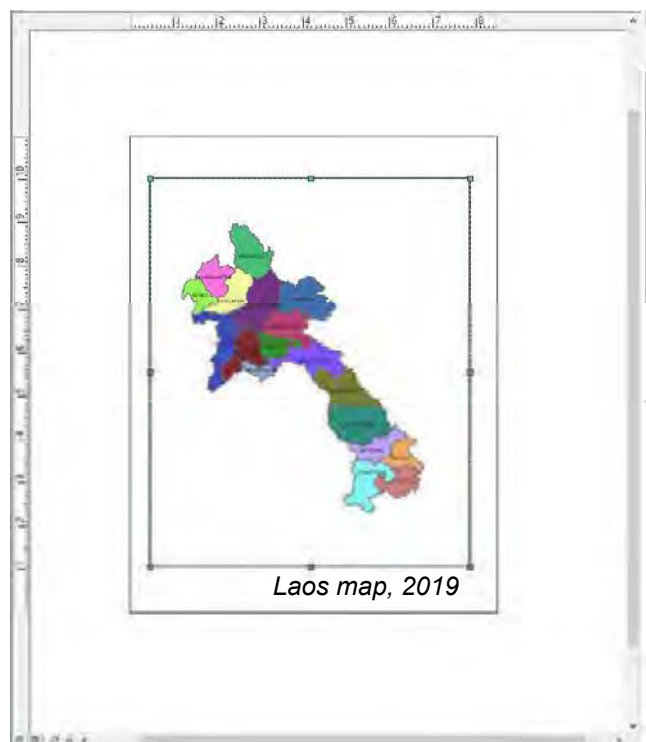
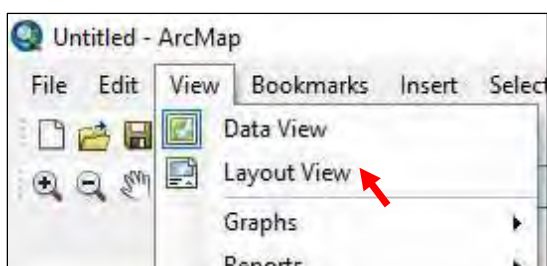


Laos map, 2019

## 5.2 Creating your own map

No template used

- Click View > [Layout View](#)

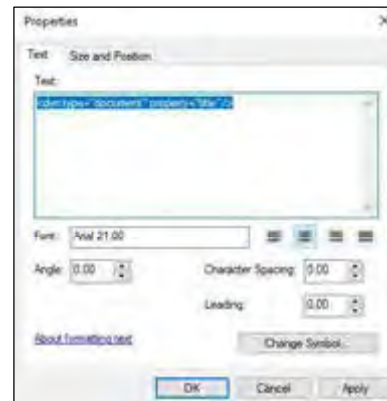
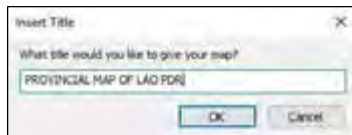




## Creating your own map

Insert a title

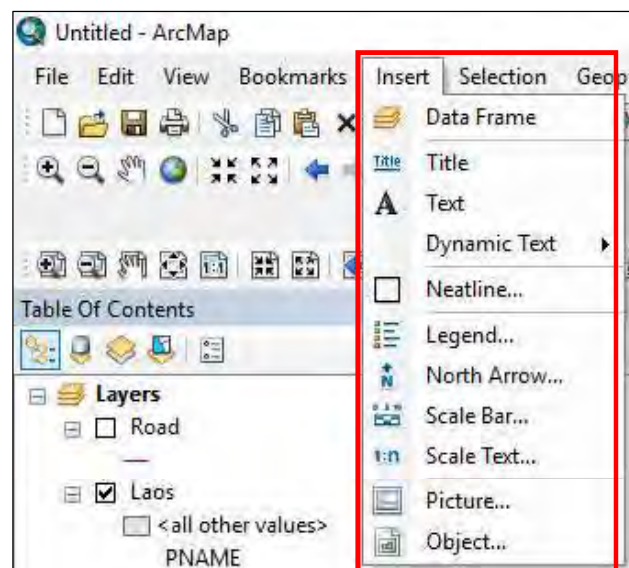
- Select the Insert menu, then select the Title
- Title appears on the page. Type in a logical title such as “PROVINCIAL MAP OF LAO PDR”
- After the title is entered move your cursor to the title and left click to select the title then right click to bring up the “Properties of the Title” window. Here you can make other changes; for example Change symbol is the button to use for increasing the text size or changing fonts.



## Creating your own map

Adding other map elements

- Select the Insert menu, then select the North Arrow. Pick one you like then select OK.
- The North arrow is put on the page with a box around it. Dragging it to where you want it or resize it by dragging with corner.
- Add a Scale bar, Legend, Text, etc... as you did above.



Note: When adding the Legend accept default, select next and then finished.  
Change the properties of the Legend matching with the layout later.



## Creating your own map

Adding other map elements

- Try laying out and styling the map on your own.  
Are there any areas you would improve upon?

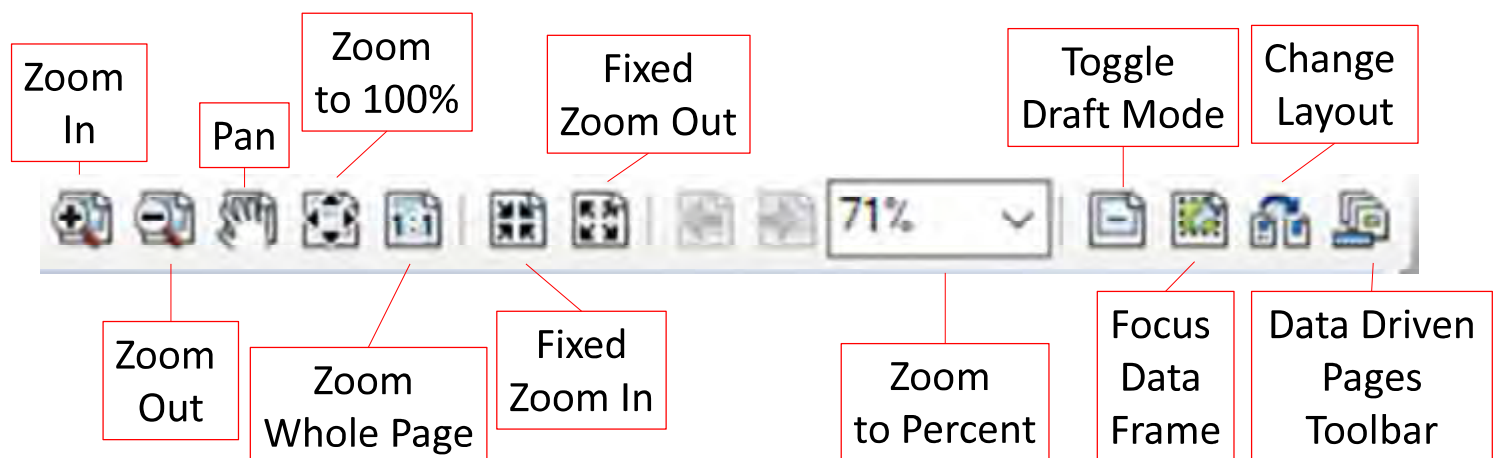


Laos map, 2019

## A closer look at the Layout toolbar

Assessment of skills – Begin at conclusion of lesson

- Zooming for layout map can be used zoom tools set
- This Zoom set use for Layout View, these will not  
Change composition in Data View

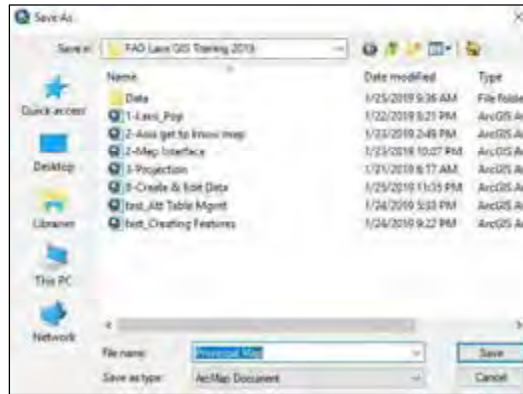
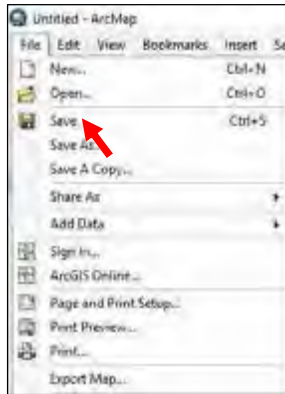




## Saving a Map

Enter file name

- To keep the new map that you have created and also keep the old template map, use Save As to save this map under a new name.



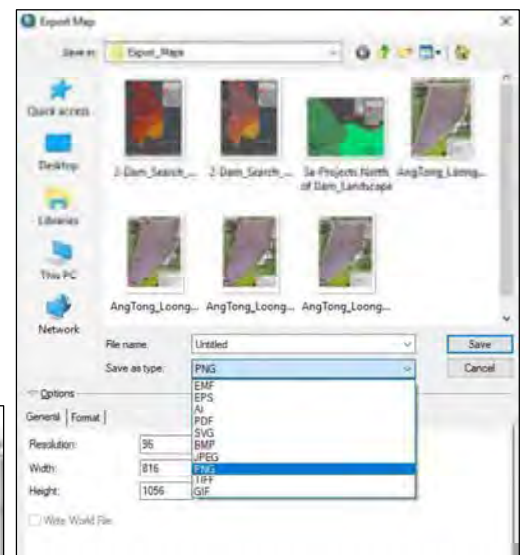
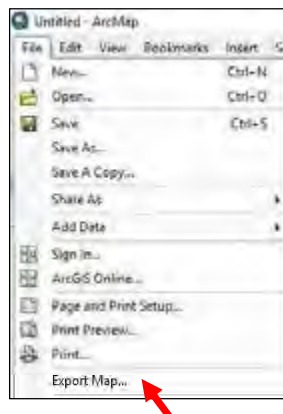
- Navigate to your directory and folder
- Type the map of map, Click Save.

## Export map

Conversion to a common file format

**Exporting map to another image format files to present into another software; PowerPoint or add your map into the report such as MS word.**

- Click File and select **Export Map**.  
Navigate to your folder, type new file's name.
- Select format type of file such as: .BMP, .JPG, .TIFF
- Options menu allows modification of exported file such as resolution and quality.
- Then click Save.





# Table Management Using ArcGIS

A first look into the concepts that comprise  
a Geographic Information System



## I. Database File Handling

### Overview

1. Start ArcGIS
2. Adding data
3. Field Data Management
  - a. Sort data based on attributes
  - b. Obtaining statistics of attributes
  - c. Summarizing attributes based on a key attribute
4. Joining tabular data to spatial data and create new layer with tabular data
5. Relate tabular data to spatial data (understanding difference between Join & Relate)
6. Table Management (select by attributes, graph, find & replace, etc.)
7. Adding and calculation in fields
  - a. Adding new field/ Data types
  - b. Calculate geometry (area, length, perimeter, etc.)
  - c. Field calculator (assign new values, recode data)
  - d. Deleting fields



## II. Selection

### Overview

1. Identify features
  - a. Identifying features by pointing to them
  - b. Change the field on/off
  - c. Hyperlinks
2. Select features
  - a. Select by attributes
  - b. Select by locations using several layers
3. Select records
  - a. Interactively selecting records in a table
  - b. Selecting record in a table by attributes
  - c. Selecting all records
  - d. Clearing the selection
  - e. Switching the selection

## Exercises to be completed on your own

Assessment of skills – Begin at conclusion of lesson

1. Calculate population density in Savannaket province
2. Recode the population density as Low, Medium, High using your own class values
3. Symbolize using above three classes
4. Find and create a village layer - which are within a distance of 800m to road layer

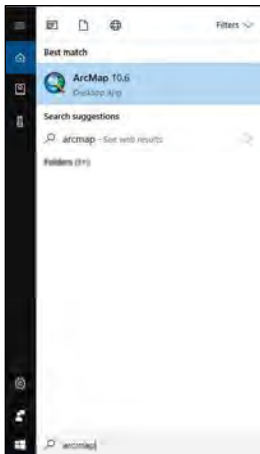


## Opening ArcMap 10.6

New empty map

❖ Type Arcmap into the Windows search bar

❖ Click ArcMap 10.6



❖ Click **Cancel**  
to open a  
new, empty  
map.

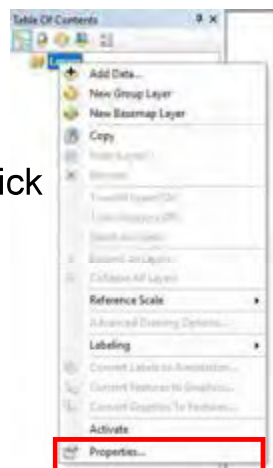


## Set up at beginning

Layer properties

### Set Up Layer Properties

❖ At Table of Contents: Right Click  
“Layers” & select **Properties**



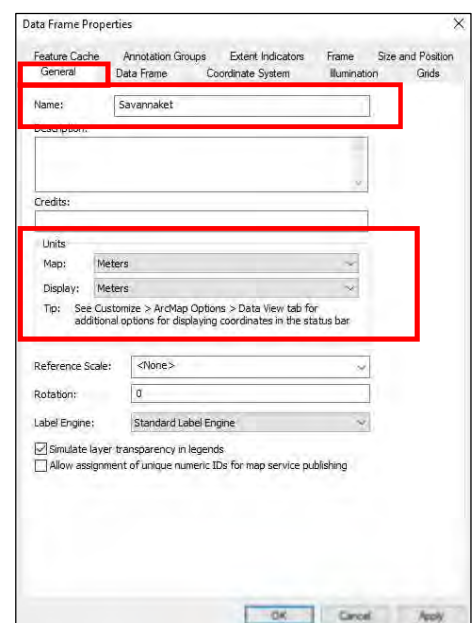
❖ Click “General Tab”

❖ Type “Savannakhet” in the name Text box

❖ Set Map Unit “Meters”

❖ Set Display Unit “Meters or Kilometers”

❖ Click OK





## Adding Data from ArcCatalog

ArcCatalog window



- ❖ Start ArcCatalog by clicking the ArcCatalog button on the Standard toolbar

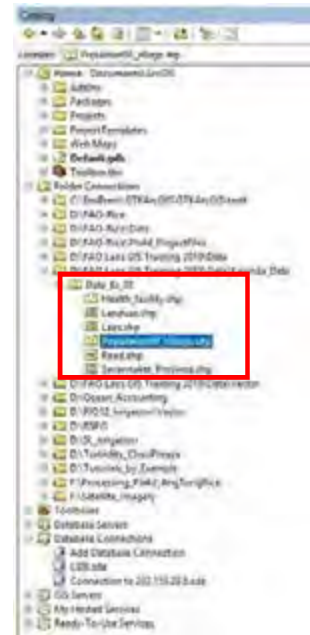


- ❖ Navigate to:

[D:\ArcGIS\\_Training\GIS\\_Data\Laos](D:\ArcGIS_Training\GIS_Data\Laos)

- ❖ Hold down the Ctrl key to select several layers

➤ Population95\_Village.shp

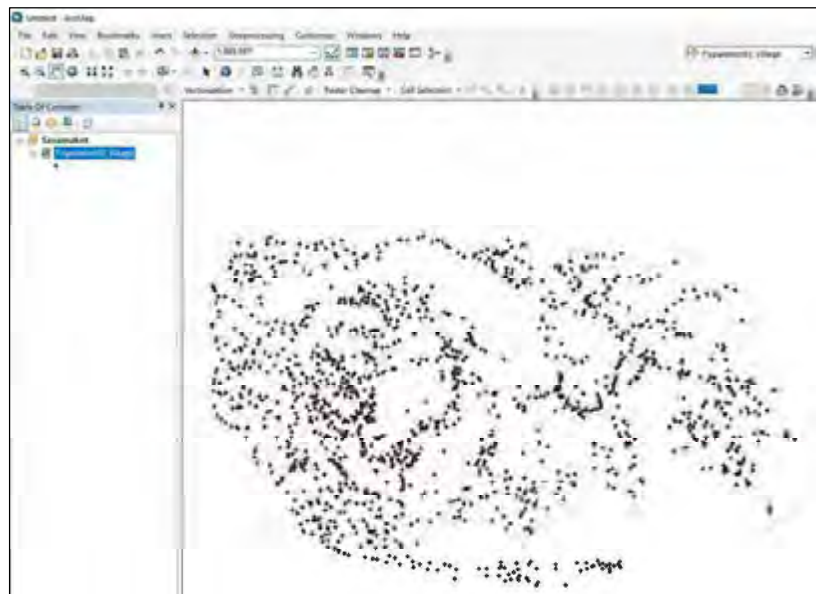


## Adding Data from ArcCatalog

ArcCatalog window

- ❖ Drag & Drop the file into ArcMap Data View

- ❖ The selected layer is added to the new data frame





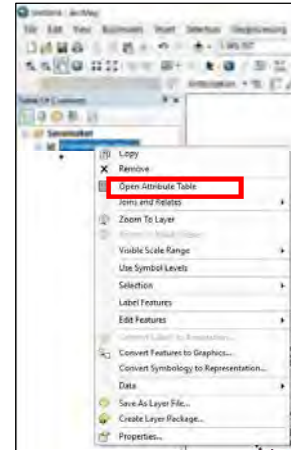
## Field Data Management

### Interacting with Attribute Tables

#### a. Sort Data

- ❖ Right click 'Population95\_Village' layer
- ❖ Select > **Open Attribute Table**

FID	Shape	VCODE	DCODE	PCODE	VNAMEE	VNAMEL	SUMOFINUMB	SUMOFTOTPE	SUMOFTOTMA	SUMOFTOTFE
0	Point	1301001	1301	13	HOUAXANG	se-hk'	88	988	315	384
1	Point	1301002	1301	13	NAMBO	ok[+	129	983	344	343
2	Point	1301003	1301	13	BEUNGTHALE	[tmtg]	74	404	207	197
3	Point	1301005	1301	13	THASANO GNAI	mk-13o.sjp	150	935	458	479
4	Point	1301006	1301	13	THASANO NOY	mk-13oohvp	74	413	202	211
5	Point	1301007	1301	13	PAKBO	xkd[+	85	473	236	237
6	Point	1301008	1301	13	TONPHEUNG	8ogzu'	87	352	109	182
7	Point	1301009	1301	13	LAONGAM	gqjk'	55	369	146	154
8	Point	1301010	1301	13	KHONKEN	o'ocdo	62	329	188	181
9	Point	1301011	1301	13	NACHALID	o'stsjyf	79	452	233	219
10	Point	1301012	1301	13	DONGDAMDUANE	fc'fef;o	81	336	181	178
11	Point	1301013	1301	13	GNANG	pk'	128	722	348	374
12	Point	1301014	1301	13	PHOSI	3lu	20	128	64	84



## Field Data Management

### Adjusting field width

Columns are called **fields** in ArcMap

Widen fields by dragging the vertical line to the right of the field name

FID	Shape	VCODE	DCODE	PCODE	VNAMEE	VNAMEL	S
0	Point	1301001	1301	13	HOUAXANG	se-hk'	
1	Point	1301002	1301	13	NAMBO	ok[+	
2	Point	1301003	1301	13	BEUNGTHALE	[tmtg]	
3	Point	1301005	1301	13	THASANO GNAI	mk-13o.sjp	
4	Point	1301006	1301	13	THASANO NOY	mk-13oohvp	
5	Point	1301007	1301	13	PAKBO	xkd[+	
6	Point	1301008	1301	13	TONPHEUNG	8ogzu'	
7	Point	1301009	1301	13	LAONGAM	gqjk'	
8	Point	1301010	1301	13	KHONKEN	o'ocdo	
9	Point	1301011	1301	13	NACHALID	o'stsjyf	
10	Point	1301012	1301	13	DONGDAMDUANE	fc'fef;o	
11	Point	1301013	1301	13	GNANG	pk'	
12	Point	1301014	1301	13	PHOSI	3lu	



## Field Data Management

Rearranging field position field width

2x click a field name and drag it to the position you like. This is helpful for organizing data

SUMOFTOTMA	VNAMEE	VNAMEL	PCODE	SUMOFTOTFE	FID	Shape	VCODE	DCODE	SUMOFPRNUMB	SUMOFTOTPE
111	THALANG	thalang	13	184	8	Point	1301001	1301	88	188
114	Thalang	thalang	13	184	9	Point	1301002	1301	179	189
115	Thalang	thalang	13	184	10	Point	1301003	1301	74	184
116	Thalang	thalang	13	184	11	Point	1301004	1301	188	188
117	Thalang	thalang	13	184	12	Point	1301005	1301	11	181
118	Thalang	thalang	13	184	13	Point	1301006	1301	85	185
119	Thalang	thalang	13	184	14	Point	1301007	1301	67	187
120	Thalang	thalang	13	184	15	Point	1301008	1301	16	186
121	Thalang	thalang	13	184	16	Point	1301009	1301	12	182
122	Thalang	thalang	13	184	17	Point	1301010	1301	76	186
123	Thalang	thalang	13	184	18	Point	1301011	1301	81	186
124	Thalang	thalang	13	184	19	Point	1301012	1301	106	196
125	Thalang	thalang	13	184	20	Point	1301013	1301	106	196
126	Thalang	thalang	13	184	21	Point	1301014	1301	106	196



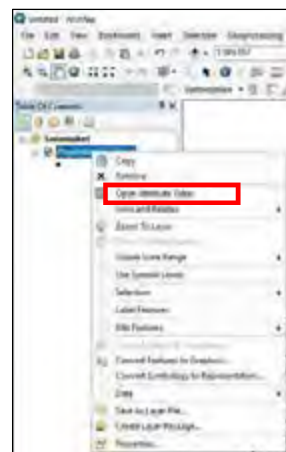
SUMOFTOTMA	VNAMEE	PCODE	SUMOFTOTFE	FID	Shape	VCODE	DCODE	SUMOFPRNUMB	SUMOFTOTPE	SUMOFTOTFE
111	THALANG	13	184	8	Point	1301001	1301	88	188	188
114	Thalang	13	184	9	Point	1301002	1301	179	189	189
115	Thalang	13	184	10	Point	1301003	1301	74	184	184
116	Thalang	13	184	11	Point	1301004	1301	188	188	188
117	Thalang	13	184	12	Point	1301005	1301	11	181	181
118	Thalang	13	184	13	Point	1301006	1301	85	185	185
119	Thalang	13	184	14	Point	1301007	1301	67	187	187
120	Thalang	13	184	15	Point	1301008	1301	16	186	186
121	Thalang	13	184	16	Point	1301009	1301	12	182	182
122	Thalang	13	184	17	Point	1301010	1301	76	186	186
123	Thalang	13	184	18	Point	1301011	1301	81	186	186
124	Thalang	13	184	19	Point	1301012	1301	106	196	196
125	Thalang	13	184	20	Point	1301013	1301	106	196	196
126	Thalang	13	184	21	Point	1301014	1301	106	196	196

## Field Data Management

Interacting with Attribute Tables

### a. Sort Data

- ❖ Right click 'Population95\_Village' layer
- ❖ Select >Open Attribute Table



FID	Shape	VCODE	DCODE	PCODE	VNAMEE	VNAMEL	SU
0	Point	1301001					
1	Point	1301002					
2	Point	1301003					
3	Point	1301004					
4	Point	1301006					
5	Point	1301007					
6	Point	1301009					
7	Point	1301009					
8	Point	1301010					
9	Point	1301011					
10	Point	1301012					
11	Point	1301013					
12	Point	1301014					

- ❖ Right click 'DCODE' field
- ❖ Select 'Sort Ascending' or 'Sort Descending'



## b. Statistics

For a given field

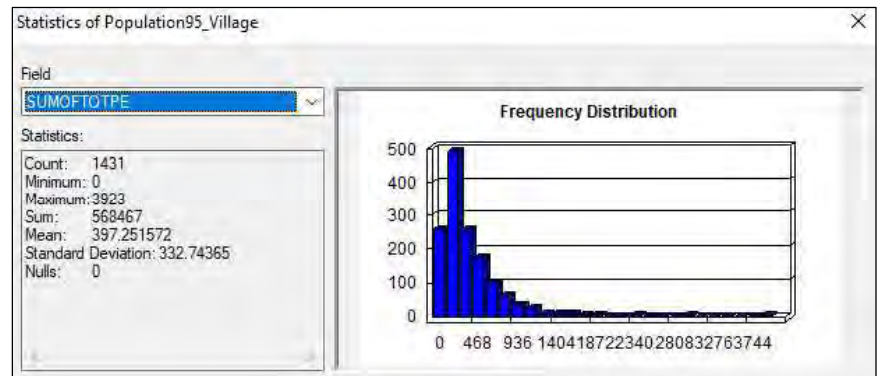
❖ In 'Population95\_Village' Attribute table, right click 'SUMOFTOTPE' field

❖ Select Statistics



❖ Table shows selected Field and statistics

- Count -- Total record
- Maximum
- Minimum
- Summary
- Mean
- Standard Deviation



## c. Summarize Data

Creates new table

❖ In 'pop95\_vill' Attribute table, right click 'SUMOFTOTPE' field

❖ Select Summarize



❖ Select a field to Summarize: DCODE

❖ Choose one or more summary statistics

To be included in the output table:

- Click DCODE, check 'Maximum'
- Click SUMOFTOTPE, check 'Sum'

❖ Specify Output table, Click browse

D:\ArcGIS\_Training\GIS\_data\Laos\Sum\_pop\_disrict.dbf, click OK

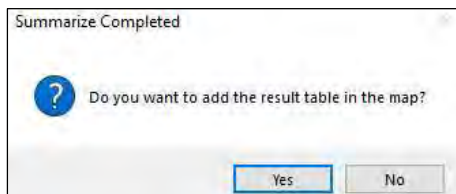




## c. Summarize Data

Creates new table

- ❖ Click Yes to add result in the map



- ❖ Right Click “Sum\_pop\_disrict.dbf”

- ❖ Open

- ❖ Table show summarizing population in 1995 each district

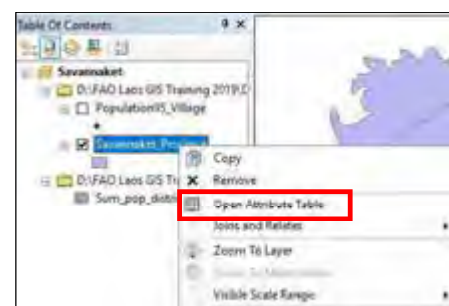
	OID	SUMOFOTPE	Count_SUMOFOTPE	Maximum_DCODE	Sum_DCODE
	354	460	1	1309	1309
	355	482	4	1313	5238
	356	483	2	1312	2620
	357	485	3	1312	3923
	358	486	5	1313	6551
	359	467	2	1309	2612
	360	468	4	1311	5225
	361	471	2	1312	2621
	362	472	2	1313	2614
	363	473	1	1301	1301
	364	475	1	1308	1308
	365	477	3	1312	3922
	366	478	2	1309	2611

## Join Table to Feature

Bring attributes together

*Establishes a one-to-one or many-to-one relationship*

*Join the table containing the ‘Sum\_pop\_district’ tabular data to the ‘Savannaket\_Province’ attribute table, using “DPCODE” as the common field.*



- ❖ Add ‘Savannaket\_Province’ from ArcCatalog window

- ❖ Right click in the table of contents and click **Open Attribute Table** to see the existing attributes

	OID	SUMOFOTPE	Count_SUMOFOTPE	Maximum_DCODE	Sum_DCODE
	354	460	1	1309	1309
	355	482	4	1313	5238
	356	483	2	1312	2620
	357	485	3	1312	3923
	358	486	5	1313	6551
	359	467	2	1309	2612
	360	468	4	1311	5225
	361	471	2	1312	2621
	362	472	2	1313	2614
	363	473	1	1301	1301
	364	475	1	1308	1308
	365	477	3	1312	3922
	366	478	2	1309	2611

	FID	Shape	DPCODE	DNAME	PNAME
0	0	Polygon	1312	Vietoun	SAVANNAKHE
1	1	Polygon	1311	Xaboun	SAVANNAKHE
2	2	Polygon	1313	Adasphat	SAVANNAKHE
3	3	Polygon	1305	Xerou	SAVANNAKHE
4	4	Polygon	1302	Outthumpong	SAVANNAKHE
5	5	Polygon	1303	Attachangthong	SAVANNAKHE
6	6	Polygon	1304	Phin	SAVANNAKHE
7	7	Polygon	1301	Khantaboun	SAVANNAKHE
8	8	Polygon	1309	Champhon	SAVANNAKHE
9	9	Polygon	1308	Itong	SAVANNAKHE
10	10	Polygon	1310	Kontoun	SAVANNAKHE
11	11	Polygon	1300	Songkhon	SAVANNAKHE
12	12	Polygon	1307	Tiaseangthong	SAVANNAKHE



## Join Table to Feature

Bring attributes together

Be able to join demography information via 'DCODE'

OLD	SUMOFTOTPE	Count_SUMOFTOTPE	Maximum_DCODE	Sum_DCODE
354	460	1	1309	1309
355	462	4	1315	4238
356	463	2	1312	2620
357	465	3	1312	3823
358	466	5	1313	4551
359	467	2	1309	2612
360	468	4	1311	5225
361	471	2	1312	2621
362	472	2	1313	2614
363	473	1	1301	1301
364	475	1	1308	1308
365	477	3	1312	3822
366	478	2	1309	2611

Table

FID	Shape	PCODE	DCODE	DNAME	PNAME
0	Polygon	13	1312	Vithoun	SAVANNAKHE
1	Polygon	13	1311	Kaloun	SAVANNAKHE
2	Polygon	13	1312	Aksaoun	SAVANNAKHE
3	Polygon	13	1305	Xepou	SAVANNAKHE
4	Polygon	13	1302	Outhoumphon	SAVANNAKHE
5	Polygon	13	1303	Aksaoungthong	SAVANNAKHE
6	Polygon	13	1304	Phin	SAVANNAKHE
7	Polygon	13	1301	Khanthaboun	SAVANNAKHE
8	Polygon	13	1306	Champion	SAVANNAKHE
9	Polygon	13	1306	Nong	SAVANNAKHE
10	Polygon	13	1319	Kendoun	SAVANNAKHE
11	Polygon	13	1308	Songkhan	SAVANNAKHE
12	Polygon	13	1307	Thapengthong	SAVANNAKHE

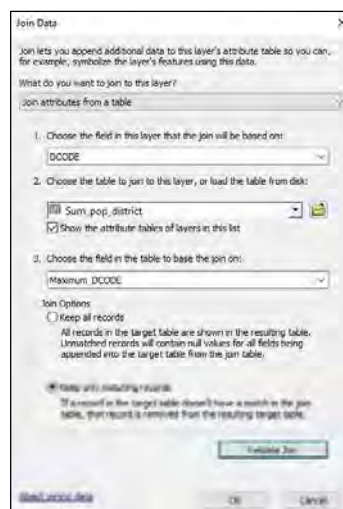
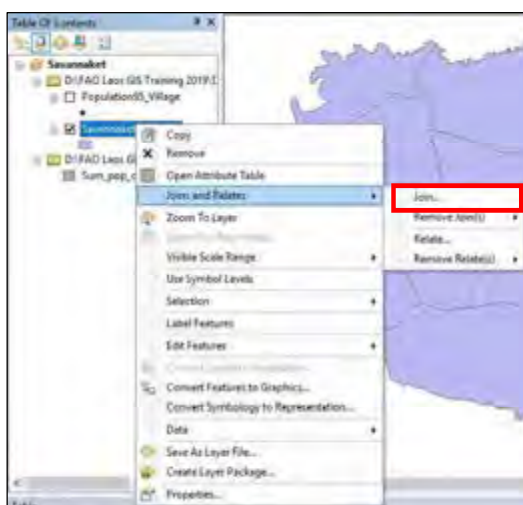


Attribute Table of Feature

## Join Table to Feature

Bring attributes together

- ❖ Right-click 'Savannakhet\_Province' (Destination Table) in the Table of Contents, point to *Joins and Relates*, and click Join.



- ❖ Setting Field of 'Based on' table, 'Table to join' and 'Field in the Table' to join on

- ❖ Click OK



## Join Table to Feature

Bring attributes together

Then open 'Savannaket\_Province' Check the joined field

	FID	Shape	PCODE	DCODE	DNAME	PNAME	OID	SUMOFTOTPE	Count_SUMOFTOTPE	Maximum_DCODE *	Sum_DCODE
	0	Polygon	13	1312	Vilabouri	SAVANNAKHE	5	40	1	1312	1312
	1	Polygon	13	1311	Xaibouri	SAVANNAKHE	29	83	1	1311	1311
	2	Polygon	13	1313	Atsaphon	SAVANNAKHE	0	0	22	1313	28715
	3	Polygon	13	1305	Xepon	SAVANNAKHE	27	81	1	1305	1305
	4	Polygon	13	1302	Outhoumphon	SAVANNAKHE	179	240	1	1302	1302
	5	Polygon	13	1303	Atsaphangthong	SAVANNAKHE	165	224	1	1303	1303
	6	Polygon	13	1304	Phin	SAVANNAKHE	2	34	1	1304	1304
	7	Polygon	13	1301	Khanthabouri	SAVANNAKHE	75	133	1	1301	1301
	8	Polygon	13	1309	Champhon	SAVANNAKHE	70	128	3	1309	3915
	9	Polygon	13	1306	Nong	SAVANNAKHE	1	21	1	1306	1306
	10	Polygon	13	1310	Xonbouri	SAVANNAKHE	42	98	2	1310	2616
	11	Polygon	13	1308	Songkhon	SAVANNAKHE	13	62	1	1308	1308
	12	Polygon	13	1307	Thapangthong	SAVANNAKHE	18	70	1	1307	1307

(0 out of 13 Selected)

Sum\_pop\_district Savannaket\_Province

## Join Table to Feature

Create new layer from joined data

- ❖ Create a new layer with joined tabular data
  - ❖ Right click on 'Savannaket\_Province' > Data > Export data, give the new layer name as 'Savannaket\_Province\_pop'
- ❖ Add new 'Savannaket\_Province\_pop' layer to ArcMap and see the attributes.



## Relate

Relate data from two different layers



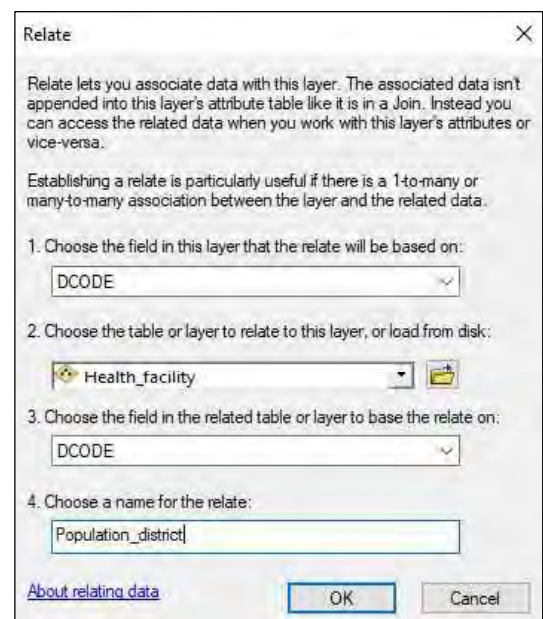
- ❖ Drag & Drop 'Health\_Facility' from ArcCatalog window

- ❖ Right-click the layer you want to relate "Savannaket\_Province", point to Joins and Relates, and click Relate.
- ❖ Click the first dropdown arrow and click the field in the layer on which the relate will be based "DCODE".
- ❖ Click the second dropdown arrow and click the table or layer to relate to, "Health\_facility", or load the table from disk.

## Relate

Relate data from two different layers

- ❖ Click the third dropdown arrow and click the field in the related table on which to base the relate "DCODE".
- ❖ Type a name for the relate "Population\_District".
- ❖ You'll use this name to access the related data.
- ❖ Click OK

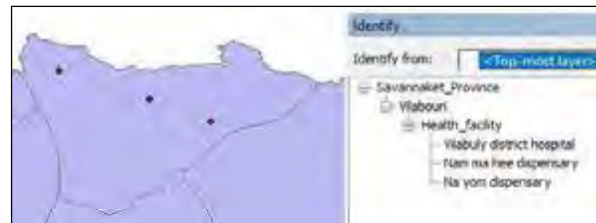
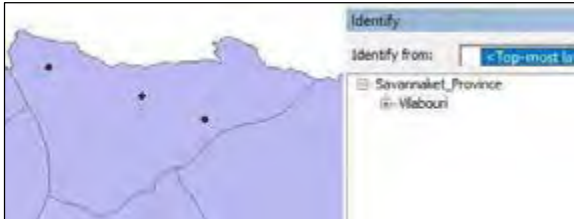




## Relate

Relate data from two different layers

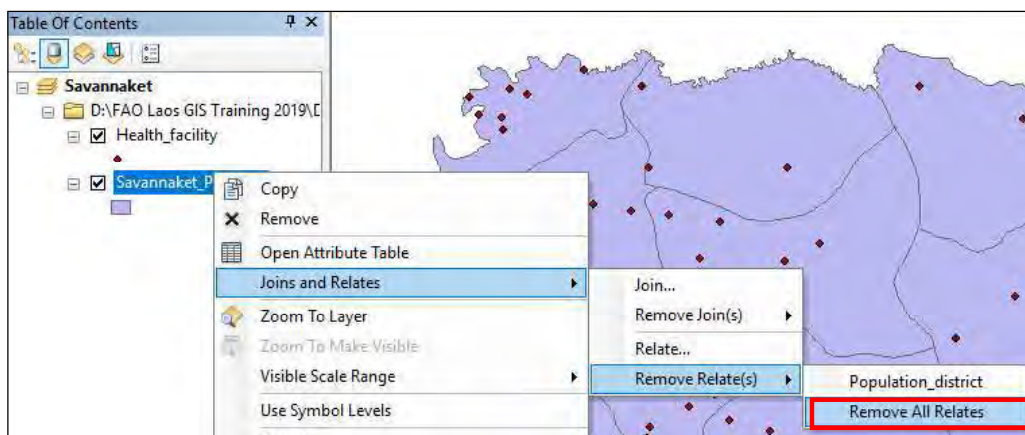
Related information appears when you use the **Identify Tool**



Opening the sub-menu reveals the names of 3 health facilities in Vilabouri district

## Remove Relate

Return to previous condition before relate



- ❖ Right-click the layer containing a relate you want to remove and point to Joins and Relates.

- ❖ Point to Remove Relate(s) and click the relate you want to remove.

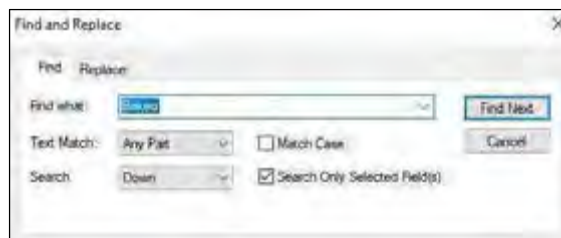


## Find & Replace - Attribute Table

Works like similar tools in MS Word or Excel

- Drag & drop Add Data 'Laos.shp' from ArcCatalog window
- Open Attribute Table
- Go to Options, Right Click
- Select Find & Replace
- Type 'Bokeo'
- Click Find Next

In order to replace text in a field you must enter **editing mode**



## Selecting by Attributes in Attribute Table

Completed within attribute table

- Open Attribute Table
- Go to Options, Select By Attributes, select "PNAME" and click the = sign
- Click Get Unique Values to reveal a list of province names
- Double-click Bokeo
- Click Apply



➤ Bokeo is now selected on the map & in the Attribute Table



## Examine other commands

Commands available for attribute table

4.3 Select All

4.4 Clear Selection

4.5 Switch Selection

4.6 Create Graph

4.7 Add Table to Layout

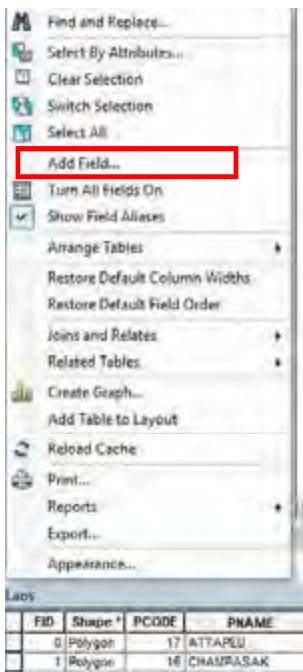
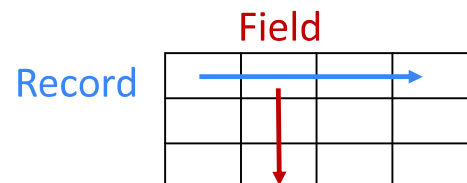
4.8 Reload Cache -- a temporary file,  
or cache, help to display and navigate  
data efficiently

4.9 Export

4.10 Appearance

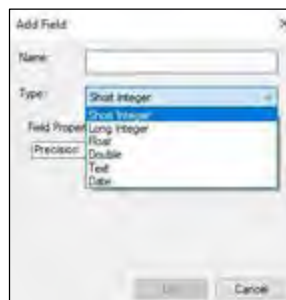
## Adding data & deleting attributes

Create and remove attribute table data



### a. Adding fields to a table

- ❖ Click Options in the table to which you want to add a field.
- ❖ Click Add Field.
- ❖ Type the name of the field.
- ❖ Click the Type dropdown arrow and click the field type.
- ❖ Set any other field properties as necessary.
- ❖ Click OK.





## Data formats available

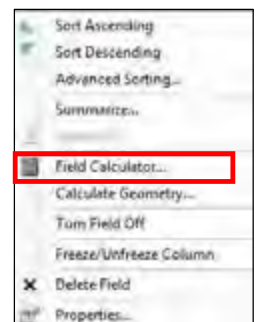
Attribute Table

Name	Specific range, length, or format	Size (Bytes)	Applications
Short integer	-32,768 to 32,767	2	numeric values without fractional values within specific range; coded values
Long integer	-2,147,483,648 to 2,147,483,647	4	numeric values without fractional values within specific range
Single precision floating point number (Float)	approximately -3.4E38 to 1.2E38	4	numeric values with fractional values within specific range
Double precision floating point number (Double)	approximately -2.2E308 to 1.8E308	8	numeric values with fractional values within specific range
Text	up to 64,000 characters	varies	names or other textual qualities
Date	mm/dd/yyyy hh:mm:ss A/PM	8	date and/or time
BLOB	varies	varies	images or other multimedia
GUID	36 characters enclosed in curly brackets	16 or 38	customized applications requiring global identifiers

## Examine other commands

Field Calculator

- ❖ Click Editor on the Editor toolbar and click Start Editing. You can make calculations without being in an editing session; however, in that case, there is no way to undo the results.
- ❖ Right-click the layer or table you want to edit and click Open Attribute Table
- ❖ Select the records you want to update
- ❖ If you don't select any, the calculation will be applied to all records.
- ❖ Right-click the field heading for which you want to make a calculation and click [Field Calculator](#).
- ❖ Use the Fields list and Functions to build a calculation expression. You can also edit the expression in the text area
- ❖ Optionally, you can type a value to set to the field.
- ❖ Click OK.
- ❖ Click Editor on the Editor toolbar and click Stop Editing

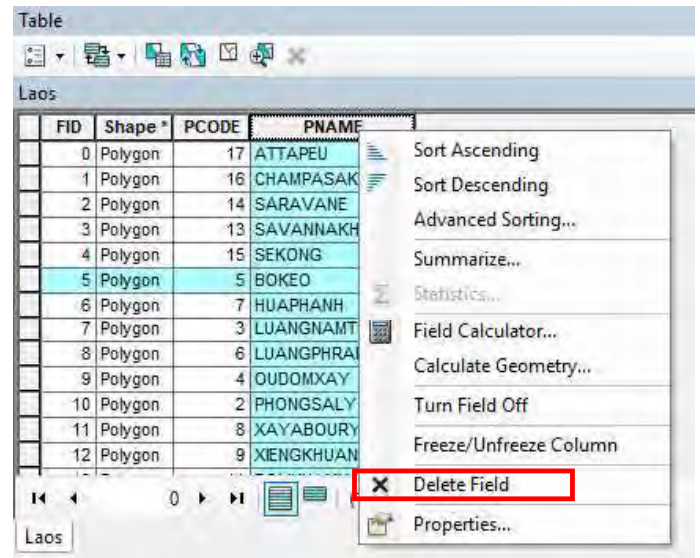




## d. Deleting fields from a table

### Attribute Tables

- ❖ Right-click the field header in the table window of the field you want to delete.
- ❖ Click **Delete Field**.
- ❖ Click Yes to confirm the deletion.
- ❖ Deleting a field cannot be undone.



## Selection

### View feature's attribute data in Data View

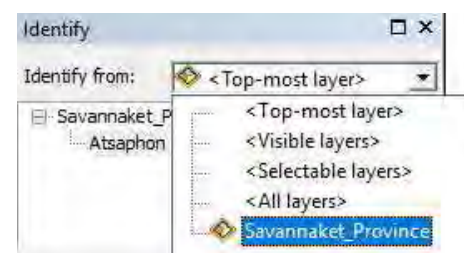


*The Identify tool allows you to see the attributes of your data.*

### a. Identifying features by pointing to them

Click the **Identify tool** on the Tools toolbar, the Identify Results dialog box opens.

Click the mouse pointer over the map feature you want to identify, the features in the topmost layer under the pointer will be identified.



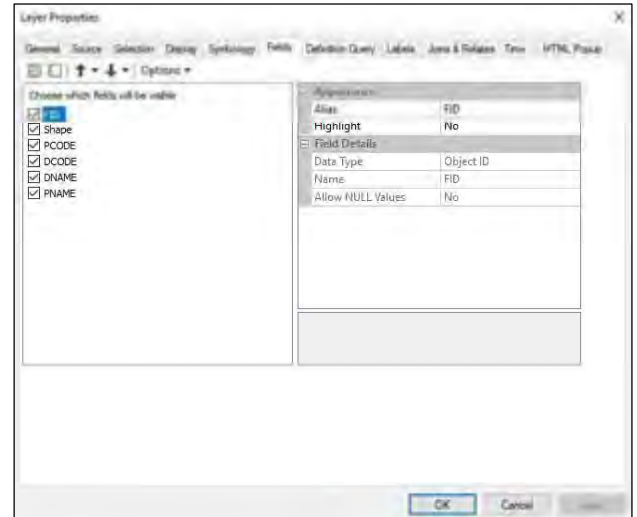


## Hiding Fields

Alters visible attributes for identify tool

### b. Format attribute data appearing in Identify dialog box

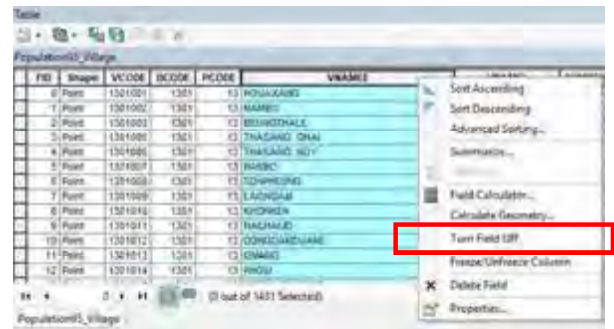
- ❖ Right-click the layer in the table of contents and click Properties.
- ❖ Click the Fields tab.
- ❖ Click the Primary Display Field dropdown arrow and click a field.
- ❖ Optionally, check the fields in the Name column which are relevant to your map and uncheck those that are not; or, click the button in the Number Format column to format your numbers.
- ❖ Click OK.



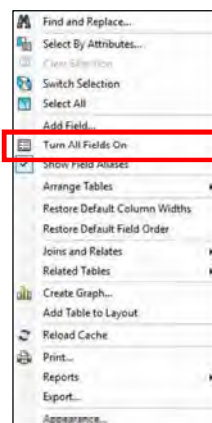
## Another way to hide fields

Hide fields at attribute table

- ❖ Another way to hide Fields – Use Attribute Table
- ❖ a. Right click field name and select **Turn Field Off**



- ❖ To turn hidden fields back on: At attribute table click **Table Options**
- ❖ Select **Turn All Fields On**



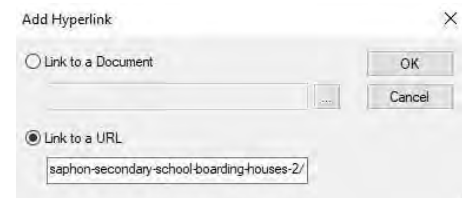
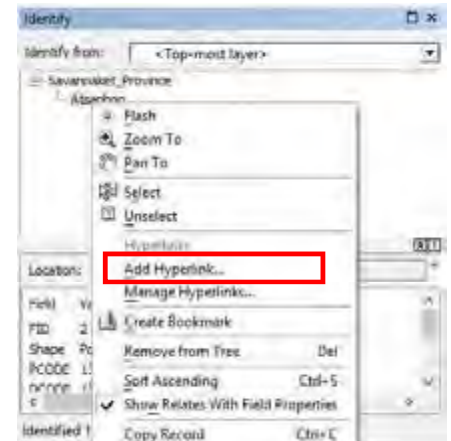


## Selection

### Identify Features

#### c. Creating hyperlinks for the Identify Results dialog box

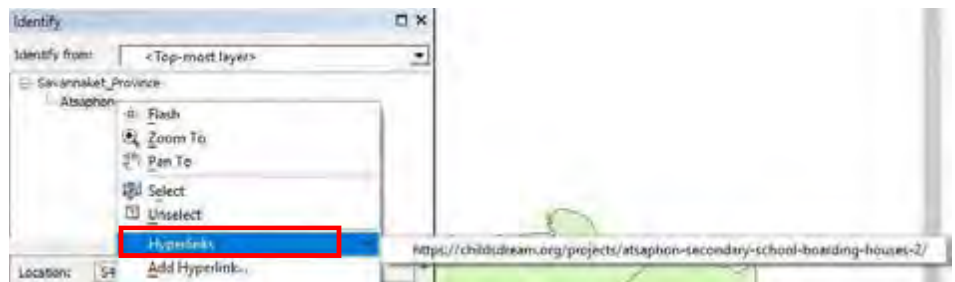
- ❖ Right-click on a feature's name in the left pane of the Identify Results dialog box, then click Add Hyperlink.
- ❖ Click Link to a Document or Link to a URL,
- ❖ Click the Browse button to select a document or type a URL, Then OK.
- ❖ To see the link, Right Click on Identify Results, Click Hyperlinks.




## Access Hyperlink

### Identify Features

- ❖ To see the link, Right Click on Identify Results, Click Hyperlinks.



Another way to access the hyperlink:

- ❖ Click Hyperlink button 
- ❖ Features with hyperlink will have blue outline
- ❖ Cursor will change to lightning bolt
- ❖ Click hyperlinked features to access website





## 2. Select Features

### Select by Attributes

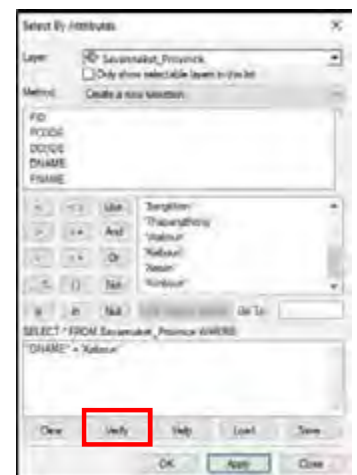
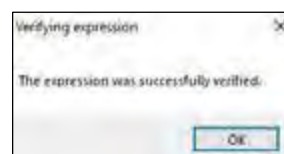
- ❖ Click Selection on the Main menu and click Select By Attributes.
- ❖ Click the Layer dropdown arrow and click the layer containing the features you want to select.
- ❖ Click the Method dropdown arrow and click a selection method.
- ❖ Double-click a field to add the field name to the expression box.
- ❖ Click an operator to add it to the expression.
- ❖ Click Get Unique Values to see the values for the selected field.
- ❖ Double-click a value to add it to the expression.



## Select by Attributes

### Use attribute data to select features

- ❖ Click the [Verify](#) button to see if you are using proper syntax or if the criteria you've entered will select any features .
- ❖ Click Apply.
- ❖ The status bar at the bottom of the ArcMap window tells you how many features are selected.
- ❖ Use the Clear button to empty the expression box.
- ❖ Use the Save and Load buttons respectively to save your current query as a file or load an existing one.
- ❖ The files used to save the queries have a .EXP extension but can be edited with any text editor. Only the content of the expression box is saved in the file, not the complete expression.
- ❖ Click Close when you are finished selecting features.

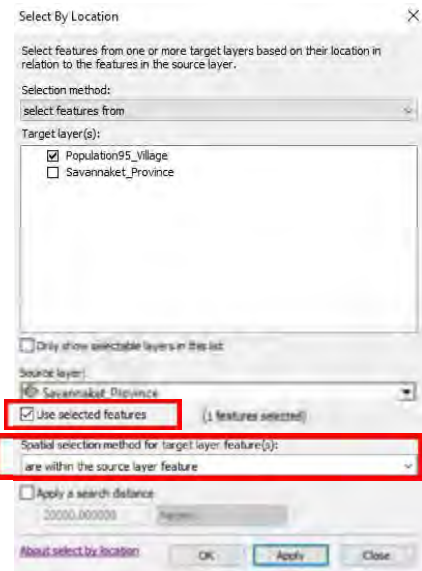
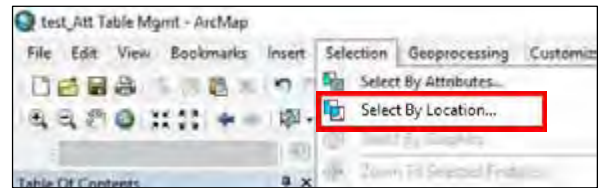




## Select by Location

Use location to select features

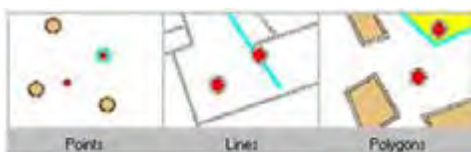
- ❖ Click Selection and click [Select By Location](#).
- ❖ Click the dropdown arrow and click a selection method.
- ❖ Check the layers whose features you would like to select.
- ❖ Click the dropdown arrow and click a selection method.
- ❖ Click the dropdown arrow and click the layer you want to use to search for the features.
- ❖ Check to use only the selected features.
- ❖ Check Apply a buffer to the features in <layer> and set the distance within which to search for features.
- ❖ Click Apply.



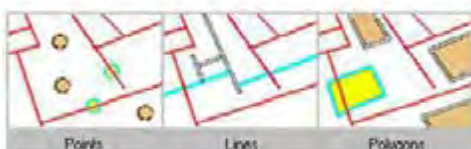
## Select Features according to their location

Select by Location – Spatial Selection Method

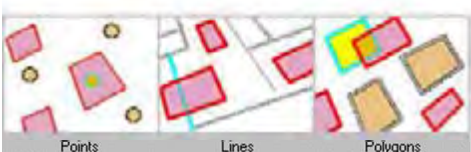
**Intersect** -- This method is similar to the Are crossed by the outline of method but also selects any features bordered by the reference features. For example, selecting wilderness areas intersected by roads will select any wilderness area with a road running within its boundaries or alongside it.



When finding features that intersect with [point](#) features



When finding features that intersect with [line](#) features



When finding features that intersect with [polygon](#) features

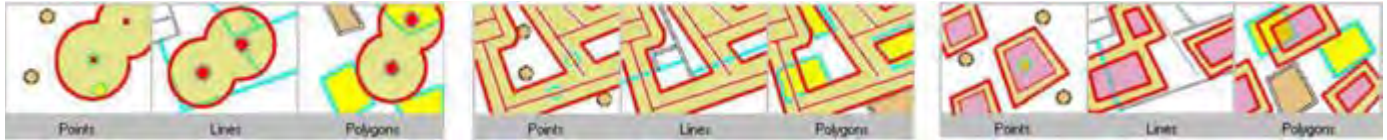
*The highlighted cyan features are selected because they intersect the red features*



## Are within a distance of

Select by Location — Spatial Selection Method

*When finding features that are within a given distance*



*point features*

*line features*

*polygon features*

*The highlighted cyan features are selected because they intersect the red features*

**Are within a distance of** -- This method selects features near or adjacent to features in the same layer or in a different layer. For example, if you have a layer of clean and polluted wells, you can find all the clean wells within 500 meters of the polluted ones. Or, you could find the reservoirs and farms in other layers that are within this distance of the polluted wells. You can also use this option to find features adjacent to other features. For example, you may have already selected land parcels that your company might purchase, and now you want to get information about adjacent parcels. In this case, you would select the parcels within zero distance of the ones you've already selected.

## Completely Contain

Select by Location — Spatial Selection Method

*When finding point, line  
and polygon features  
completely contained by  
polygon features*



*The highlighted cyan features are selected because they intersect the red features*

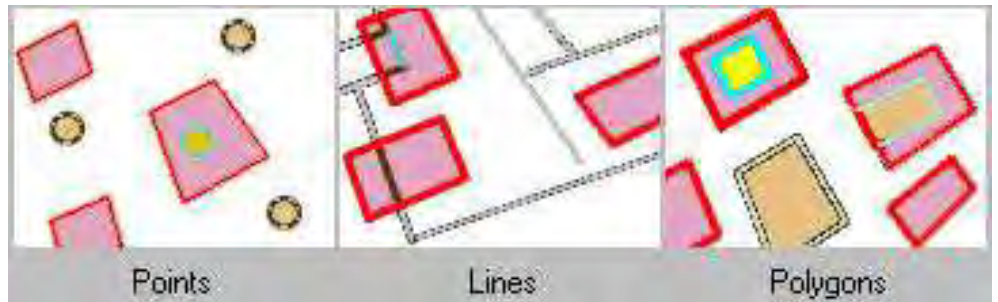
**Completely contain** -- You can select polygons in one layer that completely contain the features in another layer. For example, you can select forested areas that have lakes completely within them. To select polygons that completely contain features a certain distance within them, specify a buffer distance. For example, you can select forested areas with lakes at least 500 meters within them by buffering the lakes.



## Are Completely Within

Select by Location

*When finding features that are completely within polygon features*



*The highlighted cyan features are selected because they intersect the red features*

**Are completely within** -- This method selects features in one layer that fall completely inside the polygons of another. For example, you can select lakes completely within a forested area. To select features that are a distance from the edges of the polygon they fall inside, specify a buffer distance. For example, you can select lakes that are at least 500 meters within a forested area.

## Have Their Center In

Select by Location – Spatial Selection Method

**Have their center in** -- This method selects the features in one layer that have their center in the features of another layer.



When finding features that have their centers within a distance of **point** features



When finding features that have their centers within a distance of **line** features



When finding features that have their centers within a distance of **polygon** features

*The highlighted cyan features are selected because they intersect the red features*

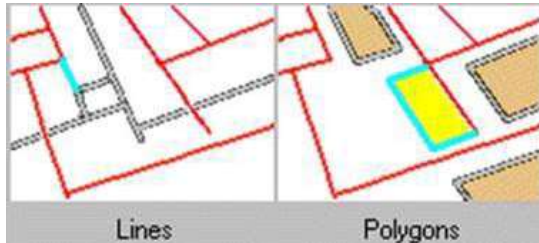


## Share a Line Segment With

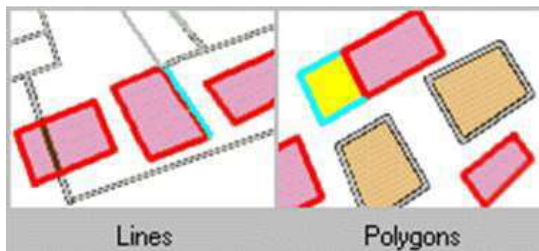
Select by Location – Spatial Selection Method

**Share a line segment with** -- This method selects features that share line segments, vertices, or nodes with other features

*You can't use this method to select point features*



When finding features that share a line segment with the **line** features



When finding features that share a line segment with the **polygon** features

*The highlighted cyan features are selected because they intersect the red features*

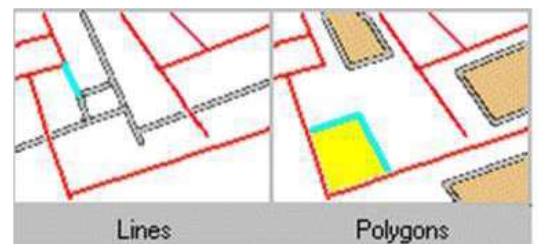
## Touch the Boundary of

Select by Location – Spatial Selection Method

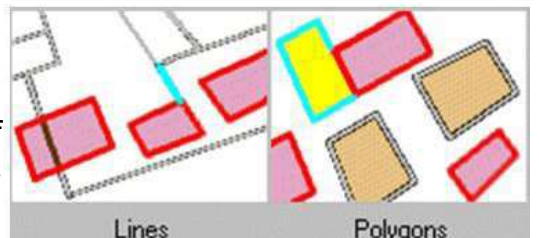
**Touch the boundary of** -- If you are selecting features using a layer containing lines, this method selects lines and polygons that share line segments, vertices or endpoints (nodes) with the lines in the layer. The lines and polygons will not be selected if they cross the lines in the layer.

If you are selecting features using a layer containing polygons, this method selects lines and polygons that share line segments or vertices with the polygon boundaries. The lines and polygons will not be selected if they cross the polygon boundaries.

When finding features that touch the boundary of **line** features



When finding features that touch the boundary of **polygon** features



*You can't use this method to select point features.*

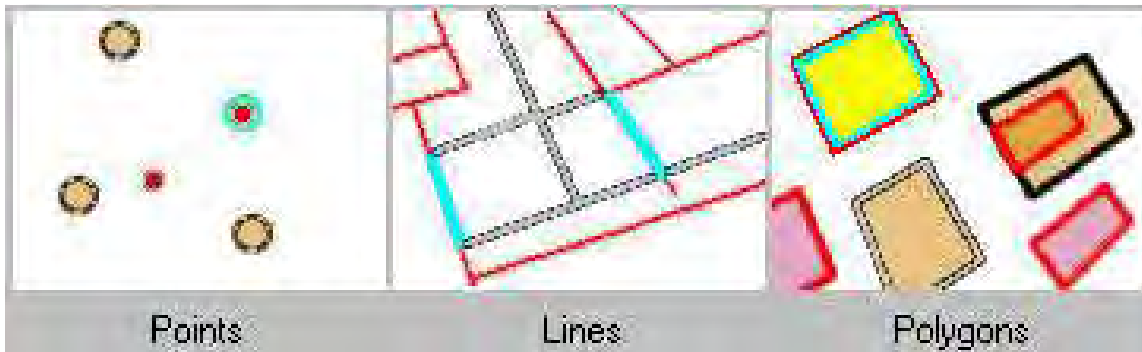
*The highlighted cyan features are selected because they intersect the red features*



## Are Identical to

Select by Location – Spatial Selection Method

When finding features that are identical to other features

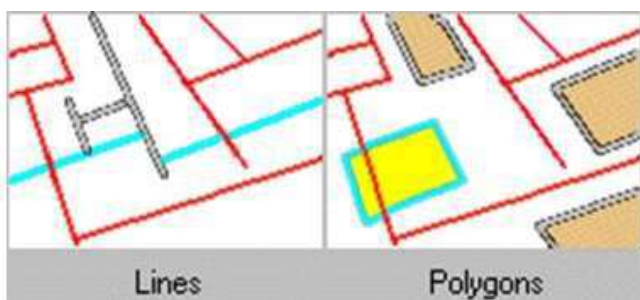


*The highlighted cyan features are selected because they intersect the red features*

**Are identical to --** This method selects any feature having the same geometry as a feature of another layer. The feature types must be the same—for example, you use polygons to select polygons, lines to select lines, and points to select points.

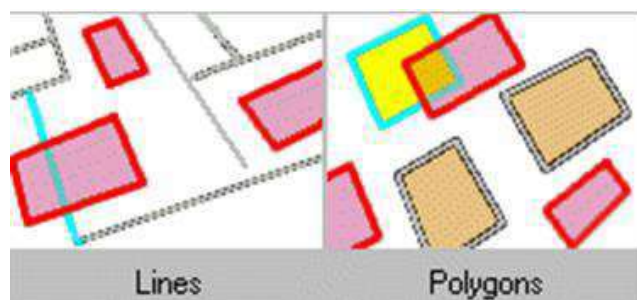
## Are Crossed by the Outline of

Select by Location – Spatial Selection Method



**Are crossed by the outline of --** This method selects any feature having the same geometry as a feature of another layer. The feature types must be the same—for example, you use polygons to select polygons, lines to select lines, and points to select points.

When finding features that are crossed by the outline of **line** features

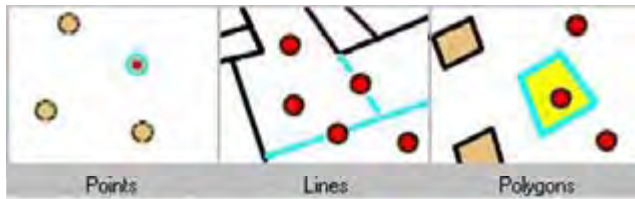


When finding features that are crossed by the outline of **polygon** features

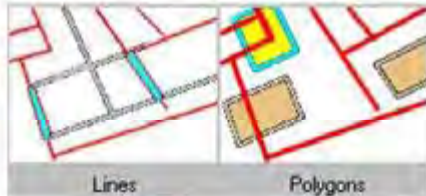


## Contain

Select by Location – Spatial Selection Method



When finding features that contain point features



When finding features that contain line features

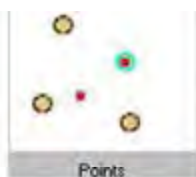


When finding features that contain polygon features

**Contain** -- This method selects features in one layer that contain the features of another. This method differs from the Completely Contain method in that the boundaries of the features can touch. For example, with the Contain method, a forest will contain a lake—and thus be selected—even if the border of the lake touches the border of the forest. The forest would not be selected using Completely Contain because the borders touch.

## Are Contained by

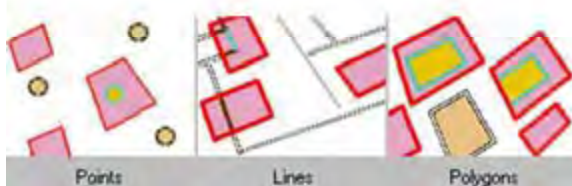
Select by Location – Spatial Selection Method



When finding features that contained by **point** features



When finding features that contained by **line** features



When finding features that contained by **polygon** features

### Are contained by

This method selects features in one layer that are contained by the features in another. For example, you can select those cities that are contained by a county. This method differs from the Are completely within method in that the edges of the features can touch.

*The highlighted cyan features are selected because they intersect the red features*



## Select Records

Select records to select features

### 3.1 Interactively selecting records in a table

- ❖ Open the attribute table for a layer on your map.
- ❖ Click the leftmost column in the table adjacent to the record you want to select.  
To select consecutive records, you can click and drag the mouse.
- ❖ Press and hold the Ctrl key while clicking additional records.

FID	Shape	PCODE	DCODE	DNAME	FNAME
0	Polygon	13	1312	Vieaboun	SAVANNAKHE
1	Polygon	13	1311	Kaiboun	SAVANNAKHE
2	Polygon	13	1313	Ataaphon	SAVANNAKHE
3	Polygon	13	1305	Xepon	SAVANNAKHE
4	Polygon	13	1302	Outhoumphon	SAVANNAKHE
5	Polygon	13	1303	Ataaphiangthong	SAVANNAKHE
6	Polygon	13	1304	Phin	SAVANNAKHE
7	Polygon	13	1301	Khamthadoun	SAVANNAKHE
8	Polygon	13	1309	Champhon	SAVANNAKHE
9	Polygon	13	1308	Issang	SAVANNAKHE
10	Polygon	13	1310	Xanboun	SAVANNAKHE
11	Polygon	13	1300	Songkhon	SAVANNAKHE
12	Polygon	13	1307	Thapangthong	SAVANNAKHE

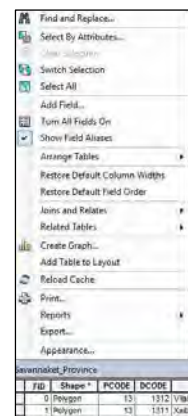


## Selecting Records in a table by attributes

Select by Attributes

### 3.2 Selecting records in a table by attributes

- ❖ Click Options in the table you want to query and click [Select By Attributes](#).
- ❖ Click the Method dropdown arrow and click the selection procedure you want to use.
- ❖ Double-click the field from which you want to select.
- ❖ Click the logical operator you wish to use.
- ❖ Click the Get Unique Values button, then scroll to and double-click the value in the Unique Values list you wish to select.
- ❖ Optionally, you can type a value directly into the text box.
- ❖ Click Verify to verify your selection.
- ❖ Click Close.
- ❖ Your selection is highlighted in the table.



FID	Shape	PCODE	DCODE	DNAME	FNAME
0	Polygon	13	1312	Vieaboun	SAVANNAKHE
1	Polygon	13	1311	Kaiboun	SAVANNAKHE
2	Polygon	13	1313	Ataaphon	SAVANNAKHE
3	Polygon	13	1305	Xepon	SAVANNAKHE
4	Polygon	13	1302	Outhoumphon	SAVANNAKHE
5	Polygon	13	1303	Ataaphiangthong	SAVANNAKHE
6	Polygon	13	1304	Phin	SAVANNAKHE
7	Polygon	13	1301	Khamthadoun	SAVANNAKHE
8	Polygon	13	1309	Champhon	SAVANNAKHE
9	Polygon	13	1308	Issang	SAVANNAKHE
10	Polygon	13	1310	Xanboun	SAVANNAKHE
11	Polygon	13	1300	Songkhon	SAVANNAKHE
12	Polygon	13	1307	Thapangthong	SAVANNAKHE



## Selecting & Unselecting Records

Attribute table options menu

### 3.3 Selecting all records

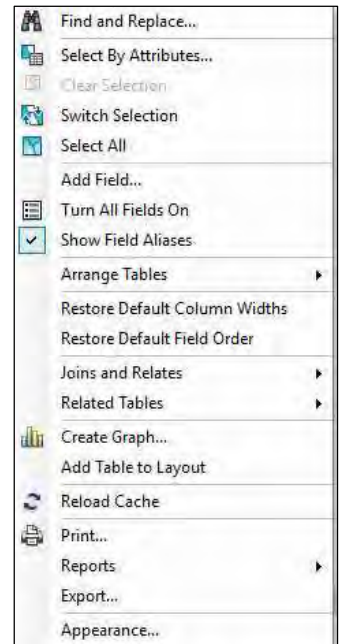
- ❖ Click Options in the table and click Select All

### 3.4 Clearing the selected set

- ❖ Click Options in the table and click Clear Selection

### 3.5 Switching the selected set

- ❖ Click Options in the table and click Switch Selection



## III. Self Task

### III. Self Task

Assessment of skills

1. Calculate population density in Savannaket province
2. Recode the population density as Low, Medium, High using your own class values
3. Symbolize using above three classes
4. Find and create a village layer - which are within a distance of 800m to road layer



# Creating & Editing Data in ArcGIS

A first look into the concepts that comprise  
a Geographic Information System



## Overview

Topics covered during this lesson

1. Create a geodatabase
2. Create a feature class
3. Digitizing
4. Edit features
5. Skills Test



## Exercises to be completed on your own - Digitizing

Assessment of skills – Begin at conclusion of lesson

1. Access [Subdivision](#) Bookmark. Extend streets into subdivision
2. Access Nam Ngum Reservoir. Add Nam Ngum Reservoir to the Inland\_Water feature class
3. Access the Airport Bookmark. Make a feature class called Airport\_Roadways; make a line feature class that has separate domains for taxiway and runway; make a feature class for apron

## Opening ArcMap 10.6

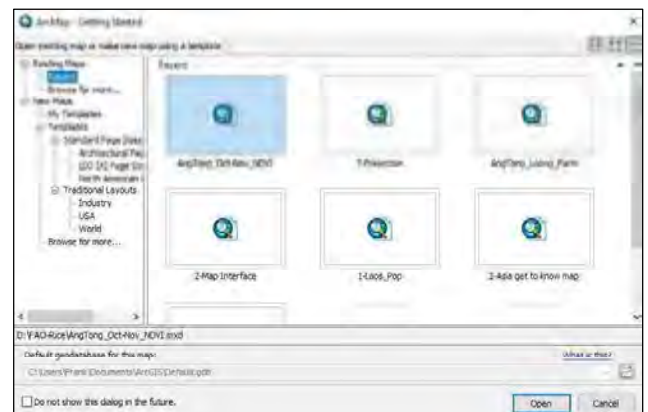
New empty map

❖ Type Arcmap into the Windows search bar

❖ Click ArcMap 10.6



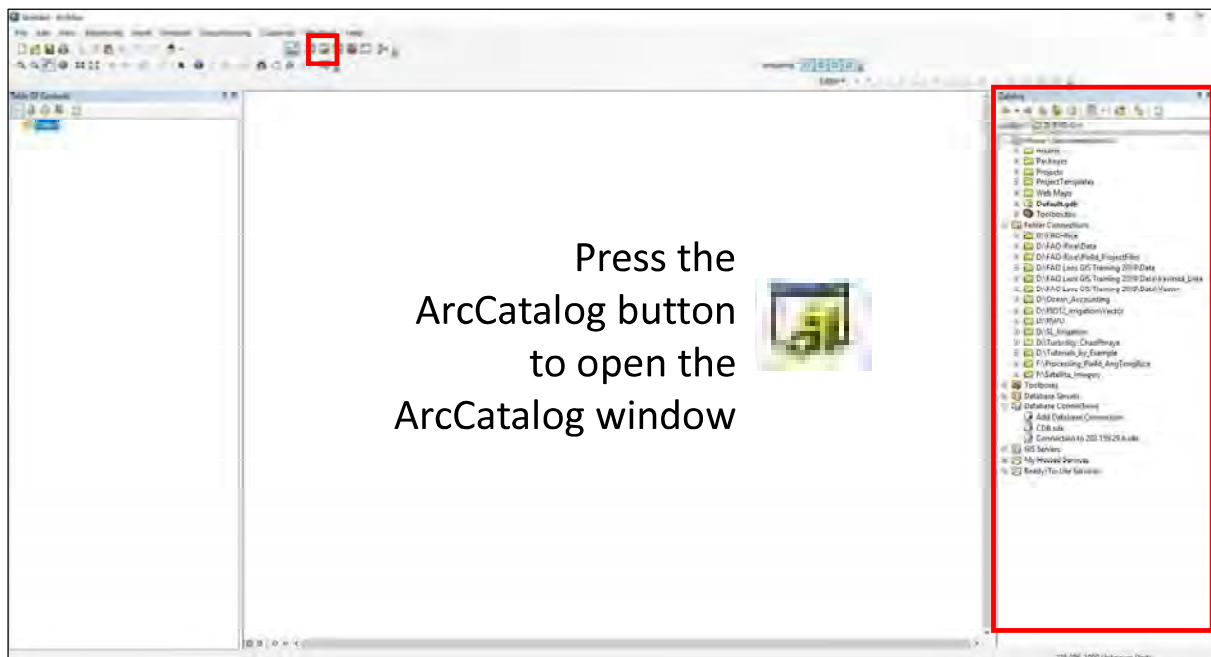
❖ Click [Cancel](#) to open a new, empty map.





## Open the Arc Catalog Window

Getting started



## Create a File Geodatabase

At Arc Catalog Window

Navigate to your preferred folder for this project

Right-click the folder and select **New**

We can see 2 types of geodatabases available:

File Geodatabase and Personal Geodatabase

Click **File Geodatabase**

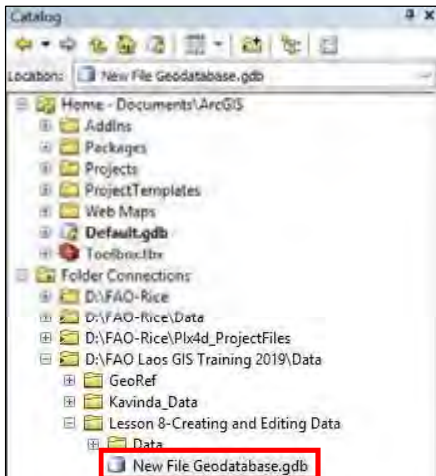
This will create a file geodatabase in your project folder



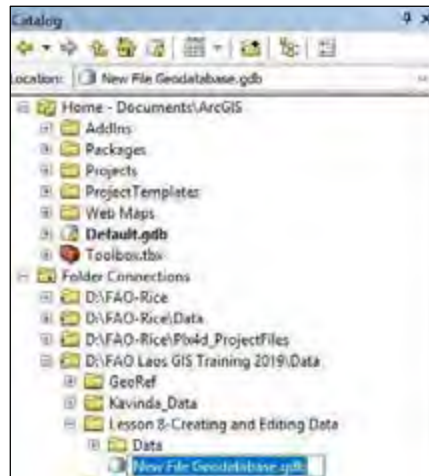


## Rename File Geodatabase

ArcCatalog Window

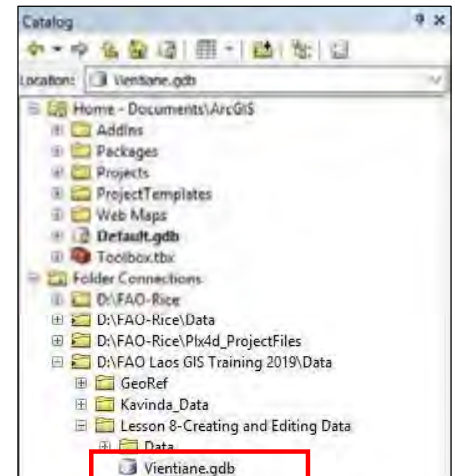


The file geodatabase has been created and is visible in your project folder



2x Click New File Geodatabase.gdb to rename it

Rename the geodatabase  
Vientiane



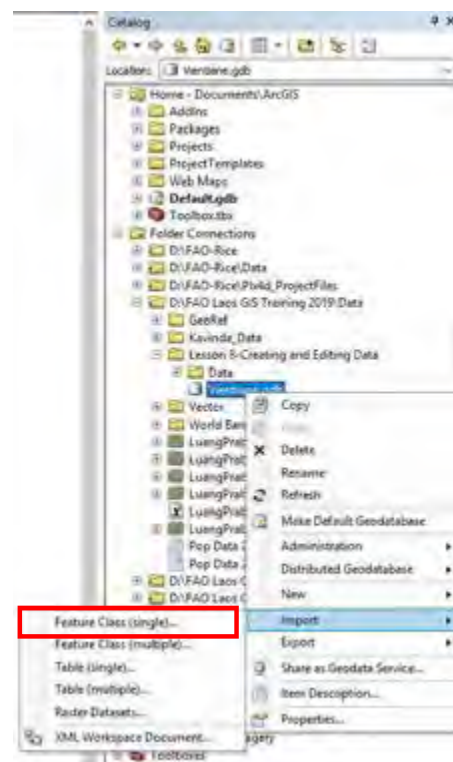
## Add data to the geodatabase

Feature Class (single)

Feature classes, tables, and raster data can be added to a file geodatabase

There are options to add a single feature class or multiple

Select Feature Class (single)





## Import feature class to file geodatabase

Single Feature class

Input Features:

Choose the [Lesson 8 – Creating & Editing Data](#) folder

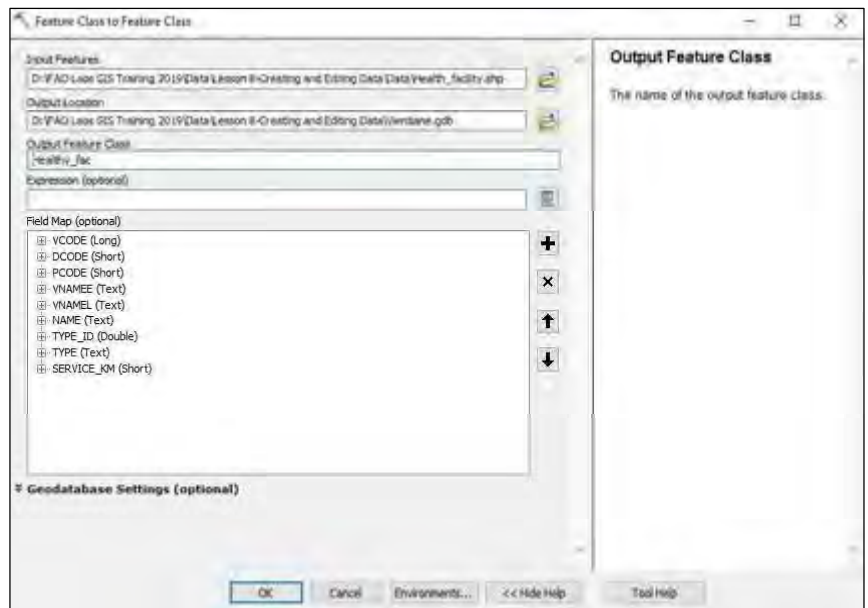
Select file:

[Health\\_facility.shp](#)

Output Feature Class:

[Healthy\\_fac](#)

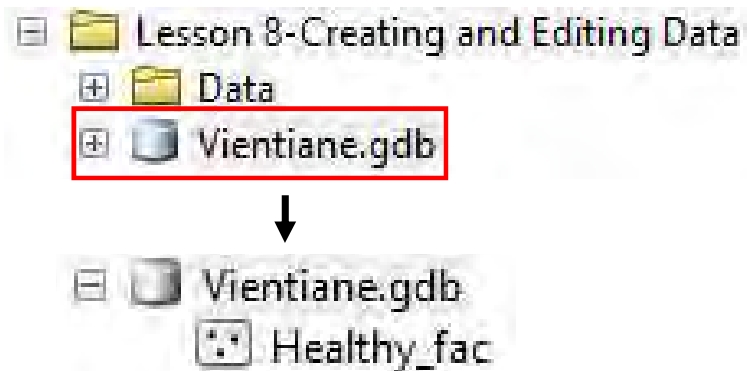
Click OK



## Overview

Overview

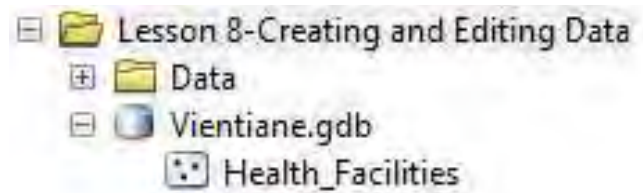
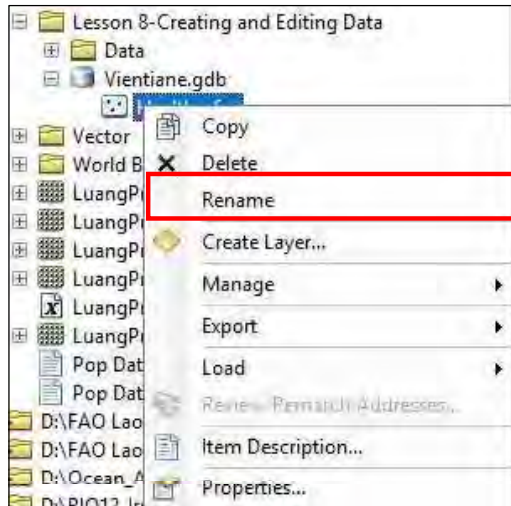
The Health\_facilities layer is now in the Vientiane file geodatabase. It also has the name we assigned, healthy\_fac





## Renaming a feature class in a geodatabase

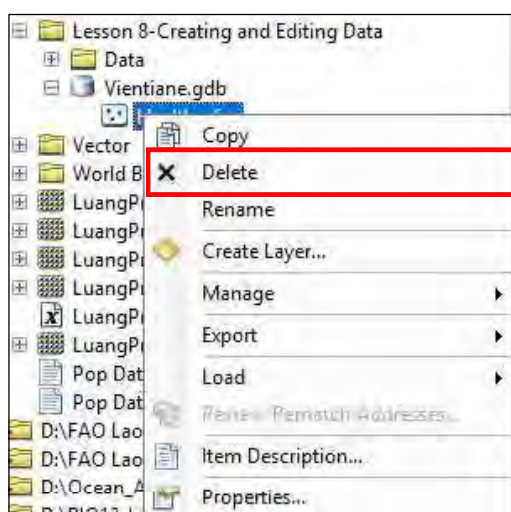
### Overview



To rename: right-click a feature class and select [Rename](#). Type new name and click outside of text box

## Deleting a feature class from file geodatabase

### Overview



To delete: right-click a feature class and select [Delete](#). Type new name and click outside of text box



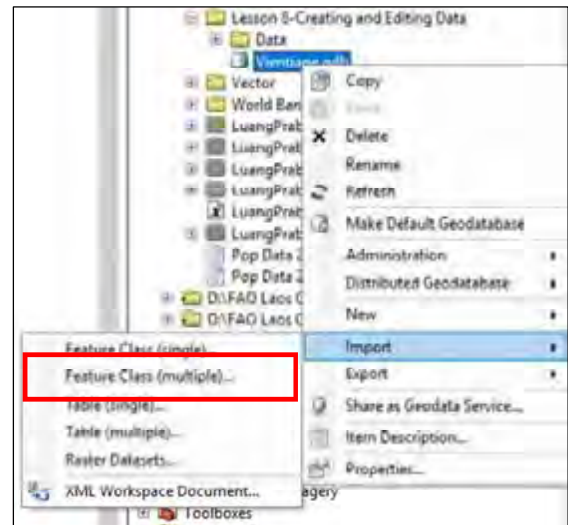
## Add data to the geodatabase

Feature Class (multiple)

Multiple feature classes can be added to a file geodatabase at once

Right-click Vientiane.gdb

Import | [Feature Class \(multiple\)](#)



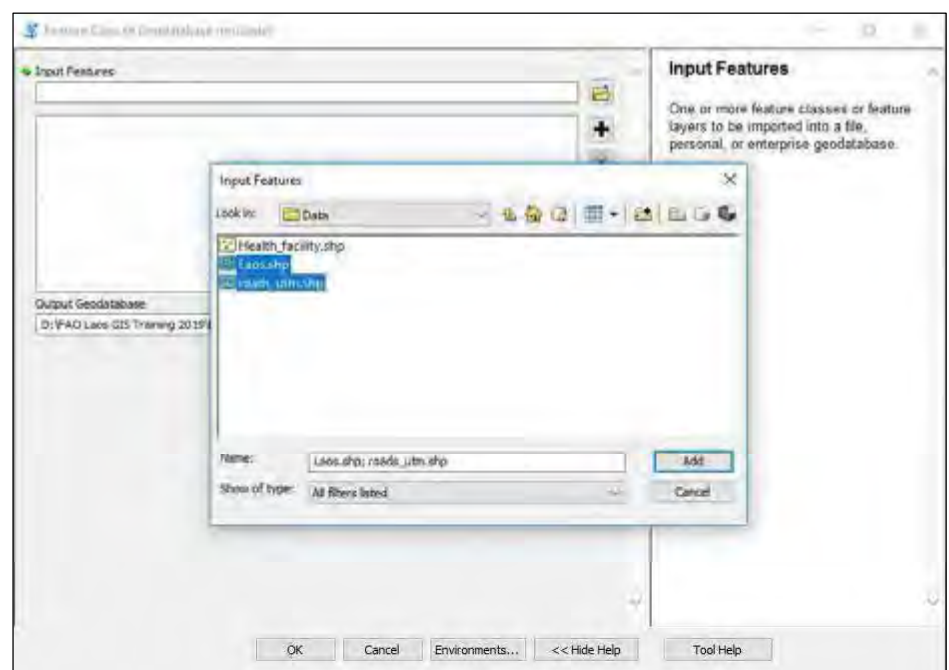
## Add data to the geodatabase

Feature Class (multiple)

Click the folder icon for Input Features to access the Lesson 8 – Creating & Editing Data folder

Shift-click Laos.shp & roads\_utm.shp, then press Add

Click OK to add both files to the file geodatabase



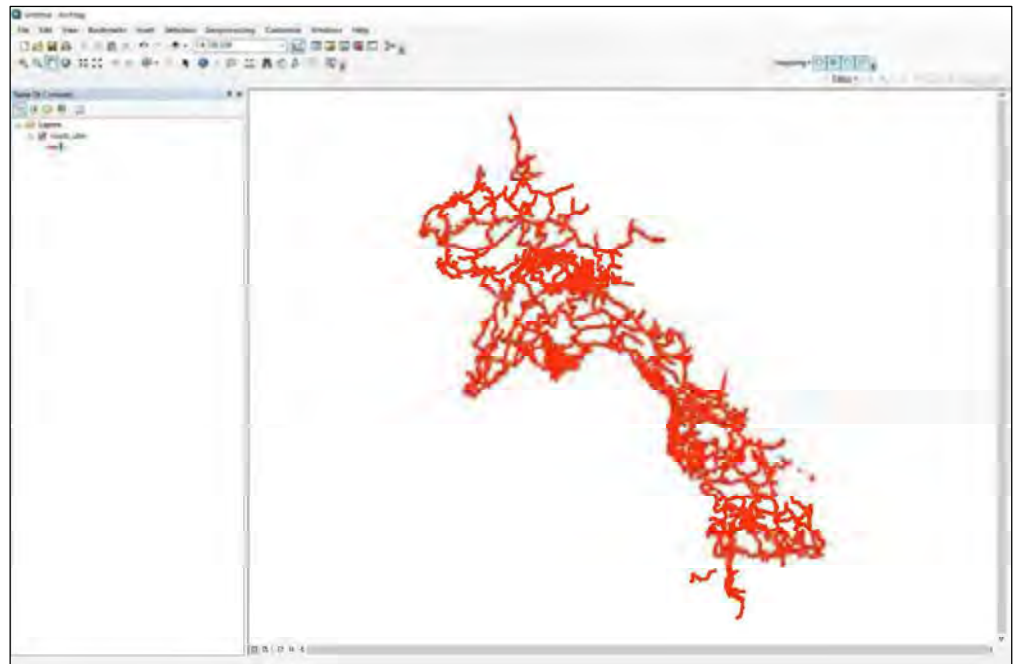


## Add data to the geodatabase

Feature Class (multiple)

Drag & drop  
roads\_utm from the  
Arc Catalog window  
to the Data View

Change the  
symbology to  
Highway



## Overview

Topics covered during this lesson

1. Create a geodatabase
2. Create a feature class
3. Digitizing
4. Edit features
5. Skills Test

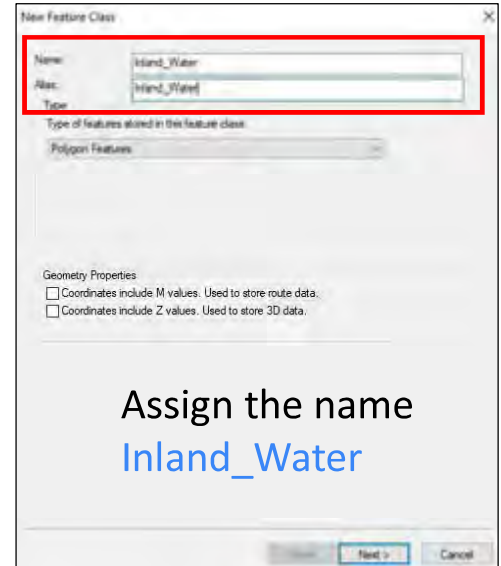
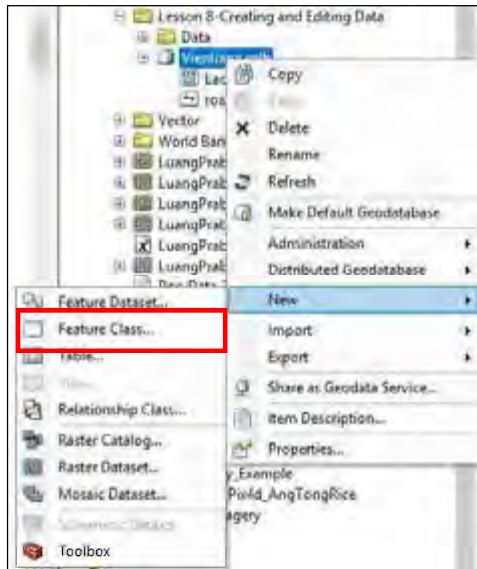


## Creating a feature class in a file geodatabase

### Overview

Right-click the file geodatabase 'Vientiane.gdb'

New | Feature Class



## Creating a feature class in a file geodatabase

### Selecting feature type

Here we define the type of features that will be in this new layer:  
Point, line, polygon, etc.

Select **polygon**

Click Next to proceed





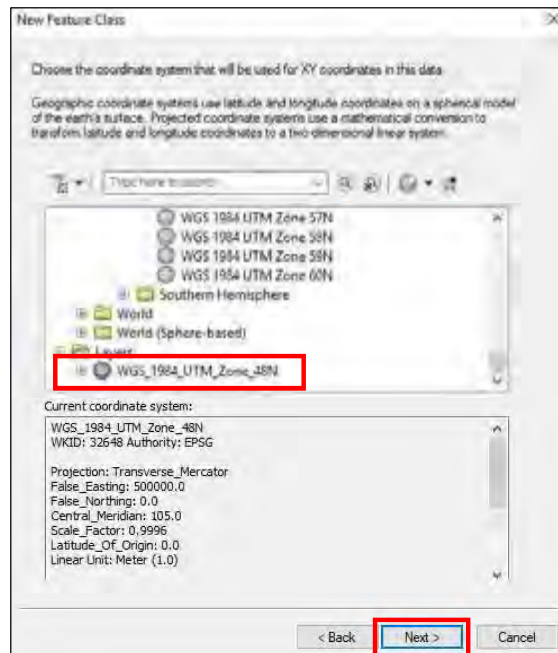
## Creating a feature class in a file geodatabase

Overview

Assign a coordinate system to the new feature class.

Use the same coordinate system as the roads\_utm and Laos layers

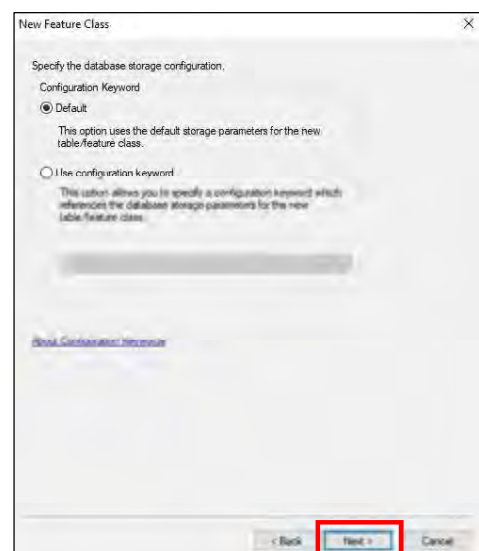
We are able to easily access that coordinate system if the layer has already been added to map view by accessing the layers folder



## Creating a feature class in a file geodatabase

XY Tolerance & Database Storage Configuration

Accept defaults for XY Tolerance & database storage configuration





## Creating a feature class in a file geodatabase

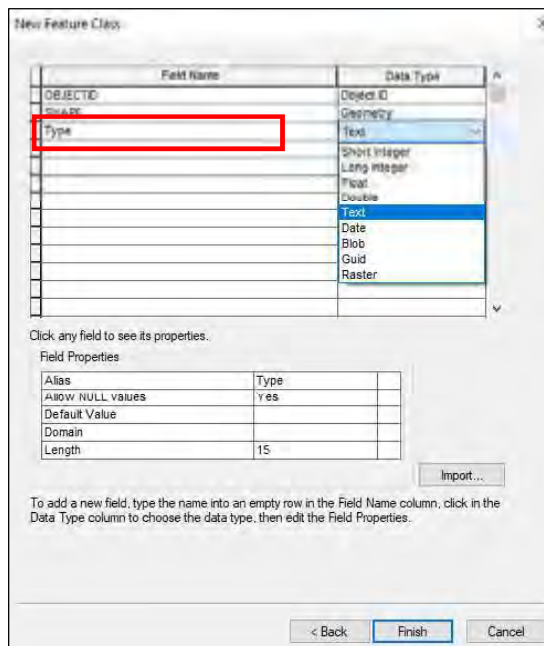
Adding a new field

Enter a new field name: **Type**

Data Type: **Text**

Limit the length to 15 characters for the Type field

Click **Finish**



## Setting Domain Values

Helps prevent errors

Why set Domain values?

Prevents clerical errors when entering attribute data

Misspelled attributes won't appear in a query; hinders usefulness of attribute data

in_district	FID	Shape *
Hadsayfong	930	Point
Hadsayfong	945	Point
Hadsayfong	959	Point
Hadsayfong	966	Point
Hadsayfong	970	Point
Hadsayfong	976	Point
Hadsayfong	984	Point
Hadsayfong	1002	Point
Hadxiaifong	924	Point
Hadxiaifong	925	Point
Hadxiaifong	908	Point
Hadxiaifong	915	Point
Hinxiboun	1422	Point

in_district	FID	Shape *
Vang Vieng	798	Point
Vang Vieng	799	Point
Vang Vieng	801	Point
Vang Vieng	803	Point
Vang Vieng	810	Point
Viangthong	1162	Point
Viangxay	1372	Point
Vieng Phouka	62	Point
Vieng Phoukha	60	Point
Xaisomboun	771	Point
Xaisomhoun	838	Point

in_district	FID	Shape *
Xamtai	1508	Point
Xanakham	292	Point
Xanakham	295	Point
Xanakham	300	Point
Xanakham	276	Point
Xaysettha	863	Point



## Creating a Domain

### Inland Water Bodies

Right-click the Vientiane.gdb  
and select Properties

Enter the **Domain** tab

Domain Name: Type

Description: Type

Field Name: Text

Enter Code & Description values  
Click OK

The screenshot shows the 'Database Properties' dialog box with the 'Domains' tab selected. It contains a table for domain definitions and a section for domain properties.

Domain Name	Description
Type	Type

Domain Properties:

Field Type	Text
Domain Type	Coded Values
Split policy	Default Value
Merge policy	Default Value

Coded Values:

Code	Description
L	Lake
P	Pond
R	River

Buttons: OK, Cancel, Apply

## Assign Domain to 'Type' Field

### Setting domain values

Open **Properties** for 'Inland\_Water' feature class

Click on Type at the Field Name box

At the Field Properties box (bottom box) click the down arrow in the cell to the right of Domain  
Select **Type**

Click OK

The screenshot shows the 'Feature Class Properties' dialog box with the 'Fields' tab selected. It contains a table of fields and a 'Field Properties' section at the bottom.

Field Name	Data Type
OBJECTID	Object ID
SHAPE	Geometry
Type	Text
SHAPE_Length	Double
SHAPE_Area	Double

Click any field to see its properties.

Field Properties:

Alias	Type
Allow NULL values	Yes
Default Value	
Domain	Type
Length	

To add a new field, type the name into an empty row in the Field Name column, click in the Data Type column to choose the data type, then edit the Field Properties.

Buttons: OK, Cancel, Apply





## Overview

Topics covered during this lesson

1. Create a geodatabase
2. Create a feature class
3. Digitizing
4. Edit features
5. Skills Test



## Overview

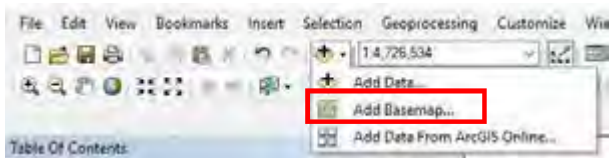
Topics covered during this lesson

3. Digitizing
  - a. Roads
  - b. Lake



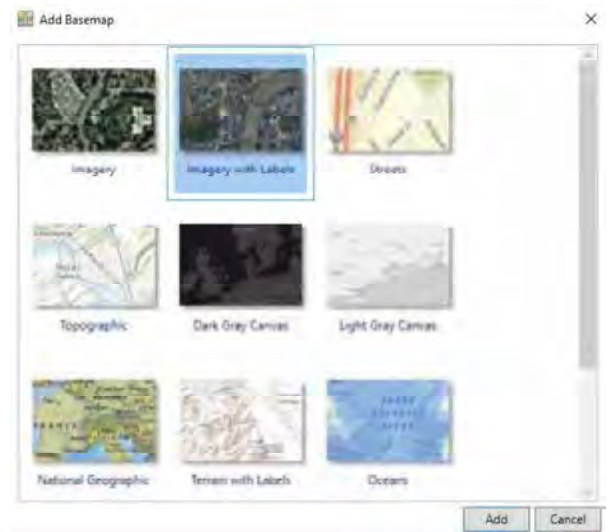
## Adding a Basemap

### Overview



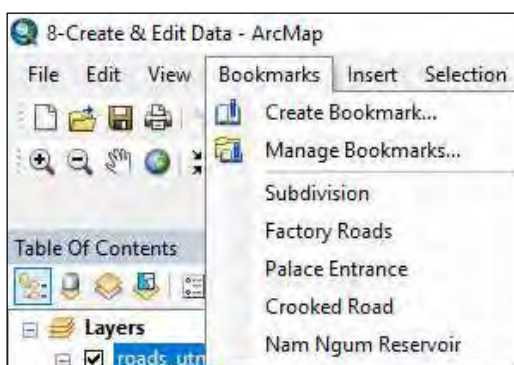
Basemaps can assist with digitizing

Add Basemap – [Imagery with labels](#)



## Bookmark

### Factory Roads



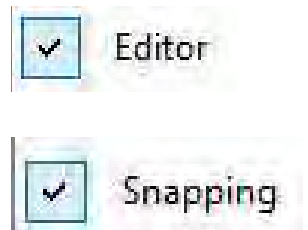
Access the Factory location by  
selecting Bookmarks | [Factory Roads](#)





## Activating Toolbars

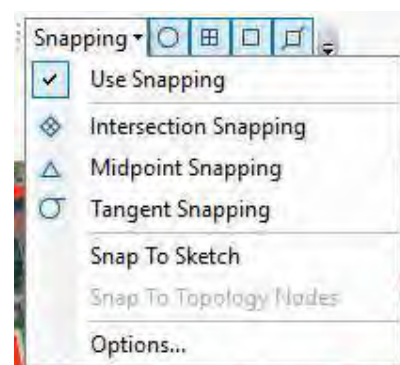
### Editor & Snapping Toolbars



The Editor toolbar contains tools that make it convenient for creating and editing features

## Setting Domain Values

### Overview



Turn on snapping at the snapping toolbar by clicking Snapping | [Use Snapping](#)



*Don Chan riverside, Vientiane, Laos map, 2019*

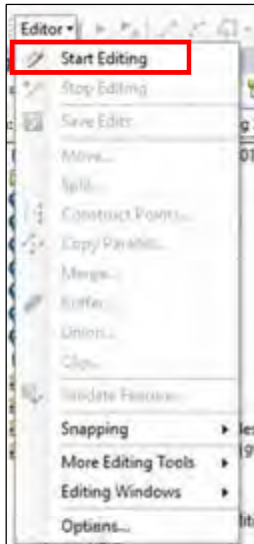


## Start an Edit Session

### Overview

Initially the Editor Toolbar is initially grey because it is inactive.

It can be activated by selecting Editor | [Start Editing](#)



Inactive

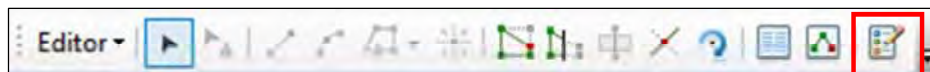


Active



## Create Features Window

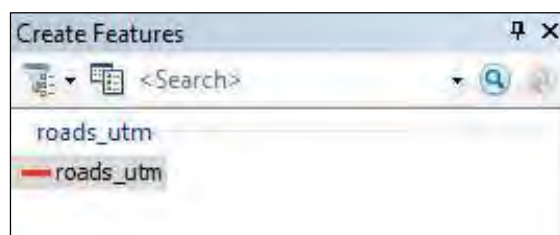
### Overview



The Create Features window allows you to add features a feature dataset



Click the Create Features button on the Editor toolbar to open it



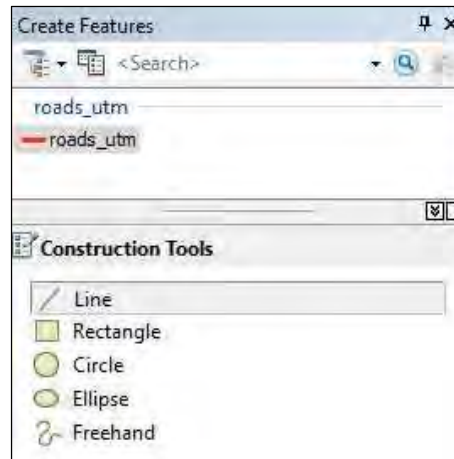
Turn on the roads\_utm layer



## Create Features Window

### Overview

Click roads\_utm in the Create Features window to make the Construction Tools window appear. Select [Line](#).



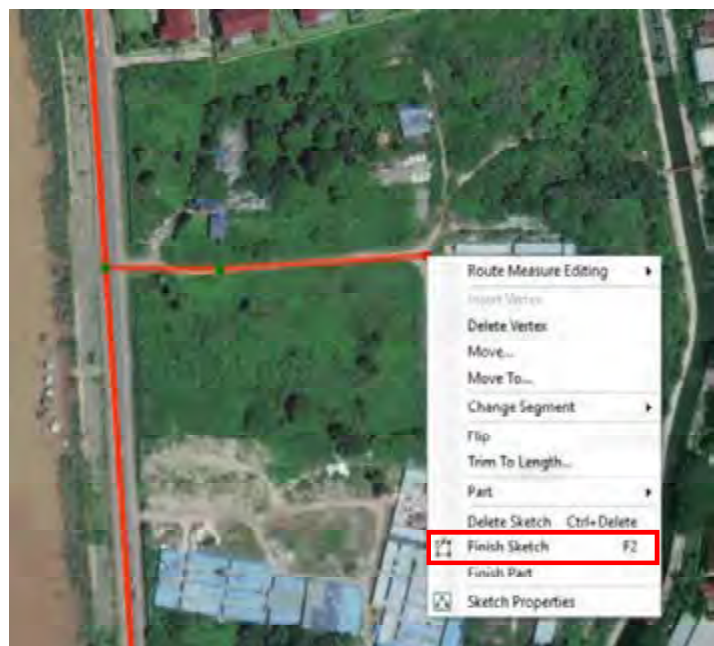
## Setting Domain Values

### Overview

Digitize a line from the perpendicular road to the factory

At your last vertex right-click and select [Finish Sketch](#)

Repeat the process for the nearby factory to the south.



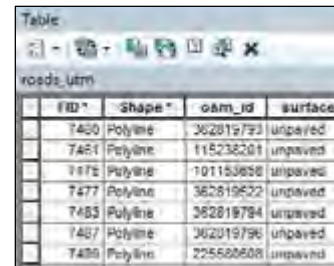
*Don Chan riverside, Vientiane, Laos map, 2019*



## Setting Domain Values



### Overview

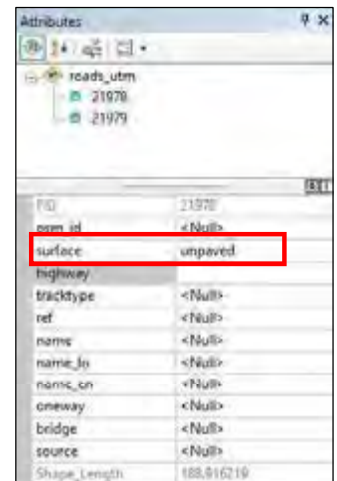
The attribute table for roads\_utm shows a field called surface. There is a class called unpaved. Next, add unpaved to the attributes for the roads you just digitized.



FID	Shape	oam_id	surface
7400	Polyline	362815733	unpaved
7481	Polyline	115238201	unpaved
7475	Polyline	101153858	unpaved
7477	Polyline	362819622	unpaved
7483	Polyline	362819794	unpaved
7487	Polyline	362819796	unpaved
7488	Polyline	225588608	unpaved



Use the Edit Tool  to select the two lines you just created. Then click the Attributes button  on the Edit toolbar. At the surface field enter **unpaved** for both lines.



FID	21978
oam_id	<Null>
surface	unpaved
highway	
tracktype	<Null>
ref	<Null>
name	<Null>
name_in	<Null>
name_en	<Null>
oneway	<Null>
bridge	<Null>
source	<Null>
Shape_Length	188.916219

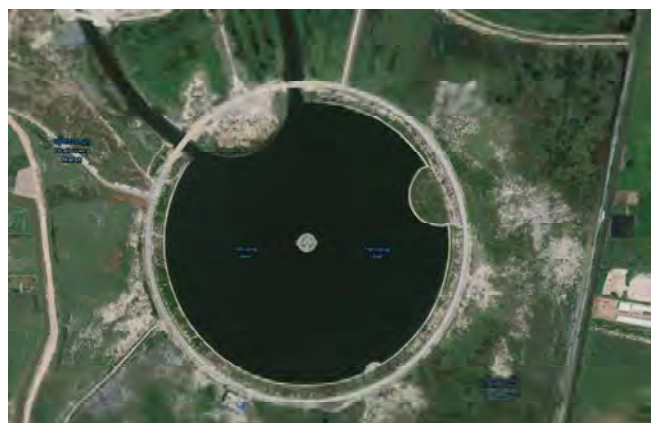
## Overview

Topics covered during this lesson

### 3. Digitizing

#### a. Roads

#### b. Lake



*Thatluang lake, Vientiane , Laos map, 2019*

Use the Bookmark to go to [Thatluang Lake](#)  
Drag & drop 'Inland\_Water' from  
ArcCatalog window to the Data View



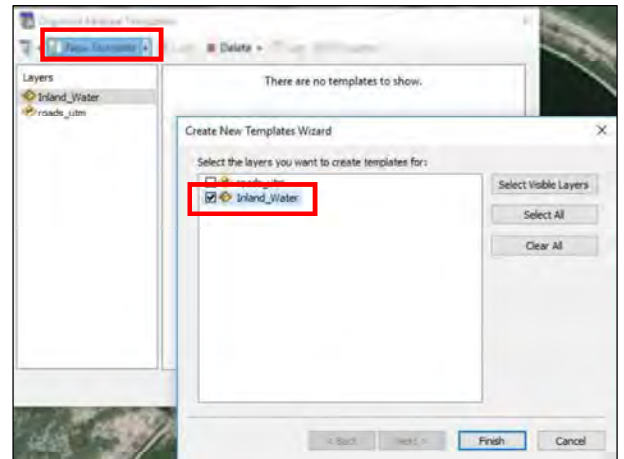
## Creating a Digitizing Template for Inland\_Water

### Overview

Select the Organize Templates button at the Create Feature window. This will let you create a template for Inland Water digitize in that layer.

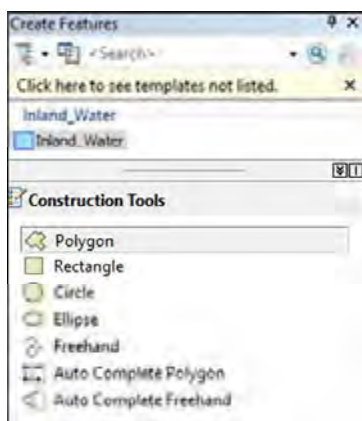


Click [New Template](#)  
Select Inland\_Water  
[Finish](#)



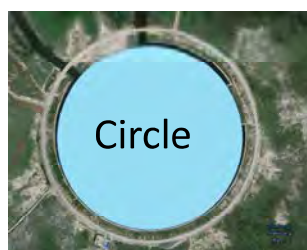
## Digitizing Template for Inland\_Water

### Overview



*Thatluang lake, Vientiane , Laos map, 2019*

A number of construction tools are available at the Construction Tools window. Experiment with different tools to understand how they work.

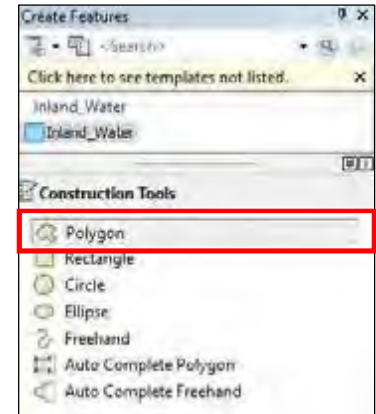




## Digitizing Tools at the Editor Menu

Polygon + Straight Segment & End Point Arc Segment

Selecting the 'Inland\_Water' template at the Create Features Menu, then selecting an option from the Construction Tools window makes more editing tools available



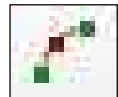
### Straight Segment

Digitize straight segments



### End Point Arc Segment

Create 2 vertices then move cursor to form a curve



## Digitizing Thatluang Lake

Create a polygon feature

Use **Straight Segment** & **End Point Arc Segment** to digitize a polygon representing Thatluang Lake

Hint: It is possible to switch between tools while digitizing

The finished polygon should look similar to the image on the right



*Thatluang lake, Vientiane , Laos map, 2019*

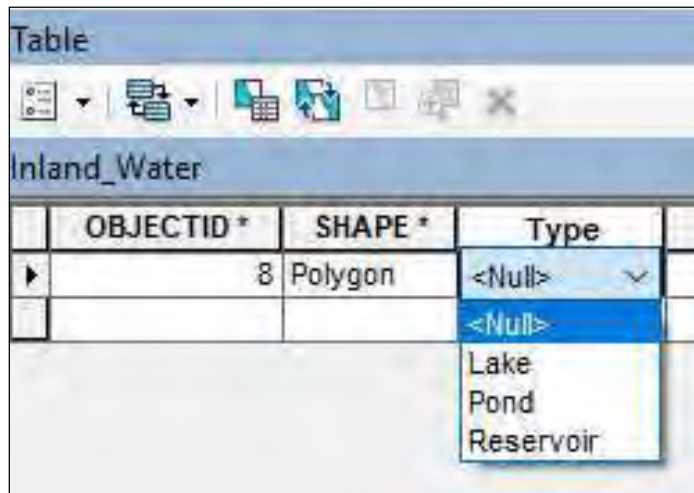


## Update Field Values for Inland\_Water

Assign Type

Open the attribute Table for  
Inland\_Water

Click in the Type field  
to select [Lake](#)



The screenshot shows a software window titled 'Table' with a toolbar. Below the toolbar is a header for 'Inland\_Water'. The table has three columns: 'OBJECTID \*', 'SHAPE \*', and 'Type'. The first row has values '8' and 'Polygon' in the first two columns, and a dropdown menu in the 'Type' column. The dropdown menu is open, showing options: '<Null>', '<Null>', 'Lake', 'Pond', and 'Reservoir'. The 'Lake' option is highlighted.

OBJECTID *	SHAPE *	Type
8	Polygon	<Null>
		<Null>
		Lake
		Pond
		Reservoir

## III. Self Task

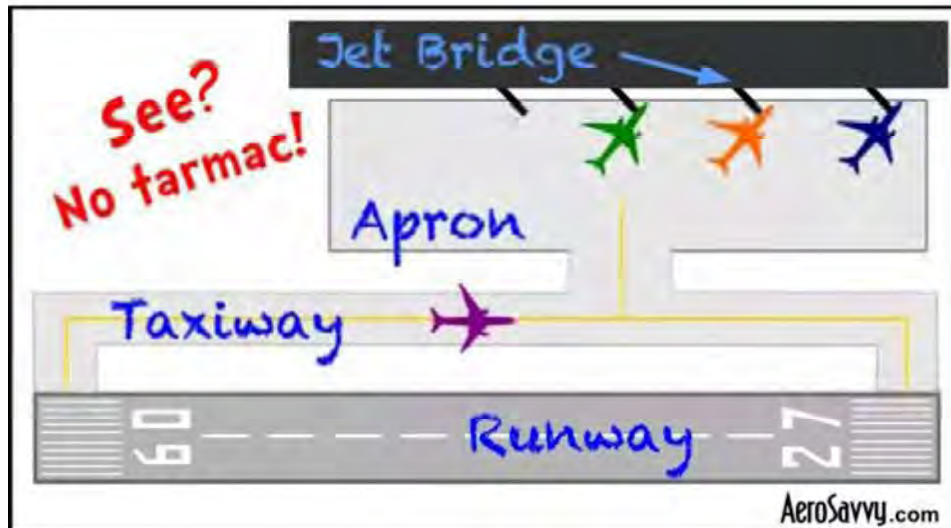
Assessment of skills - Digitizing

1. Add a Name field (text) to 'Inland\_Water'. Enter the name for Thatluang Lake
2. Extend streets into subdivision
3. Add Nam Ngum Reservoir to the Inland\_Water feature class
4. Make a feature class called Airport\_Roadways; make a line feature class that has separate domains for taxiway and runway and digitize; make a feature class for apron and digitize



## Airport Terms

See image



## Overview

Topics covered during this lesson

1. Create a geodatabase
2. Create a feature class
3. Digitizing
4. Edit features
5. Skills Test



## Editing Features

Must be in Edit Mode

### Delete features

Enable the Edit Tool



Click the segment that is to be deleted.  
The segment will be highlighted blue.

Press the **delete** key on the keyboard.



Bookmark | [Palace Entrance](#)



*Don Chan Palace, Laos map 2019*

## Editing Features

Must be in Edit Mode

### Move Vertices

- Adjust vertices if it appears that they are incorrectly placed.
- Double-click the feature.
- Vertices will appear
- Drag & drop the vertices until the feature achieves correct position



Bookmark | [Crooked Road](#)



*Roads in Vientiane, Laos map, 2019*



## Editing Features

Must be in Edit Mode



### Cut Polygons Tool

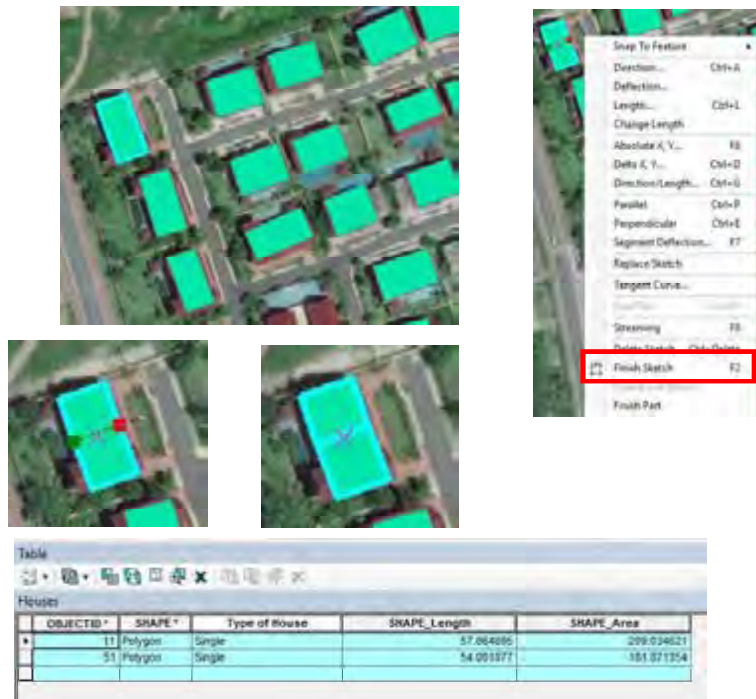
Splits a polygon feature into 2 features



Make sure snapping is on  
Select Cut Polygons Tool  
from Editor Toolbar

Click two opposite ends  
of polygon

Right-click and select  
**Finish Sketch**



## Editing Features

Must be in Edit Mode

OBJECTID *	SHAPE *	Type of House	SHAPE_Length	SHAPE_Area
24	Polygon	Duplex	54.28808	182.43152
53	Polygon	Duplex	53.386071	175.710898

### Merge Tool

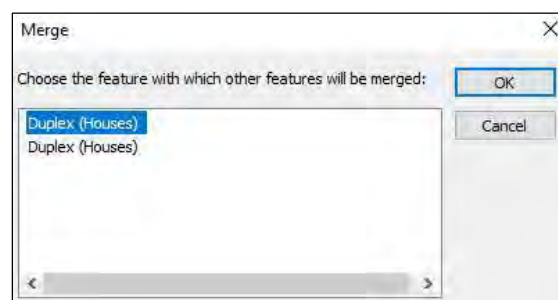
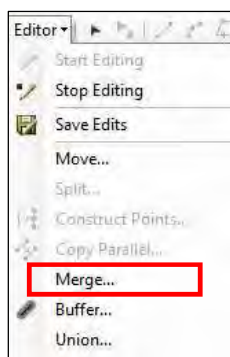
Combines two separate  
features into one feature

Select the two features to  
merge

Click Editor | **Merge**

Choose which feature to  
merge into

**OK**



Result is single feature with  
combined geometry of the  
two features merged

OBJECTID *	SHAPE *	Type of House	SHAPE_Length	SHAPE_Area
24	Polygon	Single	77.871019	358.142418



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1. Create a geodatabase
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## Self Task

Assessment of skills - Editing

1. Create a Feature class called 'Land\_Plots' in Vientiane geodatabase
2. At Subdivision: Determine the size of one lot
3. Make one large polygon the size of 5 lots. Place onto the adjacent undeveloped land and split into 5 lots.
4. Prepare enough house lots to populate the entire empty plot of land
5. Extend roads from subdivision into the undeveloped land



### Contact information

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