THE THEORY AND WORKFLOW-ORGANIZING OPERATING MODEL OF EMERGENCY INFORMATION RAPID PUBLICATION

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KEY WORDS: Emergency information rapid publication, Workflow-organizing, XML, symbol extraction arithmetic, fuzzy comprehensive evaluation

ABSTRACT:

This paper is about the new theory and modeling framework about emergency information rapid publication, we defined and analyzed the connotation and extension of emergency information published rapidly, then put forward a hierarchical concept model based on workflow and a hierarchical descriptive model of XML metadata, and upon which established a mechanism based on workflow assembly and execution navigated by XML metadata. This paper will introduce a new approach-- the symbol matrix and arithmetic of symbol pick-up by fuzzy comprehensive evaluation. By analyzing an example，the effectiveness and practice of the present method are proved.

1. INTRODUCTION

China is a disaster ridden country. Only the meteorological disasters caused more than 4,000 people dead every year, nearly 400 million people affected and nearly 50 million hectares of crops affected [1]. At present, spatial information technology, such as remote sensing (RS), geographic information system (GIS), global positioning system (GPS), has become commonly used by government emergency response as the high-tech means. In relief work of Sichuan Wenchuan "5.12" earthquake, the spatial information technology played an important role in disaster monitoring, disaster assessment, disaster relief, secondary disaster prevention, disaster recovery and reconstruction work. In China, the prevention and management of emergency incidents attached great importance, so a national emergency mechanism is established, which has great significance to "enhance the government ability of protecting public safety and dealing with emergency, maximize the prevention and reduction of sudden public events and the damage, protect the public lives and property, keep national security and social stability, promote economic and social development.[2] " The information publication of emergency incidents is an important way to obtain information to meet the needs of different receptors, is the key means for the command, coordination, maintenance social stability.

At present, the major developed countries has established relatively perfect systems for emergency disposal, and carried out research in related fields. In China, the research about emergency management is relatively lagging, especially in the emergency information management. In China, the information publishing content still remains in the original data and text-level. The dissemination of information processing systems has been mostly manual intervention, with a low degree of automation and a simple release form. So it needs to carry out the study of emergency information publication theory, publication content (integration attribute information events with closely associated spatial information and other attributes, etc.) and related technologies (visualization, automated and rapid publication).

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1.1 Definition of the emergency information distribution

In order to discuss the emergency information distribution, it is important to define its intention and extension clearly. As we know what it is, we can know what to do next. In a word, definition of the emergency information publication is the base, which can help us to understand it well. In this paper, we define the emergency information distribution from two aspects.

1.1.1 Definition of emergency incident Emergency incident is a type of disorderly incident affair. Because people have few knowledge and information about emergency incident, many problems caused by emergency incident belong to structure badness or non-structured problems. Emergency incident is very difficult to be forecast. If emergency incident cannot be deal with effectively and immediately, emergency incident will lead to crisis. Emergency incident can be considered as the former stage of crisis. Compared with common incident, there are three characters of emergency incident: emergency, ponderance and necessity.

There are many factors led to emergency incident. The factors are intricate and complex, include inside and outside, nature and man-made. Considering the region disaster system theory, emergency incident (B) can be regarded as the result of people (P), substance (S) and emergency environment (E).

$$B = P \cap S \cap E \qquad (1)$$

Where P and S are the sufficient condition of emergency incident, E is the background condition which affects P and S. Aiming to recent research area, E is the earth physical system, includes atmosphere, lithosphere, hydrosphere and biosphere. According to the origin of emergency incident, emergency incident can be divided into two types: condition emergency incident and random emergency incident. The former is caused by wrong judgments, wrong actions, substance factors and natural factors. Condition emergency incident happens with some inevitability. Through analyzing the incident condition, cause and effect, the probability is estimated, such as earthquake, flood disaster, explosion and so on. The latter is

caused by the desire change, misgovernment or social factors, such as inflection, foreign dispute, war and so on. According to the factors such as character, severity degree, controllable degree and influence area, emergency public incident is divided into four levels: Ⅰlevel (special magnitude), Ⅱlevel (magnitude), Ⅲlevel (biggish) and Ⅳlevel (common).

1.1.2 Definition for information dissemination Here is not to define the theory and method of information dissemination, but on the definition for issuance objects of information. First we define the concept of the occurrence of events, frangibility of losing and risk.

1. The occurrence of events (Hi) is the probability which the intensity occurrence is equal to or greater than disaster events of i in the range of exposure time t . It is obtained by the probability of emergence $p(\tau)$ multiplies the intensity of sensitivity $m(i)$, that is, Hi $= p(\tau) \times m(i)$. The probability of emergence $p(\tau)$ is triggering factor τ of physical processes (such as the possible greatest rainfall in 50 years) and the intensity of sensitivity $m(i)$ is the support of certain area is equal to or greater than the intensity i for the incident of disaster.

2. The frangibility of losing (Ve) is that the inherent tendency of certain type of cell is affected or subjected to the risk of loss when disaster incidents with intensity i are happened. Ve can be assessed by Hi and it also can be assessed by combining with the history treasury or expert treasury.

3. The risk (Re) is the probability of loss occurring of the impact of unit e (for example, in a given time t, exceeding the influencing probability of certain society and economy) when the incidents of disaster happened with the intensity equal to or greater than i ; Re = f (Hi, Vi). In other words, the risk can be understood as the geographical distribution of potential destroy or the spatial distribution of social and economic losses that may arise.

Through analyzing the information of unexpected incidents, we believe that obtaining emergency information at least containing the incident occurring (Hi), while the frangibility of losing (Ve) or risk (Re) is not necessary. Emergence incidents promulgating information must include the incident occurring (Hi) at the same time the frangibility of losing (Ve) and risk (Re) contain at least one (example, experts may need to release the information of emergence incidents and other information related to emergence incidents which they need, while for the general public we could release the information of unexpected events and the information forecast). Natural and socio-economic background data is the basis of carrying out emergence information publication. Background data mainly includes landform, river system, population, settlements, transportation routes, power lines, communication lines, urban and rural settlements, economic output and other important facility aim.

Through the distinction among the incident occurring (Hi), the frangibility of losing (Ve) and risk (Re) , we make part of natural and socio-economic background data to contain.

1.1.3 Definition of the speed of information dissemination Time is the units for measuring the speed of information dissemination. Acquirement, analysis, information disposal of different emergence incidents is different because of different technique and requirements. Rapid information dissemination is a process effectively by various advanced technology tools, in meeting the emergency to the required disposal time, to make the kinds of artifactitious information which is related to emergence to publish through certain channel as soon as possible. The basic factors of restricting the time T of information dissemination are as follows:

(1) The cycle $T(\alpha)$ which is original information Obtaining: Obtaining the original information which contains emergence incidents is the start of information processing and publication. $T(\alpha)$ is mainly affected by technology and sudden events, such as a satellite obtain data for the cycle of 24-hour and the data a moving target (satellite communications position) is acquired for the cycle of 10 seconds in a district; Another example is that for the country a certain level of flood disaster information is acquired for the cycle of generally not more than six hours, and for the same level of infectious diseases information is acquired for the cycle of generally not more than 24 hours. Even if the same emergence incidents, acquisition cycle for the data in different stages is not the same. Generally the higher the ponderance is, the worse the controllability is and the greater scope of the phase of access to data is, the shorter the cycle is, and vice versa is longer.

(2) The capacity of information processing (processing time $T(\beta)$): the capacity of information processing include a variety of software and hardware equipments, technical routes and arithmetic, is the greatest telescopic tache in the whole process of information dissemination. For different processing capabilities, the system's processing efficiency, accuracy, publication results are very different and they are the key to decide information dissemination.

(3) The nature of the emergency incident (the cycle $T(\mu)$ of information release for emergency incident): our country's momentous emergencies are divided into natural disasters, incidents disasters, public health and public safety incidents, that is, they are 4 categories, 15 sub-categories and 95 sub-categories. For different emergencies departments and all levels of governments have established a correlative lash-up. Some plans make a request for related information publication for emergency incident (including the cycle, the scope, timeliness, etc). Generally the higher the ponderance is, the poorer the control is and the greater the incidence is, the shorter cycle for the information of the events is, and vice versa is longer.

To sum up, in general, information publication time T at the ideal state can be expressed as follows:

When T(u) is incertitude or T(u) is certain but nonrestraint，
$0 \le T(\alpha), T(\beta) < \infty$,

$$T = T(a) + T(\beta)$$

When T(u) is certain and restriction, $0 \le T(\alpha), T(\beta), T(\mu) < \infty$,

$$T = Max((T(a) + T(\beta)), T(u))$$

For above, if $T(\alpha) + T(\beta) > T(\mu)$, then $T = T(\alpha) + T(\beta)$, we consider that this is a void publication, that is, publication

time is greater than the need to disposing of emergence incidents. General, $T(\alpha)+T(\beta)<T(\mu)$, when $T(\mu)$ is certain and restriction, $0 \leq T(\alpha), T(\beta), T(\mu) < \infty$, that is, departments or levels of governments make rigid rules for the cycle of information publication. At this time $T = T(\mu)$, $T(\mu)$ is certain. Therefore, it is outside the scope of the study. This paper aims to study when $T(\mu)$ is incertitude or $T(\mu)$ is certain but no restraint, $0 \leq T(\alpha) , T(\beta) < \infty$, $T = T(\alpha) + T(\beta)$, and $T(\alpha)$ is the cycle obtaining original information which is only restricted by external conditions, not in the scope of the study. Therefore, the objective of this paper will be how to make $T(\beta)$ the minimum. Using the new design of workflow and the arithmetic of information publication will increase the degree of automation of systems and reduce the degree of human intervention, not only reduce $T(\beta)$ but also improve the accuracy of information publication.

2. THE HIERARCHICAL INFORMATION RELEASE MODEL OF EMERGENCY BASING ON WORKFLOW

Workflow is an important coordination mechanism [5], whose aim is to achieve an automatic description and operational of the whole or part of the business process. Service is the composing units of the service workflow. A service environment is composed of web services and other services that is the workflow operation environment. Service environment includes service and resources which are used by services. All entities in service environment are resources, such as data files, processing power, storage systems, database and so on. This part introduces a hierarchical description model from the workflow of the high-level business to the bottom of services basing on workflow aiming at information dissemination for emergence incidents. In accordance with the task granularity and abstract level we make model by workflow from high to low layer by layer. From top to bottom we respectively define business workflow, abstract workflow and implementation workflow.

2.1 The definition of the concept

1. Business Workflow (Business Workflow, BWF) (or the workflow of application) is to finish the specific business functions and use business terminology to describe the workflow. BWF is constituted basing on field knowledge by the person (the compere of emergency or experts in the field) who applicants business. This layer mainly forms the general plans and business programs facing to business.

BWF is mainly composed of the task nodes for supporting semantic sharing and interoperability which is cross-field and cross-system. The task nodes in BWF all use standardized business terminology to describe. In the business workflow layer, we need to consider when the BWF is running how to interact between business users and the workflow, control to implement workflow in time and ensure workflow to finish a preconcerted disposal in accordance with the requirements.

2. Abstract workflow (Abstract Workflow, AWF) (or an abstract service workflow) is a workflow for completing a description which has a specific business function and adopt the standard resource class which is defined by the organization (abstract services or abstract resources). The task nodes in workflow are described by abstract services (the service class and interface, etc) and the data nodes are described by abstract data (the data class). The layer is the middle-tier workflow while it is implemented and it is normally disposed to the service environment by BWF. This layer also support implement the workflow, binding specific resources and services for the next layer.

3. Executable workflow (Executable Workflow, EWF) is the workflow after abstract work realizing services and data selected and bound and this layer can be directly deployed to service environment to implement. Because the service environment is dynamic,we need consider self-adaptability and robustness in the process of implementing EWF. The issues include failure of transferring resources, processes stop, deadlock, handling exception and the strategy of resource selection. Adown it ensures the effective scheduling of resources and up ensures the reliable implementation of the business process. The task nodes and data nodes in EWF respectively use services instances and data instances to describe. Table 1 gives a demonstration of a three-tier workflow to describe in words.

Workflow-level	tasks in the workflow	data in the workflow
BWF	described by business terminology, such as "calculating sequence "	described by business terminology such as "exclusion zone"
AWF	described by abstract services, such as "damage assessment"	described by virtual resources, such as "RS 11 μm wave band "
EWF	described by services, such as http://192.168.11.1:8090/-gserver/EvaluateService	described by services, such as \\192.168.11.11\5wdrg\-G45C001003.raw

Table 1 the descriptive example for a three-tier workflow

2.2 The hierarchical concept model based on workflow

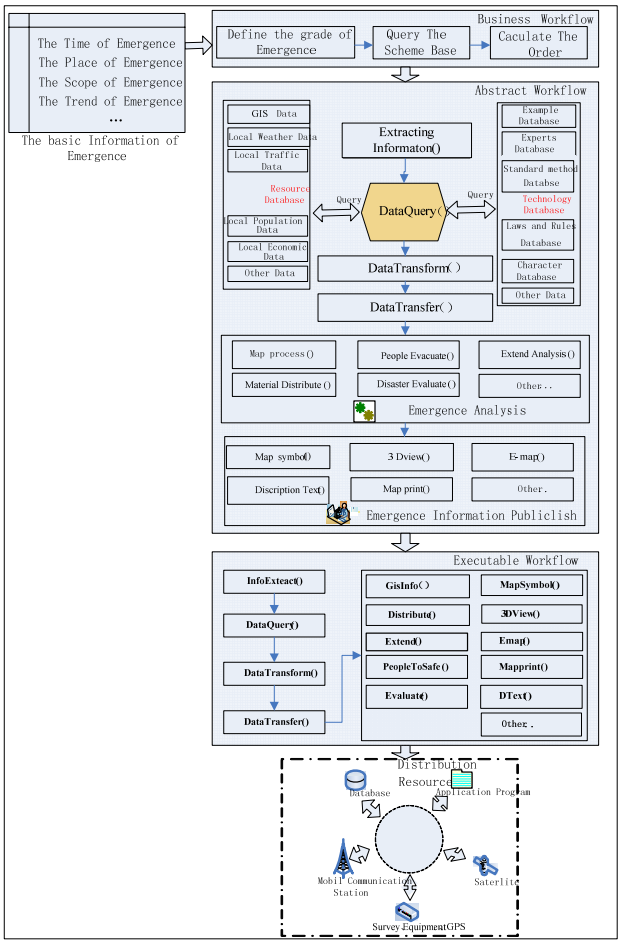

Figure1 The hierarchical concept model based on workflow

1. When the Emergence Processing center received the information about the emergence，the decision-maker made a release scheme about emergence by the emergence rulers or the leader's order，that is called emergence business workflow. Then the decision-maker made the particular scheme in order. The business workflow is absolute described by the emergence data，and independent of material or abstract resource.

2. Every business node in business workflow will be mapped to next abstract workflow layer. that is, Calculation order will be made, the necessary information for analysis or publication about the calculation will be extracted, then we catch the service by calling data. The data for query is different by the kind of the emergence, summing up as resource database (such as GIS data, weather, traffic, population, economic, etc) and technical database (such as example, the analysis standard, laws and rulers, characters about emergence).Those different data above will be translated to XML and transferred to local, then users can use those emergence to process services. These services and resource in abstract workflow are abstract described and not refer to particular services and resource.

3. The abstract services and resource in AWF should be translated to particular services and resource in EWF, and set in service computer to work as a workflow. The abstract services such as " Information extract 、 Data transfer 、 material distribution 、 map symbol match 、 map printing" will be mapped to services instance such as functions " Infoextract()、Datatransfer()、materialdistribution()、mapprinting()"，those services instance are in a computer and banded to particular resource. The services are distributing and dynamic, so the method of choosing services and resource instance should be set according some factors such as load、transfer bandwidth、services quality、etc.

3. THE METADATA OF HIERARCHICAL EMERGENCE INFORMATION PUBLICATION BASED XML

Metadata is a kind of describable information about data. including content 、 quality 、 station and other characters. Metadata in net environment mainly include the description about some kinds of net resource, such as address、service、user、authority, etc, also some wording、meaning. XML is set by W3C organization, and it is credible and has good interoperability. XML could provide the method of translating structural data from application program to system. We use XML as the description for the metadata of hierarchical emergence information published model.

3.1 The description for the metadata in Business-Layer

BWF is made in Business-Layer in hierarchical emergence information publication model. Business in BWF could be triggered semi automatic. The metadata of BWF-Layer include business knowledge metadata and meaning metadata.
Business knowledge metadata mainly includes some kinds of emergence knowledge, such as response plan、example and description of business, those metadata could help users to find the information of the business automatic and match the operation knowledge such as the response plan and rules, from those plan, business plan will form a primary solution, then form BWF, the metadata of meaning is the basic information about some emergence, it is defined based meaning rules, and it could help users to adjust and optimize the BWF fragments.

3.2 The description for the metadata in Tasks-Layer

BWF is a task sequence. Every task node could be mapped to an abstract service and an abstract resource sequence. Metadata of Tasks-Layer mainly describes the mapping relation of task node and abstract resource and service. Based those relation, a business workflow document could automatic map to abstract resource and abstract workflow described by abstract resource. The following is a sequence XML description. (Fragment):

```
<! DOCTYPE task-order SYSTEM
http://www.casmGDE.com/GDE/task-order>
<Task-order>
  <TaskName>"task sequence"</ TaskName >
    <AbstractWorkFlow>
      <activity>
        <sequence>
          <invoke portType = "extract information" operation
= "InfoExtract">
          <parameters  variable type = "string"/>
          <output  variable type = "string"/>
          </invoke>
```

```
            <invoke portType = “get data” operation = “DataQuery”>
            <parameters variable type = “string”/>
            <output variable type = “string”/>
            </invoke>
            <invoke portType = “translate data” operation = “Datatransform”>
            <parameters variable type = “string”/>
            <output variable type = “string”/>
            </invoke>
            <invoke portType = “transfer data” operation = “Datatransfer”>
            <parameters variable type = “string”/>
            <output variable type = “string”/>
            </invoke>
            …
            <return><output variable type = “string”/></return>
          </sequence>
        </activity>
    </AbstractWorkFlow>
</Task-order>
```

3.3 The description for the metadata in Criterion-Layer

Metadata in Criterion-Layer is an abstract description of the same services or data in distributed service environment. The abstract service metadata in this layer is the dependence for services of other business. The metadata in this layer is mainly composed of some inherited information, it is the united description of some standard resource class. Every resource class (or example) is different from others. For example, there are some functions such as “ Infoextract()、Datatransfer()、materialdistribution() 、 mapprinting()” in abstract service classes, abstract data class includes spatial data、non – spatial data、other data, etc.

3.4 The description of the metadata in physical layer

Metadata in physical layer mainly describe the detailed resource such as the service examples in distribution environment or data example. Metadata records in physical layer were made by the shared resource and services in every business registered in metadata database in physical layer by interface. Those records mainly included resource URL、IP、the type of service container, and so on. Metadata in physical layer describes the information not only about the shared services or data resource but also about the host machine’s hardware system for resource choosing module. Metadata for releasing mainly includes spatial data and attribute data, spatial data is mainly about layer name、spatial scope、the type of database、visit method, etc. The design of service metadata is refered to the web UDDI norm – Index Service norm in Globus Toolkit 3.x,which describes services name 、 function 、 deployment station、service interface、service port、service parameter、access right, and so on..

4. SYMBOL PUBLICATION PROCESS

Map symbols are atlas language and could express information effectively, which are composed of some graphic and character with different shape、size and color. Compared with text language, the greatest attribute of map symbol is clear at a glance. A map symbol could show the location 、 size 、 number、type，and so on. A map symbol class could show the distribution of elements, a collection of map symbols could show the relation of elements and overall regional characters, so symbols could show not only the basic function such as the location、distribution、number、quality but also the extend function such as the relation and overall regional characters. Map symbols matched is defined that extracting the symbol target which is fit for the emergence from a lot of symbols or symbol database for expressing emergence symbolic.

Definition 1 (Reliability): Things in reality is material, while the symbol is abstract, so there is gap between the abstract symbol and the things described by symbol, we use reliability (φ_{ij}) to measure this gap. So we define φ_{ij} is the degree of agreement for symbol (I) substituting the case (J). $0 \le \varphi_{ij} \le 1$， i∈ symbol， j∈ case， φ_{ij} is non dimensional。 The greater φ_{ij} shows that the gap is more little，that show that the symbol is more similar to the thing.

The value of φ_{ij} is different. For example, the degree value of φ_{ij} (Symbol ✚ substitutes the hospital) is different by different people. So φ is a self defining value, those show different people has different understanding for the same case.

Definition 2 (Symbol matrix): Symbol matrix $A(i)_{m\times n} = (\varphi_{ij})_{m\times n}$, which shows the φ_{ij} collection. The definition of φ_{ij} is from above definition 1.

Definition 3 (attribute matrix): Attribute matrix $L(i)_{1\times m} = (l_{kj})_{1\times m}$， which shows the relation of attribute K and class I, m is the number of class I. We define $l_{ij} = 1$ when K consistent with J in class I, otherwise $l_{ij} = 0$; For example, if we define class I is {drought, weather disaster, earthquake, geological disaster, typhoon, fire , …},then the attribute matrix of earthquake is {0,0,1,0,0,0,0,…}.

4.1 Symbol Extraction

We suppose the number of emergence attribute which was extracted is n, the attribute matrix is $L(i)$,（i=1,2,…n），

then the Extract and Analysis matrix $X = \begin{vmatrix} \eta_1 \\ \eta_2 \\ \cdots \\ \eta_r \end{vmatrix}$, $\eta_i = (L(i)A(i))^T$ （i=1,2,,,r,r is the symbol’s number）.

4.2 Symbol Classification & Analysis Arithmetic

How to classify X is important for symbol extraction, which we put forward the fuzzy synthetic method into. The fuzzy synthetic method classifies the samples by some index. The calculating steps are:

1. Confirm the fuzzy relation matrix Ri (including the membership function and the result),,i=1,…,n;
2. Confirm the distribution weighed vector A, A = (a1,a2,,,,an.)
3. Get the evaluating result (Bi) by blur processing, Bi = A°Ri，Bi= (bi1,bi2, , , ,bin), the sample belong to the class k* if $b_{ik}^{*} = \max_{k} |b_{ik}|$

4.3 Example and Analysis

We choose 6 symbols from some symbols collection to evaluate. After extraction the matrix X is as follows:

Symbol Factor in evaluation	A	B	C	D
1	0.9	0.0	0.5	0.2
2	0.1	0.9	0.4	0.3
3	0.0	0.1	0.3	0.7
4	0.1	0.9	0.0	0.6
5	0.2	0.4	0.1	0.0
6	0.0	0.2	0.1	0.1

Table 2: The result of extracting and analysis the character of the symbol

4.3.1 Confirm C --the factor collection in evaluating

We define C is as follows: (Table 3)

Grade Factor in evaluation	A	B	C	D
Ⅰ	0.3	0.3	0.3	0.3
Ⅱ	0.6	0.6	0.6	0.6
Ⅲ	0.9	0.9	0.9	0.9

Table 3: The factor collection in evaluating (C)

We define that the effect of symbol is better as well as the value of factor in evaluating is bigger.

4.3.2 Confirm the membership and weigh Define the membership function of single factor in evaluating is:

$$u_{ij} = \begin{cases} 1 & 0 \le d_i \le c_{ij} \\ \dfrac{c_{ij+1} - d_i}{c_{ij+1} - c_{ij}} & c_{ij} \le d_i \le c_{ij+1} \\ 0 & c_{ij} < d_i \end{cases}$$

u_{ij} is the factor I and it belongs to membership grade j. d_i is the value of factor I. c_{ij} is the criterion value of factor I in grade J, i = 1,2,3,4， j=1,2,3.

So the membership matrix for all the factors in evaluating of the Symbol K is defined $R^{(k)}{}_{4\times3} = (\mu_{ij})_{4\times3}$, k=1,2,…,6. The weigh parameter matrix A_k = (a_1,a_2,a_3,a_4) which is from

$$a_i = \frac{x_i / a_i}{\sum_{i=1}^{n} x_i / a_i}$$

4.3.3 Fuzzy Comprehensive Evaluation For evaluating the symbol K, We could get the evaluating result matrix by synthesizing A_k and $R^{(k)}{}_{4\times3}$ .In this paper, we use average weigh model M(*,+), which weighed all the factors, is fit for all factors consideration. Then Ak is as follows:

$$B_{6\times3} = \begin{bmatrix} A_1 \circ R^{(1)}{}_{4\times3} \\ A_2 \circ R^{(2)}{}_{4\times3} \\ \cdots \\ A_6 \circ R^{(6)}{}_{4\times3} \end{bmatrix}$$,put the data into,then

$$B_{6\times3} = \begin{bmatrix} 0.23, 0.21, 0.56 \\ 0.39, 0.08, 0.53 \\ 0.36, 0.42, 0.22 \\ 0.06, 0.38, 0.56 \\ 0.81, 0.19, 0.00 \\ 1.00, 0.00, 0.00 \end{bmatrix}.$$

Those show that symbol 1 is better than symbol 2, the electronic map with symbol 1 for publish is as follows:

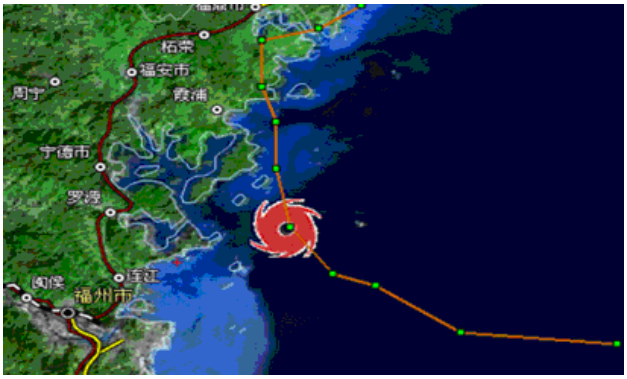

Figure 2: Electronic map with fitful symbol for publication

5. RESULT

In this paper, we studied the theory about emergence information publication, introduced the definition about the object and speech of emergence information publication for emergence management, designed a hierarchical concept model based on workflow in loose coupling and the metadata of hierarchical emergence information publication based XML and the symbol extraction arithmetic by quantizing symbol matrix. We introduced fuzzy comprehensive evaluation in math field to evaluate the result of symbol extraction. The experiment results showed that this arithmetic had good processing performance and universal. In the future, we will do some work as follows: (1) Study the metadata of hierarchical emergence information published based GML for emergence spatial expression in multiple layer. (2) Make the standard of symbol and build the database. (3) Study the complex symbols meaning in multiple symbol collection and the evaluation method.

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