

Flood map development by coupling satellite maps and three-dimensional drafting software: Case study of the Sarawak River Basin

Kuok King Kuok^{1*}, Liew Zun Ziet¹ and Chiu PoChan²

¹School of Engineering, Computing and Science, Swinburne University of Technology Sarawak Campus, Jalan Simpang Tiga, 93350 Kuching, Sarawak, Malaysia

²Department of Information System, Faculty of Computer Science and Information Technology, University Malaysia Sarawak, 94300 Samarahan, Sarawak, Malaysia

Abstract

Flood maps are important for local authorities in designing mitigation plans to minimise damage and loss due to flooding. In recent years, flood events in the Sarawak River Basin, Malaysia have caused damage to property, loss of life and disruption of productive activities. Currently, the available flood map for Sarawak River Basin is generated using InfoWorks River Simulation (InfoWorks RS) and spot levels are captured using the Light Detection and Ranging (LiDAR) system. However, the high cost of this flood mapping technique has motivated the development of an advanced but low-cost flood mapping method. This study was carried out to test the feasibility of using Google Earth coupled with Autocad Civil 3D in generating flood maps. Google Earth was used to obtain the elevation data, while Autocad Civil 3D was used to plot the water level surface. Data for the maximum water level, recorded since 1960, for 12 water level stations were fed into the model for flood map generation. This research confirmed that Autocad Civil 3D coupled with Google Earth is feasible for generating an updated and accurate flood map, after comparison with 2 flood maps developed previously.

Keywords: Autocad Civil 3D, flood map, Google Earth

Introduction

Flood maps are maps indicating the flood-prone areas and their expected water levels, based on flow models or past records (Jones, 2004). Flood maps are generated to provide communities with flood-risk information and also for development and evacuation purposes. The maps enable local authorities, organisations and developers to manage the flood risk efficiently and effectively. In addition, flood maps are used for designing drainage system as well as developing plans for mitigating flood occurrence.

Flood mapping is essential in countries with frequent and high precipitation, as well as countries affected by critical climate systems such as typhoons, and the El Niño and La Niña oscillations. In the past, heavy rainfall has led to disastrous flood events in Sarawak River Basin, Malaysia, especially during the Northeast Monsoon from October to February (River Basin Initiative Malaysia, 2002–2011). The ineffective drainage system in the undeveloped interior parts of Sarawak make the situation worse, and causes the rural areas to be the most susceptible to flooding during the rainy season.

Various methods have been developed for generating flood maps. Jones (2004) of the United States Geological Survey (USGS) presents a method utilising the TRIM2D hydraulic model coupled with elevation data obtained from Light Detection and Ranging (LiDAR) to generate flood maps in the

USA. The Department of Irrigation and Drainage Sarawak (DIDS) has generated a flood map for the Sarawak River Basin by integrating InfoWorks River Simulation (InfoWorks RS) and LiDAR systems for capturing spot levels. However, the resulting flood map was produced at an expense of approx. 330 000 USD, which is not cost-effective. A detailed survey of the river cross sections, which is a time and labour-intensive activity, and elevation data obtained from 1:50 000 topographical maps was required for generating the flood maps using InfoWorks RS (Hii et al., 2009; Bustami et al., 2011; Mah et al., 2011). Flood maps for other river basins in Sarawak are still plotted manually using outdated 1:50 000 topographical maps (KTA Tenaga, 2003).

Therefore, this study was conducted to investigate the feasibility of using updated Digital Elevation Model (DEM) data retrieved from Google Earth, and coupled with Autocad Civil 3D, to generate a 100-year flood map. The selected study area was Sarawak River Basin.

Study area

Malaysia is located within the tropical rainforest climatic and vegetation region, and experiences heavy and frequent rainfall throughout the year, with no significant dry season. The average annual rainfall for Sarawak State is approximately 3 850 mm (River Basin Initiative Malaysia, 2002–2011). The state receives most of its rainfall during the Northeast Monsoon from October to February every year. Kuching city, located within Sarawak River Basin, experiences its maximum precipitation in January (approx. 700 mm in the year 2009) (Fig. 1). This extremely high rainfall contributes to flash flooding.

* To whom all correspondence should be addressed.

☎ +6082-296850; e-mail: kelvinkuok100@gmail.com

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