A DYNAMICALLY LOAD AND UNLOAD
ENABLED AGGREGATION MODEL BASED ON THE WPS

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ABSTRACT:

The processing of web-based spatial data is an important issue in the field of Spatial Data Infrastructures (SDI). After analyzing the architecture of the fundamental conception and application supported by the OGC Web Processing Service specification, a common loading and unloading enabled aggregation model is designed, this provides the ability to conflate of geoprocessing service chains dynamically. Common processes to be pushed in the model, the relationship and the intercommunion among geoprocessing chain have to be offered in term of uml sequence. The experiments represent lightweight spatial analysis solutions could be construct flexibly.

1. INTRODUCTION

The rapid development of Networking and distributed computing technologies evolve geographic information system into the common geospatial services. Web services can be simply defined as the information related software entities running in network environment which provides special user to meet the needs of specific information or processing capabilities. With the characteristic of self-contained, and self-describing, geospatial services do not depend on the context or state of other services (Anders Friis-Christensen, 2006). The collection of spatial services has created a technology evolution that moves from standalone GIS applications towards a more loosely coupled and distributed model based on interoperable GI services (Díaz.L, 2007, Granell.C, 2007), Furthermore, most users of traditional GIS systems use only a small percentage of their systems' functionalities; the services model provides users with just the services and data they need, without having to install, learn, or pay for any unused functionalities, that is the motivation of the SDI which concentrate on the interoperability between spatial resource and the applications among the spatial domain.

Recently, traditional spatial data infrastructures had combined various kinds of geospatial services mainly include WMS (Web Mapping Services), WCS (Web Coverage Services), and WFS (Web Feature Services). (OGC,2004a; OGC, 2004b; OGC, 2005b; OGC, 2005c; OGC, 2005d) we can get the meta spatial information from SDI, also view and mapping the data online, the SDI not only provides the functionality on downloading the data but also provides an open spatial data access interface and so on. Thus currently SDI's main focus lies on distributed data storage in the form of spatial services, the retrieval through catalogues, and the visualization in form of web map services. Nevertheless, going on with the geoprocessing service applications in-depth, the functionality of SDI cannot meet the processing and modelling requirements of special users (Caldeweyher D, 2008). At the same time, geospatial services distinguish form business services, While traditional business workflows are oriented towards document processing, task management and control-flow, spatial processing workflows typically are data- and/or compute-intensive, dataflow-oriented, and often involve data transformations, analysis, and simulations. In order to complete a spatial analysis function normally, the task needs to call multiple spatial information services, access to many different types of spatial data through multiple steps, sometimes even repeat the steps. Thus, the need for adaptable interfaces and tools for accessing scientific data and executing complex analyses on the retrieved data has risen in a variety of disciplines (e.g., geology, biology, ecology). The mechanism for such assembly of services is often referred to as service chaining (Alameh N, 2003), the process of combining or pipelining results from several complementary services to create customized applications. GIS services have specific middleware requirements that current Web service technologies can only partially meet.

In this paper, firstly, we present a architecture of aggregation model describes composing the geoprocessing services for disaster assessment. In the model, we present the spatial resource such as shp file, raster, OGC services to be the objects we call layers based logic object conception. The model provides uniform access to the vast amount of spatial data and highly heterogeneous services based on open standards and Internet in the SDI environment. the model that We propose with a plug-in method, on describing the dynamics of their work processes to build geoprocessing chains to demonstrate how within our framework, services can be composed into scientific workflows and executed to perform scientific tasks.

The paper proceeds as follows: Section 2 discusses SDI and geoprocessing services. The design of the aggregation model contributes to services chains that enable to load and unload dynamically. The implementation presented in Section 5 by illustrating a specific application scenario. The paper ends with the main conclusions and an outlook for planned work.

2. SDI AND GEOPROCESSING SERVICES

2.1 Geospatial service

Geospatial Services encapsulates the spatial data access, retrieval, processing and analysis functions and be depicted through a simple and convenient way (xml) for users to provide a unified interface-oriented SOA (service-oriented architecture). spatial information services with the pattern range of the discovery, binding, execution gradually replace the tight coupling pattern between components. Its data and functional characteristics of loosely coupled build the right conditions for spatial information access and the distributed processing. In order to achieve full interoperability among spatial data, functions and software, OGC, and W3C work together to develop uniform standards. The most widespread standards adopted in web oriented spatial Information Technology are including WMS, WFS, WCS, WPS, GML(Geography Markup Language) (Anders Friis-Christensen, 2008).

The Web Map Service (WMS) is responsible for generating dynamically maps from geospatial data, custom map for the "Space Geographic Information Drawn into a suitable screen display digital image files. it can display and integrate various layers of geographic datasets onto the same map. A WMS provides a standardized access to maps rendered in a format such as PNG, GIF or JPEG by using the operations getMap and getFeatureInfo.

The Web Feature Services (WFS) provide access to the distribution of vector based data and support the function of insert, update, and delete, search and discovery geographical elements. The WFS returns a Geography Markup Language

(GML) document, which is an XML grammar to express geographical features.

The Web Coverage Services (WCS) provide the location information or attribute contains in a raster layers, rather than accessing a static map. According to HTTP protocol, client requests to send the appropriate data, including images, multi-spectral images and other scientific data, examples of different data formats supported by a WCS are: DTED, GeoTIFF, or NITF.

WPS defines a standardized interface that facilitates the publishing of geospatial processes, and the discovery of and binding to those processes by clients describes process operation that returns a description of a process including inputs and outputs and the execute operation that performs the calculations and returns the result.。

2.2 SDI orients geoprocessing service

Above the standardized base for GI service we present take the SDI share the spatial data、model、and the applications for user one step further facilitate access to distributed, heterogeneous geospatial data through a set of policies, common rules, and standards that together help improve interoperability (Efrat Jaeger, 2005) Currently, SDI open standards predominantly support the download, retrieval and visualization of spatial data, The following diagram briefly illustrates the architecture of traditional SDI.
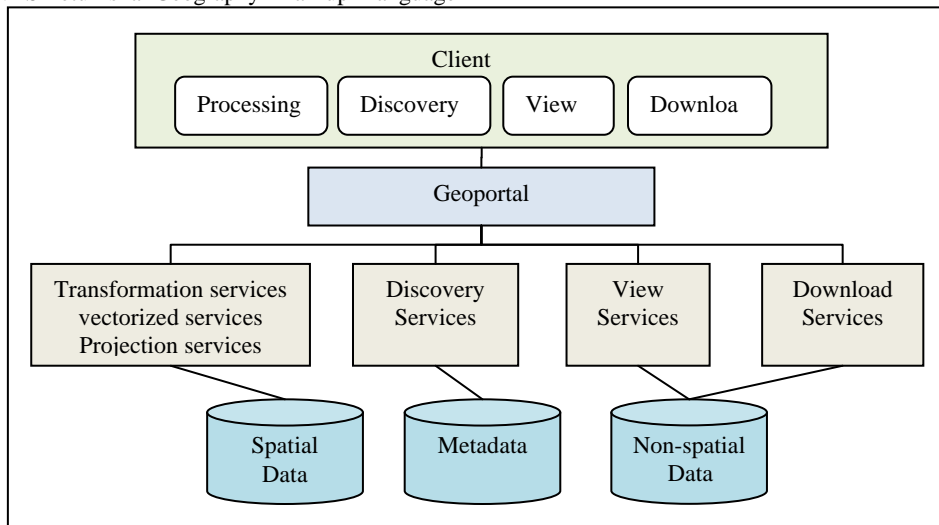

Figure 1 the traditional SDI architecture

From the figure we can see the traditional architecture of the SDI is divided into three layers. The data tier contains metadata directory libraries, geospatial data stored in the space-based database, and the professional sectors based on the topic of application. Service tier mainly provides discovery services, basic spatial data processing services, browsing services, and spatial data download service. In which discovery services called the space directory service can be extracted from the spatial metadata database from the semantic level. The basic spatial data processing services provide projection transformation, coordinate transformation and basic spatial

processing such as map algebra. View services provide WMS mapping services, and WFS services enable to extract the features. Download services provide all levels of users enable to download online data; users do not need CD-ROM, and mobile storage devices to copy the spatial data they required.

However, basic data retrieval and visualization services, far from meeting the needs of professionals or specific user. Special users often want to analysis, processing, modelling spatial data in special areas, and convenient to resolve a complex geo-related issues, that is the in-depth applications

about geoprocessing services. The next step of SDI not only need to access to the data in a unified standard interface, at the same time need to address the specialized data analysis to extract information, even in the service chains. However, the standard geoprocessing services traditional SDI used are static or independent. Lonely geoprocessing service or the simple aggregation of multiple services cannot take on the complex geographical analysis tasks. Therefore, the dynamic assembly of geoprocessing services is significance for SDI.

3. AGGREGATION PROCESSING MODEL

Aggregation processing model aims to address the complex spatial analysis tasks among the spatial domain. Modelling of the geoprocessing services can be deemed to assembly the service according to sequence about the tasks. We call the sequence service chain which is defined as a sequence of services where, for each adjacent pair of services, occurrence of the first action is necessary for the occurrence of the second action.(Di, 2004a) When services are chained, they are combined in a dependent series to achieve larger tasks.

Here we introduce the logic geo-object layer concepts benefit to construct the service chains. At same time a three-tier aggregation model architecture is presented (Figure 2).

3.1 Logic Geo-object layer concepts benefit to chains

Here, we first discuss the issue of granularity about spatial objects. Spatial objects granularity describes the thickness level of spatial objects at different scales and at different spatial coordinate system. In this article we discuss the granularity of the space object is the atomic-level involved in spatial data, space services, and space model of objects, reflects the independence degree of the spatial objects (Di, 2004a), presents a conception of a geo-object consider a granule of geoinformation, which consists of data itself, a set of attributes (metadata), and associations with a set of methods (transformation and creation methods) that can operate on it. At the same time describes the all geoinformation and knowledge products are derived from archived geo-objects based on the principle of object-oriented.

 However, all the geoinformation defined as spatial objects can be derived from the spatial data is not enough to reality. For example, we can abstract a user's request to be a spatial object; although the request can be broken down into many independent geo-objects, however, the irrelevance between the spatial objects the need to binding by the rules-driven library.

Here, we define logic geo-object layer concepts base on the geo-object. all the space features, spatial data, space services such as WMS,WFS,WCS,WPS involved in the spatial processing will be as the independent atomic-level logic object layers comparison with the actual spatial entities stored in the logic container. At the same time the model extracts the logic object layer will involve in the geoprocessing from the user's request as well as aggregation services to complete the operation of the semantic rules.

In order to build a dynamic aggregation model, there is no inheritance and derived relations among the atomic logical object layer, in other words, atomic object are stored in parallel, there is no hierarchy. However, there is a hierarchy between the spatial objects derived from the logical object layer and the atomic logical object layer. This service model can give a high degree of reconstruction between spatial objects. Atoms logic object layers can be seen as the smallest particle size of spatial objects. Due to atomic logical object layer has its own properties and methods that can be seen as plug with the ability of dynamically load or unload, and be generated according to user request. Thus, the aggregation model enables great flexible and reusable. Base on the management on logic object layers, we design the aggregation model. Figure 2 presents a simplified view of the model architecture. In which a range of resource tier prepare spatial data sets and spatial services and processing tier processes the resources and client applications are composing a variety of standards GI services and the show the results.

3.2 Resource tier

The resource tier consists of distributed data set and services container with different types of data and storage systems. at the top of the resource tier is the logic Object container，groups data and services   instances in basic functional categories(see Figure 2). Our system model has focused mainly on processing services, but our processing engine also accesses other resource types, just like topics application data，in order to facilitate access to both geospatial data processing and to discovery, viewing and download of data.

Spatial and non-spatial data container handles data access according to the available database or file system where the spatial data type range of shp file 、raster file 、GML and Poi or statistics data sets. Data services container contains most of the spatial information services in the OGC standards like WMS、WFS、WCS. Professional users not only can access symbolic maps from the WMS services directly, but also can extract interested spatial elements from the WFS, view its spatial properties and other properties. Geoprocessing services can perform complex computations on geospatial data. Which range of coordinate transformation, Rasterize service, vectorize service and so on. In our model processing service design based on wrapping. we have identified atomic spatial data formats as well as its spatial reference information, adopt a uniform coordinate transformation to the aggregation spatial information services, if necessary。

The logic Object container manages all kinds of spatial data, spatial-based services; provide logic level data protection for space aggregation engine as the core resource container of spatial system model. For the spatial processing engine is concerned, it does not need to know the path of physical storage address for the current spatial object, even do not need to know the type of the spatial object, only need to know the uniquely identify of the logic object layer. As a logical layer of spatial objects has its independent methods and properties can be used as plug-ins。
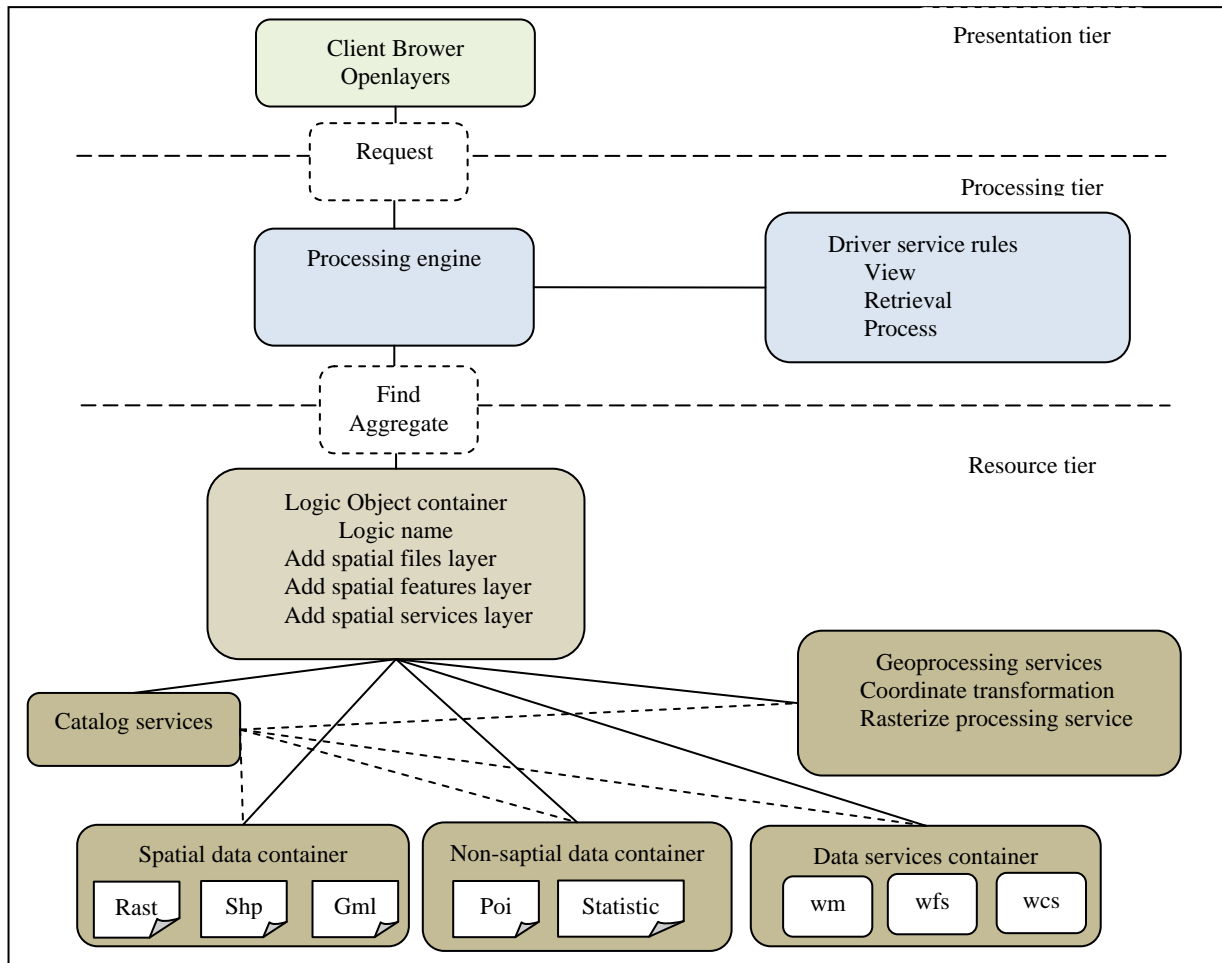
Figure 2. Aggregation model architecture

3.3 Processing tier

The Processing tier contains the business logic of the aggregate model, will be the core module of the whole model. We can take the processing engine as the brain in the whole model; in fact it is a set of GI libraries, takes analysis and decomposition of user-space process the request, while driving rules and to find the logical object layer, finally accomplishes spatial processing tasks. Space rules memory a lot of space predicate, such as browsing, searching, extraction, overlay, intersection, and buffer analysis and so on. It inducts a logical object-oriented layer, as well as behavioral constraints, which is a key node in aggregate geospatial services.

Essentially rules are many rule operators to provide semantic support and interface support; it will automatically decompose user input into a series of logical object layer and the suitable interactive computing actions for the user selection. At the same time the corresponding WPS semantic services. While receiving a series of logical object layer and the corresponding algorithms, spatial Processing engine began to query logic object layer in logic Object Layer Manager.

If it exists, the logical object layer will be instantiated according to the object-oriented thinking, then the model start to find atomic-level spatial objects from the directory services, and load the space resources. If the logic of the object does not exist, model structure it by the logic of space object metadata content which the rule presented. Thus, the task of geoprocessing service aggregation finished due to the specific

rules lead the logical object layer, while processing engine accept the result produced by logical object layer with processing spatial data structure, and in the form of GML passed to the client to carry out the display. Refer to this, spatial aggregation model to complete its life cycle.

3.4 Presentation tier

As the entrance of the aggregation model provides the portal for users to access the data and services provided by our web application. Also accept user-input requests of completing specific spatial information processing and submit it to processing tier. Our client application provides one-stop discovery, access, aggregation and spatial processing results displaying of spatial information services use pure JavaScript and Ajax(Asynchronous JavaScript and XML) method Is a typical thin-client model，For data visualization, we have used the Openlayers API，一种开源的客户端组件 an open-source client-side components for building the user-interface part of the mapping in our application .

4. IMPLEMENTATION

Based on the aggregation model architecture is depicted on Figure 2, we launch an implementation in order to gain the information of typhoon called Wipha had destroyed the GDP of the china in the neighborhood sea. This is a case of disaster assessment for making decision as shown in the figure 3.

Gong with the model needs to access varied data resource via WMS, WFS, and WCS services, besides a catalog service and four different geoprocessing services need to be involved. For the disaster assessment application we have access to the following thematic data, and services which are potentially important for disaster statistics:

- dist_county400, which is a region of the entire county in china. We use it to show the district of typhoon called Wipha traversing.
- typhoon_2007, which is a POI reference data set for the path that the typhoon called Wipha through over.
- Image _GDP_2007, which provides the properties of the GDP of china in 2007
- Image _POP_2007, which provides the properties of the population of china in 2007
- Place names used for locating specific geographic area based on geographic name input.
- The catalog service provides metadata of the various data services.
- The coordinate transformation service is responsible for transforming coordinates into requested
- The spatial intersection service is responsible for gain the region of intersection area.
- The spatial overlay service is responsible for gain the distinct code of current area.
- The GDP and population statistics service is responsible for calculating the areas affected by typhoon

Firstly, geoportal application obtains a user's request through the client application, and sent the user's request to the space rules, which is equivalent semantic decomposition unit. The model query space resources directory According to the spatial logic objects layer and spatial rules. The test under the rule generated six kinds of logical object layer, namely the background WMS layer, the user professional data we called POI published in WFS layer, distinct feature organized in WFS layers, spatial intersection WPS layer and the spatial overlay WPS layer, and the statistic WPS layer. Here, we descript rules as the assessment disaster model; it can accept four parameters, namely the region, distinct code, feature typed KML, and the poi feature. From the WFS service we can gains the distinct code and the costumed data with location information we called poi. From the spatial intersection WPS and the spatial overlay WPS we can handle the region of POI across and return the KML for showing mapping. Here we use code to extract the administrative divisions created SLD logic object layer, as WMS layer added to the client, if the pilot through the figure. The disaster statistics service is invoked after selecting all parameters necessary and a request for data is made. If necessary, coordinates are transformed into projected coordinates and then the assessed area statistics are returned and visualized as a table in the client.
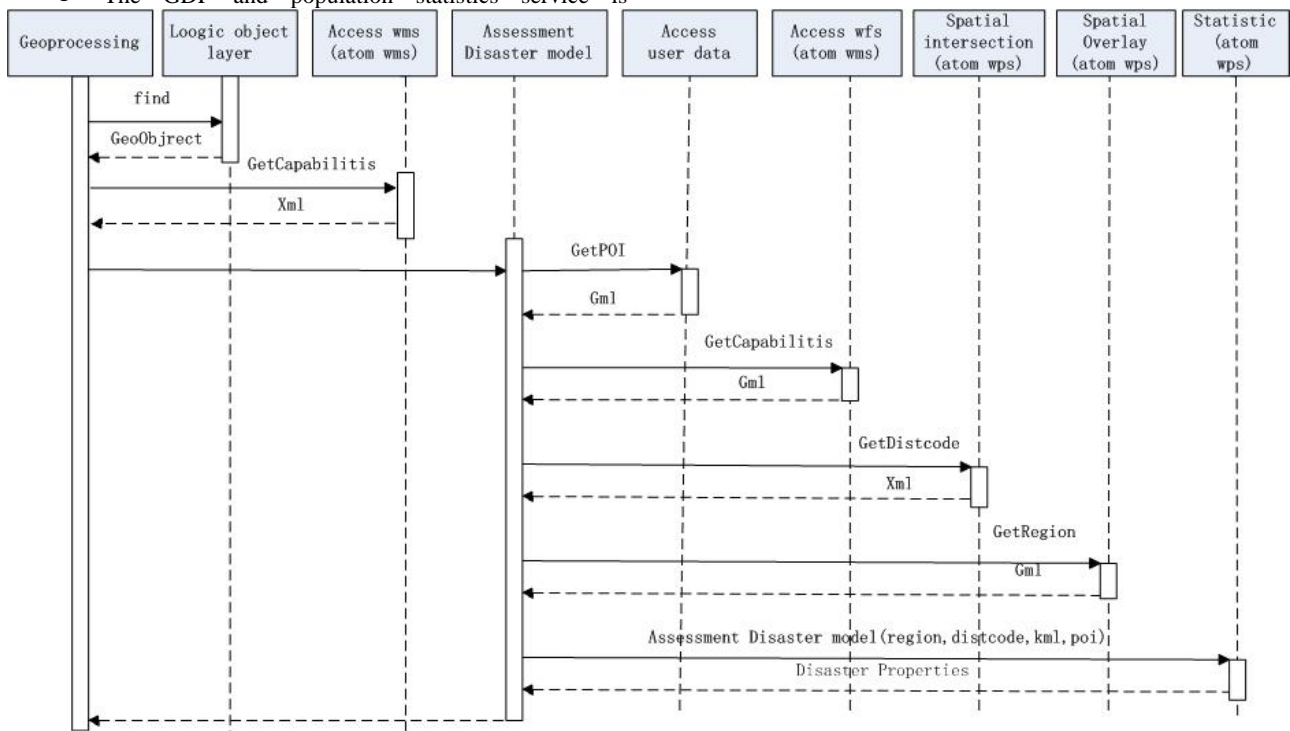

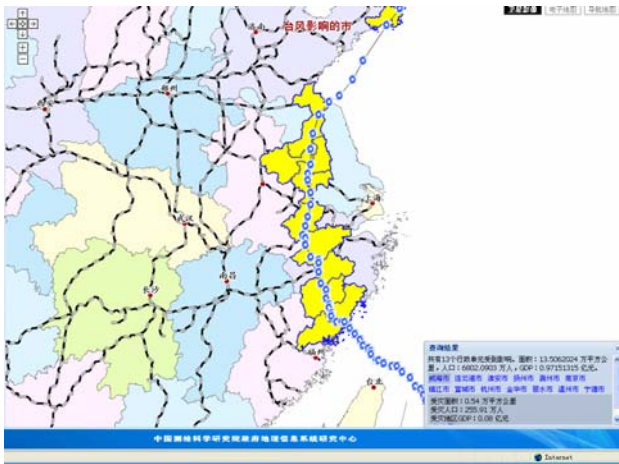Figure 3.UML sequence of the geoprocessing flows
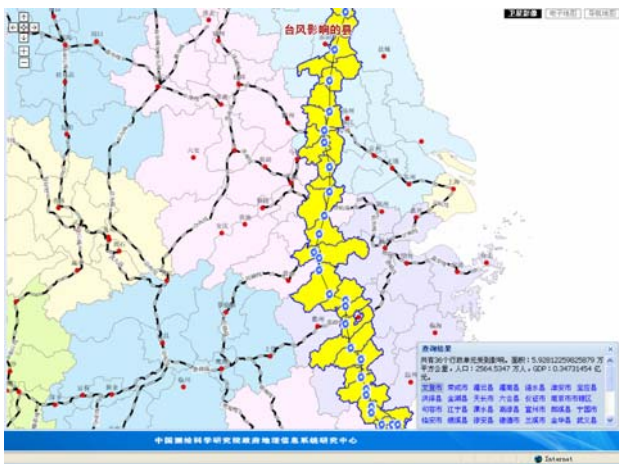
Figure 4. The GDP losses by typhoon

Figure 5. The typhoon effect on the lives of people

Figure 4 and figure 5 show us the GDP losses and effect on the lives of people by typhoon via executing the geoprocessing chains that we defined in the model.

5. CONCLUSIONS

Spatial information services technology provide a good solution for spatial information interoperability and knowledge discovery, spatial-based facilities use these standardized spatial information services access by browse-getting of spatial data services forward to spatial information processing and modelling phase. In this paper, we leads the geo-object concept of m.cloud, proposed concept of plug-in logic object layer, enable spatial services dynamic into an aggregate spatial information service chain, and illustrates the flexibility of the solution through a simple Disaster Assessment experiment.

The spatial information service chain built can be applied in simple spatial analysis and disaster information extraction, did not concern other expertise area, not enough to support the complex spatial information processing model. Meanwhile, the intermediate processing results of spatial information service chain will be re-instantiated and loaded as logic object layer, will once again participate as an input parameter when the spatial information service chain operations the difficulties, the future development will focus on solving the deeper modelling applications in the Other areas of expertise of spatial

information service chain, and researches of building complex spatial information service chains.

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