"KOil Model"

Oil Spill trajectory for Arabian Gulf waters

Developed By

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[KOil model 2012]

Models to predict the behavior of the oil spill include the calculation of the spreading, the displacement and the mass/volume balance over the different compartments (air, water surface, water column and bottom) of a released substance. The phenomenon of spreading results from a dynamic equilibrium between the forces of gravity, inertia, friction, viscosity, and surface tension. The variables that mainly influence the dispersion and evaporation are the wind speed, marine currents, time, density of the oil and the amount of the oil released. Many oil spill models are commercially available and can be setup for the Arabian Gulf and the Kuwaiti territorial waters. Such models however, require accurate data on the marine currents which are usually provided from a separate hydrodynamic model HD (Lo and Al-Salem. 1999) and (K. Al-Salem ,2008) that it takes very long computer time for simulation of the marine current condition.

Methodology

The model currently uses data from the KGulf 2D hydrodynamic HD model for the Arabian Gulf (K. Al-Salem; web address: [http://www.hceatkuwait.net/web_pas/web-KGulf/KGulfmain.aspx].

KGulf is 2D hydrodynamics Prediction model set up for the Arabian Gulf and Kuwait waters (K. Al-Salem ,2008). The model is capable of simulating 2D tidal current and water level at any selected grid inside Arabian Gulf waters with hourly output results. Also a refine grid was generated for Kuwaiti territorial water. A grid was generated covering the Arabian Gulf from the Hormoz inlet till the upper part of Arabian Gulf . The grid spacing is about 5-8 km in the Arabian Gulf with a total of 3692 grid inside the Gulf. For some local areas in Kuwait waters the refined grid spacing reached about less than 50 m Figs. 1. KGulf model was validated using a tide prediction TIDCALC model (UK's Hydrographic Office), RMA-10 HD model (King, I.P. 1988) and using some field measurements. Result showed that the model is capable of predicting the 2D tidal currents and water level variations well with very short simulation time. Four finer grids have recently been setup for the Kuwaiti territorial waters and include all the power plants in Kuwait. These grids provide detailed tidal currents near the sensitive locations in Kuwait as shown in Figs 1 and Fig A1-A3. Fig 1 shows samples of grid system in Kuwait waters. The Oil transport model is coupled with 2D hydrodynamic model for Kuwait Waters (KGulf model). The velocity distribution is calculated at each time step and is taken as an input for the oil transport simulation model (KOil model) (K. AlSalem ,1993).

Lagrangian description of turbulent diffusion

A Lagrangian discrete-parcel algorithm is used. In this algorithm, the oil slick is viewed as a large ensemble of small parcels. It looks at the subsequent coordinates (trajectories) of a number of individual fluid or fluid property particles that are advected (transported) by currents. When the current field is known then we may add turbulent diffusion as random walks that have in general Gaussian distribution with dispersion that corresponds to turbulent activity.

For a particle numbered i we get

$$dx_i = u(x_i, y_i, z_i, t)dt + Rnd_x(i)$$
$$dy_i = v(x_i, y_i, z_i, t)dt + Rnd_y(i)$$
$$dz_i = w(x_i, y_i, z_i, t)dt + Rnd_z(i)$$

Model Simulation Description

KGulf model was developed and set up for the Arabian Gulf and Kuwait territorial waters with multi grid system for solving hydraulic engineering application. To start simulate the KGulf model user must select [ ] to start the model Fig 60 will display the following input Option for user to state as follows:

- 1D/2D tidal current speed and direction hourly perdition
- 1D/2D tide Level hourly prediction and Water level analysis
- Trajectory Oil spill prediction [KOil 2009]
- Oil Spill
  - KOil model 2012 [http://www.hceatkuwait.net/web-OilSpil/KOil2/koilmain.aspx]
  - Back Track Oil Spill [http://www.hceatkuwait.net/web-OilSpil/BOil/Boil.aspx]

To Simulation Oil Spill Project KGulf model have two Models for user to select from Fig 60 as follow:

1- [KOil model 2009] User must Check [2D Prediction]. A new frame will display at Fig 60. User must select again [Time Serious 2D Prediction].

2- [KOil model 2012] User must select [Oil Spill] from Fig 60. These model will describe on next Section

*For Simulation [**KOil model 2012**]*

User after selected [***OIL SPILL***] in Fig 60.
Figure 70 will display for user two models as:

- Oil Spill Trajectory
- Back Track Oil Spill.

User must select [***Oil Spill Trajectory***] Fig 71 will display to select the following

- Grid Domain
- Domain map

User must Check [***2D hydrodynamics' Setu***p] Fig 72 will display for user to input the hydrodynamic require information as:

- Start Date
- End Date

User must check [***Wind Data Setup***] Fig 73 will display for user to input Type of wind data entry as follows:

- Constant Wind Speed data [***Constant Wind speed***].
- Variable wind Speed Data [***Load Wind Speed***]. From Data file [Wind speed, Direction]

User must Check [***Start Simulation***] Fig 74 will display to enter the following

- Time of oil spill in hour of first day.
- Oil Spill Location(Longitude/Latitude) in Degree
- Oil spill Volume

User must press on [***Save spill Location***].
To check location press [***Show***]. Spill location Will display on Map as DOT.
To start oil spill simulation in Fig 74 two option display as follows:

- Point Source Simulation
  User can setup Number of Particle as represent the oil spill volume
  Then must select **[RUN]**
  A Snapshot of oil spill simulation shown in Fig 75

- Continuous Spill Simulation
  User can set [***Spill Time in Hour***] as follows
  - [0] : mean the oil spill continuous spill until the end on simulation
  - [A number on Hour] : Mean; that the total of oil spill hours. Then after that oil spill will stop until end of simulation.

  User can setup ***Number of Particle*** as represent the oil spill volume
  Then must select **[RUN]**
  A Snapshot of Continuous oil spill simulation option shown in Fig 76

User can run the oil spill result Animation by check [***Simulation Output***] from Fig 76.
Figure 77 will display snapshot of the result animation of oil spill particle for every time step

Display Oil Spill Result On Google user must check [***Google map On/Off***] as shown in Fig 78.
A new frame will display information for selecting the Google map option as in Fig 78
Then user must select [***Google Map Show***] in fig 78
Fig 79 shows oil spill on Google Map.
Fig 79 shown The Part of Html file created to display oil spill location Data on Google Map.

Figure 70

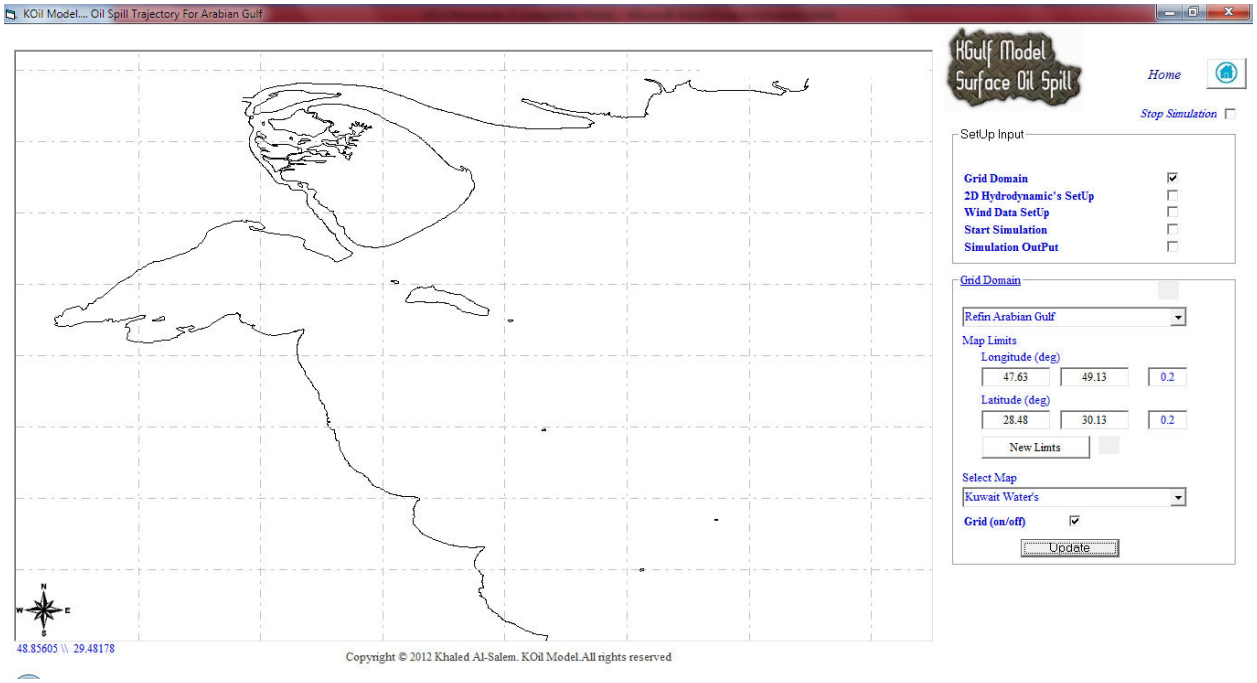

Figure 71

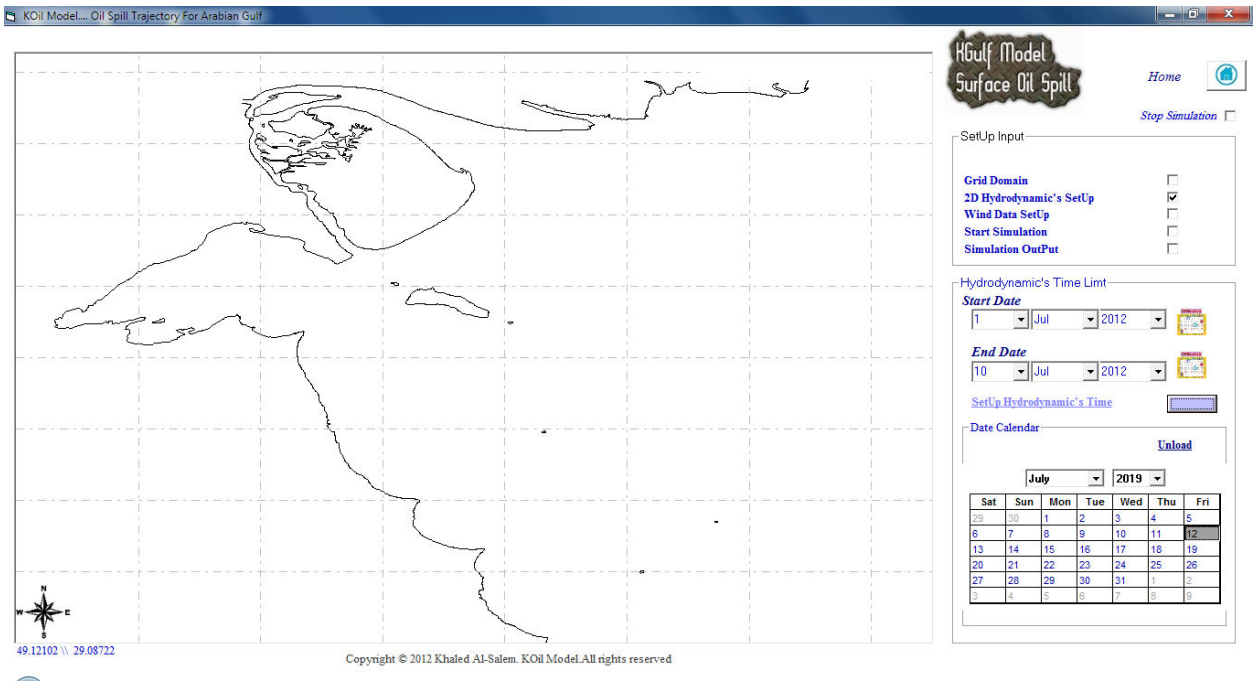

Figure 72

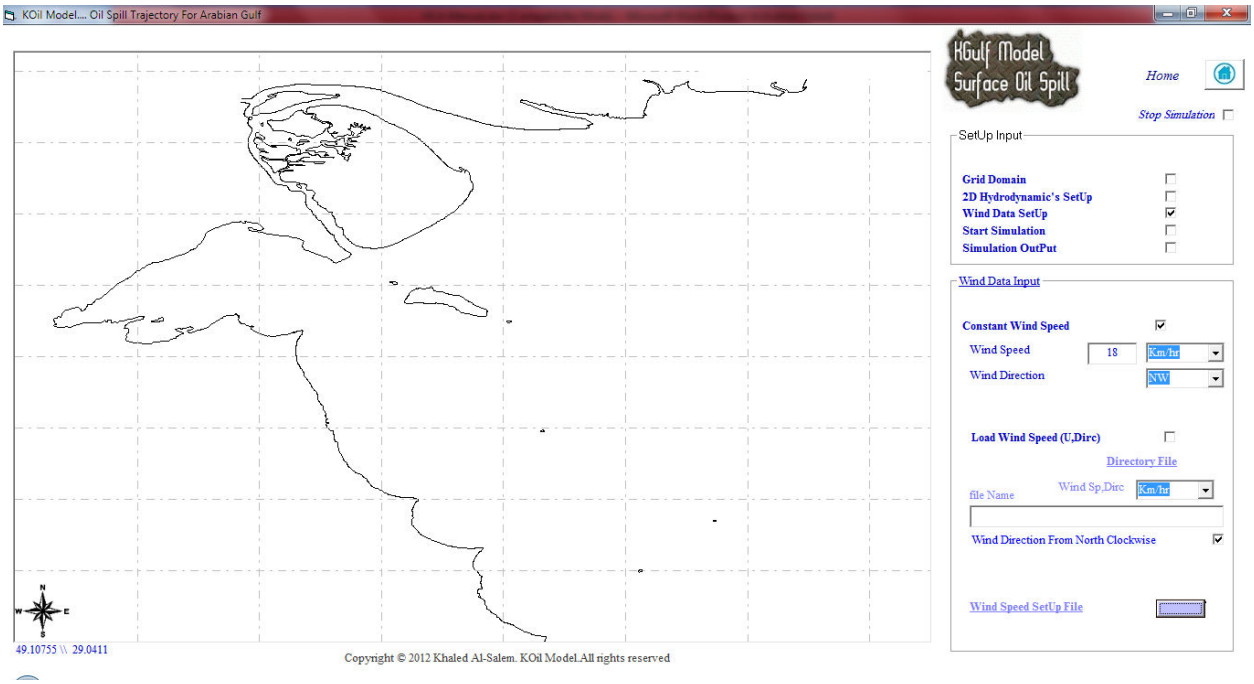

Figure 73

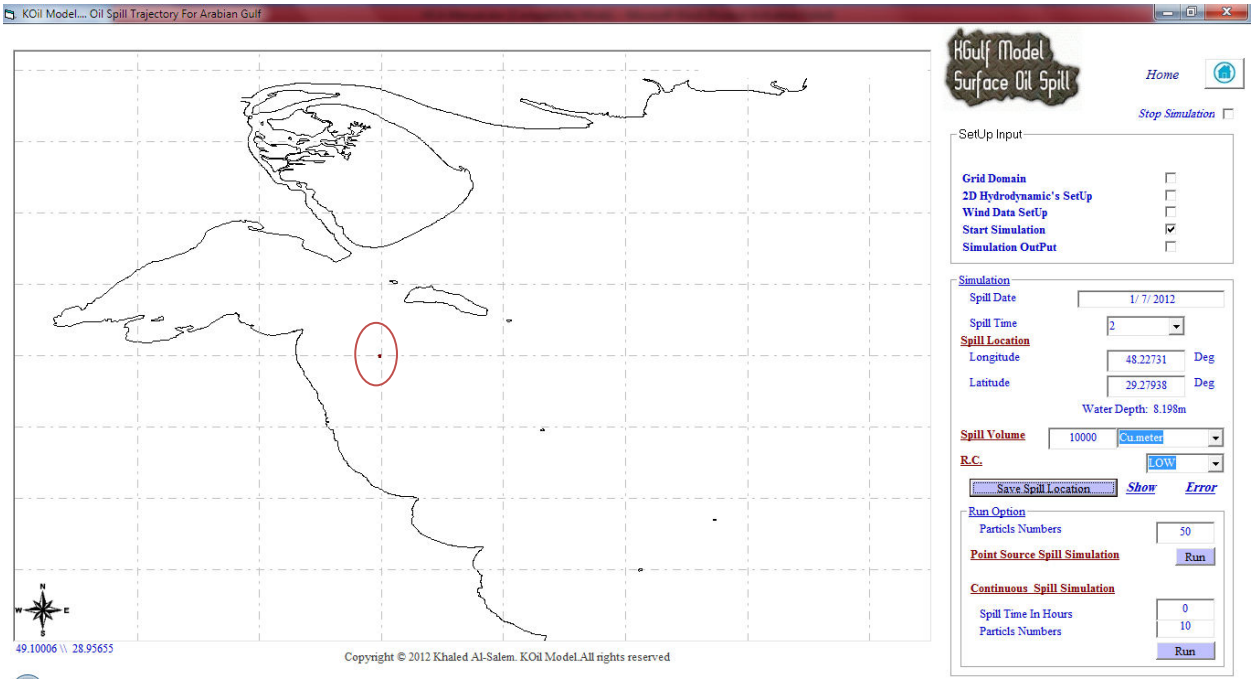

Figure 74

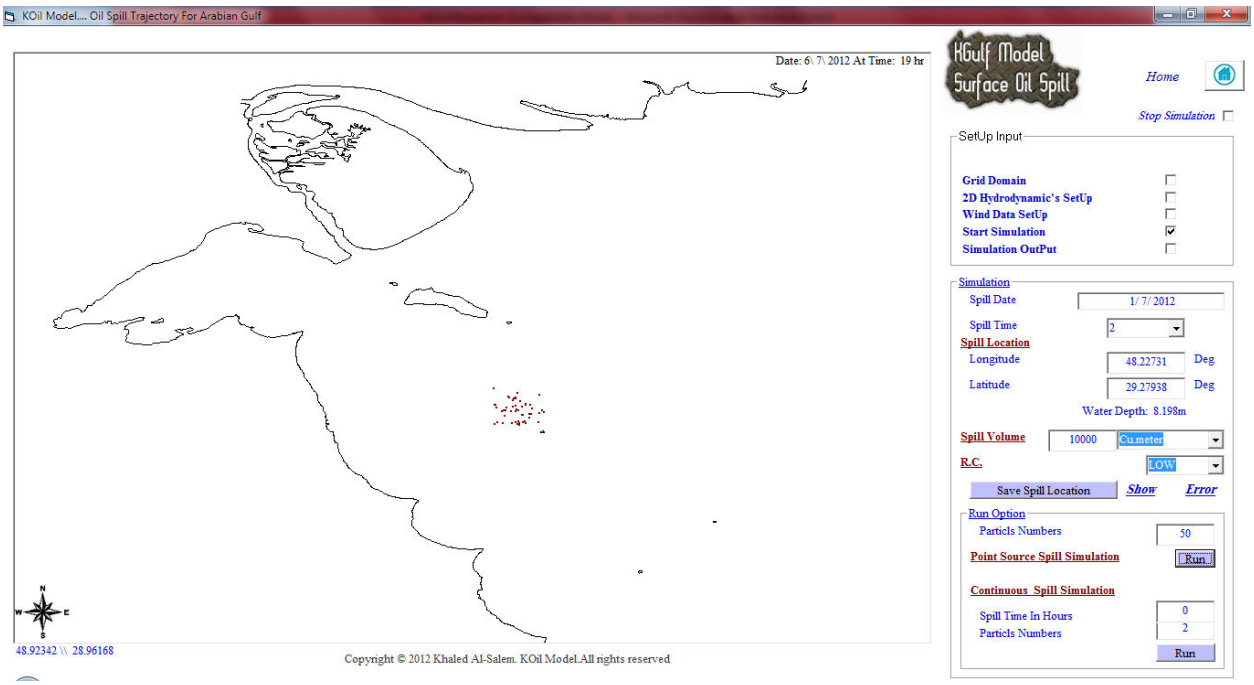

Figure 75

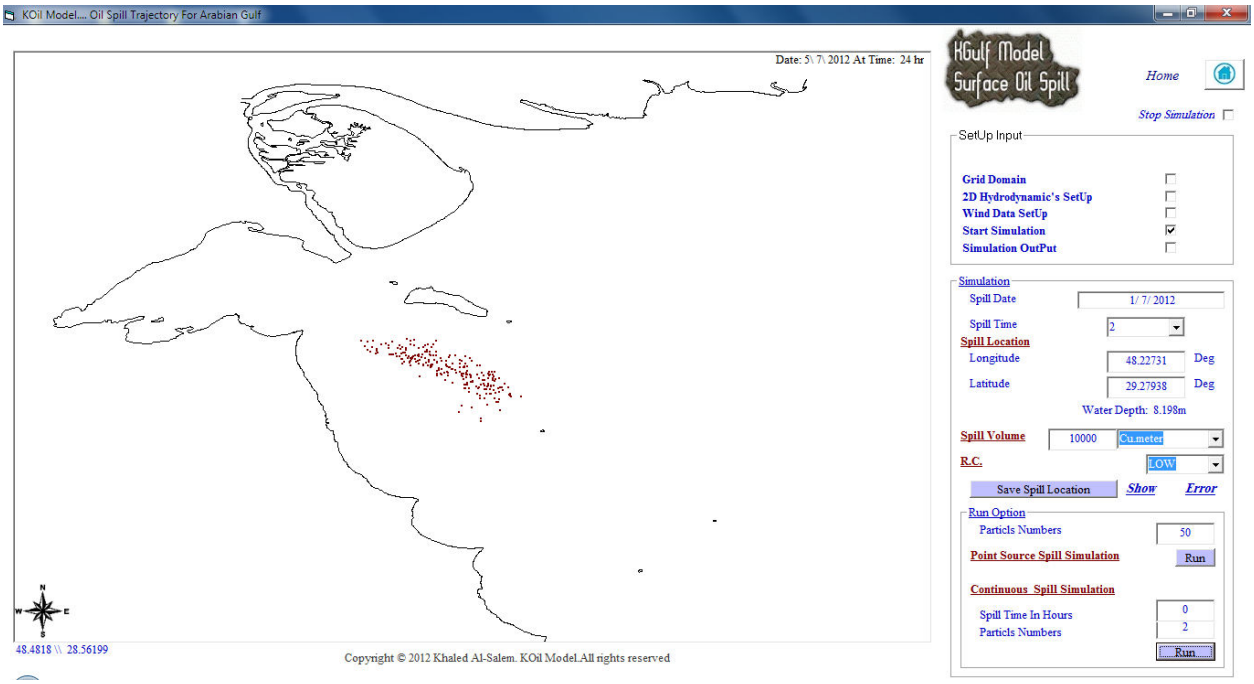

Figure 76

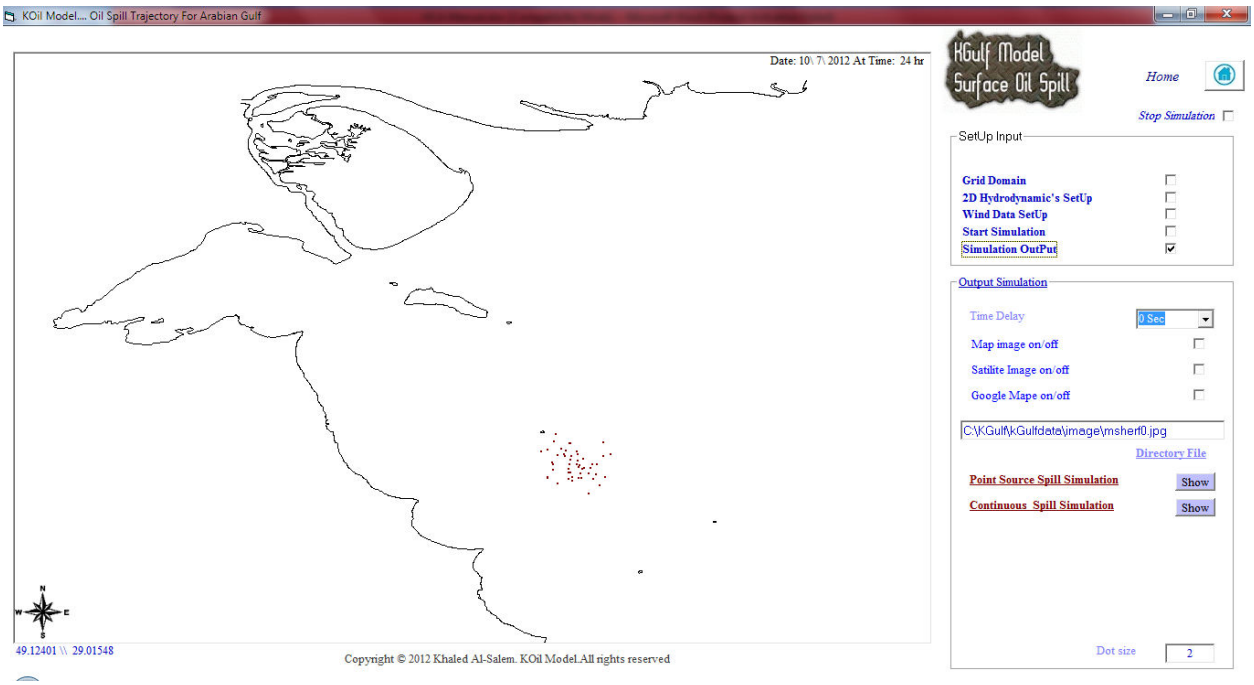

Figure 77

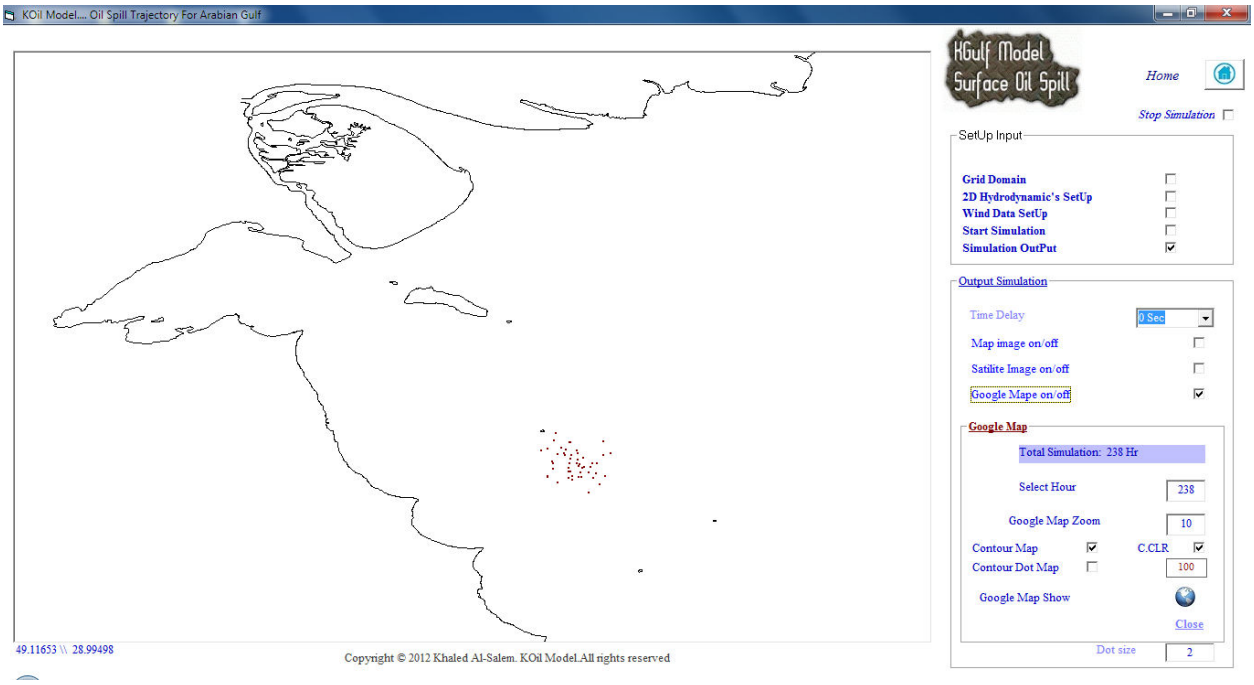

Figure 78

Copyright @ K. Al-Salem - Oil Spill Location on Google Map (KOil 2012)

Google Map

```
<!DOCTYPE html>
<html>
  <head>
  <meta http-equiv='content-type' content='text/html;charset=u
  <meta http-equiv='X-UA-Compatible' content='IE=edge'>

    <title>KOil Model(2012)</title>
    <style>
      #map {
        height: 100%;
      }
      html, body {
        height: 100%;
        margin: 0;
        padding: 0;
      }
      #floating-pane {
        position: absolute;
        top: 10px;
        left: 25%;
        z-index: 5;
        background-color: #fff;
        padding: 5px;
        border: 1px solid #999;
        text-align: center;
        font-family: 'Roboto','sans-serif';
        line-height: 30px;
        padding-left: 10px;
      }
      #floating-panel {
        background-color: #ffff;
        border: 1px solid #999;
        left: 1%;
        padding: 5px;
        position: absolute;
        top:100px;
        z-index: 5;
      }
      #floating-pane2 {
        background-color: #fff;
        border: 1px solid #999;
        left: 1%;
        padding: 5px;
        position: absolute;
        top:80px;
        z-index: 5;
      }
    </style>
  </head>
  <body>
    <div id='floating-panel'>
      <button onclick='changeOpacity()'>Intensity</button>
    </div>
    <div id='floating-pane2'>
    <textbox id='tv4' >Date: 7\ 2\ 2005 02:00 ?</textbox>
    </div>
    <div id='map'></div>
    <script>
      var map, heatmap;
```

Figure 79