筑波大学
University of Tsukuba

2020 Central Vietnam floods mapping by ArcGIS Pro

Disaster Information and Disaster Control Informatics Course
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IMAGINE THE FUTURE.

Outlines

Abbreviations list	
Label/ Short name	Description/ Long name
JTWC	Joint Typhoon Warning Center
DEM	Digital Elevation Model
SRTM	Shuttle Radar Topography Mission
LULC	Land Use Land Cover
ECMRWF	European Centre for Medium-Range Weather Forecasts
ODM, ODV	Open Development Mekong, Open Development Vietnam
MNRE	Ministry of Natural Resources and Environment

Overview

• Climate change can raise the risk of disasters by increasing hazard frequency and intensity. (Rahmstorf and Coumou, 2011)

• The earth's surface temperature increases, and so do the chances of more droughts and stronger storms. When a hurricane passed, it leaves behind effects including damage to property, people, vulnerability, etc.

Figure: Damaged homes and debris are shown in the aftermath of Hurricane Ian on September 29, 2022, in Florida. Source: Wilfredo Lee/AP

Background

Situation analysis: In October 2020, Viet Nam's central region suffered intense rainfall that led to catastrophic and widespread floods and landslides.

- It was caused by a confluence of various meteorological systems, including tropical storms (Linfa and Nangka), the Inter Tropical Convergence Zone, and cold air.
- 357 dead or missing and 876 injured; 511,172 submerged houses (MDRVN, 2022) [1]

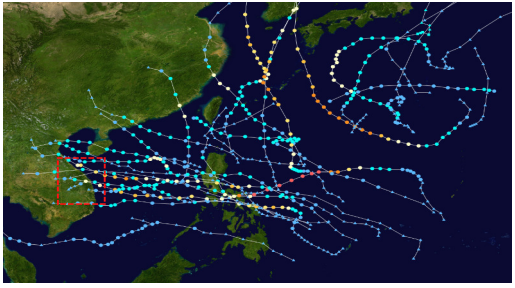


Figure: 2020 Pacific typhoon season (May-December). Source: JTWC

Figure: Homes have been submerged in Quang Binh province. Image: BBC News

Objectives and Regions of study

• The damage assessment on local scales, rescue works, recommendations, and early warnings for such disasters are still difficulties due to limited resources.

$\Longrightarrow$ It is essential to establish maps and assess flood's variations of the first period of the flood (October 9−15), which is believed to be the unique event in the last 100 years.

$\Longrightarrow$ Quang Nam, Da Nang, Hue, and Quang Tri are the places where storms make landfall directly and cause the most severe impacts.

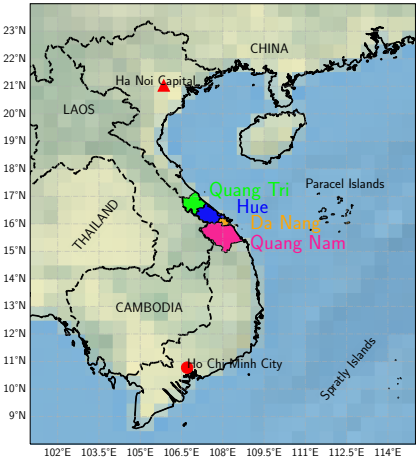
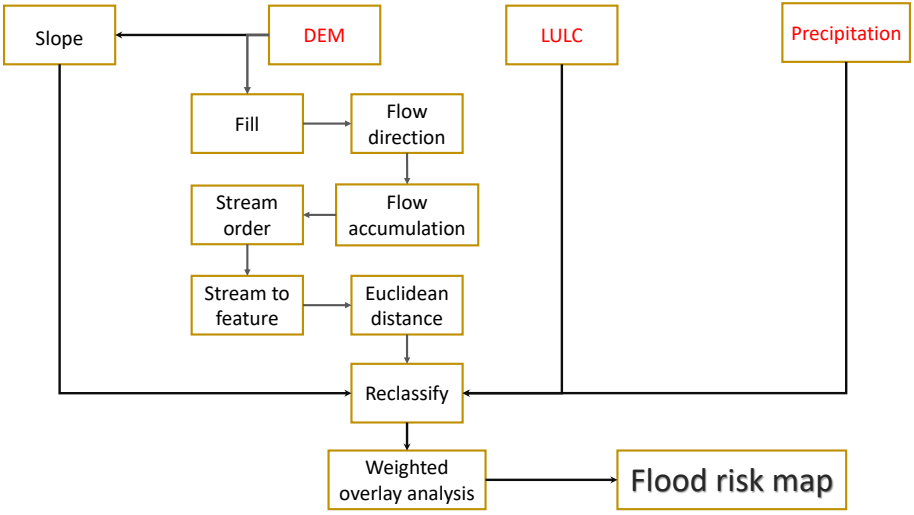


Figure: Borders of Vietnam and 4 provinces are the regions of study.

Methodology



Data

Label	Name, *source*	Type of data
DEM	SRTM 30 m in 2013, *NASA*	GeoTiff
LULC	High Resolution LULC maps ver. 2020, *JAXA*	GeoTiff
Precipitation	ERA5-Land hourly, *ECMRWF*	NetCDF
Population density	*World Bank Group* in 2015	GeoTiff
Hydroelectric power plant	Disaster and emergency response- Habitat on land, *ODM, ODV*	Shapefile
Historical landslide hot-spot	Disaster and emergency response- Habitat on land, *ODM, ODV*	Csv file
Road	International Steering Committee for Global Mapping and Vietnam, *Stanford*	Shapefile
Stream system	Global Map of Vietnam, *MNRE, ODM, ODV*	Shapefile

Table: All the datasets were accessed in 2022-11-11

2020 Central flood mapping

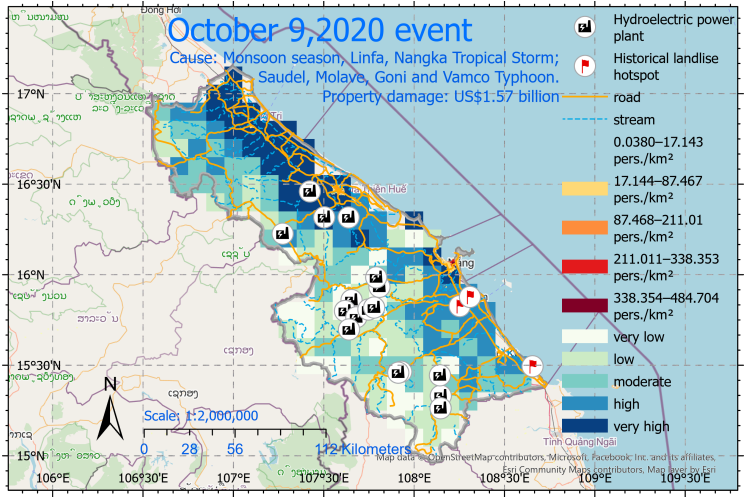
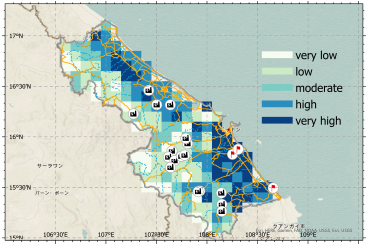


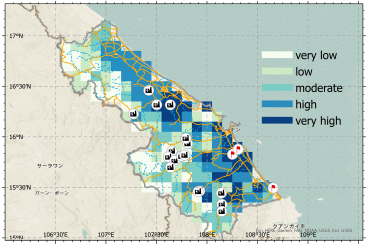
Figure: Flood risk map of October 9, 2020

- On October 9, Quang Tri and Hue suffered major flooding. The next significant flooded place is Da Nang, which has the highest population density.
- The roads through Quang Tri were completely paralyzed.
- In the landslide hot spots, there was high inundation.
- Some hydro-power plants are overloaded in flood discharge due to the huge amount of rain.

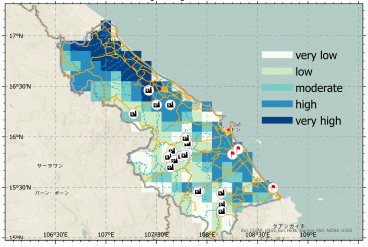
Series of floods from October 10 to October 15 [1]



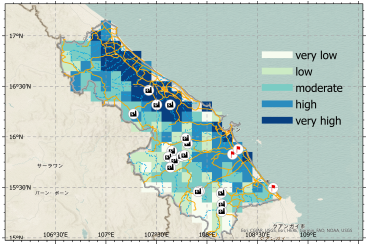
October 10



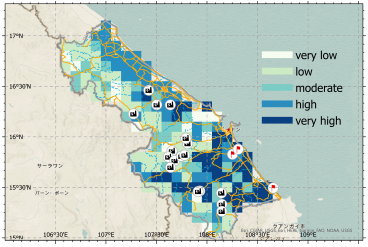
October 11



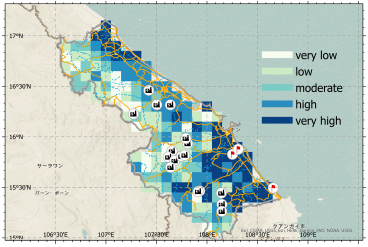
October 12



October 13

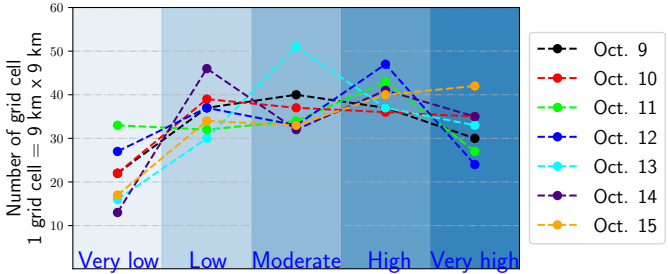


October 14

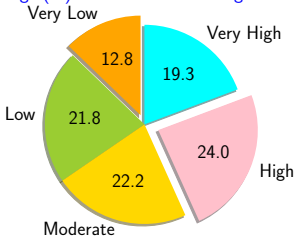


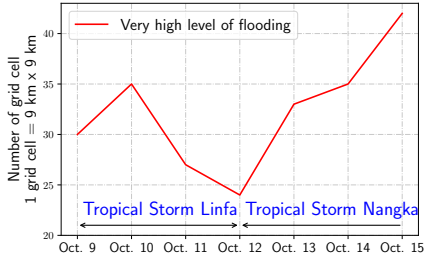
October 15

Series of floods from October 10 to October 15 [2]



Percentage (%) of flooded area during October 9-15





REPORTED EFFECTS

Figures as of October 15 [2]

36	12	681,580	136,316
DEAD	MISSING	AFFECTED PERSONS	AFFECTED HOUSES

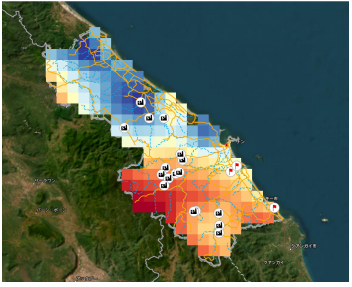
9,772 Ha	362	137/14,737m
RICE, CROPS, AQUATIC PRODUCE	AFFECTED SCHOOLS	HIGHWAY POINTS/ROADS DAMAGED

Note: Estimations are based on data reported/confirmed by National Disaster Management

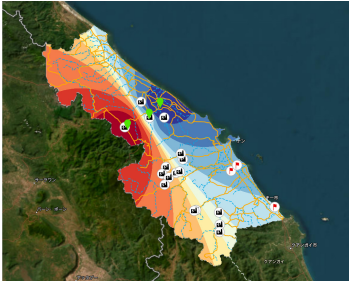
Potential improvement for future developments

Precipitation reanalysis data carries a native resolution of 9 km x 9 km, which is a rough resolution that makes difficult to identify inundation at the local scale.

$\Longrightarrow$ Suggestion: Using an interpolation method such as Inverse distance weighting (IDW) for observed/station data (**if possible**, available data, access is allowed).



ERA5-Land, 9 km grid



Using interpolation method (IDW)

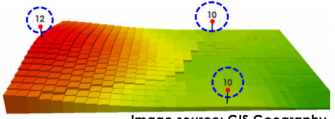


Image source: GIS Geography

$$x_p = \frac{\sum_{i=1}^{n} \frac{x_i}{d_i^p}}{\sum_{i=1}^{n} \frac{1}{d_i^p}}$$

Disaster early warning system- What if the tragedy happened again?

- Quang Nam had the heaviest flooding (nearly 4/7 days), where the heaviest rainfall (60− ≥200 mm/day) was recorded, and where storms made direct landfall.
- Surrounding area of hydroelectric plants, the amount of flooding is recorded at "very low" or "low" levels. It is possible that the hydro-power plants have been working effectively to coordinate the water flow.
- Temporary migration/relocation is essential (to shelter areas such as schools, hospitals, etc.), especially to Da Nang city, a population center of Central Vietnam.

Could GIS technology be applied automatically to produce a higher resolution and hourly flooding risk map during the tragedy on larger scales, other regions/ countries?

✓ GIS has great potential as a useful tool for decision-making by authorities and immediate rescue.

Conclusions

- Building flood maps and examining their variation from October 9−15 using ArcGIS Pro successfully with daily intervals and 9 km x 9 km in native resolution.
- About 2600 km^2 flooded "very high"; 3233 km^2 of "high" inundation, which was concentrated near the coastal area of Quang Nam, Da Nang, Hue, and Quang Tri.
- The research topic shows its urgent because natural disasters are inevitable and costly, and they could be widely deployed in an extreme way in the future climate.
- ArcGIS Pro is a powerful performance tool for emergency management for disaster preparedness, response, and recovery.

References

1. Vietnam: Floods - Final Report, Operation n° MDRVN020
2. Flash Update: No. 03 – Tropical Storm LINFA, Cambodia, Lao PDR, Viet Nam – 15 Oct 2020.

THANK YOU FOR YOUR ATTENTION!