Session G02 – Invited speaker

Operational satellite-based disaster monitoring on the cloud: Case studies from Asia

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Abstract: Recent advances in Earth observation and cloud computing have enabled near real-time monitoring of natural and anthropogenic disasters. This study introduces a satellite-based disaster monitoring system (SCV: Satellite Current View) that leverages Amazon Web Services (AWS) for automated data ingestion, processing, and visualization. The system integrates multi-mission satellite datasets (Sentinel-1/2/3, Landsat, Himawari, MODIS, ICEYE, Capella, etc.) with advanced Artificial Intelligence (AI) and Synthetic Aperture Radar (SAR) algorithms to detect and assess floods, oil spills, earthquakes, illegal vessels, and infrastructure displacement. Key case studies demonstrate the operational capability: (i) Nakdong River embankment collapse (2020), detected within a few hours using Sentinel-1 SAR; (ii) water level estimation with <0.5 m RMSE from Sentinel-1; (iii) detection of oil spill incidents (e.g., Syrian marine spill, 2021) using deep Convolutional Neural Network (CNN) models; and (iv) ship monitoring with SAR and Automatic Identification System (AIS) fusion for dark vessel detection. The cloud-native architecture ensures scalable, on-demand disaster analytics, offering a robust decision-support platform for authorities and stakeholders.

Keywords: *Satellite remote sensing, Disaster monitoring, Cloud computing, SAR, Artificial intelligence*

1. INTRODUCTION

Asia is highly vulnerable to natural disasters such as floods, earthquakes, landslides, and oil spills, many of which demand rapid response (Figure 1). SAR is particularly valuable for disaster monitoring as it operates independently of weather or illumination. Traditional ground-based monitoring is often insufficient, highlighting the need for an automated satellite-based system integrated with cloud computing for timely disaster situational awareness.

2. METHODS

The SCV system employs a cloud-native pipeline (Figure 2). Satellite data from AWS Ground Station, open repositories, and commercial providers are ingested into Amazon Simple Storage Service (S3). AWS Lambda functions trigger event-based processing, launching Amazon Elastic Compute Cloud (EC2) instances that run tailored algorithms, including:

- Flood detection using CNN models with SAR and topographic indices, such as Digital Elevation Model (DEM), slope, and Topographic Wetness Index (TWI).
- Water-level estimation via forward geocoding and Digital Surface Model (DSM)-based approaches
- Oil spill detection employing dual-model CNNs on SAR data.
- Ship detection by fusing SAR ship signatures with AIS datasets.
- Earthquake and infrastructure monitoring using time-series interferometric SAR and differential interferometry.

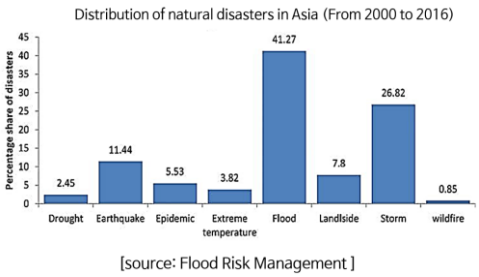

Figure 1. Distribution of natural disasters in Asia (2000–2016)

Figure 2. Cloud-based pipeline architecture with AWS S3, Lambda, and EC2.

3. RESULTS

Case studies validate system performance:

- Flood monitoring: Sentinel-1 SAR successfully delineated inundation during the Nakdong River embankment collapse (2020) within two hours (Figure 3).
- Water-level monitoring: Accuracy evaluation showed RMSE <0.5 m compared to in-situ gauges (Figure 4).
- Oil spill detection: Dual models of Deep CNN identified marine oil spills (e.g., Syria, 2021) with high accuracy.
- Illegal vessel detection: SCV visualized dark vessels by cross-referencing SAR detections with AIS data.
- Infrastructure displacement: Time-series interferometric SAR revealed cm-scale deformation trends in bridges and coastal areas.

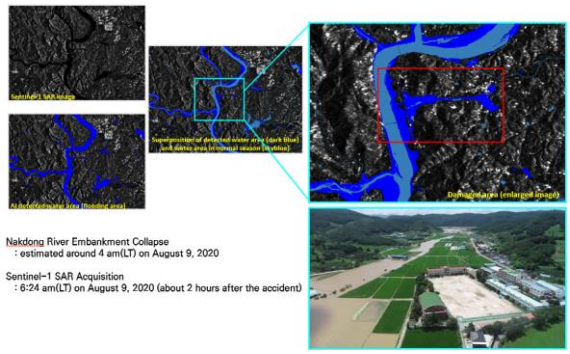

Figure 3. Flood detection from Sentinel-1 SAR (Nakdong River)

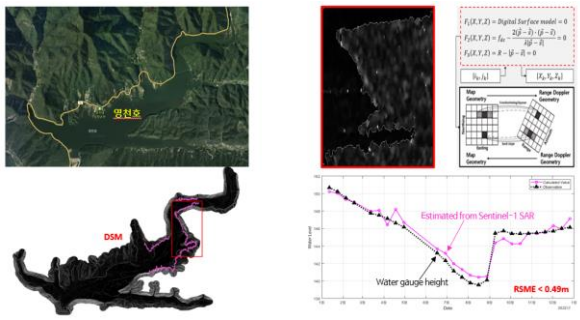

Figure 4. Water level estimation comparison with in-situ gauge

4. CONCLUSIONS

The SCV system demonstrates the feasibility of automated, cloud-enabled disaster monitoring using multi-source satellite data. Its modular architecture allows integration of new sensors and AI models, ensuring adaptability to future disaster scenarios. This approach contributes to improved disaster preparedness, response, and resilience.

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