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A visualization system for oil spills IN Qinzhou Bay based on Google Earth

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Abstract

The main aim of this paper is to provide a visualization solution for oil spillages. Using local conditions in the target research area Qinzhou Bay, an important access point to the sea for southwest China, the paper proposes a model to construct an oil spill visualization system which reveals as many impact factors as possible and is adapted for this region. Due to its rich image resources Google Earth was selected as a client when constructing the system. It also involves Oracle, which is suitable for storing large amounts of data as a backend database. This paper resolves KML data exchange and data storage issues between Google Earth and Oracle by connecting them in the Qinzhou Bay oil spill visualization system.

Keywords: Oil spill, Geoserver, Visualization system, KML

1. Introduction

Qinzhou Bay is located in the south of the Guangxi Zhuang Autonomous Region of China. It is in the north of Beibu Gulf, adjacent to the continent. It provides very important access to the sea for southwest China [1] and the most convenient sea access for shipping bound for the Middle East.

In recent years, Qinzhou City has vigorously developed the market economy, expanded trade, and changed the navigation environment of Qinzhou Bay. It has built 10 million ton refineries and reserve bases for crude oil. Due to the increased numbers of tankers in Qinzhou Bay the risk of crude oil spillages caused by maritime collision has risen, posing a serious risk to water quality and the surrounding sensitive resources of Qinzhou Bay. Its position is shown in Fig. 1.

Using the rich image resources of satellite remote sensing Google Earth and visual technology [2], this paper creates a model of an oil spill to fit the environmental characteristics of Qinzhou Bay, and the model forecasts the area and track of the oil spill. It provides effective support for decision-makers and emergency response teams and seeks to boost the coastal ecological security of Qinzhou Bay in particular, and Guangxi Province in general.

Oil spill models in previous research were developed for emergency response to incidents, and are mostly used in the emergency response system to facilitate the important role of technical support. In practical application, all of the oil spill models what-

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Figure 1: The location of Qinzhou Bay

ever their theoretical basis involve: (i) the process of inputting the status, meteorological and oceanic data and the type and physicochemical properties data of the oil spill, and (ii) outputting the predicted results and expansive drift of the oil spill through extended computer calculations.

This model is purposed to simulate the extensive trajectory and end-result of oil spill drift according to the given parameters and based on a prediction program of extensive oil spill drift through extended computer calculations [3]. The whole results-prediction and extensive drift process of the oil spill model are displayed in time sequence. The assumption underpinning the development of the oil spill model is that the computer can execute reverse operations in the prediction program of extensive oil spill drift by altering the parameters and realizing the reverse operation in the model and simulating the opposite trajectory of the oil spill.

Each subroutine in the oil spill model is capable of performing independent operations. The liquid substances in the oil spill are supposed to be solid substances. The influencing parameter in the subroutine of evaporation and emulsification are changed. The oil spill model becomes an overlay model of the wind field model, flow field model, oil spill transport model and image processing program, which achieves the aim of simulating the trajectory of a suspended solid floating in the sea.

CAROCS considers advection caused by sea currents and wind, wave height and direction vertical and horizontal diffusion of oil spill droplets and vaporization and dispersion. The model utilizes a high resolution operational model for the sea as well as a wave forecast model as input [4]. Poseidon services Live Access Server Oil Spill Drifts Data Base FerryBox Previous forecasts Satellite Images HF Remote Sensing POSEIDON mobile [5].

The two models rely on high resolution image calculation and accurate prediction, which affects the information processing capacity and translates into long computing time and high performance requirements.

2. Model

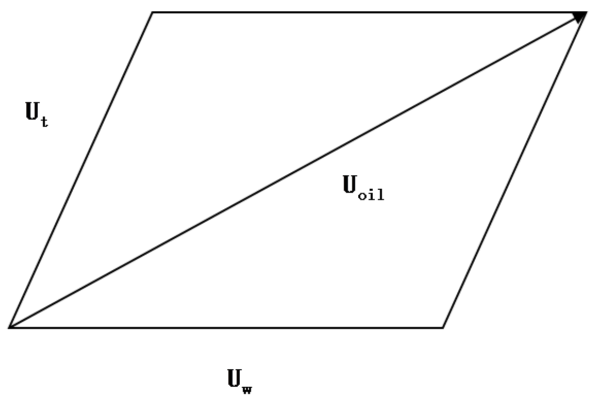

Figure 2: The analysis of oil spill stress

When an oil spill occurs, wind, current and wave play a decisive role, with another factor being evaporation. Since water carrying, emulsification and shoreline adsorption usually occur over a long time, they have less impact on the definition of the oil spill model. For the inner bay and bay area such as Qinzhou Bay, the main effects on an oil spill come from wind and water forces. Therefore, in this paper the definition of the oil spill model can be summarized as the $U_{oil} = U_w + U_t$. U_w represents the velocity components produced by the wind and the waves, measured in m/s. U_t represents velocity components produced by water flow, measured in m/s. It is shown in Fig. 2.

The figure will tend towards the elliptical when the oil spill is affected by an external force. The ratio of the long axis and short axis of the ellipse is determined by the external force U_{oil}.

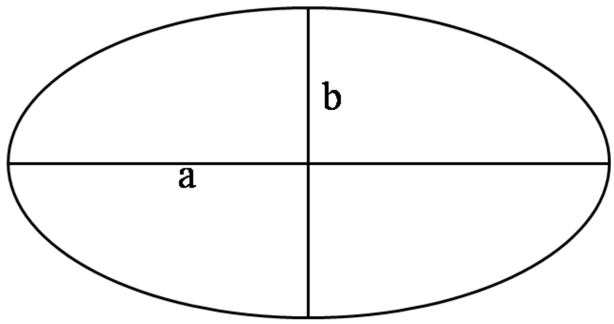

Figure 3: Oil spill elliptical model

In this paper, because the results are produced through prediction, according to observational results, the model can approximate the formula below:

$A/b = U_{oil} + t$. t refers to time, and the unit is hour.

So according to the measured force and time, the general shape of an ellipse can be described by extensible markup language. The floating direction of the oil spill is the direction of the joint force.

3. System design

3.1. System architecture diagram

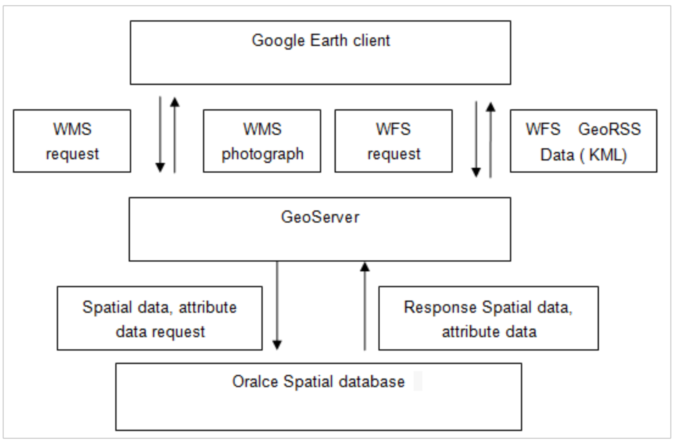

Figure 4: System architecture diagram

The system adopts C\S mode and makes full use of the rich geographic resources of Google Earth. It connects the backend database by Geoserver [6], and the system architecture is shown in the Fig. 4.

3.2. The problem of integrating spatial database

Google Earth has two main expansions. One is data expansion, and the other is function expansion. The former allows users to add data to Google Earth through the KML file. The latter allows users to develop a new function by controlling the Google Earth program through Google Earth Com Api. The kind of spatial data is variable. The formats of data are different. The acquisition time is not identical. The spatial data has various types with multiple scales, spatial references and projection. Therefore, if the spatial database and Google Earth are integrated together, the data should be converted into the standard markup language of Google Earth, namely KML.

Through the flexible view of Google Earth, both positioning information and geographic spatial relations can be observed. Oracle Locator and Oracle Spatial can be used to provide analysis of spatial and non-spatial data based on the server, and Google Earth can be used as a front-end user to analyze this kind of information. However, if the Oracle database and Google Earth can be combined together, a custom interface that can output KML or KMZ should be constructed first for the Oracle database. In this paper, GeoServer outputs KML/KMZ from Oracle Spatial. GeoServer can automatically output KML/KMZ from Oracle Spatial, or use the standard format WMS, and the value of "format" is PNG.

We know from the description above that GeoServer is a communication bridge of other geospatial service / servers, and the normative implementation of J2EE for OpenGIS Web server. It can release map data conveniently and allow users to update, delete and insert feature data by using GeoServer [7]. The spatial information can be shared rapidly between users through GeoServer. GeoServer is compatible with the properties of WMS and WFS. It supports PostGIS, Shapefile, ArcSDE, Oracle, VPF, MySQL, MapInfo and hundreds of projections [8]. It outputs the network map as jpeg, gif, png, SVG, KML and other formats. The format of the data can be converted. Through the function of middleware, the differences between a different operating system platform and database platform can be shielded after the middleware, and it professionally implements the technology required by spatial data management and application for efficient sharing and interoperability between different clients. These provide strong support technology to solve bottleneck problems. The spatial database can automatically output as KML/KMZ through GeoServer, and through the primary filter query by GeoServer, the output of the KML is provided as a service to Google Earth, which is convenient to show on the map.

(1) It completes the combination of relevant interface functions between Geoserver and the spatial database. The technology makes rational use of Geoserver, and realizes the transformation, access and analysis of spatial data by relevant interface functions. Hence, it delivers the desired high efficiency, simplicity, flexibility etc.

(2) The technology integrates the spatial database, Geoserver and Google Earth. GeoServer integrates the spatial database and Google Earth. The date information of the spatial database can be observed by Google Earth. Both the positioning information and the geographic spatial relations can be observed due to its economic and flexible view. It researches the efficiency of the system processing user requests, which improves the response speed of the system.

The data achieves incredible transparency and can be used immediately through powerful tools, such as Oracle Locator/Oracle Spatial and Google Earth. These two tools also increase the complexity of the structure of the whole system, because they were not developed together.

GeoServer is a communication bridge of other geospatial service / servers, and the format of the data can be converted easily, dynamically (improvisationally).

4. System development

Based on the development platform of Microsoft Visual Studio 2005 and Google Earth API, the Uoil model defined by KML can be applied in the visualization project to deal with an oil spill incident in Qinzhou Bay, and the process is shown in Fig. 5.

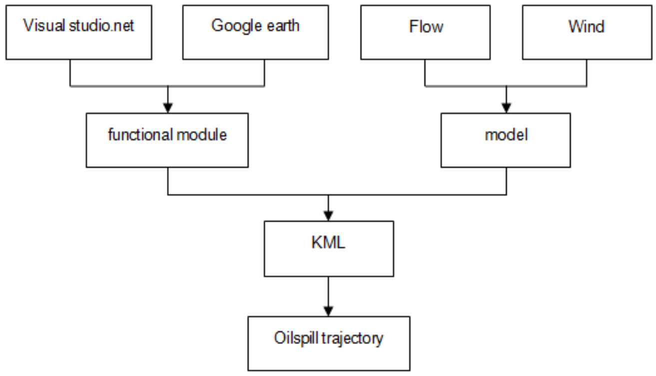

Figure 5: Flow chart of system design

The system can measure currents and wind speed around a known oil spill site. The basic situation of the oil spill after 6 hours can be gained by inputting data. The effect diagram is shown as follows:

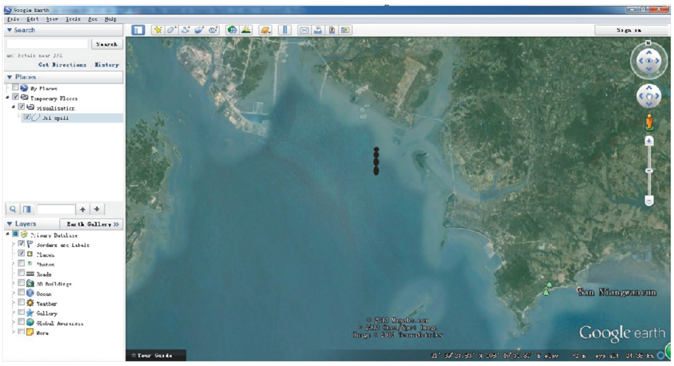

Figure 6: The Client interface

Figure 7: Client displays of the oil spill diagram

At 9 am on July 30, 2012 a simulation test was done of an oil spill in the Gulf of Qinzhou. The system model was inputted with currents and wind field parameters and tasked with predicting the track 24 hours after the oil spill, the diffusion area and other property changes, using the Google Earth system dynamic display (as shown in Fig. 7). The distance between the system forecast of the July 31st 9 a.m. position and the actual position measured with instruments was less than1km. The degree of error is acceptable. The simulation of the oil spill incident basically accords with the actual movement of the oil spill, so the predictions of the oil spill forecasting system can be applied to the actual behavior of oil spills.

5. Conclusions and future work

This paper fully proves that it is completely feasible for the oil spill model to use Google Earth as the client, and connect it with the spatial database to save the data, which performs the general prediction for the visual process and trend of the oil spill in the sea. Geoserver plays the bridge role, and it converts the spatial database format into KML format. The whole process is an assembly of components, and the workload is relatively light.

But at the same time, we also must be aware that behavior of oil spills in the ocean is a complex process, which is influenced by all aspects of factors and constraints. The oil spill model is the key to accurately predicting the development of an ocean oil spill. During the design process, the oil spill model and the offshore actual situation of Qinzhou Bay only factored in the main effects of the oil spill model to predict results. In practical work, it is also necessary to make appropriate adjustments and modifications to fit the present situation.

Acknowledgements

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References

[1] Y. Bai, S. Liao, Analysis on the features of seabed stability in qinzhou bay, guangxi, Marine Science Bulletin -Tianjin-Chinese edition 24 (2) (2005) 27–33.

[2] N. Francula, D. Tutic, R. Zupan, Google earth, Kartografija i Geoinformacije 5 (5) (2006) 112–115.

[3] P. Deborah, F. McCay, Modeling impacts of oil and chemical releases, Sea Technology 47 (9) (2006) 21–26.

[4] J. K. Thakur, S. K. Singh, A. Ramanathan, M. B. K. Prasad, W. Gossel (Eds.), Geospatial Techniques for Managing Environmental Resources, Springer and Capital Publishing Company, 2012.

[5] [link].
URL `http://www.poseidon.hcmr.gr`

[6] J. Sherwood, J. Fitzgerald, Security in the client/server environment, Computer Fraud & Security Bulletin 1994 (12) (1994) 8–16.

[7] X. Yu, H. Liu, Y. Yang, X. Zhang, Y. Li, Geoserver based forestry spatial data sharing and integration, Applied Mechanics and Materials 295–298 (2) (2013) 2394–2398.

[8] T. Rafoss, K. Slid, A. Sletten, L. F. Gyland, L. Engravslia, Open geospatial technology standards and their potential in plant pest risk management-gps-enabled mobile phones utilising open geospatial technology standards web feature service transactions support the fighting of fire blight in norway, Computers and Electronics in Agriculture 74 (2) (2010) 336–340.