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A Cloud-based Global Flood Disaster Community Cyber-infrastructure (CyberFlood): Development and Demonstration

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Introduction

Flood disasters have significant impact on the development of communities globally, often causing loss of life and property. It is increasingly important to create a globally shared flood cyber-infrastructure (**cyberFlood**) to collect, organize, and manage flood databases that visually provide useful information back to both authorities and the public in real-time. The community shared cyberFlood infrastructure described in this study uses **cloud computing** services and **crowdsourcing** data collection methods to provide location-based visualization, statistical analysis and graphing capabilities. It also involves public participation, allowing the public to submit their entries of flood events. This cyberFlood presents an opportunity to eventually modernize the existing paradigm used to collect, manage, analyze, and visualize water-related disasters (e.g. floods, landslide, and droughts).

Cyber-infrastructure Design

The global flood cyber-infrastructure consists of four components: the Global Flood Inventory (GFI) data source, cloud service, web server, and client interface.

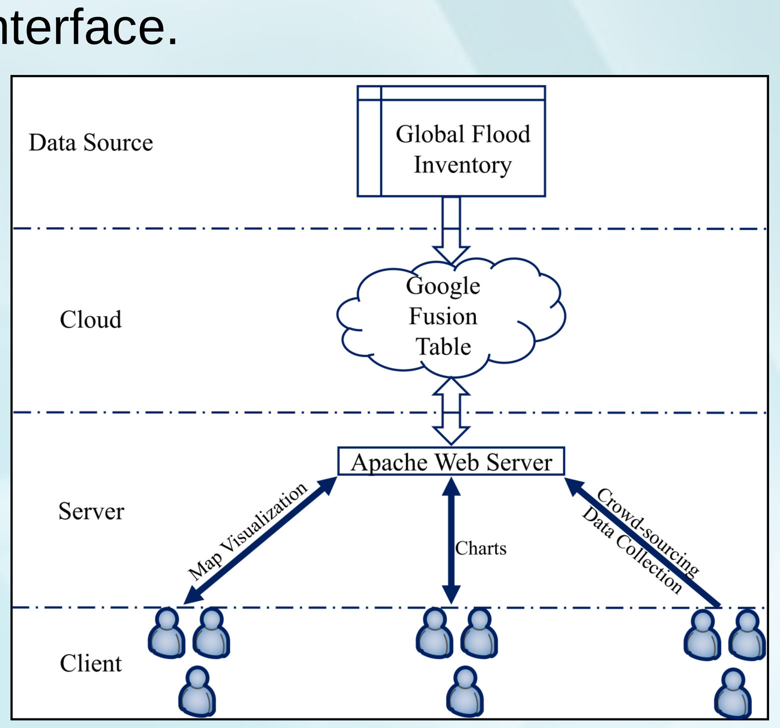

Fig 1. The global flood community cyber-infrastructure framework.

GFI

- Primary database in this cyber-infrastructure.
- Contains global flood events from 1998 to 2008.
- Pre-processed before being imported into Google Fusion Table.

ID	Year	Month	Day	Duration	fatality	Severity	Cause	Lat	Long	Country code	Continent Code
2707	2008	12	28	23	25	1	2, 1	-22.92	34.03	140	1
2706	2008	12	26	18	24	1	1	-3.33	103.14	93	3
2705	2008	12	26	3	-9999	1	1	44.66	-123.53	213	6
2704	2008	12	26	3	-9999	1	1	41.04	-89.46	213	6
2703	2008	12	25	12	9	1	1	16.89	107.06	219	3
2702	2008	12	13	31	76	1.5	1	9	-74.23	42	8
2701	2008	12	13	2	2	1	1	51.49	-1.73	212	5

a. Global Flood Inventory Data Table

ID	Year	Month	Date	Duration	Fatality	Severity	Cause	Geometry	CountryCode	ContinentCode
2707	2008	12	12/28/2008	23	25	Class 1	Tropical cyclone, Heavy rain	-22.92,34.03	Mozambique	Africa
2706	2008	12	12/26/2008	18	24	Class 1	Heavy rain	-3.33,103.14	Indonesia	South East Asia
2705	2008	12	12/26/2008	3		Class 1	Heavy rain	44.66,-123.53	United States	North America
2704	2008	12	12/26/2008	3		Class 1	Heavy rain	41.04,-89.46	United States	North America
2703	2008	12	12/25/2008	12	9	Class 1	Heavy rain	16.89,107.06	Vietnam	South East Asia
2702	2008	12	12/13/2008	31	76	Class 2	Heavy rain	9,-74.23	Colombia	South America
2701	2008	12	12/13/2008	2	2	Class 1	Heavy rain	51.49,-1.73	United Kingdom	Europe

b. Google Fusion Table

Fig 2. Comparison of data tables a) global flood inventory and b) Google fusion table.

An example of a flood event in New Hampshire is illustrated in Fig 3. Fig. 3a shows the event in the original GFI. Five locations were associated with it. Fig. 3b shows the same flooding event but in a Google Fusion Table. Fig. 3c is the visualization.

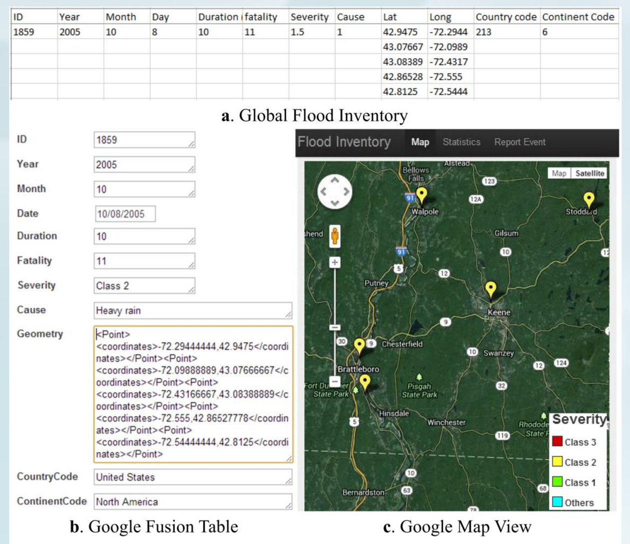

Fig 3. Flood event over Northeast U.S. in New Hampshire in October 2005 a) global flood inventory, b) Google fusion table attributes, and c) Google map view.

Cloud service

- Google Fusion Table is a "Software as a Service" type of cloud-based service.
- Provides rapid responses to user requests for data querying, summary, and visualization.

Web server and client interface

- Web server interacts between the cloud and clients and protects the Fusion Table.
- The client side is programmed with HTML and JavaScript for visualization.

Demonstration

The global flood cyber-infrastructure is currently running at http://eos.ou.edu/flood/ (Fig. 4).

- Flood events points are color coded by severity or fatalities in the map.
- Severity is classified into classes 1, 2, and 3 (least severe to most severe).
- Fatalities are categorized into four classes.
- Controls are provided for real-time mapping.

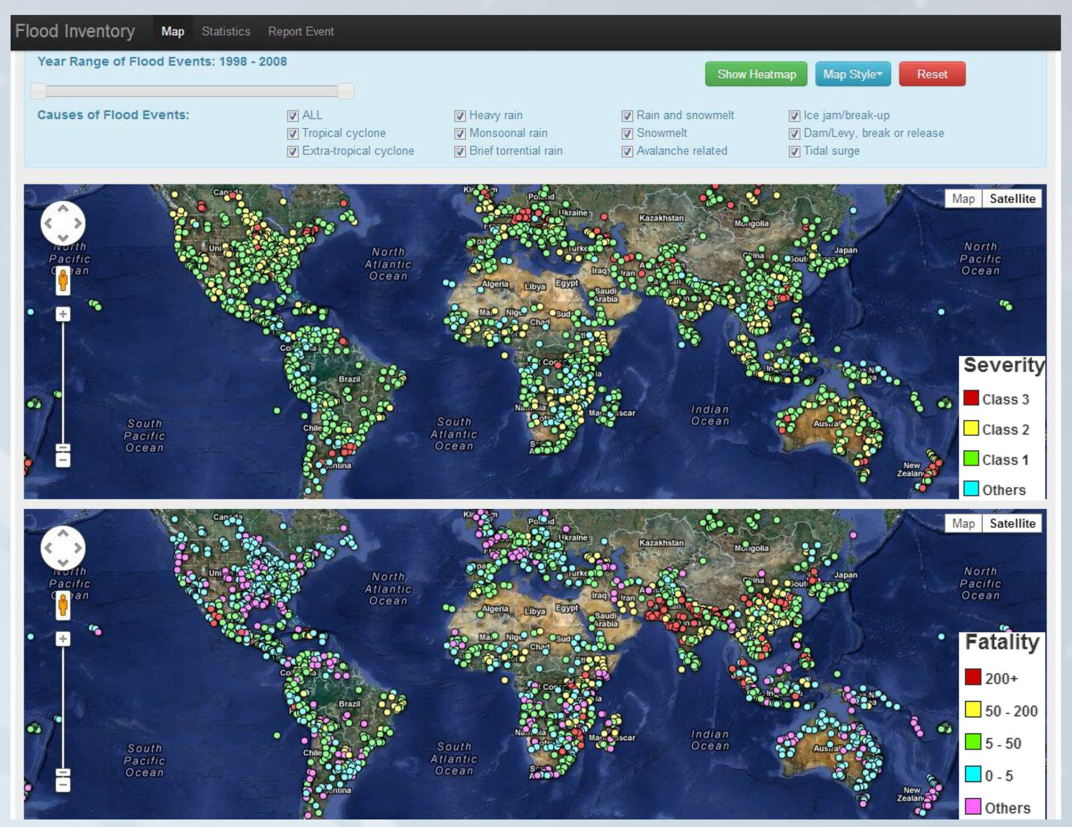

Fig 4. The map visualization of cyberFlood.

Heatmap is provided by Google Fusion Table cloud service to show the density of flood events. The east coast of US, Europe and southeast Asia have higher density than other parts of the world.

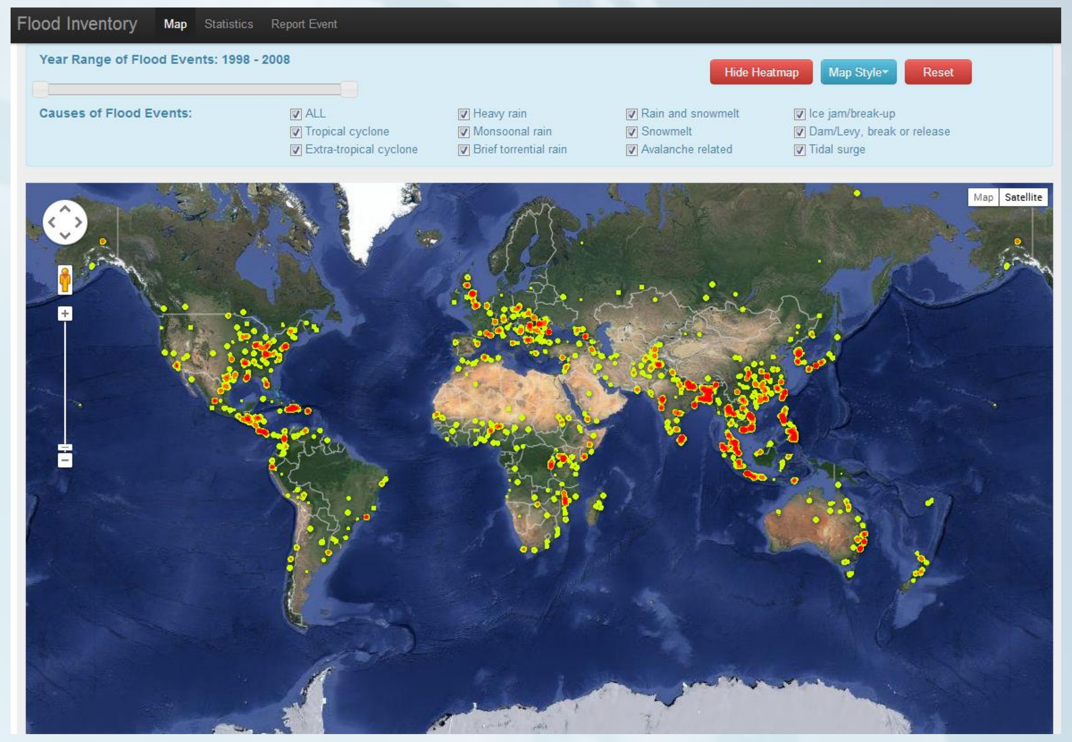

Fig 5. The heatmap of global flood cyber-infrastructure.

Google Chart API is utilized to create analytic charts for statistical analysis of the flood events (Fig. 6). Variables can be analyzed in a chart and a table and summarized by the count, sum of fatalities, or average of fatalities.

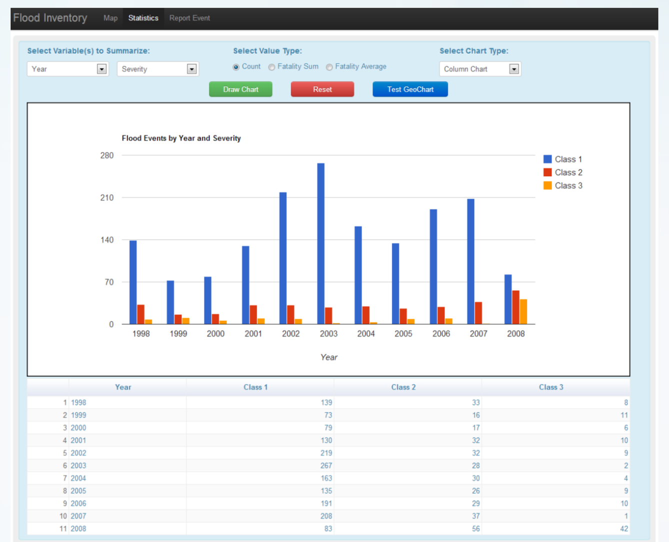

Fig 6. The summary of global flood events by year and severity.

Figures 6, 7, and 8 demonstrate some of the analytic results from cyberFlood using statistical chart and table.

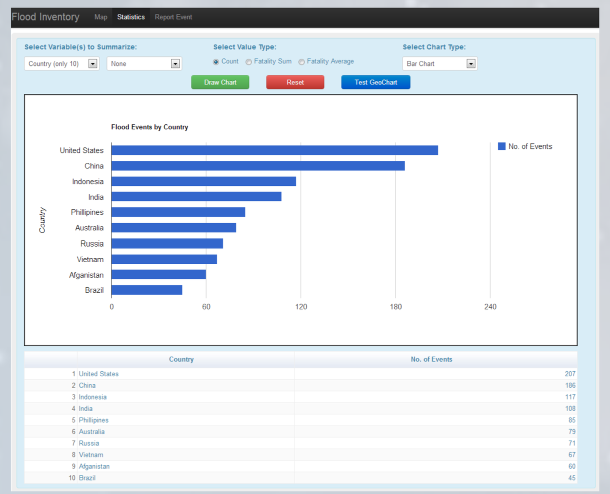

Fig 7. Top 10 countries which has the highest number of flood events in the cyber-infrastructure.

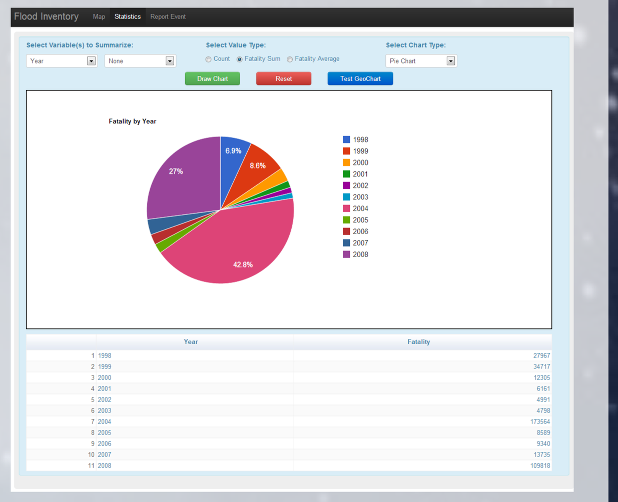

Fig 8. The summary of global flood events fatalities by year.

In order to expand and update the data in cyberFlood, crowdsourcing from public entries is implemented by providing a report form (Fig. 9). Location is required for map visualization. Data quality control from is done by validating reported events with news, satellite imagery, and other resources.

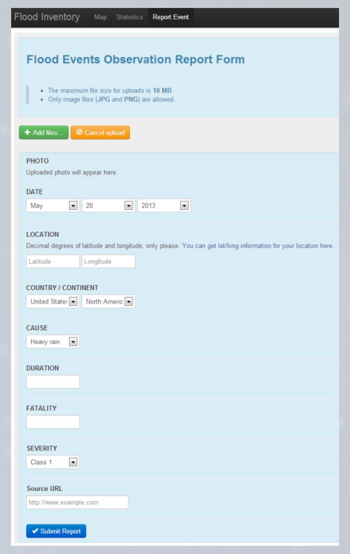

Fig 9. The flood events report form.

Conclusion

This cyberFlood, with cloud computing service integration and crowdsourcing data collection, provides location-based visualization, statistical analysis and graphing functions. It involves citizen-scientist participation, allowing the public to submit their personal accounts of flood events to help the flood disaster community to archive comprehensive information, analyze past flood events, and get prepared for future flood events.

This paper has already been submitted to Environmental Modelling & Software. For references in the poster, please contact:

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