KUnami Interface

KUnami Interface
For Tsunami Wave Height Prediction
Based on Comcot Model
For
Arabian Gulf, Gulf of Oman and Arabian Sea

Developed by
Khaled Al-Salem
2015
www.hceatkuwait.net
Email: ksms001@gmail.com

Introduction

KUnami interface adopts the setup and organized the input data for simulation Comcot model for tsunami wave prediction that covered the Arabian Gulf, Gulf of Oman and Arabian Sea. Let's user to generate and presents the simulation output in 1D, 2D and 3D graphics; Also to generate 2D and 3D results animation by using the Surfer Software Utilities. . KUnami interface also linked to the internet system for public awareness through webside address (http://www.hceatkuwait.net/KUnami/kunami.aspx) and through smart mobile technology. Model were developed in (visual basic 6) were linked to Comcot model in (visual Fortran 90) and Surfer plotting Software using (GS Scripter program).And for internet webside coding were used (Active sever page) and for smart mobile technology coding were used Object-C++.

Comcot adopts finite difference schemes to solve Shallow Water Equations. A nested grid system, dynamically coupled up to four regions (which will be referred to as layers) with different grid resolution, is adopted in the model to fulfill the need for tsunami simulations in different scales. Nested grid system means in a region of one grid size, there is one or more regions with smaller grid sizes situated in, which eventually, forms a hierarchy of grids, or grid levels. The region with largest grid size is called 1st level grid and all the grid regions directly nested in the 1st level grid, are called 2nd level grids, so on and so forth. In one grid region, up to 4 sub-level grid regions can be defined. It should be noted that in one grid region, a uniform grid size is adopted in Comcot.

Surfer Software uses GS Scripter program is a basic-like interpreter that loads and executes scripts (also called macros). GS Scripter is automatically installed when you run the Golden Software Setup program. GS Scripter consists of two windows. The GS Scripter Edit window is a standard Windows ASCII text editor that allows you to open, create, edit and save ASCII text files. Scripts are executed from the GS Scripter Edit window. Scripts are text files created within GS Scripter, an Editor window, Windows Notepad, or any ASCII editor of your choice. When a script file is displayed in the GS Scripter Edit window, you can run the script. The operations specified in the script will be carried out. Scripts executed from the GS Scripter Edit window can contain commands necessary to automatically run the Surfer plotting program. .

Files required in KUnami Interface

KUnami main Interface files are included in this package which is:

1. **KUnami**

   KUnami is program developed using Visual basic 6.0 for main control of the interface to allow user to navigate between the model program options.

2. **Kudata**

   Kudata is program developed using Visual Fortran 90 for organizing the main data entry for the Comcot model.

3. **DepX**

   DepX program developed using Visual Basic 6.0 to generate 2D bathymetry interpolation for the sub grids system in Comcot model input data requirement (refined 2D grid system)

4. **FDep**

   FDep is program developed using Visual Fortran 90 for organizing the bathymetry files such as (Layer21-4, Layer31-4 and Layer41-4) in Comcot model main input.

5. **GEBCO**

   Software Interface allows the user to view and access data from GEBCO's gridded data sets of the digital bathymetry Atlas used in forming the sub grid systems.

6. **Sim**

   Sim program is developed using Visual Fortran 90 to run Comcot program from KUnami main interface.

7. **Comcot**

   Comcot is developed using Visual Fortran 90 for tsunami wave simulations and perdiction model.

8. **GSMAC32**

   GS Scripter program complier for Surfer Plotting software Utilities.

9. **KUnami2D**

   KUnami2D is developed using GS Scripter programing for generate a different type of plots and create images for animation. Plot can be 1D, 2D and 3D using Surfer software utilities routine.

Input Files required in KUnami Interface

1. Comcot.CLT

   Main Input data for Comcot model

2. layer01.DEP

   Main bathymetry data file for main grid system in Comcot model

3. layer01_x.DAT, layer01_y.DAT

   Location of main grid system in Longitude and Latitude Direction (degree)

If Sub grid system was activated in Comcot.clt data input, the following has to be included for the activated one

Layer21.DEP, Layer22.DEP, Layer23.DEP, Layer24.DEP

A bathymetry data file for Sub grid Level 2 from grid system in Comcot model

Layer31.DEP, Layer32.DEP, Layer33.DEP, Layer34.DEP

A bathymetry data file for Sub grid Level 3 from sub grid level 2 system in Comcot model

Layer41.DEP, Layer42.DEP, Layer43.DEP, Layer44.DEP

A bathymetry data file for Sub grid Level 4 from sub grid level 3 system in Comcot model

Input File used in GS Scripter programing for Graphic development from Surfer software files are:

1. AGcoast.BLN

   Input file for Coastal line of the main grid system

2. AGBLANK.BLN

   Input file for Blanking data uses in Surfer software

3. Gulf2d.DAT

   A Control input file for GS Scripter programing to generate Surfer plot

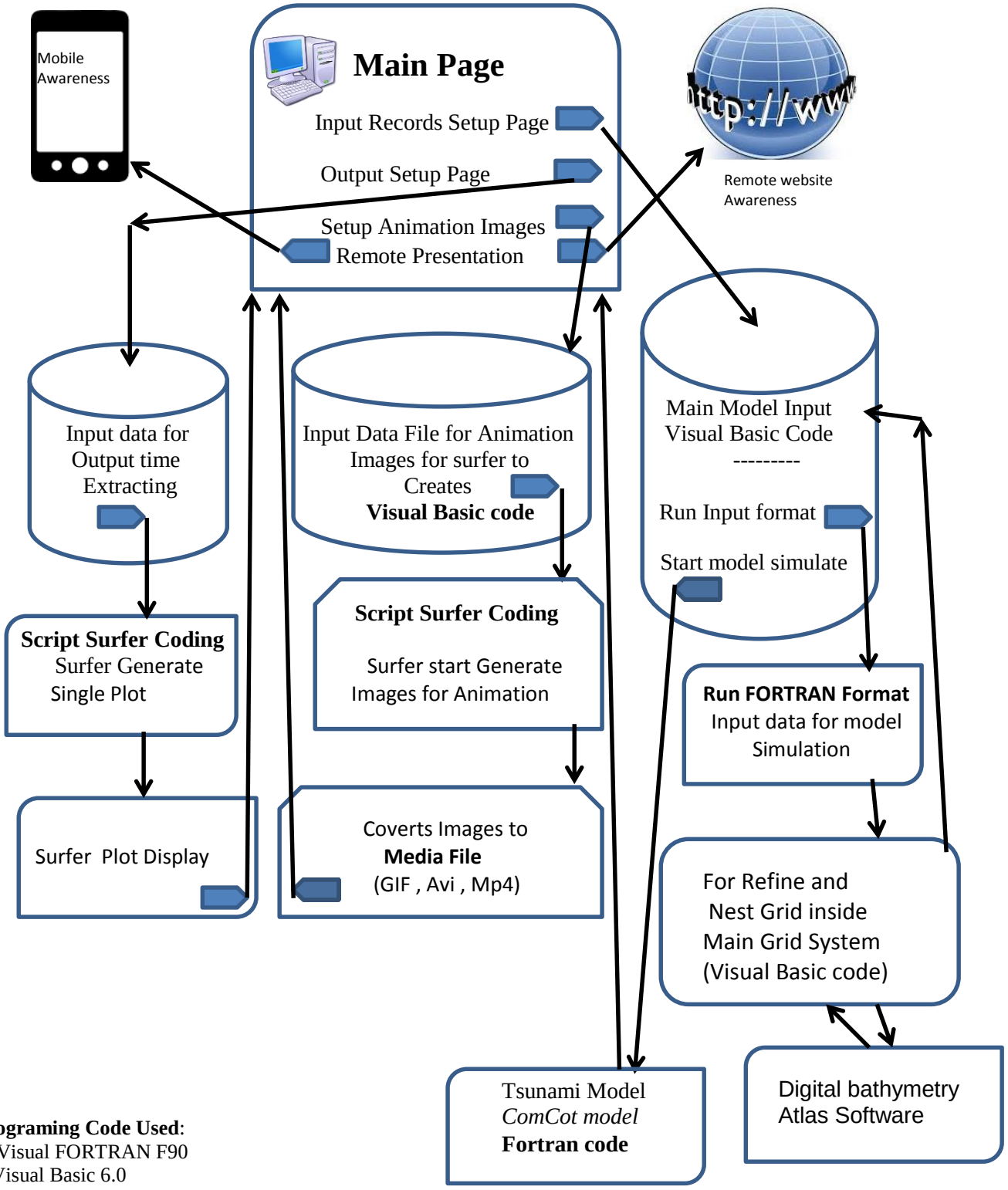
4. PLV0.LVL

   A File for control the contour level in 2D Surfer plot

5. col3d.CLR

   A File for control the contour level in 3D Surfer plot

Flow Chart Display for KUnami Interface



Programing Code Used:
1- Visual FORTRAN F90
2-Visual Basic 6.0
3- Script coding For Surfer Utility
4-Active Server Page for web coding
5-Objective-C for Mobile coding

Procedures for using of (The KUnami Interface)

KUnami interface is an efficient and easy-to-use data entry and model simulation. This version is sufficiently user-friendly and can provide the basic information of simulation for tsunami wave prediction. In this section of the report, step-by-step instructions are given for using the model interface.

The procedures outlined here consist of number of steps which can be summarized as:

The model can be run by select the icon ( ) .Figure 1, will display for the user.

User can select the option, which shows a number of selections as follows:

1- To start the new project by setup the input data for Comcot simulation model.

2-Start generate from selected output time step to form Surfer plot in 1D or line plot.

3- Start generate from selected output time step to form Surfer plot in 2D or 3D plot

4. Start generate from selected output time step to form a set on images for Surfer plot in 2D or 3D Animation

Figure 1. KUnami Interface model main page

New project option

If user select to start new project a number of procedure should follows as:

From figure 1 the project input check box should checked then the group option will display for user to start as:

1- The location of the earthquake in longitude and latitude textbox. To select the location user checkbox the ON/OFF as shown in Figure 1 should be activate. Then move the mouse over the Satellite map then click at select location or by enter the location manual then click on the button.

2- Load input Pages as shown in Figure 1.

A- To load the General input parameter is by check on the check box then Figure 2 will display for user to show the type of input data parameter.

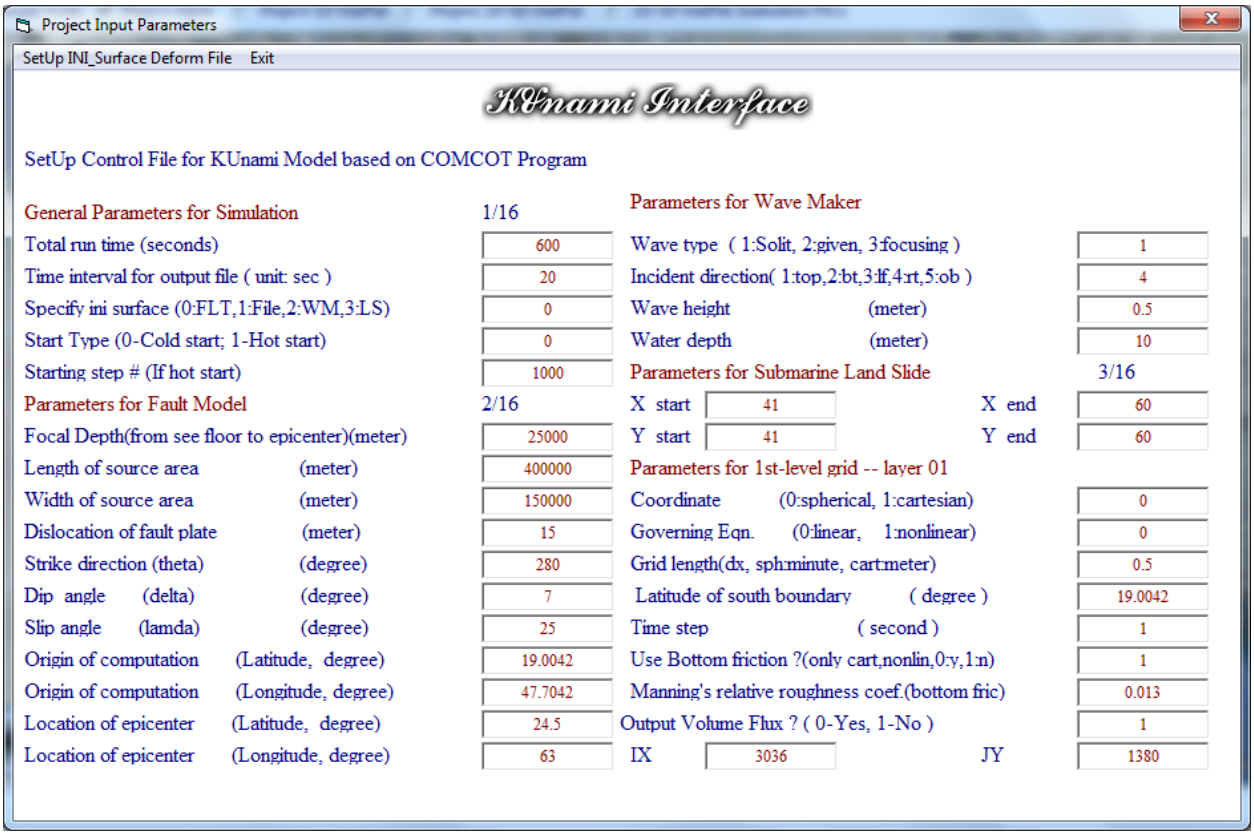


Figure 2. Project General Input Parameter

Figure 2 will show for user all earthquake data parameter and simulation time and time step. Also show the total grid dimension for the main system assign. Which cover all Arabian Gulf,

Gulf Of Oman and Arabian Sea with grid spacing 30 sec in DX/DY.
Then if user wants to simulate the Comcot model for Wave tsunami prediction for only the system main grid. User can select from Figure 1 **model Simulate** to start the model.

If user want to assign new refined grid inside main grid system user must follow these option as follows:
For level 2nd refined grid user have 4 section to assign as new bathymetry Layer (21, 22, 23 24) So user must select option checkbox (**Project for 2nd level grid**). Then Figure 3 will display for user.

- In Figure 3 there are 4 sub grid can be use. To Activate the the 2nd level layer is to check the corresponding checkbox.
- If Layer21 activated then go to Figure 1 and select two points on the map to form the refined grid domain. Then the same for the other layer 22,23,24.
- Then from Figure 3 user must select **Sub Grid Dimension** to generate the location index of the sub grid level 2 inside the main grid system and form the total sub grid with the assign ratio also to calculate the dx/dy for the sub grid as shown in Figure 3.

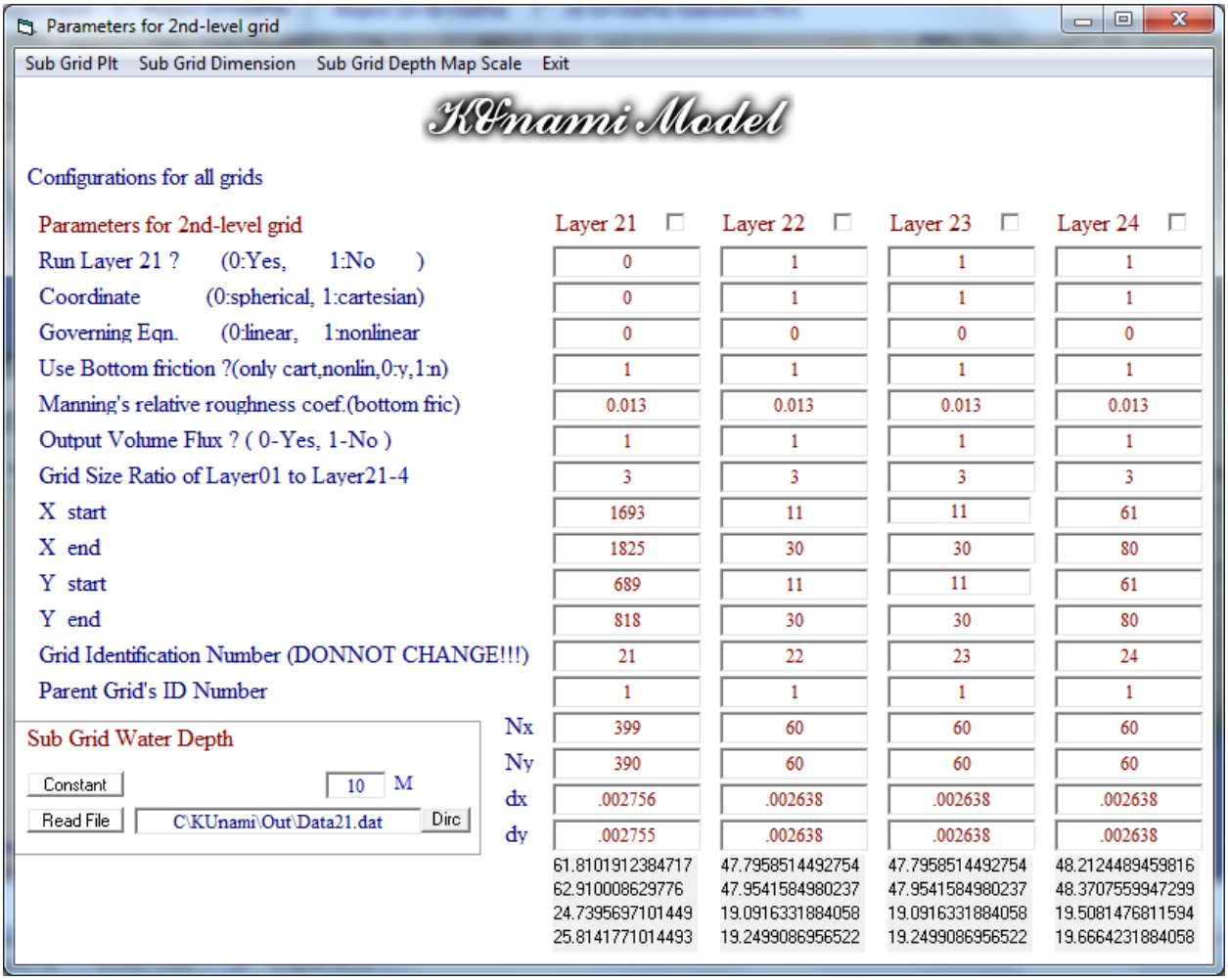


Figure 3. Project for 2nd Level Grid

- User must select **Sub Grid Depth Map scale** to store information for the 2D Bathymetry interpolate program for later based on the new sub domain of new (NX/NY) as shown in Figure 3.
- To show the new sub grid border line on the map in Figure 1 by selecting **Sub Grid Plt**.
- By default the border color of sub grid 2nd level is **RED**
- **There are two important number must user check which are**
    - **. Grid indication number must not change**
    - **. Parent Grid ID number if user in 2nd level, then the ID must be 1**

For level 3rd refined grid user have 4 section to assign as new bathymetry Layer (31, 32, 33 34) So user must select option checkbox (**Project for 3rd level grid**). Then Figure 4 will display for user.

- In Figure 4 there are 4 sub grid can be used. To activate the 3rd level layer is to check the corresponding checkbox.
- If Layer31 activated then go to Figure 1 and select two points on the map to form the refined grid domain. But make sure that user select the point inside the 2nd grid level as shown in Figure 6.
- When grid was selected the program generate the location index of the sub grid level 3 inside the 2nd level grid system and form the total sub grid with assign ratio also calculate the dx/dy for the sub grid as shown in Figure 4.
- To show the new sub grid border line on the map in Figure 1 by selecting **Sub Grid Plt**.
- By default the border color of sub grid 3rd level is **Green**
- **There are two important number must user check which are**
    - **. Grid indication number must no change**
    - **. Parent Grid ID number if user in 3rd level, then the ID must be 2#**
- In this section user can store the input for this grid level information by selecting from Figure 4 **Load/Save Info** . Input/output file information will display in Figure 4 to let user to store or load the grid information.
- Then user must select **Sub grid Depth Map Scale** to calculate sub grid information and store in inf3.dat for 2D bathymetry interpolation program, Will discuss later.

For level 4th refined grid user have 4 section to assign as new bathymetry Layer (41, 42, 43 44) So user must select option checkbox (**Project for 4th level grid**). Then Figure 5 will display for user.

- In Figure 5 there are 4 sub grid can be used. To Activate the 4th level layer is to check the corresponding checkbox.
- If Layer41 activated then go to Figure 1 and select two point on the map to form the refined grid domain. But make sure that user select the point inside the 3rd grid level as shown in Figure 6.
- When grid was selected the program generate the location index of the sub grid level 4 inside the 3rd level grid system and form the total sub grid with assign ratio also to calculate the dx/dy for the sub grid as shown in Figure 5.
- To show the new sub grid border line on the map in Figure 1 by selecting **Sub Grid Plt**.
- By default the border color of sub grid 3rd level is **Blue**
- **There are two important number must user check which are**

. Grid indication number must no change

. Parent Grid ID number if user in 4th level, then the ID must be 3#

- In this section user can store the input for this grid level information by selecting from Figure 5 **Load/Save Info** . Input/output file information will display in Figure 5 to let user to store or load the grid information.
- Then user must select **Sub grid Depth Map Scale** to calculate sub grid information and store in inf4.dat for 2D bathymetry interpolation program, Will discuss later.

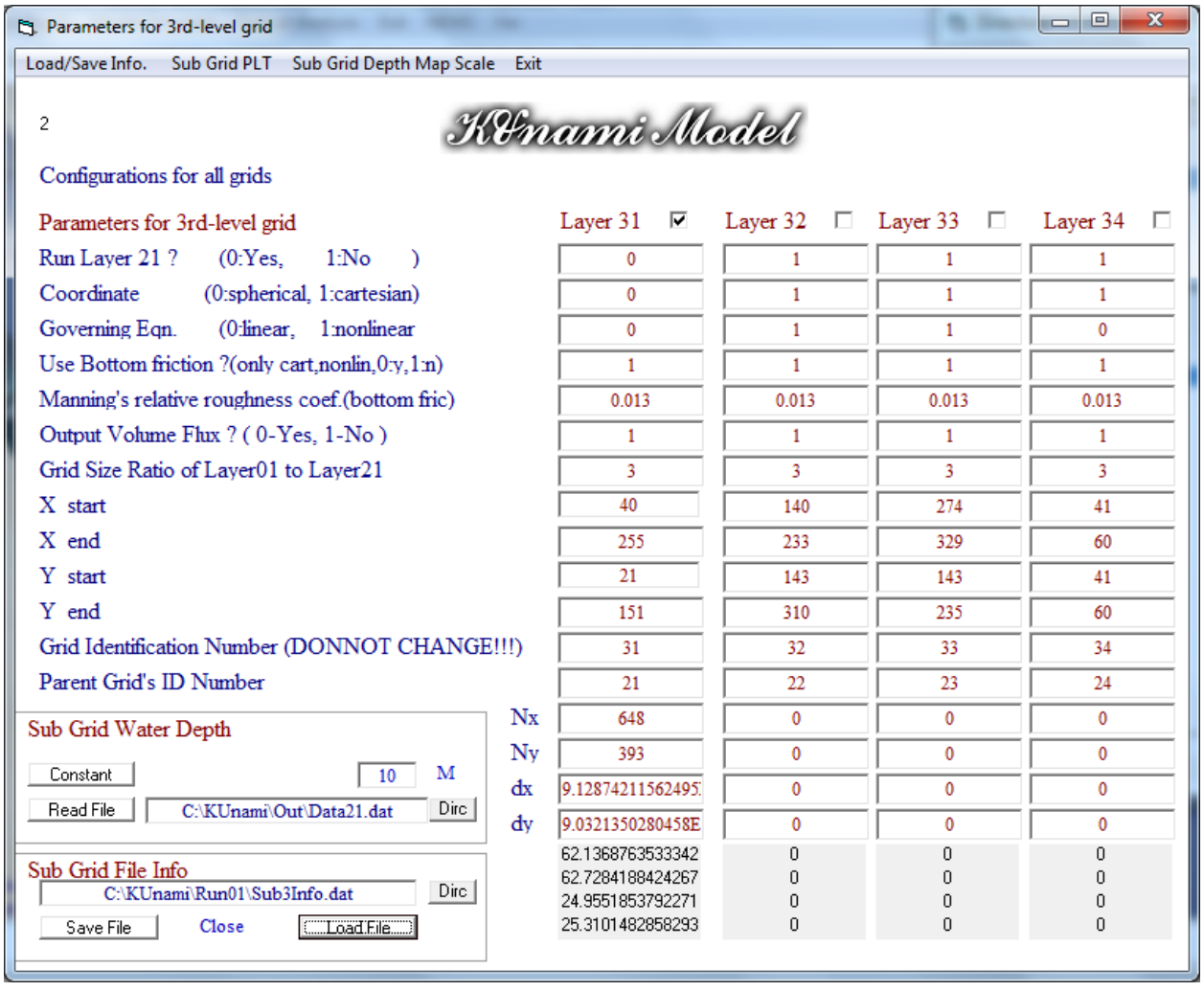


Figure 4. Project for 2rd Level Grid

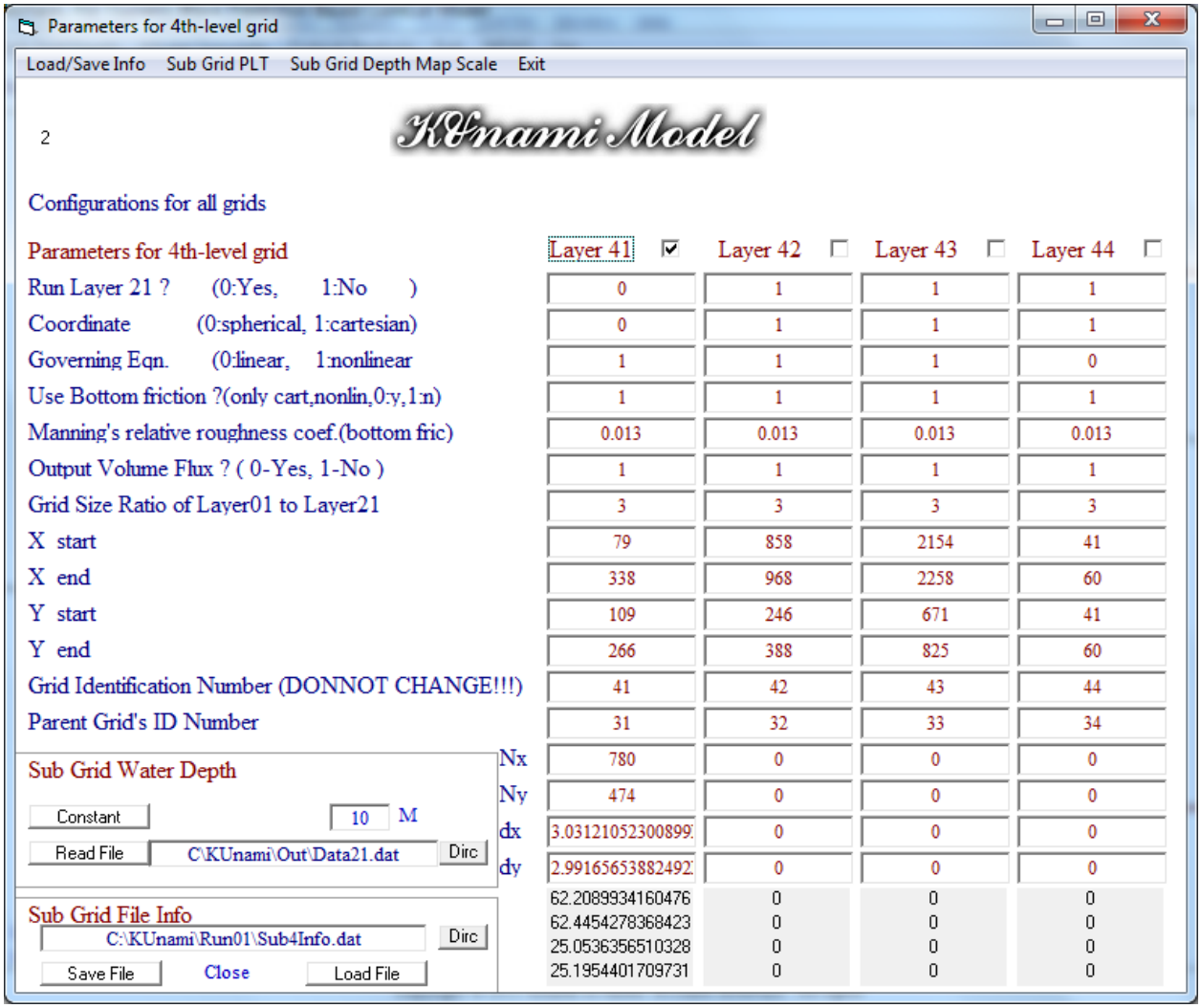


Figure 5. Project for 4th Level Grid

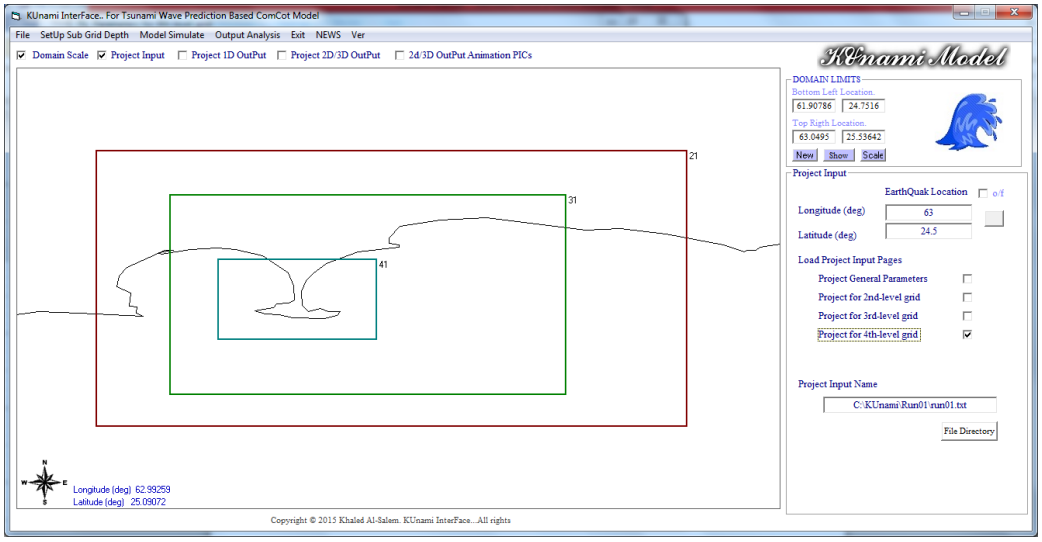


Figure 6. Project Sub Grid Level (21,31 and 41)

If user want to include the refined sub grid level inside the system main grid user must select **SetUp Sub Grid Depth** shown in Figure 6 to activate DEPX program for interpolation the 2D bathymetry layer file as shown in Figure 7. There is some step to generate the file as follows:

- User must select the Sub Grid File Info. These default file stored in OUT directory as (for Level 2nd file name inf2.dat and for level 3rd file name inf3.dat and for level 4th file name inf4.dat). Then select Button **Load File** as shown in Figure 7.
- Figure 7 display for user information for the sub grid data dimension and what be the dimension of the bathymetry file collected from Digital atlas bathymetry software as shown in following step.
- User must run **GEBCO program** to generate the bathymetry file by using the map scale shows in Figure 7 (X1,X2 Y1,Y2) as shown in Figure 8. Then the new row/col must match the rows/col in Figure 7.
- Then user must select the file name in **GEBCO Digital Atlas Bathymetry textbox** which just created from GEBCO program.
- Then assign the file layer level name in **Setup Bathymetry for sub grid 2,3 and 4** and corrected path. Then select **Start** to generate the 2D bathymetry interpolation.

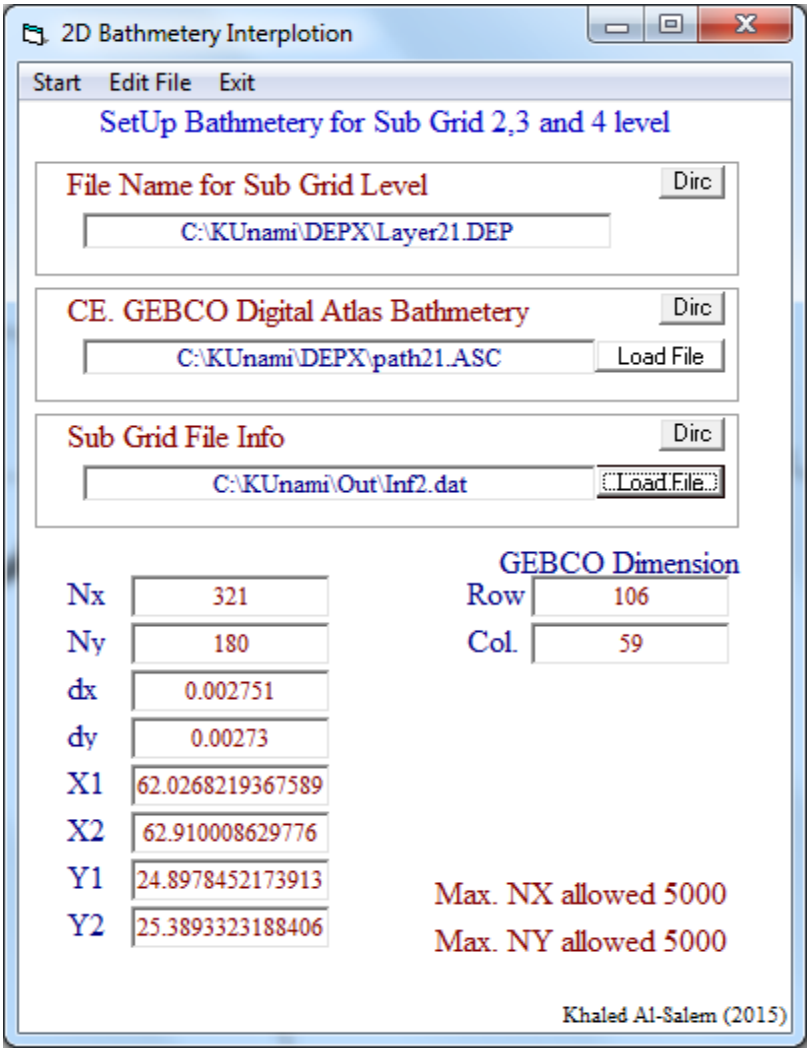


Figure 7. 2D Bathymetry Interpolation Page

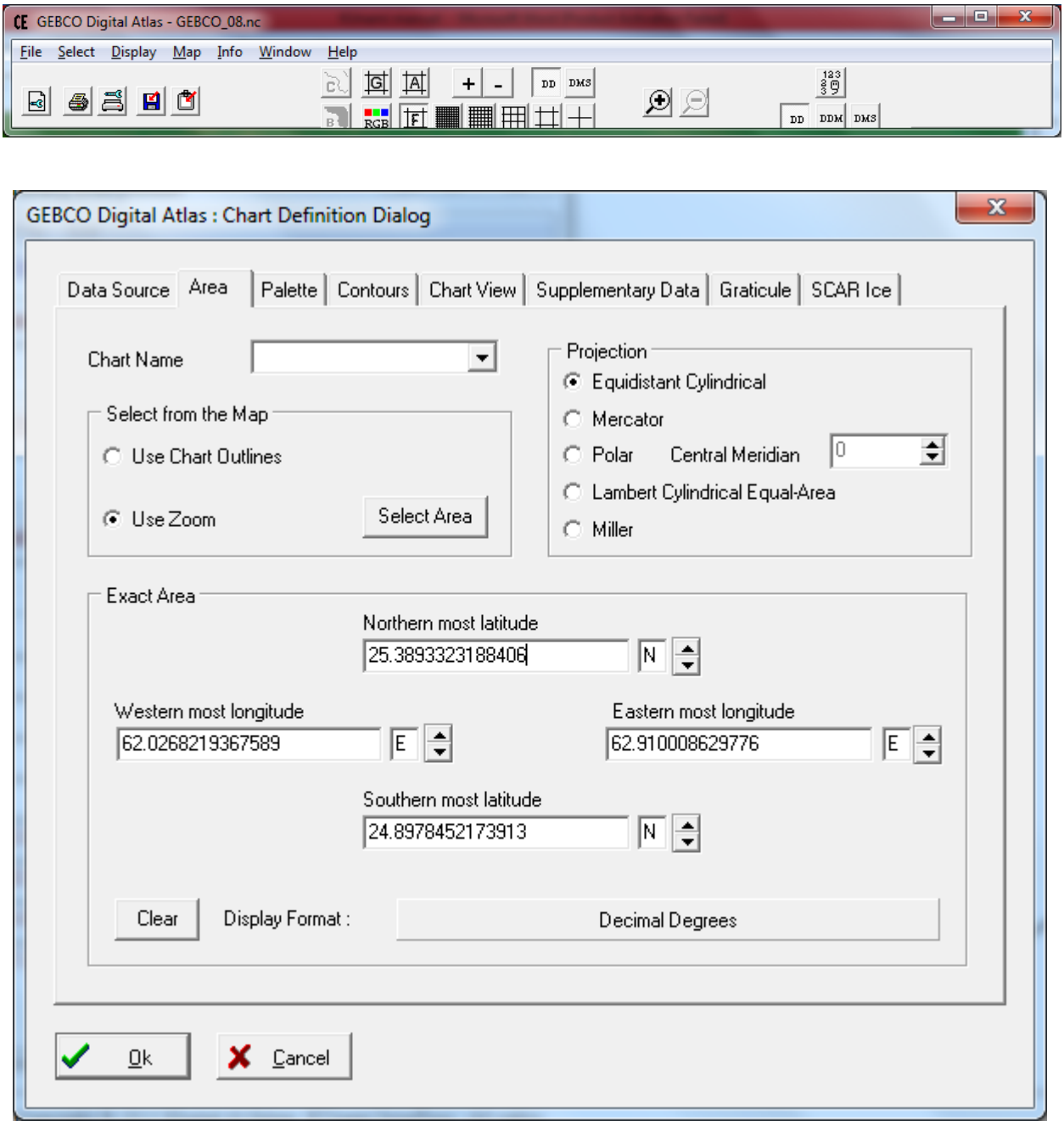


Figure 8. The GEBCO Digital Atlas Bathymetry Program

Then in Figure 9 user must select from File & **Save Project Input**
Figure 9 also shows the grid system and the sub grid levels (2, 3 and4).

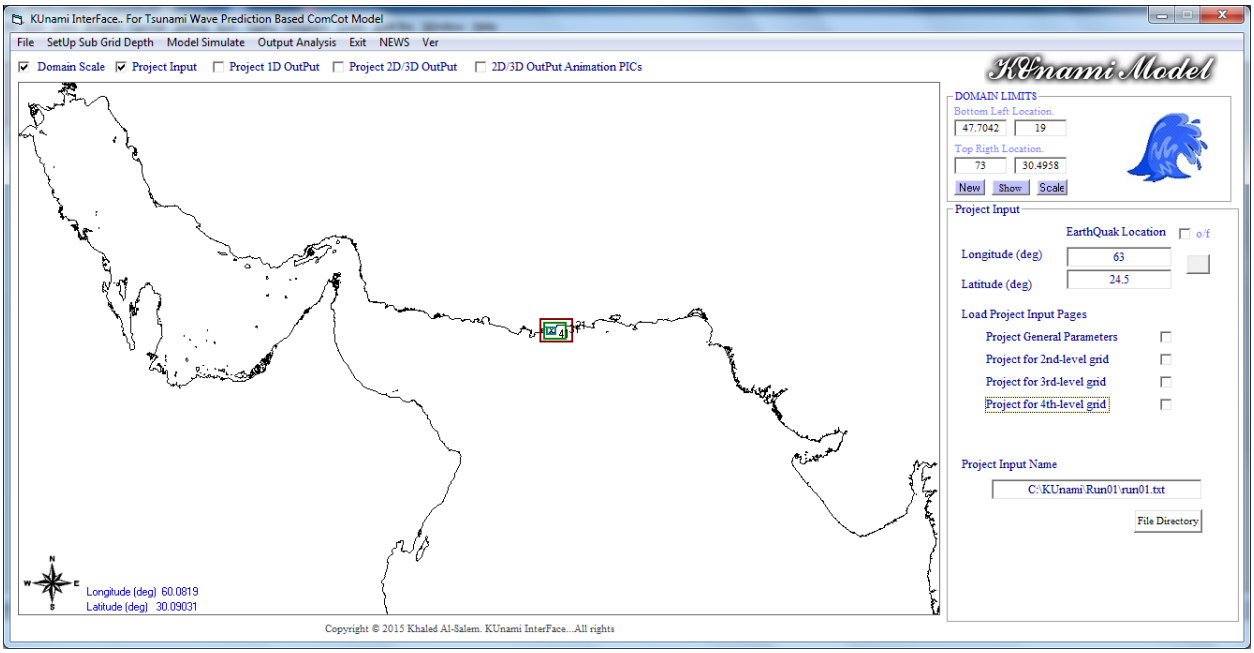


Figure 9. Main Grid System and sub Level grids of (2,3 and 4)

Comcot Model simulation

To start simulate Comcot model for tsunami wave prediction. User must select from Figure 9 **Model simulation.** Then the **Sim** program will activate to run Comcot model as shown in Figure 10.

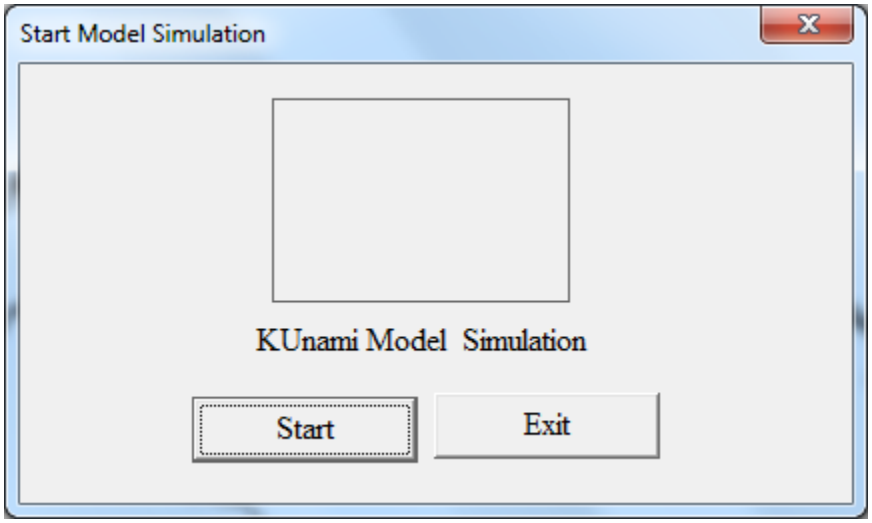


Figure 10. The Sim Program Page.

KUnami Interface Main Grid system Results Persenation

Project 1D Output Presentation

From Figurer 9 user should select the checkbox of **Project 1D output,** then Figure 11 will display with a number of inputs for user to select from time serious file to plot and also a drop down list of the grid type now user must select grid 01. Which is the main grid system as follows

1- User can select **Dirc** button to see the output file stored.
2- User should select Start Time and End time and time step for the output files.
3- User must Input the Directory Path for the Input files
4- User must select the output directory location for the converted files.
5- Then user must select **Start** button prepare the output files
6- Then User select the location of plot output file with extension *.bln

Now user ready to select the set of point locations from the map for plotting as

7-User must enter the **Number of Location** then activate the checkbox of On/OFF.
8- Move the mouse over the Map then click on the desire location for all location selected, then When all location is selected the checkbox will turn OFF.
9-User must select **End and Save** button to store the data in the file.
10-To see the location selected (**Edit Location**) button.

Now user ready to extract the data from the input file selected as

11-User Select Extract Data.
12-To See the final plot User must select as

A- Create Line Plot from KUnami interface System as shown in Figure 12.
B- Create Line Plot from Surfer Plotting Software.

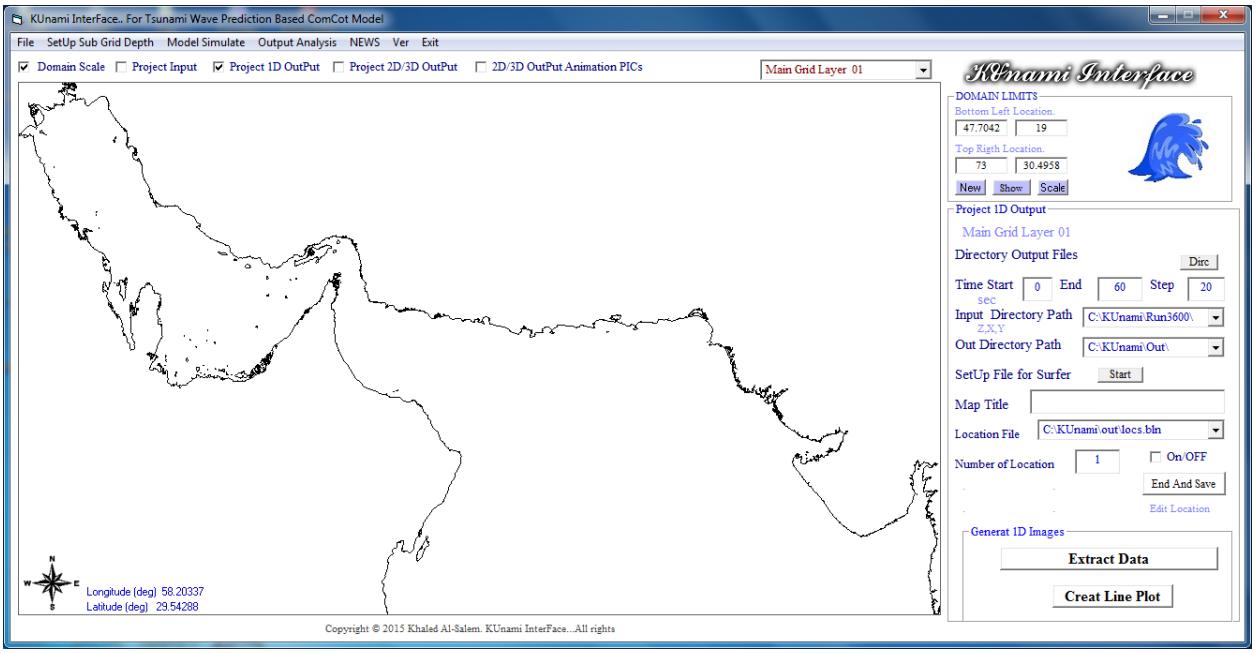


Figure 11. Project 1D output Option

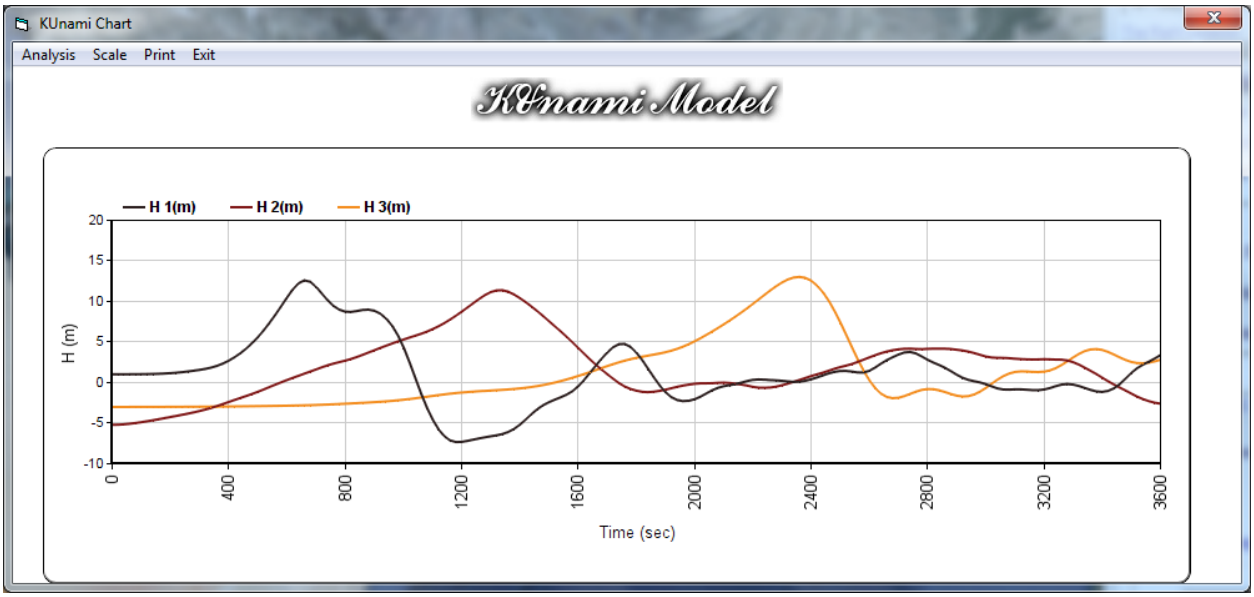


Figure 12. Time serious 1D line for a number of Selected Location for Wave Height.

Data Analysis option for 1D

From Figure 12 user has as option called **Analysis** for calculation the time of maximum wave height occur for each selected location. There a number of input require from user as follow:

1- From Figure 12 user must select Analysis button then Select **Date/Time,** then Figure 12B will display for user to enter Earth Quake Occur Date and Time.

2- From Figure 12 user must select Analysis button then Select **Time of W.H. Max,** then Figure 12C will display for user the Selected location Longitude/Latitude and Date/Time of the maximum wave height occur and the value of the wave height (m)

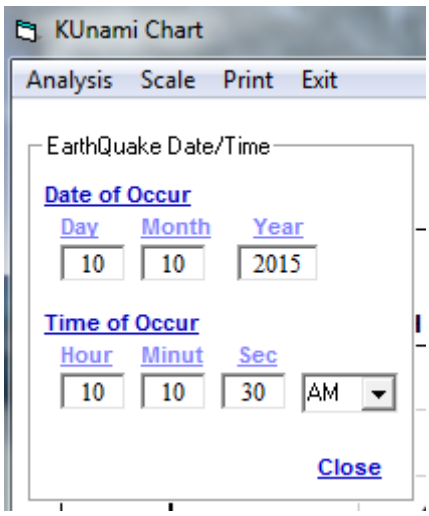


Figure 12B. Earth Quake Date/Time

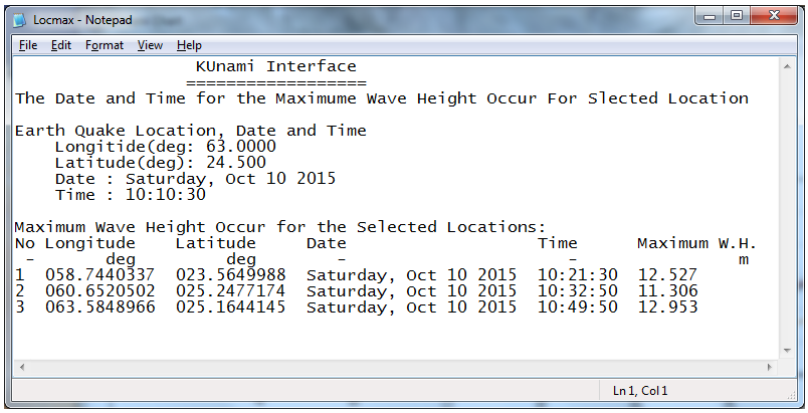


Figure 12C. Text File for a list of Selected Location Output.

Project 2D/3D Output Presentation

In this section user can display an image from selected time step file in two types as:

1- 2D Image with coast line background or with satellite map background.
2- 3D Image.

From Figurer 11 user should select the checkbox of **Project 2D/3D Output,** then Figure 13 will display with a number of inputs for user to select but user must select the type of grid domain as shown in the dropbox list as show in Figure 13 and then user must follow the input requirement as follows:

1- User can select **Dirc** button to see the output model file locations.
2- User should enter location of the Input file name
3- User must select Directory Path for the output file
4- Then user must select **Start** button prepare the output files
5- Then User selects the contour level file for Surfer software.
6-User can add text title to Image at MAP plot.

Now user ready to select Plot type as displayed in Figure 14. For user to Plot 2D image user have two options as

1-User must select **Create Surfer Plot** (coast line background) as shown in Figure 15
2- User must select **Create Surfer Plot with Sat. Image** (map background) as shown in Figure 16

Or user to select 3D image

1-User must enter the 3D Color Level file (Default file is col3d.CLR).
2-User must select **Create Surfer 3D Image** button as shown in Figure 17.

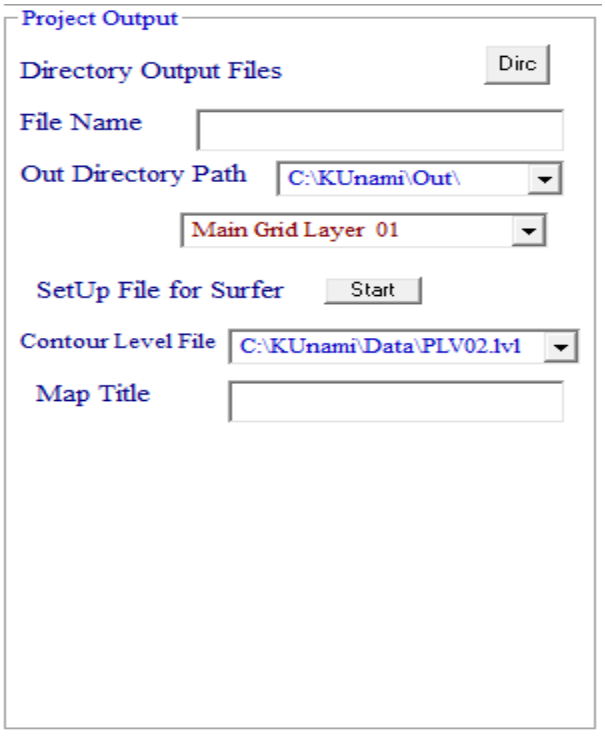


Figure 13. Project Output for 2D/3D Option

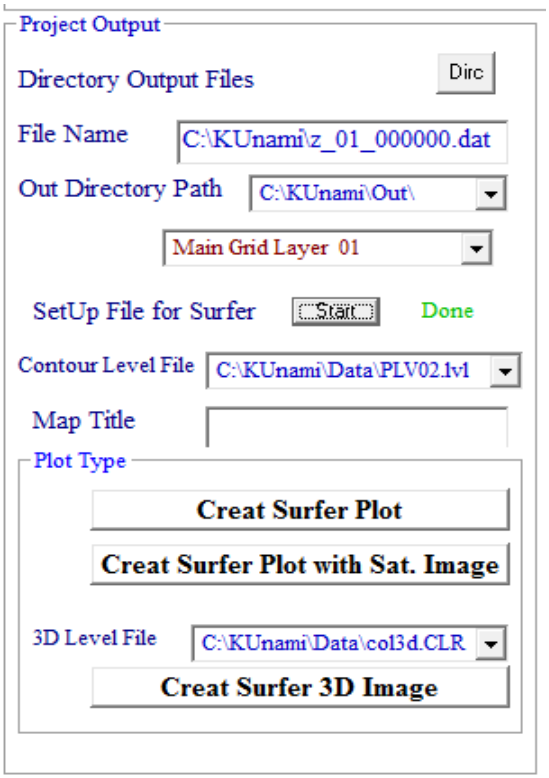


Figure 14. Image Type Selection Option

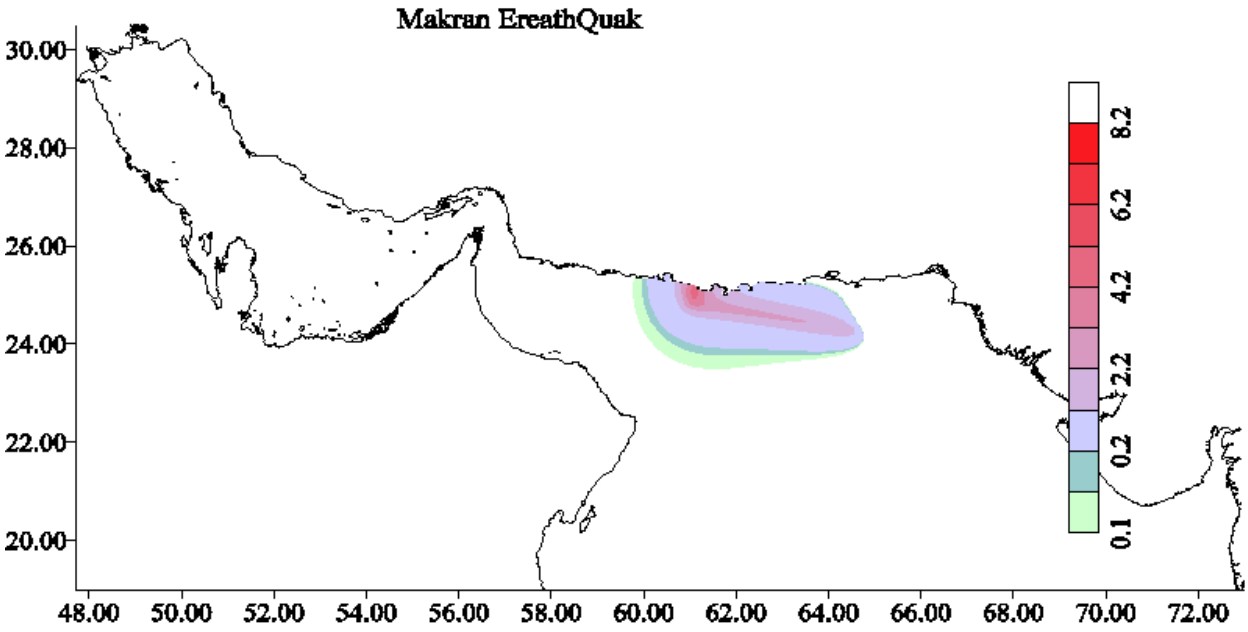


Figure 15. 2D Wave height Contour Plot with Coast line background from Surfer Software

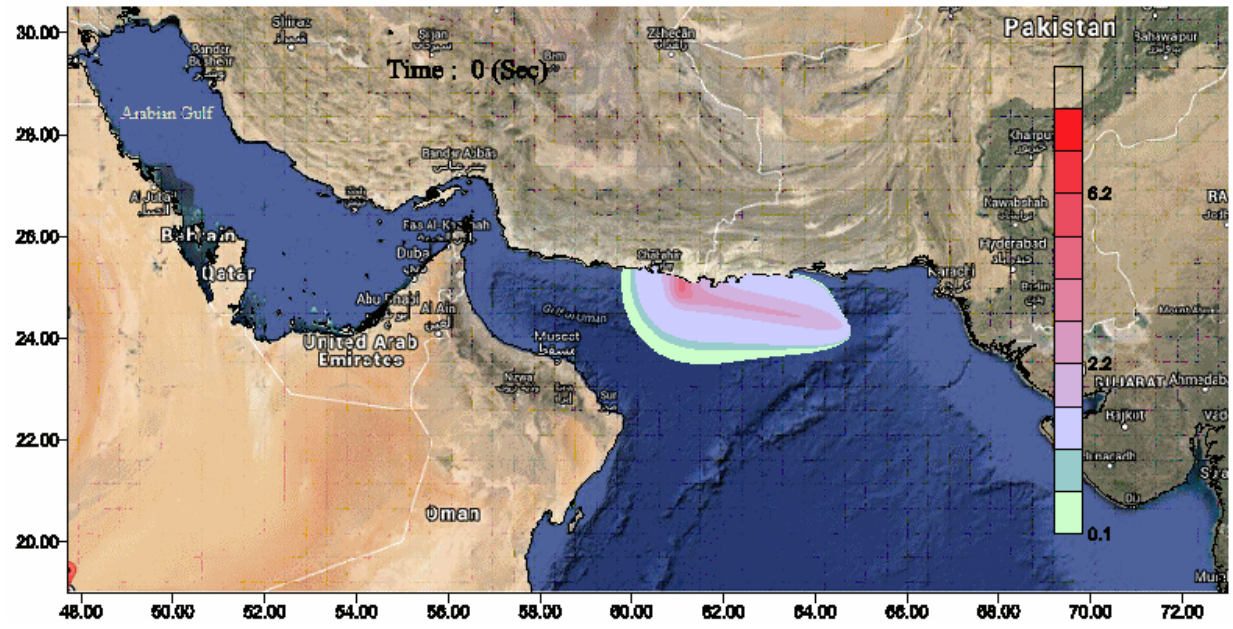


Figure 16. 2D Wave height Contour Plot with Satellite Map background from Surfer Software

(A)

(B)

Figure 17. 3D Wave height Contour Plot Created by Surfer Software for A at 600 sec and B for 1200 sec.

Project 2D/3D Output Animation Pics

In this section user can create a set of images from selected time step file. From this images user can create a media file by using media program to generate video animation such as:

-Movie Maker program
-ImageToGif animation program
-…….
-Other program

The two type Animation are follows:

1- 2D Animation with coast line background or with satellite map background.
2- 3D Animation.

From Figurer 11 user should select the checkbox of **Project 2D/3D Output Animation PICS,** then Figure 18 will display with a number of input of inputs for user to select but user must select the type of grid domain as shown in the dropbox list as show in Figure 18 and then user must follow the input requirement as follows:

1- User can select **Dirc** button to see the output model file locations.
2- User should select start time, end time and time step
2- User must enter Directory Path input file
3- User must enter Directory Path output file
4- Then user must select **Start** button prepare the output files
5- Then User selects the contour level file for Surfer software.
6-User can Add text title to Image at MAP plot.

Now user ready to select Image type for animation as displayed in Figure 19. For user to create 2D images for Animation user have two options as

1-User must select **Create Surfer Plot with coast line** (background) images
2- User must select **Create Surfer Plot with Sat. Image** (background) images

Or user to select 3D images for Animation

1-User must enter the 3D Color Level file (Default file is col3d.CLR) .
2-User must select **Create Surfer 3D Image** for Animation.

If user used Movie Maker Program from Microsoft to generate Animation file from a set of Images that create from the above option were shown in Figure 20. Which shows the main page of the Movie Maker program with all selected images loaded and ready to compile or generate the animation file.

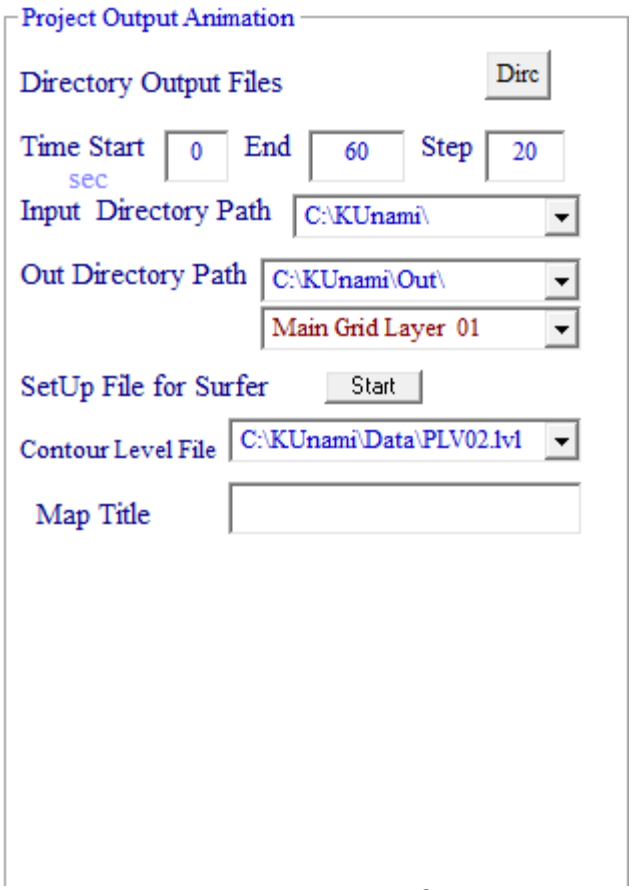


Figure 18. Project Output for 2D/3D Animation Option

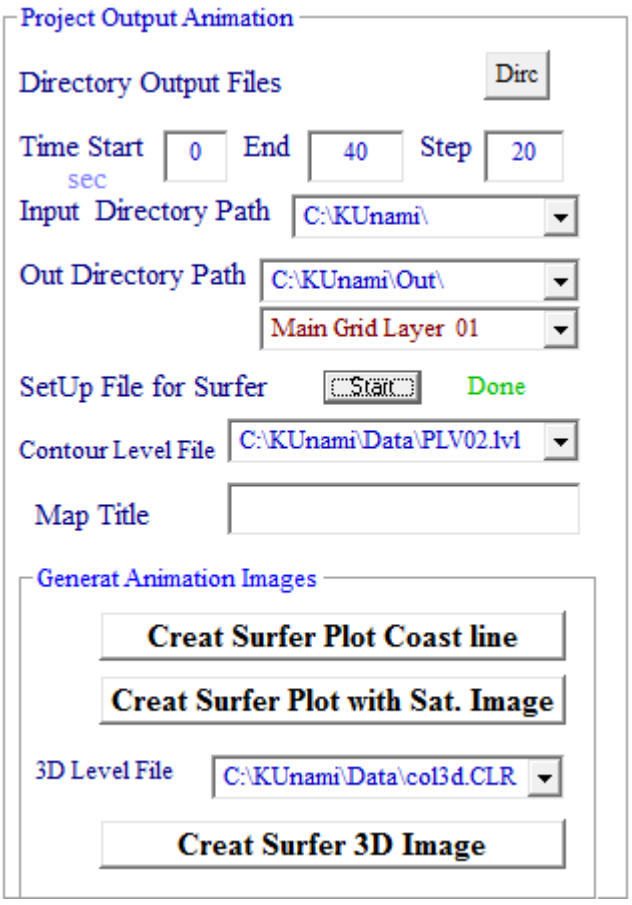


Figure 19. Create Surfer 3D Images for Animation

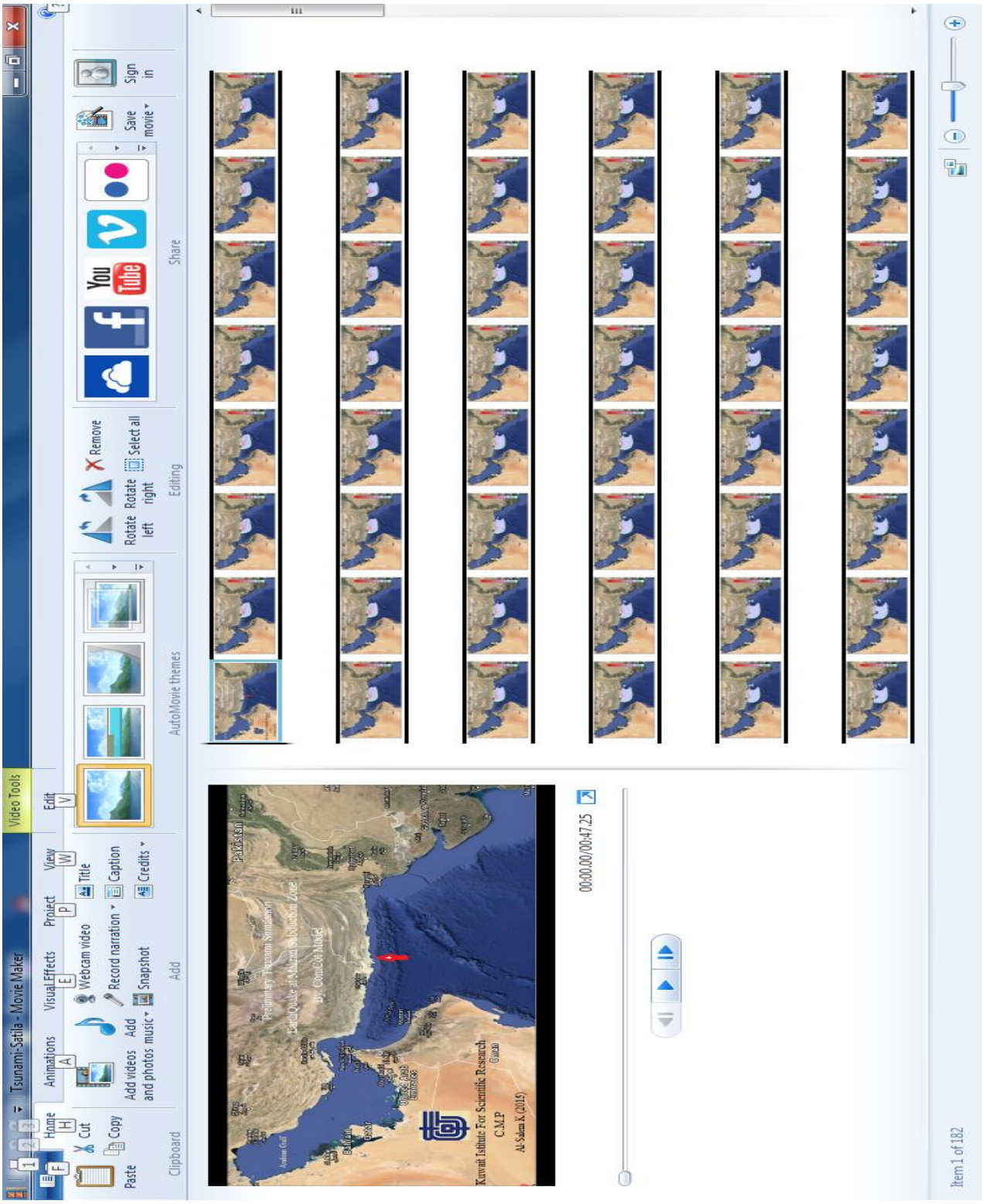


Figure 20. Main Page Of Movie Maker Program With All Selected images Loaded

KUnami Interface Sub Grid system Results Personation

Presentation for results from simulation of ComCot model for Sub grid (refine grid) system require some input from user as follows:

1- Sub Grid 1D Output Presentation for (Layer21 to 44)

From Figure 11 user must select and follow these steps as:

- From the dropbox the Type of sub grid system
- Then base on the sub grid select user must follow as:

- If user select to present sub grid layer (21,22,23,24) user must activate the layer number by select from Figure 21 the **Sub Grid Dimension** to show and calculate the (NX,NY,DX,DY and the Scale for the sub grid selected) as shown in Figure 21.
- To Show or plot the sub grid user must check the checkbox at the top of layer selected then click on **Sub Grid Plt.**
- If user select to present sub grid layer (31,32,33,34) user must activate the layer number by select from Figure 22 . Then user must select **Load/Save Info** to load the (NX,NY,DX,DY and the Scale for the sub grid selected) as shown in Figure 22
- Same If user select to present sub grid layer (41,42,43,44)

- User can select **Dirc** button to see the output file stored.
- User should select Start Time and End time and time step for the output files.
- User must Input the Directory Path for the Input files
- User must select the output directory location for the converted files.
- Then user must select **Start** button prepare the output files
- Then User select the location of plot output file with extension *.bln
- Now user ready to select the set of point locations from the map for plotting as
- User must enter the **Number of Location** then activate the checkbox of On/OFF.
- Move the mouse over the Map then click on the desire location for all location selected, then
- When all location is selected the checkbox will turn OFF.
- User must select **End and Save** button to store the data in the file.
- To see the location selected (**Edit Location**) button.
- Now user ready to extract the data from the input file selected as

User Select Extract Data.

To See the final plot User must select as

A- Create Line Plot from KUnami interface System.

B- Create Line Plot from Surfer Plotting Software.

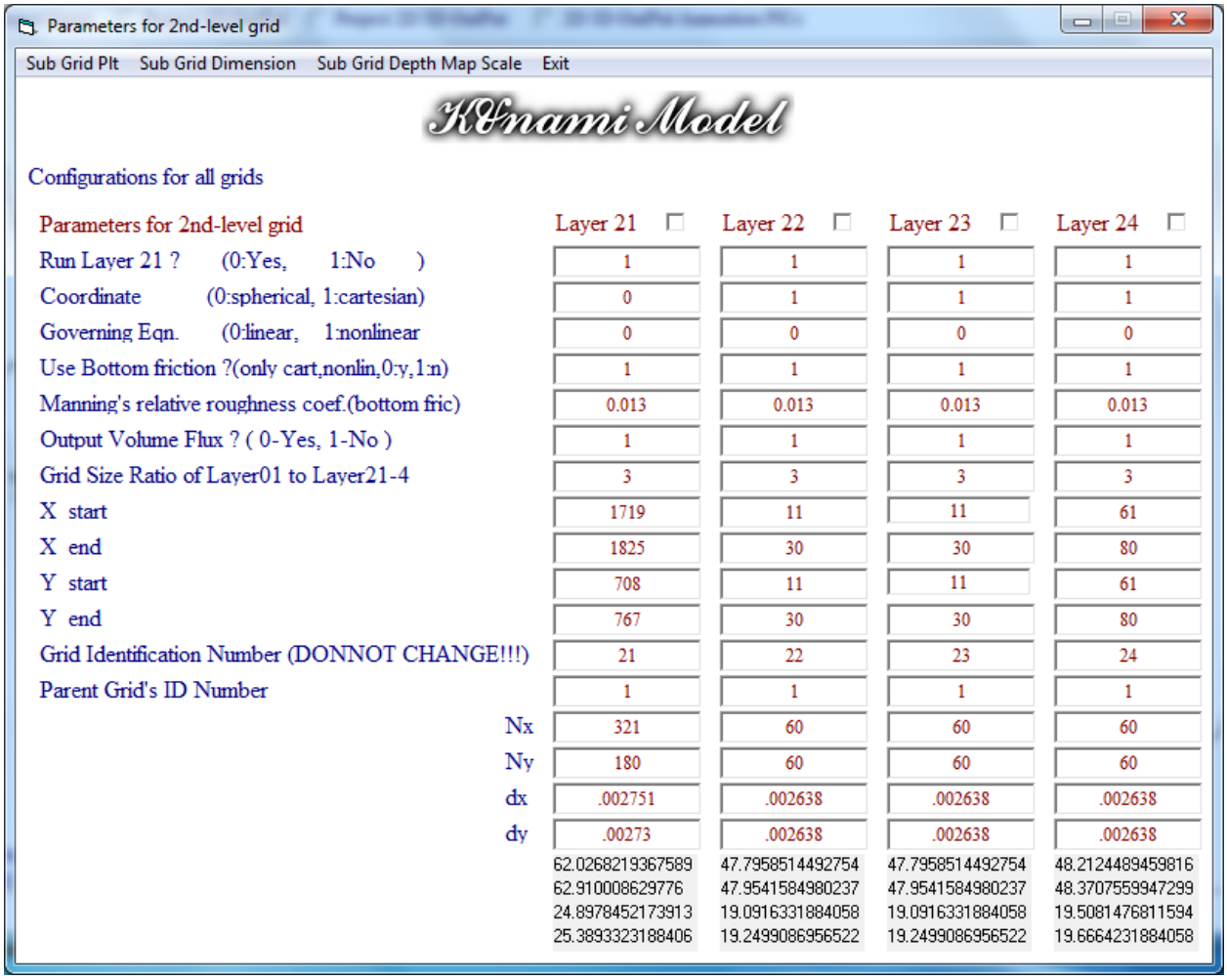


Figure 21: Activate Layer Sub Grid (21,22,23,24)

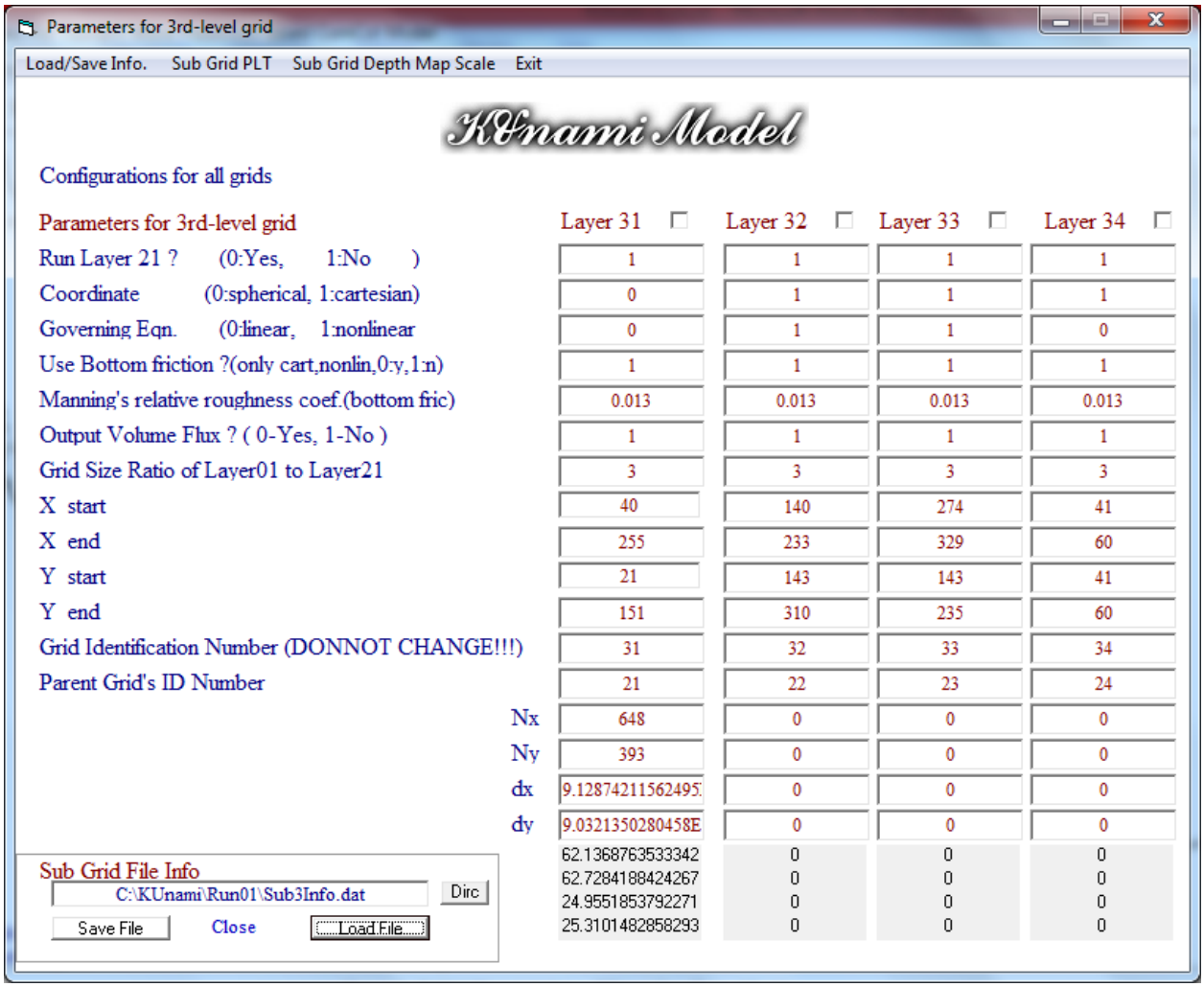


Figure 22: Activate Layer Sub Grid (31,32,33,34)

2- Sub Grid 2D/3D Output Presentation for (Layer21 to 44)

From Figure 13 user must select and follow these steps as:

- From the dropbox the Type of sub grid system
- Then base on the sub grid select user must follow as:

- If user select to present sub grid layer (21,22,23,24) user must activate the layer number by select from Figure 21 the **Sub Grid Dimension** to show and calculate the (NX,NY,DX,DY and the Scale for the sub grid selected) as shown in Figure 21.
- To Show or plot the sub grid user must check the checkbox at the top of layer selected then click on **Sub Grid Plt.**
- If user select to present sub grid layer (31,32,33,34) user must activate the layer number by select from Figure 22 . Then user must select **Load/Save Info** to load the (NX,NY,DX,DY and the Scale for the sub grid selected) as shown in Figure 22
- Same If user select to present sub grid layer (41,42,43,44)

- Then User must follow same step in **Page 16** for the rest of the selection.

3- Setup Ini Surface Deformation File

Kunami Interface will Simulate the Comcot model by default in one Fault case as shown in Figure 2 by using the parameters for Fault model entry data section. But user want to start the simulation with an initial deformation surface user must follows as:

- From Figure 2 user must select at section (**General Parameters for Simulation**) the **specify ini surface as 1**. This to tell the model the ini-surface data read from file name data.
- From Figure 2 user must select **SetUp INI_Surface Deform File** option. To setup the require input data for creating the ini-surface deform file. Figure 23 will display.
- In Figure 23 shows a number of required data must enter as follows:
  1-General fault parameter data for number of events and number of Fault segments and (single as 0 or multi as 1 fault events). User allowed changing.
  2-General Domain dimension for number of events and number of domain grid in x and y and grid size in x and y. User not allowed to change.
  3-Main Domain Axis its (x,y) data for lower left corner and Top right corner of the main domain grid system for KUnami interface. User not allowed to change.
- Now user ready to enter the fault data by click on **General Input Fault Data** button. Then Figure 24 will display for user to enter the fault data. When finished entry user must save the file as default name (Don't change the file name or save as other name. it must be save as default name).

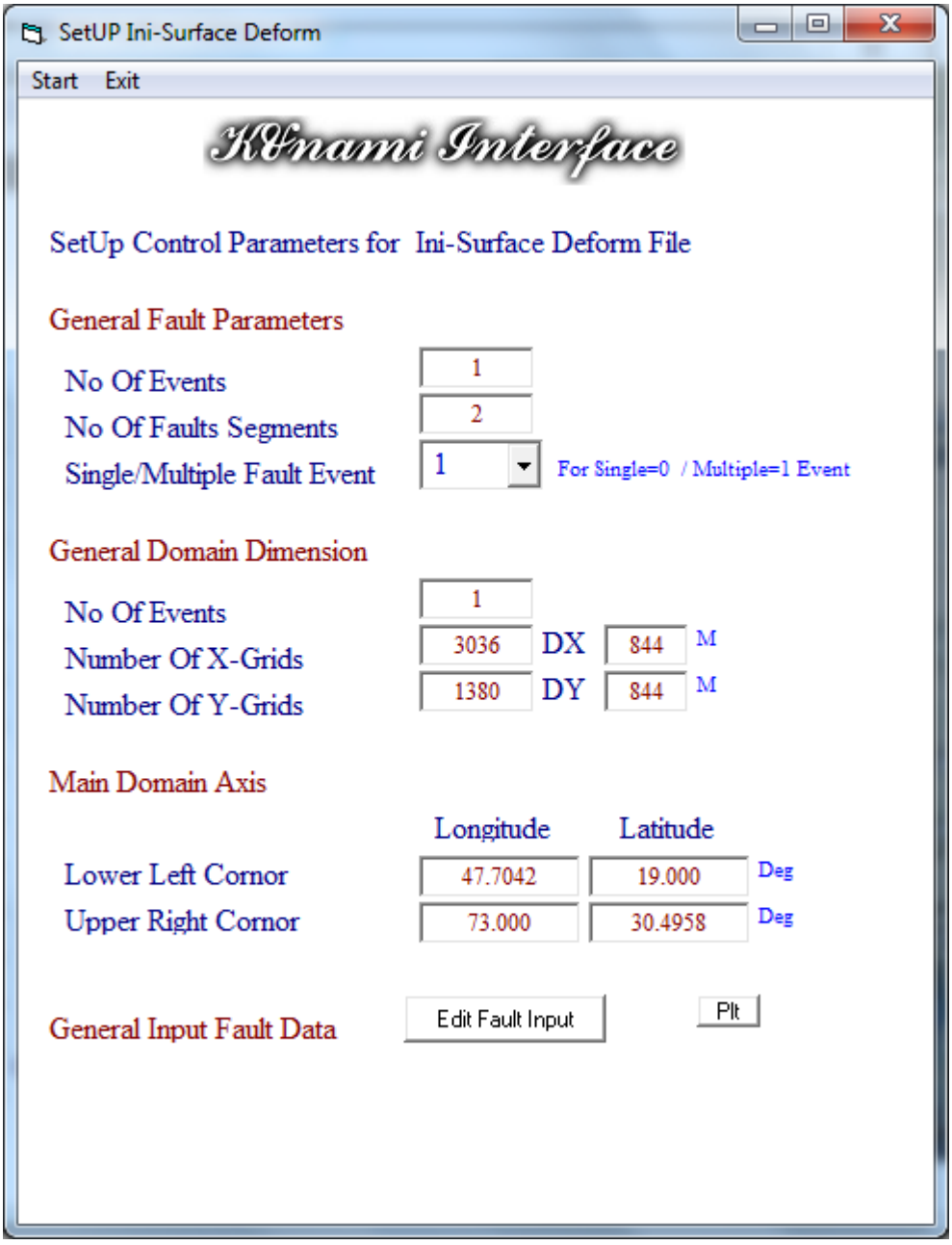


Figure 23: SetUp Ini Surface deformation Page

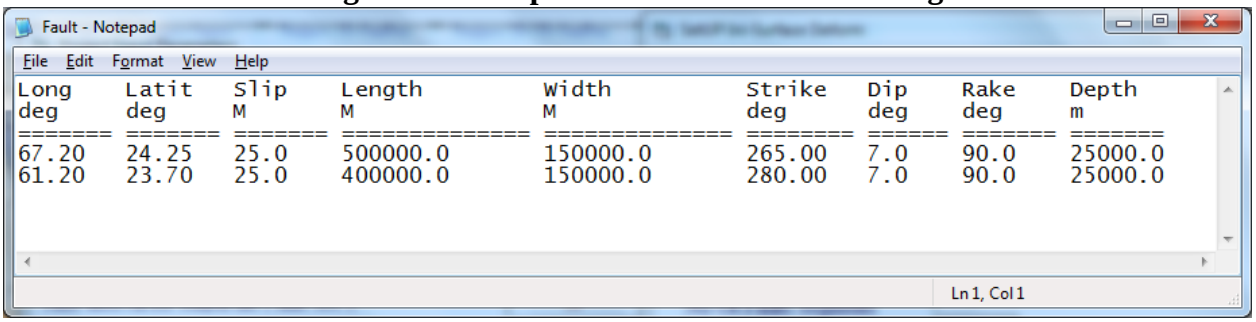


Figure 24: Entry Page for Deformation Fault Data

Volume Flux 1D Output Presentation

Volume Flux Presentation for results from simulation of ComCot model for main grid and Sub grid (refine grid) system require some input from user as follows:

From Figure 1 user must select the check box for **Volume Flux 1D Output** then Figure 25 will display to user to follow these steps as:

- From the dropbox the Type of sub grid system
- Then base on the sub grid select user must follow as:

- If user select to present sub grid layer (21,22,23,24) user must activate the layer number by select from Figure 21 the **Sub Grid Dimension** to show and calculate the (NX,NY,DX,DY and the Scale for the sub grid selected) as shown in Figure 21.
- To Show or plot the sub grid user must check the checkbox at the top of layer selected then click on **Sub Grid Plt.**
- If user select to present sub grid layer (31,32,33,34) user must activate the layer number by select from Figure 22 . Then user must select **Load/Save Info** to load the (NX,NY,DX,DY and the Scale for the sub grid selected) as shown in Figure 22
- Same If user select to present sub grid layer (41,42,43,44)

- User can select **Dirc** button to see the output file stored.
- User should select Start Time and End time and time step for the output files.
- User must Input the Directory Path for the Input files
- User must select the output directory location for the converted files.
- Then user must select **Start** button prepare the output files
- Then defualt location of plot output file with extension locVF.bln as shown in Figure 25.
- Now user ready to select the set of point locations from the map for plotting as
- User must enter the **Number of Location** then activate the checkbox of On/OFF.
- Move the mouse over the Map then click on the desire location for all location selected, then
- When all location is selected the checkbox will turn OFF.
- User must select **End and Save** button to store the data in the file.
- To see the location selected (**Edit Location**) button.
- Now user ready to extract the data from the input file selected as

User Select Extract Data.

To See the final plot User must select as

A- Create Line Plot from KUnami interface System as shown in Figure 26.

B- Create Line Plot from Surfer Plotting Software.

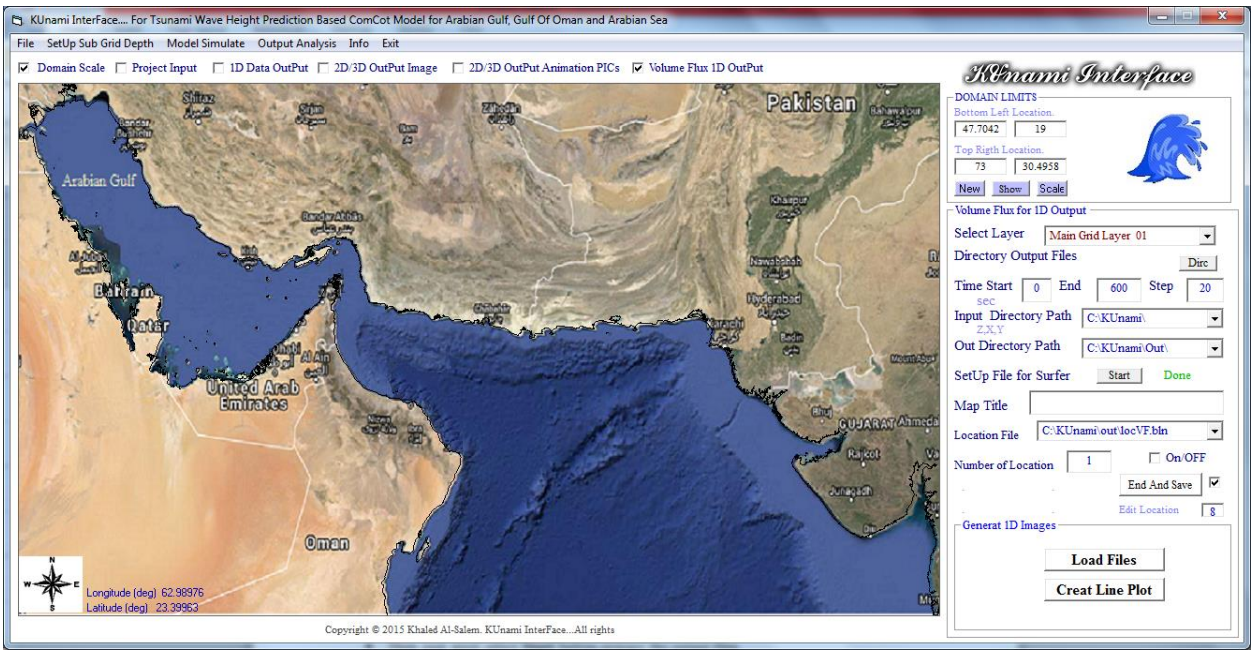


Figure 25. Vulme Flux 1D Outout page

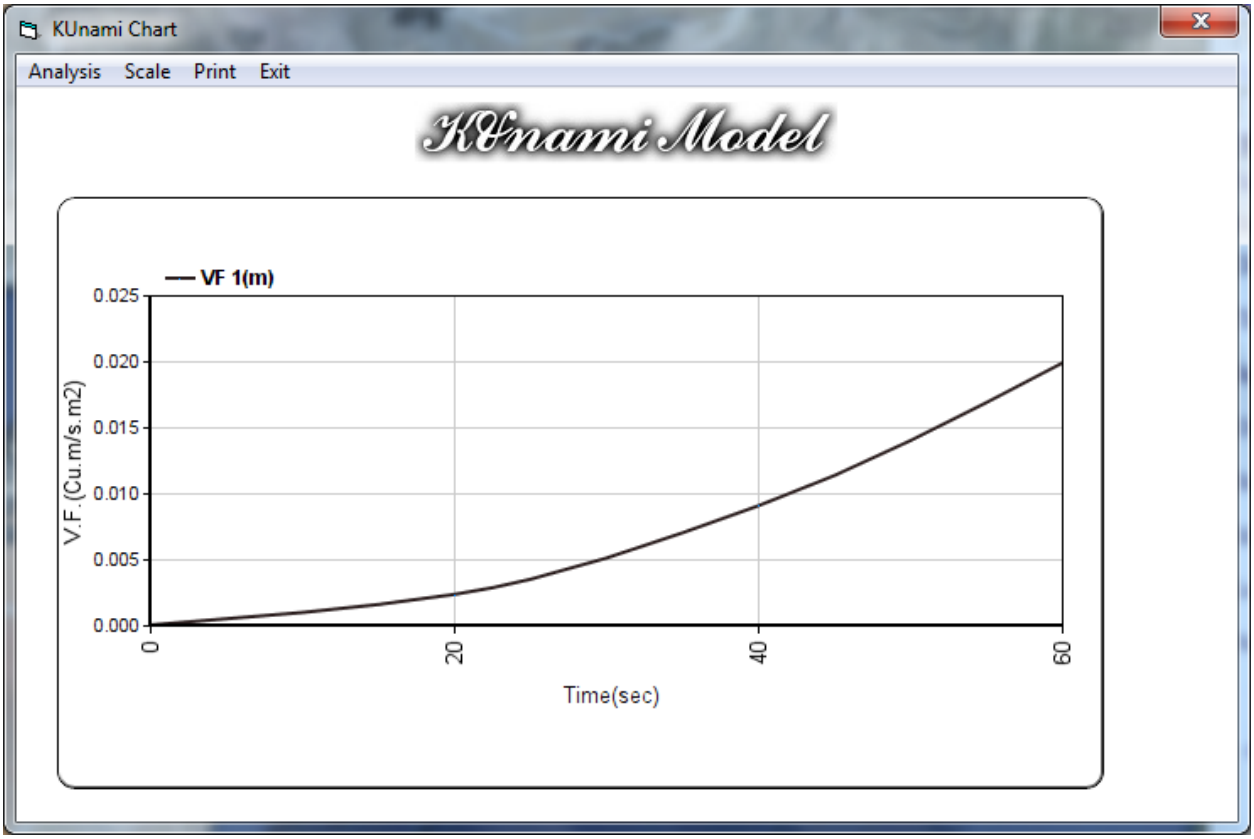


Figure 26. 1D Volume Flux for a selected Location

KUnami Output Presentation at A Remote Website
http://www.hceatkuwait.net/

http://www.hceatkuwait.net/, It's a Remote website hold the KUnami Interface awareness system for a selected location in Arabian Gulf, Gulf of Oman and Arabian Sea waters.
The system will hold the posted awareness data in the system is for 6 hours. The awareness data for selected location will display for user the select as shown in Figure 27.

The system will start at the following website Address:
http://www.hceatkuwait.net/KUnami/KUnami.aspx
Figure 28 will display for user when there are no Tsunami Hazard data post and the system is in standby mode and no posted Pins on the Google map.
Figure 29 will display for user when system received a Tsunami Hazard data at selected location from the operator and the posted location will be on the Google map.
From Figure 29 user can select to show the time serious data posted for each location as shown in Figure 30 and 31.

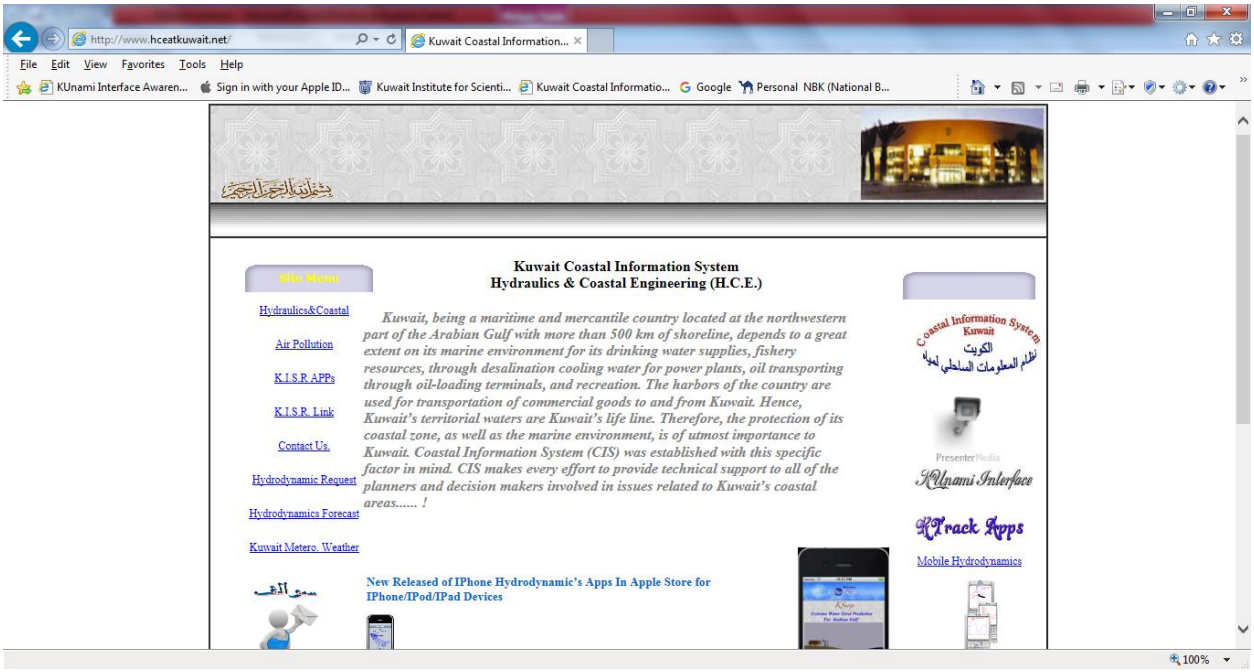


Figure 27. Main Remote Website Page.

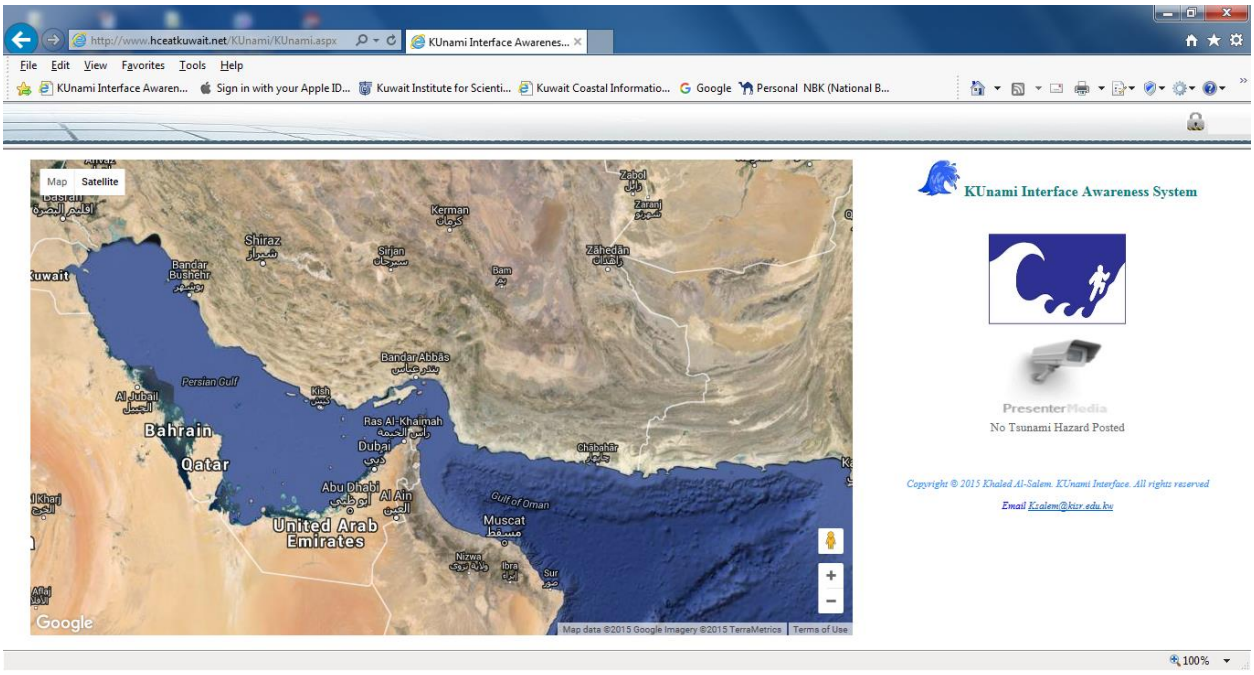


Figure 28. KUnami Interface Remote website (Standby mode)

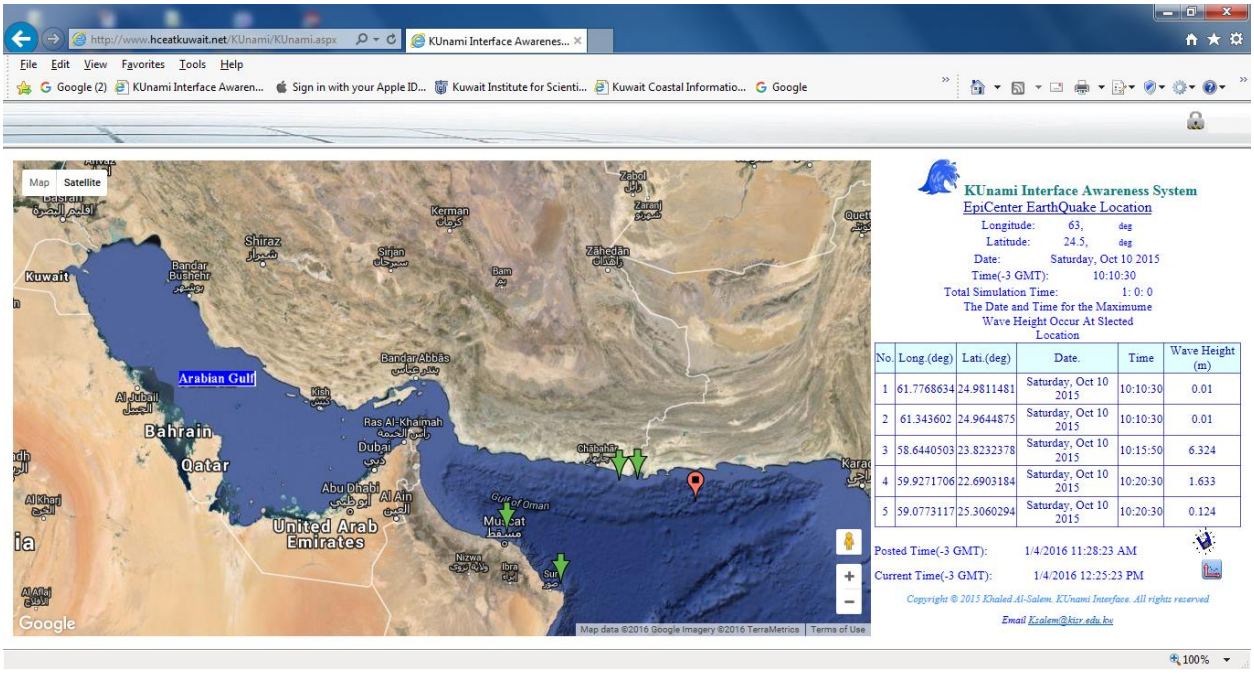
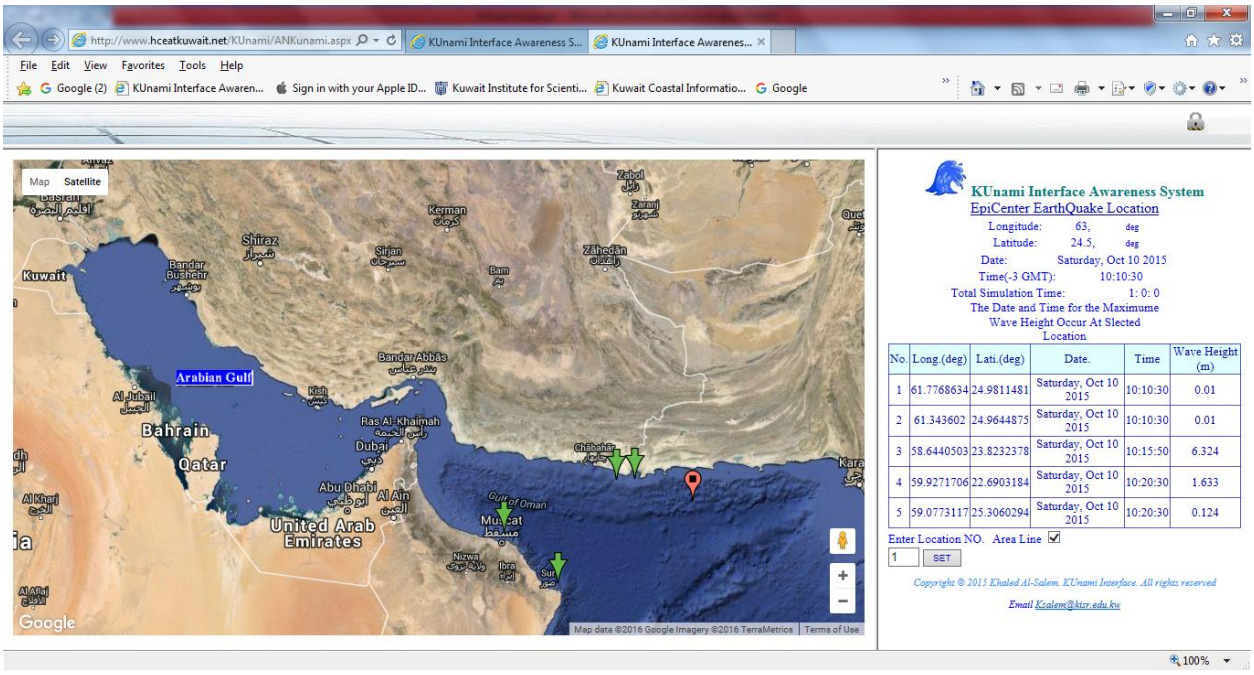
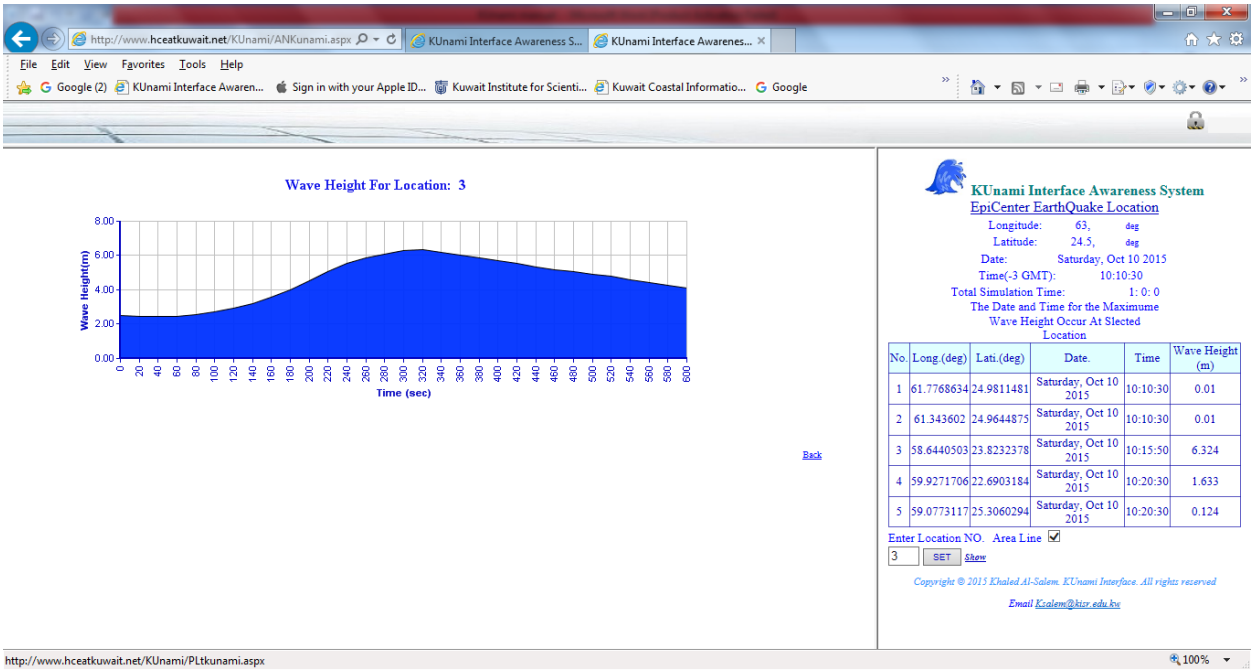


Figure 29. KUnami Interface Remote website with awareness hazard data posted



No.	Long.(deg)	Lati.(deg)	Date.	Time	Wave Height (m)
1	61.7768634	24.9811481	Saturday, Oct 10 2015	10:10:30	0.01
2	61.343602	24.9644875	Saturday, Oct 10 2015	10:10:30	0.01
3	58.6440503	23.8232378	Saturday, Oct 10 2015	10:15:50	6.324
4	59.9271706	22.6903184	Saturday, Oct 10 2015	10:20:30	1.633
5	59.0773117	25.3060294	Saturday, Oct 10 2015	10:20:30	0.124

Figure 30. Selection of Time serious Data Location



No.	Long.(deg)	Lati.(deg)	Date.	Time	Wave Height (m)
1	61.7768634	24.9811481	Saturday, Oct 10 2015	10:10:30	0.01
2	61.343602	24.9644875	Saturday, Oct 10 2015	10:10:30	0.01
3	58.6440503	23.8232378	Saturday, Oct 10 2015	10:15:50	6.324
4	59.9271706	22.6903184	Saturday, Oct 10 2015	10:20:30	1.633
5	59.0773117	25.3060294	Saturday, Oct 10 2015	10:20:30	0.124

Figure 31. KUnami Interface Remote website with Time serious data Plot Posted

KUnami Output Presentation at A Smart Mobile techonolgy
KUnami Apps

KUnami Apps, It's a mobile apps that hold the KUnami Interface awareness system for selected location in Arabian Gulf, Gulf of Oman and Arabian Sea waters as shown in Figure 32. The system will hold the posted awareness data in the system is for by default a 6 hours or more. The awareness data for selected location will display for user as shown in Figure 34.
The system will start after user select **Monitor button** as show in Figure 33, Figure 33 will stay and display for user when there are no Tsunami Hazard data post and the system is in standby mode and no posted Pins on the Google map.
Figure 34 will display for user when system received a Tsunami Hazard data at selected location from the operator and the posted location will be on the Google map.
From Figure 35 user can select **LOC Bottun** the earth quake information. If user want display the time serious data posted location user must select the following:
1- Post location number.
2-Time interval for the plot as(1 for sec, 60 for mint and 3600 for hrs)

Then user must select  button to show the time serious data posted for each location as shown in Figure 36.
User can send the Tsunami Hazard post data from selection **Contact Button** as shown Figure 37. There are two option for communication which
1- user can send data by SMS system.
2-User can send data by Email system as shown in Figure 38

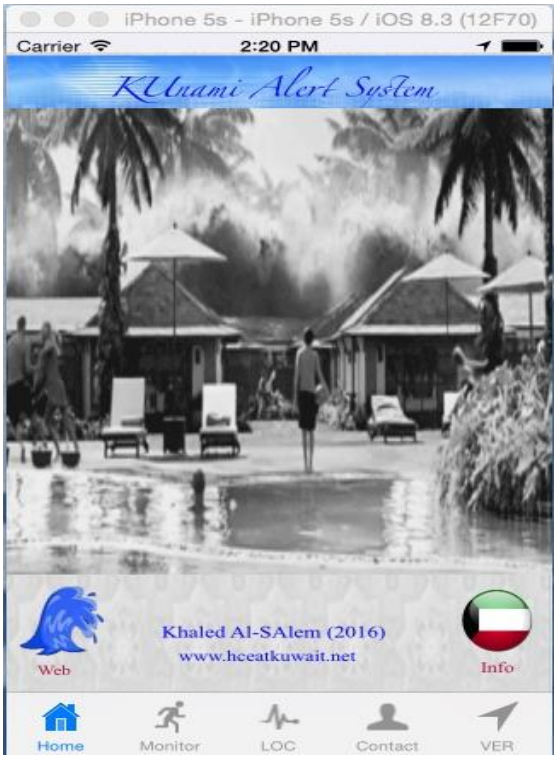


Figure 32. KUnami Apps main Page.

Figure 33. Stand by

Figure 34. Posted Locations

Figure 35. Earth Quake Information

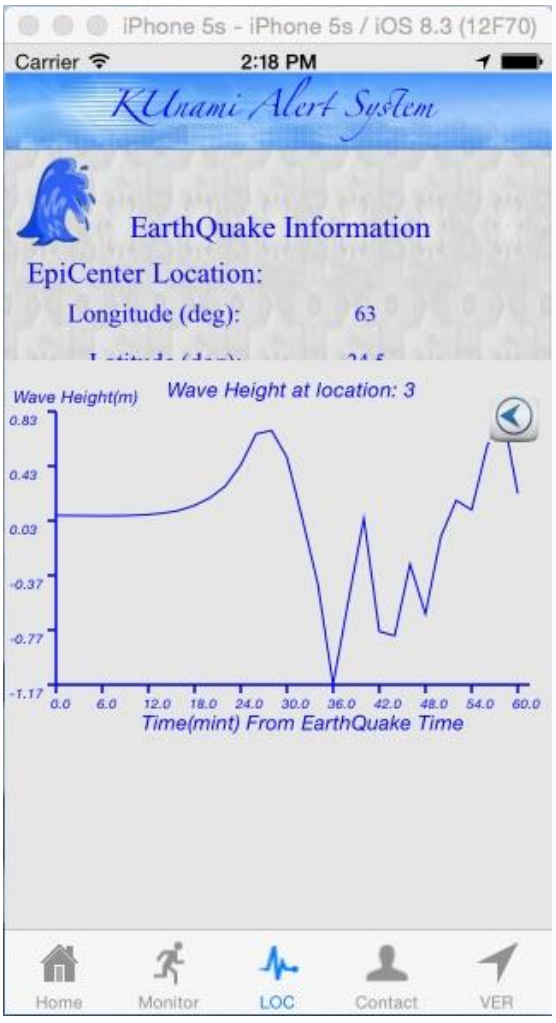


Figure 36. Plot Time Serious Data for a location

Figure 37. Communication Page

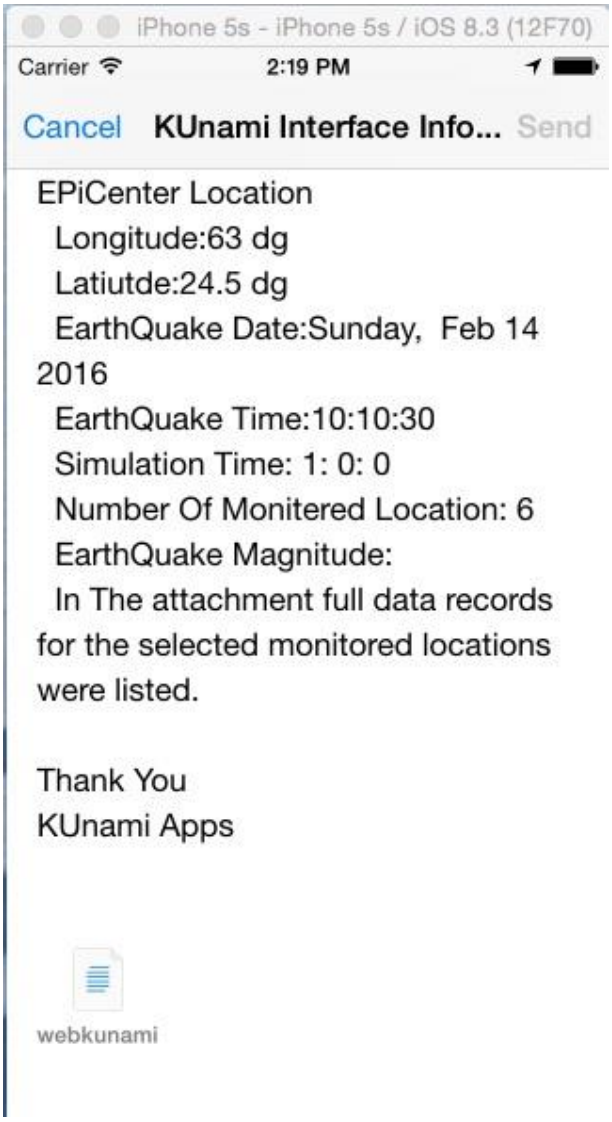


Figure 38. Email Page

Appendix

Important Note for Bathymetry Data

Extremely important to make sure that in water depth file, bathymetry (water area) data takes positive sign and topographical (Land area) data takes negative sign.

GS Script Data Input Format From KUnami Interface

The Data are:

Parameters Value	Parameters Value Description
C:\KUnami\Out\filedat.dat	Input data file for plot
C:\KUnami\Out\filegrd.dat	Input Grid file Name Which will create from Surfer Software
C:\KUnami\Out\filebmp.dat	Input Image file Name Which will create from Surfer Software
C:\KUnami\Data\AGcoast.bln	Input Coast Line file Name for Surfer Software
C:\KUnami\Data\AGBLANK.bln	Input Blanking file Name for Surfer Software
C:\KUnami\Data\PLV02.lvl	Input 2D Contour level file Name for Surfer Software
C:\KUnami\Data\col3d.CLR	Input 3D image contour file Name for Surfer Software
3	Total Time
0	Start Time
40	End Time
20	Time Step
0	Type of back ground 0 for coast line 1 for satile image background
Title plot	Plot Title
47.7042	Domain Scale X1
73	Domain Scale X2
19	Domain Scale Y1
30.4958	Domain Scale Y2
2	For 2D plot is 2 and 3D is 3
1	Animation control 1 on 0 off
3036	Total domain Dimension Ny
1380	Total domain Dimension Nx

Volume Flux

In fluid dynamics, the volumetric flux is the rate of volume flow across a unit area (m3·s-1·m-2). Volumetric flux = liters/(second*area). The density of a particular property in a fluid's volume, multiplied with the volumetric flux of the fluid, thus defines the advective flux of that property. The volumetric flux through a porous medium is often modelled using Darcy's law.