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An Oil Spill Spatial Data Model for Qinzhou Bay Based on the KML

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Abstract: Qinzhou Bay is an important channel of Chinese southwest goes to sea. The Qinzhou Bay was chosen as the study area in this paper. Using the international advanced model Oilmap, Analysis of oil spill on the initial oil membrane formation factors, exclude some of initial oil film effects are not important factors, Find suitable for oil spill earlier an oil spill force model. Combined with the natural condition of Qinzhou Bay, The transport process of oil membrane in the condition of different wind and current was observed in Qinzhou Bay by means of experiments. This paper analyzes the main factors, such as the shape of oil membrane and migration directions, which leads to the oil spill, and got a suitable model of oil spill to Qinzhou Bay. In order to achieve its visual in the software of geographic information system, the model of oil spill was defined through the KML. *Copyright © 2013 IFSA.*

Keywords: Qinzhou bay, Oil spill, Spatial data, Model, KML.

1. Introduction

Qinzhou Bay is located in the south of Qinzhou city, Guangxi province China. It is in the north of Beibu Gulf, adjacent to the continents. The Bay faces to Southeast Asia, backs the southwest of China. It is the most convenient sea access for Southwest China to Southeast Asia, Europe and Africa, and to enter the international market [1]. Its position is shown in Fig. 1.

The Qinzhou Bay looks like a gourd. It is composed of three parts, external bay, internal bay, and neck bay. The external bay is main body portion of Qinzhou Bay, the neck bay is near to Longmen Port, and the internal bay refers to the area of Maowei Sea. The entrance of the Bay is width 29 km, depth 39 km, coasting long 336 km, and its total area is 380 km [2], as shown in Fig. 2.

In recent years, Qinzhou City vigorously develops the market economy, expands trade, and changes the navigation environment of Qinzhou bay. Along with the settling of million tons oil refineries

of PetroChina in Qinzhou, and the settling of 20000000 cubic meters of large-scale oil storage project in Qinzhou port, the number of tanker in Qinzhou Bay increases. The ship collision event in the region, especially the oil spill caused by the tanker collision, would seriously affect the water and surrounding sensitive resources of the Qinzhou Bay. With the construction of port terminals, the expansion of capacity of navigation channel, and the ton increase of oil dock, the shipping traffic within Qinzhou Bay will grow exponentially, thus the possibility of the vessel traffic accident increases, and eventually the occurrence risk of ship oil spill accident increases too. So, the oil spill accidents of Qinzhou Bay may occur mainly in the waterway and near the mouth of the Qinzhou Bay. The grounding and collision accidents of ships may be the main reason of oil spill acid accident [3].

Fig. 1. The location of Qinzhou Bay.

Fig. 2. The shape of Qinzhou bay.

2. Oil Spill Process

General oil spill process: after entering into the sea, the oil spreads around and formats large areas of oil membrane under the effect of gravity, inertia, viscosity and surface tension. The different components of Crude oil, diffuse and migrate in the sea under the actions of the wind and the tide, and then dissolute and emulsification. Finally they gradually fade away after photolysis, hydrolysis and biological degradation [4], as shown in Fig. 3.

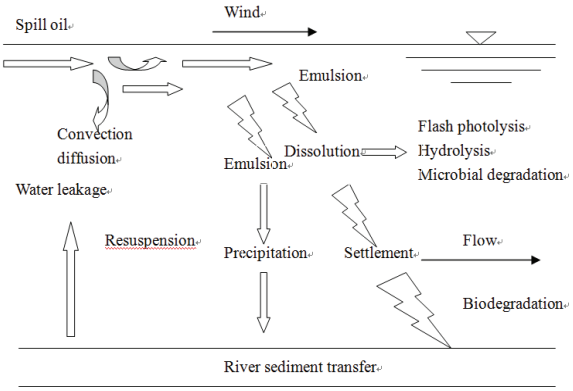

Fig. 3. The process of oil spill.

3. Principle and Application of Oilmap

3.1. Principle of Oilmap

Oilmap is an trajectory and fate model of oil spill developed by an applied science company in the United States (ASA – Applied Science Associates, Inc.). Since the 1984, when McCay Deborah [5] French applied Oilmap model for the assessment of natural resource damage, the model have frequently applied in the risk assessment of oil spill has and it was used in the simulation verification of the oil spill accident of Exxon Valdez tanker. Up to now, Oilmap also have application case in China.

The leak oil can be simplified as oil particles with the quality in Oilmap trajectory model, and each particle represents corresponding scores of the quantity of oil leakage. The drift algorithm of oil film in this model considers the joint action that wind, wave and current, density bring to the slick. The Lagrange particle tracking method is used in the push flow process and the calculation of random walk method is used in the diffusion process. Particle drift velocity Uoil (unit: m/s).

$$Uoil = Uw + Ut + Ur + \alpha Ue + \beta Up,$$

where Uw is the velocity components generated by the interaction of the wind and waves, m/s; Ut is the velocity components generated by the interaction of flow, m/s; Ur is the velocity components generated by the interaction of residual current, m/s; Ue is the velocity components generated by the interaction of Ekman stream, m/s; Up is the velocity components generated by the interaction of the jet stream, m/s; α

is the parameter, floating particles is 0, and particles under the surface of water is 1; β is the parameter, non-jet type of leakage is 0, jet type of leakage is 1.

Oilmap model is used for the calculation of the weathering process of oil spill. The weathering process includes extension, evaporation, water, emulsification and adsorption with shoreline. Comply with quality conservation; the calculation process covers the spilled oil existing in water, sediment, atmosphere, shoreline adsorption and the spilled oil by manual control and removal. The oil diffusion is a very complex process. It is affected not only by a variety of internal factors of the oil itself, but also by the meteorological, hydrological and other external factors. In general, the three stages that the oil enters into the sea are the stage of experiencing, chronic proliferation diffusion, the stage of viscous diffusion and the stage of surface tension diffusion.

3.2. Application of improved Oilmap

When the oil spills, wind, currents, waves play a decisive role. The evaporation, water carrying, emulsification and shoreline adsorption occurs in long periods, which have small effect in the definition and evaluation of the oil spill model, especially, for the inner bay and the mouth area of the bay, such as Qinzhou Bay near shore wave source in deep water waves. The waves from deep into the shallow waters, water depth on its effects become more and more important, from the viewpoint of energy, this effect can be divided into three forms: one is the energy change caused by shallow, it through the shallow make fluctuation energy accumulation; the second is the topography and flow induced by wave refraction, diffraction and reflection, the adjustment of the direction of propagation of the wave, the wave energy in the horizontal spatial convergence and divergence occurs; the bottom friction and crushing function, it swings at bottom and internal loss fluctuation energy, resulting in the attenuation of wave. So, on the Gulf of Qinzhou oil spill models are mainly the wind and waves. The main roles of oil spill are from wind and water power. So, in this paper, the definition of oil spill model can be generally described as Uoil =Uw+Ut. Uw means the velocity components generated by the interaction of the wind and waves, m/s; Ut means the velocity components generated by the interaction of flow, m/s. Fig. 4 shows:

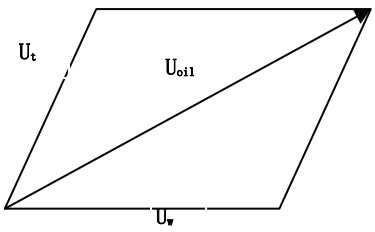

Fig. 4. The analysis of oil spill stress.

4. Application of Oilmap in Qinzhou Bay

4.1. The natural condition of Qinzhou bay

Wind velocity, wind direction: the average wind speed in the Qinzhou Bay is 17.5 m/s, and maximum wind speed is 36 m/s. N-NNE winds prevail in winter, and S-SSW winds prevail in summer.

The characteristics of tide: hydrological factors directly affect the movement of the oil film in water. Qinzhou Bay tide is diurnal tide, and its characteristics are as follows: the highest tide level is 5.83 m; minimum tide level is -0.69 m; the mean level is 2.40 M; the average high tide level is 3.66 M; the average low tide level is 1.15 m; the maximum tidal range is 2.51 M; the average duration of rising tide is 23 min; the average duration of ebb tide 8 h.

The characteristics of tide current: the average velocity is 0.08-0.28 m/s; maximum velocity is 0.54 m/s; the mean velocity and maximum velocity are both faster than ebb tide's.

Wave characteristics: Qinzhou bay locates the south of Beibu Gulf. The wave frequency of NNE and NE is max, and the wave of SE-SSW is second-rate wave, while the wave of SE-S is the main wave. The average wave is 0.52 M in height. The average cycle is 3.1 s. The maximum wave is 4.1 m in height. The maximum cycle is 8.7 s.

4.2. Experimental Observation

Within a year, Chose Qinzhou bay two main wind direction in three time points, with three times the same amount of oil. In the outer bay near the port area, Conducted three experimental observations. Observational data as shown in Table 1, the observation area such as Fig. 5, three observation results as shown in Fig. 6, Fig. 7, and Fig. 8.

Fig. 5. Target position.

Table 1. The measured data with three times.

Obervation time	Wind directions	Wind speed m/s	Flow direction	Flow velocity m/s	The tide
2012.01.03	15	2.7	150	0.15	The ebb tide
2012.06.03	160	4.1	160	0.2	The ebb tide
2012.11.05	25	5.0	290	0.18	The ebb tide

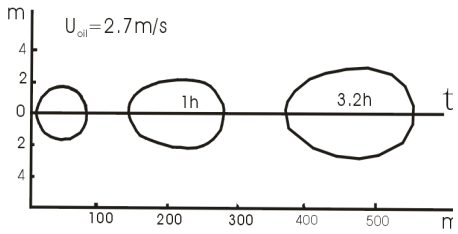

Fig. 6. Observations in January.

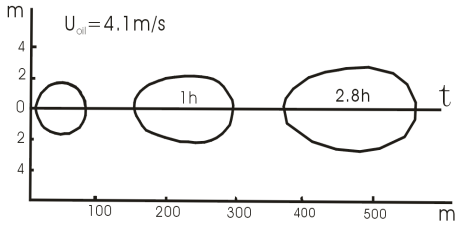

Fig. 7. Observations in June.

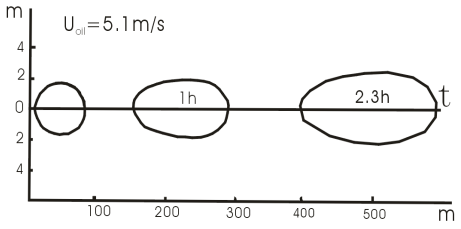

Fig. 8. Observations in November.

5. Model Definition

From the results of observation, when the oil spill is affected by external force, it will develop towards the ellipse. Although is not a regular ellipse. But to predict the practical sense, the ellipse to define could objectively show the oil spill model in initial shape, and is favorable to the KML or XML definition, reach a kind of automatic drawing and display requirements.

The ellipse shape in oil spill model can be defined with the statement.

5.1. Definition of Ellipse

```
<body>
    <svg xmlns="http://www.w3.org/2000/svg" version="1.1">
        <ellipse cx="180" cy="80" rx="100" ry="50"
            style="fill:black;stroke:purple;stroke-width:2"/>
    </svg>
</body>
```

Define the code:

Xml define the namespace and version use the program. The cx and cy defines the x and y coordinates center of the circle. ry defines the vertical radius. rx defines the horizontal radius.

The initial center of ellipse is oil spill point, behind the center position is Uoil force action distance. The ratio of the long axis and the short axis is determined by the external force Uoil. So, according to the measured force and time, with the extensible markup language, the elliptical shape can be described. The floating direction of oil spill is decided by the external force.

5.2. Describing Track

```
<kmlxmlns="http://earth.google.com/kml/2.2">
<Document><Placemark>
<name><%=bb.getoilcode()%></name><%//
code%>
<visibility><%=bb.getVisible()
.equals("1")?"1":"0"%></visibility>
<LookAt>
<longitude><%=bb.getLocX()%></longitude>
<latitude><%=bb.getLocY()%></latitude>
<altitude>0</altitude>
<styleUrl>……<styleUrl><%// Display style >
<Point><coordinates><%=bb.getLocX()%>,<%=
bb.getL
ocY()%>,0</coordinates></Point>
<Folder><name> Trajectory
<%=bb.getBoatName()%></name>
<Placemark>
<LineString>
<tessellate>1</tessellate> <%// Track line
attached on the surface of the earth %>
<coordinates><%=locstr%></coordinates>
```

Oil spill position and path to the KML file; including oil spill NEWReal time location (<Placemark> tag), as well as from the location specified period orbit (<LineString> tag).

5.3. Oil Spill Dynamic Position

```
<NetworkLink>
<name> position </name><open>1</open>
<Url>
<href>
<![CDATA[http://<%=request.getServerName()
%>:<%
request.getServerPort()%>/boatloc.jsp?
start=<%=starttime%>&to=<%=totime%>]]>
</href>
<refreshMode>onInterval</refreshMode>
<refreshInterval><%=interval%></refreshInterval>
```

Through the network access to the latest oil spill position calculation results

6. Conclusions

The major factors that affect the drift of oil spill are wind and surface sea current, so it can identify the direction and speed of oil spill by meteorological and hydrological conditions. But at the same time, it should also be noted that oil spill is a complex process affected by many factors. The observation and prevention should be closely related with the actual situation.

The shape of oil film is related to wind and surface current. The faster these two synthesize, more slender the ellipse appears. Conversely, the ellipse is short round. In the prediction process, it can be considered as an ellipsoid, and the axis of ellipse can be drawn by the speed at that time, which does not affect the overall prediction results. But in the actual process, there has broken trend, because the film is intricately affected by a variety of natural factors.

Due to a long period of spill, the large area of influence and the complicated factors, some oil spill events should especially pay close attention to local conditions in real time.

Acknowledgements

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