A Cloud-based China's Landslide Disaster Database (CCLDD)

Development and Analysis

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***Abstract*—Landslide is among the most dangerous natural disasters globally, frequently causing a large number of casualties and economic damages. Especially in China, there suffers the largest of deaths in the world [1]. At present, landslide events have been reported increasingly from newspapers, magazines and many cyber-hazard databases. Cyber-hazard database concerned provides powerful functions, such as query, update, share, management, mass storage and so on. However, there is often a lack of specific spatiotemporal characteristics of landslide impacts or a failure to visualize complete statics of landslide records due to variable entry criteria. We developed China's landslide disaster community cyber-infrastructure with cloud computing service integration and data collection, providing statistical landslide visualization in the period 1949-2011 based on Google platform. This work indicates cloud computing is further integrated into this cyber-infrastructure by utilizing public cloud services provided by Google, which effectively accelerates the speed during landslide data processing and visualization over the internet.**

Keywords-landslide, database, cloud, cyber-infrastructure

I. Introduction

Under the circumstances of global climate change, geologic process and human effect, landslide is the most frequent and severely disaster on the earth, as demonstrated in the world atlas of natural hazards [2]. Every year, landslide cause serious casualties and economic losses in some hotspots of global high landslide potential regions [3, 4]. Particularly in China, more than 90,000 hazards associated with landslides have been reported in some southern and northwestern regions [5]. From 2004 year to 2010 year, a total of 6,860 people were killed by landslides in China, accounting for over one-fifth fatalities around the world.

At present, landslide events are recorded from news reports and many cyber-hazard databases. Cyber-hazard database concerned that is a main access to obtain information provides powerful functions, such as query, update, share, management, mass storage and so on. There are several existing landslide cyber databases, such as International Consortium on Landslide (ICL, http://iclhp.org), International Landslide Center (ILC, http://www.landslidecentre.org), Emergency Disasters Database (EM-DAT, http://www.em-dat.net), United States Geological Survey (USGS, http://landslides.usgs.gov/recent), and AGU landslide Blog (http://blogs.agu.org/landslideblog/). However, the utility of these mentioned databases, for landslide mapping or assessment is limited because the entries do not include the spatiotemporal distribution features of landslide, just enlisting landslide events due to the entry criteria; moreover, for national landslide study, fewer data can not satisfy the analysis. Therefore, it's necessary to input the collected landslide events from news report and above mentioned database and develop a special digitized Cloud-based China Landslide Disaster Database (CCLDD) with the basic functions and revealing the regulation of landslide spatiotemporal distribution. We propose to utilize a cloud-computing service provided by Google to establish CCLDD to share previous results; in the future, it will be used for landslide susceptibility mapping and evaluation.

II. CCLDD Design

CCLDD consists of four parts (Figure 1):

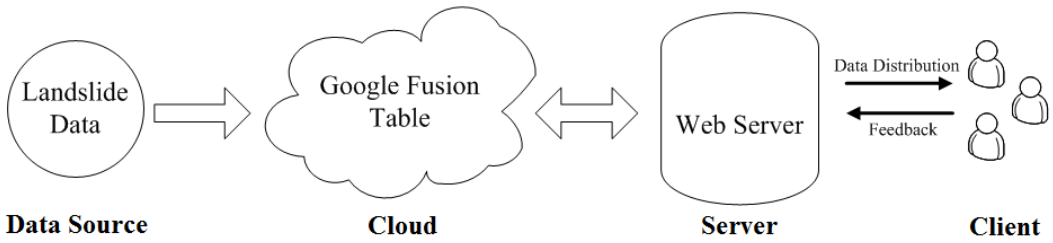

Figure 1. CCLDD structure flow

A. *Data Source*

Since 1949 (the founding of People Republic of China), some corresponding researches on landslide started; therefore, the starting time of collected data is in 1949. Data were acquired from statistical yearbook, news reports and some cyber databases. However, the data sources are limited: firstly, the most of data were from eyewitness interviews, belonging to unmapped events, which lack accurate time, location, fatalities and economic losses information; secondly, the data is inadequate in some sparsely populated areas and the less attention makes the fewer reports, and due to the government restrictions to data sharing; thirdly, to facilitate the study for compiling the CCLDD, we assign a point value to represent a landslide center location, that may be uncertainty to the exact landslide location and extent damage; last but not least, the data are of different scales, which make the accuracy vary significantly by regions, counties, and provinces. From above data sources, we obtained 1221 landslide records in the period 1949-2011 year.

We define several labels in the collected data to describe the landslide events: (a) Identification (ID), expressed as order; (b) Date, the landslide occurring time; (c) Province, the administrative division; (d) location, the geographic coordinate (longitude, latitude); (e) Cause, the induced factor to landslide; (f) Fatality, the death toll from landslides without missing and injury; (g) Direct economic losses; (h) Indirect economic losses, NaN represents data missing; (i) Class, the classification standard according to fatality (class 1, fatality=0; class 2, fatality<3; class 3, fatality is between 3 and 10; class 4, fatality is between 11 and 30; class 5, fatality>30).

B. *Cloud*

The processed landslide data is imported into Google Fusion Table which is a platform of online cloud storage for landslide data (Figure 2). Google Fusion Table provides application programming interface (API) to programmatically perform structured query language (SQL) on tables via using hypertext transfer protocol (HTTP) requests.

C. *Server*

Web server only deals with requests and responses between the cloud and clients. Meanwhile, it also protects the Google Fusion Table on the cloud from being accidentally modified by clients.

D. *Clients*

Finally, clients acquire landslide data and give feedback to web service.

china_landslide

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ID	Date	Month	Day	Year	Province	longitude	latitude	Cause	Fatality	Direct_economic_l...	Ind...	Class
1219	9/29/2011	9	29	2011	Sichuan	101.51	26.40	rainfall				1
1220	9/29/2011	9	29	2011	Chongqing	105.43	29.42	rainfall		800,000		1
1218	9/28/2011	9	28	2011	Henan	113.23	34.32	rainfall				1
1216	9/26/2011	9	26	2011	Sichuan	107.30	31.11	rainfall				1
1217	9/26/2011	9	26	2011	Yunnan	100.55	24.17	rainfall		1,400,000		1
1214	9/25/2011	9	25	2011	Shandong	119.56	37.10	rainfall		50,000		1
1215	9/25/2011	9	25	2011	Yunnan	98.35	24.26	rainfall	6			3
1213	9/24/2011	9	24	2011	Yunnan	100.58	22.47	rainfall				1
1211	9/23/2011	9	23	2011	Yunnan	100.27	24.00	rainfall		60,000		1
1212	9/23/2011	9	23	2011	Gansu	104.23	34.02	rainfall		7,200		1
1209	9/22/2011	9	22	2011	Yunnan	100.42	23.29	rainfall				1
1210	9/22/2011	9	22	2011	Henan	111.52	34.44	rainfall		80,000		1
1207	9/21/2011	9	21	2011	Yunnan	100.58	22.46	rainfall		535,000		1
1208	9/21/2011	9	21	2011	Yunnan	98.35	24.26	rainfall		30,000		1
1204	9/20/2011	9	20	2011	Shaanxi	107.04	34.21	rainfall		15,000		1
1205	9/20/2011	9	20	2011	Henan	111.12	34.46	rainfall				1
1206	9/20/2011	9	20	2011	Chongqing	108.48	31.00	rainfall			200,0	1

Figure 2. Google Fusion Table

III. Results

CCLDD is currently running at http://eos.ou.edu/hazards/landslide/. The 'China' column consists of two parts: Map and Statistics. The former implements map visualization: locations of landslide events from Google Fusion table are loaded on the Google Map with API. Different colors represent the above mentioned classification of landslide events. Users can query landslides location based on the year selection (Figure 3). The latter is previous statistical results according to different features (Year, Month, Province, Cause, and Fatalities Class) (Figure 4). Users can select different chart to express the count, sum and average of fatalities or economic losses on different features. The following shows the quantitative results in the tabular form.

Figure 3. Map visualization from 1949 to 2011

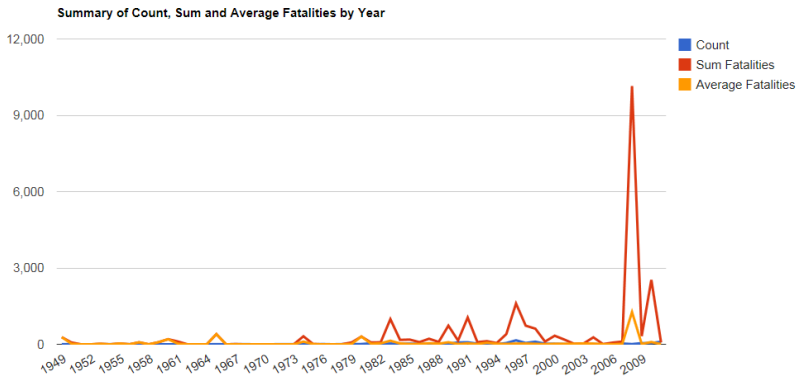

Figure 4. One of statistical results

IV. Conclusion

CCLDD provides on-demand location-based visualization as well as the previous statistical results with cloud computing service integration and presents an opportunity to change the existing way for landslide disaster monitoring to data integration, visualization and analysis. In the future, this work will add the user interface to update data in real time, meanwhile is a basis for landslide disaster evaluation.

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