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MODULE OF TRAINING

INCREASING CAPACITY OF LOCAL SCIENTISTS FOR CLIMATE CHANGE IMPACT & VULNERABILITY ASSESSMENT ON INDONESIA ARCHIPELAGOS:

TRAINING IN IN-SITU/SATELLITE SEA LEVEL MEASUREMENT

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Edited by

Jonson Lumban Gaol

ASIA PACIFIC NETWORK FOR GLOBAL CHANGE RESEARCH (APN)

DEPARTMENT OF MARINE SCIENCE AND TECHNOLOGY

BOGOR AGRICULTURAL UNIVERSITY

2010

TRAINING MODULE

DEVELOPMENT OF COASTAL VULNERABILITY INDEX

"INTRODUCTION TO GIS"

Compiled by :

Samsul B. Agus

Anggi Afif Muzaki

BOGOR AGRICULTURAL UNIVERSITY, 2010

CONTENTS

I. Introduction

ArcGIS is a software package in the Graphical User Interface design for processing spatial data (Geographic Information System). Through this software, can perform display (visualization data), explore, query, and analysis of spatial data following tabular data attached to them. Designed on the Windows Desktop as Windows NT, Windows 2000, Windows XP, Windows Vista and Windows 7. The software has 3 standard application of **ArcMap, ArcCatalog, ArcGlobe and ArcToolbox**. ArcGis provide applications that can adjusted with the capabilities and needs of its users.

- **ArcMap :** designed to display data, editing, spatial analysis and printing high quality maps.
- **ArcCatalog :** functions to access and arrange data management (spatial and non spatial data) with easily. Use of the bus looking for the desired data, display, view or create metadata. ArcCatalog can also access external databases (Ms Access, SQL Server, Oracle, etc.).
- **ArcGlobe :** designed to display data in 3 dimensions.
- **ArcToolbox :** contains the tools (the tools) for various geoprocessing and data conversion between formats.

II. Objective

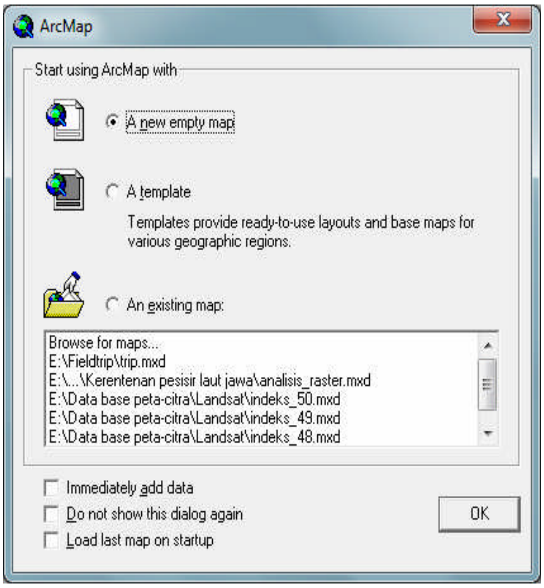
- Introduce common functions found in **Arc GIS**
- Providing training to use and analyze spatial data and attribute data and how to manipulate the data

III. Getting Started Using ArcMap Application

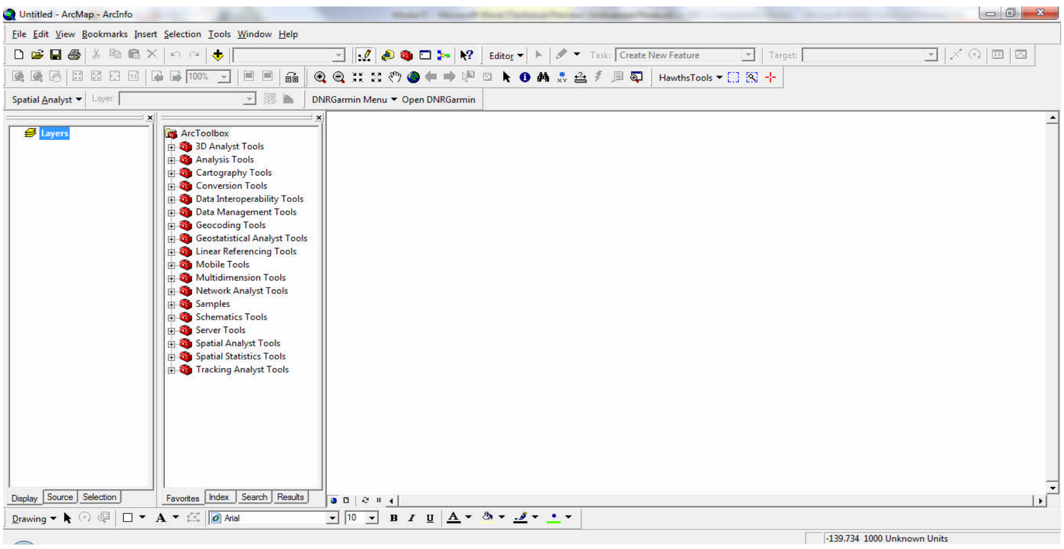
1. Starting and Opening Project

a) Open the **Arc Map**, Click **Start**, select **Program**, select **Arc GIS** and select **Arc Map** or double-click icon 

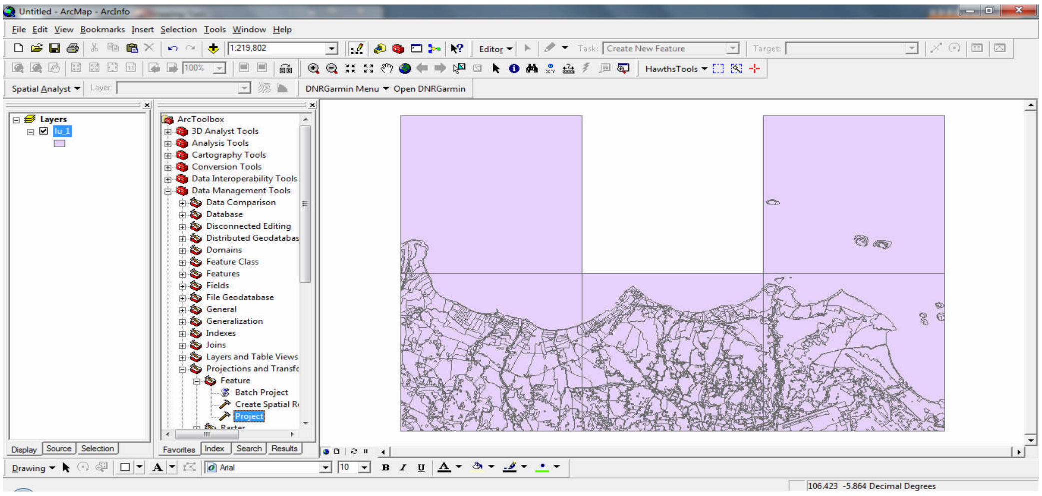
b) Then appear **Arc Map Startup** dialog box. When will open a new work sheet select **a new empty map** and when we will open a map that was created earlier select **Open an existing map.**



c) It would appear one data frame

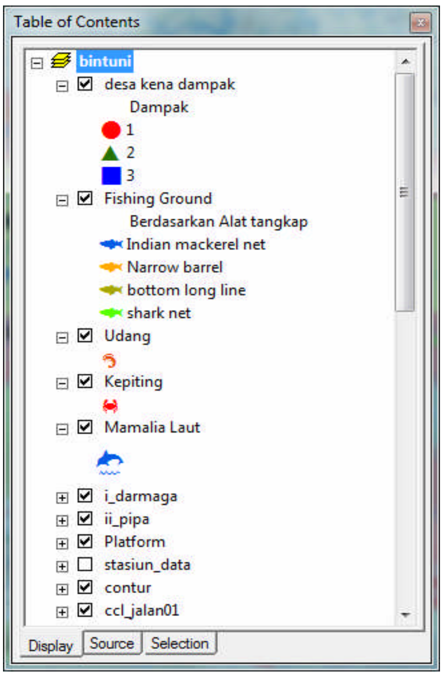


Open file  lu_1 pada D:\@-IK-Training\Modul-01-PengenalanGIS\RBI Tangerang



2. Tables of Contents

Every map has **table of content**. Some map showing all the layers on a single data frame. **Table of content** will show how the layers are arranged in a single frame of data. When displaying a map, usually we'll use the **table of content** to activate or deactivate a layer. At the moment we want to form a map then that would a lot of work is a **table of contents** included in the add, remove and determine how the layer is displayed.



How/ steps showing **Table of Content :**

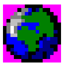
a) Click menu **View**, on standard toolbar

b) Click on **table of content**

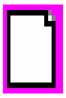
c) It would appear **Table of Content**

3. Displaying Data View and Lay Out View

Arc Map has two View : **Data View** and **Lay Out View**



Data View allows you to display data and explore data, how to bring it up is by clicking the image at the bottom of the frame data.



Lay Out View useful to prepare maps when will the lay out, to be inserted in the report and to publish on the web.

4. Enabling or Disabling Layer

By default, all layers in the project will be displayed in the window view. This is indicated by a check (√) in each theme. This means we can view spatial data in the **Table of Content**.

To set a particular theme that is not shown, we can make these themes seem or not (on or off) by clicking on the check so that the check was not displayed. Conversely also, if we want to show again the theme.

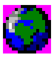
5. Tools On The Toolbar

ArcMap provides several tools that can be used for bias interacts with data, the tools are :

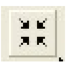
Zooming

ArcGIS provides Zooming function (enlarge and shrink) to change the map scale to view the document. We can do it with three ways to use the **menu, button** or **toolbar**.

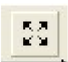
Zooming using button



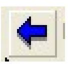
Zoom to Full Extent. This button is used to view the overall theme (all spatial data is displayed).



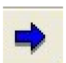
Zoom In. Button is used for magnification once the center of view as a central point.



Zoom out. This button is used to small once the center of view as a central point.



Zoom to Previous Extent. This button is used to display the state of zooming back we used previously.

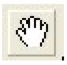


Zoom to Next Extent.

Tool Zoom In. This tool is used for magnification once by placing the cursor position as a central point. If the button is clicked and the cursor is placed on the map and then clicked and held (click and drag), making a rectangle, it will display the field that we choose these areas.

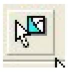
Tool Zoom Out. This tool is used to small once by placing the cursor position as a central point. If the button is clicked and the cursor is placed on the map and then clicked and held (click and drag), making a rectangle, it will display the field that we choose these areas.

Pan

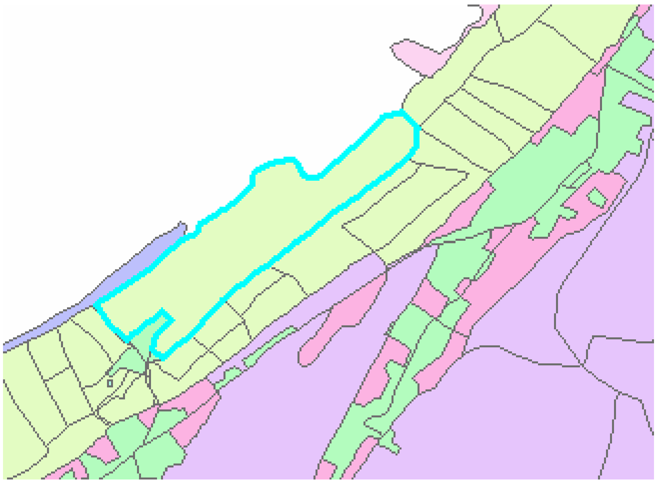


This tool is used for sliding on the map, by clicking the left and move towards the desired pointer.

i. **Select Features Tool**



This tool is used to choose *features* that we want.



Click on these *features*, or slide the mouse pointer around the features.

Select Elements Tool

This tool is used to select graphical objects such as lines, dots, labels or the north and the other, by using this tool to resize draw bias and remove the object.

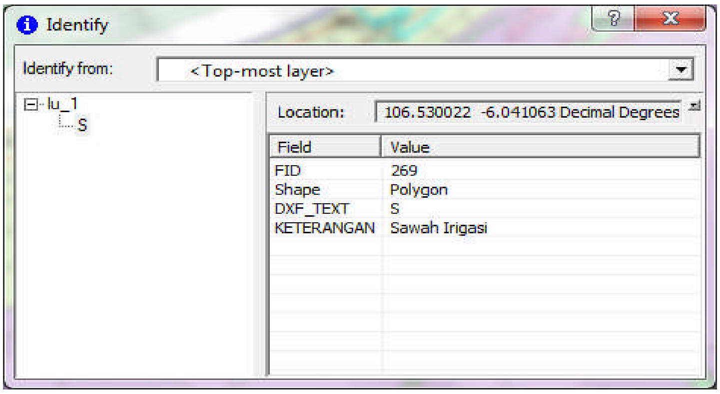
Identification Tool

This tool is useful for displaying information about selected features, as follows:

a) Click **Identify tools**

b) Click the mouse and point the pointer to the data that will **identify**

c) All existing data on the *visible layer* will be identified.



Find

This tool is useful for finding information on a feature allows you to search based on specific information. 

Searching for data with certain attributes

a) Click the **Find** button on the toolbar tools

b) Click the **Features** tab

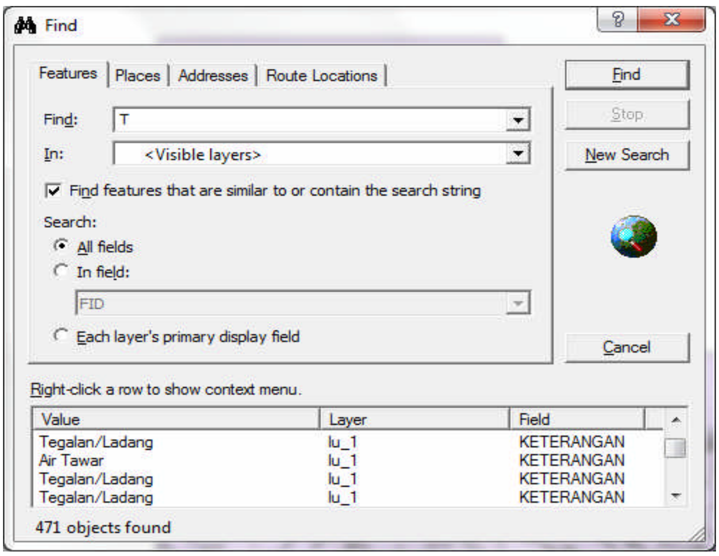
c) Type the word you want to display the **Find Text** box

d) Click the down arrow in the In and then click on the desired layer or can be selected *Visible Layers*

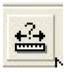
e) Put a check box in the **Find Features** that are similar to or contain the search string

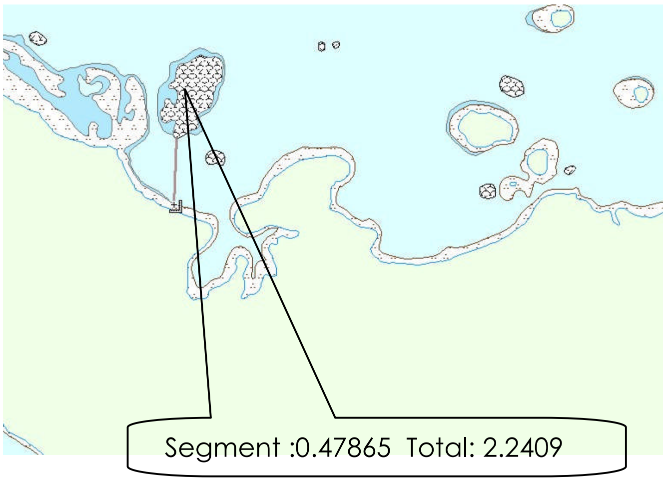
f) Select an Option on the columns that will be in the search, example *all fields*.

g) Then click **Find**



Measure Tool

 This tool is useful for measuring distances on maps, will appear as a long distance from the line segment in the status bar, with the following stages:



a) Click the **Measure** button on the tool toolbars

b) Move your mouse pointer to draw a line that describes the distance that want to be measured

c) The line can consist of several *segment*

d) At the bottom of the frame will display the data segment that measured distance and total distance of all *segments*

Segment :0.47865 Total: 2.2409 Km

e) Click 2 times to end it

6. Starting and Call Data

Calling Data Shape file Format

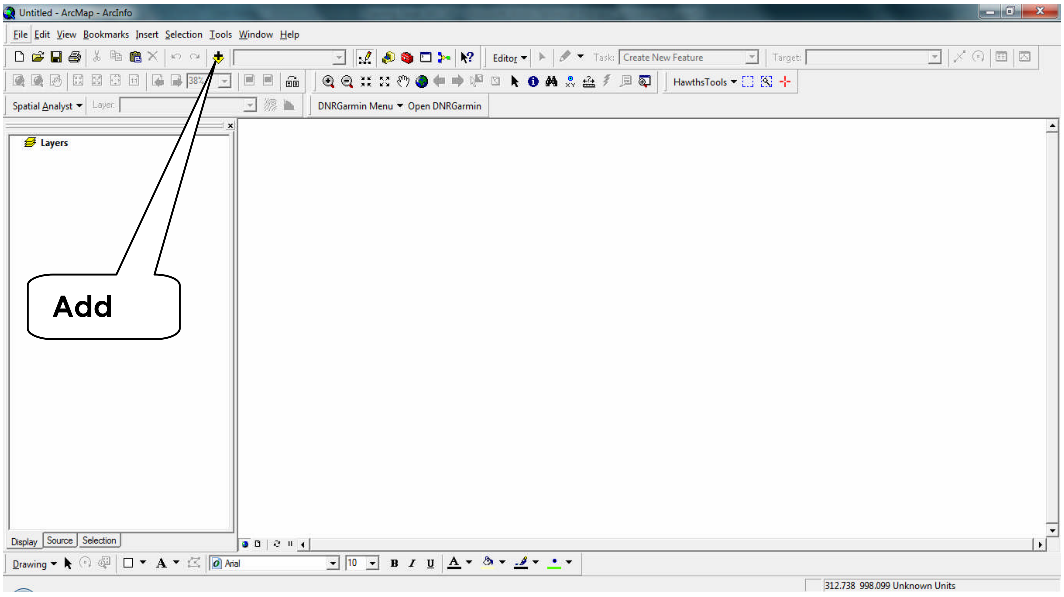
Open the Arc Map, Click Start, select Program, highlight Arc GIS and select the Arc Map or double-click the icon 

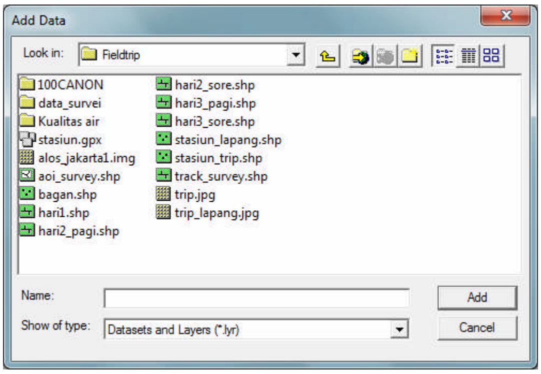
a) Then appear **Arc Map Startup** dialog box and select **a new empty map.**

b) It would appear one data frame

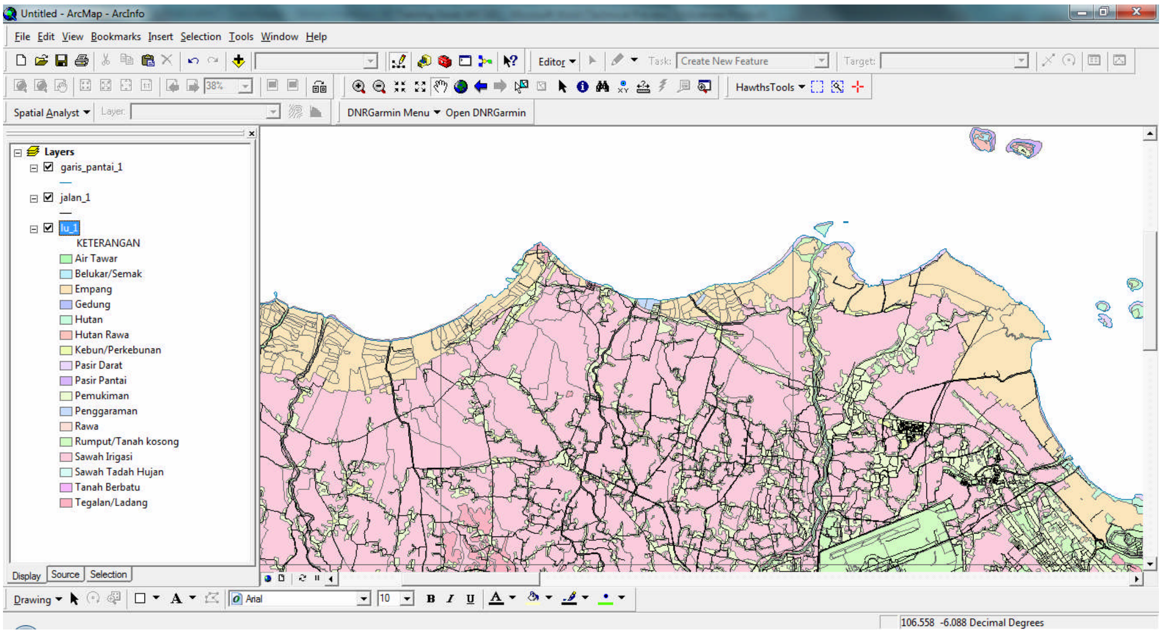
c) To call and add data to the data frame click the **Add Data** button, add the data to be displayed 

d) Then select the file *feature class* that will be displayed



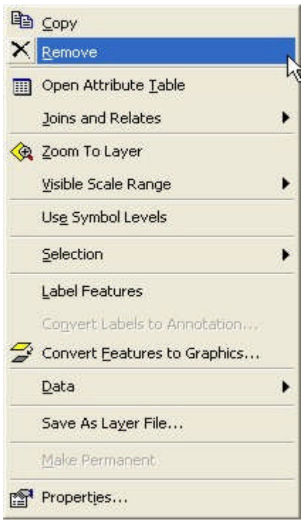


e) Click Add button to continue the call data process. After all process is finished can be seen in the data frame.



7. Deleting One Layer in ToC

If the data that has been called and has appeared on the ToC, we used not to remove the data that is in the following steps:



a) As an example we will remove the street layer

b) Enable layer street layer

c) Then right-click to display the pop up menu

d) Choose **Remove** menu path to remove the street layer

Perform the same stepss to remove the other layers in the data Frame

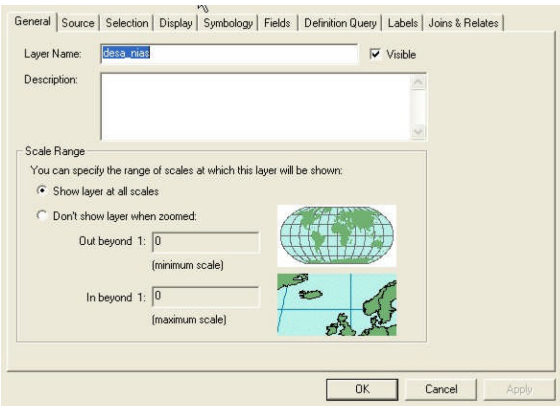
8. Setting Layer Name

Layers contained in the data frame bias in the settings and changed its name in accordance with the information it has, for example layer *Lu_1*, will be replaced with land cover. Steps:

a) Select layer *Lu_1*. Then right click and select **properties**

b) Select **general** tab in the layer **properties** dialog box then change the name of the layer on the *layer* name dialog box with the village administration.

c) Click *Apply* to change the name of the layer or press F2 on the toolbar name those layers.



9. Layer Setting

If the data displayed on the frame data is overwhelming, so the data should be sorted according to the TIPA data, ranging from points, lines and then broadcast. For data which is located at the top then the data will be placed on the top, this will be very influential if the data area placed at the top, this data will cover the data with a line or point data type. Layers can be arranged by clicking on the layer and moving it upwards or downwards according to the position of the chill.

10. Create Categories On Feature

Category features the same group data based on the value of its attributes, examples of land use will be classified into residential, field, fields, marshes and others in accordance with information on data attributes.

Map of Unique Value Based

Map is usually described by attribute data that can identify each feature.
Example: display layer based on the district *lu_1,* and steps :

a) Right click the layer *lu_1*

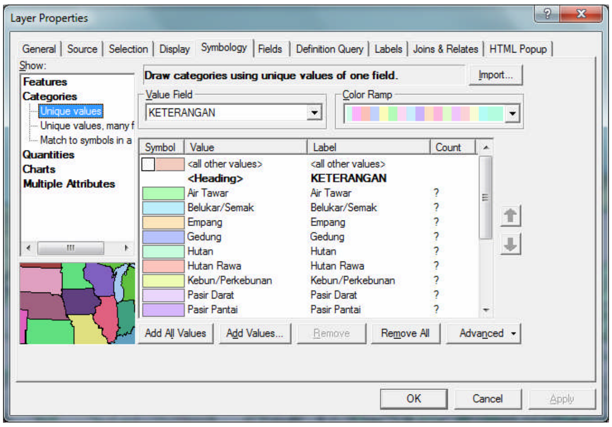
b) Select **Properties** and **Layer Properties** dialog box appears and then select the **symbology**

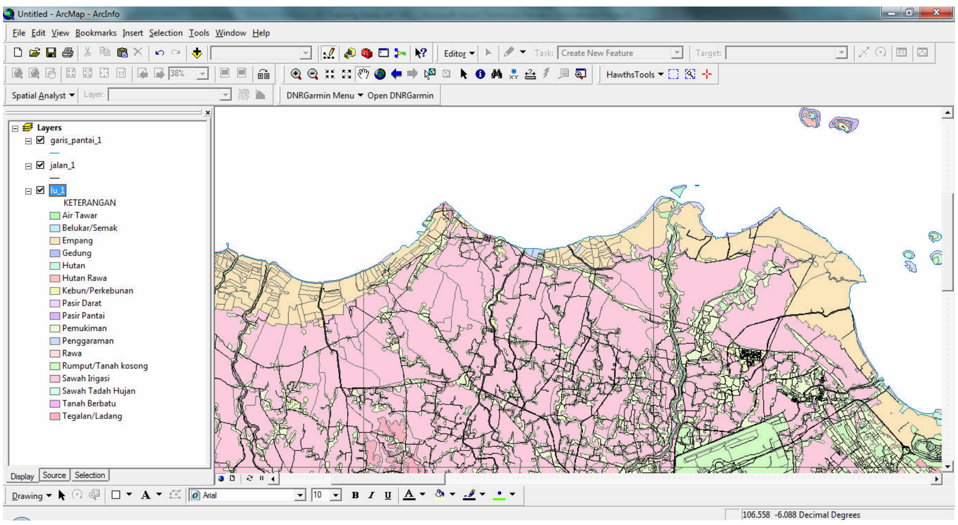
c) Click on the **categories** and sets option of **unique values**

d) Set **unique values** based on the district name in the **Value Field** combo box

e) Set the color scheme and then click the **Add All Values**

f) Then click the **Apply** button to activate the settings made





IV. ATTRIBUTES DATA

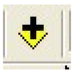
Geographic information system has two data elements are spatial data and attribute data. Spatial data refers to the geometric data that provides information on the object position and also the spatial relationships between objects, while the attribute data is data complement of spatial data that provides additional information about the bias of spatial data in the form of the id, name objects, etc. In the neighborhood Geographic Information System data is stored in table form.

1. Exercise At Attribute Data

In this exercise we will try to do the editing and changes to the attribute data so it can be done the analysis on the data attributes.

Open a new file *map* and then enter all the data contained in the folder "D: \ @-IK-Training \ Modules-05-PengenalanGIS \ RBI FC" into the data frame and steps:

a) Click **Start** button**-Program**-highlight **ArcGIS** and then click **ArcMap.**

b) Click **Add Data** button  to enter data into the *map frame*.

c) Select the data contained in the folder "D: \ @-IK-Training \ Modules-01-PengenalanGIS \ RBI FC", select all the spatial data contained in the folder and then click the **Add** button.

d) Arrange the data and show the layers of administration based on the unique value of attribute data sub-district.

A. Opens the Attribute Table

Exercises in each data attribute contained in the ToC and steps:

1. Right click on the layer *lu_1* contained in the ToC
2. Then select the **Open Attribute Table** 
3. Then came the attribute table l*u_1*

Attributes of lu_1

FID	Shape *	DXF_TEXT	KETERANGAN
0	Polygon	AL	Air Laut
1	Polygon	TL	Tegalan/Ladang
2	Polygon	GD	Gedung
3	Polygon	BP	Pasir Darat
4	Polygon	E	Empang
5	Polygon	P	Pemukiman
6	Polygon	E	Empang
7	Polygon	E	Empang
8	Polygon	E	Empang
9	Polygon	R	Rumput/Tanah kosong
10	Polygon	GD	Gedung
11	Polygon	E	Empang
12	Polygon	P	Pemukiman
13	Polygon	TL	Tegalan/Ladang
14	Polygon	E	Empang
15	Polygon	E	Empang
16	Polygon	GD	Gedung
17	Polygon	E	Empang
18	Polygon	P	Pemukiman

Record: 0 Show: All

B. Adjusting columns in Table Attributes

Exercises change column width attribute on table administration and steps:

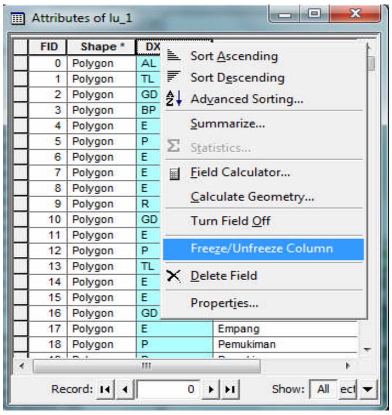
1. Put the mouse on the end of the column to be widened.
2. Click and drag the mouse in accordance with the width of the chill.

Exercise set position on the attribute column *lu_1.* and steps:

1. Place the mouse at the end of the column you want to move its position.
2. Click and drag the mouse toward the desired.

Exercise **freeze** columns in the table attribute *lu_1.* and steps:

1. Place the mouse pointer on the column that will defreeze.
2. Right-click and then select **Freeze / Unfreeze Column**.
3. Then slide the horizontal scroll bar to see results

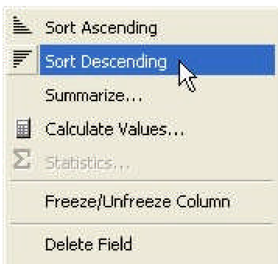


Exercise sorted value *lu_1* attribute table based on a particular column using *descending* and *ascending* and steps:

1. Place the mouse pointer on the column whose value will be sorted.
2. Right click and select Short Descending menu. Similarly to the menu Ascending Short, and steps :

   a) Place the mouse pointer on the column whose value will be sorted.

   b) Right click and select **Short Descending** menu. Similarly to the menu **Ascending Short**.

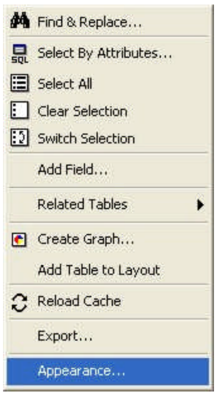


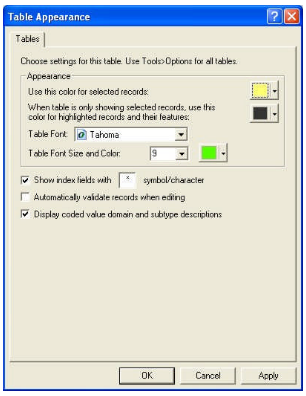
C. Set Display Table

Exercises change the font on the table with the Tahoma font with a green color and size 9, and steps :

a) Click the **Options** button and then select the Appearance menu.

b) Setting font type to Tahoma, size 9 green color in the Attributes window *u_1.*





Exercises change the color of the selected data with the color yellow, and steps:

a) Click the **Options** button and then select the Appearance menu to display the **Table Appearance** window.

b) Set **the Selection Color** in yellow.

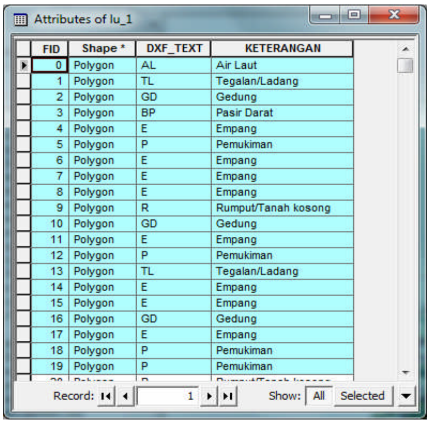
D. Choosing Data Table

In the table we can choose the attribute data in accordance with the criteria that we want by choosing to direct the mouse pointer to the data and we can do this manually.

Choosing the first ten data on administrative layer attribute table, and steps :

a) Open the attribute table *lu_1* layer.

b) Press Ctrl and then click the first data on the far left column, hold and drag the mouse until the data to ten.

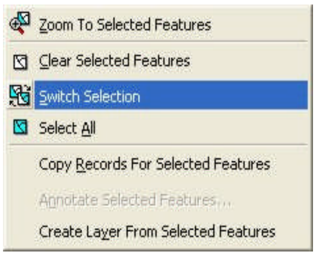


FID	Shape *	DXF_TEXT	KETERANGAN
0	Polygon	AL	Air Laut
1	Polygon	TL	Tegalan/Ladang
2	Polygon	GD	Gedung
3	Polygon	BP	Pasir Darat
4	Polygon	E	Empang
5	Polygon	P	Pemukiman
6	Polygon	E	Empang
7	Polygon	E	Empang
8	Polygon	E	Empang
9	Polygon	R	Rumput/Tanah kosong
10	Polygon	GD	Gedung
11	Polygon	E	Empang
12	Polygon	P	Pemukiman
13	Polygon	TL	Tegalan/Ladang
14	Polygon	E	Empang
15	Polygon	E	Empang
16	Polygon	GD	Gedung
17	Polygon	E	Empang
18	Polygon	P	Pemukiman
19	Polygon	P	Pemukiman

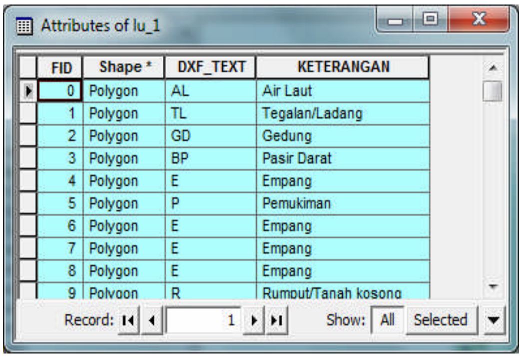
Changing the selected data with data that has not been selected, and steps :

a) Right click the layer of administration.

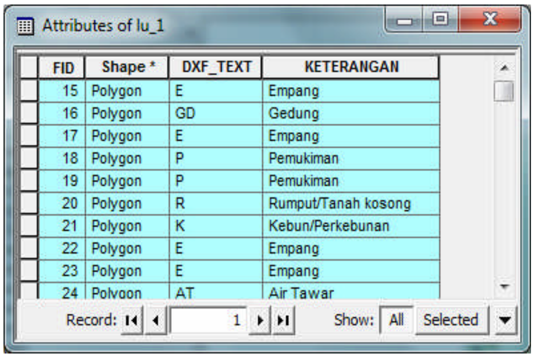
b) Choose the Selection menu and then click Switch Selection menu.



Before selection switched



After selection switched



Selects all data in the table attribute lu_1, and steps :

a) Right click the layer of administration.

b) Choose the Selection menu and then click Select All.

To disappear Select All on the data, can perform the following steps :

a) Right click the layer of administration.

b) Select the menu and then click menu the **Clear Select Features**.

2. Choosing Attribute Data

We can do the analysis using the data attribute.

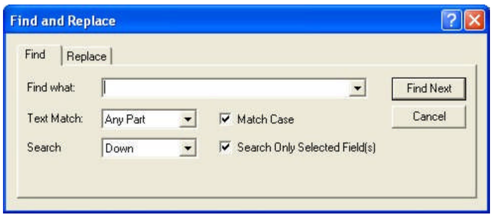
A. Looking for a certain data

We can determine the specific data of the many data we have to use certain values such as ID, name the object or other information.

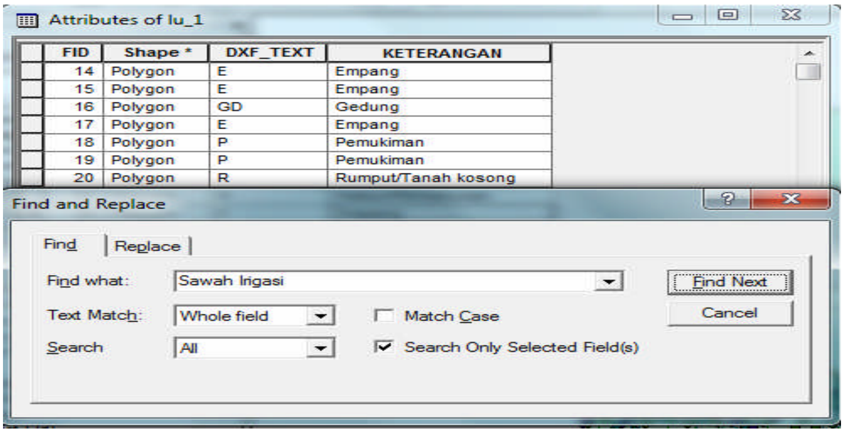
➢ Looking for object description = sawah, and steps:

a) Open the *attribute table lu_1 layer*, then click the **Option** button.

b) Select the Find and Replace command 



c) Type "Sawah Irigasi" in the Find what text box and then click **Find Next** to find the desired data.



d) Click **Find next** button to get the data "Rice Irrigation" the other. If no data "Rice Irrigation" the other, then in ArcMap will display a warning message.

B. Choosing Attribute Data Using SQL Expressions

Arc Map has the ability to process the request using SQL expressions, when using a SQL expression, we have to make an expression on the dialog box *Select By Attributes*.

SELECT * FROM table_name WHERE Expression

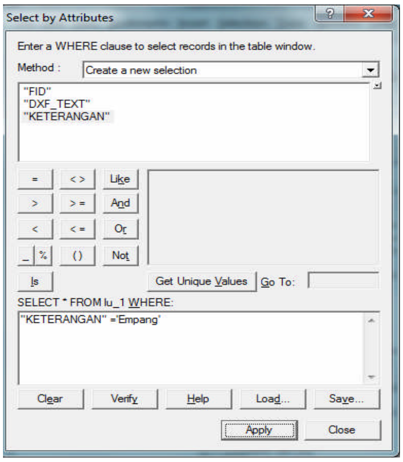
Select all the data on land coverage layer attribute table whose ID is more than 500 use the SQL Expression Select, and steps :

a) Open the table *attribute lu_1 layer*.

b) Click the **Selection** menu and choose **Select By Attributes**.

c) Ensure that the selected layer is *Lu_1* (check the *Layer* text box)

d) Write a SQL expression: "Keterangan" = "Empang", then click the **Apply** button to select all the data that has Keterangan = Empang



SQL Expression Selection result

3. Attribute data manipulation in Arc GIS

After we have explored a lot of spatial data in Arc Map and customize the data attributes, we can also add and editing tabular data. Before doing the editing on the table, we must activate the **Editor toolbar** and select the layer you want to edit attributes. For example, to edit the data *lu_1*.

- Editing Record in the column
  - a) Click **Start edit session** on Arc Map
  - b) Open the table you want to edit
  - c) Click the cell you want to edit
  - d) Type the new data and press enter
- Adding new record
  - a) Click the **Start edit session** on Arc Map
  - b) Open the table you want to edit
  - c) Click the move to get to the last row in the table
  - d) Click the cell you want to add data and type the new value
- Delete record
  - a) Click the **Start edit session** on Arc Map
  - b) Open the table you want to edit
  - c) Select the record you want deleted, press and hold down the Ctrl key to select another record
  - d) Press the delete button on key board

4. CALCULATING AREA, LONG AND POSITION

To calculate the area of an area can be done by making a simple formula using VBA scripts (Visual Basic), as well as to calculate the length and position of a location.

The steps are performed:

a) Open ArcGIS and then come up with data that will be calculated the extent

b) Click the right mouse

c) Select Open attribute table

d) Add a new column to put the broad in the attribute table

e) Click Ok

f) Highlight the new column

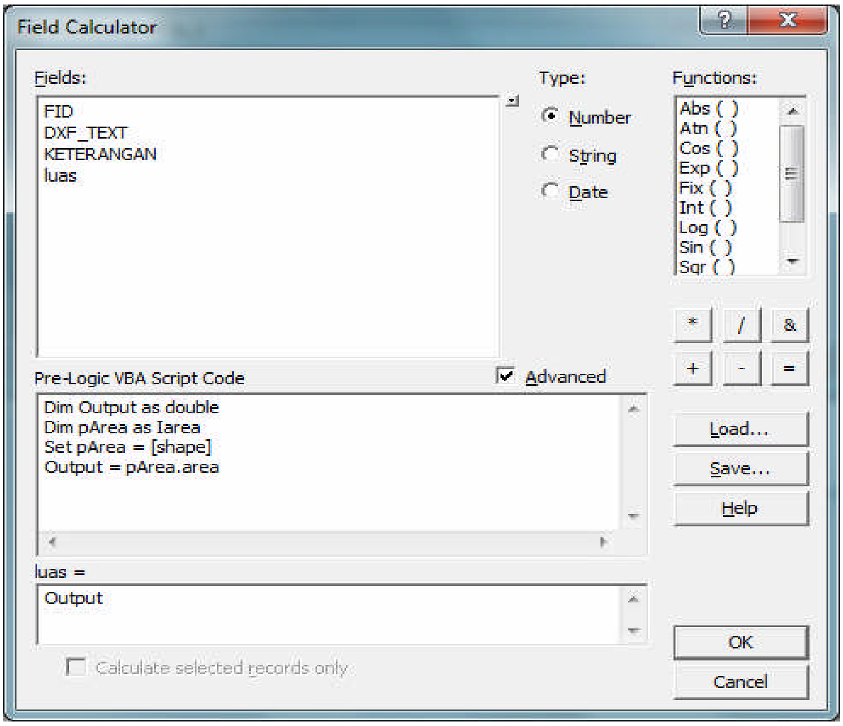
g) Click the right mouse

h) Select the "Calculate"

i) The Emerging Field Calculator, there is a choice of yes and no

j) Select yes

k) and enable advanced



To calculate the area write the formula in the fields

A. Calculating area

Example of a simple formula that uses VB for extensive calculations, where the unit area is calculated based on coordinate system:

Dim Output as double

Dim pArea as Iarea

Set pArea = [shape]

Output = pArea.area

Output

B. Calculating length

Unit length is also calculated according to the coordinate system used on the maps, using VB is an example formula:

Dim Output as double

Dim pCurve as ICurve

Set pCurve = [shape]

Output = pCurve.Length

Output

C. Calculating the position of x and y

Value of location position, eg in the form of point / points can also be determined based on the latitude and longitude coordinates, the formula is an example:

Dim Output As Double

Dim pPoint As IPoint

Set pPoint = [Shape]

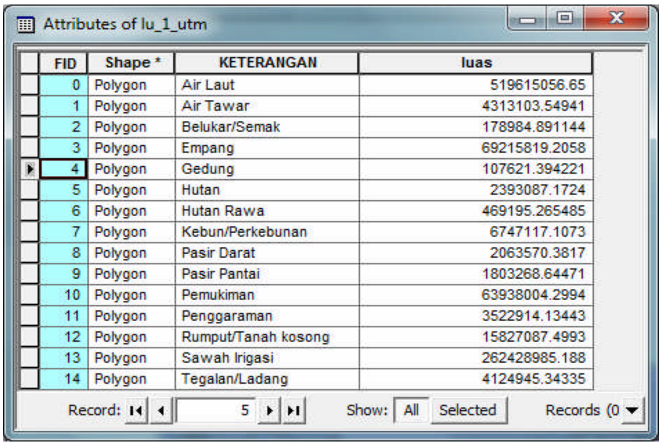
Output = pPoint.X

Output

For y or longitude value in the formula above where the letter x is replaced with the letter y. In the field "Field Calculator" column of the most under populated "output". If the desired formula is written correctly then the next steps is:

- Click OK

Wait until the process is complete, the calculated area will appear in m^2 (depending on the map coordinate system used)


Attributes of lu_1_utm

FID	Shape *	KETERANGAN	luas
0	Polygon	Air Laut	519615056.65
1	Polygon	Air Tawar	4313103.54941
2	Polygon	Belukar/Semak	178984.891144
3	Polygon	Empang	69215819.2058
4	Polygon	Gedung	107621.394221
5	Polygon	Hutan	2393087.1724
6	Polygon	Hutan Rawa	469195.265485
7	Polygon	Kebun/Perkebunan	6747117.1073
8	Polygon	Pasir Darat	2063570.3817
9	Polygon	Pasir Pantai	1803268.64471
10	Polygon	Pemukiman	63938004.2994
11	Polygon	Penggaraman	3522914.13443
12	Polygon	Rumput/Tanah kosong	15827087.4993
13	Polygon	Sawah Irigasi	262428985.188
14	Polygon	Tegalan/Ladang	4124945.34335

Record: 5 Show: All Selected Records (0

5. Displaying Data Attributes In Graphic Form

Charts can display information from the data on maps and explain the relationship between the data in an attractive and easy to understand. The graph can also display other information relating to the data on a map or can also display the same data in different ways. Graphics complement the map because it can provide complete information and easily understood and can quickly compare the data with each other.

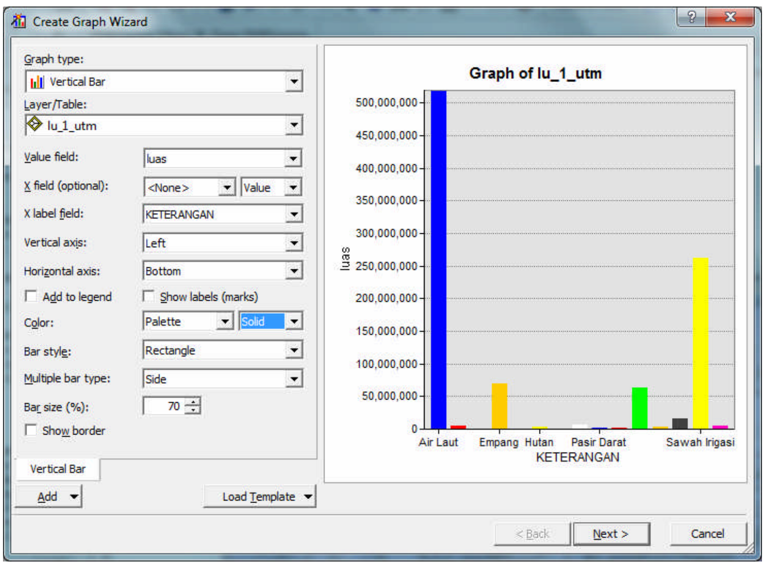
Create New Graph

ArcMap makes it easy to create a new chart based on attribute data, and easily paste them on the map, and steps:

a) Open the attribute table of the layer *lu_1_utm*

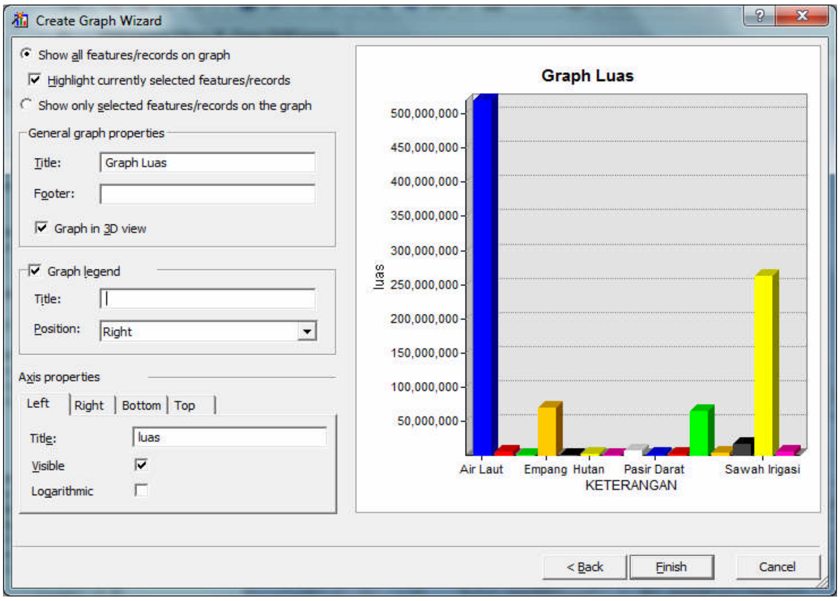
b) Click the **Options** button and select **Create Graph**

c) Select the type of chart to be displayed and the sub type



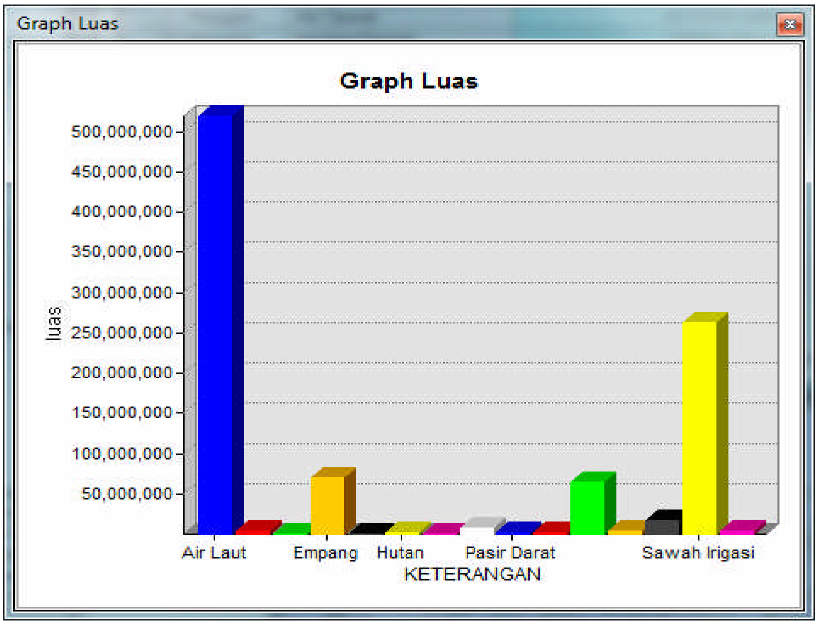
d) Set the layer *value field* with the value of extensive field, enter the x labels etc.

e) Click the **Next** button to continue the process.



f) Set the display of graphics such as the name of the graph, the Y axis, X axis (axis properties) and others

g) Click the **Finish** button, to end the process.



V. PROJECTION SYSTEM

Projection is a way of displaying the object with a specific shape and dimension and into another dimension. Map projection means a way to convert the three-dimensional position of a point on the earth's surface into two-dimensional representation of position on the media map. Projection system means all things (including mathematical models), which involves depictions of the earth's surface in two dimensions.

A good map projection system must meet criteria such as:

- The earth's surface depicted on the map has not changed.
- The surface area of the earth's surface area similar to that depicted on the map (after taking into account the scale factor).
- The distance between the earth's surface point equal to the distance between points on the map (after taking into account the scale factor).
- The direction and angle between points of each other and should remain unchanged (after taking into account the scale factor).

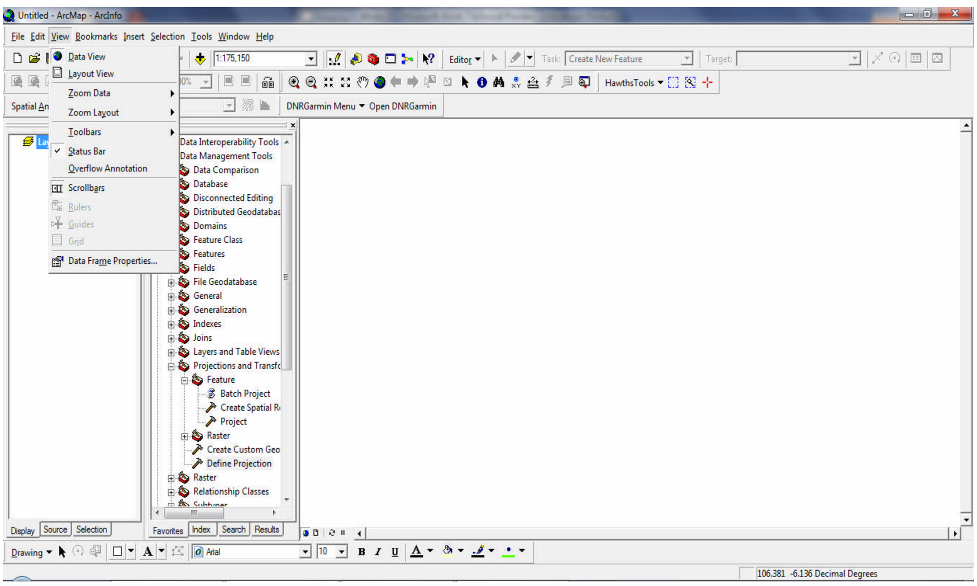
Purpose

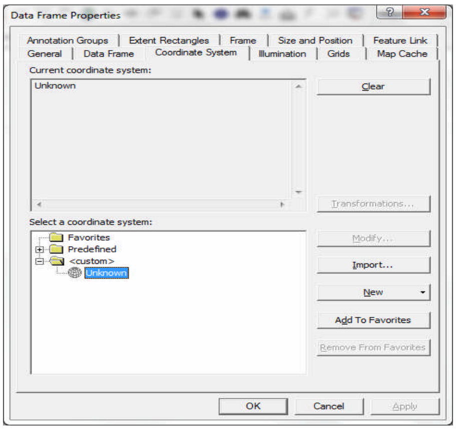
- Introduce the concept and stages of projection maps / data vector
- Can perform projection transformations on vector data

a) Definition of projection on the layer

In processing the data in ArcGIS we have to get used to define the coordinate system on the layer to smooth the processing.

Go to view>the data frame properties : select the menu tab “data frame”

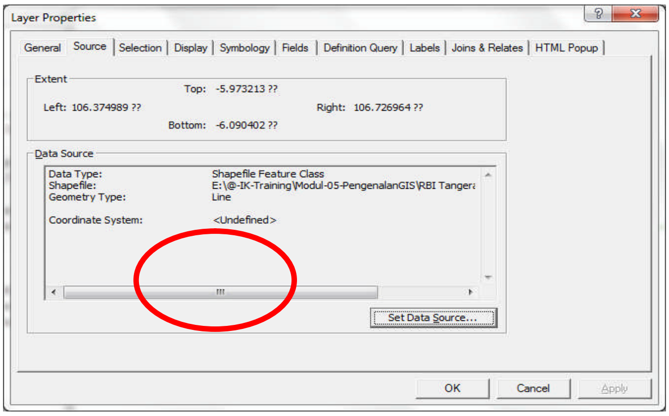




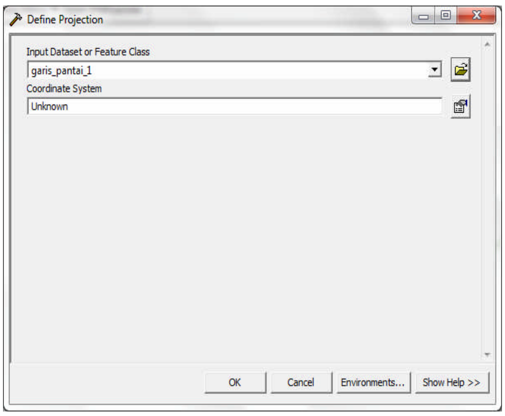
Then we predefined coordinate the desired system: for example Predefined> Geographic coordinate system> World> WGS84

b) Defines vector data that do not yet have the projection system

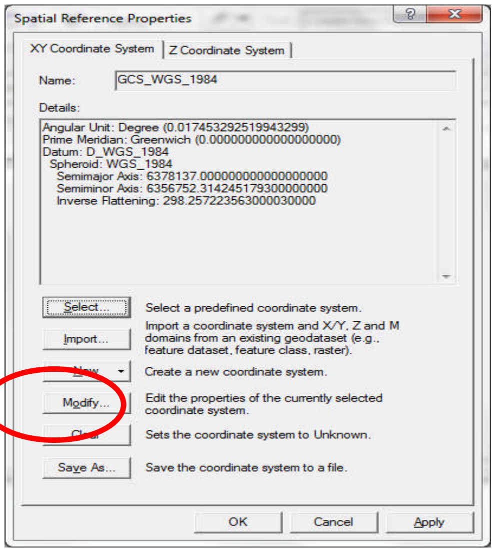
Open the file "garis_pantai_1" in D: \ @-IK-Training \ Modules-05-PengenalanGIS \ RBI Tangerang. If the file has not been define vector coordinate system, we can see the layer properties on the tab "source": Coordinate system <undefined)



To define this feature we select the menu on the toolbox  Data management tools> Projection and transformation> Raster> Define projection



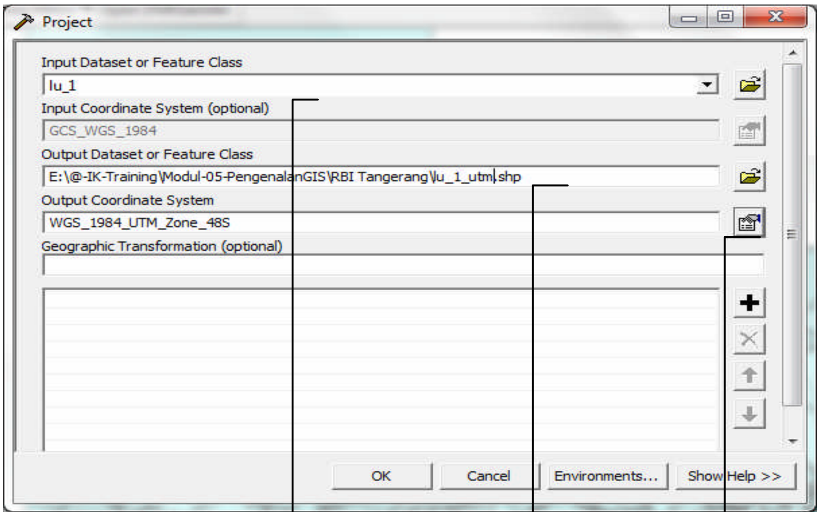
Choose a coordinate system coastline on geographic coordinate systems> World> WGS84> OK



c) Transformation of projection on a vector data

At this time steps will be served vector data that have a geographical projection system, we will transform into a universal form Tranvers Mercator.

Select meno on tool box ..Data management tools >Projection and transformation>Feature>Project



Enter data input "*lu_1*"

Enter the new file name in the "*output dataset*"

In the Output folder coordinate system, enter the coordinates system

The new "projected coordinate system> UTM> WGS84> Zone 48S

VI. GEOREFERENCE

Georeference is to give value analog coordinates on a map or maps that have not been corrected geometric. This process is the stage before we want to make the process of further geographical analysis such as digitized maps.

Objective

Introducing the concept and stages georefence

Working Steps

Raster data is one of the commonly used data on the environmental information system is usually presented data thematic geographic data raster, such as land use, geology and other. To use raster data should be, the data in advance so that corrections can be overlay with other vector data.

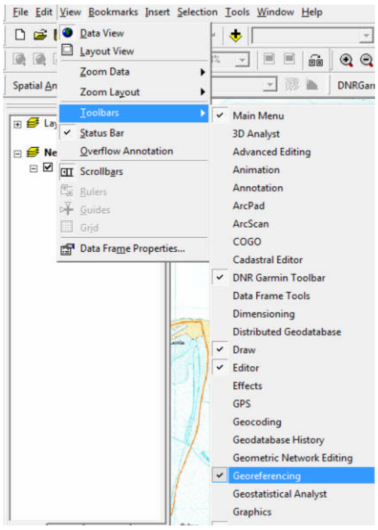
1. Georeference Process Based On Information Grid Map

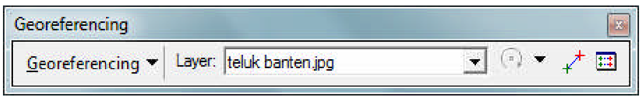
Georeference process requires a minimum of 4 points of known coordinates so that data can be in a correction to the coordinate system, and steps:

a) Create a new frame folder, then click the **Add Data.**

b) Call the data contained in the folder "D: \ @-IK-Training \ Modules-02-PengenalanGIS \ RBI FC \ Teluk Banten"

c) Come up with **Georeferencing tools**



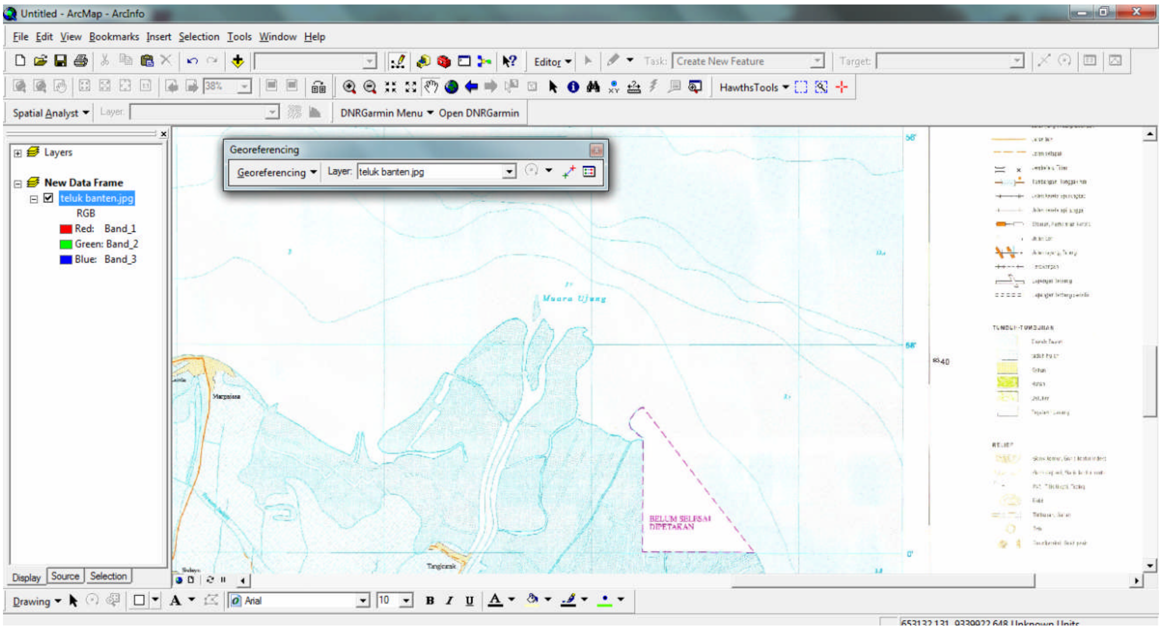


d) Click the Add button to continue the process Georeferencing

e) Then will appear Map

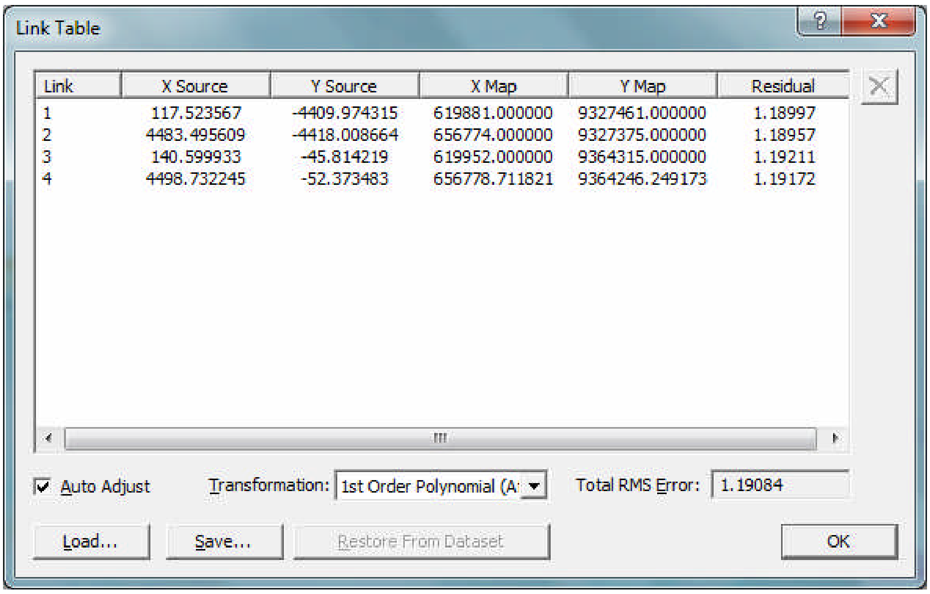
f) Click the **add button control** point 

g) Click on a point that has the information grid coordinates



h) Click the **view link table**, and then edit the value X map and Y map based on the information grid numbers

i) Repeat steps 7-8 to add the reference points, a minimum of 4 points.



Link	X Source	Y Source	X Map	Y Map	Residual
1	117.523567	-4409.974315	619881.000000	9327461.000000	1.18997
2	4483.495609	-4418.008664	656774.000000	9327375.000000	1.18957
3	140.599933	-45.814219	619952.000000	9364315.000000	1.19211
4	4498.732245	-52.373483	656778.711821	9364246.249173	1.19172

j) Click the Georeferencing tool and then select Rectify. Set cell size and resample type and output file names. Then click the save button (Ok).

2. Georeference based on existing Spatial Data Geo-referenced

Raster data that does not have a system of coordinates can be transformed into data that already has a coordinate system. Arc Map allows us to define the coordinate system on data that do not have a coordinate system by registering the data.

In this exercise we will try to register the data that do not have a system of coordinates to data that already have data coordinates, and steps :

a) Open a new frame of data, then call Basemap.shp vector data and raster data also appear map1.tiff.

b) Come up with **georeferencing tools**

c) Ensure the active layer is a layer map1

d) Click the **georeferencing** and select **fit to display**

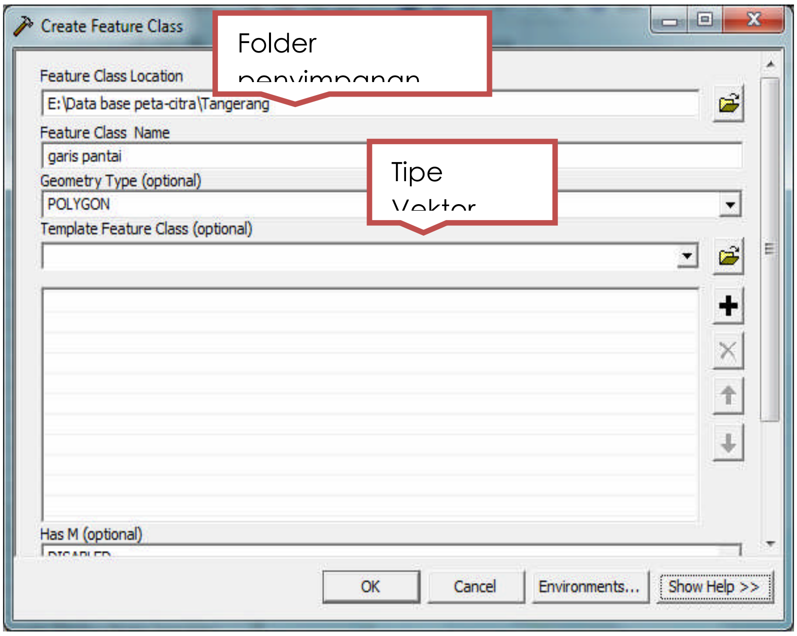
e) Click the **add control point** button, then click the **link**, to add a link, point the mouse pointer on the location of known and recognizable in the target data.

f) Click the **georeferencing** tool, then select **rectify**

Extract Feature (Digitize)

In this exercise we will perform extracts features a fault line by using the heads-up digitizing (digitized directly on the monitor screen).

In ArcToolBox> Data Management Tools> Feature Class> Create Feature Class created a feature class with the type of line (as below):



Noted that for the *spatial reference* GCS_WGS_84 selected by selecting> select> Geographic Coordinate Systems> World> WGS 84.prj and click **Ok** and **Ok** means we are ready to create a shape file editing and ready to do the digitization:

Select **Tools Editor> Start Editing** and select **Create New Feature** with the **target** file is created, (see below)

Note: The addition of control points should be done diagonally like the upper left, lower right, upper right and lower left. To perform data modifications we live change the task menu on the toolbar editing.

VII. CAPTURING DATA (DIGITIZATION)

Digitization is the process or analog over print media into digital or electronic media through the scanning process, photograph digitation or other techniques. This usually requires time, effort, and cost is not small. In the process of digitization, digitization required expertise / technical high enough.

The objective of this process is:

- Introducing the concept and stages of digitization feature
- Practicing to capture data using a scanning tool found on Arc GIS

Before starting the digitization should first we create a place to store features the results of digitization. Create the file in the Arc Catalog

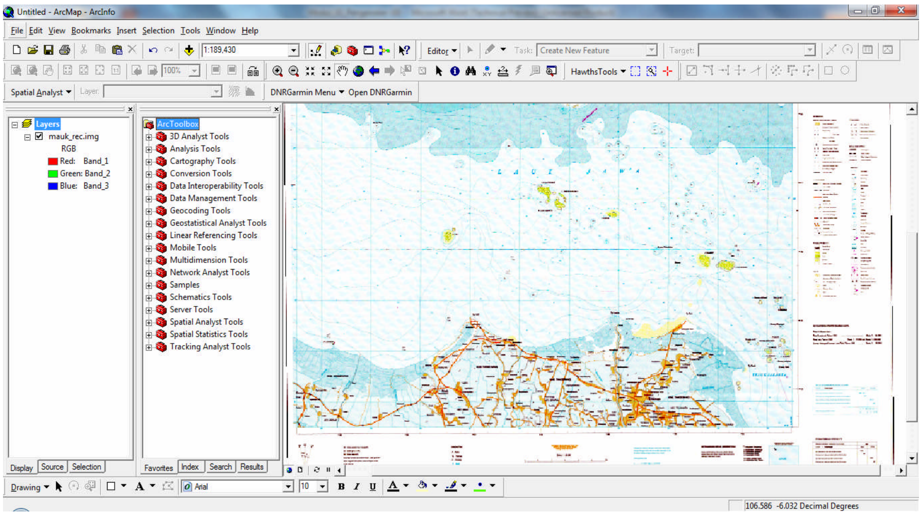
1. Displays the Editor toolbar

a. Start **Arc Map**

b. Click **Editor Toolbar** on the standard toolbar

2. Starting digitization

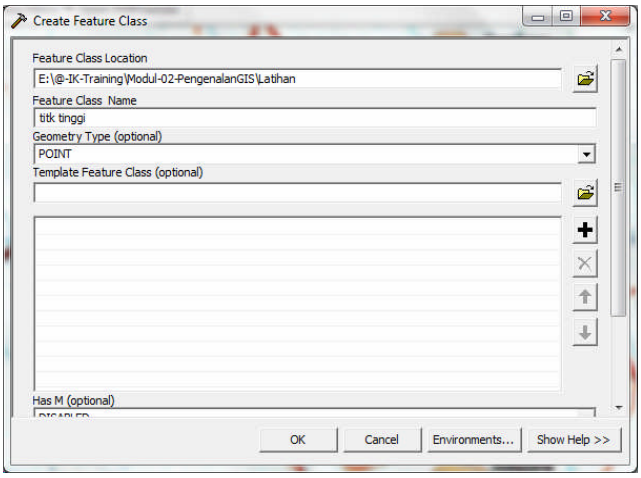
Open the file "mauk_rec.img" D: \ @-IK-Training \ Modules-01-PengenalanGIS \ RBI Tangerang



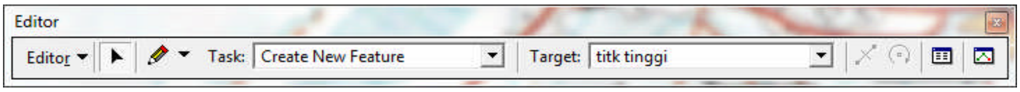
Making a Point and a line by digitize

a) Go who want digitized raster data

b) Create a new feature such as "high point": ArcToolBox> Data Management Tools> Feature Class> Create Feature Class



c) Then open the **Editor Toolbar**, then select **Create New Task** in the *Current Task*



d) Click the **Start Editing** want digitized layer

e) Click the **Tools palette** and select the **Sketch Tool**

f) Assign a single point on the map you want digitized

3. Making a Point by The Distance-Distance Tool

a) Click the **Tools palette,** and select the **Distance-Distance Tool**

b) Click once to determine the center point on the first circle and press D on key board

c) Type the desired radius distance for the second circle and press enter

d) Position the pointer on the place you want to add point

e) A new point will appear on the map

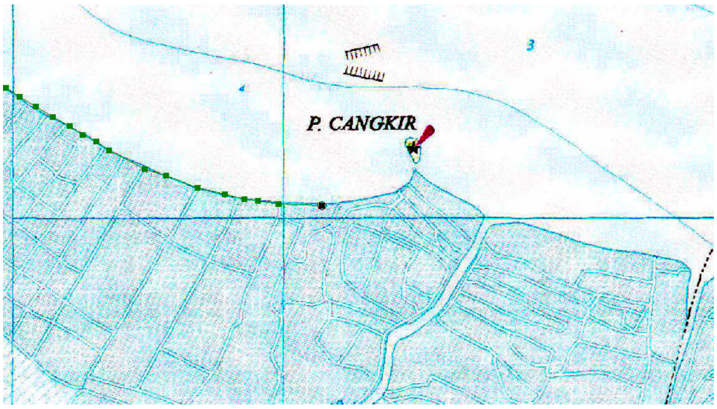
4. Creating lines and Polygons by digitization

a) Open the raster data that want digitized

b) Create a new feature such as "garis pantai": ArcToolBox> Data Management Tools> Feature Class> Create Feature Class

c) Click the **Start Editing** want digitized layer

d) Then open the **Editor Toolbar**, then select **Create New** Task in the *Current Task*



e) Click the Target layer and click the Line or Polygon

f) Click the **Tools palette** and select the **Sketch Tool**

g) Click on the map to digitize the desired features

h) To end it, double click

i) Line or polygon will appear on the map

5. Modified feature and Snapping

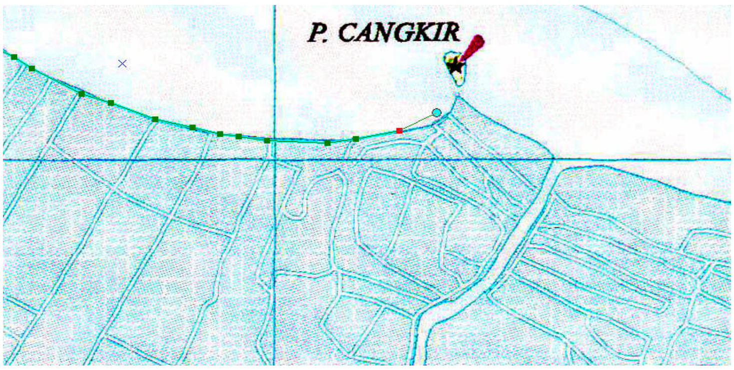
If the map digitize sometimes we want to continue my existing data. How the data will be connected (no break). Just as when digitizing "garis pantai", we will continue the process of digitization:

a) Open the feature " garis pantai "

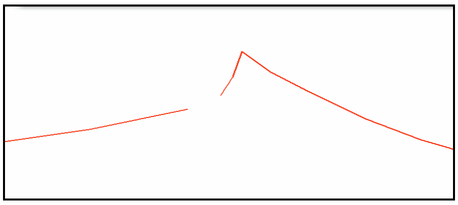
b) Click **Start Editing** want digitized layer

c) Select the feature you want to edit, then open the **Editor Toolbar**, then select Modify **feature** on *Current task*

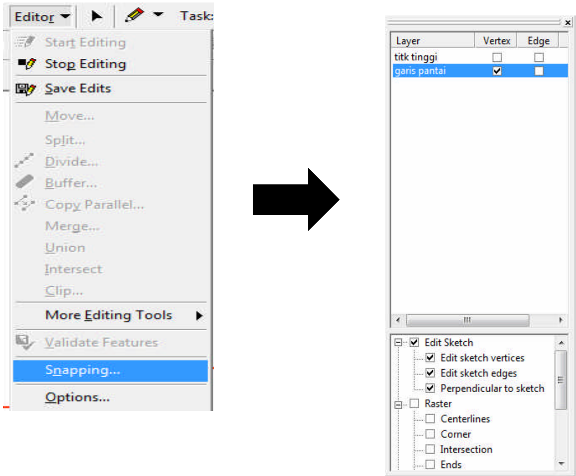
d) Continue the process of digitization



Unify data line that has not fused the vertex



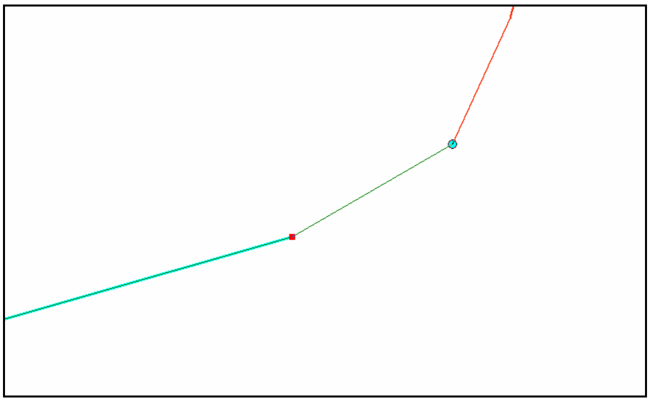
a) Click on the toolbar editor> Snapping. will display the toolbar Snapping



b) Check list for the features you want to edit, and check the edit sketch

c) Select the feature you want to edit, then open the **Editor Toolbar**, then select **Modify feature** on *Current task*

d) Move your pointer over a feature that will display, then the pointer will point to the last vertex.



VIII. DATA PREPARATION CELL (GRID)

Visualization techniques applied to simulation models of coastal vulnerability along the coast of Tangerang by dividing each location with a cell size of 1 km alongshore and 250 m to the mainland. These cells will be used to visualize the results of modeling of coastal vulnerability index (IKP).

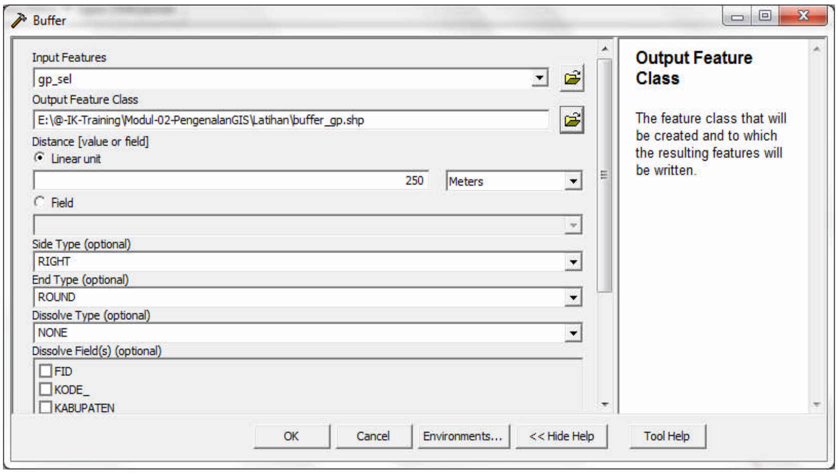
Purpose

Manufacture and preparation of cell data, spatial database design

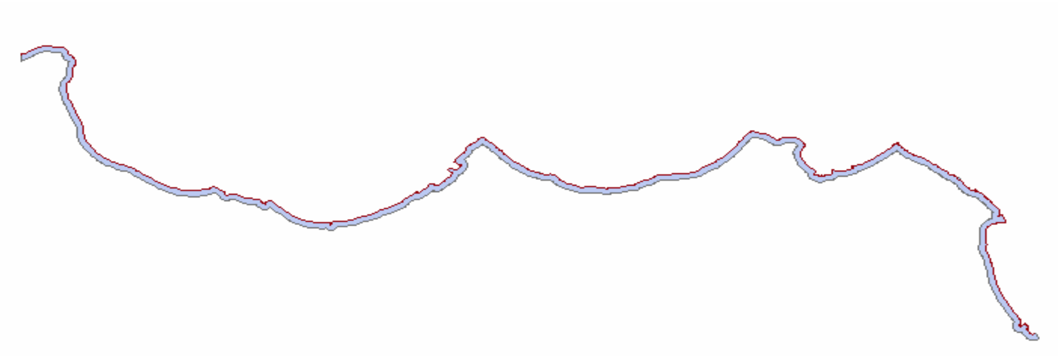
Data processing

In the manufacture of cell data, which is required as reference data as a baseline shoreline.

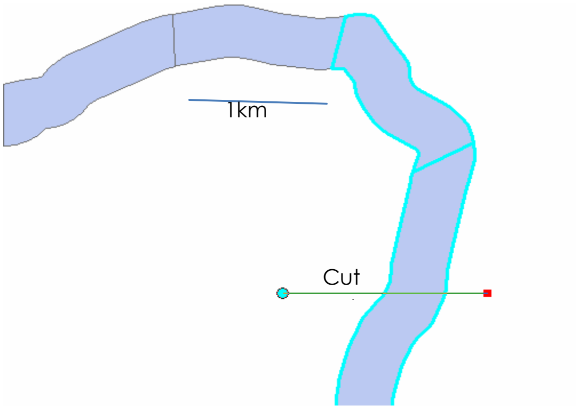
1. Open the file "gp_sel" in D: \ @-IK-Training \ Modules-02-PengenalanGIS \ Latihan
2. Perform the menu on the shoreline buffer: ArcToolbox> Analysis Tools> Proximity> Buffer



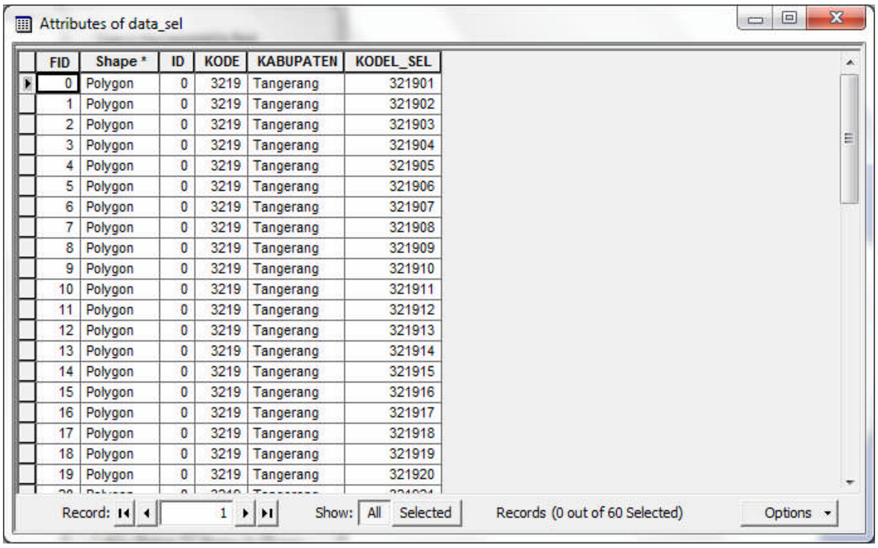
Enter gp_sel data on the input feature, change the value of distance units, and side type "RIGHT"



3. Make cuts in the buffer as far as 1 km respectively.
   Start editing the file "buffer_gp"> select feature> on the task "Cut polygon by feature"



4. Next we set up a database on the cell, by adding fields for encoding data for later data standard.

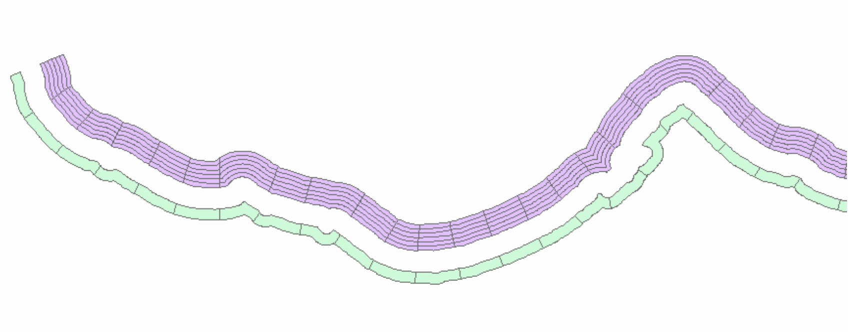


Attributes of data_sel

FID	Shape *	ID	KODE	KABUPATEN	KODEL_SEL
0	Polygon	0	3219	Tangerang	321901
1	Polygon	0	3219	Tangerang	321902
2	Polygon	0	3219	Tangerang	321903
3	Polygon	0	3219	Tangerang	321904
4	Polygon	0	3219	Tangerang	321905
5	Polygon	0	3219	Tangerang	321906
6	Polygon	0	3219	Tangerang	321907
7	Polygon	0	3219	Tangerang	321908
8	Polygon	0	3219	Tangerang	321909
9	Polygon	0	3219	Tangerang	321910
10	Polygon	0	3219	Tangerang	321911
11	Polygon	0	3219	Tangerang	321912
12	Polygon	0	3219	Tangerang	321913
13	Polygon	0	3219	Tangerang	321914
14	Polygon	0	3219	Tangerang	321915
15	Polygon	0	3219	Tangerang	321916
16	Polygon	0	3219	Tangerang	321917
17	Polygon	0	3219	Tangerang	321918
18	Polygon	0	3219	Tangerang	321919
19	Polygon	0	3219	Tangerang	321920

Record: 1 Show: All Selected Records (0 out of 60 Selected) Options

5. Preparation of cell data is done at 250 m in the direction of the mainland coastline and 250 m *buffer* to the sea as much as 6 cells.

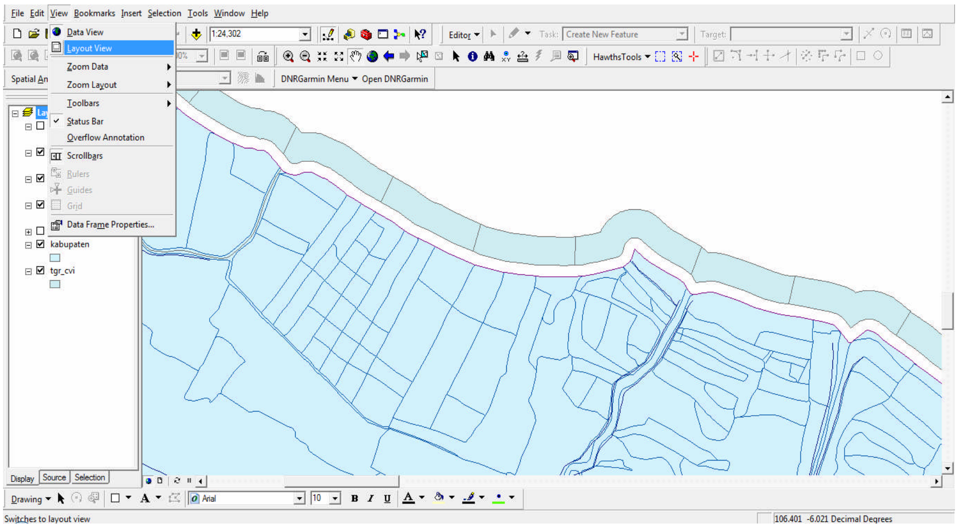


IX. MAP LAYOUT

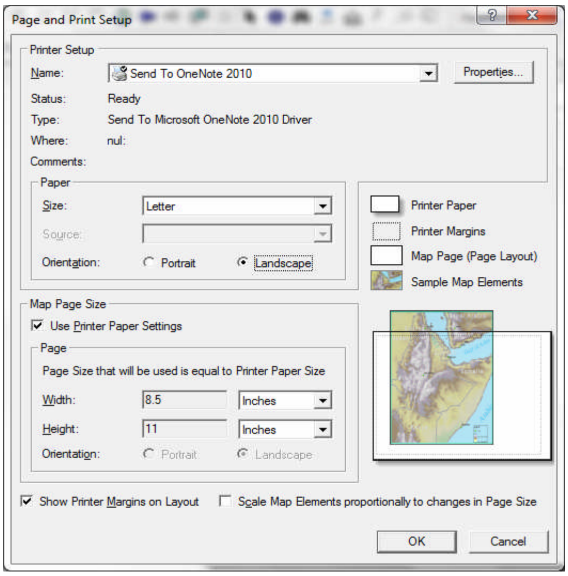
1. Settings page and print setup layout

1). ArcMap and load some data  that need. Open the file in D: \ @-IK-Training \ Modules-02-PengenalanGIS \ Data layout

2). After all desired data has been there to call, then the Standard click View menu and select Layout View, or you can also enter through the Switch button located bottom left of the display map. In the standard layout is the default condition of a vertical format with a size of paper/paper print letter/A4 and also in a state of default options



3). To change the setting / display page layout you can go to the Page and Print Setup on the File menu standard.



a). In the Print Setup select the type of print used (if the layout is made larger than standard size / default paper)

b). Then the paper select the paper size to be used, (if you do not have a printer that larger size (A3, A1 or A0) you can perform a custom option and enter the paper size you'll use In accordance with the scale of the map that you want later

c). On the orientation of the map select whether vertical (Portrait) or horizontal (Landscape)

d). Press OK when you have finished setting.

In layout view the map frame will be visible position is at the bottom left side of the map because the paper size has been enlarged. Frame size of this map we change the way pulled one point vertex (colored blue) towards the top right of the layout.

4). Click and drag one corner of the map frame in accordance with the desired major. After you enlarge the Data Frame will be otomatic scale of the map will change (note the standard toolbar ArcMap). The size of the enlarged size is still a while since we have not adapted to the scale and cropping as desired.

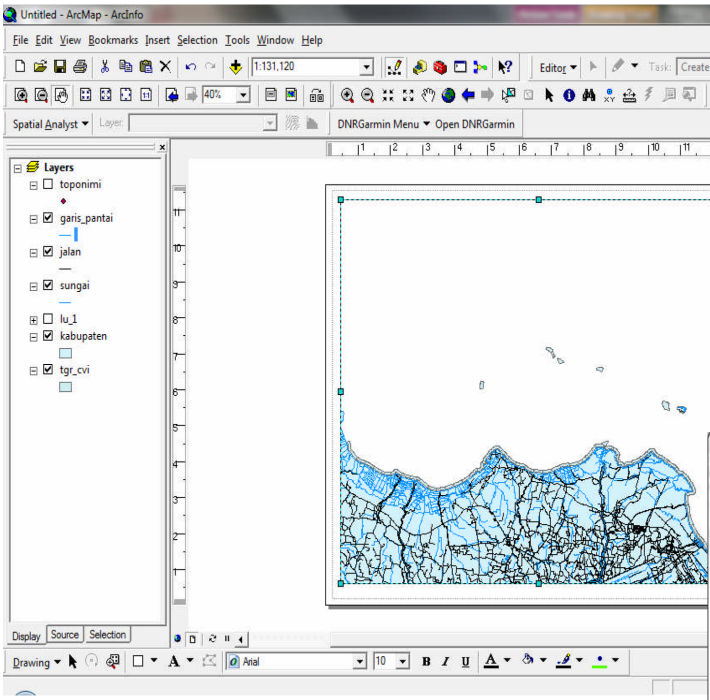
Setting the data frame / main layer

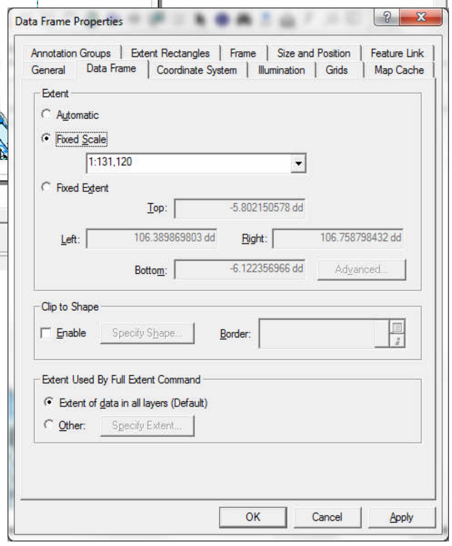
Setting a fixed scale and extend clipping (How to clip first)

In the map below there are two features of the map data administration and data features Frame. Now we are set to display a map in accordance with the scale and extents / frame as desired. The steps undertaken were:

5). Click / make sure the Data Frame elected / selected

6). In the data frame active / select press the right mouse button and select **Properties.** To get into these properties you can also go to the ***View*** menu and select **Data Frame Properties**.





Data Frame Properties on the menu to do the settings

e). Click Data Frame Tab

f). Select Fixed Scale, and fill the desired scale ratio

g). Press the Apply button to see changes in the map view

h). In the Enable Clip to Shape, and then click Specify Shape (this function is used when we want to hide / hidden map view beyond the specified frame.

i). On Menu Data Frame Clipping Select / activate the Outline of Feature (if using a polygon feature data as a source target clip.) extents Custom option, used when we perform clipping by including a reference coordinate points.

j). Click OK button,

k). On the Border select the type and size of the boundary line

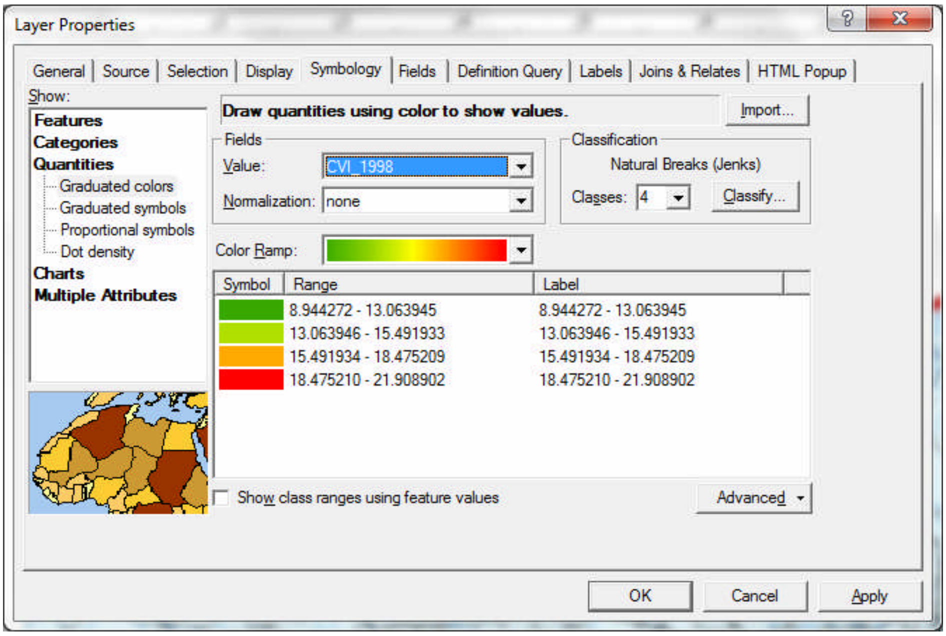
l). Then press OK

In layout view the map, is in conformity with the settings that you are doing both map scale and clipping her. If size is not the same Data Frame Clip layout of the maps that there could liken it to reduce/enlarge the size of Data Frame.

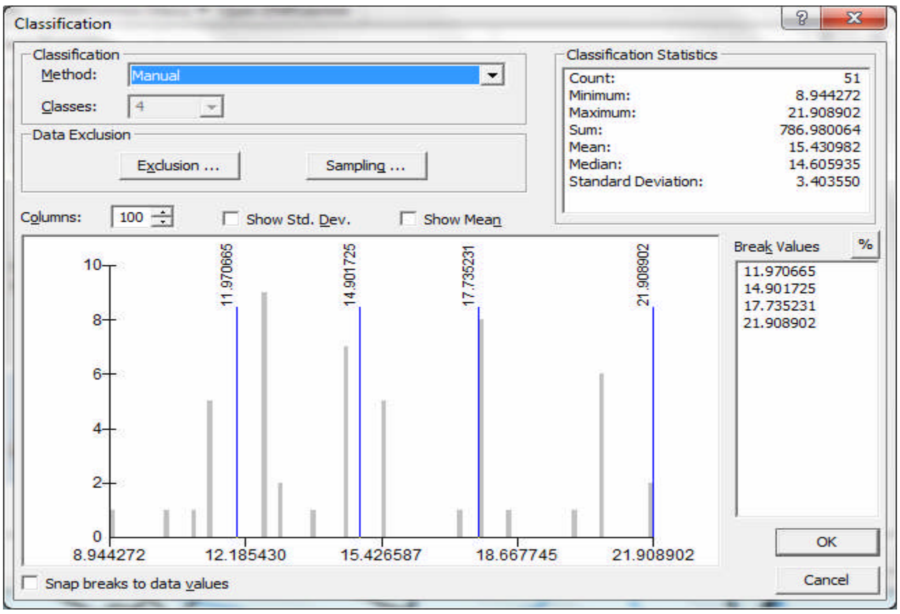
2. Data visualization layer

In the data that we have our bias visualization based on existing data (not a color) so that the view is more interesting and representative.

Open layer properties in the data "tgr_cvi" and went into the symbology tab



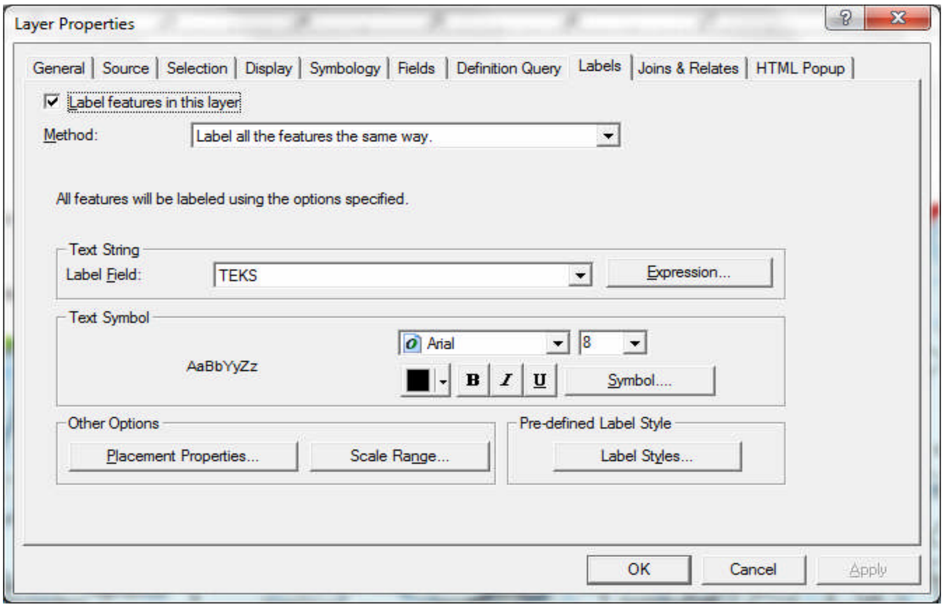
- For single feature (one picture) select menu features> single symbol
- To display the unique data select categories> unique value: enter the desired value based on value
- To display a value based on the sequence data (graduation) select quantities> graduated color. Enter the desired value and set the class to be created "classify". We can set the interval classes that will be created based on existing methods.



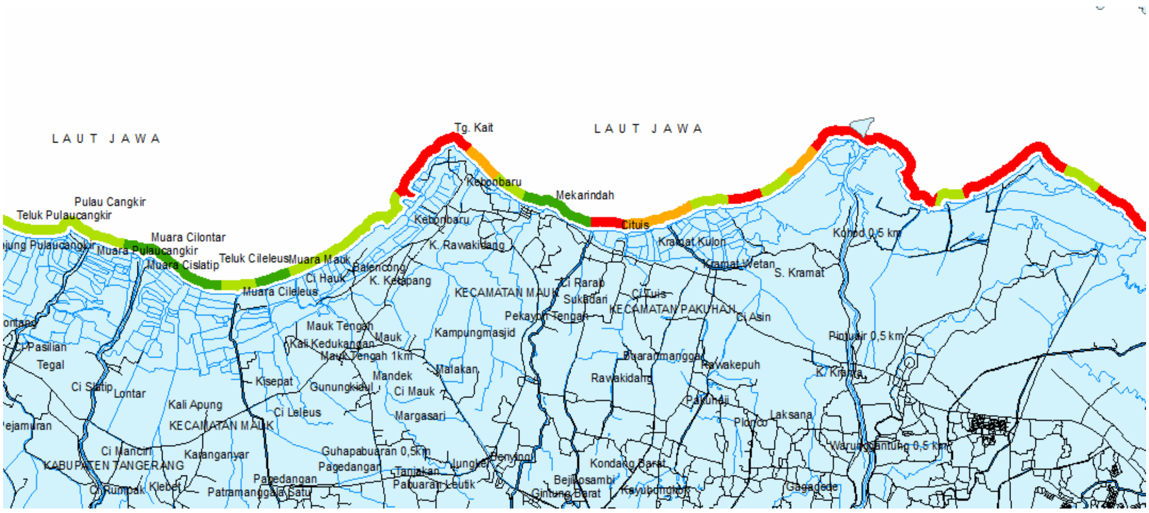
3. Labelling

To display information on maps using data labeling, then the computer will automatically display the information data.

Open layer properties in the data "toponomy" enter tabs "label"



- Check the labels list feature in this layer
- Change the Label field with text description
- To format the letter bias changed in the text symbol
- OK



4. Creating a Grid System

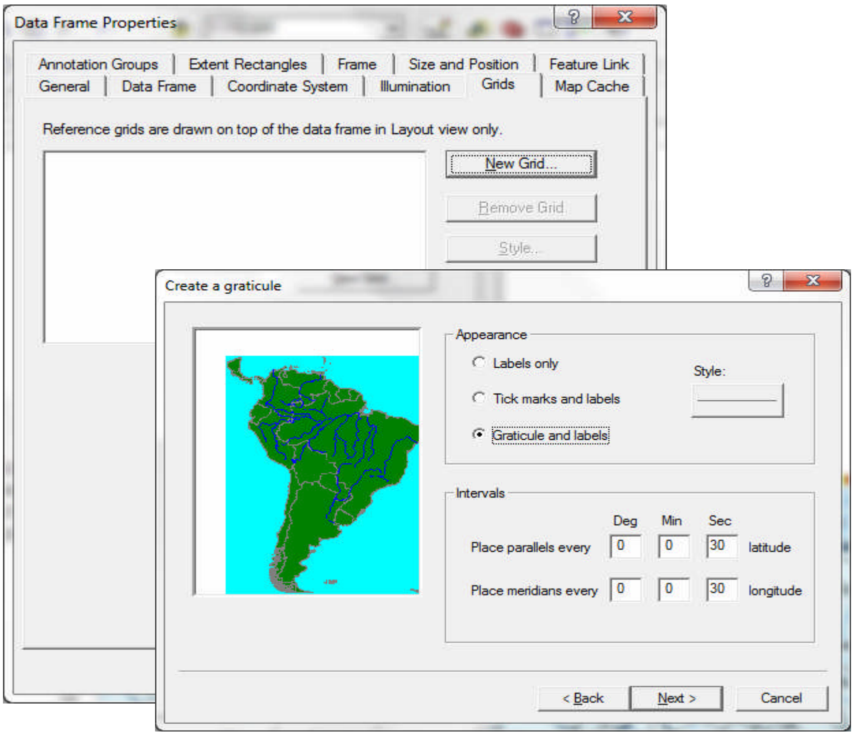
a. Geographic Grid System

1). Make sure the Data Frame elected / selected, then on the Standard Toolbar click the View menu and select Data Frame Properties, or click the right mouse button select Properties.

2). Click Tab Grids

3). Click the New Grid button

4). In Which Do You Want to create, select Graticule: divide map by meredians and parallels



5). Set the interval to be made

6). In the Grid Name you please replace the name of the grid or you select a name in the default condition.

7). Click Next button

8). On the Appearance select the type of display grid (select Tick Marks and Labels)

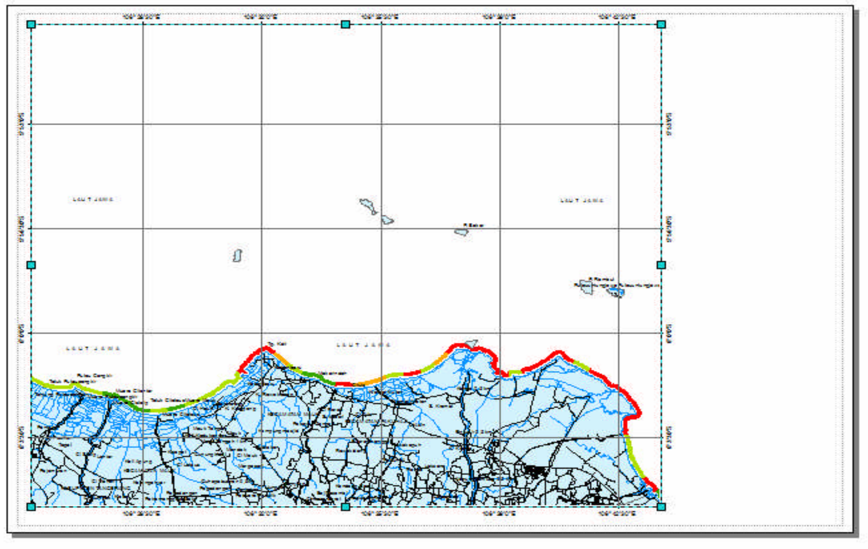
9). In the interval distance between the Input Value Coordinates (Latitude, Longitude)

10). Click Next button

11). On the Menu Axes and Label Allow the default condition, then press the Next button

12). On Grid Properties select the Store That grid is fixed as an update with change to the data frame

13). Click Finish button



b. Universal Transverse Mercator Grid System (UTM)

a). Make sure the Data Frame elected / selected, then on the Standard Toolbar click the View menu and select Data Frame Properties, or click the right mouse button select Properties

b). Click Tab Grids

c). Click the New button Grid

d). In Which Do You Want to create, select Measured Grid: divide map into a grid of map units

e). In the Grid Name you please replace the name of the grid or you select a name in the default condition.

f). Click Next button

g). On the Appearance select the type of display grid (Style)

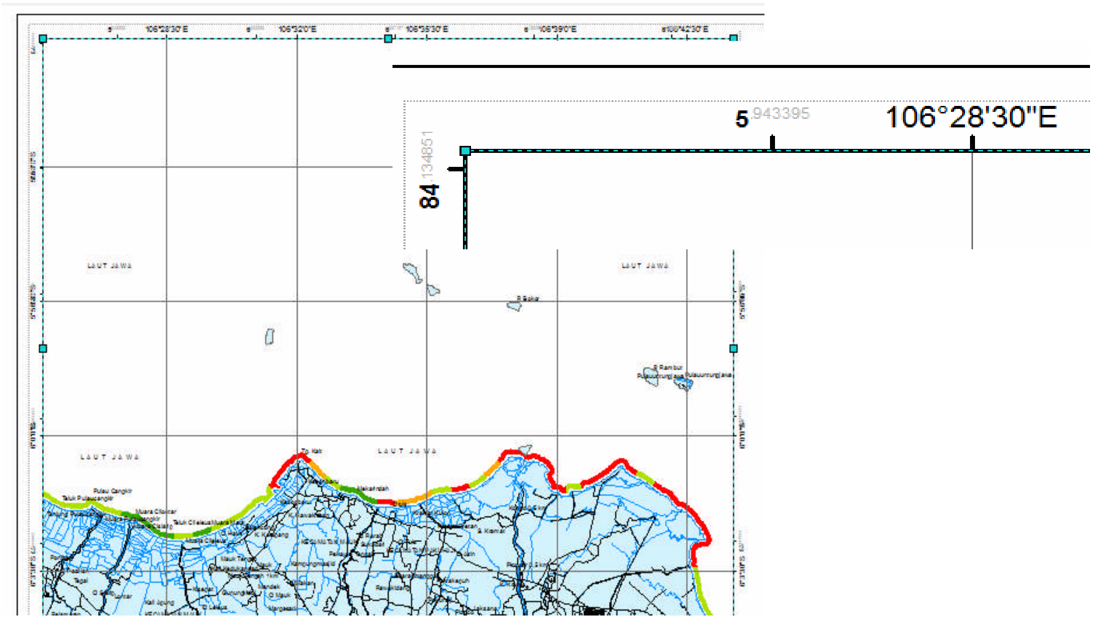
h). In the interval distance between the Input Value Coordinates (Meters)

i). Click Next button

j). On the Menu Axes and Label Allow the default condition, then press the Next button k). On Grid Properties select the Store That grid is fixed as an update with change to the data frame

Click Finish button

You have to manufacture two of the UTM grid system and Geography. But on the grid by default labels on UTM raises particular decimal, while for the left and right labels on the grid geography appear horizontally. For that we need to set the grid style to look more tidy and the second grid system labels do not coincide with each other.



5. Frame Design with Drawing Tools

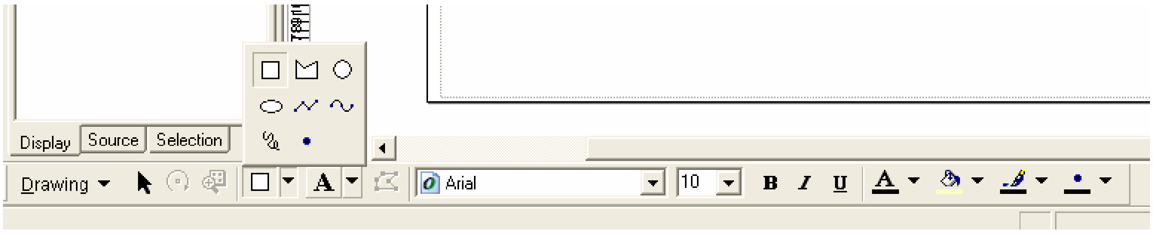
Now we do manufacture frames and perform design in the layout by using the function on the tool drawing. The function of these tools may not be familiar to you if you are already accustomed to using it in application programs made by Microsoft (Word, Excel, and Powerpoint, etc.).

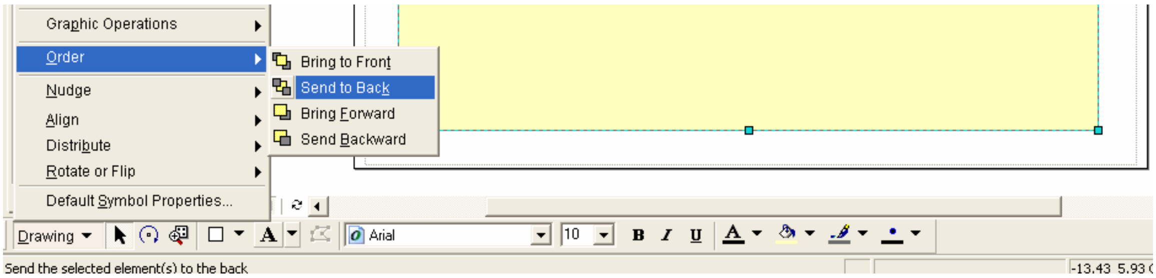
Now we make some boundary lines (Frame) in the layout

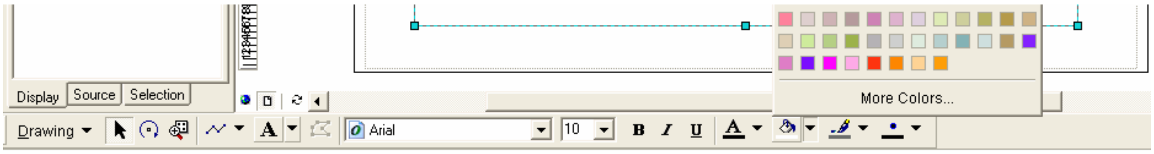
a) On Drawing select the Rectangle tool (a rectangle) and then describe the layout by confining all the elements in the layout

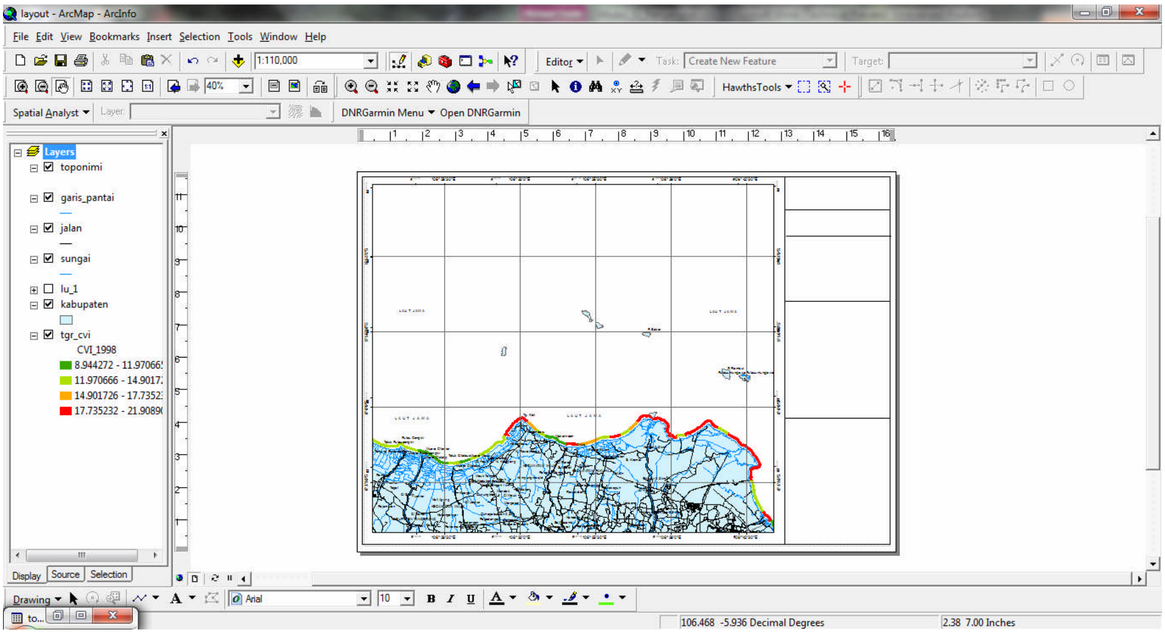
b) Move the rectangle is backward object as a whole element layout background.

c) Use the Drawing line to make some boundary line to separate the theme of objects in the layout. And use other functions such as the Fill Color and Line Color and other functions.


Display
Source
Selection
Drawing
Arial
10


Graphic Operations
Order
Nudge
Align
Distribute
Rotate or Flip
Default Symbol Properties...
Bring to Front
Send to Back
Bring Forward
Send Backward
Drawing
Arial
10
Send the selected element(s) to the back
-13.43 5.93


Display
Source
Selection
More Colors...
Drawing
Arial
10

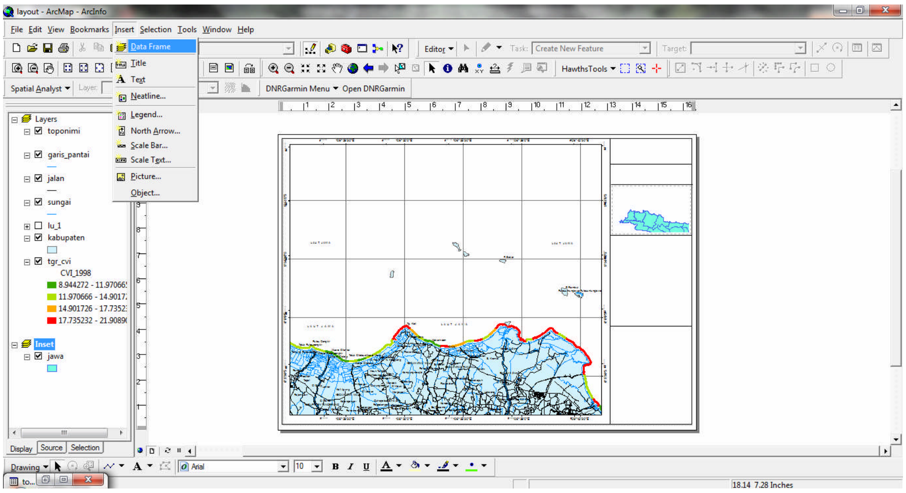

layout - ArcMap - ArcInfo
File
Edit
View
Bookmarks
Insert
Selection
Tools
Window
Help
1:110,000
Editor
Task:
Create New Feature
Target:
HawthsTools
Spatial Analyst
Layer:
DNRGarmin Menu
Open DNRGarmin
Layers
toponimi
garis_pantai
jalan
sungai
lu_1
kabupaten
tgr_cvi
CVI_1998
Display
Source
Selection
Drawing
Arial
10
106.468 -5.936 Decimal Degrees
2.38 7.00 Inches

6. Description and Map Information

Adding the Insert / Chart Map

1). Click on the ***Insert*** Toolbars Standard and Select ***Data Frame***

2). In the conditions selected / elected to add  the reference data as a diagram the position of the main map, and then complete the grid, geography. Frame Data Name can be changed with a new name.



Adding Eyes Wind Direction Signs

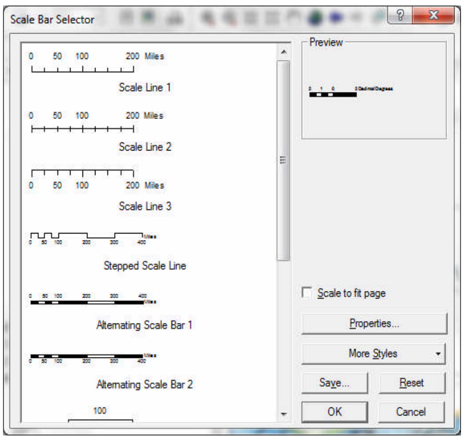
1). Click on the Insert Toolbars Standard and Select North Arrow; Select Type / Type of the wind direction

2). Click OK button

Add and Edit Scale Bar Map

1). Click on the Insert Toolbars Standard and Select Scale Bar

2). Select Type / Type Scale used (select Alternating Scale Bar 1)



3). In the When resizing select Adjust width

4). In Division Value length scale input values created

5). Fill Value Number of division and subdivision so the value of 2 (two)

6). In Division Unit Select a folder created scale units

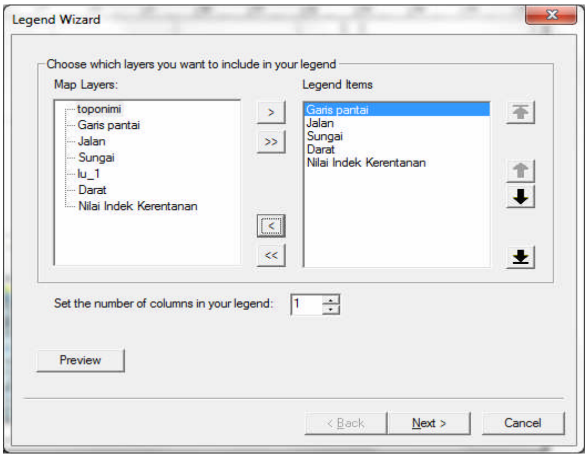
7). Edit the label scale

8). Click the OK button

Adding Map Legend

1). Main Data frame Click (Selected)

2). On the Insert menu Then Select Standard click Legend

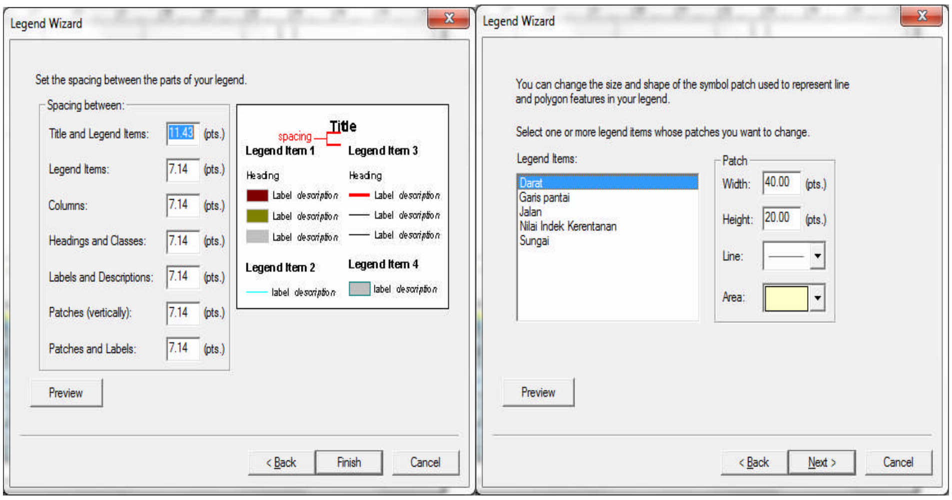


3). Select the layer-layer features to be shown a legend (Put on Legend items)

4). Click ***Next*** button

5). Legend Title Edit (Text, Color, Font Size and Type font) If you need, then click the ***Next*** button.

6). Click Next button



7). For the meantime we just select the default first, but if you need to edit his pacth please try it, Click Preview button if you want to see change if you do editing pacth

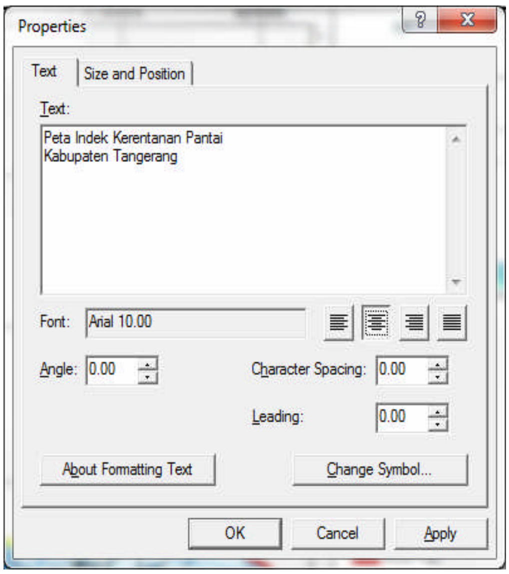
8). Click ***Next*** button

9). Click ***Finish***

Adding a Text Description Map

1). On the ***Insert*** menu and select Standard Click ***Text*** or you can use the Text in the Drawing tools

2). Click On display layout and content with the text. For editing you can click the right mouse button and select Properties



3). Click the **OK** button

4). You can also format the size, color, and font type using Drawing tools (Make sure the font is still in the elected / selected) and click **OK**

Adding Logos and Images

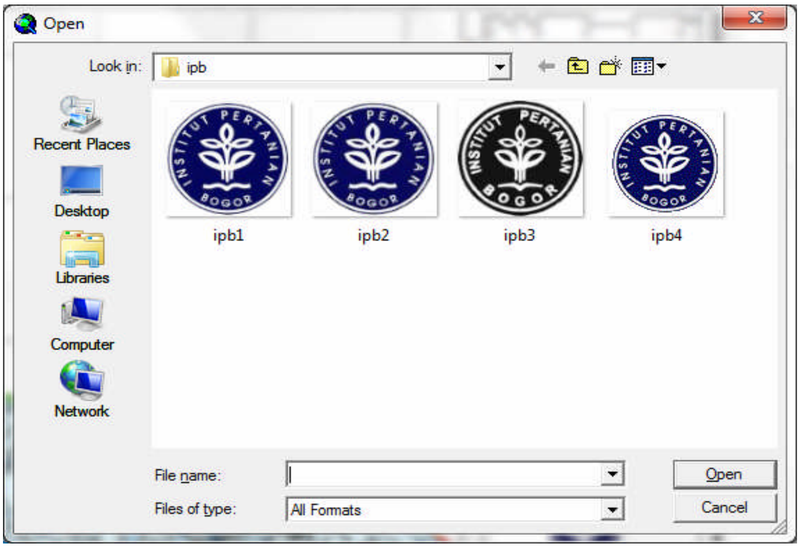
1). Click the Insert In Standard Menu, then select Picture

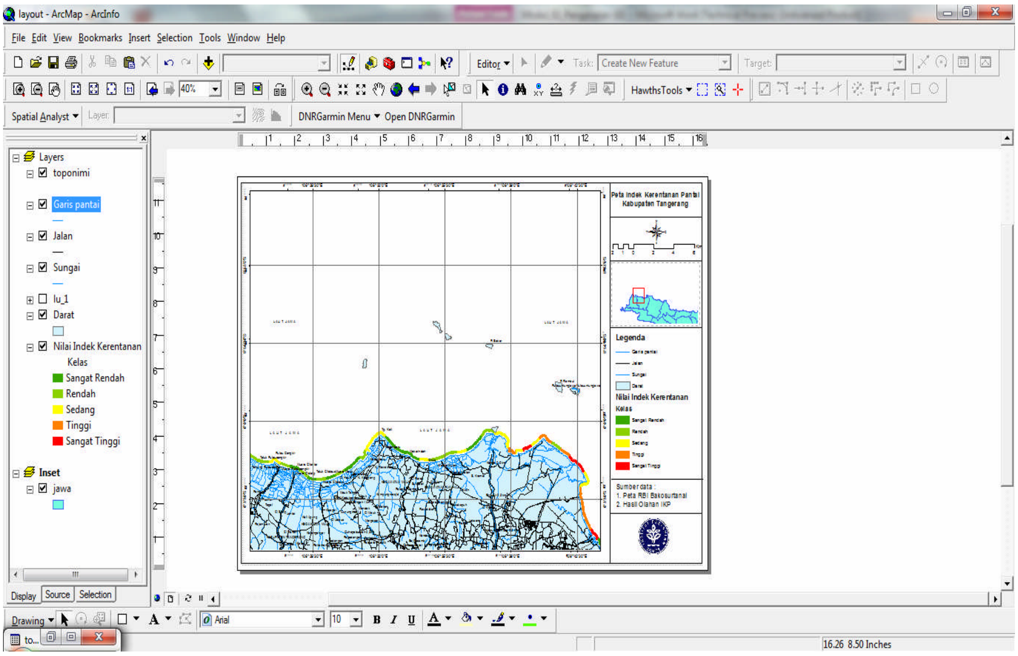
2). In the Look In: looking for a logo or an image folder location that you input

3). Select the file name (logo / image)

4). Click the Open button

5). Edit picture (size) to move place format.





7. Saving map

Storing into the Project and Templates

1). On the Standard menu Click File and select Save As

2). In the *Save In*: Choose a Folder as a storage location or a template Project

3). In the *File Name* Enter Name

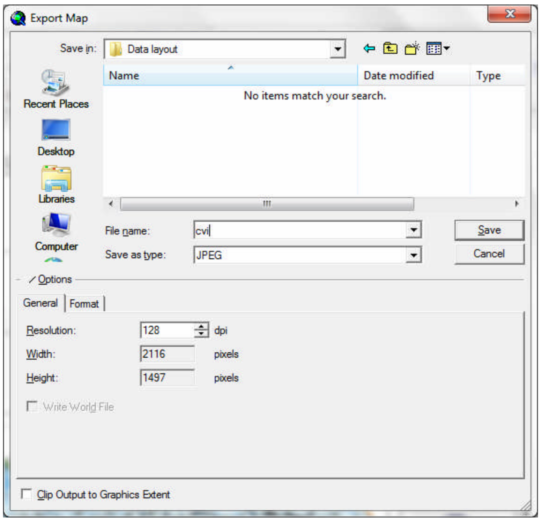
4). In the Save as type Choose whether you save it as ***.mxd** Project select, but if you want to keep it as a template select ***. mxt***

5). Click ***Save*** button

Project Export Layout to format Raster / Images

1). On the standard menu click File and select Export Map

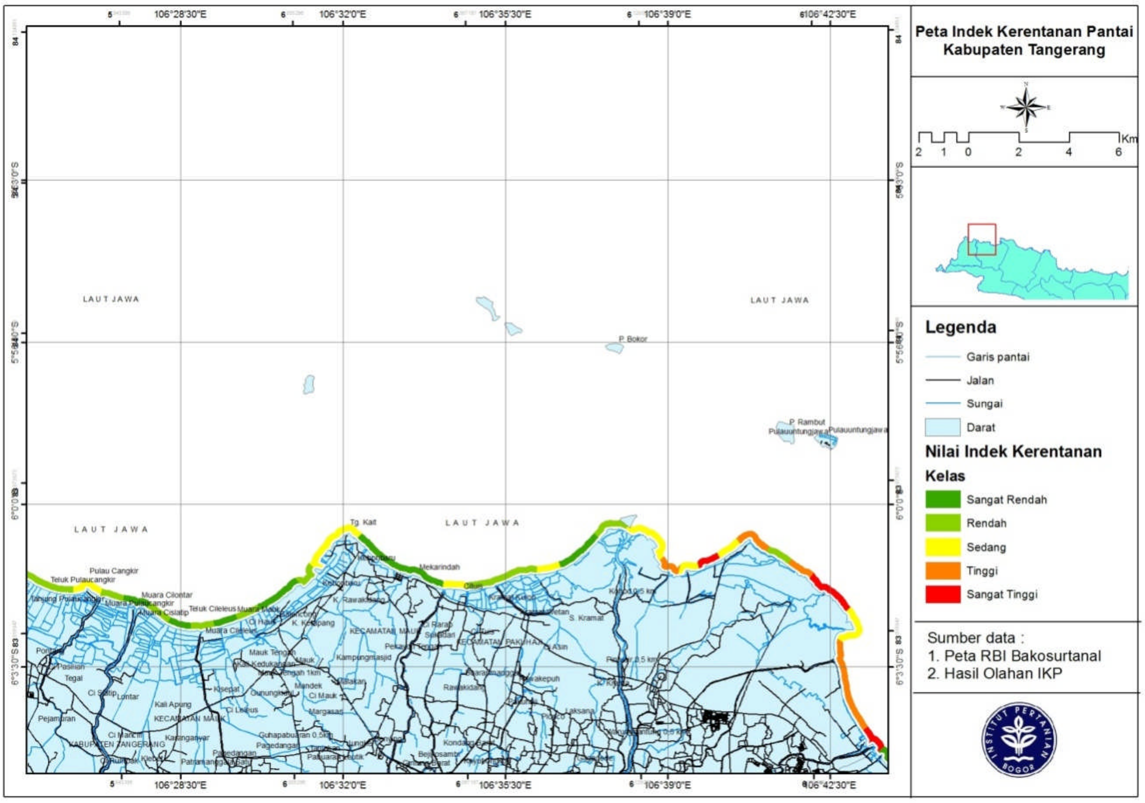
2). In the Save In: Choose Folder Venue Map data is stored Raster



3). In the File Name; Enter Map Name

4). In the Save as Type, select the extension of data storage formats that you want.

5). Click ***Save*** button



X. Instructors

1. Name : Syamsul B. Agus

   Email : mycacul@gmail.com

   Phone : 08129294181

   Institution : Bogor Agriculture University

2. Name : Anggi Afif M

   Email : afif_muzaki@yahoo.co.id

   Phone : 085696952400

   Institution : Bogor Agriculture University

TRAINING MODULE

DEVELOPMENT OF COASTAL VULNERABILITY INDEX

"DATA PROCESSING OF COASTAL GEOMORPHOLOGY"

Compiled by :

Sakka

Anggi Afif Muzaki

BOGOR AGRICULTURAL UNIVERSITY, 2010

CONTENTS

I. Introduction

In determining index of vulnerability coastal, the component of geomorphologic is one of variables that need to be assessed. Geomorphology is the study of landscape (landscape), including the nature and characteristics from morphology, classification, difference and responsible process toward the formation of morphology.

Geomorphological process is a natural process that took place on the earth surface so that there is a change of land forms on the surface of the earth. Changes in land forms, resulting in formation on the surface of the earth that differ from one another, thus will have a range of composition and physical characteristics and different visual. These differences can be clearly identified through the characteristic relief / morphology, structure/lithology, and processes, geomorphology. Basically, in explaining the characteristics of land form a region, therefore the classification of landform units (third-order relief) that is characterized by forms on the earth surface on the basis of the characteristics possessed by each group form the earth's surface. Landform characteristics mainly influenced by the surface configuration (relief), the characteristics of geological structures or rock types, and characteristics of the processes that result in the form of land.

Based on morphology, the coastal areas can be grouped into 4 types, namely:

a. Steep rugged coast (cliff)

The beach is a steep rugged landform formed by the marine erosion of the most widely available. Roman cliff formations and different from one another, because it is influenced by rock structures and rock types and rock properties. Cliff on igneous rocks would have been different with a cliff in sedimentary rock. Sedimentary rocks such coatings will be different with a sloping plating and coating flat. In the border area above the waves, are generally covered by vegetation while the lower part generally in the form of rock outcrops. Tidal and wave activity eroded the cliff, thus forming the abrasion marks such as: cliff, cliffs dependent (notch) and the average tidal wave.

On steep rugged area, beaches are usually rocky (rocky beach), a winding with many of the rock mass movement (mass movement rock fall type). This process moves backward cause cliff (slope retreat), particularly in coastal abrasion process is active. If the rocks making up this region of limestone or other rock that has many cracks (joints) of inland water flowing through the system cracks and pops in the coastal areas and coastal regions. In Indonesia, steep rugged coast are numerous in the western part of Sumatra Island, South coast of Java, Sulawesi, and South coast of the islands of Nusa Tenggara. Cliff dependent (nocth) is also a cliff, only on the cliff near the sea surface curved toward the ground, so that there are niches in the cliff. Recesses occur as a result of the collision wave continuously into the cliff wall. When the roof is not strong niche, the cliff is a cliff will collapse and become flat back and in front of the beach there are a lot of material in the form of blocks or chunks of various sizes.

The average tidal waves on the steep rugged coast is a zone that is sometimes submerged in sea water at high tide and sometimes dry during low tide. The average tidal wave is often also a beach with material that can be fines up to rough waves that depend on the strength of that work on coastal cliffs. Under these tidal flats exist in the form of a harder material contained beach sometimes called the Plat form.

b. Coastal coral reefs

Coral reef is formed by the activity of coral animals and other microorganisms. This process occurs in areas large enough. Bird (1970: 190-193) states that the coral animals can live with certain conditions ie conditions: clear water, the temperature not more than 18^{o}C, salinity between 27-38 ppm, ocean currents are not heavy. Coral reefs are a lot surfaced numerous in the Indonesian archipelago. On coral islands which rise generally there are many deposits of debris and coral sand off the beach. Rubble and sand grain size is more coarse in the direction of wave if the wave without hindrance. Tectonic processes often influence also on coral reefs. Atoll is the result of a combination of the coral animal with tectonic processes in the form of subsidence.

c. Bergisik beach

Bergisik Beach is basically a tidal area that contained the results of abrasion material deposits. This material can be a fine material and also can be a rough material. The beach is marked by a beach on the coast cliff with coarse material as a result of the abrasion cliff. But do not just coast bergisik found on the beach cliff, but can also be found on a sloping beach area. On a sloping beach material is mostly sand beach, and in part the form of small grains of material with gravel up to a bigger one. In general, beach sand, a beach from inland areas under river water into the sea, and deposited by ocean currents along the beach. This beach can be found around the mouth of river.

d. Coastal brackish swampy

Brackish marsh also characterizes the coastal region that grows or accretion. The process of sedimentation is a cause of increasing the advance towards the sea coast. Composition, this beach is generally fine grained and the field is growing on a small wave locations or obstructed and the condition of sea water is relatively shallow. Because the water is brackish, then this area is very limited possibilities for development. Brackish marsh are generally covered by brackish marsh plants such as mangroves, palm, and other marsh plants that live in brackish water. These mangroves may function as a breakwater and a barrier on beach erosion, sedimentation opposite could happen. Hence accretion beach experience. Role in stimulating the growth of mangroves in coastal mangrove proved obvious if the missing or dead, cut out, then what happens is the opposite of beach erosion. On the beach experience accretion, generally there is a sequence that there is mangrove at the front, behind palm, plants, fresh water marsh/ wetlands. Upper limit of mangrove is as high as the maximum high-water mark. The surface of the highest tides occur at the time of spring tide (when the full moon) and pairs neap tide (at the time of the dark moon/month died).

The data used to identify geomorphological classes can be obtained from the Map Arts Earth (RBI), RBI data which produce BAKOSURTANAL. Land data parameters is fresh water, swamp forest, shrubs / bushes, Marsh, Point, Pond, dry land and irrigated. Parameter data are then classed according to the class of indicators proposed by Gornitz (1991). Groups of land cover types are:

1. Aluvial, include: Pond, Salting, Rice Irrigation, Rain fed Low, moor / Field.
2. Briny Swamp, including: shrubs / bushes and swamps.
3. Mongrove forest, including: Swamp Forest.
4. Beach building, including: building of Settlement.
5. Estuary and lagoon covers: fresh water and coast land.
6. Beach Sand, includes: sand beach and sand land.

The last parameter of the morphological class of low rugged coast, beaches are rugged and high rugged coast is calculated by using the slope of the terrain near the coast of elevation data or Quick Bird satellite imagery of Google Earth.

The preparation of geomorphological data obtained are grouped into classes in the modification of Thieler and Hammar-Klose. 2000; USGS as follows:

Parameter	**Class**				
	Very Low	**Low**	**Medium**	**High**	**Very High**
Geomorphology	High cliff	Medium cliff	Low cliff, aluvial	Building, Estuaries, Laguna	Beach Building Structure, sandy beaches, brackish swamps, mud Expose, Delta, Mangrove, Coral

Geomorphology data is qualitative data so that in determining the coastal vulnerability index data needs to be converted into quantitative data. Value of weight on each hump as follows:

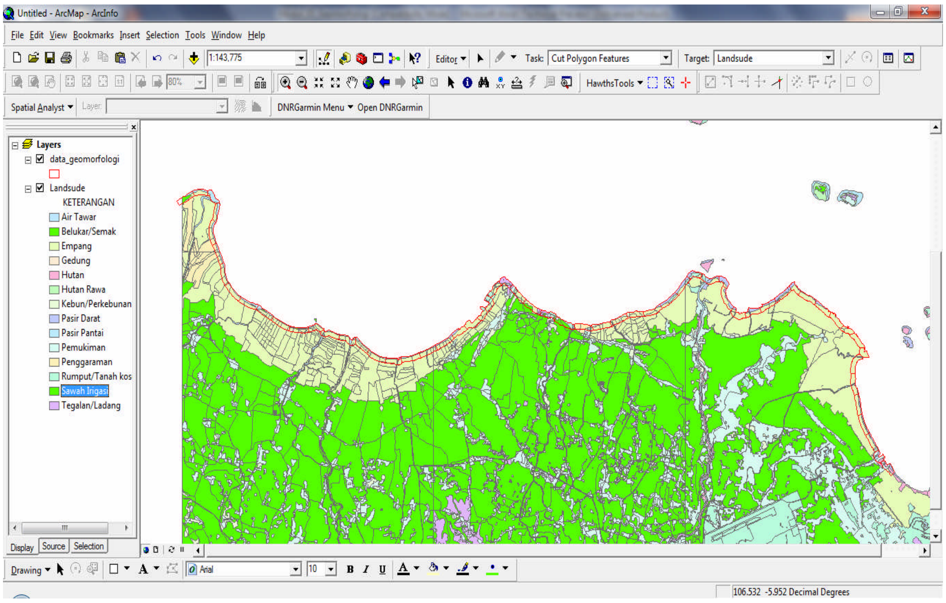
1. Very low class is a value of 1
2. Low class is the value 2
3. Medium class is a value of 3
4. High Grade is a grade 4
5. Very high class is the value of 5

II. Objective

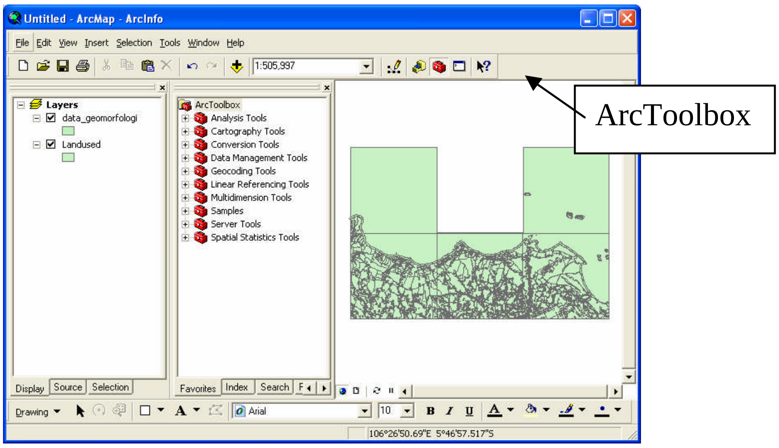
The objective of this module is that each participant is able to do the acquisition, processing and integrating data for the determination of geomorphology Coastal Vulnerability Index (IKP).

III. Stages of Data Acquisition Geomorphology

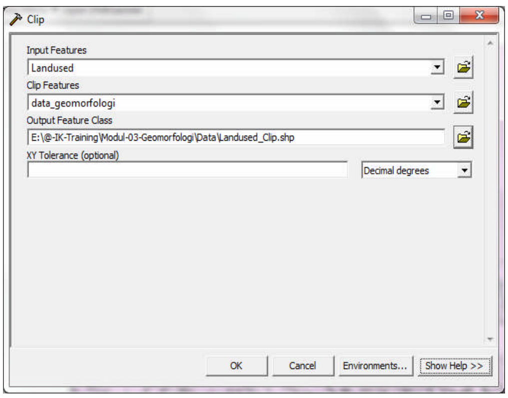
1. Open file “data_geomorfologi” and “Landuse” in folder D:\@-IK-Training\Modul-03-Geomorfologi\Data



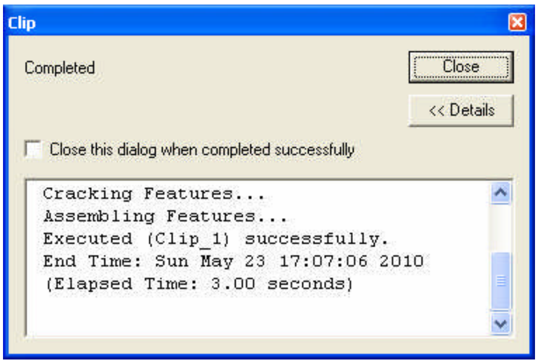
2. Do clip geomorphology data (file : landuse) with cell data (file : geomorphology data) do with click ArcToolbox select Analysis Tools select Extract select Clip,



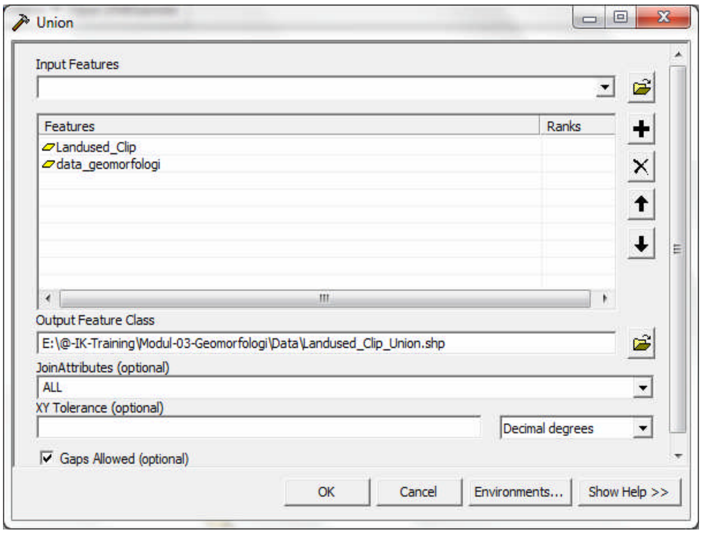
will appear like the picture below.



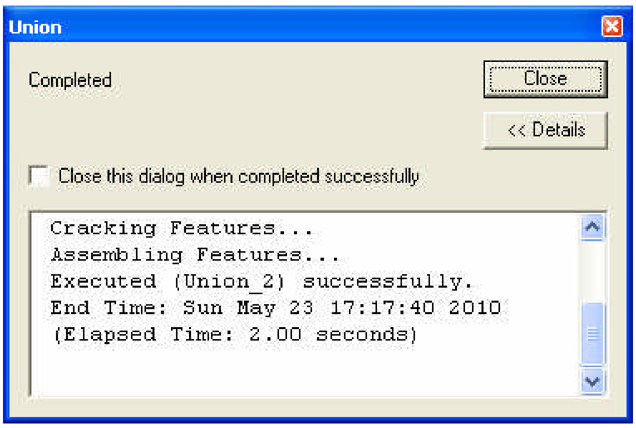
Contents geomorphological data (files: landused) on Input Features and cell data (files: geomorphological data) to the Clip Feature like in the picture above. Click Ok, the image will appear as below, click close



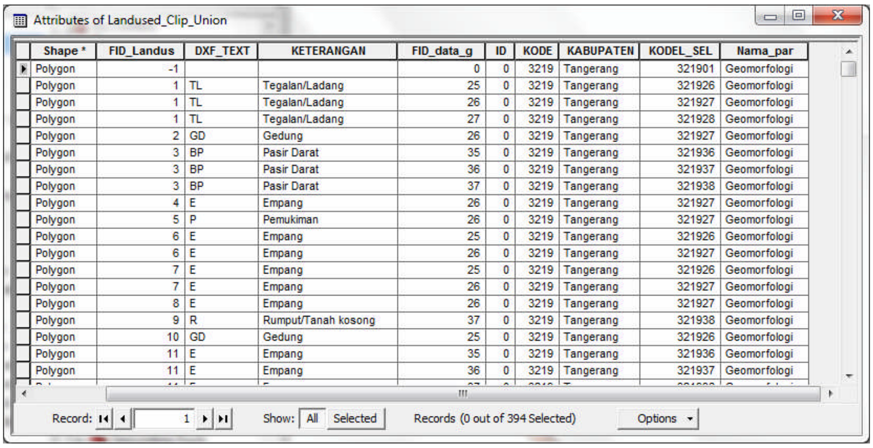
3. To integrate the data table then do the Union on the data resulting clip with cell data geomorphology. Click the ArcToolbox select Analysis Tools select Overlay select union, such union table will appear below.



Enter your data files and data_geomorfologi Landused_Clip on "Input feature" click Ok will appear like the picture below.



Click close. So that the data are integrated in one file. Data tables are the result of integration can be seen by the right-click "Landused_Clip_Union" select open attribute table will display table that is generated as follows:

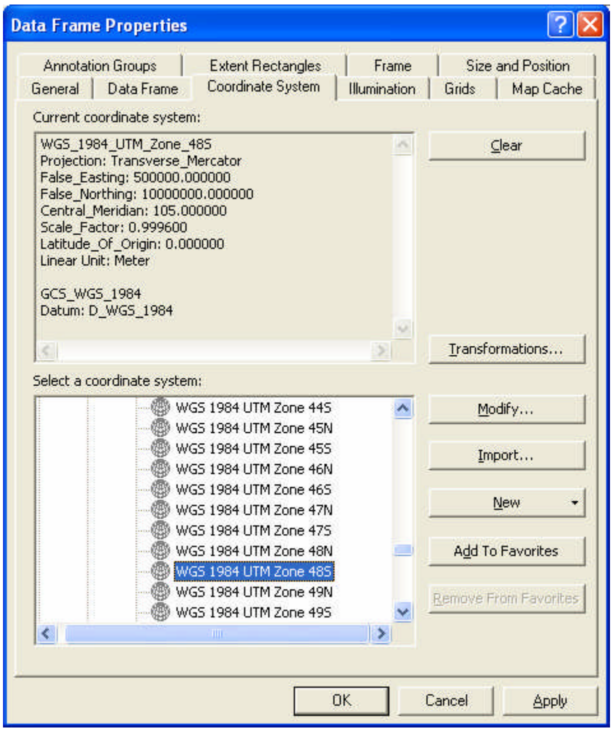


Attributes of Landused_Clip_Union

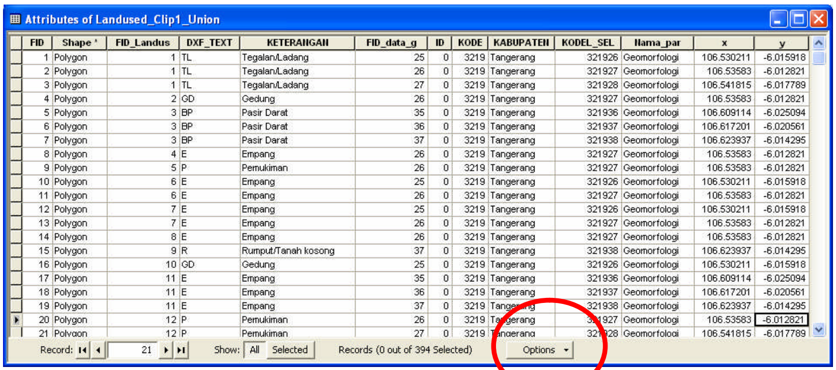
Shape *	FID_Landus	DXF_TEXT	KETERANGAN	FID_data_g	ID	KODE	KABUPATEN	KODEL_SEL	Nama_par
Polygon	-1			0	0	3219	Tangerang	321901	Geomorfologi
Polygon	1	TL	Tegalan/Ladang	25	0	3219	Tangerang	321926	Geomorfologi
Polygon	1	TL	Tegalan/Ladang	26	0	3219	Tangerang	321927	Geomorfologi
Polygon	1	TL	Tegalan/Ladang	27	0	3219	Tangerang	321928	Geomorfologi
Polygon	2	GD	Gedung	26	0	3219	Tangerang	321927	Geomorfologi
Polygon	3	BP	Pasir Darat	35	0	3219	Tangerang	321936	Geomorfologi
Polygon	3	BP	Pasir Darat	36	0	3219	Tangerang	321937	Geomorfologi
Polygon	3	BP	Pasir Darat	37	0	3219	Tangerang	321938	Geomorfologi
Polygon	4	E	Empang	26	0	3219	Tangerang	321927	Geomorfologi
Polygon	5	P	Pemukiman	26	0	3219	Tangerang	321927	Geomorfologi
Polygon	6	E	Empang	25	0	3219	Tangerang	321926	Geomorfologi
Polygon	6	E	Empang	26	0	3219	Tangerang	321927	Geomorfologi
Polygon	7	E	Empang	25	0	3219	Tangerang	321926	Geomorfologi
Polygon	7	E	Empang	26	0	3219	Tangerang	321927	Geomorfologi
Polygon	8	E	Empang	26	0	3219	Tangerang	321927	Geomorfologi
Polygon	9	R	Rumput/Tanah kosong	37	0	3219	Tangerang	321938	Geomorfologi
Polygon	10	GD	Gedung	25	0	3219	Tangerang	321926	Geomorfologi
Polygon	11	E	Empang	35	0	3219	Tangerang	321936	Geomorfologi
Polygon	11	E	Empang	36	0	3219	Tangerang	321937	Geomorfologi

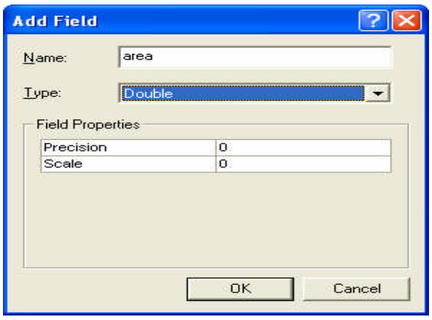
Record: 1 Show: All Selected Records (0 out of 394 Selected) Options

4. Change coordinat system on the layer into the UTM system is done by right-clicking the layer select properties select predefined projected coordinate systems select UTM select WGS 1984, because of the location used is the Tangerang Municipality then select WGS 1984 Zone 48S.

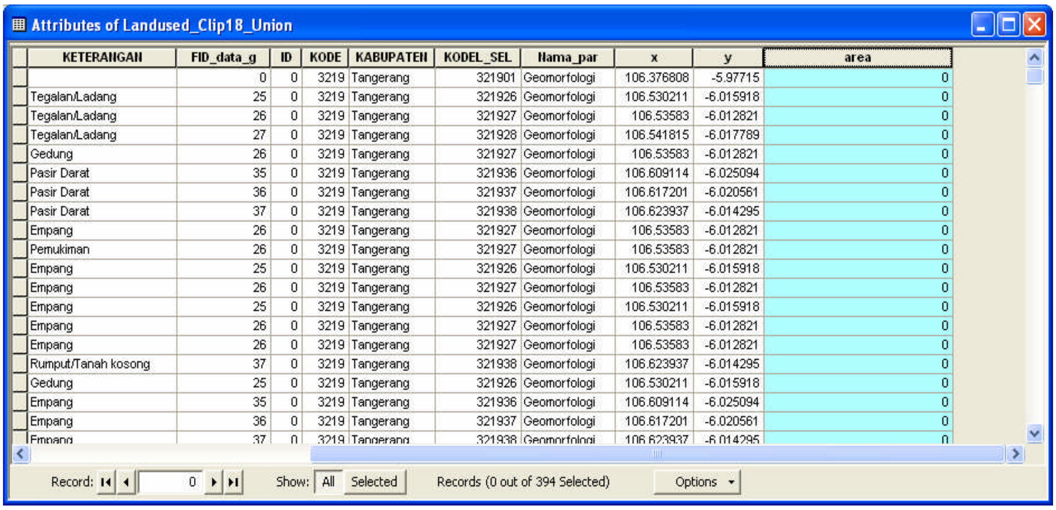


5. Calculate the area of vector data "Landused_Clip_Union" in each cell is done by opening the data table "Landused_Clip_Union" add a column in the table by clicking options at the bottom of the table select the add field will appear as in the picture below, give the column name such as "area" change the type to double, click Ok.



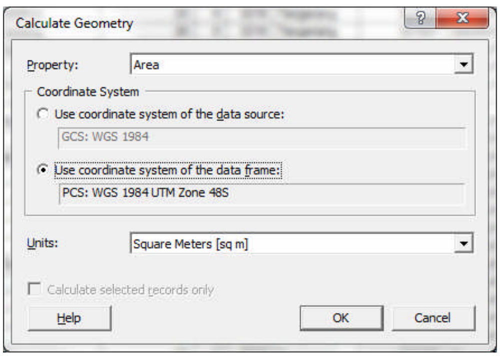


So on the table "Landused_Clip_Union" had increased in the column "area" as in Figure below.

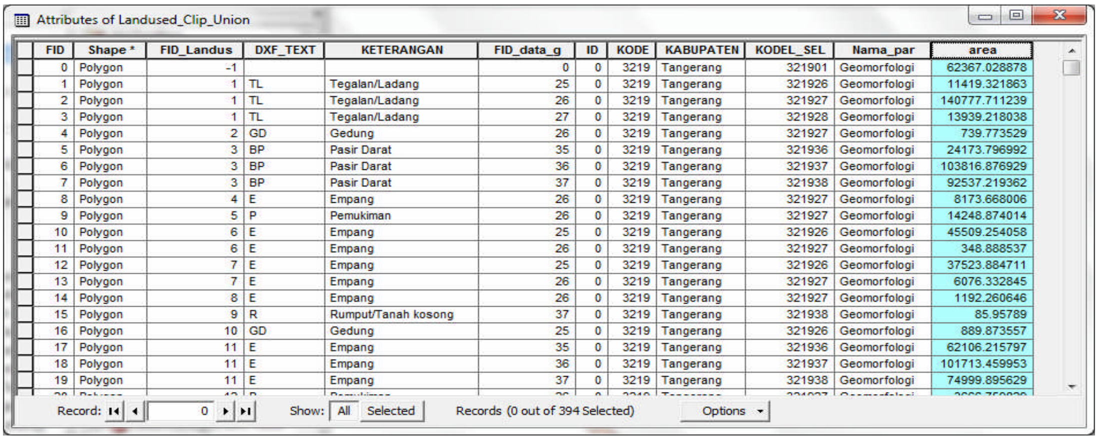


KETERANGAN	FID_data_g	ID	KODE	KABUPATEN	KODEL_SEL	Nama_par	x	y	area
	0	0	3219	Tangerang	321901	Geomorfologi	106.376808	-5.97715	0
Tegalan/Ladang	25	0	3219	Tangerang	321926	Geomorfologi	106.530211	-6.015918	0
Tegalan/Ladang	26	0	3219	Tangerang	321927	Geomorfologi	106.53583	-6.012821	0
Tegalan/Ladang	27	0	3219	Tangerang	321928	Geomorfologi	106.541815	-6.017789	0
Gedung	26	0	3219	Tangerang	321927	Geomorfologi	106.53583	-6.012821	0
Pasir Darat	35	0	3219	Tangerang	321936	Geomorfologi	106.609114	-6.025094	0
Pasir Darat	36	0	3219	Tangerang	321937	Geomorfologi	106.617201	-6.020561	0
Pasir Darat	37	0	3219	Tangerang	321938	Geomorfologi	106.623937	-6.014295	0
Empang	26	0	3219	Tangerang	321927	Geomorfologi	106.53583	-6.012821	0
Pemukiman	26	0	3219	Tangerang	321927	Geomorfologi	106.53583	-6.012821	0
Empang	25	0	3219	Tangerang	321926	Geomorfologi	106.530211	-6.015918	0
Empang	26	0	3219	Tangerang	321927	Geomorfologi	106.53583	-6.012821	0
Empang	25	0	3219	Tangerang	321926	Geomorfologi	106.530211	-6.015918	0
Empang	26	0	3219	Tangerang	321927	Geomorfologi	106.53583	-6.012821	0
Empang	26	0	3219	Tangerang	321927	Geomorfologi	106.53583	-6.012821	0
Rumput/Tanah kosong	37	0	3219	Tangerang	321938	Geomorfologi	106.623937	-6.014295	0
Gedung	25	0	3219	Tangerang	321926	Geomorfologi	106.530211	-6.015918	0
Empang	35	0	3219	Tangerang	321936	Geomorfologi	106.609114	-6.025094	0
Empang	36	0	3219	Tangerang	321937	Geomorfologi	106.617201	-6.020561	0
Empang	37	0	3219	Tangerang	321938	Geomorfologi	106.623937	-6.014295	0

Right-click on the "area" in the table select calculate geometry, click Yes the image will appear as below:

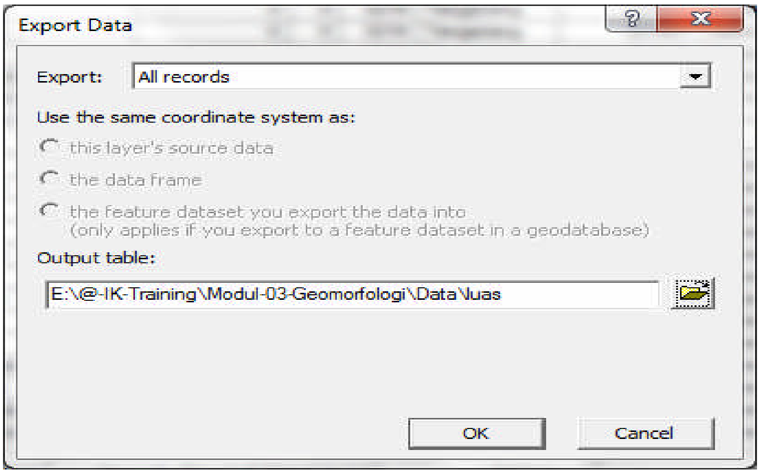


Click Ok will show the value in the "area" as shown below:

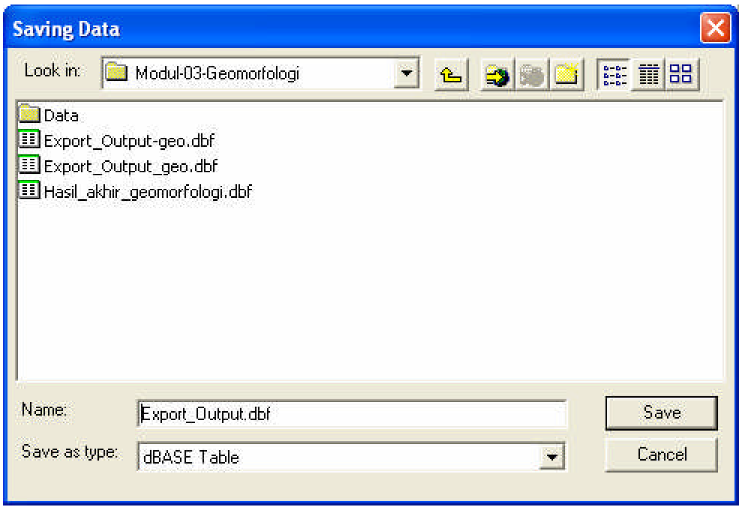


FID	Shape *	FID_Landus	DXF_TEXT	KETERANGAN	FID_data_g	ID	KODE	KABUPATEN	KODEL_SEL	Nama_par	area
0	Polygon	-1			0	0	3219	Tangerang	321901	Geomorfologi	62367.028878
1	Polygon	1	TL	Tegalan/Ladang	25	0	3219	Tangerang	321926	Geomorfologi	11419.321863
2	Polygon	1	TL	Tegalan/Ladang	26	0	3219	Tangerang	321927	Geomorfologi	140777.711239
3	Polygon	1	TL	Tegalan/Ladang	27	0	3219	Tangerang	321928	Geomorfologi	13939.218038
4	Polygon	2	GD	Gedung	26	0	3219	Tangerang	321927	Geomorfologi	739.773529
5	Polygon	3	BP	Pasir Darat	35	0	3219	Tangerang	321936	Geomorfologi	24173.796992
6	Polygon	3	BP	Pasir Darat	36	0	3219	Tangerang	321937	Geomorfologi	103816.876929
7	Polygon	3	BP	Pasir Darat	37	0	3219	Tangerang	321938	Geomorfologi	92537.219362
8	Polygon	4	E	Empang	26	0	3219	Tangerang	321927	Geomorfologi	8173.668006
9	Polygon	5	P	Pemukiman	26	0	3219	Tangerang	321927	Geomorfologi	14248.874014
10	Polygon	6	E	Empang	25	0	3219	Tangerang	321926	Geomorfologi	45509.254058
11	Polygon	6	E	Empang	26	0	3219	Tangerang	321927	Geomorfologi	348.888537
12	Polygon	7	E	Empang	25	0	3219	Tangerang	321926	Geomorfologi	37523.884711
13	Polygon	7	E	Empang	26	0	3219	Tangerang	321927	Geomorfologi	6076.332845
14	Polygon	8	E	Empang	26	0	3219	Tangerang	321927	Geomorfologi	1192.260646
15	Polygon	9	R	Rumput/Tanah kosong	37	0	3219	Tangerang	321938	Geomorfologi	85.95789
16	Polygon	10	GD	Gedung	25	0	3219	Tangerang	321926	Geomorfologi	889.873557
17	Polygon	11	E	Empang	35	0	3219	Tangerang	321936	Geomorfologi	62106.215797
18	Polygon	11	E	Empang	36	0	3219	Tangerang	321937	Geomorfologi	101713.459953
19	Polygon	11	E	Empang	37	0	3219	Tangerang	321938	Geomorfologi	74999.895629

6. Export data table "Landused_Clip_Union" into the format. ".txt" so that it can be opened in Excel with the click select export options will appear the image below :



Change to the directory to the choose directory, done by click on Browse will display the image:



Give the desire file name such as "luas.txt."

IV. Interpretation of the Qualitative Data To Quantitative Data Geomorphology

1. Open the file "luas.txt" using excel program. Input wide value landused every cell in the table below

No Sel	Empang	Sawah Irigasi	Penggar aman	Tegalan/ Ladang	Kebun/ Perkebunan	Air Tawar	Gedung	Pemukiman	Pasir Pantai	Belukar/ Semak	Pasir Darat	Rumput/ Tanah kosong	Mangrove
1	23970.1	89328	26976						35553.6				
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													

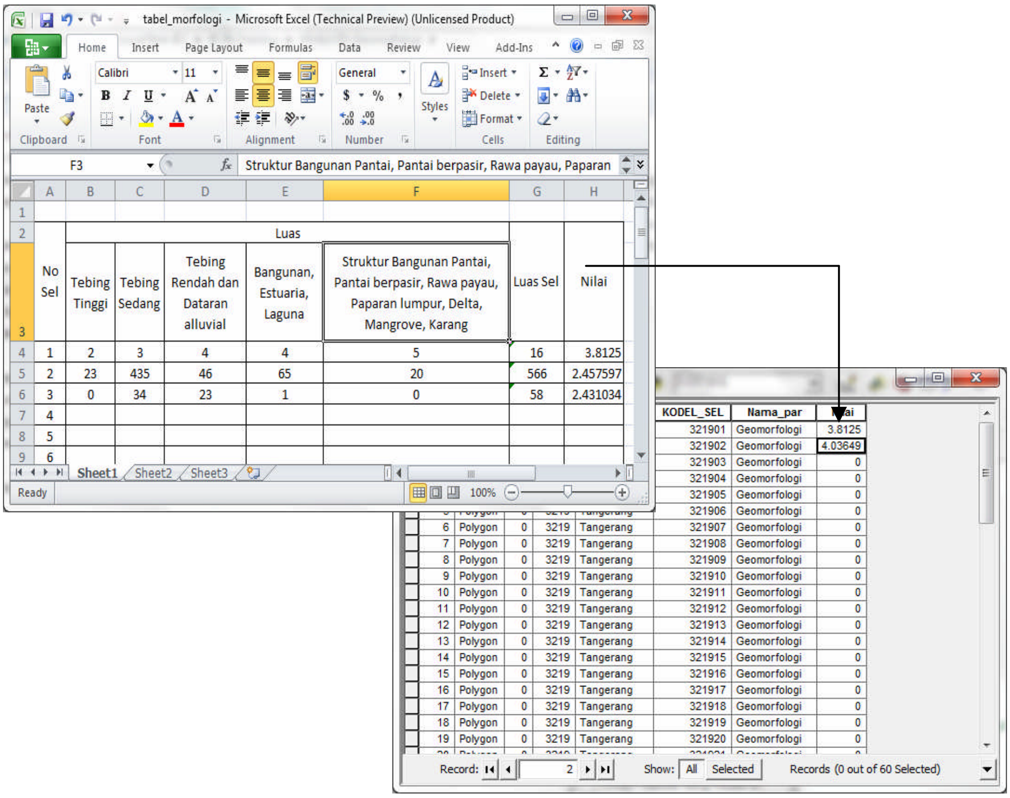
Then grouped into broad landused every cell in the appropriate classes as in the table below and provide value by:

1. Very low class is a value of 1
2. Low class is the value 2
3. Class Medium is the value 3
4. High Grade is a grade 4
5. Very high class is the value of 5

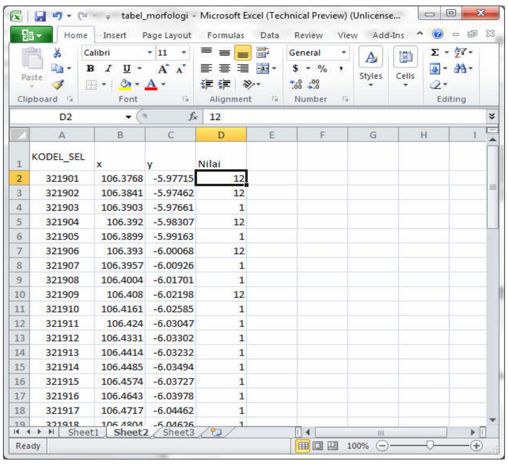
By considering the large percentage of every landused contained in a single cell.

No Sel	Kelas					Luas Sel	Nilai
	Sangat Rendah	Rendah	Sedang	Tinggi	Sangat Tinggi		
	Tebing Tinggi	Tebing Sedang	Tebing Rendah dan Dataran alluvial	Bangunan, Estuaria, Laguna	Struktur Bangunan Pantai, Pantai berpasir, Rawa payau, Paparan lumpur, Delta, Mangrove, Karang		
1	0	0	140274.2279	0	35553.59561	175828	3.40
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							

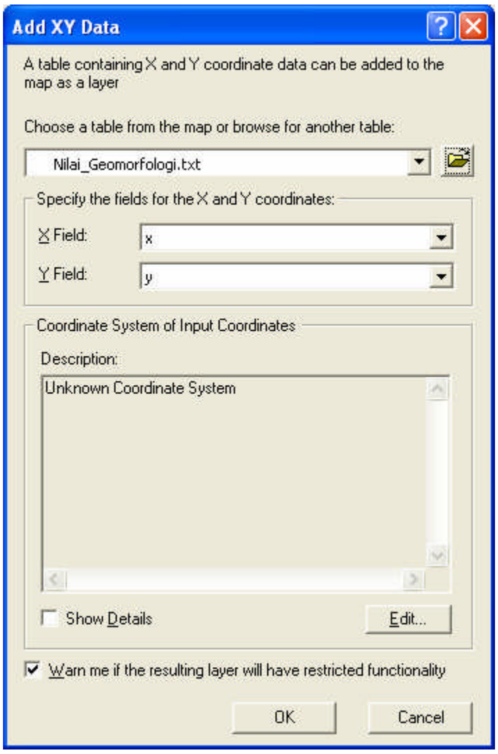
2. After the value of variable geomorphology in each cell is obtained, enter that value into cell "data_geomorfologi" on ArcGis.



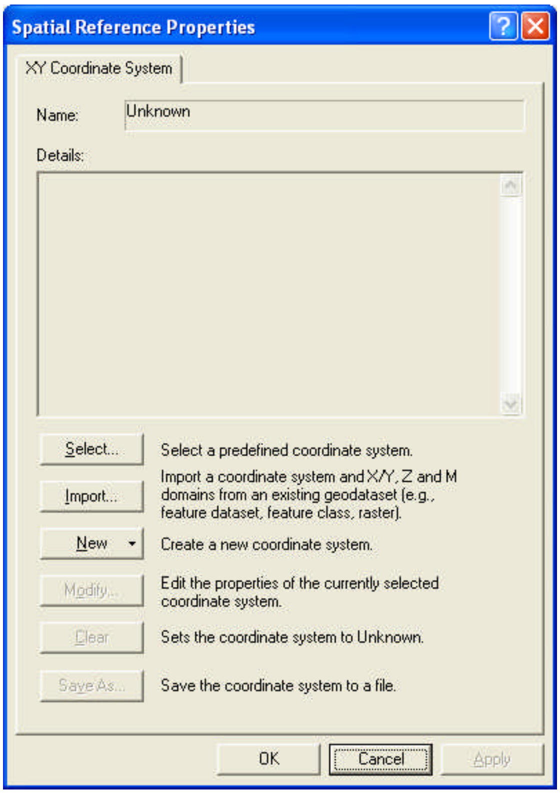
3. To enter the value from excel program to ArcGIS program, we can use the Join menu table in ArcGIS. At first the contents of a value into the table where every cell has the coordinates x, y as shown below. Save As table into txt format, for example nilai_geomorfologi.txt.



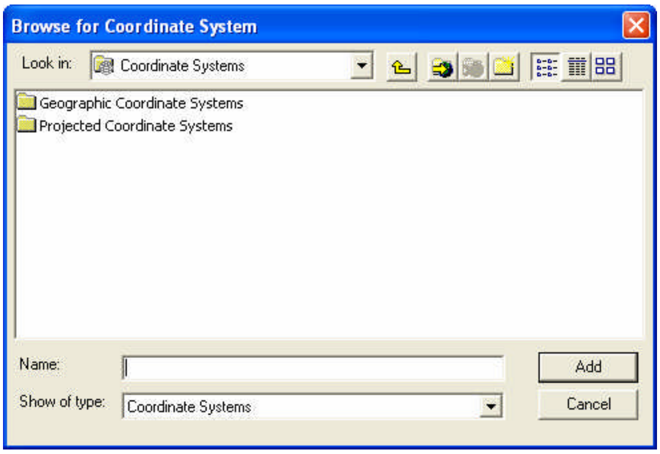
4. Call the processed data (file name: nilai_geomorfologi.txt) in a way: Click on Tools select add xy data will appear like the picture below.



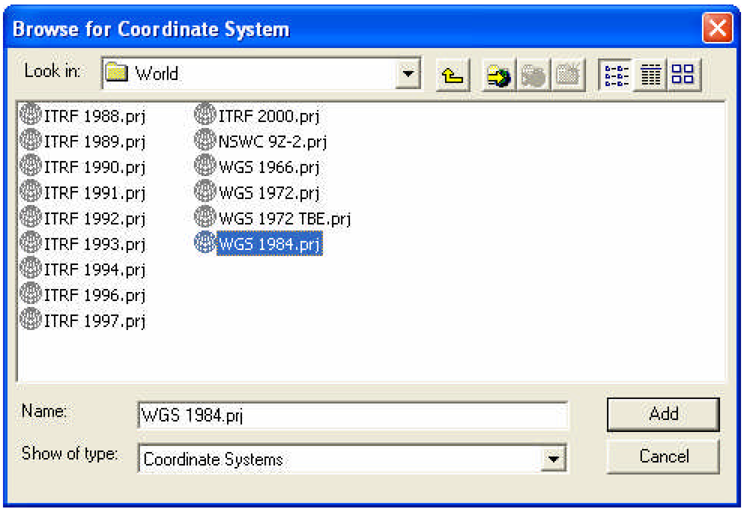
Click browse on the Choose a table from the map, select the file nilai_geomorfologi.txt, initialization x field with the value longitude, and y fields with value latitude. Determine coordinat system in use by clicking the edit will appear like the picture below:



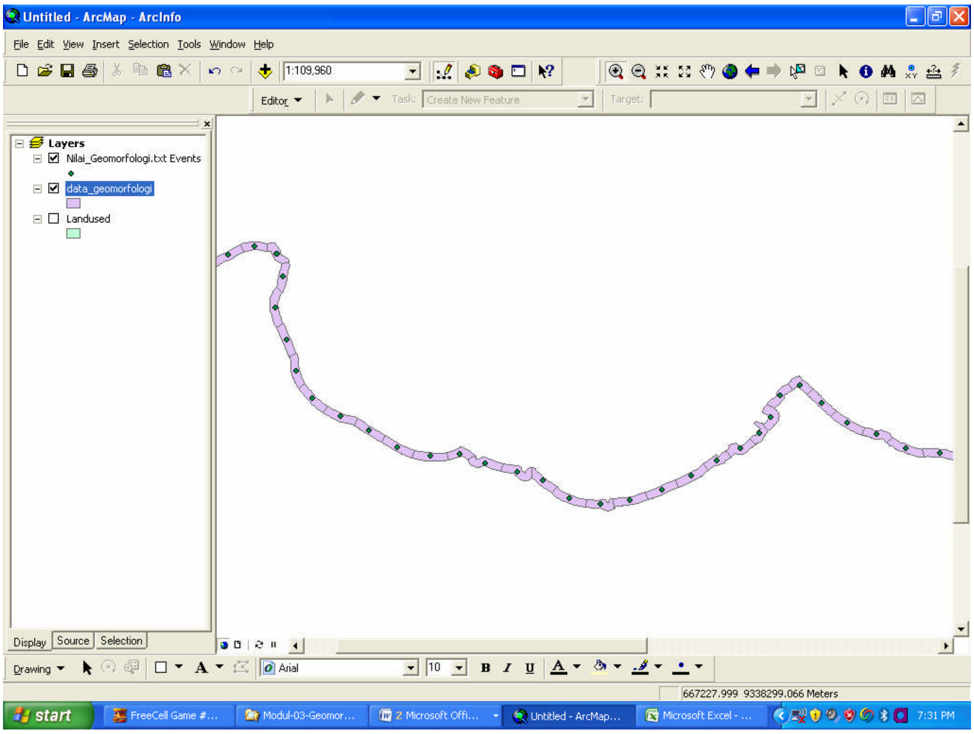
Click the Select button will display the picture as below:



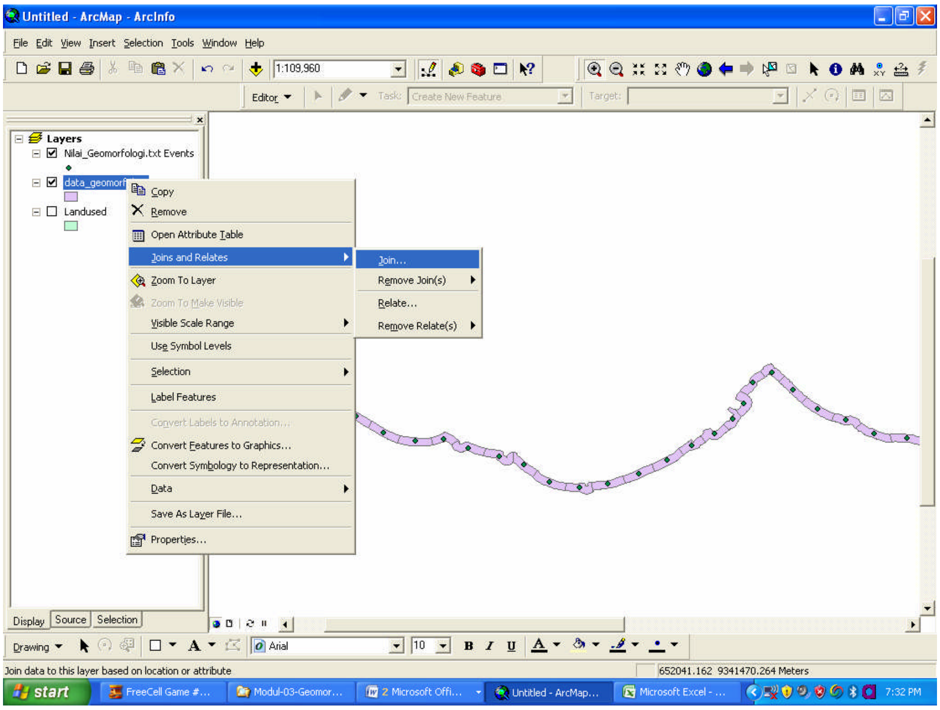
Click the geographic coordinate system, select the word select WGS 1984 as shown below.



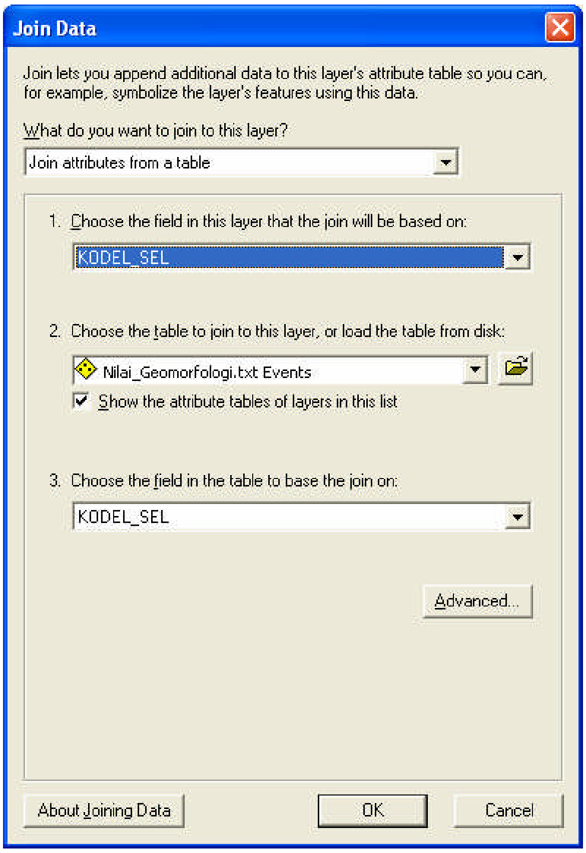
Click Add, click Ok, then in the Layers will appear nilai_geomorfologi.txt file events.



5. Right-click the file data_geomorfologi, select the join and Relate, select the join

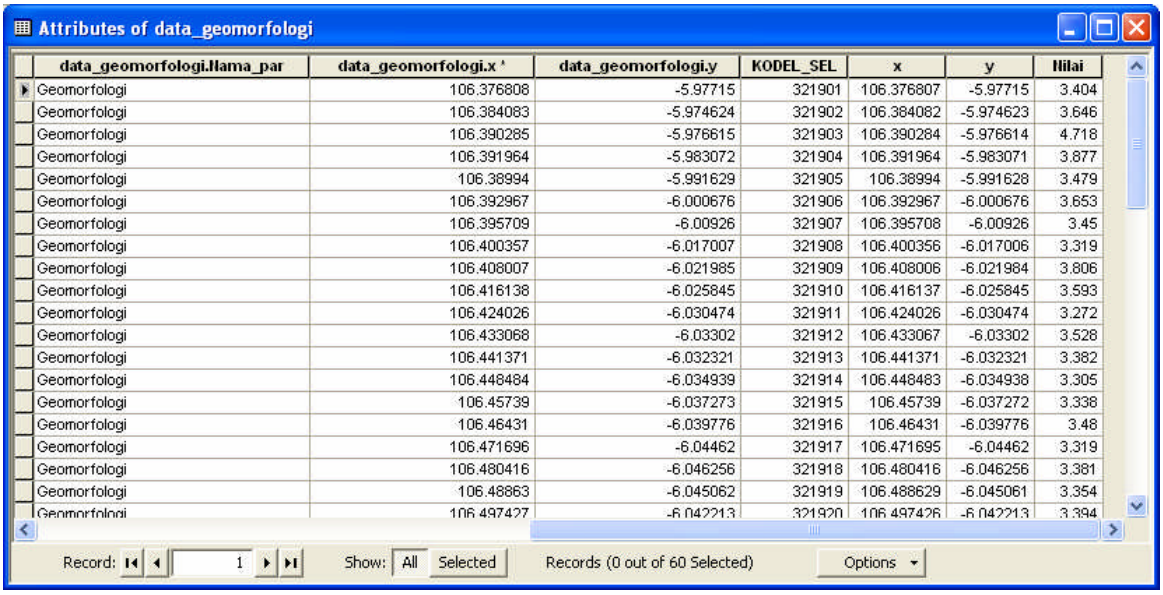


It will appear like the picture below. Select KODE_SEL on the Choose the field that the joint will of be based on. Click Ok.



Once completed, the geomorphological data in each cell is already available and can be used to determine the value of CVI.

6. To view the data geomorphology Data_Geomorfologi then right-click the file, select open attribute table, geomorphological data table will appear as below:



Attributes of data_geomorfologi

data_geomorfologi.Nama_par	data_geomorfologi.x	data_geomorfologi.y	KODEL_SEL	x	y	Nilai
Geomorfologi	106.376808	-5.97715	321901	106.376807	-5.97715	3.404
Geomorfologi	106.384083	-5.974624	321902	106.384082	-5.974623	3.646
Geomorfologi	106.390285	-5.976615	321903	106.390284	-5.976614	4.718
Geomorfologi	106.391964	-5.983072	321904	106.391964	-5.983071	3.877
Geomorfologi	106.38994	-5.991629	321905	106.38994	-5.991628	3.479
Geomorfologi	106.392967	-6.000676	321906	106.392967	-6.000676	3.653
Geomorfologi	106.395709	-6.00926	321907	106.395708	-6.00926	3.45
Geomorfologi	106.400357	-6.017007	321908	106.400356	-6.017006	3.319
Geomorfologi	106.408007	-6.021985	321909	106.408006	-6.021984	3.806
Geomorfologi	106.416138	-6.025845	321910	106.416137	-6.025845	3.593
Geomorfologi	106.424026	-6.030474	321911	106.424026	-6.030474	3.272
Geomorfologi	106.433068	-6.03302	321912	106.433067	-6.03302	3.528
Geomorfologi	106.441371	-6.032321	321913	106.441371	-6.032321	3.382
Geomorfologi	106.448484	-6.034939	321914	106.448483	-6.034938	3.305
Geomorfologi	106.45739	-6.037273	321915	106.45739	-6.037272	3.338
Geomorfologi	106.46431	-6.039776	321916	106.46431	-6.039776	3.48
Geomorfologi	106.471696	-6.04462	321917	106.471695	-6.04462	3.319
Geomorfologi	106.480416	-6.046256	321918	106.480416	-6.046256	3.381
Geomorfologi	106.48863	-6.045062	321919	106.488629	-6.045061	3.354
Geomorfologi	106.497427	-6.042213	321920	106.497426	-6.042213	3.394

Record: 1 Show: All Selected Records (0 out of 60 Selected) Options

7. Geomorphological data export by right-clicking the geomorphological data, choose Export, name the file.

V. INSTRUCTORS

1. Name : Sakka
   Email : sakka_psl@yahoo.com
   Mobile : +6281355635506
   Office : Hassanudin University

2. Name : Anggi Afif Muzaki
   Email : afif_muzaki@yahoo.co.id
   Mobile : +6285696952400
   Office : Bogor Agriculture University

TRAINING MODULE

DEVELOPMENT OF COASTAL VULNERABILITY INDEX

"DATA PROCESSING OF TREND SEA LEVEL CHANGES"

Compiled by :

M. Tri Hartanto

Erwin Maulana

BOGOR AGRICULTURAL UNIVERSITY, 2010

CONTENTS

I. Introduction

Sea-level rise is one of the parameters used in determining the vulnerability of coastal areas. This phenomenon will cause flood some coastal areas even able to submerge small island with a low slope in the time period is generally relatively long, so higher the sea level rise in a region and the sloping topography, it can be said the region are vulnerable. Determination of this process would require the observation of sea surface height information for a relatively long, so sometimes difficult to obtain accurate information for a variety of vast coastal areas such as Indonesia. Determination in situ sea level rise is done by measuring the water level with the tide gauge, since the development of satellite technology then this process can be observed by using satellite altimetry. Observation of sea level with tide gauge and satellite altimetry can certainly complement each other information about sea level rise, where these data can be combined (merged) and the reanalysis process.

Data trend of sea level changes can be obtained by satellite altimeters such as TOPEX/POSEIDON. Jason JASON 1 and 2 which can be downloaded at the site http://www.aviso.oceanobs.com/en/news/ocean-indicators/mean-sea-level/index.html. The resulting data format NetCDF (Network Common Data Form) using a grid system size $0,25^{o}$x $0,25^{o}$ or approximately 27,8 km x 27,8 km and is available from October 1992 to July 2009 with worldwide coverage. In **Figure 1** can be seen that the global sea level rise (GMSL) of approximately 3,32 mm/year, calculated after removing the annual signal and semi-annual seasonal patterns include screening, atmospheric pressure, sea baroclinic process and the influence of wind. Filter 2 is applied monthly to the blue dots, while the 6-month filter used on the red curves and applying the correction to postglacial rebound (-0.3 mm/year). Calculation of global sea level rise uncertainty analysis of each correction altimetry and comparison with tide gauge trends that give an error of about 0,6 mm/year at 90% confidence interval.

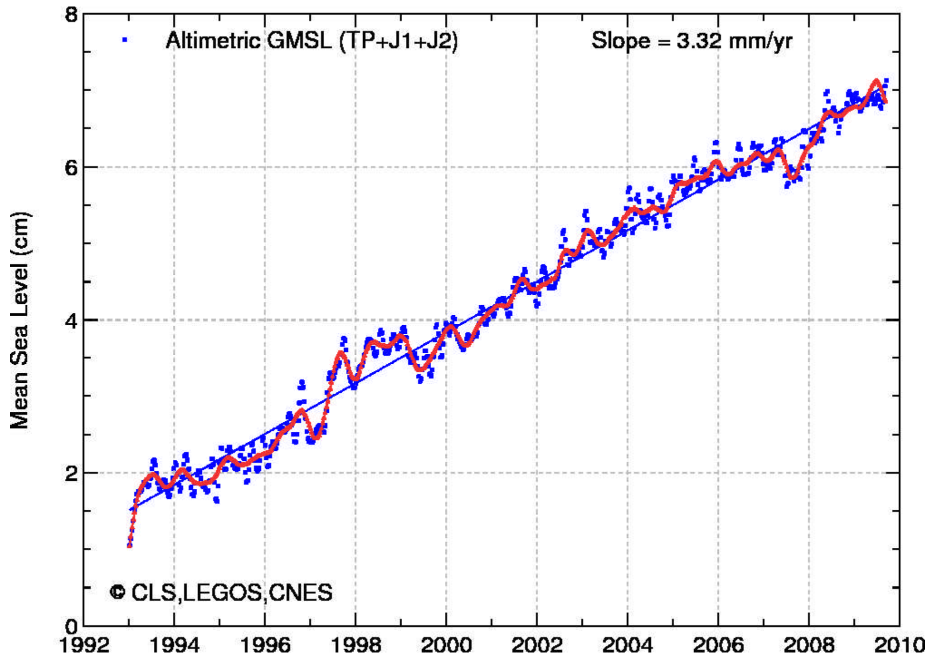


Figure 1. Trends in global sea level rise from AVISO (October 1992 - July 2009).

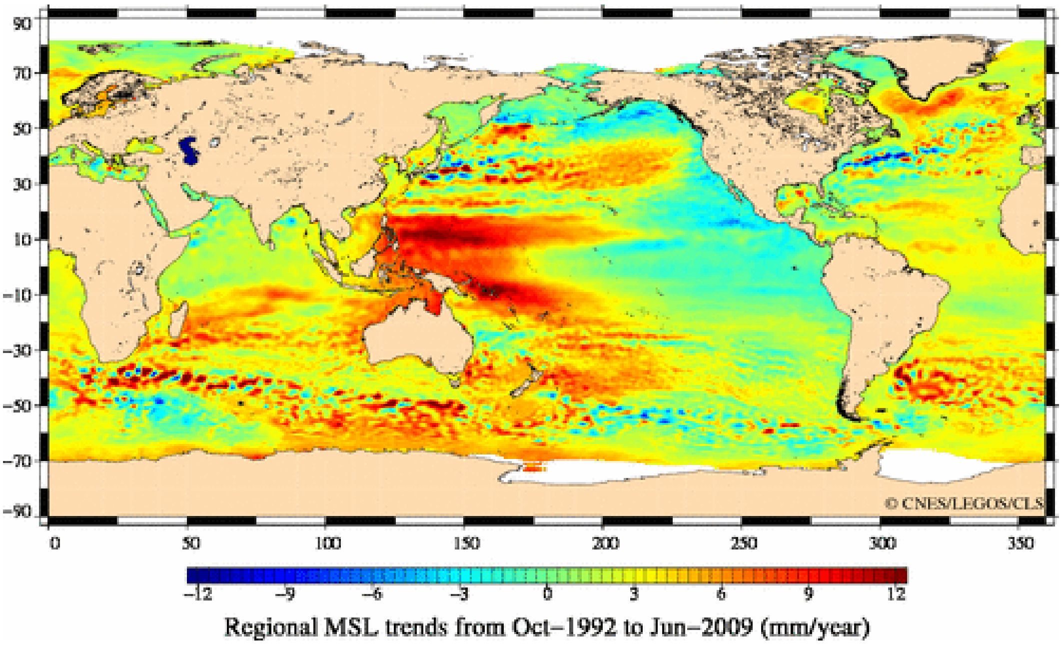


Figure 2. Regional MSL Trends from AVISO (October 1992 - July 2009).

II. Objective

The objective of this module is that each participant is able to do the acquisition, processing and integrating data trend of relative sea level rise to the determination of Coastal Vulnerability Index (CVI).

III. Data Processing

Data processing changes in sea level trends (Sea Level Trend) can be done using two methods. Method 1 is the process of manual that is quite effective for data that is not too large. Method 2 is much more effective for large data because the process is assisted with programming. The use of these methods is also determined by the ability of participants in particular an understanding of the basics of BASIC programming language. The second method starts by extracting data netcdf format (*.nc) by using the ODV (Ocean Data View) into data formatted text (*. txt) in a wider area than the desired limit. This was done so that the interpolation results for the better. For the purposes of more detailed information as input in a cell at the beach it is necessary to interpolate to the size of spatial grid can be adjusted to the desired cell size by using Surfer (eg 1 km x 1 km). The result is truncated interpolation (cropping) as the desired area and exported into XYZ format data using Global Mapper. The last to enter the cell closest to the shoreline then be overlaid with coastline cells and digitized by using Surfer.

Method 2 performed after interpolation with Surfer and then Program 1 is used to determine croping area after interpolated, where the program lines can be seen in **Section VIII**. Results from Program 1 as input to Program 2 which run with Macro MS. Excel where the output of the nearest value in the cell the coastal. The overall result of this process is made in a table that will serve as input in the process of data integration in GIS. The data processing stages can be viewed in flow chart in **Figure 3**.

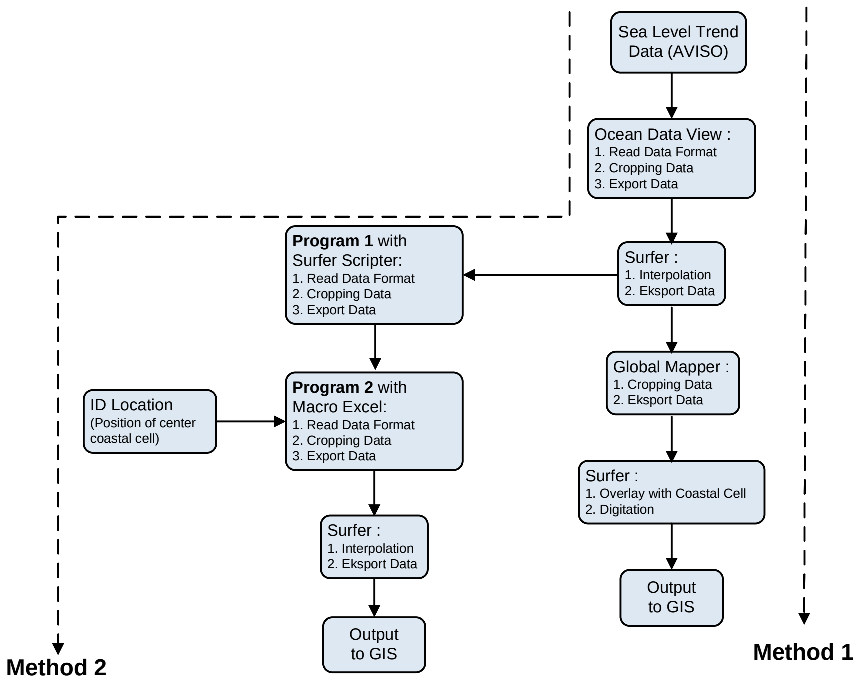
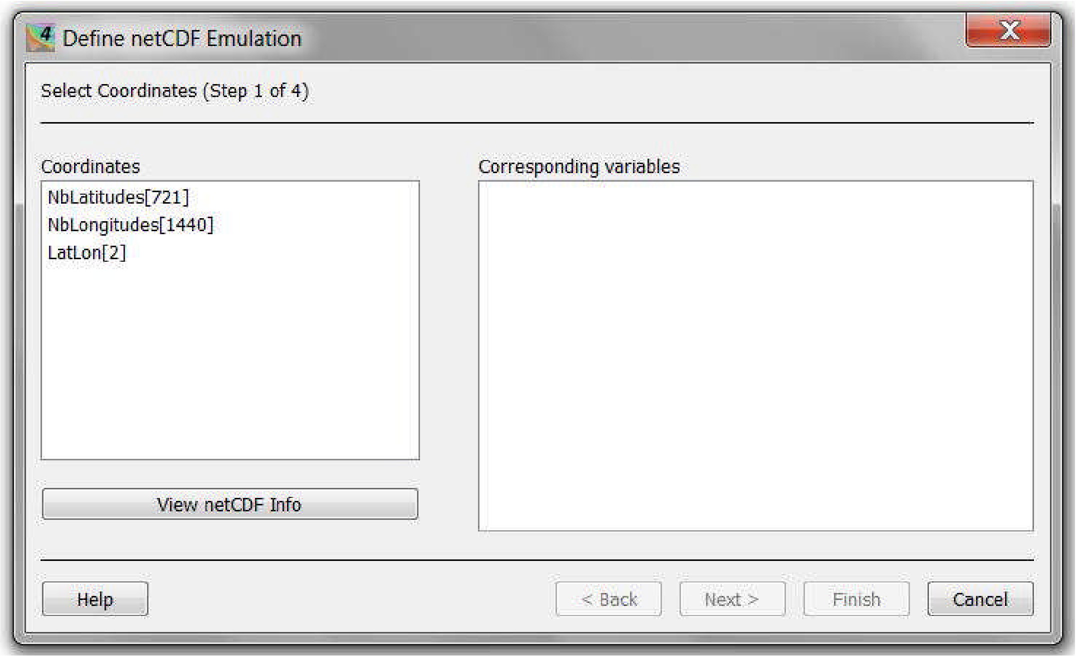


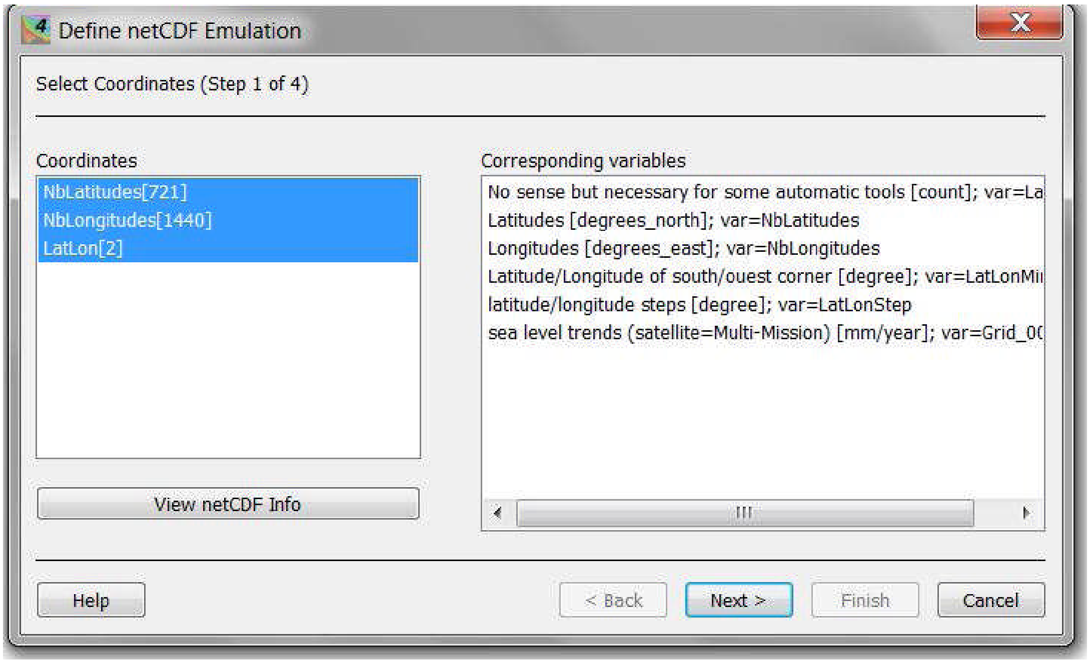
Figure 3. Flow Chart of Sea Level Trends Data Processing to GIS Integration data.

IV. Extract Sea Level Trend Data in Netcdf format (*. nc) with Ocean Data View (ODV)

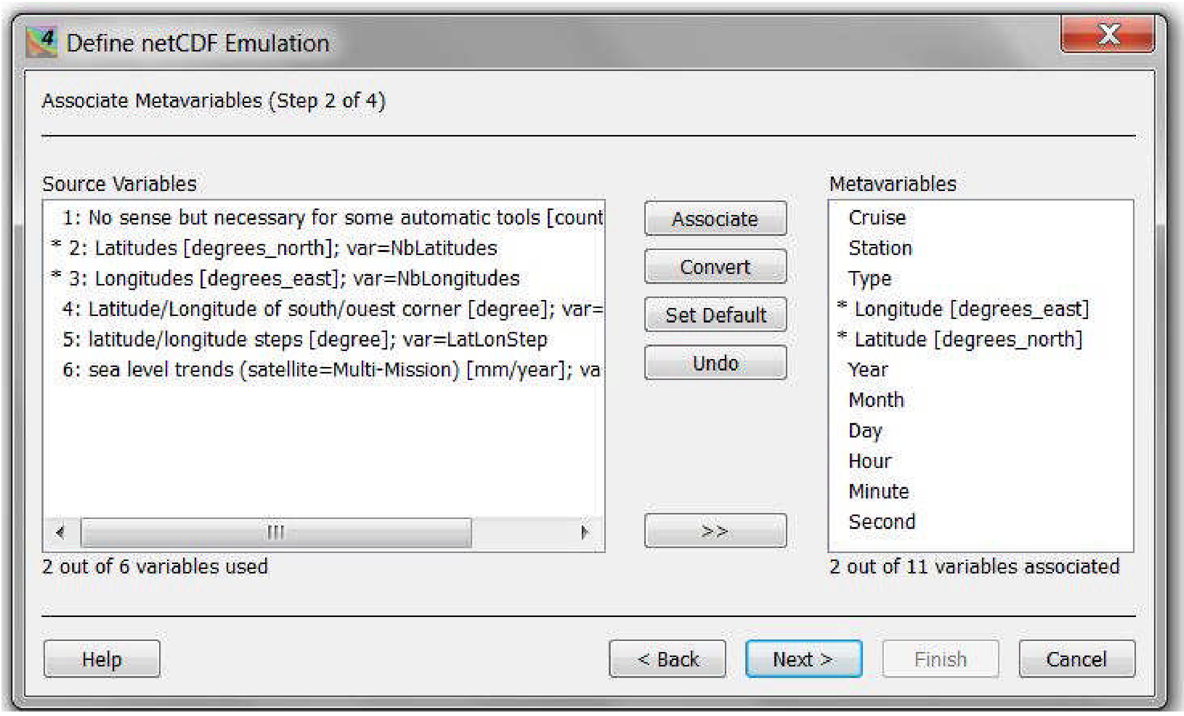
1. Open file MSL_Map_MERGED_Global_IB_RWT_NoGIA_Adjust.nc with double-click on the file, so that the display will appear as follows :



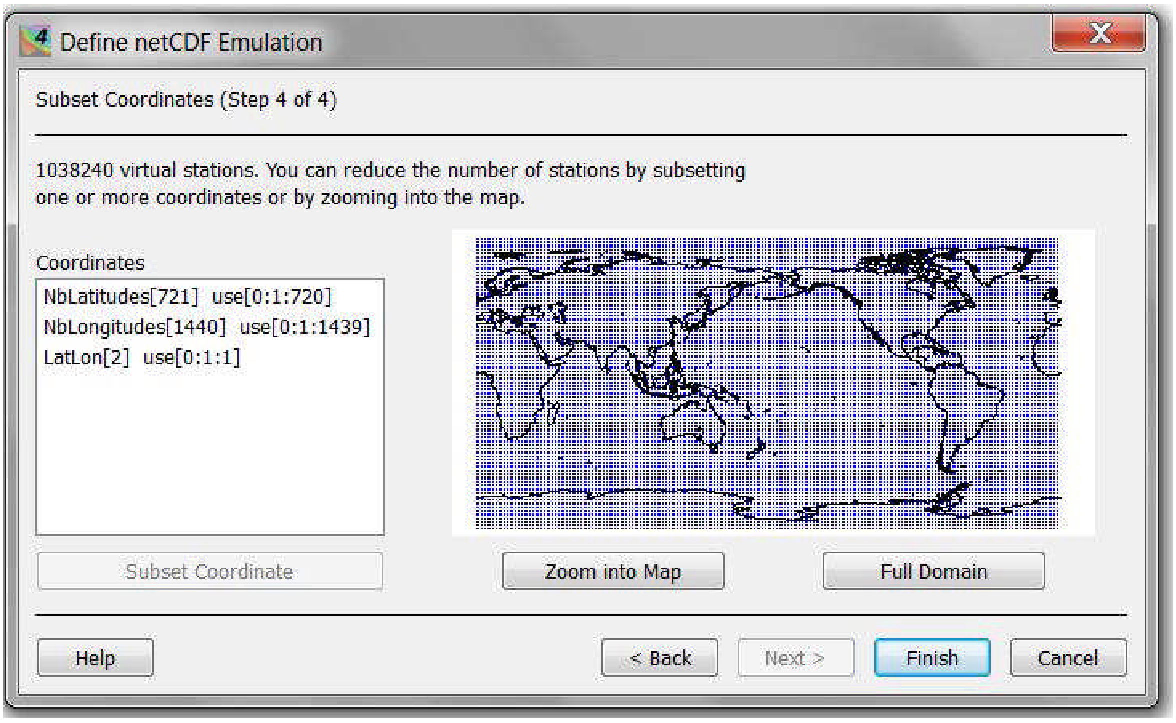
2. Select all variable in part ***Coordinates*** by pressing Ctrl and click one by one variable or block with the mouse cursor so that all the variables selected and will appear as follows :



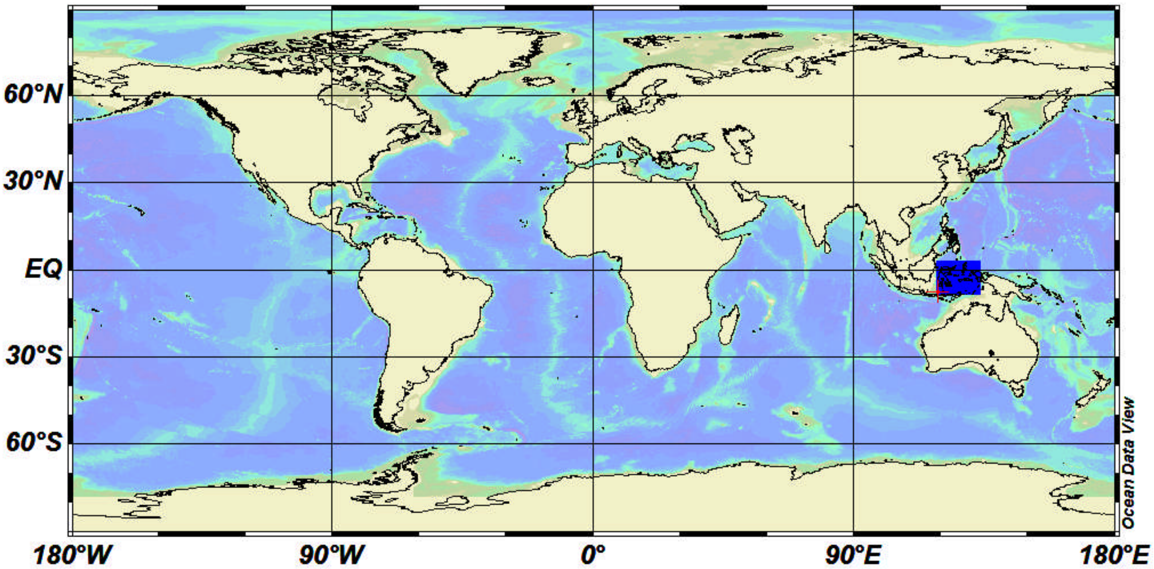
3. Click Next and will appear equating the variables that exist in ODV (Metavariabel) and the data (source variable) which is marked with * following :



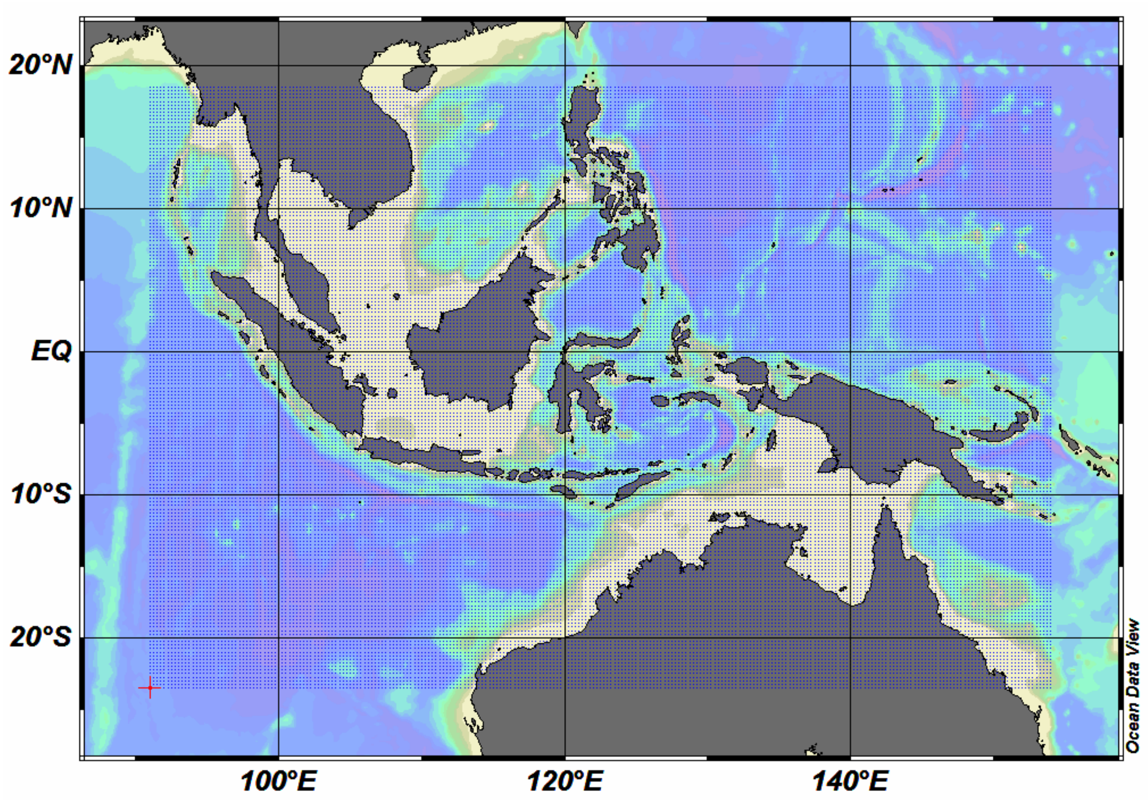
4. Click Next and select the **Use Dummy Variable** and click Next it will display showing the distribution of data stations were as follows:



5. Select **Zoom into a Map** and set appropriate limits red color desired area, this needs to be done so in the process of reading the data becomes faster because the ODV does not need to read the data overall (global). Having given the limits of the desired area, double click on the domain and then click Finish and press F8 it will display :

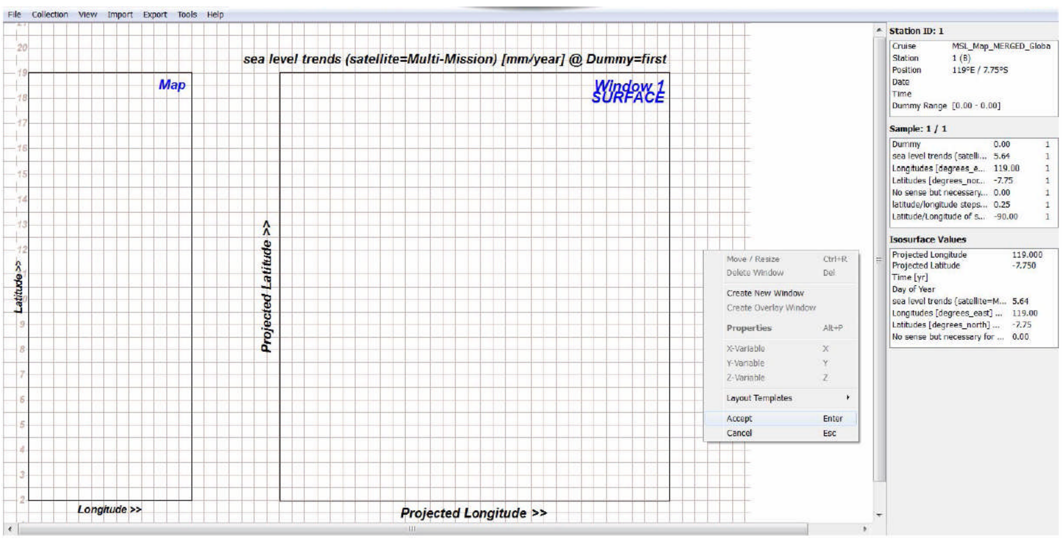


6. Right click on the map and select **Full Domain**, it will display the distribution of stations according to the area that we want the following:

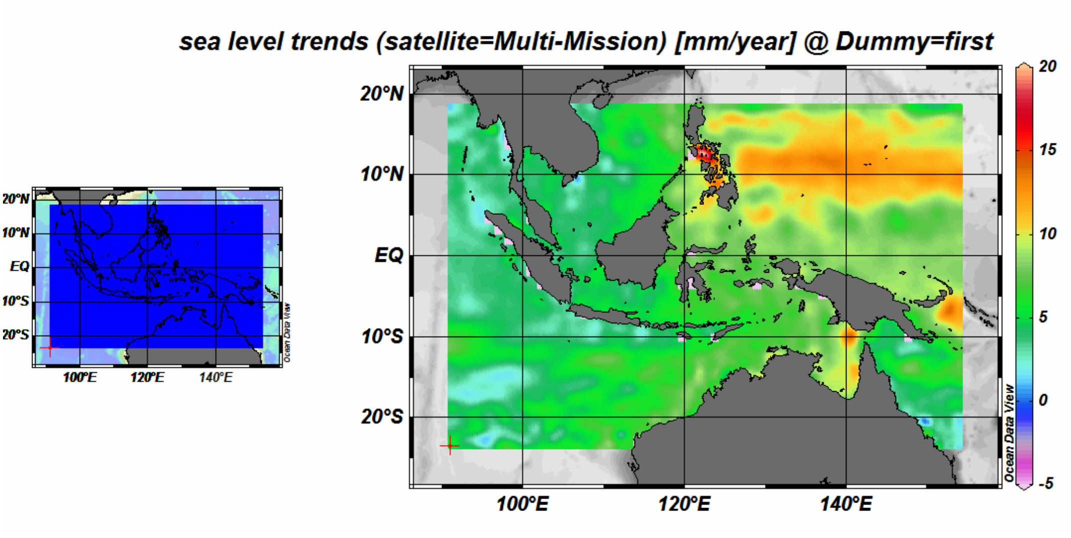


7. To obtain the text data from the distribution of stations according to the selected area, then click **Export** and select **ODV spreadsheet** and save according to the desired name.

8. To create a surface distribution, right-click outside the map and select **Layout Templates** and **Surface Windows** or can simply press **F12** and will appear as follows:



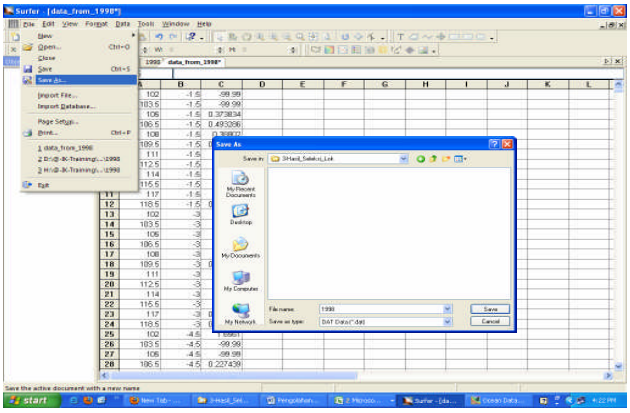
9. Right click and select **Accept** so the display appears as follows:



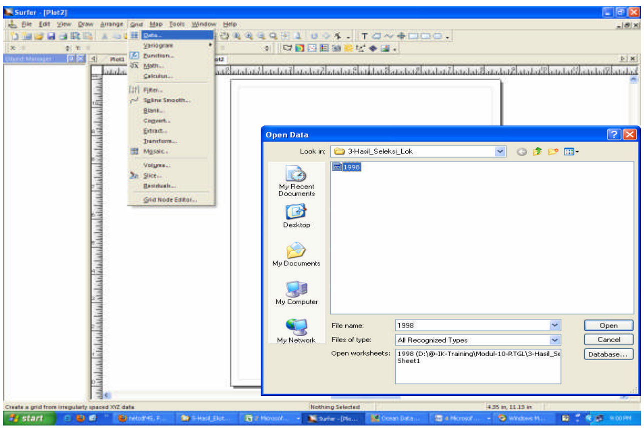
10. To make the better visualization for surface distribution it is necessary to perform interpolation process with right click on distribution maps and select **Properties** and select **Display Style** and then select **DIVA Gidding** on gridded field and set the X scale Length (permile) and Y scale Length (permile) until distribution looks optimal. Set the contour interval on the **Contours** and **Contours Do** check to make contours.

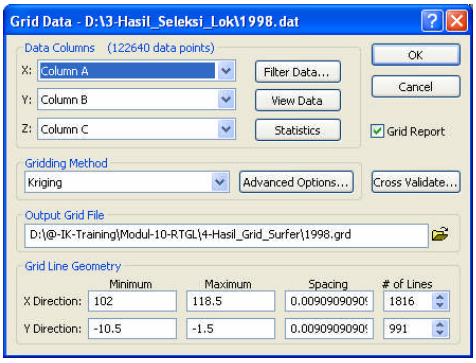
V. Interpolation Data Grid with Surfer

1. Open the data that has been extracted in the format * txt in Excel. Selection of data on the worksheet by selecting File and click New and then select Worksheet. The data will be used is longitude, latitude and Sea Level Rise, where is the longitude column A, column B is the latitude and column C is the Sea Level Rise. After the selected data and then save it in txt format in folder * \ 2-Data_Eksport_ODV.



2. The data already in the format *txt then do interpolation with open the Surfer worksheet click File select New Plot. After the worksheet and then use the command appears Grid and select data. So it can be seen the picture as follows:

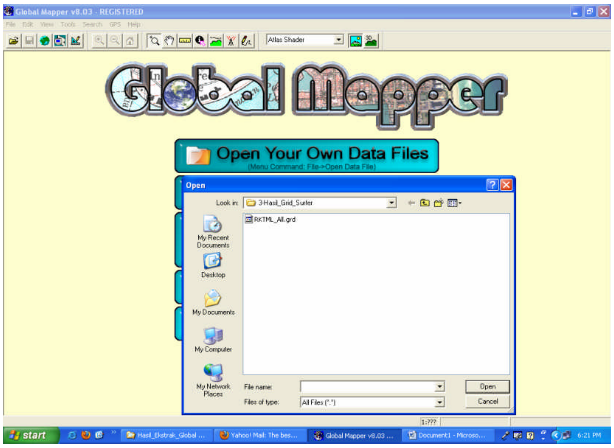


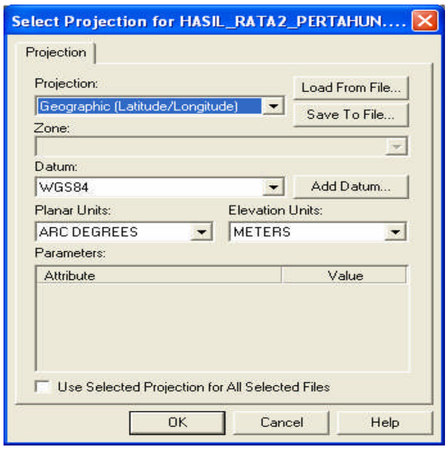


3. Choose x as column A, column B and y as z as column C, for we use Kriging gridding method, output Grid file to the address file to save. Grid line Geometry we just simply replace spacing with spatial grid size to 1 km x 1 km due in the form of degrees we change to a decimal degree with the value of x 0.009090909091 0.009090909091 spacing, after all occupied click OK.

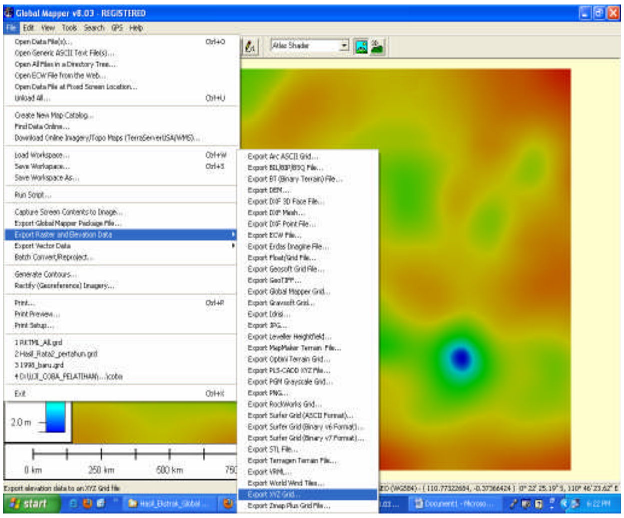
VI. Cut Boundary Area and Export Data with Global Mapper

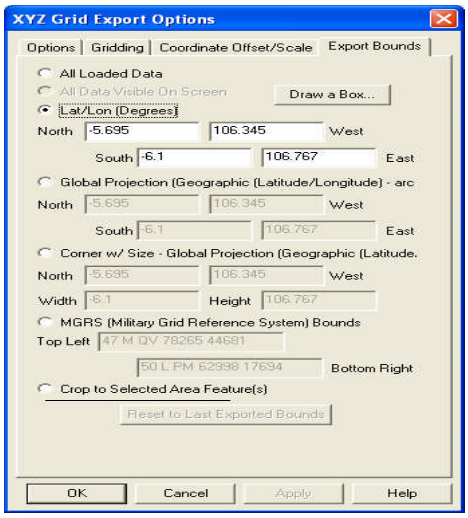
1. After Kriging process is complete and then converting the Grid into ASCII format (xyz) by clicking the crop area will be used, by opening the grid in Global Mapper program. Click **Open Your Own Data Files** and select the data grid that result from surfer and we can be seen as an image as follows:





2. Click *File* and select *Eksport Raster File and Elevation Data* and then *Export XYZ Grid* and click OK and we can be seen display as follows:

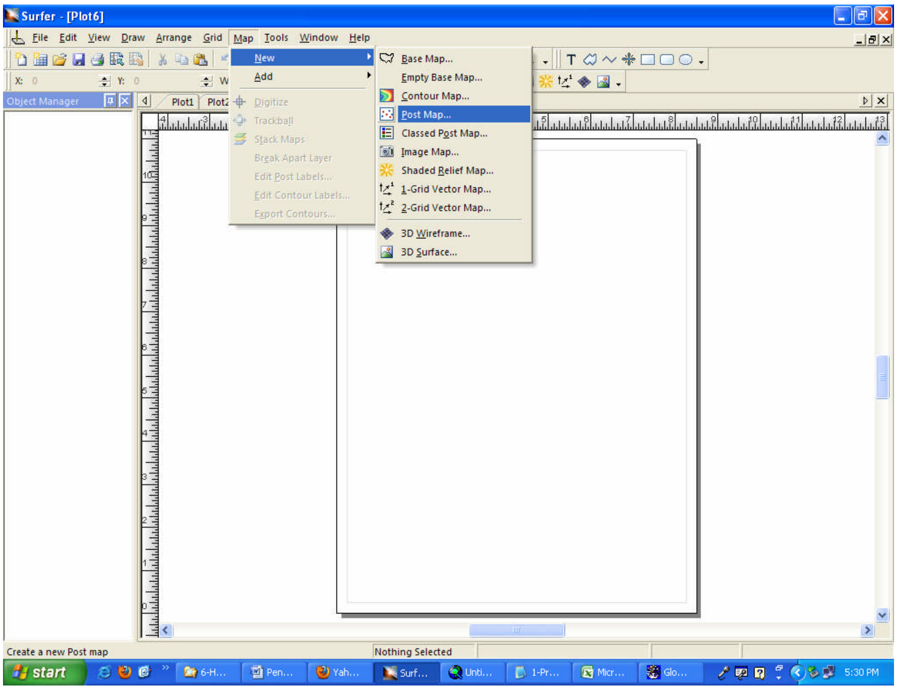




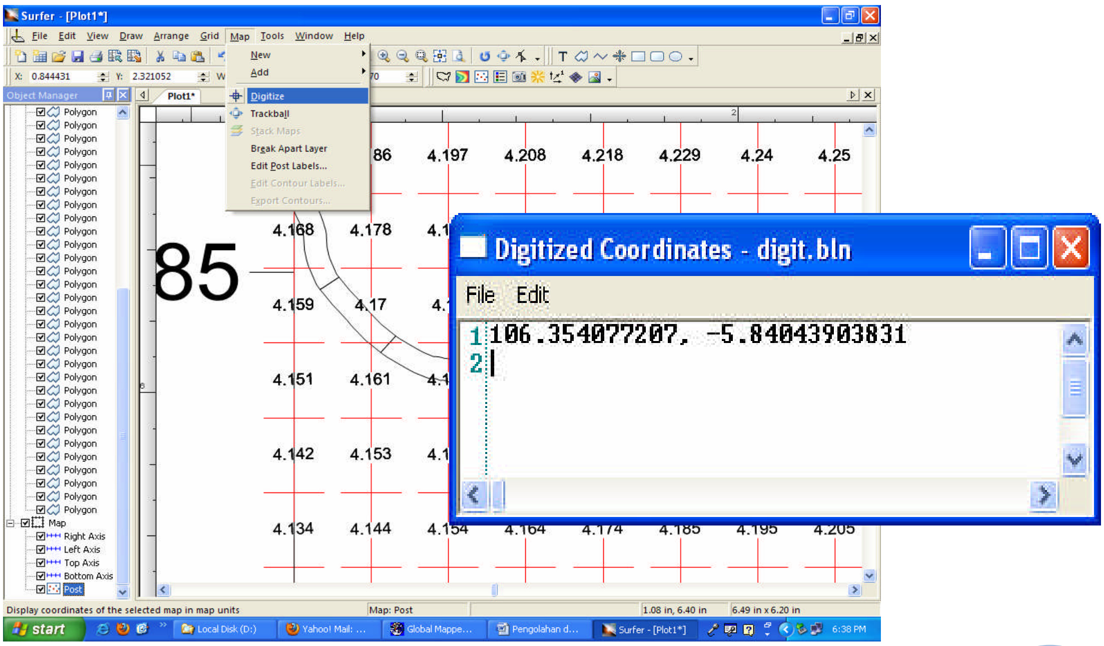
Change Lat/Lon, Global Projection, Corner w / size-Global Project to coordinate the desired limit in accordance with the observation domain. Then press OK and Save the file in a format * txt.

VII. Find the Nearest Point of Sea Level Trends Data on Central Coastline Cell

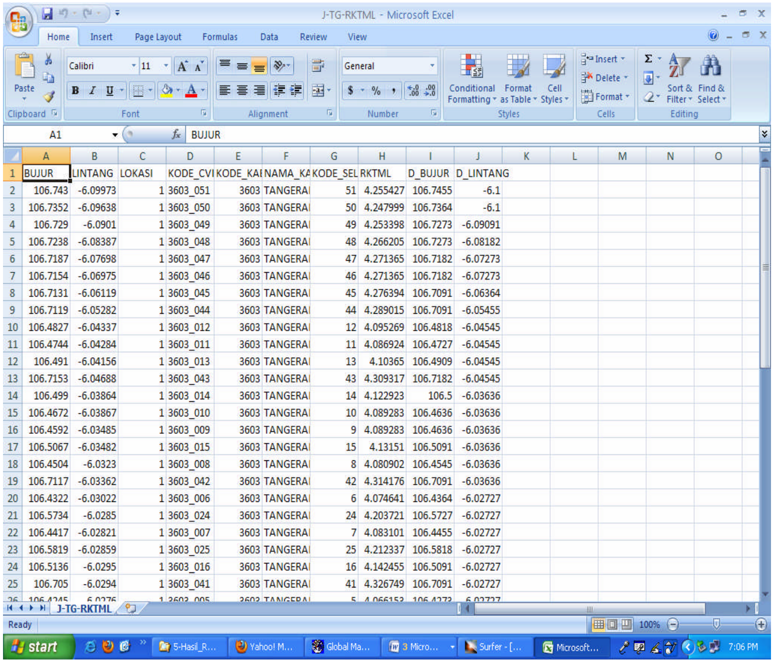
1. To determine the value of Sea Level Rise position closest to the cell which is on the beach every year for the cell data to be overlay with data points Sea Level Rise, using Surfer software. First, open Sea Level Rise data poin on menu Map then New and then Post Map and will appear as follows:



Second, to open a data cell by selecting File then Import and then Open file data cell. It can be seen as following picture:



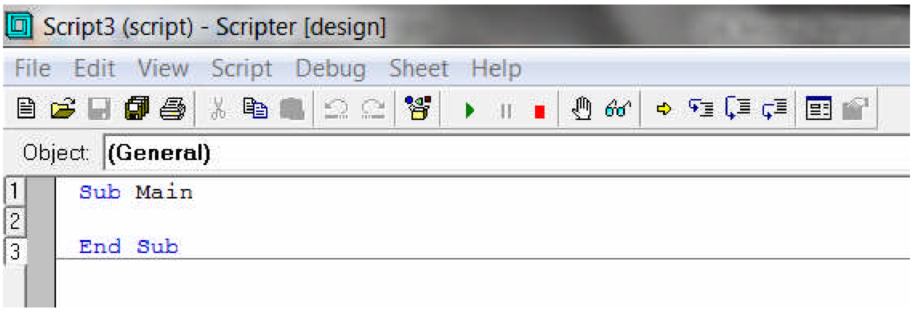
To be able to see the point of our stations can use the **Digitize** command with click Map then Digitize and then click on the station point, having to point the coordinates of Sea Level Rise with the closest distance, and then input the high value of Sea Level Rise and depth coordinates of integration format. It can be seen as following picture:



BUJUR	LINTANG	LOKASI	KODE_CVI	KODE_KAI	NAMA_KA	KODE_SEL	RKTML	D_BUJUR	D_LINTANG
106.743	-6.09973	1	3603_051	3603	TANGERAI	51	4.255427	106.7455	-6.1
106.7352	-6.09638	1	3603_050	3603	TANGERAI	50	4.247999	106.7364	-6.1
106.729	-6.0901	1	3603_049	3603	TANGERAI	49	4.253398	106.7273	-6.09091
106.7238	-6.08387	1	3603_048	3603	TANGERAI	48	4.266205	106.7273	-6.08182
106.7187	-6.07698	1	3603_047	3603	TANGERAI	47	4.271365	106.7182	-6.07273
106.7154	-6.06975	1	3603_046	3603	TANGERAI	46	4.271365	106.7182	-6.07273
106.7131	-6.06119	1	3603_045	3603	TANGERAI	45	4.276394	106.7091	-6.06364
106.7119	-6.05282	1	3603_044	3603	TANGERAI	44	4.289015	106.7091	-6.05455
106.4827	-6.04337	1	3603_012	3603	TANGERAI	12	4.095269	106.4818	-6.04545
106.4744	-6.04284	1	3603_011	3603	TANGERAI	11	4.086924	106.4727	-6.04545
106.491	-6.04156	1	3603_013	3603	TANGERAI	13	4.10365	106.4909	-6.04545
106.7153	-6.04688	1	3603_043	3603	TANGERAI	43	4.309317	106.7182	-6.04545
106.499	-6.03864	1	3603_014	3603	TANGERAI	14	4.122923	106.5	-6.03636
106.4672	-6.03867	1	3603_010	3603	TANGERAI	10	4.089283	106.4636	-6.03636
106.4592	-6.03485	1	3603_009	3603	TANGERAI	9	4.089283	106.4636	-6.03636
106.5067	-6.03482	1	3603_015	3603	TANGERAI	15	4.13151	106.5091	-6.03636
106.4504	-6.0323	1	3603_008	3603	TANGERAI	8	4.080902	106.4545	-6.03636
106.7117	-6.03362	1	3603_042	3603	TANGERAI	42	4.314176	106.7091	-6.03636
106.4322	-6.03022	1	3603_006	3603	TANGERAI	6	4.074641	106.4364	-6.02727
106.5734	-6.0285	1	3603_024	3603	TANGERAI	24	4.203721	106.5727	-6.02727
106.4417	-6.02821	1	3603_007	3603	TANGERAI	7	4.083101	106.4455	-6.02727
106.5819	-6.02859	1	3603_025	3603	TANGERAI	25	4.212337	106.5818	-6.02727
106.5136	-6.0295	1	3603_016	3603	TANGERAI	16	4.142455	106.5091	-6.02727
106.705	-6.0294	1	3603_041	3603	TANGERAI	41	4.326749	106.7091	-6.02727

VIII. Program to Extracts, Cropping, and Export Sea Level Trend Data After Interpolated With Surfer

Run the Scipter Scripter in Surfer, then the initial display will appear as follows:



On the Edit menu choose Select All, then copy the program lines below and paste it in sheet scipt. Furthermore, to perform program execution (run) click on the icon or select Run Script menu or by pressing F5 on the keyboard. Be sure and adjust the location of the necessary data directory data in the form of ODV export results are in accordance with the location of the directory on line program. Next specify the storage location of the executable program that has been interpolated grid data.

```
Sub Main()

' SETTING SURFER
On Error Resume Next 'Turn off error reporting.
Set SurferApp = GetObject(, "Surfer.Application")
If Err.Number <> 0 Then
 Set SurferApp = CreateObject("Surfer.Application")
End If
On Error GoTo 0 'Turn on error reporting.
If SurferApp.Windows.Count = 0 Then SurferApp.Documents.Add (srfDocPlot)
SurferApp.Visible = True
SurferApp.WindowState = srfWindowStateNormal
SurferApp.Width = 1024
SurferApp.Height = 200
SurferApp.Windows(1).Zoom (srfZoomPage)

 FL$ = "RKTML"

 DDIRD$ = "F:\@-IK-Training\Modul-08-RKTML\3-Hasil_Grid_Surfer\"
 DDIRH$ = "F:\@-IK-Training\Modul-08-RKTML\4-Hasil_Ekstrak_Grid_5_Lok\"

 FLO$ = DDIRD$ + "RKTML_All.grd"

 'BATAS WILAYAH
 SurferApp.GridExtract(InGrid:=FLO$, r1:=705, r2:=749, c1:=534, c2:=581, _
 OutGrid:=DDIRH$ + "Tg-" + FL$ + ".txt", _
 OutFmt:=srfGridFmtXYZ)
 Set doc = SurferApp.Documents.Open(Filename:=DDIRH$ + "Tg-" + FL$ + ".txt")
 doc.SaveAs(FileName:=DDIRH$ + "Tg-" + FL$ +
".txt",FileFormat:=srfSaveFormatDat,Options:="Delimiter=comma;TextQualifier=none")
 doc.Close(SaveChanges:=srfSaveChangesNo)
```

```
End Sub
```

IX. Program to Determine the Nearest Distance to Coastline Cell Using Macro Excel

```
Sub Main()

Dim DDIRK$, DDIRD$, NM$, HBJR$, HLNT$, HDDD$, T$, PAR$, KLOK$, KCVI$
Dim I, JD, JJ, J, DJRK, DBJR, DLNT, JRK
Dim IKKAB$(100), INKAB$(100), IKSEL$(100), IXX(100), IYY(100), DIXX$(100), DIYY$(100),
IKLOK$(100), IKCVI$(100)

T$ = Chr(9)

DDIRK$ = "F:\@-IK-Training\Modul-08-RKTML\4-Hasil_Ekstrak_Grid_5_Lok\"
DDIRD$ = "F:\@-IK-Training\Modul-08-RKTML\5-Hasil_Running_Jarak_Min\"
DDIRID$ = "F:\@-IK-Training\Modul-08-RKTML\ID_Lok\"

For I = 1 To 5
 If I = 1 Then NM$ = "BK"
 If I = 2 Then NM$ = "JK"
 If I = 3 Then NM$ = "PK"
 If I = 4 Then NM$ = "SB"
 If I = 5 Then NM$ = "TG"

 Open DDIRID$ + NM$ + "_ID.TXT" For Input As 1
 JD = 0
 Line Input #1, PAR$
 While Not EOF(1)
  JD = JD + 1
  Input #1, XX$, YY$, KLOK$, KCVI$, KKAB$, NKAB$, KSEL$
  IKKAB$(JD) = KKAB$
  INKAB$(JD) = NKAB$
  IKSEL$(JD) = KSEL$
  IKLOK$(JD) = KLOK$
  IKCVI$(JD) = KCVI$
  IXX(JD) = Val(XX$)
  DIXX$(JD) = XX$
  IYY(JD) = Val(YY$)
  DIYY$(JD) = YY$
 Wend
 JJ = JD
 Close #1

 Open DDIRD$ + "J-" + NM$ + "-RKTML.TXT" For Output As #2
  Print #2, "BUJUR" + T$ + "LINTANG" + T$ + "LOKASI" + T$ + "KODE_CVI" + T$ +
"KODE_KAB" + T$ + "NAMA_KAB" + T$ + "KODE_SEL" + T$ + "RKTML" + T$ + "D_BUJUR" +
T$ + "D_LINTANG"
 For J = 1 To JJ
  Open DDIRK$ + NM$ + "-RKTML.TXT" For Input As #1
  DJRK = 99999
  While Not EOF(1)
   Input #1, BJR$, LNT$, DDD$
   DBJR = Val(BJR$)
   DLNT = Val(LNT$)
   JRK = Sqr(((DBJR - IXX(J)) ^ 2) + ((DLNT - IYY(J)) ^ 2))
   If JRK < DJRK Then
    DJRK = JRK
    HBJR$ = Trim(BJR$)
```

```
    HLNT$ = Trim(LNT$)
    HDDD$ = Trim(DDD$)
   End If
  Wend
  Print #2, DIXX$(J) + T$ + DIYY$(J) + T$ + IKLOK$(J) + T$ + IKCVI$(J) + T$ + IKKAB$(J) + T$ +
INKAB$(J) + T$ + IKSEL$(J) + T$ + HDDD$ + T$ + HBJR$ + T$ + HLNT$
  Close #1
 Next J
 Close #2

Next I

End Sub
```

X. INSTRUCTORS

3. Name : M. Tri Hartanto

Email : tri_itk@yahoo.com

Mobile : +6281314402527

Office : Laboratory of Oceanography
Marine Science and Technology Departement
Faculty of Fisheries and Marine Science
Bogor Agricultural University

4. Name : Erwin Maulana

Email : erwin_maulana2002@yahoo.com

Mobile : +6285694901356

Office : Laboratory of Oceanography
Marine Science and Technology Departement
Faculty of Fisheries and Marine Science
Bogor Agricultural University

TRAINING MODULE

DEVELOPMENT OF COASTAL VULNERABILITY INDEX

“DATA PROCESSING OF TIDAL RANGE”

Compiled by :

Asyari Adisaputra

M. Tri Hartanto

BOGOR AGRICULTURAL UNIVERSITY, 2010

CONTENTS

I. INTRODUCTION

Tide is one of the parameters used to determination of coastal vulnerability index, which information about vertical difference between high tide and low tide is called the tidal range that contribute to coastal inundation hazard. Coastal which have a high tidal range generally have a low vulnerability to impact of inundation because sea level rise.

Information about the tides can be obtained through measurements on the field or using the tidal prediction. Along with the improvement of science and technology, so information about the tide can be obtained via the internet in the form of real-time data or model result. Based on the periodic characteristic nowadays sea surface level because tides can be predicted / modeled more accurately in the long time range, so the highest range of tidal can be known.

More information about sea surface level can be accessed from http://uhslc.soest.hawaii.edu/uhslc/data.html which produced by Joint Archive for Sea Level (JASL), the official of JASL now is Global Sea Level Observing System (GLOSS) data center. In Indonesia BAKOSURTANAL became contributor of this data. The other information about sea level can be accessed from http://www.ioc-sealevelmonitoring.org/list.php which is global monitoring station services for measurement of real time sea surface. These service are part of the IOC programme consist of (i) the Global Sea Level Observing System Core Network; dan (ii) the networks under the regional tsunami warning systems in the Indian Ocean (IOTWS), North East Atlantic & Mediterranean (NEAMTWS), Pacific (PTWS) and the Caribbean (CARIBE-EWS). In Indonesia contributor of data is BAKOSURTANAL where there are 19 stations scattered in the Indonesian seas.

In this training module, tidal information obtained through the prediction with the tide prediction model global NAOTIDE which is assimilation from TOPEX/POSEIDON data and global and regional model around of Japan. This model was developed by Matsumoto, K., T. Takanezawa, and M. Ooe and run with the FORTRAN software.

II. OBJECTIVE

The objective of this module is each of participant is be able to prediction and integrate tidal data to determination of Coastal Vulnerability Index (CVI).

III. DATA PROCESSING STEPS

Tide prediction begins with search the central point coordinate of the cell that we created earlier. The central point will be input in the tidal prediction using NAOTIDE. After getting the central point of the cell, NAOTIDE will be running on FORTRAN software. In this program you only needs to changed coordinates the place to had tide prediction (center point of cell), time prediction, and output file name from this program. After running, the result of this program will be printed on the file that had been definite early. The result of prediction is hourly sea level, then to obtain the tidal range we calculate the difference between the highest water level (high water) and lowest (low water). The overall result of this process is made in a table that will serve as input in the data integration in GIS process. The steps of general processing data can be seen in **Figure 1.**

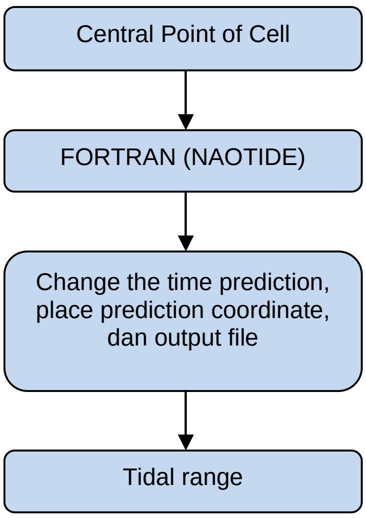
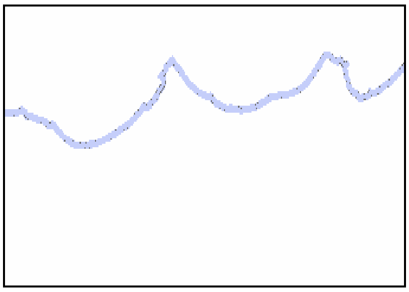
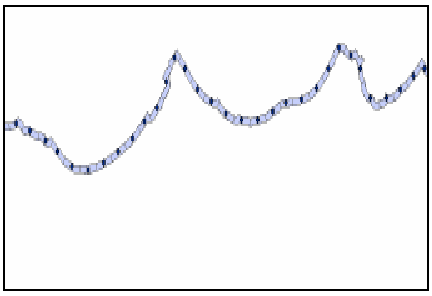


Figure 1. Flowchart tide prediction data

IV. TIDAL PREDICTION USING NAOTIDE

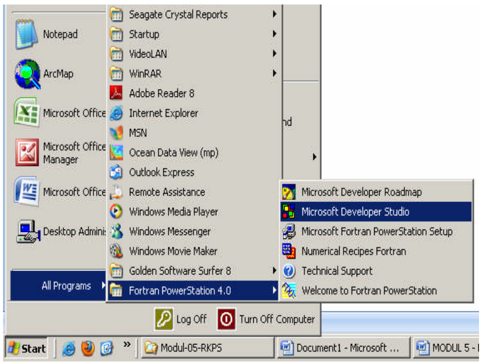
1. Before predict the tide in a place, we must determine center point of cell was made early, because input to prediction the tidal is coordinate of the point.

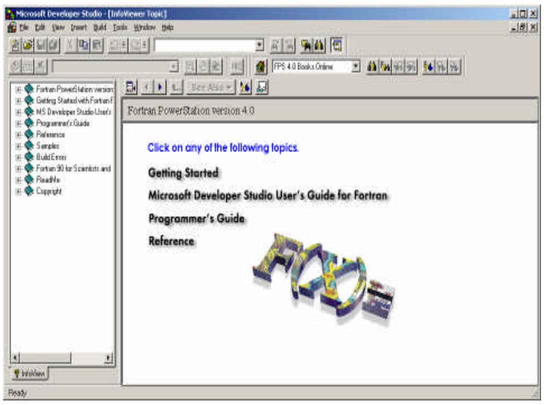




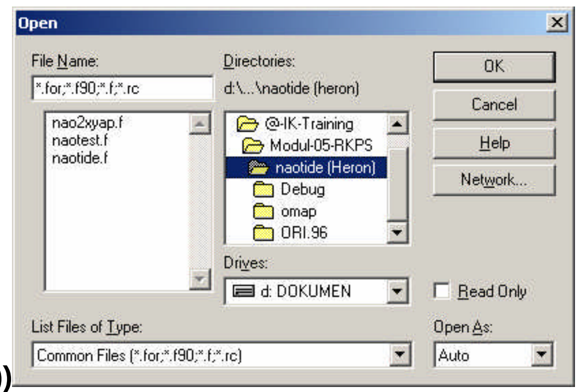
Coordinate of the point to be searched the tidal can be seen in **D:\@-IK-Training\Modul-05-RKPS\1-ID_Sel\Point_Tide_Tg.txt**

2. Open *fortran powerstation 4.0* software ⟶ *Microsoft Developer Studio*



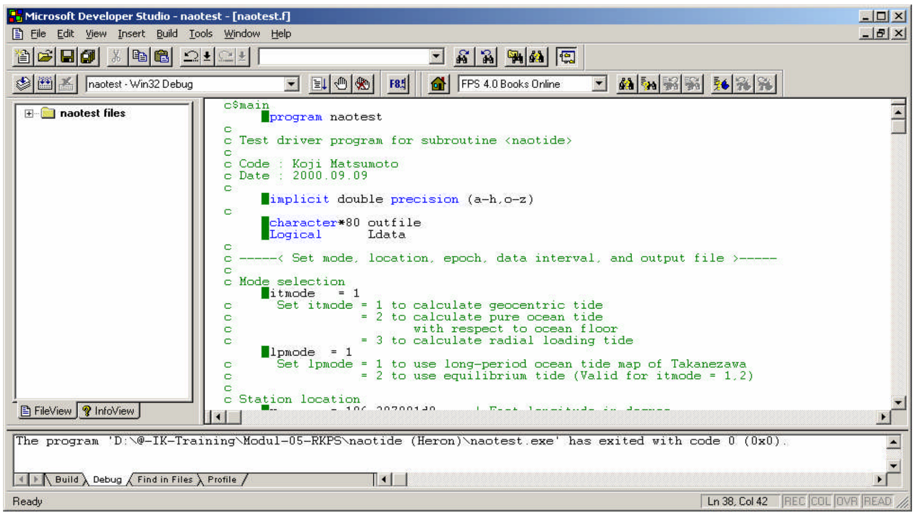


3. Choose open ( ) then choose directory where we save the folder **naotide (D:\@-IK-Training\Modul-05-KPS\naotide(Heron))**



After that, then will appear three choices after we choose naotide, (*nao2xyap.f*, *naotest.f*, *naotide.f*) then we choose *naotest.f*.

4. Then will appear listing program from that file, we only have to change tide prediction time, tide coordinate and output file name.



- Change tide prediction time

> Function of this program is change the of start prediction time.
>
> *Start epoch*
> *iyear1 = 2008 ! year*
> *imon1 = 12 ! month*
> *iday1 = 1 ! day*
> *ihour1 = 0 ! hour*
> *imin1 = 0 ! minute*

> Function of this program is change the end of prediction time.
>
> *End epoch*
> *iyear2 = 2008 ! year*
> *imon2 = 12 ! month*
> *iday2 = 15 ! day*
> *ihour2 = 0 ! hour*
> *imin2 = 0 ! minute*

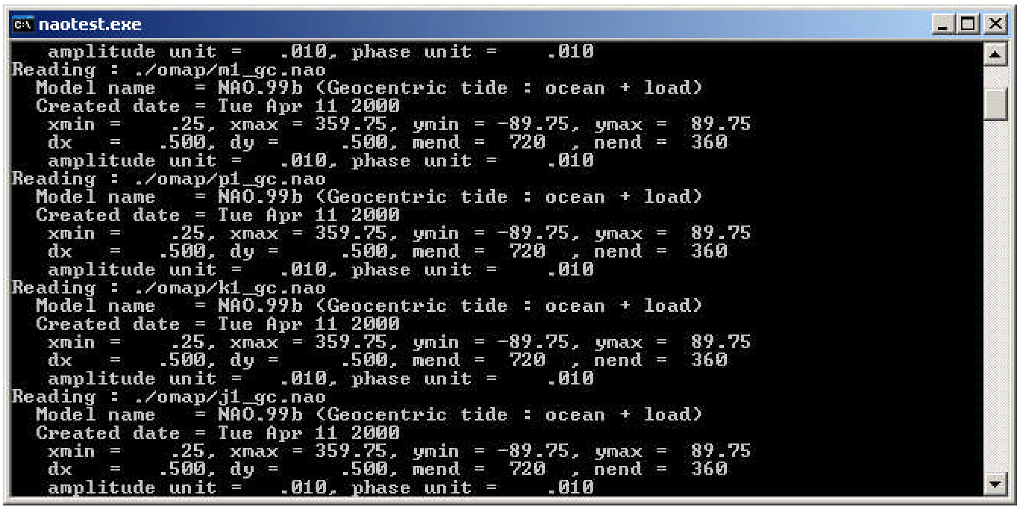
- Change tide coordinate

> Function of this program is change the station of tidal
>
> *Station location*
> *x = 106.397991d0 ! East longitude in degree*
> *y = -6.007711d0 ! North latitude in degree*

- Change output file name

> Function of this program is change the output file name
>
> *Output file name*
> *outfile = 'TideTg1.out'*

5. After all that we change, choose compile then after the *compile* ( ) done choose *build* ( ). After build is done choose sign *go* ( ) to running the raw program. Then will appear the running program.




```
   amplitude unit =    .010, phase unit =     .010
Reading : ./omap/m1_gc.nao
  Model name    = NAO.99b (Geocentric tide : ocean + load)
  Created date = Tue Apr 11 2000
   xmin =     .25, xmax = 359.75, ymin = -89.75, ymax =  89.75
   dx    =   .500, dy =      .500, mend =  720  , nend =  360
   amplitude unit =    .010, phase unit =     .010
Reading : ./omap/p1_gc.nao
  Model name    = NAO.99b (Geocentric tide : ocean + load)
  Created date = Tue Apr 11 2000
   xmin =     .25, xmax = 359.75, ymin = -89.75, ymax =  89.75
   dx    =   .500, dy =      .500, mend =  720  , nend =  360
   amplitude unit =    .010, phase unit =     .010
Reading : ./omap/k1_gc.nao
  Model name    = NAO.99b (Geocentric tide : ocean + load)
  Created date = Tue Apr 11 2000
   xmin =     .25, xmax = 359.75, ymin = -89.75, ymax =  89.75
   dx    =   .500, dy =      .500, mend =  720  , nend =  360
   amplitude unit =    .010, phase unit =     .010
Reading : ./omap/j1_gc.nao
  Model name    = NAO.99b (Geocentric tide : ocean + load)
  Created date = Tue Apr 11 2000
   xmin =     .25, xmax = 359.75, ymin = -89.75, ymax =  89.75
   dx    =   .500, dy =      .500, mend =  720  , nend =  360
   amplitude unit =    .010, phase unit =     .010
```

6. Then, open the result program file. For example, if we saved the file with name TideTg1.out then open the file in **D:\@-IK-Training\Modul-05-RKPS\naotide(Heron)**

7. Open the file in Microsoft excel to see the result, the naotide program has format like in **Table 1,** the part in color yellow shows the tide prediction in that coordinate. The last result from tide prediction is tidal range. Tidal range is get from highest tide (HW) minus lowest tide (LW).

$$KP = Maks\ L - Min\ L$$

Where

KP = Tidal range

Maks.L = Maximum value of sea level

Min.L = Minimum value of sea level

Table 1. Sample output tidal prediction with NAOTIDE program

Geocentric	tidal	height										
Elapsed	day	Tide(cm)	Short-p	Long-p	M	D	Yr	H	M	MJD	Longitude	Latitude
	0	21.802	24.51	-2.708	12/	1	2008	0:00	0	54801	106.398	-6.0077
	0.041667	32.262	34.959	-2.697	12/	1	2008	1:00	0	54801.04	106.398	-6.0077
	0.083333	39.455	42.141	-2.686	12/	1	2008	2:00	0	54801.08	106.398	-6.0077
	0.125	42.662	45.336	-2.674	12/	1	2008	3:00	0	54801.13	106.398	-6.0077
	0.166667	41.748	44.41	-2.662	12/	1	2008	4:00	0	54801.17	106.398	-6.0077
	0.208333	37.153	39.803	-2.649	12/	1	2008	5:00	0	54801.21	106.398	-6.0077
	0.25	29.753	32.39	-2.637	12/	1	2008	6:00	0	54801.25	106.398	-6.0077
	0.291667	20.651	23.275	-2.623	12/	1	2008	7:00	0	54801.29	106.398	-6.0077
	0.333333	10.943	13.552	-2.61	12/	1	2008	8:00	0	54801.33	106.398	-6.0077
	0.375	1.515	4.111	-2.595	12/	1	2008	9:00	0	54801.38	106.398	-6.0077
	0.416667	-7.071	-4.49	-2.581	12/	1	2008	10:00	0	54801.42	106.398	-6.0077
	0.458333	-14.597	-12.031	-2.566	12/	1	2008	11:00	0	54801.46	106.398	-6.0077

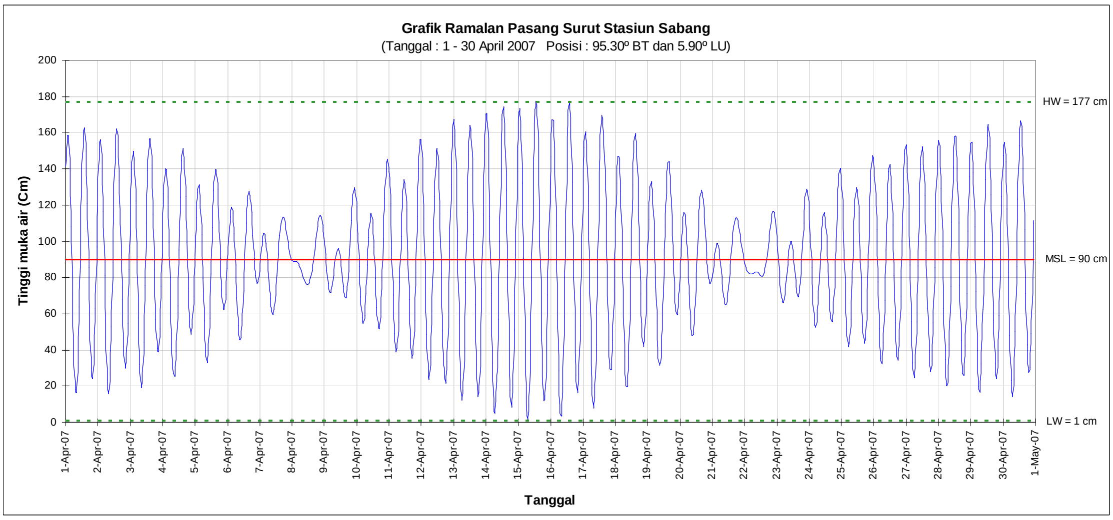


Figure 3. Sample of visualitation data tidal prediction in 1 – 30 April 2007 at Sabang station.

V. INSTRUCTOR BIOGRAPHY

5. Name : Asyari Adisaputra

Email : duadua_maret@yahoo.co.id

Mobile : +6281381597676

Office : Laboratory of Oceanography
Marine Science and Technology Departement
Faculty of Fisheries and Marine Science
Bogor Agricultural University

6. Name : M. Tri Hartanto

Email : tri_itk@yahoo.com

Mobile : +6281314402527

Office : Laboratory of Oceanography
Marine Science and Technology Departement
Faculty of Fisheries and Marine Science
Bogor Agricultural University

TRAINING MODULE

DEVELOPMENT OF COASTAL VULNERABILITY INDEX

"DATA PROCESSING OF SIGNIFICANT WAVE HEIGHT"

Compiled by:

Erwin Maulana

M. Tri Hartanto

BOGOR AGRICULTURAL UNIVERSITY, 2010

CONTENTS

I. Introduction

Significant wave height is wave tall average (from peak to valley) from one-third highest sea wave. In coastal vulnerability, the significant wave height becomes a parameter related to the coastal inundation hazard. Utilization of this wave of data given the severe lack of data on a national scale waves in the waters of Indonesia.. Given there are rarely observed wave data in situ, so it requires data derived from satellite altimetry.

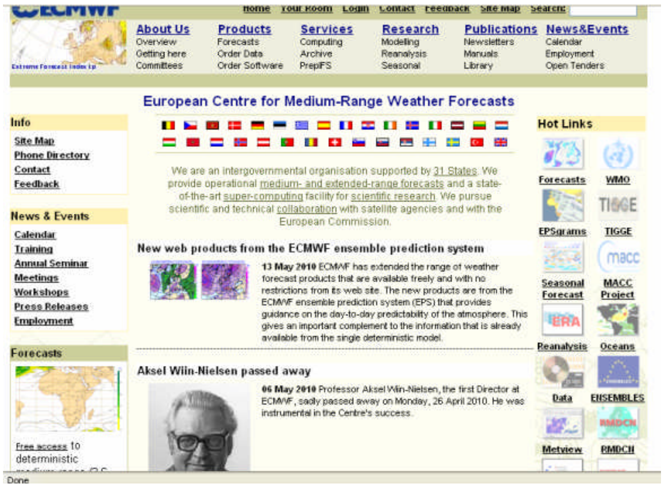
Significant wave height data derived from ECMWF (European Centre for Medium-Range Weather Forecasts) can be downloaded from http://ecmwf.int/. Processing method is a reanalysis of the data used, and the assimilation model (numerical weather prediction) satellite and in situ data. This organization provides a medium-long term forecasting for the data's atmosphere / weather, and super-computing facilities for scientific research and the scientific and technical cooperation with the satellite agency and the European Commission. ECMWF is also a result of the development of dynamic and synoptic meteorology more than 100 years and more than 50 years of development in numerical weather prediction (Numerical Weather Prediction). ECMWF forecasting system consists of general circulation models, ocean wave models, data assimilation systems and since 1992 an ensemble forecasting system. In 1998 the seasonal forecasting system started operation and in 2002 introduced a monthly forecasting system.

II. OBJECTIVE

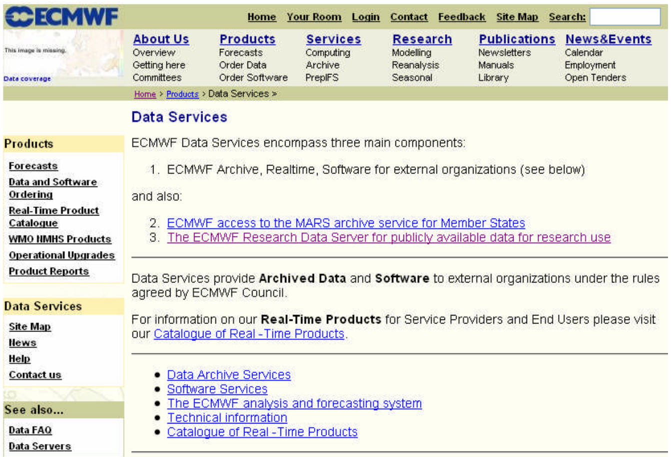
The objective of this module is for each participant is able to do the acquisition, processing and integration of significant wave height data for the determination of Coastal Vulnerability Index.

III. Data Acquisition

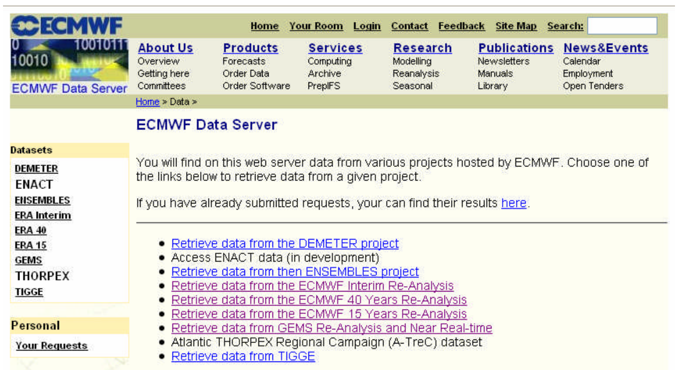
1. Data acquisition from http://ecmwf.int/, will emerge as follows:



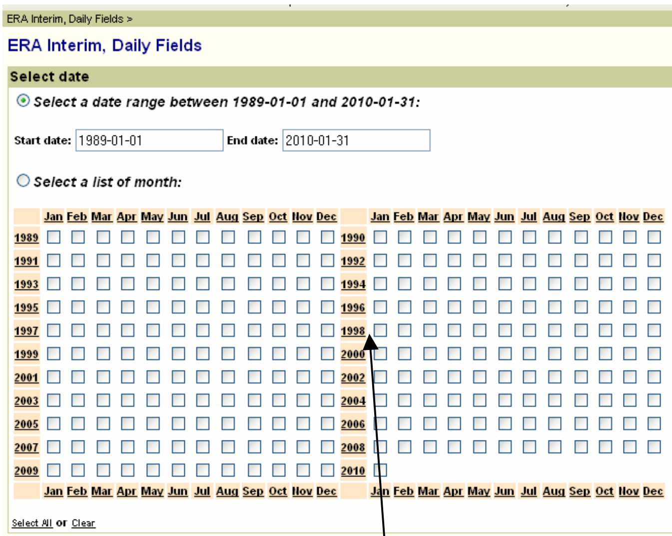
2. On part **Hot links** sectioned click **<u>Data</u>** so will emerge as follows:



3. Click [The ECMWF Research Data Server for publicly available data for research use](#), will emerge as follows:

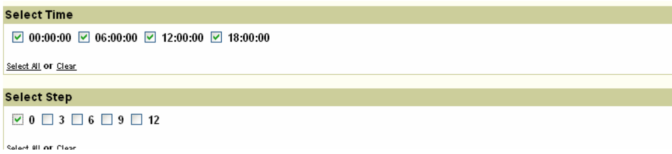


Click [Retrieve data from the ECMWF Interim Re-Analysis]() to get present year presage data, and appears appearance as follows:

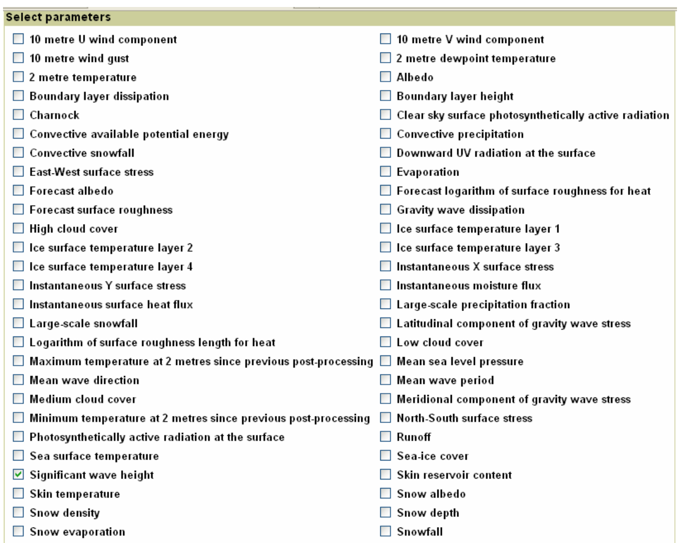


4. Select for desirable time gyration, better elective, data that produced not too big and easy accustommed in data group so that make easy in processing.

5. Hereafter on page same elective the time of day and step is desirable time as on following appearance:

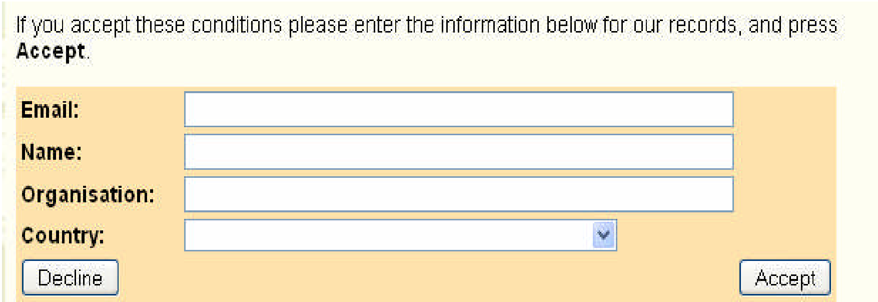


6. Select for parameter one that will be utilized, as follows:



7. Select for parameter which will be utilized deep this study data which is utilized is Significant wave height. Then press conditions of use present under.

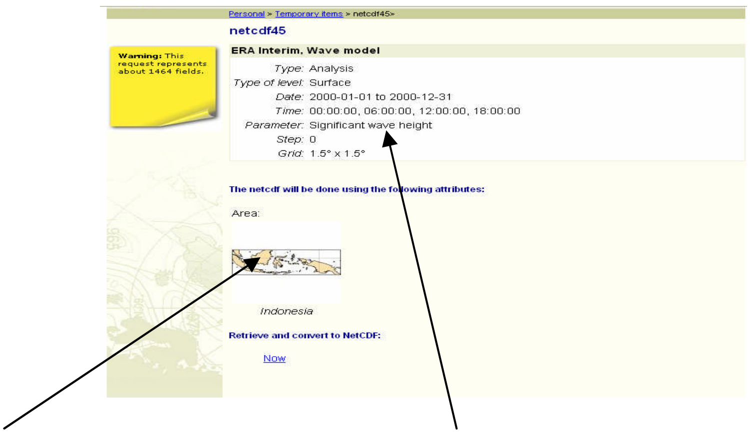
8. Then input on sheet as hereunder, insert you information and click Accept.



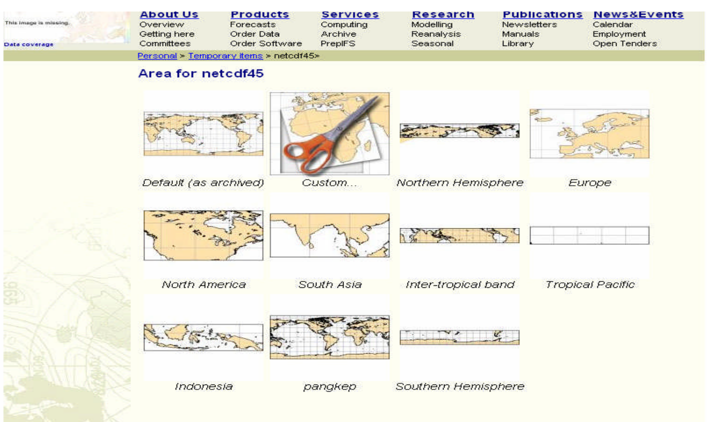
Then screen look will return to sheet that early, and reenacts as upon. Then press 

at down section page.

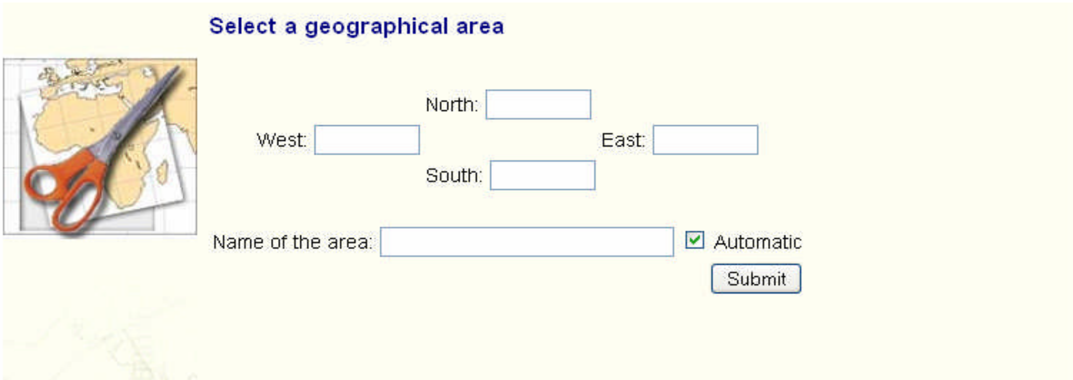
9. Succeeding sheet as on figure under this!



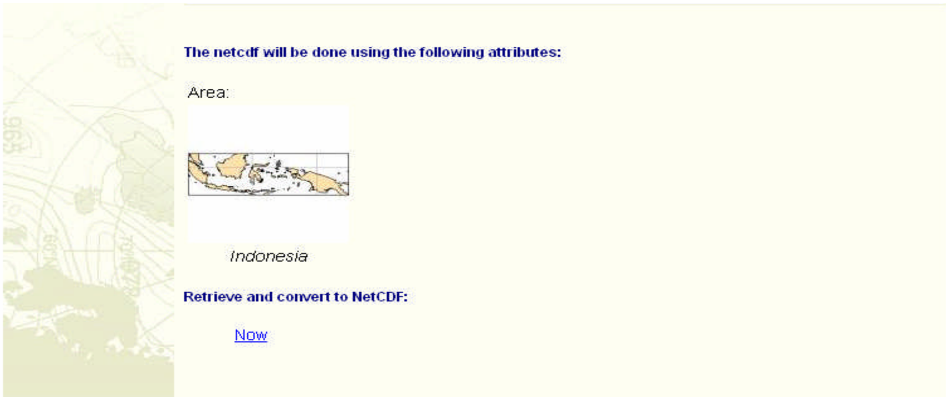
click to choose area, a part one upstairsing to constitute data information that will be chosen, if has accorded click area Now therefore succeeding will see appearance as follows:



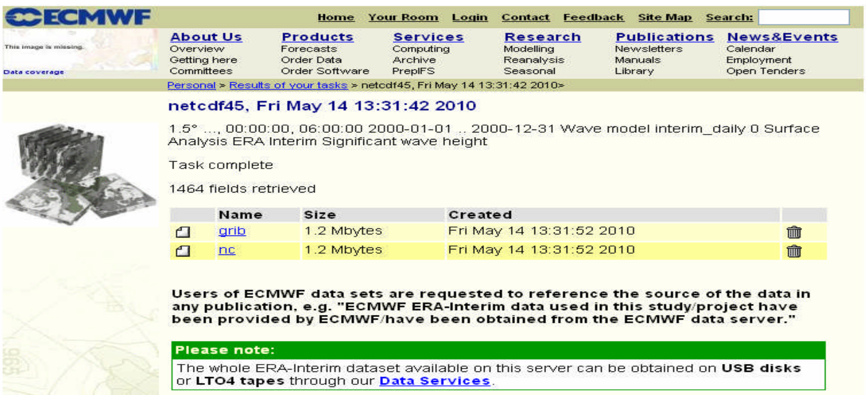
Click custom to make area bases particular coordinate, afterwards will emerge appearance as follows:



insert limit coordinate area and name area, necessary payed that in longitude sign (-) longitude west and (+) longitude east, furthermore in latitude sign (-) latitude south and (+) latitude north. Click so area and name appearance corresponds to coordinate already be inserted. Better we choose wider area (all Indonesia) that we ifrequently do Download.



10. Click Now to download areas appropriate data already be made, and its appearance as follows: then click nc to begin download.



IV. Data Processing

Data processing average Significant wave height started by extracts data get netcdf format(*. nc) by use of ODV (Ocean Data View) into data formatted text format(*.txt) in a wider area from desirable bounds. Further data at intervals of 6 hours of it each year are averaged and the result is the average annual significant wave height. For the purposes of more detailed information as input in a cell at the beach then performed to measure spatial interpolation grid using the surfer into 1 km x 1 km. Then the interpolation results are further cut to the desired area and exported into XYZ format data using Global Mapper. The next step sought the position closest to the cell position on the beach using Surfer

The data processing step can be viewed in a systematic way in Figure 1 below.

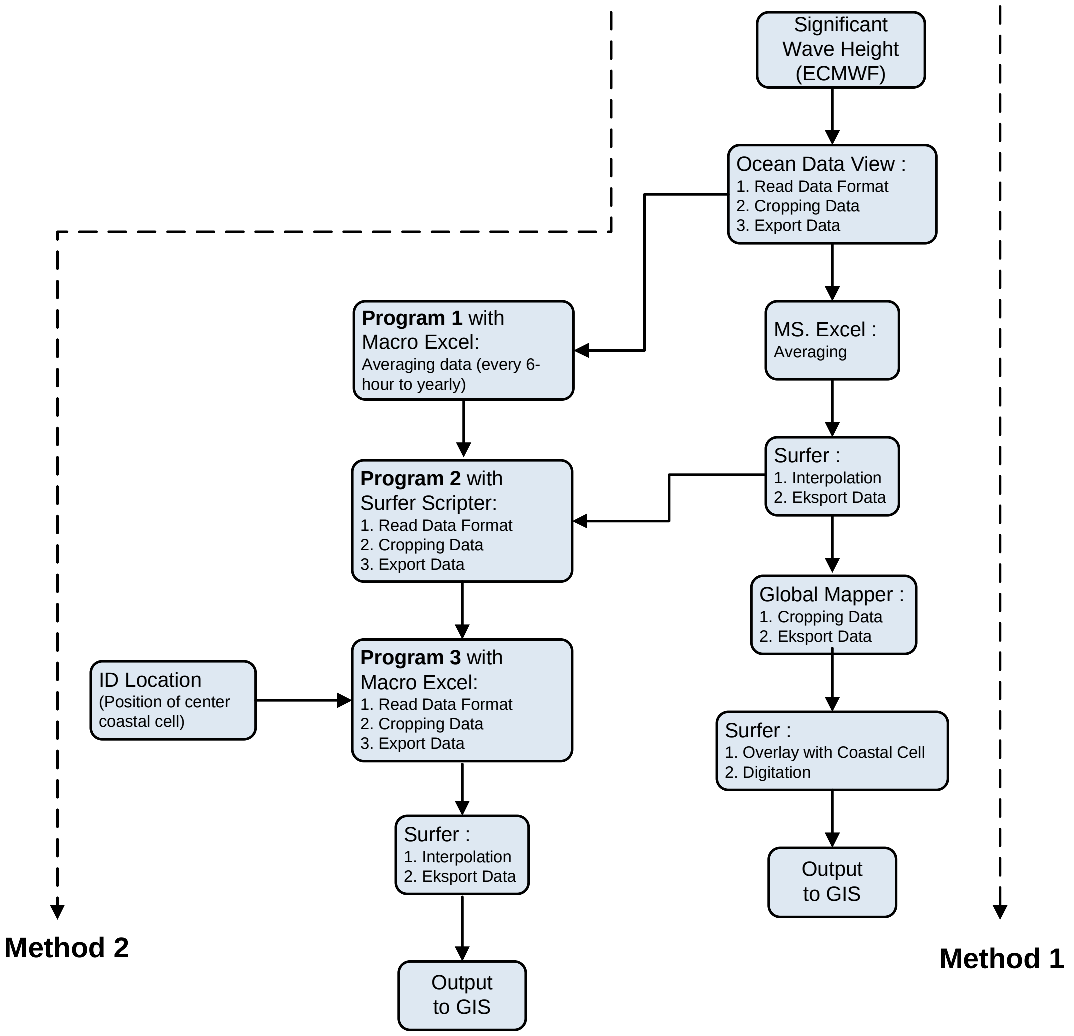
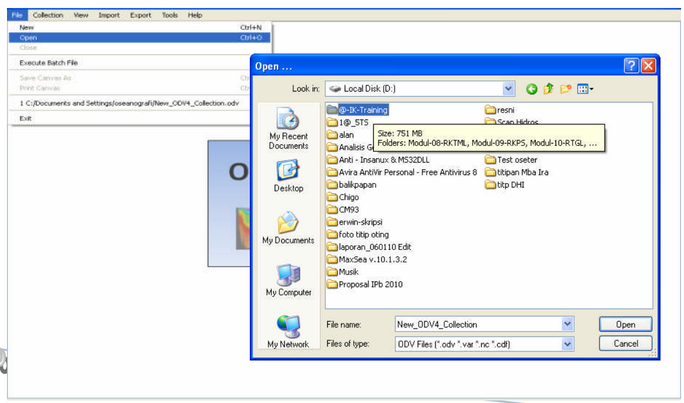


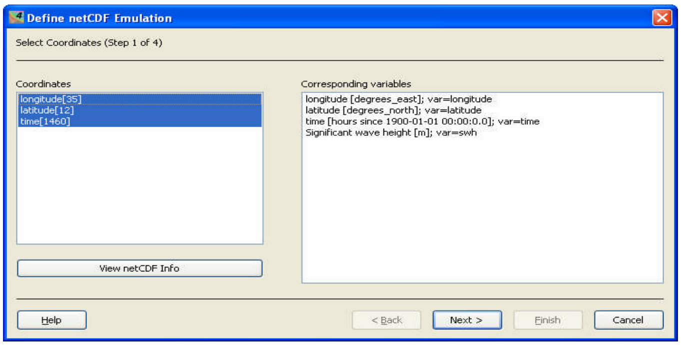
Figure 1. Process Flow Chart of Significant Wave Height Data Acquisition Value to Nearest with cells Coastal.

V. Extract Data Significant Wave Height Netcdf's format (*.nc) with Ocean View's Data (ODV)

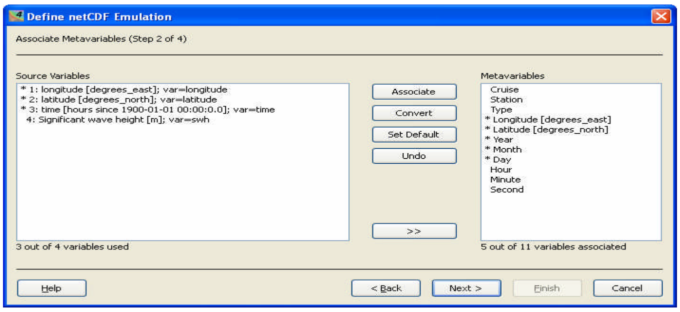
1. Data processing average significant wave height already being downloaded started by extracts data get format NetCdf (*. nc) by use of ODV (Ocean is View's Data) as data gets text format(*. txt). Earlier we open at ODV'S software(Ocean is View's Data). Then chooses File > open data already saved.



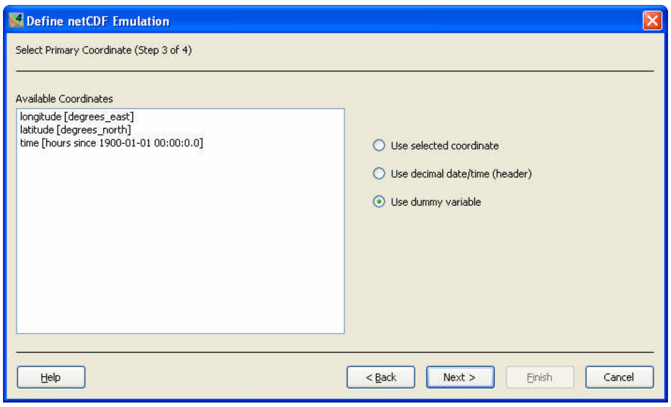
2. Will appear as shown below, then click on the longitude of the left while pressing Ctrl and click all the variables until all blocked. Then press Next.



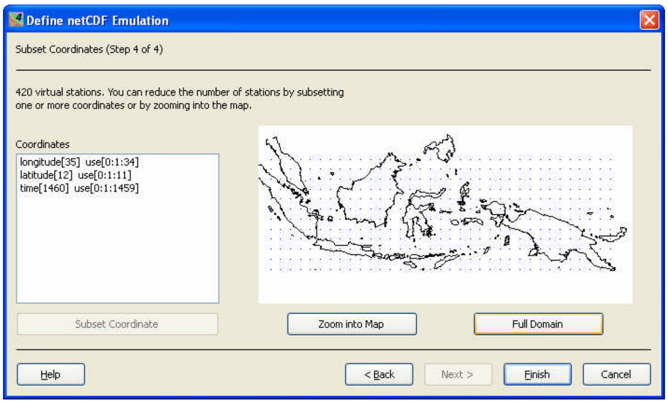
3. Next's click > since all variable that exists on sheet self acting data have most associate with proprietary variable by ODV.



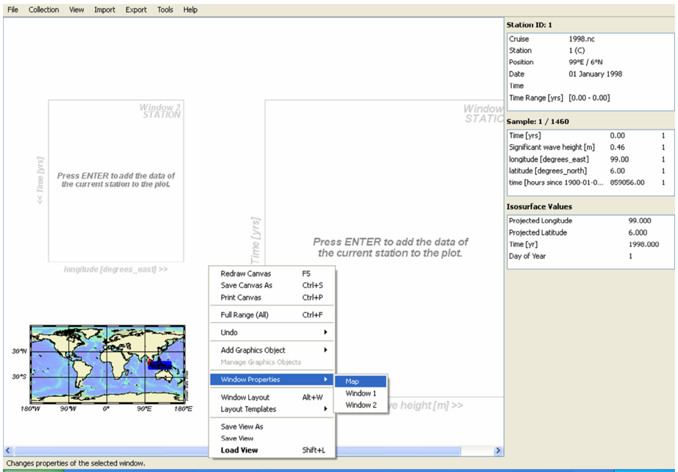
4. Select Use the dummy variable for the data extracted in the format * txt based on sequence data distribution, but if we choose use decimal date (header) data is extracted in the format * txt in the order in each station.



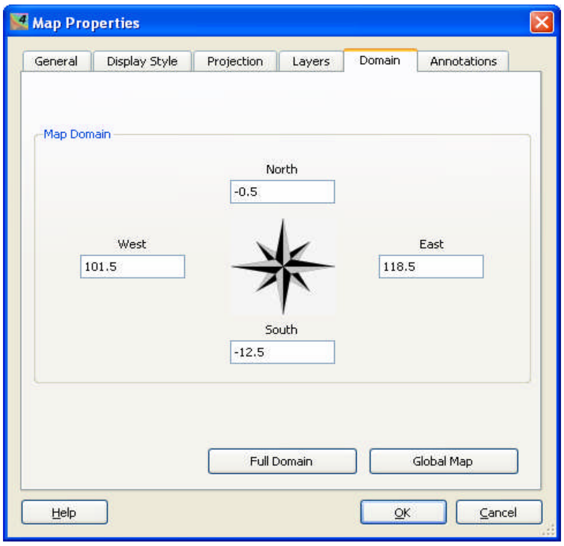
5. Select for into zoom to cropplng data bases region who will be utilized. Then finish.



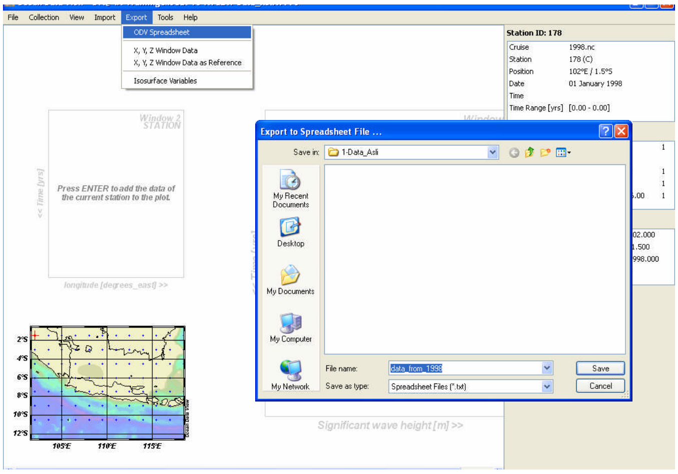
6. Cropping region which will be utilized on this sheet by click outboard right map then select for properties's windows > map.



7. So it looks like the following view, select the domain based on the area to be, on the border area coordinat 0.5 ° LS – 12.5 ° LS and 101.5 ° BT – 118.5 ° BT, and press Ok.



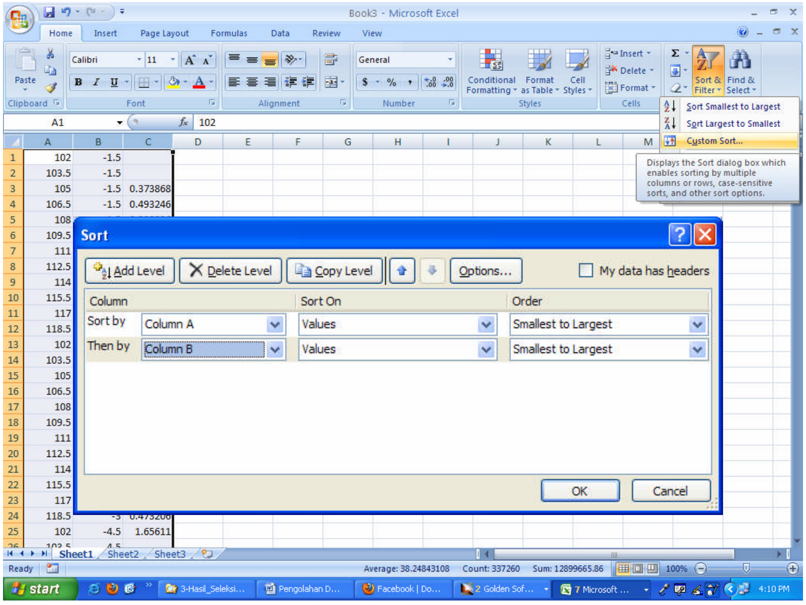
10. To export data to *txt format by export's press at up section then select for ODV is spreadsheet . Save file on folder \2 Data_Eksport_ODV, then press save.



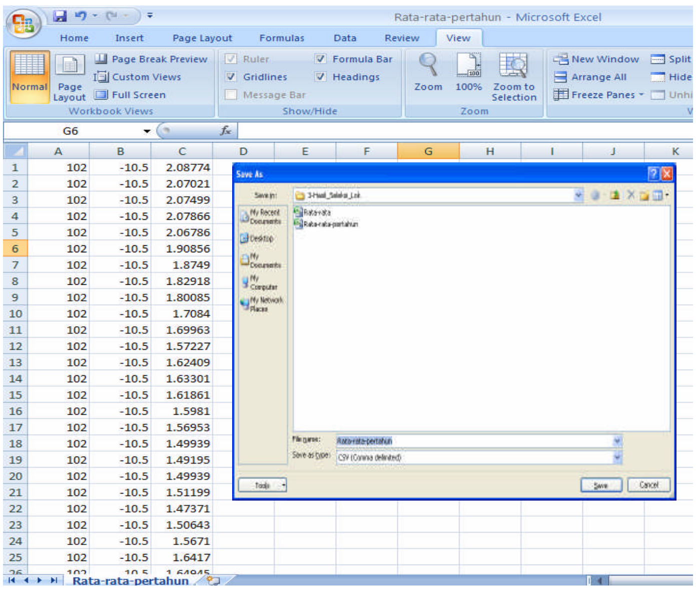
VI. Average Significant Wave Height Data with Interval 6 Hours of Being Average Annual use MS Macro Excel

1. Hereafter data with interval 6 hour is flattened annual and its result as average as significant wave height annual. Earlier we open data already most format deep

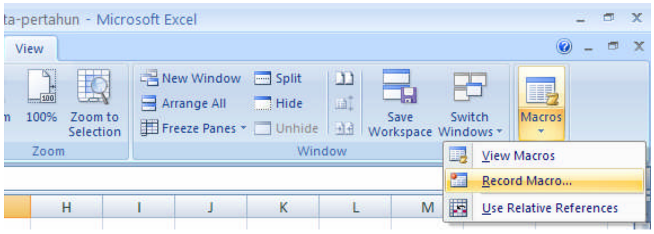
extract *txt at Microscoft Excel, drawned out by data selection, data who will be utilized which is longitude, latitude and Significant wave height. Before we begin average earlier we sort data a station by undertaking instruction Sorting & Filter data on job sheet excel , by obstructs all beforehand data, click Sorting & Filter > Custom is Sorting > add is level > by's sorting (Column A) > Then by (Column b) as looked as on figure as follows:



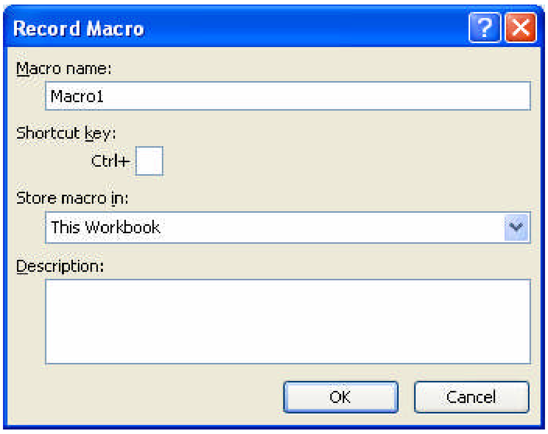
2. Data already most massage bases our station dot average up to annual. Hasten average data, we do at Macro is Excel's Visual Basic by, earlier we input data entry into display Microsoft excel where is column A. as Longitude column B as Latitude and column C as significant wave height then that data we save in format *csv (comma delimited) after at save sheet excel doesn't be closed, can we see on figure as follows:



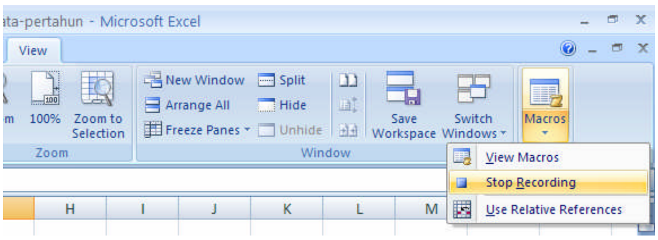
3. After data was save by us click command View> Macros click chooses Record Macros.



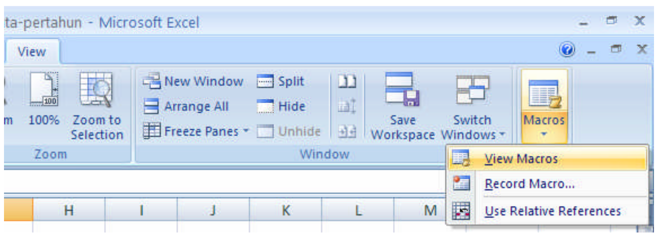
4. Will Appear as below click OK.



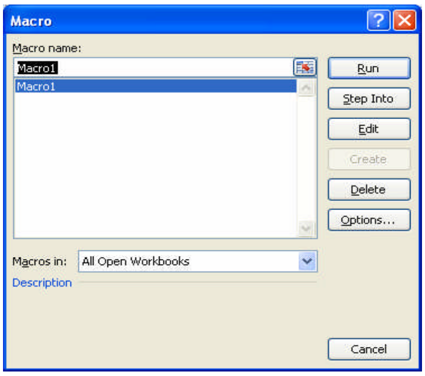
5. Then click View > Macros > select for Recording's stop.



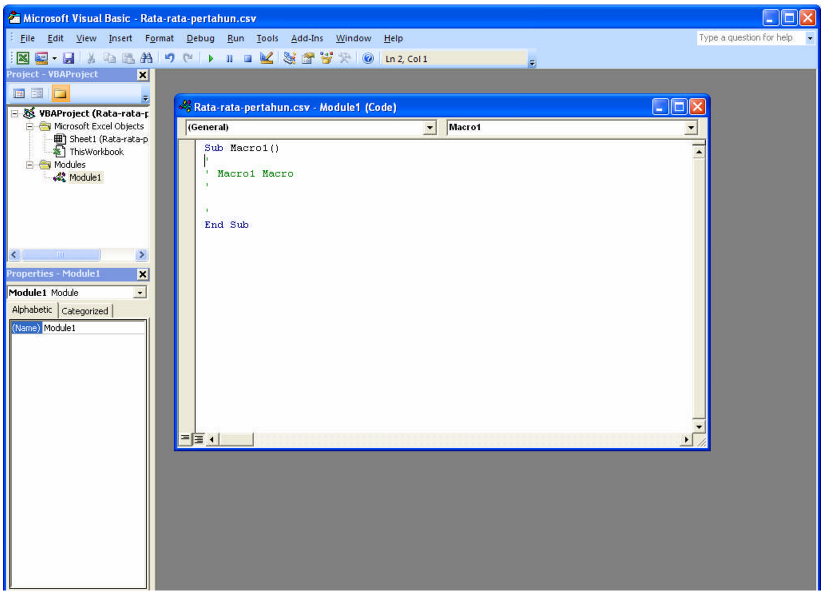
6. Click View again then click Macros > select for View Macros.



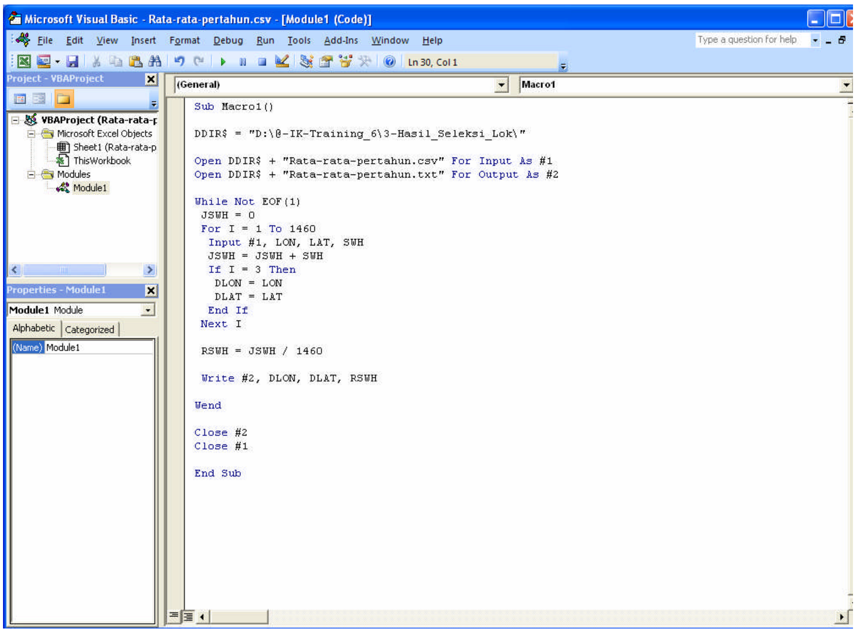
So that would appear like the following figure:



7. Click Edit, so that the display appears as follows::



8. On sheet Microscoft is Visual Basic we insert to program already we make, can we see hereunder, after programs to be inserted changes directory the then total data who will be divided. Hereafter we begin to click Run (▶).



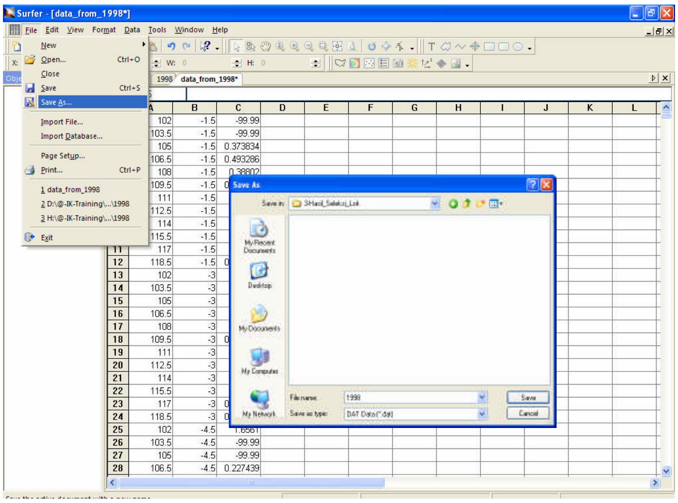
Row formation programs as follows:

```
Sub Macro1()

DDIR$ = "D:\@-IK-Training_6\3-Hasil_Seleksi_Lok\"

Open DDIR$ + "Rata-rata-pertahun.csv" For Input As #1
Open DDIR$ + "Rata-rata-pertahun.txt" For Output As #2

While Not EOF(1)
 JSWH = 0
 For I = 1 To 1460
   Input #1, LON, LAT, SWH
  JSWH = JSWH + SWH
  If I = 3 Then
   DLON = LON
   DLAT = LAT
  End If
 Next I

 RSWH = JSWH / 1460

  Write #2, DLON, DLAT, RSWH

 Wend

 Close #2
 Close #1

 End Sub
```

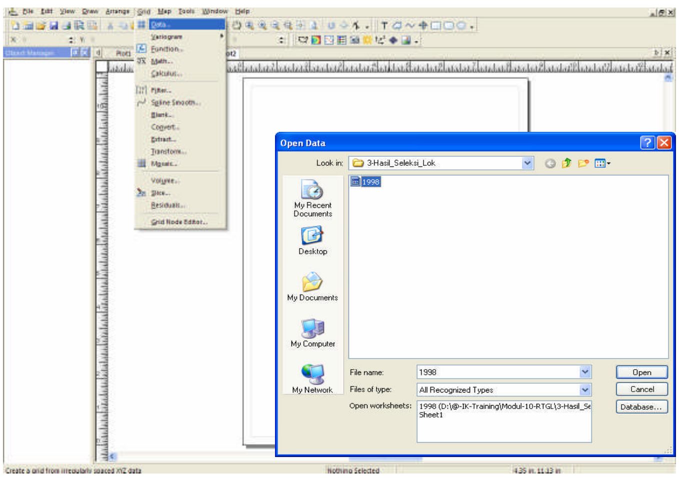
VII. Interpolation Using Data Grid With Surfer

1. Data already annual therefore done by spasial grid's interpolating until measure becomes 1 km x 1 km by use of software Surfer as stationary as information which more detail as entry in cell at coast.

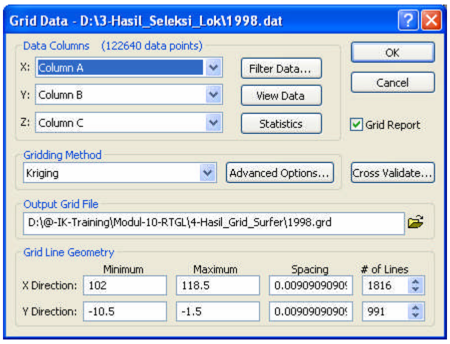
2. Earlier we open data already most *txt format extract at Surfer. Sort that data on job sheet worksheet by File > New vote for Worksheet , data who will be utilized which is longitude, latitude and Significant wave height. Where is column A is longitude , column B is latitude and column C is Significant wave height. After data most selection then save in *DAT's format on folder \3 Hasil_Seleksi_Lok.



3. Data already *DAT format then at interpolating by job sheet open Surfer click File vote for New Plot. After job sheet emerges then utilize instruction Grid > select for data. So gets visually figure as follows:



So that the display will appear as follows:

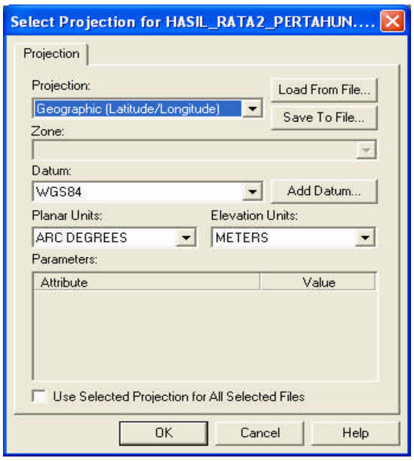


4. Select for x as A column, y. as column B and z as column C, to Gridding method we utilize Kriging , Output Grid is file for file address that will at save. Grid line Geometry we only just substitute Spacing with spasial grid's measure becomes 1 km x 1 km because of in form degree we change to go to decimal degree with point Spacing 0. 009090909091 x 0.009090909091, after all filled click OK.

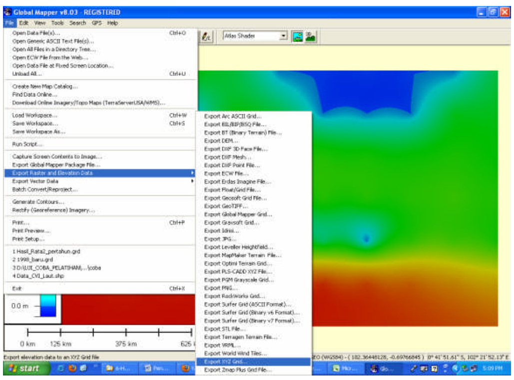
VIII. Cropping Area Boundary and Data Export with Global Mapper

1. After processes Kriging all through then drawned out by conversion Grid into ASCII format (xyz) with cropping region who will be utilized, by opens grid's result at programs Global mapper. Its trick is open Mapper Is global > **Open Your Owen Data Files** > So get as been see figure as follows:

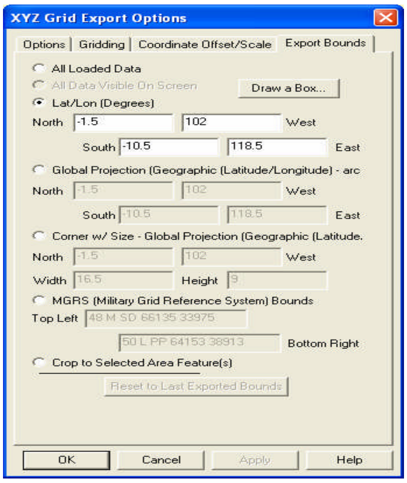
Will emerge as follows, click OK.



After data is opened then click File > Eksport Raster File and Elevasion Data > Export XYZ Grid > OK.



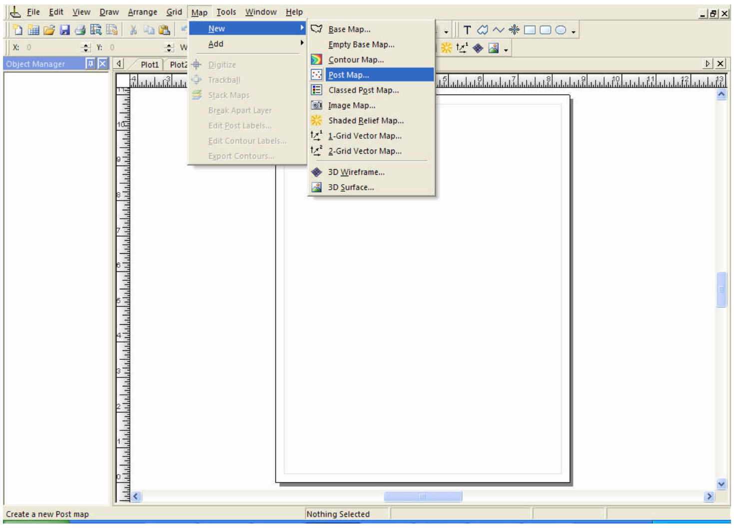
Will appear as below: Click the Export Bounds



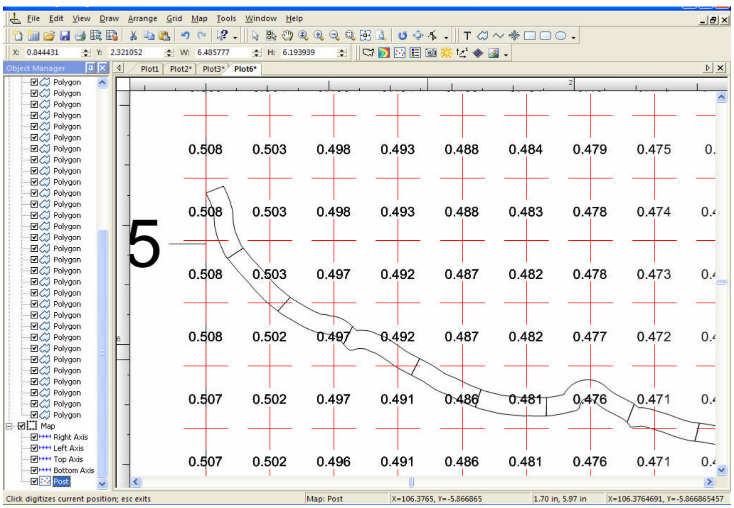
Change Lat / Lon, Global Projection, Corner w/size-Global Project with coordinate bounds that at wants to correspond to domain watch region. Let say domain observing Tanggerang region by fills North -5.695 South -6.1 West 106.345 East 106.763 Then pressing OK and Save is file in *txt format.

IX. Find The Nearest Point of Significant Wave Height on on Central Coastline Cell

1. The next step sought significant wave height is the position closest to the position of cells in the coast for annual with an overlay to the cell data with the data point of the wave, using the software Surfer. Open Surfer> (to open a significant wave height data point) Map> New> Folder Post> Post to regulate Properties click on Post dabel Map.

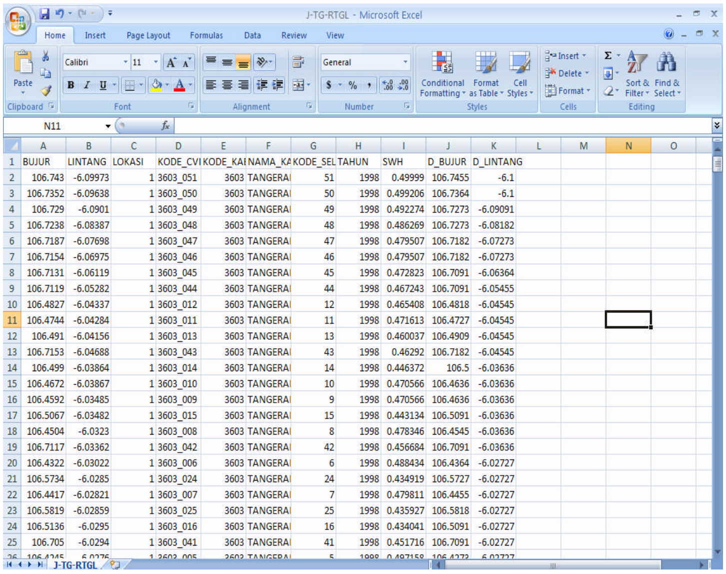


2. To open a data cell by selecting File> Import> Open file data cell. Can we look like the following figure:



3. To be able to see the point of our stations can use the Digitize command by clicking the Folder> Digitize, then click on the station nearest point on the cell spacing. Having to point the coordinates of significant wave height with the shortest

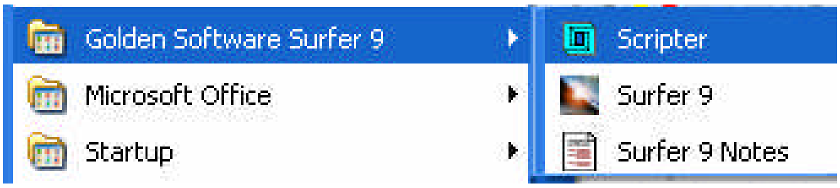
distance, then enter the value of significant wave height and depth coordinates of integration cell format, can dilhat on the following figure:



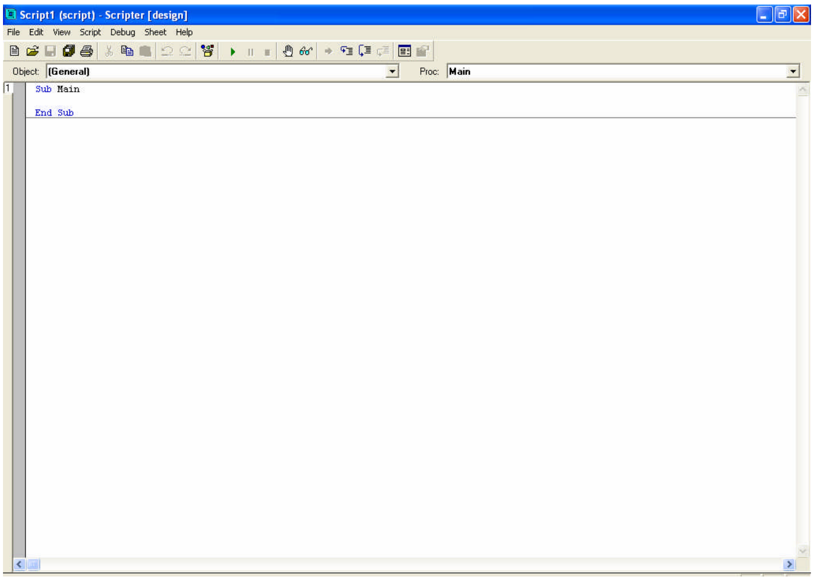
BUJUR	LINTANG	LOKASI	KODE_CVI	KODE_KA	NAMA_KA	KODE_SEL	TAHUN	SWH	D_BUJUR	D_LINTANG
106.743	-6.09973	1	3603_051	3603	TANGERAI	51	1998	0.49999	106.7455	-6.1
106.7352	-6.09638	1	3603_050	3603	TANGERAI	50	1998	0.499206	106.7364	-6.1
106.729	-6.0901	1	3603_049	3603	TANGERAI	49	1998	0.492274	106.7273	-6.09091
106.7238	-6.08387	1	3603_048	3603	TANGERAI	48	1998	0.486269	106.7273	-6.08182
106.7187	-6.07698	1	3603_047	3603	TANGERAI	47	1998	0.479507	106.7182	-6.07273
106.7154	-6.06975	1	3603_046	3603	TANGERAI	46	1998	0.479507	106.7182	-6.07273
106.7131	-6.06119	1	3603_045	3603	TANGERAI	45	1998	0.472823	106.7091	-6.06364
106.7119	-6.05282	1	3603_044	3603	TANGERAI	44	1998	0.467243	106.7091	-6.05455
106.4827	-6.04337	1	3603_012	3603	TANGERAI	12	1998	0.465408	106.4818	-6.04545
106.4744	-6.04284	1	3603_011	3603	TANGERAI	11	1998	0.471613	106.4727	-6.04545
106.491	-6.04156	1	3603_013	3603	TANGERAI	13	1998	0.460037	106.4909	-6.04545
106.7153	-6.04688	1	3603_043	3603	TANGERAI	43	1998	0.46292	106.7182	-6.04545
106.499	-6.03864	1	3603_014	3603	TANGERAI	14	1998	0.446372	106.5	-6.03636
106.4672	-6.03867	1	3603_010	3603	TANGERAI	10	1998	0.470566	106.4636	-6.03636
106.4592	-6.03485	1	3603_009	3603	TANGERAI	9	1998	0.470566	106.4636	-6.03636
106.5067	-6.03482	1	3603_015	3603	TANGERAI	15	1998	0.443134	106.5091	-6.03636
106.4504	-6.0323	1	3603_008	3603	TANGERAI	8	1998	0.478346	106.4545	-6.03636
106.7117	-6.03362	1	3603_042	3603	TANGERAI	42	1998	0.456684	106.7091	-6.03636
106.4322	-6.03022	1	3603_006	3603	TANGERAI	6	1998	0.488434	106.4364	-6.02727
106.5734	-6.0285	1	3603_024	3603	TANGERAI	24	1998	0.434919	106.5727	-6.02727
106.4417	-6.02821	1	3603_007	3603	TANGERAI	7	1998	0.479811	106.4455	-6.02727
106.5819	-6.02859	1	3603_025	3603	TANGERAI	25	1998	0.435927	106.5818	-6.02727
106.5136	-6.0295	1	3603_016	3603	TANGERAI	16	1998	0.434041	106.5091	-6.02727
106.705	-6.0294	1	3603_041	3603	TANGERAI	41	1998	0.451716	106.7091	-6.02727

X. The program extracts, cropping, and Significant Wave Height Data Export Once interpolated With Surfer

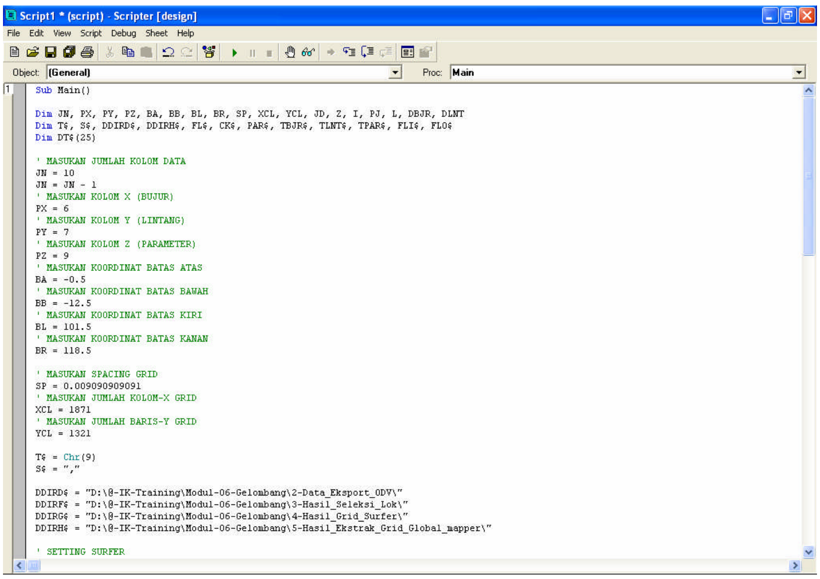
1. Open the software Surfer Scripter can be seen in the figure below:



So it can appear like the figure below:



2. Enter the program lines Prog-Seleksi_GRD_Ekstrak_Lok on the scrip sheet that has been made: change the directory and then Run ()



Line program

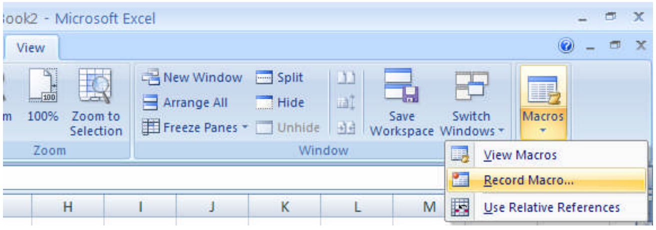
```
Sub Main()

Dim JN, PX, PY, PZ, BA, BB, BL, BR, SP, XCL, YCL, JD, Z, I, PJ, L, DBJR,
DLNT
Dim T$, S$, DDIRD$, DDIRH$, FL$, CK$, PAR$, TBJR$, TLNT$, TPAR$, FLI$,
FLO$
Dim DT$(25)

' MASUKAN JUMLAH KOLOM DATA
JN = 10
JN = JN - 1
' MASUKAN KOLOM X (BUJUR)
PX = 6
' MASUKAN KOLOM Y (LINTANG)
PY = 7
' MASUKAN KOLOM Z (PARAMETER)
PZ = 9
' MASUKAN KOORDINAT BATAS ATAS
BA = -0.5
' MASUKAN KOORDINAT BATAS BAWAH
BB = -12.5
' MASUKAN KOORDINAT BATAS KIRI
BL = 101.5
' MASUKAN KOORDINAT BATAS KANAN
BR = 118.5

' MASUKAN SPACING GRID
SP = 0.009090909091
' MASUKAN JUMLAH KOLOM-X GRID
XCL = 1871
' MASUKAN JUMLAH BARIS-Y GRID
YCL = 1321

T$ = Chr(9)
S$ = ","

DDIRD$ = "D:\@-IK-Training\Modul-06-Gelombang\2-Data_Eksport_ODV\"
DDIRF$ = "D:\@-IK-Training\Modul-06-Gelombang\3-Hasil_Seleksi_Lok\"
DDIRG$ = "D:\@-IK-Training\Modul-06-Gelombang\4-Hasil_Grid_Surfer\"
DDIRH$ = "D:\@-IK-Training\Modul-06-Gelombang\5-
Hasil_Ekstrak_Grid_Global_mapper\"

' SETTING SURFER
On Error Resume Next 'Turn off error reporting.
Set SurferApp = GetObject(, "Surfer.Application")
If Err.Number <> 0 Then
 Set SurferApp = CreateObject("Surfer.Application")
End If
On Error GoTo 0 'Turn on error reporting.
If SurferApp.Windows.Count = 0 Then SurferApp.Documents.Add (srfDocPlot)
SurferApp.Visible = True
SurferApp.WindowState = srfWindowStateNormal
SurferApp.Width = 1024
SurferApp.Height = 200
SurferApp.Windows(1).Zoom (srfZoomPage)

For Z = 1998 To 1998
 FL$ = Trim(Str(Z))
```

```
 Open DDIRD$ + "data_from_" + FL$ + ".txt" For Input As #1
 Open DDIRF$ + FL$ + ".dat" For Output As #2

 While Not EOF(1)
  Line Input #1, PAR$
  CK$ = Mid$(PAR$, 1, 2)

  If CK$ = "Cr" Then
   CK$ = "//"
  End If

  If CK$ <> "//" Then
   For I = 1 To JN
    PJ = Len(PAR$)
    L = InStr(1, PAR$, T$)
    DT$(I) = Mid$(PAR$, 1, L - 1)
    PAR$ = Mid$(PAR$, L + 1, PJ - L)
    If I = JN Then DT$(I + 1) = PAR$
   Next I

   TBJR$ = DT$(PX)
   TLNT$ = DT$(PY)
   TPAR$ = DT$(PZ)
   DBJR = Val(DT$(PX))
   DLNT = Val(DT$(PY))

   If DBJR >= BL And DBJR <= BR And DLNT >= BB And DLNT <= BA And TPAR$
<> "-99.99" Then
     Print #2, TBJR$ + T$ + TLNT$ + T$ + TPAR$
   End If

  End If 'CK$

 Wend 'LOAD DATA
 Close #2
 Close #1

 FLI$ = DDIRF$ + FL$ + ".DAT"
 FLO$ = DDIRG$ + FL$ + ".GRD"

 'GRIDING
 SurferApp.GridData(DataFile:=FLI$, xCol:=1, yCol:=2, zCol:=3,
ShowReport:= False, _
 DupMethod:=srfDupAvg, NumCols:=XCL, NumRows:=YCL, xMin:=BL, xMax:=BR,
yMin:=BB, yMax:=BA, _
 Algorithm:=srfKriging, OutGrid:=FLO$, OutFmt:=srfGridFmtS7)

 'BATAS TANGERANG
 SurferApp.GridExtract(InGrid:=FLO$, r1:=705, r2:=749, c1:=534, c2:=581,
_
 OutGrid:=DDIRT$ + "Tg-" + FL$ + ".txt", _
 OutFmt:=srfGridFmtXYZ)
 Set doc = SurferApp.Documents.Open(Filename:=DDIRT$ + "Tg-" + FL$ +
".txt")
 doc.SaveAs(FileName:=DDIRH$ + "Tg-" + FL$ +
".txt",FileFormat:=srfSaveFormatDat,Options:="Delimiter=comma;TextQualif
ier=none")
 doc.Close(SaveChanges:=srfSaveChangesNo)

Next Z
```

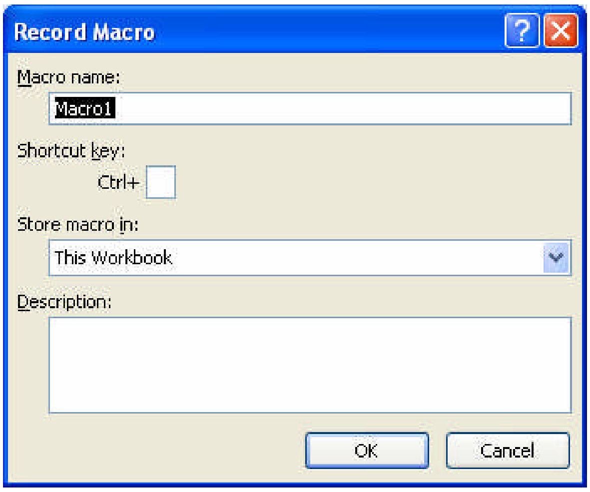
```
End Sub
```

XI. Determining the Shortest Results with Microsoft Visual Basic Language

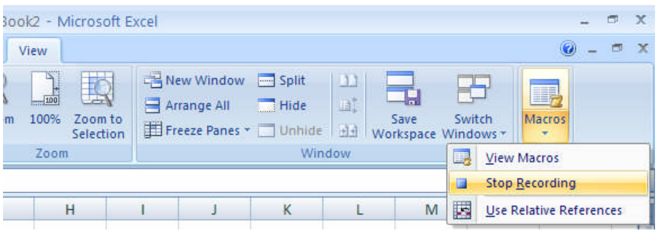
1. Open program Microsoft Excel, choose View > click Macros > select Record Macros.



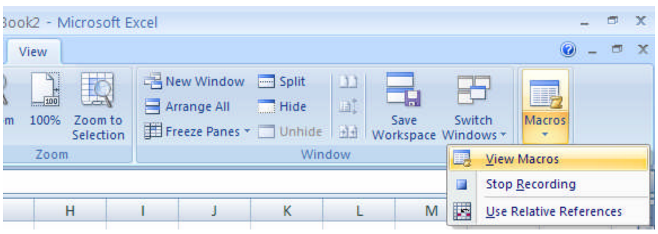
Record Macros so that its display appears as shown in the figure below: and click Ok.



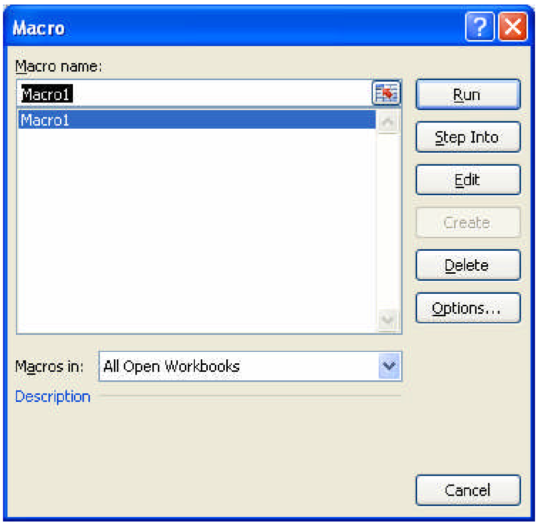
2. Choose again View > Macros > Select Stop Recording.



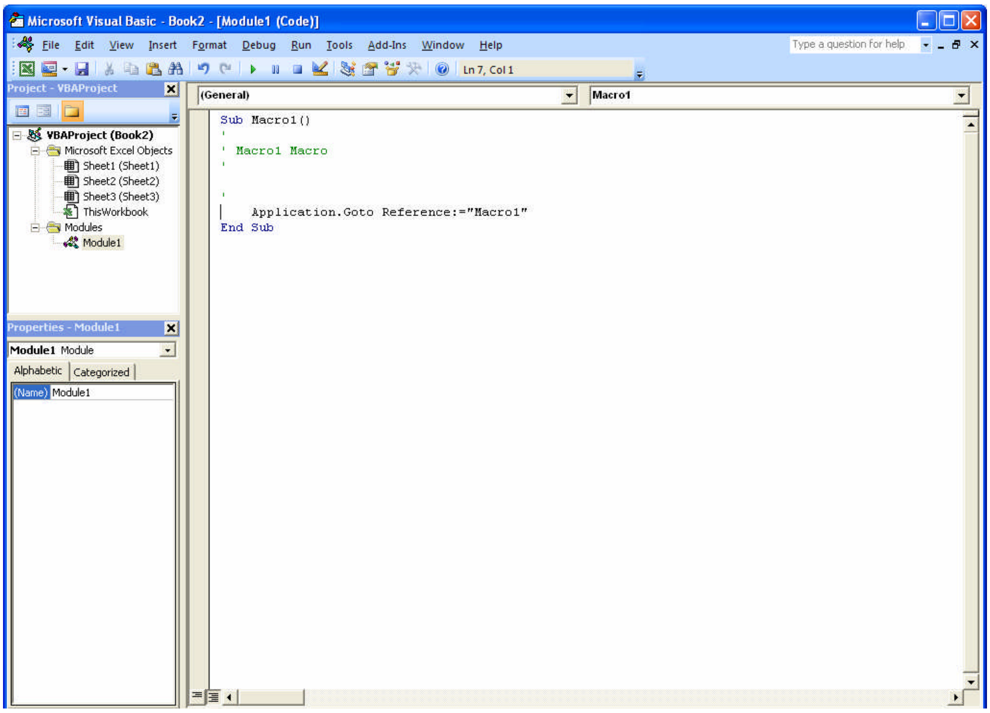
3. To display the Microsoft visual basic screen us choose again the command View> Macros> View Macros.



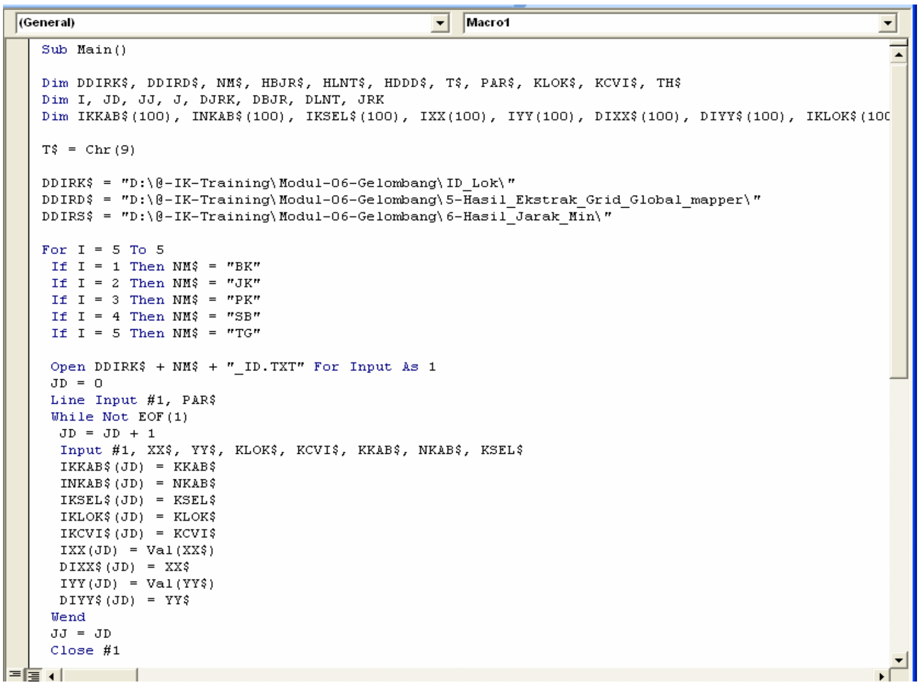
Macro display will appear:



4. Then click Edit, and the screen will display the Microsoft Visual Basic as the following figure.



5. Then line program we've created, we put on the sheet visual basic.



```
Sub Main()

Dim DDIRK$, DDIRD$, NM$, HBJR$, HLNT$, HDDD$, T$, PAR$, KLOK$, KCVI$, TH$
Dim I, JD, JJ, J, DJRK, DBJR, DLNT, JRK
Dim IKKAB$(100), INKAB$(100), IKSEL$(100), IXX(100), IYY(100), DIXX$(100), DIYY$(100), IKLOK$(10

T$ = Chr(9)

DDIRK$ = "D:\@-IK-Training\Modul-06-Gelombang\ID_Lok\"
DDIRD$ = "D:\@-IK-Training\Modul-06-Gelombang\5-Hasil_Ekstrak_Grid_Global_mapper\"
DDIRS$ = "D:\@-IK-Training\Modul-06-Gelombang\6-Hasil_Jarak_Min\"

For I = 5 To 5
 If I = 1 Then NM$ = "BK"
 If I = 2 Then NM$ = "JK"
 If I = 3 Then NM$ = "PK"
 If I = 4 Then NM$ = "SB"
 If I = 5 Then NM$ = "TG"

 Open DDIRK$ + NM$ + "_ID.TXT" For Input As 1
 JD = 0
 Line Input #1, PAR$
 While Not EOF(1)
  JD = JD + 1
  Input #1, XX$, YY$, KLOK$, KCVI$, KKAB$, NKAB$, KSEL$
  IKKAB$(JD) = KKAB$
  INKAB$(JD) = NKAB$
  IKSEL$(JD) = KSEL$
  IKLOK$(JD) = KLOK$
  IKCVI$(JD) = KCVI$
  IXX(JD) = Val(XX$)
  DIXX$(JD) = XX$
  IYY(JD) = Val(YY$)
  DIYY$(JD) = YY$
 Wend
 JJ = JD
 Close #1
```

Then change the file directory, then run the program by clicking on the RUN icon (▶)

Program line following:

```
Sub Main()

Dim DDIRK$, DDIRD$, NM$, HBJR$, HLNT$, HDDD$, T$, PAR$, KLOK$, KCVI$,
TH$
Dim I, JD, JJ, J, DJRK, DBJR, DLNT, JRK
Dim IKKAB$(100), INKAB$(100), IKSEL$(100), IXX(100), IYY(100),
DIXX$(100), DIYY$(100), IKLOK$(100), IKCVI$(100)

T$ = Chr(9)

DDIRK$ = "D:\@-IK-Training\Modul-06-Gelombang\ID_Lok\"
DDIRD$ = "D:\@-IK-Training\Modul-06-Gelombang\5-
Hasil_Ekstrak_Grid_Global_mapper\"
DDIRS$ = "D:\@-IK-Training\Modul-06-Gelombang\6-Hasil_Jarak_Min\"

For I = 5 To 5
 If I = 1 Then NM$ = "BK"
 If I = 2 Then NM$ = "JK"
 If I = 3 Then NM$ = "PK"
 If I = 4 Then NM$ = "SB"
 If I = 5 Then NM$ = "TG"

 Open DDIRK$ + NM$ + "_ID.TXT" For Input As 1
 JD = 0
 Line Input #1, PAR$
 While Not EOF(1)
  JD = JD + 1
  Input #1, XX$, YY$, KLOK$, KCVI$, KKAB$, NKAB$, KSEL$
  IKKAB$(JD) = KKAB$
  INKAB$(JD) = NKAB$
  IKSEL$(JD) = KSEL$
  IKLOK$(JD) = KLOK$
```

```
  IKCVI$(JD) = KCVI$
  IXX(JD) = Val(XX$)
  DIXX$(JD) = XX$
  IYY(JD) = Val(YY$)
  DIYY$(JD) = YY$
 Wend
 JJ = JD
 Close #1

 Open DDIRS$ + "J-" + NM$ + "-RTGL.TXT" For Output As #2
  Print #2, "BUJUR" + T$ + "LINTANG" + T$ + "LOKASI" + T$ + "KODE_CVI" +
T$ + "KODE_KAB" + T$ + "NAMA_KAB" + T$ + "KODE_SEL" + T$ + "TAHUN" + T$
+ "SLT" + T$ + "D_BUJUR" + T$ + "D_LINTANG"

 For K = 1998 To 1998
  TH$ = Trim(Str(K))
  For J = 1 To JJ
   Open DDIRD$ + NM$ + "-" + TH$ + ".TXT" For Input As #1
   DJRK = 99999
   While Not EOF(1)
    Input #1, BJR$, LNT$, DDD$
    DBJR = Val(BJR$)
    DLNT = Val(LNT$)
    JRK = Sqr(((DBJR - IXX(J)) ^ 2) + ((DLNT - IYY(J)) ^ 2))
    If JRK < DJRK Then
     DJRK = JRK
     HBJR$ = Trim(BJR$)
     HLNT$ = Trim(LNT$)
     HDDD$ = Trim(DDD$)
    End If
   Wend
   Print #2, DIXX$(J) + T$ + DIYY$(J) + T$ + IKLOK$(J) + T$ + IKCVI$(J)
+ T$ + IKKAB$(J) + T$ + INKAB$(J) + T$ + IKSEL$(J) + T$ + TH$ + T$ +
HDDD$ + T$ + HBJR$ + T$ + HLNT$
   Close #1
  Next J
 Next K

 Close #2

Next I

End Sub
```

XII. Instructors

7. Name : Erwin Maulana

Email : erwin_maulana2002@yahoo.com

Mobile : +6285694901356

Office : Laboratory of Oceanography
Marine Science and Technology Departement
Faculty of Fisheries and Marine Science
Bogor Agricultural University

8. Name : M. Tri Hartanto

Email : tri_itk@yahoo.com

Mobile : +6281314402527

Office : Laboratory of Oceanography
Marine Science and Technology Departement
Faculty of Fisheries and Marine Science
Bogor Agricultural University

TRAINING MODULE

DEVELOPMENT OF COASTAL VULNERABILITY INDEX

"DATA PROCESSING OF DEM (DIGITAL ELEVATION MODEL)"

Compiled by :

Santoso

BOGOR AGRICULTURAL UNIVERSITY, 2010

CONTENTS

I. Introduction

The elevation or coastal slope is one of parameters for determining coastal vulnerability index. The important of elevation data in coastal area relating with estimate the flooding area causes sea level rise. Understanding information of elevation an area, it can be predicted the area will be flood due the rising sea level rise.

There are many ways in the present elevation of the earth's surface in digital. One way to present the earth's surface with a limited storage capacity is the Digital Elevation Model (DEM). DEM is a model to describe the topography of the earth's surface so it can be visualized in 3D (three dimensional). There are many way to obtain DEM data, Interferometric SAR (Synthetic Aperture Radar) is new algorithm to create a new DEM data. Image data from SAR or radar images used in the process of interferometry can be obtained from satellite or plane rides, other from the radar DEM can also be obtained from the ASTER. In this training will be used for DEM data is GDEM (Global Digital Elevation Model) derived from satellite ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer).

GDEM has the accuracy (spatial resolution) are pretty good that is 30 meters, while the coverage area is nearly the entire surface of the earth. GDEM data can be downloaded on http://www.gdem.aster.ersdac.or.jp, which released the data format is TIF (Tag Image Format) which can be opened directly in GIS software, making it easier for purposes of further analysis.

I. Objective

The objective of this module is to provide guidance how to obtain DEM data by downloading from the internet and to determination coastal slope value from DEM data by using GIS software.

II. Coastal Area

The term of beach or coastal areas are often known as an interplay between land and sea, which has special characteristics geosphere, landward restricted by the physical properties of marine and nautical socioeconomic, while the direction to sea is bordered by natural processes and due to human activity of the land environment. Coastal is a system between the oceans and land have relationship each other. How much land affect to the ocean and how far ocean affect to the mainland, it's all a system of coastal states. Coastal system can be describe like Figue 1.

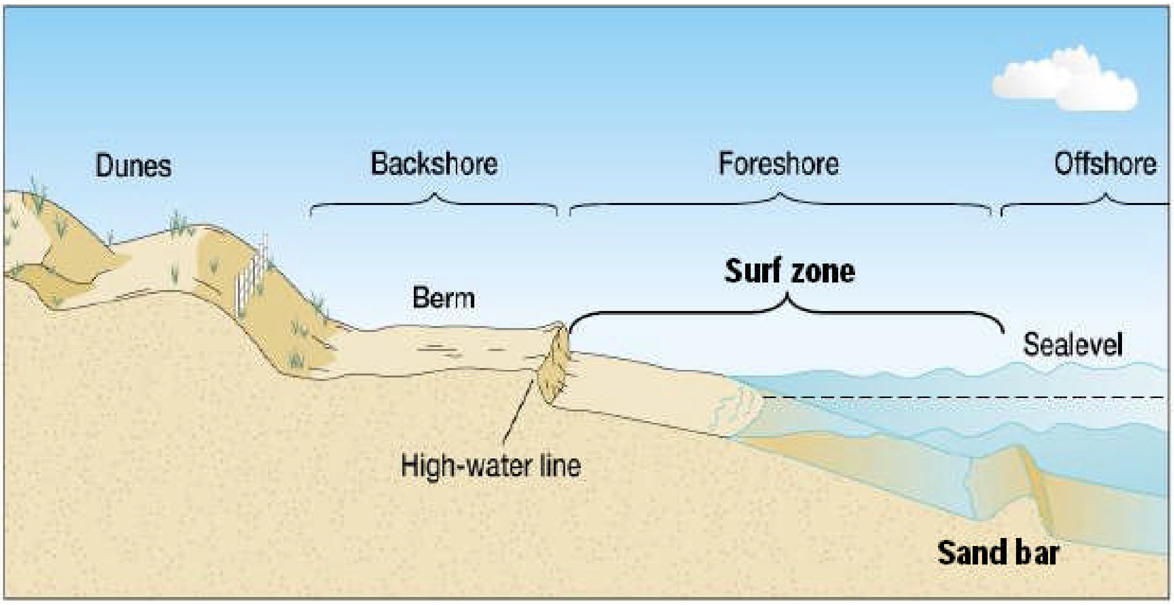


Figure 1. Coastal system.

Coastal area is a zones which varies in width, which covers the shore which extends towards the mainland to the limit of marine influence is still felt. Basic classification of coastal is change shoreline to forward and backward. Change shoreline to forward can be caused by the removal of coastal or deposition by progradation, while backward caused by coastal erosion sink or retrogradation.

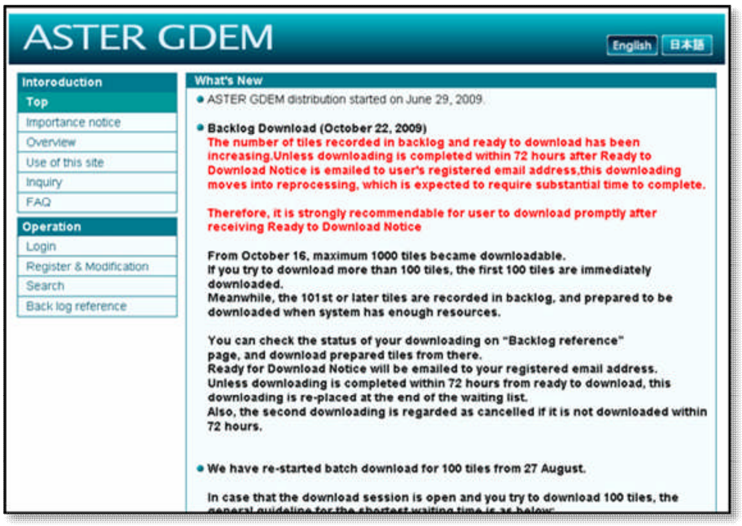
Coastal environment is an area that is always to be change, because the area became a meeting place of two forces, which is from land and from sea. Coastal environmental changes can occur slowly or very fast, depending on the power balance between topography, rocks, and its properties with waves, tides and wind. Coastal change varies greatly from one place to other place, so the spatial study of coastal environments is required in order to manage the coastal environment. Coastal environment to be managed properly considering the function in human life is very large since antiquity to the present and even future.

III. Data Aquisition

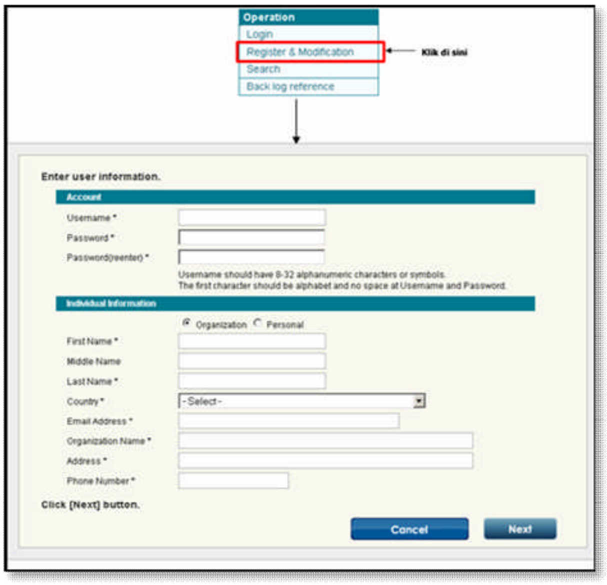
Generally, there are three main step to obtaining DEM data from internet, namely the registration as member, select the desired area, the latter is the process of downloading data. This is detail step by step to obtaining data :

1. Type website address into the address bar http://www.gdem.aster.ersdac.or.jp, in which case we are using Mozilla Firefox, then press enter.

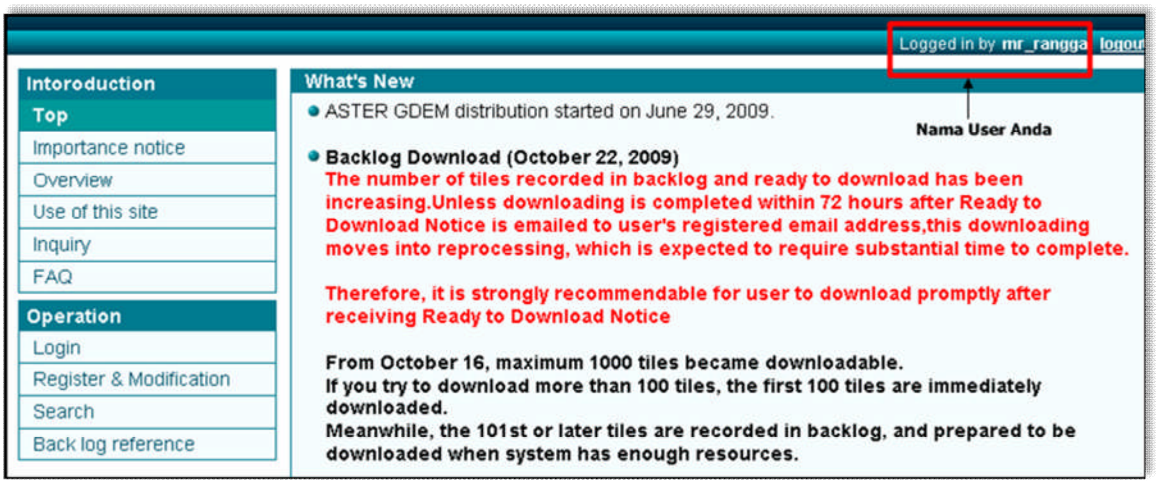
2. If your computer is connected to the internet it will show a web page as follows



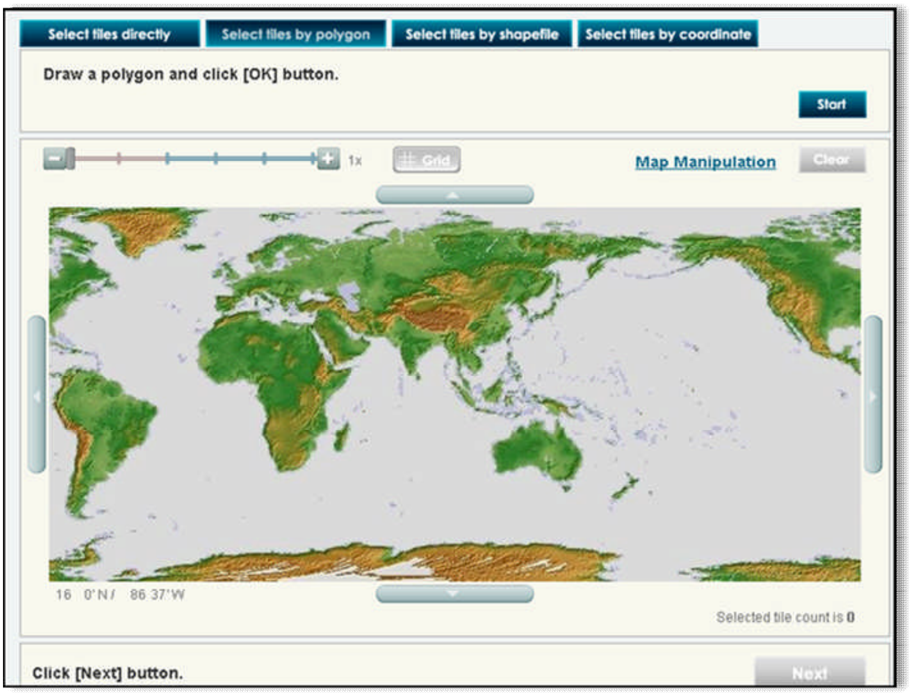
3. Click register & modification menu to login →then you will enter in personal data form filling page.



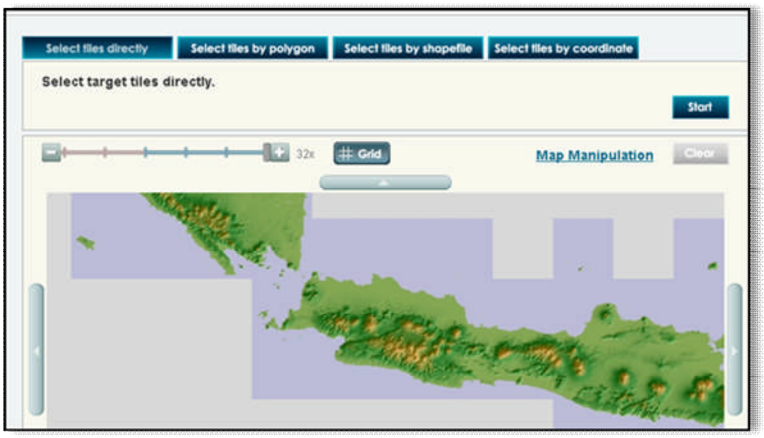
4. Fill the form in accordance with his orders, that marked with an asterisk (*) is a sign of the command fields are mandatory → After filling the form is completed click the Next button → if registration is successful then you will return to the main page and means registration is successful, and your user name will be show on the side upper right corner.



5. Next click search menu to start searching DEM data → you will go to the page map as follows :



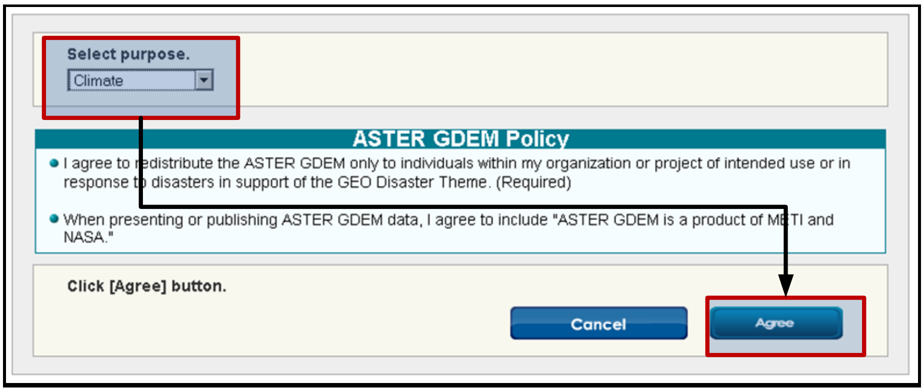
6. With help of a computer mouse zoom the area you want to download → in this case we will zoom Tangerang area.



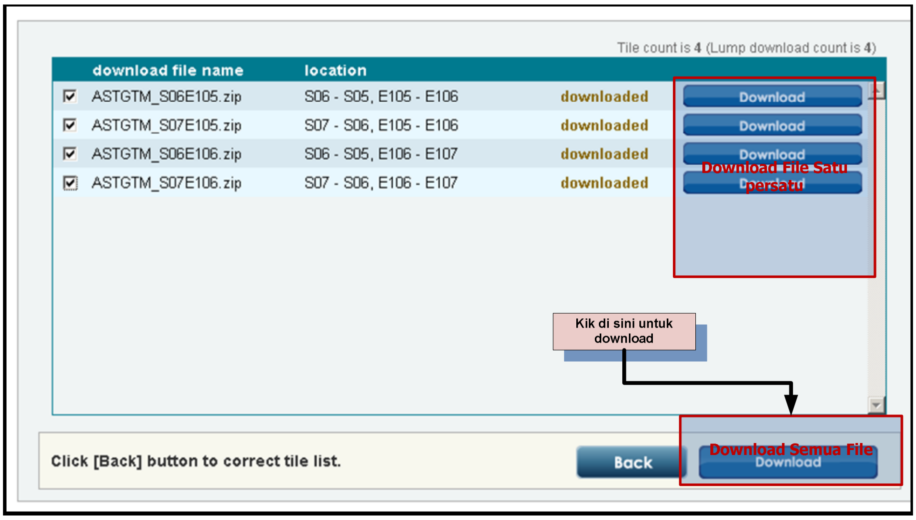
7. Before you are downloading data you must first choose any location that you will download → Chose select tiles directly menu→ then click start menu → then cursor will change shape like a plus sign (plus)→ then click the area you want, in this case we choose the Tangerang region.

8. After your location have been selected → then click next menu →the data will be show and ready to download

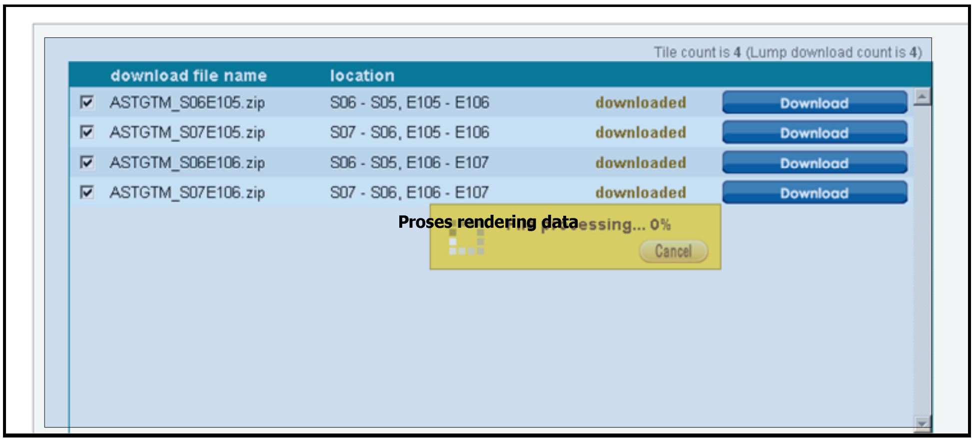
9. After the data has been show → click next menu, then you will enter to agreement page → in select purpose menu chose climate according to your needs) → then click Agree→ then you will in the download page

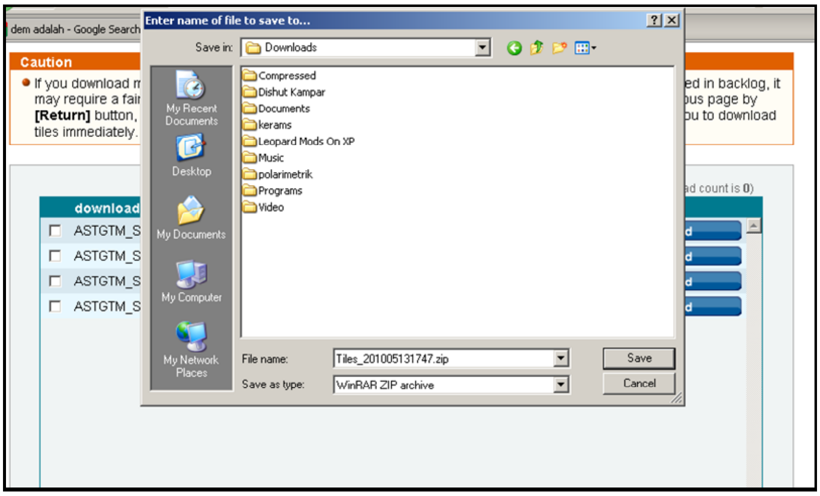


10. In this page file ready to download, there are two way to download file, that is download file one by one or download all file directly → In this exercise we will download files at once →click download menu to obtaining data



11. The next process there will be rendering data → after rendering data finished → then you will be asking directory to save file → save file data at your computer





12. Wait saving process until complete → if downloaded file is complete, the download process or completion of data acquisition is done.

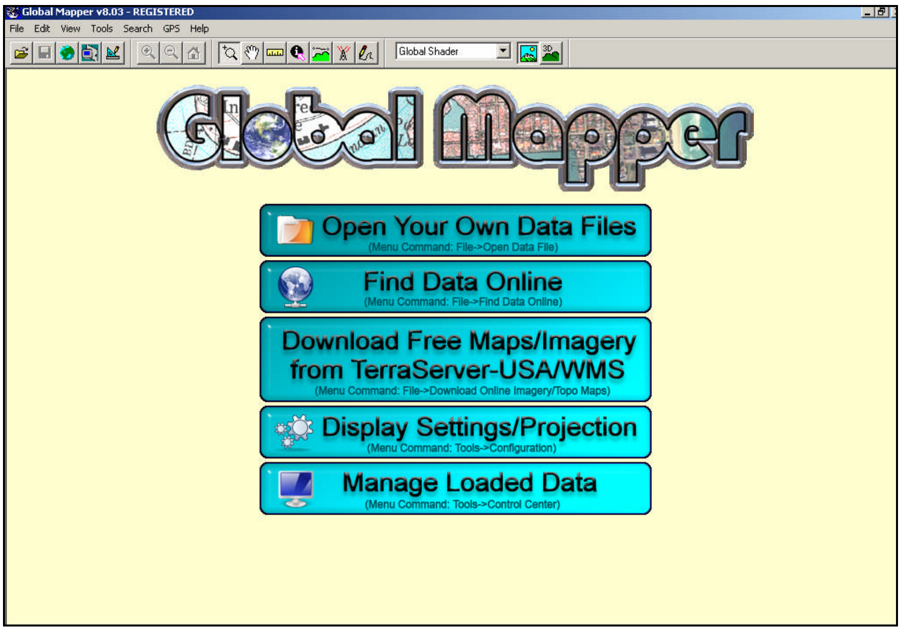
IV. Data Processing

In the DEM data processing there are two software that is used for processing, namely the Global Mapper and ArcGIS 9.2 is substituted, equipped with Hawths Analysis Tools. In general there are several steps in the processing of DEM data, such as reading data, crooping data, extraction of data, reading data into ArcGIS, the search slope, Grid statistical each cell, the integration of data into GIS. The following step is complete in data processing :

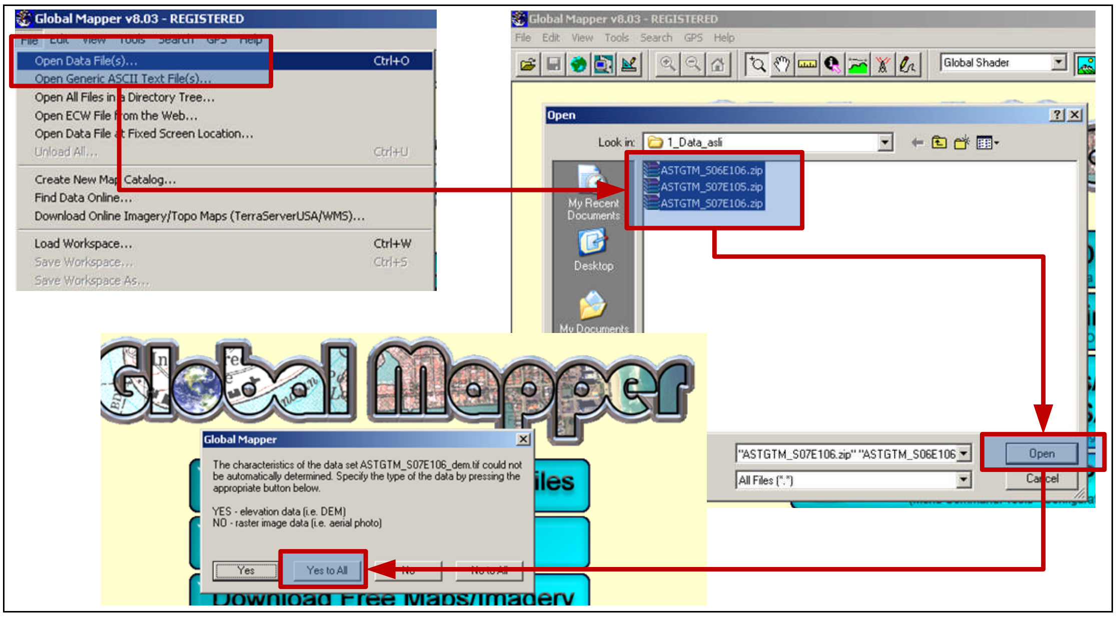
a. Reading of data

GDEM (Global Digital Elevation Model) data downloaded from the Internet are formatted "zip" and consists of several files, to open and combine files we will use the Global Mapper software. Here are the steps the reading process, merging, and export data in Global Mapper

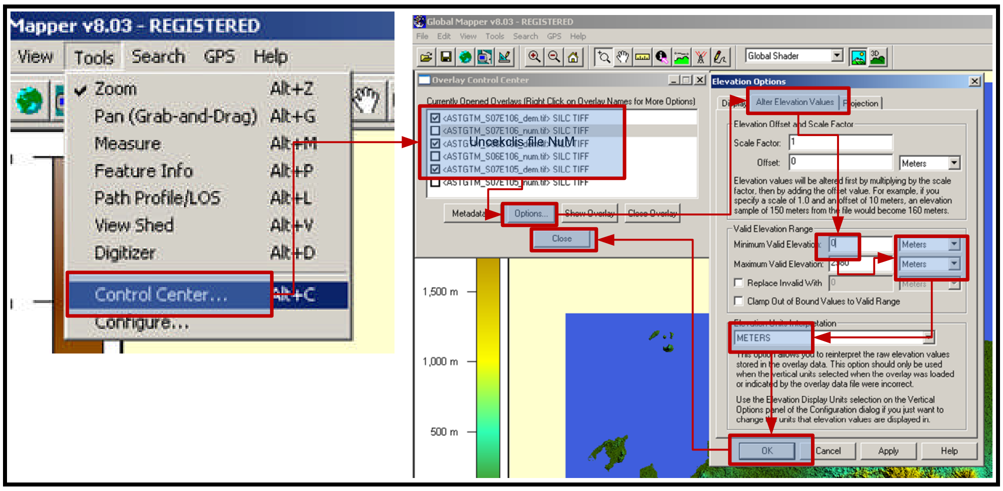
1. Open program global mapper at your computer →start →program →global mapper → then you will be enter to following page global mapper



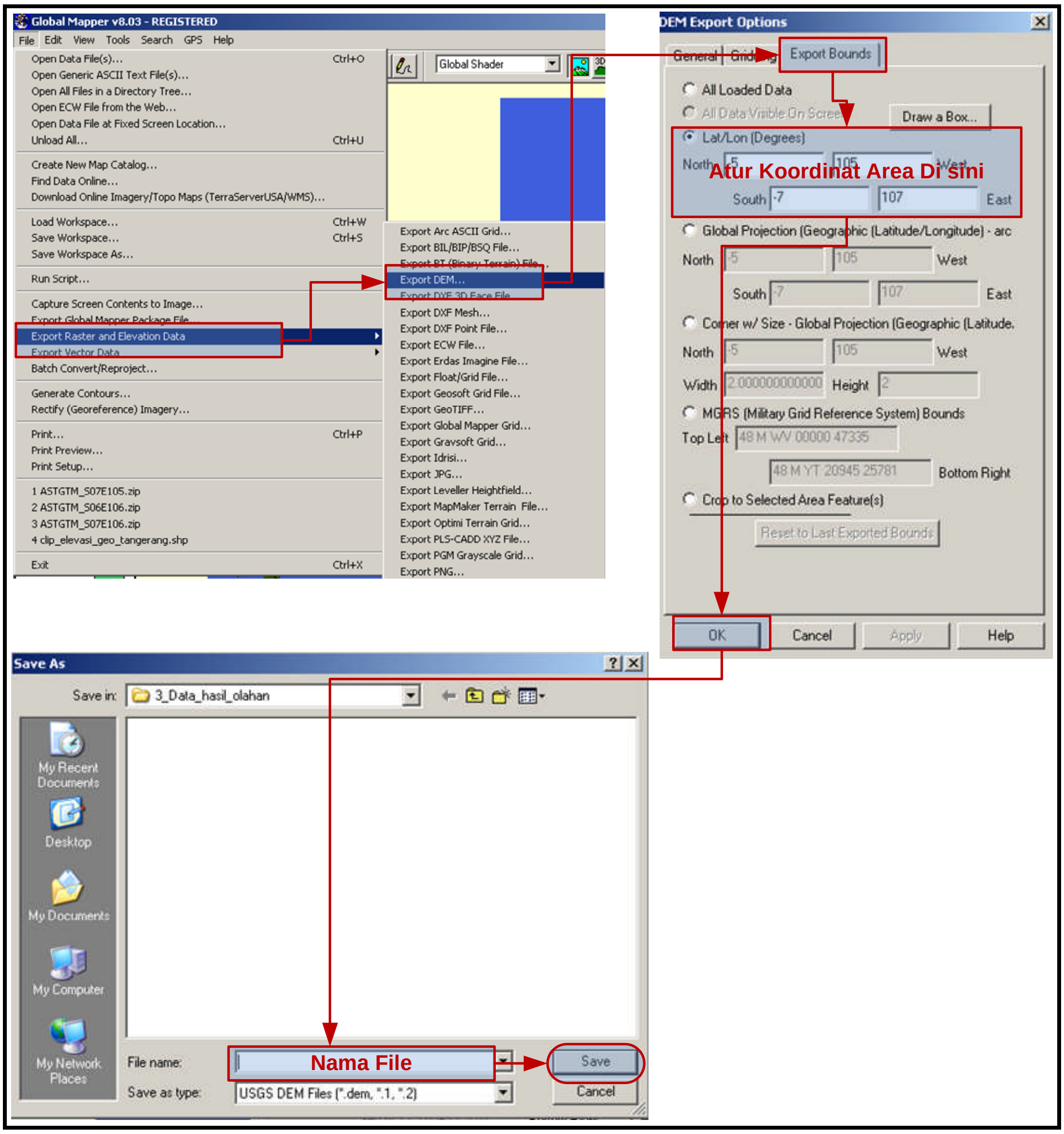
2. Open your file GDEM data →file→open data file(s) → locate the data files on your data storage directory (D: \ @-IK-Training \ Module-7-DEM \ 1_Data_asli) → Select the file you want to open (press the CTRL key on your keyboard to select more than one data file) → click open menu → click yes all when there is a warning window on the Global Mapper → Wait a moment, then the file will open



3. You will see file that is open GDEM, Next..there are some configuration to choose the data, that is → choose tool menu → Control Center →Unchecklist all file "NUM" cause we are not to use it → click option →at the window elevation option choose alter elevation values → make sure unit is meters → make sure minimum valid elevation have zero value → click OK→then click close menu to close windows



4. After configuration is finished, the next step is export data as you want → click file → export raster and elevation data → export DEM → on Windows DEM Export Option choose export bounds → set the coordinates of the area you want, in this training we will download the Tangerang area with boundary coordinates 106 345 BT - BT 106 767 and LS 5695 - 6:15 LS → save the file in your directory (D: \ @-IK-Training \ Module-7-DEM \ 3_Data_hasil_olahan) give the name of the file to your liking →Wait the process till 100% export → data export process is complete

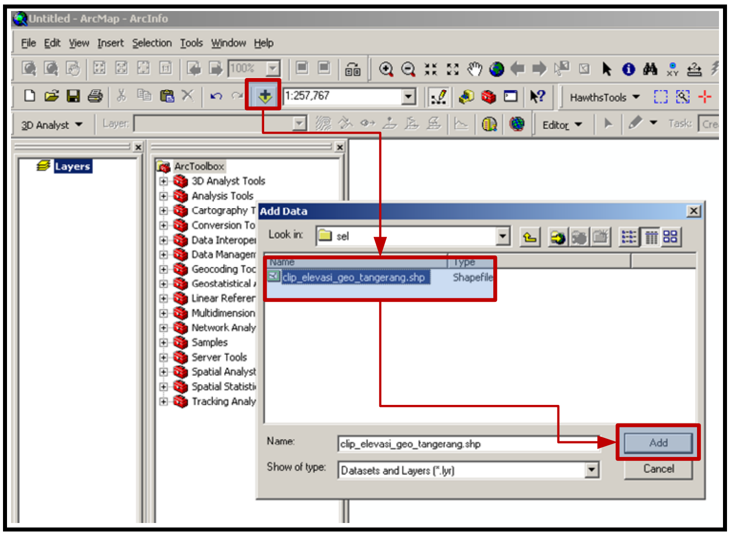


b. Data Analysis in ArcGIS

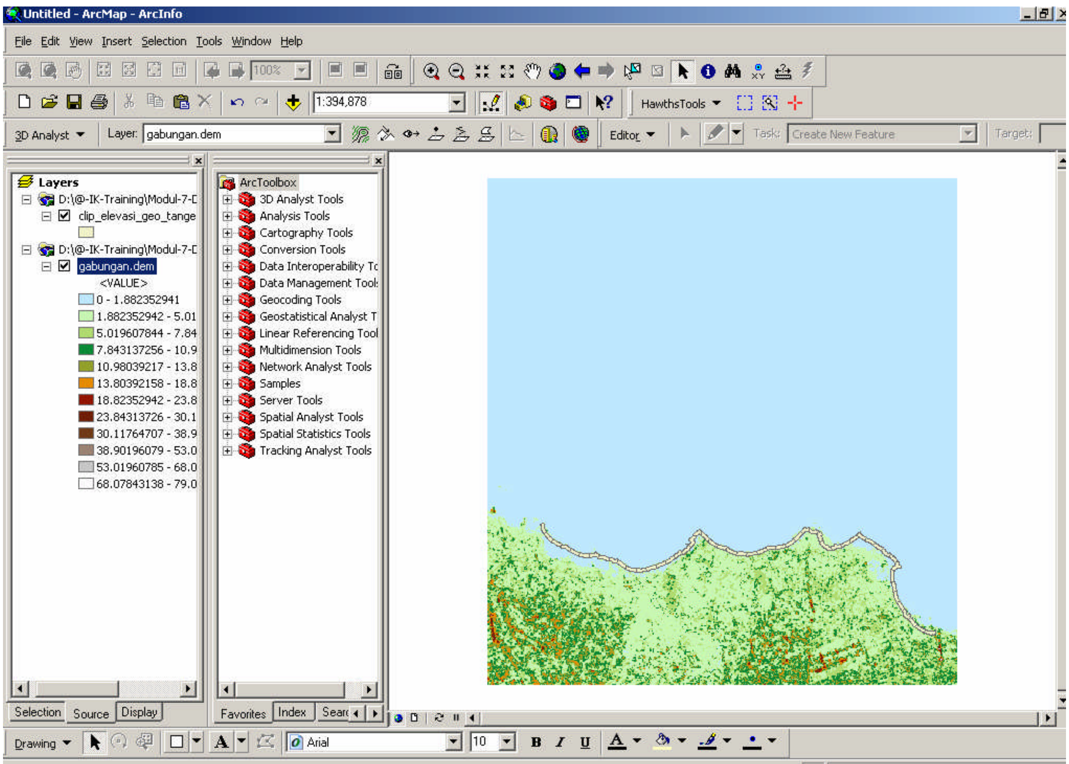
In the ArcGis program data will be analysis to determine slope value according grid has been made before in exercise introduction GIS. The slope value that taken just inside in the grid, because in one grid there are a lot of slope values, then the value is in one grid were averaged to obtain one value in a single grid. Completely steps is following

1. Open your Arcgis program→start →program → Arcgis →ArcMap →set your projection system with coordinat geographic and WGS84 system
2. Before opening the DEM file results from Global Mapper first activate the layer of fgrid that have been made previously, in this exercise I use the grid Tangerang area with the number of grid 51. These grid will function as a cutter (crooper) slope values within the grid. Way to open that layer is →click add data  → search the directory layer of grid on your computer, in this exercise are the grid files in the

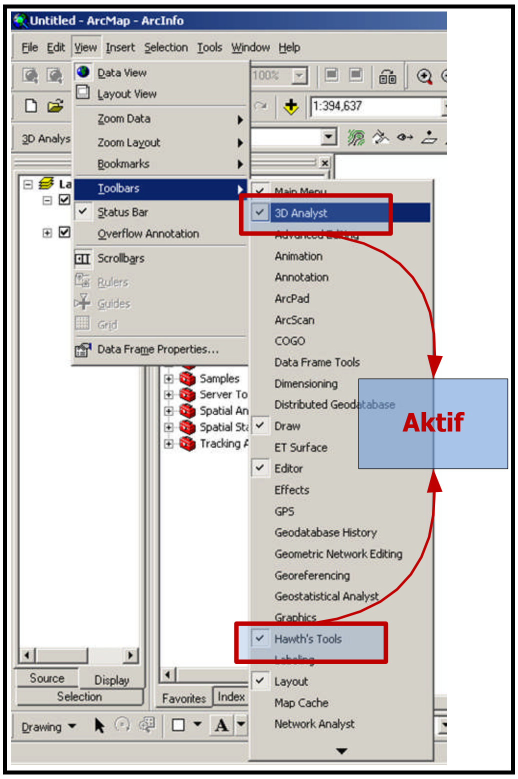
directory D: \ @-IK-Training \ Module-7-DEM \ 2_Data_Peta \ sel → choose clip_elevasi_geo_tangerang.shp → click add



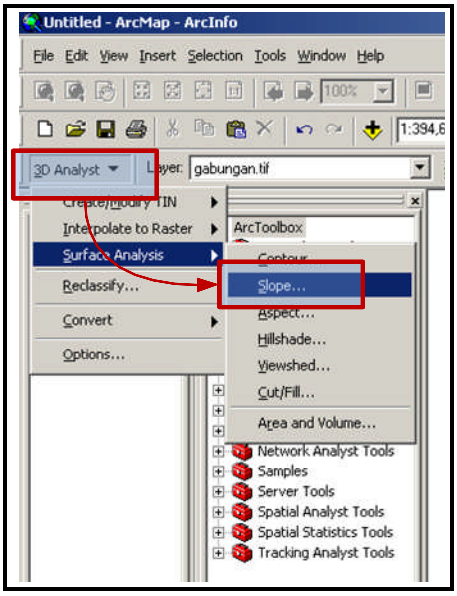
3. After the grid layer is active then open DEM file that produced from Global Mapper → add data →search file in your directory computer, in this exercise files are located in the directory D: \ @-IK-Training \ Module-7-DEM \ 3_Data_hasil_olahan →select a file gabungan.dem→ click add → then there are two layer active, that is grid layer and DEM layer are like the following :



4. The next step is to determine slope value of the composite layer. Before starting the determination of the slope value. Make sure the 3D analyst toolbar and the Hawth's tools in an active state→ Select View menu →Toolbars

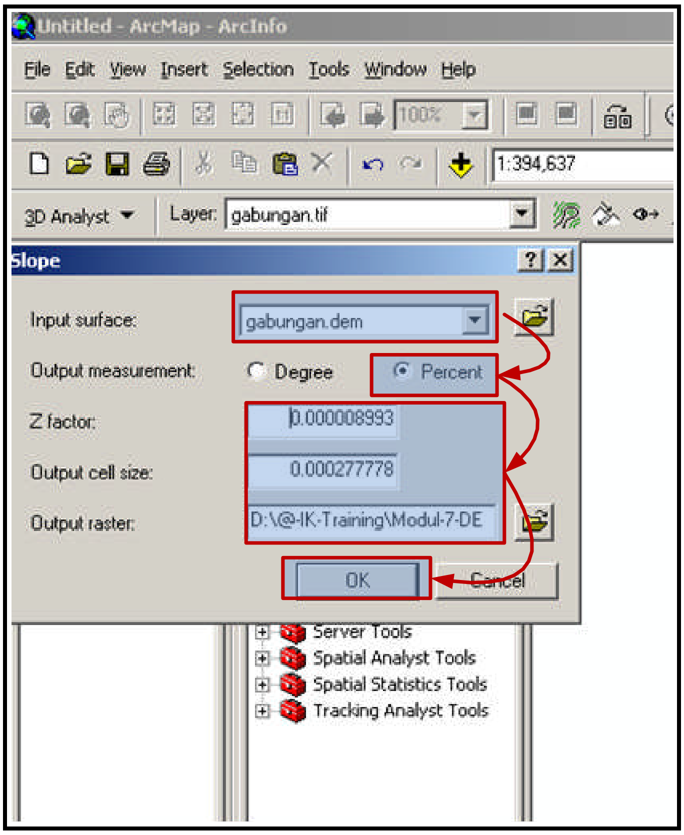


5. Determining the slope value is ready to made →select 3d analyst menu →surface analyst → select slope



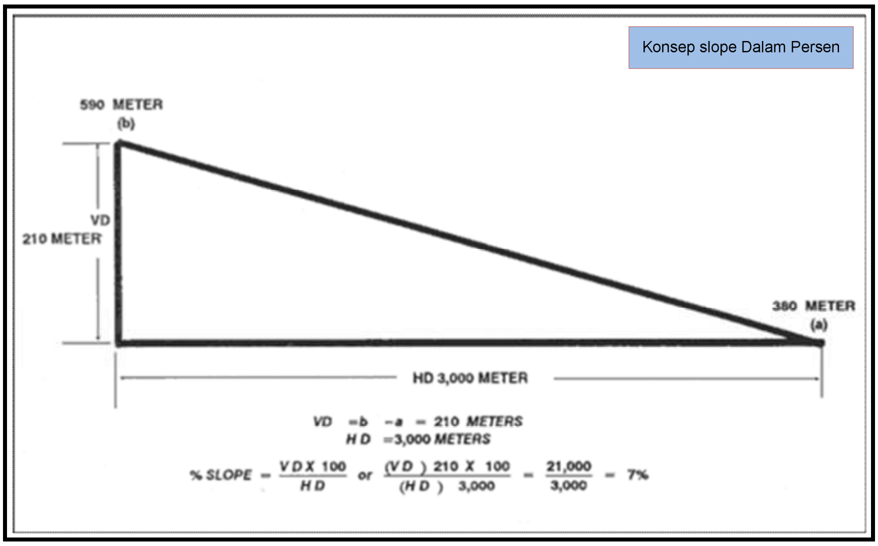
6. After you selecred slope menu you will enter at the page configuration slope → make sure input surface : gabungan.dem (or another raster file) → select output

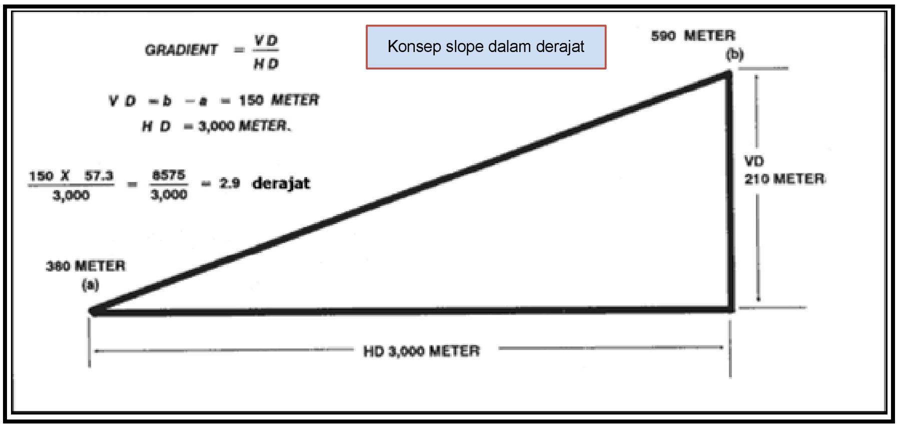
measurement as percent → Z factor : 0.00000899281→ output cell size let default value → save file in your directory computer



information :

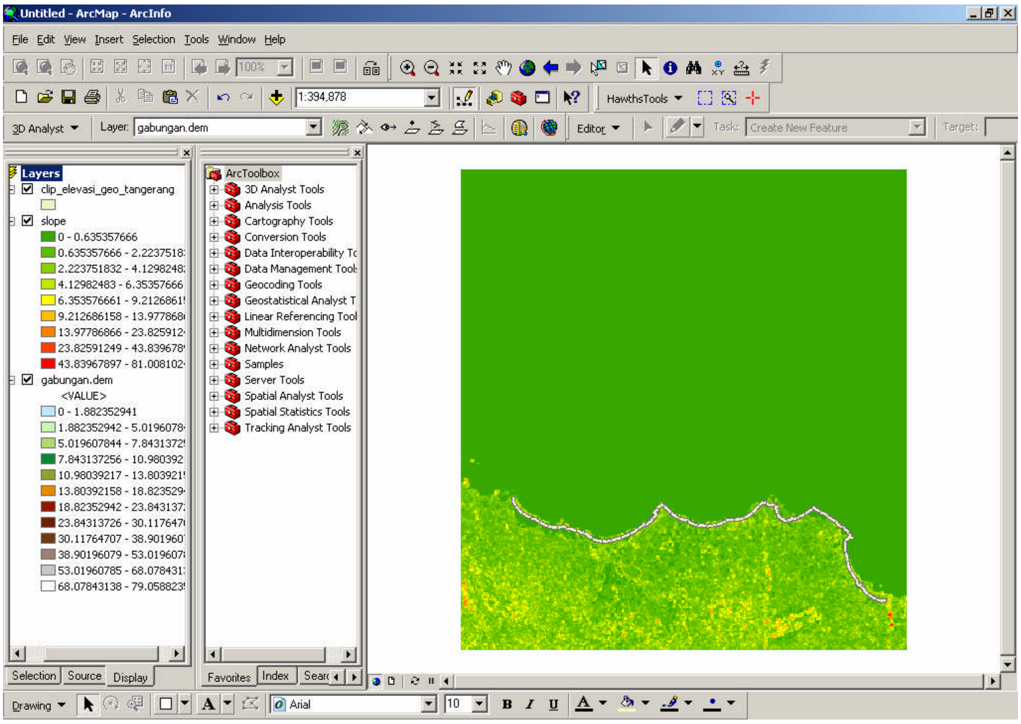
- Output measurement : **percent → is** a unit of the slope in percent. The concept of unit slope are expressed as percent on the following figure:



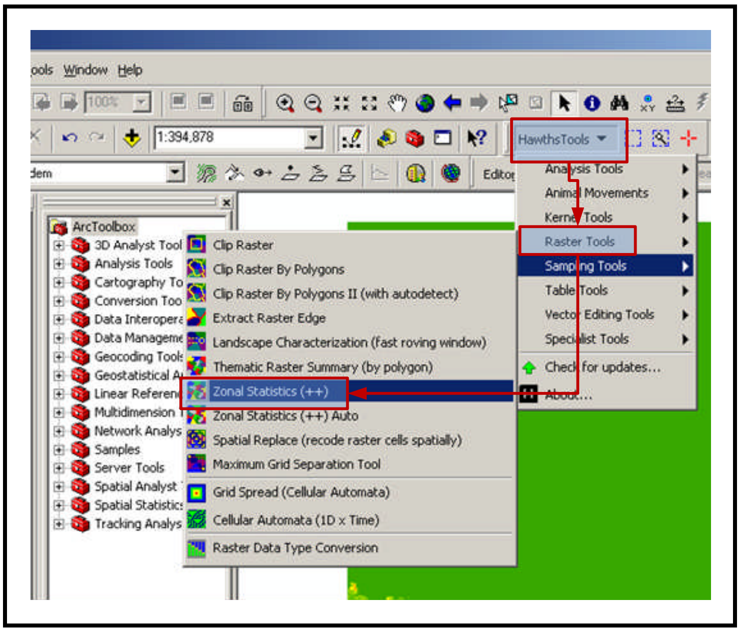


- **Z faktor** → is a unit adjustment factor, because the unit value of Z (elevation) is the meter shall be adjusted to the unit coordinate system of degrees. Z factor value is 1, assuming the value of 1^{o} is 111.2 km, the 1 meter equal to 0.00000899281^{o}

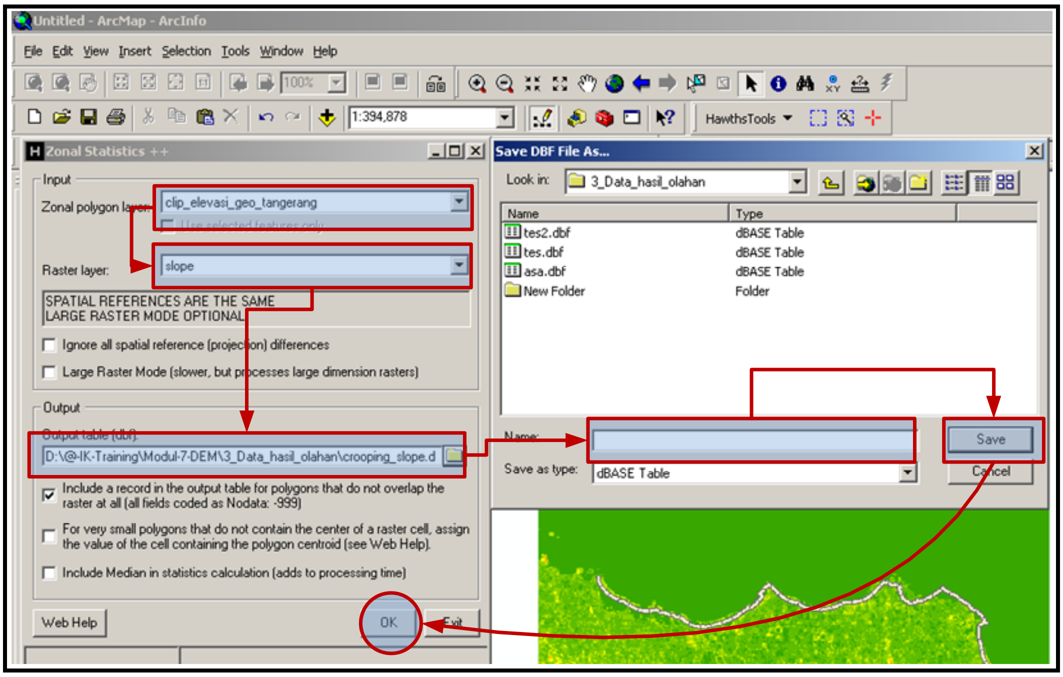
7. Wait few moments to complete the process of forming the slope, after the process is finished slope will automatically appear as a new layer in ArcGIS as follows:



8. The next process is to take (crooping) slope value which resides in the grid by using the Hawth's tools. This tool able to average value in one grid, so that at the grid only have one slope value. Select **Hawth's tools menu** → Raster tool → Zonal Statistics (++)



9. Then you will be asking to determine slope value base on option that available → on Zonal polygon layer select grid data which serves as the boundary crooping (in this case we use clip_elevasi_geo_tangerang.shp file) → on the raster layer select the slope (the slope of the layer formation process results) → select the output table name according to your liking → save →ok



10. Wait until the process crooping is complete. After finished make sure that cropping process succed and have logic value. File that produced have format "dbf" so we can open this file with Arcgis as directly. The values are the result crooping minimum value, maximum, average, standard deviation, and the number in each cell, because

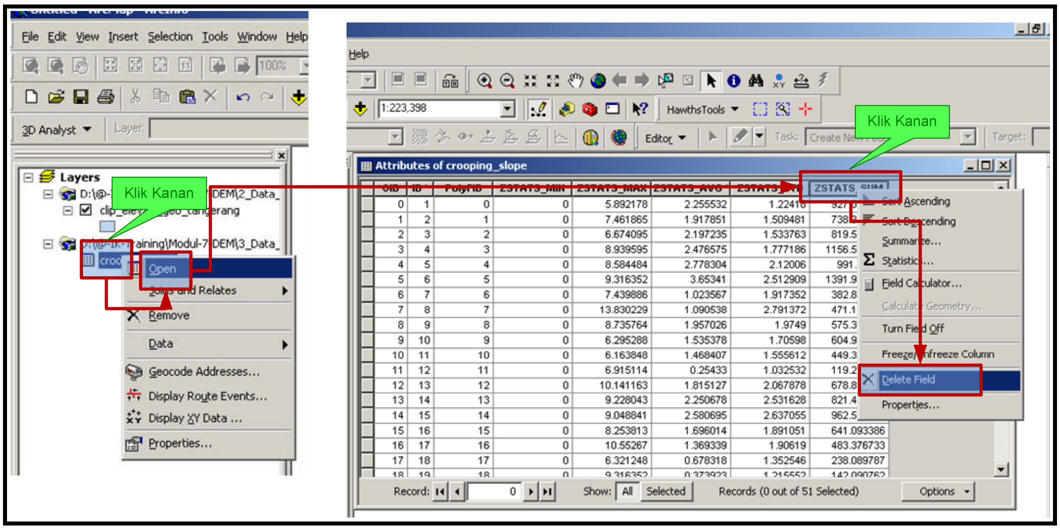
grid used was 51 so rows of data that comes out is also numbered 51. In this training we only require the average value in each grid for the parameter determining coastal vulnerability index. Here is sample result data cropping

ZSTATS_MIN	ZSTATS_MAX	ZSTATS_AVG	ZSTATS_STD	ZSTATS_SUM
0	5.892178	2.255532	1.22418	927.023818
0	7.461865	1.917851	1.509481	738.372469
0	6.674095	2.197235	1.533763	819.568494
0	8.939595	2.476575	1.777186	1156.560407
0	8.584484	2.778304	2.12006	991.85441
0	9.316352	3.65341	2.512909	1391.949304
0	7.439886	1.023567	1.917352	382.814155
0	13.830229	1.090538	2.791372	471.112494
0	8.735764	1.957026	1.9749	575.365609
0	6.295288	1.535378	1.70598	604.938995
0	6.163848	1.468407	1.555612	449.332651
0	6.915114	0.25433	1.032532	119.280555
0	10.141163	1.815127	2.067878	678.857525
0	9.228043	2.250678	2.531628	821.497429
0	9.048841	2.580695	2.637055	962.599303
0	8.253813	1.696014	1.891051	641.093386
0	10.55267	1.369339	1.90619	483.376733
0	6.321248	0.678318	1.352546	238.089787
0	9.316352	0.373923	1.215552	142.090762
0	11.672653	2.44472	2.873329	941.217073
0	10.506012	1.846895	2.701853	253.024584
0	12.167242	3.376886	3.197707	1036.703931
0	13.311334	3.121209	2.63428	1129.877695
0	6.190359	0.119496	0.668435	45.528001
0	10.125002	2.249294	2.361969	805.247323
0	10.933756	2.39582	2.4569	888.849143
0	10.521587	2.545494	2.399655	1051.288926
0	11.052928	1.834784	2.707975	627.495983

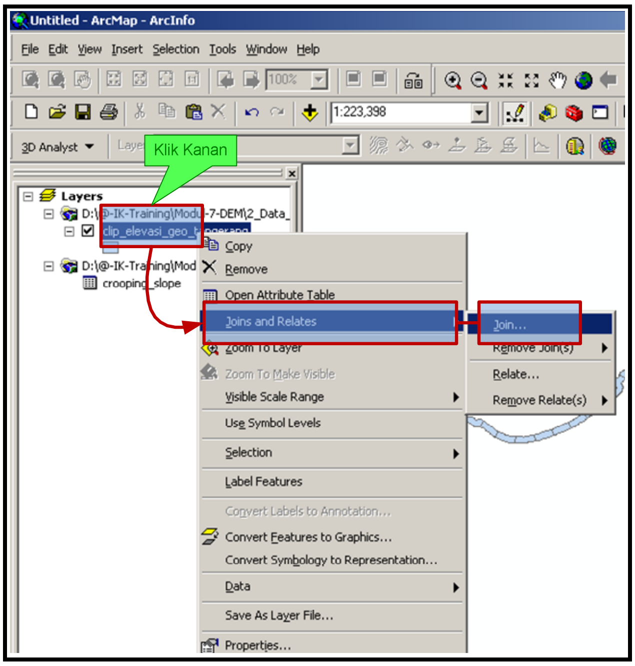
c. Combine data slope value in grid

The process of incorporation is a step which the slope value (slope) is inserted into the attributes of cells for analysis GIS. This process is quite easy because only do the join table only. The steps are as follows

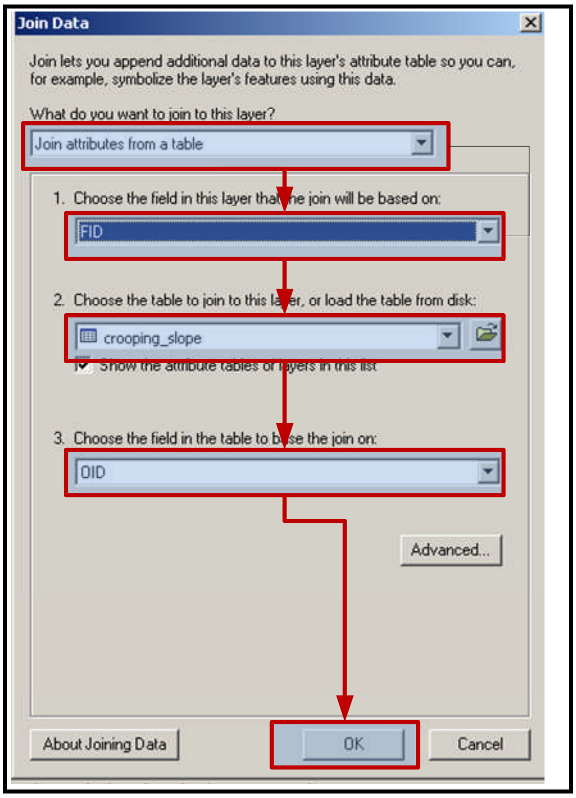
1. Make sure at the Arcgis there are two layer has been active, that is grid layer and (clip_elevasi_geo_tangerang) and slope layer (crooping_slope)
2. Because of this training we only require the average value of the slope in each cell then delete the values that are not necessary, as a minimum, maximum, standard deviation → Step-by-step to removal is → right click at the crooping_layer slope → open → after the table is active → right click on the header data → delete field



3. After processing delete data are finished → then processing join table has ready → right click on clip_elevasi_geo_tangerang layer → join and relates → select join



4. Next, you'll go to the menu choices in the join table as follows:



Customize options such as figure above

5. Processing of join has been finished → samples of the join is as follows:

Attributes of clip_elevasi_geo_tangerang

clip_el	clip_elevasi	clip_elevasi	clip_elevasi	clip_elevasi	clip_elevasi	clip_elevasi	Kemiringan (%) *
23	Polygon	106.702222	3603_041	3603	TANGERANG	41	0.119496
43	Polygon	106.68058	3603_038	3603	TANGERANG	38	0.135181
39	Polygon	106.687634	3603_039	3603	TANGERANG	39	0.178929
11	Polygon	106.711262	3603_043	3603	TANGERANG	43	0.25433
18	Polygon	106.431679	3603_006	3603	TANGERANG	6	0.373923
49	Polygon	106.630286	3603_031	3603	TANGERANG	31	0.383444
33	Polygon	106.695062	3603_040	3603	TANGERANG	40	0.460007
41	Polygon	106.673736	3603_037	3603	TANGERANG	37	0.577811
40	Polygon	106.528747	3603_018	3603	TANGERANG	18	0.635233
17	Polygon	106.708758	3603_042	3603	TANGERANG	42	0.678318
35	Polygon	106.666209	3603_036	3603	TANGERANG	36	0.805078
47	Polygon	106.533758	3603_019	3603	TANGERANG	19	0.822173
6	Polygon	106.709069	3603_045	3603	TANGERANG	45	1.023567
7	Polygon	106.707797	3603_044	3603	TANGERANG	44	1.090538
34	Polygon	106.648562	3603_034	3603	TANGERANG	34	1.337794
16	Polygon	106.448761	3603_008	3603	TANGERANG	8	1.369339
10	Polygon	106.492173	3603_013	3603	TANGERANG	13	1.468407
9	Polygon	106.473232	3603_011	3603	TANGERANG	11	1.535378
29	Polygon	106.658153	3603_035	3603	TANGERANG	35	1.661871
15	Polygon	106.509003	3603_015	3603	TANGERANG	15	1.696014
45	Polygon	106.623962	3603_030	3603	TANGERANG	30	1.748557
50	Polygon	106.394464	3603_001	3603	TANGERANG	1	1.774676
12	Polygon	106.500746	3603_014	3603	TANGERANG	14	1.815127
27	Polygon	106.59906	3603_027	3603	TANGERANG	27	1.834784
20	Polygon	106.440768	3603_007	3603	TANGERANG	7	1.846895
42	Polygon	106.399111	3603_002	3603	TANGERANG	2	1.884796
38	Polygon	106.616835	3603_029	3603	TANGERANG	29	1.903377
1	Polygon	106.733128	3603_050	3603	TANGERANG	50	1.917851

V. Instructor

Name : Santoso

Email : matihsantos@gmail.com

Mobile : +6281385911257

Office : Laboratory of Oceanography
Marine Science and Technology Departement
Faculty of Fisheries and Marine Science
Bogor Agricultural University

TRAINING MODULE

DEVELOPMENT OF COASTAL VULNERABILITY INDEX

“PROCESSING OF COASTLINE CHANGES”

Compiled by :

Samsul B. Agus

Anggi Afif M

BOGOR AGRICULTURAL UNIVERSITY, 2010

CONTENTS

I. Introduction

Changes in shoreline is one of the parameters used in the determination of Coastal Vulnerability Index. The beach is a zone that is dynamic because it is a zone of intersection and interaction between air, land and sea. The coastal zone continues to experience ongoing adjustment process leading to a natural balance to the impact of external and internal influences both natural and human intervention. Natural factors such as waves, currents, tides, wind action, climate, and tectonic and volcanic activity. While the activity of human intervention is the use of coastal areas such as industry, fisheries, ports, mining and settlement. That the coastal shoreline change of the coastal region was declared vulnerable.

Shoreline change can be divided into positive and negative changes. Positive change is if the process of sedimentation occurred in the coastal region. So in coastal areas that experienced positive changes, will experience the addition of coastline towards the sea. While the negative changes in case of abrasion on coastal processes, so that the coastline will retreat toward the mainland. Shoreline change can be determined through satellite imagery or a mathematical model based on the proportion of coastal sediments. In this activity data used to identify variables shoreline change obtained from the SPOT image in 2003 as an information and 2008 shoreline early as the end of the shoreline information.

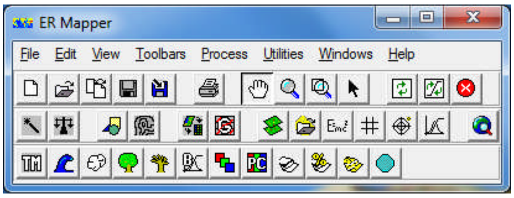
II. Objective

- Provide guidance on how to obtain data on changes in the coastline from satellite imagery
- Provide guidance shoreline change data processing using ArcGIS software
- Provide guidance in making the data cells to variable shoreline change.

III. Data Processing

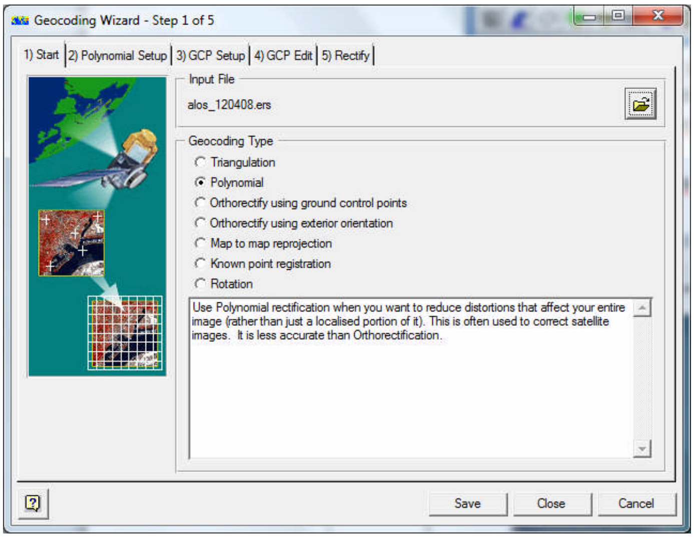
In the data processing rate of shoreline change, we do digitization process map "shoreline" in the good image of the old year (2003) and new year (2008). Previously must be ensured that the two images were geometrically corrected properly..

1. Geometric correction process: open the program ermapper 

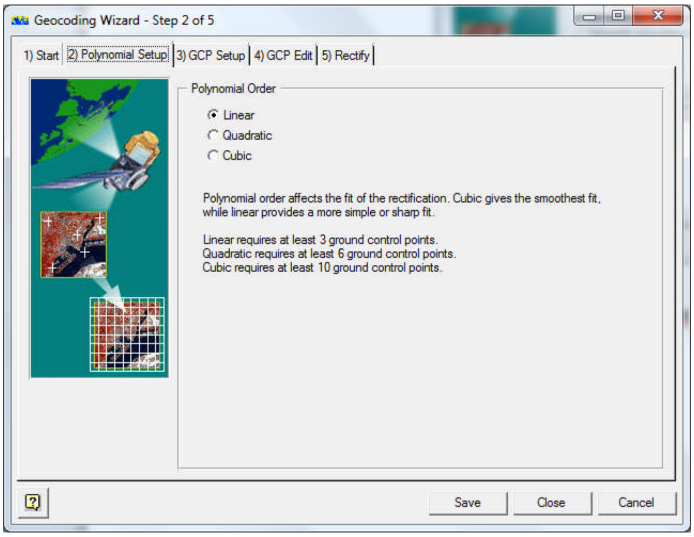


Select the menu geocoding wizard: Process> geocoding wizard. There will be five steps to perform the geometric correction process.

a. The first stage of open files that will be corrected (ALOS 2008): at D: \ @-IK-Training \ Modules-08-LPGP \ Data. Select the type of geocoding (usually we use polynomial type because the result would be great)



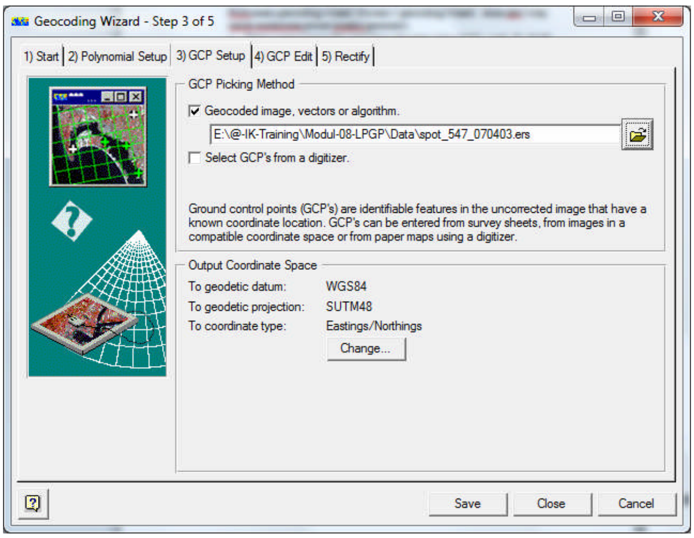
b. Step two: select the type of polynomial setup.



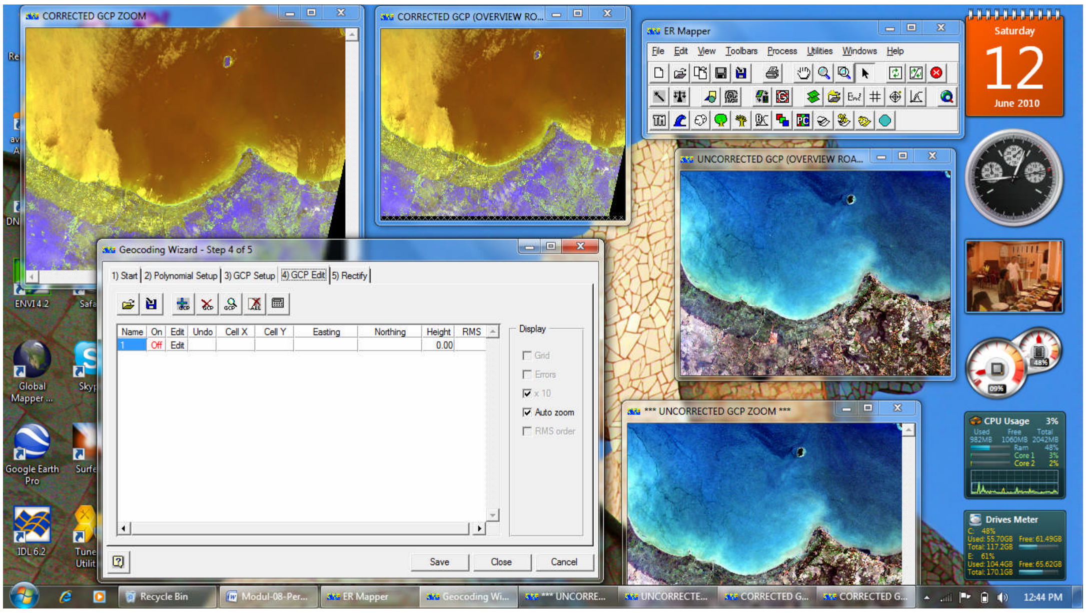
c. The third stage (GCP Setup): check list Geocoding image, vector, or algorithm then call the image that has been corrected (ALOS 2003) in D: \ @-IK-Training \ Modules-08-LPGP \ Data \ spot_2003. If the Output Coordinate Space could tradition is still unknown according to data datum and projection system. At this time the image of geodetic datum: WGS84

Geodetic projection: SUTM48

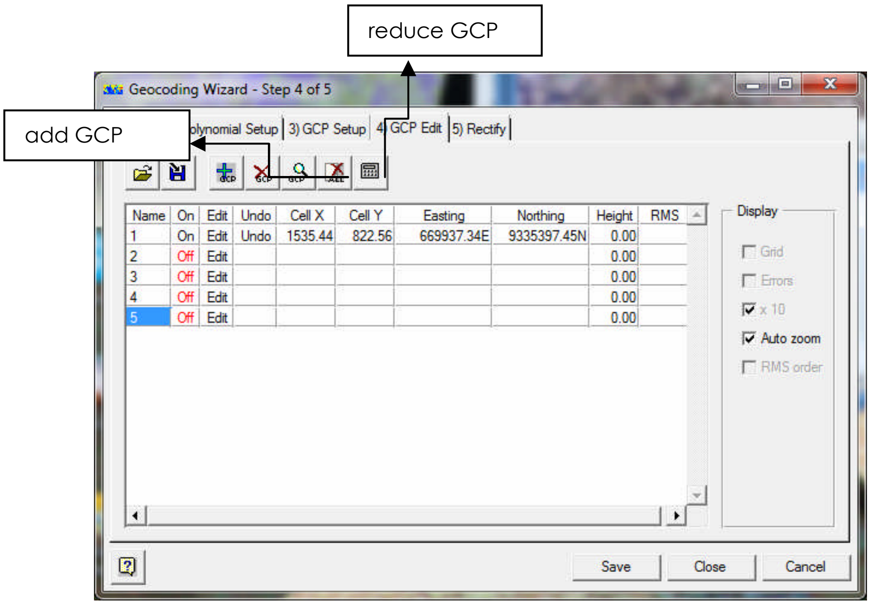
Coordinate type: eastings/northings



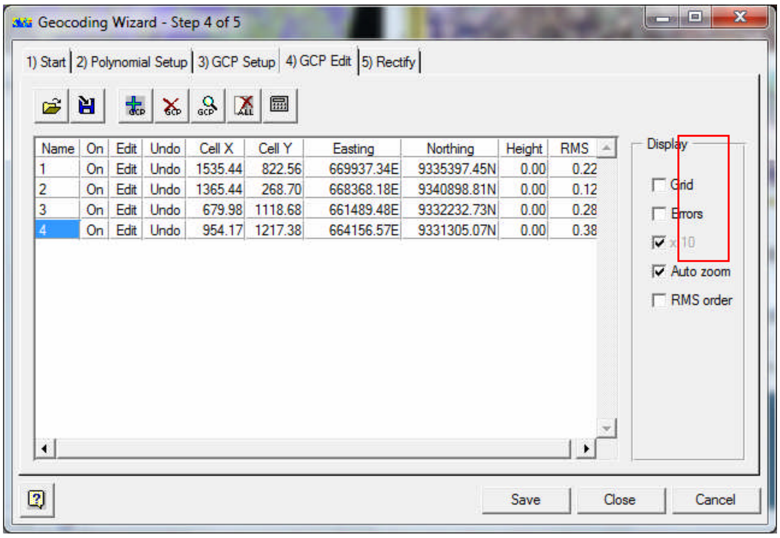
d. Fourth stage (GCP Edit). At this stage we set where the point to be used as a point of ground control points. GCP is a point that became clear in the image and are fixed for example coastal structures.



At this stage would appear four new windows 2 windows image that has not been corrected and 2 imagery has been corrected (1 windows is an overview, so that when closed it does not matter)

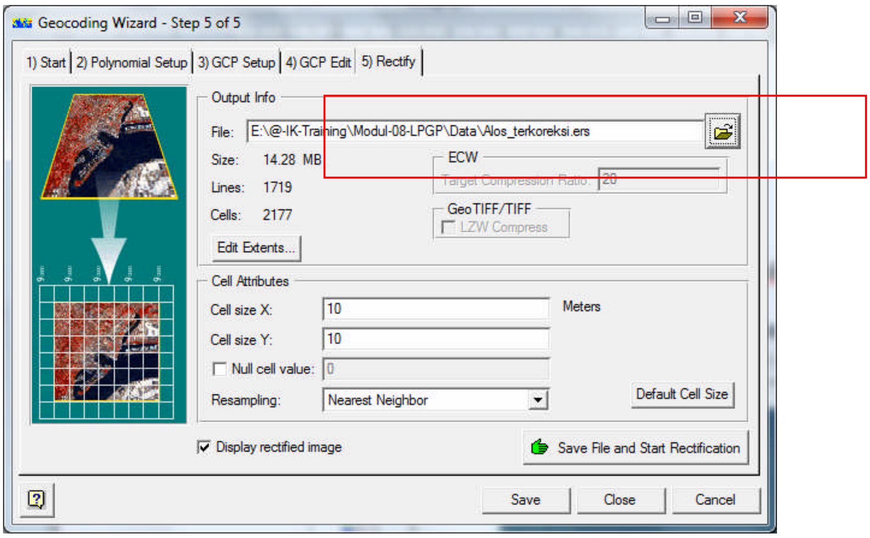


To make GCP select which will be created and click on the image that has not been corrected and that has been corrected in the same location. Create GCP least 4 so that the RMS value will appear. For geometric correction try RMS value of less than 0.5 (the smaller, the better the results)



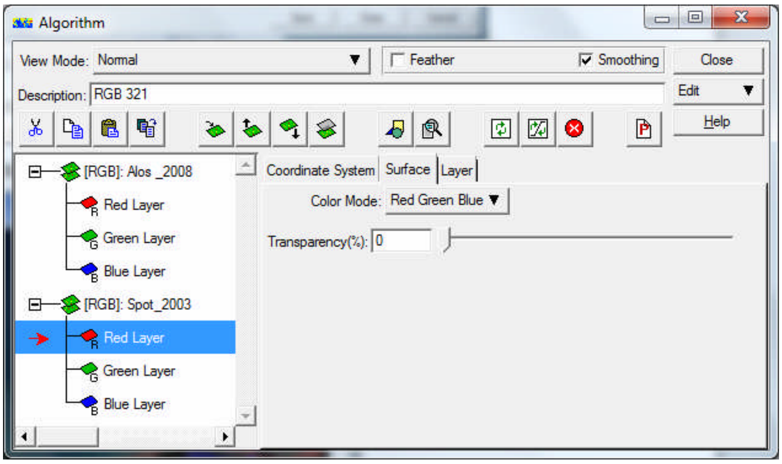
GCP values can also be stored, so if we want to perform geometric correction on the same location but different year, we can call an existing GCP.

e. The fifth stage (Rectify): At this stage an image rectification phase (storing the result).

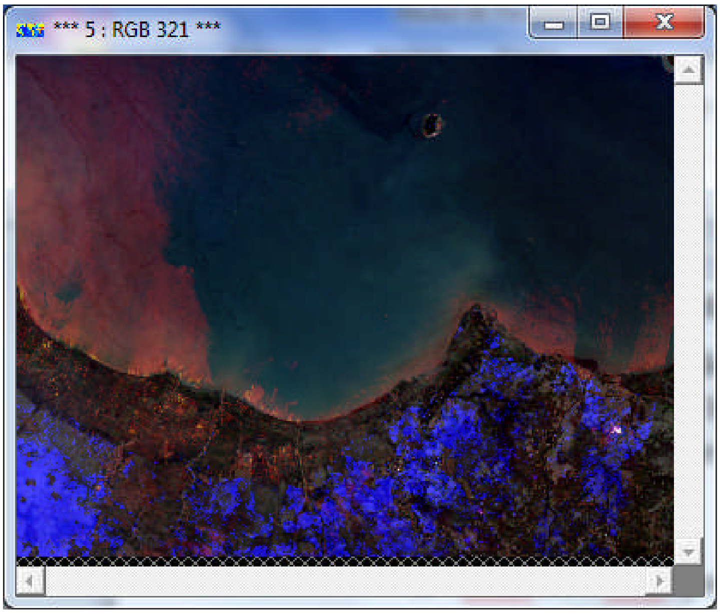


Cell attributes of the content in accordance with a resolution of satellites used. The last step is to "save the file and start Rectification"

To view the results and compare between the old with the new image open image file on the same layer.

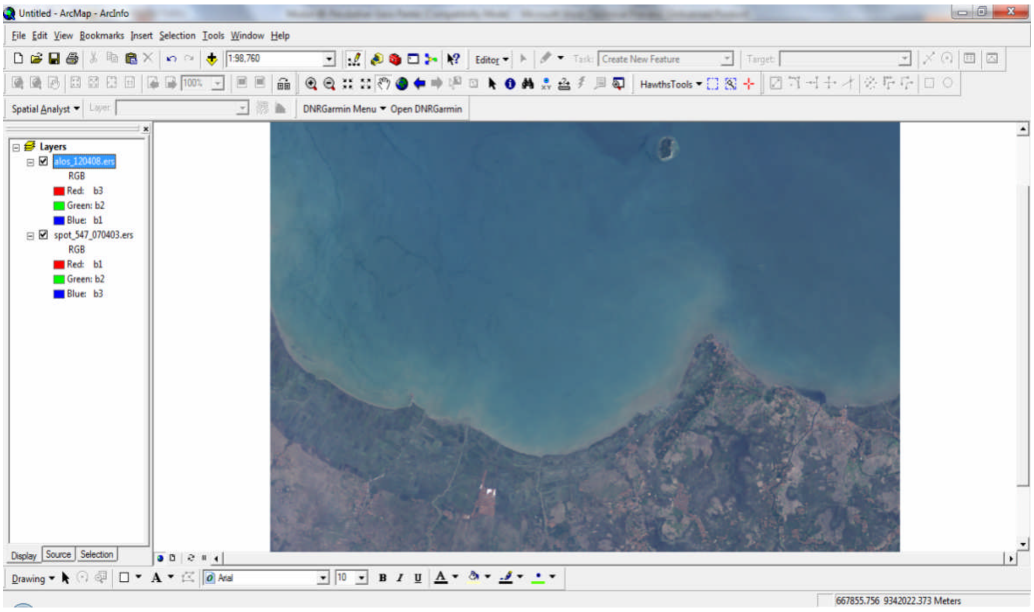


Set transparency to see the changes..



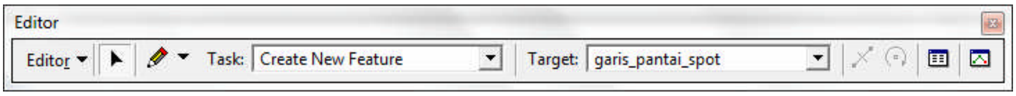
Transparency 75% on Alos_2008 image

2. Open the image data ALOS spot in 2003 and 2008 in D: \ @-IK-Training \ Modules-08-LPGP \ Data

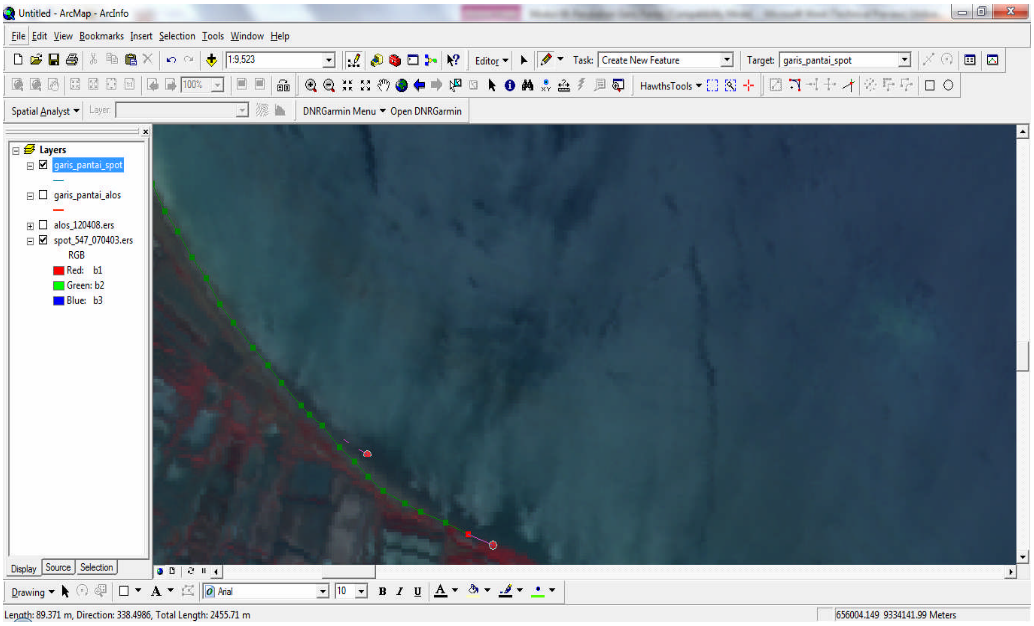


3. Create new feature "shoreline" of type polyline> do the process of digitization

- Create new features such as "shoreline": ArcToolBox> Data Management Tools> Feature Class> Create Feature Class
- Click the Start Editing want digitized layer
- Then open the Editor Toolbar, then select Create New Task in the Current Task

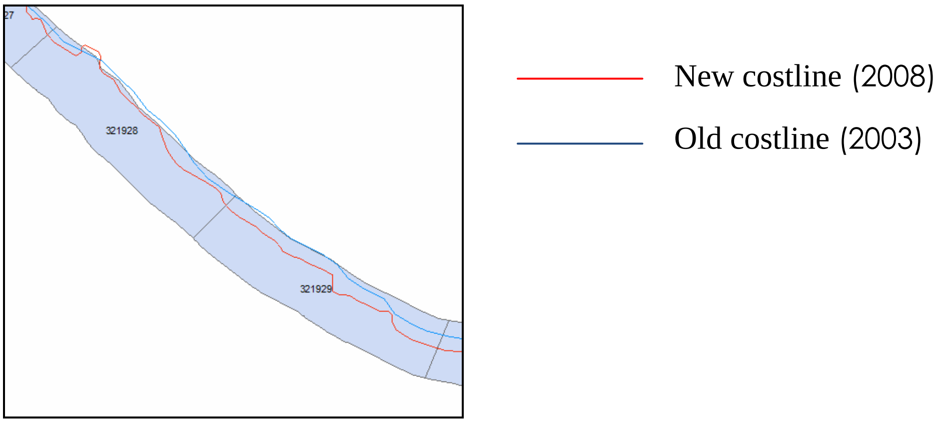


- Click the Tool palette and select the Sketch Tool

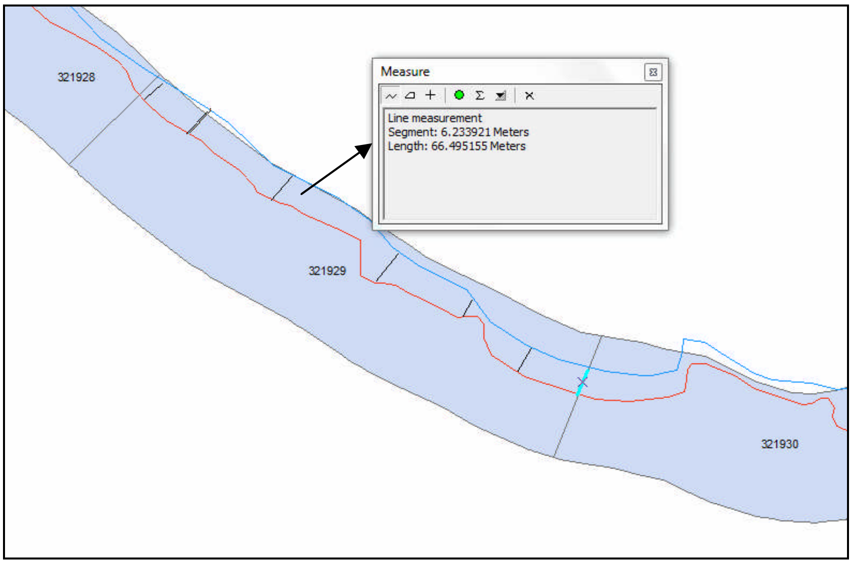


Note: Once digitized, the shoreline should be corrected for tidal data.

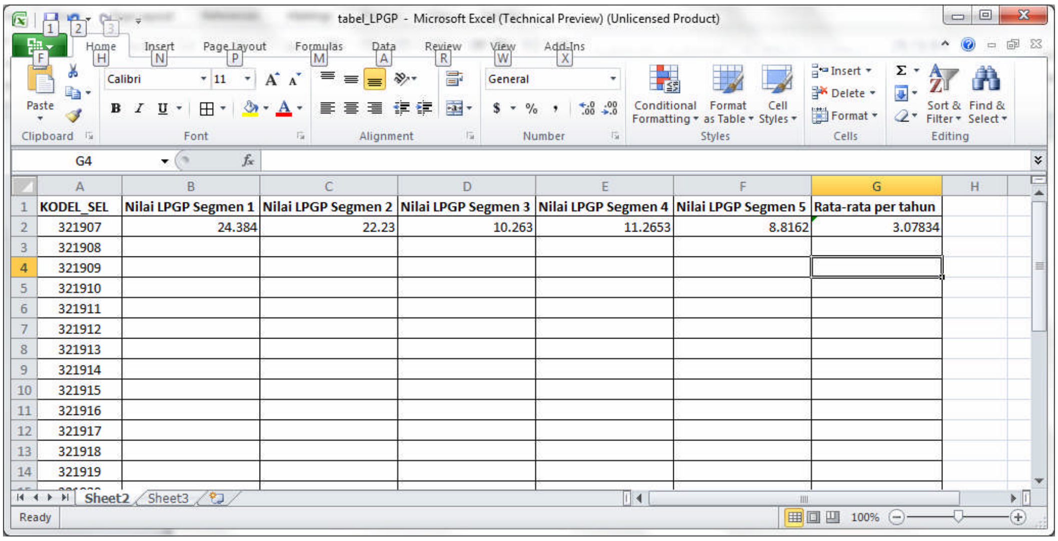
4. Show data digitized shoreline of old and new in a single layer.



5. Calculating the rate of shoreline change in each cell, by calculating the difference between the average distance between the old shoreline (spot 2003) with new (ALOS 2008) in each cell.



If the new shoreline (2008) in front of an old coastline (2003) then there is the process of sedimentation (accretion), in other words the rate of shoreline change is positive. Conversely if the new shoreline (2008) behind a long coastline (2003), the abrasion process occurs, in other words the rate of shoreline change is negative. If the shoreline of old and new means no changes to the shoreline so that the value of the rate of shoreline change 0.



KODEL_SEL	Nilai LPGP Segmen 1	Nilai LPGP Segmen 2	Nilai LPGP Segmen 3	Nilai LPGP Segmen 4	Nilai LPGP Segmen 5	Rata-rata per tahun
321907	24.384	22.23	10.263	11.2653	8.8162	3.07834
321908						
321909						
321910						
321911						
321912						
321913						
321914						
321915						
321916						
321917						
321918						
321919						

6. Results The average annual rate of shoreline change data entered into the existing cell

Attributes of data_sel

FID	Shape *	ID	KODE	KABUPATEN	KODEL_SEL	LPGP
8	Polygon	0	3219	Tangerang	321915	0
9	Polygon	0	3219	Tangerang	321916	0
10	Polygon	0	3219	Tangerang	321917	0
11	Polygon	0	3219	Tangerang	321918	0
12	Polygon	0	3219	Tangerang	321919	0
13	Polygon	0	3219	Tangerang	321920	0
14	Polygon	0	3219	Tangerang	321921	0
15	Polygon	0	3219	Tangerang	321922	0
16	Polygon	0	3219	Tangerang	321923	0
17	Polygon	0	3219	Tangerang	321924	0
18	Polygon	0	3219	Tangerang	321925	0
19	Polygon	0	3219	Tangerang	321926	0
20	Polygon	0	3219	Tangerang	321927	0
21	Polygon	0	3219	Tangerang	321928	0
22	Polygon	0	3219	Tangerang	321929	0
23	Polygon	0	3219	Tangerang	321930	0
24	Polygon	0	3219	Tangerang	321931	0
25	Polygon	0	3219	Tangerang	321932	0
26	Polygon	0	3219	Tangerang	321933	0
27	Polygon	0	3219	Tangerang	321934	0

Record: 1 Show: All Selected Records (0 out of 28 Selected) Options

VI. Instructors

9. Name : Syamsul B. Agus

   Email : mycacul@gmail.com

   Mobile : 08129294181

   Institution : Bogor Agriculture University

10. Name : Anggi Afif

    Email : afif_muzaki@yahoo.co.id

    Mobile : 085696952400

    Institution : Bogor Agriculture University

TRAINING MODULE

DEVELOPMENT OF COASTAL VULNERABILITY INDEX

"DATA INTEGRATION AND DETERMINING OF COASTAL VULNERABILITY INDEX (CVI)"

Compiled by :

Asyari Adisaputra

BOGOR AGRICULTURAL UNIVERSITY, 2010

CONTENTS

I. Introduction

The value of coastal vulnerability index influenced by six parameter, that is geomorphology, relative sea level rise, mean tidal range, mean wave height, coastal slope, and shoreline change. There parameters have constant and dynamic value changed to time. The parameters which have changed value are geomorphology, relative sea level, and coastal slope. While the parameters that have a dynamic value that is mean tidal range, mean wave height, and shoreline changed.

Before get the value of coastal vulnerability index, the sixth parameter values must be classed into five classes namely class is very low, low, medium, high, and very high. This process have four cases that will affect the range of classes from the sixth parameter. The case are west coast, east coast, national and local, but in here will be discussed only in local cases. Value of coastal vulnerability index can be calculated by the formula :

$$CVI = \sqrt{\left(\frac{a \times b \times c \times d \times e \times f}{6}\right)}$$

Where

a = Class of geomorphology parameter

b = Class of relative sea level rise parameter

c = Class of mean tidal range parameter

d = Class of mean wave height parameter

e = Class of coastal slope parameter

f = Class of shoreline changed parameter

Table1. Coastal Vulnerability Index (Thieler and Hammar-Klose, 2000; USGS).

Parameters	Units	Ranking				
		Very Low	Low	Medium	High	Very High
		1	2	3	4	5
Geomorphology	-	Rocky, cliffed coastal, fjords,	Medium cliffs, indented coasts	Low cliffs, glacial drift, alluvial plain	Cobble beaches, estuary, lagoon	Barrier beaches, sand beaches, salt marsh, mud flats, deltas, mangrove, coral reefs
Coastal Slope	%	>1,9	1,3 – 1,9	0,9 – 1,3	0,6 - 0,9	<0,6
Relative sea level rise	mm/ year	<-1,21	-1,21 – 0,1	0,1 – 1,24	1,24 – 1,36	>1,36
Shoreline erosion/accretion	m/ year	>+2,0 Accretion	+1,0 - +2,0 Accretion	-1,0 - +1,0	-1,1 - -2,0 Erosion	<-2,0 Erosion
Mean tidal range	m	>6,0	4,1 – 6,0	2,0 – 4,0	1,0 – 1,9	<1,0
Significant wave height	m	<1,1	1,1 – 2,0	2,0 – 2,25	2,25 – 2,60	>2,60

II. Objective

The objective of this module is :

- Integrate the value of all parameters into one file format
- Capable to classify the value of each parameters appropriate with the local case.
- Capable to calculate the Coastal Vulnerability Index based of the value class of each parameters.

III. Data Processing

Output values for each parameter will be integrated into a cell. After all the values has integrated into the cell then we will calculate the class of each parameters. At each parameters in each region we must calculate the percentile value previously, then from that we can calculate the range value to classify at each parameters. From class value at parameters in each cell, we will get the value of Coastal Vulnerability Index. We can calculate the Coastal Vulnerability Index with this formula

$$CVI = \sqrt{\left(\frac{a \times b \times c \times d \times e \times f}{6}\right)}$$

Where

a = Class of geomorphology parameter

b = Class of relative sea level rise parameter

c = Class of mean tidal range parameter

d = Class of mean wave height parameter

e = Class of coastal slope parameter

f = Class of shoreline changed parameter

After we get the CVI value, there values will be integrated to spatial into each cell. Integration this values will use *ArcGis* software.

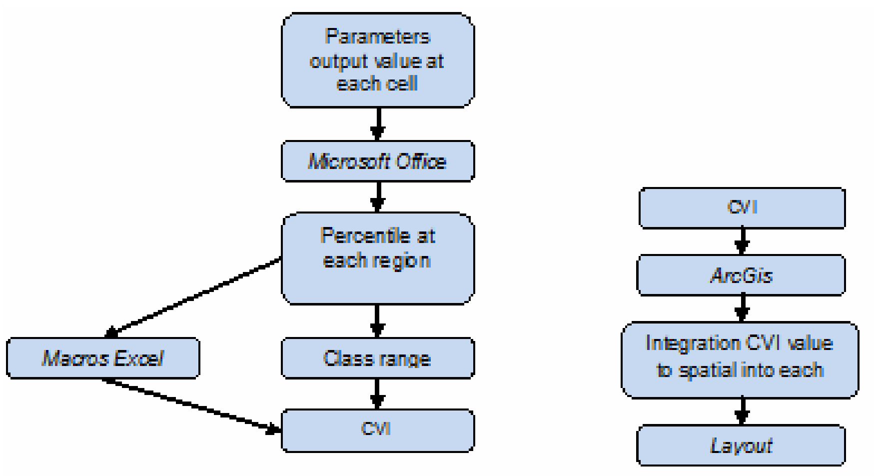


Figure 1. Flowchart Integration Variable Data and Integration CVI Data into Cell.

IV. Data Integration, Classification and Determine Coastal Vulnerability Index (CVI)

1. For this integration data we will integrate six parameters which influence the coastal vulnerability index (geomorphology, trend of sea level rise, mean tidal range, significant wave height, coastal slope, and shoreline changed). There six value of the parameters during 11 years (1998-2008) arranged like figure below.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	LOKASI	KODE_INI	KODE_KAI	NAMA_KA	KODE_SEL	KODE_PAI	NAMA_PA	IND_1998	IND_1999	IND_2000	IND_2001	IND_2002	IND_2003	IND_2004	IND_2005	IND_2006	IND_2007	IND_2008	RATA_IND
2	1	3603_001_	3603	TANGERAI	1	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
3	1	3603_002_	3603	TANGERAI	2	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
4	1	3603_003_	3603	TANGERAI	3	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
5	1	3603_004_	3603	TANGERAI	4	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
6	1	3603_005_	3603	TANGERAI	5	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
7	1	3603_006_	3603	TANGERAI	6	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
8	1	3603_007_	3603	TANGERAI	7	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
9	1	3603_008_	3603	TANGERAI	8	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
10	1	3603_009_	3603	TANGERAI	9	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
11	1	3603_010_	3603	TANGERAI	10	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
12	1	3603_011_	3603	TANGERAI	11	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
13	1	3603_012_	3603	TANGERAI	12	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
14	1	3603_013_	3603	TANGERAI	13	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
15	1	3603_014_	3603	TANGERAI	14	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
16	1	3603_015_	3603	TANGERAI	15	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
17	1	3603_016_	3603	TANGERAI	16	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
18	1	3603_017_	3603	TANGERAI	17	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
19	1	3603_018_	3603	TANGERAI	18	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
20	1	3603_019_	3603	TANGERAI	19	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
21	1	3603_020_	3603	TANGERAI	20	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
22	1	3603_021_	3603	TANGERAI	21	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
23	1	3603_022_	3603	TANGERAI	22	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
24	1	3603_023_	3603	TANGERAI	23	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
25	1	3603_024_	3603	TANGERAI	24	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
26	1	3603_025_	3603	TANGERAI	25	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
27	1	3603_026_	3603	TANGERAI	26	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4

2. Value which used to calculate the coastal vulnerability index not original value but the class value of this parameters. So the original value of this parameters must be classed previously.
3. Value classify parameters has 4 sample case, The case are west coast, east coast, national and local, but in here will be discussed only in local cases. To calculate range in classify process, we will use percentile in Microsoft excel.
4. We must calculate five percentile value to classify the parameters

Percentile 1=percentile (block all data,0)

Percentile 2=percentile (block all data,0.25)

Percentile 3=percentile (block all data,0.5)

Percentile 4=percentile (block all data,0.75)

Percentile 5=percentile (block all data,1)

Example :

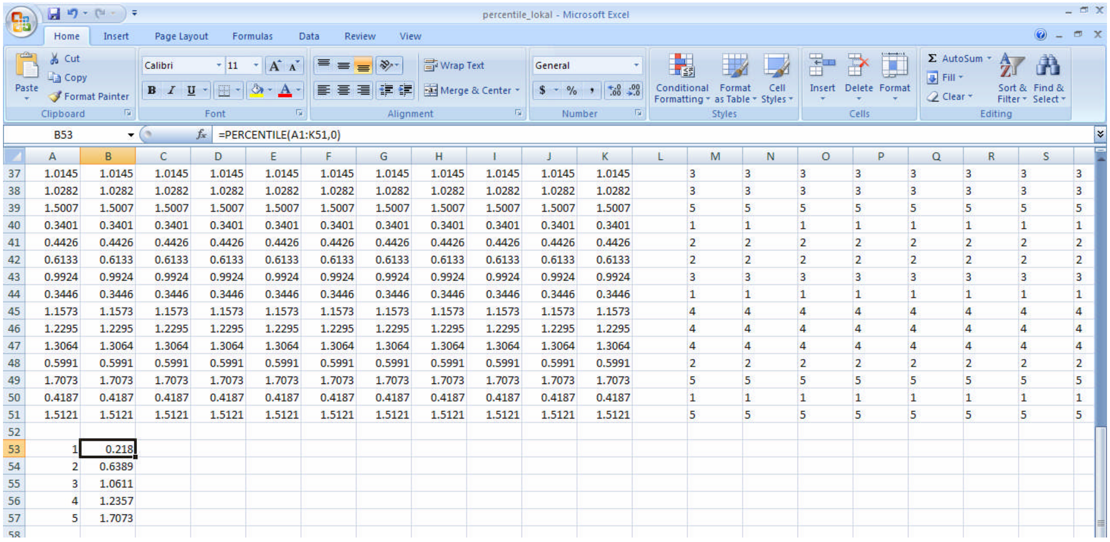
=percentile (A1:K51,0)

=percentile (A1:K51,0.25)

=percentile (A1:K51,0.5)

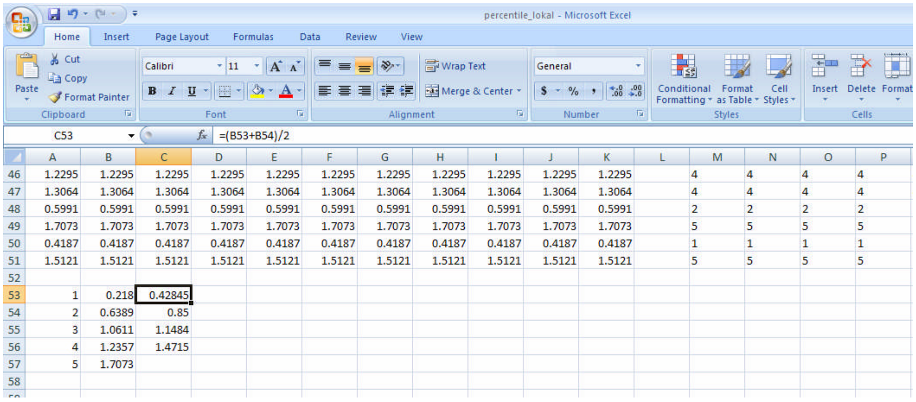
=percentile (A1:K51,0.75)

=percentile (A1:K51,1)



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	
37	1.0145	1.0145	1.0145	1.0145	1.0145	1.0145	1.0145	1.0145	1.0145	1.0145	1.0145		3	3	3	3	3	3	3	3
38	1.0282	1.0282	1.0282	1.0282	1.0282	1.0282	1.0282	1.0282	1.0282	1.0282	1.0282		3	3	3	3	3	3	3	3
39	1.5007	1.5007	1.5007	1.5007	1.5007	1.5007	1.5007	1.5007	1.5007	1.5007	1.5007		5	5	5	5	5	5	5	5
40	0.3401	0.3401	0.3401	0.3401	0.3401	0.3401	0.3401	0.3401	0.3401	0.3401	0.3401		1	1	1	1	1	1	1	1
41	0.4426	0.4426	0.4426	0.4426	0.4426	0.4426	0.4426	0.4426	0.4426	0.4426	0.4426		2	2	2	2	2	2	2	2
42	0.6133	0.6133	0.6133	0.6133	0.6133	0.6133	0.6133	0.6133	0.6133	0.6133	0.6133		2	2	2	2	2	2	2	2
43	0.9924	0.9924	0.9924	0.9924	0.9924	0.9924	0.9924	0.9924	0.9924	0.9924	0.9924		3	3	3	3	3	3	3	3
44	0.3446	0.3446	0.3446	0.3446	0.3446	0.3446	0.3446	0.3446	0.3446	0.3446	0.3446		1	1	1	1	1	1	1	1
45	1.1573	1.1573	1.1573	1.1573	1.1573	1.1573	1.1573	1.1573	1.1573	1.1573	1.1573		4	4	4	4	4	4	4	4
46	1.2295	1.2295	1.2295	1.2295	1.2295	1.2295	1.2295	1.2295	1.2295	1.2295	1.2295		4	4	4	4	4	4	4	4
47	1.3064	1.3064	1.3064	1.3064	1.3064	1.3064	1.3064	1.3064	1.3064	1.3064	1.3064		4	4	4	4	4	4	4	4
48	0.5991	0.5991	0.5991	0.5991	0.5991	0.5991	0.5991	0.5991	0.5991	0.5991	0.5991		2	2	2	2	2	2	2	2
49	1.7073	1.7073	1.7073	1.7073	1.7073	1.7073	1.7073	1.7073	1.7073	1.7073	1.7073		5	5	5	5	5	5	5	5
50	0.4187	0.4187	0.4187	0.4187	0.4187	0.4187	0.4187	0.4187	0.4187	0.4187	0.4187		1	1	1	1	1	1	1	1
51	1.5121	1.5121	1.5121	1.5121	1.5121	1.5121	1.5121	1.5121	1.5121	1.5121	1.5121		5	5	5	5	5	5	5	5
52																				
53	1	0.218																		
54	2	0.6389																		
55	3	1.0611																		
56	4	1.2357																		
57	5	1.7073																		

5. After that we must average percentile 1 and percentile 2 (Y1), percentile 2 and percentile 3 (Y2), percentile 3 and percentile 4 (Y3), and percentile 4 and percentile 5 (Y4) then from this we get four value, we mention it with Y1, Y2, Y3, and Y4.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
46	1.2295	1.2295	1.2295	1.2295	1.2295	1.2295	1.2295	1.2295	1.2295	1.2295	1.2295		4	4	4	4
47	1.3064	1.3064	1.3064	1.3064	1.3064	1.3064	1.3064	1.3064	1.3064	1.3064	1.3064		4	4	4	4
48	0.5991	0.5991	0.5991	0.5991	0.5991	0.5991	0.5991	0.5991	0.5991	0.5991	0.5991		2	2	2	2
49	1.7073	1.7073	1.7073	1.7073	1.7073	1.7073	1.7073	1.7073	1.7073	1.7073	1.7073		5	5	5	5
50	0.4187	0.4187	0.4187	0.4187	0.4187	0.4187	0.4187	0.4187	0.4187	0.4187	0.4187		1	1	1	1
51	1.5121	1.5121	1.5121	1.5121	1.5121	1.5121	1.5121	1.5121	1.5121	1.5121	1.5121		5	5	5	5
52																
53	1	0.218	0.42845													
54	2	0.6389	0.85													
55	3	1.0611	1.1484													
56	4	1.2357	1.4715													
57	5	1.7073														

6. After we get four percentile value so we will get five class

First class	:	X < Y1
Second class	:	Y1 ≤ X < Y2
Third class	:	Y2 ≤ X < Y3
Fourth class	:	Y3 ≤ X < Y4
Fifth class	:	X ≥ Y4

Case upper happen for sea level rise and significant wave height. But for tidal range, coastal slope and shoreline changed like below

First class	:	X ≥ Y4
Second class	:	Y3 ≤ X < Y4
Third class	:	Y2 ≤ X < Y3

Fourth class : $Y1 \leq X < Y2$

Fifth class : $X < Y1$

But for parameter geomorphology this case not valid, because parameter geomorphology have same value range at each region.

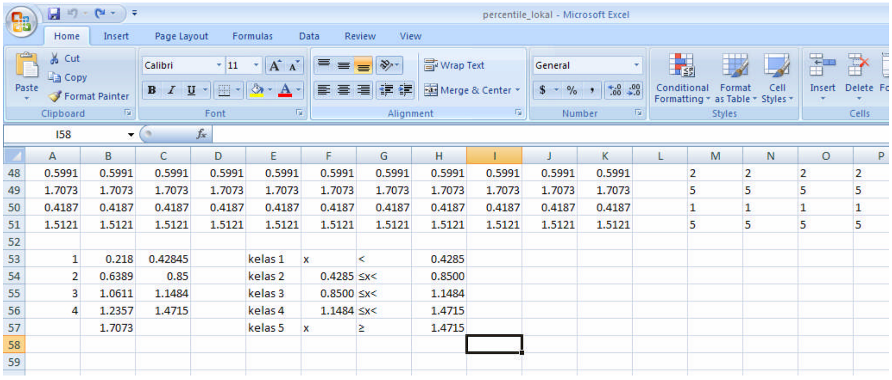
First class : $X < 1.5$

Second class : $1.6 \leq X < 2.5$

Third class : $2.6 \leq X < 3.5$

Fourth class : $3.6 \leq X < 4.5$

Fifth class : $X \geq 4.6$



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
48	0.5991	0.5991	0.5991	0.5991	0.5991	0.5991	0.5991	0.5991	0.5991	0.5991	0.5991		2	2	2	2
49	1.7073	1.7073	1.7073	1.7073	1.7073	1.7073	1.7073	1.7073	1.7073	1.7073	1.7073		5	5	5	5
50	0.4187	0.4187	0.4187	0.4187	0.4187	0.4187	0.4187	0.4187	0.4187	0.4187	0.4187		1	1	1	1
51	1.5121	1.5121	1.5121	1.5121	1.5121	1.5121	1.5121	1.5121	1.5121	1.5121	1.5121		5	5	5	5
52																
53	1	0.218	0.42845		kelas 1	x	<	0.4285								
54	2	0.6389	0.85		kelas 2	0.4285	≤x<	0.8500								
55	3	1.0611	1.1484		kelas 3	0.8500	≤x<	1.1484								
56	4	1.2357	1.4715		kelas 4	1.1484	≤x<	1.4715								
57		1.7073			kelas 5	x	≥	1.4715								
58																
59																

7. After we get range value of this class we will begin classify original value for each parameters.

   =IF(geomorphology value >range fifth class,"class",IF(geomorphology value > range fourth class," class ",IF(geomorphology value > range third class,"class "

   Example :

   =IF(A1>4.5,"5",IF(A1>3.5,"4",IF(A1>2.5,"3",IF(A1>1.5,"2","1"))))

8. After we get class value for each parameters, we can calculate the coastal vulnerability index. Formula to calculate the Coastal Vulnerability Index is

$$CVI = \sqrt{\left(\frac{a*b*c*d*e*f}{6}\right)}$$

where

CVI = Coastal Vulnerability Index

a = Class of geomorphology parameter

b = Class of relative sea level rise parameter [mm/year]

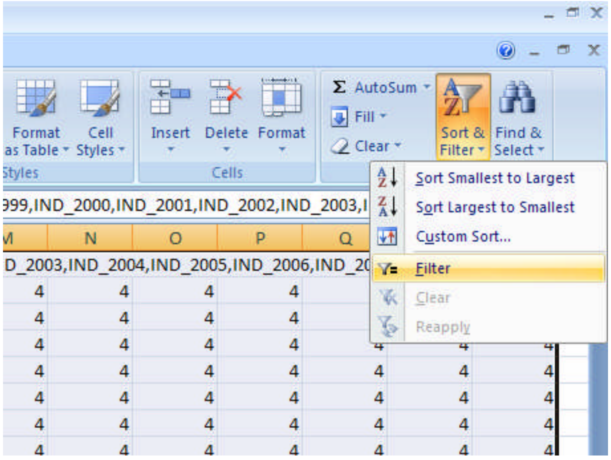
c = Class of mean tidal range parameter [m]

d = Class of mean wave height parameter [m]

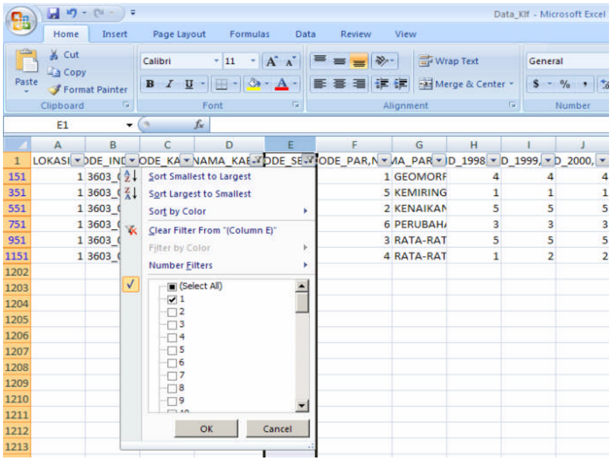
e = Class of coastal slope parameter [m]

f = Class of shoreline changed parameter [m/year]

9. To calculate CVI with *Microsoft Excel* we must arranged the same cell in a region using filter in *Microsoft excel*



After that we choose the same cell number at this region



After the same cell number arranged, we calculate class value from each parameters at cell with this formula

$$= sqrt((a * b * c * d * e * f)/6)$$

Where

a = Class of geomorphology parameter

b = Class of relative sea level rise parameter [mm/year]

c = Class of mean tidal range parameter [m]

d = Class of mean wave height parameter [m]

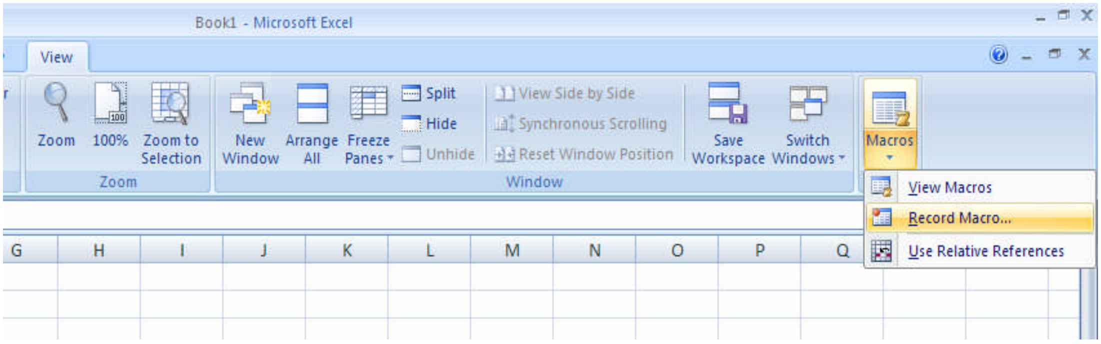
e = Class of coastal slope parameter [m]

f = Class of shoreline changed parameter [m/year]

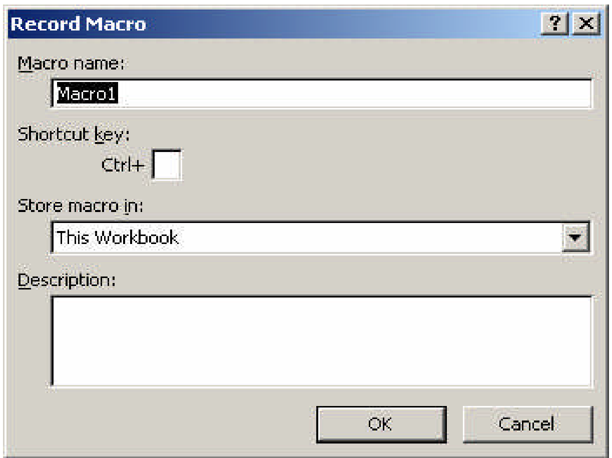
The result from this calculate is Coastal Vulnerability Index at a cell in a region

V. Classification And Calculation CVI Using Macro Excel

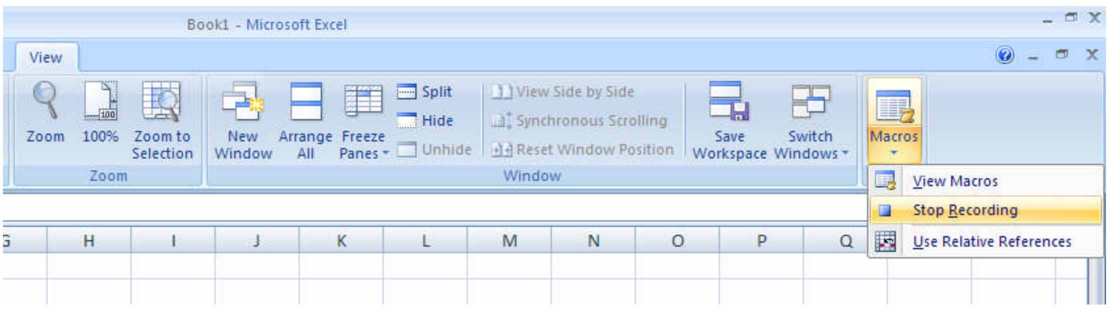
1. Beside use the pervious method, to classify parameters value and calculate the CVI we can use program which made in *macro excel*.
2. After value of the parameters arranged like in point 1, then this file saved in **.txt* format into folder **D:\@-IK-Training\Modul-09-Integrasi\1-Data_Indikator_Gabungan**
3. Then open listing program in folder **D:\@-IK-Training\Modul-09-Integrasi\Prog**
4. Open that program in *macro excel*, choose *view* ⟶ *macros* ⟶ *record macro*



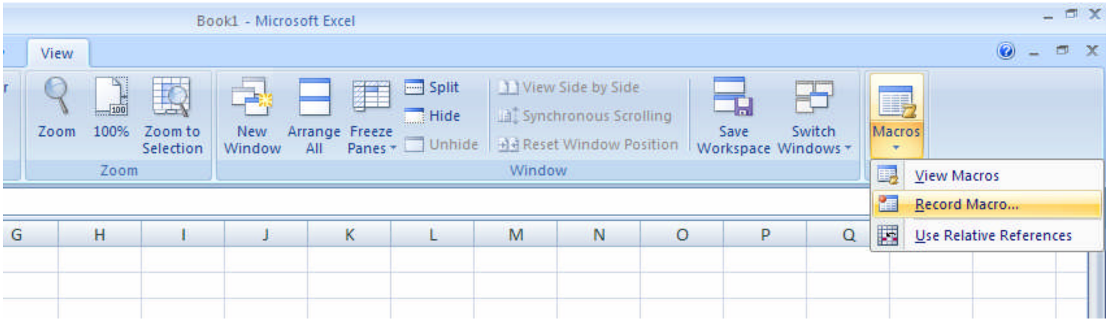
5. Then will record macro display. At this display we don't need to change the macro name.



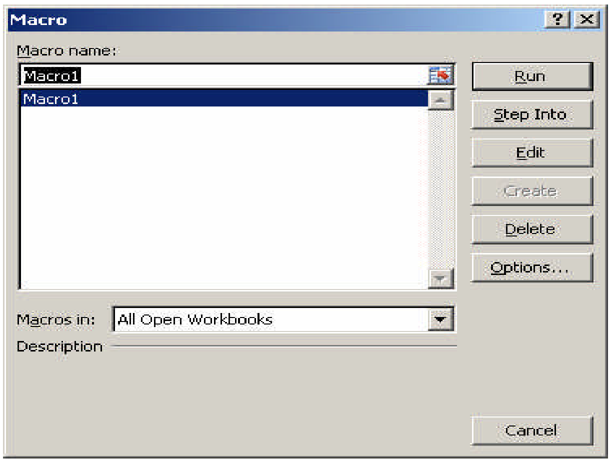
6. Choose *view* ⟶ *macros* ⟶ *stop recording*



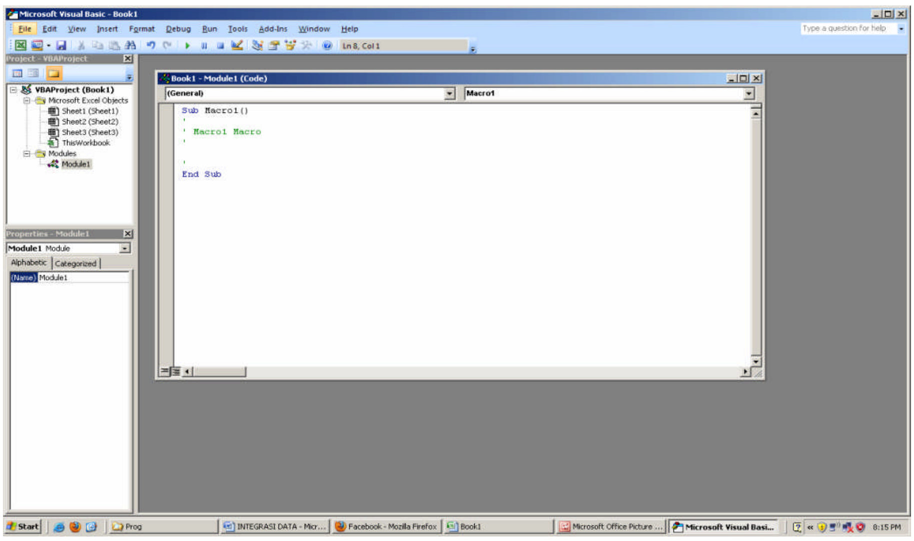
7. To show display to copy the listing program we choose *view* ⟶ *macros* ⟶ *view macros*



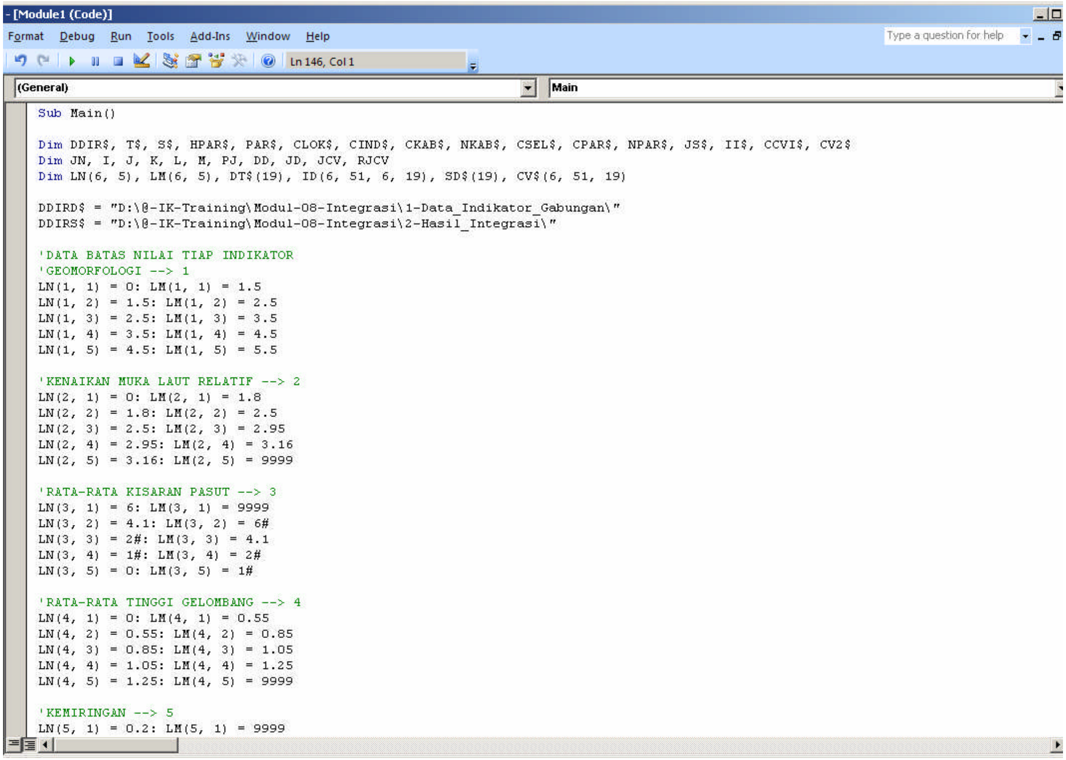
8. Then will show the macro display, we choose *edit*



9. After that Microsoft visual basic display will be showed, the program in main display can be deleted.



Then copy the listing program to main display




```
Sub Main()

Dim DDIR$, T$, S$, HPAR$, PAR$, CLOK$, CIND$, CKAB$, NKAB$, CSEL$, CPAR$, NPAR$, JS$, II$, CCVI$, CV2$
Dim JN, I, J, K, L, M, PJ, DD, JD, JCV, RJCV
Dim LN(6, 5), LM(6, 5), DT$(19), ID(6, 51, 6, 19), SD$(19), CV$(6, 51, 19)

DDIRD$ = "D:\@-IK-Training\Modul-08-Integrasi\1-Data_Indikator_Gabungan\"
DDIRS$ = "D:\@-IK-Training\Modul-08-Integrasi\2-Hasil_Integrasi\"

'DATA BATAS NILAI TIAP INDIKATOR
'GEOMORFOLOGI --> 1
LN(1, 1) = 0: LM(1, 1) = 1.5
LN(1, 2) = 1.5: LM(1, 2) = 2.5
LN(1, 3) = 2.5: LM(1, 3) = 3.5
LN(1, 4) = 3.5: LM(1, 4) = 4.5
LN(1, 5) = 4.5: LM(1, 5) = 5.5

'KENAIKAN MUKA LAUT RELATIF --> 2
LN(2, 1) = 0: LM(2, 1) = 1.8
LN(2, 2) = 1.8: LM(2, 2) = 2.5
LN(2, 3) = 2.5: LM(2, 3) = 2.95
LN(2, 4) = 2.95: LM(2, 4) = 3.16
LN(2, 5) = 3.16: LM(2, 5) = 9999

'RATA-RATA KISARAN PASUT --> 3
LN(3, 1) = 6: LM(3, 1) = 9999
LN(3, 2) = 4.1: LM(3, 2) = 6#
LN(3, 3) = 2#: LM(3, 3) = 4.1
LN(3, 4) = 1#: LM(3, 4) = 2#
LN(3, 5) = 0: LM(3, 5) = 1#

'RATA-RATA TINGGI GELOMBANG --> 4
LN(4, 1) = 0: LM(4, 1) = 0.55
LN(4, 2) = 0.55: LM(4, 2) = 0.85
LN(4, 3) = 0.85: LM(4, 3) = 1.05
LN(4, 4) = 1.05: LM(4, 4) = 1.25
LN(4, 5) = 1.25: LM(4, 5) = 9999

'KEMIRINGAN --> 5
LN(5, 1) = 0.2: LM(5, 1) = 9999
```

Then we change the file directory and the range value for each parameters class. After that we can running the program by push the run icon (▶)

10. The result of classify parameters and CVI value will be showed in folder **D:\@-IK-Training\Modul-09-Integrasi\2-Hasil_Integrasi**

VI. LISTING PROGRAM

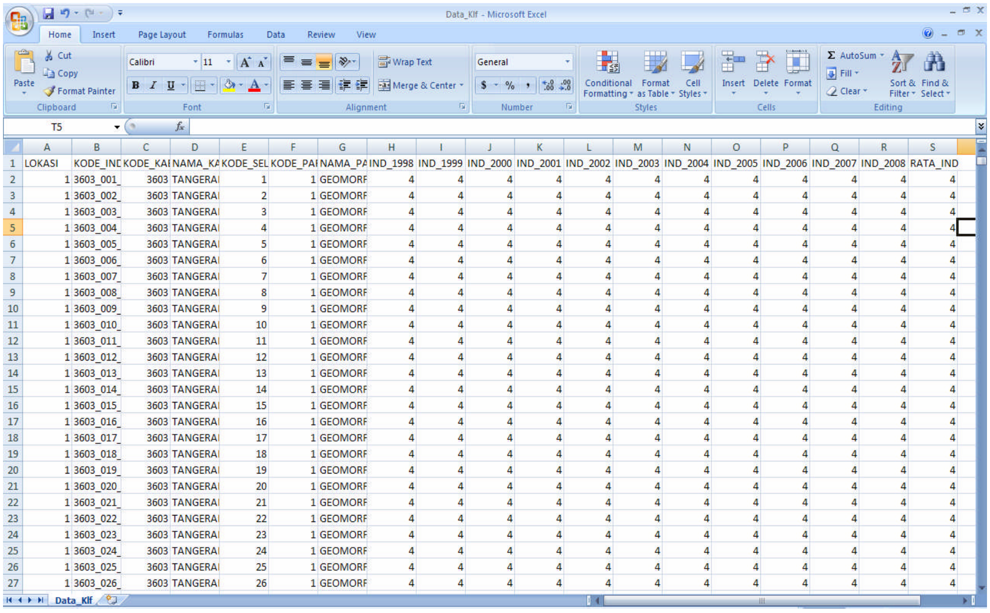
```
Sub Main()
Dim DDIR$, T$, S$, HPAR$, PAR$, CLOK$, CIND$, CKAB$, NKAB$, CSEL$, CPAR$, NPAR$, JS$, II$, CCVI$, CV2$
Dim JN, I, J, K, L, M, PJ, DD, JD, JCV, RJCV
Dim LN(6, 5), LM(6, 5), DT$(19), ID(6, 51, 6, 19), SD$(19), CV$(6, 51, 19)

'DDIRD$ = "D:\My Documents\Modul-14-Integrasi\1-Data_Indikator_Gabungan\"
DDIRS$ = "D:\My Documents\Modul-14-Integrasi\2-Hasil_Integrasi\"

'DATA BATAS NILAI TIAP INDIKATOR
'GEOMORFOLOGI --> 1
LN(1, 1) = 0: LM(1, 1) = 1.5
LN(1, 2) = 1.5: LM(1, 2) = 2.5
LN(1, 3) = 2.5: LM(1, 3) = 3.5
LN(1, 4) = 3.5: LM(1, 4) = 4.5
LN(1, 5) = 4.5: LM(1, 5) = 5.5
'
'KENAIKAN MUKA LAUT RELATIF --> 2
LN(2, 1) = 0: LM(2, 1) = 4.077179
LN(2, 2) = 4.077180: LM(2, 2) = 4.162275
LN(2, 3) = 4.162276: LM(2, 3) = 4.252121
LN(2, 4) = 4.252122: LM(2, 4) = 4.305794
LN(2, 5) = 4.305795: LM(2, 5) = 9999

'RATA-RATA KISARAN PASUT --> 3
LN(3, 1) = 0.960942: LM(3, 1) = 9999
LN(3, 2) = 0.928148: LM(3, 2) = 0.960941
LN(3, 3) = 0.885715: LM(3, 3) = 0.928147
LN(3, 4) = 0.800665: LM(3, 4) = 0.885714
LN(3, 5) = 0: LM(3, 5) = 0.800664

'RATA-RATA TINGGI GELOMBANG --> 4
LN(4, 1) = 0: LM(4, 1) = 0.448335
LN(4, 2) = 0.448336: LM(4, 2) = 0.493923
LN(4, 3) = 0.493924: LM(4, 3) = 0.521222
LN(4, 4) = 0.521223: LM(4, 4) = 0.569881
LN(4, 5) = 0.569882: LM(4, 5) = 9999
'
'KEMIRINGAN --> 5
LN(5, 1) = 1.4716: LM(5, 1) = 9999
LN(5, 2) = 1.1485: LM(5, 2) = 1.4715
LN(5, 3) = 0.8501: LM(5, 3) = 1.1484
LN(5, 4) = 0.4286: LM(5, 4) = 0.8500
LN(5, 5) = 0: LM(5, 5) = 0.4285
'
'PERUBAHAN GARIS PANTAI --> 6
LN(6, 1) = 4.449935: LM(6, 1) = 9999
LN(6, 2) = 0.583983: LM(6, 2) = 4.449934
```

```
LN(6, 3) = -0.02136: LM(6, 3) = 0.583982
LN(6, 4) = -0.935521: LM(6, 4) = -0.02137
LN(6, 5) = -9999: LM(6, 5) = -0.935522

JN = 19
JN = JN - 1
T$ = ","
S$ = Chr(9)

Open DDIRD$ + "Data_Indikator.txt" For Input As #1
 Line Input #1, HPAR$
Open DDIRS$ + "Data_Klf.txt" For Output As #2
 Print #2, HPAR$

While Not EOF(1)
 Line Input #1, PAR$
 For I = 1 To JN
  PJ = Len(PAR$)
  L = InStr(1, PAR$, T$)
  DT$(I) = Mid$(PAR$, 1, L - 1)
  PAR$ = Mid$(PAR$, L + 1, PJ - L)
  If I = JN Then DT$(I + 1) = PAR$
 Next I

 CLOK$ = Trim(DT$(1))
 CIND$ = Trim(DT$(2))
 CKAB$ = Trim(DT$(3))
 NKAB$ = Trim(DT$(4))
 CSEL$ = Trim(DT$(5))
 CPAR$ = Trim(DT$(6))
 NPAR$ = Trim(DT$(7))

 If CKAB$ = "3603" Then I = 1
 If CKAB$ = "3175" Then I = 2
 If CKAB$ = "3216" Then I = 3
 If CKAB$ = "3326" Then I = 4
 If CKAB$ = "3375" Then I = 5
 If CKAB$ = "3578" Then I = 6
 J = Val(CSEL$)
 K = Val(CPAR$)

 For L = 8 To 19
  For M = 1 To 5
   DD = Val(DT$(L))
   If DD > LN(K, M) And DD <= LM(K, M) Then
    ID(I, J, K, L) = M
    SD$(L) = Trim(Str(M))
   End If
  Next M
 Next L
```

```
 Print #2, CLOK$ + S$ + CIND$ + S$ + CKAB$ + S$ + NKAB$ + S$ + CSEL$ + S$ + CPAR$ + S$ + NPAR$ + _
          S$ + SD$(8) + S$ + SD$(9) + S$ + SD$(10) + S$ + SD$(11) + S$ + SD$(12) + S$ + SD$(13) + _
          S$ + SD$(14) + S$ + SD$(15) + S$ + SD$(16) + S$ + SD$(17) + S$ + SD$(18) + S$ + SD$(19)

Wend

Close #2
Close #1

Open DDIRS$ + "Data_CVI.txt" For Output As #2
 Print #2, "LOKASI" + S$ + "KODE_CVI" + S$ + "KODE_KAB" + S$ + "NAMA_KAB" + S$ + "KODE_SEL" + S$ +
         "CVI_1998" + S$ + "CVI_1999" + S$ + "CVI_2000" + S$ + _
          "CVI_2001" + S$ + "CVI_2002" + S$ + "CVI_2003" + S$ + "CVI_2004" + S$ + "CVI_2005" + S$ + "CVI_2006" + S$
         + "CVI_2007" + S$ + "CVI_2008" + S$ + "RATA_CVI_1" + S$ + "RATA_CVI_2"

 For I = 1 To 1
  If I = 1 Then JD = 51: II$ = "1": CKAB$ = "3603": NKAB$ = "TANGERANG"
  If I = 2 Then JD = 37: II$ = "2": CKAB$ = "3175": NKAB$ = "KOTA JAKARTA UTARA"
  If I = 3 Then JD = 46: II$ = "3": CKAB$ = "3216": NKAB$ = "BEKASI"
  If I = 4 Then JD = 11: II$ = "4": CKAB$ = "3326": NKAB$ = "PEKALONGAN"
  If I = 5 Then JD = 10: II$ = "4": CKAB$ = "3375": NKAB$ = "KOTA PEKALONGAN"
  If I = 6 Then JD = 45: II$ = "5": CKAB$ = "3578": NKAB$ = "KOTA SURABAYA"
  For J = 1 To JD
   If J < 10 Then JS$ = "00" + Trim(Str(J))
   If J >= 10 And J < 100 Then JS$ = "0" + Trim(Str(J))
   If J >= 100 And J < 1000 Then JS$ = Trim(Str(J))
   CCVI$ = CKAB$ + "_" + JS$
   For L = 8 To 19
    CV$(I, J, L) = Trim(Str(Sqr((ID(I, J, 1, L) * ID(I, J, 2, L) * ID(I, J, 3, L) * ID(I, J, 4, L) * ID(I, J, 5, L) * ID(I, J, 6, L)) / 6)))
   Next L
   JCV = Val(CV$(I, J, 8)) + Val(CV$(I, J, 9)) + Val(CV$(I, J, 10)) + Val(CV$(I, J, 11)) + Val(CV$(I, J, 12)) + Val(CV$(I, J,
         13)) + Val(CV$(I, J, 14)) + _
      Val(CV$(I, J, 15)) + Val(CV$(I, J, 16)) + Val(CV$(I, J, 17)) + Val(CV$(I, J, 18))
   If JCV <> 0 Then
    RJCV = JCV / 11
   Else
    RJCV = 0
   End If
   CV2$ = Trim(Str(RJCV))
   Print #2, II$ + S$ + CCVI$ + S$ + CKAB$ + S$ + NKAB$ + S$ + JS$ + S$ + CV$(I, J, 8) + S$ + CV$(I, J, 9) + S$ +
         CV$(I, J, 10) + S$ + CV$(I, J, 11) + S$ + CV$(I, J, 12) + S$ + _
           CV$(I, J, 13) + S$ + CV$(I, J, 14) + S + CV$(I, J, 15) + S + CV$(I, J, 16) + S + CV$(I, J, 17) + S + CV$(I, J, 18) +
         S + CV$(I, J, 19) + S + CV2$
  Next J
 Next I
Close #2
End Sub
```

VII. Data Integration to GIS

1. Open **D:\@-IK-Training\Modul-09-Integrasi\2-Hasil_Integrasi\Data_Klf.txt** make sure this file have value of six parameters at one region

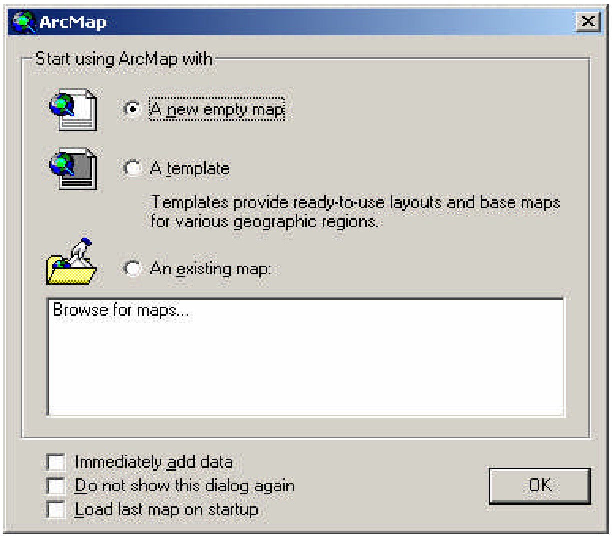


LOKASI	KODE_IND	KODE_KAI	NAMA_KA	KODE_SEL	KODE_PAI	NAMA_PA	IND_1998	IND_1999	IND_2000	IND_2001	IND_2002	IND_2003	IND_2004	IND_2005	IND_2006	IND_2007	IND_2008	RATA_IND
1	3603_001_	3603	TANGERAI	1	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_002_	3603	TANGERAI	2	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_003_	3603	TANGERAI	3	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_004_	3603	TANGERAI	4	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_005_	3603	TANGERAI	5	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_006_	3603	TANGERAI	6	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_007_	3603	TANGERAI	7	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_008_	3603	TANGERAI	8	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_009_	3603	TANGERAI	9	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_010_	3603	TANGERAI	10	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_011_	3603	TANGERAI	11	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_012_	3603	TANGERAI	12	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_013_	3603	TANGERAI	13	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_014_	3603	TANGERAI	14	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_015_	3603	TANGERAI	15	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_016_	3603	TANGERAI	16	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_017_	3603	TANGERAI	17	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_018_	3603	TANGERAI	18	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_019_	3603	TANGERAI	19	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_020_	3603	TANGERAI	20	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_021_	3603	TANGERAI	21	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_022_	3603	TANGERAI	22	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_023_	3603	TANGERAI	23	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_024_	3603	TANGERAI	24	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_025_	3603	TANGERAI	25	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4
1	3603_026_	3603	TANGERAI	26	1	GEOMORF	4	4	4	4	4	4	4	4	4	4	4	4

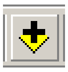
Make sure the number of parameters arranged in series (geomorphology, relative sea level rise, mean tidal range, mean wave height, coastal slope, and shoreline changed) then open file **D:\@-IK-Training\Modul-09-Integrasi\3-GIS_Lokasi\1-Tangerang\ID_Indikator.txt**

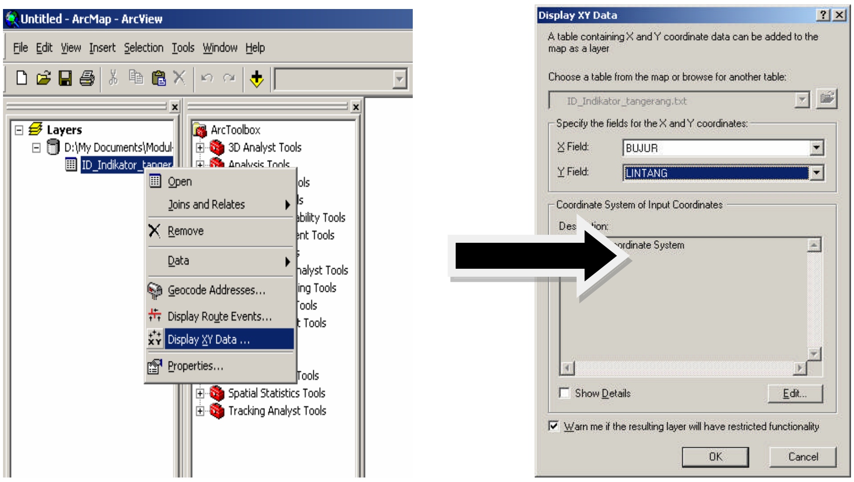
Copy class value each parameter at file **Data_Klf** into this file.

2. Open *ArcMap* () at *ArcGis*, then display like below will be showed

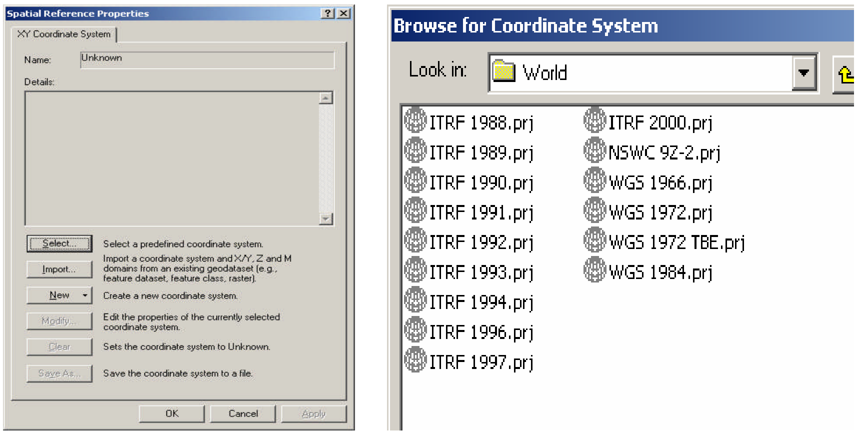


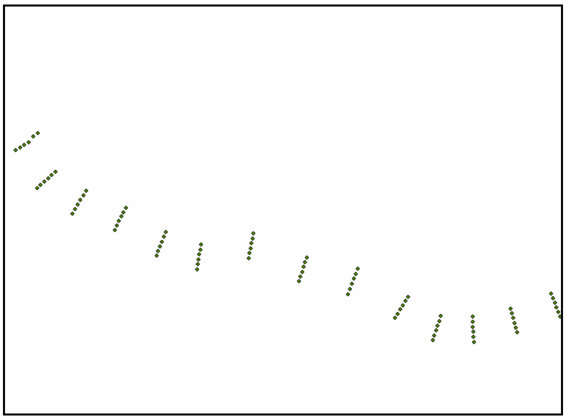
Choose *A new empty map*.

3. Then we choose  to input file that we will integration to GIS, then after we add file **D:\@-IK-Training\Modul-09-Integrasi\3-GIS_Lokasi\1-Tangerang\ID_Indikator.txt,** double click on that file to showing the data of that file. choose *Display XY Data*

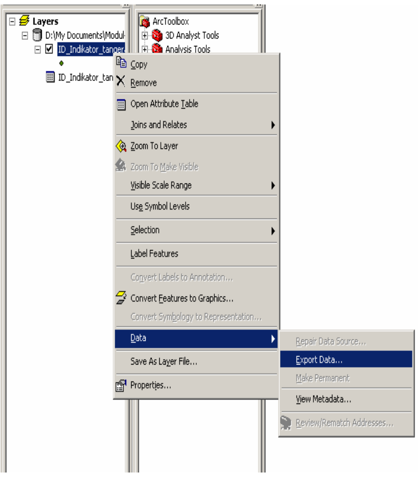


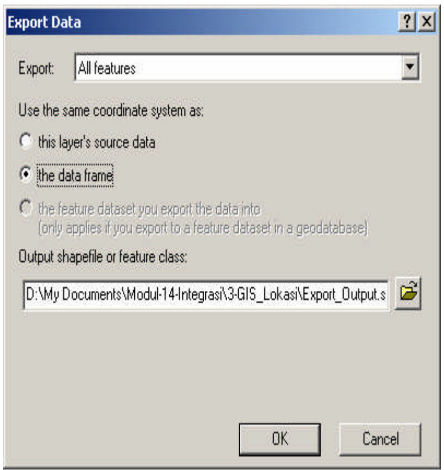
After that at *Display XY data* fill *X Field* as longitude and *Y Field* as Latitude. After that we choose edit, after the display like below showed we choose *Select* ⟶ *Geographic coordinate system* ⟶ *world* ⟶ *WGS 1984.prj*



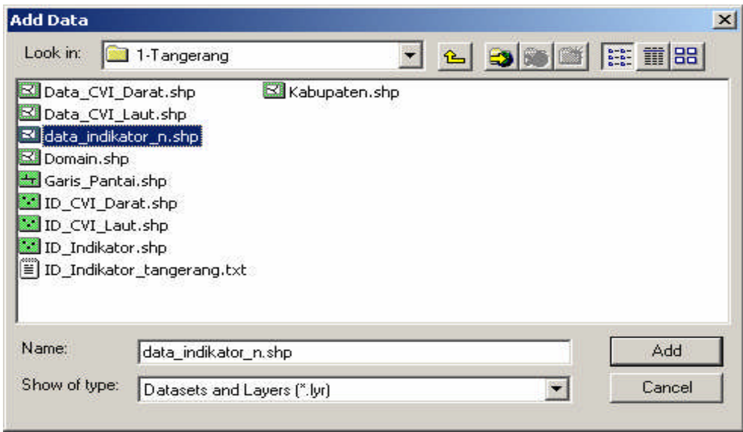


4. Then export that file into spatial. Right click at that file then choose *data* ⟶ *export data.* Choose data frame, then choose sign  to choose folder to save the data.

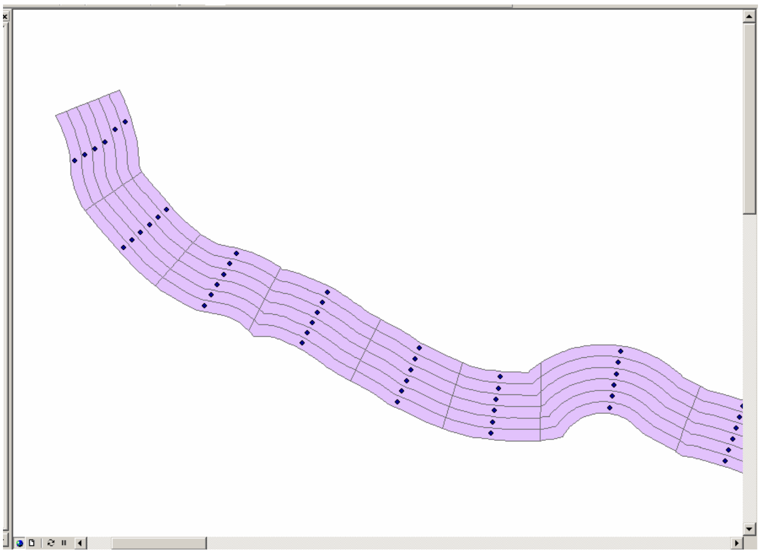




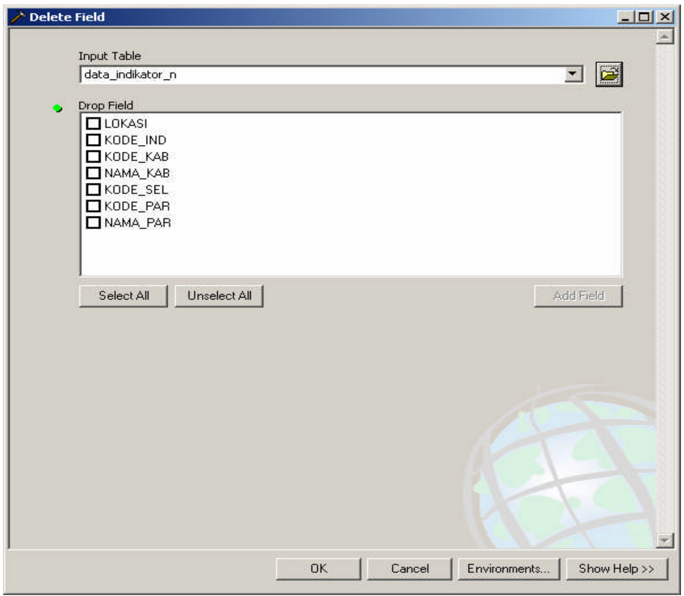
5. Then add file **D:\@-IK-Training\Modul-09-Integrasi\3-GIS_Lokasi\1-Tangerang\data_indikator_n**



Overlay with previously result until produce figure like this

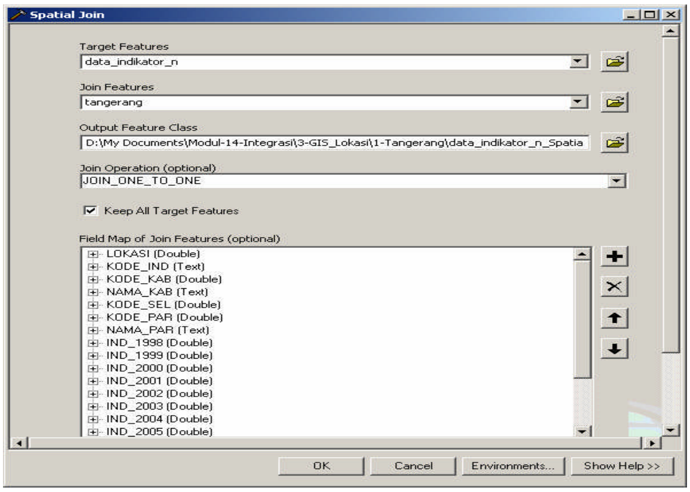


6. Before that we search *delete field* at *toolbox ArcGis* to delete doesn't needed field. Then figure like below will be showed

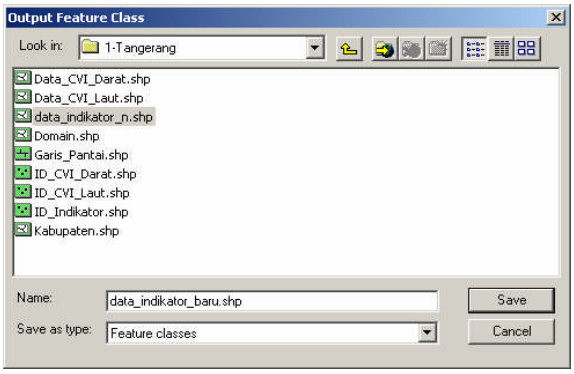


Beside that seven fields except 7 field, we can delete another fields.

7. Then we choose spatial join at ArcGis toolbox column to integrate data.

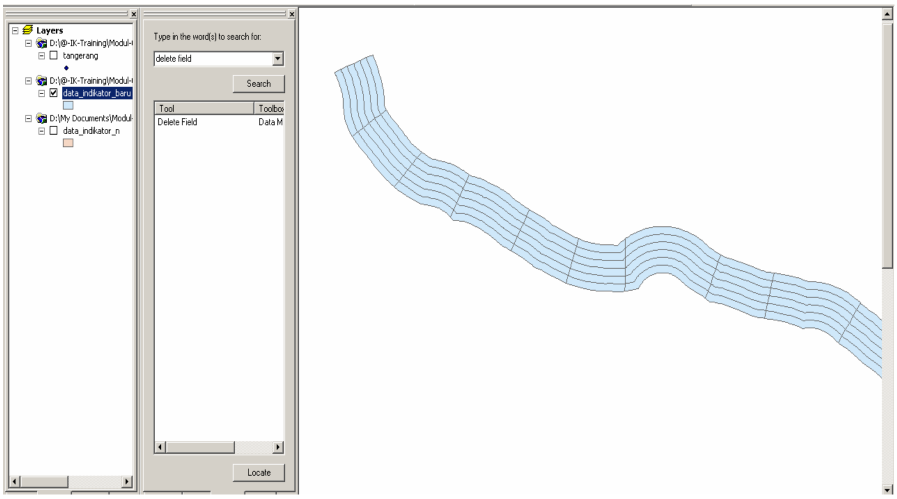


Fill the target feature with *data_indikator_n*, while fill the first result at join feature.



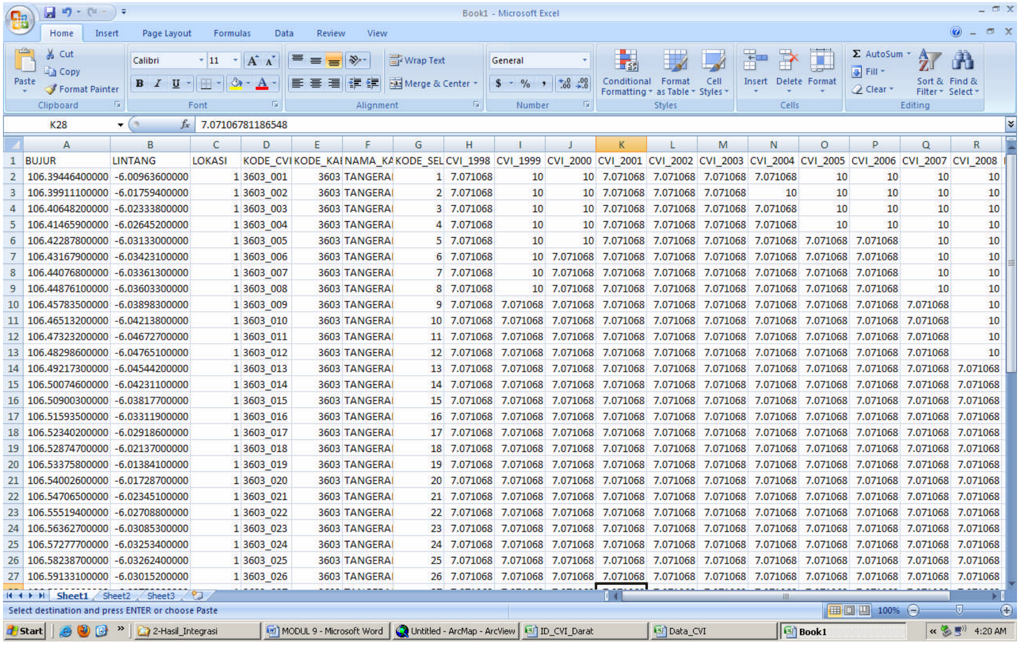
Then we choose OK.

8. After that will show new display that mark the two file have been integrated. To show the graduated color display can be showed like previously instruction at GIS introduction.

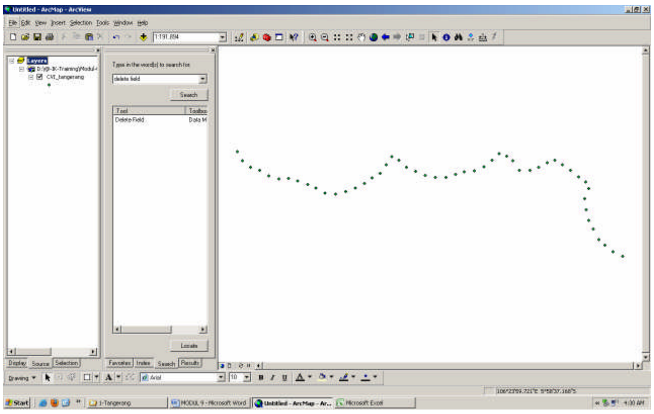


9. The same method can be used to integrate CVI to GIS. For CVI we use file at **D:\@-IK-Training\Modul-09-Integrasi\2 Hasil_Integrasi\Data_CVI.txt** and **D:\@-IK-Training\Modul-09-Integrasi\3-GIS_Lokasi\1-Tangerang\ID_CVI_Darat.dbf.** Copy

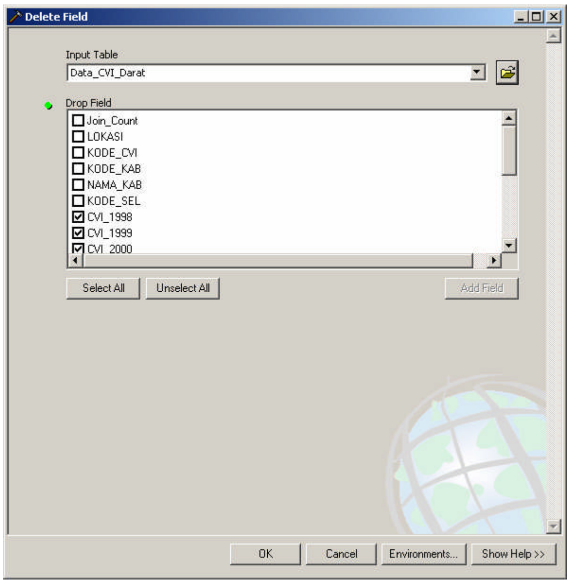
column BUJUR, LINTANG, LOKASI, KODE_CVI, KODE_KAB, NAMA_KAB, and KODE_SEL from second file and CVI_1998, etc from first file. Integrated to one file and save to *.txt format (ASCII).



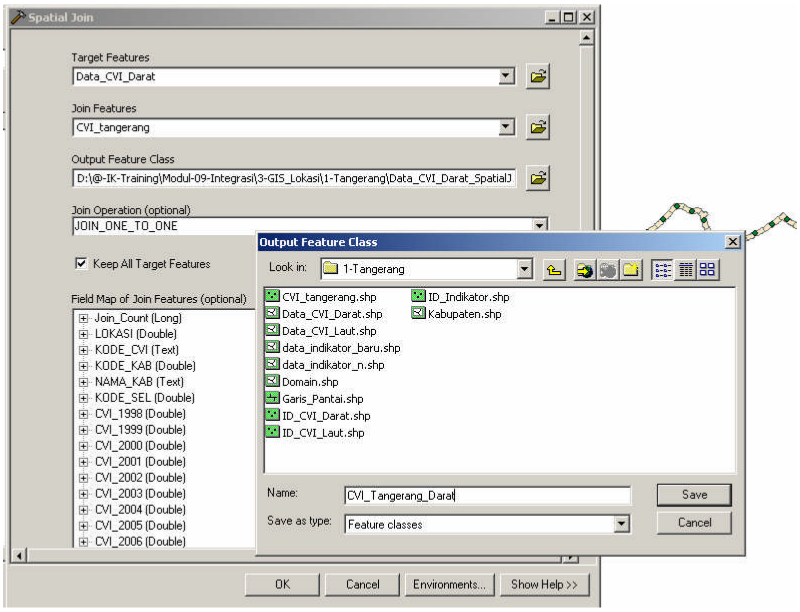
10. Then the same method like number 2 and etc can be applied. That file will showed, then change the projection use WGS 1984. Then export the data to *.shp format.

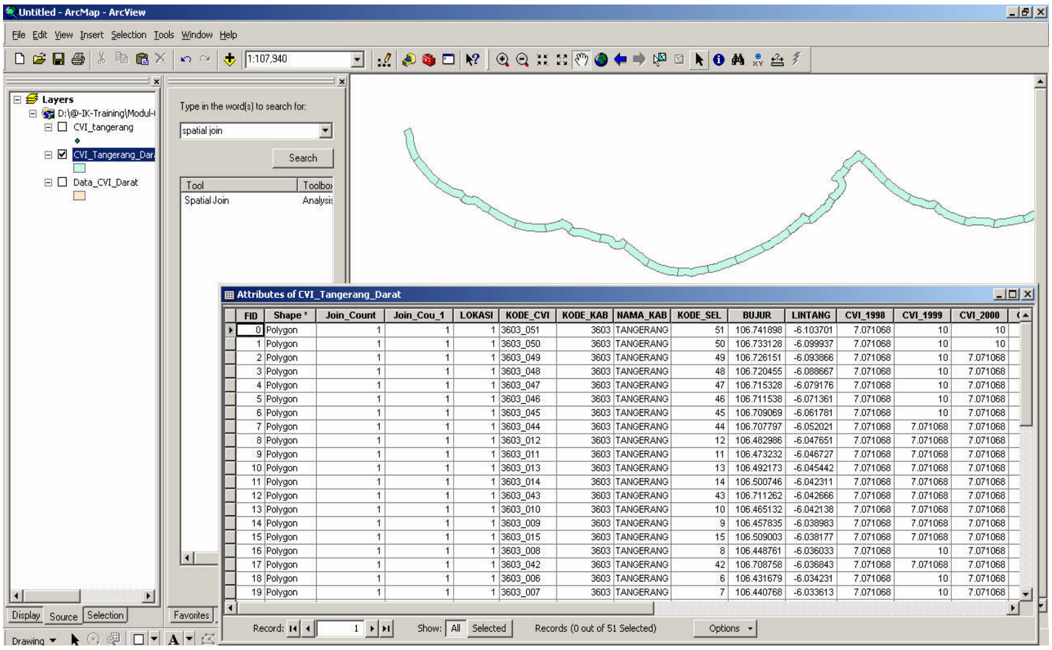


Then we display **D:\@-IK-Training\Modul-09-Integrasi\3-GIS_Lokasi\1-Tangerang\Data_CVI_Darat.shp,** previously we need to delete the field that not used.



Then we need to make spatial join to integrate two file.





11. Combination between Data_CVI with Data_Indikator can we visualization at same time to see the influential parameters to coastal vulnerability.

VIII. Instructors

Name : Asyari Adisaputra
Email : duadua_maret@yahoo.co.id
Mobile : +6281381597676
Office : Bogor Agricultural University

Name : Heron Surbakti
Email : heronsurbakti@yahoo.com
Mobile : +6285267009495
Office : Sriwijaya University

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MODULE OF TRAINING

SATELLITE ALTIMETRY

INCREASING CAPACITY OF LOCAL SCIENTISTS FOR CLIMATE CHANGE IMPACT & VULNERABILITY ASSESSMENT ON INDONESIA ARCHIPELAGO:

TRAINING IN IN-SITU/SATELLITE SEA LEVEL MEASUREMENT

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Research Professor Robert R. Leben
Colorado Center for Astrodynamics Research
University of Colorado at Boulder

APN
Asia-Pacific Network for Global Change Research

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1. What is an altimeter and radar altimetry?

Altimeter - An instrument that determines height above a reference level, commonly by measuring the change of atmospheric pressure, or by measuring vertical distance directly with a radar or laser system.

Radar Altimetry - The measuring of range from an aircraft or satellite to the sea surface using a short pulse of microwave radiation with known power toward the sea surface. The pulse interacts with the rough sea surface and part of the incident radiation reflects back to the altimeter. The techniques for determining the range to the ocean surface based on the travel time of such a microwave pulse is commonly referred to as altimetry.

Since 1996, global, near-real-time maps of mesoscale anomalies derived from tandem sampling provided by altimeters aboard the TOPEX/Poseidon and ERS-2 satellites have been posted on web pages hosted at the Colorado Center for Astrodynamics Research. The original, near-real-time processing system was based on a quick-look analysis that referenced the data to a high-resolution gridded mean sea surface available at the time. Recently, state-of-the-art mean sea surfaces have been derived that are based on a more complete record of altimeter observations. An updated mesoscale monitoring system based on a new mean surface is described and shown to provide improved mesoscale monitoring to the successful system implemented in 1996 (Leben *et al*., 2000).

The measurement of sea surface height from space by a satellite borne altimeter is deceptively simple:

1. Send a microwave pulse to the ocean surface and detect the reflected pulse, measuring the two-way travel time between sending and receiving the pulse.
2. Calculate the distance of the ocean surface from the satellite, the altimeter range, by multiplying the one-way travel by the speed of light. The one-way travel time is equal to 1/2 the two-way travel time.
3. Adjust range measurement to account for atmospheric, pulse reflection, instrument and external geophysical corrections to the path length.
4. Determine the ocean height by subtracting the range from the orbit height of the satellite.

While measuring sea surface elevation from space is conceptually simple, satellite altimetry is in fact quite complex, requiring nearly 60 algorithms and a variety of external measurements to accurately determine the sea surface height elevation associated with dynamic ocean currents.

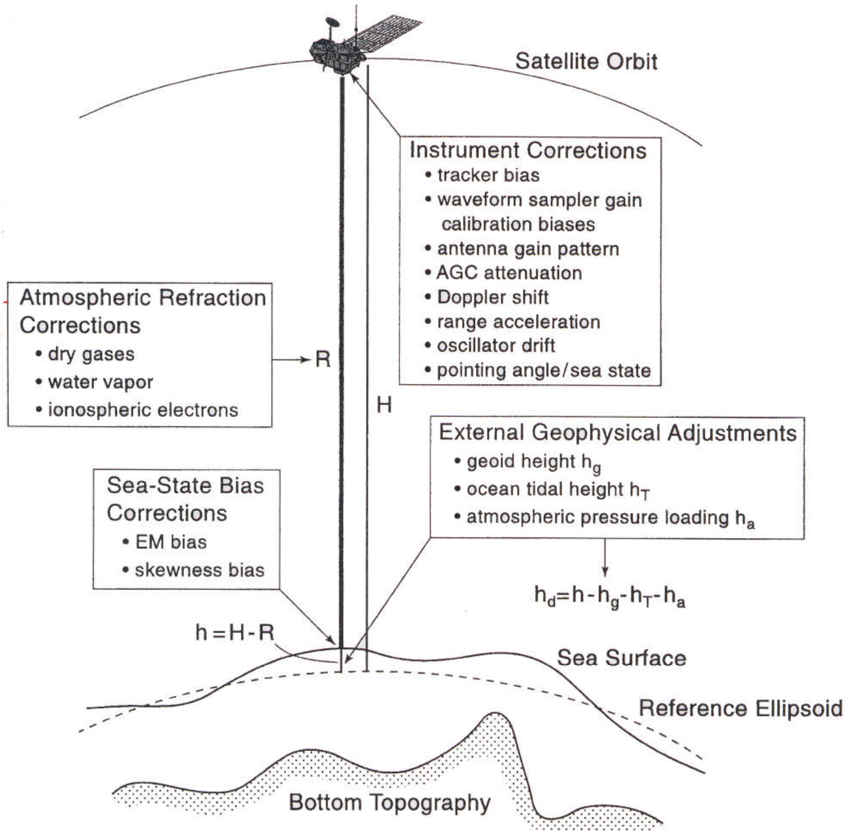

Figure 1. Schematic Summary Corrections

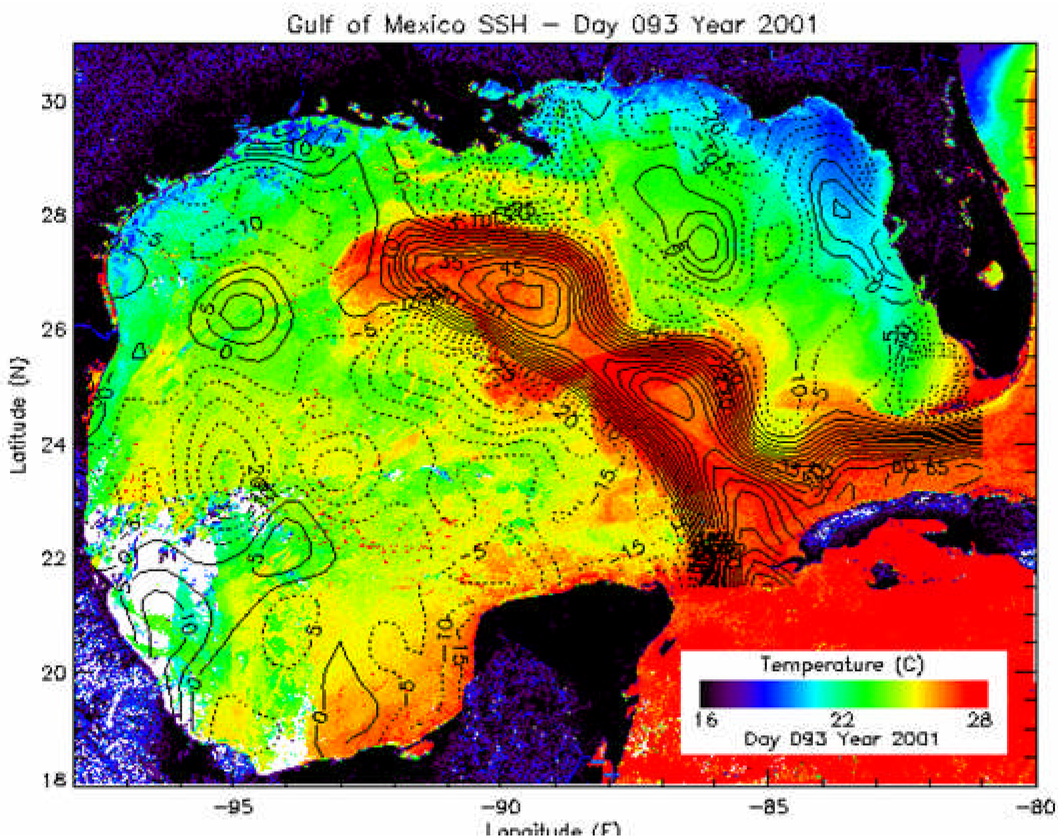

Figure 2. Sample Altimeter Data Product, Contoured altimeter data overlaid on SST

2. Altimeter History

The first space borne microwave altimeter few on Skylab in 1973. This was a proof of concept study to test instruments for the Seasat mission to be flown later in the decade. A scatterometer and radiometer were also flown and tested aboard Skylab.

- The altimeter, scatterometer and radiometer shared the same antennae.
- The antennae was gimbaled to look at backscatter and irradiance as a function of incident angle.
- The ground coverage at nadir was 11.1 km in diameter.

NASA's Geodynamics Experimental Ocean Satellite (GEOS-3) carried the first instrument to yield useful measurements of sea level and its variability with time.

- Primary Mission - Geodesy
- Launched in April 8, 1975
- Near circular orbit, inclination 115°, 843 km altitude of 843, non repeating ground tracks where successive tracks cross the equator every 101.8 minutes with a precession of about 26°. Mapped the ocean a 1° by 1° resolution in approximately one month.
- The altimeter operated at 13.9 GHz with a pulse repetition frequency of 100 Hz.
- Precision is estimated to be 50 cm rms.
- Operational from 1975 through approximately 1981

Seasat was the first satellite dedicated to the study of the global oceans with microwave sensors. It carried five sensors: a radar altimeter, a scatterometer system, a synthetic aperture radar, a visible and infrared radiometer and a scanning multi-channel microwave radiometer. Despite its short lifespan, this mission and the data collected served a crucial role in advancing satellite altimetry to a preeminent role in global ocean circulation monitoring.

- Launched on June 26, 1978 and failed due to a "massive short circuit in the satellite electrical system" on October 10, 1978.
- Near circular orbit, inclination 108°, period 101 min., and altitude 790 km.
- Orbit pattern - 3-day and 17-day near repeat. Ground track later overflown during GEOSAT Exact Repeat Mission so that data could be released unclassified.

The U.S. Navy GEOdetic SATellite carried an altimeter that was capable of measuring the distance from the satellite to the ocean surface with a relative precision of about 5 cm.

- Primary mission phase, the Geodetic Mission, was dedicated to mapping the marine geoid at high spatial resolution. Data were originally classified. The data around Antarctica were declassified in 1990 and the entire data set in June, 1995.
- Launched on March 12, 1985.
- Near circular orbit, inclination 108°, period 101 min, and altitude 800 km.
- The Exact repeat mission phase began on November 8, 1986 after the satellite was maneuvered into a 17-day repeat orbit (actually 17.05 days) until the satellite ultimately failed in January 1990.
- Public release of the high resolution Geodetic data allowed the estimation of sea floor topography using satellite altimetry.

Respectively launched by the European Space Agency (ESA) in 1991 and 1995, the ERS-1 and ERS-2 satellites for Earth Observation both carried satellite altimeters in addition to a wide variety of other instruments.

- ERS-1 had multiple mission phases including: Commissioning (3-day repeat), Ice 1 (3-day repeat), Multidisciplinary 1 (35-day repeat), Ice 2 (3-day repeat), Geodetic 1 & 2 (168-day repeat with 8 km offset between 1&2), and Multidisciplinary 2 (35-day repeat). ERS-1 failed on March 10, 2000.

- A tandem mission phase of ERS-1 & 2 was flown in 1995.
- ERS-2 was launched on April 21, 1995 and was immediately placed in the 35-day repeat orbit used for the multidiciplary phases of the ERS missions.
- ENVISAT, the third satellite in the series, was launched on March 1, 2002 and placed in the same orbit.

The U.S. Navy's GEOSAT Follow-on Mission (GFO) is the follow-on mission to the highly successful GEOSAT mission. This mission is dedicated to providing operational oceanographic products to maintain continuous ocean monitoring from the GEOSAT ERM orbit.

- Launched on February 10, 1998.
- Placed in 17-day repeat orbit flown during GEOSAT ERM mission phase.
- Hardware problems delayed data release until March 2001.
- Decommissioned in December 2008.

A joint NASA/CNES satellite altimeter mission launched on August 10, 1992.

- Carried two altimeters: the dual frequency TOPEX altimeter and the solid-state Poseidon altimeter, which shared a single antennae on the satellite.
- Highly successful primary and extended missions collected 364 10-day repeat cycles of data through 8/11/2002.
- TOPEX and Jason-1 flew in the same orbit (with Jason leading by 60 seconds) for the first 21 repeat cycles of the Jason mission to intercalibrate the satellites.
- Starting on August 15, 2002 T/P was maneuvered into an interleaved orbit for tandem sampling mission with Jason-1. The interleaved mission phase started on September 20, 2002.
- Decommissioned in January 2006.

Operational Missions: Near real-time and archival data are available from the following ongoing missions:

- Jason-1
- Envisat
- OSTM/Jason-2

All of these data are currently being processed and archived at CU/CCAR.
http://argo.colorado.edu/~realtime/welcome/

Jason-1: A joint U.S./French NASA/CNES satellite altimeter mission.
Jason-1 is a T/P "follow-on" and was placed in the T/P 10-day repeat orbit.

- Launched on December 7, 2001.
- Initial 6-month calibration phase, in which Jason-1 was on orbit 60 seconds behind T/P, was followed by a maneuver of T/P into a "tandem" interleaved 10-day repeat orbit to increase mesoscale sampling. T/P was placed into "interleaved" orbit on September 20, 2002.
- After calibration of Jason-2/OSTM, Jason-1 was placed into in the "interleaved" orbit where it is flying today.

Envisat: This is the European Space Agency (ESA) Environmental Satellite (Envsat) a follow-on to the ERS-1&2 altimeter missions.

- Launched March 1, 2002.
- Envisat replaced the ERS-2 satellite. Tandem mission plans are not clear, but CU/CCAR has existing processing capabilities to use data as soon as available, as was done during the ERS-1&2 tandem missions in 1995-1996.

- Calibration and validation was completed and the satellite became operational in January 2003.

- Dr. Leben is a USA Envisat P.I. working on the project titled “Monitoring the Intra-Americas Sea Through-flow with Satellite Altimetry”. USA P.I.s are not funded by ESA, but are given full access to the data stream and may disseminate derived products.

Ocean Surface Topography Mission (OSTM)/Jason-2: A joint U.S./French NASA/CNES satellite altimeter mission.

- OSTM/Jason-2 is a T/P “follow-on” mission and was placed in the T/P 10-day repeat orbit.
- Launched on June 20, 2008.
- Initial 6-month calibration phase, in which Jason-2 was in orbit 58 seconds behind Jason-1, was followed by a maneuver of Jason-1 into the “tandem” interleaved 10-day repeat orbit to increase mesoscale sampling on 14 Feb 2009.

Tabel 1. Ocean Altimeter Mission Summary

Satellite	Agency	Mission period	Measurement precision (cm)	Orbit accuracy (cm)	Repeat period (days)
Skylab	NASA	May 1973–February 1974	100	>1000	
GEOS-3 (Geodetic Earth Orbiting Satellite 3)	NASA	9 April 1975–December 1978	25	~500	
SEASAT	NASA	28 June 1978–October 1978	5	~100 (20)	17.05 3
Geosat (Geodetic Satellite)	U.S. Navy	12 March 1985–December 1989	4	30–50 (10–20)	~23.07 17.05
ERS-1 (Earth Remote Sensing Satellite 1)	ESA	17 July 1991–May 1996	3	8–15 (<5)	3,35,168
TOPEX/Poseidon (TOPography Experiment)	NASA/ CNES	10 August 1992–January 2006	1.7	2–3	9.9156
ERS-2 (Earth Remote Sensing Satellite 2)	ESA	21 Apr 1995–present	3	7–8 (< 5)	35
GFO-1 (Geosat Follow-On 1)	U.S. Navy	10 February 1998–December 2008		10 (5)	17.05
JASON-1 (T/P Follow-On)	NASA/ CNES	7 December 2001–present	1.5	1 (goal)	9.9156
ENVISAT (ENVIronmental SATellite)	ESA	2 March 2002–present		1 (goal)	35
OSTM/Jason-2	NASA/ CNES	20 June 2008–present	TBD	1 (goal)	9.9156

3. Altimeters Range Corrections

Altimeter range corrections can be grouped as follows:

- Atmospheric Refraction Corrections
- Sea-State Bias Corrections
- External Geophysical Corrections
- Instrument Corrections

The presence of dry gases, water vapor and free electrons in the atmosphere reduces the propagation speed of the radar pulse. These are the so-called atmospheric range corrections.

- Dry Gases
- Water Vapor
- Ionospheric Free Electrons

Atmospheric Range Corrections: Dry Gases

All of these corrections cause a delay in the returned signal and are often referred to as a *path delay*, acting to make the range measurement too long.
At microwave frequencies the troposphere is a non-dispersive medium, and the index of refraction is independent of frequency. For convenience the path delay is broken into a dry and wet component. The dry component reflects primarily the refractive effects of oxygen on the path delay.
A simplified expression for the dry troposphere range correction, which takes into account the variation in gravity with latitude, is given by the formula:
$\Delta R\_dry \approx 0.2277 * P(1 + 0.0026\cos(2\ \text{latitude}))$
Where P is the sea level pressure in millibars and ΔR_dry is in cm.
This range correction averages 226 cm with variations of 2 cm. The uncertainty associated with errors in the pressure fields from numerical weather models is about 1 cm.

Atmospheric Range Corrections: Water Vapor
The atmospheric range correction associated with columnar water vapor is called the *wet troposphere* correction and reflects water vapor and cloud liquid water droplet contributions to atmospheric refraction.
This effect is parameterized by empirical formula: $\Delta R\_wet \approx 1.6\ L$
where L is the integrated columnar liquid water in gm/cm^2 and ΔR_wet has units of cm.
This range correction averages 10 cm at high latitudes to 24 cm in tropical regions. Time variations are about 5 cm. The uncertainties is about 1 cm when corrected using a three-frequency microwave radiomenter.

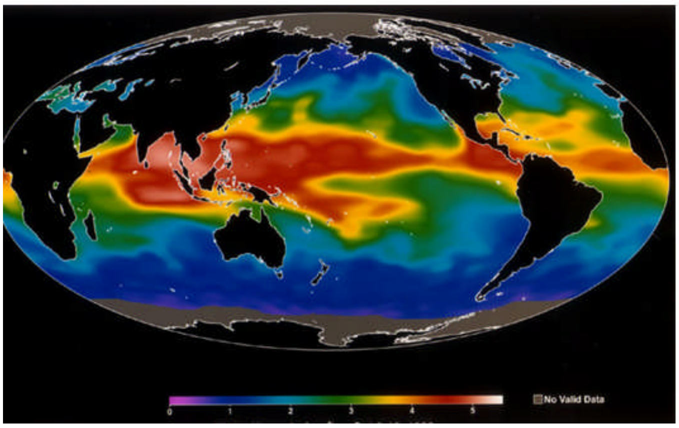

Figure 2. TMR Water Vapor (g/cm2)

Microwave Radiometry

Modern altimeter rely on bore-sight radiometers to estimate the ΔR_wet.

- Algorithms using three frequency (18, 21 and 37 GHz) brightness temperature trained on a large global database of radiosonde profiles to estimate ΔR_wet have accuracies of about 1 cm in rain free conditions
- Algorithms based on the two frequencies (23.8 and 36.5 GHz) used in the ERS radiometers have accuracies of about 2 cm rms.

Atmospheric Range Corrections: Ionospheric Free Electrons

Electrons liberated from atoms in the ionosphere by energetic solar radiation interact with microwaves to slow their propagation. Since the ionosphere is a dispersive medium, the refraction is a function of the frequency so that the free electron density can be calculated using the ranges measuremetns at different frequencies.
The ionosphere range correction is calculated from the total electron content unit (TECU) using the formula: $\Delta R\_iono = 0.22$ TECU, where TECU is given in 10^16 electrons per meter^2 with ΔR_iono in cm.

Like the wet troposphere correction, accurate measurements of TECU are required for accurate altimetry given the time and space scales of ionospheric variability
Note: The ability to correct satellite altimeter data for water vapor attenuation requires coincident measurements from a passive microwave radiometer onboard the satellite because the columnar water vapor at any particular location varies with time.
This was an important lesson learned from GEOSAT.

Scales of the Ionospheric Delay
The ionosphere exhibits spatial and temporal variations that are difficult to reproduce with numerical models. Observations show:

- Mean values of the ionospheric delay range from 12 cm near the equator to 6 cm at higher latitudes.
- Variations about the mean are as large as 5 cm near the equator and 2 cm at higher latitudes.
- Meridional gradients as large as 2 cm per 100 km can occur during mid to late afternoon at latitudes of 20° to 30°.
- Uncertainty in the measurements are about 1 cm after smoothing the ionospheric correction at length scales less than 100 km.

Sea State Bias Corrections
The sea state bias is made up of two components

- Electromagnetic (EM) Bias - the difference between mean sea level and the mean scattering surface.
- Skewness Bias - the difference between the mean scattering surface and the median scattering surface.

Recall that the returned signal measured by an altimeter is the pulse reflected from the small wave facets within the antenna footprint that are oriented perpendicular to the incident wave fronts.
The shape of the returned waveform is thus determined from the distribution of these scatterers rather than the distribution of the actual sea surface height.
The half power point on the leading edge of the returned wave form corresponds to the median scattering surface.

External Geophysical Corrections

- Geoid height - An accurate geoid is needed to calculate the total dynamic topography signal that includes both the mean ocean circulation and its variations. Early geoids have not been accurate enough for this application, however, by including gravity measurements form GRACE mission have reduced geoid errors at scales greater than 300 km so that scientifically useful information can be derived.
- Ocean and solid earth tidal height - Both ocean and solid earth tides are measured by the altimeter and are considered noise on the non-tidal dynamical signal. Existing models derived from T/P data are accurate to better than 2 cm rms in the deep ocean.

External Geophysical Corrections (cont.)

- Atmospheric pressure loading - This is simply the depression of the sea surface by the atmosphere pressure force on the ocean surface. Spatial and temporal variations of this force are compensated partially by variations in the surface elevation. To first order, the ocean response as an “inverse barometer”, changing height by about one centimeter per milli bar of pressure change.

  $$\Delta \text{ IB (cm)} \approx 0.995\ (P\text{-}1013)$$

  where P is the sea level pressure and 1013 is the mean sea level pressure.
  In reality, the ocean responds both statically and dynamically depending on the spatial and temporal scales of the forcing.

- Barotropic ocean signals, which are have significant power at periods shorter than 20 days and are aliased by altimetric sampling, also an important external geophysical correction being studied. Barotropic ocean models forced with wind and pressure, however, are not sufficiently accurate reliable corrections for barotropic variability in routine altimeter data processing.

Instrument Corrections (some)

- Doppler shift - Doppler shifting of the transmitted chirp affects the range calculation. This is corrected using the range rate, the rate of change of the range. Range rate is calculated in ground processing by least squares fitting of the range data over about 3 seconds of TOPEX data.
- Range acceleration - The tracker algorithm is affected by the range acceleration. The range acceleration is calculated using the least squares employed for the range rate. Range rates can be as high as 10 meters per second^2 over ocean trenches.
- Oscillator drift - any drift in the frequency of the oscillator direct affects the range calculated by counting cycles of the on board oscillator. This is calibrated by timing of telemetry signals at a ground receiving station. The distinction between frequency and counts per second resulted in an error in the ground based software for TOPEX causing a significant drift and bias in the altimeter measurement.
- Pointing angle/sea state - the largest source of instrumental error is caused by of nadir pointing of the altimeter instrument. To varying degrees this affects the adaptive tracker unit (ATU) estimates of two-way travel time, the significant wave height and the sigma naught.

Original CCAR Near Real-time Altimeter System

- Quick-look processing designed to retain and map mesoscale variability.
- Went online in early 1996.
- Used NOAA Laboratory for Satellite Altimetry ERS and Geosat Follow-on near real-time altimeter data products.
  - Enhanced NOAA corrections.

    - Delft Institute for Earth-Oriented Space Research orbits.
- Used near real-time TOPEX RGDRs
    - Processed by the Naval Oceanographic Office Altimeter Data Fusion Center.
    - JPL Earth Orbiter Systems Group GPS orbit.
- CCAR system was designed so that quick-look products are processed and posted by 12:00 p.m. MST.

Original CCAR Quick-look mesoscale analysis

- All altimeter data were referenced to an independent gridded mean sea surface.
    - The data were treated as non-repeating ground tracks and were referenced directly to the mean sea surface (non-collinear processing).
    - Saved a significant amount of computational effort during near real-time processing.
- Along track loess filtering was used to remove residual orbit and environmental correction errors.
    - The loess filtering removed a running least squares fit of a tilt and bias (line) within a sliding window from the along-track data.
    - The window width was approximately 15 degrees (or 200 seconds) along track.
- The detrended data were objectively mapped to a 1/4° grid.
- In the Gulf, a model mean or mean dynamic height was added to the anomaly to estimate the total sea surface height.

Current CCAR Near Real-time Altimeter System

- Updated “collinear” processing and new reference mean sea surface.
- Went online in summer 2003.
- Uses NOAA Laboratory for Satellite Altimetry Geosat Follow-on (GFO) near real-time altimeter data products.
- Uses near real-time Jason-1 and OSTM Jason-2 RGDRs
- JPL Earth Orbiter Systems Group GPS orbits and real-time data.
- ESA Envisat data were added in the summer of 2004.
- Entire system was moved to an Apple Mac G5 in the summer of 2005.
- Products posted at 8 am MST or MDT Time (GMT-7 or -6)
-

Online Data Access Tools

Gulf of Mexico Interactive Online Data Forms

- Gulf of Mexico Near Real-Time Data Viewer
- Gulf of Mexico Near Real-Time Geostrophic Velocity Viewer
- Gulf of Mexico SST/SSH Overlay
- Gulf of Mexico Ocean Color/SSH Overlay

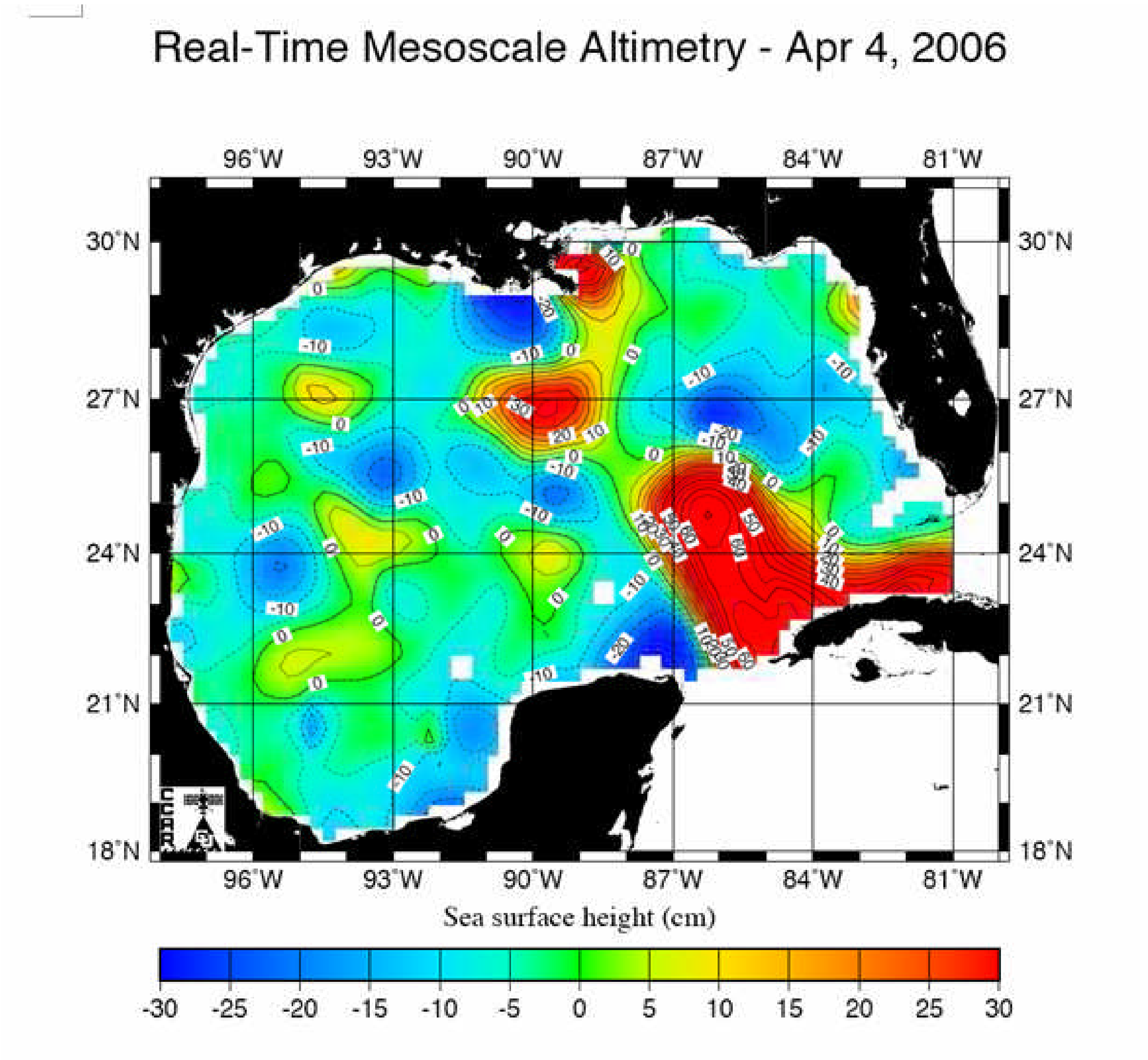

Figure 3. Example Real time Mesoscale Altimetry

4. Sea Level Reconstruction Using Tide Gauges and Satellite Altimetry

Estimating Rate of Sea Level Rise

- Rates of sea level rise over the past several decades using either fully empirical or semi-empirical techniques have been published recently.
    - Church et al. (2004), Jevrejeva et al. (2006),Church et al. (2006),Rahmstorf et al. (2007),Grinsted et al. (2009),Merrifield et al. (2009)
- Each technique uses satellite altimetry data, tide gauge data or some combination of the two.
- Over the period from 1950 to 2010, estimates of global mean sea level (GMSL) range from around 1.5 mm/yr to 2.1 mm/yr.
- Such studies often form the basis for projecting GMSL into the future.

Reconstructing Sea Level with CSEOFs

A procedure for reconstructing sea level has been implemented using CSEOFs in place of the more conventional EOFs.

1. Compute CSEOF loading vectors (LVs) from 16-year satellite altimeter record, 1993-2008, and truncate to 10 LVs to avoid overfitting of the tide gauge data.

2. High-pass filter tide gauge data using a 3-year window to retain signals well represented by the CSEOF LVs and to remove tide gauge datum artifacts.
3. Calculate a weighted least-squares fit of the LVs to compute the reconstructed PCs and time series.

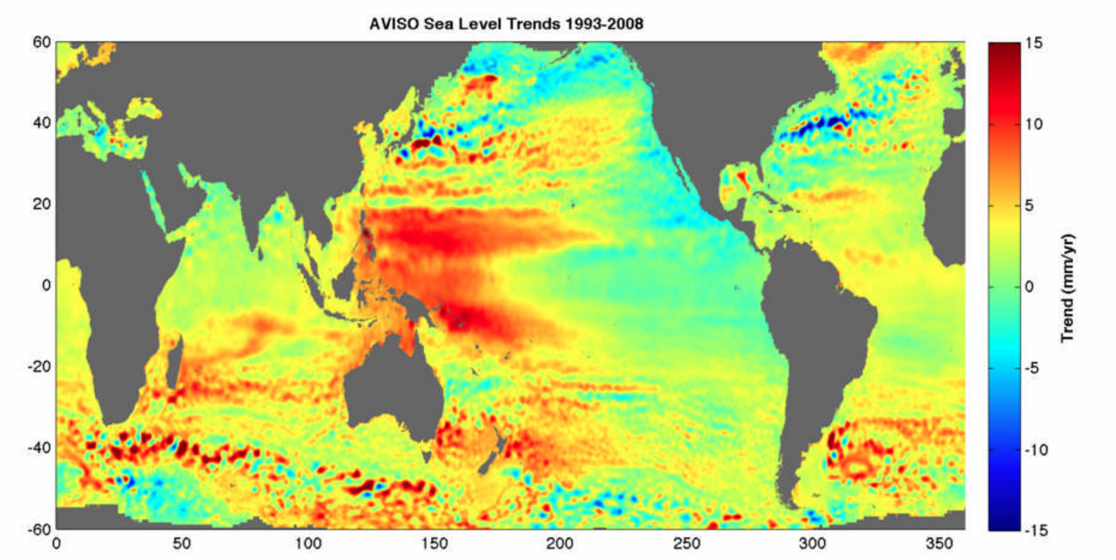

Figure 4. AVISO Sea Level Trends 1993-2008

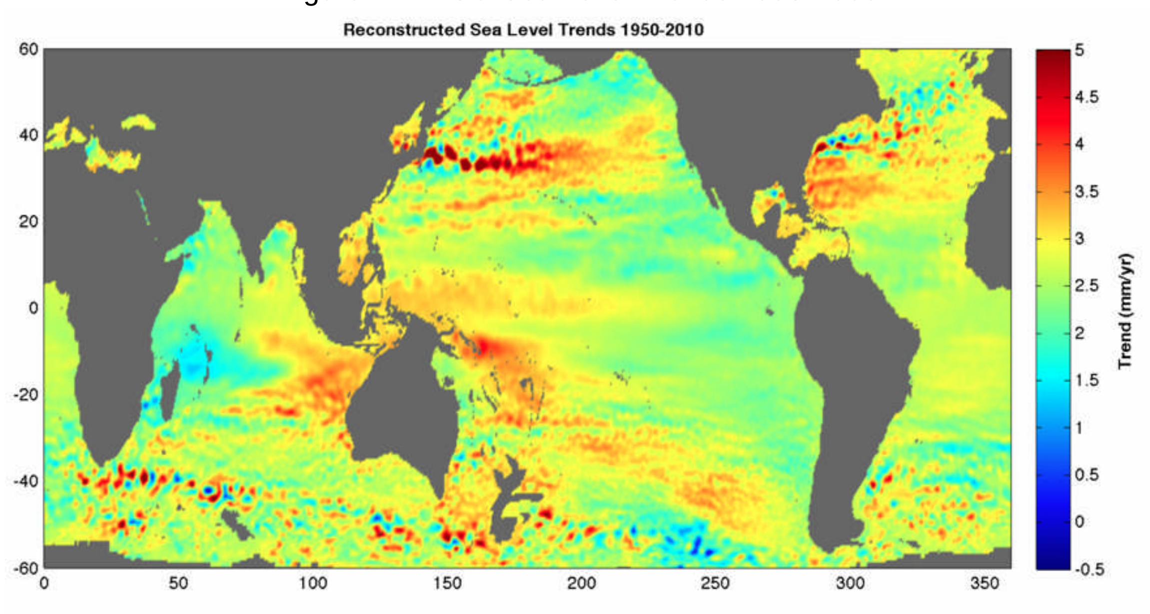

Figure 5. Reconstructed Sea Level Trends: 1950-2009

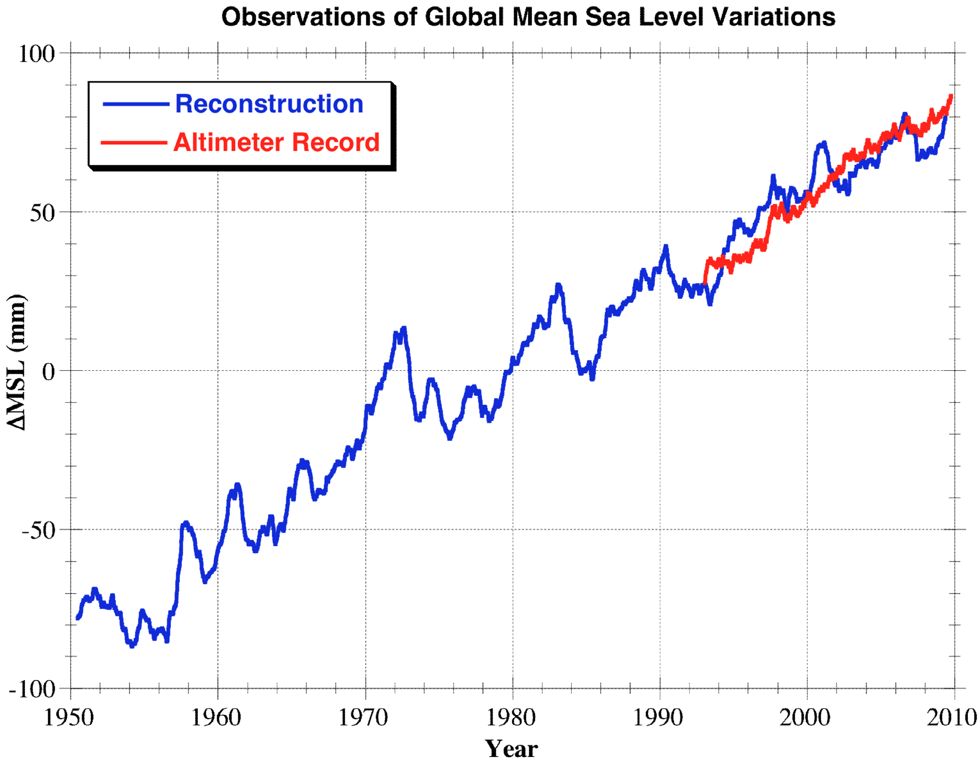

Figure 6. observation of Global Mean Sea Level Variation

- The CSEOF reconstructed trend and trend computed from the AVISO altimeter record show good agreement over the period from 1993 to 2010.
  - The GMSL trend computed from the CSEOF reconstruction over the period from 1950 to 2010 is 2.5 mm/yr, higher than previous estimates over the same period.
- Caution must be used when interpreting GMSL trends computed from sea level reconstructions.
  - The GMSL obtained from reconstructions depends heavily on the tide gauge editing and on the selected method of weighting for the reconstruction procedure.
  - Ideally, regional clustering of tide gauges should be avoided by using equal area weighting (Merrifield et al. 2009).
  - The effects of tide gauge editing and weighting on the results of reconstructions still needs to be better understood.

Empirical Orthogonal Functions (EOFs)

- The large amounts of data that are usually studied in climate exhibit a complex mixture of signal and noise. The purpose of statistical analysis is to disentangle this mixture to find the needle (the signal) in the haystack (the noise).
- The allegory with the needle in the haystack has two sides. First, it is difficult to find the needle in the haystack. Second, after it has been found, it should be easily recognizable as a needle simply by looking at it.
- To identify a climatic signal, advanced techniques may be required, but after its identification, the signal usually may be described by means of simple techniques such as composites, correlations, etc.”

- Von Storch & Frankinoul (1998)

- A fundamental characteristic of ocean data is the high dimension of the variables representing the state of the system at any given time. Often it is advantageous to perform a subspace decomposition to split the full phase space into two subspaces, i.e. the signal subspace and the noise subspace.
- One such statistical method is Empirical Orthogonal Functions.
- The roots of this method arose in the early 1900's as objective tests of intelligence were being developed. Although, later on several other fields independently developed the statistical techniques.

Computing EOFs with SVD

Basic Algorithm

1. Put the data into a matrix, F, so that each row is a time series of the data at a point and the columns are variables or spatial data at specific times.
2. Remove the mean from each row so that there is no time mean signal in the data set.
3. Use SVD to decompose the data into three matrices:

F = U*S*VT
where:
U = the left eigenvectors
VT = the right eigenvectors
S = singular values
In this example:
U = the EOFs (spatial patterns)
S*VT = the EOF time series or Principal Components (PCs).

There is no consistent terminology for EOF and PC analyses. Here are some terms commonly used.

- EOFs may be called the loading vectors.principal component loading patterns, principal vectors, or principal loadings.
- The EOF time series may be called eigenvector time series, expansion coefficient time series, expansion coefficients, time coefficients, time components, principal component time series, principal component scores, principal component amplitudes, principal components, or scores.

We will call the EOFs the loading vectors (LVs) and the EOF time series the principal components (PCs).
Note that switching the association of time and space indices in the data matrix, F, does not make a difference in the SVD decomposition. The EOFs are now associated with VT, and the PCs with U*S.

The eigenvalues of the expansion are equal to the square of the singular values. To compute the percent of variance explained by a given EOF use the following formula:

% variance of component i = Si2 / trace(SST)
or
% variance of all components = diag(S*ST)/ trace(SST)

SST is sometimes referred to as the communalities matrix.

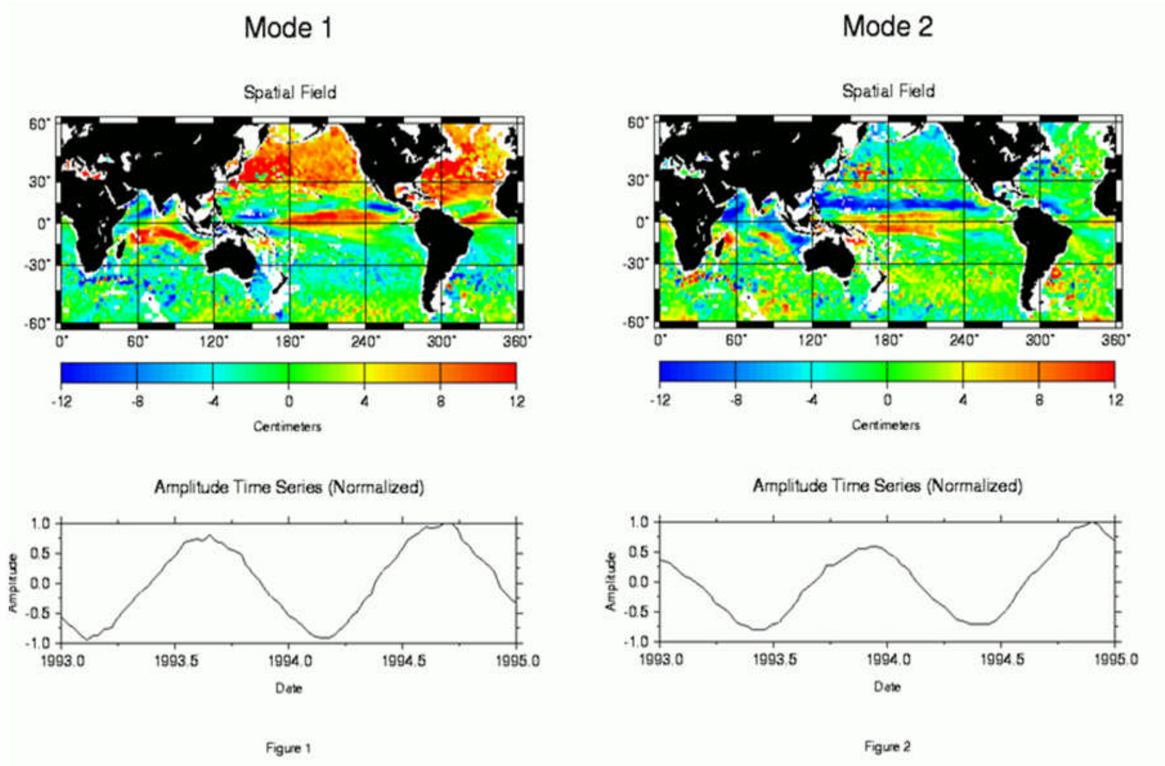

Figure 6. Global SSH EOFs and PCs - Modes 1 & 2

Non-Stationary Periodic Signals

- The spatial patterns of many geophysical processes change in time at longer time-scales than their well-defined periods. For example, most annual cycles are not stationary and change amplitude over time.
- In many studies, the signal associated with the annual cycle is removed prior to analyzing the data.
    - The annual cycle is often not of scientific interest and certain types of analysis can be hindered by the presence of this signal.
    - Techniques commonly applied for removing the annual cycle do not handle the time-dependent spatial patterns well.
    - Simply removing the time-invariant annual cycle is often not sufficient.

Cyclostationary EOFs

- To account for time-varying spatial patterns, Kim et al. (1996) introduced Cyclostationary EOFs (CSEOFs).
- In traditional EOF analysis, space-time data are represented in terms of loading vectors (LVs) and principal components (PCs).
    - LVs represent patterns or spatial variability in the dataset.
    - PCs represent the temporal variability of the LVs.
- The significant difference between CSEOF and EOF analysis is the time-dependence of the LVs.
    - The temporal evolution of the LVs is constrained to be periodic with a certain "nested period".
    - For the analysis of the annual cycle, this nested period is equal to one year.
    -

Computing CSEOFs

- The method for computing CSEOFs is based on the theory of harmonizable functions.
- CSEOFs are defined as products of Bloch functions and Fourier functions.
- Several papers by K.-Y. Kim establish the theoretical basis of CSEOFs in addition to providing methods for efficiently computing CSEOFs.
  - Kim et al. (1996);
  - Kim and North (1997);
  - Kim and Wu (1999);
  - Kim and Chung (2001).

CSEOFs are computed from the multi-mission AVISO altimeter dataset spanning the 16-year record from 1993-2008.

- CSEOF #1 accounts for 35% of the variability in the dataset and reflects the annual SSH variability.
- CSEOF #2 accounts for 17% of the variability in the dataset, which is associated with the El Nino/Southern Oscillation (ENSO) signal.
- In total, just 17 CSEOFs account for 99% of the SSHA variability in the AVISO dataset.

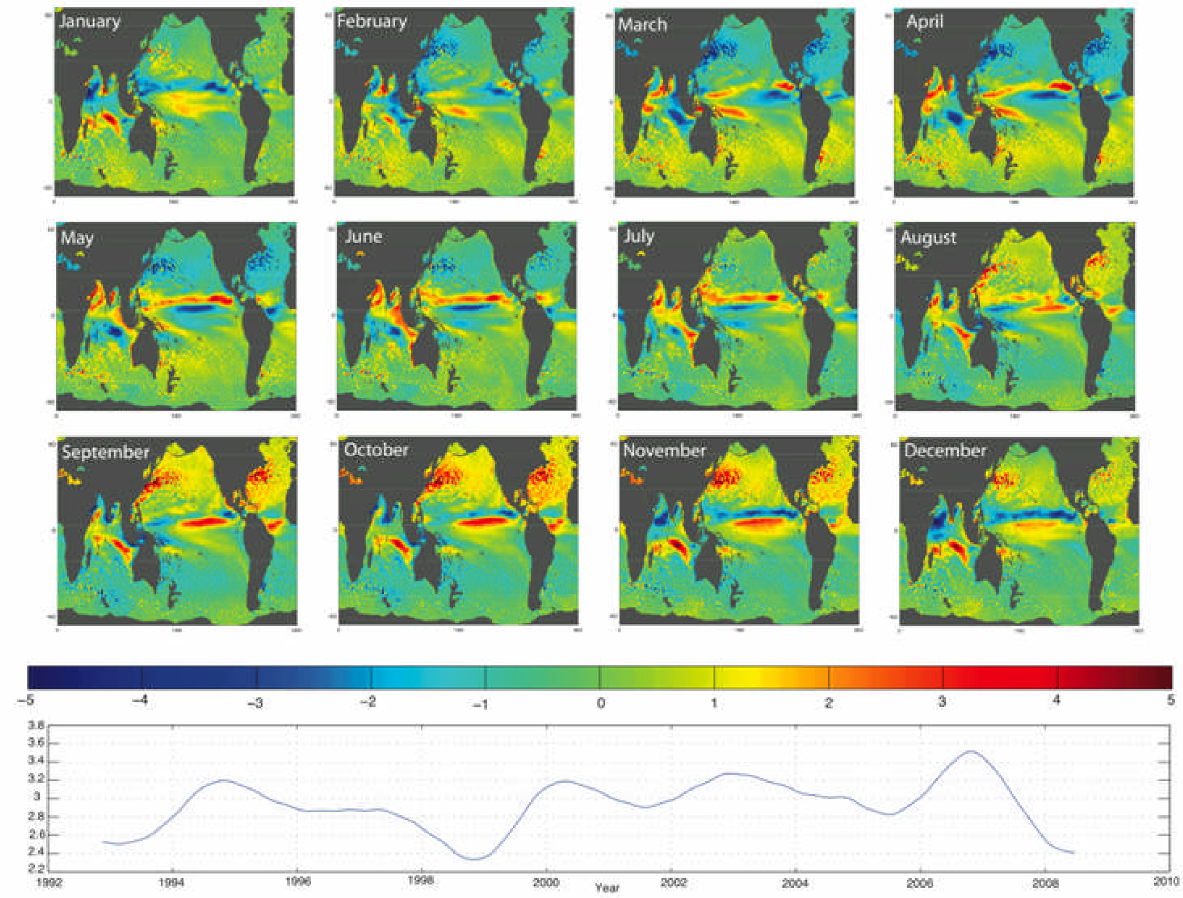

Figure 7. CSEOFs

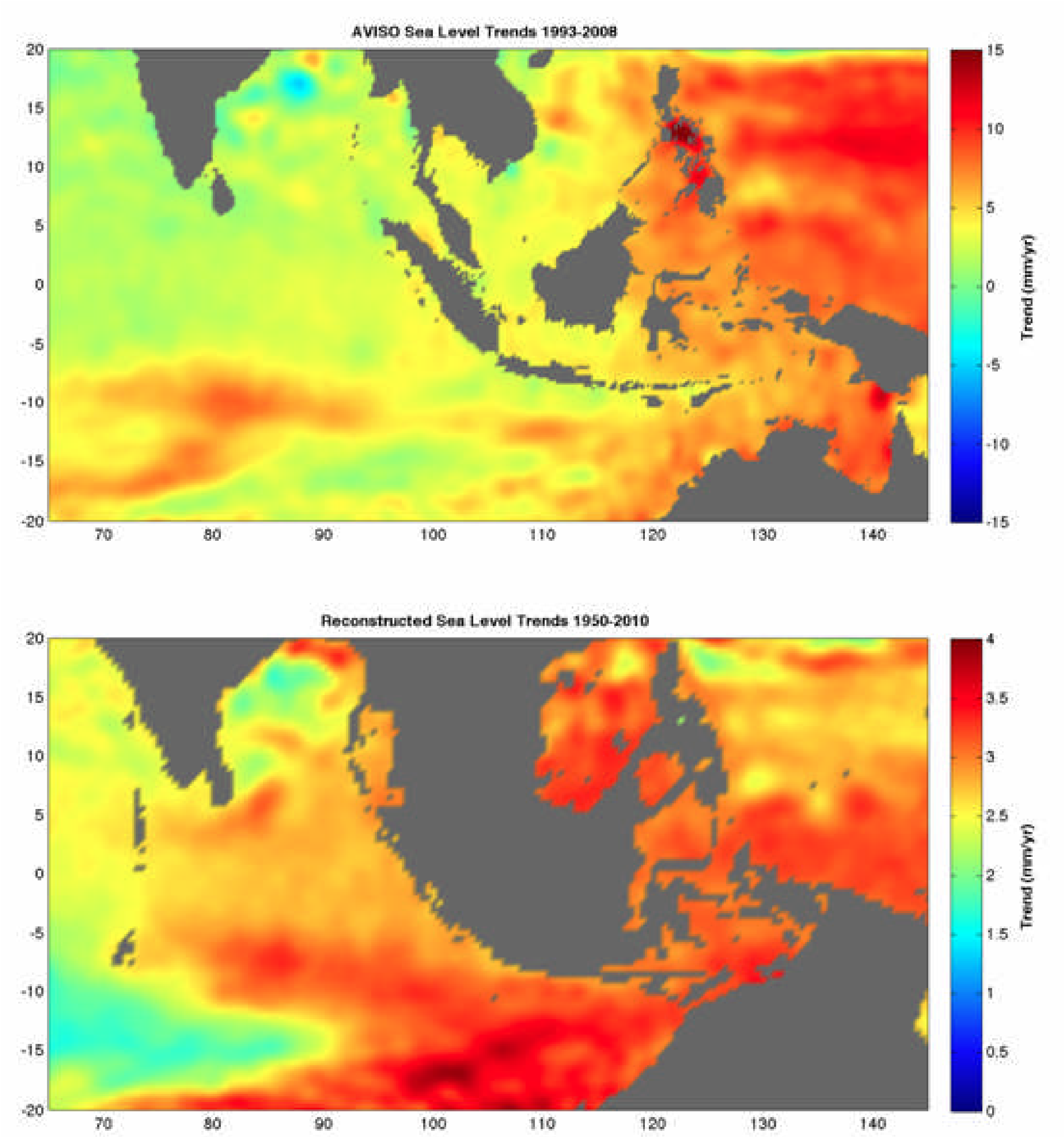

Figure 8. Indonesia Region Sea Level Trends

Future Studies

- Future studies are planned to use Seasat and Geosat altimeter data to assess the *quantitative* accuracy of the reconstructed times series.
- We also plan to exploit the reconstructed fields to improve filtering of residual Seasat and Geosat orbit and pathlength errors.
- A validated dataset will allow us to study in detail the long-term climate signals described by the sea level record.
- Please use our reconstructed dataset in your research. We have given you a preliminary version of the dataset. Check with us for updates and for literature citation if you intend to publish a paper. leben@colorado.edu

Dedication/Acknowledgements

- This paper is dedicated to George H. Born in honor of his 25 years of service as Director of CCAR. We thank him for his dedicated effort to advance satellite altimetry from the pioneering Seasat and TOPEX/Poseidon programs through to the present, ongoing, and planned operation satellite altimeter missions that are essential for monitoring the Earth’s climate system. Not too bad for a farm boy from Edna, Texas.
- This work was supported by NASA OSTM Science Team grants NNX08AR60G and NNX08AR48G. BDH and RRL are deeply indebted to K.-Y. Kim for the great amount of assistance he has provided in the development of the CSEOF sea level reconstruction algorithms.

5. Laboratory Work for processing altimeter data using Matlab Software

Example Using Datenum to Create AVISO Filenames

```
% Example using datenum to create AVISO filenames
clear
clc
% Aviso dataset:
% start date 14-Oct-1992
%   end date 22-Feb-2006  use datenum(year,month,day)
num1 = datenum(1992,10,14)
num2 = datenum(2006,2,22)
% check
[ datestr(num1) ' to ' datestr(num2) ]
% create Aviso date text string e.g. 19921014
n = num1
dateval = datestr(n,30);
dateval = dateval(1:8);
dateval = [ dateval(1:8) '_' dateval(1:8)]
% now make Aviso filename
% dataset info
dataset_name = 'dt_ref_global_merged_msla_h_qd_';
dataset_date_stamp = '_20080107.mat';
% filename
filename = [ dataset_name dateval dataset_date_stamp ]

for n=num1:7:num2
    dateval = datestr(n,30);
    dateval = dateval(1:8);
    dateval = [ dateval(1:8) '_' dateval(1:8)];
    % filename
    filename = [ dataset_name dateval dataset_date_stamp ]
end


% loop to load data and calculate mean
datadir = [ '/Users/leben/presentation/data/avisomerged/globalMat/'];
for n=num1:7:num1
    dateval = datestr(n,30);
    dateval = dateval(1:8);
    dateval = [ dateval(1:8) '_' dateval(1:8)];
    % filename
    filename = [ dataset_name dateval dataset_date_stamp ]
    load([ datadir filename]);
    mean_ssh = mean(mean(ssh(find(ssh<8.7e+18))))
end
% now loop over all files and save mean
npts = size([num1:7:num2],2)
mean_ssh = NaN*ones(npts,1);
dnum = NaN*ones(npts,1);
np=0;
for n=num1:7:num2
% for n=num1:7:num1
    np = np + 1;
    dateval = datestr(n,30);
    dateval = dateval(1:8);
    dateval = [ dateval(1:8) '_' dateval(1:8)];
    % filename
    filename = [ dataset_name dateval dataset_date_stamp ]
```

```
    load([ datadir filename]);
    % calculate mean
    mean_ssh(np) = mean(mean(ssh(find(ssh<8.7e18))));
    % save datenum
    dnum(np) = datenum(n);
end
mean_ssh(1)
%
figure(1)
subplot(3,1,1)
plot(mean_ssh)
subplot(3,1,2)
plot(dnum,mean_ssh)
subplot(3,1,3)
plot(dnum,mean_ssh)
datetick
save aviso_mssh mean_ssh dnum
%
% %mean_ssh = mean(mean(ssh(find(ssh<8.7e18))))
```

Sample Matlab Code to Compute Dates of along Track Data Points

```
% Sample Matlab code to compute dates of along track data points
% from OSTM real time collinear data sets
%
clear
% Note that cycle times are given in seconds past 1/1/2000 00:00 GMT
toolsdir = ['/Users/leben/presentation/tools/'];
filename = [ toolsdir 'cycleTimesOSTM.txt'];
load(filename)

% there are 856711 once-per-second points in a 10-day repeat
point = 1;
ncycles = size(cycleTimesOSTM,1);
for ncyc=1:ncycles
%   calculate how many data past y2000 the time is
    ndays = (cycleTimesOSTM(ncyc,2)+point-1)/24/3600;
    cycle = cycleTimesOSTM(ncyc,1);
    [ 'Cycle #',int2str(cycle), '  Point #' int2str(point) '  '
datestr(datenum(2000,1,1) + ndays)]
    pause
end
```

Sample Matlab Code to Compute Dates of along Track Data Points

```
% Sample Matlab code to compute dates of along track data points
% for OSTM collinear data sets
%
clear
% Note that cycle times are given in seconds past 1/1/2000 00:00 GMT
load cycleTimesOSTM.txt

% there are 856711 once-per-second points in a 10-day repeat
point = 700000;
ncycles = size(cycleTimesOSTM,1);
for ncyc=1:ncycles
%   calculate how many days past y2000 the time is
    ndays = (cycleTimesOSTM(ncyc,2)+point-1)/24/3600;
    cycle = cycleTimesOSTM(ncyc,1);
    [ 'Cycle #',int2str(cycle), '  Point #' int2str(point) '  '
datestr(datenum(2000,1,1) + ndays)]
    pause
end
```

Read and Plot Colinear OSTM Data

```
% read and plot colinear OSTM data
clear
clc
%window version
%datadir = [ 'D:\presentation\data\OSTM\colinear\' ];
datadir = [ '/Users/leben/presentation/data/OSTM/colinear/' ];
filename = [ datadir 'c034.col' ]'
fid = fopen(filename,'r')
ssha = fread(fid,'int32');
% NaN flagged data
iflag = 2^31-1;
ssha(find(ssha==iflag))=NaN;
figure(1)
clf
plot(ssha)

% read OSTM ground track lat lon file - topex_latlon.mat
gtdir = [ '/Users/leben/presentation/groundtracks/' ];
filename = [ gtdir 'topex_latlon.mat' ];
load(filename);
figure(2)
clf
% plot alongtrack data in cm
ssha = (ssha - 205)/10;
ssha(ssha>30)=30;
ssha(ssha<-30)=-30;
plotcol(lon,lat,ssha); colorbar
%h = mesh(x,y,z,c,'LineStyle',['none'],'Marker','o','MarkerSize',[2]);
%h = mesh(x,y,z,c,'LineWidth',[3]);
```

Plot Using Pcolor

```
datadir = ['/Users/leben/presentation/data/avisomerged/tioMat/' ]

% plot using pcolor
figure(1)
clf
subplot(3,1,1)
load ( [ datadir
'dt_ref_global_merged_msla_h_qd_19980107_19980107_20080107.mat'] )
%iflag = ssh(1,1)
iflag =  1.8e+19;
ssh(find(ssh>iflag)) = NaN;
pcolor(lon,lat,ssh);shading flat;colorbar
% overlay coastline
hold on
% load and plot coastline
toolsdir = ['/Users/leben/presentation/tools/'];
filename = [ toolsdir 'global_coastline.mat'];
load (filename)
plot(coastline(:,1),coastline(:,2),'r')
hold on
%axis([ 0 180 -60 60])
id_lat=find(lat==-10);
subplot(3,1,2)
plot(lon,ssh(id_lat,:))
```

Plot Bathymetry

```
% clear workspace
clear
clc
% load and plot bathymetry
% D:\presentation\tools\
toolsdir = ['/Users/leben/presentation/tools/'];
% toolsdir = ['D:\presentation\tools\'];
filename = [ toolsdir 'bath.25.xyz'];
data = load(filename);
lon = data(:,1);
lat = data(:,2);
bath = data(:,3);
ni = 1441;
nj = 489;
bath = flipud(reshape(bath,ni,nj)');
lon = flipud(reshape(lon,ni,nj)');
lon=lon(1,:);
lat = flipud(reshape(lat,ni,nj)');
lat=lat(:,1);
figure(1)
clf
pcolor(lon,lat,bath);shading flat;colorbar
save bath_1_4deg lon lat bath
title('Ocean Depth - Batymetry')
```

PLOTCOL

```
function handle = plotcol(x,y,z,c,linestyle);
% PLOTCOL generates a line plot that uses the color map.
%
% PLOTCOL(X,Y,Z,C,LINESTYLE) plots a colored parametric
% line based on X, Y, Z, and C using the line style
% LINESTYLE. The color scaling is determined by the
% values of C or by the current setting of CAXIS. The
% scaled color values are used as indices into the
% current COLORMAP.
%
% Any combination of inputs can be used. If C is not
% given, it is assigned to Z, Y, or X, depending on the
% input. Below is a table which describes this:
%
% GIVEN VALUE OF C
% X,Y,Z Z
% X,Y Y
% X X
%
% SEE ALSO: mesh

if nargin == 0;error('Requires at least one input');end

% Determine which inputs were given:
if nargin == 1; % 2-D plot, X given.
  % Make all inputs into row vectors
  x = x(:)';
  [m,n] = size(x);
  y = [x;x];
  x = [1:n;1:n];
  z = zeros(2,n);
  c = y;

elseif nargin == 2; % 2-D plot, X and Y, C,
            %or LINESTYLE are given
  x = x(:)';
  [m,n] = size(x);
  z = zeros(2,n);

  if isstr(y) % X and LINESTYLE given.
    y = [x;x];
    x = [1:n,1:n];

  else % X and Y given.
    y = y(:)';
    y = [y;y];
  end

  c = y;

elseif nargin == 3; % X, Y, and Z, or
            %LINESTYLE given.
  x = x(:)';
  y = y(:)';
  [m,n] = size(x);
```

```
  x = [x;x];
  y = [y;y];

  if ~isstr(z) % X, Y, and Z given
    z = z(:)';
    z = [z;z];
    c = z;


  else % X, Y, and LINESTYLE
       % given
    linestyle = z;
    z = zeros(2,n);
    c = y;
  end

elseif nargin == 4 % X, Y, and Z, C, or
                   % LINESTYLE given.
  x = x(:)';
  y = y(:)';
  [m,n] = size(x);
  x = [x;x];
  y = [y;y];

  if isstr(c) % 2-D plot with X, Y,
              % C, and LINESTYLE
    linestyle = c;
    c = z;
    z = zeros(2,n);

  else % 3-D plot with X, Y,
       % Z, and C or LINESTYLE
    z = z(:)';
    c = c(:)';
    z = [z;z];
    c = [c;c];
  end

elseif nargin == 5 % Everything given.
  x = x(:)';
  y = y(:)';
  z = z(:)';
  c = c(:)';
  [m,n] = size(x);
  x = [x;x];
  y = [y;y];
  z = [z;z];
  c = [c;c];

end
h = mesh(x,y,z,c,'LineStyle',['none'],'Marker','o','MarkerSize',[2]);
% h = mesh(x,y,z,c,'LineWidth',[3]);
if all(z == 0), view(2), end

if nargout == 1
  handle = h;
end

view(2);
```

Sample Filename Loop Over Recon Dataset

```
% sample filename loop over recon dataset
clear;clc
% loop to load data and calculate mean
datadir = [ '/Users/leben/presentation/data/ReconSeaLevel/'];
n = 0
for iyear = 1951:2008
%for iyear = 1951:1951
    for iweek=1:52
        n = n + 1
        year(n) = iyear + (iweek-1)/52;
        if iweek < 10
           yr_week = [int2str(iyear) 'wk0' int2str(iweek)]
        else
           yr_week = [int2str(iyear) 'wk' int2str(iweek)]
        end
        % filename
        filename = [ 'reconsl' yr_week '.mat'];
        load([ datadir filename]);
        mean_ssh(n) = mean(mean(reconsl(~isnan(reconsl))));
    end
end
figure(1);clf
subplot(3,1,1);plot(year,mean_ssh)
subplot(3,1,2);plot(year,mean_ssh);axis([1973 1974 -5 5])
```

Make Movie

```
% make movie of year 1973
clear;clc
% using reconstructed sea levelmovie
datadir = [ '/Users/leben/presentation/data/ReconSeaLevel/'];
figure(1);clf
n=0
for iyear = 1951:1960
    for iweek=1:4:52
        n = n + 1
        year(n) = iyear + (iweek-1)/52;
        if iweek < 10
           yr_week = [int2str(iyear) 'wk0' int2str(iweek)]
        else
           yr_week = [int2str(iyear) 'wk' int2str(iweek)]
        end
        % filename
        filename = [ 'reconsl' yr_week '.mat'];
        load([ datadir filename]);
        pcolor(lon,lat,reconsl);shading flat; colorbar; caxis([-30 30])
        text(116,-22,['Year: ' int2str(iyear)])
        text(116,-24,['Week #' int2str(iweek)])
        title(['\bf CCAR Reconstructed Sea Level'])
        M(n) = getframe;
    end
end
movie2avi(M,'CCAR_RSL_Movie')
%movie(M)
```

Circle

```
function H=circle(center,radius,NOP,style)
%-------------------------------------------------------------------------
----------------------
% H=CIRCLE(CENTER,RADIUS,NOP,STYLE)
% This routine draws a circle with center defined as
% a vector CENTER, radius as a scaler RADIS. NOP is
% the number of points on the circle. As to STYLE,
% use it the same way as you use the rountine PLOT.
% Since the handle of the object is returned, you
% use routine SET to get the best result.
%
%   Usage Examples,
%
%   circle([1,3],3,1000,':');
%   circle([2,4],2,1000,'--');
%
%-------------------------------------------------------------------------
----------------------

if (nargin <3),
 error('Please see help for INPUT DATA.');
elseif (nargin==3)
    style='b-';
end;
THETA=linspace(0,2*pi,NOP);
RHO=ones(1,NOP)*radius;
[X,Y] = pol2cart(THETA,RHO);
X=X+center(1);
Y=Y+center(2);
H=plot(X,Y,'color',style);
axis square;
```

Cycle STR

```
function [ cycstr ] = cycle_str( cycle )
%CYCLE_STR Adds zero pad to cycle string

if(cycle < 10)
    cycstr = [ '00' num2str(cycle) ];
elseif(cycle < 100)
    cycstr = [ '0' num2str(cycle) ];
else
    cycstr = [ int2str(cycle) ];
end

end
```

GetPassThroughROI

```
function [passStart passEnd passNum] = ...
    getPassThroughROI( refLon, refLat, ROIcen, ROIrad, ...
                       timeStepSample, passPerCycle, ...
                       plotit )

% [passStart passEnd passNum] =
%     getPassThroughROI( refLon, refLat, ROIcen, ROIrad, ...
%                        timeStepSample, passPerCycle, ...
%                        plotit )
%
% Function to find passes that go through a cicular region of interest
%
% Inputs:
%   refLon = longitude of reference track (must be for a full cycle)
%   refLat = lattitude of reference track (must be for a full cycle)
%   ROIcen = point of interest [lon lat]
%   ROIrad = radius around point of interest to include
%   timeStepSample = time step per sample
%   passPerCycle = number of passes per cycle
%   plotit = plot the result [1] or not [0]
%
% Outputs:
%   passStart = array of start times of the passes that enter the ROI
%   passEnd   = array of end times of the passes that enter/leave the
ROI
%   passNum   = array of pass numbers that enter the ROI


if( nargin ~= 7 || nargout ~= 3 )
    disp( 'Incorrect Usage:' )
    disp( ['[passStart passEnd passNum] = ' ...
           'getPassThroughROI( refLon, refLat, ROIcen, ROIrad, '...
           'timeStepSample, passPerCycle, '...
           'plotit'] )
    error( 'See above' )
end

samplePerCycle = length( refLon );

refTime = [1:1:samplePerCycle]*timeStepSample;

secondsPerPass = refTime(end) / passPerCycle;

idx = find( (refLon-ROIcen(1)).^2 + (refLat-ROIcen(2)).^2 ...
            <= ROIrad^2 );

goodTime       = refTime(idx);
goodTimeDiff   = diff(goodTime);
goodTimeDiffBk = find( goodTimeDiff > timeStepSample );

if( ~isempty( idx ) )
    numPasses = length(goodTimeDiffBk) + 1;
else
    numPasses = 0;
end
```

```
goodTimeDiffBk = [0 goodTimeDiffBk length(goodTime)];

passStart = [];
passEnd   = [];
passNum   = [];

if( plotit ~= 0 )
    figId = figure;
    plot( refLon, refLat, '.' )
    hold on
    circle( ROIcen, ROIrad, 1000, 'r' );
end

if( numPasses < 1 )
   disp( 'Did not find any passes going through the area of interest' )
else
    for ii=1:numPasses
        passStart(ii) = goodTime(goodTimeDiffBk(ii)+1);
        passEnd(ii)   = goodTime(goodTimeDiffBk(ii+1));
        passNum(ii)   = floor( passStart(ii) / secondsPerPass ) + 1;

        if( plotit ~= 0 )
            plot( refLon(passStart(ii):passEnd(ii)), ...
                refLat(passStart(ii):passEnd(ii)), 'g.');
        end
    end
end

end
```

Plot Tide Guage

```
clear all

% Include tide guages that have data past this year
year = 2005;

% tide gauge data file
gaugeFile = '../data/TideGauge/indonesiatg_edit.mat';

% Search radius (deg) around tide gauges. This will find reference
ground
% tracks that pass within this distance from each TG.
TGrad = 2;

% Load the reference ground track from ascii (0) or mat file (1)
asciiOrMat = 1;

% Load the reference ground track (deg)
if( asciiOrMat == 0 )
    refTrack = '../groundtracks/topex_latlon.ascii';
    temp = load( refTrack );

    refLon = temp(:,1);
    refLat = temp(:,2);
else
    refTrack = '../groundtracks/topex_latlon.mat';

    temp = load( refTrack );
    refLon = temp.lon;
    refLat = temp.lat;
end

% Time step per sample of the ref. ground track data
timeStepSample = 1;

% number of passes per cycle
passPerCycle = 254;

% Coastline file
coastFile = 'global_coastline.mat';
load( coastFile )
idx = find( coastline(:,1) < 0 );
coastline(idx,1) = coastline(idx,1)+360;

% ----------------------------------------------------------------------
--
% Load the tide gauges and find which ones have data past the given year
gaugeData = load( gaugeFile );

idx = find( gaugeData.time > year );

temp = ~isnan( gaugeData.sltg(idx,:) );

count = 1;
for ii=1:length(gaugeData.lat)
   if( ~isempty( find(temp(:,ii) == 1) ) )
```

```
        goodTGData(count) = ii;
        count = count + 1;
    end
end

% Plot the TG data
figure
plot( gaugeData.time(idx), gaugeData.sltg(idx,goodTGData) )

% Plot the TG locations on the earth
markerList = {'x' '+' '*' 's' 'd' 'v' '^' '<' '>'};

if( length(goodTGData) < 8 )
    numColors = 8;
else
    numColors = goodTGData + 1;
end

colorList  = hsv( numColors );

plotCnt = 1;
plotH = [];
plotM = {};

figId = figure;
plotH(plotCnt) = plot( coastline(:,1), coastline(:,2), ...
                       'k.', 'markersize', 4 );
plotM{plotCnt} = 'Coastline';
plotCnt = plotCnt + 1;
hold on
grid on

for ii=1:length(goodTGData)
    marker = markerList{ mod( plotCnt-2, length(markerList) ) + 1 };

    plotH(plotCnt) = plot( gaugeData.lon(goodTGData(ii)), ...
                           gaugeData.lat(goodTGData(ii)), ...
                           [marker], 'color', colorList(plotCnt-1,:));
    plotM{plotCnt} = ['TG IDX ' num2str(goodTGData(ii))];
    plotCnt = plotCnt + 1;
end

% -----------------------------------------------------------------------
--
% Find ref. ground tracks that pass near the TG

totalPassStart = [];
totalPassEnd   = [];
totalPassNum   = [];

for ii=1:length(goodTGData)

    ROIcen = [gaugeData.lon(goodTGData(ii))
gaugeData.lat(goodTGData(ii))];

    [passStart passEnd passNum] = ...
        getPassThroughROI( refLon, refLat, ROIcen, TGrad, ...
                           timeStepSample, passPerCycle, ...
                           0 );
```

```
    totalPassStart = [totalPassStart passStart];
    totalPassEnd   = [totalPassEnd passEnd];
    totalPassNum   = [totalPassNum passNum];

    circle( ROIcen, TGrad, 1000, ...
            colorList(plotCnt+ii-2-length(goodTGData),:) );

end

if( length(totalPassNum) < 8 )
    numColors2 = 8;
else
    numColors2 = length(totalPassNum) + 1;
end

colorList2  = hsv( numColors2 );

for jj=1:length(totalPassNum)
    plotH(plotCnt) = ...
        plot( refLon( totalPassStart(jj):totalPassEnd(jj) ), ...
              refLat( totalPassStart(jj):totalPassEnd(jj) ), ...
              'color', colorList2(jj,:) );
    plotM{plotCnt} = ['Pass ' num2str(totalPassNum(jj)) ];
    plotCnt = plotCnt + 1;
end

figure( figId )
legend( plotH, plotM )
axis normal
axis( [90 120 -15 15] )
```

Plot Track

```
clear all
%close all

% Load the reference ground track from ascii (0) or mat file (1)
asciiOrMat = 1;

% Start and stop times (assumes the cycle start time is 0)
timeStart = 375000;
timeStop  = 395000;

% Seconds per cycle
cycleTime = 856710;

% Start and end cycles to plot
cycleStart = 50;
cycleEnd   = 60;

% File with the approximate start cycle times (in time since 1/1/2000)
cycleTimes = 'cycleTimesOSTM.txt';

% Data location
rawDataFolder = '../data/OSTM/raw/';

% Coastline file
coastFile = 'global_coastline.mat';

% Marker size for the plotted data
markersize = 4;

% Load the reference ground track (deg)
if( asciiOrMat == 0 )
    refTrack = '../groundtracks/topex_latlon.ascii';
    temp = load( refTrack );

    refLon = temp(:,1);
    refLat = temp(:,2);
else
    refTrack = '../groundtracks/topex_latlon.mat';

    temp = load( refTrack );
    refLon = temp.lon;
    refLat = temp.lat;
end

clear temp

% Build the refernce track time (note the ref. track is 1Hz)
refTime = 0:1:cycleTime;

% Trim the refernce track to be within the start and end cycle times
timeIdx = find( refTime >= timeStart & refTime <= timeStop );
refTime = refTime(timeIdx);
refLon  = refLon(timeIdx);
refLat  = refLat(timeIdx);
```

```
% Load the start cycle times
cycleTime = load( cycleTimes );

% Generate some color map stuff. Remove blue from the mix b/c the
reference
% groundtrack is plotted in blue
if( cycleEnd - cycleStart < 8 )
    numColors = 8;
else
    numColors = cycleEnd - cycleStart + 1;
end

temp = hsv( numColors + 1);

colorCount = 1;
for count=1:size(temp,1);
    if( ~isequal( temp(count,:), [0 0 1] ) )
        colorList( colorCount, : ) = temp(count,:);
        colorCount = colorCount + 1;
    end
end

markerList = {'x' '+' '*' 's' 'd' 'v' '^' '<' '>'};

plotCnt = 1;
plotH = [];
plotM = {};

% load the coastline data
load( coastFile )
idx = find( coastline(:,1) < 0 );
coastline(idx,1) = coastline(idx,1)+360;

% Plot the crude world map and reference track
figId = figure;
plotH(plotCnt) = plot( coastline(:,1), coastline(:,2), ...
                       'k.', 'markersize', 3 );
plotM{plotCnt} = 'Coastline';
plotCnt = plotCnt + 1;
hold on
grid on

plotH(plotCnt) = plot( refLon, refLat, 'b--o', 'markersize', markersize
);
plotM{plotCnt} = 'Ref Track';
plotCnt = plotCnt + 1;

xlabel( 'Longitude (deg)' )
ylabel( 'Latitude (deg)' )

for cycle=cycleStart:cycleEnd
    % format the cycle string
    cycleString = ['c' cycle_str(cycle)];

    rawCombinedFileName = [ rawDataFolder cycleString '.bin'];

    % Get the data for this cycle (note it is little-endian format)
    rawFile = fopen(rawCombinedFileName, 'r', 'l' );
    data = fread( rawFile, inf, 'int32' );
```

```
    fclose( rawFile );

    % Note the time stamp of the data is seconds past 1/1/1985
    data = reshape( data, 4, length(data)/4 );
    time = data(1,:);
    lat  = data(2,:) / 1e6; % convert mDeg -> deg
    lon  = data(3,:) / 1e6; % convert mDeg -> deg
    ssha = data(4,:) / 10;  % convert mm -> cm

    % Find the approx start time of this cycle in time since 1/1/2000
    % and convert it to time since 1/1/1985
    idx = find( cycleTime(:,1) == cycle );

    cycleStartTime = cycleTime(idx,2) + 473299200;

    % Convert the time data to time past the start of the cycle
    time = time - cycleStartTime;

    timeIdx = find( time >= timeStart & time <= timeStop );


    lat  = lat( timeIdx );
    lon  = lon( timeIdx );
    ssha = ssha( timeIdx );

    marker = markerList{ mod( plotCnt-2, length(markerList) ) + 1 };

    figure( figId )
    plotH(plotCnt) = plot( lon, lat, [marker], ...
                           'markersize', markersize, ...
                           'color', colorList(plotCnt-2,:) );
    plotM{plotCnt} = ['Cycle ' num2str(cycle)];
    plotCnt = plotCnt + 1;

end

figure( figId )
legend( plotH, plotM )

% save the figure temporarily so we can load another copy
saveas( figId, 'temp.fig' );
open( 'temp.fig' )
axis( [89.6549   89.7651    0.6643    0.980] )
```

Ground Tracks

(Get Latitude Longitude)

```
clear all

tol = eps;

sat = 'nvs';

%fid = fopen( [sat '.latlon'], 'r', 'b' );
%data = fread(fid, inf, 'int32');
%fclose(fid);

%data = reshape( data, 2, length(data)/2 );

%lon = data(2,:)' / 1e6;
%lat = data(1,:)' / 1e6;

%--------------------------------------------
fid = fopen( [sat '.lon'], 'r', 'b' );
lon2 = fread(fid, inf, 'int32');
fclose(fid);

fid = fopen( [sat '.lat'], 'r', 'b' );
lat2 = fread(fid, inf, 'int32');
fclose(fid);

lon2 = lon2 / 1e6;
lat2 = lat2 / 1e6;

lon = lon2;
lat = lat2;

if( ~isempty( find( lat ~= lat2, 1 ) ) )
    disp( 'Lats diff' )
end

if( ~isempty( find( lon ~= lon2, 1 ) ) )
    disp( 'Lons diff' )
end

% Write out to ascii

data = [lon lat];
fid = fopen( [sat '_latlon.ascii'], 'w+' );

fprintf( fid, '%.8e   %.8e\n', data' );
fclose(fid);

% Write out to mat
save( [sat '_latlon.mat'], 'lat', 'lon', '-v7.3' )


% ---------------- CHECK
```

```
origLat = lat;
origLon = lon;

load( [sat '_latlon.mat'] )

if( ~isempty( find( origLat ~= lat, 1 ) ) )
    disp( 'MAT Lats diff' )
end

if( ~isempty( find( origLon ~= lon, 1 ) ) )
    disp( 'MAT Lons diff' )
end

data = load( [sat '_latlon.ascii'] );
lon2 = data(:,1);
lat2 = data(:,2);

if( ~isempty( find( abs( origLat - lat2 ) > tol, 1 ) ) )
    disp( 'ASCII Lats diff' )
end

if( ~isempty( find( abs( origLon - lon2 ) > tol, 1 ) ) )
    disp( 'ASCII Lons diff' )
end

% -------------
figure
plot(origLon,origLat,'.')
hold on
plot(lon,lat,'ro')
plot(lon2, lat2, 'g+')


return
```

EOF Analysis

```
clear; clc
load sealeveldata
%insert data - should be a lat x lon x time matrix
data = sldata;

errval = 998;
%Data Processing
I = [];
J = [];
timedim = 76;
data2 = zeros(64000,timedim);
obvmat = zeros(64000,timedim);
k = 1;

for i = 1:360
    for j = 1:180
        datawin = data(i,j,:);
        m = find((datawin) ~= errval);

        if length(m) > timedim/2
            I = [I;i];
            J = [J;j];
            d = reshape(datawin,timedim,1);
            obvmat(k,:) = d;
            k = k+1;
        end
    end
end

m = find(obvmat(:,1) == 0);
obvmat = obvmat(1:m(2)-1,:);

x = 1:timedim;

data3 = zeros(size(obvmat,1),timedim);
for i = 1:size(obvmat,1)
    c2 = obvmat(i,:);
    m1 = find(c2 == errval);
    m2 = find(c2 ~= errval);
    c2(m1) = interp1(x(m2),c2(m2),x(m1),'linear','extrap');
    data3(i,:) = c2;
end

%Center Data
H = eye(size(x',1)) -
(1/(size(x',1))*(ones(size(x',1),1))*(ones(size(x',1),1))');

HQ = H*data3';

[U,S,V] = svd(HQ,'econ');

V1 = V*S;

for i = 1:size(V,2)
Vmean(i) = nanmean(V1(:,i));
end
%Form temporal EOFs with physical units
```

```
for j = 1:size(U)
    Udata(:,j) = U(:,j)*Vmean(j);
end

Vmap = zeros(360,180);

%Reconstruct map, n corresponds to EOF #
n = 1;

for i = 1:size(obvmat,1)
    Vmap(I(i),J(i)) = V1(i,n)/mean(Vmean(n));
end

m = find(Vmap == 0);
Vmap(m) = NaN;
pcolor(lon,lat,Vmap')
title('EOF #1')
colorbar

shading interp

%Percent variance in each mode
Sperc = 100*diag(S).^2/sum(diag(S).^2);
```

Indian Oocean Dipole

1. calcIODipole

```
clear all

% calculate the indian ocean dipole mode index. DMI is the mean of the
% ssh in ROI1 minus the mean of the ssh in ROI2.

% Box 1, deg E and N
ROI1 = [50 70 -10 10];
ROI2 = [90 110 -10 0];

% bathymetry file and depth to trim
bathFile  = '../../tools/bath.5.grd';
bathDepth = 500; % meters

% Flagged value and comparison tolerance
flagged   = double( intmax('uint64') );
tolerance = 1;

% load the bath data and generate to sets covering the regions of
interest
fid = netcdf.open( bathFile, 'noclobber' );

bathLon  = netcdf.getVar( fid, 0 );
bathLat  = netcdf.getVar( fid, 1 );
bathData = double(netcdf.getVar( fid, 2 ));

bathData( bathData <  bathDepth ) = NaN;
bathData( bathData >= bathDepth ) = 1;

% Region 1
idxLon = find( bathLon >= ROI1(1) & bathLon <= ROI1(2) );
idxLat = find( bathLat >= ROI1(3) & bathLat <= ROI1(4) );

bathLon1  = bathLon( idxLon );
bathLat1  = bathLat( idxLat );
bathData1 = bathData( idxLon, idxLat )';

% Region 2
idxLon = find( bathLon >= ROI2(1) & bathLon <= ROI2(2) );
idxLat = find( bathLat >= ROI2(3) & bathLat <= ROI2(4) );

bathLon2  = bathLon( idxLon );
bathLat2  = bathLat( idxLat );
bathData2 = bathData( idxLon, idxLat )';

% ---------------------------------------------------------------------
--
n=0
fileList = dir( pwd );

for fileCount=1:length(fileList)
    % Find only files with .nc extension
    if( fileList(fileCount).isdir ~= 1 ...
            && ~isempty( strfind( fileList(fileCount).name, '.mat' )) )
```

```
        clear lat lon reconsl
        load( fileList( fileCount ).name );

        % Get box 1
        idxLon = find( lon >= ROI1(1) & lon <= ROI1(2) );
        idxLat = find( lat >= ROI1(3) & lat <= ROI1(4) );

        r1Lon = lon( idxLon );
        r1Lat = lat( idxLat );
        r1Ssh = reconsl( idxLat, idxLon );

        r1Ssh = r1Ssh .* bathData1;

        % Get box 2
        idxLon = find( lon >= ROI2(1) & lon <= ROI2(2) );
        idxLat = find( lat >= ROI2(3) & lat <= ROI2(4) );

        r2Lon = lon( idxLon );
        r2Lat = lat( idxLat );
        r2Ssh = reconsl( idxLat, idxLon );

        r2Ssh = r2Ssh .* bathData2;

        if( 0 )
            figure
            pcolor( r1Lon, r1Lat, r1Ssh )
            shading flat
            colorbar
            hold on
            pcolor( r2Lon, r2Lat, r2Ssh )
            shading flat
            axis( [40 110 -15 15] )
        end

        % Find the average ssh in each box after removing flagged and
NaN
        % data
        if( ~isempty( find( abs( r1Ssh - flagged ) < tolerance, 1 ) ) ||
...
            ~isempty( find( abs( r2Ssh - flagged ) < tolerance, 1 ) ) )
            disp( ' ' )
            disp( 'Flagged data in:' )
            disp( fileList( fileCount ).name )
        end

        r1Ssh  = reshape( r1Ssh, size(r1Ssh,1)*size(r1Ssh,2), 1 );
        r1Ssh  = r1Ssh( abs( r1Ssh - flagged ) > tolerance );
        r1Ssh  = r1Ssh( isnan( r1Ssh ) ~= 1 );
        r1Mean = mean(r1Ssh);

        r2Ssh  = reshape( r2Ssh, size(r2Ssh,1)*size(r2Ssh,2), 1 );
        r2Ssh  = r2Ssh( abs( r2Ssh - flagged ) > tolerance );
        r2Ssh  = r2Ssh( isnan( r2Ssh ) ~= 1 );
        r2Mean = mean(r2Ssh);

        DMI = r1Mean-r2Mean;
        n=n+1
dmi(n) = DMI;
```

```
year(n) = 1950+(n    +27-1)/52;

        disp( ' ' )
        disp( fileList( fileCount ).name )
        disp( ['R1:R2:DMI ' num2str(r1Mean) ' : ' num2str(r2Mean) ...
               ' : ' num2str(DMI)] )

%        save( fileList( fileCount ).name, 'lat', 'lon', 'reconsl',
'DMI' );
    end
end
save IOD dmi year
```

2. Plot IOD

```
clear
load IOD
figure(1)
clf
subplot(3,1,1)
plot(year,dmi,'LineWidth',[2])
title('\bf Raw dipole region differences')
% now remove climatological mean
% trim points before 1951
id = find(year==1951);
start = id(end)
id = find(year==2009);
stop = id(1)
year= year(start:stop-1);
dmi = dmi(start:stop-1);
dmi = reshape(dmi,52,58);
dmi_clim = mean(dmi');
subplot(3,1,2)
plot(dmi_clim,'LineWidth',[2])
axis tight
title('\bf Weekly Climatological Values (1951-2008)')

% remove climatological values from dmi
for i=1:58
    for iweek=1:52
    dmi(iweek,i) = dmi(iweek,i)-dmi_clim(iweek);
    end
end
subplot(3,1,3)
dmi = reshape(dmi,58*52,1);
plot(year,dmi,'LineWidth',[2])
title('\bf Dipole Mode Index (DMI)')
orient 'landscape'
print -depsc2 bobo1
figure(2)
subplot(2,1,1)
dmi = reshape(dmi,58*52,1);
plot(year,dmi,'LineWidth',[2])
grid on
title('\bf Dipole Mode Index (DMI)')
print -depsc2 bobo2
```

INSTRUCTOR:

Name : Dr. Robert R. Leben

Email : leben@colorado.edu

Telp. : (303) 492-3105

Office : Colorado Center for Astrodynamics Research Center, Colorado University, Boulder. USA.
ECNT 320, 431 UCB
University of Colorado
Boulder, CO 80309-0431