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Sediment Disaster Management Information System Established for the Reservoirs in Southern Taiwan

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Abstract: Typhoon Morakot seriously attack southern Taiwan awaken the public awareness of sediment disasters. Sediment disasters have negative effects on the operating functions of reservoirs. To decrease the risk of these disasters within reservoir watershed, the establishment of a powerful tool for hazard mitigation / disaster prevention is necessary. Real time data and numerous archives of engineering data, environment information, photo, and video, will not only help people make appropriate decisions, but also bring the biggest concern for people to process and value added. The study collected various types of data about these reservoirs and tried to define some basic data formats / standards, then provide a management platform based on these formats / standards. Meanwhile, to satisfy the practicality and convenience, the disaster management information system is built both provide and receive information, which user can use this disaster management information system on different type of devices. The IT technology progressed very quickly, the most modern system might be out of date anytime, to provide long term service, the system reserved the possibility of user define data format/standard and user define system structure. The system established by this project was based on HTML5 standard language, and use the responsive web design technology. This will make user can easily handle and develop this disaster management information system.

Key words: disaster management information system (DMIS), sediment disasters, Zengwen Reservoir, Nanhua Reservoir, Wusanto Reservoir

1. Introduction

In 8th August 2009, typhoon Morakot struck southern Taiwan and brought more than 2,900 mm accumulated rainfall within 3 days [1]. Some extreme serious sediment disasters such as landslide and debris flows were induced by this event, for example, SWCB(Soil and Water Conservation Bureau, 2010) mentioned there were more than 10,904 sites of landslide with total sliding area of 18,113 ha happened in Zengwen reservoir watershed after typhoon Morakot [2]. This event awakens the public awareness of sediment disasters. Sediment disasters have negative effects on the operating functions of reservoirs [3]. Base on the formats and characteristics of sediment disasters, here are some issues must be conquered [4-7]:

(1) The trigger mechanism of large scale compound sediment disaster under extreme rainfall condition.

(2) The establishment of disaster prevention database and the revise of disaster prevention strategy.

(3) The predominance of sediment disasters information and status.

(4) The strategy and measure for disaster prevention, reducing and mitigation.

After these issues were conquered, the disaster resistance of reservoir catchment will be enhanced, the land conservation will be ensured, the reservoir development will be sustained, and most important is the water supply in southern Taiwan will be stable. To decrease the risk of these disasters within reservoir

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watershed, the establishment of a powerful tool for hazard mitigation/disaster prevention is necessary.

2. The Establishment of Sediment Disaster Management Information System

2.1 System Functions and Goals

The Sediment Disaster Management Information System (DMIS) is not traditional Management Information System (MIS) or Geographic Information System (GIS) [8], DMIS is a system based on user friendly concept and considerate about the business needs of reservoir managers, the scalability of system structure, and the safety of information exchange, the main system functions and goals are:

(1) To collect complete environment information of disaster regions.

Each kind information about the study area will be digitized and imported into system database. Meanwhile, all archive documents will be kept in two forms, one is the original file format made by professional software, the other one is the pre-defined portable document format.

(2) To establish convenient interface for query and management.

For efficiency usages for both data query and study area management a user-friendly interface is necessary to be established. This interface should provide easiest way for users to get information they want and feedback useful information to system.

(3) To enhance the security of data access

In the trend of “Big Data” and “Open Data”, the achievements of database will be utilized cross-sectorally, even will be open to public. For the balancing between “Open Data” and “information security”, the “three–tier” structure was used. Users can not contact data directly; all requests will be authorized by the interface.

(4) To improve the efficiency of catchment management

The mobilized needs were also considered. To provide more flexible interface, HTML5 standard was followed, meanwhile, Responsive Web Design (RWD) was used with. This means users could easily get the same use experience using this system in any kind of device and would not have to install any special plugins.

2.2 Standardization Specification for Data

In the requirements analysis phase, many archival materials were found to be stored in various forms. Although various types of data were used in the past for various business needs, these materials need to be redefined to meet the needs of disaster management. Therefore, there were four data formats defined by this study.

(1) General documents

- Definition: General software output, data file contains text, pictures, figures, or tables.
- Demonstration format: Portable Document Format (PDF), *.pdf.
- Archive format: *.pdf.
- Original formats: common file types include plain text files (*.txt), Word files (*.doc, *.Docx), Excel files (*.xls, *.xlsx), presentation files (*.ppt, *.pptx) Portable Document (*.pdf) ... and so on.

(2) Graphics file

- Definition: A data file presented in a Raster format.
- Demonstration format: Joint Photographic Experts Group (Joint Photographic Experts Group, JPEG) format, *.jpg.
- Archive format: *.jpg.
- Original formats: common file types include image files (* .jpg, *.png, *.bmp, *.tiff, *.img), AutoCAD files (.dwg).

(3) Geographic information file

- Definition: A data file presented in a Vector format.
- Demonstration format: Joint Photographic Experts Group (JPEG) format, *. jpg.

- Archive format: Keyhole Markup Language (KML) format, *. kml.
- Original formats: common file types include Shapefile (* .shp), track file (* .kml).

(4) Multimedia file

- Definition: A data file made up of audio, video, or audio and video.
- Demonstration format: Moving Picture Experts Group-4 Part 10 Advanced Video Coding (MPEG-4 AVC) format, *.mp4.
- Archive format: *.mp4.
- Original formats: common file types include audio and video files (*.avi, *.mpg, *.Mp4), QuickTime ring file (*.mov), three-dimensional nested engineering environment project (*.sxd).

The flexibility of system architecture and standardization specification was reserved, the new data types and formats will be easily declared the definition by system administrator when there were some new data categories or formats will be used in this system in the future.

2.3 System Design

To provide users with comprehensive service, this system was developed by Microsoft Visual Studio 2013, Microsoft IIS 7(Internet Information Server 7) was used as the operating platform, database was built by Microsoft SQL Server 2012, and the Map Service was powered by Google Map API. Meanwhile, HTML5 standard was followed, RWD, CSS, JavaScript, Ajax, and JQuery API were used to provide better user experience. There were three major concepts about the system design.

(1) Service structure

As shown in Fig. 1, the “three-tier” structure was used, all services no matter data require or data feedback were authorized by the web hosting.

(2) Interface architecture

As shown in Fig. 2, user can easy use this system to access some public information, but for some advanced system service an ID-Password type account verification was needed. This architecture design was based on the considerations of data classification control and information security.

(3) Authority structure

The system is divided into four functional categories: entrance function, main function, auxiliary function and reference information. The user authorization authority is divided into four categories: public information, authorized personnel, project manager and system administrator,as shown in Fig. 3.

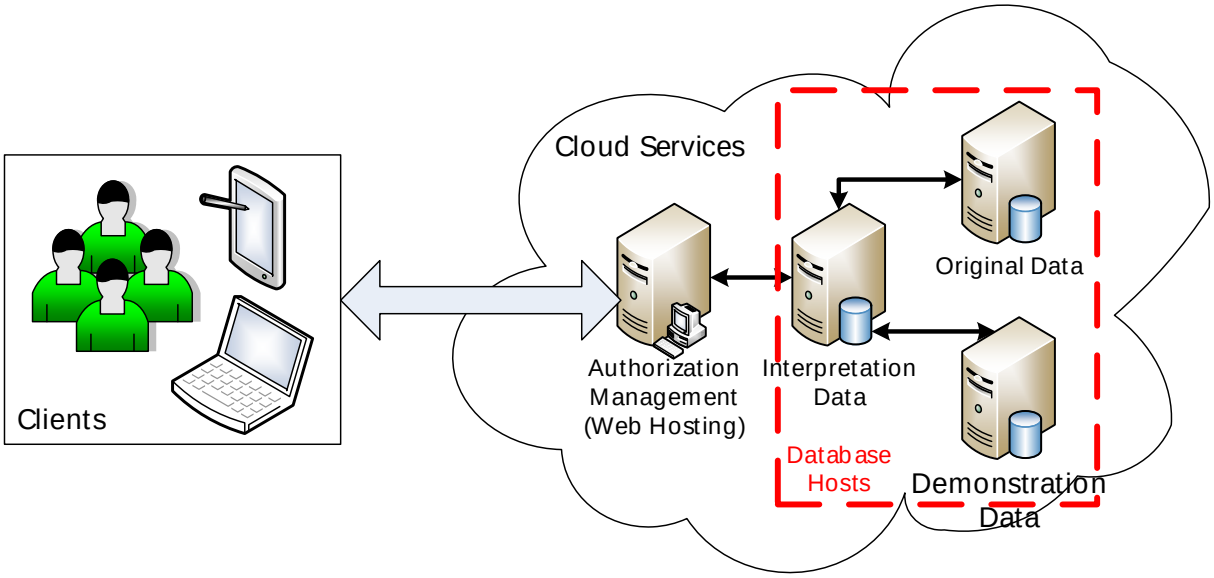

Fig. 1 Service structure.

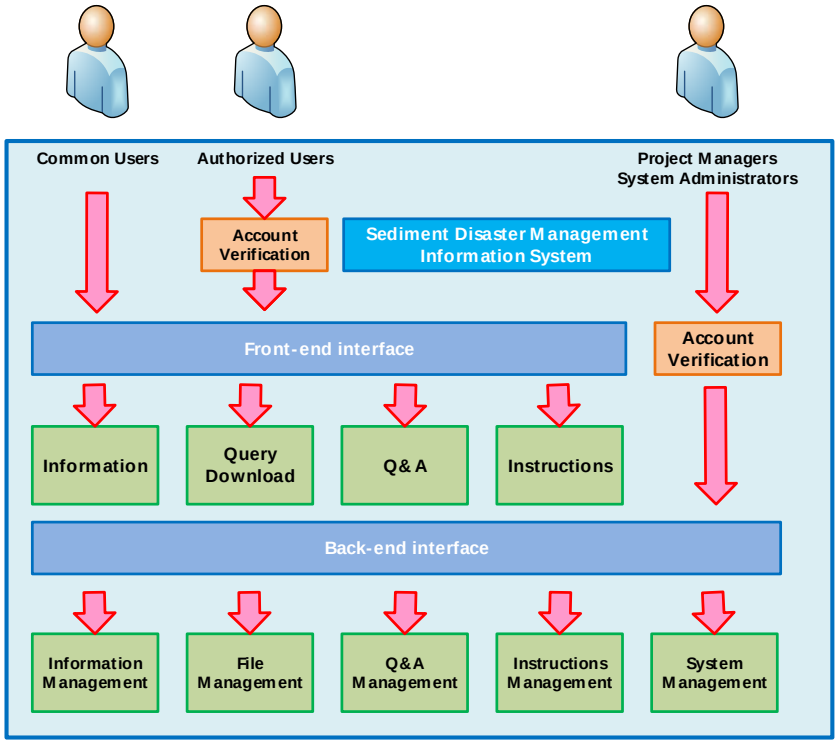

Fig. 2 Interface architecture.

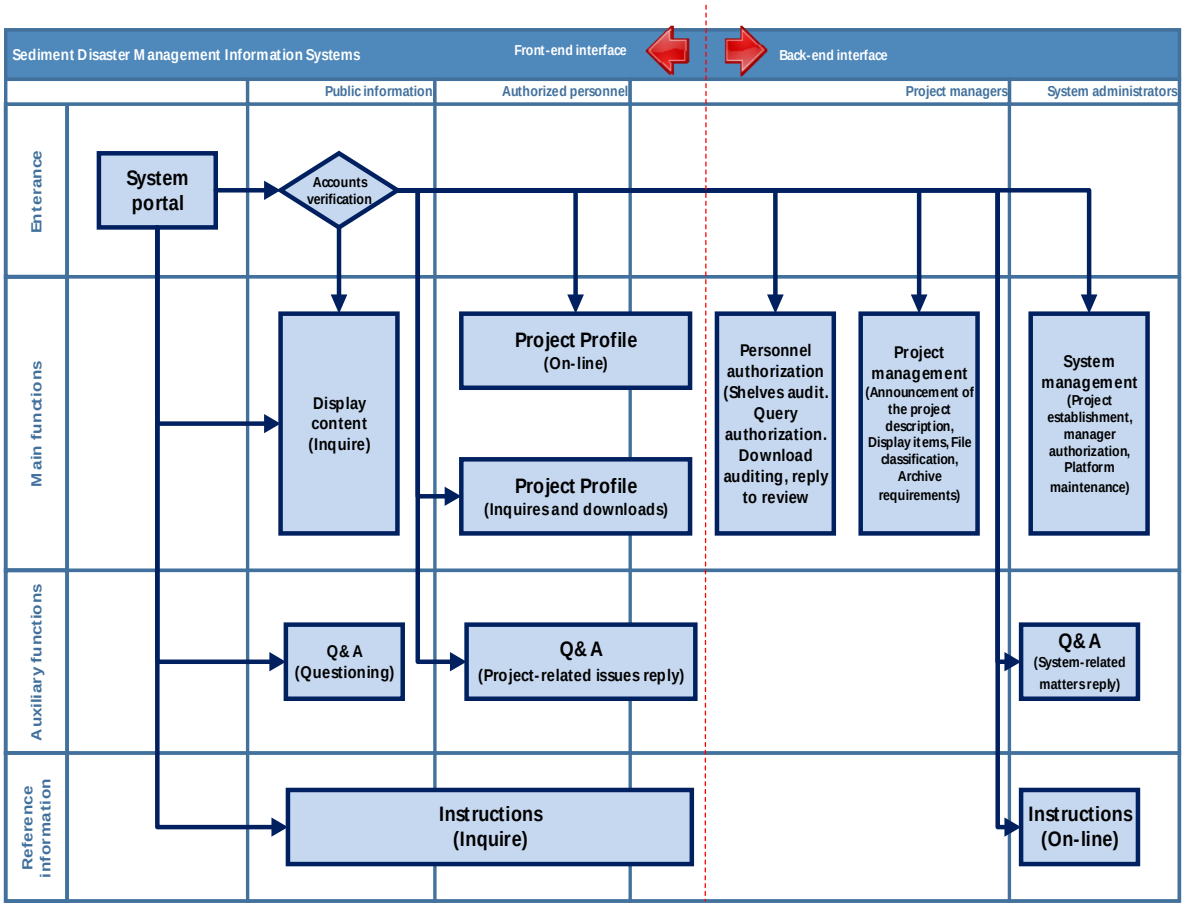

Fig. 3 Authority structure.

3. Results

The establishment of sediment disaster management information system has been established, the environmental information and sediment disaster information in Zengwen reservoir watershed was collected and archived. All significant result includes materials of GPS/GIS/RS related to environmental hydrology, hydrological variation analysis, land use, environmental geology, spatial analysis of sediment disasters, etc.; to reduce the difficulty of data processing, the standardization specification for data has been made. The integration and delivery of information about disaster prevention and mitigation will be accelerated by this research. The benefit will also be found on both related manpower training and technology transferring. The application of mobile devices was also being considered for users to apply easily in any situation.

4. Conclusion

The import of standardization specification for data is a new concept for data transform, related to the traditional MIS, this system provides more efficient way for data requirement and achievement but required less resources. Although the establishment of sediment disaster management information system has developed for application done, the system still need some modification before officially operation to make sure each requirement was fitted by the system function.

Extreme heavy rainfall events do have serious contribution to compound sediment disasters, include the spatial distribution of extreme rainfall information the time series analysis and spatial distribution information of large-scale sediment disaster become important materials. Those data are the kernel of this DMIS, the quantity and quality of those data will make this DMIS useful or useless, that why more information should be required to collect and verify soon.

In next stage, the importing of some real-time information and auto alarm mechanism will make this system more practical able.

Acknowledgments

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