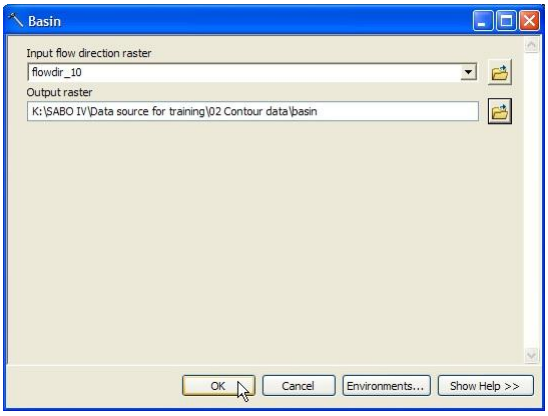
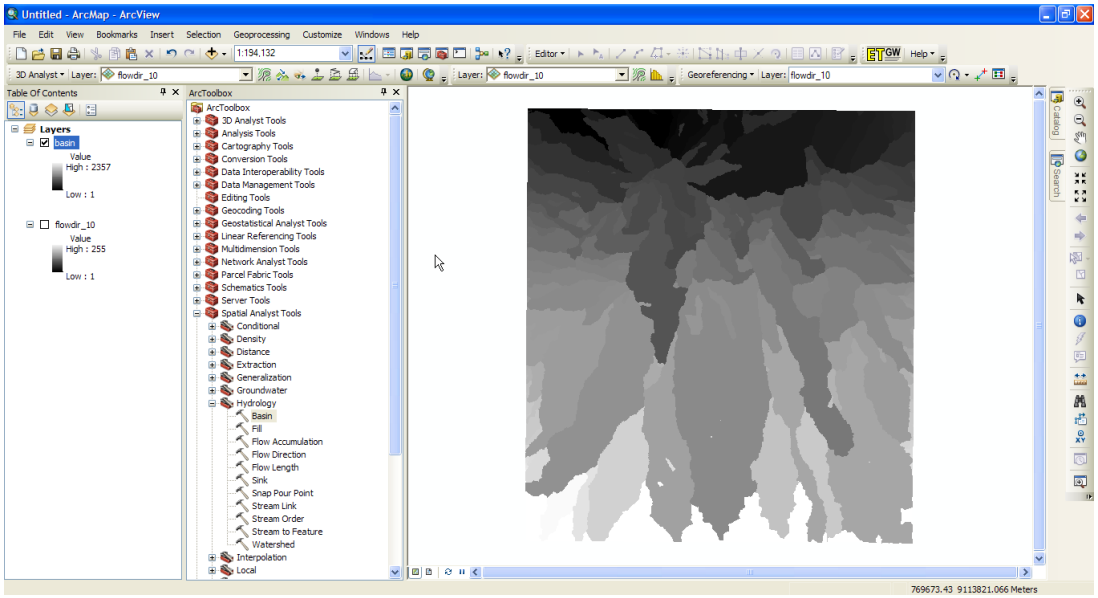
6) Click OK button on Basin window.

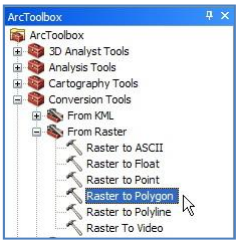


7) The figure below is a view of basin data. This data will be used for analysis of watershed determination.

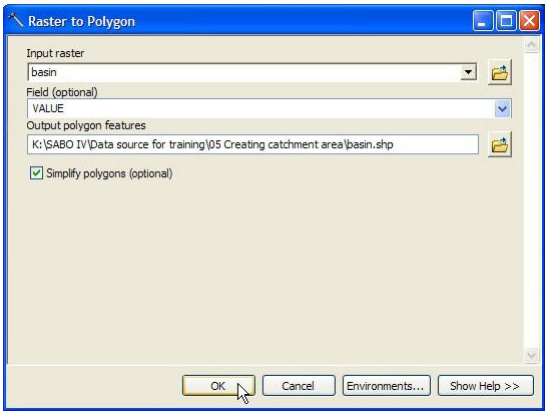


Step 2. <u>Choosing basin for making catchment area</u>

1) On ArcToolbox, click + symbol on Conversion Tool → From Raster, then double click Raster to Polygon. Next will appear Raster to Polygon window.



2) On Input raster combo box, choose “basin”. On Field combo box, choose Value. Save the data into folder: Data source for training\05 Creating catchment area, and give the name of “basin.shp”. Give check sign on Simplify polygons check box. Click OK button.

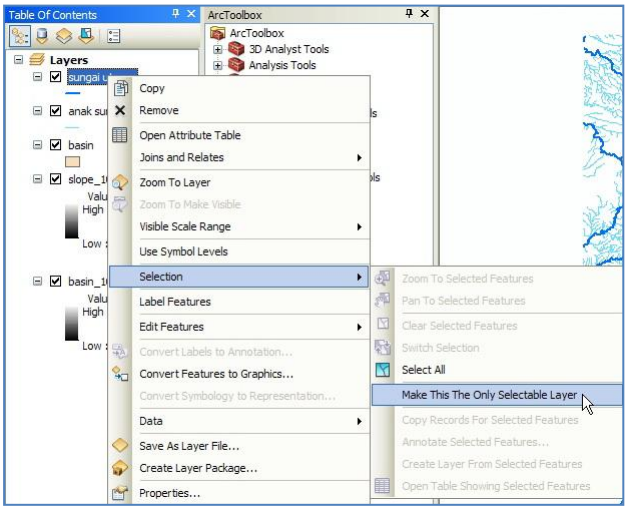


Once the process is complete, automatically there will be a new layer named "basin" (polygon).

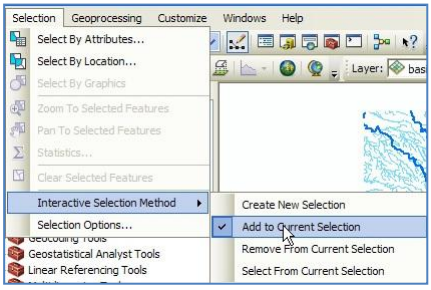
3) Add “sungai utama.shp” and “anak sungai.shp” data from the folder: Data source for training\03 River vector data.

4) To determine the boundary of catchment area manually, focus on one of the main river that has flow from upstream to downstream. And then focus on the seasonal river that connect to the main river.

The first step, focus the one of main river object. To choose/select the object that we want, right click “sungai utama” layer -- > Selection, click Make This Only Selectable Layer

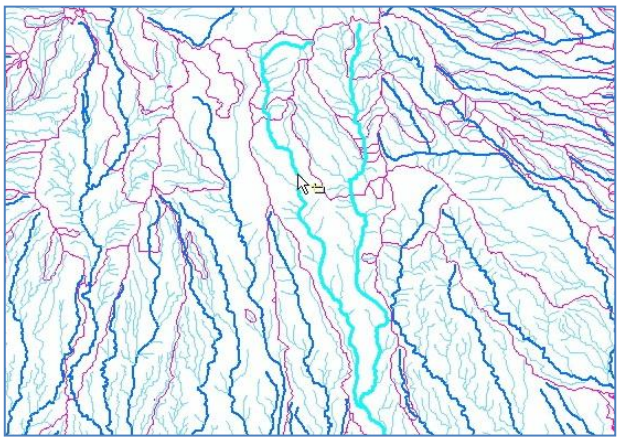


5) To make continuous selection, click Selection on ArcMap main menu → Interactive Selection Method, click Add to Current Selection.

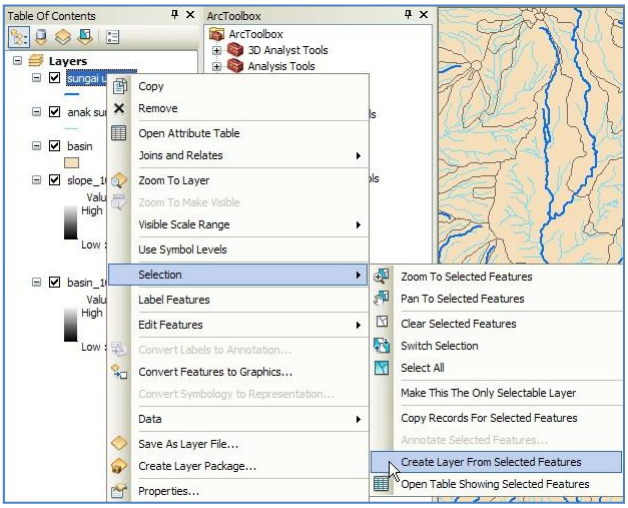


6) Click Select Features by Rectangle  button on Tools toolbar.

7) Select one of the main river object. Zoom-in or zoom out the view to ease the selection process.



8) Right-click on layer "sungai utama", point the mouse cursor to Selection, then click Create Layer From Selected Features.

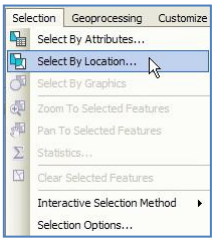


9) Automatically, will form a new layer called "sungai utama selection".

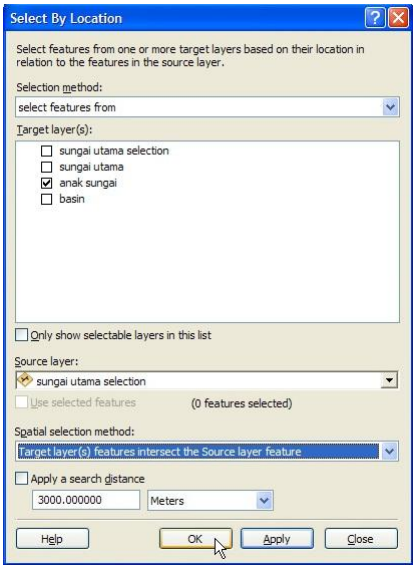
10) Press Clear Selected Features  button on Tools toolbar to clear the previous selected object.

11) To clarify the view of "sungai utama selection" layer, uncheck or turn off the “sungai utama” layer.

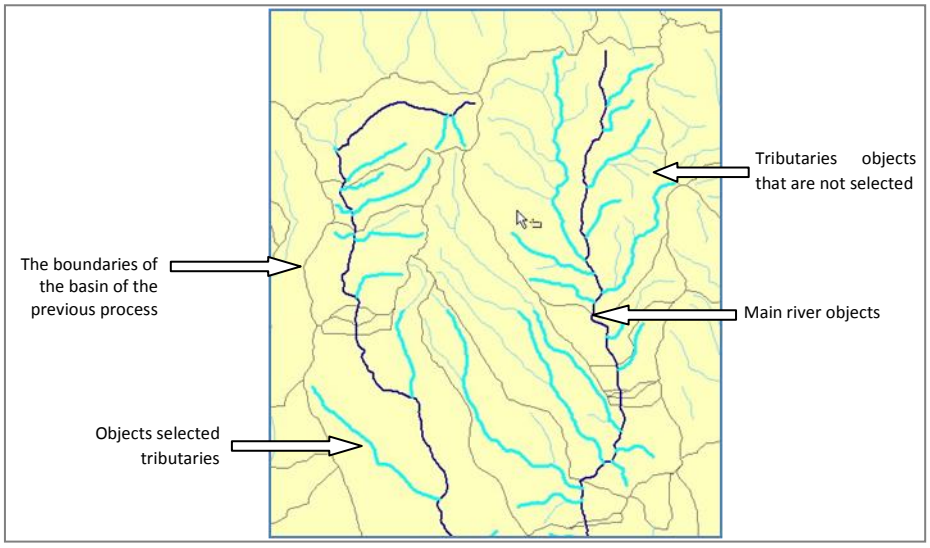
12) The second phase, focus on the seasonal river object which is a tributary branch of the main rivers of the previous selection ("sungai utama selection" layer). To assist in selecting an object which is a tributary branch of the main river, click Selection in ArcMap main menu, then click Select By Location. The next window will appear Select By Location.



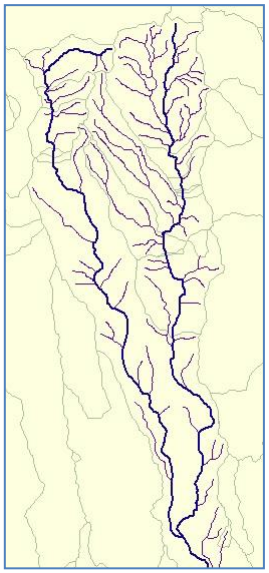
13) On Selection method combo box, choose “select features from”. On part of Target layer(s), choose “anak sungai”. On Source layer combo box, choose “sungai utama selection” layer. On Spatial selection method combo box, choose “Target layer(s) features intersect the Source layer feature”. Click OK button.



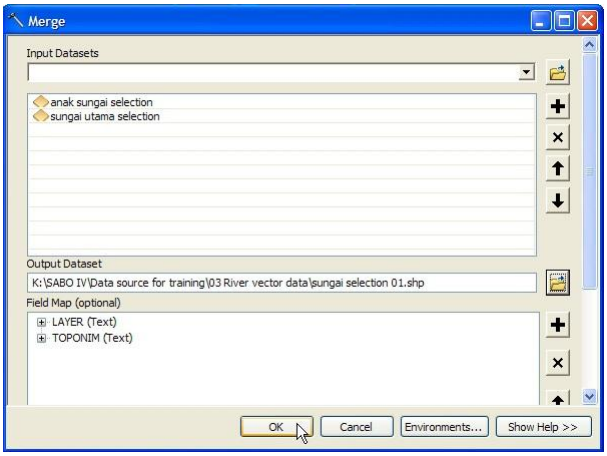
14) The selected tributary is the objects that connect or intersect the main river object. There will be tributary object that wasn’t not selected, one of the cause is that object is a second branch (the position was not intersect with main river, but still is branch of main river. We can select the tributary objects by manually regarding process on previous step 4 – 7.



15) After all of tributary that are the branch of main river are selected, the next step is making a new layer based on this selected tributary.
Right click on “anak sungai” layer → Selection, click Create Layer From Selected Features. Automatically, there will form a new layer named “anak sungai selection”. Figure on below is the view of “anak sungai selection” layer and “sungai utama selection” layer.

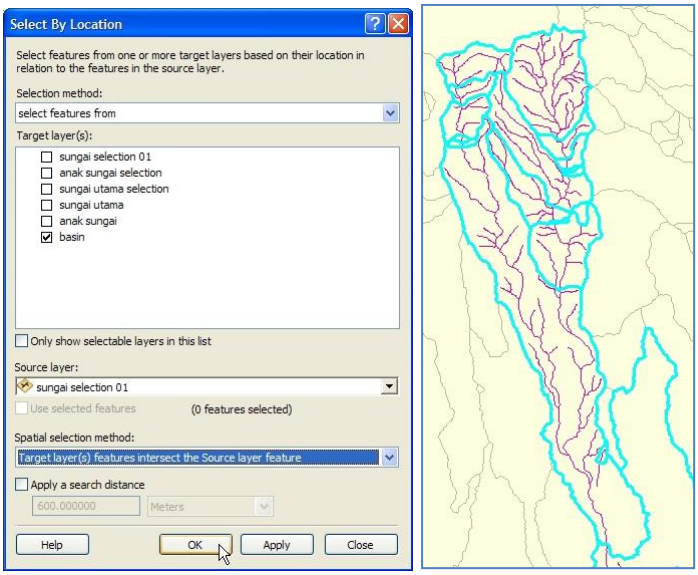


16) The next step is combining “sungai utama selection” layer and “anak sungai selection” layer. On ArcToolbox window, click + symbol on Data Management Tools, → General, double click Merge. Next will appear Merge window.
17) On Input Datasets combo box, insert “sungai utama selection” and “anak sungai selection” layer. On Output Dataset, save the process result into the folder: Data source for training\03 River vector data. Give the name of “sungai selection 01.shp”. click OK button. Automatically, will form a new layer on Table of Contents named “sungai selection 01”.

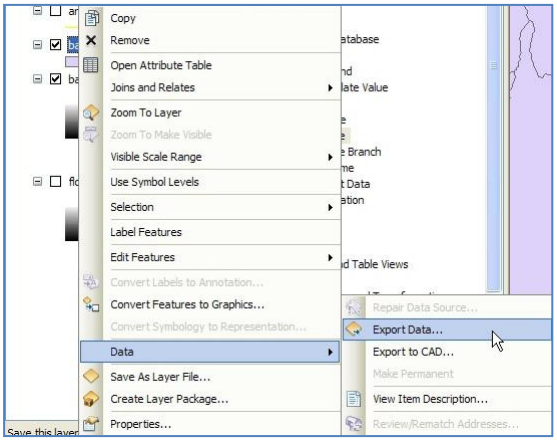


18) Uncheck or turn off the "main stream selection" layer and "selection creeks" layer.
19) Next we will select the basin (sub-DAS) that are part of this river object. Click Selection on ArcMap main menu, and then click Select By Location. Next will appear Select By Location window.

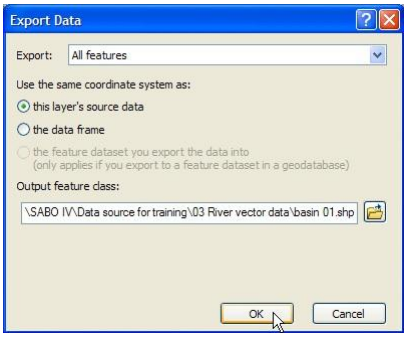
20) On Selection method combo box, choose “select features from”. On Target layer (s) check box, check or choose “basin”. On Source layer combo box, choose “sungai selection 01”. On combo box of Spatial selection method, choose Target layer(s) features intersect the source layer feature. Click OK button. We will see the selection result of several basin objects.



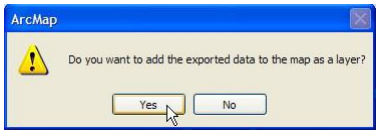
21) To make shapefile data based on this selection result, right click “basin” layer, point the mouse cursor to Data, and then click Export Data. Next will appear Export Data window.



22) Click  button on text box of Output feature class. Save the new shapefile into the folder: Data source for training\05 Creating catchment area, with a name of “basin 01.shp”.



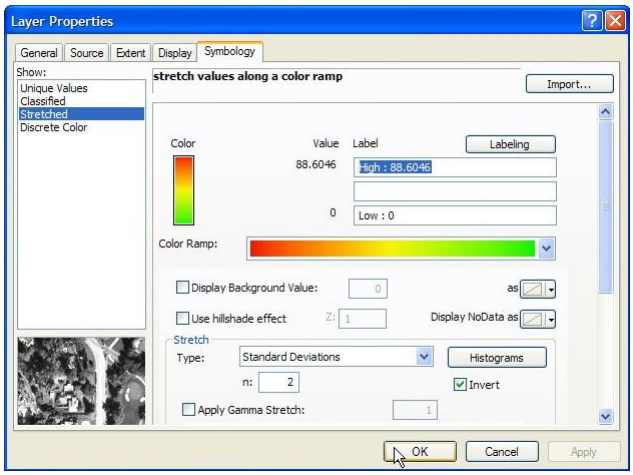
23) If a window appears asking if the exported data will be incorporated into ArcMap as a layer, press the Yes button.



24) Save the ArcMap workspace into the folder: Data source for training\05 Creating catchment area. Give the name as "DAS 1.mxd".

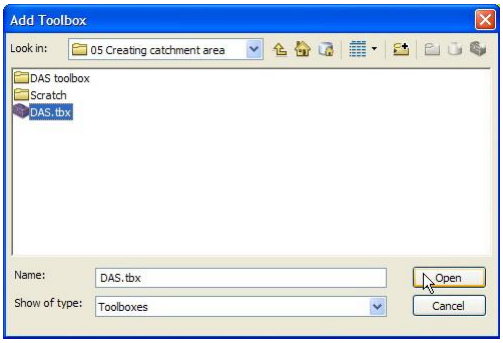
Step 3. Determining downstream part of catchment area

1) On this step we will determine the downstream part of a catchment area based on topographic slope. Open/run ArcMap, choose Blank Map.
2) Input "sungai selection 01.shp" data from the folder: Data source for training\03 River vector data.
3) Input "basin_01.shp" data from the folder: Data source for training\05 Creating catchment area.
4) Change the symbol view of "basin_01" layer, by changing Fill Color become No Color, Outline Width: 1.5, and Outline Color: Blue (Lapis Lazulli).
5) Input the "flowdir_10", "flowacc_10", and "slope_10" data from the folder: Data source for training\02 Contour data. If there are questions to make the Pyramids, click the Yes button.
6) Right click "slope_10" layer, and click Properties.
7) On Layer Properties window, click Symbology tab, choose Stretched on part of Show, choose the color gradation green to red on part of Color Ramp, click Invert on part of Stretch, choose Type Stretch Standard Deviation with n: 2. Click OK button.



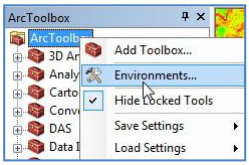
8) On ArcToolbox window, right click ArcToolbox, choose Add Toolbox.

9) Next will appear Add Toolbox window. Point into the folder: Data source for training\05 Creating catchment area, choose DAS.tbx, click Open button.

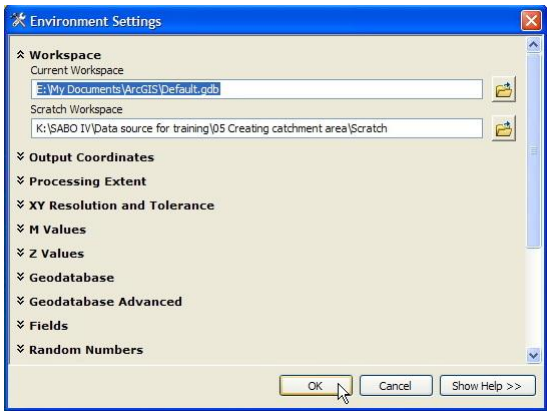


Automatically, on ArcToolbox window, will add a new Toolbox named DAS.

10) Right click ArcToolbox and then click Environments.



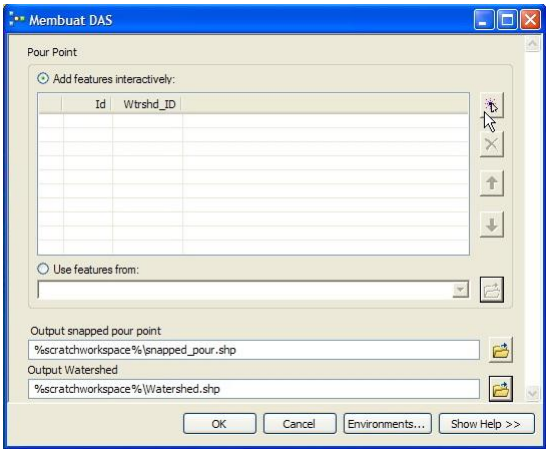
11) On Environments window, click Workspace. On text box of Scratch Workspace, click button and point the mouse cursor into the folder: Data source for training\05 Creating catchment area\Scratch. Click OK button.

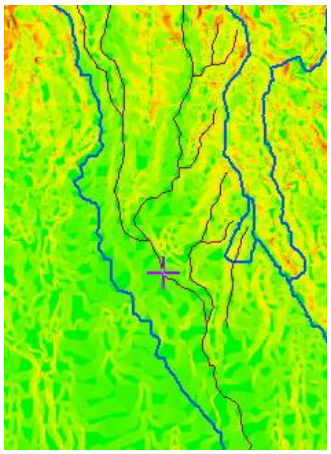


12) Make sure that “snapped_pour.shp” and “watershed.shp” file has been erased or there should be no in the folder: Data source for training\05 Creating catchment area\Scratch. If these two files are in the folder, using the Catalog, delete both files.

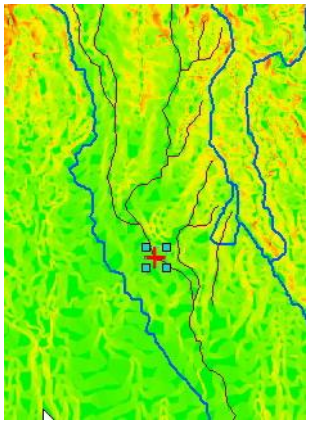
13) Click + symbol on DAS toolbox and then double click “Membuat DAS”.

14) Next will appear Membuat DAS window. Click Add feature button and then point the cursor to the river flow on the upstream area, that has topographic slope which began sloping. Click the cursor on that position.

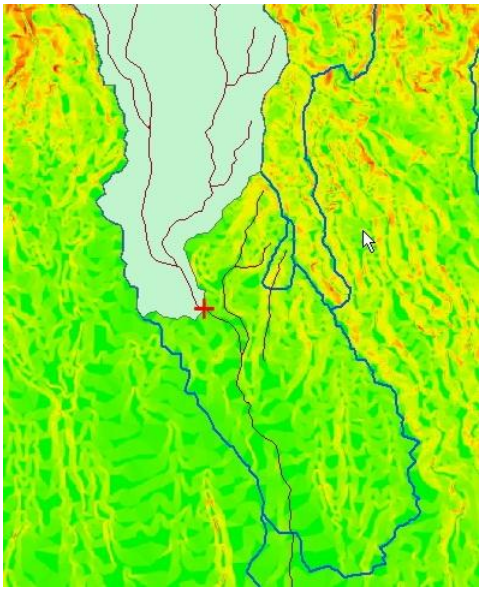


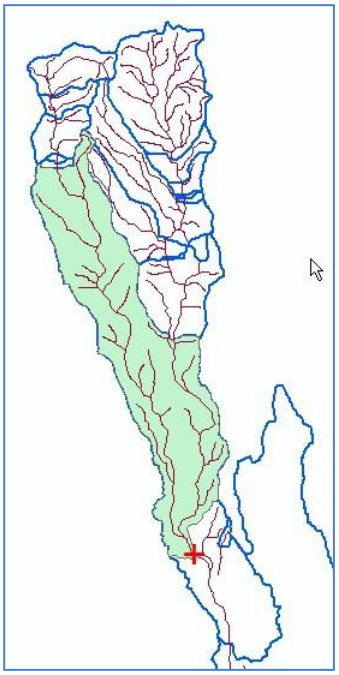


15) After appear icon + on the area that we have chosen, click OK button on Membuat DAS window.



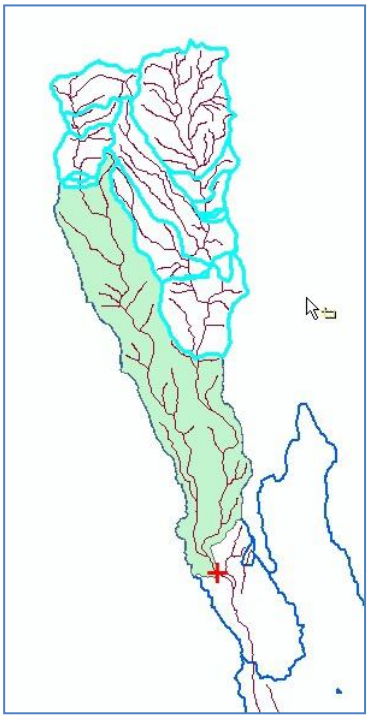
16) Automatically will form two new layer which are “snapped_pour” layer and “Watershed” layer. “Watershed” layer is the resulted basin of river downstream area.





17) Right click “basin_01” layer → Selection, click Make This Only Selectable Layer.
18) Click Selection on ArcMap main menu → Interactive Selection Method, click Add to Current Selection.

19) Click Select Features by Rectangle button on Tools toolbar, select the basins from "basin_01" layer that on the upper area of Watershed layer previously produced.

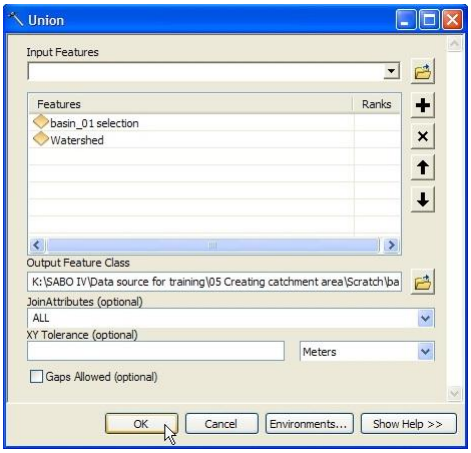


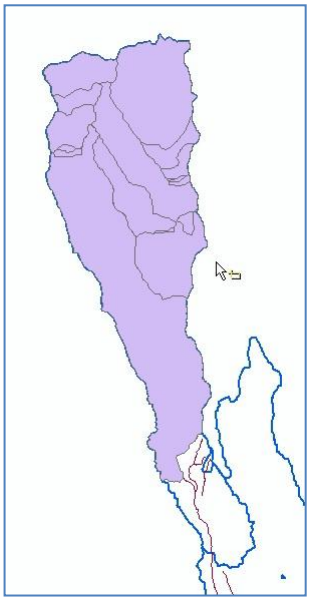
20) Make a new layer based on the previous selected basin. Automatically will form a new layer named "basin_01 selection".

21) Press Clear Selected Features button on Tools toolbar to clear the view of previous selected objects.

22) On ArcToolbox window, click + symbol on Analysis Tools → Overlay, and then double click Union. Next will appear Union window.

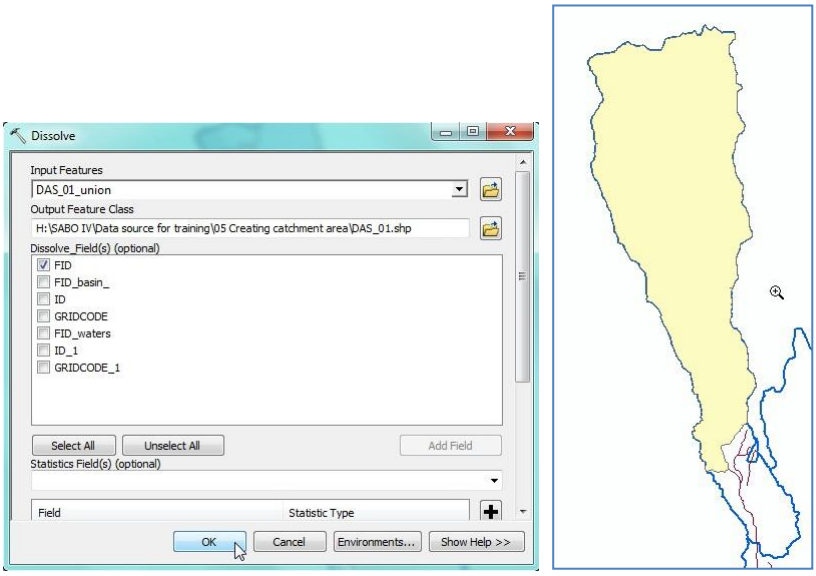
23) On combo box of Input, input the selected basin layer (basin_01 selection) and "Watershed" layer. On part of Output Feature Class, place the shapefile that will be made in the folder: Data source for training\05 Creating catchment area. Name the file with "DAS_01_union.shp". Uncheck Gaps Allowed. Click OK button.
Automatically will form a new layer named "DAS_01_union" in the Table of Contents.





24) The next step is to combine all of objects/features that are in one shapefile. On ArcToolbox window, click + symbol on Data Management Tools → Generalization, double click Union. Next will appear Dissolve window.

25) On combo box of Input Features, choose “DAS_01_union” layer. On text box of Output Feature Class, place the shapefile that will be made into the folder: Data source for training\05 Creating catchment area, and name the file with “DAS_01.shp”. On check box of Dissolve Field(s), check FID. Click OK button. The result as shown on the bottom right figure.



26) Do the process of making of catchment area based on the steps on Step 2 (choosing basins for making catchment area) and Step 3 (Determining downstream part of catchment area) for catchment area on another location.

27) For the purposes of this training, we use the catchment area data that contained in the folder: Ref, the file name is "das ref.shp".

28) Save the workspace into the folder: Data source for training\05 Creating catchment area, name it with “DAS 2.mxd”.

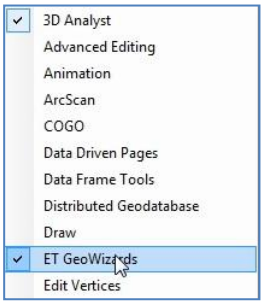
Step 4. Making sub-area data

1) On this step we would like to make sub-area data, which is data in the form of square grid with the size of 1 sq-km, surrounding area or watershed data that has been made previously.
To ease in making the sub-area data, we use an additional application for ArcGIS called ET Geo Wizards. The use of this application for purposes of sub-area generation data is free, and can be downloaded directly at the address
http://www.et-st.com/downloads/etgw/ETGeoWizards101_100.zip.
If on the ArcGIS 10 have not installed this application, then the first thing to do is install the ET Geo Wizards.

2) Open/run ArcMap, choose Blank Map.

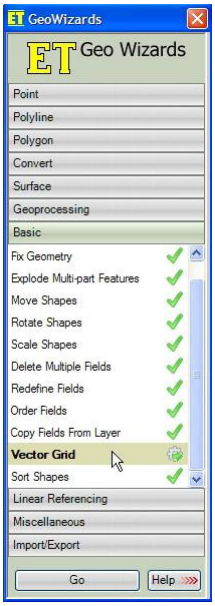
3) Input “das ref.shp” file from the folder: Ref into ArcMap workspace.

4) Input ETGeoWizards toolbar into ArcMap by right click on any empty space of ArcMap workspace, and then click “ETGeoWizards”.

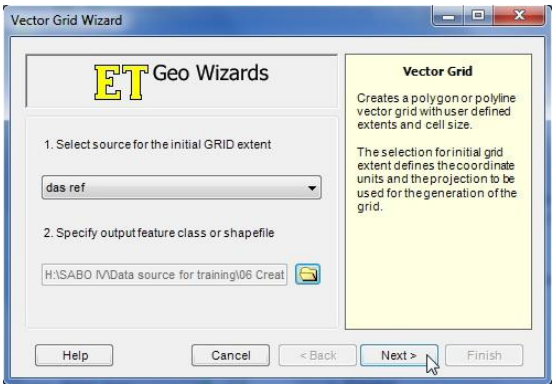


5) After the ETGeoWizards toolbar has been entered into ArcMap workspace, click ETGW button. Next will ETGeoWizards window.

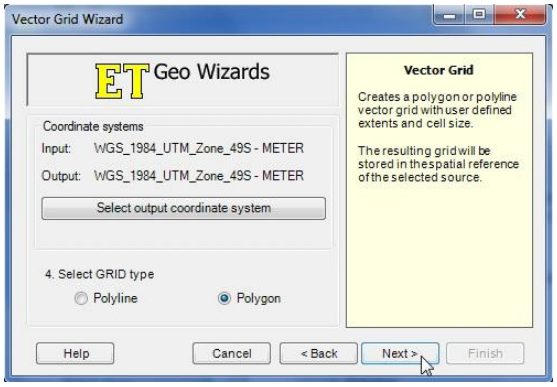
6) Click “Basic” and then double click “Vector Grid”. Next will appear Vector Grid Wizards window.



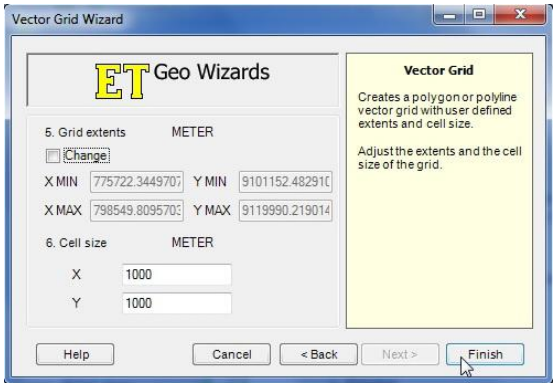
7) On combo box of Select source for the initial GRID extent, choose “das ref “layer. On text box of no.2, input the resulted data into the folder: Data source for training\06 Creating sub-area, give name “grid.shp”. Click Next button.



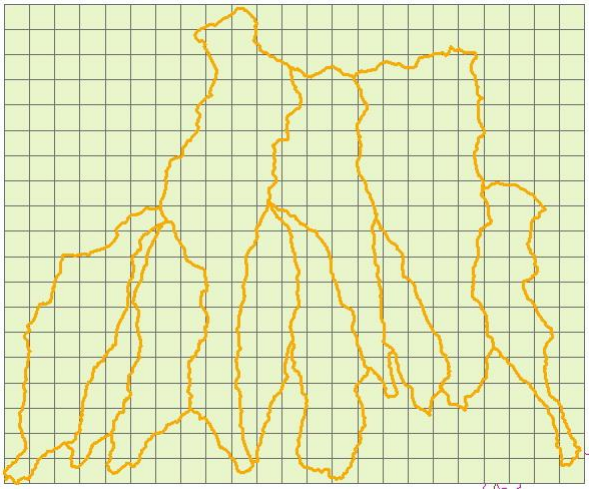
8) On the next page, make sure that the coordinate system of Input and Output are WGS 1984 UTM Zone 49S. Choose “Polygon” on radio box of Select GRID type. Click Next button.



9) On the next page, on text box of Cell size, write the X and Y with value “1000”. Click Finish button.

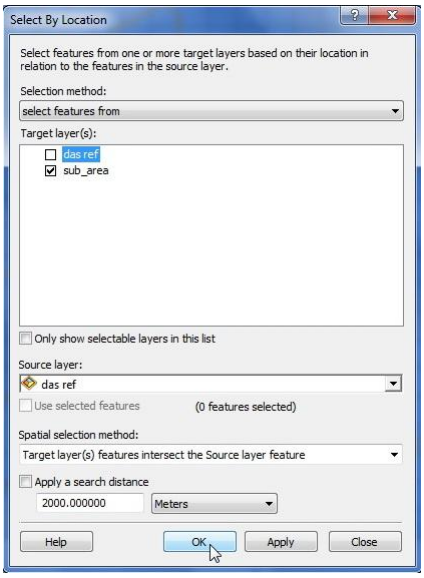


10) The display of data grid generated is as below.

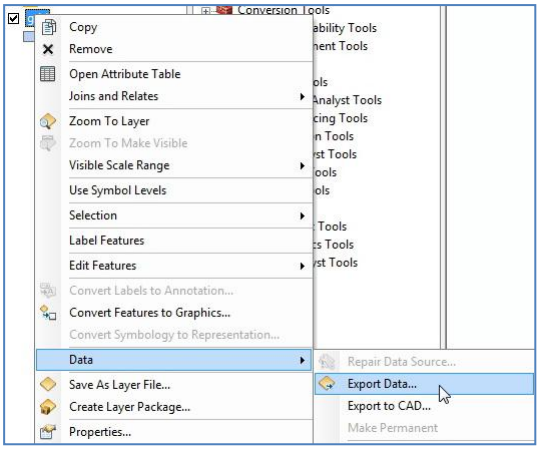


11) The next step is choosing objects/features from grid data that intersect with watershed region. On ArcMap main menu, click Selection, and click Select By Location.

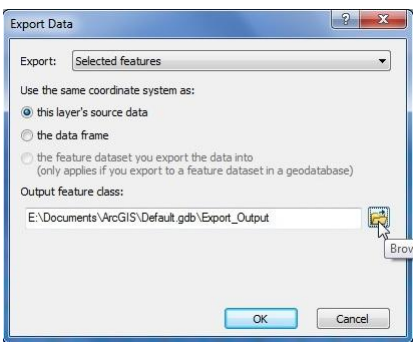
12) On combo box of Selection method, choose select features from. On combo box of Source layer, choose “das ref” layer, and choose Target layer(s) features intersect the Source layer feature. Click OK button.

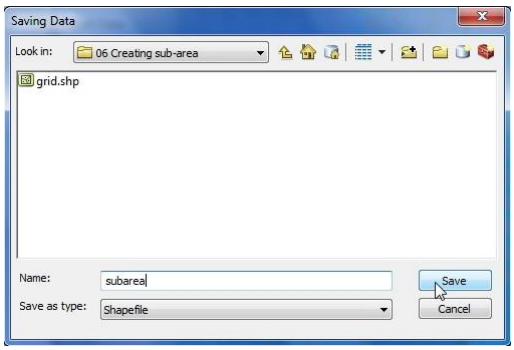


13) Next will appear feature of grid data that intersect/overlaps with watershed data. Right click “grid” layer, point the cursor to Data, and then click Export Data.

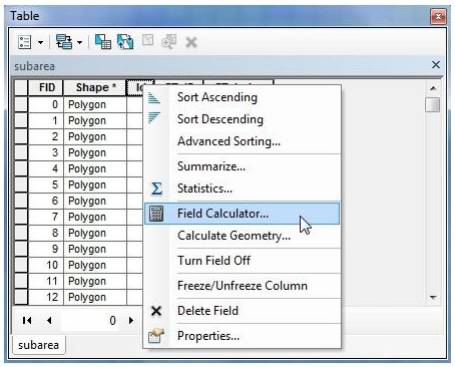


14) Next will appear Export Data window. Click Browse button.
On Saving Data window, point into folder: Data source for training\06 Creating sub-area, choose the type of file that will be save as Shapefile, and give name as “subarea”.

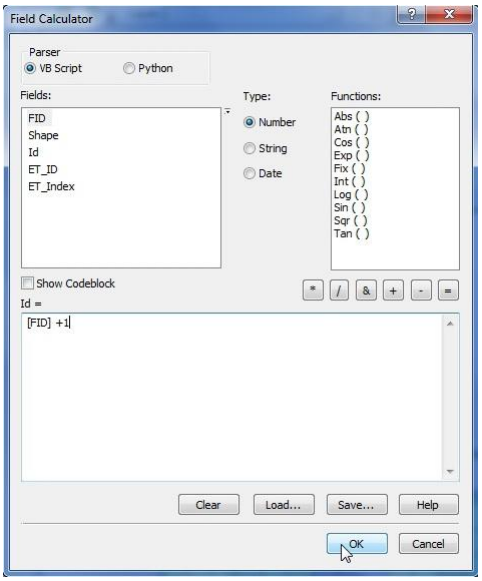


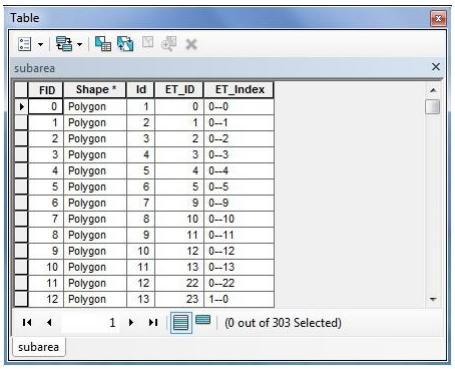


15) Right click “subarea” layer, and click Open Attribute Table. After the table of subarea appears, right click the column header of Id, and click Field Calculator.

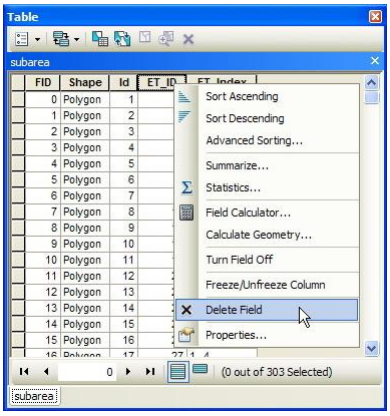


16) After that will appear Field Calculator window. On area of text box formula, write with: [FID] + 1, and then click OK button. The result from this Field Calculator is the serial number on column “Id”.





17) Delete column “ET_ID” and column “ET_Index” by right click on the header of the columns and then click Delete Field.

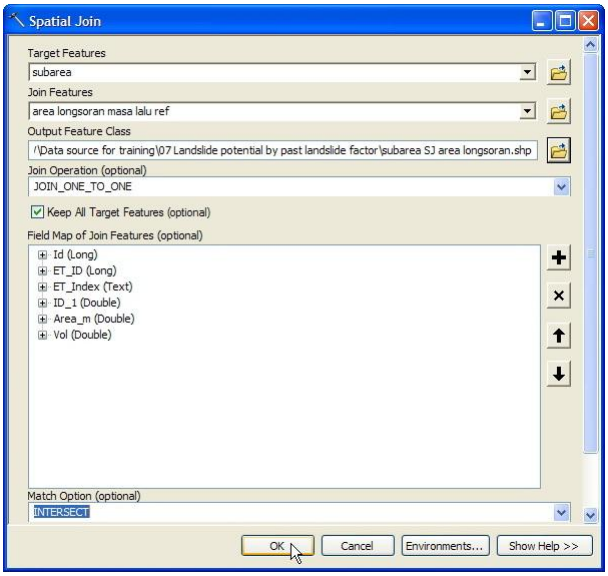


18) Save the ArcMap workspace into the folder: Data source for training\06 Creating sub-area, and give name with “subarea.mxd”.

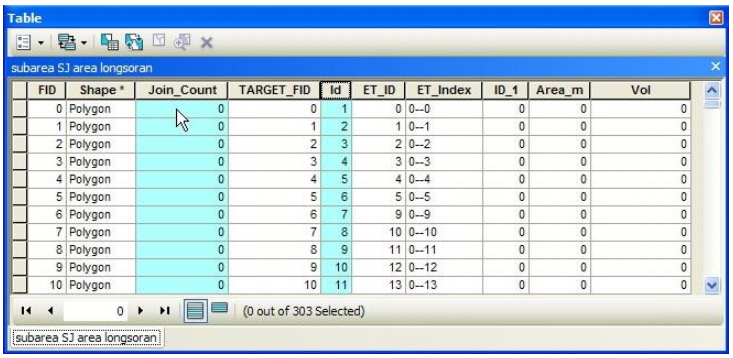
II. Making Landslide Potential Map Based On Past Landslide Events

1) Open/run ArcMap, choose Blank Map.
2) Input “subarea ref.shp” file and “area longsoran masa lalu ref.shp” file from the folder: Ref.
3) The next step is to look for information about the subarea that intersects with the landslide area. Subarea that intersect with the landslide area will we conclude as the landslide-prone subarea based on past landslide events.
   In the ArcToolbox window, click the + symbol on Analysis Tools, a + symbol on Overlay, and double click Spatial Join. Next will appear Spatial Join window.

On combo box of Target Features, choose “subarea ref” layer. On combo box of Join Features, choose “area longsoran masa lalu ref” layer. On text box of Output Feature Class, save the file into folder: Data source for training\07 Landslide potential by past landslide factor, and give name as “subarea SJ area longsoran.shp”. On combo box of Join Operation, choose “JOIN_ONE_TO_ONE”. Check “Keep All Target Features”. On combo box of Match Option, choose “INTERSECT”. Click OK button.



4) Automatically will be formed data and new layer named “subarea SJ area longsoran”. Right click that layer and click Open Attribute Table. On the next step we only focus to the content of column “Join_Count” and column “Id”. Column “Join_Count” contain values that show how many intersection of a subarea with past landslide area, whereas column “Id” shows the identity number of subarea.



FID	Shape *	Join_Count	TARGET_FID	Id	ET_ID	ET_Index	ID_1	Area_m	Vol
0	Polygon	0	0	1	0	0--0	0	0	0
1	Polygon	0	1	2	1	0--1	0	0	0
2	Polygon	0	2	3	2	0--2	0	0	0
3	Polygon	0	3	4	3	0--3	0	0	0
4	Polygon	0	4	5	4	0--4	0	0	0
5	Polygon	0	5	6	5	0--5	0	0	0
6	Polygon	0	6	7	9	0--9	0	0	0
7	Polygon	0	7	8	10	0--10	0	0	0
8	Polygon	0	8	9	11	0--11	0	0	0
9	Polygon	0	9	10	12	0--12	0	0	0
10	Polygon	0	10	11	13	0--13	0	0	0

5) To analyze landslide potential, we use calculation table using Microsoft Excel.
Open “Analisa potensi longsor - source.xlsx” file from folder: Data source for training. Open/see sheet “Analisa potensi longsor”.

ANALISA POTENSI LONGSOR

	Faktor kejadian longsoran gelincir		Faktor-faktor geologi dan mikrotopografi	Faktor topografi		Potensi longsor		
ID subarea	Jumlah kejadian longsor per subarea	Potensi longsor berdasarkan kejadian longsor masa lalu	Potensi longsor berdasarkan faktor geologi dan mikrotopografi	Jumlah titik potensi longsor	Potensi longsor berdasarkan faktor topografi (jumlah titik potensi longsor ≥ 25)	ID subarea	Nilai potensi longsor	Peringkat potensi longsor
1	0	0	0	0	0	1	0	Tidak Potential
2	0	0	0	0	0	2	0	Tidak Potential
3	0	0	0	0	0	3	0	Tidak Potential
4	0	0	0	0	0	4	0	Tidak Potential
5	0	0	0	0	0	5	0	Tidak Potential

Analisa potensi longsor | Ekstraksi elemen geologi | Kombinasi elemen | Faktor topografi | Peringkat longsor | Peringkat geo | Peringkat topo

On that sheet, can be seen four main column which are: past landslide factor, geological and micro-topographic factor, topographic factor, and landslide potential. On this step we only focus on the first step that is past landslide factor.

6) By using Windows Explorer, enter to the folder: Data source for training\07 Landslide potential by past landslide factor. In this folder, there is “subarea SJ area longsoran.shp” file that split into several file. Find the file of “subarea SJ area longsoran.**dbf**”, open the file by using Microsoft Excel. This file contains attribute data of “subarea SJ area longsoran.shp” file. We open this file only wants to copy it contain. Do not changes, edit, and Save As the file because the file can be corrupted.

7) Copy the content of column “Id” (subarea SJ area longsoran.dbf), and paste to the column “ID subarea” (Analisa potensi longsor - source.xlsx). Copy also the data content of “Join_Count” column (subarea SJ area longsoran.dbf), and paste to the column “Jumlah kejadian per subarea” (Analisa potensi longsor - source.xlsx).

	A	B	C	D	E	F	
1	Join_Coun	TARGET_FI	Id	ET_ID	ET_Index	ID_1	Area_
2	0	0	1	0	0--0	0	
3	0	1	2	1	0--1	0	
4	0	2	3	2	0--2	0	
5	0	3	4	3	0--3	0	
6	0	4	5	4	0--4	0	
7	0	5	6	5	0--5	0	
8	0	6	7	9	0--9	0	
9	0	7	8	10	0--10	0	
10	0	8	9	11	0--11	0	
11	0	9	10	12	0--12	0	
12	0	10	11	13	0--13	0	
13	0	11	12	22	0--22	0	
14	0	12	13	23	1--0	0	
15	0	13	14	24	1--1	0	

8) After we copied the data, close “subarea SJ area longsoran.dbf” file without save changed it.

9) In the Analisa Potensi Longsor table, column “Jumlah kejadian per subarea” shows how many landslide events were happen in a subarea. Whereas column “Potensi longsor” shows subarea that have experienced landslides or can we call that subarea is potential to landslide (based on past landslide data).

	A	B	C
1			
2			
3		Faktor kejadian longsoran gelincir	
4	ID subarea	Jumlah kejadian per subarea	Potensi longsor berdasarkan kejadian longsor masa lalu
105	101	0	0
106	102	0	0
107	103	1	1
108	104	2	1
109	105	2	1
110	106	1	1
111	107	1	1
112	108	0	0
113	109	0	0
305	301	0	0
306	302	0	0
307	303	0	0
308			29

To make the content of column “Potensi longsor”, for example we can input the formula of “=IF(B=0,0,1)” on the first row column “Potensi longsor”, and copy the formula to every row. This formula has meaning that is: if there is a value of 0 on column “Jumlah kejadian per subarea”, then column “Potensi longsor” contains the value 0, whereas if there is a value other than 0 on column “Jumlah kejadian per subarea”, then column “Potensi longsor” contains the value 1.

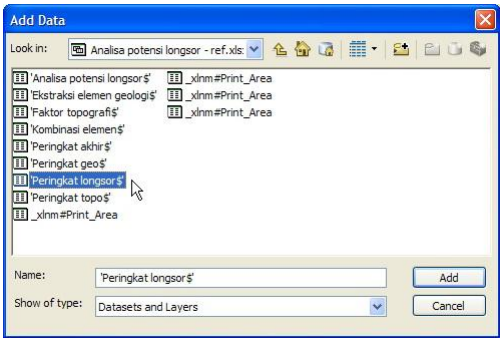
Do the sum of column “Potensi longsor”. Total value of the column “Potensi longsor” on the table is 29, which mean there are 29 subarea that potential to landslide based on past landslide events factor.

10) On the file of “Analisa potensi longsor”, open sheet “Peringkat longsor”.

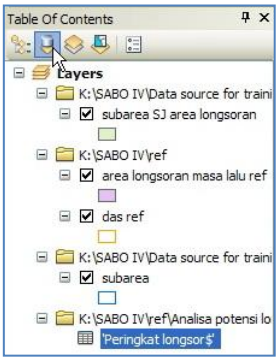
In this sheet, the first row contains the column title, whereas from the second row and so on, on the first column contains the value or link from column “ID subarea”, sheet “Analisa potensi longsor”, and the second column contains the value or link from column “Potensi longsor berdasarkan kejadian longsor masa lalu”, sheet “Analisa potensi longsor”.

	A	B	C
1	ID subarea	Peringkat	
2	1	0	
3	2	0	
4	3	0	
5	4	0	
6	5	0	
7	6	0	
8	7	0	
9	8	0	
10	9	0	
11	10	0	

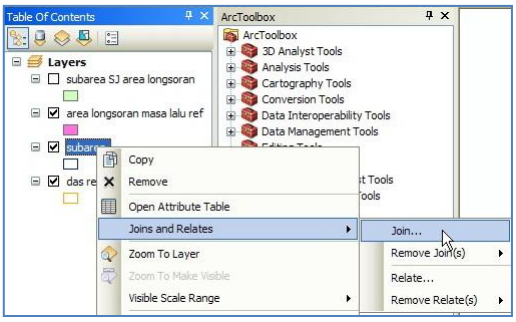
11) Save the file “Analisa potensi longsor.xlsx”.
12) On the ArcMap workspace, click Add Data, then point to the folder: Data source for training.
13) Double click file of “Analisa potensi longsor - source.xlsx”, then double click ”Peringkat longsor$”.



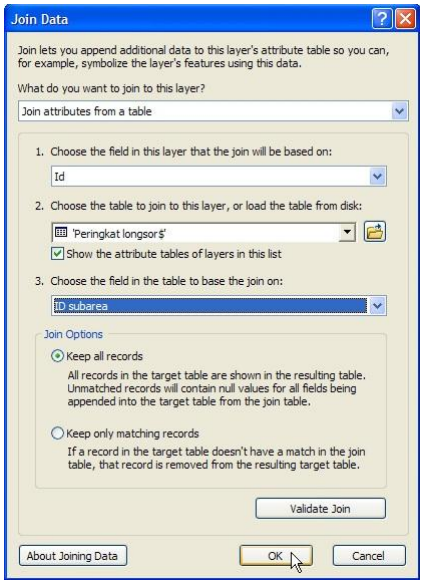
14) Automatically, the sheet or the data from “Peringkat longsor” will enter to the ArcMap workspace. This data will appear on Table Of Contents, part of “List By Source”.



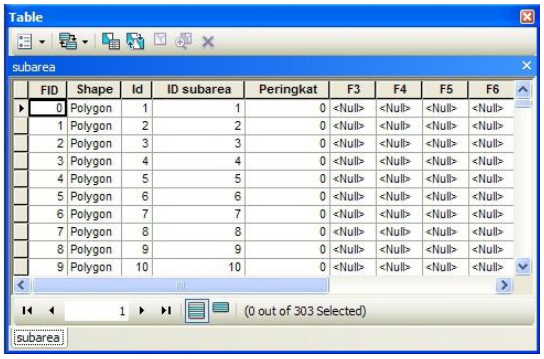
15) On Table Of Contents window, click List By Drawing Order  button.
16) On this step, we would like to connect the data of the sheet “Peringkat longsor” with attribute data on “subarea ref” layer based on the same subarea ID.
Right click “subarea ref” layer, point the cursor to Joins and Relates, then click Join.



17) Next will appear Join Data window. On the combo box of What do you want to join to this layer, choose Join attributes from a table. On the combo box 1, choose “Id”. On the combo box 2, choose “Peringkat longsor” layer. On the combo box 3, choose “ID subarea”. On button radio of Joins Options, choose Keep all records. Click OK buttton.



18) Open attribute table from “subarea ref” layer. The view of the table it looks like figure below.

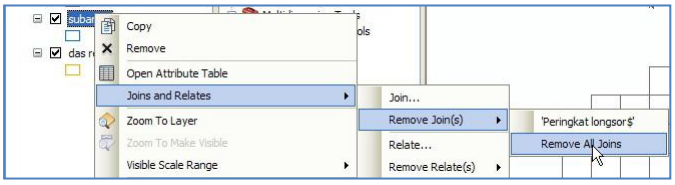


FID	Shape	Id	ID subarea	Peringkat	F3	F4	F5	F6
0	Polygon	1	1	0	<Null>	<Null>	<Null>	<Null>
1	Polygon	2	2	0	<Null>	<Null>	<Null>	<Null>
2	Polygon	3	3	0	<Null>	<Null>	<Null>	<Null>
3	Polygon	4	4	0	<Null>	<Null>	<Null>	<Null>
4	Polygon	5	5	0	<Null>	<Null>	<Null>	<Null>
5	Polygon	6	6	0	<Null>	<Null>	<Null>	<Null>
6	Polygon	7	7	0	<Null>	<Null>	<Null>	<Null>
7	Polygon	8	8	0	<Null>	<Null>	<Null>	<Null>
8	Polygon	9	9	0	<Null>	<Null>	<Null>	<Null>
9	Polygon	10	10	0	<Null>	<Null>	<Null>	<Null>

19) Right click “subarea ref” layer, point the cursor to Data, then click Export Data. Input data that want to be exported into the folder: Data source for training\07 Landslide potential by past landslide factor, and give name of “potensial longsor berdasarkan kejadian longsor masa lalu.shp”.

If there is question whether the exported data will be inserted into ArcMap as a layer, answer Yes.

20) Right click “subarea ref” layer, point the cursor to Joins and Relates, then Remove Join(s) and clickk Remove All Joins.



21) Open the attribute table of “analisa potensial berdasarkan kejadian longsor masa lalu” layer. If needed, delete the other column by leaving column: “FID”, “Shape”, “Id”, “Peringkat”.

22) Right click “analisa potensial berdasarkan kejadian longsor masa lalu” layer and click Properties. On Layer Properties window, click Symbologi tab.