

# LandSAGE: Southeast Asia Program for Visualization-Rich Landslide Management

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## ABSTRACT

Landslides are devastating events in Southeast Asia, causing extensive damage and loss of life. Understanding and responding to these events remains a significant challenge. To address this, we initiated the LandSAGE program to bring visualization tools and expertise to Southeast Asia. This work will present updated information on our program and its achievements to date.

**Keywords:** Large Display Systems; Landslide Monitoring, Climate Disaster Mitigation; Collaborative Systems; SAGE3.

**Index Terms:** Human-centered computing—Visualization—Visualization application domains—Scientific visualization; Human-centered computing—Visualization—Visualization systems and tools

## 1 INTRODUCTION

Between 1980 and 2008, the United Nations Office for Disaster Risk Reduction recorded 3,341 disasters, including landslide events affecting an estimated 4.7 billion people in Asia [1]. Southeast Asian countries have an abundance of landslides [2] and suffer higher fatality rates compared to the rest of the globe [3]. To address this challenge, we initiated the LandSAGE (landsage.info) program, which is designed to bring visualization tools to Southeast Asia that help execute the multi-faceted, collaborative work required to monitor and mitigate landslides. The program, in its fourth year, is currently led by Mahidol University in Thailand with participation by institutions from Laos, Vietnam, and Cambodia. This work will present updates on this growing community, milestones achieved, and the LandSAGE prototype application.

## 2 OUTCOMES

The goals of this program are: 1) to better understand the needs and difficulties of researchers and decision makers involved with disaster management, 2) build visualization capacity in Southeast Asia through system/application training and hardware deployments, and 3) continued development of a prototype application. The technology focus is on collaborative large display systems Cyber-enabled Collaboration, Analysis, Navigation and Observation Environments (CyberCANOE) driven by the Scalable Amplified Group Environment (SAGE3) for landslide disaster management.

### 2.1 Capacity Building

We successfully deployed 8 CyberCANOE systems in Thailand, Laos, Vietnam, and Cambodia. Four were fixed installations of 8

(9 in Cambodia) displays each. Another four were portable systems with 4 displays each. A series of training workshops were held in Thailand, Laos, and Cambodia for researchers and students.

### 2.2 Data Sources

We obtained environmental monitoring data from the Mekong River Commission and 28 government agencies or open repositories. The landslide data were shapefiles or raster images that were preprocessed for ingestion into the application.

### 2.3 LandSAGE Application

The main features of the software consisted of map and time navigation for 3 flood and 10 landslide factors. Visualization of hydro-meteorological time-series data consisted of interactive graphs, whereas landslide factors were presented as map layers. Multiple factors can be visualized simultaneously on the wall in high resolution reducing the need for window switching. Views were synchronized across windows to facilitate information exploration and multiple windows can share factor selections. The backend interface enabled users to add, edit, and delete data without programming knowledge.

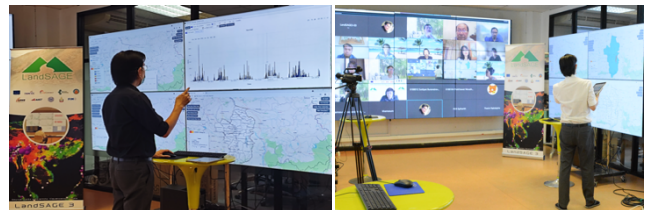


Figure 1: Images of the prototype application in use.

## 3 DISCUSSION AND FUTURE PLANS

Despite the impact of the global pandemic, the LandSAGE program successfully concluded three years of activities. The prototype was well received, especially by the Mekong River Commission, and is furthering activities around CyberCANOE/SAGE3 technologies in Southeast Asia for landslide management. In the future, we expect this growing visualization capacity to lead to the development of additional functionality of the LandSAGE application as well as new initiatives in visualization-rich, data-intensive science.

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